CANADIAN METALS

Canadian Metals Inc.

NI 43-101 Technical Report on Pre-Feasibility Study for Langis Project

M03846C

June 1st, 2018

4303—M03846C

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CANADIAN METALS

NI 43-101 Technical Report on PFS for Langis

Project Nr. 4303—M03846C

Qualified Persons:

Georgi Doundarov (CIMA+)

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June 1st, 2018

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CERTIFICATE OF QUALIFIED PERSON

Georgi Doundarov, M.Sc., P.Eng., PMP, CCP

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To Accompany the Report entitled:

"NI 43-101 Technical Report on Pre-Feasibility Study for Langis Project" dated June1st, 2018.

I, Georgi Doundarov, M.Sc., P.Eng., PMP, CCP do hereby certify that:

1) I am an independent consultant with CIMA+;
2) I am a graduate from the University of Mining and Geology, Sofia, Bulgaria, 1996 with a M.Sc. in Mineral Processing and Metallurgy, and I have practised my profession continuously since that time;
3) I am a graduate from the Yokohama National University, Yokohama, Japan, 2005 with a M.Sc. in Infrastructure Management - Mineral Processing and Metallurgy, and I have practised my profession continuously since that time;
4) I am a registered member of the Professional Engineers Ontario (PEO) (Licence Number 100107167). I am also a Project Management Professional (PMP) (Licence Number 1218345) under the Project Management Institute (PMI) and a Certified Cost Professional (CCP) (Licence Number 42319) under the Association for Advancement of Cost Engineering International (AACEI). I am a Member of the Canadian Institute of Mining, Metallurgy and Petroleum (Member Number 141909);
5) I have worked as an engineer continuously since graduation from university in 1996. My relevant experience for the purpose of the Technical Report is over 22 years of consulting in the field of Mining, Mineral Processing and Metallurgy, Marketing, Costs and Financials;
6) I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) and certify that by reason of my education, affiliation with a professional association (as defined by NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101;
7) I have participated in the preparation of the report entitled "NI 43-101 Technical Report on Prefeasibility Study for Langis Project" dated June 1st, 2018, under CIMA+ consultation company as Project Director, Costs and Financials Lead, and Lead Metallurgist on the project. I have participated, and I am responsible for sections 2, 3, 4, 5, 6, 13, 17, 18, 19, 21, 22, 24 and parts of 1, 25, and 26.

8) I have not visited the site;

9) I have had prior involvement with the property with the preparation of the revised Preliminary Economic Assessment (PEA) Canadian Metals, titled “NI 43-101 Technical Report on Revised Preliminary Economic Assessment Langis” and dated October 4th 2016 for that is the subject of this technical report. I certify that there is no circumstance that could interfere with my judgment regarding the preparation of this technical report;

10) I state that, as the date of the certificate, to the best of my qualified knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading;

11) I have no personal knowledge, as of the date of this certificate, of any material fact or material change which is not reflected in this Technical Report;

12) I am independent of the issuer as defined in section 1.5 of NI 43-101;

13) I have read National Instrument 43-101 and Form 43-101F1, and the Technical Report has been prepared in compliance with that instrument and form;

This 1st day of June, 2018.

Original signed and sealed

(Signed) “Georgi Doundarov”

Georgi Doundarov, M.Sc., P.Eng., PMP, CCP

CERTIFICATE OF QUALIFIED PERSON

Nathalie Fortin, M.Env., P.Eng.

1276 de La Misaine, Lévis, G7A0T8
Telephone: 514-296-3372
Email: Nathalie.fortin@wsp.com

To Accompany the Report entitled:

"NI 43-101 Technical Report on Prefeasibility Study for Langis Project" dated June 1st, 2018.

I, Nathalie Fortin, M.Env., P.Eng., do hereby certify that:

1) I am an independent consultant with WSP;

2) I am a graduate from the University of Sherbrooke, 1993 (Chemical Engineering) and 1999 (Master degree in Environmental Management), and I have practiced my profession continuously since 1994;

3) I am a registered member of the Professional Engineers of Quebec (OIQ) (Licence Number 112062);

4) I have worked as an engineer continuously since January 1994. My relevant experience for the purpose of the Technical Report is over 13 years of practices in Mining and Metal sector and environmental consulting in the fields of Environmental Management, Environmental Studies, Permitting, and Social and Community Impact;

5) I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) and certify that by reason of my education, affiliation with a professional association (as defined by NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101;

6) I have participated in the preparation of the report entitled "NI 43-101 Technical Report on Prefeasibility Study for Langis Project" dated June 1st, 2018, under CIMA+ consultation company as Environmental Expert on the project. I have participated, and I am responsible for section 20.

7) I did not visit the site;

8) I had no prior involvement with the property;

9) I state that, as the date of the certificate, to the best of my qualified knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading;

10) I have no personal knowledge, as of the date of this certificate, of any material fact or material change which is not reflected in this Technical Report;

11) I am independent of the issuer as defined in section 1.5 of NI 43-101;

12) I have read National Instrument 43-101 and Form 43-101F1, and the Technical Report has been prepared in compliance with that instrument and form.

This 1st day of June, 2018.

Original signed

(Signed) "Nathalie Fortin"

Nathalie Fortin

Nathalie Fortin, M.Env., P.Eng.
OIQ: 112062

CERTIFICATE OF QUALIFIED PERSON

Claude Bisaillon Eng.
2999, Ch. Ste-Foy, suite 200
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Telephone: 418-653-9559
c.bisaillon@goldmindsgeoservices.com

To Accompany the Report entitled:

“NI 43-101 Technical Report on Pre-Feasibility Study for Langis Project” dated June1st, 2018.

I, Claude Bisaillon Eng., do herby certify that:

1. I am a senior engineer and consultant with GoldMinds Geoservices Inc. with an office at 2999 Chemin Ste-Foy, Suite 200, Quebec, Quebec, Canada, G1W 3N3;

2. I am a graduate from Concordia University in Montreal in 1991 with a B.Sc. in geology and from the Université Laval in Quebec City in 1996 with a B.Ing. in geological engineering; and I have practised my profession continuously since that time. My relevant experience for the purpose of the Technical Report is: Over 20 years of consulting in the field of Mineral Resource estimation, orebody modelling, mineral resource auditing and geotechnical engineering;

3. I am a registered member of the Ordre des Ingénieurs du Québec (#116407). I am also a registered engineer in the province of British Columbia (#25669). I am a Member of the Canadian Institute of Mining, Metallurgy and Petroleum;

4. I have not visited the Langis property;

5. I have participated in the preparation of the report entitled “NI 43-101 Technical Report on Prefeasibility Study for Langis Project” dated June 1st, 2018, under GoldMinds Geoservices consultation company. I am co-author of 1, 2, 3, 15, 16, 18, 23 to 27.

6. I am an independent “qualified person” within the meaning of section 1.5 of National Instrument 43-101 – Standards of Disclosure for Mineral Projects of the Canadian Securities Administrators;

7. I have had no prior involvement with the property. I certify that there is no circumstance that could interfere with my judgment regarding the preparation of this technical report;

8. I have read NI 43-101 and Form 43-101F1 and have prepared and read the report entitled: “NI 43-101 Technical Report on Pre-Feasibility Study for Langis Project” dated June1st, 2018 for Canadian Metals Inc. in compliance with NI 43-101 and Form 43-101F1;

9. That, at the effective date of this technical report April 19th 2018, to the best of my knowledge, information, and belief it contains all scientific and technical information that is required to be disclosed to make the technical report not misleading.

This 1st day of June 2018

‘Original Signed and Sealed’

(Signed) “Claude Bisaillon”

Claude Bisaillon Eng.

CERTIFICATE OF QUALIFIED PERSON

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c.duplessis@goldmindsgeoservices.com

To Accompany the Report entitled:

“NI 43-101 Technical Report on Pre-Feasibility Study for Langis Project” dated June1st, 2018.

I, Claude Duplessis Eng., do herby certify that:

1. I am a senior engineer and consultant with GoldMinds Geoservices Inc. with an office at 2999 Chemin Ste-Foy, Suite 200, Quebec, Quebec, Canada, G1W 3N3;

2. I am a graduate from the University of Quebec in Chicoutimi, Quebec in 1988 with a B.Sc.A in geological engineering and I have practiced my profession continuously since that time, I am a registered member of the Ordre des Ingénieurs du Québec (Registration Number 45523). I have worked as an engineer for a total of 29 years since my graduation. My relevant experience for the purpose of the Technical Report is: Over 25 years of consulting in the field of Mineral Resource estimation, orebody modeling, mineral resource auditing and geotechnical engineering.

3. I visited the Langis Property several times since September 28th, 2016 up to 2017, I have supervised the latest drilling campaign of 2017 and my latest site visit was made June 2nd 2017;

4. I have participated in the preparation of the report entitled “NI 43-101 Technical Report on Prefeasibility Study for Langis Project” dated June 1st, 2018, under GoldMinds Geoservices Inc. I am responsible for sections 7, 8, 9, 10, 11, 12, 14 and co-author of 1, 2, 3, 4, 5, 6, 15, 16, 18, 23 to 27.

5. I am an independent “qualified person” within the meaning of section 1.5 of National Instrument 43-101 – Standards of Disclosure for Mineral Projects of the Canadian Securities Administrators;

6. I have had prior involvement with the property with the preparation of the revised Preliminary Economic Assessment (PEA) Canadian Metals, titled “NI 43-101 Technical Report on Revised Preliminary Economic Assessment Langis” and dated October 4th 2016. I have also had prior involvement with the property with the preparation of the Mineral Resource Estimation Update for Canadian Metals NI 43-101 Technical Report dated February 5th 2018 for that is the base for this technical report. I certify that there is no circumstance that could interfere with my judgment regarding the preparation of this technical report;

7. I have read NI 43-101 and Form 43-101F1 and have prepared and read the report entitled: “NI 43-101 Technical Report on Pre-Feasibility Study for Langis Project” dated June1st, 2018 for Canadian Metals Inc. in compliance with NI 43-101 and Form 43-101F1;

8. That, at the effective date of this technical report April 19th 2018, to the best of my knowledge, information, and belief it contains all scientific and technical information that is required to be disclosed to make the technical report not misleading.

This 1st day of June 2018

Original Signed and Sealed

(Signed) “Claude Duplessis”

Claude Duplessis Eng.

Table of Contents

CIMA+ M03846C

CIMA+ M03846C

CIMA+ M03846C

List of Figures

CIMA+ M03846C

List of Tables

List of Appendices

List of Abbreviations

AD	Anti-Dumping
AC	Alternating Current
Al	Aluminum
Alumina	Aluminum oxide, Al_2O_3
AS	Anti-Subsidy
ASP	Average Selling Price
A	Annum
BAPE	Bureau d’audiences publiques sur l’environnement
BE	Basic Engineering
BOP	Balance-of-Plant
bps	Basis Points
CAN$	Canadian Dollar
CAGR	Compounded Annual Growth Rate
C	Carbon
Ca	Calcium
CA	Certificate of Authorization
Capex	Capital Expenditure
cm	Centimeter
CME	Canadian Metals Inc.
CMEx	Chicago Mercantile Exchange
CO	Carbon Monoxide
CO_2	Carbon Dioxide
Companion Policy 43-101 CP	Companion Policy 43-101CP to National Instrument 43-101 “Standards of Disclosure for Mineral Projects”
CSA	Canadian Securities Administrators
CSE	Canadian Stock Exchange
CTMP	Centre de Technologie Minérale et de Plasturgie
CVGS	Connecticut Valley—Gaspe Synclinorium
D	Day
DFC	Direct Field Costs
EIA	Environmental Impact Analysis

EIS	**Environmental Impact Statement**
EQA	**Environmental Quality Act**
FCFF	**Free Cash Flow to Firm**
Fe	**Iron**
Fe_2O_3	**Hematite, Iron Ore**
FeSi	**Ferrosilicon**
FeSi75	**Ferrosilicon with 75% Silicon Content**
FOB	**Free on Board**
Form 43-101F1	**Technical Report Form for NI 43-101**
FS	**Feasibility Study**
G&A	**General and Administrative (Costs)**
GMG	**GoldMinds Geoservices**
HP	**Horsepower**
IFC	**Indirect Field Costs**
IRR	**Internal Rate of Return**
kg	**Kilogram**
kPa	**Kilopascal**
kt	**Kilotonne (1,000 Metric Tonnes)**
ktpy	**Kilotonnes per Year (1,000 Metric Tonnes per Year)**
LME	**London Metal Exchange**
LOM	**Life-of-Mine**
MDC	**Map-Designated Claims**
MDDELCC	**Québec Ministère du Développement Durable, de l'Environnement et de la lutte contre les changements climatiques**
MERN	**Ministry of Energy and Natural Resources**
MSEP	**MineSight® Economic Planner**
NI 43-101	**National Instrument 43-101**
NPV	**Net Present Value**
NSR	**Net Smelter Return**
Opex	**Operating Expenditure**
QA/QC	**Quality Assurance / Quality Control**
QP	**Qualified Person**

PEA	**Preliminary Economic Assessment**
PFS	**Pre-Feasibility Study**
RCM	**Regional County Municipality**
RQD	**Rock Quality Designation**
SAF	**Submerged Arc Furnace**
SGS	**Services Geotechniques Shickshocks Inc.**
SEDAR	**System for Electronic Document Analysis and Retrieval**
SOPOR	**Société du port ferroviaire de Baie-Comeau Haute-Rive**
US$	**American Dollar**
WSP	**WSP Global Inc.**

1. Summary

1.1 Overview

Canadian Metals Inc. (CME), which is headquartered in Montreal, Quebec, is the issuer of this Technical Report. Canadian Metals Inc. retained CIMA+ (CIMA), GoldMinds Geoservices (GMG), and a number of other specialists in the fields of metallurgy, geology, mining, and environmental engineering in preparing this Technical Report and conduct a Pre-Feasibility Study (PFS) for a proposed integrated Langis silica quarry and silica processing plant in the Province of Quebec. CME is a publicly listed company on the Canadian Stock Exchange (CSE), trading under the stock symbol CME since August 1st, 2013. The company's main activities are directed towards the development of Langis project, a high-purity silica deposit located in the province of Quebec with fully permitted with the BEX and the Certificate of Authorization (CA) from the *Québec Ministère du Développement Durable, de l'Environnement et de la lutte contre les changements climatiques* (MDDELCC).

This Technical Report provides a comprehensive assessment of geological, technical, engineering, operational, and commercial aspects (economic analysis), as well as presenting estimated inferred resources, related to the vertical integration project concerning a ferrosilicon (FeSi) smelting facility that utilizes silica feedstock from the Canadian Metals Inc. Langis deposit. Both operations (the quarry and the metallurgical plant) are planned to be located in the Province of Quebec.

The current Langis Sandstone mineral resources are estimated by GMG for the purposes of a FeSi production.

The authors of the PFS have developed, verified, and reviewed the works and the assumptions. The work includes but is not limited to the estimates of SiO_2, cut-off grade, geological continuity at the selected cut-off, metallurgical recovery, smelter payments, commodity price or product value, mining and processing methods, as well as mining, processing, general, and administrative costs.

This Technical Report has been prepared in accordance with the Canadian "Standards of Disclosure for Mineral Projects", National Instrument 43-101 (NI 43-101), and referred forms, companion policy, and other instruments supporting it, as set forth by the Canadian Securities Administrators (CSA) for electronic filing and disclosure on CSA's "System for Electronic Document Analysis and Retrieval" (SEDAR).

This study also takes into consideration the following reports filed by qualified persons within specialized fields:

- **WSP, 2018 –N. Fortin: 181-00791-00_PFS_chap20_Prv8**;
- **MINTEK, 2015**, T. Kekana, M. Thethwayo, and K. Bisaka, principal lead authors; External Report 7204: Investigations on the Production of Ferrosilicon from Canadian Quartzite Using Mintek's 100KVA DC Arc Facility; prepared by Mintek for Canadian Metals Inc., August 10th, 2015;

In addition, it takes into consideration the following external project and market-related report:

- **BBA, 2015**, M. Brisson, L. Charron and A. Grandillo, Analyse des sites potentiels pour l'implantation d'une fonderie de ferro-silicium, Document Nr. BBA / Rev.: 3635001-000000-47-ERA-0001/R00; prepared by BBA for Canadian Metals Inc., May 20th, 2015.

The PFS is intended to support CME's decision makers in the determination of the potential viability of both the exploitation of the Langis silica deposit with downstream processing of the feedstock in a metallurgical plant (smelter). The planned smelter is designed to produce ferrosilicon (FeSi).

1.2 Description of Langis Silica Deposit

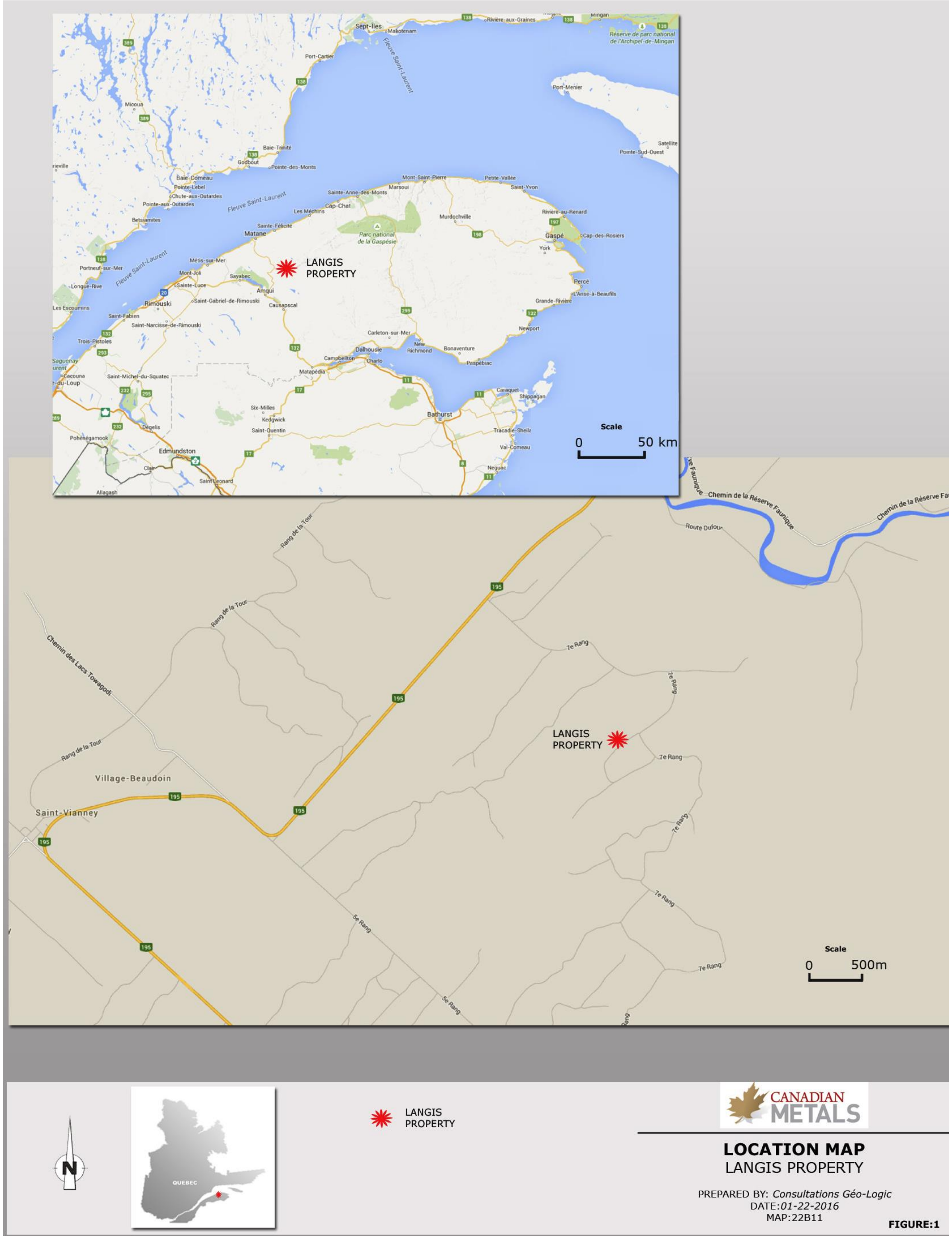
The Langis Property is made up of four (4) regular MDCs (map-designated claims), covering a total surface area of 227.62 ha. The MDCs are valid until November 7th, 2019. The Property is located within NTS map sheet 22B11, in the Matapedia Region of the Gaspe Peninsula of Quebec, within the Regional County Municipality (RCM) of Matapedia. The geographic center of the Property is approximately at latitude 48° 37' 30" N and longitude 67° 20' 00" W or 5,387,200 N and 622,800 E in UTM Zone 19. The Property covers parts of Ranges VI and VII of Langis Township.

The Property was bought from 9285-3696 Québec Inc. Canadian Metals Inc. now holds 100% of the mining titles. Production from the Property is subject to a 3% Net Smelter Return (NSR) payable to 9285-3696 Québec Inc., according to Canadian Metals Inc.

To the knowledge of the authors, there are no environmental liabilities pertaining to the Langis Property, based on the information received from Canadian Metals Inc. The claims cover both private and crown land, but current exploration is limited to crown land, thus the only permit required to carry out exploration on the Property is the usual forestry management permit.

The Property is located in gently rolling Appalachian terrain. A set of elongated hills oriented NNE dominates the topography. The Property is largely covered by a mixed forest of hardwoods such as maple, poplar, and birch mixed with conifers such as white spruce, white pine, and cedar.

Figure 1: Location Map



The Property is easily road-accessible via paved provincial highway 195 and a gravel road in good condition (Range VII road). The Property is 20 km by road (highway 195) from the town of Amqui (the administrative center of the Matapedia RCM) on highway 132. It is also accessible via highway 195 from highway 132 in the town of Matane, a distance of 40 km.

There are several smaller villages in the area of the Property, such as Saint-Vianney, Saint-Tharcisius, Saint-Rene-de-Matane, Lac-au-Saumon, and Val-Brillant, with adequate skilled labour for the operation of a silica quarry.

The nearest source of a continuous substantial flow of fresh water is a stream called Rivière Tamagodi, 1.8 km to the east-southeast of the present Langis quarry. High-voltage transmission lines cross the Property 300 meters south of the existing quarry, and there is already a transformer substation 400 meters southwest of the existing quarry.

The Property experiences a cool humid continental climate with warm summers and cold winters. The spring-summer-fall period begins in early May and ends in the latter part of October. Winter conditions normally last from early November to late April. Precipitation is moderate and fairly evenly distributed throughout the year.

Geological mapping and exploration of the area by governmental institutions began with the investigations of Logan in 1844. Gradually, over the years, many regional and local surveys were done on the Langis area and the Gaspe Peninsula by the Geological Survey of Canada and the Quebec Ministry of Natural Resources. A synthesis of the Gaspe regional geology was produced by Slivitsky et al. (1991), and the stratigraphy was reinterpreted and integrated into the Appalachian geology by Brisebois and Morin (2003).

The first known investigations and comprehensive report on the sandstones of Langis and Tessier Townships were done by R. A. Marleau (1979) for Placement Appalaches Inc. Uniquartz Inc. took over the project from Placement Appalaches Inc. in 1982. Between August and October of 1982, an extensive diamond drilling program was completed on Langis and the neighbouring Tessier sandstone occurrences. A total of 4,102.5 feet (1,243.1 meters) were drilled in 25 drill holes, eight of which, totalling 1,568 feet (475.1 meters), were drilled on the Langis Property. Subsequently (1983), extensive physical and geochemical testing was done on the drill cores in order to determine the physical and geochemical characteristics of the sandstones of the Langis and Tessier deposits.

In 1984, historical tonnages published in the environmental study for the project (GM 42387) stood at 25.5 million tonnes at average grades of 0.11% Fe_2O_3 and 0.41% Al_2O_3, including 9.0 million tonnes at 0.11% Fe_2O_3 and 0.26% Al_2O_3 or 5.7 million tonnes at 0.05% Fe_2O_3 and 0.183% Al_2O_3. SiO_2 grade calculated from 750 feet of core was reported to be 99.25%.

In 1985, Uniquartz obtained Mining Lease nr. 741. In December 1985 and May 1986, a total of some 22,000 tonnes of lump silica were sent to Norway and Iceland for testing in the existing ferrosilicon smelting facilities. The results were positive, and a 150,000 tonne-per-year supply contract was signed. In 1988, the cost of project start-up was estimated at $8.4M. There is no record of difficulties encountered; however, the project never went into production. Apparently, material was extracted intermittently after 1991 for construction purposes. Several elongate piles of crushed waste rock remain to the west of the quarry. From the current size of the quarry, it is estimated that around 400,000 tonnes have been extracted from the site over the years.

The Matapedia Region forms part of the Appalachian Geological Province, which stretches from Alabama in the southeast USA to Newfoundland. The portion of Quebec that hosts the rocks pertinent to this report is known as the Connecticut Valley—Gaspe Synclinorium (CVGS). These rocks were folded, faulted, intruded, and weakly metamorphosed during what is generally known as the Appalachian Orogeny.

The CVGS rocks of Matapedia-Gaspe are of Ordovician-Siluro-Devonian age. They are comprised of wackes and conglomerates of the Cabano Group (Ordovician to Silurian in age), overlain by the Siluro-Devonian rocks of the Chaleurs Group. The stratigraphy of the Chaleurs Group comprises green shales of the Awantjish Formation at the base, overlain by the white-to-pink quartz arenites of the Val-Brillant Formation. The quartz arenite of the Val-Brillant Formation is highly siliceous. It appears as thick (up to several meters) white layers, and locally pink to mauve layers that result from hematite discolouration. Total thickness is usually 40-60 meters. This highly siliceous sandstone constitutes the exploration target at the Langis project.

Canadian Metals Inc. completed prospecting, mapping, and sampling along with two drilling programs in 2013 and 2015 on the Langis Property. The 2013 reconnaissance drilling program included nine holes/456.97 meters, while the 2015 infill program consisted of 18 holes/701.6 meters. Other work done on the Langis sandstones includes metallurgical tests in 2015 by MINTEK of South Africa, which confirmed the favourable physical and chemical characteristics of material to produce ferrosilicon.

This work led to the understanding of the local stratigraphy and structures as well as the preparation of a sufficiently reliable geological model of the deposit to define resource blocks.

On the Langis Property, it is now established that the underlying shales of the Awantjish Formation are overlain successively by a transition zone (impure sandstones, 10 meters), a Lower White Sandstone (pure sandstone, 15-35 meters), a Red Bedded Sandstone (impure, 15 meters), and an Intermediate Sandstone (pure). The Lower White Sandstone constitutes the resource of the Langis deposit. About 25% of the Lower White Sandstone is covered by the Red Bedded and Intermediate Sandstones in the eastern part of the deposit.

The laboratory results obtained were found to be reliable by the QA/QC program realized by Canadian Metals Inc.

1.3 Site for Downstream Processing

Baie-Comeau (population 28,789) is a city located approximately 420 kilometers northeast of Quebec City in the Côte-Nord region of the province of Quebec. It is located on the shores of the Saint-Lawrence River near the mouth of the Manicouagan River, and is the seat of Manicouagan Regional County Municipality. The base case site for the ferrosilicon downstream smelter operation is located in Baie-Comeau, Quebec.

Figure 2: Aerial View, City of Baie-Comeau, Quebec

The site is an industrial zone site and is virtually untouched in its natural form as well as heavily wooded with one gravel access road on the southwest side of the Property. The main railway line is adjacent to the site; power and sewer/water services are available nearby.

1.4 Mineral Resource Estimate

Highlights:

- High-grade silica sandstone deposit at surface open-pit constrained resources:
  - 3,900,000 tonnes Measured @ 99.01% SiO_2;
  - 3,700,000 tonnes Indicated @ 98.92% SiO_2;
  - Total of 7,600,000 tonnes M&I @ 98.96%SiO_2 at a cut-off grade of 97% SiO_2;
  - 14,000,000 tonnes Inferred @ 98.97% SiO_2.
- Major increase in resource estimates 217% for Langis vs. October 2016 resources.

Quarry permit in place with an average of 84,286 tpy with a maximum of 100,000 tpy with extraction of 674,000 tonnes in the M&I at 99% SiO_2 in the original quarry design based on resource update.

The updated resource calculation, accompanied by a revised interpretation and Block Model for the entire area drilled at Langis to date, is the most significant update since the company's initial works of 2013. It underscores the continuous nature of the sedimentary rocks at Langis where recent infill drilling and extension to the northeast suggests that there could be even more sandstone with grade of interest in extension and at depth of the actual mineral resource area.

The mineral resources incorporate the new 533 m of drilling in 16 holes of 2017.

Note that mineral resources are not mineral reserves and do not have demonstrated economic viability. However, the reported mineral resources are considered by the qualified persons to have reasonable prospects for economic extraction as per CIM 2014 definitions.

Original sample length varies from 1 to 1.5 m, composites of 3 m were used for the estimation of blocks.

The density to convert volume to tonnage is now 2.33.

The open-pit constrained resources were modeled on 5 m E x 5 m N x 3 m Z block size within a 3D envelope.

Search ellipsoid estimation ID3 are: 60 x 60 x 1.5 m, 120 x 120 x 3 m, 600 x 600 x 6 m to enable connection of the structure of the southwest holes to the highly drilled sector. Saucers dipping southeast at 3 degrees. Five (5) composites maximum in estimation.

Classification: a minimum of 3 holes within 75-m radius for Measured, 4 holes within 120-m radius for Indicated, the remaining Inferred.

The database used for this estimate includes drill results obtained from drill programs in 2013, 2015, 2017, and 1984 for geological contacts.

The reasonable economic prospect of economic extraction is based on mining cost of $5/t, processing cost of $10, recovery of 95%, pit slope walls of 45 degrees, and assumed selling price of CAN$44/t with a COG of 97% SiO_2.

GoldMinds is not aware of any known environmental, permitting, legal, title-related, taxation, socio-political, marketing, or other relevant issues that could materially affect the mineral resource estimate.

The Langis Val-Brillant sandstones with their Lower White sandstones, which are 15 to 35 metres thick, are found to be fairly uniform in term of chemistry and meet the specifications indicated to the authors for ferrosilicon plant feed. The deposit is dissected by numerous faults, the most important being NNE-SSW or NE-SW oriented thrust faults with a steep dip to the north and uprising of the northwest block relative to the southeast block with apparently not much effect on the quality of the material. Horizontal movement is also present along these faults.

Inclined holes drilled in 2017 have shown that the grades are not affected by the displacement faults; however, two major faults were highlighted in location and width of ferruginous alteration aside the plane. For that reason, these tow faults with their perimeters have been modelled as waste and excluded from the resource model.

As there are vertical displacements caused by some fault movements, follow-up with 3D mapping of the face will be necessary, should a specific strata selection be made in the white material. The strata with higher iron content can easily be observed in the face visually and therefore set apart, if required.

The new drilling has allowed the transformation of Inferred mineral resources to Indicated and Measured mineral resources in a positive manner.

In GMG opinion, the actual resource appears sufficient for the contemplated project of CME. Most of the recommendations of 2016 have been realized and place the Property in good position for the next step. Our suggestions are now:

- Conduct a feasibility study with the current Measured and Indicated resources within the crown land;
- Negotiate to acquire the surface right with Inferred resources to the west of the existing quarry, where there is an open face and it is technically ready for quarrying. Once acquisition or agreement with neighbour is completed, and should additional resources be required for the project, then drill on regular grid of 60 x 60 m ($250k to $350k). The author suggests the acquisition at evaluation and a reasonable percentage factor associated with a limited royalty per tonne for a fixed amount;
- As part of the additional drilling proposed above, proceed with a hydrogeological study to better understand the groundwater behaviour in the quarry area and how quarrying will affect the water table (100k);
- As part of the additional drilling requested above, proceed with more geotechnical data gathering to better define rock mass properties to increase confidence in mining parameters used and reduce rock waste removal.

1.5 Mineral Reserves and Mining Methods

1.5.1 Pit Optimization and Quarry Pit Design

The pit optimization analysis was done using the MineSight® Economic Planner (MSEP) module of MineSight® Version 11.0. The optimizer uses the 3D Lerchs-Grossmann algorithm to determine the economic pit limits based on input of costs and revenue per block. The optimization was limited to proximity of 10 m from the Property limits. As per NI 43-101 guidelines regarding the Standards of Disclosure for Mineral Projects, only blocks classified in the Measured and Indicated categories drove the pit optimizer for this study; Inferred resource blocks are treated as waste, bearing no economic value.

The cost and operating parameters that were used are preliminary estimates for developing the economic pit and should not be confused with the operating costs subsequently developed for the PFS and presented in section 21.

The pit optimization analyses considered the SiO_2% grade without considering quarry dilution, which is accounted for at a later stage. Quarry dilution is discussed in the next section of this report.

Using the cost and operating parameters, a series of four (4) pit shells were generated by varying the selling cost of $44/tm, varying from 40%, 60%, 80%, and 100% of the agreed upon selling price.

The cut-off grade is used to determine whether the material being quarried will generate a profit after paying for the drilling, blasting, loading, haulage, processing, as well as general and administration costs. Material that is quarried below the cut-off grade is sent to the waste dump. A cut-off grade of 97% SiO_2 was considered for mineral reserve estimations. The material below 97%SiO_2 could be used for other purposes; however, this material is valuated in aggregates and by-product.

The pit designed for the Langis Deposit consists of only one (1) phase in size and grade. The final pit is approximately 350 m long with minimum and maximum width at surface of 100 and 225 m respectively, and a maximum pit depth from surface of 47 m. The total footprint of the quarry is expected to be around 118,000 m^2. The overburden thickness varies between 2 to 3 m with an average of 2.5 m.

The pit considers a single permanent access ramp located on the east side. The deepest part of the open pit is at an elevation of 200 m at a depth of 47 m below original surface. The open-pit design is constrained by the Property limits to the west.

1.5.2 Open-Pit Mineral Reserves Estimate

The open-pit design includes 6.3 Mt of Probable & Proven Mineral Reserves at a grade of 99% SiO_2. In order to access these reserves, 0.8 Mt of overburden and 2.6 Mt of waste rock will need to be removed. This results in a stripping ratio (waste to ore) of 0.41. Table 1 presents the open-pit reserves for the Langis deposit.

Table 1: Open-Pit Mineral Reserves

Category	Tonnage	SiO_2 Grade (%)
Proven	3.5 Mt	99.0
Probable	2.8 Mt	99.0
Proven & probable	6.3 Mt	99.0

Source: GoldMinds Geoservices Inc.

In GMG opinion, trial quarrying with the current BEX and the next step of a feasibility study will allow CME to:

- Adjust the drilling and blasting pattern to minimize fines and control the number of oversized rocks that need to be re-handled to minimize damage to quarrying equipment;
- Compile and analyze the on-going abrasion tests and Bond index tests to better define the energy required for crushing the material;
- Review quarry plans with new drilling information to optimize ore to waste ratio and reduce dilution;
- Provide optimized quarrying plans to contractors to refine quarrying costs.

1.6 Mineral Processing and Metallurgical Testing

Various metallurgical test programs were undertaken by Canadian Metals and executed in different laboratory testing facilities with special expertise of production of FeSi. *Centre de Technologie Minérale et de Plasturgie* (CTMP) performed various chemical and physical analyses on the samples under the supervision of Genivar, as the goal was to establish the characteristics of the Langis sandstone in relation to various potential commercial uses.

From the initial test results in 2013, Canadian Metals Inc. retained that the Langis Property sandstone can provide suitable material for ferrosilicon production. This lead to a pilot smelting testing at MINTEK in 2015.

Based on the various tests performed over the years for different samples of Langis quartzite in various reputable testing facilities, the general conclusion is that commercial production of ferrosilicon can be achieved using Langis silica products.

CIMA+ recommends that further testing be performed for samples from the latest 2017 drilling program in order to optimize the process, the raw materials types, and consumption, as well as pilot plant testing to simulate commercial production. Such recommendations are presented in detail in section 26 of this Technical Report.

1.7 Recovery Methods

This section of the report details the metallurgical processes to utilize the Langis silica as a raw material to produce Ferrosilicon75 (FeSi75) standard along with microsilica (silica fumes) as final plant products to be sold to the market. The Langis silica deposit will be quarried and recovered for use as a feedstock into a downstream ferrosilicon smelter in Baie-Comeau, Quebec, from where it will be shipped to its final destination.

After the silica is quarried by the means of open-pit quarry type of operations, detailed in section 16 of this report, the process steps at the quarry site will consist of blasting, crushing, and screening the silica before its transportation to the metallurgical facility (smelter) by truck. Silica that is too fine for use in the smelter can be marketed to local industries, while the coarser material will be used directly in the smelter.

The smelter at Baie-Comeau will produce ferrosilicon by a pyrometallurgical process that combines silica from the Langis quarry with a carbon source (coal), iron ore, and wood chips in a Submerged Arc Furnace (SAF) in which the above listed raw materials are smelted into ferrosilicon. Molten ferrosilicon is tapped from the furnace into ladles and then poured into molds to cool and solidify into large ingots. The ingots are removed from the mold after they have cooled sufficiently, then crushed and classified into the required size fraction for sale.

1.7.1 Raw Material Requirements

The raw materials required for production of FeSi75 are listed and described in detail below.

- Silica (quartzite)—Langis silica;
- Reducing agent—coal;
- Iron supplement—iron ore;
- Wood chips;
- Electrode paste—Søderberg paste.

1.7.1.1 Silica (Quartzite)—Langis Silica

The physical requirements of silica for FeSi process should be well controlled at the same level as for other ferroalloys. The thermostability is very important, as well as the size distribution and chemical contents for some agents such as aluminum (that impacts the slag production inside the furnace); some other contaminants such as titanium, calcium, and phosphorous are also important. The Langis silica, based on the geological survey and technical reports as well as previously completed NI43-101 PEA is suitable for FeSi production. In addition, various metallurgical test programs performed before and for the purposes of the PFS also determined Langis silica has acceptable thermal degradation (thermostability), explosive disintegration, and reduction to silicon for use in ferrosilicon smelting.

1.7.1.2 Reducing Agent—Coal

The requirements for the carbon source to be used in FeSi smelting are not as severe, as a result of lower purity requirements for the product and thermodynamic factors. Petroleum coke can be, and often is, used in FeSi furnaces when economic conditions warrant. However, it is still not the optimum choice for a carbon source due to its lower reactivity than coal or charcoal. Using charcoal to produce FeSi would be overkill, unless it is plentiful and inexpensive in the vicinity of the smelter. Metallurgical coal, albeit with a higher ash content than that used for MgSi, is again the best compromise. The reducing agents (reductants) for ferrosilicon process should have good reactivity levels, even size distribution, and controlled ash content which would impact the chemical contribution for the output quality. Based on the review of the potential sources of carbon, “Colombian coal” was assumed the optimal reducing agent due to the fact that it has been successfully used in many other similar operations, showing best performance from the technical stand point.

1.7.1.3 Iron Supplement—Iron Ore

Either iron ore (hematite) or scrap iron is used to control the iron content in FeSi. The chemical analysis of the FeSi product may be easier to control with the use of hematite, and hematite pellets or lumps are better suited for automatic raw material handling equipment than non-uniform pieces of scrap steel.

Magnetite or another tailing iron ore source is also a possible solution in the FeSi75 production, as well as steel scrap as iron source. It is important to highlight that there are some commercial, logistic, and technical questions involved in this discussion that could be revisited in further project phases.

1.7.1.4 Wood Chips

Wood chips are added to the furnace to increase porosity of the entire raw material mixture during the smelting process. This allows the key SiO intermediate gas species to travel through as well as react with other raw materials and reaction products to complete the reduction of silica to FeSi.

Hardwood or semi-hardwood chips are often specified by smelters; however, any chips can be used as long as they meet requirements for specified physical and chemical parameters.

Wood chips are also a minor source of reactive carbon due to the in-situ formation of the reducing agent in the high-temperature, oxygen-free furnace environment.

A source of wood chips can also be soft wood, and due to the fact that it is conveniently available in the proposed metallurgical plant area, it has been selected as the best option of wood chips for the purposes of the PFS.

1.7.1.5 Electrode Paste—Søderberg Paste

A variety of chemical and physical characteristics can be specified for paste used to produce electrodes. Parameters like softening point and swelling index are adjusted to specific smelter conditions and must sometimes be fine-tuned by trial-and-error. The paste used must be capable of producing electrodes in the required size as well as have appropriate physical characteristics to prevent breakage under normal operating conditions. Paste is supplied as briquettes, small bricks, or large cylinders. The choice of material format is based on smelter preferences. The presence of fines with the paste must be avoided due to high risk of segregation in the electrode columns and breakage risks.

Due to the fact that the Søderberg paste is very commonly used in similar operations with best performance, it has been selected as electrode paste material for the purposes of the PFS.

1.7.1.6 Raw Materials and Consumables Summary

Projected requirements for the major raw materials described herein are given in Table 2, in consideration of two (2) furnaces producing FeSi75. A 100% silica source from Langis silica is considered. Also included in this table are various other consumables used to aid furnace tapping operations.

Table 2: Raw Materials Annual Requirements

Raw Material	Annual Requirement, in mtpy
Langis silica	129,692
Coal	83,839
Hematite	25,218
Wood chips	72,051
Søderberg paste	3,603

1.7.2 Process Flow Sheet

The following process flow sheet is assumed for FeSi75 production.

Figure 3: FeSi Process Flow Sheet (Page 1)

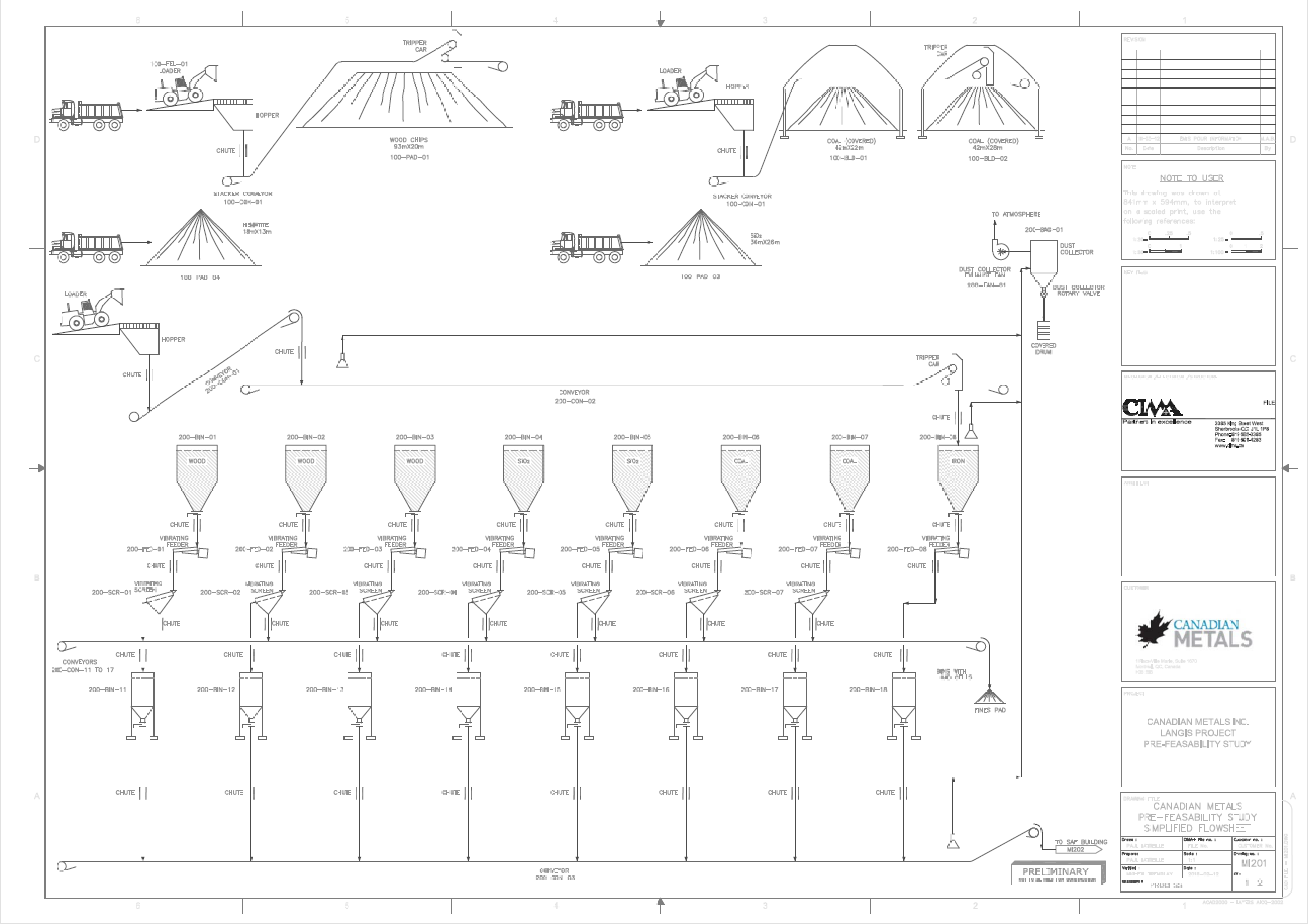
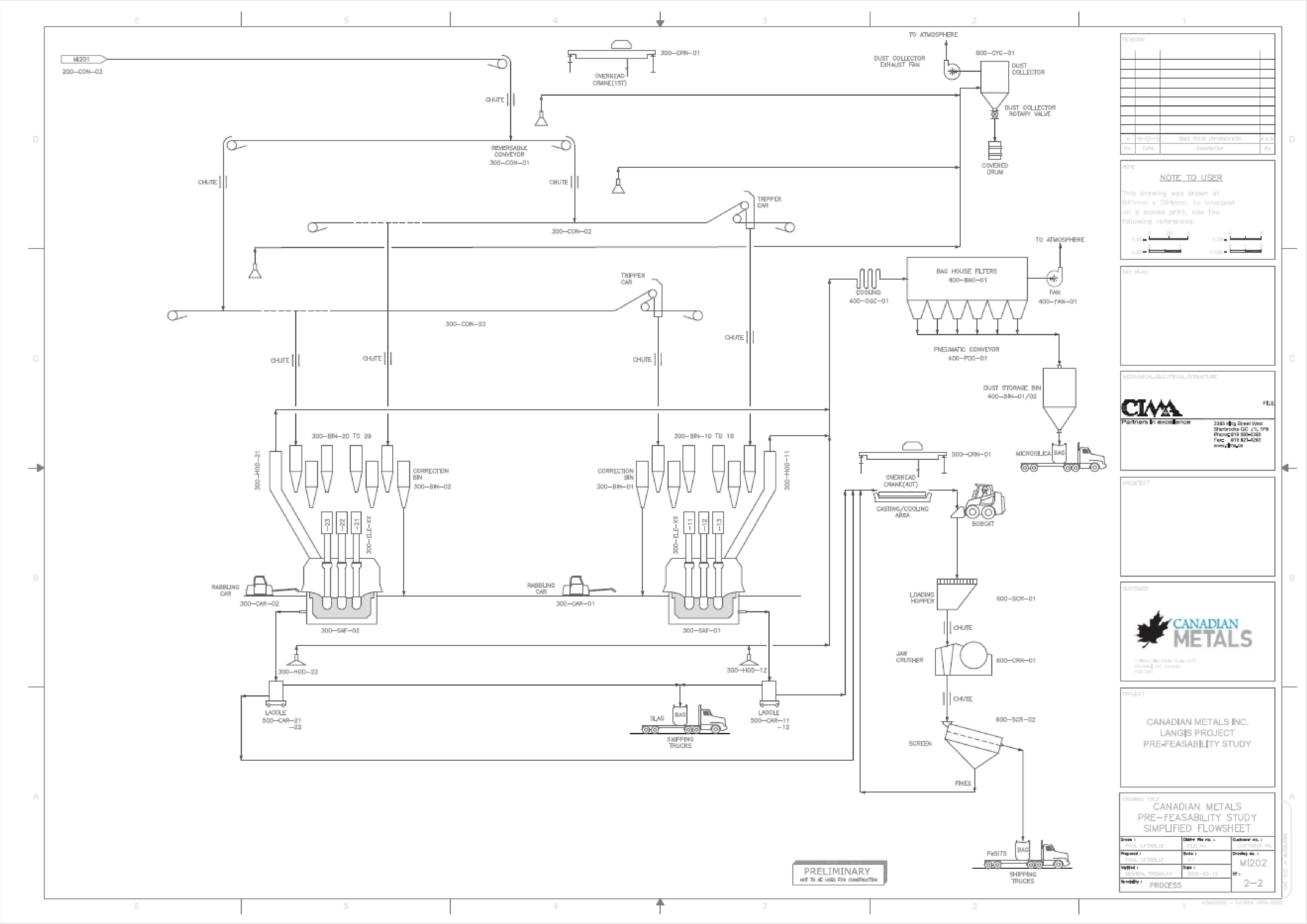


Figure 4: FeSi Process Flow Sheet (Page 2)



1.7.3 Process Description

1.7.3.1 Area 100—Raw Materials Reception and Storage

The raw materials reception and storage area is located at the front end of the plant area and consists of buildings and pads for the different raw materials.

It is assumed that two (2) months of capacity would be required for the silica raw material storage in order to ensure smooth metallurgical plant operation through the year.

Due to the different raw materials specifications, different storage options were considered. Coal and Søderberg paste must be stored in a covered area; therefore, buildings are required for those two raw materials. In addition, a separate building is required for other materials and consumables such as furnace electrodes, steel casting, ribs, tubes, etc. The rest of the raw materials will be stored in an open area with specific pads designed and built for each of them—Langis silica, hematite, and wood chips.

Area for truck scale is also planned at the raw materials reception area.

1.7.3.2 Area 200—Raw Materials Reclaim, Weighing, and Dosing

Raw materials reclaim, weighing, and dosing consists of the raw materials feed conveyor, three-day silos for each of the raw materials, prior to the feed conveyors for the two SAF units, each equipped with vibrating feeder to avoid clogging and a discharge chute.

The furnace feed system has raw material storage bins above the furnace which are manufactured from steel with a wear-resistant bottom section. The bins contain the blended raw materials received from the proportioning system.

Each furnace feed bin is fitted with instrumentation to determine the material level in the bin. The automatic control system compares the levels of the storage bins and determines which bin has the highest priority for receiving material. The furnace operator can manually insert a bin priority list if required.

Feed chutes connect the bottom of the feed bins to the furnace, terminating under the smoke hood in a water-cooled section. Vibrating feeders are installed in the feed chutes, providing the ability to shut off the feed system to the furnace and charge the furnace with material.

It is not common to have a blockage in the feed chute. The chute is made up of multiple sections which can be disconnected and unblocked. The feed chutes are positioned to be at a 60-degree angle from the bin center, and no horizontal section can be used because the material moves under gravity.

The cooling area of the feed chute is approximately 1.8 m from the feed chute tip (portion of feed chute below furnace roof). The feed chutes are insulated by a sealing rope on the join to the furnace roof as well as supported by brackets and hangers to the building structural steel.

1.7.3.3 Area 300—Smelting

The production of FeSi takes place in large, open, submerged arc furnaces (SAF) using alternating current and three (3) large, carbon-based electrodes. The production process has been industrialized over the last century and the basic process has not changed significantly over time. It is a function of the specific conditions in which silicon dioxide “rocks” transform into silicon monoxide gas (SiO) and combine with carbon, which is reproducible in the unique furnace environment. The process takes place in an industrial environment and is highly energy intensive, on the order 7 to 9 MWh per tonne of FeSi75% output. This energy consumption is concentrated mainly in the smelting step (“furnacing”) in the SAF, due to the need to disassociate highly stable silicon dioxide in the form of silica or quartzite into the final product.

Smelting area is where the actual process occurs, and consists of the two (2) 35-MW SAFs, each equipped with accumulation bins, smoke hood, three (3) graphite electrodes, water-cooled off-gas ducts, stoking car, blow-down ducting, and ancillaries to produce a total of 72,051 mtpa FeSi75 as a primary product, with additional 12,969 mtpa of microsilica and 4,323 mtpa slag as secondary products saleable to different markets.

1.7.3.4 Area 400—Off-Gas and Treatment

The smelting process is accompanied by an intense emission of gases with a high content of carbon and silicon monoxide (CO and SiO) as well as entrained particulates. This off-gas must be captured by a dust removal system before being released into the air. The captured dust can be sold as a by-product called “microsilica” or “silica fume” for use in high-strength and other specialty concrete production, as well as for refractory industry applications. The waste heat from the process might be captured and reused for preheating of ladles and other equipment or to generate electricity.

1.7.3.5 Area 500—Tapping and Casting

Molten ferrosilicon is collected in large, refractory-lined, steel ladles when it begins flowing from the furnace. A refining step is not necessary to produce standard FeSi75. The molten FeSi is poured into molds to solidify, and then discharged from the casting system fed to the final product crushing area.

1.7.3.6 Area 600—FeSi75 Crushing and Sizing

The cooled FeSi is mechanically crushed and screened to the typical (+10 mm -100 mm) size fraction or to specific customer requirements. The crusher is set up at an opening of 100 mm, and the screen is a triple deck with a top deck at 100 mm and bottom deck at 10 mm as well as the third deck in between, acting as a relieve deck to increase screening efficiency use to the wide range between the top and the bottom deck. The oversize of the bottom deck representing the (+10 mm -100 mm) final FeSi75 product is stockpiled, and the undersize of the screen bottom deck at -10 mm is resent back to the casting unit and used as a bed during the casting to improve the process and minimize loss.

1.7.3.7 Area 700—Final Products Handling

Final products being the primary FeSi75 as well as secondary microsilica and slag are stacked as final product stockpiles and then packaged in big bags or containers. In the case of the microsilica, it has to be captured in bags right from the off-gas treatment unit in order to avoid loss and dust.

1.7.3.8 Area 800—Utilities and Services

Metallurgical plant utilities and service area include plant air compressor, instrument air dryer, as well as dust collection system, fire protection system, process and potable water systems, and eye wash stations.

Under this area are also accounted various SAF ancillaries and supporting systems such as hydraulic system, cooling water system, SAF lubrication units, SAF transformer, and SAF bus-tubes system. SAF automation and control systems are also allocated here.

Services include standard plant crane/monorail systems, service crawl, as well as supporting units such as welding platform with welding machines, oxygen and nitrogen gas line, and pressurization units.

1.7.3.9 Area 900—Non-Producing Assets

Non-producing assets area consists of plant shop, maintenance, laboratory, offices, first aid, guard house, spare parts storage, small equipment and tools storage, as well as small mobile equipment parking area.

1.8 Infrastructure

This section is a summary of section 18.

Camp sites are not considered for the Langis Quarry or the Metallurgical Plant. The Langis Quarry is located near Amqui, while the Metallurgical Plant is located near Baie-Comeau. It is expected that nearby town will provide some of the workforce as well as all housing and other needs to employees. The local hospital will provide first response in case of trauma.

For both sites, all surface run-offs and any on-site water will be channeled to a sedimentation pond. No special treatment will be required for now. Spill kit will be placed, and water quality will be controlled and monitored prior to discharge, as prescribed by regulations.

No permanent fuel storage is planned for either site.

1.8.1 Langis Quarry

Main access to the Langis Property is from Highway 195 from Matane (Quebec). The main-haul gravel logging road is reachable from the main access to the Langis. Silicon Ridge is located approximately 14.6 km from Highway 381.

Site and service roads will be 10 m wide, except for quarry haul roads which will be 17.2 meters wide.

An existing power line reaches the Langis site. Electricity will be provided to the office and gatehouse as well as equipment like pumps and the crusher/screen. All other equipment and the mobile fleet will run on diesel. Potable water for human consumption will be supplied either in bottles or by water trucks.

A few containers will be used to provide temporary storage as required.

1.8.2 Baie-Comeau Metallurgical Plant

Main access to the Baie-Comeau metallurgical plant will be from rerouted Highway 389. Once rerouted, Highway 389 will border the eastern edge of the Metallurgical Plant lot.

Two different site access roads are planned; one access road shall be dedicated to incoming raw materials, while the other one will be dedicated to personnel and finished products. Service roads will be required to access various areas within the site.

Port of Baie-Comeau is located 12 kilometers east of the Metallurgical Plant. A train ferry services the Port of Matane on the Saint-Lawrence River’s south shore. There is a rail transhipment yard 3 kilometers south of the Metallurgical Plant alongside the rerouted Highway 389.

Silica, coal, wood chips, and hematite will be stockpiled on site. Stockpiles are sized according to the specific criteria for each material.

The City of Baie-Comeau will provide raw water, potable water, and sewage treatment.

Electrical power will be supplied by Hydro-Québec power grid. An existing 161-kV power line borders the southern edge of the Metallurgical Plant lot.

Cellular and wired networks are accessible in the area and will be used for data transfer and most communications. Two-way radios will be used for communication with mobile equipment operators.

1.9 Market Studies and Contracts

The ferrosilicon market is highly disparate with little to no overlap in the end market applications. The market is subject to its own distinct drivers and shares only one key similarity, namely the existence of large, underutilized production capacities in China. As a counter-effect to this build-up of capacities in China, non-Chinese producers have evolved to combat this reality by improving cost and technology efficiencies, economies of scale, and the installation of trade barriers to keep Chinese production exports in check. Regulatory, environmental, and labour costs in China constantly push the production costs higher in that country.

The ferrosilicon market in North America is tied to the volatilities of the steel industry, which is currently in a correction phase. The prospects might therefore be regarded as less attractive than those for metallurgical silicon. Further market-related investigations should be conducted at later project stages. In that respect, the flexibility of the project to serve diverse end-market segments seems to be an advantage.

Due to the market reality of ferrosilicon being a bulk commodity, the different spot prices and reports presenting information and projection of the future market prices vary considerably. Because of that, Canadian Metals and CIMA+ decided to assume sales price for the FeSi75 as the final product from the Baie-Comeau Plant for the purposes of the PFS to be based on the several inputs such as Roskill reports, projecting a forecast to 2019 at the US$1,200 per tonne. Currently, CIMA+ believes that the price of US$1,819 (US$1.10 per lb) is a reasonable assumption for this stage of the project development; CME and CIMA+ have followed the market tendency and updated the data from the last forecast of different analysis firms (listed in reference list). We have used CIM Best Practice Guidelines for Mineral Processing (last five-month price) methodology to estimate our spot price, which has not been considered aggressive or conservative, as the different data reviewed show spot prices in China in the range of US$1,000 per tonne and reports for North American market forecast potential of over US$2,200 per tonne.

In Asia, the billet prices have been very strong over the last few years. Thus, the margins are good for the Chinese steel mills. What that has meant is less exports out of China which in turn has meant better prices for steel production elsewhere in the world, whether it is the US or Europe. It has improved a lot, whereas forecasts were previously much more concerned about exports out of China, but domestic demand in China is very good. Moreover, China is the largest producer of steel in the world.

In addition, in spite of the recent decline in the markets of raw materials (iron ore) and steel products, CME and CIMA+ believe that the demand of steel products in general, and therefore FeSi as well, will remain durable due to the continuous requirements of steel products in China, the world always demanding infrastructure projects, as well as the proposed new silk route development plan, etc.

During the next phase of the project, a further detailed market study shall be developed. The Baie-Comeau spot price needs to be set up more definitely, a sales price based on the detailed evaluation of the potential products and specifically based on further negotiation with potential clients.

1.10 Environmental, Permitting, and Social or Community Impact

The project under study is based on two distinct but complementary components: an open quarry and an industrial complex with the process plant.

The quarry mainly consists of the development and extraction of a silica (SiO_2) deposit. The deposit is easily accessible by existing roads.

A production of 130,000 tonnes of coarse silica per year will require approximately 165,000 tonnes per year to be extracted and processed at the Langis quarry. The life of the project is expected to be 28 years. The quarry project includes notably the following activities: standard drilling/blasting, excavation, dump trucks, stockpiling, and crushing. The water for dust control will come from a sedimentation basin.

The quarry will supply the industrial complex producing silicon. The process plant will mainly consist of an electric arc smelting plant where silica is mixed with hematite, coal, electrode paste, and wood chips for the production of ferrosilicon (FeSi). This process requires two electric arc furnaces (70 MW). Electricity will come from hydropower and will be provided through the Hydro-Québec grid (Rate L). Process water will come from the city water supply system.

The base case configuration assumes an annual production of about:

- 72,051 tonnes of FeSi;
- 12,384 tonnes of silica fume, a by-product of the smelting process;
- 4,128 tonnes of slag.

Raw materials will be brought to the plant by road, water, and railway. Final products may go through the same transportation modes but will be highly dependent on clients' locations and needs.

The two main project components have different locations, both in eastern Quebec. The quarry is located in the municipality of Saint-Vianney in the Bas-Saint-Laurent region, while the silicon plant will be located in Baie-Comeau in the Côte-Nord region.

The quarry is located in a forested area with a low human activity density. The proposed exploitation area covered by the quarry is 9.34 ha.

The silicon plant footprint is about 12 ha. It is located north of an industrial park within the municipality of Baie-Comeau. The site is underdeveloped, mainly forested, and the existing industrial and commercial features are located in the south.

The biophysical components are described for both the quarry and the industrial process plant. They include surface and ground water, air, and noise, while the biological components include terrestrial wildlife, vegetation and wetlands, aquatic fauna, and habitats.

Quarry

The quarry's study area is located in the eastern Matapedia region of Quebec, within a hilly terrain with a low elevation, generally less than 300 m. The study area is included in the Appalachian geological region and covered by glacial deposits with highly siliceous sandstone (Li and Ducruc, 1999). There is no known soil contamination site or soil and industrial waste deposition within the study area (MDDELCC, 2018a, b).

Industrial Process Plant

The natural substrate at the plant site, located in the Canadian Shield's Grenville geological province, is characterized by metamorphic rocks (MRN, 2002). The rounded hills, often bordered by steep escarpments, are lined with glacial deposits, mainly formed by undifferentiated thin tills. These rocky hills are separated by more or less deep valleys, filled in many places by large amounts of glaciofluvial sediments (GENIVAR, 2012). There is no known soil contamination site or soil and industrial waste deposition in the process plant's study area (MDDELCC, 2018a, b).

1.11 Capital and Operating Costs

1.11.1 Capital Costs

The estimated consolidated direct capital requirements for CME's integrated Langis project, which encompasses the development of the Langis silica deposit as well as the proposed first phase of the downstream smelter operation in Matane, is expected to amount to approximately CAN$311.1M within a range of ±25%. Included in the estimation is approximately CAN$220.3M of direct and CAN$90.8M of indirect costs.

Table 3: Summary of Capital Cost Estimate

Capex Item	Cost in CAN$
Direct Costs	
Quarry Development / Pre-Stripping	$250,000.00
Quarry Infrastructure	$821,000.00
Metallurgical Plant—Buildings	$50,422,495.53
Metallurgical Plant—Process	$135,921.509.69
Metallurgical Plant—Infrastructure	$32,884,236.21
TOTAL DIRECT	**$220,299,241.43**
Indirect Costs	
Owner's Costs	$8,029,992.00
Freight	$5,867,813.25
Heavy Lift (250-T Crane)	$620,000.00
Construction Indirect Costs	$11,509,212.07
EPCM	$21,922,824.14
Contingency	$32,884,236.21
TOTAL INDIRECT	**$90,834,077.68**
TOTAL DIRECT & INDIRECT	**$311,133,319.11**

1.11.2 Operating Costs

The operating costs for the project were estimated and calculated on an annual basis. A summary of the operating costs is shown below.

The operating costs are presented as a total annual cost in CAN$ and on a per-unit basis on a cost per tonne of SiO_2 production at the Saint-Vianney quarry site as well as on a cost per tonne of final FeSi75 product.

The summary of the annual operating costs and the cost per tonne of SiO_2 and FeSi75 for an average year of operations is shown in the table below.

Table 4: Summary of Annual Operating Costs per Area

Area	Annual Cost in CAN$	Unit Cost	Unit Cost
		(CAN$/t SiO_2)	(CAN$/t FeSi)
Labour	$11,750,693.76	$90.60	$163.09
Power	$26,396,120.18	$203.53	$364.00
Materials, Consumables, Supplies	$46,491,423.61	$358.48	$645.26
Other	$6,484,590.00	$50.00	$90.00
TOTAL	**$91,122,827.55**	**$702.61**	**$1,264.70**

1.12 Economic Analysis

An economic analysis based on the production and cost parameters of the project has been carried out and the results are shown in Table 5. In the analysis used were Ex-Works Metallurgical Plant selling prices of US$1,819 per tonne for ferrosilicon, US$250 per tonne for silica fume, and US$100 per tonne for silica slag. A US$/CAN$ exchange rate of 0.750 was assumed.

Table 5: Summary of the Life of Project Production, Revenues, and Costs

Description	Units	
Production—Mineralization	k tonnes	6,293
Production—Silica Product Feed to FeSi Plant	k tonnes	3,561
Production—Excess Silica Product Sold	k tonnes	1,159
Revenue	M CAN$	5,030.4
Initial Capital Costs (excludes Working Capital)	M CAN$	311.1
Sustaining Capital Costs	M CAN$	21.0

Operating Costs (excludes Royalty Payments)	M CAN$	2,500.5
Royalty Payments	M CAN$	150.9
Closure Costs	M CAN$	0.525
Total Pre-Tax Cash Flow	M CAN$	2,085.8
Total After-Tax Cash Flow	M CAN$	1,573.3

The financial indicators associated with the economic analysis are summarized in Table 6. Figure 5 and Figure 6 show the sensitivity of the after-tax NPV and IRR, respectively, to variations in capital costs, operating costs, selling prices, and the US$/CAN$ exchange rate.

This study has been compiled according to widely accepted industry standards. Nonetheless, there is no certainty that the conclusions reached in this study will be realized.

Table 6: Summary of Financial Indicators

Base Case Results	Unit	Value
Pre-Tax (P-T) NPV @ 8%	M CAN$	525.6
After-Tax (A-T) NPV @ 8%	M CAN$	388.8
P-T IRR	%	24.5
A-T IRR	%	22.0
P-T Payback Period	years	3.8
A-T Payback Period	years	4.0

Figure 5: Sensitivity of Project NPV @ 8% (After Tax)

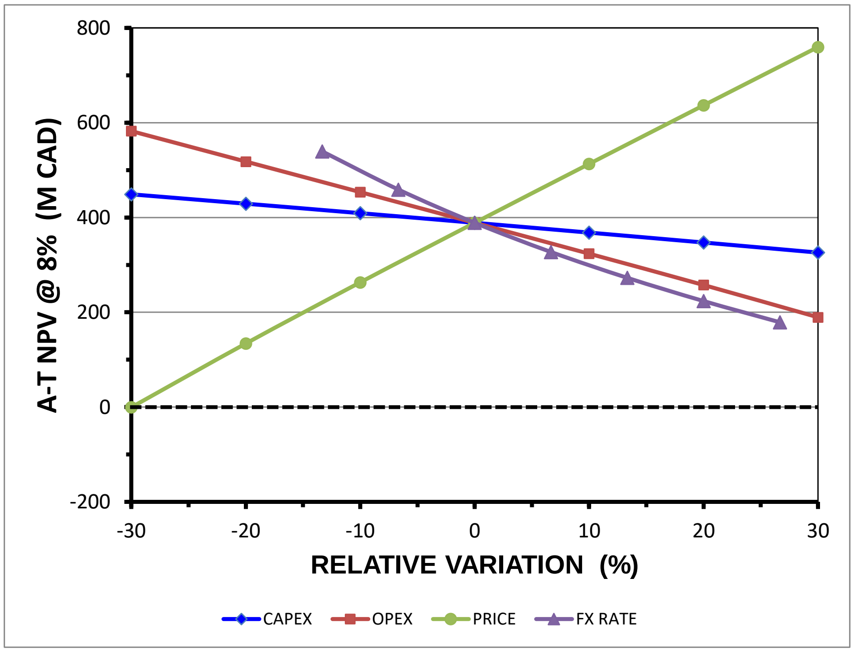
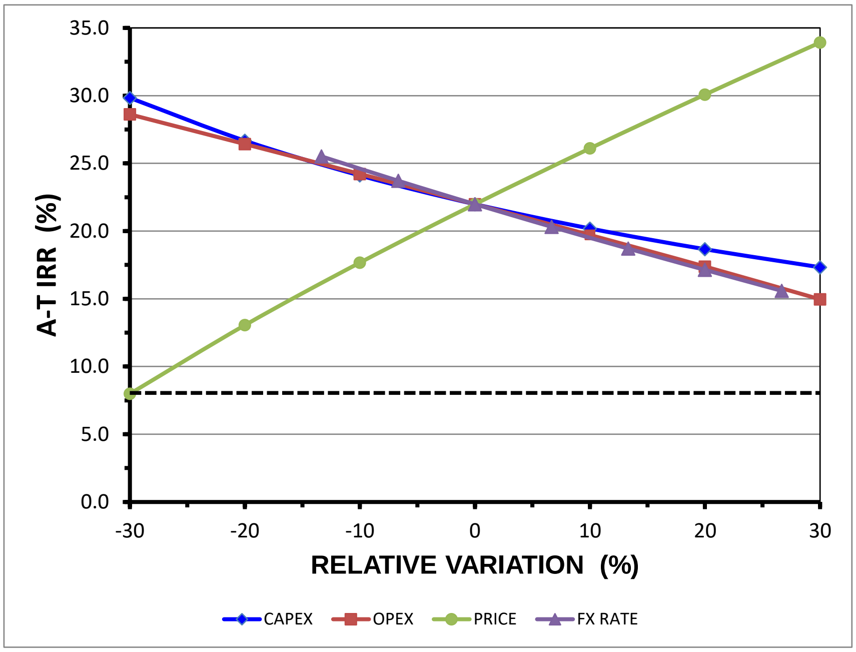


Figure 6: Sensitivity of Project IRR (After Tax)



1.13 Interpretations and Conclusions

The Langis Val-Brillant sandstones with their Lower White sandstones, which are 15 to 35 metres thick, are found to be fairly uniform in terms of chemistry and meet the specifications indicated to the authors for ferrosilicon plant feed. The deposit is dissected by numerous faults, the most important being NNE-SSW or NE-SW oriented thrust faults with a steep dip to the north and uprising of the northwest block relative to the southeast block with apparently not much effect on the quality of the material. Horizontal movement is also present along these faults.

Inclined holes drilled in 2017 have shown that the grades are not affected by the displacement faults; however, two major faults were highlighted in location and width of ferruginous alteration aside the plane. For that reason, these tow faults with their perimeters have been modelled as waste and excluded from the resource model.

The pit optimization analysis was done using the MineSight® Economic Planner (MSEP) module of MineSight® Version 11.0. The optimizer uses the 3D Lerchs-Grossmann algorithm to determine the economic pit limits based on input of costs and revenue per block. The optimization was limited to proximity of 10 m from the property limits. As per NI 43-101 guidelines regarding the Standards of Disclosure for Mineral Projects, only blocks classified in the Measured and Indicated categories drove the pit optimizer for this study. Inferred resource blocks are treated as waste, bearing no economic value.

The pit designed for the Langis Deposit consists of only one (1) phase in size and grade. The final pit is approximately 350 m long with minimum and maximum width at surface of 100 and 225 m respectively, and a maximum pit depth from surface of 47 m. The total footprint of the quarry is expected to be around 118,000 m^2. The overburden thickness varies between 2 to 3 m with an average of 2.5 m.

The pit considers a single permanent access ramp located on the east side. The deepest part of the open pit is at an elevation of 200 m at a depth of 47 m below original surface. The open-pit design is constrained by the property limits to the West.

The open-pit design includes 6.3 Mt of Probable & Proven Mineral Reserves at a grade of 99% SiO_2. In order to access these reserves, 0.8 Mt of overburden and 2.6 Mt of waste rock will need to be removed. This results in a stripping ratio (waste to ore) of 0.41.

Various metallurgical test programs were undertaken by Canadian Metals and executed in different laboratory testing facilities with special expertise of production of FeSi. *Centre de Technologie Minérale et de Plasturgie* (CTMP) performed various chemical and physical analyses on the samples under the supervision of Genivar, as the goal was to establish the characteristics of the Langis sandstone in relation to various potential commercial uses.

Based on the various tests performed over the years for different samples of Langis quartzite in various reputable testing facilities, the general conclusion is that commercial production of ferrosilicon can be achieved using Langis silica products.

This report design is based on the metallurgical processes to utilize the Langis silica as a raw material to produce Ferrosilicon75 (FeSi75) standard along with microsilica (silica fumes) as final plant products to be sold to the market. The Langis silica deposit will be quarried and recovered for use as a feedstock into a downstream ferrosilicon smelter in Baie-Comeau, Quebec, from where it will be shipped to its final destination.

After the silica is quarried by the means of open-pit quarry type of operations, detailed in section 16 of this report, the process steps at the quarry site will consist of blasting, crushing, and screening the silica before its transportation to the metallurgical facility (smelter) by truck. Silica that is too fine for use in the smelter can be marketed to local industries, while the coarser material will be used directly in the smelter.

The smelter at Baie-Comeau will produce ferrosilicon by a pyrometallurgical process that combines silica from the Langis quarry with a carbon source (coal), iron ore, and wood chips in a 2 x 35 MW Submerged Arc Furnaces (SAF), in which the above listed raw materials are smelted into ferrosilicon. Molten ferrosilicon is tapped from the furnace into ladles and then poured into molds to cool and solidify into large ingots. The ingots are removed from the mold after they have cooled sufficiently, then crushed and classified into the required size fraction for sale.

The raw materials required for production of FeSi75 are listed and described in detail below.

- Silica (quartzite)—Langis silica;
- Reducing agent—coal;
- Iron supplement—iron ore;
- Wood chips;
- Electrode paste—Søderberg paste.

1.14 Recommendations

1.14.1 Geology and Resources

In GMG opinion, the actual resource appears sufficient for the contemplated project of CME. Most of the recommendations of 2016 have been realized and place the Property in good position for the next step. Our suggestions are now:

- Conduct a feasibility with the current Measured and Indicated resources within the crown land;
- Negotiate to acquire the surface right with Inferred resources to the west of the existing quarry where there is an open face and it is ready for quarrying technically. Once acquisition or agreement with neighbour is done and should additional resources be required for the project, then drill on regular grid of 60 x 60 m ($250k-$350k). The author suggests the acquisition at evaluation and a reasonable percentage factor associated with a limited royalty per tonne for a fixed amount;
- As part of the additional drilling proposed above, proceed with a hydrogeological study to better understand the groundwater behaviour in the quarry area and how quarrying will affect the water table (100k);
- As part of the additional drilling requested above, proceed with more geotechnical data gathering to better define rock mass properties in order to increase confidence in mining parameters used and reduce rock waste removal.

1.14.2 Mining and Quarry Processing

In GMG opinion, trial quarrying with the current BEX and the next step of a feasibility study will allow CME to:

- Adjust the drilling and blasting pattern to minimize fines and control the number of oversize rocks that need to be re-handled to minimize damage to quarrying equipment;
- Compile and analyze the on-going abrasion tests and Bond index tests to better define the energy required for crushing the material;
- Review quarry plans with new drilling information to optimize ore to waste ratio and reduce dilution;
- Provide optimized quarrying plans to contractors to refine quarrying costs.

1.14.3 Mineral Processing and Metallurgy

For the next stage of project development, namely the Feasibility Study, CIMA+ recommends several very important steps and tasks regarding the metallurgical testing and design in order to firm up and optimize the process design to ensure optimal metallurgical plant performance that will produce the optimal final products and thus maximize the project economics. Those steps and measures are:

- Develop a strategy and recipe for a detailed metallurgical test program to optimize process performance and confirm the metallurgical design. Such test program should include mineralogy, characterization of heating properties of quartz, and simulation of Si-production process in medium scale. In addition, a Pilot scale ferrosilicon production will be undertaken for clearly defining the process flow sheet.

The proposed budget to execute the above listed activities is expected to be in the range of \$500k-\$750k and the work will be included into the feasibility study.

2. Introduction

The present work is a revised Technical Report on the Pre-Feasibility Study according to NI 43-101 standards for the establishment of silica quarrying operation and a recovery operation in the Saint-Vianney Regional Municipality (MRC) of Matapedia and Baie-Comeau, Quebec, respectively.

2.1 Scope of Study

The Pre-Feasibility Study Scope of Work (SOW) included the following:
CIMA+ is responsible for achieving the completion of the Pre-Feasibility Study the Langis project.

Based on the 2017 drill program results, the mineral resource estimates were updated to the Indicated and Measured categories, respectively. GoldMinds Geoservices Inc. is responsible for that work.

Quarry pit design is based on the updated resources including mineral reserves estimation and quarry plan. GoldMinds Geoservices Inc. is responsible for that work.

Environmental and background aquatics work executed by WSP was used as primary input in the execution of the pre-feasibility study.

CIMA+ is responsible for the overall metallurgical design with Tenova Minerals Pty, presenting the metallurgical plant design, as well as for the plant building and infrastructure.

In summary, the objectives of this project are:

- Project budget accuracy at ±20 to 25%;
- Project management of the Pre-Feasibility Study;
- Completion of the Pre-Feasibility Study within the NI 43-101 requirements;
- Identification of the marketing strategy for the product(s);
- Implementation of a procurement and supply chain analysis;
- Some major items to be considered in the pre-feasibility report are:
    - Drilling and geological work; resource modelling;
    - Infrastructure requirements;
    - Health and safety recommendations;
    - Operational readiness;
    - Cost estimates—Capex and Opex;
    - Opportunities and risk register;
    - Manpower strategy and human resource plan.
- All recommendations to perform the next phase.

CIMA+ had performed the overall design with the best mining practices and in accordance with Canadian codes and standards. The purpose of the studies is to optimize the project execution and present a financial evaluation of the project at the PFS level based on the existing Measured and Indicated mineral resources.

2.2 Sources of Information

The information presented in this Technical Report is derived from the previously completed technical reports for the Langis Property such as the Preliminary Economic Assessment (PEA) from 2016, as well as the new updated resources from 2017. Location of historic holes from 1984 and older have been integrated in the database. Drill holes older than 2013 have been integrated in the resource estimation for geological contacts and thicknesses only.

Personal inspection of the Property by qualified person: Mr. Claude Duplessis, P. Eng., Senior Engineer, GoldMinds Geoservices Inc., visited the Langis Property on several occasions as an independent Qualified Person, as defined in the NI 43-101. Mr. Duplessis started working with CME (Canadian Metals Inc.) in 2016 and was the QP for the revised PEA of October 2016. Furthermore, Mr. Duplessis was present at the beginning of the 2017 exploration campaign and visited the site twice during the 2017 campaign. Mr. Duplessis is responsible for all sections of the Technical Report defining the geology and resources statement.

Additional sources of information used in this report are metallurgical test reports from MINTEK, 2015, as well as reports and documentation from Tenova Minerals Pty Ltd.

2.3 Responsibility Matrix

Table 7: Responsibility Matrix

Report Section	Responsible	Comments
Section 1—Summary	CD/CB/GD	and others
Section 2—Introduction	CD/CB/GD	
Section 3—Reliance on Other Experts	CD/CB/GD	
Section 4—Property Description and Location	CD/GD	
Section 5—Accessibility, Climate, Local Resources, Infrastructure, and Physiography	CD/GD	
Section 6—History	CD/GD	
Section 7—Geological Setting and Mineralization	CD	
Section 8—Deposit Types	CD	
Section 9—Exploration	CD	
Section 10—Drilling	CD	
Section 11—Sample Preparation, Analyses, and Security	CD	
Section 12—Data Verification	CD	

Section 13—Mineral Processing and Metallurgical Testing	GD	
Section 14—Mineral Resource Estimates	CD	
Section 15—Mineral Reserve Estimates	CB/CD	
Section 16—Mining Methods	CB/CD	
Section 17—Recovery Methods	GD	
Section 18—Project Infrastructure	CB/CD/GD	
Section 19—Market Study and Contracts	GD	
Section 20—Environmental Studies, Permitting, and Social or Community Impact	NF	
Section 21—Capital and Operating Cost	GD	and others
Section 22—Economic Analysis	GD	
Section 23—Adjacent Properties	CD/CB/GD	
Section 24—Other Relevant Data and Information	CD/CB/GD	
Section 25—Interpretation and Conclusions	GD	and others
Section 26—Recommendations	GD	and others
Section 27—References	GD	and others

2.4 Qualified Persons

Qualified persons are as follows:

- CD—Claude Duplessis, P. Eng., Goldminds;
- CB—Claude Bisaillon, P. Eng., Goldminds;
- GD—Georgi Doundarov, P. Eng., PMP, CCP. CIMA+;
- NF—Nathalie Fortin, P. Eng., WSP.

2.5 Site Visit

The following qualified persons for this Technical Report personally inspected the Langis Property; the dates of the visits are shown in the table below.

Table 8: Site Visit

Qualified Person	Company	Date
Claude Duplessis	GoldMinds	September 28th, 2016 Multiple times during the 2017 drilling campaign

3. Reliance on Other Experts

CIMA+ has reviewed and considered data and information provided by Canadian Metals Inc., with respect to the Langis Property, as well as used them to develop conclusions for this Technical Report.

The QP Claude Duplessis of Goldminds Geoservices Inc. has visited the Langis Property.

CIMA+ has retained WSP to execute the independent environmental assessment for the purposes of the PFS relying on the data and information provided by WSP and their QP, Nathalie Fortin, P. Eng., through Canadian Metals Inc. to create section 20 of this Technical Report.

CIMA+ has not carried out any independent metallurgical evaluations of silica from the Langis Property, that information being provided by MINTEK through Canadian Metals Inc. for use in section 13 of this Technical Report.

CIMA+ has utilized the input from Tenova Minerals Pty Ltd. on the metallurgical design and equipment requirements to create section 17 of this Technical Report.

The economic analysis and section 22 was prepared in collaboration with Mr. Michel L. Bilodeau, B. Eng., M. (App.) Sc., Ph. D.

Some of the figures and tables in this Technical Report were reproduced or derived from current or historical reports written on the Property, as well as the previous Preliminary Economic Assessment (PEA). Various data were supplied to CIMA+ by Canadian Metals Inc. In cases where photographs, figures, or tables were supplied by other entities, they are referenced below the inserted item.

All sections of this Technical Report are covered by the above named QP and have been reviewed and approved by CIMA+ QP Georgi Doundarov, M. Sc., P. Eng., PMP, CCP (CIMA+).

4. Property Description and Location

4.1 Langis Property

4.1.1 Property Location

The Langis Property is located in the Matapedia Region of the Gaspe, Peninsula of Quebec, within the Regional Municipality (MRC) of Matapedia, about 650 km northeast of Montreal. The nearest city with all major services is the city of Matane, located about 40 km northwest. The village of Saint-Vianney is located about 5 km west. The Langis Property is easily accessible via paved provincial highway 195 and a gravel road.

The Property is located within National Topographic Series map sheet 22B11. The geographic center of the Property is approximately at latitude 48°37’30” N and longitude 67°20’00” W or 5,387,200 N and 622,800 E in UTM zone 19. The Property covers parts of Ranges VI and VII of Langis Township.

Figure 7: Langis Property Location Maps

4.1.2 Property Description and Ownership

At the time of writing this Technical Report, the Langis Property is made up of four (4) regular contiguous CDCs (map-staked claims), with a total surface area of 227.62 ha. All claims are 100% owned by Canadian Metals Inc. and in good standing until July 2019. The claims cover both private and crown lands.

Canadian Metals Inc. owns an exclusive mining lease of surface mineral substances (BEX) on the existing quarry located on the Property on crown lands.

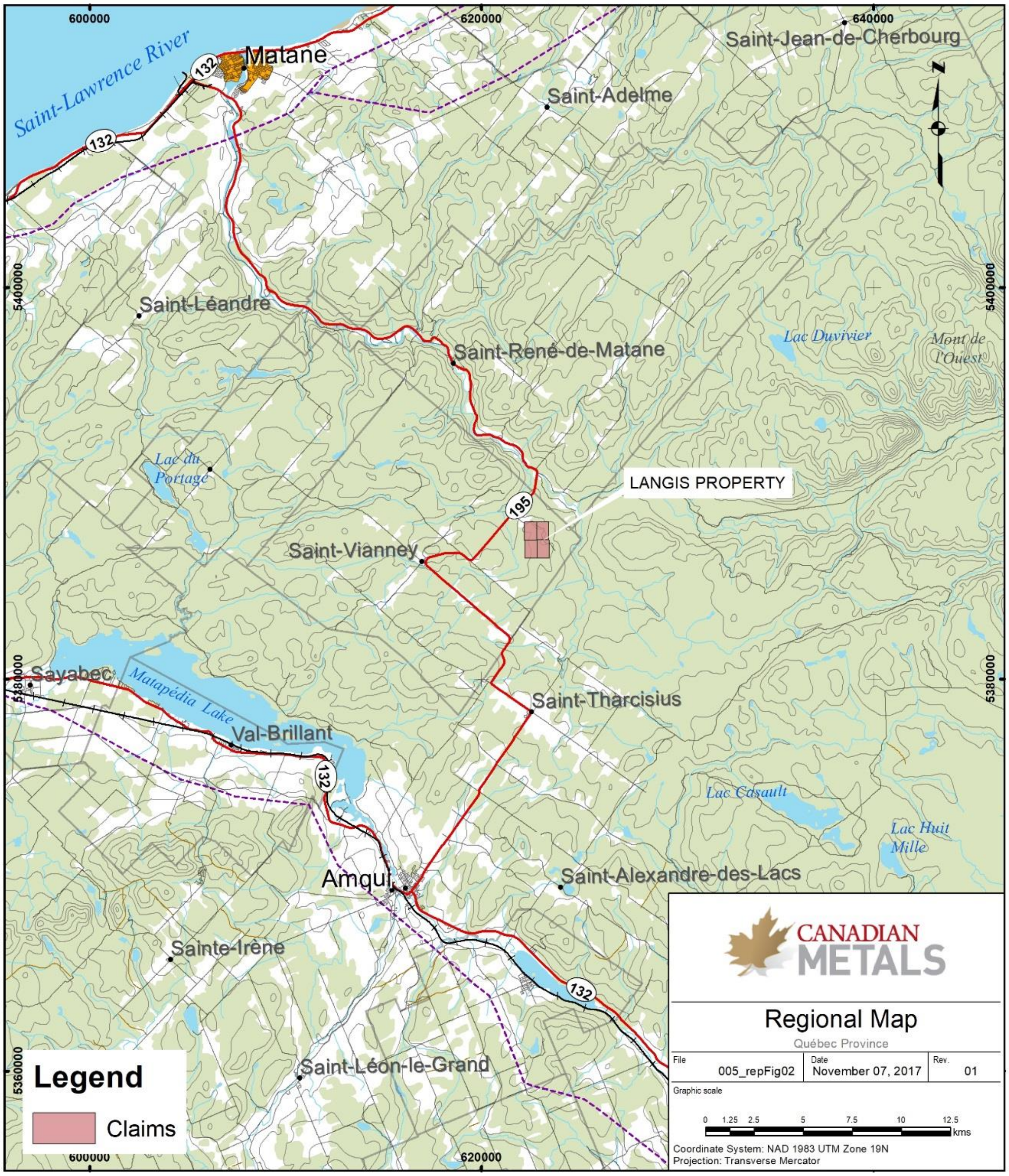
Canadian Metals has received its operating lease from the Quebec Ministry of Energy and Natural Resources. This lease is one of the two main regulatory approvals required to begin the operation of the Langis project and was issued by the Quebec authorities after over two years of official studies, community engagement, and public consultation (announced in Press Release of October 3rd, 2017). The BEX 1710 covers a portion of the four claims of the Property, not the whole Property. The BEX area is 9.34 hectares and in force up to September 18th, 2025.

The Table 9 below lists the details of the registered claims and mining lease, based on information from the MERN of Quebec GESTIM website updated as of January 25th, 2018. The Figure 8 below shows the location of claims.

Table 9: List of Claim and Mining Lease

Type of Title	Title Nr.	Status	Registration Date	Expiry Date	Area (Ha)	Accrued Work (CAN$)	Required Work (CAN$)	Required Fees (CAN$)
BEX	1710	Active	2017-09-19	2025-09-18	9.35	0.00		
CDC	2387521	Active	2013-07-12	2019-07-11	56.91	0.00	780.00	64.09
CDC	2387522	Active	2013-07-12	2019-07-11	56.91	0.00	780.00	64.09
CDC	2387523	Active	2013-07-12	2019-07-11	56.9	0.00	780.00	64.09
CDC	2387524	Active	2013-07-12	2019-07-11	56.9	149,955.62	780.00	64.09

Figure 8: Claims Localization



4.1.3 Issuers Interests

The production of the Property is subject to a 3% Net Smelter Return (NSR) according to Canadian Metals Inc. This is a 3% surcharge on smelter in proportion to the Langis silica supply relative to the overall silica consumption. In the financial model, this charge is treated as a cash operating expense. This contractual obligation by Canadian Metals Inc. is payable to 9285-3696 Québec Inc.

4.1.4 Legal Survey

The only permit required to carry out exploration work on the Property is the usual permit for forestry management. The company must also respect all the environmental laws applicable to the type of work done. On private lands, if exploration activities need to be carried out, agreement must be negotiated with surface rights owners. The exploration activities completed to date and planned in the near future are on crown lands.

4.1.5 Environmental Liabilities

To the knowledge of the authors, there is no environmental liabilities pertaining to the Langis Property, as reported by Canadian Metals Inc.

4.1.5.1 BEX

Canadian Metals has received its operating lease from the Quebec Ministry of Energy and Natural Resources. This lease is one of the two main regulatory approvals required to begin the operation of the Langis project and was issued by the Quebec authorities after over two years of official studies, community engagement, and public consultation (announced in Press Release of October 3rd, 2017). The BEX 1710 covers a portion of the four (4) claims of the Property, not the whole Property. The BEX area is 9.34 hectares and in force up to September 18th, 2025.

4.1.5.2 Certificate of Authorization

CME has received the Certificate of Authorization (CA) for the Langis silica project from the MDDELCC. The CA represents the principal regulatory approval required to start the operation of the Langis quarry and has been issued by the Quebec regulators (announced in Press Release of December 5th, 2017); document number nr. 401645327.

4.1.6 Significant Factors and Risks

The known socio-economic risk which may affect access or the right or ability to perform work on the land is the social acceptability of the project by the population in the area.

There are no known legal or title risks that may affect access, the right, or ability to perform work on the land.

There are no other known significant factors or risks other than as disclosed herein that may affect access, title, the right, or ability to perform work on the land.

The BEX and CA are for approximately 590,000 tonnes and will require modifications and amendments in order to supply the amount of rock required and scheduled in this Preliminary Feasibility Study.

4.2 Baie-Comeau Site

4.2.1 Property Location

The ferrosilicon smelter site is located in the Jean-Noël Tessier industrial park in the city of Baie-Comeau, Quebec. The site is located on highway 389. The geographic center of the Property is approximately at latitude 49°14’18” N and longitude 68°14’36” W.

4.2.2 Property Description and Ownership

The land of the Baie-Comeau site is currently unused and owned by SEBC. It is included in a large industrial development project of the City of Baie-Comeau. The land is zoned for heavy industries and fully compatible with the projected industrial activities and ore storage for Canadian Metals activities. The site is already included in the Baie-Comeau city’s zoning plan with a “heavy industrial” indication, which allows the implementation of projects requiring large volumes of raw materials to be handled and able to tolerate impacts by noise and dust.

A rail link connects industrial lands to the Port of Baie-Comeau, which would be used to transport raw materials and end products. Access to power and water services is available. There is hydropower available for new customers in the Baie-Comeau area.

4.2.3 Significant Factors and Risks

The known socio-economic risk which may affect access, the right, or ability to perform work on the land is the social acceptability of the project by the population in the region of Baie-Comeau.

There are no known environmental liabilities for this land.

There are no known legal or title risks which may affect access, the right, or ability to perform work on the land.

There are no other known significant factors and risks other than as disclosed herein that may affect access, title, the right, or ability to perform work on the land.

5. Accessibility, Climate, Local Resources, Infrastructure, and Physiography

Portions of this section were summarized from previous reports after validation of accuracy.

5.1 Topography, Elevation, Vegetation, and Drainage

The Langis Property is located in gently rolling Appalachian terrain. A set of elongated NNE-oriented hills dominates the topography. These are transected along the northeast by the valley of the Matane River. In the Property area and immediate surroundings, elevations range from a high of 279 meters to a low of 90 meters along the river. In the area of interest around the quarry, there is a gentle incline from the access road at 240 meters up to just over 250 meters proceeding across the hill toward the northwest.

The Property is largely covered with forest. It is a mixed forest of hardwoods such as maple, poplar, and birch mixed with conifers such as white spruce, white pine, and cedar. Locally, there are areas of second or third growth dominated by alders and other low bushes.

5.2 Accessibility

The Langis Property is easily road-accessible via paved provincial Route 195 and a gravel road in good condition (Range VII road). The Property is 20 km by road (Route 195) from the town of Amqui which is located on Route 132 and is the administrative center of the Matapedia Regional County Municipality (RCM). It is also accessible via Route 195 from Route 132 at the town of Matane, a distance of 40 km. The Langis gravel access road runs southeast from Route 195, half a kilometer to the east of the Saint-Vianney village. From this intersection, it is 2.5 km to the existing quarry on the Langis Property.

5.3 Climate

The closest climate data collection site is the Mont-Joli airport, which is located 64 km straight west of the Property. Mont-Joli’s climate is somewhat modified due to its seashore location, the most obvious difference being stronger winds.

Table 10: Temperature (ºC)

	J	F	M	A	M	J	J	A	S	O	N	D
Average Temperature	-12.3	-10.9	-5	1.6	8.5	14.4	17.5	16.2	11.4	5.3	-0.7	-8.3
Record High	13	12.4	20	29.1	31.4	33.3	35.9	33.3	32.2	26.7	21.8	16.7
Date	Jan 19th, 1996	Feb 27th, 2000	Mar 30th, 1962	Apr 21st, 1987	May 24th, 1977	Jun 28th, 1965	Jul 4th, 1983	Aug 14th, 1947	Sep 4th, 1949	Oct 3rd, 1968	Nov 3rd, 1999	Dec 12th, 1950
Record Low	-33.3	-31.1	-29.4	-19.9	-12.2	-1.1	0.8	1.8	-5	-8.4	-18.3	-30.6
Date	Jan 4th, 1947	Feb 11th, 1973	Mar 3rd, 1950	Apr 2nd, 1994	May 1st, 1947	Jun 18th, 1956	Jul 16th, 1982	Aug 28th, 1990	Sep 27th, 1947	Oct 26th, 1993	Nov 30th, 1947	Dec 30th, 1972

Source: GoldMinds Geoservices Inc.

Table 11: Historical Precipitations

	J	F	M	A	M	J	J	A	S	O	N	D
Rain (mm)	9	6	15	34	82	73	85	89	78	80	41	14
	Total annual: 606											
Snow (cm)	78	59	58	30	2	0	0	0	0	5	38	80
	Total annual: 350											
Monthly Precipitations (mm)	80	59	69	63	84	73	85	89	78	84	78	87
	Total annual: 928											
Rain Record (mm)	35	19	64	41	50	41	60	74	77	74	52	36
Date	Jan 5th, 1992	Feb 22nd, 1974	Mar 11th, 1955	Apr 22nd, 1992	May 18th, 1948	Jun 9th, 1981	Jul 19th, 1996	Aug 28th, 1971	Sep 10th, 1999	Oct 3rd, 1952	Nov 7th, 1953	Dec 16th, 1960
Snow Record (cm)	34	60	38	35	12	0	0	0	0	18	35	51
Date	Jan 12th, 1995	Feb 5th, 1995	Mar 14th, 1993	Apr 11th, 1973	May 7th, 1970	Jun 1st, 1943	Jul 1st, 1943	Aug 1st, 1943	Sep 1st, 1943	Oct 30th, 1964	Nov 26th, 1974	Dec 12th, 1944
Precipitation Record for 1 Day (mm)	36	60	64	41	50	41	60	74	77	74	52	51
Date	Jan 5th, 1992	Feb 5th, 1995	Mar 11th, 1955	Apr 22nd, 1992	May 18th, 1948	Jun 9th, 1981	Jul 19th, 1996	Aug 28th, 1971	Sep 10th, 1999	Oct 3rd, 1952	Nov 7th, 1953	Dec 12th, 1944

Source: GoldMinds Geoservices Inc.

Figure 9: Existing Site Conditions

Source: GoldMinds Geoservices Inc.

5.4 Local Resources and Infrastructure

The Langis Property is 20 km by paved road from Amqui. CN Rail passes through Amqui connecting it to the ports of Rimouski, Matane, and Campbellton, New Brunswick.

The Property is 40 km by paved road from the Port of Matane. The quarry will operate between the month of June and October. Matane is presently considered to be the most likely transshipment point for the potential silica product. These transportation alternatives will require research in the next phase of work. The road to the existing quarry area from the paved road appears to be in good condition and may be capable of handling heavy truck traffic, although upgrading may be required.

The town of Amqui has a population of approximately 6,300 habitants, while the town of Matane has a population of approximately 14,500 habitants. There are several smaller villages in the area of the Property such as Saint-Vianney, Saint-Tharcisius, Saint-Rene-de-Matane, Lac-au-Saumon, and Val-Brillant. There is an adequate skillset locally available for the operation of a silica quarry.

The nearest source of a continuous substantial flow of fresh water is a stream called Tamagodi River, located 1.8 km to the east-southeast of the present Langis quarry. This stream flows northeastward into the Matane River. The Matane River flows northward into the Saint-Lawrence estuary. The Tamagodi River can potentially be used as a source of raw water for activities such as pit wetting, car and equipment washing, workshops, and fuel station washing, as well as for the processing plant, but this is a topic to be addressed in later project stages and the Environmental Impact Assessment (EIA). Since water from Tamagodi River and the Matane River cannot be considered as potable for human consumption, the water demand for this purpose can be supplied by water trucks from the nearest water treatment company.

High-voltage transmission lines cross the Property 300 meters south of the existing quarry. A transformer substation is already installed 400 meters southwest of the existing quarry.

At the southwest corner of the existing quarry, foundations for a loading and crushing facility, installed by an earlier operator, appear to be in good condition (concrete quality assessment is required prior to use these). About 400 meters southwest of the existing quarry, there is a 25 meters x 12 meters finished concrete floor that might be suitable for a new building. There is adequate flat area for storage of waste rock from a quarrying operation stand point.

Figure 10: View of the Former Quarry looking Southwest

Source: GoldMinds Geoservices Inc.

6. History

Portions of this section were summarized from previous reports after validation of accuracy.

6.1 General Geological Survey

Geological mapping and exploration of the Langis area of the Matapedia Region by governmental institutions began with the investigations of Logan in 1844 and his assistant Murray in 1846. A. P. Low visited the area in 1884, followed by Ells in 1885, as well as L. W. Bailey and W. McInnes in 1884-85, the latter work resulting in the first geological map of the region (1888). Later, during the period 1928-31, F. J. Alcock and G. W. Crickney surveyed the area as part of a larger regional mapping effort. Following up on that work, J. W. Laverdière and L. G. Morin concentrated specifically on the Langis area. A general geological map of the Matapedia-Matane region was completed by E. Aubert de la Rue in 1941 (RG 009). Still later, H. W. McGerrigle completed geological work in the area as part of his compilation of the Geological Map of the Gaspé Peninsula (1953).

Mapping the Region Rimouski-Matapedia, J. Beland touched on the area in 1960 (RP 430). Subsequently detailed geological mapping of the Cuoq-Langis Area of Matane and Matapedia Counties was completed by N. C. Ollerenshaw in 1961 and 1967 (RG 121). This is the most comprehensive geological mapping of the Property area. Synthesis of the area into Gaspe regional geology was completed by Slivitsky et al. (1991). Stratigraphy was reinterpreted and integrated into the Appalachian geology by Brisebois and Morin (2003). Most pertinent publications are listed in section 27 (References) herein.

6.2 Exploration

The first known examination and comprehensive report on the sandstones of Langis and Tessier Townships was done by R. A. Marleau (1979) for Placement Appalaches Inc. (GM 36008). This work on the Val-Brillant Sandstone was entitled a “Comparative Study in regard to other Commercial Silica/Sands of North-Eastern America”. At the time, the sandstone was seen as a possible source for high-purity sands.

Uniquartz Inc. took over the project from Placement Appalaches Inc. in 1982. Between August and October of 1982, an extensive diamond drilling program was completed on Langis and neighbouring Tessier sandstone occurrences. A total of 4,102.5 feet (1,243.1 meters) was drilled in 25 drill holes, eight (8) of which, totalling 1,568 feet (475.1 meters), were completed on the Langis Property. The drilling was supervised by R. A. Marleau of Services Geotechniques Shickshocks Inc. (SGS) for Uniquartz Inc. (GM 40477).

Subsequently (1983), extensive physical and geochemical testing was completed on the drill core in order to determine the physical and geochemical characteristics of the sandstones of the Langis and Tessier deposits. This testing comprised over 3,000 feet (914.4 meters) of drill core in sample lengths of 10 feet (3.05 meters). Additionally, two (2) bulk samples were taken, each weighing more than 2.5 tonnes.

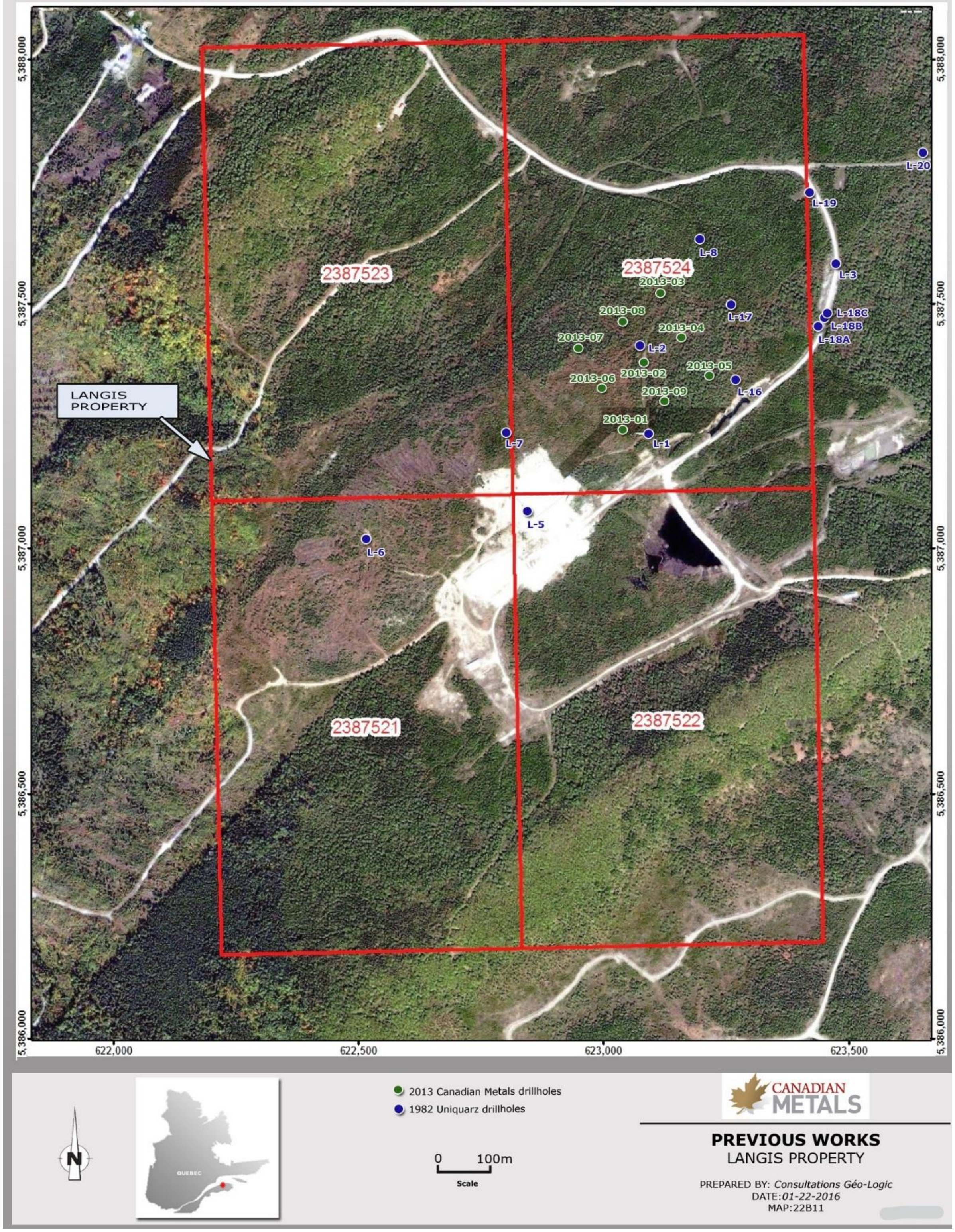
In 1984, historical tonnages published in the environmental study of the project (GM 42387) stand at 25.0 million tonnes at average grades of 0.11% Fe_2O_3 and 0.41% Al_2O_3, including 9.0 million tonnes at 0.11% Fe_2O_3 and 0.26% Al_2O_3 or 5.7 million tonnes at 0.05% Fe_2O_3 and 0.183% Al_2O_3. SiO_2 grade calculated from 750 feet (228.6 meters) of core is reported to be 99.25%; however, no details are given about this result. This was classified as an Indicated Reserve. *This resource is historic in nature and does not meet the requirements for Resource Categorization as set out in NI 43-101.*

In 1985, Uniquartz obtained the Mining Lease nr. 741. In December 1985 and May 1986, a total of some 22,000 tonnes of lump silica was sent to Norway and Iceland for testing into the existing ferrosilicon facilities. The results were positive and 150,000-tpy supply contract was signed. In 1988, start-up of the project was estimated at CAN$ 8.4 million. There are no records about difficulties encountered; however, the project never went into production.

In 1991, the site was visited by a geologist of the Quebec Ministry of Natural Resources during a quarries inventory. No activities were noted at the time, but the site was identified as Aristide Brousseau & Fils. Apparently, material was extracted intermittently after 1991 for construction purposes. Several elongated piles of crushed waste rock remain to the west of the quarry. From the actual size of the quarry, it is estimated that around 400,000 tonnes have been extracted from the site over the years.

Figure 11 presents a compilation of historical works completed on the Langis Property and section 27 lists all private and public documents available for the Langis Property.

Figure 11: Previous Work on the Langis Property



6.3 Historical Resources

Historical resources were calculated for the first time at the end of 1982, following a drilling program carried out by Uniquartz Inc. on the Langis Property and its northeastern extension in Tessier, as both were part of the same Property at the time. From early 1983, historical resources on the Langis portion of the Property were established (GM 42388) by Uniquartz at:

Table 12: Historical Resources

Millions Short Tons	% SiO_2	% Fe_2O_3	% Al_2O_3	
25.5	not specified	0.12	0.41	
9.0	not specified	0.11	0.26	including
5.7	not specified	0.05	0.183	including

In the public documents made available by Uniquartz, the only reference to the SiO_2% is from GM 42387, where an average grade of 99.25% has been calculated from 750 feet (228.6 meters) of core.

Authors have not done sufficient work to classify the historical estimates as current resources and the Owner of the Property is not treating the historical estimate as current mineral resources.

The historical resources were calculated using the following parameters (GM 42387, pp. 20-26):

Tonnages (short tons) were estimated using interpreted vertical cross-sections. The silica was interpreted on one section from the drill results giving a surface in square feet. These surfaces were divided by the density which has been established at 13.3 cubic feet per short tonne (2.46 g/cm^3); there is no record of how the density was calculated. This generated a tonnage per horizontal foot. Finally, the horizontal tonnage was multiplied by a width of 900 feet (274.3 meters) to produce the final tonnages for the deposit.

The notion of tonnage per vertical or horizontal foot is no longer in use to calculate resources. Moreover, in this particular case, the limits of the deposit in a plane view form an elongated polygon that thins out gradually at both ends. The 900 feet (274.3 meters) of width appears to correspond to the widest part of the deposit.

For all the categories of sandstone estimated and reported above, the thickness of the sandstone includes the overburden. Some tonnage must therefore be removed to account for this. For the 25.5-Mt categories, 8% of the tonnage was removed from the estimate to take into consideration the worst parts of the sandstone, namely those showing a deep red hematization, as their distinctive colour would permit this material to be discarded in a selective quarry pit operations approach. Comparing the database, the Uniquartz resources calculation looks to be overestimated.

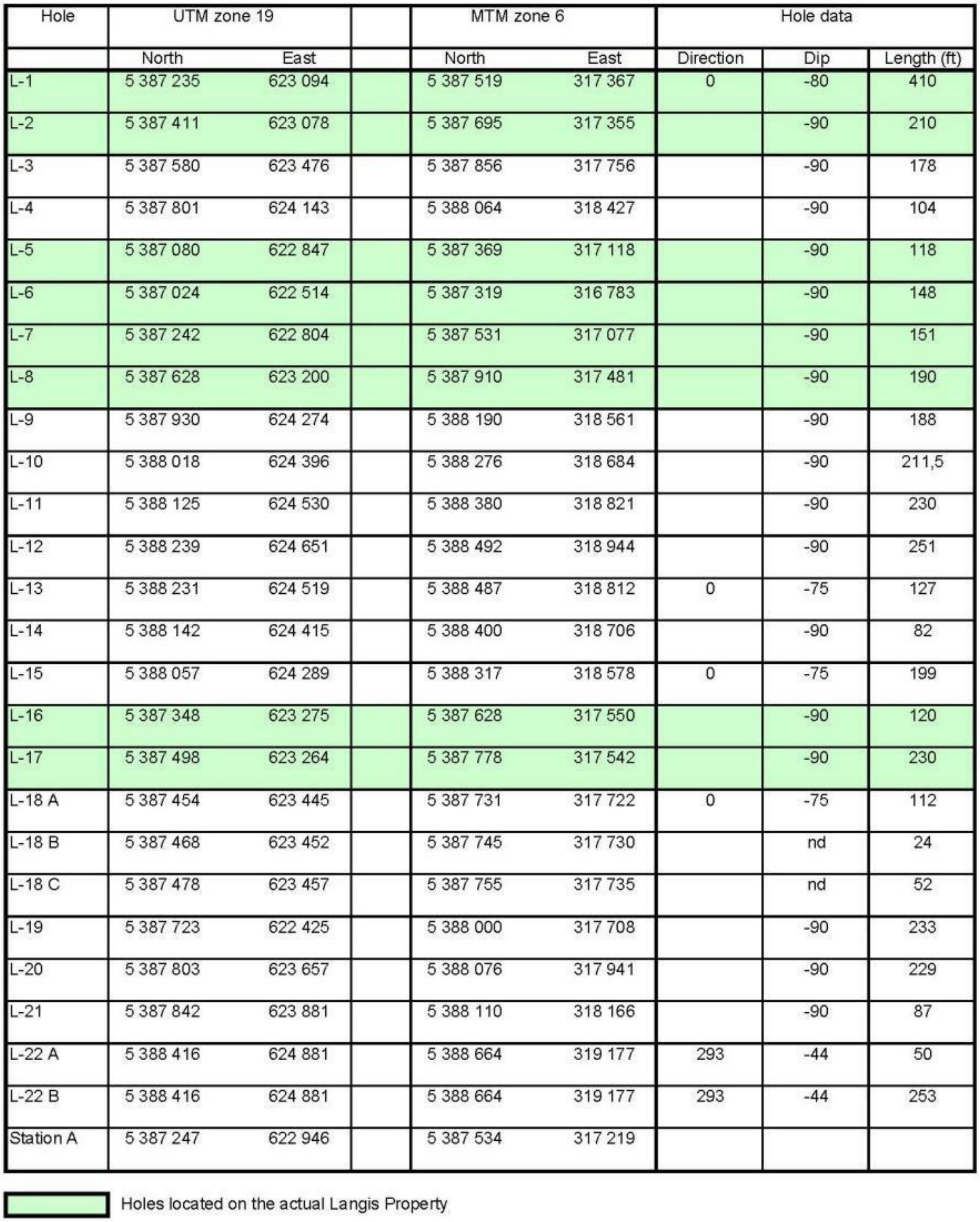
6.4 Past Production

Some 22,000 short tonnes are known to have been extracted in 1985-86 and sent to Europe to test the conformity of the material in ferrosilicon processes. Additional tonnages estimated at some 400,000 short tonnes were extracted from the site to produce aggregates for construction and concrete. These are unverified numbers by the QP.

6.5 Historical Drilling

Historical drilling has been described in section 6.2. The Uniquartz drilling program of 1982 was located on the actual Langis Property and its extension to the east. Table 13 presents the complete data about the 1982 program. Only the holes highlighted in green are located on the current Langis Property. All historical holes are shown in blue in Figure 11 above.

Table 13: Historical Drilling



Hole	UTM zone 19			MTM zone 6		Hole data		
	North	East		North	East	Direction	Dip	Length (ft)
L-1	5 387 235	623 094		5 387 519	317 367	0	-80	410
L-2	5 387 411	623 078		5 387 695	317 355		-90	210
L-3	5 387 580	623 476		5 387 856	317 756		-90	178
L-4	5 387 801	624 143		5 388 064	318 427		-90	104
L-5	5 387 080	622 847		5 387 369	317 118		-90	118
L-6	5 387 024	622 514		5 387 319	316 783		-90	148
L-7	5 387 242	622 804		5 387 531	317 077		-90	151
L-8	5 387 628	623 200		5 387 910	317 481		-90	190
L-9	5 387 930	624 274		5 388 190	318 561		-90	188
L-10	5 388 018	624 396		5 388 276	318 684		-90	211,5
L-11	5 388 125	624 530		5 388 380	318 821		-90	230
L-12	5 388 239	624 651		5 388 492	318 944		-90	251
L-13	5 388 231	624 519		5 388 487	318 812	0	-75	127
L-14	5 388 142	624 415		5 388 400	318 706		-90	82
L-15	5 388 057	624 289		5 388 317	318 578	0	-75	199
L-16	5 387 348	623 275		5 387 628	317 550		-90	120
L-17	5 387 498	623 264		5 387 778	317 542		-90	230
L-18 A	5 387 454	623 445		5 387 731	317 722	0	-75	112
L-18 B	5 387 468	623 452		5 387 745	317 730		nd	24
L-18 C	5 387 478	623 457		5 387 755	317 735		nd	52
L-19	5 387 723	622 425		5 388 000	317 708		-90	233
L-20	5 387 803	623 657		5 388 076	317 941		-90	229
L-21	5 387 842	623 881		5 388 110	318 166		-90	87
L-22 A	5 388 416	624 881		5 388 664	319 177	293	-44	50
L-22 B	5 388 416	624 881		5 388 664	319 177	293	-44	253
Station A	5 387 247	622 946		5 387 534	317 219			

🟩 Holes located on the actual Langis Property

Source: Uniquartz

CIMA+ M03846C

7. Geological Setting and Mineralization

Portions of this section were summarized from previous reports after validation of accuracy.

7.1 Regional Geology

The Matapedia Region forms part of the Appalachian Geological Province, which stretches from Alabama in the southeast USA to Newfoundland. The portion of this Province that hosts the rocks pertinent to this Technical Report is known as the Connecticut Valley—Gaspe Synclinorium (CVGS). These rocks were folded, faulted, intruded, and weakly metamorphosed during what is generally known as the Appalachian Orogeny. In Matapedia, the Appalachian Orogeny is comprised of three main episodes of deformation:

- The Taconic Orogeny in late Ordovician time, when a volcanic island arc collided with the pre-existing Laurentia landmass as the Lapetus Ocean closed;
- The Acadian Orogeny of mid-Devonian time, whence the micro-continents Avalonia and Baltica abutted the accreted margins of the Laurentian continental mass;
- The Alleghenian Orogeny in the Permo-Carboniferous, when the continent of Gondwana accreted onto and joined with Laurentia to form Pangea.

The latter phase is of minor importance in Matapedia and Gaspe. However, a fourth phase, known as the Salinian (Silurian in age) is interpreted to have been a significant tectonic event in this region.

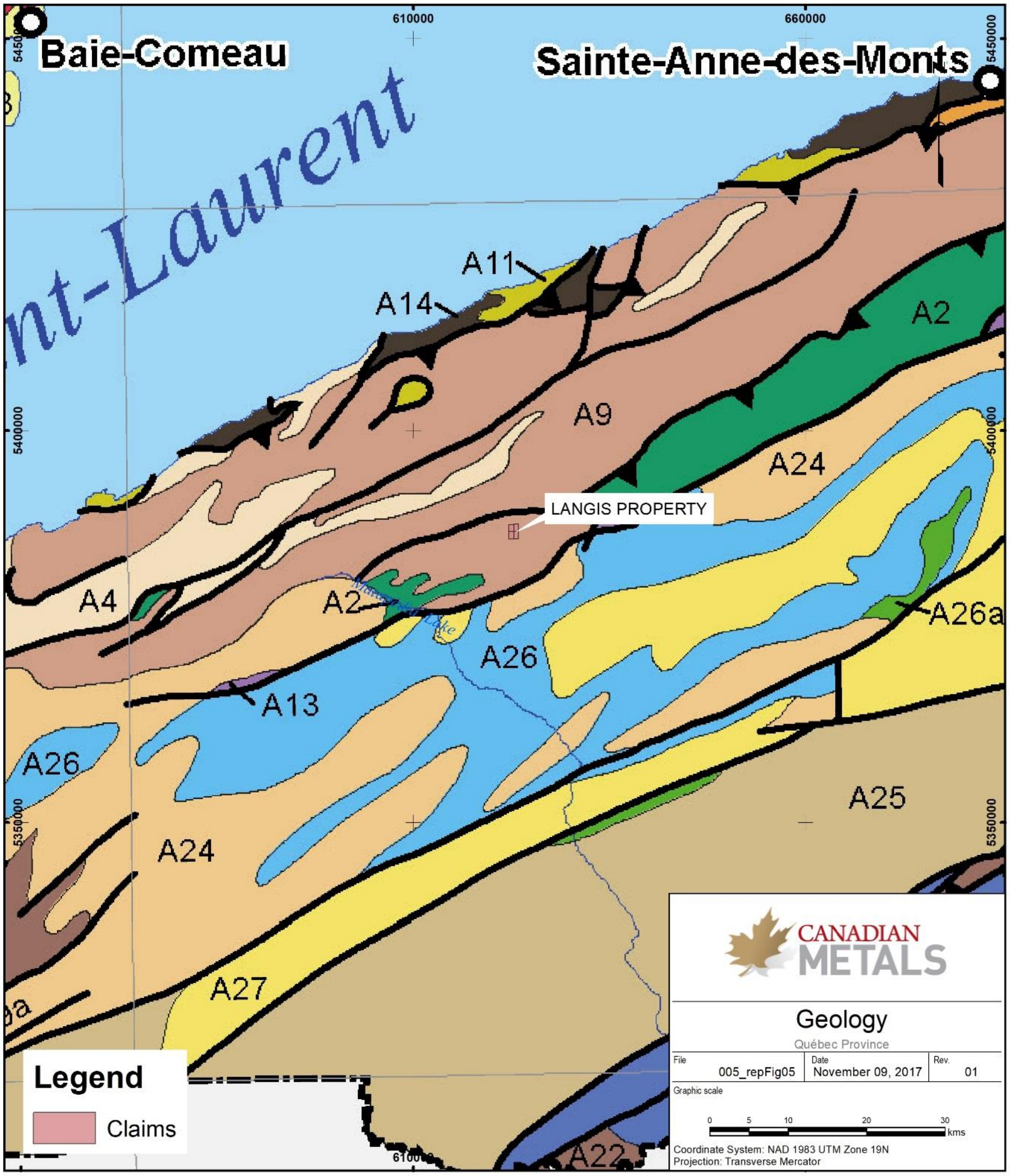
The CVGS rocks of Matapedia-Gaspe are of Ordovician-Silurian-Devonian ages (see Figure 12). They are comprised of wackes and conglomerates of the Cabano Group (Ordovician to Silurian in age), overlain by the Siluro-Devonian rocks of the Chaleurs Group, which are overlain concordantly to locally discordantly by Devonian limestones and sandstones of the Gaspe Group. The north contact of the CVGS is a discordant, tectonic contact with Cambro-Ordovician rocks to the north. Dominant structural features are kilometric, northeast-trending fold axes and major thrust faults.

The stratigraphy of the Chaleurs Group is, from bottom to top, the green shales of the Awantjish Formation, the white to pink quartz arenites of the Val-Brillant Formation, the limestones of the Sayabec Formation, and the mudstones and siltstones of the Saint-Leon Formation.

The Val-Brillant Formation forms two distinct north and south arms. The north arm, in which the Langis Property is located, extends 97 km from Mont Comi, just south of Mont-Joli, to Lac Matane. It is affected by thrust faulting and lateral faulting. The south arm is exposed along a 40-km strike length from Esprit-Saint and Grand Lac Neigette. Northeast-southwest oriented synclines and anticlines characterize this area.

The quartz arenites of the Val-Brillant Formation are highly siliceous. It appears as thick (up to several meters) white layers, and locally pink to purple layers which result from hematite discolouration. The grains are medium-fine, well-rounded, and welded together with silica cement (GM 57849). Total thickness is usually 40 to 60 meters. These highly siliceous sandstones constitute the exploration target at the Langis project.

Figure 12: Regional Geology Map showing the Position of the Property



Source: GoldMinds Geoservices Inc.

CIMA+ M03846C

7.2 Local Geology

In the area of the Property, the Siluro-Devonian Val-Brillant sandstones form a prominent remnant of a formerly more extensive sandstones cover. They average approximately 60 meters in thickness and sit conformably upon green shales of the Awantjish Formation, themselves overlying unconformably dolomitic claystones and calcilutites of the Ordovician Romieu Formation.

The Val-Brillant sandstone is conformably overlain by a 10-meter thick layer of arenaceous dolomites which transition into true dolomites at the top. These formations are interpreted to form the core of a shallow syncline that extends southeast to Lac Matapedia and is truncated to the northeast by the Shickshock Fault at the Matane River (ET 2003-01). The Val-Brillant sandstones are of multi-cyclic origins, having been derived from older sandstones situated to the north. They formed in a marine, well-oxygenated environment along an active but stable Silurian seashore.

Drilling by Uniquartz in 1982 and by Canadian Metals Inc. in 2013-15 defined a local stratigraphy of the Val-Brillant sandstones Formation in the Langis-Tessier area. Upper, Intermediate, and Lower sandstones are the most attractive units for industrial uses as they are all white to pale grey highly siliceous horizons with obviously low impurities. Descriptions from various Uniquartz and Canadian Metals drill logs and observations by Forbes, É. and Charlton, J. are as follows:

Upper Sandstone is pale greyish-white with local pink patches. It is fine grained and forms thin beds (maximum 0.6 meter) that are characterized by laminae and cross-bedding. The grey colour signifies higher clay content than that of the Intermediate Sandstone. It is 10-15 meters thick, absent in the Langis area.

Intermediate Sandstone is medium-grained, with well-rounded to subrounded grains and has a white sugary appearance. Finer grained layers are interstratified. Individual beds are up to 2 meters in thickness. Sporadic pink colouration is not necessarily indicative of an abundance of iron but is normally caused by occurrences of particles of hematite. Bedding planes and fractures are commonly marked by paper-thin layers of hematite. It is a 12-20 meters thick unit that is locally present in the upper parts of the Langis area.

Lower White Sandstone is generally fine-grained and exhibits less pink discolouration than the Intermediate Sandstone. It is comprised of sandstone beds from a few centimeters up to 0.5 meters in thickness. It is more compacted than the Upper and Intermediate Sandstones. In the Langis area, the Lower Sandstone is up generally around 20-22 meters but it is reported that locally, it may reach 60 meters in thickness where it abuts the east-west fault along the southern sandstone limit.

7.3 Geology of the Deposit

The Langis deposit is exposed in the contiguous Uniquartz quarry to the southwest. The quarry exposes a 20 to 30 meters thickness of Val-Brillant sandstones on its northeast wall forming a gently (-5° to -10°) south-dipping monocline. Sub-vertical faults cutting the sandstone strata-oriented N-S and NE-SW, the latter exhibiting near-horizontal slickensides (strike-slip faults) were observed by Forbes, É. and Charlton, J. in 2013.

Drilling in 2013, 2015, and 2017 by Canadian Metals enabled the construction of a geological model for the Langis deposits (Figure 13, 2013 & 2015 holes).

Holes 13-01, 13-07, 15-12, 15-18, and 15-21 reached the underlying Awantjish shales which constitute a good marker horizon.

From the Awantjish shales, the first Val-Brillant units are composed of impure, gray sandstones that grade into reddish sandstones. These impure units usually form a transition zone some 5-10 meters thick. Above that transition zone begin the Lower White Sandstones, mostly white, with minor amount of pink to red horizons.

Bedding observed in all holes indicate horizontal to gently dipping (3-10^0) units to the south. However, along any northwest-southeast section, one can see that the location or elevation of the Awantjish Formation shales is not coherent with a regular 5-100 dip to the south. Irregularities observed in the trace of this marker horizon from the northwest to the southeast are explained by vertical displacement along thrust faults. These interpreted structural zones have been traced from one section to another and appear to be consistent. They are either single faults or closely spaced faults systems striking NNE and dipping steeply to the south. Movement along these fault zones is west block up relative to east block.

The thickness of the Lower White Sandstone gradually increases from around 15 meters to the northwest to 30-35 meters to the southeast, a combination of the topography with the fact that dip of the unit is 5-10° to the south. In the southeast part of the deposit, the Lower White Sandstone becomes overlain by two younger sandstone units. First, the Red Bedded Sandstone forming a horizon between the Lower and Intermediate sandstones start to outcrop. Farther southeast, after gradually reaching some 15 meters thick, the Red Bedded Sandstone itself becomes overlain by the Intermediate Sandstone. Currently, the Langis deposit is considered to be the part of the Lower Sandstone, which either outcrops or is covered by a relatively thin, removable Red Bedded Sandstone cover that is considered as waste material.

7.4 Mineralization

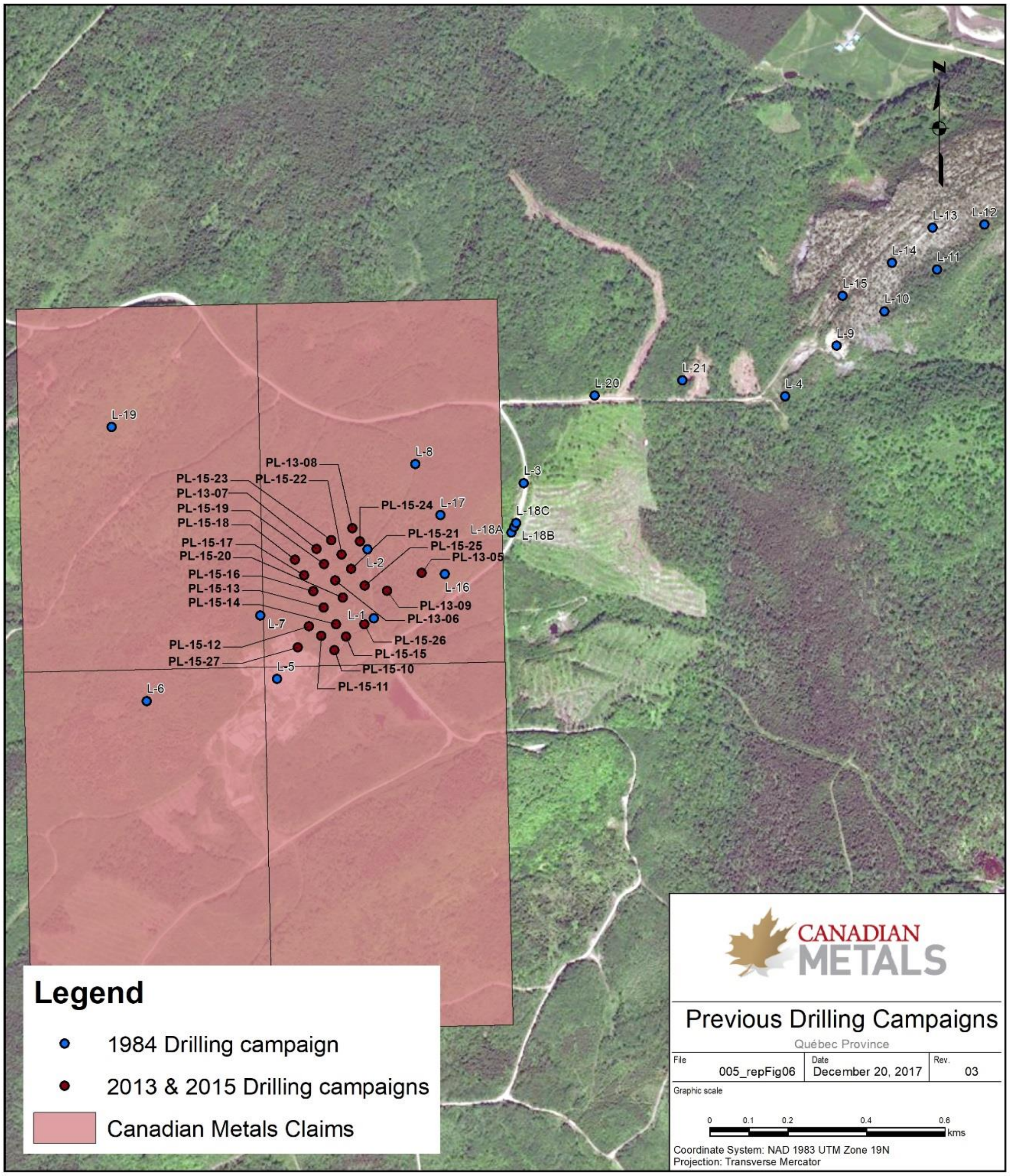
Mineralization at Langis is defined as sandstones that meet the chemical and physical specifications to produce lump silica suitable for a ferrosilicon plant or smelter grade silicon. Physical tests done earlier by Uniquartz and more recently by Canadian Metals have confirmed that the Langis sandstones have the characteristics of an acceptable feed for a ferrosilicon plant.

In 2016, preliminary specifications were given by Viridis.IQ for the study, a consultant specialized in ferrosilicon and silicon projects. The term “mineralization” at Langis will therefore be applicable to sandstone material whose chemical characteristics are within the specifications in the following table, unless indicated differently.

Table 14: Preliminary Raw Material Specification for FeSi Quartz

Parameter	Units	Typical	Range
SiO_2	wt%	98.4	>97.7
Al_2O_3	wt%	0.45	<1.00
Fe_2O_3	wt%	0.13	<0.20
CaO	wt%	0.03	<0.25
MgO	wt%	0.11	<0.25
TiO_2	wt%	0.06	<0.10
K_2O	wt%	0.1	<0.40
Na_2O	wt%	<0.01	<0.20
MnO	wt%	<0.01	<0.02
P	wt%	<0.01	<0.02
LOI	wt%		<0.25
Moisture	wt%	1	<3
Physical Properties			
Specific Density	mt/m^3	2.6	
Bulk Density	mt/m^3		1.5-1.7
Angle of Repose	°		30-40
Particle Size Distribution			
Overall	mm	25-100 (>98%)	
-25	%	Not determined	
+100	%	Not determined	
Stability			
Basic Mechanical	Must pass one of the commonly used test methods		
Thermal Shock	Must pass one of the commonly used test methods		

Figure 13: Location of 1984, 2013, and 2015 Drilling Campaigns



Source: GoldMinds Geoservices Inc.

The sandstone presents iron spots in irregular shape and size with variable distribution, three of the typical facies are shown in the picture below with a high-purity piece (see following picture). Even if the rock seems to have a high iron content, these iron oxide spots do not represent a high weight in the sample.

The author believes these iron oxydes spots and stains are associated with the formation of the sandstone and represent agglomeration of iron and replacement of organic matters as well as oxidation of the original iron rich minerals within the sandstone.

Figure 14: Typical Sandstone Mineralization of Langis

Source: GoldMinds Geoservices Inc.

8. Deposit Types

Portions of this section were summarized from previous reports after validation of accuracy.

8.1 General

Siliceous sediments form on the shallow continental shelf and in inland seas or large lacustrine basins with a relatively low-energy environment and a steady supply of well-sorted silica sand.

The source area has to be rich in siliceous sedimentary, igneous, or metamorphic rocks to provide a steady supply of well-sorted and weathered clastic material to estuaries along the shoreline. Weathering conditions before and during transportation should be able to separate resistant silica from less stable feldspars, hornblende, and pyroxenes, and transportation will separate the clay minerals and mica with heavy minerals from the silica particles. Silica-rich sediments typically have uniform grain size, may be well lithified or friable, and can be layered, cross bedded, or massive beds. After deposition, the accumulated sediment will be cemented by compaction, a minor clay component, or introduced secondary silica. The siliceous sediments occur as meters thick beds that can extend more than tens of kilometers.

Each use has its very specific requirement for the particle size and shape, physical strength, and permissible amounts of different impurities. For lump silica, the concerns are purity, sizing of crushed rock (fracture and bedding density), thermal shock resistance, and contamination by Ca, Fe, Mn, Ti, Al, Na, and K minerals or graphite. Generally, worldwide, silica contents have to be 98% with significant impurities removable by processing.

8.2 Quebec Deposits

In the province of Quebec, silica deposits can be grouped in three categories: the sandstones, the quartzites, and quartz veins. The Langis deposit belongs to the first category.

Four different sandstones formations have been recognized in Quebec to meet the requirements for different uses in the silica industry.

8.2.1 The Cairnside Formation

The Cairnside Formation is a sandstone unit located in the upper part of the Cambrian Potsdam Group at the base of the Saint-Lawrence Lowlands formations. It outcrops both on the south and north shore of Montreal. It is composed of medium-sized quartz grains accumulated as massive beds totalling up to 30 meters thick. This pure quartzitic sandstone unit has been the source material particularly for the glass industry. A typical analysis of this formation gives 98.5-99.2% SiO_2, 0.30% Al_2O_3, and 0.10% Fe_2O_3 (ET 99-04).

Because of its proximity to the Montreal industry and markets, many quarries have been opened within the Cairnside Formation; Unimin and Sainte-Scholastique on the north shore; Chromasco (ferrosilicon), Schink, Arcoite, E. Montpetit, Radius, Ste-Chlothilde, and En-Ola on the south shore.

8.2.2 The Guigue Formation

The Guigue Formation is Ordovician sandstone located in western Quebec and Ontario in the lake Temiscamingue area where it outcrops along the shore. The formation lies unconformably on the Precambrian rocks. It is composed of a 30 meters thick sequence that includes a conglomeratic unit at the base, fairly pure sandstone in the middle and calcitic-to-dolomitic sandstone at the top.

The median sandstone is a poorly consolidated unit composed of fine to large and rounded quartz grains with an argillaceous to dolomitic cement.

Two quarries have extracted material: the Saint-Bruno-de-Guigue quarry with a sandstone analysis of 97.0% SiO_2, 1.75% Al_2O_3, and 0.18% Fe_2O_3, used in filtration, sandblasting, and horticulture; and the Joannes quarry with material analyzed at 96.1% SiO_2, 2.67% Al_2O_3, and 0.34% Fe_2O_3, used as flux for the Noranda foundry during the seventies.

8.2.3 The Kamourasaka Formation

The Kamouraska Formation is an early Ordovician formation of the Trois-Pistoles Group that can be traced from Montmagny (east of Quebec City) up to the Gaspe Peninsula. This pale grey quartzitic sandstone forms northeast-trending ridges that are well exposed, particularly east of Rimouski.

The sandstone is composed of mostly fine rounded quartz grains and silica cement. Layers are some five meters thick and the unit can reach a total thickness of some 60 meters. Sampling by Tifane (1975) indicated that the average composition of the formation was 95.5-98.5% SiO_2, 0.46-1.44% Al_2O_3, and 0.56% Fe_2O_3.

Quarries are known to have been developed in the Kamouraska Formation to extract material for aggregates and rock fill. The most important was the Grande-Vallée quarry in the Murdochville area, where the sandstone was used as flux for the Noranda smelter.

8.2.4 The Val-Brillant Formation

The Val-Brillant Formation has been described in section 7 since it hosts the Langis Property. Over the years, exploration on the Val-Brillant Formation led to the discovery of many favorable areas for pure sandstones. These are referred to as the Tessier, Colline de la Tortue, Saint-Tharcisius, Awantjish, and Fleuriau deposits. No production is reported from these sites.

From the above, we can see that several of the province’s deposits have the characteristics needed for uses in the silica industry. Substantial production has resulted when the quarry is directly linked to a major industrial project (e.g., flux agent for a foundry). The absence of a major industrial project in the Rimouski area is the main reason that the Val-Brillant deposits have never been quarried.

9. Exploration

In the last decade, Canadian Metals Inc. has completed prospecting, mapping, and sampling along with three drilling programs on the Langis Property. The first drilling program in 2013 (see section 10) was a reconnaissance program designed to validate the Uniquartz global interpretation of the deposit and to collect material for metallurgical testing.

Nine whole core samples from the drill holes and three block samples collected from the wall of the quarry were provided for the thermal shock testing. The three block samples for thermal shock tests were located some 180 meters south-southwest from diamond drill hole PL-13-01. More details on the sampling and test results are available in the 2013 report for the Langis Property. The conclusions of these tests are presented in section 24 of the PEA 2016 report and prove the material at Langis to have low decrepitation under thermal shock.

The second drilling program took place in June 2015. The objective of the 2015 drilling program was to increase the level of confidence in the deposit with infill holes in order to estimate the resources. A total of 18 holes totaling 701.6 meters were drilled.

Finally, a third drilling program took place in June and July 2017. During this recent drilling campaign, 16 holes were drilled for a total of 526.64 meters.

10. Drilling

Portions of this section were summarized from previous reports after validation of accuracy and the 2017 drilling information was added afterward.

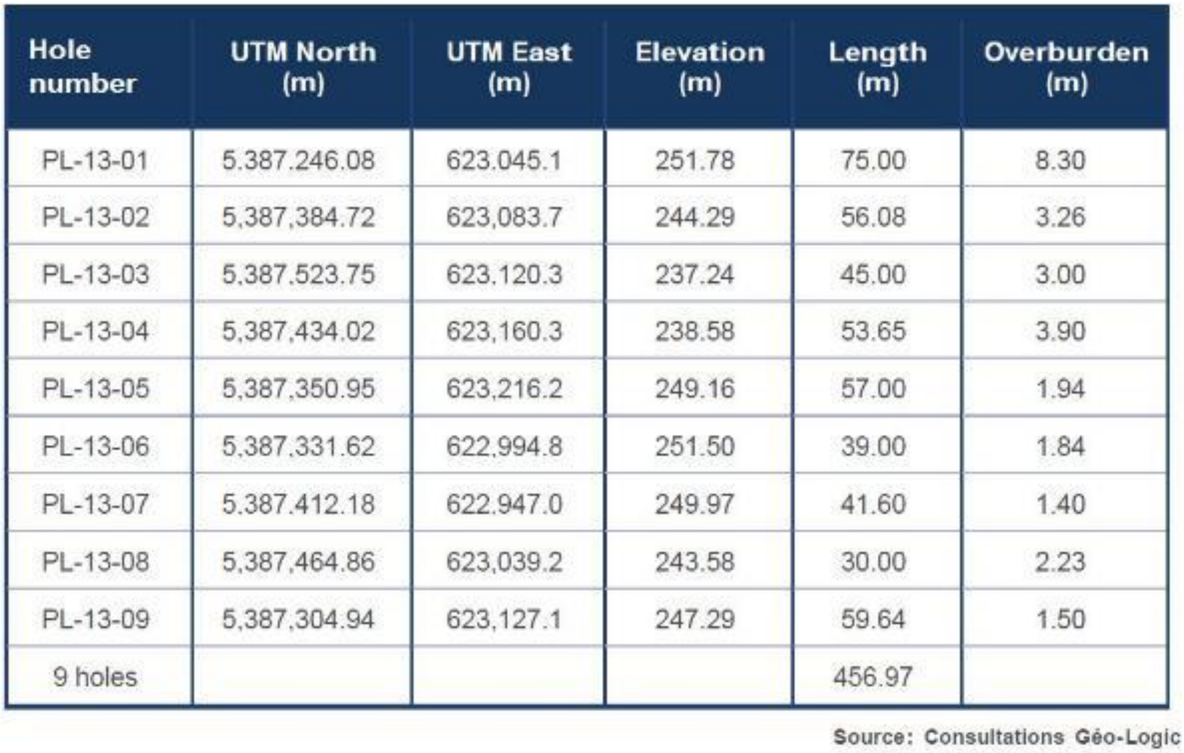
Since the historical drilling completed in 1982 by Uniquartz and described in section 6 (History), three additional drilling programs were carried out by Canadian Metals Inc. in 2013, 2015, and 2017. Figure 15 below presents the image of the refereed drill holes.

10.1 The 2013 Drilling Program

The first drilling program by Canadian Metals Inc. conducted on the Property had one principal objective: to obtain a representative bulk sample of quartzitic sandstone for petrological and metallurgical characterization. Les Forages Dibar Inc. / André Roy from Ste-Anne-des-Monts, Quebec, was commissioned to drill nine NQ diamond drill holes. This program was performed from September 16th to 20th, 2013. Drilling sites were first located with a handheld GPS with ±5 m accuracy and were more precisely surveyed at the end of the program. In total, nine diamond holes were drilled for 456 meters. The drill pattern consisted of three sections with three holes per section. The lines and holes were spaced at approximately 100 m. The area tested consisted of a 200 x 200 m^2, or four (4) ha.

All holes were drilled vertically to allow intersection of the geological units at a high angle and thus obtaining sample length very close or equal to true thickness. The 2013 holes locations are shown in Figure 15 below. The program successfully recovered core from the entire local stratigraphy. As discussed in section 7.2, the local geology was found to be constituted, from bottom to top, by argillite/mudstone, followed by a 15-meter thick transitional zone comprising impure gray and pink to red sandstones. This is overlain by the pure white Lower Sandstones which ranges from 15 to 35 meters thick. This formation outcrops in some parts of the drilling area, for example around holes 13-06, 07, and 08. East of that area, a pinkish to red sandstone some 15 meters thick, and the first layers of the Intermediate sandstone overlay the Lower Sandstone. Only parts of the core were analyzed. Table 15 and Table 16 summarize the 2013 drilling program and the core sections analyzed.

Table 15: Summary of the 2013 Drilling Program



Hole number	UTM North (m)	UTM East (m)	Elevation (m)	Length (m)	Overburden (m)
PL-13-01	5.387.246.08	623.045.1	251.78	75.00	8.30
PL-13-02	5,387,384.72	623,083.7	244.29	56.08	3.26
PL-13-03	5.387.523.75	623.120.3	237.24	45.00	3.00
PL-13-04	5,387,434.02	623,160.3	238.58	53.65	3.90
PL-13-05	5,387,350.95	623,216.2	249.16	57.00	1.94
PL-13-06	5.387.331.62	622.994.8	251.50	39.00	1.84
PL-13-07	5.387.412.18	622.947.0	249.97	41.60	1.40
PL-13-08	5,387,464.86	623,039.2	243.58	30.00	2.23
PL-13-09	5,387,304.94	623,127.1	247.29	59.64	1.50
9 holes				456.97	

Source: Consultations Géo-Logic

Table 16: Core Sections analyzed in the 2013 Drilling Program

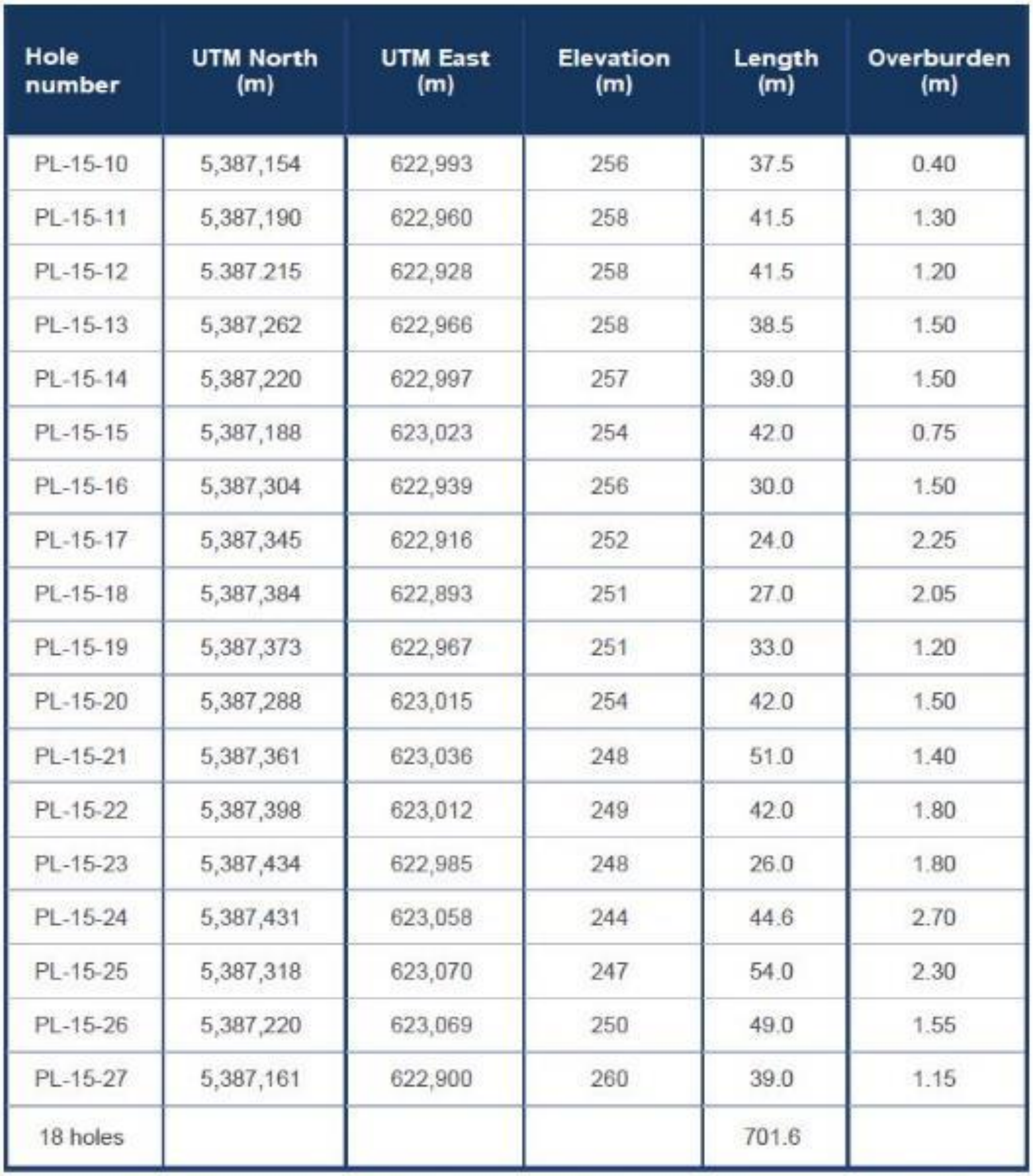
Hole number	From (m)	To (m)	Length (m)	SiO_2 (%)	Fe_2O_3 (%)	Al_2O_3 (%)
PL-13-01 incl. Incl.	12.10 14.30 14.30	41.05 32.00 23.00	28.95 17.70 8.70	98.69 99.05 99.22	0.15 0.12 0.11	0.42 0.28 0.23
PL-13-02 incl.	10.80 10.80	51.00 33.00	40.20 22.20	98.72 99.15	0.13 0.08	0.48 0.29
PL-13-05 incl.	2.00 32.00 32.00	9.00 53.30 44.00	7.00 21.30 12.00	99.10 99.09 99.33	0.07 0.08 0.06	0.37 0.32 0.24

Source:Consultations Géo-Logic

10.2 The 2015 Drilling Program

The second drilling program was completed between June 1st and 22nd, 2015. The drilling contract was again awarded to Forage Dibar / André Roy. This time, the objective was to reduce the drilling pattern and concentrate on a promising part of the deposit in order to estimate the resources for at least a part of the drilling area. NQ vertical holes were drilled on an approximately 50-meter grid. In total, 18 holes were drilled, totaling 701.6 meters, adding to the nine previous 2013 nine holes (see following Table 17). Holes were located with a handheld GPS with ±5 m accuracy. The total area investigated is 350 meters by 400 meters and covers approximately 8.5 ha.

Table 17: Summary of the 2015 Drilling Program



Hole number	UTM North (m)	UTM East (m)	Elevation (m)	Length (m)	Overburden (m)
PL-15-10	5,387,154	622,993	256	37.5	0.40
PL-15-11	5,387,190	622,960	258	41.5	1.30
PL-15-12	5.387.215	622,928	258	41.5	1.20
PL-15-13	5,387,262	622,966	258	38.5	1.50
PL-15-14	5,387,220	622,997	257	39.0	1.50
PL-15-15	5,387,188	623,023	254	42.0	0.75
PL-15-16	5,387,304	622,939	256	30.0	1.50
PL-15-17	5,387,345	622,916	252	24.0	2.25
PL-15-18	5,387,384	622,893	251	27.0	2.05
PL-15-19	5,387,373	622,967	251	33.0	1.20
PL-15-20	5,387,288	623,015	254	42.0	1.50
PL-15-21	5,387,361	623,036	248	51.0	1.40
PL-15-22	5,387,398	623,012	249	42.0	1.80
PL-15-23	5,387,434	622,985	248	26.0	1.80
PL-15-24	5,387,431	623,058	244	44.6	2.70
PL-15-25	5,387,318	623,070	247	54.0	2.30
PL-15-26	5,387,220	623,069	250	49.0	1.55
PL-15-27	5,387,161	622,900	260	39.0	1.15
18 holes				701.6	

Source Consultations Géo-Logic

10.3 The 2017 Drilling Program

The 2017 drilling program was completed by GMG between June and July 30, 2017. The drilling was executed by Forage André Roy Inc. and supervised by GMG qualified personal.

This time, the program had three objectives:

- Convert the Inferred to Measured and Indicated to enable preparation of a PFS;
- Extend the resources of the deposit and increase knowledge of deposit geology;
- One specific aspect was the determination of the extent of iron migration along modelled faults and measure the impregnation extent along them.

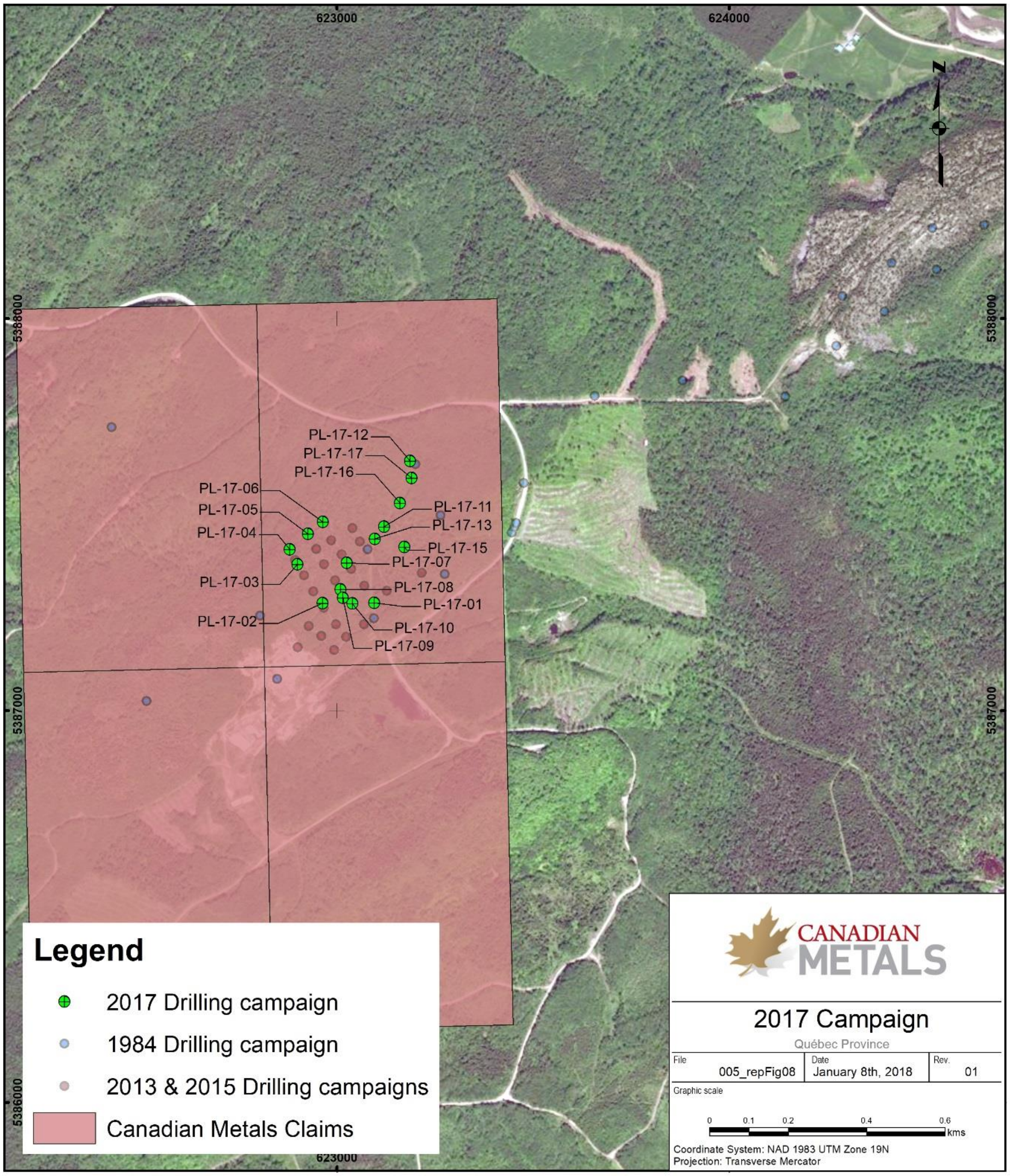
The objectives were met with increase in confidence and grade continuity, the model was extended, and impregnation along these faults is very limited as proven by drill holes drilled at 45 degrees across.

Hole location was surveyed initially with hand-held GPS and holes were surveyed with a total station afterward.

NQ vertical and inclined holes were drilled on an irregular pattern. In total, 16 holes were drilled, totaling 526.64 meters, adding to the previous 27 holes. Following the drilling campaign of June and July, holes were located with a total station in August 2017.

The following map presents drill hole collar location.

Figure 15: Drill Hole Position 2017



Source: GoldMinds Geoservices Inc.

Table 18: Summary of the 2017 Program

Name	UTM North (m)	UTM East (m)	Elevation (m)	Azimuth (°)	Dip (°)	Length (m)
PL-17-01	623090.7	5387270	247.45	313.88	-81.13	45
PL-17-02	622961	5387272	257.63	130.48	-59.97	24.53
PL-17-03	622892.2	5387375	251.05	103.33	-65.79	24
PL-17-04	622877.9	5387410	249.93	-	-90	30
PL-17-05	622925.2	5387444	248.4	-	-90	28.5
PL-17-06	622967	5387478	244.32	-	-90	30
PL-17-07	623024.5	5387374	247.84	118.16	-53.99	20
PL-17-08	623012.7	5387292	253.58	-	-90	23.2
PL-17-09	623013.3	5387288	253.81	325.09	-57.23	24
PL-17-10	623033	5387276	252.43	-	-90	33
PL-17-11	623126.4	5387472	238.29	129.28	-43.86	42
PL-17-12	623190.7	5387641	225.81	-	-90	30
PL-17-13	623093.7	5387434	241.5	-	-90	45
PL-17-15	623171.4	5387415	239.04	-	-90	38.11
PL-17-16	623163.2	5387528	232.79	-	-90	45.03
PL-17-17	623190	5387593		290	-45	44.27
16 holes						526.64

Source: GoldMinds Geoservices Inc.

11. Sample Preparation, Analyses, and Security

11.1 Sample Preparation, Analyses, and Security

The sampling approach was discussed with Mr. Claude Duplessis, P. Eng., as part of the evolution of the drilling program. All core logging was performed by Ms. Isabelle Hébert, Jr. Eng., at the temporary core shack located at the office (2999, Sainte-Foy road, Quebec City) following procedures further described herein.

At reception, all core boxes were stored at the office. Prior to drilling on site of Langis Property, an authorization for storage and set-up of a core shack has been officially requested to the *Ministère de l'Énergie et des Ressources naturelles* (MERN), but not received on time. As the project was moving forward, it was decided that a temporary core shack would be erected in the parking lot of the GMG office. A 14-ft cube truck was secured and used as a core shack for the duration of the logging. For this purpose, all core boxes were progressively opened and placed in order on the logging table. All meterage wood blocks were verified to control core box numbers and any possible mistakes made during drilling procedures.

Then, start and end intervals of core inside each core box were measured and recorded on a Microsoft Excel® sheet for future reference. All core boxes were tagged with an aluminum tape marked with the hole and box numbers with start and end intervals.

Logging procedures included a mineral description of geological units and subunits in terms of colour, grain size, bedding angle to core axis, alteration, accessory minerals, and fracture angle to core axis. The recovery and Rock Quality Designation (RQD) were measured. This descriptive data were entered in the Microsoft Excel® sheet at the temporary core shack.

Finally, pictures of each individual core boxes were taken, one with dry core and the second slightly damp.

As the entire materiel drilled during the 2017 campaign would be analyzed, it was decided that sample length would be one (1) meter. Samples were started after the overburden or noticeable low-grade silica material, i.e. three (3) meters measured from the beginning of every hole for casing installation. Rock in casing was recovered but not assayed. Very little overburden is present at Langis.

Numbered sample tags were placed at the beginning of each sample, together with distinctive arrows on the core marking the beginning and end intervals. Marks were made to divide the core in two distinctive but representative halves along an axis as an indication for where to cut.

No aspect of sample preparation was conducted by an employee, officer, director, or associate of Canadian Metals Inc.

11.2 Sample Presentation

All core samples received from 2017 drilling program were cut in half along the long axis by a hydraulic-powered core splitter. Half of the core sample was retained and placed back in the core box, respecting the original orientation and position. Sample tags were stapled to the bottom of the core tray at the start of each sample, so that each sample could be relocated following future handling, transportation, and storage (Figure 16).

A total of 517 samples totalling 478 meters of core were prepared. Unfortunately, seven (7) samples were lost in shipping due to damaged wood crate, and five (5) were ripped off (at reception of SGS Lakefield laboratory); further inquiry did not allow to retrieve them, and hole was not resampled. These samples were from the bottom of one hole. The 517 samples include 39 standards and 466 core samples. This length represents 90.8% of the total core length, which reaches 526.64 meters.

All samples were securely bagged and closed with plastic zip-ties in translucent bags before being placed, by group of six or seven, in larger Fabrene bags (rice bags, see Figure 17). These second bags were also secured with plastic zip-ties prior to shipment. All the shipment data, including sample numbers, hole names attached to it, and Fabrene bag numbers, were entered in Microsoft Excel® sheet.

All rice bags were dispatched in two shipments and shipped by Groupe Guilbault directly from the office located in Quebec City to the SGS Minerals Services geochemistry laboratory (SGS laboratory) in Lakefield, Ontario.

The sample submittal forms were included in email informing the laboratory of the date and method of expedition of both shipments.

First shipment arrived to SGS laboratory damaged. One of the Fabrene bags has been ripped open and five of the six samples included in that bag could not be analyzed due to this incident. In Quebec City, the core boxes of that specific hole were reopened, and core were split again to ship a quarter as new samples in a third shipment to SGS laboratory in Lakefield, Ontario.

All other samples were received in good standing by the laboratory.

Figure 16: Sample cut and placed in Plastic Bag with Tag

Source: GoldMinds Geoservices Inc.

Figure 17: Rice Bags filled with Samples and placed in larger Handmade Wood Box in order to be transported to the Laboratory

Source: GoldMinds Geoservices Inc.

11.3 Analyses

Upon receipt of our samples, SGS laboratory employees proceeded with the following preparation procedures:

- Bar code labels were attached to every sample bag. This bar code is used to compile information, from sample preparation to storage;
- Samples were dried at a temperature of 105°C (DRY11) in gas-heated forced air furnaces. According to the laboratory, this method of drying does not affect the sample because volatile elements are not lost at this temperature;
- Samples were crushed in a jaw crusher to obtain 75% of passing 2 mm particles (CRU22). The jaw crusher is cleaned after every sample.

A fraction of the sample (up to 250 g) was split by a riffle splitter and pulverized to obtain 85% passing 75 µm particles (PRP89). At first, crushed samples were added to a standard mild steel bowl and subjected to centrifugal force by mechanical action. The sample is subject to considerable grinding action by a puck and/or ring(s) that are free to move inside the bowl, resulting in a very fine sample. This first standard ferrochromium bowl was used regardless of GMG's instruction for analysis of the samples for high-purity silica (there was a misunderstanding with the lab and administration of the lab). In order to supress the iron contamination during laboratory sample preparation, all the process of pulverization was repeated with a tungsten carbide bowl from the rejects. Main contamination of this second bowl selection can result in addition of mainly tungsten. As the tungsten is absent from the primary rock sample, it is easy to demonstrate possible laboratory contamination. This has caused delays in preparation of the mineral resource update.

Assays were performed by X-ray fluorescence (GO XRF76V). Fusion is the industry-standard sample preparation technique employed and involves melting the sample with flux and casting it into a glass disc. The XRF has been used to analyze thirteen (13) elements in sample: Al_2O_3, CaO, Cr_2O_3, K_2O, MgO, MnO, Na_2O, P_2O_5, Fe_2O_3, SiO_2, TiO_2, and V_2O_5.

GMG inserted a custom-made standard between intervals of approximately ten (10) samples. The custom standards were prepared using approximately 500 g of pool filter sand in translucid bags identified per their own sample tags.

Lakefield SGS laboratory is accredited to the ISO/IEC 17025:2005 standard for these in-house methods. In addition, SGS Lakefield laboratory participates in SGS's internal PT program which holds accreditation to the conformity assessment standard ISO 17043: General Requirements for Proficiency Testing. Every month, subsamples of reference materials and various mineral product, prepared and packaged by LQSi, are submitted to laboratories. The results of analyses are collected and reported to the program. To ensure compliance with this system, laboratories that perform poorly are subjected to a rigorous internal audit to undertake corrective actions.

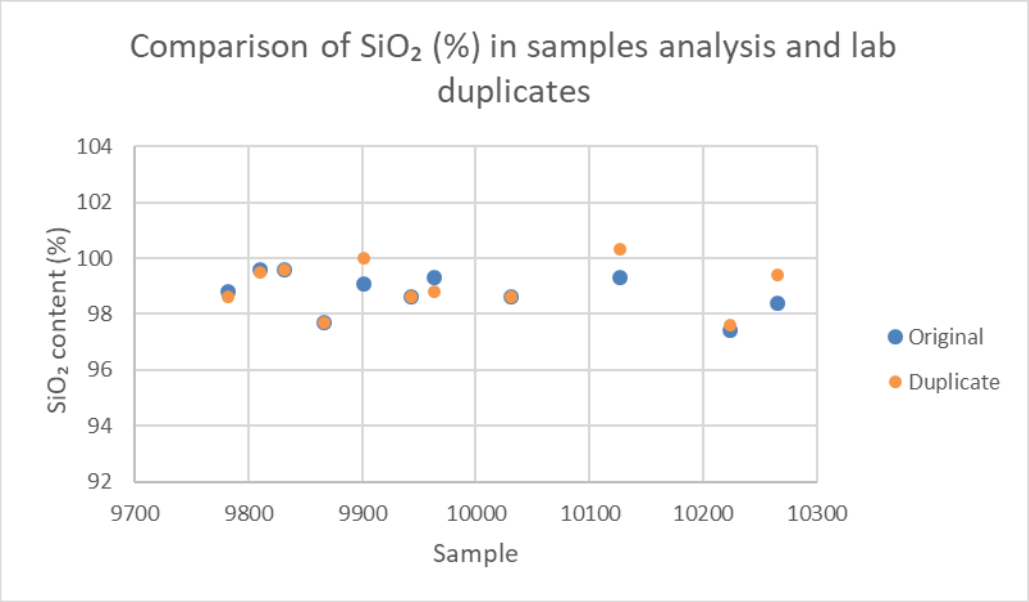
11.4 Laboratory QA/QC

SGS's analysis protocol includes inserting its own check samples at a frequency of 14% in the assay batch. The check samples for exploration grade samples include sample reduction blanks and re-assays (duplicates), method blanks, weighed pulp replicates, and reference materials.

11.5 Re-Assays (Duplicates)

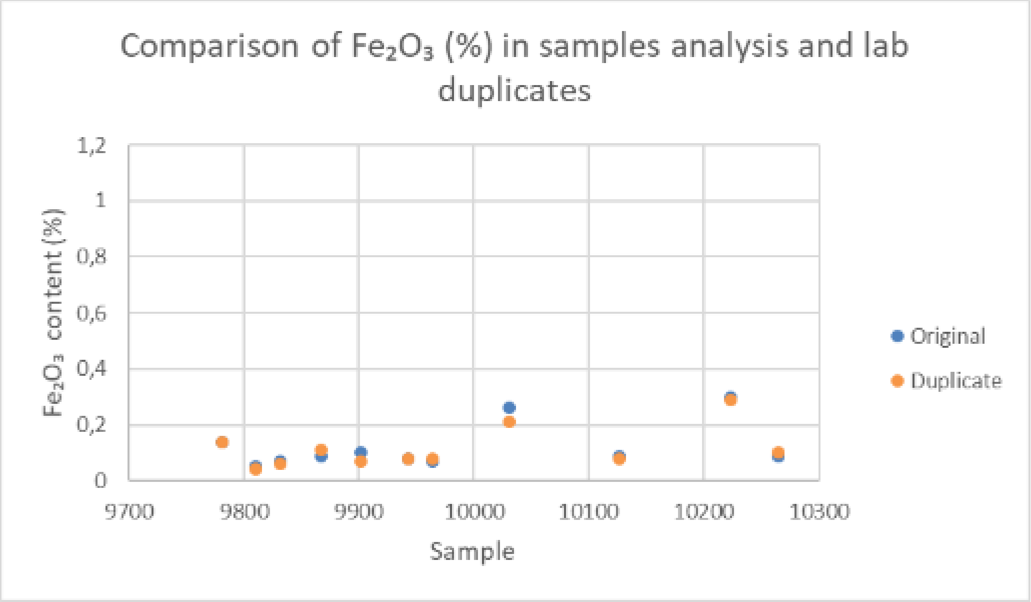
SGS's protocols include reanalyzing samples at a regular interval to confirm that the samples are homogeneous, preparation process is performed properly, and that there is no sample cross contamination. A total of eleven (11) samples were thus analyzed twice. Figure 18 and Figure 19 indicate very weak variation of two different oxides in each sample (blue dot) versus the duplicate one (orange dot). The percentage of SiO_2 is the oxide that seems to be most variable, but it generally maintains the same pattern. These results show there are some variations but stay within an acceptable range as high grade is still high grade and considered reliable.

Figure 18: Comparison of SiO_2 (%) in Samples Analysis and Lab Duplicates



Source: GoldMinds Geoservices Inc.

Figure 19: Comparison of Fe_2O_3 (%) in Samples Analysis and Lab Duplicates

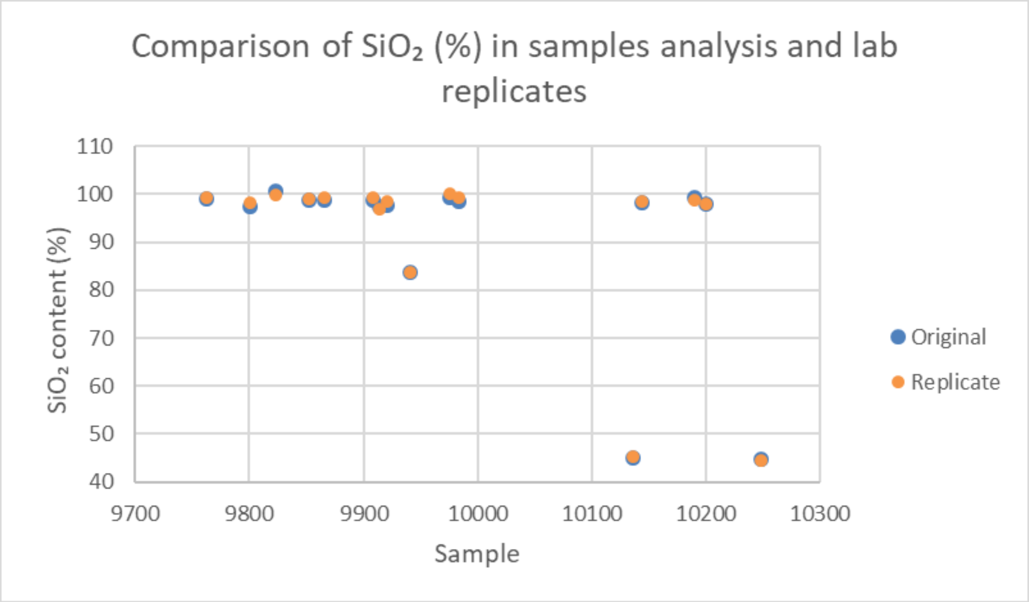


Source: GoldMinds Geoservices Inc.

11.5.1 Laboratory Replicates

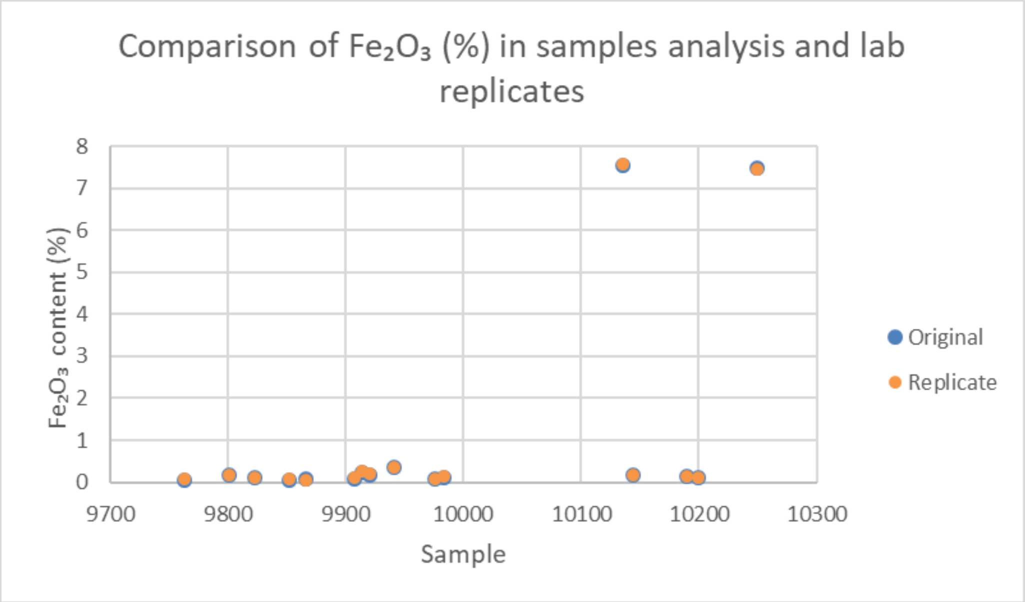
SGS's protocols include analyzing weighed replicates that are added randomly to each sample batch. A total of 16 replicate samples were analyzed. The replicate is used to confirm that the pulverized sample is homogeneous and that there is no sample cross contamination. Figure 20 and Figure 21 indicate very weak variation of two different oxides in each sample (blue dot) versus in the duplicate one (orange dot). These results clearly confirm that samples are homogeneous, and no contamination occurred during any of the steps—from sample preparation to analysis, from the laboratory point of view.

Figure 20: Comparison of SiO_2 (%) in Samples Analysis and Lab Replicates



Source: GoldMinds Geoservices Inc.

Figure 21: Comparison of Fe_2O_3 (%) in Samples Analysis and Lab Replicates



Source: GoldMinds Geoservices Inc.

11.6 Independent QA/QC

In addition to laboratory check samples, GMG inserted one type of independent check samples. The following describes the results obtained from these standards.

11.6.1 Standard Samples

A total of 39 standard samples were inserted into the sample batch during core sampling and preparation. Standard samples consisted of fine-grained pool filter sand which is dry silica sand. Approximately 500 g of pool filter sand were poured in translucent bag closed by a plastic zip-tie.

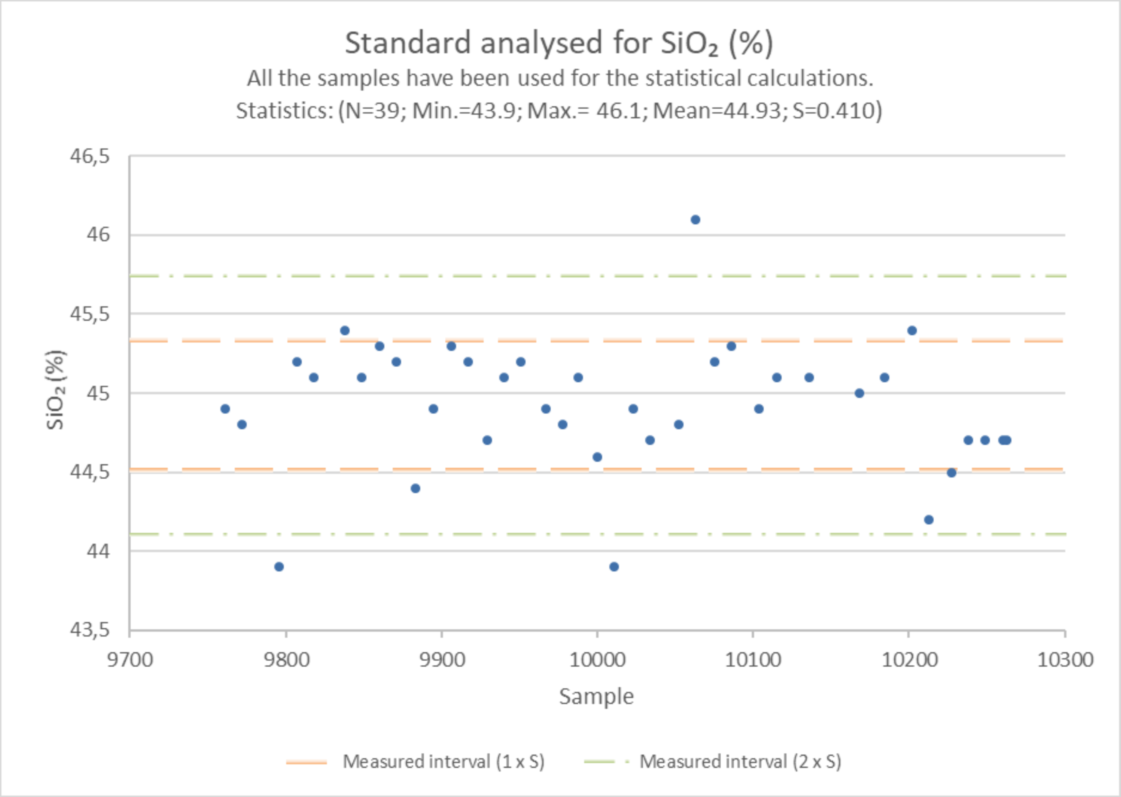
Figure 22 below reports the percentage of SiO_2 variation in the 39 samples. It can be observed on the chart that most of the samples are inside the second standard deviation, except for three samples (9796, 10011, and 10063) which are nevertheless very close to the second standard deviation. This standard was not certified and homogeneous and was basically inserted to validate grades and possible mix-ups at the lab which did not happen.

Based on these results, it can be considered that SGS's assay method was accurate from the beginning of the second analyses using the right method to avoid any form of iron contamination until the end of the project.

11.7 Adequacy

According to what was done at all stages of the program, Mr. Claude Duplessis, P. Eng., GMG, firmly believes that sampling preparation, security, and analytical procedures meet industry standard and are therefore reliable.

Figure 22: Percentage of SiO_2 in the independent Standard Samples



Source: GoldMinds Geoservices Inc.

12. Data Verification

Portions of this section were summarized from previous reports after validation of accuracy with complement of 2017.

12.1 The 2013 and 2015 Drilling Programs

12.1.1 Controls and Verification Measures

All Canadian Metals 2013 and 2015 geological data were collected and verified by Mr. Alain Tremblay. The author has reviewed the work and measures taken and considers them adequate for the industry standards.

12.1.2 Limitation of Data Verification

Assays performed by CTMP Laboratory in 2013 on diamond drill holes PL-13-01, 02, and 05 were not re-assayed by ALS Chemex; however, the standards used in the two programs were the same. The authors believe the 2015 and 2013 data are reliable and representative of the mineralization on the Langis Property. The precision obtained and verified by the QA/QC program for the silica content and impurities at Langis confirms that specifications are met for the material to be used as a source for ferrosilicon. Table 19 shows only minor discrepancies between assays from one laboratory to the other, which means that data from both programs can be used together in the present resource calculation.

12.1.3 Author's Opinion on the Adequacy of the Data

The authors believe the 2015 and 2013 data are reliable and representative of the mineralization on the Langis Property. The precision obtained and verified by the QA/QC program for the silica content and impurities at Langis confirms that specifications are met for the material to be used as a source for ferrosilicon.

Table 19: Standards analyzed by STMP and ALS Chemex

Lab.	DDH	Sample #	Name	Al2O3	CaO	Fe2O3	K2O	MgO	MnO	Na2O	SiO2	TiO2
				%	%	%	%	%	%	%	%	%
CTMP	PL-13-01	P179760	sil	0.42	0.02	0.16	0.05	0.08	0.01	0.03	98.83	0.06
CTMP	PL-13-02	P179784	sil	0.45	0.02	0.11	0.05	0.08	0.01	0.04	98.83	0.06
CTMP	PL-13-02	P179775	sil	0.44	0.03	0.09	0.05	0.09	0.01	0.04	98.70	0.06
CTMP	PL-13-05	P179791	sil	0.39	0.02	0.11	0.05	0.08	0.01	0.04	98.92	0.05
Avg				**0.43**	**0.02**	**0.12**	**0.05**	**0.08**	**0.01**	**0.04**	**98.82**	**0.06**
ALS	PL-13-06	P179612	SL1	0.41	0.01	0.13	0.05	0.11	0.01	0.01	98.63	0.06
ALS	PL-13-07	P175662	SL1	0.41	0.02	0.16	0.06	0.11	0.01	0.02	98.77	0.07
ALS	PL-13-08	P179621	SL1	0.45	0.02	0.15	0.06	0.11	0.01	0.01	98.99	0.07
ALS	PL-15-10	R143760	SL1	0.42	0.02	0.15	0.05	0.08	-0.01	0.02	98.36	0.06
ALS	PL-15-11	R143775	SL1	0.43	0.02	0.14	0.05	0.12	0.01	0.01	98.74	0.06
ALS	PL-15-13	R143816	SL1	0.44	0.02	0.16	0.06	0.12	-0.01	0.01	98.89	0.07
ALS	PL-15-15	R143858	SL1	0.42	0.02	0.14	0.06	0.13	0.01	-0.01	99.32	0.06

ALS	PL-15-15	R143850	SL1	0.45	0.03	0.15	0.06	0.14	0.01	0.01	98.21	0.07
ALS	PL-15-16	R143871	SL1	0.42	0.02	0.14	0.06	0.11	0.01	0.01	98.79	0.07
ALS	PL-15-19	R143906	SL1	0.43	0.02	0.14	0.06	0.11	0.01	0.01	98.64	0.06
ALS	PL-15-21	R143957	SL1	0.41	0.02	0.22	0.05	0.12	0.02	-0.01	98.81	0.06
ALS	PL-15-22	R143980	SL1	0.43	0.02	0.16	0.05	0.10	0.01	-0.01	98.72	0.06
ALS	PL-15-24	R143708	SL1	0.44	0.03	0.16	0.05	0.11	0.01	0.01	99.04	0.07
ALS	PL-15-24	P175734	SL1	0.44	0.02	0.16	0.06	0.09	-0.01	0.01	98.08	0.07
ALS	PL-15-25	R143738	SL1	0.43	0.03	0.15	0.05	0.10	0.01	0.02	98.57	0.07
ALS	PL-15-26	P175681	SL1	0.45	0.03	0.15	0.05	0.11	0.01	0.01	98.81	0.06
ALS	PL-15-27	P179835	SL1	0.43	0.03	0.16	0.05	0.11	-0.01	0.01	98.52	0.07
ALS	PL-13-04	P175859	SL1	0.41	0.02	0.13	0.05	0.10	-0.01	0.01	98.85	0.06
ALS	PL-13-05	P175884	SL1	0.46	0.02	0.14	0.05	0.12	-0.01	-0.01	98.48	0.06
Avg				**0.43**	**0.02**	**0.15**	**0.05**	**0.11**	**0.01**	**0.01**	**98.70**	**0.07**

Source: Consultation Géo-Logic

12.2 The 2017 Drilling Program

12.2.1 Controls and Verification Measures

All Canadian Metals 2017 geological data were collected and verified by Mr. Claude Duplessis, P. Eng., and under his supervision. The author has reviewed the work, and measures taken are considered adequate for the industry standards. The control and verification measures allow the author to visually identify the issue with the iron content in the new drilling campaign first assay results which had passed all the standard QA/QC procedures put in place at the lab as well as internal in the campaign. All the samples were re-prepared from the reject with a less contaminating equipment and re-assayed.

12.2.2 The Database

The required steps to produce a suitable geological database from the information received has been done. After receiving basic information, a field inspection took place to verify the location of drill hole collars in the field. Information regarding hole name and position were entered on a Microsoft Excel® sheet and this file has been used as the base for the creation of the new drill hole database.

12.2.3 Author's Opinion on the Adequacy of the Data

For this third drilling campaign, the author believes the 2017 data are reliable and representative of the mineralization on the Langis Property. Thereby, the adequacy of the database is confirmed for the purpose of this Technical Report.

13. Mineral Processing and Metallurgy Testing

This section of the Langis PFS details all the metallurgical test programs, undertaken by Canadian Metals and executed in various laboratory testing facilities with special expertise of production of FeSi.

13.1 Centre de Technologie Minérale et de Plasturgie (CTMP) Testing—2013

Following the 2013 drilling program, a number of samples were collected from three (3) drill holes (PL-01, 02, and 05) as well as from the surface. Detailed sampling procedures are described in section 11: Samples Preparation, Analyses, and Security.

The tests were performed at the CTMP laboratory, lead and summarized by Genivar in their report “Characterization Study of the Langis Silica Deposit, 2013”.

Various chemical and physical analyses were performed on the samples, as the goal was to establish the characteristics of the Langis sandstone in relation to various potential commercial uses. The main conclusion of the 2013 tests is that based on the preliminary test work by CTMP, basic chemical, physical, and thermal properties of the Langis sandstone indicate it has good potential to be a usable source of silica. The impurities contained in the core samples are about 1% with a silica grade in the order of 98.55% SiO_2 and a loss on ignition ranging from 0.3% to 0.5%. When corrected for loss on ignition incurred during high-temperature lump silica applications, the averages are 98.95% SiO_2, 0.14% Fe_2O_3, 0.48% Al_2O_3, and 0.05% TiO_2. Thermal shock tests on twelve (12) representative lump samples reveal that this material has relatively strong cementation, making it a potential source for lump silica applications in high-temperature furnaces. For applications requiring silica sand grains, it can be shown that a significant amount of impurities can be eliminated with the removal of fine sand below 100 microns. The residual sand then averages 99.44% SiO_2, 0.05% Fe_2O_3, 0.20% Al_2O_3, and 0.03% TiO_2. With attrition, iron oxides and clays can be scrubbed from the surface of the sand grains, thereby producing a cleaner silica sand averaging 99.56% SiO_2, 0.03% Fe_2O_3, 0.16% Al_2O_3, and 0.03% TiO_2.

High-intensity magnetic separation removed a very small fraction of magnetic material with the objective of reducing the Fe_2O_3 content to below 0.03%; however, the average impurities content in the sand product was left relatively unchanged. Physical characteristics of the silica sand were evaluated with respect to particle size distribution; AFS grain fineness numbers, coefficient of uniformity, roundness, sphericity, and crush resistance. Based on the chemical, physical, and thermal properties observed from the test work at CTMP, by crushing and screening to -120 +20 mm lump particles, the Langis silica deposit may be a potential source for the production of ferrosilicon. Further crushing to -25 +5 mm particles will also make it a potential source as a flux agent for base metal smelting. The chemical composition of this material, however, does not meet the requirements for the production of silicon metal. Crushing to -600 microns and desliming the -100 microns fines as well as attrition, size classification, dewatering, and drying can be considered to provide a potential source of glass sand, foundry sand, and other uses like abrasive sand, sodium silicate, silicon carbide. The material was also tested for frac sand and based on an initial evaluation, the presence of many clusters as well as the issue with the grains’ roundness should be considered a stumbling block for its potential as a source of frac sand. Further tests are recommended to better evaluate this product by a specialized frac sand laboratory. From the above, Canadian Metals Inc. retained that the Langis Property sandstone can provide suitable material for ferrosilicon production. This conclusion tends to confirm historical information previously mentioned in section 6, History, whereby some 22,000 tonnes of material is reported to have been shipped by Uniquartz to Norway and Iceland, leading to an agreement by which Uniquartz could supply 150,000 tonnes per year of lump material for ferrosilicon production.

13.2 MINTEC Testing—2015—Pilot Smelting

Additional testing of the Val-Brillant sandstone was conducted by Canadian Metals Inc. in 2015. Approximately 130 kg of sandstones were collected in the quarry contiguous to the Langis deposit as 100-mm pieces and sent to MINTEK in May 2015. MINTEK is a metallurgical test laboratory and consulting company with offices in South Africa and specific experience and expertise in ferrosilicon production. The sandstone was crushed and screened in order to prepare four (4) batches of 12-kg feed material that were used in MINTEK's test facility to produce ferrosilicon. Different proportions of additives were used in order to perform a preliminary evaluation of the optimal recipes for production of ferrosilicon with the Langis sandstone.

A total of 130 kg of lumpy quartzite of about 100 mm in size was received. A lump size hematite sample was acquired from Metmar, while a low-ash reductant was acquired from Matech. The received quartzite, hematite, and low-ash reductant were crushed separately and screened to +10 -31 mm.

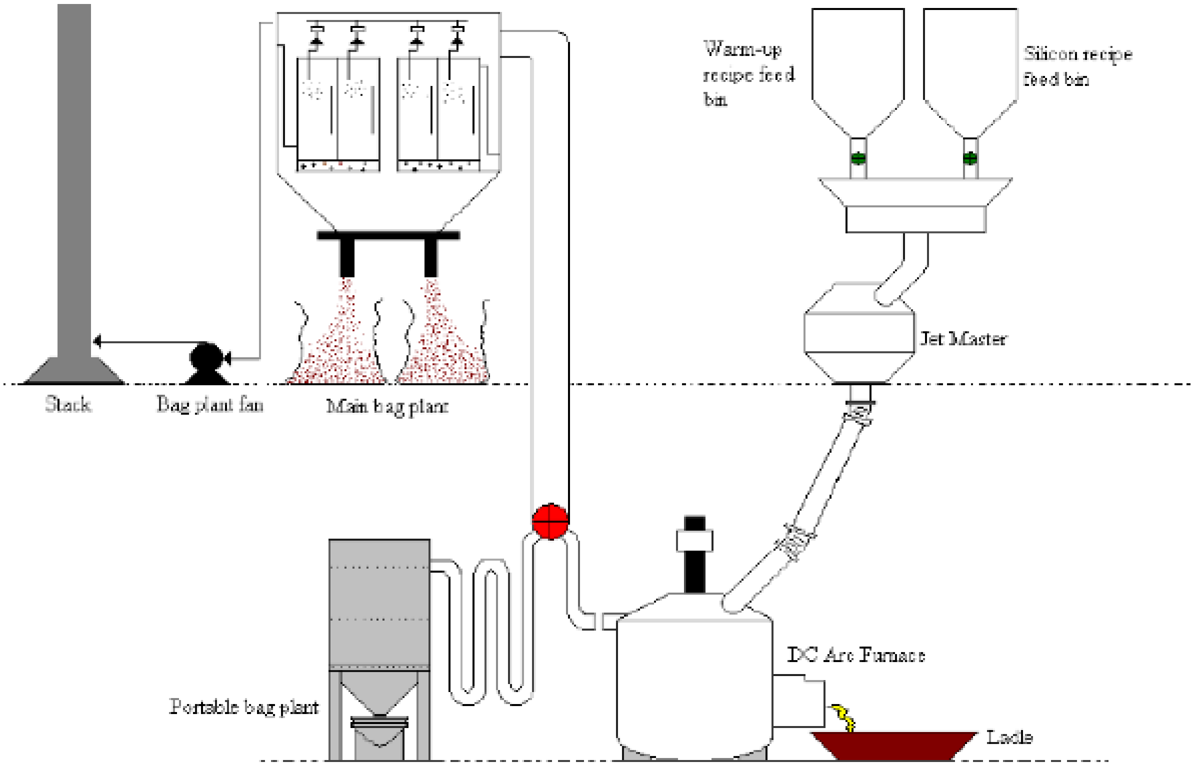
Woodchips were cut from pinewood into squares of two sizes, i.e. 20 x 20 mm and 30 x 30 mm. The chemical analyses of the quartzite are shown in Table 20. Quartzite impurities were mostly Ca, Fe, and Al. The Canadian quartzite chemical composition meets the requirements for the production of FeSi as it contains more than 97% SiO_2 and less than 1.5% Al_2O_3.

Table 20: Quartzite Chemical Analysis

SiO_2	Al_2O_3	CaO	Fe_2O_3	MgO	Mn_2O_3	P_2O_5	BaO	Na_2O	K_2O
98.62%	0.64%	0.11%	0.34%	0.10%	0.09%	0.032%	0.022%	0.009%	0.035%

The experimental equipment facility employed in this investigation consisted of a DC power supply, a furnace, and an off-gas handling system as shown in Figure 23.

Figure 23: Laboratory Plant Flow Sheet



The power supply consisted of a three-phase 100-kVA transformer with a 17-step, on-line tap changer with a single-phase reactor connected in each secondary phase. The DC supply is obtained via a 2000-A rated water-cooled rectifier bridge unit (diode pack). The electrode movement controls are available via an UP/DOWN switch on the control panel as well as on a hand-held switch station for operator convenience. The switches operate the hydraulic solenoid valves to move the electrode. The tap changer was fixed at a predetermined setting to give the voltage and current values that were displayed on the analog meters. A power input of 40 kW was targeted for the present work.

The vacuum breaker is installed to break under load, should a transformer fault occur, and cannot be remotely opened or closed. An isolator and contactors provide the electrical isolation between the transformer and vacuum breaker. The contactors are designed to break under load and can be opened and closed remotely by the operator, while the isolator must be manually operated. A dedicated de-ionized water-cooling circuit serves the rectifier, while the busbar water cooling is provided by the Mintek plant water supply.

The furnace consisted of a flat base, a steel shell, and a flat roof. The dimensions of the unlined cylindrical shell were 395 mm ID, 400 mm OD, and 400 mm height.

Based on the test results, MINTEK made the following conclusions:

- A pilot smelting test project to investigate the feasibility of smelting a Canadian quartzite to produce a ferrosilicon of 75% Si was carried out in the Mintek's 100-kVA DC arc facility during the latter part of May 2015. Four (4) smelting tests were successfully carried out. The recipes were composed of varied ratios of quartzite, hematite, low-ash reductant, and woodchips.

- The total fixed carbon was maintained constant for all the four (4) recipes tested; the variable tested was the woodchip-to-reductant ratio. The ratios evaluated were as follows: 1.5-to-1, 1-to-2, and 1-to-1.
- The furnace was operated at a power of about 30 to 40 kW. A batch of about 12 kg of material was smelted during each test. At the completion of each test, which lasted about six (6) hours (including warm-up period), the products were left to solidify inside the furnace crucible for a period of at least 14 hours, after which the solid material was dug out from top to bottom using a chisel and a hammer. Metal pieces were visually sorted out and these metal pieces as well as the remaining materials were analyzed by various methods. The test crucible for the 4th test was longitudinally cut across to investigate various layers of the frozen material inside the furnace.
- The cut sections were scanned using a handheld XRF instrument to establish semi-quantitative compositions of the various zones.
- The chemical analyses of the Canadian quartzite meet the specifications required for the production of ferrosilicon as the SiO_2 content is above the threshold limit of 97%, while the alumina content is below 1.5%. From visual inspection of the furnace top burden, thermal disintegration of this material was acceptable, and no explosive disintegration was observed.
- Thus, efficient operation of the furnace should be possible, as it appears to be possible to maintain acceptable porosity of the burden during the smelting of the Canadian quartzite.
- Based on the results of the chemical, SEM, and XRF analyses of the dug products, it was evident that FeSi alloy was formed during the test work.
- This ratio requires further optimization. These tests satisfactorily demonstrated that the Canadian quartzite material provided could be reduced to Si and normal furnace operation was possible. The Canadian quartzite is thus deemed a viable material to produce FeSi75.

In summary, all tests succeeded in producing ferrosilicon of commercial quality. In addition, the thermal shock resistance of the sandstone, an essential criterion for a silica feed, was confirmed. MINTEK’s conclusion was that Langis sandstone would be an acceptable feedstock for ferrosilicon production, and they suggested testing on a larger scale be performed to better define the parameters for commercial-scale production of ferrosilicon.

13.3 Metallurgical Testing Summary

Based on the various tests performed over the years for different samples of Langis quartzite in various reputable testing facilities, the general conclusion is that commercial production of ferrosilicon can be achieved using Langis silica products.

CIMA+ recommends that further testing be performed for samples from the latest 2017 drilling program in order to optimize the process, the raw materials types, and consumption, as well as pilot plant testing to simulate commercial production. Such recommendations are presented in detail in section 26 of this Technical Report.

14. Mineral Resource Estimates

Canadian Metals Inc. engaged GoldMinds Geoservices Inc. to prepare an updated Mineral Resource Estimation with the integration of the new drilling data from the 2017 drilling campaign. This mineral resource update was carried out using the existing drilling data and the new drilling data of 2017.

GMG carried out the update of the resource estimation of the Langis silica Property. This section presents the methodology used and the results of the mineral resource estimation. One resource model was produced by GMG (Mr. Claude Duplessis, P. Eng., and Ms. Isabelle Hébert, Jr. Eng.) using model with blocks dimensions of 5 m (EW) x 5 m (NS) x 3 m (Z).

Cautionary note: Mineral resources that are not mineral reserves have not demonstrated economic viability. Additional trenching and/or drilling will be required to convert inferred mineral resources to Indicated or Measured mineral resources. There is no certainty that the assumptions and forecasts used in this updated mineral resource report will be realized.

14.1 Previous Estimates 2016

Mineral resources statement of the Langis quartz Property 2016. All classified as Inferred mineral resources 9.95 million tonnes of resources in pit, with average SiO_2 98.71%, Al_2O_3 0.38%, TiO_2 0.05%, and Fe_2O_3 0.12%. Waste in pit: 3.76 million tonnes for a stripping ratio of 0.38 to 1 mining cost. Mineralized Material CAN$5/t, Mining Cost waste CAN$4/t, Processing Cost of Quarry including G&A CAN$10/t, Recovery 95%, Slope angle of 45 degrees, Product value fixed at CAN$44/t purchase price at the Quarry (these mineral resources are free of constrains and surface right limits). Effective date: September 28th, 2016.

Notes: 1) Mineral Resources are not Mineral Reserves and have no demonstrated economic viability. The estimate of Mineral Resources may be materially affected by mining, processing, metallurgical, infrastructure, economic, marketing, legal, environmental, social, and government factors. 2) CIM definitions of May 10th, 2014 were followed with reasonable prospect of economic extraction. 3) The resources are pit constrained by Lersch-Grossman pit optimizer with MineSight® software. 4) Density of rock used 2.5 T/m^3. 5) Parameters used for the definition of mineral resources. + Mining cost of CAN$5/t; + Processing cost (crushing, screening, hauling to plant plus Quarry G&A) CAN$10/t; + Plant purchase price to quarry CAN$44/t with pit recovery of 95% with no dilution. 6) Definition of cut-off grade used comparable to similar projects: 98.1% SiO_2, 0.8% Al_2O_3, 0.075% TiO_2, and 0.24% Fe_2O_3. About the cut-off: the cut-off used in the mineral resources of GMG is higher in silica than the one used in the similar model of Viridis used for the quarry sequence in the PEA. The use of this COG by GMG which comparable to similar public projects demonstrates that even in applying a more restrictive COG the mineral resources in pit are still sufficient to provide the required feed in the PEA analysis. The quarry sequence with COG of 97% has demonstrated it can meet the percentage of SiO_2 specification of the planning.

14.2 Exploration Database

The database used for this Technical Report was prepared by GoldMinds Geoservices up to April 2017. This database is the master database covering the Langis Property. It gathers the information on historical to recent work.

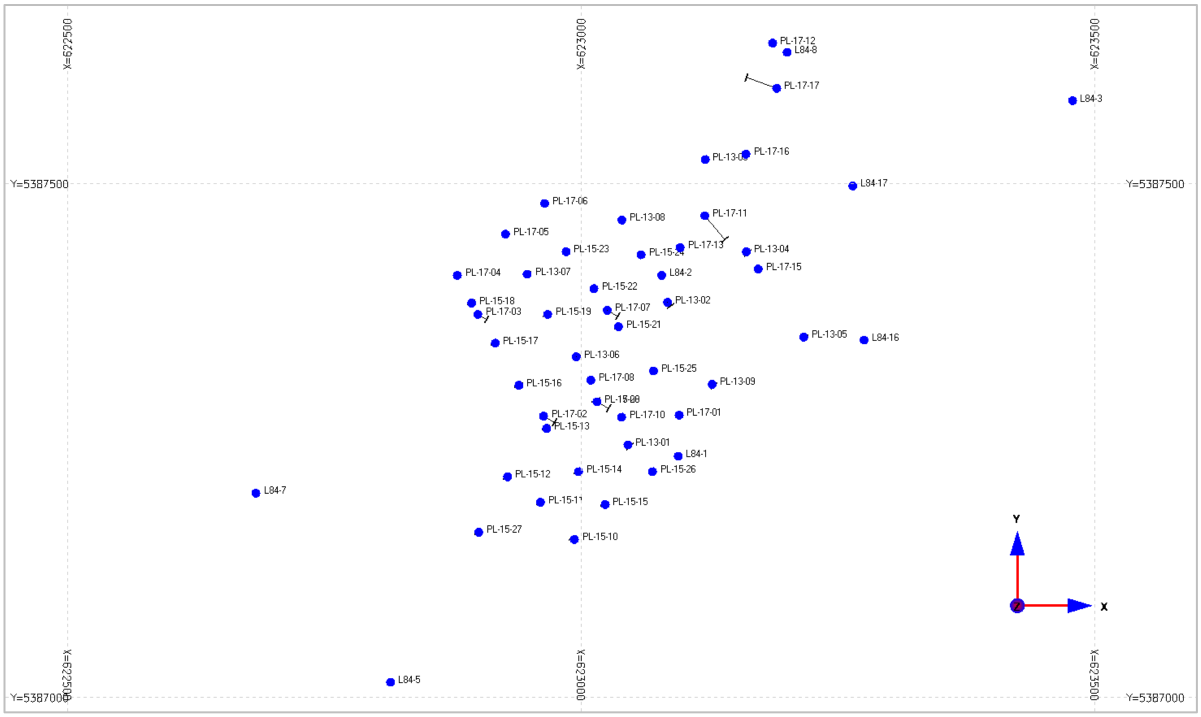
The file name is accesslangis2017_5decMMV3MR.accdb. The database contains the following components:

- Drill hole collar table with collar coordinates, bearing, and dip at collar and length of 51 holes;
- A drill hole deviation table with 419 entries (hole name, depth, azimuth, dip);
- A drill hole assay table with 943 assays data (hole name, from, to, major elements in %: SiO_2, Al_2O_3, Fe_2O_3, TiO_2, BaO, CaO, Cr_2O_3, K_2O, MgO, MnO, Na_2O, P_2O_5, SO_3, and SrO);
- A drill hole lithology table with 396 entries (hole name, from-to, lithology code).

These drill holes are the results from exploration works done between 1984 and 2017. Because of our database construction and revision, the author believes the database is accurate enough for the preparation of a resource estimate.

The coordinate system used is UTM NAD 1983 ZONE 19N.

Figure 24: Drill Hole Plan View



Source: GoldMinds Geoservices Inc.

14.3 Geological Model—Envelopes

The Langis deposit is composed of sedimentary rocks in which lateral variations of composition are gradual and very continuous but vertical variations may be found to be important over short distances. The results obtained at a particular point have more continuity to extrapolate horizontally than vertically.

The Langis deposit is part of the Val-Brillant Formation and located in an area where northwest-southeast tectonic compressive forces were active subsequent to the consolidation of the sandstones. As a result, the deposit is now on the north limb of an east-west regional structure. Locally, this means that the geological units dip gently to the south. Drilling and surface reconnaissance indicate that the general dip is around 5-10º to the south.

Compression also forced a horizontal shortening of the geological units. This was accommodated by vertical movements along NNE and NE north-dipping faults. These sets of faults have been identified in the walls of the old Uniquartz quarry.

A geological model must be stable from one section to another and consistent with the various structures (bedding, faults) identified in the core of the drill holes. In the previous model, high importance was given to this displacement, and interpretation of blocks movements was attributed to these faults with important implication on grades. A portion of 2017 drilling has tested these faults with drilling across the interpretation. We also had schedule trenching on surface to locate them as they where all interpreted between vertical holes. It was found that some of these movements are late events (recent in geological time) compared to two other major faults we found which have affected the quality of the stone by migration by limited impregnation along these two faults (about 5 m wide sub-vertical as shown in hole PL 17-11). One of the faults can be observed in the topographic depression, the little valley aligns NE with that fault. The small faults do not present significant impregnation and migration of iron. The quality and grade, if not affected or very little and limited vertical displacement, will have to be followed during the extraction process as the scale observed range from 0.5 to 3-m shift, but when conjugated can be higher than that on a portion where an uplift is observed at the eastern limit of the existing quarry.

The modelling of the silica formation is within the claims Property boundaries.

14.4 Density

Twenty-two (22) individual core samples from hole PL 17-07 of 2017 campaign which were used for modelling the Mineral Resource were submitted for density measurements. Cores were weighed and placed in a graduated cylinder and the difference in water levels was noted. Given the porous nature of the rock, cores were wrapped in a plastic film to avoid infiltration of water inside the cores (Figure 25). The mass divided by the difference of volume gave the density of the core. Therefore, the initial rock weight, weight in water, and water displacement were recorded on a Microsoft Excel® sheet.

These samples are taken from 9.23 m to 15.19 m, which is an interval with an average SiO_2 grade of 98.73% and an average Fe_2O_3 grade of 0.58%. The average length of samples is 0.14 m. The weights were then used to calculate the specific gravity of the ore. The average density obtained is 2.33 g/cm^3, ranging from 2.21 g/cm^3 to 2.44 g/cm^3. The density of pure quartz (SiO_2) is 2.65 g/cm^3. This would put the porosity of the rock at about 14%. Given the fact that density measurements were taken in only one hole, it may not represent the whole deposit; however, the author prefers to remain on conservative, measured side. The density used in 2016 was 2.5 T/m^3 and we are now using 2.33 T/m^3.

Figure 25: Core wrapped in a Plastic Film to avoid Water Infiltration in Pores

Source: GoldMinds Geoservices Inc.

Table 21: Density Measurements on Samples from Hole PL-17-07

Length (m)			Density (g/ml)	
From	To	Total	Dry Rock (with Plastic Film)	Wet Rock (without Plastic Film)
9.23	9.42	0.19	2.315	2.482
9.42	9.52	0.1	2.206	
9.92	10.08	0.16	2.338	
10.08	10.17	0.09	2.300	2.463
10.21	10.39	0.18	2.352	2.523
10.39	10.53	0.14	2.364	2.496
10.53	10.64	0.11	2.277	2.545
10.64	10.67	0.03	2.343	2.509
10.67	10.87	0.2	2.436	2.493
10.87	10.99	0.12	2.360	2.512
10.99	11.1	0.11	2.323	2.523
11.1	11.3	0.2	2.384	2.527
11.39	11.55	0.16	2.343	
11.55	11.7	0.15	2.325	
11.7	11.87	0.17	2.336	
11.87	11.99	0.12	2.292	
11.99	12.14	0.15	2.303	
12.14	12.28	0.14	2.272	
12.28	12.43	0.15	2.311	
12.65	12.82	0.17	2.287	
15.07	15.19	0.12	2.333	
15.19	15.34	0.15	2.444	

Source: GoldMinds Geoservices Inc.

Table 22: Density Measurement Results, Samples from Hole PL-17-07

Density Method	Min (g/cm^3)	Max (g/cm^3)	Weighted Average (g/cm^3)
Dry rock	2.206	2.444	2.329
Wet rock	2.463	2.545	2.507

Source: GoldMinds Geoservices Inc.

14.5 Geological and Block Modelling 2017

14.5.1 Introduction

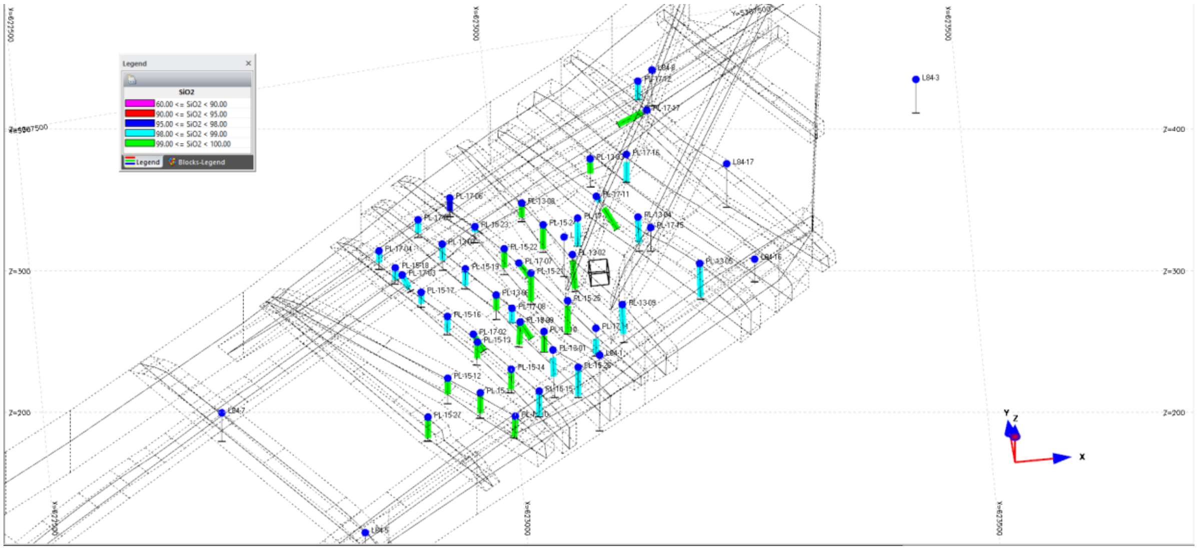
The mineral resource was estimated by Mr. Claude Duplessis, P. Eng., consulting Geological Engineer of GoldMinds Geoservices Inc. Mr. Duplessis is an independent qualified person (QP) as per section 1.4 of the NI 43-101 Standards of Disclosure for Mineral Projects.

14.5.2 Modelling

Vertical cross-sectional views oriented towards NNW/SSE looking NE and mostly 45 m apart were used to study mineralization patterns and group assays into mineralized intervals. Prisms were created by snapping to the mineralized intervals. A cut-off grade of 98% of SiO_2 was considered while modelling; however, waste or lower-grade material was included for structure continuity. Mineralized solids were generated based on the linked prisms, and faults were designed based on new findings of the 2017 drilling. The faults are discussed in further detail in the previous section. A solid consisting of all the mineralized solids was generated and the waste fault solid were subtracted. Equal-length composites of 3 m were produced from the mineralized intervals and no capping was applied. The author is aware that higher selectivity could be reached as the siltstone deposit is sub-horizontal and specific layers could be selectively mined, should higher-grade specifications be required.

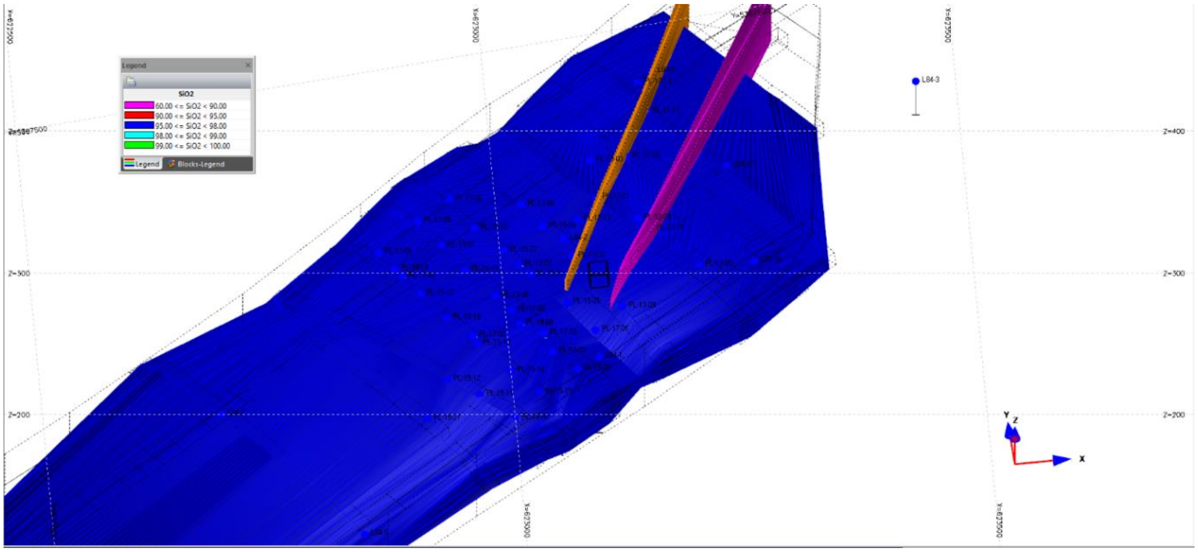
CIMA+ M03846C

Figure 26: Perspective View of the Prisms and Drill Hole with Colour-Coded Mineralized Intervals



Source: GoldMinds Geoservices Inc.

Figure 27: Perspective View of the good Sandstone Envelope and the 2-Fault Zone Envelopes



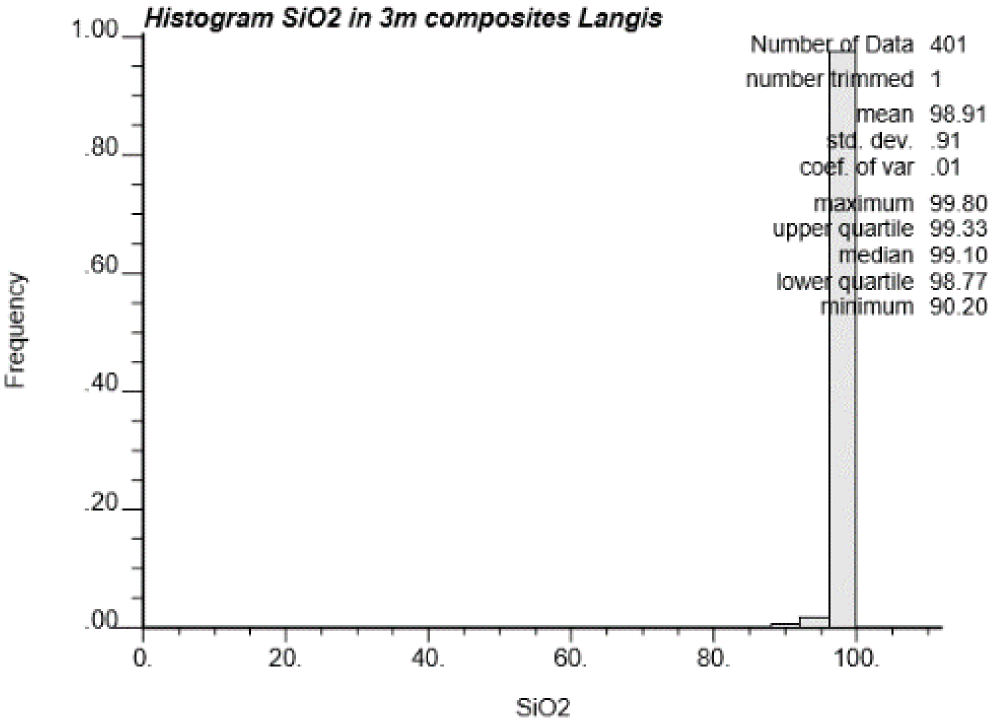
Source: GoldMinds Geoservices Inc.

14.5.3 Compositing, Statistical Analysis

After compositing, an assessment of the grade distribution for the SiO_2 and the Fe_2O_3 has been done.

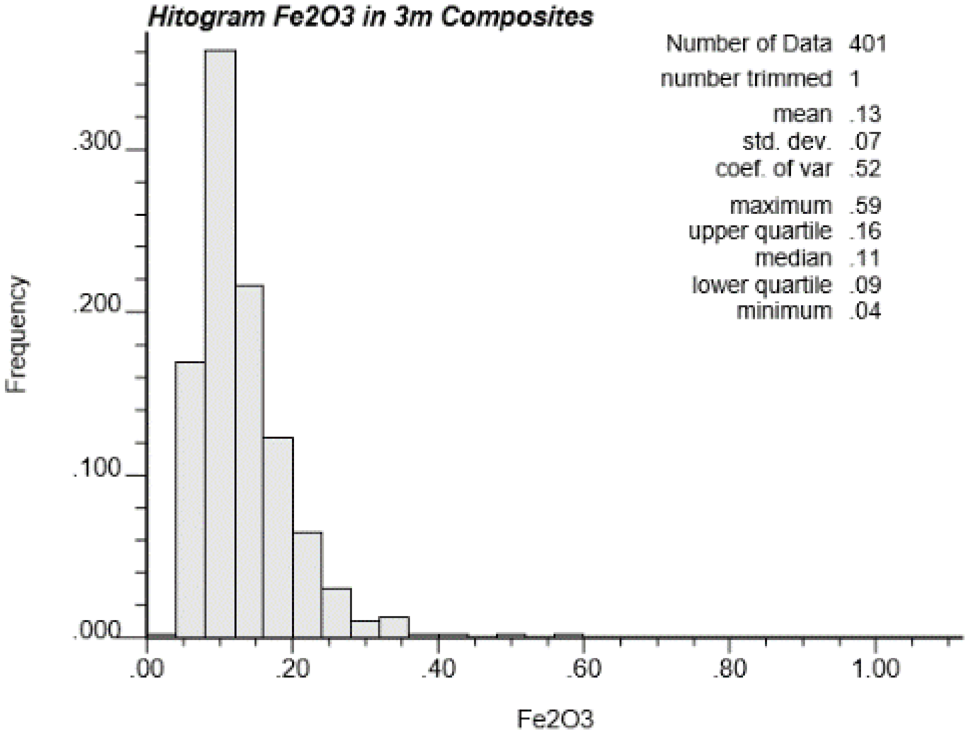
It can be found a tight SiO_2 distribution with an average of 98.91%. The iron has an average of 0.13% of Fe_2O_3. The iron is inversely proportional to the percentage of SiO_2 as the more iron we have, the less SiO_2 we have, which is normal.

Figure 28: Histogram of Percentage of SiO_2 in 3-m Composites



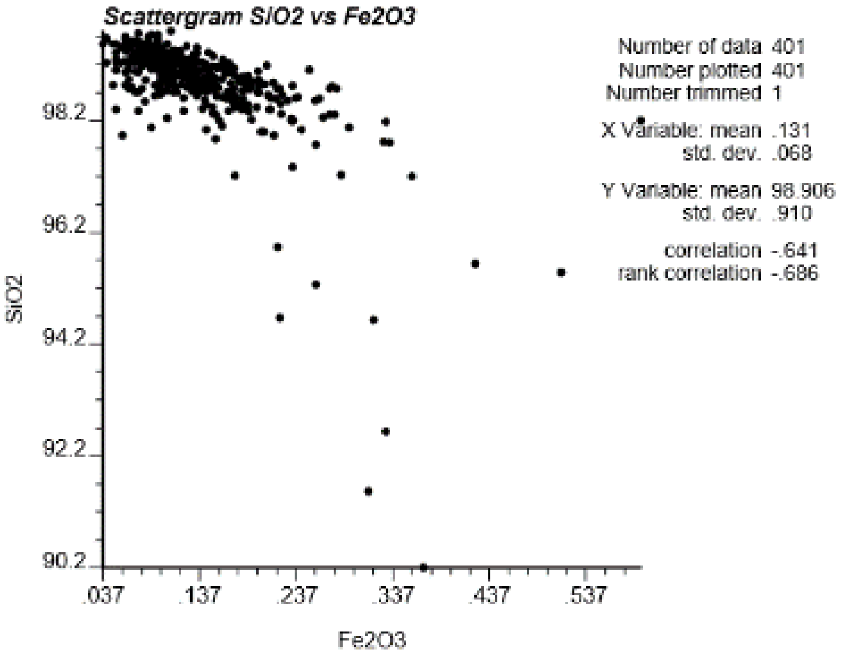
Source: GoldMinds Geoservices Inc.

Figure 29: Histogram of Percentage of Fe_2O_3 in 3-m Composites



Source: GoldMinds Geoservices Inc.

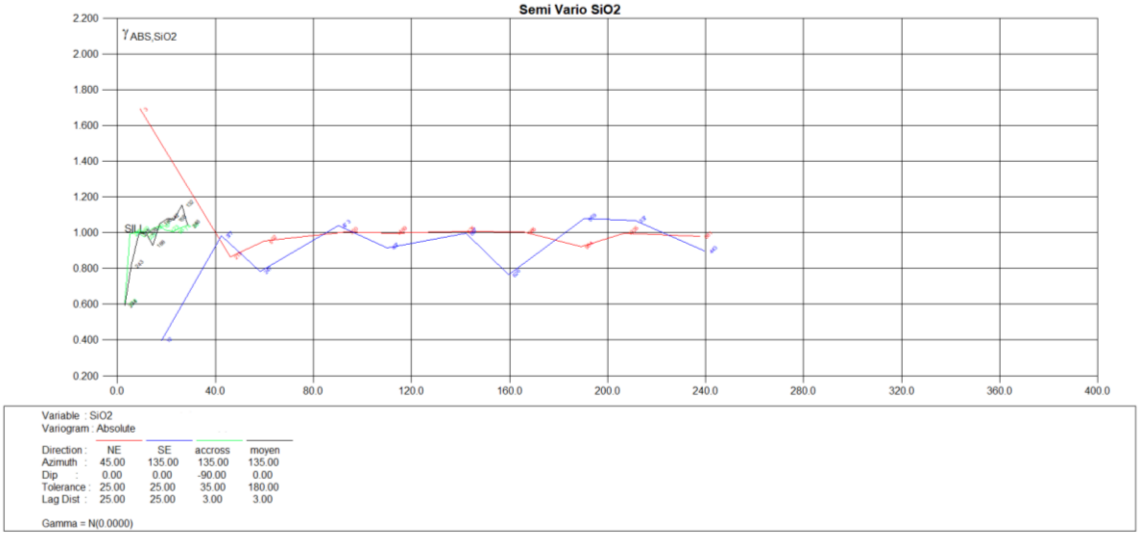
Figure 30: Scatterplot Percentage of SiO_2 vs. Percentage of Fe_2O_3



Source: GoldMinds Geoservices Inc.

The variography presents a very good continuity northeast as well as southeast and has expected across the strata is much shorter range.

Figure 31: Variogram 3-m Composites Percentage of SiO_2 Absolute



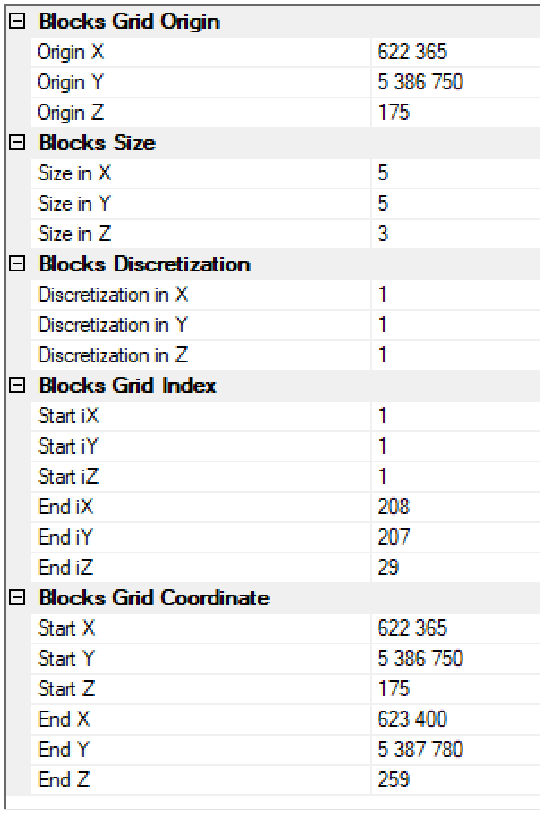
Source: GoldMinds Geoservices Inc.

We can observe the anisotropy as well as the effect of the few low SiO_2 grade samples kept in the envelope in a conservative manner.

14.5.4 Block Model

The material within the resource model is discretized with the blocks of 5 m (E-W) by 5 m (N-S) by 3 m (vertical). The 3-m vertical side corresponds to the bench height of a potential future open-pit operation. The 5-m E-W dimension corresponds to about 1/8 the minimum spacing between CME surface holes. The 3-m vertical accounts for the perceived greater grade variability across the strata. With fixed density of 2.33 t/m^3, each full block (5 m x 5 m x 3 m) represents about 174.75 tonnes and it is assumed reasonable for the selective mining unit (SMU) or minimum size block which can be selectively extracted as mineralized material or waste in a future potential open-pit operation. The block model parameters are presented in the following table.

Table 23: Block Grid Parameters



⊟ **Blocks Grid Origin**	
Origin X	622 365
Origin Y	5 386 750
Origin Z	175
⊟ **Blocks Size**	
Size in X	5
Size in Y	5
Size in Z	3
⊟ **Blocks Discretization**	
Discretization in X	1
Discretization in Y	1
Discretization in Z	1
⊟ **Blocks Grid Index**	
Start iX	1
Start iY	1
Start iZ	1
End iX	208
End iY	207
End iZ	29
⊟ **Blocks Grid Coordinate**	
Start X	622 365
Start Y	5 386 750
Start Z	175
End X	623 400
End Y	5 387 780
End Z	259

Source: GoldMinds Geoservices Inc.

14.5.5 Ellipsoid Parameters and Interpolation of Grades

The average grades of major elements (14) in percent SiO_2, Al_2O_3, Fe_2O_3, MgO, MnO, TiO_2, P_2O_5, Na_2O, K2O, Cr_2O_3, CaO, BaO, SrO, and SO_3 is computed for each block using interpolation according to the inverse of the distance power 3 from the nearest composites. Interpolation parameters were based on drill spacing, envelope extension, and orientation. The blocks model was then cut by surface, and envelope was built below overburden and waste material.

Three runs were used in the mineral resource estimation; all three runs have different ellipsoids. Three search ellipsoids with dimensions following the geological interpretation trends were used in the grade estimation. The subsequent table shows the size of the ellipsoid used to generate the mineral resource estimation.

Table 24: Search Ellipsoid Parameters and Estimation Parameters

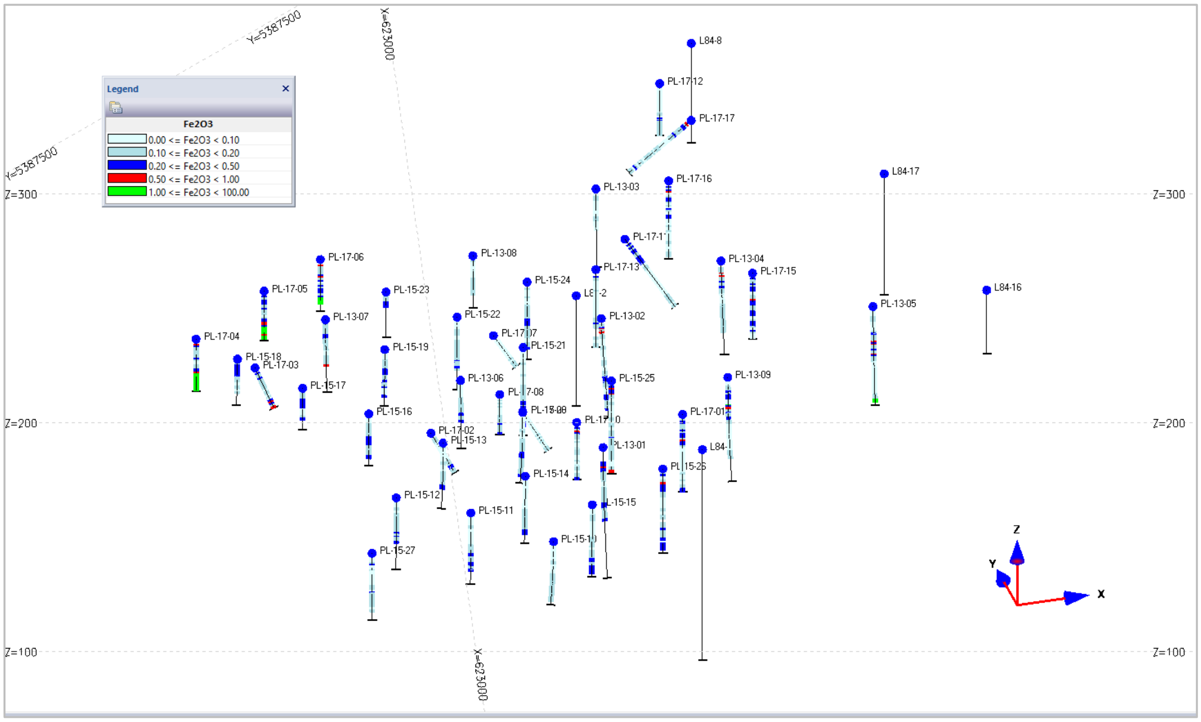
Run	Azimuth	Dip	Spin	X (m)	Y (m)	Z (m)	Minimum Comp per Block	Maximum Comp per Block	Maximum per Drill Hole
1	135	-3	0	60	60	1.5	5	5	1
2	135	-3	0	120	120	3	5	5	1
3	135	-3	0	600	600	6	1	5	1

Block Model Classification

Source: GoldMinds Geoservices Inc.

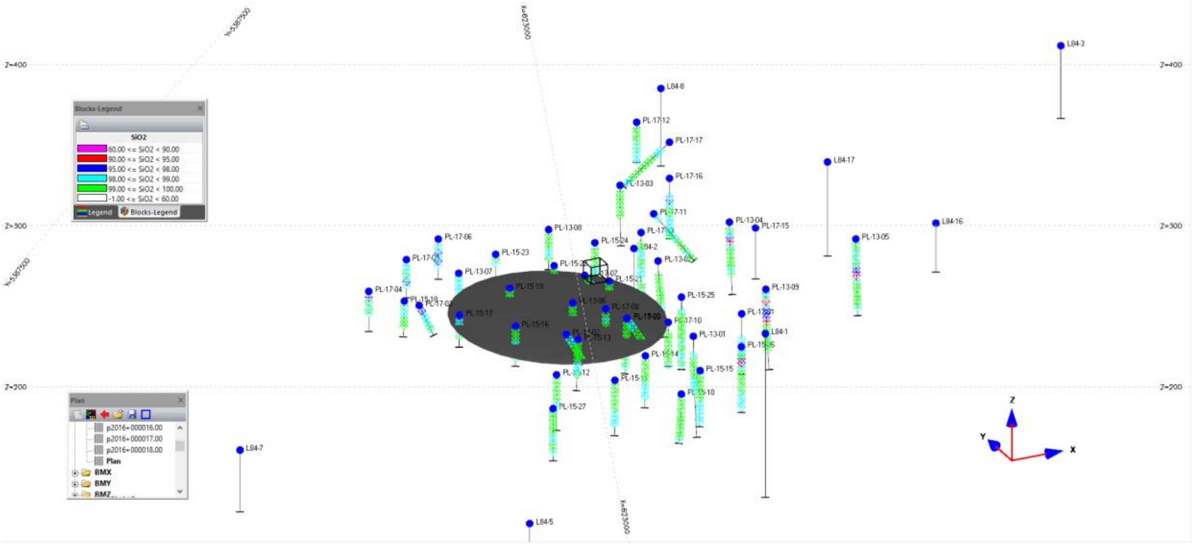
The classical search ellipsoid method was used to classify the deposit where one defined class is used by ellipsoid. A total of two ellipsoids and two runs were used in the Blocks Model classification. In run one (Measured), a minimum of three (3) composites within 75-m radius were established per block with a limited number of one (1) composites per drill hole. In run two (Indicated), a minimum of four (4) composites within the 120 radii were established per block with a limited number of one (1) composite per drill hole. The remaining blocks classified as Inferred.

Figure 32: Isometric View of Iron Grades in the Drill Holes



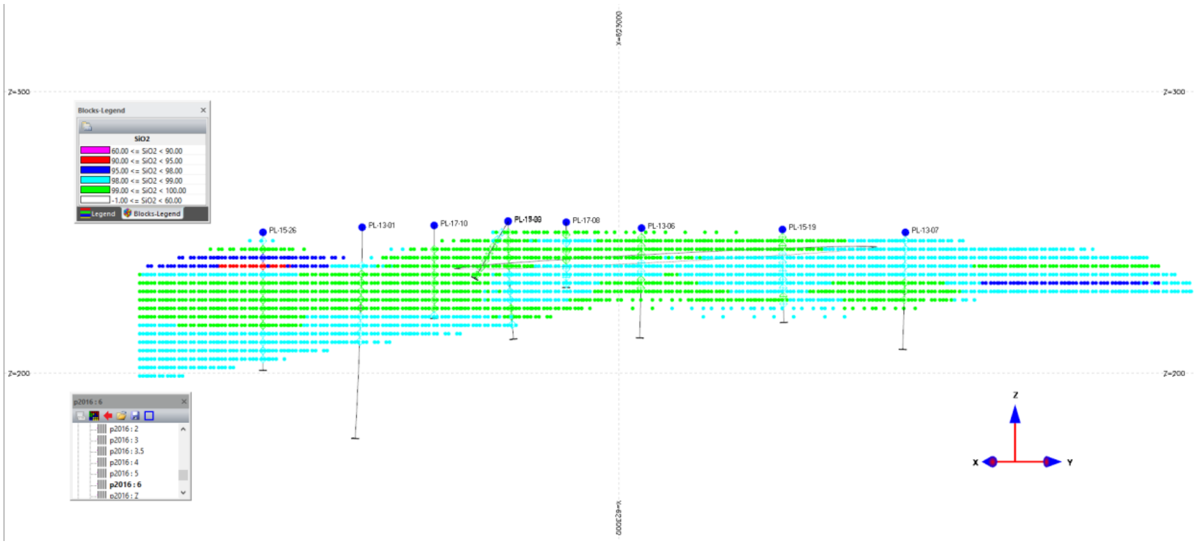
Source: GoldMinds Geoservices Inc.

Figure 33: Isometric View of the Percentage of SiO_2 Composite and the short Search Ellipsoid



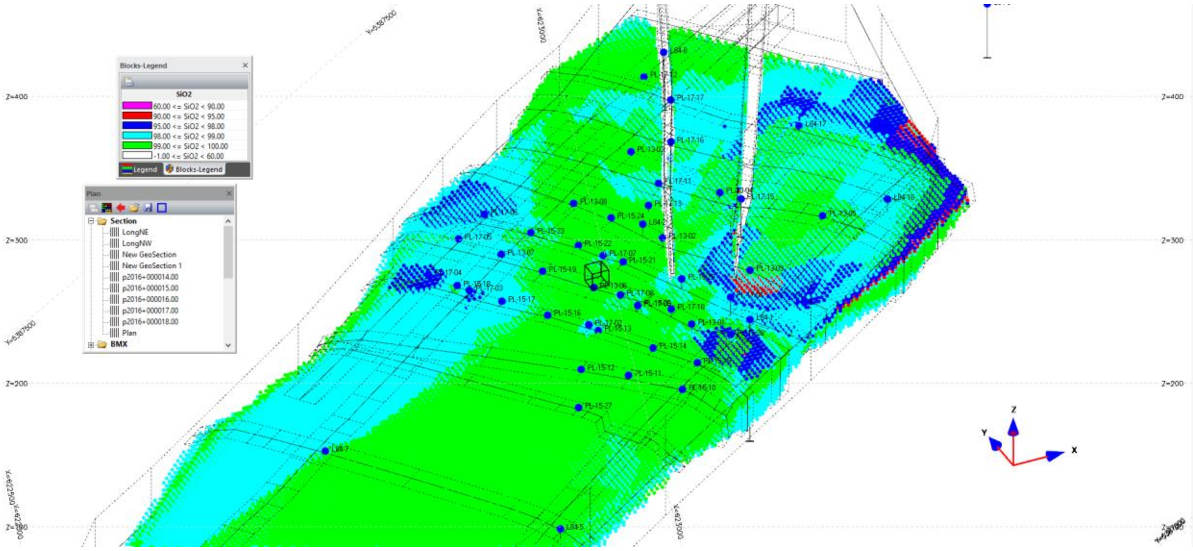
Source: GoldMinds Geoservices Inc.

Figure 34: Block Model Cross Section with the Percentage of SiO_2 Grade



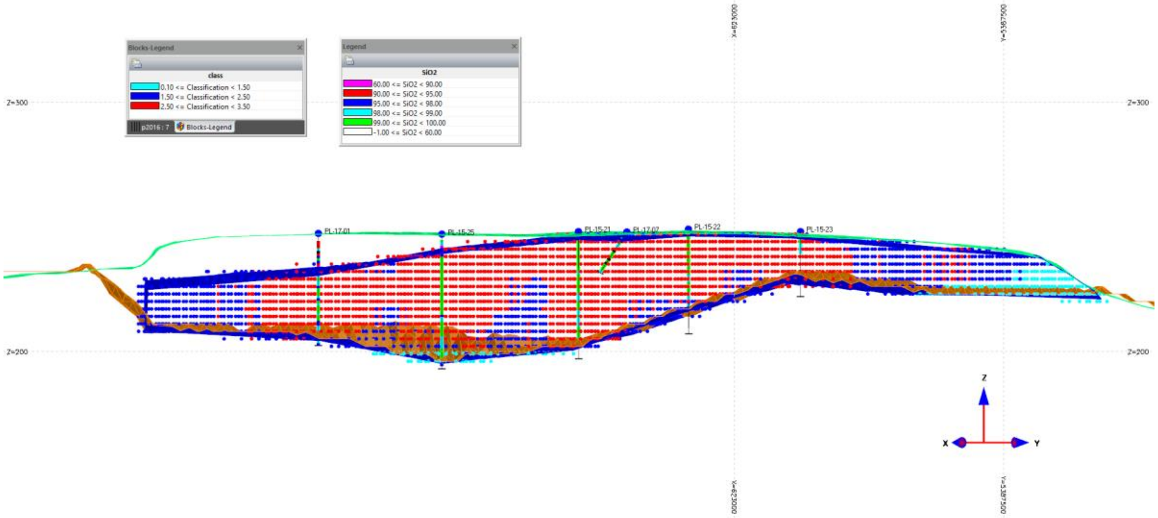
Source: GoldMinds Geoservices Inc.

Figure 35: Isometric View of the Block Model Grades Colour-Coded by the Percentage of SiO_2



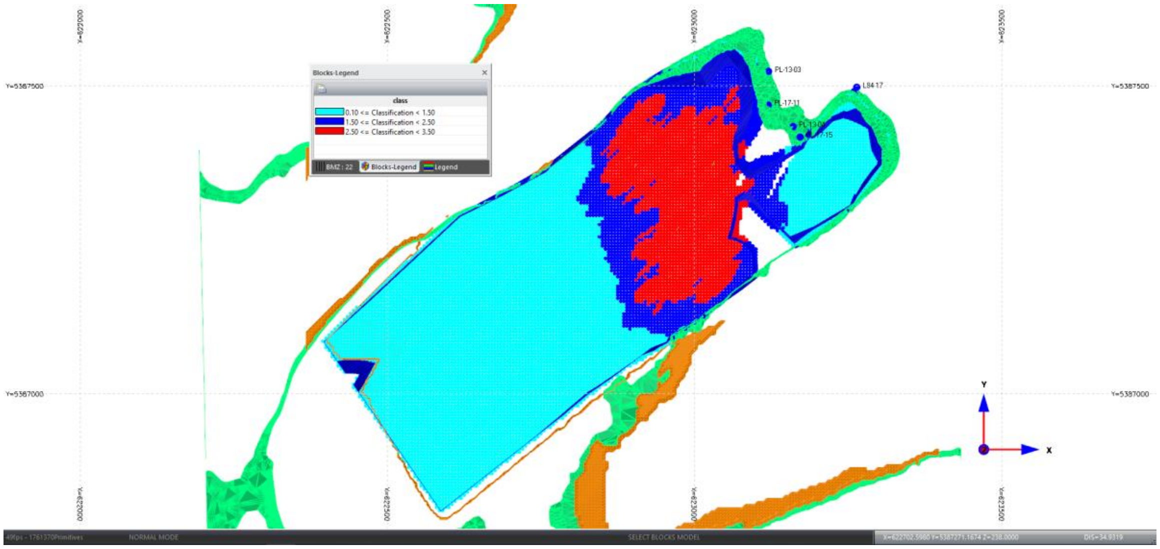
Source: GoldMinds Geoservices Inc.

Figure 36: Cross Section with Block Classification Colour-Coded with Silica Grades



Source: GoldMinds Geoservices Inc.

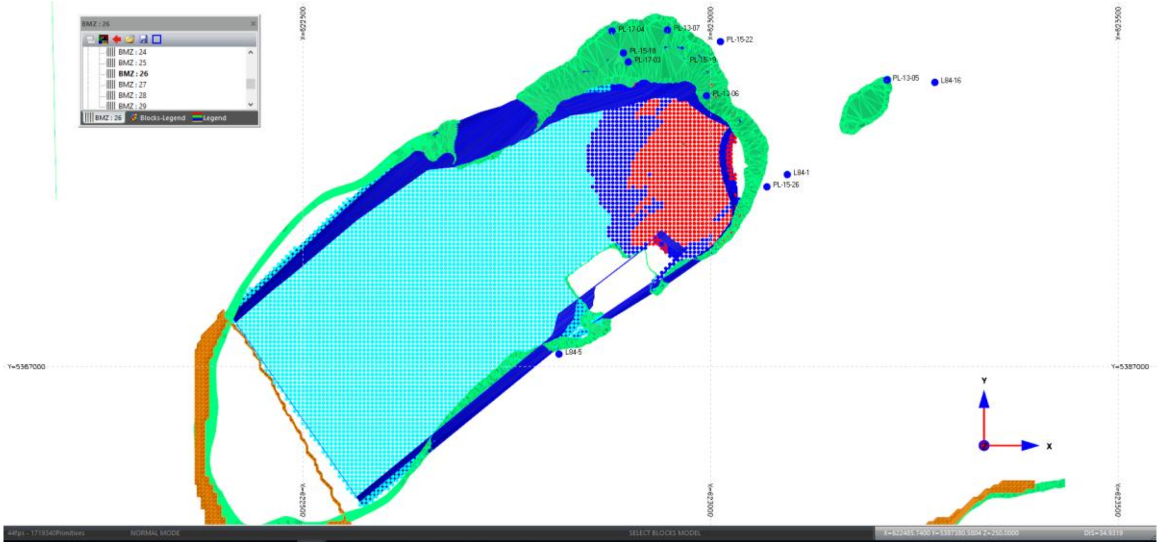
Figure 37: Plan View of Blocks Classification at Z = 238 m



Source: GoldMinds Geoservices Inc.

The portion of Measured and Indicated is consistent with the drilling and knowledge of the deposit.

Figure 38: Plan View of Blocks Classification at Z = 250 m



Source: GoldMinds Geoservices Inc.

It is possible to see the notch of the existing quarry wall in the above Figure 38.

14.6 Mineral Resources Pit Constrained

The mineral resource statement is based on pit-constrained shell of the classified block model.

Pit optimization has been done with specific mining and milling operation costs.

The pit optimization results in a single base case scenario of parameters (mining cost, processing cost, processing recovery, and one commodity-selling price). The parameters were estimated by GoldMinds

Geoservices based on the knowledge of similar operations and parameters defined in the PEA of 2016 which are still considered valid. The author is aware of the fact that a PFS study is being prepared with the new mineral resources.

The optimization uses a mining cost of \$5/t; the quarry processing cost is \$10/t with recovery of 95% for mineralized material above 97% SiO_2 with slopes of 45 degrees and an assumed selling price of CAN\$44/t. The pit optimization includes Measured, Indicated, and Inferred material.

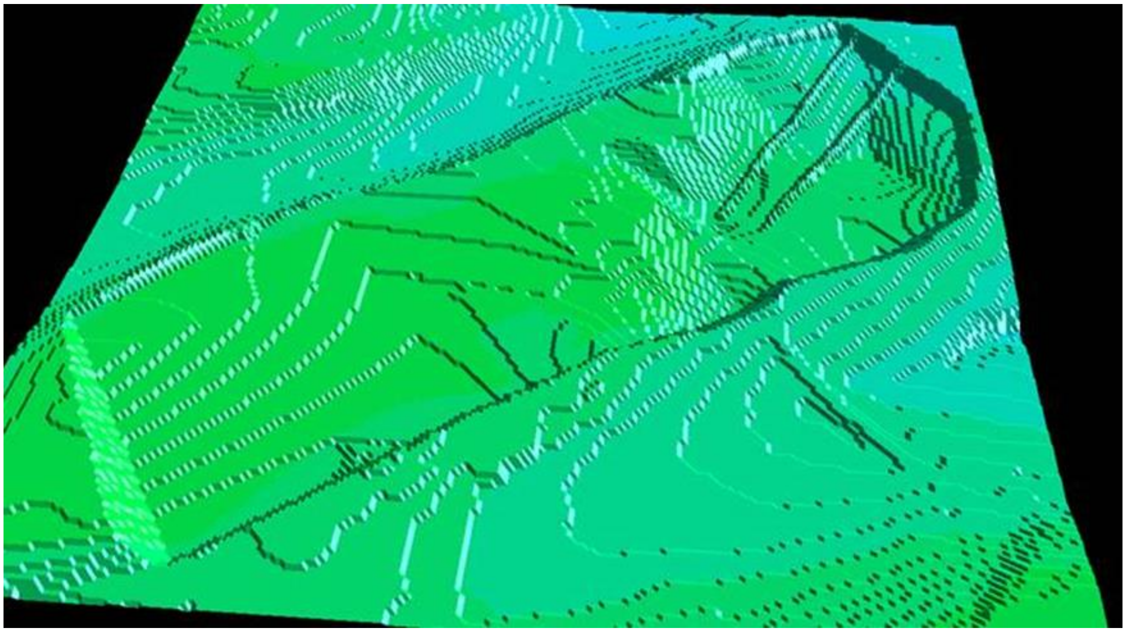
The high-grade silica sandstone deposit at surface open-pit constrained resources:

- 3,900,000 tonnes Measured @ 99.01% of SiO_2;
- 3,700,000 tonnes Indicated @ 98.92% of SiO_2;
- total of 7,600,000 tonnes M&I @ 98.96% of SiO_2 at a cut-off grade of 97% of SiO_2;
- 14,000,000 tonnes Inferred @ 98.97% of SiO_2.

Cautionary note: Mineral resources that are not mineral reserves have not demonstrated economic viability. Additional trenching and/or drilling will be required to convert inferred mineral resources to Indicated or Measured mineral resources. There is no certainty that the assumptions and forecasts used in this updated mineral resource report will be realized.

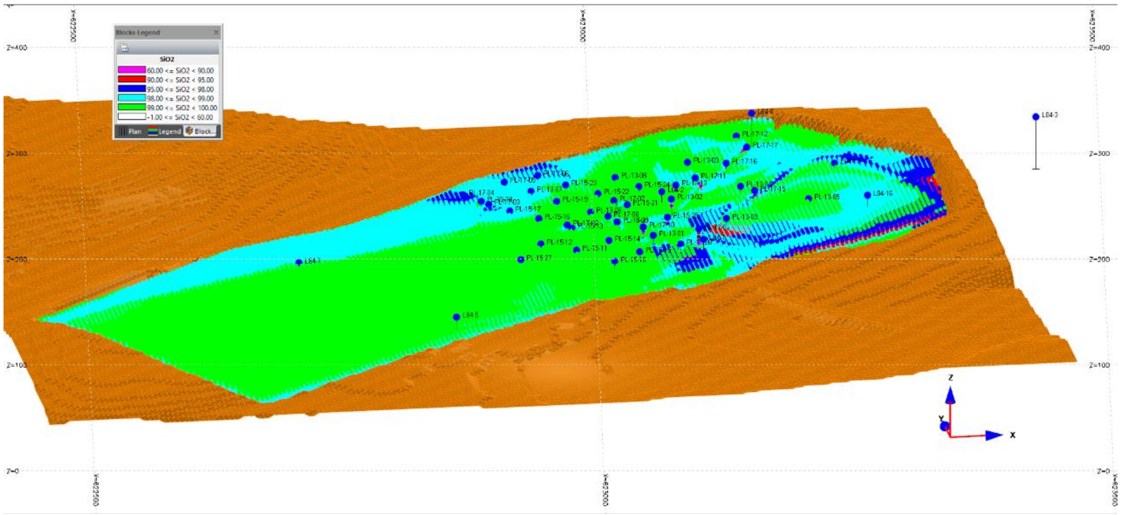
The next figure shows the pit optimization generated by MineSight® software and the block model in the pit shell within GENESIS®.

Figure 39: Perspective Views of Optimized Pit



Source: GoldMinds Geoservices Inc.

Figure 40: Perspective Views of Optimized Pit with Blocks Colour-Coded by the Percentage of SiO_2



Source: GoldMinds Geoservices Inc.

Globally, the morphology of the deposit is very favorable for the development of an open pit with no waste or a very low waste-to-mineralized material ratio. Quarrying could be started quickly at the northeast end of the old quarry, extending north-northeast. The overburden thickness averages approximately two meters. A thicker zone of overburden is located at the eastern edge of the deposit, where some waste material overlies the Lower White Sandstone.

14.7 Discussion and Risks

Other than the known standard risk in mineral resource project in Canada, the principal technical risk is in the market value of the product. For the mineral resources, there may be some changes in the amount of waste to be removed, if the additional faults in the inferred sectors have contaminated the sandstone to a point it cannot be blended. It has to be verified and measured in order to increase the quality of the inferred mineral resources. The estimate of Mineral Resources may be materially affected by mining, processing, metallurgical, infrastructure, economic, marketing, legal, environmental, social, and government factors.

On the positive side, the company has been able to obtain a BEX (Quarry Lease) from the MERN for a quarry with an attached CA from the Ministry of Environment of Quebec (MDDELCC). This has removed the risk of not being able to move forward in the development of the mineral resources. The permits do not encompass the whole resources but a portion of it. Modifications to the exiting permits with additional studies will be required to have access to the whole resources.

15. Mineral Reserve Estimates

The Open-Pit Mineral Reserves for the Langis Deposit, located in Saint-Vianney was prepared by Mr. Pierre-Garant Gagnon Mines & Geological Technologist, MineSight® software Specialist, and supervised by QP Mr. Claude Duplessis, P. Eng., both with GMG. Open-Pit Mineral Reserves have been developed using best practices in accordance with CIM guidelines and NI 43-101 reporting.

The effective date of the Mineral Reserve estimate is March 22nd, 2018.

The Mineral Reserves were derived from the Mineral Resource Block Model that was presented in section 14 of the mineral resource update report filed on February 5th, 2018. The Mineral Reserves are the Measured and Indicated Mineral Resources that have been identified as being economically extractable and which incorporate mining loses and mining dilution. The Mineral Reserves form the basis for the quarry plan presented in section 16.

All work related to the quarry pit design for the PFS was carried out utilizing MineSight® version 11.0. The 2016 PEA Study MineSight® data were used as a starting basis for this 2018 PFS report. Updates were made from this point forward for the geological block model, as discussed in section 14 of this report, as well as to the pit optimization, designs, and schedule, as discussed in section 16 below.

15.1 General Parameters Common to the Open-Pit Mineral Reserves

The following section discusses the geological information that was used for the quarry pit plans and mineral reserve estimate. This information includes the topographic surface, the geological block model and the material properties for ore, waste, and overburden.

The quarry planning work carried out for the PFS was done using MineSight® version 11.0.

15.1.1 Topographic Surface

The quarry pit design for this PFS was carried out utilizing a topographic surface elaborated in 2017 by WSP technical services. The existing site condition numeric surface was created by WSP using stereoscopic Aerial Photo dated 2015. The wireframe was checked to ensure coverage of the entire MineSight® project limits.

15.1.2 Resource Block Model

The quarry pit design for the PFS is based on the three-dimensional geological block model that was prepared by Mr. Claude Duplessis, P. Eng., within Genesis®, see section 14 of this report, then imported into MineSight® version 11.0. Each block in the model is 5 m (E-W) by 5 m (N-S) by 3 m (vertical). The 5 m E-W dimension corresponds to about 1/8 the minimum spacing between CME surface holes. The 3 m vertical accounts for the perceived greater grade variability across the strata. With fixed density of 2.33 t/m3, each full block (5 m x 5 m x 3 m) represents about 174.75 tonnes and it is assumed reasonable for the selective mining unit (SMU) or minimum size block which can be selectively extracted as mineralized material or waste in a future potential open-pit operation.

Each block in the model contains major elements SiO_2%, Fe_2O_3%, Al_2O_3%, MgO%, MnO%, K_2O%, CaO%, Na_2O%, TiO_2% grades, density, and resource classification (Measured, Indicated, and Inferred). Using the drill hole data, an overburden surface was interpreted; GMG differentiated the non-mineralized material as either overburden or waste rock.

15.1.3 Material Properties

The material properties for the different rock types are outlined below. These properties are important in estimating the Mineral Resources as well as the dump and stockpile design capacities.

15.1.3.1 Density

As was discussed in section 14 of this report, the in-situ dry density of the mineralized material is 2.33 t/m^3. Densities used for this study were 2.33 t/m^3 for all rock (below the OVB wireframe) and 2.0 t/m^3 for the overburden (above the OVB wireframe).

15.1.3.2 Swell Factor

The swell factor reflects the increase in volume of material from its in-situ state to after it is blasted and loaded into the haul trucks. A swell factor of 25% was used in this study, which is within a reasonable range for similar quarrying operations.

15.1.3.3 Moisture Content

The moisture content reflects the amount of water that is present within the rock formation. It affects the estimation of haul truck requirements and should be considered during the payload calculations. A moisture content of 6% is assumed for this study.

The Mineral Reserves are estimated using the dry density; therefore, they are not affected by the moisture content value.

15.2 Open-Pit Mineral Reserves

15.2.1 Open-Pit Optimization

The first step in the mineral reserve estimate is to carry out a pit optimization analysis. This optimization uses economic criteria to determine the cut-off grade and to what extent the deposit can be quarried profitably.

The pit optimization analysis was done using the MineSight® Economic Planner (MSEP) module of MineSight® version 11.0. The optimizer uses the 3D Lerchs-Grossmann algorithm to determine the economic pit limits based on input of costs and revenue per block. The optimization was limited to proximity of 10 m from the Property limits. As per NI 43-101 guidelines regarding the Standards of Disclosure for Mineral Projects, only blocks classified in the Measured and Indicated categories drove the pit optimizer for this study. Inferred resource blocks are treated as waste, bearing no economic value.

The following Table 25 presents the parameters that were used for the pit optimization analysis. All figures are in Canadian dollars. The cost and operating parameters that were used are preliminary estimates for developing the economic pit and should not be confused with the operating costs subsequently developed for the PFS and presented in section 21.

The processing costs are quarry costs for crushing and screening of the sandstone. Selling price assumption is for crushed and screened product.

Table 25: Pit Optimization Parameters

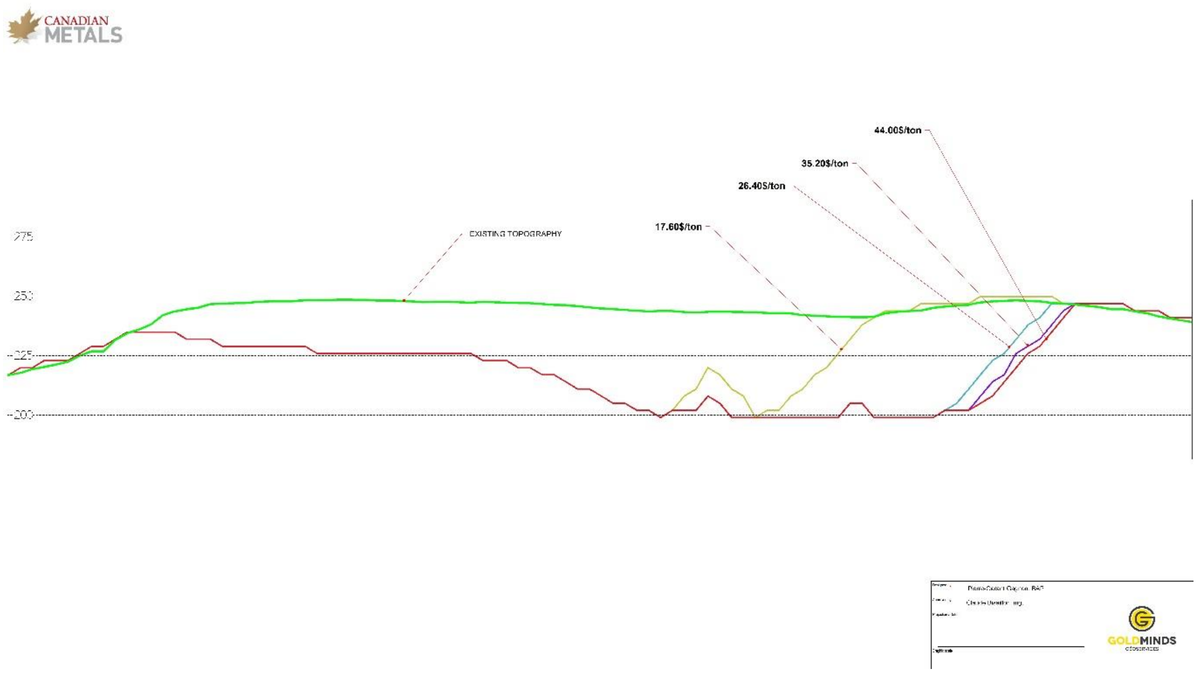
Item	Value	Units
Mining cost—ore and waste	5.00	$/t (quarried)
Processing cost	10.00	$/t
Quarry recovery	95.0	%
%SiO_2 cut-off grade	97.0	%
Overall pit slope	45	degree
Material density	2.33	t/m3
Selling price assumption	44	$/t
Limiting resource classification	Measured and Indicated	
Pit design method	Lerchs-Grossmann	

Source: GoldMinds Geoservices Inc.

The pit optimization analyses considered the SiO_2% grade without considering mining dilution, which is accounted for at a later stage. Mining dilution is discussed in the next section of this report.

Using the cost and operating parameters, a series of four (4) pit shells was generated by varying the selling cost of $44/tm from 40%, 60%, 80%, and 100% of the agreed upon selling price for the determination of reasonable prospect of economic extraction in the mineral resources estimates update. Figure 41 shows a typical section through the Langis deposit displaying the four pit shells.

Figure 41: Pit Optimization Shells



Source: GoldMinds Geoservices Inc.

15.2.2 Pit Optimization Results

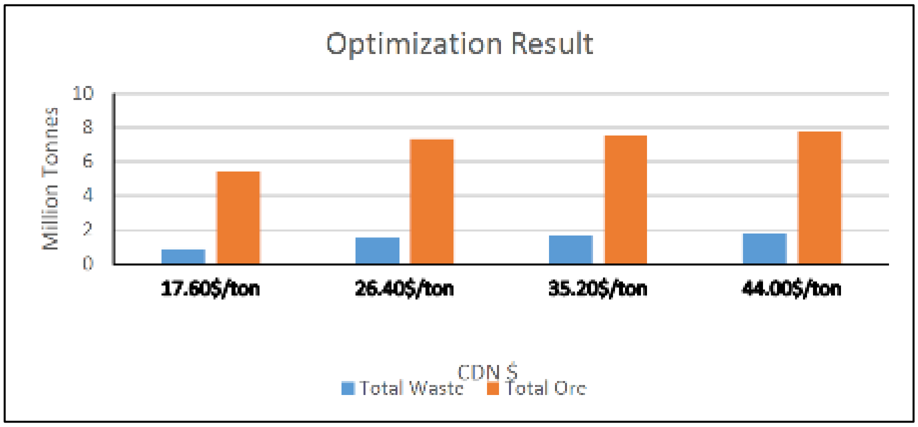
A summary of the generated set of pit shells is presented in Table 26 and Figure 42.

Table 26: Optimized Pit Shells

Percentage of the Selling Price	Selling Price (CAN$)	Total Silica (kt)	Total Waste (kt)	Percentage of the SiO_2	Strip Ratio
0.4	17.6	5,409	862	98.97	0.16
0.6	26.4	7,329	1,535	98.95	0.21
0.8	35.2	7,524	1,634	98.95	0.22
1.0	44.0	7,756	1,759	98.95	0.23

Source: GoldMinds Geoservices Inc.

Figure 42: Optimization Results by Selling Price

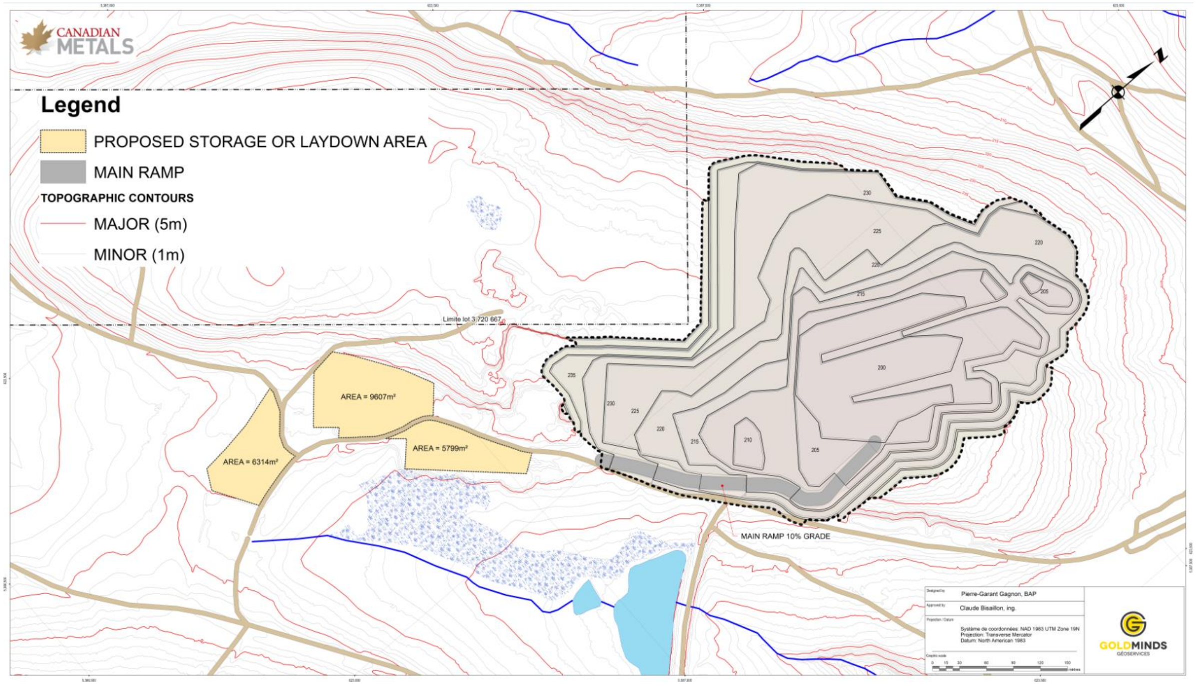


Source: GoldMinds Geoservices Inc.

The optimization with reduced selling price shows that most of the tonnage is extracted even at $26.4/tonne. The deposit is not sensitive between $26.4 and $44 per tonne. This means that CME quarry could run on lower selling price than $44/t without affecting the access to the mineral resources.

Figure 43 shows the conceptual final Langis quarry in year 28, showing the relationship between quarry location with respect to Property limit, current access roads, as well as potential locations for stockpiling and current access roads.

Figure 43: Conceptual Final Quarry (Year 28)



Source: GoldMinds Geoservices Inc.

15.2.3 Cut-Off Grade

The cut-off grade is used to determine whether the material being quarried will generate a profit after paying for the drilling, blasting, loading, haulage, processing, as well as General and Administration costs. Material that is quarried below the cut-off grade is sent to the waste dump. A cut-off grade of 97% SiO_2 was considered for mineral reserve estimations in order to supply the appropriate grade to the plant. The material below 97% SiO_2 could be used for other purposes; material between 90 and 97% is tabulated and will be sold as aggregate. Material below 90% SiO_2 could also be used for construction material but is considered as waste in the current study for ferrosilicon plant feed.

15.2.4 Open-Pit Design

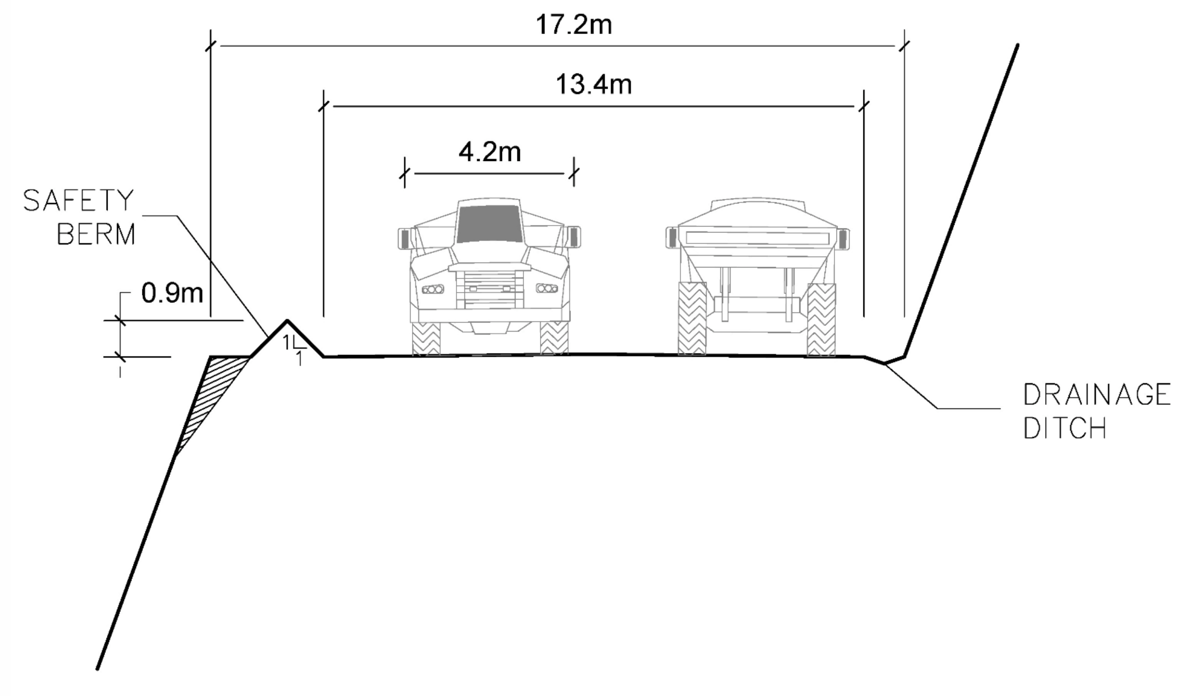
The second step in the Mineral Reserve estimation process is to design an operational pit that will form the basis of the production plan. This pit design uses the pit shell as a guideline and includes smoothing the pit wall, adding ramps to access the pit bottom and ensuring that the pit can be quarried using the initially selected equipment. The following section provides the parameters that were used for the open-pit design and presents the results.

15.2.4.1 Haul Road Design

The ramps and haul roads were designed with an overall width of 17.2 m. For double-lane traffic, industry practice and regulations indicate the running surface width to be a minimum of three (3) times the width of the largest truck. The overall width of a 45-tonne articulated haul truck is 4.2 m, which results in a running surface of 14.1 m. The allowance for berms and ditches increases the overall haul road width to 17.2 m. The road width was designed a tad larger to allow access to larger trucks. The quarried and crushed material will be transported (+20 -120 mm) to the smelter in Baie-Comeau via Matane by large trucks, and they may at some point need to access specific benches depending on the location of the crushing station.

A maximum ramp grade of 10% was used. This grade is acceptable for a 45-tonne articulated haul truck. Figure 44 presents a typical section of the in-pit ramp design.

Figure 44: Haul Ramp Design



Source: GoldMinds Geoservices Inc.

15.2.4.2 Quarry Dilution and Ore Loss

In every quarry operation, it is impossible to perfectly separate the ore and waste, as a result of the large scale of the quarry equipment and the use of drilling and blasting. The relatively flat bedding of the sandstone as well as the ease to identify and separate the bad horizons, no dilution was applied at this stage. Ore loss is being dealt with on the crushing side. Material <20 mm, expected to be around 25% of ore processed (Run of Mine), will be set aside in a stockpile for further use.

15.2.4.3 Minimum Quarry Width

A minimum quarry width of 25 m was considered for the open-pit design. This is based on a 9.1-m turning radius for a 45-tonne articulated haul truck plus several meters on each side for safety.

15.2.5 Open-Pit Design Results

The pit designed for the Langis Deposit consists of only one (1) phase in size and grade. The final pit is approximately 350 m long with minimum and maximum width at surface of 100 and 225 m respectively, and a maximum pit depth from surface of 47 m. The total footprint of the quarry is expected to be around 118,000 m^2. The overburden thickness varies between 2 and 3 m with an average of 2.5 m.

The pit considers a single permanent access ramp located on the east side. The deepest part of the open pit is at an elevation of 200 m at a depth of 47 m below original surface. The open-pit design is constrained by the Property limits to the west.

15.2.6 Open-Pit Mineral Reserves Estimate

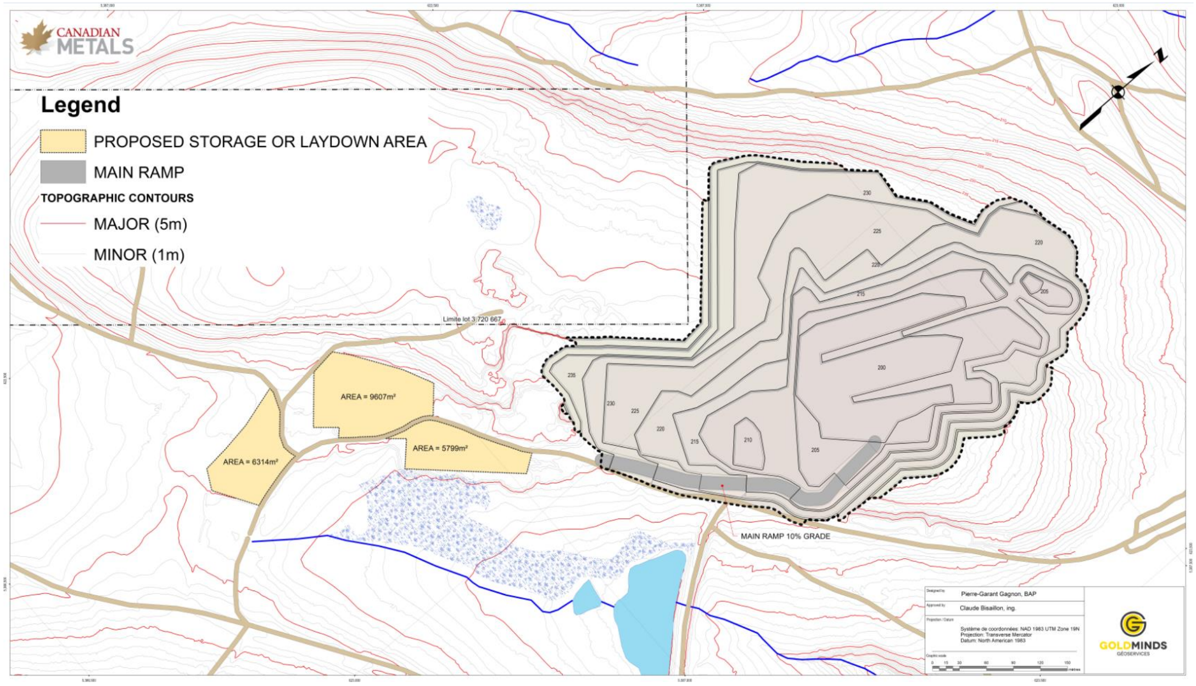
The open-pit design includes 6.3 Mt of probable & proven mineral reserves at a grade of 98.96% SiO_2 rounded to 99% SiO_2. In order to access these reserves, 0.8 Mt of overburden and 2.6 Mt of waste rock will need to be removed. This results in a stripping ratio (waste to ore) of 0.41. Table 27 presents the open-pit reserves for the Langis deposit and Figure 45 shows the final pit in 28 years.

Table 27: Open-Pit Mineral Reserves

Category	Tonnage	SiO_2 Grade (%)
Proven	3.5 Mt	99.0
Probable	2.8 Mt	99.0
Proven & probable	6.3 Mt	99.0

Source: GoldMinds Geoservices Inc.

Figure 45: Conceptual Open-Pit Design



Source: GoldMinds Geoservices Inc.

16.Mining Methods

16.1 Open-Pit Quarry

16.1.1 Open-Pit Quarry Method

The quarry operations method selected for the project is a conventional open-pit, truck and shovel, drill and blast operation. Vegetation, topsoil, and overburden will be stripped and stockpiled for future reclamation use. The ore and waste rock will be quarried considering twelve (12) 5-m high benches, drilled, blasted, and loaded into articulated haul trucks with hydraulic excavators and/or wheel loaders.

16.1.2 Geotechnical Slope Parameters

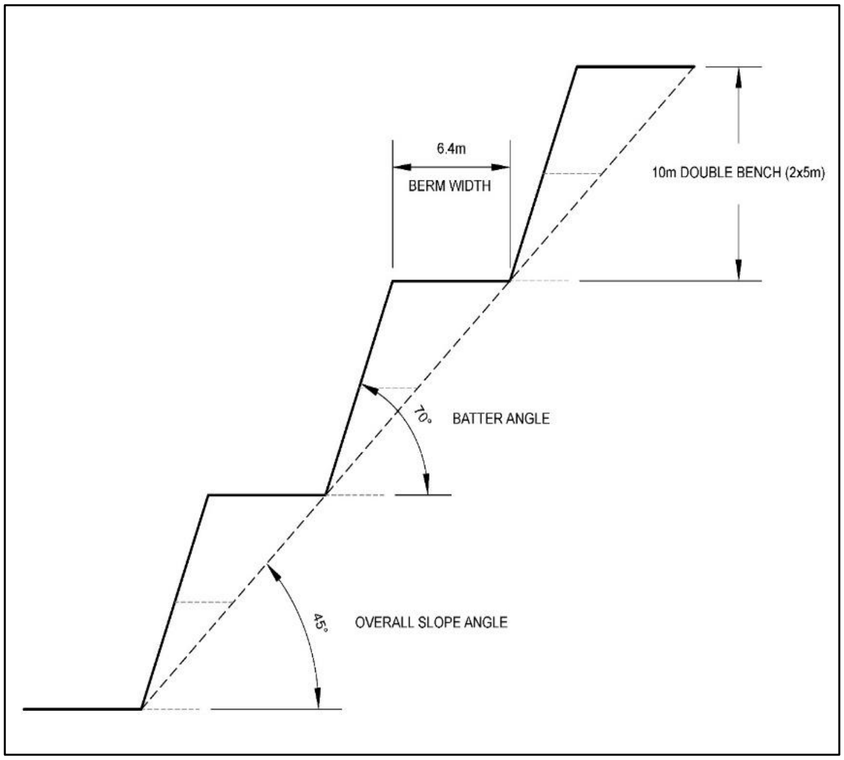
No geotechnical study has been specifically done but past performance of the old quarry walls indicate that no specific geotechnical issues will affect the pit slopes. The rock has a high RQD value. Further studies may be necessary if plans are to deepen the quarry or go below the water table.

Table 28: Pit Slope Reserves

Parameter	Value
General angle of slope (°)	45.0
Batter slope (°)	70.0
Berm width (m)	6.4
Batter height (m)	5.0 (10)
Road width (m)	17.2
Road gradient (%)	10

Source: GoldMinds Geoservices Inc.

Figure 46: Pit Design



Source: GoldMinds Geoservices Inc.

The recommended slope through the overburden is 25° with a 10-m wide catch bench at the overburden bedrock contact.

An updated pit slope design should be considered in the next level of study. An increase in the overall pit slope angle provides opportunity as a reduction in overall pit strip ratio that can help reduce mining costs.

16.1.3 Hydrogeology and Hydrology Parameters

Very little is known about the potential water sources that may affect the quarry operation. Further studies on surface run-off, rainfall, snowmelt, and groundwater should be performed. The quantity for each of these sources of water will need to be estimated in the next stage of study in order to calculate the quarry pit dewatering requirements.

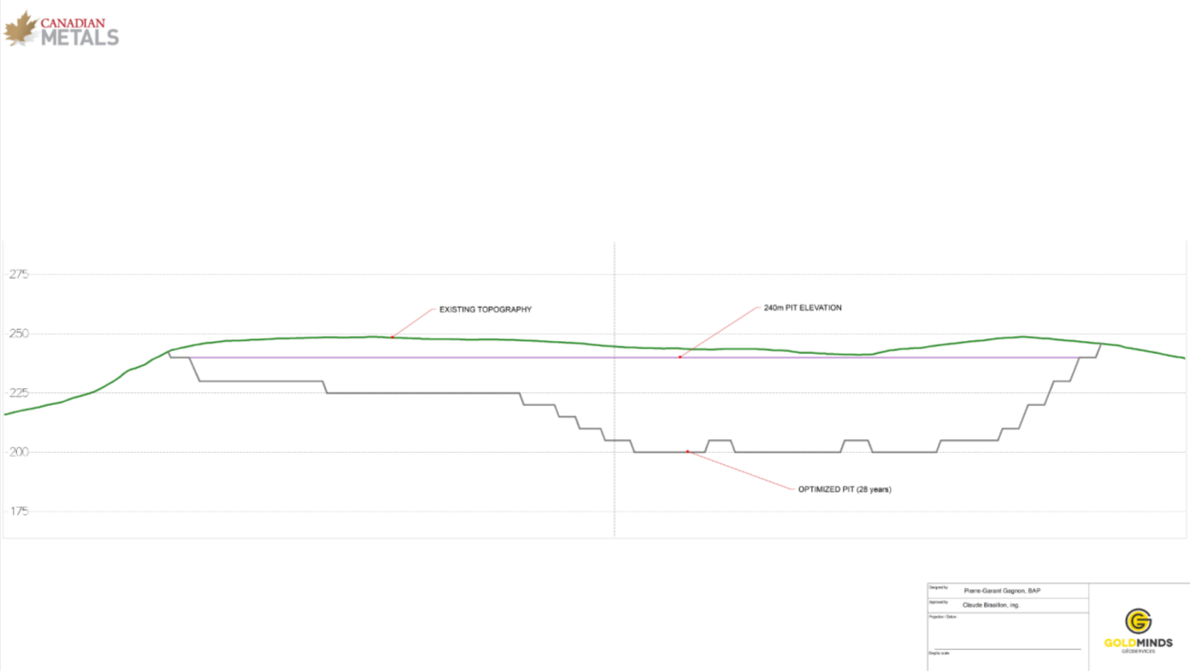
16.1.4 Property Limits

The pit design has been done respecting the Property limits at the time. During the PFS, it was realized that the Property limits could be extended to the west to reach additional mineral resources. The Property extension should be considered in the next stage of the study.

16.1.5 Phase Design

The pit was designed in two phases. The phase 1 (years 1 to 5) is intended to quarry all the available material down to the 240-m level, slightly above the water table at 235 m (see E-W section on Figure 47), effectively reaching the full lateral footprint of the quarry. Phase 2 is designed to bench down below the presently known location of the water table. Exact volume of water needing to be pumped out is still unknown and will have to be addressed in the next stage of the study.

Figure 47: East-West Section showing two Phases (above and below expected Water Table)



Source: GoldMinds Geoservices Inc.

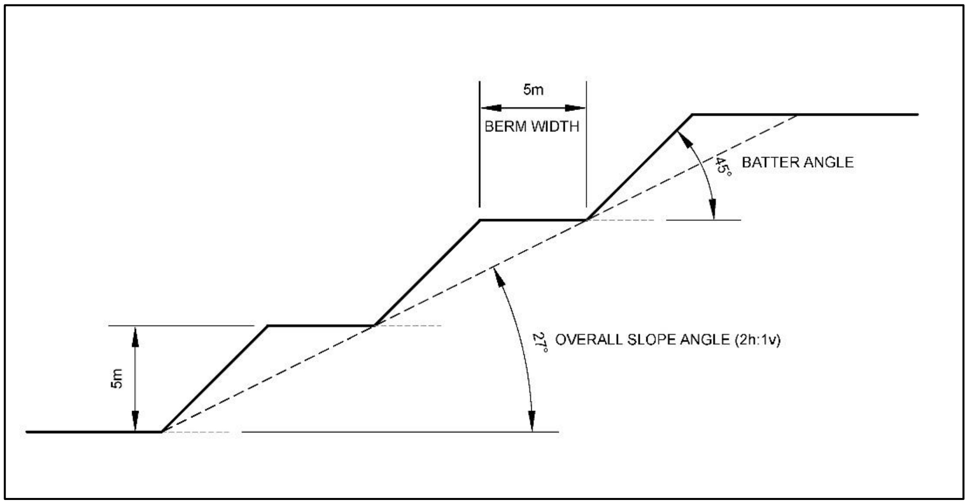
16.1.6 Stockpile Design

All stockpile designs consider four (4) m safety berms to comply with Quebec Regulation respecting pits and quarries (R.R.Q., 1981, c. Q-2, r. 2, s. 39).

The overburden stockpile is designed on the southwest of the pit. It is designed considering 5-m lifts with an overall slope of 26.6° (2H : 1V). Material placed in this stockpile is designated for future reclamation.

The waste dump and in-pit backfilling (from year 5 on) was also designed considering 5-m lift heights and an overall slope of 26.6° (2H : 1V). The waste material will be put in two areas. Years 1 to 5, the waste will be stockpiled in a dump located immediately west of the quarry. This dump is parallel to the “colline” and along the neighbouring Property limit, and also included the former quarry. After year 5, waste material will be backfilled into the pit in several areas depending on space and time availability. Backfilling the quarry is done in parallel with progressive reclamation.

Figure 48: Waste Dump Design



Source: GoldMinds Geoservices Inc.

A low-grade material stockpile is designed on the south side of the pit. See Table 29 for the volume of waste material generated by the quarry, based on tonnages and converted from banked cubic meters (bcm) to loose cubic meters (lcm) with SG of 2.0t/bcm for overburden and 2.33t/bcm for rock, and a swell factor of 25%. Although a low-grade product has not been included in the resource estimate, the sterile waste and a low-grade waste have been separated for stockpile design and scheduling purposes, for the possibility of future potential marketed products. This provides options for future decisions and takes advantage of available space within the permit area near the contractor's crushing location. The report presents the situation where all fines (25% of ROM crushed and screen rejects) plus the waste are totally stored at the site.

Table 29: Waste Volume by Material

	Grade Stockpile k lcm	OVB Stockpile k lcm	Waste Rock Stockpile k lcm	Total Stockpiles k lcm
TOTAL	3,556	436	1,960	5,952

Source: GoldMinds Geoservices Inc.

Backfilling of waste material in the pit is considered to reduce the environmental footprint of the project. As a result, most material mined after year 6 will be placed in-pit, given the current quarry plan.

16.2 Quarry Operations Planning

The quarry plan forms the basis of the economic cash flow quarry capital and operating cost estimate presented in section 22. The quarry plan was established annually for the first five years of production, followed by two five-year periods for the remaining ten years of the 28-year plan.

16.2.1 Contract Operator

Based on client's request, contract operation was used as a basis for the PFS Study, and GMG was provided with four (4) budgetary pricings from different regional contractors after running RFP for the turnkey operation of the quarry based on the required tonnage.

16.2.2 Quarry Operations Planning Parameters

The contractor will operate a seasonal quarry operation with five (5) days per week, eleven (11) hours per day, five (5) months of the year during the warmer seasons. Tree cutting and overburden removal may take place during the winter to take advantage of the frozen ground conditions if necessary.

16.2.2.1 Work Schedule

Quarry operations for the Langis quarry will be for five (5) months per year (warmer months), operating five (5) days per week, eleven (11) hours per day.

16.2.2.2 Annual Production Requirements

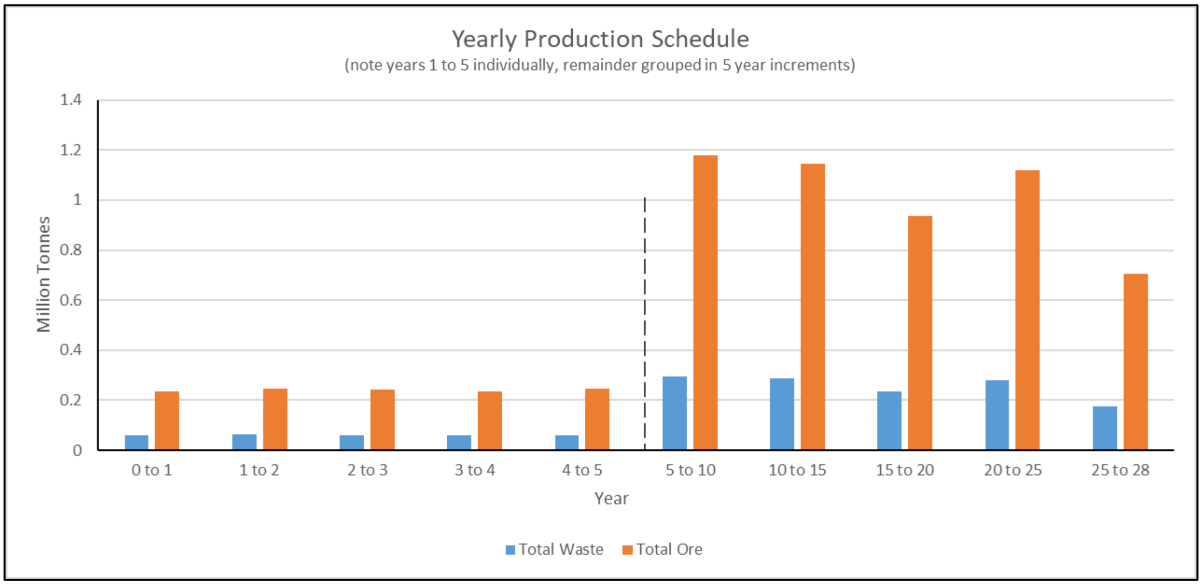
In this study, the quarry has to supply 162,680 tonnes of lump (+20 mm to -120 mm) per year. To achieve this requirement, it is necessary to consider the estimated crushing and screening yield of 75%, which bring the tonnage required to 203,350 plus a 10% buffer. This finally brings the target of annual extraction to 223,685 rounded at 225,000 tonnes of sandstone per year. It is expected that up to 25% (56,250 tonnes) of the production will be lost in fines during crushing and screening process to prepare the +20 mm to -120 mm plant feed, not suitable for the furnace, i.e. a yield of 75%. This material that is lower than 20 mm will be sold to a regional company as additive. Actual discussions see 75% of the fines sold at $32.50 per tonne as well as the waste material between 90-97% SiO_2 sold as well at $32.50 per tonne as regular aggregate at the moment of writing this report. This situation may change, and higher price could be achieved; these are base prices that can be publicly disclosed with public comparable. A limited amount of fines and aggregates is taken as a secondary commercial product in the study. All the quarry plan and waste/rejects storage sequence assume zero valuation of fines and waste to confirm the management is possible in the worst case, if no secondary product is sold.

16.2.3 Quarry Production Schedule

The following table presents the quarry production schedule that was developed for the 28-year life of the quarry. This schedule does not include pre-production phase required for pit development, since a starter pit already exists.

The total sandstone quarried per year during the 28-year period ranges from 187,000 to 247,000 metric tonnes (averaging 231,000 metric tonnes). Figure 49 represents a chart showing the projected tonnages quarried each year.

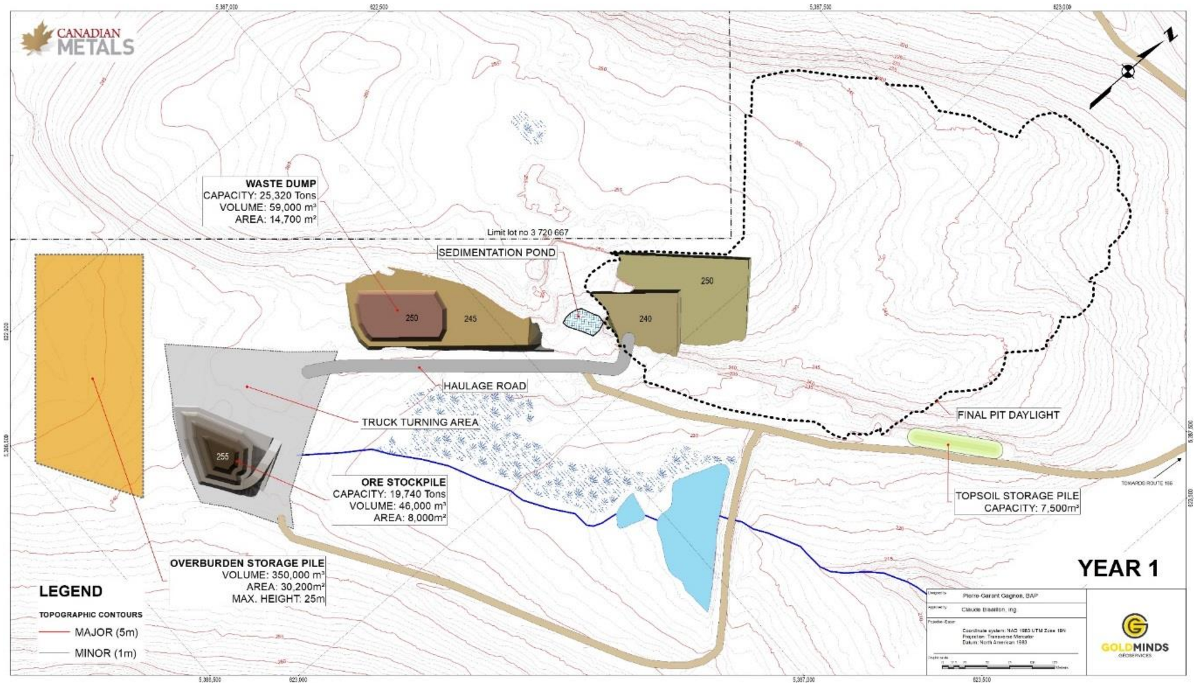
Figure 49: Yearly Production



Source: GoldMinds Geoservices Inc.

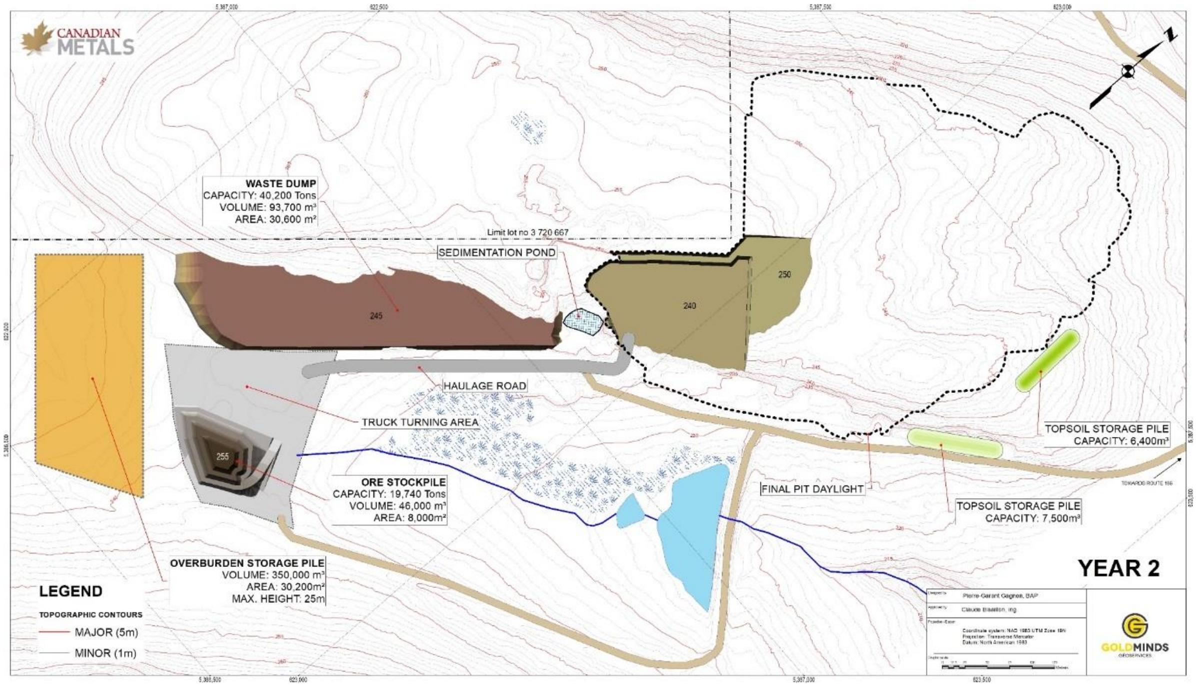
Figures 50 to 59 show the pit, waste pile, and overburden stockpile advances on years 1 to 5, 10, 15, 20, and 25 as well as the final pit configuration.

Figure 50: Year 0 to 1



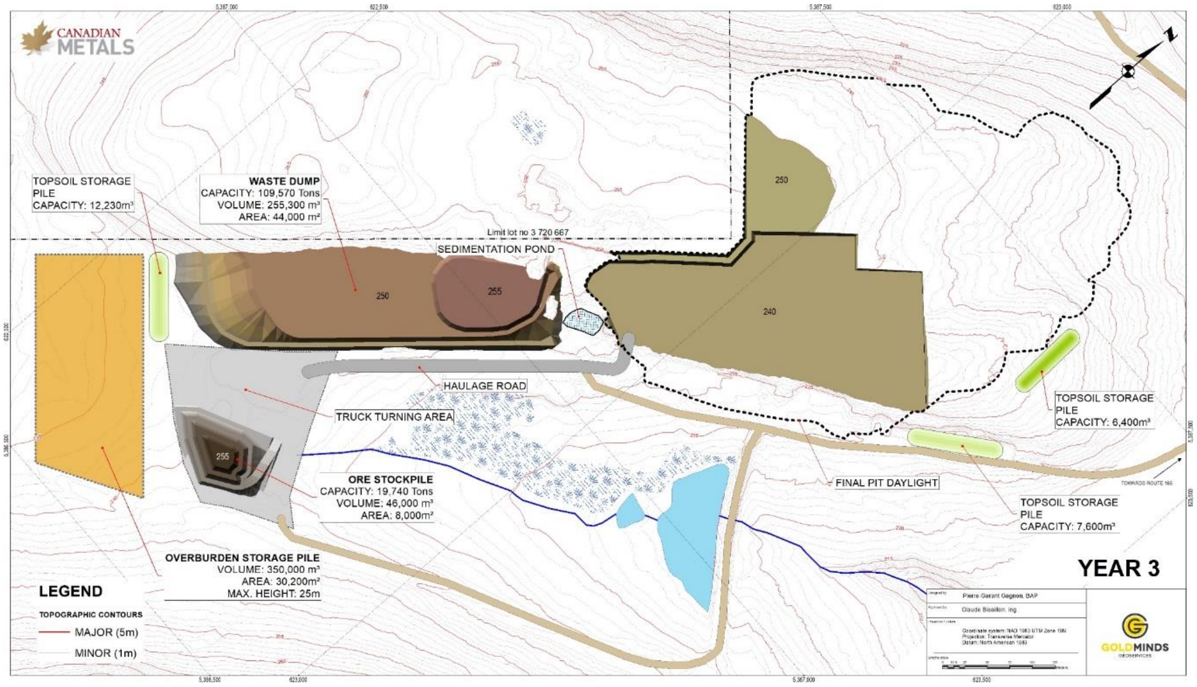
Source: GoldMinds Geoservices Inc.

Figure 51: Year 1 to 2



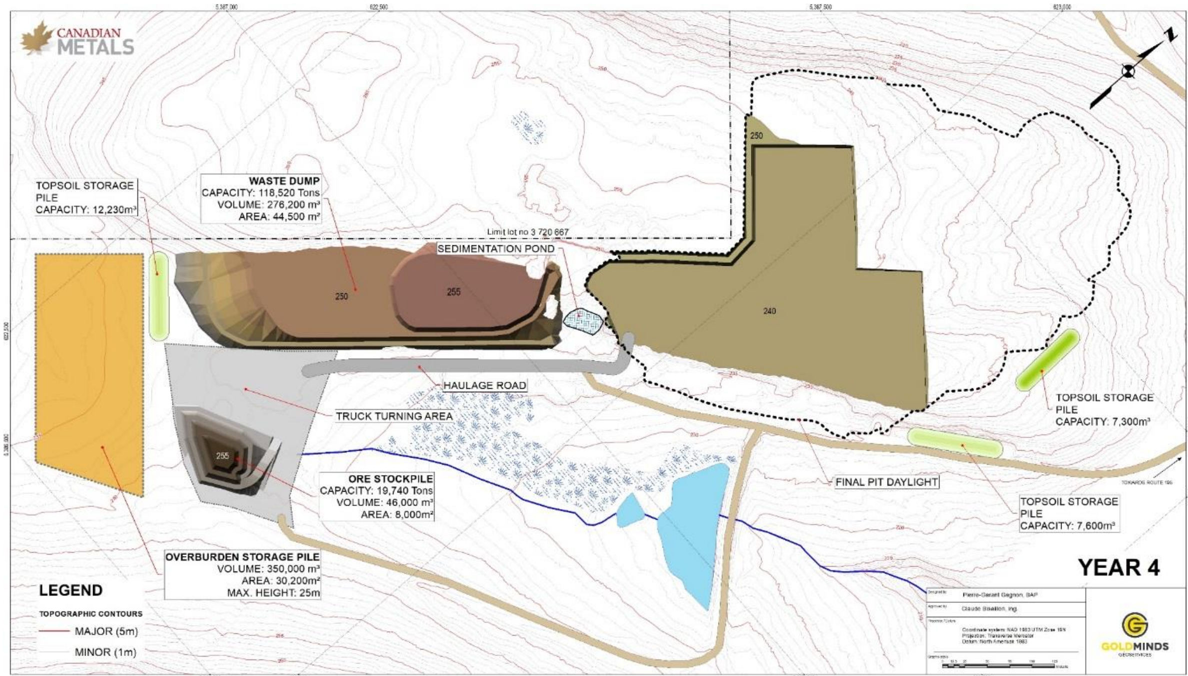
Source: GoldMinds Geoservices Inc.

Figure 52: Year 2 to 3



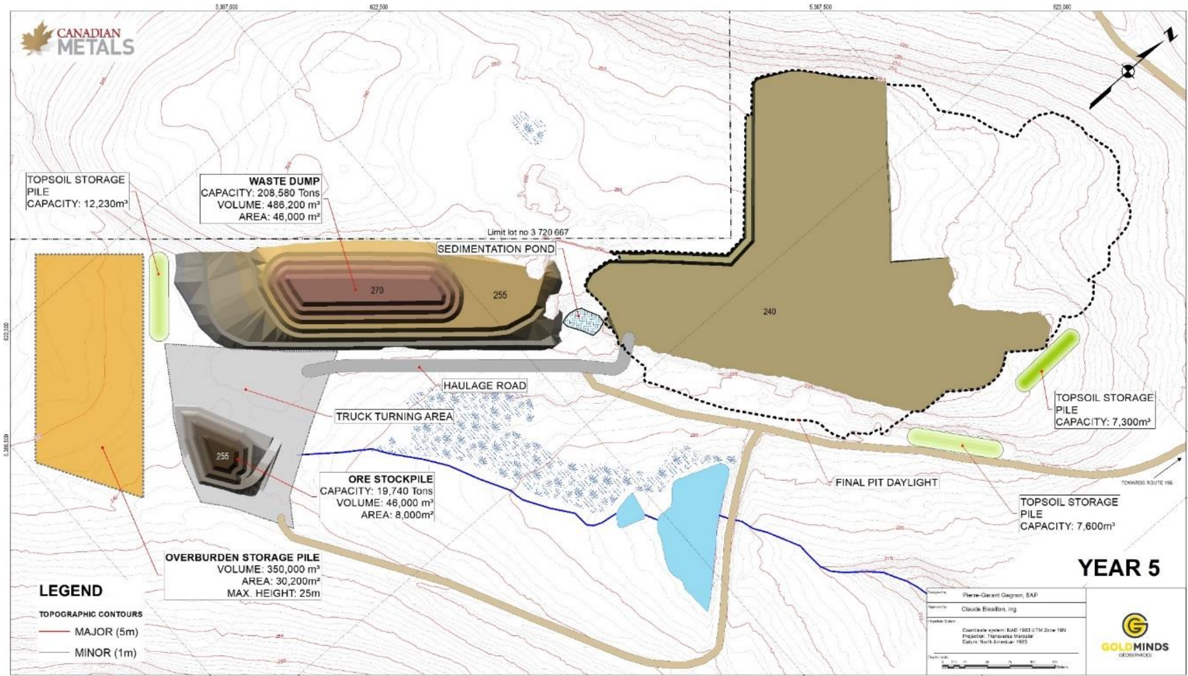
Source: GoldMinds Geoservices Inc.

Figure 53: Year 3 to 4



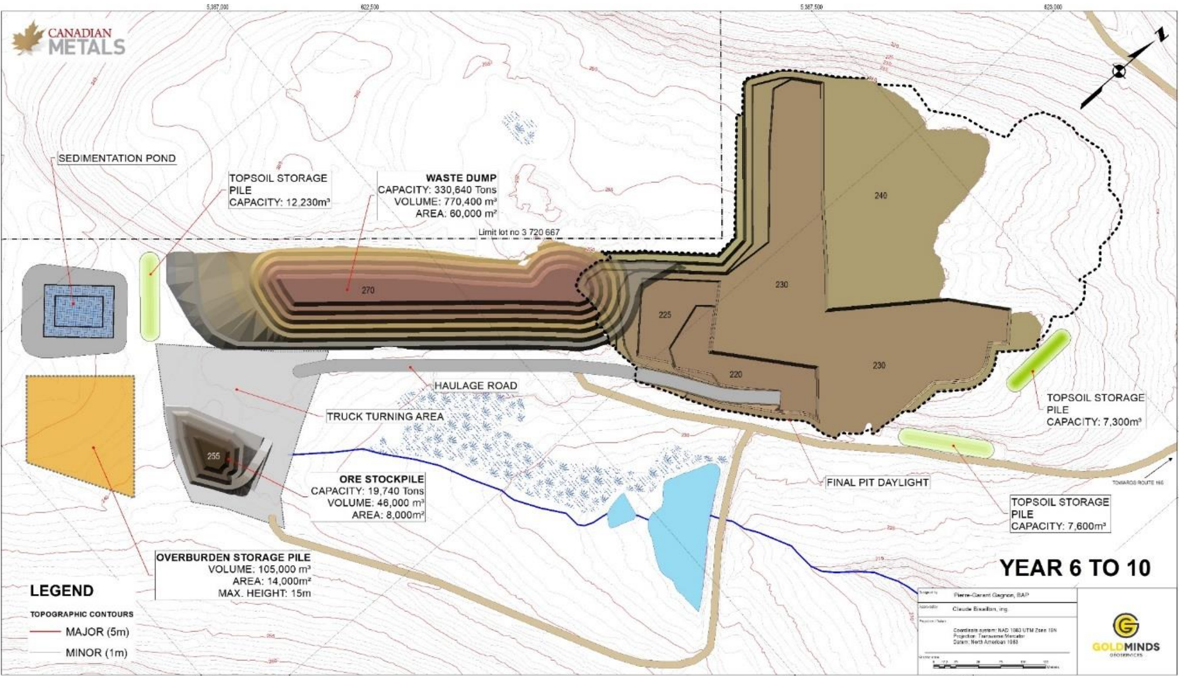
Source: GoldMinds Geoservices Inc.

Figure 54: Year 4 to 5



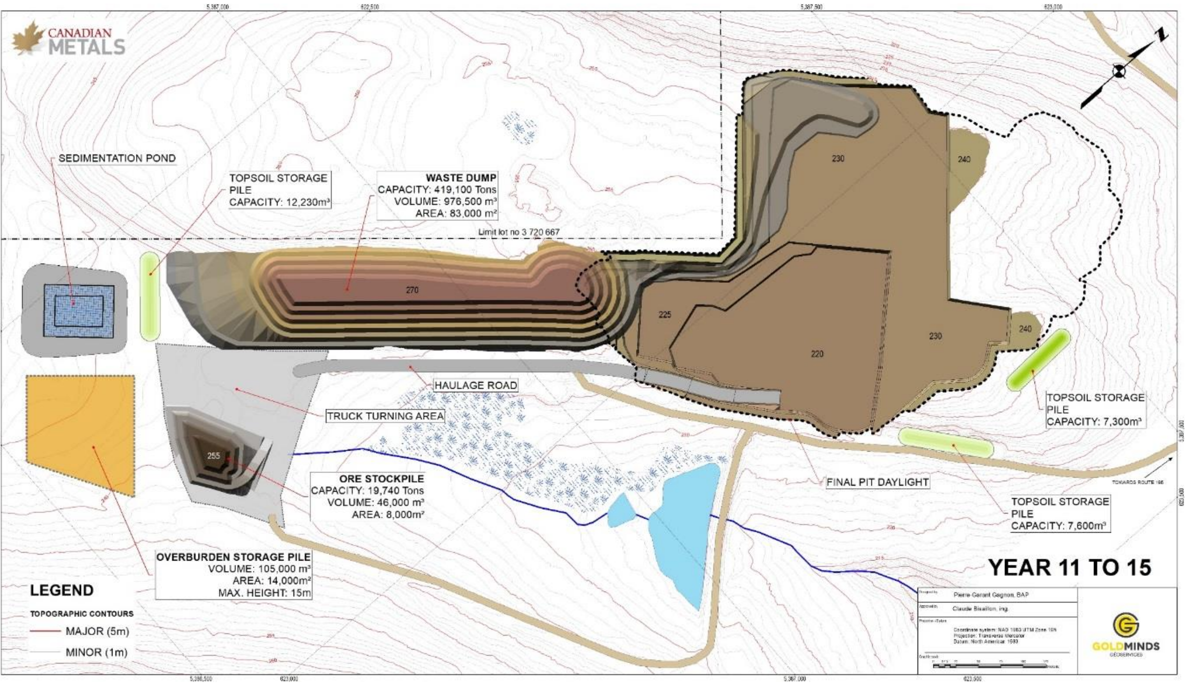
Source: GoldMinds Geoservices Inc.

Figure 55: Years 6 to 10



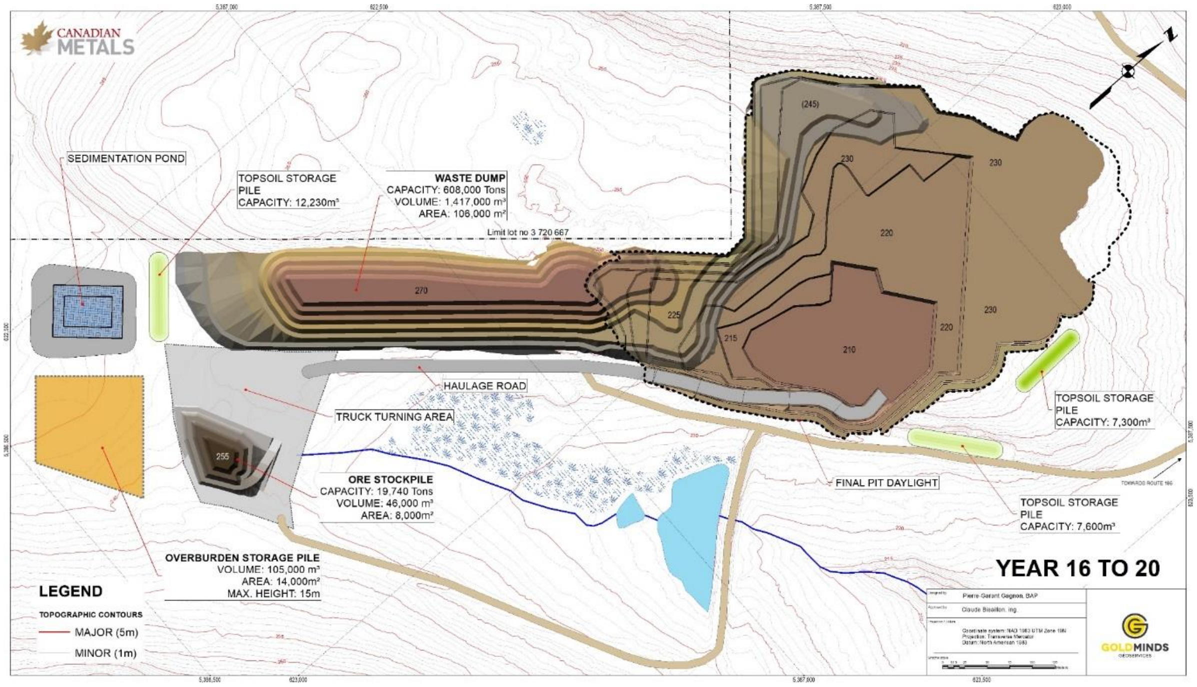
Source: GoldMinds Geoservices Inc.

Figure 56: Years 11 to 15



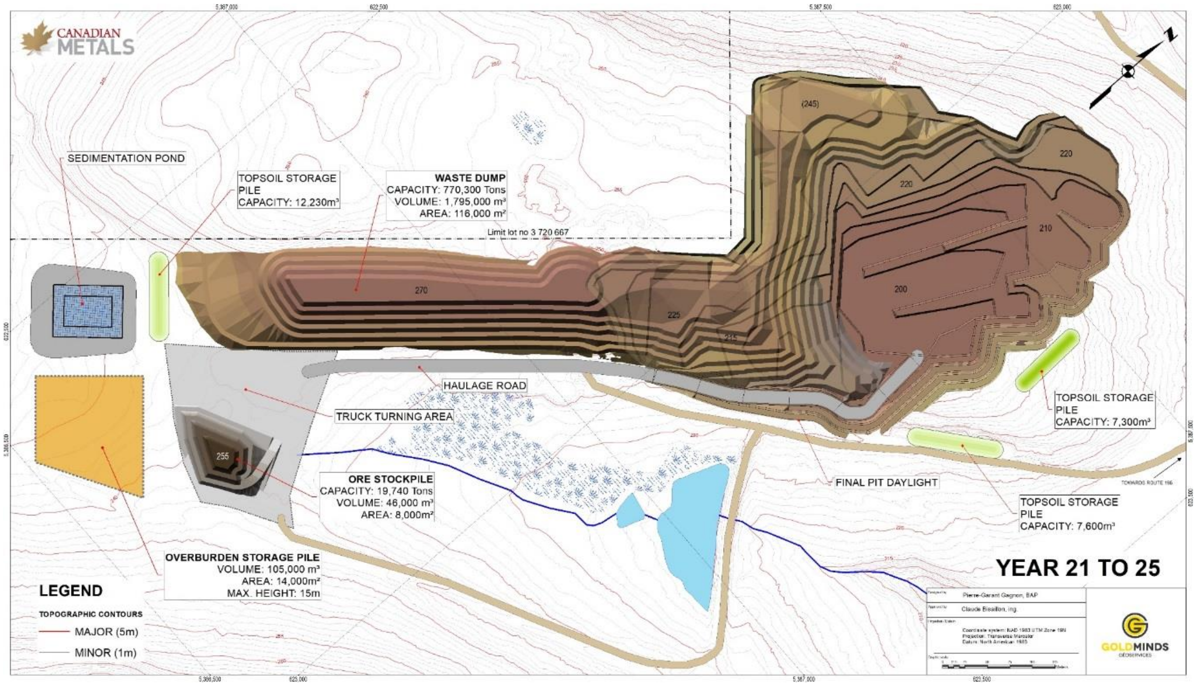
Source: GoldMinds Geoservices Inc.

Figure 57: Years 16 to 20



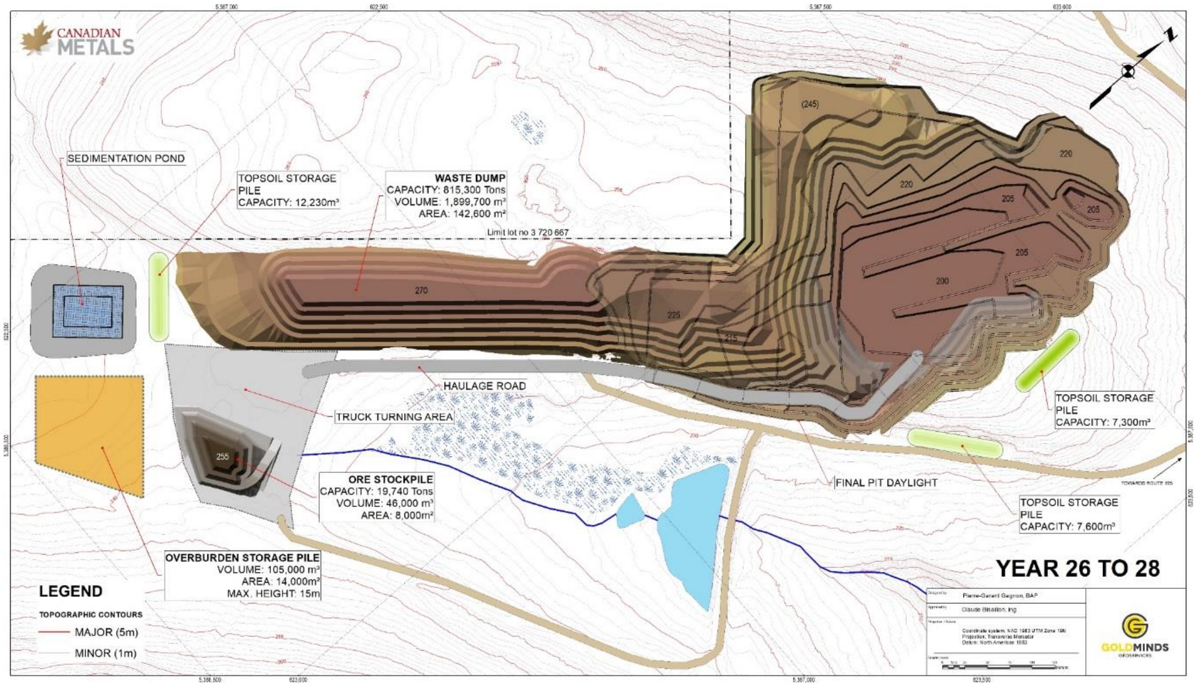
Source: GoldMinds Geoservices Inc.

Figure 58: Years 21 to 25



Source: GoldMinds Geoservices Inc.

Figure 59: Years 26 to 28



Source: GoldMinds Geoservices Inc.

Table 30: Quarry Plan Tonnage

BENCH→	**1**	250 - 260m			**2**	240 - 250m			**3**	230 - 240m			**4**	220 - 230m			**5**	210 - 220m			**6**	200 - 210m					Ratio
Period (years)↓	**ore (tons)**	waste (tons)	waste (m³)	ore+waste	**ore (tons)**	waste (tons)	waste (m³)	ore+waste	**ore (tons)**	waste (tons)	waste (m³)	ore+waste	**ore (tons)**	waste (tons)	waste (m³)	ore+waste	**ore (tons)**	waste (tons)	waste (m³)	ore+waste	**ore (tons)**	ste (tons)	aste (m³)	ore+waste	TOTAL Ore	Total Waste	W/O
0 to 1	**161 370**	50 616	21 724	211 986	**74 805**	15 721	6 747	90 526	**-**	-		-	**-**	-		-	**-**	-		-	**-**	-		-	**236 175**	66 337	0,28
1 to 2	**16 321**	10 946	4 698	27 267	**230 942**	22 825	9 796	253 768	**-**	-		-	**-**	-		-	**-**	-		-	**-**	-		-	**247 263**	33 771	0,14
2 to 3	**36 675**	11 544	4 955	48 220	**206 408**	319 531	137 138	525 938	**-**	-		-	**-**	-		-	**-**	-		-	**-**	-		-	**243 083**	331 075	1,36
3 to 4					**236 230**	13 178	5 656	249 408	**-**	-		-	**-**	-		-	**-**	-		-	**-**	-		-	**236 230**	13 178	0,06
4 to 5					**244 821**	150 725	64 689	395 546	**-**	-		-	**-**	-		-	**-**	-		-	**-**	-		-	**244 821**	150 725	0,62
5 to 10					**46 828**	30 816	13 226	77 645	**960 492**	547 823	235 117	1 508 315	**170 171**	94 326	40 483	264 497	**-**	-		-	**-**	-		-	**1 177 491**	672 965	0,57
10 to 15									**673 591**	92 840	39 845	766 431	**472 617**	135 526	58 166	608 143	**-**	-		-	**-**	-		-	**1 146 208**	228 366	0,20
15 to 20									**172 583**	89 227	38 295	261 811	**303 847**	218 694	93 860	522 541	**458 999**	116 082	49 821	575 081	**-**	-		-	**935 429**	424 003	0,45
20 to 25													**557 900**	433 008	185 840	990 908	**562 499**	133 580	57 330	696 080	**-**	-		-	**1 120 399**	566 588	0,51
25 to 28																	**157 786**	71 373	30 632	229 158	**548 562**			548 562	**706 348**	71 373	0,10
Total																									**6 293 447**	2 558 381	0,41

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16.3 Quarry Equipment Fleet

Although the quarry will be operated by a contractor, the following section presents the mine equipment selection and methodology that was used to estimate the fleet requirements and manpower from the owner operated perspective. The owner fleet is based on five (5) months, 22 days per month, Monday to Friday operations from 7 am to 6 pm. The following table identifies the quarry fleet for year 6 of the quarry plan to give an appreciation of the size of the operation.

Table 31: Quarry Equipment Year 6

Equipment	Typical Model	Short Description	Units required
Major Equipment			
Haul Truck	CAT 745, CAT 735, Or Komatsu HM400-5	40-45 t articulated haul trucks, 40-41 t payload, 24-25 m^3 heaped load	3-5
Wheeled loader	CAT 980H, 988H or 966 H	Bucket capacity from 4.3 to 8.2 m^3	2
Production drill	Panterra DP 1500i	114 mm hole	2-3
Support Equipment			
Track Dozer	D6T	Dozer for pond construction, pushing material and other	2
Road Grader	Road cleaning	1	
Fuel and Lube Truck	Operational support	1	
Pickup Truck	Ford F250, Dodge Ram, etc.	To carry personnel around and for general use around the quarry	3
Dewatering Pump	Pumping requirements still under consideration	2	

Source: GoldMinds Geoservices Inc.

16.3.1 Haul Trucks

The haul trucks selected for the project is an articulated frame mining truck with a 45-tonne payload. This size of truck was chosen to match the production requirements, and results in a manageable fleet size. Several parameters were used to calculate the number of trucks required to carry out the quarry plan by the contractor:

- Mechanical availability—90%;
- Utilization—90%;
- Nominal payload—45 tonnes (33.8 m^3 heaped);
- Shift schedule–one 11-hour shift per day, five (5) days per week;
- Operational delays—70 min/shift (includes equipment inspection and lunch time, while fueling will be carried out during off hours);
- Job efficiency—95% (57 min/hr; represents lost time due to haul road interference and queuing at shovels).

Table 32: Haul Trucks

Description		Annual Hours	Details
Total hours	**1210**	**A**	**5 months x 22 days/month x 11 hrs/days**
Mechanical breakdowns	121	B	10% of total hours
Available	1089	A-B=C	Total hours minus breakdowns
Standby	109	D	10% of available hours (90% utilization)
Operating	980	C-D=E	Available hours minus standby hours
Operating delays	110	F	60 min/shift
Net operating hours	870	G	Operating hours minus operating delays
Working hours	783	H	90% of net operating hours

Source: GoldMinds Geoservices Inc.

These parameters result in 783 working hours per year for each truck.

A fleet of three to four (3-4) trucks is required during the first five (5) years, then four to five (4-5) trucks from years 5 to 28 due to additional workload and travel distance.

16.3.2 Loaders/Excavators

The main loading machine considered for this project is a wheeled loader (loader) with a 6-9 m^3 bucket. It is recommended to have two (2) machines on site: one actively working, while the second one used for material re-handling and as a backup to the first loader.

16.3.3 Drilling and Blasting

The mineralized material and waste rock will be drilled and blasted. The blast pattern for the project is still being defined. The rock is expected to be extremely abrasive, and experienced drillers will need to be used. Production drilling will be done using a diesel powered rotary drill with 114 mm (4-1/2 inch) diameter holes. Two (2) drills are required for the project, assuming 80% mechanical availability, 80% utilization, and a penetration rate of 35 m/h for each. During full production, there will be roughly two (2) blasts per week each producing approximately 7,000 t.

Table 33: Drilling and Blasting Parameters

Parameter	Units	Production
Bench height	m	5
Blast hole diameter	cm	5.1
Burden	m	1.5
Spacing	m	2
Sub-drilling	m	1
Stemming	m	1
Explosives density	t/m3	1.28
Powder factor	kg/t	0.3
Explosives quantities	kg/hole	13.1

Source: GoldMinds Geoservices Inc.

The contractor will be responsible for the handling and provision of explosives for the site.

16.3.4 Quarry Manpower Requirements (Operations)

Owner-operated manpower requirements were estimated and range from 18 to 22 during the first five (5) years of production. Table 34 shows the quarry operator manpower requirement at year 5.

Table 34: Manpower

Description	Personnel
Quarry Foreman	1
Truck Operator	3-5
Loader Operator	2
Drill Operators	2-3
Dozer Operators	2
Grader Operator	1
Mechanic	2
Labourer	2
Total Quarry Workforce	**14-17**

Source: GoldMinds Geoservices Inc.

16.4 Quarry Equipment Fleet and Manpower (Contract Operations)

The quarry contract, whose pricing was based on the cost estimate that is presented in section 21, has elected to use a similar fleet to the one that was presented in this section of the report.

The contractor’s workforce includes all the operators, a drill and blast crew, as well as a pit foreman to assign work objectives to the operators, plus support staff.

In order to supervise the contractor and provide engineering and geology support, CME will need to have a mining engineer and geologist available on site to support the operation and QA/QC.

17.Recovery Methods

Cautionary note: Metallurgical testing will be required to provide details of process recovery of the FeSi. For the purposes of the PFS, such tests are not performed and will be part of the next stage of project development.

This section of the report details the metallurgical processes to utilize the Langis silica as a raw material to produce Ferrosilicon75 (FeSi75) standard along with microsilica (silica fumes) and slag to be used for aggregate industry as final plant products to be sold to the market. The Langis silica deposit will be quarried and recovered for use as a feedstock into a downstream ferrosilicon smelter in Baie-Comeau, Quebec, from where it will be shipped to its final destination.

After the silica is quarried by the means of open-pit quarry type of operations, previously detailed in section 16 of this report, the process steps at the quarry site will consist of blasting, crushing, and screening the silica before its transportation to the metallurgical facility (smelter) by truck. Silica that is too fine for use in the smelter will be marketed to local industries, while the coarser material will be used directly in the smelter.

The smelter at Baie-Comeau will produce ferrosilicon by a pyrometallurgical process that combines silica from the Langis quarry with a carbon source (coal), iron ore, and wood chips in a Submerged Arc Furnace (SAF) in which the above listed raw materials are smelted into ferrosilicon. Molten ferrosilicon is tapped from the furnace into ladles and then poured into molds to cool and solidify into large multilayer casting. The casts are removed from the mold after they have cooled sufficiently, then crushed and classified into the required size fraction for sale.

17.1 Process Design Criteria

The table below summarizes the design criteria assumed for the purposes of the PFS engineering and design work.

Table 35: Process Design Criteria

Quarry Plant Operations		
Operation Schedule		
Hours per day	10	hpd
Days per week	5	dpw
Days per year	60	dpa
Availability	90%	%
Plant capacity	300	tph
Production capacity	231,000	MTPY

Operation Capacity		
Run of mine	162,680	MTPY
Primary product—metallurgical plant silica feed specifications	-120 +20	mm
Secondary product—silica fines	-20	mm
Mass recovery	75%	%
Shipment to metallurgical plant	129,692	MTPY
Silica fines	41,278.83	MTPY
Metallurgical Plant Operations		
Location		
Metallurgical plant location (Baie-Comeau)		
Hydro-Québec grid (Baie-Comeau)	161	kV
Electrical plant load	77	MW
Operation Schedule		
Hours per day	24	hpd
Days per week	7	dpw
Days per year	365	dpa
RAW MATERIALS		
Raw Materials Design Criteria		
Langis silica (SiO_2)	1.80	MTPY FeSi75
Reducing agent (carbon)—coal	1.16	MTPY FeSi75
Hematite—iron ore	0.35	MTPY FeSi75
Electrode paste	0.05	MTPY FeSi75

Wood chips	1.00	MTPY FeSi75
Raw Materials Design Annual Requirements		
Langis silica (SiO_2)	129,692	MTPY
Reducing agent (carbon)—coal	83,839	MTPY (incl. fixed C values from wood chips)
Hematite—iron ore	25,218	MTPY
Electrode paste	3,603	MTPY
Wood chips	72,051	MTPY
PRODUCTION		
Metallurgical plant product	FeSi75	Type
Submerged arc furnace power	35	MW
Submerged arc furnace unit numbers	2	unit
Primary output (FeSi75)	72,051	MTPY
Secondary output (microsilica/silica fumes)	12,969	MTPY
Tertiary output (slag)	4,323	MTPY
Royalties—net smelter run	3	%
Silica		
Product density (storage and shipment)	2.33	g/cm^3
Product density (loads)	2.75	g/cm^3
Angle of repose	38	degrees
Water content	6	%/vol
Wood Chips		
Product density (storage and shipment)	0.3	g/cm^3

Product density (loads)	0.35	g/cm^3
Angle of repose	45	degrees
Water content	1	%/vol
Reductant		
Coal	$C_{137}H_{97}O_9NS$	formulae
Product density (storage and shipment)	0.8	g/cm^3
Product density (loads)	0.85	g/cm^3
Angle of repose	38	degrees
Water content	4	%/vol
Hematite (Fe 62%, Lump or Sinter Fines)		
Hematite	Fe_2O_3	formulae
Product density (storage and shipment)	2.8	g/cm^3
Product density (loads)	2.9	g/cm^3
Angle of repose	35	degrees
Water content	6	%/vol
FeSi75—Primary Product for Sale		
FeSi75 PSD specifications	-100 +10	mm
Product density (storage and shipment)	2.6	g/cm^3
Product density (loads)	2.8	g/cm^3
Angle of repose	38	degrees
Water content	<1	%/vol
Microsilica—Secondary Product for Sale		
Product density (storage and shipment)	2.5	g/cm^3
Product density (loads)	2.7	g/cm^3

Angle of repose	40	degrees
Water content	<1	%/vol
Slag—Tertiary Product for Sale		
Product density (storage and shipment)	1.3	g/cm^3
Product density (loads)	1.4	g/cm^3
Angle of repose	25	degrees
Water content	<1	%/vol
FeSi75—Fines for Reuse (Casting Bed)		
FeSi75 PSD specifications	-10	mm
Product density (storage and shipment)	2.6	g/cm^3
Product density (loads)	2.8	g/cm^3
Angle of repose	38	degrees
Water content	<1	%/vol

17.2 Raw Material Requirements

The raw materials required for production of FeSi75, as described in the design criteria (Table 35 above), are described in detail below:

- Silica (quartzite)—Langis silica;
- Reducing agent—coal;
- Iron supplement—iron ore;
- Wood chips;
- Electrode paste—Søderberg paste.

17.2.1 Silica (Quartzite)—Langis Silica

The physical requirements of silica for FeSi process should be well controlled at the same level as for other ferroalloys. The thermostability is very important for ensuring optimal plant performance, as well as the size distribution and chemical contents for some agents such as aluminum (that impacts the slag production inside the furnace); some other major elements such as titanium, calcium, and phosphorous are also important for the behaviour of the SAF. The Langis silica, based on the geological survey and technical reports as well as previously completed NI43-101 PEA, is suitable for FeSi production. In addition, various metallurgical test programs performed prior to and for the purposes of the PFS also determined that Langis silica has acceptable thermal degradation (thermostability), explosive disintegration, and reduction to silicon for use in ferrosilicon smelting.

17.2.2 Reducing Agent—Coal

The requirements for the carbon source to be used in FeSi smelting are not as severe, as a result of lower purity requirements for the product and thermodynamic factors. Petroleum coke can be, and often is, used in FeSi furnaces when economic conditions warrant; however, it is still not the optimum choice for a carbon source due to its lower reactivity than coal or charcoal. Using charcoal to produce FeSi would be too expensive, unless it is plentiful and inexpensive in the vicinity of the smelter. Metallurgical coal, albeit with a higher ash content than that used for MgSi, is again the best compromise. The reducing agents (reductants) for ferrosilicon process should have a good reactivity levels, even size distribution, and controlled ash content which would impact in the chemical contribution for the output quality. Based on the review of the potential sources of carbon, “Colombian coal” was assumed the optimal reducing agent because it has been successfully used in many other similar operations, showing better performance from the technical standpoint.

17.2.3 Iron Supplement—Iron Ore

Iron ore (hematite) is used to control the iron content in FeSi. The chemical parameters of the FeSi product may be easier to control with the use of hematite, and hematite pellets or lumps are better suited for automatic raw material handling equipment than uniform or non-uniform pieces of scrap steel.

Magnetite or another tailing iron ore source is also a possible solution in the FeSi75 production. It is important to highlight that there are some commercial, logistic, and technical questions involved in this discussion that could be revisited as part of the next phase of project development—feasibility study. The iron-forming process from the three different iron sources (hematite, wurtzite, magnetite) mentioned are:

- $Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$ (hematite);
- $FeO + C \rightarrow Fe + CO$ (wurtzite);
- $Fe_3O_4 + 4CO \rightarrow 3Fe + 4CO_2$ (magnetite).

The formation heat enthalpies are approximately Fe_2O_3 (-824.2 kJ/mol), FeO (-272 kJ/mol), and Fe_3O_4 (-1.118 kJ/mol). The entropy is not critical, considering the fact that no interface between the silicon, iron, and carbon based on different sources of iron will bring different results for the process; however, it is important in a more specific technical sense.

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The Si-O-C and Fe-C-O are important points, and the risk during the kinetics inside the SAF for the iron source (hematite, magnetite, or FeO) transfers directly to metallic iron or is going through intermediate stages via the different by-products. The hematite would disintegrate into magnetite according to the reaction:

- $3Fe_2O_3\ (s) + CO\ (g) = 2Fe_3O_4\ (s) + CO_2\ (g)$.

The formed hematite would then react further according to the reaction with carbon monoxide in similar indirect reaction (considering everything running smoothly in the production control):

- Fe_3O_4 (s) + CO (g) = 3FeO (s) + CO_2 (g).

The wurtzite could also go through an indirect reduction with carbon monoxide according to this reaction:

- FeO (s) + CO (g) = Fe (l) + CO_2 (g);

or through a direct reduction with carbon as follows:

- FeO(s) + C(s) = Fe (l) + CO(g).

Having the liquid Fe, this molten iron dissolves carbon and droplets of carbon-saturated iron and may form at as low as 1,150°C; a rich gas containing SiO would then react and take Si into the solution as mentioned in the reaction:

- SiO (g) + C = Si + CO (g).

The capacity of iron to take the Si in solution at temperatures below 1,512°C is determined by the equilibrium of the reaction:

- SiO_2 (s) + 2C (s) = Si + 2CO (g).

Considering that this equilibrium occurs under the temperature range between 1,512°C and 1,811°C determined by the reaction:

- SiO_2 (s) + 2SiC = 3Si + 2CO (g)—equilibrium of the Si-C-O System.

To summarize the evaluation from technical and strategic standpoint, the reason why the authors recommend the usage of hematite in the FeSi production process could be evaluated in the following table.

Table 36: Iron Source Selection Quantitative Analysis

Characteristic	FeO	Fe_2O_3	Fe_3O_4
Thermodynamics	+++	++	++
Kinectics	++	+++	+
System (Si-C-O/Fe-C-O)	+++	++	++
Grade	NA	+++	++
Contaminants	+	+++	+++
Production (empirical)	NA	+++	++
Market availability	+	+++	++
Commercial (price)	+	+++	+

Logistics	NA	+++	+++
Sum	**11**	**25**	**18**

Based on the considerations above, it has been concluded that hematite would be the optimal choice for iron supplement for the FeSi75 production process.

17.2.4 Wood Chips

Wood chips are added to the furnace to increase porosity of the entire raw-material mixture during the smelting process. This allows the key SiO intermediate gas species to travel through as well as react with other raw materials and reaction products to complete the reduction of silica to FeSi.

Hardwood or semi-hardwood chips are often specified by smelters; however, any chips can be used as long as they meet requirements for specified physical and chemical parameters.

Wood chips are also a minor source of reactive carbon due to the in-situ formation of the reducing agent in the high-temperature, oxygen-free furnace environment.

A source of wood chips can also be soft wood, and due to the fact that it is conveniently available in the proposed metallurgical plant area, it has been selected as the best option for the purposes of the PFS with the fixed carbon content included in the calculations for overall fixed carbon requirements.

17.2.5 Electrode Paste—Søderberg Paste

A variety of chemical and physical characteristics can be specified for paste used to produce electrodes. Parameters like softening point and swelling index are adjusted for specific smelter conditions and must sometimes be fine-tuned by trial-and-error. The paste used must be capable of producing electrodes in the required size and have appropriate physical characteristics to prevent breakage under normal operating conditions. Paste is supplied as briquettes, small bricks, or large cylinders. The choice of material format is based on smelter preferences. The presence of fines with the paste must be avoided due to high risk of segregation in the electrode columns and breakage risks.

Due to the fact that the Søderberg paste is very commonly used in similar operations with best performance, it has been selected as electrode paste material for the purposes of the PFS.

17.2.6 Raw Materials and Consumables Summary

Projected requirements for the major raw materials described herein are given in Table 37, in consideration of two furnaces producing FeSi75. A 100% silica source from Langis silica is considered. Also included in this table are various other consumables used to aid furnace tapping operations.

Table 37: Raw Materials Annual Requirements

Raw Material	Annual Requirement
Langis silica	129,692
Coal	83,839
Hematite	25,218
Wood chips	72,051
Søderberg paste	3,603

17.3 Process Flow Sheet

The following process flow sheet is assumed for FeSi75 production.

Figure 60: FeSi Process Flow Sheet (Page 1)

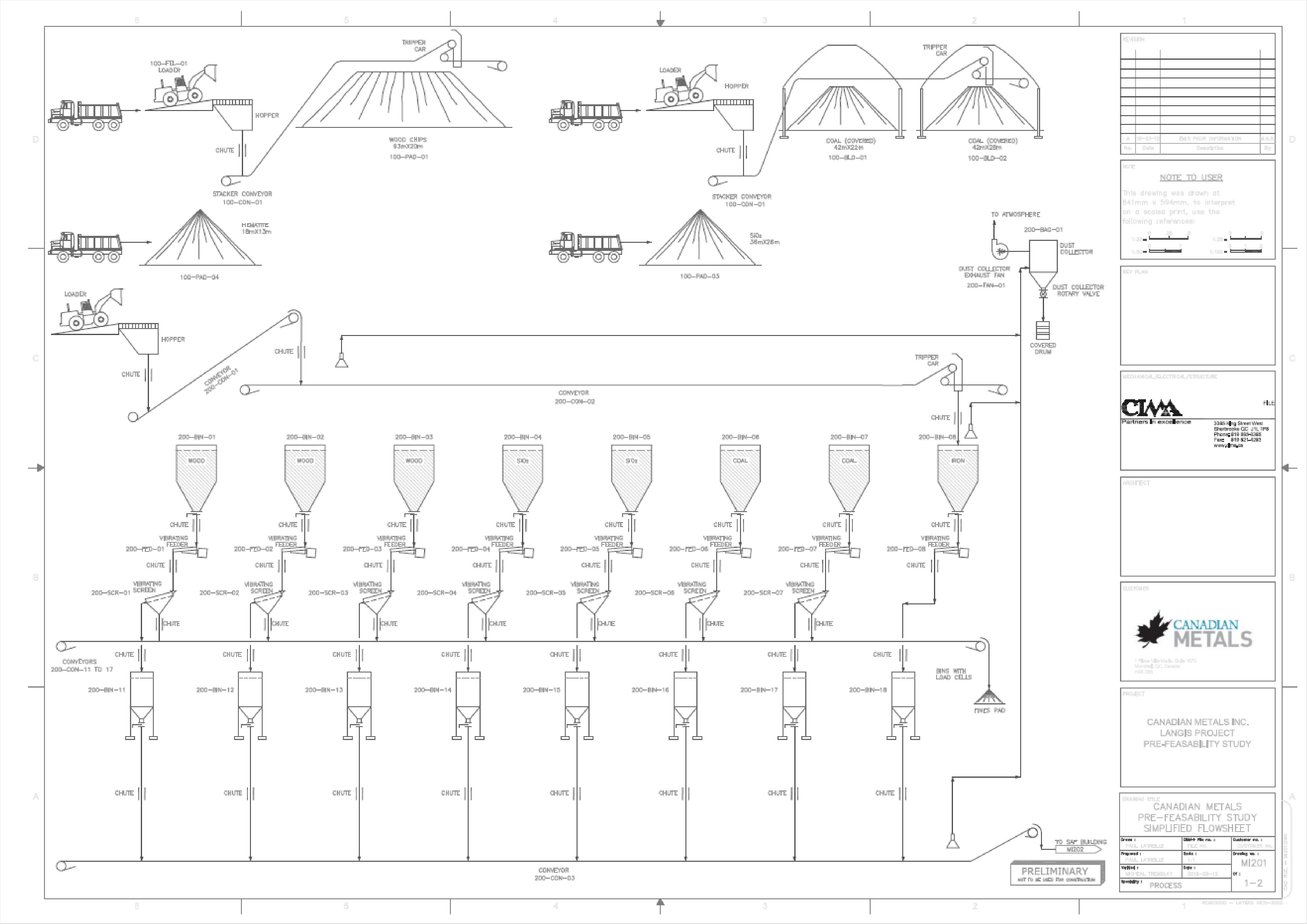
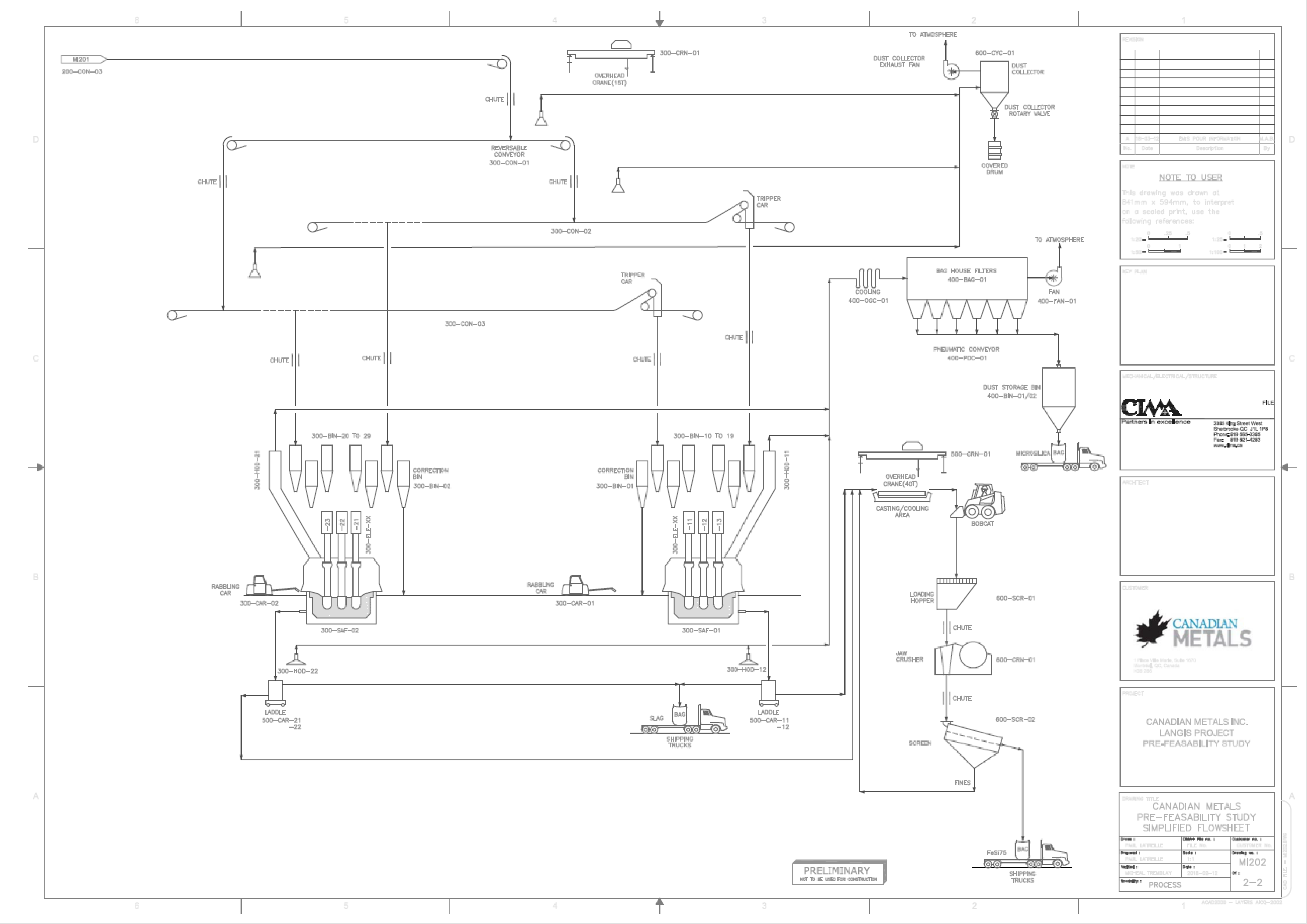


Figure 61: FeSi Process Flow Sheet (Page 2)



17.4 Process Description

17.4.1 Area 100—Raw Materials Reception and Storage

The raw materials reception and storage area is located at the front end of the plant area and consists of buildings and pads for the different raw materials.

Due to the different raw materials specifications, different storage options were considered. Coal must be stored in a covered area; therefore, building is required for this raw material. Søderberg paste will be stored within a designated area inside the smelter building. In addition, a separate storage area is required for other materials and consumables such as furnace electrodes, steel casting, ribs, tubes, etc. The rest of the raw materials will be stored in an open area with specific pads designed and built for each of them—Langis silica, hematite, and wood chips.

There will be stacker conveyors to service the wood chips and coal piles respectively.

Area for truck scale is also planned at the raw-materials reception area.

17.4.2 Area 200—Raw Materials Reclaim, Weighing, and Dosing

Raw materials reclaim, weighing, and dosing consists of the raw-materials feed conveyor, three-day silos for each of the raw materials, prior to the feed conveyors for the two SAF units, each equipped with vibrating feeder to avoid clogging, as well as a discharge chute.

The furnace feed system has raw material storage bins above the furnace which are manufactured from steel with a wear-resistant bottom section. The bins contain the blended raw materials received from the proportioning system.

Each furnace feed bin is fitted with instrumentation to determine the material level in the bin. The automatic control system compares the levels of the storage bins and determines which bin has the highest priority for receiving material. The furnace operator can manually insert a bin priority list if required.

Feed chutes connect the bottom of the feed bins to the furnace, terminating under the smoke hood in a water-cooled section. Vibrating feeders are installed in the feed chutes, providing the ability to shut off the feed system to the furnace and charge the furnace with material.

It is not common to have a blockage in the feed chute. The chute is made up of multiple sections which can be disconnected and unblocked. The feed chutes are positioned to be at a 60-degree angle from the bin center and no horizontal section can be used because the material moves under gravity.

The cooling area of the feed chute is approximately 1.8 m from the feed chute tip (portion of feed chute below furnace roof). The feed chutes are sealed on the join to the furnace roof as well as supported by brackets and hangers to the building structural steel.

17.4.3 Area 300—Smelting

The production of FeSi occurs in large, open, submerged arc furnaces (SAF) using alternating current and three large, carbon-based electrodes. The production process has been industrialized over the last century and the basic process has not changed significantly over time. It is a function of the specific conditions in which silicon dioxide "rocks" transform into silicon monoxide gas (SiO) and combine with carbon, which is reproducible in the unique furnace environment. The process takes place in an industrial environment and is highly energy intensive, on the order 7 to 9 MWh per tonne of FeSi75% output. In this current study, the value of 8 MWh per tonne of FeSi75% is used. This energy consumption is concentrated mainly in the smelting step ("furnacing") in the SAF, due to the need to disassociate highly stable silicon dioxide in the form of silica or quartzite into the final product.

Smelting area consists of the two (2) 35-MW SAF each equipped with accumulation bins, smoke hood, three (3) graphite electrodes, water-cooled off-gas ducts, stoking car, blow-down ducting, and ancillaries.

The overall global reaction for the production of FeSi75 in a SAF can be shown in a simple way to account for what is the complex set of reactions occurring as follows:

- $SiO_2 + 2C \rightarrow Si + 2CO \qquad T_{reaction} \sim 2{,}000°C$.

The production processes for ferrosilicon alloy are in principle very similar and primarily involve the reduction of silicon dioxide with carbon in an electric arc furnace where the iron oxide is also reduced. Reactions in the furnace are, however, more complex and generally schematically classified into taking place in either the hot ($T > 1{,}811^{o}C$) and lower part of the furnace or the cooler ($T < 1{,}512^{o}C$) part of the furnace. The reduction of iron oxide to metallic iron takes place in the upper furnace zone, primarily through reactions with CO and volatiles produced in the lower part of the furnace. Carbon-saturated iron droplets in the furnace may also dissolve silicon through reactions with SiO gas according to:

- $SiO(g) + C = Si + CO(g)$.

The raw materials charged to a furnace for ferrosilicon smelting are silica, iron ore, carbon (coal petroleum coke and/or charcoal), and wood chips. In metallurgy, a flux (derived from Latin "fluxus" meaning "flow") is a chemical cleaning agent; in the case of ferrosilicon process, the most indicated flowing agent is the $CaCO_3$ (limestone). Fluxes may have more than one function at a time, used in extractive metallurgy mostly.

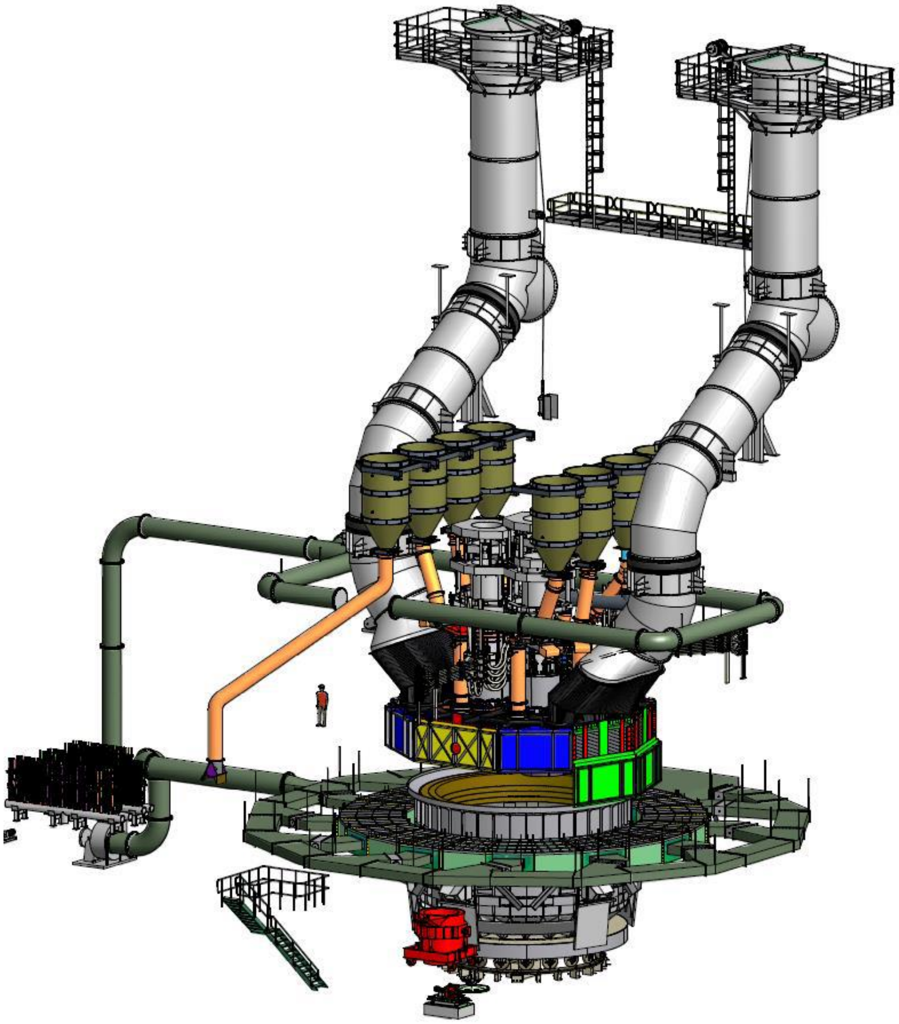
Ferrosilicon production will use iron ore (hematite). In the case of ferrosilicon production using iron ore in the charge mixture, the oxide iron ore will also be reduced to metallic iron by a global reaction similar to the one shown above for silicon production:

- $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$.

Silica and iron ore reduction to Si and Fe, respectively, occur simultaneously in a ferrosilicon furnace.

The different temperature zones in a SAF have different, on-going chemical reactions occurring in them. The actual conversion of the SiC (silicon carbide) intermediate species to silicon itself takes place in the lowest zone of the furnace and is a continuous process. As such, the furnace is designed to allow constant removal (tapping) of the molten alloy produced. The use of wood chips in the furnace charge or "burden"—the raw material mixture undergoing smelting—is crucial as it promotes the distribution of gases within the charge to help prevent loss of the critical SiO intermediate species. The main gas species formed in the furnace are SiO and CO, which are converted to SiO_2 and CO_2 when exposed to the atmosphere. Since the furnace is open and exposed to the atmosphere at the top of the charge, a major responsibility of the furnace operator is to keep these reactive gases inside the charge mixture to promote reaction with fresh raw materials.

Figure 62: Typical SAF Positioning



Source: Tenova Minerals Pty Ltd.

17.4.4 Area 400—Off-Gas and Treatment

The smelting process is accompanied by emission of gases such as carbon and silicon monoxide (CO and SiO) as well as entrained particulates that cause a high loss of energy. This off-gas is captured by a dust removal system before being released into the air. The captured dust can be sold as a by-product called "microsilica" or "silica fume" for use in high-strength and other specialty concrete production, as well as for refractory industry applications.

17.4.5 Area 500—Tapping and Casting

Molten ferrosilicon is poured in large, refractory-lined steel ladles when it begins flowing from the furnace. A refining step is not necessary to produce standard FeSi75. The molten FeSi is casted into multilayer casting to solidify, and then discharged from the casting system fed to the final product crushing area.

17.4.6 Area 600—FeSi75 Crushing and Sizing

The cooled FeSi is mechanically crushed and screened in a mobile crushing and screening plant to the typical (+10 mm -100 mm) size fraction or to specific customer requirements. The crusher is set up at an opening of 100 mm and the screen is a triple deck with a top deck at 100 mm and bottom deck at 10 mm with the third deck in between, acting as a relieve deck to increase screening efficiency use to the wide range between the top and the bottom deck. The oversize of the top screen deck is returned to the crusher as a recirculating load, the oversize of the bottom deck representing the (+10 mm -100 mm) final FeSi75 product is stockpiled for packing, and the undersize of the screen bottom deck at -10 mm is resent back to the casting unit and used as a bed during the casting to improve the process and minimize loss.

17.4.7 Area 700—Final Products Handling

Final products being the primary FeSi75 as well as secondary microsilica and slag are stacked as final product stockpiles and then packaged in big bags or containers. In the case of the microsilica, it has to be captured in bags right from the off-gas treatment unit in order to avoid loss and dust.

17.4.8 Area 800—Utilities and Services

Metallurgical plant utilities and service area include plant air compressor, instrument air dryer, as well as dust collection system, fire protection system, process and potable water systems, and eye wash stations.

Under this area are also accounted various SAF ancillaries and supporting systems such as hydraulic system, cooling water system, SAF lubrication units, SAF transformer, and SAF bus-tubes system. SAF automation and control systems are also allocated here.

Services include standard plant crane/monorail systems, service crawl, as well as supporting units such as welding platform with welding machines, oxygen and nitrogen gas line, and pressurization units.

17.4.9 Area 900—Non-Producing Assets

Non-producing assets area consists of plant shop, maintenance, laboratory, offices, first aid, guard house, spare parts storage, small equipment and tools storage, as well as small mobile equipment parking area.

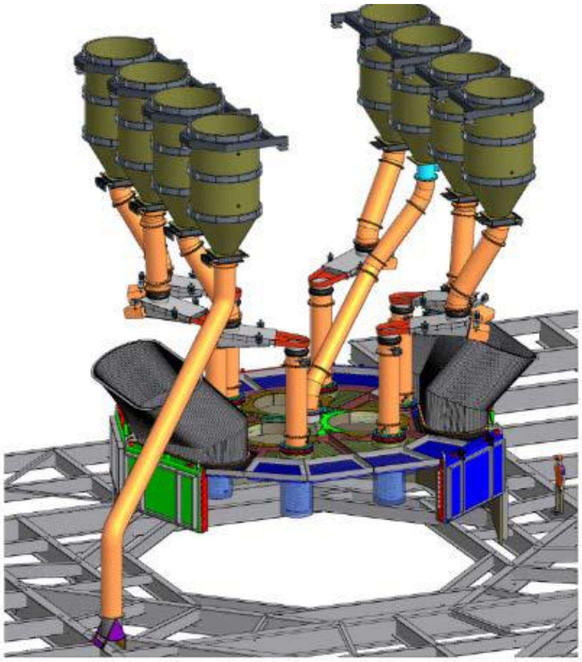
17.5 Ferrosilicon Production Process

17.5.1 SAF Feed System

The Submerged Arc Furnace (SAF) feed system includes:

- Raw materials storage bins with the following characteristics:
  - Bins are manufactured from steel with a wear-resistant bottom section. The bins contain the blended raw materials received from the proportioning system;
  - Bins have their own level control (separate per bin) with instrumentation to determine the material level and automatic control system to compare the levels of the storage bins and to determine refill requirements to be dealt with manually by the furnace operator.
- Feed chutes:
  - Feed chutes are connected at the bottom of the feed bins to the furnace, terminating under the smoke hood in a water-cooled section;
  - Vibrating feeders are installed in the feed chutes, providing the ability to shut off the feed system to the furnace and to charge the furnace with material;
  - Feed chutes are positioned at a 60-degree angle from the bin center and no horizontal section to avoid blockages;
  - Feed chutes cooling area is placed at approximately 1.8 m from the feed chute tip;
  - Feed chutes are insulated by a sealing rope on the join to the furnace roof and supported by brackets and hangers to the building structural steel.

Figure 63: Furnace Feed System designed by Tenova



Source: Tenova Minerals Pty Ltd.

17.5.2 SAF Roof and Smoke Hood

The Submerged Arc Furnace (SAF) top part consists of water-cooled steel panels suspended from the slipping floor:

- Central panels between the electrodes are manufactured from a non-magnetic stainless steel to avoid electromagnetic heating and from plate sections with channels for the cooling water;
- Outer panels are horizontally placed and manufactured from thick-walled seamless pipe. Fabricating the roof from pipes eliminates the possibility of short circuiting between adjacent cooling channels as well as reduces the amount of welds which are potential sources of stress cracking in the water channels;
- Panels around the electrodes are insulated from each other to prevent stray currents circulating in the roof.

The smoke hood has water-cooled lifting doors that can be raised and lowered for stoking and maintenance access. The doors are raised and lowered by means of hydraulic cylinders connected to the doors with steel cables. The inside of the smoke hood, including the side skirts and lifting doors, is lined with a high-temperature refractory castable. The castable is secured in place with stainless-steel anchors which are stud-welded to all surface areas exposed to the radiant heat generated from the furnace burden.

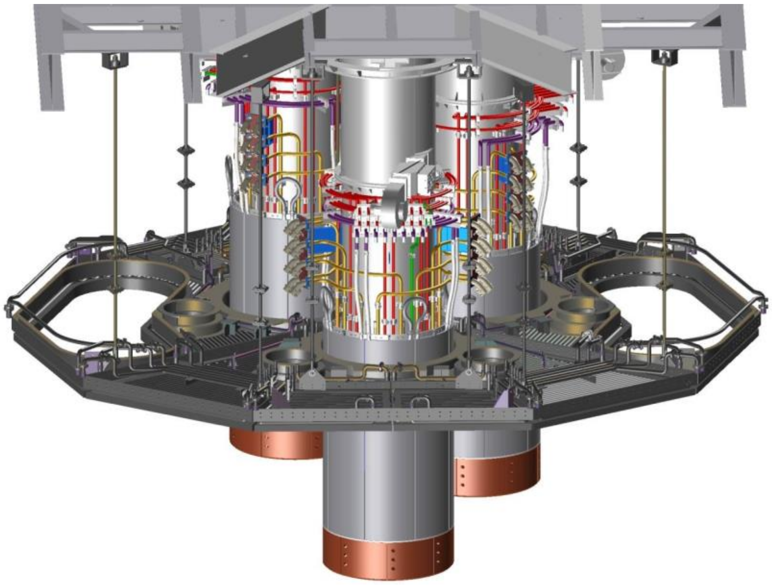
The assembled furnace roof has apertures for:

- Electrode assemblies—3 of 1,500 mm electrodes, complete with a PCD of 3,500 mm;
- Feed chutes—the design allows for ten (10) feed chutes, including a center feed chute;
- Gas off-take duct—two (2) custom shaped off-takes that maximize efficient off-gas suction.

Figure 64: Furnace Smoke Hood

Source: Tenova Minerals Pty Ltd.

Figure 65: Furnace Smoke Hood with Electrodes and Off-Gas and Feed Chute Apertures

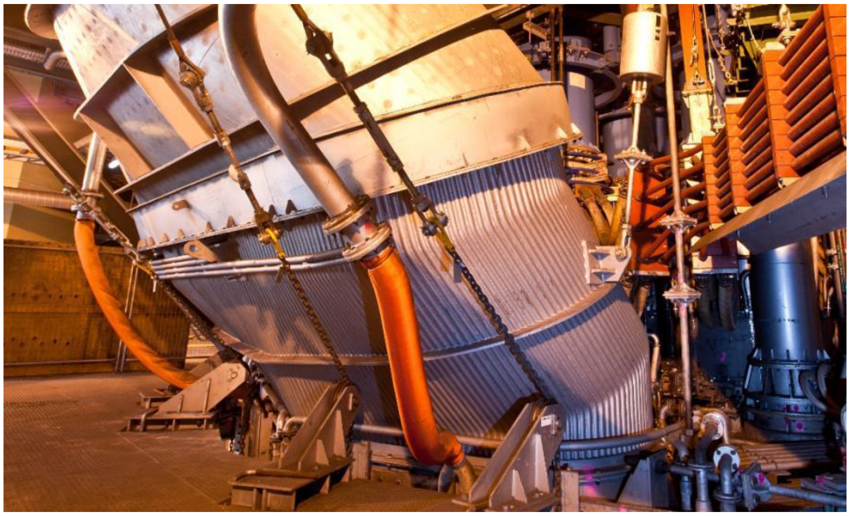


Source: Tenova Minerals Pty Ltd.

17.5.3 Water-Cooled Off-Gas Ducts

Water-cooled off-gas ducts are used to extract the gases produced in the furnace through the smoke hood into the fumes treatment plant.

Figure 66: Furnace Off-Gas System designed by Tenova



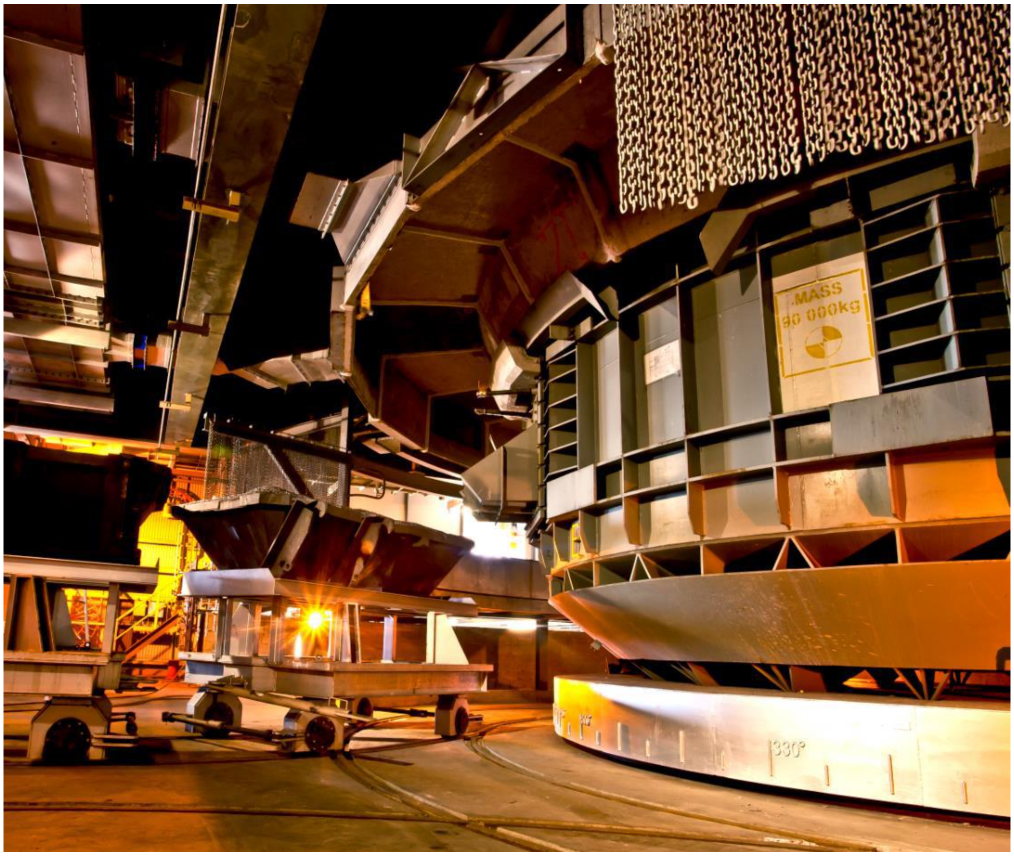
Source: Tenova Minerals Pty Ltd.

17.5.4 SAF Shell

The SAF shell is designed as follows:

- The shell is manufactured from steel and reinforced with steel plates to allow for operation at the elevated temperatures which may be associated with the furnace tapping operation;
- The shell has a dished bottom to provide additional mechanical strength;
- The shell is designed to facilitate cooling by having an angled top section which facilitates the flow of air across the shell and into the furnace roof;
- The shell has five tap holes which are of heavy construction and removable to allow for replacement or maintenance repairs;
- A removable plate with a castable refractory is provided above the tap hole to deflect the flames, hot gas, and fumes generated during tapping into the tapping fume extraction hood.

Figure 67: Furnace Shell designed by Tenova



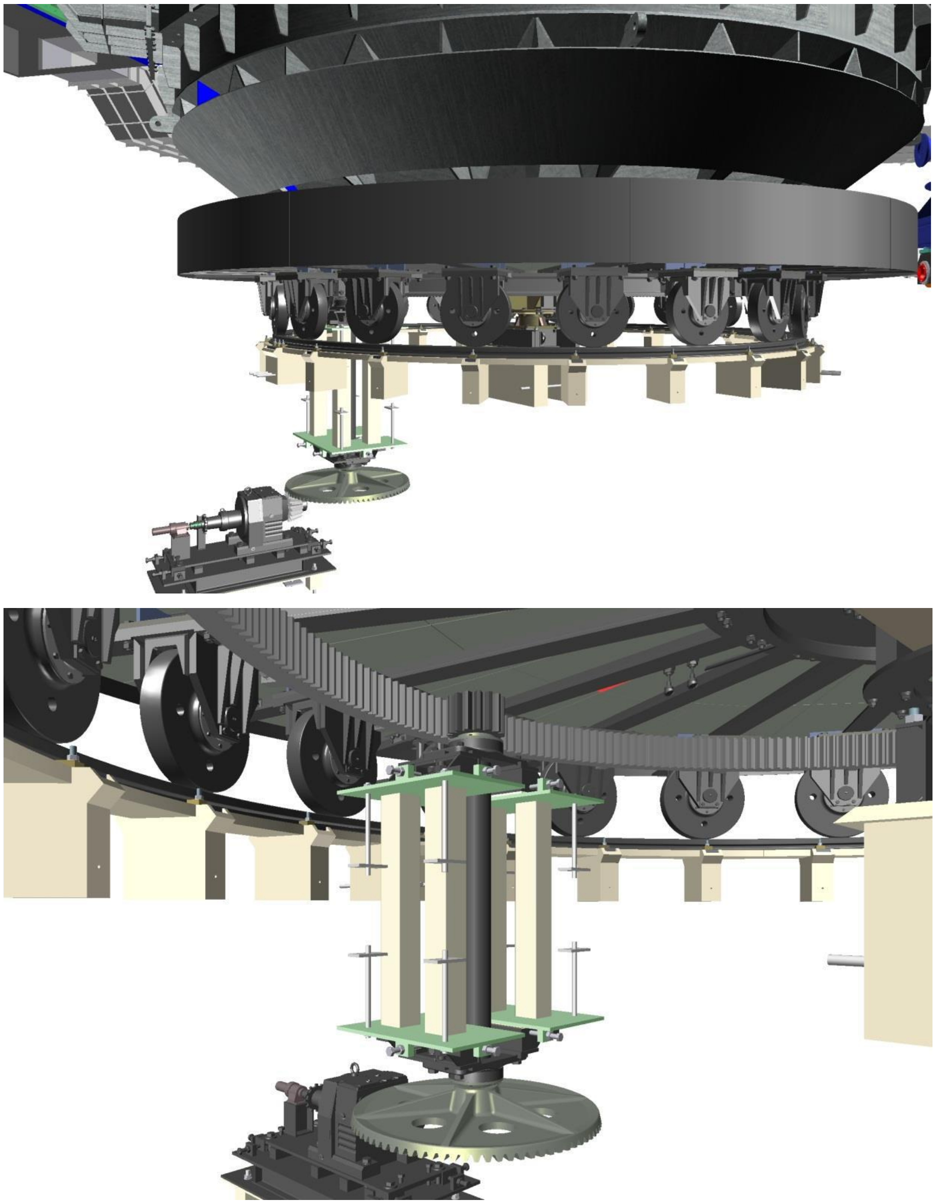
Source: Tenova Minerals Pty Ltd.

17.5.5 SAF Shell Rotating Mechanism

The SAF shell is supported on a circular table that rotates on a set of fabricated high-strength wheels and is centered by a heavily constructed center pivot.

The designs include wheels, fabricated (not casted to better withstand cracks caused from solidified material inside the SAF) traveling on a circular heavy crane rail. A geared drive assembly is used to rotate the furnace shell. The shell can be rotated through 360 degrees, rotating with a speed of between 100-480 hours per revolution.

Figure 68: Furnace Rotating System designed by Tenova



Source: Tenova Minerals Pty Ltd.

17.5.6 Stoking Car

A stoking car is required to facilitate the process. The main functions of the stoking car are:

- Manually move the raw materials mix around the electrodes;
- Break through the crust formed at the top of the burden;
- Transport materials, with a special skip, from the correction bin discharge clamshell to the furnace.

Some of the most important stoke car design characteristics include:

- It has access to stoke the furnace for approximately 300 degrees;
- It will be utilized for stoking and rabbling;
- It will be driven by an electrical supply, complete with a trailing cable and drum configuration. The front boom is hydraulic operated and fed by a hydraulic station mounted on the car.

17.5.7 Electrode Columns

The electrode columns system is designed to provide improved availability and lower risk of electrode breakage.

The main features of the electrode columns design considerations are:

- There are three (3) electrode columns to transfer the electrical energy to the furnace bath. Each column consists of a Søderberg electrode, held in position by a hydraulic slipping and regulating device, a pressure ring, and contact shoes with an electrode seal on the furnace smoke hood.
- The electrodes operate in a submerged arc configuration. The electrodes are in full contact with the raw material and the arc is below the surface of the furnace bed. A high-energy arc is created submerged in the raw material. The energy for this arc comes from electrical power that is transferred from the furnace transformer via a conduction path from the water-cooled bus tubes, through flexible copper connections to the lower electrode and contact shoes and into the baked electrode tip.
- Surrounding the contact shoes is a pressure ring that clamps the contact shoes against the electrode casing to ensure sufficient electrical contact between the shoes and the surface of the electrode casing. The pressure ring clamping force is generated by high-pressure water supplied by a booster pump.
- Each electrode column is divided into an upper and lower electrode assembly:
  - The upper electrode assembly consists of two hoist cylinders, a lower clamping collar that moves with the hoist cylinders, and a fixed upper clamping collar;
  - The collars and the hoist cylinders are used for both, the slipping and regulation of the electrodes.
- The Søderberg electrode is made from lengths of steel casings that are added to the top of the electrode column by bolting the sections together and then seal-weld these sections. Paste is added to the inside of these casings and baked to a solid graphite tip in the region of the contact

shoes. The working platform that surrounds the area where new electrode casings are added will be electrically isolated from the building and each electrode to ensure the safety of the personnel doing the electrode casing additions.

- The electrode seal is located on top of the smoke hood. The lower electrode passes through the electrode seal and descends into the raw material. The pressure ring and contact shoes are located below the furnace smoke hood.

17.5.7.1 Upper Electrode

The upper electrode comprises three main components—slipping device, electrode guiding, and upper mantle.

The slipping device features the following design considerations:

- The slipping device features fail-safe spring clamping. The primary clamping force is supplied by the specially designed springs, and hydraulic power is used to retract the clamping shoes. In the event of any service failure, the electrode will always be securely clamped by the clamping springs. The specially designed springs allow the slipping device to be less sensitive to casing diameter fluctuations;
- The slipping device consists of a modular design allowing the same segment to fit in all eight positions and thus enabling easy maintenance as well as reducing spare requirements. This compact design also reduces the required headroom;
- The slipping device is either supported by four regulating hydraulic cylinders or suspended by two (or four) regulating cylinders. The layout is dependent on the building structure (in the case of a rebuild). A supporting layout provides superior guiding characteristics and is our preferred choice.

Figure 69: Typical Upper Electrode designed by Tenova

Source: Tenova Minerals Pty Ltd.

The electrode is guided at two places—on the casing floor with a guide tube and on the slipping floor with a ring of guide rollers.

The compact design reduces the required headroom, and the modular arrangement allows easy maintenance and reduced spares holding.

17.5.7.1.1 Supporting the Electrode Holder

The normal arrangement used is for the entire column to be supported under the slipping device with four hydraulic cylinders. The advantage of using four cylinders is that any of the four can be removed for maintenance, without having to provide additional support for the electrode assembly.

Whether the electrode is supported from below or suspended from above will depend on an investigation into the available support steelwork.

Figure 70: Slipping Device designed and supplied by Tenova

Source: Tenova Minerals Pty Ltd.

17.5.7.1.2 Electrode Paste Heaters

The electrode paste heaters are used for improving the baking of the electrode.

The paste heaters heat the air supplied by the mantle fans, then this warm air passes between the electrode casing and the mantle. The increased ambient temperature around the electrode casing assists with increasing the liquid paste level and helps to improve the overall baking process. The heaters are supplied with a control unit for automatic temperature control.

17.5.7.2 Lower Electrode

17.5.7.2.1 Pressure Ring

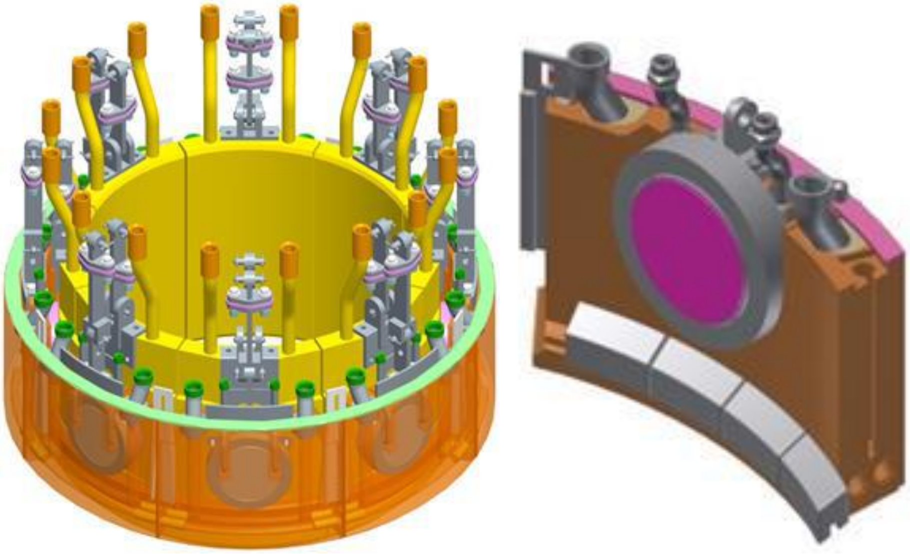
The pressure ring has the following design advantages:

- It is designed to operate in very severe open and closed furnace temperatures;
- It provides a complete shield around the contact shoe, thereby ensuring improved electrode baking and operating availabilities;
- It is large and robust, thus able to withstand severe furnace conditions. The new locking fork design is simple to install and reduce assembly time;
- It is very easy to install and maintain;
- It has quick release locking fork;
- It enables uniform baking;
- It is robust and long-lasting.

Figure 71: Lower Electrode Columns designed and supplied by Tenova

Source: Tenova Minerals Pty Ltd.

Figure 72: Electrode Pressure Ring designed by Tenova



Source: Tenova Minerals Pty Ltd.

17.5.7.2.2 Heat Shields

The heat shields main features include:

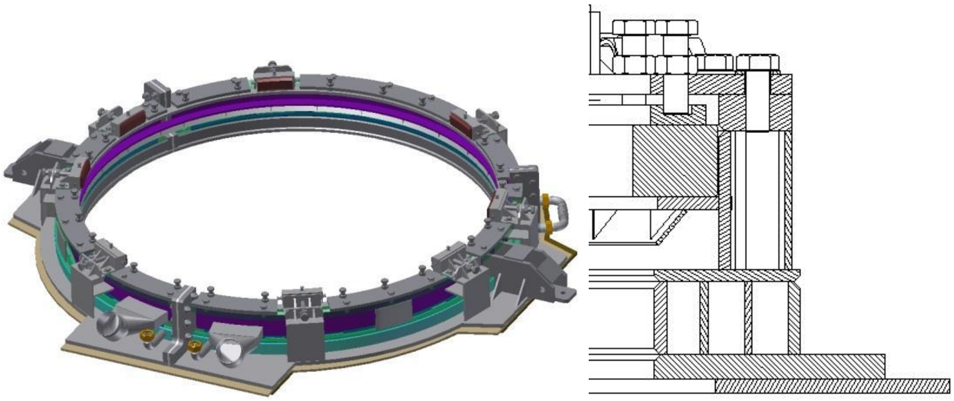
- Made of smooth type stainless-steel;
- Consists of four 90-degree segments that will be supplied;
- The heat shields are laser-cut, producing a highly accurate circumference providing better sealing between the smoke hood seal and heat shield surface. Welding is located on the inner face of the heat shield, thereby creating a smooth outer surface which contributes to increasing the lifespan of the rope seal;
- The eight (8) segments are welded together, and the design can allow for the easy lift of the complete assembly in order to provide convenient access to the lower electrode equipment.

Figure 73: Electrode Heat Shield and Risers designed and supplied by Tenova

Source: Tenova Minerals Pty Ltd.

17.5.7.3 Electrode Smoke Seal

Figure 74: Electrode Seal designed by Tenova



Source: Tenova Minerals Pty Ltd.

The smoke hood seal is designed to seal the area between the furnace hood and the electrode heat shield. The seal is key to protecting the equipment above the furnace roof from damage caused by flames and smoke escaping between the openings around the electrodes. The seal purpose is to compensate for electrode movement and will float with the electrode in order to maintain the seal's integrity if the Pitch Control Diameter (PCD) of the furnace is adjusted. Air is blown down (recirculated from tap hole fume extraction system) the seal base and provides a constant pressure to prevent fumes from escaping. The seal is manually adjustable and easy to assemble.

17.5.8 Tap Hole Fume Extraction

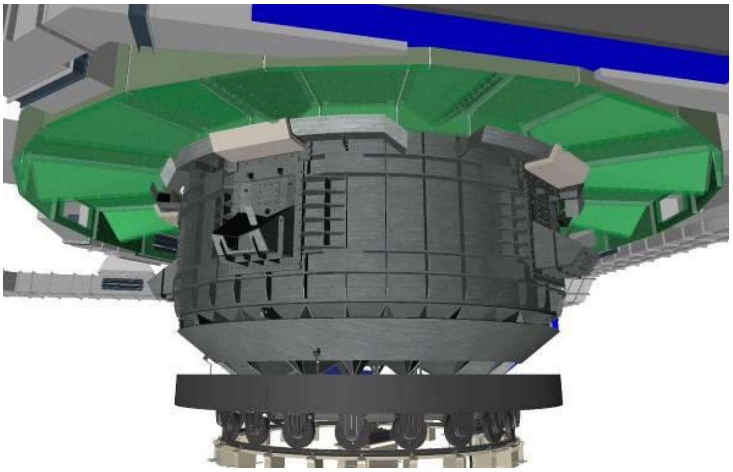
A tapping fume extraction hood is located around the full circumference of the furnace to be able to extract fume from any position where the tap holes may be located.

The hood is attached to the underside of the furnace operating floor.

The inside of the hood is refractory lined. In addition, the hood also provides protection for the underside of the operating floor. The hood is divided into various compartments.

The extraction hood is located above the tap hole to evacuate fumes from the tapping area. The main objective of the tap hole fumes extraction system is to ensure that the fumes generated during the taping process are effectively extracted to the furnace bag filter plant.

Figure 75: 3D Model of Rotating Mechanism, Shell, Tapping Fume Extraction Hood, and Ducting



Source: Tenova Minerals Pty Ltd.

The tap hole fume extraction system utilizes a dedicated fan connected to the hood which then blows the fumes collected from the tapping zone into the main stream coming from the furnace.

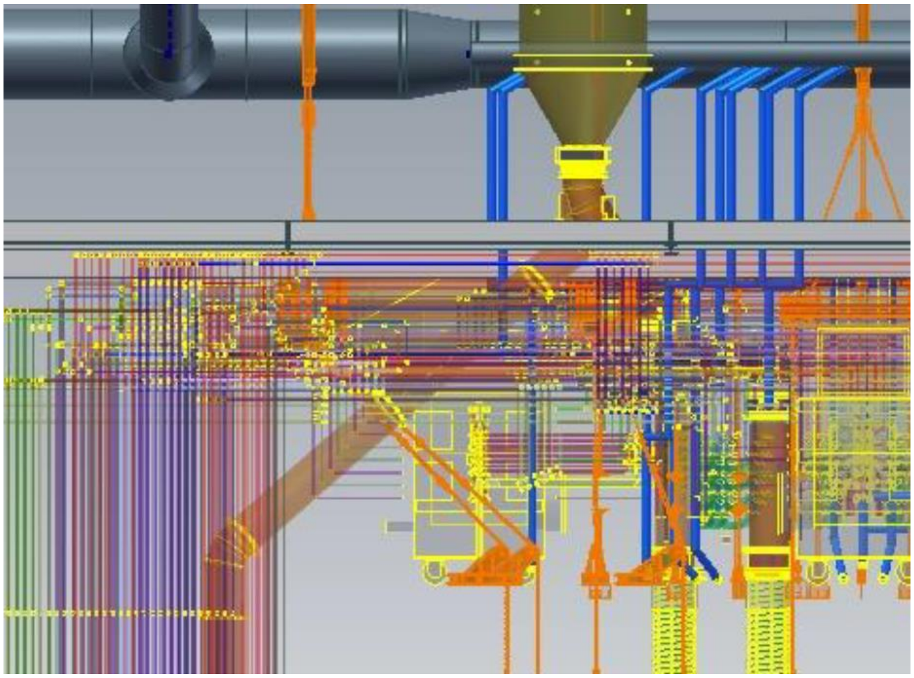
17.5.8.1 Blow-Down Ducting

The air sucked from the tap hole fume is fed to the main off-gas duct. Some of the fume is used to create positive pressure in the feed chutes in order to minimize furnace gas build-up and blows within the feed system.

Blow-down will be used to:

- Blow into the feed chutes;
- Blow into the electrodes, creating a positive pressure and minimizing blows around the electrode.

Figure 76: 3D Model of Blow-Down Ducting



Source: Tenova Minerals Pty Ltd.

17.5.9 Hydraulic System

Figure 77: Furnace Hydraulic System by Tenova

Source: Tenova Minerals Pty Ltd.

The hydraulic system operates the furnace electrodes and the hood doors and comprises two pumps with the one used as a standby unit.

The electrode hydraulic system consists of an oil reservoir, which is shared with the regulating and slipping. One common hydraulic pump is used for regulating and slipping the electrode.

The regulating and slipping systems each have a standby manifold block and valves.

A separate pump is used for circulating the oil to the oil cooler. The hydraulic system uses water glycol.

A hydraulic power performs the following operations:

- Raising and lowering the electrodes;
- Raising and lowering the furnace roof door;
- De-clamping the slipping clamps;
- Stack cap cylinders.

17.5.10 SAF Cooling Water System

Figure 78: Furnace Cooling Water Supply Header and Tundish and Small-Bore Piping

Source: Tenova Minerals Pty Ltd.

The furnace cooling system includes supply and return headers located on the slipping floor.

Each header will feed a separate circuit by means of small-bore piping reticulations from the header to the water-cooled portion of the furnace.

The following parts of the furnace are water-cooled:

- Smoke hood;
- Secondary delta closure;
- Flexible cables;
- Transformers;

- Electrode components;
- Electrode seals;
- Feed chutes tips;
- Water-cooled off-takes;
- Hydraulic heat exchanger(s).

The cooling water system for the furnace will be served by a single source.

A complete system of alarms is provided for furnace transformer and flexible cable circuits.

17.5.11 Lubrication System

Lubricating points will be equipped with local fittings for manual greasing by portable pump.

17.5.12 SAF Transformer

Figure 79: Typical Furnace Transformer

Source: Tenova Minerals Pty Ltd.

Each furnace has three (3) single-phase step-down transformers. The transformers are connected to the three (3) furnace electrodes in an open delta configuration.

Voltage changes on the primary side of the transformers are made with on-load tap changers. Local and remote control of each tap changer is possible from the control room.

The transformer has been conservatively designed so that maximum operating flexibility can be achieved without compromising production rates.

The oil in the diverter switch compartment is filtered continuously to extend the life between services.

The supply to the primary side of the transformers allows star/delta switching to increase the secondary voltage range, thereby increasing the flexibility of the transformer. The star configuration is used when low-electrode currents are used, for example during start-up or electrode baking schedules. The star/delta switching equipment is located in the furnace building for convenient access. The star/delta switching is manual at the star/delta switch.

Transformer cooling is done by oil that will in turn be cooled in forced air heat exchangers. These heat exchangers are, where possible, located on an outside platform on the same floor level as the transformers.

Each transformer is housed in a brick enclosure with appropriate fire extinguishing equipment. A single cooling fan ventilates each transformer room with an air filter. A sloping floor drains spilled transformer oil to an outlet that is piped to a tank located outside the building.

The transformers are lifted onto an outside platform using a mobile crane and moved into position using rollers fitted to the transformer and beams that are cast into the floor. After the furnace transformers are installed, the transformer rooms are bricked closed, with a lintel to allow a section of the wall to be broken out if the transformer needs to be removed.

17.5.13 SAF Bus-Tubes System

The low-tension current is carried from the transformers to the electrodes by water-cooled copper bus tubes and flexibles. Care is taken in the design to minimize the length of bus tubing and particularly the length of uncompensated conductors so that the resistance and reactance of the conductor system is minimized.

Flexible conductors are fitted between the bus tube ends and the transformer connections. Cooling water is piped to the bus tube ends by non-conductive flexible piping to insulate the piping system from the bus tubes. The bus tubes terminate at fixed positions around each electrode. Flexible water-cooled copper conductors are used from these terminations to the terminals on the electrodes and carry the cooling water from the bus tubes to the contact shoe riser tubes. Each bus tube is wrapped with an insulating material.

The bus tube clamps and hangers are made of non-magnetic stainless steel as well as insulated between the bus tubes and the building support steelwork.

Figure 80: Typical Picture of the Bus Tube System used for Three Single-Phase Transformers

Source: Tenova Minerals Pty Ltd.

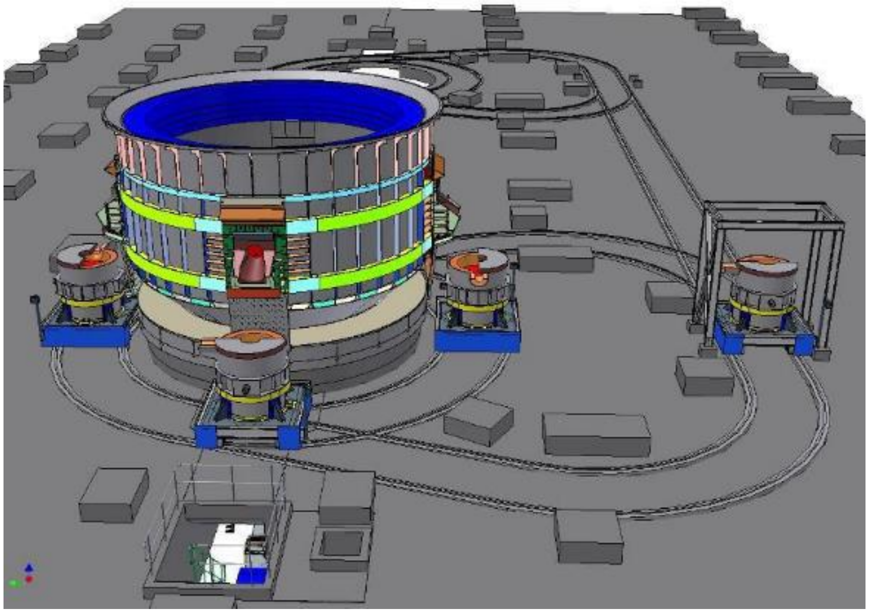
17.5.14Furnace Control and Automation System

The whole smelter operation will be fully equipped with control system as well as fully automated with a state-of-the-art control room and capacities to facilitate the operations and ensure proper smelter performance.

The automation and control system will be further defined as part of the feasibility design.

A gas-fired ladle heater is used to preheat the ladle. A second gas-burner ladle heater will be used to cure the newly cast ladle refractory. Once the ladle is filled with hot metal, it will be transferred to the refining station by the ladle car. The ladle car runs on a set of rails.

Figure 81: FeSi Furnace Tapping Arrangement by Tenova Pyromet



Source: Tenova Minerals Pty Ltd.

17.5.14.1 *Ladles*

Each ladle will be provided with one (1) tapping spout suitable for casting.

The ladle will be provided with two (2) stiffening rings. The trunnions will be welded to the ladle wall and connected to the reinforcing rings by steel plate ribs. The rings will also be used to position the ladle on the transfer car.

The trunnions will be fitted with braces which will be permanently fastened and allow for ladle tilting.

The ladle will have a hole at the bottom for the installation of a porous plug.

17.5.14.2 *Ladle Car*

The ladle car will receive the ladles by means of the bay crane and transfer them to the furnace.

Once the tapping operation is complete, each ladle car will deliver the hot metal ladle to the casting machine. The ladle will be transferred from the ladle car to the tilting mechanism without the need to use the hot metal crane. The ladle car will be manually manoeuvred using a plant vehicle.

The wheels will be manufactured in carbon steel of which the surface will be hardened by adequate treatment. Supports will be equipped with grease-lubricated roller bearings.

17.5.15 Casting

The typical casting process employed by ferrosilicon smelters has not changed much over the last 100 years. It is very basic technologically, yet the least expensive and most reliable option available today. More elegant casting methods have been conceived and tested by equipment suppliers in recent years; however, these new solutions to an old issue suffer from reliability and safety problems at this stage of their development, so they will not be considered herein.

Once refining of the molten alloy is complete, it is cast into molds to solidify. Casting is a process that consists of the sum of the following processes:

- Pouring of molten, refined silicon, or ferrosilicon into an iron mold;
- Solidification of the molten material by cooling in ambient air or with water-cooled molds.

The pouring operation is extremely important and requires a skilled crane operator to avoid slag contamination in the product as well as product loss due to splashing. To avoid ladle skulls (the accumulation of solid silicon and slag compounds on inner ladle surfaces that eventually reduce ladle volume), the pouring temperature must be well above the melting point of the product. Silicon has a high heat of solidification when compared to most metals and a large amount of heat is released during solidification, which results in technical challenges for the casting equipment employed.

Figure 82 and Figure 83 show examples of the basic casting process for ferrosilicon. The molten alloy can destroy the mold very easily. This can generally be avoided by spreading a layer of crushed ferrosilicon on the bottom of the iron mold. Ferrosilicon fines accumulated from crushing operations or crushed, “in-grade” ferrosilicon product can be used for this purpose. Ferrosilicon fines often have higher levels of undesirable contaminants, so preservation of the molds comes at some risk to product purity when they are used. Crushed, “in-grade” ferrosilicon does not suffer from this drawback but is costlier to use.

Accurate control of pouring temperature is very important for the final product quality of ferrosilicon. Pouring temperatures higher than 1,480ºC increase the risk of slag contamination due to similar densities of the slag and molten ferrosilicon at those temperatures.

The two main types of pouring and casting processes are static casting and continuous casting.

17.5.15.1 Static Casting

In the static casting process, the mold is stationary, and the ladle is moved by crane from mold to mold. The ladle is tilted, and the liquid ferrosilicon is poured into a mold. The ladle is returned to a partially upright position after the mold is filled, then moved to the next mold for the next pouring motion. While a common method, this type of casting can impart a higher risk of slag and ferrosilicon mixing due to the motion of the ladle and the pouring process, resulting in higher slag content in the final material.

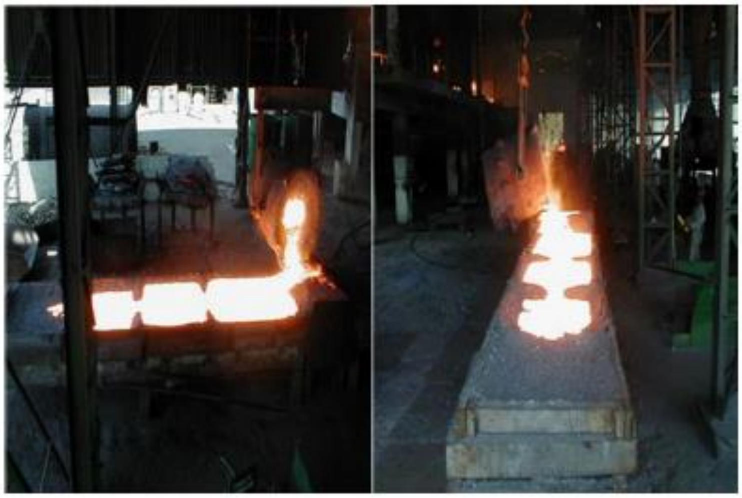
Figure 82: Example of Static Casting

Source: Viridis.iQ GmbH

17.5.15.2 Continuous Casting

Improvements to static casting have been made in the past decades by following innovations in the steel industry, i.e. by making only one pouring motion and moving the molds or by use of a continuously connected series of molds. In the latter case, the first iron mold is modified at one end with the addition of a graphite block, which is the singular pouring point for the entire series of molds. Each individual mold is connected to the next, and the mold is slightly inclined so that the flow of molten ferrosilicon from one mold to the next one can proceed unimpeded. This process optimization reduces the possibility of slag carry over due to fewer ladle tilts, and provides a safer, more controlled casting environment. An example of continuous casting is shown in the Figure 83. Such operation would be studied as part of the next stage of project development—feasibility study.

Figure 83: Continuous Casting Operation



Source: Viridis.iQ GmbH

17.5.15.3 Optimizing the Quality of Cast Alloy

The quality and performance of ferrosilicon can, to a small extent and for the end user, be influenced by the casting process. The following variables influence quality during casting:

- Fines recycling procedure;
- Iron mold depth.

17.5.15.4 Fines Recycling Procedure

Due to the high solubility of iron in molten ferrosilicon, some form of protection for the iron molds is required. Low-value ferrosilicon fines from milling and sizing processes are often used for this purpose. Special attention must be given to recycling procedures to avoid cross contamination of high-grade ferrosilicon product with low-quality fines used to line the mold. While the use of fines is a simple and common procedure, the downside is a risk of contamination that—while unavoidable—can be minimized. As mentioned previously, using crushed "in-grade" ferrosilicon in place of recycled fines eliminates possibilities for cross contamination but is a costlier alternative.

17.5.16 Crushing and Milling

Ferrosilicon is not usually milled to fine sizes. Its journey through the smelter can end at the 5-100 mm size or it may be crushed further to 0-35 mm or even 0-20 mm, depending on customer requirements. Screening may also be necessary to separate a particular ferrosilicon size fraction for a customer.

Criteria for the design of a crushing and milling system are highly dependent on the characteristics of the material to be processed. Its hardness, initial size distribution, desired final size distribution, as well as the production capacity of the plant must all be factored into the design. While many equipment configurations exist, most are designed as fully automatic package units with a local control panel and an interface for data transfer to the process control system for the smelter.

17.5.16.1 Crushing System

The crushing system is the first step in the crushing process. In this step, ferrosilicon chunks from the multilayer casting department are discharged from big bags into the system.

The material is transported to the main collecting silo following the crush. An important factor to highlight in the engineering and design of the crushing system is the combined performance of the jaw crusher and vibrating screens. These subsystem elements serve the sole function of ensuring that all the ferrosilicon processed and stored in the main collection silo has the required size distribution for sale or use as a feedstock to the secondary milling system. Some essential equipment for the crushing system is described below.

The crushing machine, usually a jaw crusher, is the first step in the sizing process. The jaw crusher reduces the maximum particle size of the silicon or ferrosilicon from 5-100 mm to 0-35 mm. The crushed material is then transported to the next step in the process, often a horizontal roll crusher, by a conveyor belt.

17.5.16.2 Big Bag Discharge Station

Ferrosilicon arrives at the discharge station for the crusher packaged in big bags. The size distribution of the material is typically 5-100 mm at this stage of the process. The discharge station is constructed from a steel frame and houses a cyclone dust collector and lifting device and is used to feed the material to be crushed into the hopper of the crusher.

17.5.16.3 Dust Collector for the Crushing System

A cyclone is used to collect dust generated in the crushing system. Ductwork from different points in the system conducts dust-laden air to the cyclone. Contaminated air is cleaned, and the dust stored for use in other processes. If not properly abated, fine particulate matter escaping from the crushing system can become a health risk for equipment operators due to the inhalation of fine particles.

17.5.16.4 Vibrating Screen

Vibrating screen is also used in the crushing and milling process to control the size of the material being processed. The screening unit separates the correct size to feed into the next step in the process and uses a recycling loop to move oversize material back to the previous sizing unit; in this example, the next step is the roll crusher and the previous unit is the jaw crusher.

17.5.17 FeSi Product Grades

The grades for FeSi are mainly based on the elemental silicon content and the amount of contamination with carbon and aluminum, while the spectrum of grades within the mgSi market is much broader in terms of parameters that define the quality of the material and its usability in the various end-market applications described in section 19.1.

The typical standard grade of ferrosilicon on which the clear majority of global trade is based is FeSi75 with the following specifications:

- Si content of 72% minimum;
- Al content of 2% maximum;
- C content of 0.2% maximum.

There are also higher-purity ferrosilicon grades for specialty steel and iron applications which are not defined by higher silicon content but through maximum impurity levels for aluminum, carbon, titanium, or magnesium. The specific impurity levels are typically negotiated with the end user.

17.5.18 Final Smelter Products

The final smelter products are listed below:

- Ferrosilicon 75 (FeSi75) standard;
- Microsilica (silica fumes);
- Slag.

While the main product is the FeSi75, the microsilica is also a product of value to be sold to the market. In addition, the slag can also be sold for ballast as well as in the concrete and aggregate industry.

The Table 38 below shows the details of expected final smelter products quantities in MTPY.

Table 38: Smelter Production Quantities (in MTPY)

Production	Total, mtpy
FeSi75	
Submerged Arc Furnace 1 (SAF1)	36,025
Submerged Arc Furnace 2 (SAF2)	36,025
TOTAL FeSi75	**72,051**
Microsilica	
Submerged Arc Furnace 1 (SAF1)	6,484
Submerged Arc Furnace 2 (SAF2)	6,484
TOTAL Microsilica	**12,969**
Slag	
Submerged Arc Furnace 1 (SAF1)	2,161
Submerged Arc Furnace 2 (SAF2)	2,161
TOTAL Slag	**4,323**

17.6 Transportation and Logistics

Raw materials and other inbound supplies to the smelter as well as FeSi75, microsilica, and slag products sold to customers can arrive and depart by a variety of transportation modes.

Highways in the area are plentiful and capable of accommodating heavy truck traffic, which is especially important for delivery of silica from the Langis quarry to the smelter via highways 195 and 132 and then by water transportation (boat) to and from the Baie-Comeau smelter.

Large inbound or outbound shipments can be loose bulk or packed in containers. Containerized shipments can also be loose bulk, or the materials can be packaged in big bags when necessary.

The most cost-effective mode of transportation for high-volume inbound raw materials arriving from overseas is small bags to avoid compromising the quality of the products transported. This relates specifically to raw materials such as coal and iron ore.

Wood chip deliveries fall into the same category as silica with respect to the number of dedicated trucks required. Although the annual requirement for wood chips is lower in weight than that for silica, the low density of wood chips means that the volume capacity of the truck becomes the limiting factor, not the weight capacity.

Transportation modes and packaging for outbound product shipments are highly customer-dependent and will need to be considered once a customer base is developed.

17.7 Manpower Requirements

Year-round operation of the smelter was assumed for the purposes of the PFS, while the quarry plant will only operate for approximately three (3) months of the year producing enough capacity of Langis silica to be able to accommodate the annual smelter raw materials requirements.

The smelter will require approximately 137 employees of varying disciplines and skillsets. The overall labour for the smelter is shown in Table 39.

Table 39: Smelter Manpower Requirements

PROCESS FACILITIES Hourly Staff Furnace Operation STAFF:	TOTAL REQUIRED
Plant Superintendent	1
Senior Metallurgist	1
Metallurgist	1
Metallurgical Technician	1
General Operations Foreman	1
Chief Chemist	1
Lab Technicians (Assay Lab)	4
Sample Prep	4
Plant Trainer	1
Clerk	1
HOURLY:	
Shift Supervisor	4
Furnace Operator	36
Unloading Raw Materials	4
$FeSiO_2$ Crushing	4
Product Shipment	4
Helpers/Labour	8
Production Loader Operator	8
MAINTENANCE STAFF:	
Mill Mechanical Foreman	1
Mill Maintenance Planner	2
Electrical Foreman	1
MAINTENANCE HOURLY:	
Mechanical Leader	4
Electrical Leader	4
Mechanics	12
Electricians	6
Instrument Technician	2
Helpers	2
Sub-Total	*118*
ADMINISTRATION Yearly Staff Administration	**TOTAL REQUIRED**
General Manager	**1**
Administrative Superintendent	1
Accountant	1
Clerk	1

Administrative Assistant	1
Human Resources Officer	1
Regional Public Relations Coordinator	1
First Aid Attendant	2
IT Technologist	2
Health and Safety	1
Senior Environmental Engineer	1
Environmental Monitor	1
Purchasing Officer	1
Warehouse Supervisor	1
Warehouse Crew	2
Surface Crew Operator and Logistic	1
Sub-Total Administration	19
Total	**137**

The smelter will work on a 24/7 schedule—four-shift model with 12-hour shifts. Working hours for the management, administration, and yard will be Monday through Friday, 40 hours per week, from 8 am to 5 pm.

17.7.1 General Description of Manpower Requirements

17.7.1.1 General Manager

The General Manager supervises and coordinates all plant activities. This person works regular hours mainly in an office environment but must also have technical and business understanding, interdisciplinary experience, entrepreneurial thinking, and leadership capability. Travel to national or international destinations is required to benchmark with other companies and cultivate business contacts.

17.7.1.2 Supervisors/Managers

Supervisors/Managers usually work in an office environment. Their hours are mostly regular, although additional time may be required when deadlines approach or critical issues have to be addressed.

17.7.1.3 Engineers

Engineers supervise technical processes and communicate with Supervisors/Managers as well as the production staff.

Process Engineers work in production areas of the smelter. The working hours are usually regular but could be extended in special circumstances. These engineers oversee manufacturing processes and services to insure they meet all standards and quality requirements. They communicate with Supervisors/Managers, Engineers, Technicians, and Operators.

17.7.1.4 Technicians

Technicians work under the direction of engineering staff and carry out technical support of production. They work in the production areas, laboratories, maintenance workshops, and only to a small degree in an office. Technicians usually work in a team with Engineers as well as Operators. The working hours are regular but might be extended in special cases.

17.7.1.5 Operators

Operators perform repetitive tasks along the production lines. Shift work is obligatory for this staff category due to the uninterrupted production process. Their working hours are regular on a shift model. Conditions may be noisy and/or hot. Operators may have to sit or stand for long periods.

17.8 Preliminary Layout of the Baie-Comeau Smelter

The proposed layout was developed respecting the characteristics and topography of the selected for the purposes of the PFS base case site at Baie-Comeau.

The complete infrastructure and equipment required for the project was designed and considered in the layout development.

The layout process was entirely developed based on a 2D model, and all furnace equipment was included with a pre-feasibility level of engineering effort. This insures high levels of reliability in the layout, even at this early stage of the project.

The position of all equipment, including furnace and auxiliary equipment, was defined considering all site access routes and topography.

The cross-sectional view of the site given in Figure 84: Elevation View Layout of the Baie-Comeau Smelter below shows the varying elevation of the plant, based on the topographic studies provided during the layout process and the engineering design. The earthworks calculated in the project were considered in the CAPEX.

The layout was designed respecting natural topography as much as possible. The material storage area was placed at the back of the site, on the second plateau.

All the other raw materials are stored in the same area, decreasing the transport distance as well as consequently decreasing the fuel and man-hour requirement.

The raw materials are transported from the storage point to the three (3) day bins using a feed hopper, installed next to the storage areas, and fed using front-end loaders. The bin feed hopper location will decrease fuel consumption, the equipment utilization, and the man-hours used in these activities.

Raw materials are transported to the three-day bin system, scales, and batch preparation through a conveyor belt.

From the batching preparation, the mixed raw material charge will be transported to the furnace using conventional belt conveyors.

The casting stations, crushing system, as well as final product storage and handling area are located close to the furnace building, minimizing transportation costs and increasing production integration for process waste reduction/avoidance, as well as minimizing operating costs.

All the furnace auxiliary equipment, including the gas storage area and water treatment plant, are installed close to the furnace area in order to minimize installation costs.

The workshop and warehouse are installed in a strategic position, close to the furnace building, the crushing system, and the raw material discharging system.

The main substation is located close to the main entrance on the clean side of the plant—in the best position to be connected to the transmission lines.

The in-plant street layout was designed in order to allow easy access to all buildings, shorten travel distances for the supply of materials and equipment, as well as facilitate production flow.

Figure 84: Elevation View Layout of the Baie-Comeau Smelter

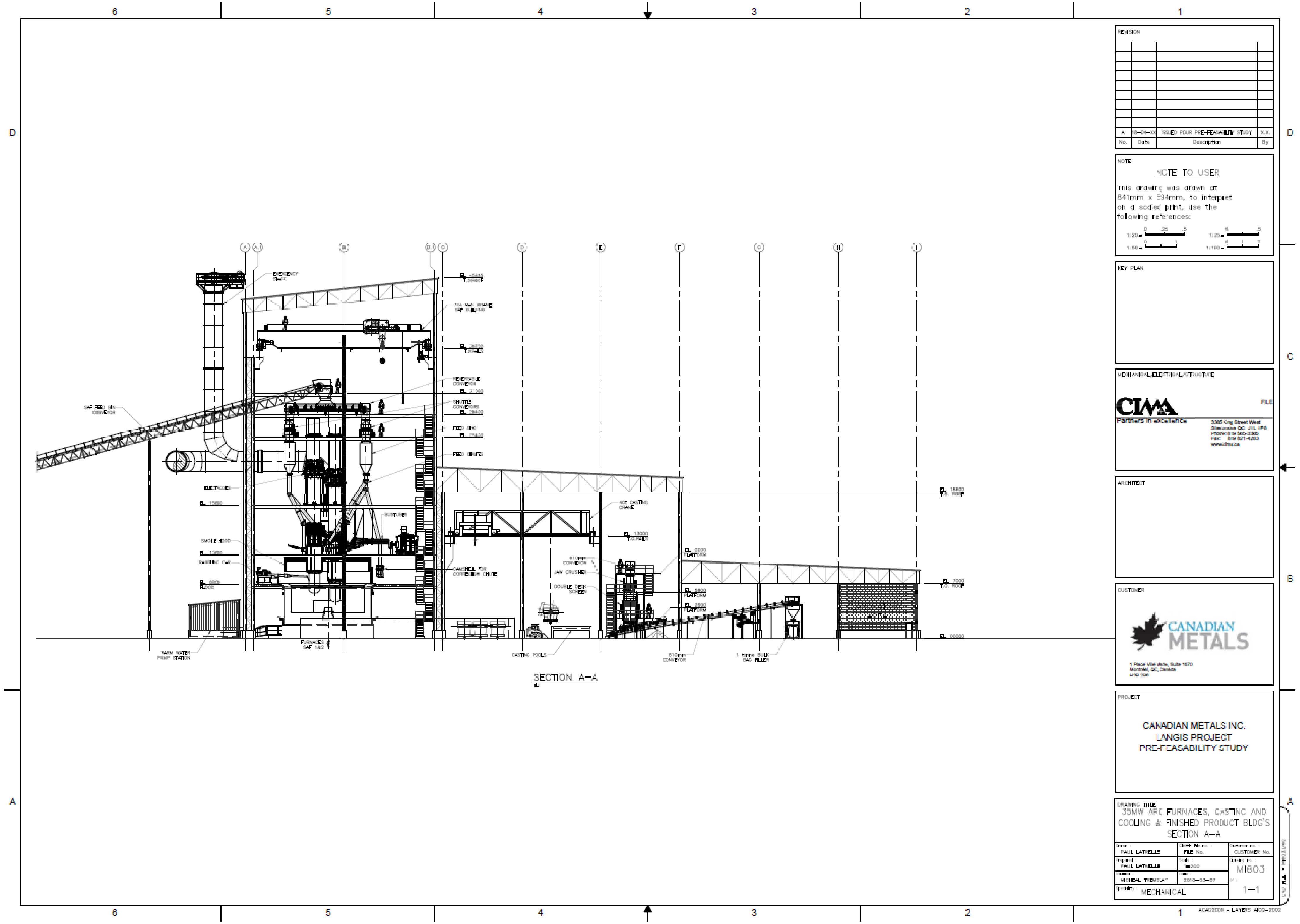
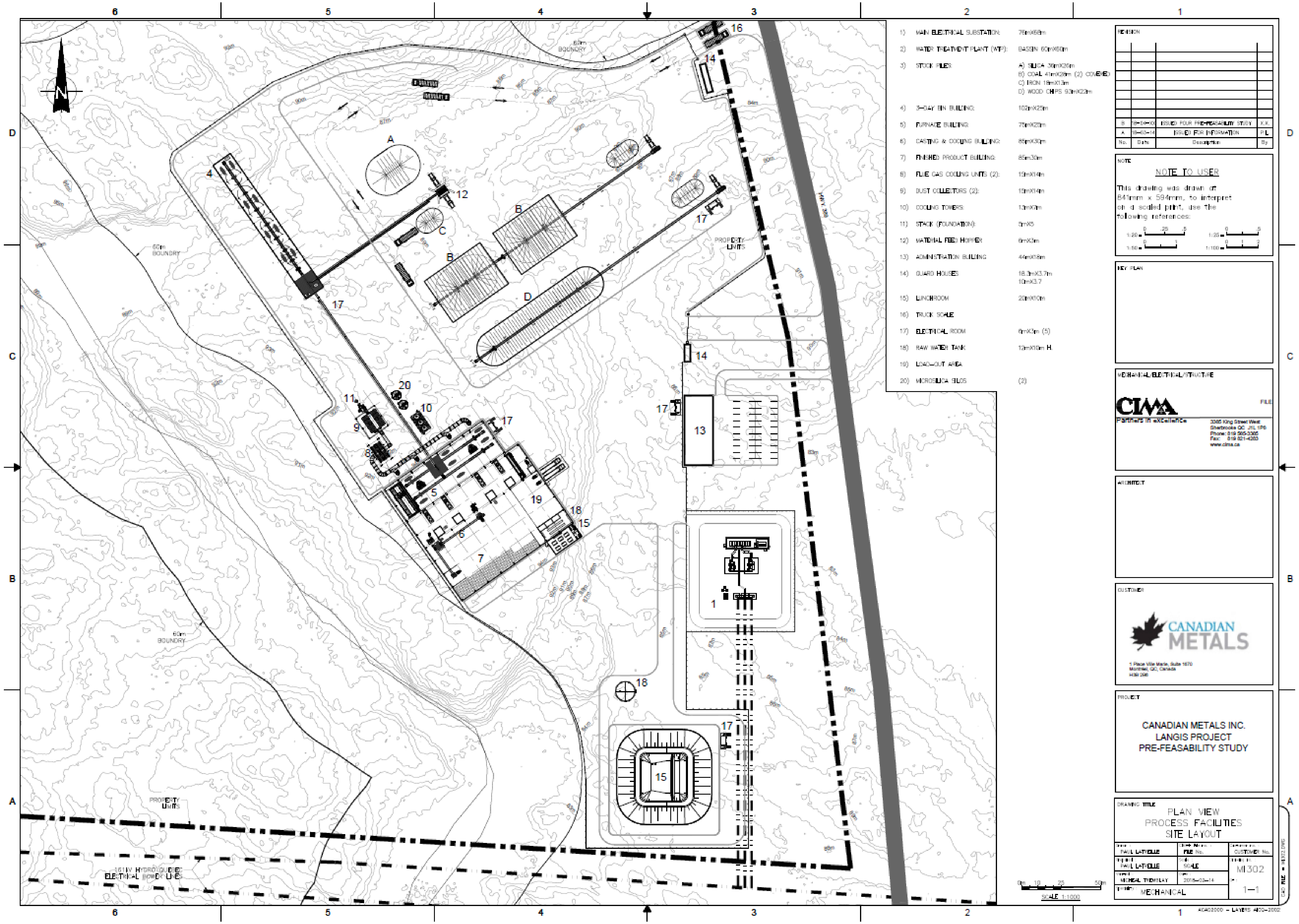


Figure 85: Top View Layout of the Baie-Comeau Smelter



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18. Project Infrastructure

This section summarizes infrastructure, buildings, as well as other facilities and services that are required to allow operations at both processing locations, the Langis Quarry and the Baie-Comeau metallurgical plant.

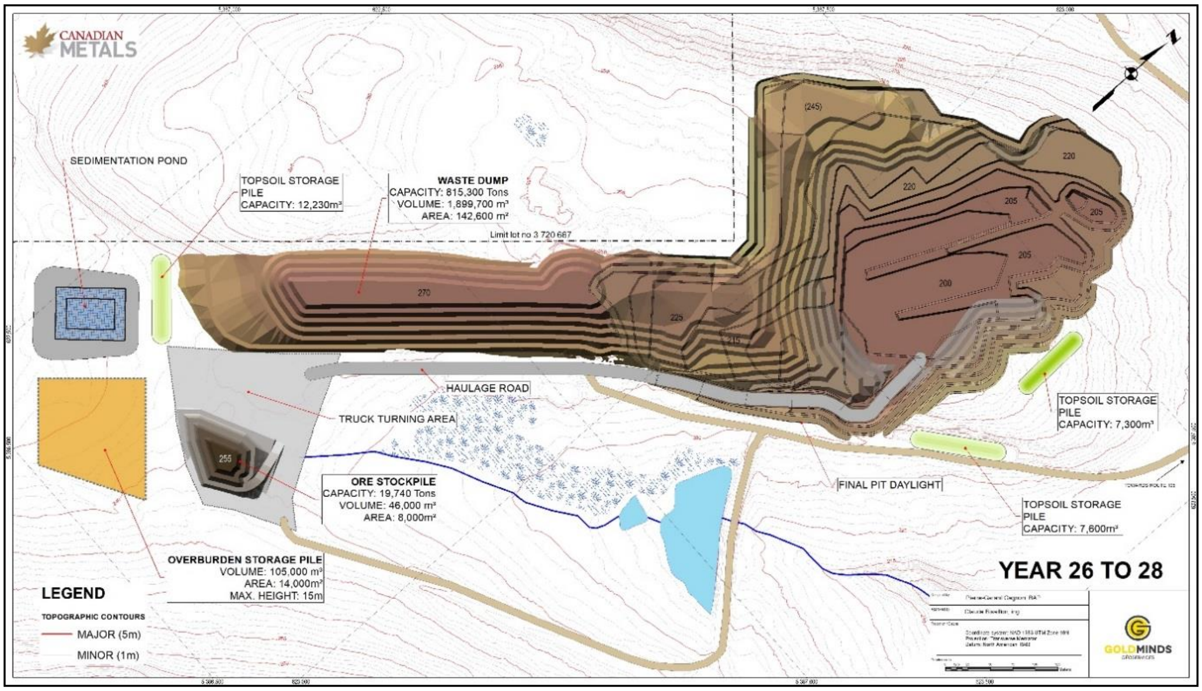
18.1 Langis Quarry

This subsection summarizes infrastructure, buildings, as well as other facilities and services that are required to complement the processing of the Langis Property quartzite and produce lump silica ore.

All topographic information for the location of infrastructure relies on WSP survey over the Property and 1-m contours were used.

There have been no geotechnical investigations for surface infrastructure performed to date. It is understood that appropriate field geotechnical investigations will be required for subsequent phases of the project. Illustrations of main access to site as well as an overall general site layout are provided on Figure 86. Mineralization will be quarried and sent to the crushing and screening during a period of five (5) months. The quarry contractor will crush and screen the quartzite to generate a lump silica product with a size range from +20 mm to -120 mm and prepare stockpiles of material for shipment.

Figure 86: Conceptual Layout of the Site



All off-road equipment traffic will be limited to the Property to eliminate intersections between off-highway equipment and highway trucks. Highway trucks will reach the Property from the northeast.

18.1.1 Main Access Road

Main access to the Langis Property is from the paved all-weather Highway 195 from Matane (Quebec). The main-haul gravel logging road is reachable from the main access to the Langis. Silicon Ridge is located approximately 14.6 km from Highway 381.

Provision has been made to upgrade part of the existing gravel access roads and the last part of the road that reaches the site along an existing access route. Based on current access road alignment, approximately 2.0 km of the existing trails will be upgraded and approximately 1.1 km of new road needs to be constructed.

Further work to develop a basis for the road upgrade and extension costs will be conducted in the next phase.

18.1.2 Site Access and Roads

Site and service roads will be 10 m wide, except for the quarry haul roads which will be 17.2 m wide. They will take advantage of the existing forest road network, whenever possible. A site road will be required to provide access to the various stockpiles and the sedimentation pond area.

18.1.3 Stockpiles

Stockpiles are planned on the properties to properly manage the excavated materials—temporary stockpile for overburden and low-grade ore as well as the waste rock stockpile. Potential stockpile locations are presented in Figure 86 above. It has also been decided to do some in-pit storage of material in order to reduce the environmental footprint of the operation.

18.1.4 Security Gatehouse

The site will also include a modular prefabricated administration building, located at the entrance of the site, which will also serve as a gatehouse with camera and first aid station. The hospital at Amqui is identified as the major first response site in case of trauma.

18.1.5 Fencing

It is proposed to fence up the entire Property for safety using deer fencing to redirect people and migrating fauna. It is also proposed to use chain linked fence in localized area for safety and security reasons.

18.1.6 Fuel Storage and Filling Station

The quarry contractor will be responsible for the maintenance of their equipment. Considering the small fleet that will be required and the quarrying operation that will be restricted to the summer months, it is expected that site maintenance will be limited and temporary required infrastructure (maintenance garage) will be provided by the contractor and located on the plant site pad. No permanent fuel storage is planned on site. The contractor will need to provide or install temporary fuel storage along with all spill emergency equipment and procedures.

18.1.7 Site Drainage and Settling Ponds

All surface run-offs and any water on site will be channeled to a sedimentation pond. No special treatment will be required at this point for now. Spill kit will be placed, and water quality will be controlled and monitored prior to discharge as prescribed by regulations.

18.1.8 Explosives Preparation and Storage

The contractor will be responsible for the preparation and storing of explosives on site, if any with associated permitting. A proper storage location, if any, has not been decided yet.

18.1.9 Services

18.1.9.1 Potable Water

The nearest source of a continuous substantial flow of fresh water is a stream called Tamagodi River located 1.8 km to the east-southeast of the present Langis quarry. This stream flows northeastward into the Matane River. The Matane River flows northward into the Saint-Lawrence estuary. The Tamagodi River can potentially be used as a source of raw water for activities such as pit wetting, truck and equipment washing, and dust suppression at the crushing plant; however, this topic will be addressed in later project stages and the EIA. A historical water well is also under consideration as a source of water.

Since water from the Tamagodi River and the Matane River cannot be considered as potable for human consumption, the water demand for this purpose can be supplied in bottle and by water trucks from the nearest water supplier.

18.1.9.2 Warehouse

A few containers will be used to provide temporary storage of miscellaneous supplies and/or mechanical equipment parts for use by the various contractors and located on the old garage pad. No permanent structures will be built.

18.1.9.3 Camp Site Accommodations

Considering the close proximity to Amqui and the surrounding area with the expected workforce number, no permanent camp has been provided for the project. It is expected that nearby town will provide some of the workforce as well as all the housing and other needs to the employees.

18.1.9.4 Power

A power line reaches the Langis site; it may need to be reactivated by Hydro-Québec. Given the low power requirement for the project, the electrical power will be used to provide electricity for the office/gatehouse as well as power some of the equipment like pumps and the crusher/screen. All other equipment as well as mobile fleet equipment is expected to run on diesel for the 28 years life of the quarry. No provisions have been made to increase the voltage of the Hydro-Québec power line located on site. Optimization between fuel-run equipment vs. Hydro-Québec electric power will have to be made at the next step.

18.1.9.5 Communications

No particular site communication system has been planned. The area has cellular coverage; therefore, it is planned that the contractor will use mobile phones for site communications.

18.2 Metallurgical Plant

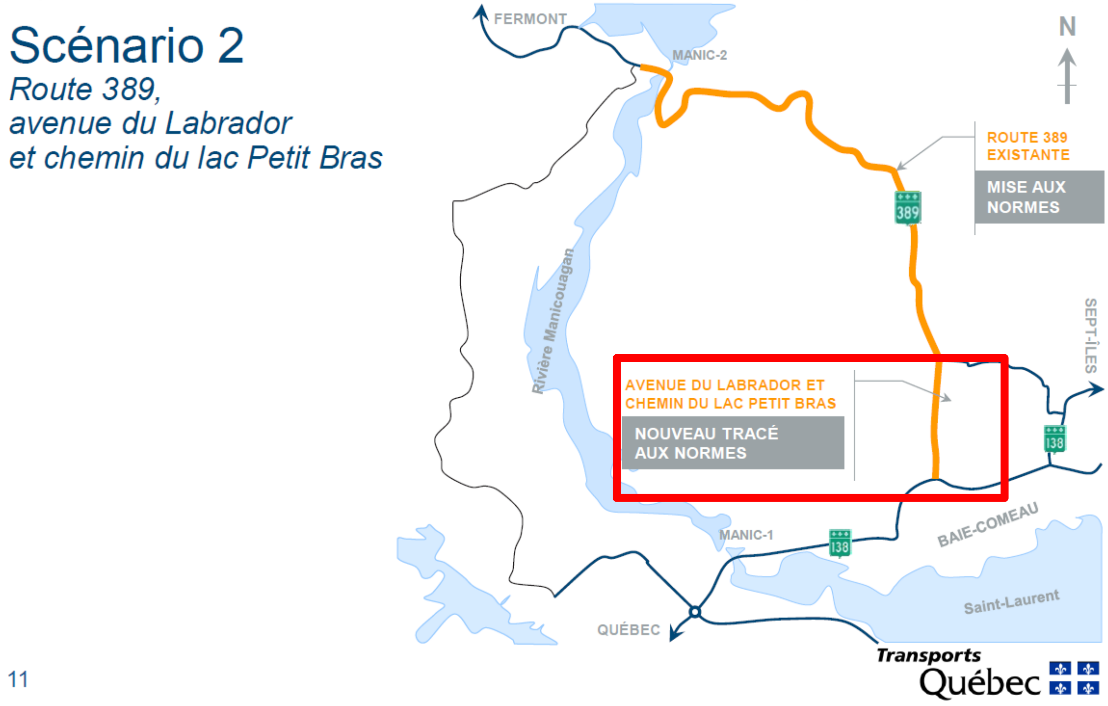
This subsection summarizes infrastructure and services that are required to complement the metallurgical plant operations and maintenance.

18.2.1 Main Access Road

There are rail and port facilities near the facility, but roadway is the only direct site access to all incoming and outgoing freight. Train shipments must be transferred to or from trucks at *Société du port ferroviaire de Baie-Comeau Haute-Rive* (SOPOR, rail transhipment yard in Baie-Comeau). Boat shipments must be transferred to or from trucks at the Baie-Comeau port facilities.

Quebec Ministry of Transportation is planning to reroute Highway 389 alongside the east side of the Metallurgical Plant location. Quebec Ministry of Transportation began work on the southern portion also known as “Avenue du Labrador, Projet B” in March 2017. “Projet B” is shown in the next figure within the red box. Work alongside Canadian Metals Property shall be completed in 2018.

Figure 87: Highway 389 Improvement Planning



Source: Transports Quebec website

18.2.2 Site Access and Roads

There will be two (2) different site accesses to and from Highway 389. The northernmost access will be dedicated to raw materials transport trucks. The southernmost access will be used either for the employee and visitor parking lot or for finished products transport trucks. Service roads will provide access to the various areas such as stockpiles, buildings, and service infrastructure.

18.2.3 Rail

SOPOR operates a train ferry as Baie-Comeau is not directly connected to the North American railway system. SOPOR's transhipment yard is located less than 3 km south of the metallurgical plant alongside provincial road 389.

The train ferry connects port of Baie-Comeau to port of Matane, which is serviced by Canadian National Railway.

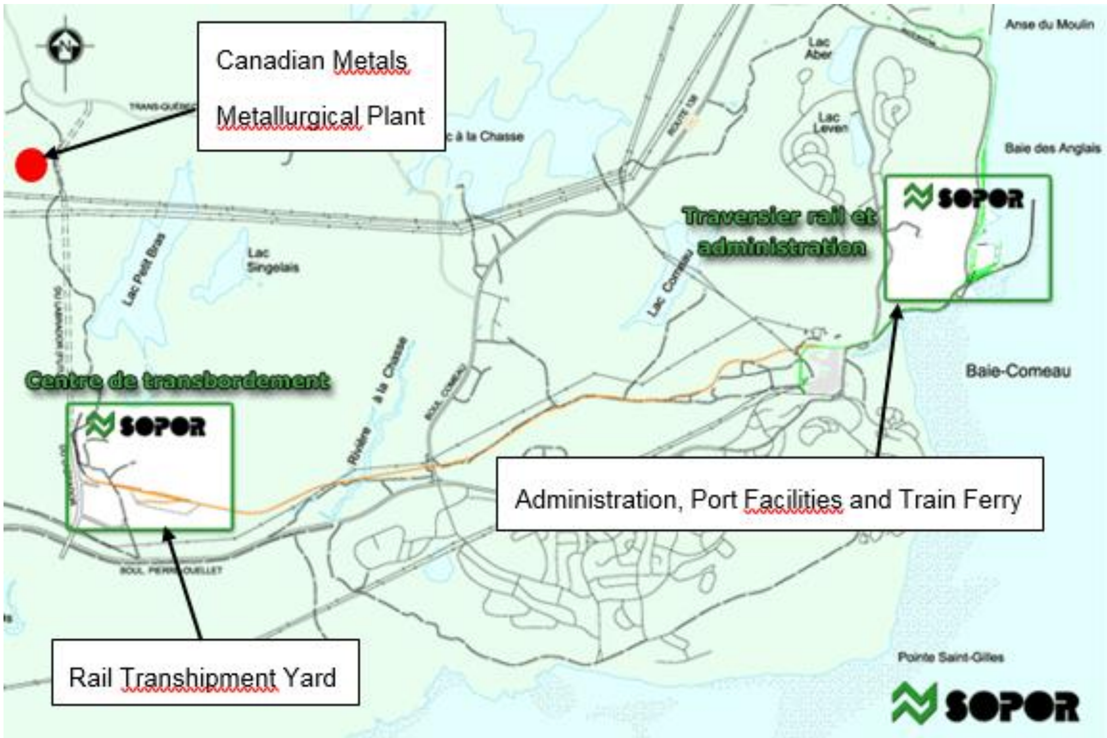
Figure 88: CN rail line access to Baie-Comeau

Source: http://cnebusiness.geomapguide.ca/

18.2.4 Port

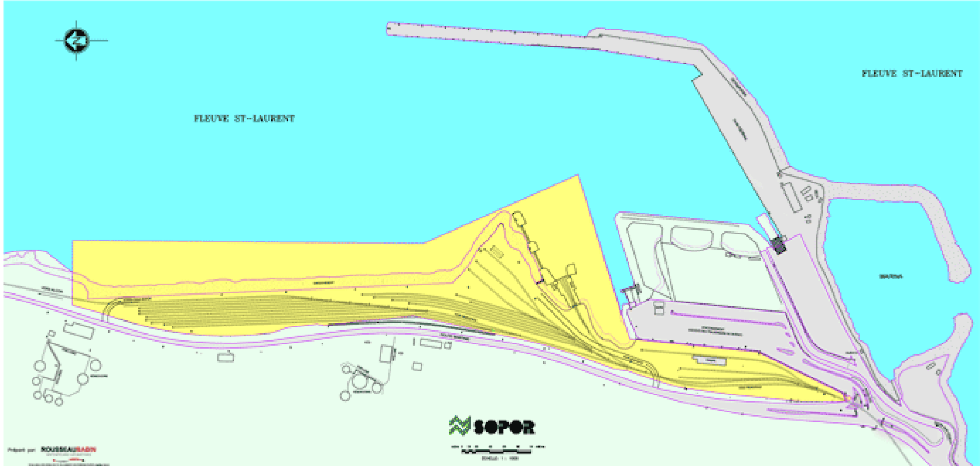
Port of Baie-Comeau facilities are located 12 km east of the plant. The following figure shows the location for SOPOR administration, train ferry and port facilities, the rail transhipment yard, and the metallurgical plant.

Figure 89: SOPOR Facilities



Source: SOPOR website

Figure 90: Port of Baie-Comeau Facilities



Source: SOPOR website

18.2.5 Stockpiles

The metallurgical plant will use large quantities of raw materials. The four main raw materials are silica, coal, wood chips, and hematite. All stockpiles will have a similar foundation that is designed to prevent picking up soil or rocks during reclaiming.

The silica stockpile is sized for two (2) months of plant operation. This period is equivalent to the thawing season load restrictions on transport trucks. Load restrictions are usually in effect in April and May of each year in the Baie-Comeau and Matane areas. This stockpile will hold around 22,000 tonnes on a surface of 1,000 m^2.

The coal stockpile is sized for 120% of a 10,000 metric tonnes ship transport. The ship unloads at the port of Baie-Comeau. The coal is then trucked to the metallurgical plant. A tripper conveyor is used to stack coal in either of two superdome type enclosures. This stockpile will hold around 142,000 tonnes on a surface of 2,000 m^2.

The wood chips stockpile is sized for one (1) month of plant operation. This period is considered sufficient to compensate for difficulties in wood harvesting and transportation on logging roads during thawing. A tripper conveyor is used to stack wood chips onto its dedicated pad. This stockpile will hold around 6,000 tonnes on a surface of 1,700 m^2.

The hematite stockpile is sized for two (2) months of plant operation. This period is equivalent to the thawing season load restriction on transport trucks. This stockpile will hold around 4,200 tonnes on a surface of 200 m^2.

18.2.6 Security Gatehouse

A security gatehouse will be required at both site entry points. The site will also include a modular prefabricated administration building located at the southernmost entrance. The hospital in Baie-Comeau is identified as the major first response site in case of trauma.

18.2.7 Fencing

It is proposed to fence up the entire Property for safety using deer fencing to redirect people and migrating fauna. It is also proposed to use chain linked fence in localized area for safety and security reasons.

18.2.8 Fuel Storage and Filling Station

No permanent fuel storage is planned on site. A fueling truck will refuel mobile equipment on a permanent dedicated refueling pad with all spill emergency equipment and procedures.

18.2.9 Site Drainage and Settling Ponds

All surface run-offs and any water on site will be channeled to a sedimentation pond. The metallurgical plant does not require process water other than for cleaning and closed loop cooling. No special treatment will be required at this point for now. Spill kit will be placed, and water quality will be controlled and monitored prior to discharge as prescribed by regulations.

18.2.10 Services

18.2.10.1 Water

The City of Baie-Comeau will supply raw water from Lake Petit Bras to the metallurgical plant. Raw water is required for support services, fire protection, process, and cooling water make-up. Mechanical and chemical water treatment will be required for cooling water. The City will also provide potable water, which is required for domestic use by the plant workforce as prescribed by the building code. The metallurgical plant make-up water requirement is expected to be 1,425 m^3/day of raw water and 25 m^3/day of potable water.

A comprehensive chemical analysis of local water quality has not been undertaken but is recommended in future project stages. Analysis results will be used in future stages of the project to define the specification of the raw water treatment system.

Table 40: Metallurgical Plant Water Requirements

Metallurgical Plant Water Requirements	
Cooling Water Evaporation Losses	950 m^3/day
Cooling Water Bleeding Losses (blowdown)	475 m^3/day
Total Make Up Water	**1,425 m3/day**

Table 41: Metallurgical Plant Potable Water Requirements

Metallurgical Plant Potable Water Requirements	
Potable (0.3 m^3/person/day)	**25 m^3/day (83 persons)**

18.2.10.2 Warehouse

Dedicated storage areas for finished products are included within the metallurgical plant main process building.

18.2.10.3 Camp Site Accommodations

Considering the proximity to Baie-Comeau and the surrounding area with the expected workforce number, no permanent camp has been provided for the project. It is expected that nearby town will provide some of the workforce as well as all the housing and other needs to the employees.

18.2.10.4 Power

The metallurgical plant requires a significant amount of electrical energy.

Table 42: Metallurgical Plant Power Requirements

Metallurgical Power Requirements	
Submerged Arc Furnace	70,000 kW
Electrical Motor Rating from Equipment List	4,000 kW
Building and Site Services	3,000 kW
Total Power	**77,000 kW**

There is an existing 161-V power lines corridor owned and operated by Hydro-Québec alongside the southern edge of the metallurgical plant land lot. High-voltage conductors between utility power lines and plant main substation will be a few hundred meters in length.

18.2.10.5 Communications

Different basic communication systems will be used according to specific needs.

Multi-frequency two-way radios shall be used for communications with mobile equipment operators and field workers.

The plant is located in an urbanized area therefore cellular and wired communication networks are accessible. All other communication requirements shall be satisfied with either cellular or wired networks. A comprehensive telecommunication strategy should be developed during the next projects stages.

18.2.11 Dump and Disposal

The metallurgical plant should generate low volumes of solid waste. The bulk of the plant solid waste will come from fines screened out of silica, coal, and wood chips. Combustible material fines such as coal and wood chips shall be sold to local users.

19. Market Studies and Contracts

The present section is based on an in-depth review of the “Silicon and Ferrosilicon 15th Edition” market report from Roskill Information Services. Whenever appropriate, other credible and renowned market sources are referred to substantiate conclusions and certain aspects. These are disclosed in the respective footnotes as well as in the reference section of this report (section 27).

19.1 Global Market Drivers

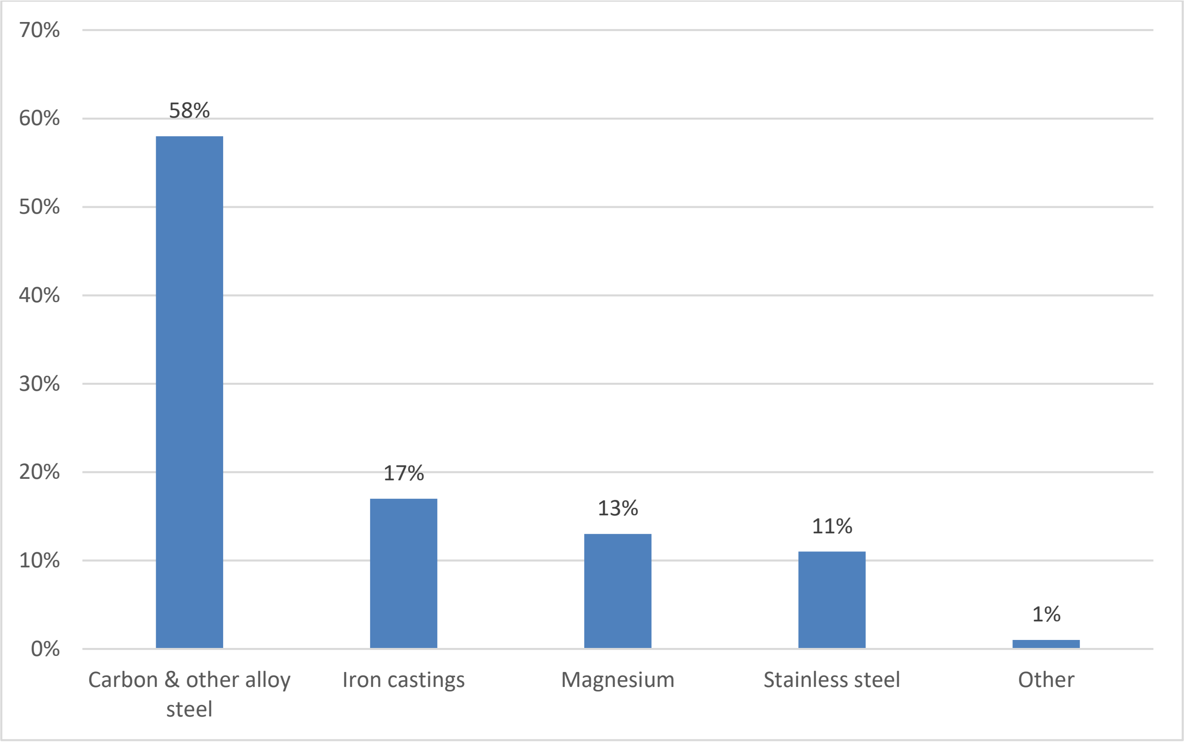
19.1.1 FeSi End-Usage Markets

FeSi is basically consumed in steel, iron casting, and manganese production processes. The steel industry is the largest consuming sector for ferrosilicon, using 4.4 Mt of ferrosilicon in 2016, thus representing 68% of global consumption. A growth of almost 6% over the past 15 years is mainly a result of the infrastructure investment boom in China and other emerging markets, which led to a corresponding increase in the demand for steel products. The use of ferrosilicon in cast iron accounted for a further 17%, and almost all the remaining 15% was used in the production of magnesium. The three sectors mentioned before represent 99% of the global ferrosilicon demand.

Basically, the ferrosilicon demand was practically doubled for the steel industry between 2000 and 2011—from around 2.8 Mt in 2000 to almost 5.8 Mt in 2011. In 2016, however, the ferrosilicon consumption was 22% lower than in 2011 for the steel market. Cast iron has around 2% of ferrosilicon content on average, though only around 60% comes from ferrosilicon. Consumption of ferrosilicon in cast iron in 2016 was estimated to be 1.1 Mt; magnesium accounted for 13% of the ferrosilicon consumption in 2016, corresponding to 876 kt. In terms of volume, the total ferrosilicon market was 6.5 Mt in 2011.

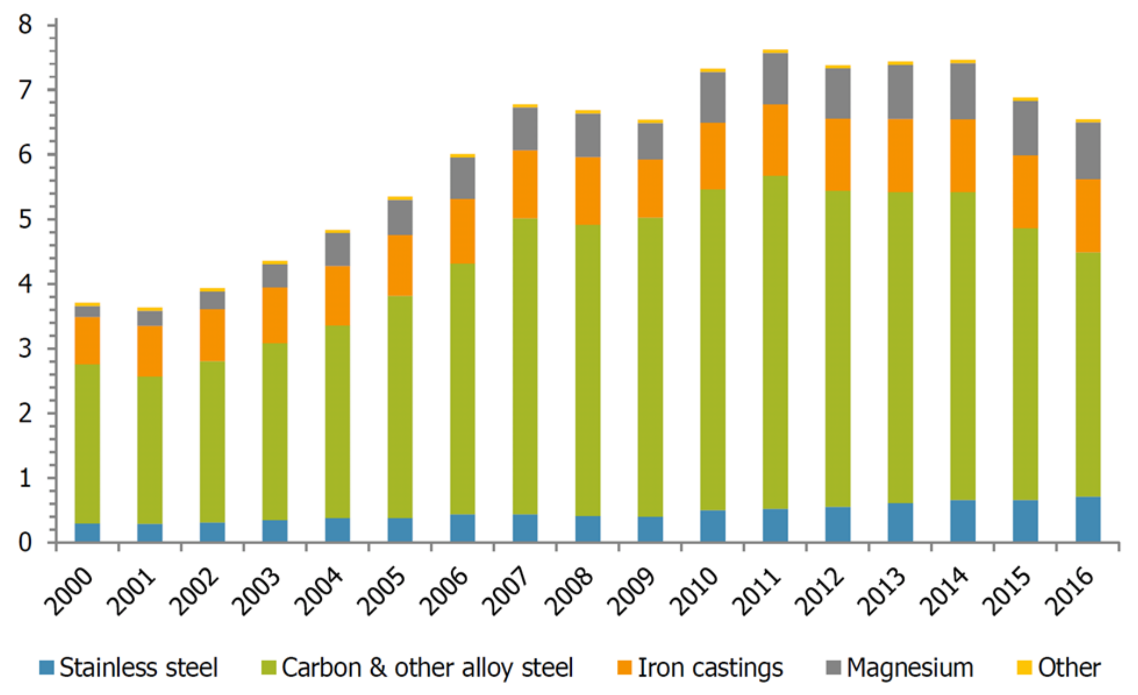
Figure 91 gives an overview of the relative distribution of FeSi consumption for its different end uses. Figure 92 shows that the decline of FeSi consumption is mainly due to the decreasing utilisation of FeSi in carbon and other alloy steel. This is mostly due to the falling consumption price of FeSi per tonne of crude steel in China.

Figure 91: Distribution of FeSi End-Use Markets



Source: Roskill

Figure 92: World Ferrosilicon Real Consumption by End Use (2000 to 2016)



Source: Roskill

19.2 Global Productions Capacity Distribution

This section provides an overview of the capacity distribution by region, individual smelter sites, and companies for the ferrosilicon market. This section concludes with a brief comparative assessment and discussion of CME's prospective capacities.

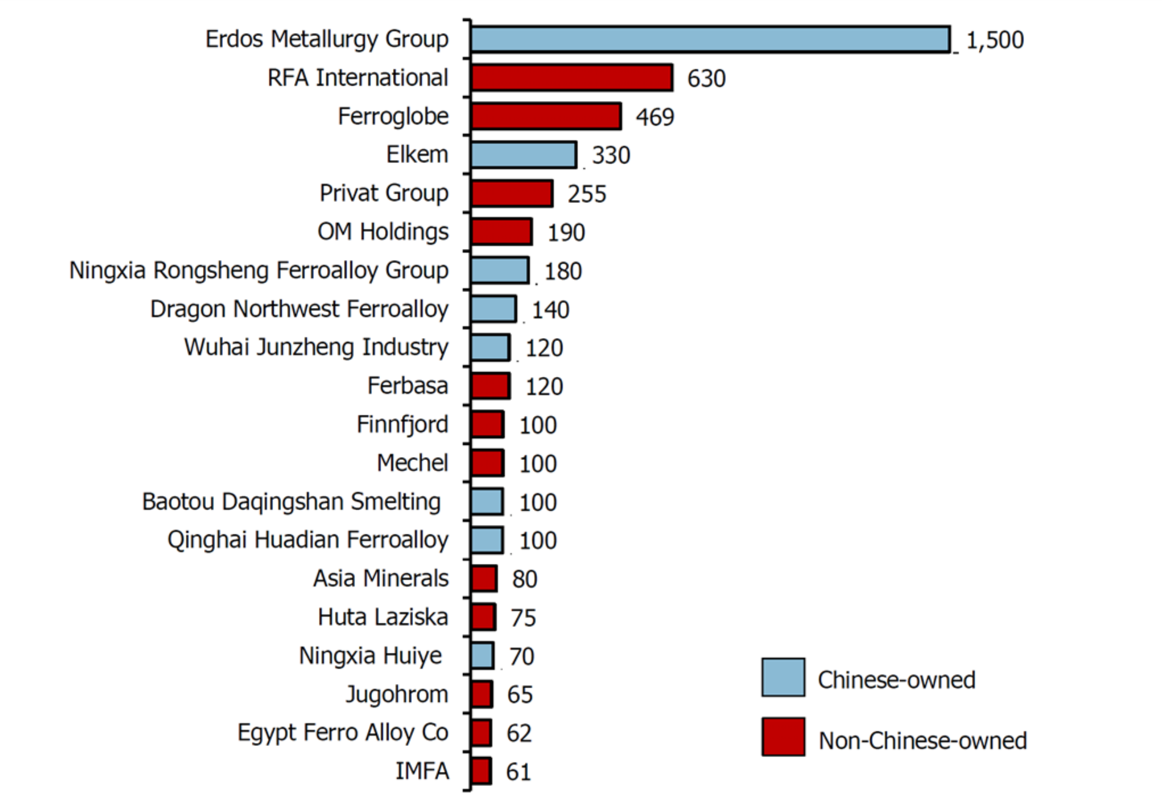
Out of the top five production sites, only two are based in China. However, one of them has a production capacity that is 5 x higher than the second biggest production site. The list below provides an overview of the top five production sites:

- **Erdos**—Inner Mongolia; Qinghai, China, with an estimated production capacity of 1,500 ktpy;
- **RFA International**—Kuznetsk, Russia, with an estimated production capacity of 300 ktpy;
- **OM Holdings**—Samalaju, Malaysia, with an approximate nameplate capacity of 190 ktpy;
- **Ningzia Rongshend Ferroalloy**—Rongsheng, China, with a nameplate production capacity of 180 ktpy;
- **RFA International**—Chelyabinsk, Russia with a nameplate capacity of 180 ktpy.

As some producers own and operate multiple sites, a capacity-based comparative assessment on individual producers yield valuable insights as regards to company specific economies of scale.

Figure 93 shows the global distribution of producer-specific manufacturing capacities.

Figure 93: Top 20 Global Ferrosilicon Producers by Capacity, 2017 (ktpy)



Source: Roskill

CIMA+ M03846C

19.2.1 FeSi Production Capacity Distribution

A smelter survey conducted by specialized firms has shown an interesting statistic of ferrosilicon capacity distribution. The global ferrosilicon production base is in comparison significantly larger with over 1,110 smelter sites recognized by ferroalloy market research firms such as Roskill or CRU.

Most of these smelter sites are located in China (>1,020), of which almost 1,000 have a sub-optimal plant capacity of below 10 ktpy.[1] The second biggest country, in terms of number of smelter sites, is India with "at least 30" production sites, "the vast majority with an annual production capacity of below 10 ktpy".[2]

Consequently, the focus of the Roskill ferrosilicon market report is placed on capacities with a threshold of more than 10 ktpy, an approach that is deemed rational and adopted in the present PFS.

The regional concentration of production capacity in China is a direct consequence of the country's infrastructure investment boom over the past decades. These infrastructure-related investments led to a rise in steel demand and a corresponding need for alloying materials.

Where the Chinese manufacturers responded with an unplanned capacity expansion spree that brought China's global capacity share to approximately three quarters of the market, in 2013. This regional distribution is expected to have not changed significantly because the data already reflect OMH Holding's capacity from its Malaysian mega ferrosilicon Greenfield facility, which has gradually been ramping up over the past years.[3]

However, in the past few years, Chinese Government has been pursuing an aggressive policy of eliminating excess capacities and reducing pollution. That has led to a lot of closure of small and outdated production site in China.

Figure 94 provides a top ten capacity breakdown by country. For each market the cumulated capacity is given in absolute (percentage of production) and relative terms (relative position compared with other countries). As can be seen, the second biggest region is Russia with a share of production capacity of 8.5%, and the third biggest region is Norway that follows quite far behind with a share of production capacity of 3.6%.

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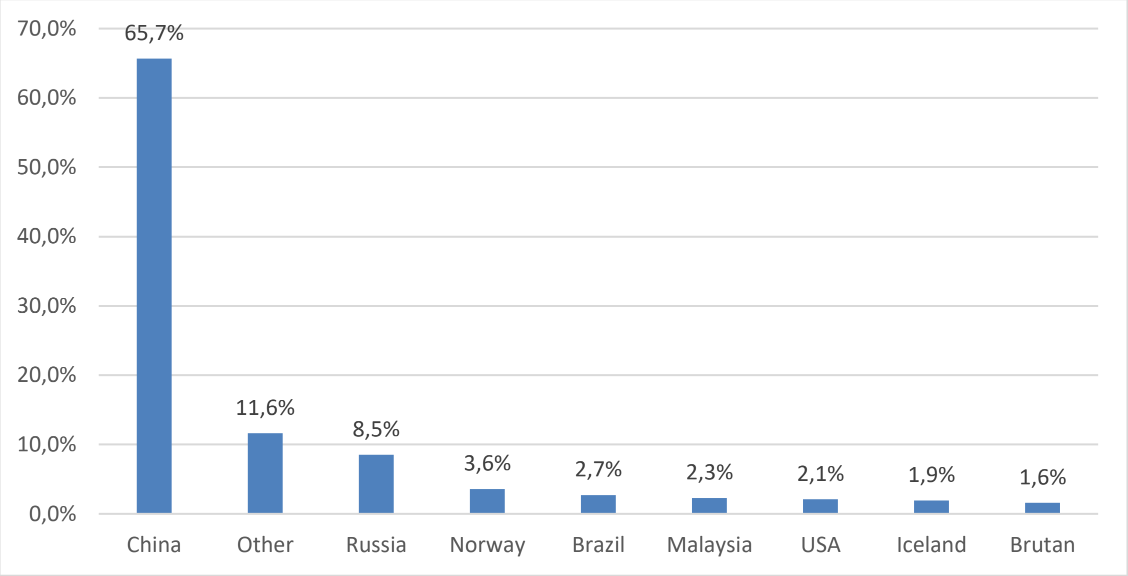
[1] Roskill Information Services Ltd. (2014), p. 81; Table 23 of the report lists major ferrosilicon producers in China and states that roughly 1,000 additional producers command a cumulative capacity of an estimated 8,300 ktpy which equates to an average smelter capacity of 8.3 ktpy.

[2] Roskill Information Services Ltd. (2014), p. 92.

[3] Compare "September 2014 Quarterly Production and Market Update", in which OM Holdings Ltd. discloses initial FeSi production volumes; http://www.omholdingsltd.com/news_announce14/24.pdf.

Figure 94: FeSi Production Capacity Distribution by Region (2016)



Source: Roskill

Figure 95 gives an overview of the global capacity distribution by country for a single-production sites, including some of the aforementioned sub-scale, below 10 ktpy capacities in China and India. As shown in the graph, the majority of the FeSi smelter sites have a production capacity of below 50 ktpy with a median capacity of 42 ktpy. The global average capacity of single-smelter sites based on the same universe with 91 constituents stands at 65 ktpy, significantly skewed upward by the following five (5) mega sites with annual capacity in excess of 200 ktpy:

- Erdos Metallurgy Group—Inner Mongolia, China, with an estimated production capacity of 1,500 ktpy;
- OM Holdings Ltd.—OM Sarawak, Malaysia, with nameplate capacity of 308 ktpy. The authors of this PEA categorize this smelter as operational. The plant is in the ramp-up phase according to a trading statement from July 2015;[4]
- Russian Ferro Alloys (RFA)—Novokuznetsk, Russia, with a production capacity of 300 ktpy;
- Erdos Metallurgy Group—Quinghai/ Baitong, China, with an estimated production capacity of 300 ktpy;
- Erdos Metallurgy Group—Quinghai/ Wutong, China, with an estimated production capacity of 250 ktpy.

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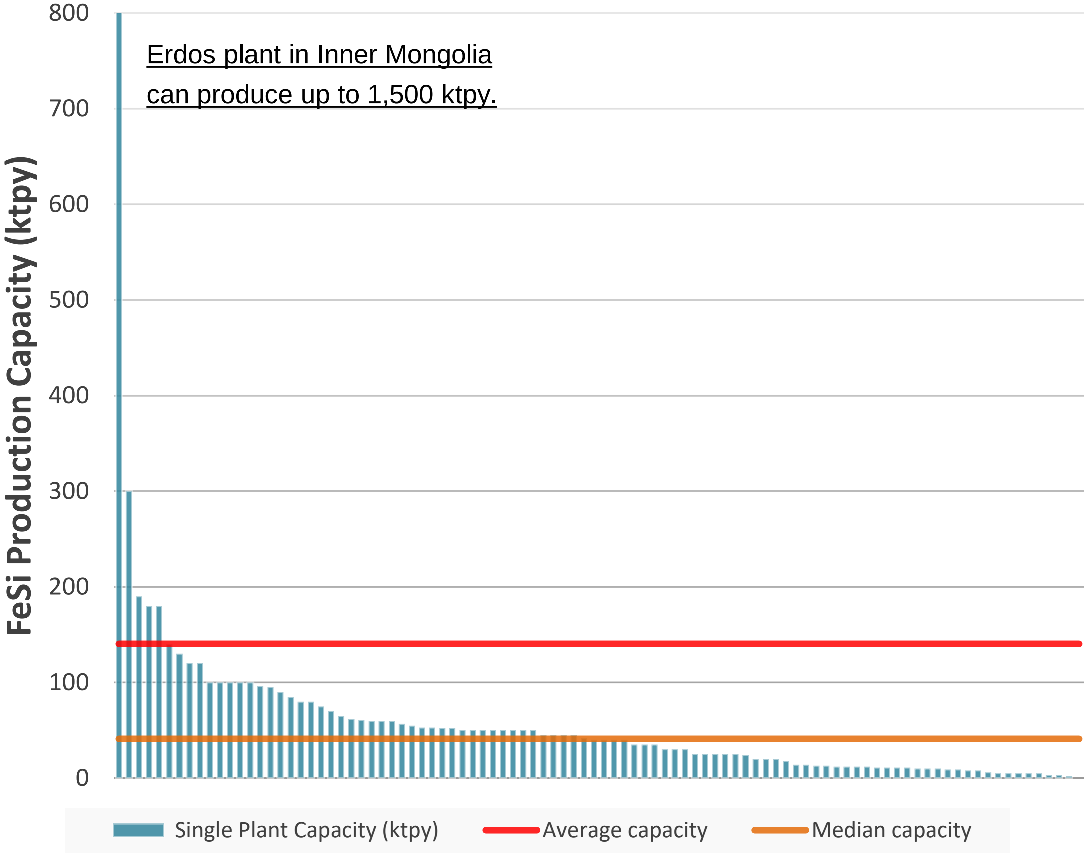
[4] According to a trading statement with the ASX Group (Australian Securities Exchange) from 30th of July, 2015, the site produced a total of 16,294 tonnes of ferrosilicon during the 2nd quarter of 2015; http://www.omholdingsltd.com/news_announce15/11.pdf.

Figure 95: Global FeSi Production Site Ranking by Single-Plant Capacity



Source: Industry sources; company websites and annual reports; press reports; Roskill estimates

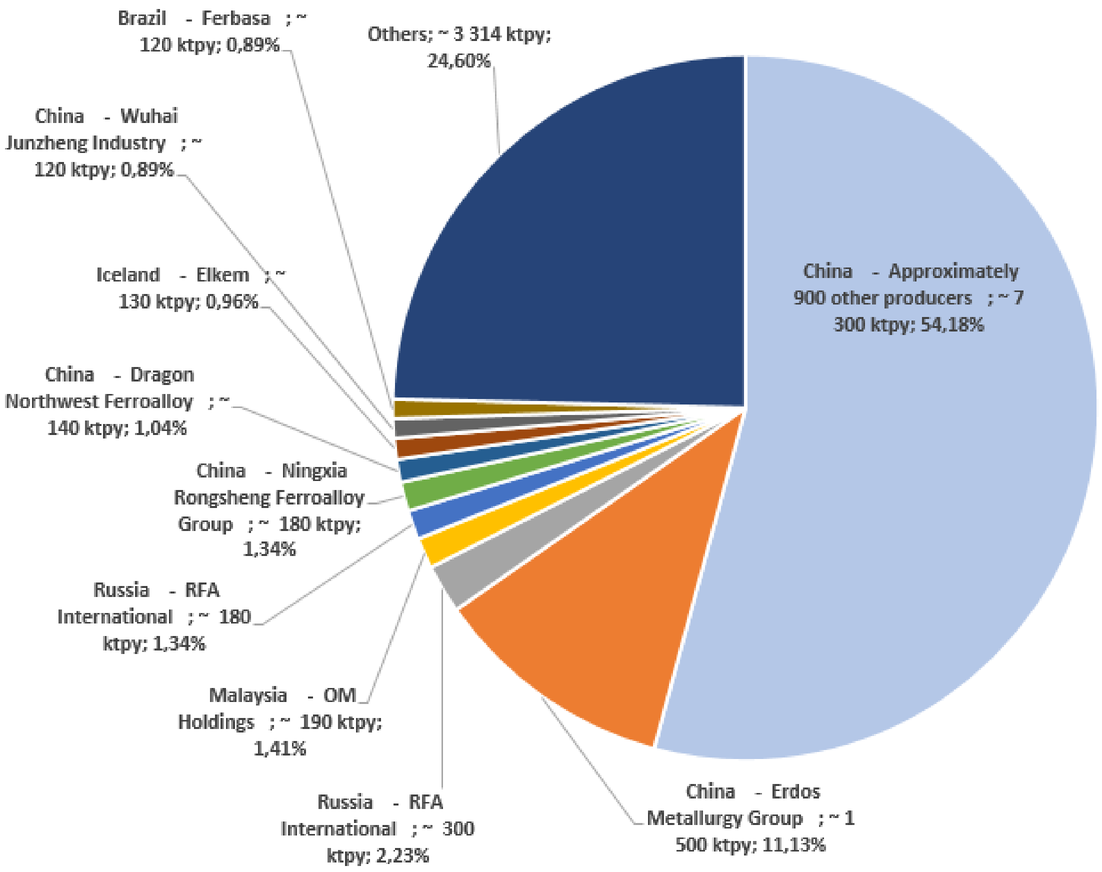
Published in: Silicon and Ferrosilicon: Global Industry, Markets and Outlook, 2017

If we compare all the companies in the world that produce ferrosilicon and exclude sub-scale Chinese and Indian FeSi producers, we can reveal that the top ten producers comprise roughly 60% of the manufacturing capacity.

The capacity range within the top ten group is very large, reaching from 120 ktpy at the low- to 1,500 ktpy at the high-end. The remaining 81 producers have a cumulative capacity share of roughly 40%. The company-specific distribution of manufacturing capacities mirrors to some extent the observation for the single-production site ranking introduced above.

The pie chart in Figure 96 provides a capacity breakdown for the top ten FeSi producers. Next to the company’s name, the estimated consolidated company-specific production capacity is disclosed in absolute and relative terms.

Figure 96: Capacity Breakdown for Top Ten FeSi Producers (2013)



Source: Industry sources; company websites and annual reports; press reports; Roskill estimates

Published in: Silicon and Ferrosilicon: Global Industry, Markets and Outlook, 2017

In conclusion, the global FeSi market is characterized by a very large number of production sites and producers. However, this situation does not constitute a state of perfect competition, as concentration tendency is clearly observable, both on a geographic and producer-specific level.

The top ten producing companies together account for 29% of world ferrosilicon capacity, and the top 20 account for 35%. These market shares are a bit higher than they were a few years ago, due to the closure of many small Chinese plants; nevertheless, the ferrosilicon industry remains quite fragmented.

Though the world's biggest ferrosilicon producer is Chinese, China is underrepresented amongst the leading ferrosilicon companies, considering that this country accounts for 66% of global ferrosilicon production and 75% of its capacity. Only two of the five biggest ferrosilicon producers are Chinese-owned; there are five in the top ten and eight in the top 20. The two new Malaysian ferrosilicon producers (OM Holdings and Asia Minerals) both make the list of the 20 biggest ferrosilicon producers, ranking sixth and fifteenth, respectively.

19.2.2 Synthesis: Benchmarking CME

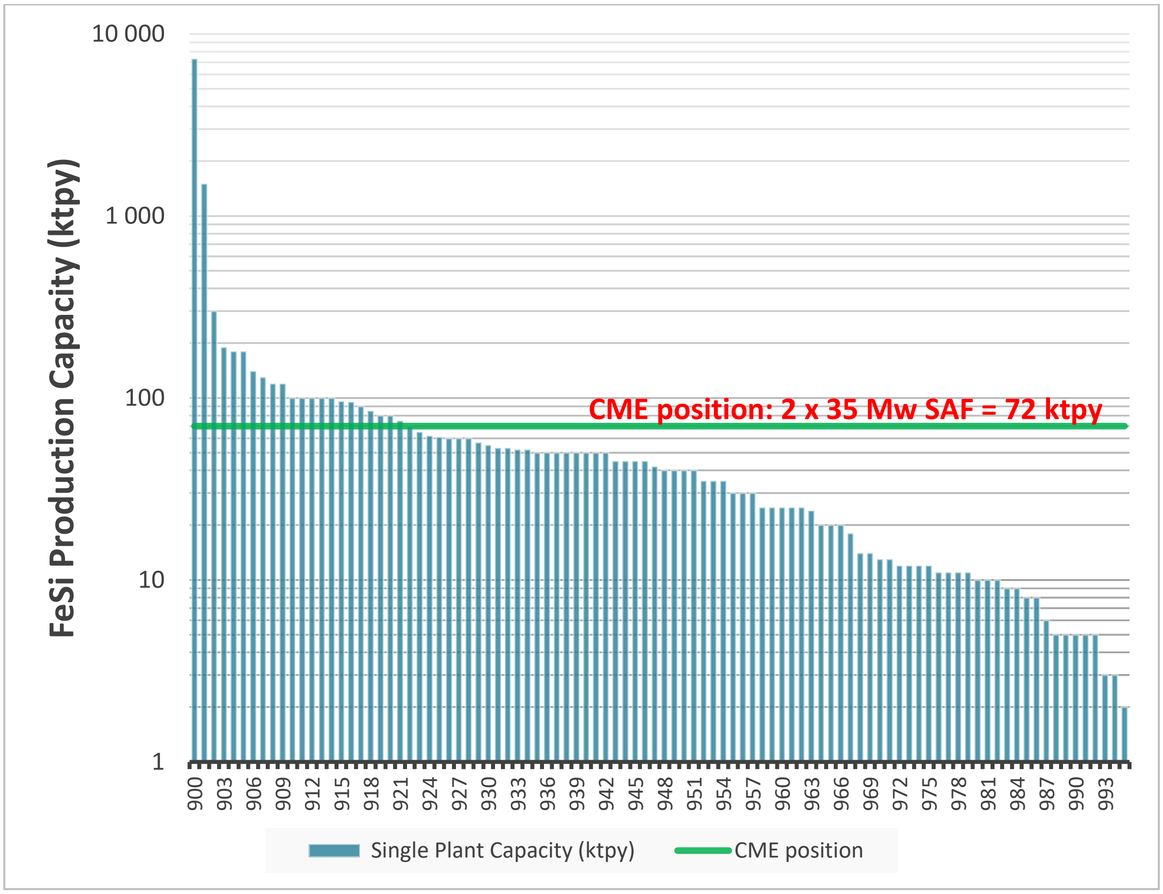
The base case operating assumption for the CME's smelter plant is that all tow furnaces are completely dedicated to ferrosilicon production.

The analysis of the capacity ranges provided below is based on the presumption that the respective produce is manufactured either in single- or two-furnace operation mode. Hence, two furnace outputs have been explicitly modelled for this PFS.

Figure 97 shows the CME smelters' capacity compared to the international competition. As depicted in the graph, the potential capacity of 72,051 tonnes of FeSi75 for an output of 94% of the smelters capacity availability located MME at the 21th position in the market. Again, the majority of the previously mentioned sub-scale Chinese smelters (<10 ktpy) have been omitted from this analysis, making the comparative ranking more conservative and meaningful.

This constitutes a capacity rank within the 3rd to 1st quartile of a global peer-group of ferrosilicon smelter sites.

Figure 97: Comparative Capacity between Benchmark CME vs. Competition—FeSi



Source: Industry sources; company websites and annual reports; press reports; Roskill estimates

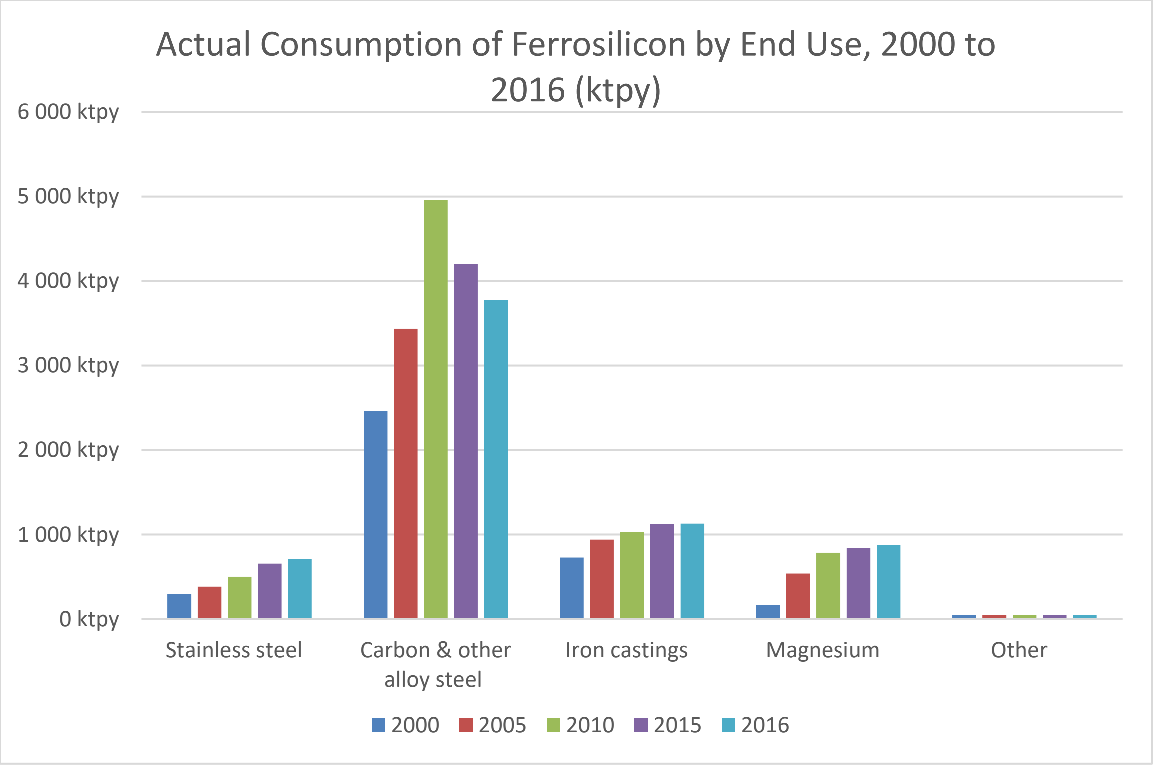
Published in: Silicon and Ferrosilicon: Global Industry, Markets and Outlook, 2017

19.2.3 Global Demand Profile FeSi

The regional distribution of the apparent consumption of ferrosilicon has shifted from western markets to Chinese and other Asian markets over the past decade. As the majority of FeSi75 is consumed in steel production (>60%), this shift in regional consumption patterns for ferrosilicon can be traced to the secular West-East-Shift of the steel industry.[5]

Figure 98 provides a breakdown of the actual ferrosilicon consumption by end use (in ktpy) for the period from 2000 to 2016, while Figure 99 provides a forecast of the consumption for 2017 to 2026.

Figure 98: Actual Consumption of Ferrosilicon by End Use



Source: Roskill—Silicon and Ferrosilicon: Global Industry, Markets and Outlook, 2017

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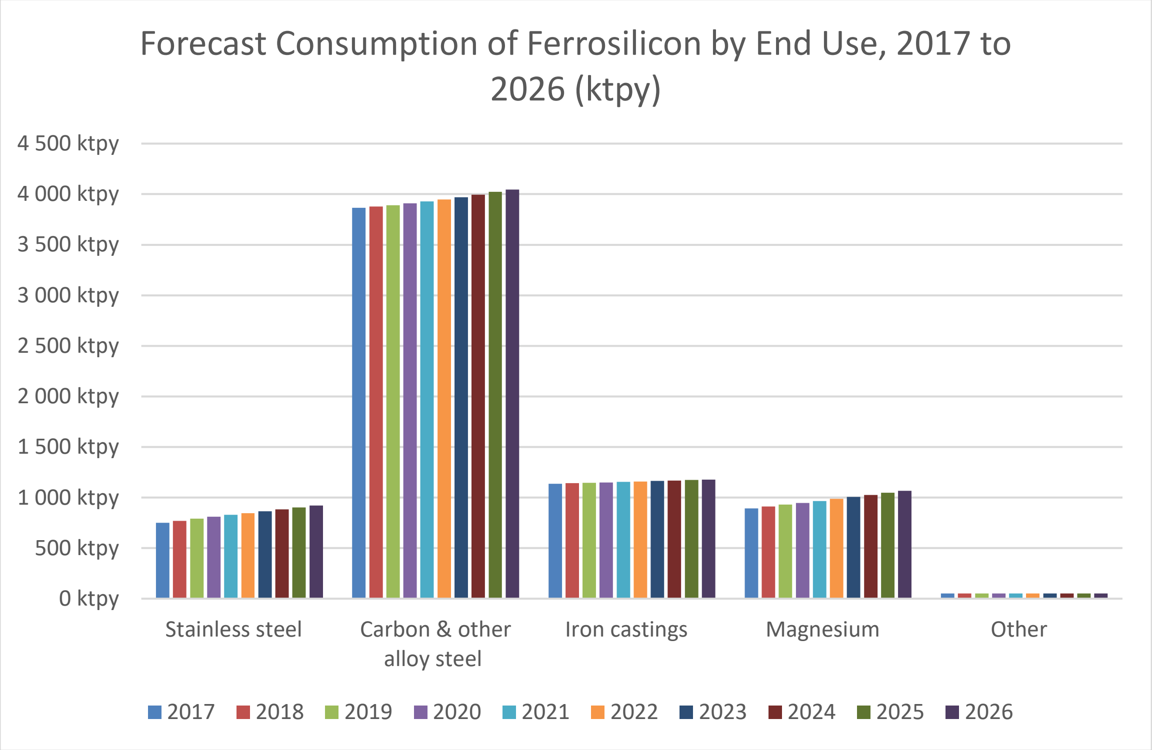
[5] Apparent consumption is deduced from export and import trading statistics and does therefore not reflect the changes in the inventory stock for the respective region. The Roskill report provides a global consolidated "reported consumption" figure which incorporates annual changes in inventory. The reported consumption figure is provided on worldwide basis without a breakdown by geographies.

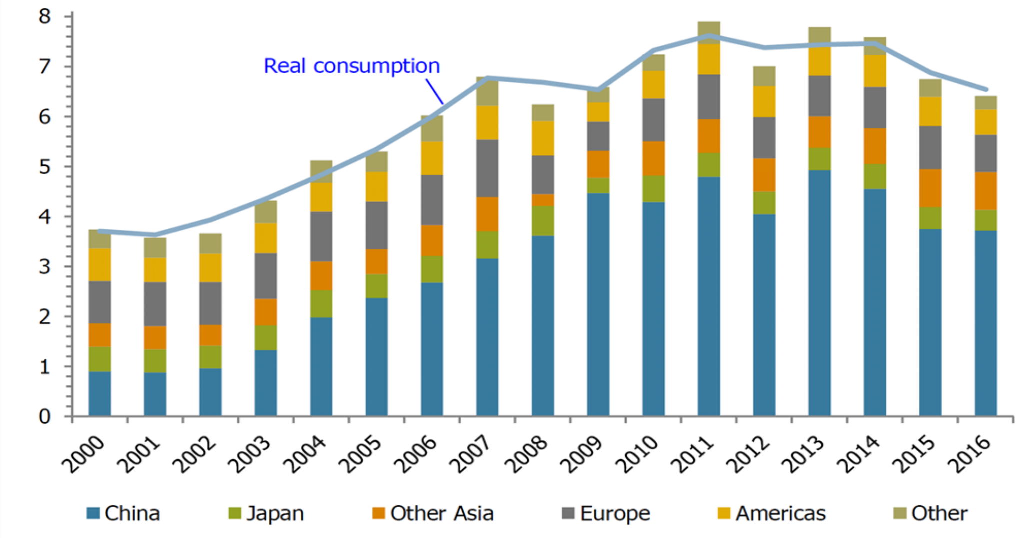
Figure 99: Forecast Consumption of Ferrosilicon by End Use



Source: Roskill—Silicon and Ferrosilicon: Global Industry, Markets and Outlook, 2017

The discrepancy between the total apparent consumption as used for the geographic breakdown and the reported FeSi75 consumption by end usage is a consequence of global inventory fluctuations. In cases where apparent consumption is greater (smaller) than reported consumption, the aggregated world FeSi75 inventory decreased (increased) in the respective year.

Figure 100: Historical Apparent FeSi75 Consumption by Region in Mt (2000 to 2016)



Source: Roskill

There is a strong and increasing dependency on steel market related ferrosilicon consumption. The share of FeSi usage for different steel products increased from ca 57.0% in 2005 to almost 65.0% in 2013. In the future, the steel market related end-usage share of FeSi is expected to stabilize and fluctuate around the 65.0% threshold, established in 2009.

Figure 100 above shows historical apparent FeSi75 consumption by region (2000-2016). The total global apparent consumption of FeSi75 increased by a CAGR of 5.0% from ca 5,300 ktpy in 2003 to >7,800 ktpy in 2013. As can be seen, the consumption in China increased more than twofold, while the second biggest consumers are other Asian countries excluding China. In the other regions, demand either stagnated or declined over the same assessment period. While the average linear annual trend growth of FeSi75 consumption was approximately 5.0%, annual changes in apparent consumption fluctuated between -12.0 and 14.0%.

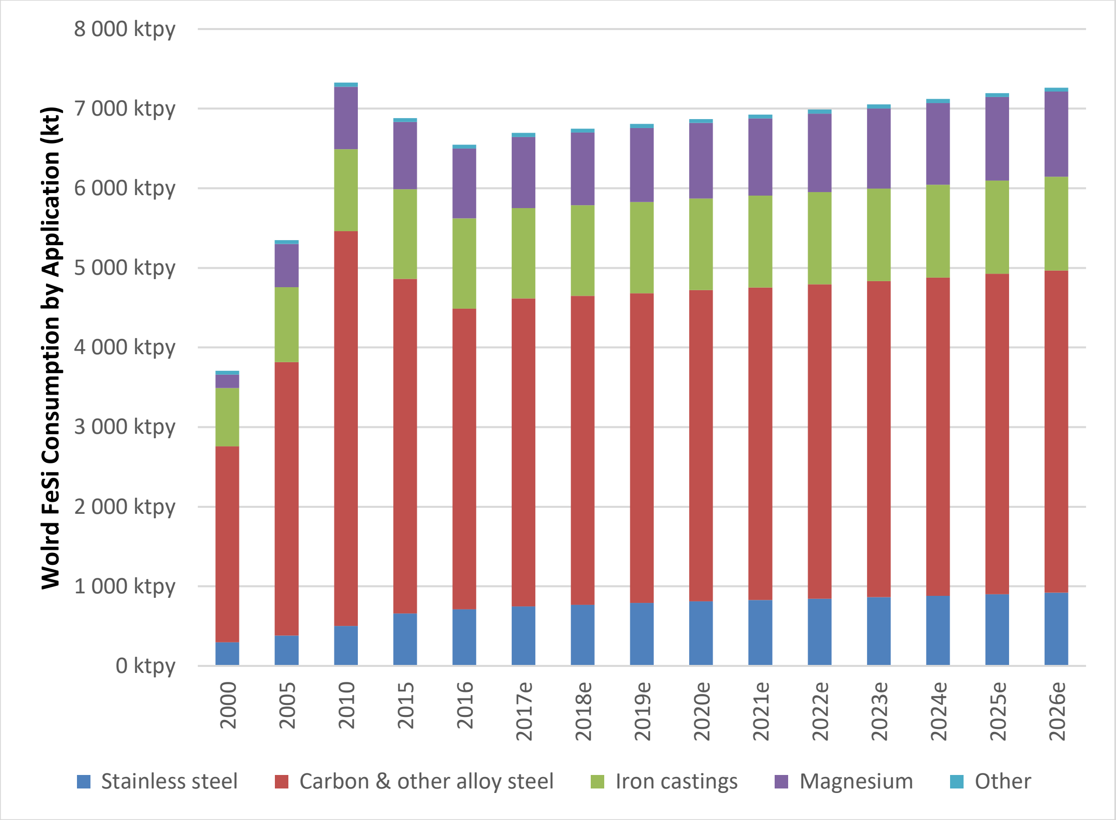
The market researchers from Roskill estimate the following indicators for the Compound Annual Growth Rates (CAGR) for the period from 2000-2010 and 2010-2016 and make a projection for the period from 2016-2026:[25]

Table 43: Compound Annual Growth Rates, Actual and Prediction for the Period 2000-2026

CAGRs	Stainless	Carbon & Other Alloy Steel	Iron Casting	Magnesium	Other	Total
2000-2010	5.4%	3.5%	3.5%	16.7%	0.0%	7.0%
2010-2016	6.1%	-4.4%	1.6%	1.8%	0.0%	-1.9%
2016-2026	0.7%	0.7%	0.4%	2.0%	0.0%	1.0%

Hence, total average FeSi demand is expected to increase more modestly at a compounded growth rate of approximately 1.0%, reflecting a saturation of the investment spending related steel boom in China and other emerging markets. Figure 101 shows the underlying annual FeSi demand forecast by end use.

Figure 101: FeSi Consumption by End-Market Consumption—Absolute



Source: Roskill—Silicon and Ferrosilicon: Global Industry, Markets and Outlook, 2017

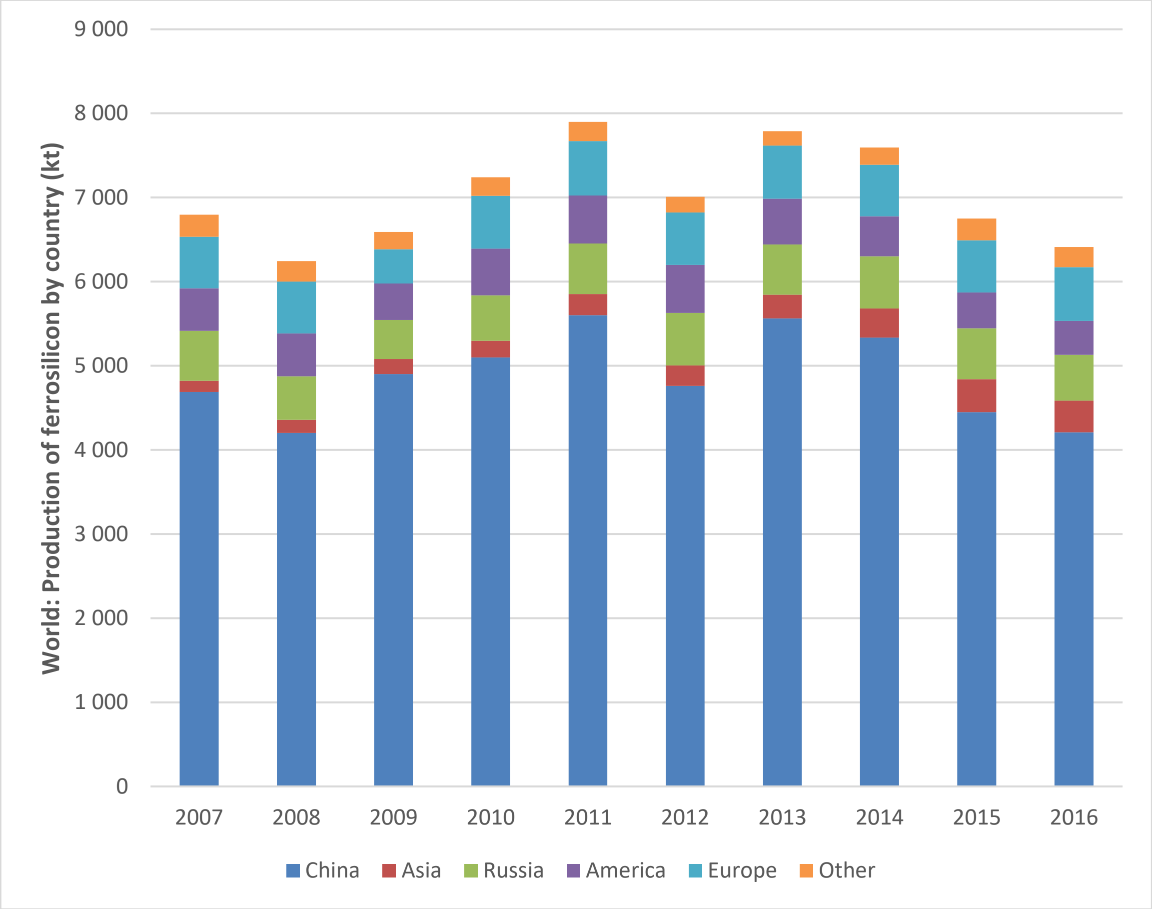
19.3 Supply, Demand, and Utilization

Even though the empirical data try to demonstrate that production closely tracks demand in both end markets, meaning that a large proportion of global production capacity remains underutilized, the USA, Canada, and Europe are potential target off-take markets for CME's prospective metallurgical ferrosilicon output.

19.3.1 FeSi Production

The total global production of ferrosilicon decreased by 6.0% in the period from 2007 to 2016 or in absolute terms from ~6,796 ktpy in 2007 to ~6,411 ktpy in 2013, which represents a CAGR of approximately 4.8%. A large proportion of this reduction is attributable to the infrastructure investment and environmental policy in China, which is expected to be moderate in the future as the country transitions from a consumer-/service-driven investment economic growth model. The regional production distribution and the year-to-year growth rate are exhibited in Figure 102. While the global production of ferrosilicon fluctuated moderately around its trend growth rate of 5.1% from 2004 to 2008, volatility in growth rates jumped drastically with the financial crisis.

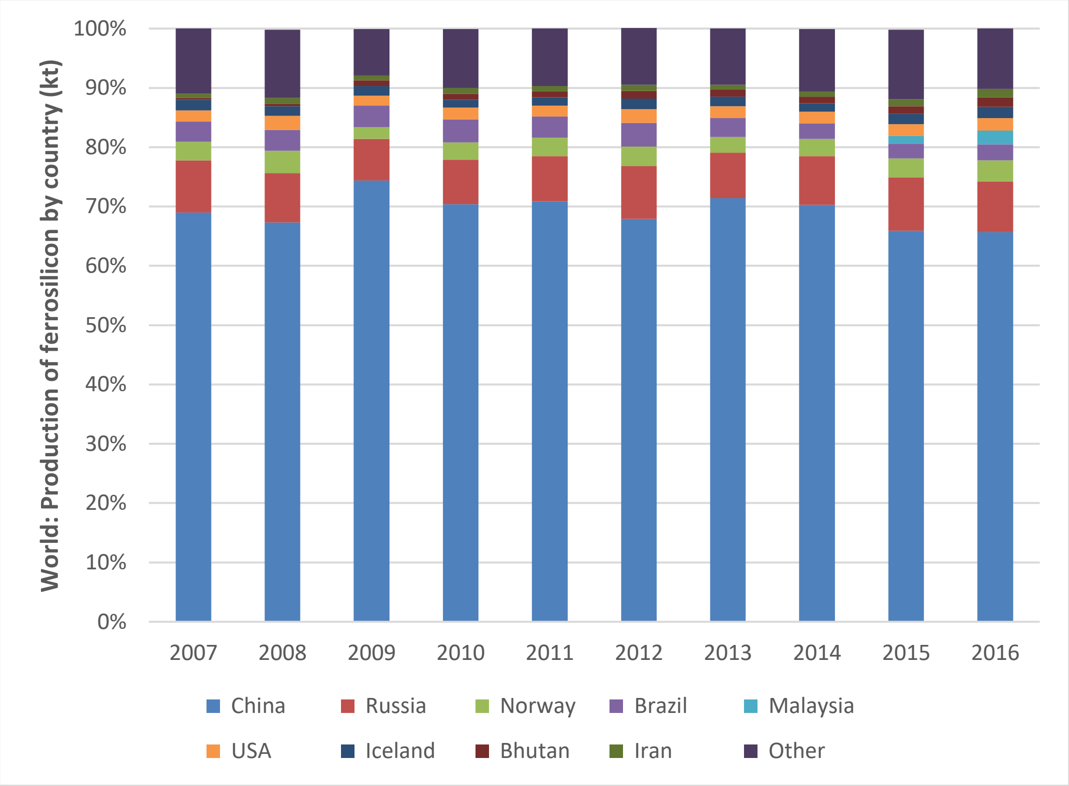
Figure 102: FeSi Production by Region—Absolute



Source: Roskill—Silicon and Ferrosilicon: Global Industry, Markets and Outlook, 2017

The dominance of Chinese production is not a surprise, given that more than 65% of the global production capacity is in this country. The share has increased from circa 69% in 2007 and peaked in 2009 with a share of almost 74.4%. In the subsequent years, the Chinese FeSi production share dropped back to the 68.9% range, a level where it has remained and fluctuated around. Figure 103 provides an overview of the relative production breakdown by region for the period from 2007 to 2016.

Figure 103: FeSi Production by Region—Relative



Source: Roskill—Silicon and Ferrosilicon: Global Industry, Markets and Outlook, 2017

The USA, Canada, and Europe would be potential target off-take markets for CME's prospective ferrosilicon output, if the project moves forward.

19.3.2 Industry Utilization

In the context of this PFS, industrial utilization levels are computed with the same indicators that they were used in the PEA, by dividing the aggregated production volume of a given year for pre-defined regions by the relevant nameplate capacities. To improve understanding of the dynamics within CME's relevant target markets, the following utilization levels are of interest and have been compiled for the end market based on data disclosed in the previously referenced Roskill market report:

- Global industry utilization;
- Chinese industry utilization;
- USA industry utilization;
- Canadian industry utilization;
- European industry utilization;
- Rest of World (ROW) industry utilization.

The higher industrial utilization levels in markets that are protected by trade tariffs underscores that there is room for new entrants with competitive cost structures that can supply regional material needs at reasonable price points. Trade legislation-based market-entry barriers are reviewed in section 19.6.

19.4 Contracts, Grades, and Prices

This section gives an overview of typical market exchange practices or seller-buyer relations within the silicon and ferroalloy industries before it briefly touches on quality- and material grading-related aspects that constitute a source of differentiation which can potentially increase average selling price (ASP) premiums for producers with sufficient operational excellence.

19.4.1 Contract Structures and Supplier-Buyer Relations

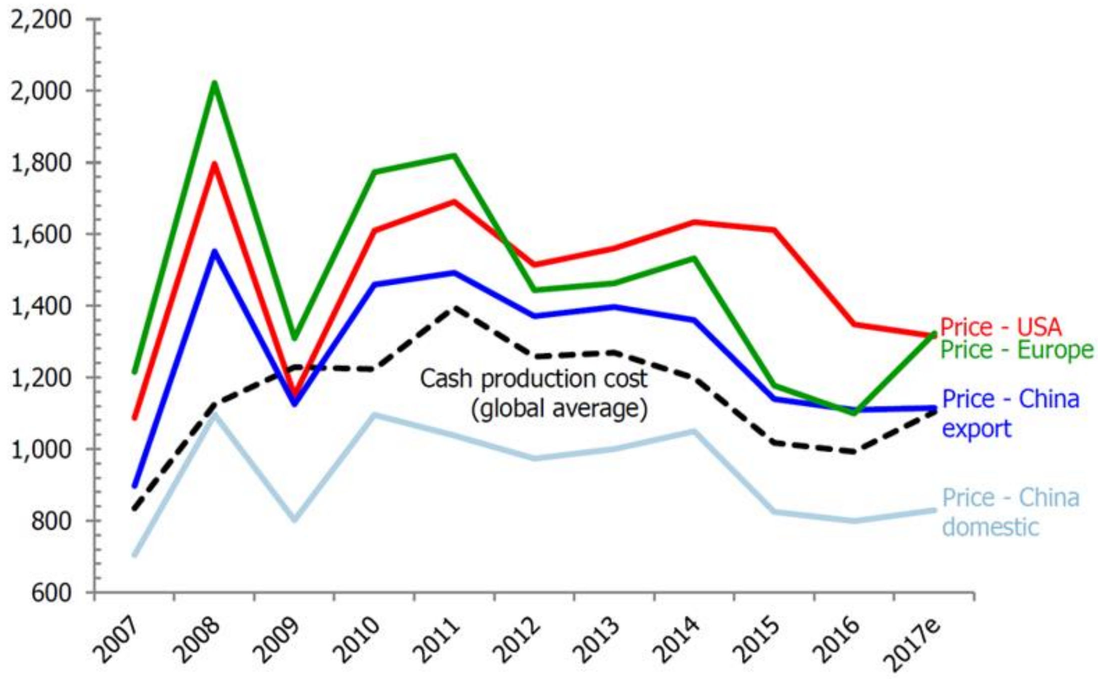
The market exchange mechanism for ferrosilicon is facilitated based on private contractual agreements. The commodities are not traded on metal exchanges such as the London Metal Exchange (LME) or Chicago Mercantile Exchange (CME). Consequently, the markets are less transparent when compared to other commodities such as steel or aluminum, for which market transaction prices are instantaneously available. Hence, aggregated price information as reference for benchmark purposes needs to be obtained from specialized market research firms that track prices and provide various time series for different geographies in regular time intervals. In many instances, contracts are indexed to various price publications such as Ryan’s Notes, Platts, and others.

Typical contract durations for ferrosilicon are observed to be short to medium term, where the former refers to a period of less than twelve (12) months, and the latter to a period of two to three (2-3) years. The contract duration is a function of the material specification, meaning that higher and consistent quality producers usually can obtain longer-term off-take agreements. To gain acceptance as a higher or specialty grade material supplier with additional value-creation potential, the ferrosilicon producer needs to pass a customer-specific qualification process that is more or sometimes less extensive, depending on the end-use application. Once a long-term relationship is established, the inter-value-chain linkage between the supplier and the customer increases with corresponding benefits for both parties. Volume and price settlement follows in accordance with contractual specifications and might contain a variable price index for energy price inflation. In general, established partners tend to roll over contracts at expiration date due to high transaction costs associated with expensive qualification procedures.

19.4.2 Historical and Forecasted FeSi Pricing

The average grade ferrosilicon spot market prices have been hovering between the US$1,721-1,389/t range over the past five years in the EU and the USA, while the Chinese FeSi prices fluctuated around the US$1,100/t mark. In conjunction with the throttling of the investment spending-based GDP growth in China and other emerging markets, the global demand for steel declined which led to a corresponding decrease in the demand for FeSi. Therefore, prices started to retreat from their respective levels in all major geographies since 2014, and recently reached temporary local troughs at an average of US$1,356/t in western markets (Europe and USA) and US$1.15/t for the export price in China. Another factor has impacted supply dynamic and prices over the past years: a substantial volume has entered the market from a mega smelter site in Sarawak, Malaysia, and this has coincided with a decrease of ferrosilicon output from other makers. Figure 104 gives an overview of regional spot prices for standard grade material and different regions.

Figure 104: Average FeSi Spot Market Price History by Region

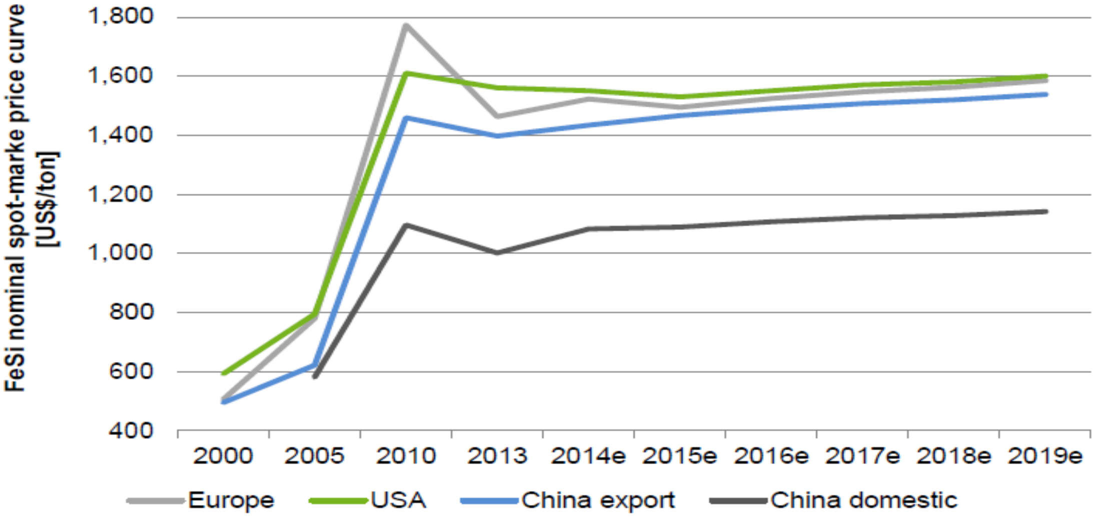


From: Silicon and Ferrosilicon: Global Industry, Markets and Outlook, 2017
Source: Figure A2; Table 30; Table 31; Table 32

The major determinants of FeSi prices are prevailing sourcing conditions for production resources (cost determinant), region of origin and consumption of end product (institutional determinant), as well as the absolute level of demand that determines the marginal cost producer within the merit order (marginal producer determinant). These determinants explain discrepancies in the price level by geography (e.g. export and import tariffs, anti-dumping, and countervailing duties, etc.) and short- to medium-term fluctuations due to the economic cycle and implicit FeSi market tightness (e.g. number of producers with cash-costs below the current price level). Obviously, each of these influencing factors is a function of multiple and correlated sub-parameters, explaining the interdependency of the major FeSi price determinants.

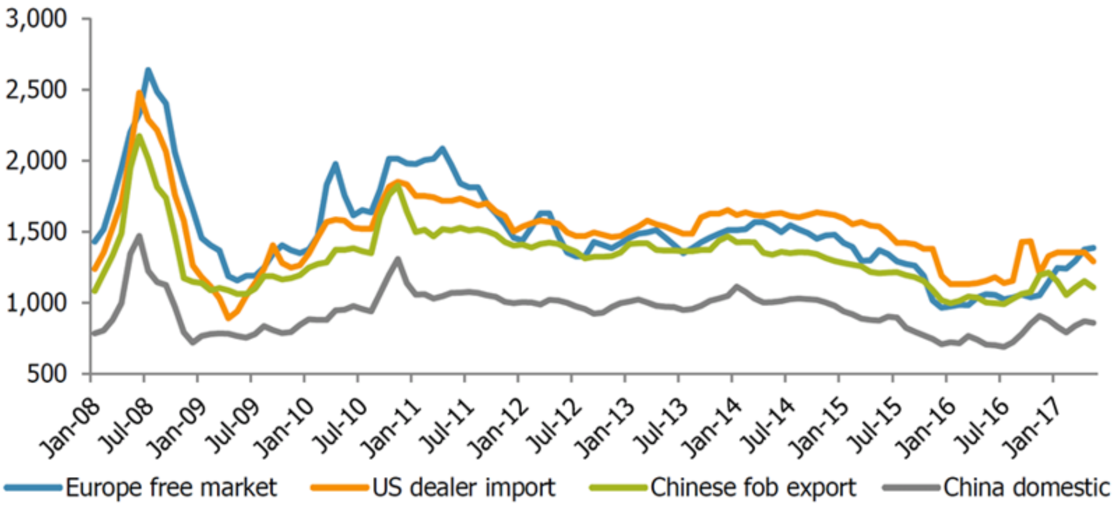
Detailed price forecasts for commodities or quasi-commodities are by nature error prone due to the inherent complexities associated with the projection of dynamic and randomly interrelated parameters. A comparison can be made between Figure 105 and Figure 106. The comparison shows the linear forecast for regional FeSi spot prices (nominal), as introduced in the Roskill market report from 2014. As it can be seen, a slight decline in western spot prices for the period from 2014 to 2015 had been anticipated at the time when the report was published. From 2015 onwards, nominal prices were expected to increase at a moderate compounded average rate of 1.2-1.5%.

Figure 105: FeSi Nominal Spot Market Price Forecast



Source: Roskill

Figure 106: Monthly Average Spot Prices for Standard 75% Ferrosilicon, 2008-2017 (US$/t)



From: Silicon and Ferrosilicon: Global Industry, Markets and Outlook, 2017

Source: Table 30, Table 31 and Table 32

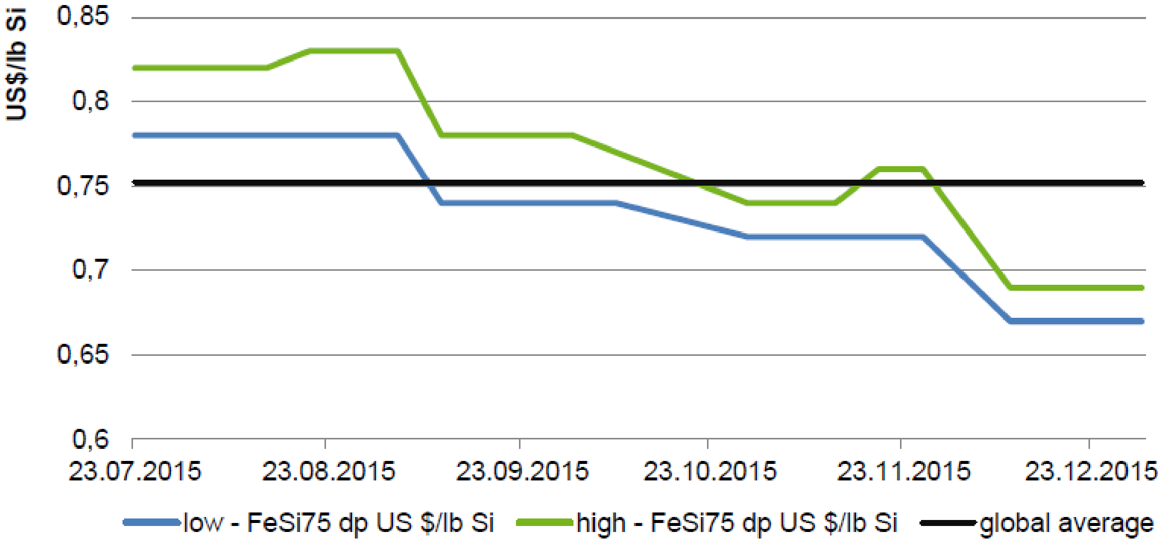
In conclusion, FeSi75 prices cannot be expected to increase to a large extent over the medium term due to an overcapacity issue which is currently being magnified because of declining steel production volumes. The different scenario driven FeSi forward price curves, introduced in later economic sections, incorporate the implications of this secular market imbalance to different degrees.

19.4.3 Spot Market Trends for the USA

This section provides a brief review of current spot market trends for the USA, which would likely be the main off-take market for CME's smelter output. While the price curves introduced in the previous sections give a good indication on longer-term pricing histories, trends, and cycles for major geographies, the presented data are not sufficient to establish solid reference price points for project evaluation purposes. In order to overcome this shortcoming, recent spot market price curves are introduced for 553-grade silicon material and FeSi75, respectively.

Figure 107 shows the bandwidth for low- and high-FeSi75 prices for the same time period. The price quote is provided in US$ per pound silicon content. Over the past five (5) months, prices retreated by approximately 14% to 16%. The global average price for the time under investigation is US$0.752 per lb of Si.

Figure 107: FeSi75 dp US Low and High Price for a 5-Month Period



Source: Argus Ferro-Alloys

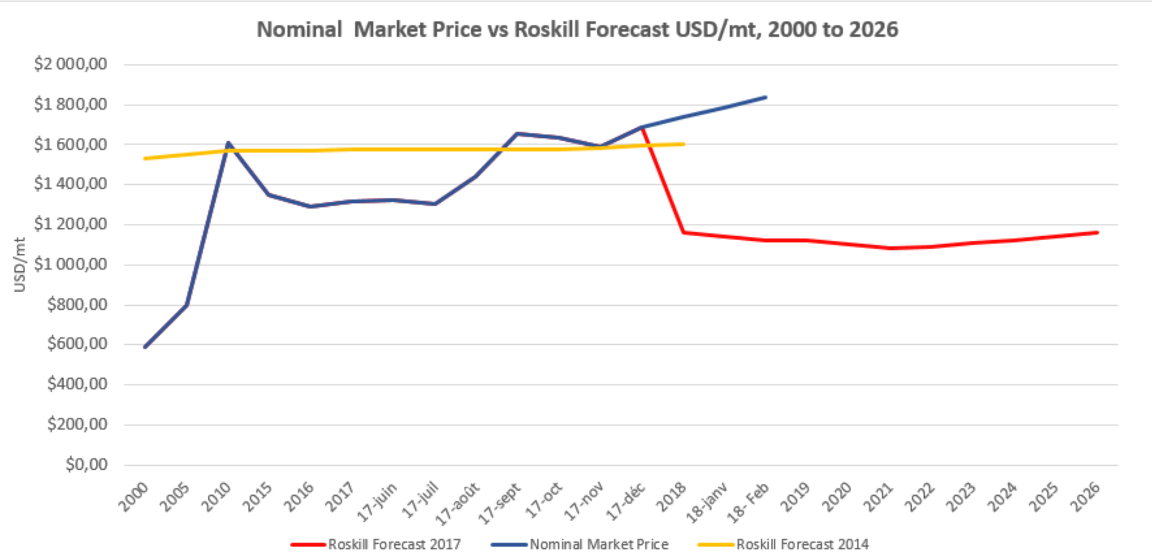
19.5 Price Estimate

To determine the price used for the Economic Analysis, a six-month moving average was used. The method uses the moving or trailing average of the metal prices for the last three (3) years. This allows to remove some of the volatility of the prices by comparison to current prices.

For the base cases of the price, Platts, CRU, Argus Metals International, Ryan's Notes (now part of CRU), and Roskill were used to determine nominal market price and future trend for FeSi75.

Figure 108 shows the comparison between the Roskill's forecast and the actual market price. As shown, Roskill seems to have overestimated the price of FeSi75 in its 2014 edition, whereas for now, they seem to underestimate the price trend.

Figure 108: Comparison between Roskill Forecast and Nominal Market Price



Data show that the market price went from around US$1,650 in September 2017 to US$1,850 in March 2018. It cannot be assumed that the price will continue to increase at that rate, but if Roskill's prediction of a stable price in the next years becomes reality, a price of around US$1,800 per tonne (US$1.10 per lb of Si) is reasonable.

In the context of this PFS, the price assumed for the project duration is estimated at US$1.10 per lb of Si for a selling price of US$1,819.13 per tonne of FeSi75.

19.6 Trade Restrictions in CME's Target Markets

This section provides a high-level overview of current trade barriers being in place in CME's likely off-take markets, e.g. USA, Canada, and potentially Europe. The next two product quality determinants are anti-dumping (AD) and anti-subsidy (AS) as trade barriers. It is therefore essential to understand present trade practices in relevant markets and get an understanding of uncertainties associated with recurring review processes by national trade bodies as well as super-ordinated WTO rules. The latter point is of particular importance, as a number of international trade clauses that apply non-market economy status to China have expired in 2016.

All the listed AD and AS rates have been enacted or reconfirmed in the period between 2013 and 2014. Hence, formal review processes will in most instances be initiated after a period of five (5) years in the timeframe from 2018 to 2019.

The regular duty is payable upon import of the goods and custom clearance and applied on the respective CIF price. In case where AD and AS duties need to be applied, the applicable rate will be charged on top of the regular duty. A local import agent normally pays the duty, based on an agreement between the shipper and consignee, and the goods are recorded into the countries import register.

China has implemented an export tax of 25% on ferrosilicon in 2007, which led to a decrease in the export share of FeSi from a bandwidth of 30-40% to 10-15% starting in 2008. This export tax has been prolonged in 2013 for a period of one year. The status of the duty review process on Chinese ferrosilicon exports is not well known.

The upcoming expiration of certain non-market economy status clauses for China is likely to increase complexity in future anti-dumping and anti-subsidy proceedings in general, as well as affect the determination process of the respective dumping margins. While the reference price for the determination of the normal value can be based on third country export prices in cases where proceedings target companies that are situated in non-market economies, the investigating body must take into consideration the domestic price structure in cases where subject companies are based in market economies. While the expiration of WTO clauses will not automatically render China a market-based economy, the anticipated diplomatic struggle on the interpretation of the actual status is likely to increase complexity of future trade proceedings.

19.7 Conclusion

The ferrosilicon market is highly disparate with little to no overlap in the end-market applications. The market is subject to its own distinct drivers and share only one key similarity, namely the existence of large, underutilized production capacities in China. As a counter-effect to this build-up of capacities in China, non-Chinese producers have evolved to combat this reality by improving cost and technology efficiencies, economies of scale, and the installation of trade barriers to keep Chinese production exports in check. Regulatory, environmental, and labour costs in China constantly push the production costs higher.

The ferrosilicon market in North America is tied to the volatilities of the steel industry, which is currently in a correction phase. The prospects might therefore be regarded as less attractive than those for metallurgical silicon. Further market-related investigations should be conducted at later project stages. In that respect, the flexibility of the project to serve diverse end-market segments seems to be an advantage.

Due to the market reality of ferrosilicon being a bulk commodity, the different spot prices and reports presenting information and projection of the future market prices vary considerably. For that reason, Canadian Metals and CIMA+ decided to assume sales price for the FeSi75 as the final product from the Baie-Comeau Plant for the purposes of the PFS to be based on the several inputs such as Roskill reports, projecting a forecast to 2019 at the US$1,200 per tonne. Currently, CIMA+ believes that the price of US$1,819 (US$1.10 per lb) is a reasonable assumption for this stage of the project development; CME and CIMA+ have followed the market tendency and updated the data from the last forecast of different analysis firms (listed in reference list). We have used CIM Best Practice Guidelines for Mineral Processing (last five-month price) methodology to estimate our spot price, which has not been considered aggressive or conservative, as the different data reviewed show spot prices in China in the range of US$1,000 per tonne and reports for North American market forecast potential of over US$2,200 per tonne.

In Asia, the billet prices have been very strong over the last few years. Thus, the margins are good for the Chinese steel mills. What that has meant is less exports out of China which in turn has meant better prices for steel production elsewhere in the world, whether it is the US or Europe. It has improved a lot, whereas forecasts were previously much more concerned about exports out of China, but domestic demand in China is very good. Moreover, China is the largest producer of steel in the world.

In addition, in spite of the recent decline in the markets of raw materials (iron ore) and steel products, CME and CIMA+ believe that the steel products demand in general, and therefore of FeSi as well, will remain durable due to the continuous requirements of steel products in China, the world always demanding infrastructure projects, as well as the proposed new silk route development plan, etc.

During the next phase of the project, a further detailed market study shall be developed. The Baie-Comeau spot price needs to be set up more definitely, a sales price based on the detailed evaluation of the potential products and specifically based on further negotiation with potential clients.

20. Environmental Studies, Permitting, and Social or Community Impact

20.1 Project Components and Main Characteristics

The project under study is based on two distinct but complementary components: an open quarry and an industrial complex with the process plant.

The quarry mainly consists of the development and extraction of a silica (SiO_2) deposit. The deposit is easily accessible by existing roads.

A production of 130,000 tonnes of coarse silica per year will require approximately 231,000 tonnes per year to be extracted and processed at the Langis quarry. The life of the project is expected to be 28 years. The quarry project notably includes the following activities: standard drilling/blasting, excavation, dump trucks, stockpiling, and crushing. The water for dust control will come from a sedimentation basin.

The quarry will supply the industrial complex producing silicon. The process plant will mainly consist of an electric arc smelting plant where silica is mixed with hematite, coal, electrode paste, and wood chips for the production of ferrosilicon (FeSi). This process required two electric arc furnaces (70 MW). Electricity will come from hydropower and will be provided through the Hydro-Québec grid (Rate L). Process water will come from the city water supply system.

The base case configuration assumes an annual production of about:

- 72,051 tonnes of FeSi;
- 12,969 tonnes of silica fume, a by-product of the smelting process;
- 4,323 tonnes of slag.

Raw materials will be brought to the plant by road, water, and railway. Final products may go through the same transportation modes but will be highly dependent on clients' locations and needs.

20.2 Study Area

The two main project components have different locations, both in eastern Quebec. The quarry is located in the municipality of Saint-Vianney in the Bas-Saint-Laurent region, while the silicon plant will be located in Baie-Comeau in the Côte-Nord region.

The quarry is located in a forested area with a low human activity density. The proposed exploitation area covered by the quarry is 9.34 ha.

The silicon plant footprint is about 12 ha. It is located north of an industrial park within the municipality of Baie-Comeau. The site is underdeveloped, mainly forested, and the existing industrial and commercial features are located to the south.

20.3 Description of the Biophysical Components

20.3.1 Physical Components

20.3.1.1 Substrates

Quarry

The quarry's study area is located in the eastern Matapedia region of Quebec, within a hilly terrain with a low elevation of generally less than 300 m. The study area is included in the Appalachian geological region and covered by glacial deposits with highly siliceous sandstone (Li and Ducruc, 1999). There is no known soil contamination site and soil and industrial waste deposition within the study area (MDDELCC, 2018a, b).

Industrial Process Plant

The natural substrate at the plant site, located in the Canadian Shield's Grenville geological province, is characterized by metamorphic rocks (MRN, 2002). The rounded hills, often bordered by steep escarpments, are lined with glacial deposits, mainly formed by undifferentiated thin tills. These rocky hills are separated by more or less deep valleys, filled in many places by large amounts of glaciofluvial sediments (GENIVAR, 2012). There is no known soil contamination site or soil and industrial waste deposition in the process plant's study area (MDDELCC, 2018a, b).

20.3.1.2 Water

(a) Hydrology

Quarry

There are no major watercourses or lakes within the quarry study area, the closest river being 2 km from the site. Only two small and intermittent streams have been identified at the limits of the exploitation site. A 75-m protection buffer zone will be maintained for watercourses and wetlands.

Industrial Process Plant

There is no lake inside the implantation area. The lakes located nearby are: Petit bras, Singelais, and du Nord lakes. The closest main permanent watercourses are the tributaries and emissaries of du Nord and Petit Bras lakes (GENIVAR, 2012).

A hydrological study will be carried out as part of the environmental impact study. This will determine the flow rate of streams impacted by the project. Data were collected in 2017 and will be analyzed in 2018.

(b) Surface Water and Sediments

Quarry

There is no watercourse within 75 m from the operating area (Biofilia, 2016). Only one ditch, following the access road, is located within the biophysical study area, and going through the exploitation site over a length of 20 m. Although generally stagnant, it slowly flows towards the northeast.

Industrial Process Plant

There are no data available on surface water and sediments, but sampling campaigns will be carried out in 2018. Water and sediment quality of permanent flow streams likely to be impacted by the project will be identified.

(c) Groundwater

Quarry

The hydrogeological information system provided access to the existing data regarding groundwater. The nearest sampling point is located at 1,200 m from the exploitation area. At this location, the groundwater lever is 9.45 m below the ground surface (Biofilia, 2016). Exploitation will be at least 5 m above the groundwater table.

Industrial Process Plant

There are no data available on groundwater. A preliminary characterization will be carried out in 2018 to establish the quality of the groundwater in place. The study area’s hydrogeological characteristics will be defined, including the piezometric contours.

20.3.1.3 Air

Quarry

Activities that are likely to impact air quality are mainly the following: drilling, extraction and loading of aggregates, crushing, and sieving. Mitigation measures will be applied to reduce dust emissions in accordance with section 25 of the Regulation Respecting Pits and Quarries.

Industrial Process Plant

The site is located north of Jean-Noël Tessier industrial park, about 3.5 km from residential neighborhoods. The dispersion of air contaminants generated by the plant operations will be modeled. Mitigation measures will be implemented as needed following the recommendations in the Environmental Impact Statement (EIS).

20.3.1.4 Noise

Quarry

The crushing area will be located in a depression, which naturally reduces the sound dispersion. Furthermore, the site is located at more than 600 m from residential areas as defined in the regulation. The nearest habitation is 1 km away. No mitigation measures are planned to minimize the effects of noise induced by the operations.

Industrial Process Plant

The plant infrastructure's noise propagation model will be carried out as part of the EIS. If needed, modifications or adjustments will be recommended to ensure the project complies with MDDELCC requirements.

20.3.2 Biological Components and Species at Risk

20.3.2.1 Terrestrial Wildlife

Quarry

According to literature, 102 bird species are likely to be found in Saint-Vianney on an annual basis (AONQ, 2018; Ebird, 2018). The request made to the CDPNQ did not reveal any special-status wildlife species within a radius of 25 km, and no species at risk were found in the study area during the inventory conducted in 2015 (Biofilia, 2016). Fifteen (15) herpetofauna (frog, salamander, tortoise, and snake) and 44 mammal species are likely to be found in Saint-Vianney (Desrosiers *et al*. 2002; Prescott and Richard, 2004; AARQ, 2018; MFFP, 2018). Among those species, the Red squirrel (*Tamiasciurus hudsonicus),* the Snowshoe hare (*Lepus americanus*), and the Moose (*Alces alces*) were inventoried in 2015 (Biofilia, 2016).

Industrial Process Plant

According to the biodiversity portrait of the Saint-Lawrence River, 259 bird species are likely to be found in Baie-Comeau (Environnement Canada, 2002). As part of the EIS, wildlife (bird, anuran, and chiropteran), inventories were completed in 2017 in order to confirm their presence and validate the presence of species at risk.

In 2017, 54 bird species were recorded in the study area. The Common nighthawk (*Chordeiles minor*) and the Olive-sided Flycatcher (*Contopus cooperi*), two species likely to be designated threatened or vulnerable in Quebec, were observed but no major impacts of the project are expected. Thirteen (13) herpetofauna and 46 mammal species are likely to be found in the Baie-Comeau area (Bélisle *et al*., 2000, CRBA, 2007, CRÉCN 2010, AARQ, 2018, MFFP, 2018). Among those species, the presence of the North American beaver (*Castor canadensis*), the black bear (*Ursus americanus*), and the moose were confirmed (GENIVAR, 2012). An inventory of the Salamander, the snake, and small mammals will be completed in 2018.

20.3.2.2 Vegetation and Wetlands

Quarry

The study area belongs to the plains and hillsides of Simard Lake's ecological region (4h) (*Gouvernement du Québec*, 2018). The area is dominated by terrestrial vegetation (80.4%) with aspen (*Populus* sp.), balsam fir (*Abies balsamea*), spruce (*Picea* sp.), and birch (*Betula* sp.) being the most common trees. The second largest unit is represented by the existing quarry itself (16.2%). Finally, wetlands represent only a small portion of the area (3.4%) (Biofilia, 2016).

A few small and isolated wetlands have been identified within the boundaries of the future exploitation site. However, these wetlands have a non-natural origin (from the last quarry operations) and a very low quality. Two other wetlands, also small in size, are located at the limits of the future exploitation site. No floristic or wildlife species designated as threatened or vulnerable were observed throughout the surveys (Biofilia, 2016).

Industrial Process Plant

The study area belongs to the Baie-Comeau–Sept-Îles Highlands' ecological region (5g) (*Gouvernement du Québec*, 2018). The main tree species found are: balsam fir, white spruce (*Picea glauca*), black spruce (*Picea mariana*), paper birch (*Betula papyrifera*), trembling aspen (*Populus tremuloides*), and jack pine (*Pinus banksiana*).

Significant wetlands are mostly associated with streams and lakes. The riparian strip of permanent and intermittent streams is colonized by shrub swamps where alder dominates. A large cattail marsh is also located along du Nord Lake. In addition, wooded peatlands, with varying degrees of forest cover, are located in depressions where organic matter accumulates.

The project might overlap some wetlands. Floristic inventories will allow to determine the impact of the project on wetlands and validate the presence of species at risk.

20.3.2.3 Aquatic Fauna and Habitats

Quarry

There is no fish habitat in the study area (Biofilia, 2016).

Industrial Process Plant

According to previous studies, fish species likely to be observed in the main watercourses are: yellow perch (*Perca flavescens*), sucker (*Catostomus* sp.), golden shiner (*Notemigonus crysoleucas*), and American eel (*Anguilla rostrata*) (GENIVAR, 2012). Fish populations will be inventoried in 2018 using the electric fishing method, and potential fish habitats will be determined.

20.4 Description of the social Environment

20.4.1 Site's local Study Area

Quarry

The quarry site is located in the Bas-Saint-Laurent administrative region, within the Matapedia Regional County Municipality (MRC), inside the boundary of the city of Saint-Vianney. The site is located at 980 m to the closest habitation and 4.3 km of the city of Saint-Vianney.

There are no leisure and residential areas within 600 meters of the boundaries of the operating area. Commercial and public uses are limited. There are some recreational, agricultural, and forestry operations uses.

Industrial Process Plant

The industrial process plant is located in the Côte-Nord administrative region, within the Manicouagan Regional County Municipality (MRC), inside the boundaries of the city of Baie-Comeau. The site is also located in the territory of the Innu community of Pessamit. The plant will be built north of the Jean-Noël Tessier industrial park, about 3.5 km away from residential neighborhoods.

The site will be connected to the future section of Road 389. On the proposed site, there is no permanent leisure, recreational, or tourism infrastructure. However, a snowmobile trail, three hunting camps, a hunting stand, and an explosives storage site are nearby (GENIVAR, 2012). Two powerlines are located south of the proposed site.

This site also benefits from the proximity of industrial partners and efficient infrastructure for both maritime and rail and road transport.

There are no known heritage sites within the study area (GENIVAR, 2012). As part of the project to improve Highway 389 between Baie-Comeau and Manic-2, potential archaeological areas have been identified near Petit Bras Lake and its tributaries (MTQ, 2014). Archaeological studies will be carried out by a specialized firm in 2018.

20.4.2 Ore and Finished Product Transportation

The silica ore will leave the quarry by truck to the loading dock located in Matane. From there, the trucks will cross the Saint-Lawrence River and arrive at the Baie-Comeau wharf, either by barge or by rail ferry. The trucks will go to the plant via Road 138 and then Road 389.

Finished products will be exported by container, allowing transport by truck, rail, or boat, depending on the location and customer needs.

20.4.3 Silica Transformation

Reducing agents (ex.: coal), iron supplements (iron ore), wood chips, and electrode paste resources will be added to silica (Quartzite) to generate the following products:

- Silicon, granules of 10 to 100 mm in diameter;
- Silica fume, a co-product used as an additive in concrete;
- Slag, a co-product used for manganese alloys.

The plant will produce 72,051 tonnes of silicon alloy, 4,323 tonnes of slag, and 12,969 tonnes of silica fume per year.

20.4.4 Hazardous Materials and Waste Management

Hazardous materials will be stored and managed by authorized firms and disposed of on licensed sites.

Generated waste that cannot be reused will also be stored and managed in accordance with environmental regulation.

20.5 Environmental Issues

20.5.1 Quarry

With the environmental studies completed and the authorization obtained for the quarry, the potential issues and impacts are well understood. A forest intervention permit will be required for the land-clearing. An evaluation of the wood volume involved will be carried out. Based on our analysis, there are no major issues or impacts that may affect the project implementation or its outcome.

The remote location of the quarry contributes to the low level of impacts. Access roads are already in place. There are no residential or intensive human activities in the area that could interfere with the quarry location or with operations.

Only a few environmental features (wetlands) at the limits of the future extension of the quarry are of concern but will be dealt with through proper measures to ensure that a safe distance between the working zone and these features is implemented and respected. Measures will also be identified to control potential sources of disturbance and contamination.

The construction of the quarry and its operations could affect physical, biological, and human components of the project area. These issues include:

- The loss of terrestrial fauna habitats through vegetation cutting, excavation, and backfilling as well as through operations of the quarry;

- The potential disturbances of local fauna activities through the increased noise levels, vibration and dust generation (dust fallout generated by operations activities), handling, and transportation (raw material expedition);
- Significant positive residual impacts are expected, especially:
  - Job creation (source of employment and spinoffs for the municipality).

20.5.2 Industrial Process Plant

Since the EIS is yet to be initiated, the analysis of issues and impacts has not been completed. However, the knowledge of the study area from the baseline studies as well as the experience from similar projects allow for a higher level of understanding of the main issues and impacts of the project. The project's small footprint, located outside the city center and away from residential neighborhoods, will contribute to reducing the impacts.

The environmental and social issues mainly related to the project are described below.

20.5.2.1 Physical Environment

The main components of the physical environment potentially impacted by the project construction, operations, or closure are the following: ambient air quality, noise, soil quality, groundwater quality and flowrate, as well as surface water and sediment quality. The main anticipated residual impacts are:

- Reduction of air quality and increase in greenhouse gas (GHG) emissions;
- Increase in ambient noise levels;
- Reduction of surface water and sediment quality;
- Change in the landscape.

20.5.2.2 Biological Environment

Regarding the biological environment, the main components potentially impacted are: terrestrial wildlife, vegetation, wetlands, and aquatic fauna. The main potential impacts are:

- Loss of vegetated areas;
- Loss of wetlands;
- Disturbance of fish habitat;
- Modification and loss of wildlife habitats;
- Disturbance of wildlife.

20.5.2.3 Human Environment

The main issues of the project related to the human environment are local and regional economy, infrastructure and services, quality of life, land use and natural resources, archaeological heritage, landscape, and the Aboriginal presence. The expected residual impacts are:

- Traffic related to the transportation of raw material to the industrial process plant;
- Increased noise especially associated with transportation and the plant;
- Natural landscape modifications;
- Job creation (source of employment and spinoffs for the municipality).

20.5.3 Mitigation Measures

Mitigation measures will be identified to ensure that impacts are minimized as much as possible in terms of intensity, range, and duration. Compensation measures will be identified for key impacts that cannot be mitigated properly.

In order to minimize or eliminate impacts from the project, all aspects of the project will be optimized. The objective is to preserve the natural environment and promote social acceptability, while maintaining the feasibility of the project.

20.5.4 Compensation Program

In the event that encroachments are made in fish habitat, hydrous environments, or wetlands, compensation measures will be proposed according to different regulations under provincial and federal legislation.

The preservation of fish habitats is covered at the provincial level by the Regulation respecting Wildlife Habitats and at the federal level by the Fisheries Act.

Sustainable development concerns and the need to meet the provisions of the Fisheries Act resulted in site optimization efforts intended to avoid, as much as possible, sensitive elements of the environment such as the study area’s watercourses and water bodies.

Finally, monitoring and follow-up programs will be set up to ensure that environmental and social impacts are managed throughout the life of the project and in respect with the authority’s requirements and permitting conditions.

20.6 Social and Community Services

Continuous engagement and information will be sustained with the municipality of Saint-Vianney to make sure any questions arising from the local community can be answered promptly and properly.

Throughout the EIS procedure for the process plant, consultations with the community and the stakeholders are part of EIS best practices as well as strongly recommended by the authorities.

Consultations serve many objectives: provide information to the community and stakeholders about the project and its impacts, give the opportunity to the community to express concerns and questions, and obtain information from the community in order to adjust the project and apply mitigation measures if needed.

Since the EIS has not started, no activities pertaining to community and stakeholder engagement have been initiated yet. However, activities are planned and will include the following:

- A first consultation early at the beginning of the EIS to present the project and inform the population and First Nation about the upcoming steps and studies;
- A second consultation near the end of the EIS to present the population and First Nation with the results of the EIS impact analysis;
- A public hearing with the government representatives and *Bureau d'audiences publiques sur l'environnement* (BAPE) at the end of the environmental assessment procedure;
- All along the course of the project, communications will also be on-going with the community to make sure information is always available and engagement is sustained.

20.6.1 Community Meetings

Quarry

As part of the exclusive lease request, a public consultation process was implemented to inform and consult the local population about the project. The meeting was conducted on June 21st, 2017, and 54 participants from the Municipality of Saint-Vianney and surrounding areas took part in the meeting (WSP, 2017b).

This consultation was conducted in three phases: 1) explain how the consultation process fits into the process of obtaining the exclusive lease request; 2) a PowerPoint presentation of the project and; 3) a period for citizens to express their opinions, suggestions, and comments as well as ask questions.

Industrial Process Plant

Canadian Metals is very committed to maintaining good relations with the communities that are concerned by the development of its project. Through information and the consultation process, Canadian Metals will be able to incorporate the regional community's sensitive issues and concerns while developing the project.

20.6.2 Meetings with the First Nations

The Canadian Metals industrial process plant project is located on the Nitassinan of the Innu First Nations from Pessamit. Discussions will take place between the community and Canadian Metals.

20.6.3 Meetings with Local Elected Officials

Canadian Metals will have meetings with various elected municipal, provincial, and federal officials as well as representatives and officials from many ministries in order to discuss different aspects of the project (plant and quarry).

20.6.4 Other Communications and Visibility Initiatives

In order to provide information to stakeholders, population, and any other group or individual seeking up-to-date information on the Canadian Metals project, the company developed many information tools on its website, such as a corporate video. As part of the public meeting held on June 21st, 2017, in Saint-Vianney, a CBC news article covered the event.

20.7 Environmental Permitting and Applicable Regulations

20.7.1 Quarry

The operation of the quarry is currently authorized. If the quarry extent increases (area of volume/year) beyond what was allowed by the existing environmental authorization, an environmental repercussion study will be carried out. If wetlands are impacted, the new 132 law will be applied.

The quarry's environmental assessment procedure is under the responsibility of Quebec's *Ministère du Développement Durable, de l'Environnement et de la Lutte contre les Changements Climatiques* (MDDELCC) (Ministry of Sustainable Development, Environment, and Fight against Climate Change).

The project is subject to Quebec's Environmental Quality Act (EQA), section 22, which states that no one can erect or modify a construction, undertake the exploitation of an industry, exercise an activity or use an industrial process, nor increase the production resulting in the emission, deposit, release of contaminants or the modification of environmental quality, without first obtaining the authorization from the ministry.

The Quebec Regulation on quarries and sand pits also states that no one can undertake the exploitation of a quarry or a sand pit unless the authorization from the ministry has been obtained under section 22 of the EQA. The Quebec regulations as well as municipal by-laws will also apply to the project.

The requirements are mainly related to the knowledge of the surrounding environment and the project's main characteristics and the application and respect of guidelines related to the location of the quarry and its distance from key neighborhood features such as houses, wells, roads, and watercourses. The federal procedure on environmental impact assessments does not apply to the quarry component.

The quarry will be operated ±150 days/year.

20.7.2 Industrial Process Plant

20.7.2.1 Legal Context

The preparation of the Canadian Metals project's EIS is guided by a series of provincial and federal laws, regulations, and administrative procedures presented below.

20.7.2.2 Provincial Permitting Process

Environment Quality Act (EQA)

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

Under Subsection 31.1 of Quebec's Environment Quality Act, (R.S.Q., c. Q-2):

"*No person may undertake any construction, work, activity or operation, or carry out work according to a plan or program, in the cases provided for by regulation of the Government without following the environmental impact assessment and review procedure and obtaining an Authorization certificate from the Government (1978, c. 64, s. 10)*."

PROJECTS SUBJECT TO THE EIS PROCEDURE

DIVISION II

PROJECTS SUBJECT TO THE ENVIRONMENTAL IMPACT ASSESSMENT AND REVIEW PROCEDURE

2. List: *The constructions, works, plans, programs, operations and activities described below are subject to the environmental impact assessment and review procedure provided for in Division IV.1 of the Act and must be the subject of a certificate of authorization issued by the Government in accordance with section 31.5 of the Act:*

(n.3) the construction of a mill that produces metals, metal alloys or metalloids and has an annual production capacity of 20,000 metric tonnes or more.

(n.9) the construction of a metal products processing plant that has an annual production capacity of 20,000 metric tonnes or more.

Since the project production capacity is over 20 000 metric tons, it is subject to an EIS.

It should be noted that, as stated in the same regulation, projects involving several elements subject to an EIA require a single EIS and a single application for a Certificate of Authorization (CA).

ADMINISTRATIVE PROCEDURE

Adjustments are to be expected with the new legislation which has been in effect since March 23rd, 2018:

- Law project Nr. 132: Wetland and Hydrous Environment Conservation Act;
- Law project Nr. 102: Environmental Quality Act Modification:

In order to reach the decision stage for the Authorization of the Project by a Government decree, there is a total of eight (8) phases to complete the EIA process as described hereafter.

1 Issuing of an Instruction by the *Ministère du Développement durable, de l'Environnement, et de la Lutte contre les changements* (MDDELCC).

Any person wishing to undertake projects contemplated in section 31.1 of the EQA must file a written notice with the Minister, describing the general nature of his project. The Minister, in turn, will indicate, through an instruction to the proponent of the project, the nature, scope, and extent of the environmental impact assessment statement to be prepared ((ss. 31.2) 1978, c. 64, s. 10).

2 Environmental Impact Assessment

In broad terms, there are four key steps to an EIA:

- Describe the project in detail;
- Describe the biophysical and human environments;
- Assess the negative environmental effects;
- Determine ways (mitigation measures) to eliminate or reduce the negative effects on the environment.

The specific steps in the process can vary depending on the scope of the project, the anticipated level of the impact on the environment, and several other factors.

3 Public Consultation

Public participation (BAPE).

After confirming acceptance of the EIS, the Minister will make the document public, and public information and the consultation process, as required by law, will then be initiated.

4 Public Hearing

Any person, group, or a municipality may, within the timeframe prescribed by law, apply to the Minister to hold a public hearing for the project.

5 Report

Unless he or she considers such an application to be unfounded, the Minister shall require the Environment Public Hearing Board (the Board or as commonly known in French, the BAPE) to hold a public hearing and report its findings and its analysis thereof to him or her ((ss. 31.3) 1978, c. 64, s. 10; 1999, c. 40, s. 239).

6 Analysis by the MDDELCC

In order to study certain matters more thoroughly, or to research elements which he or she considers necessary to fully assess the impact of the proposed project on the environment, the Minister may, at any time, request that the proponent of the project provide additional information ((ss. 3.4) 1978, c. 64, s. 10).

7 Decision

Once the EIS is considered satisfactory by the Minister, it is submitted to the Government, along with an application for Authorization. The Government may or may not issue the decree authorizing the project, with or without amendments, and on such conditions as it may determine. That decision may be made by any committee of ministers of which the Minister is a member and to which the Government has delegated that power (ss. 3.4).

8 Control

The MDDELCC reserves the right to conduct site inspections during the various work phases of the project to ensure that the terms of the decree and certificates of Authorization emitted are respected.

Other Laws, Regulations, and Guidelines

Once the required EIA and review procedure for the Canadian Metals project has been completed, and the decree obtained from the provincial Government, the project's detailed engineering will be finalized. This step shall take into account the environmental mitigation measures associated with the plant equipment and infrastructure as presented in the EIS and incorporated by the Government in the decree. It shall also consider all applicable environmental standards included in other relevant provincial laws and regulations. These include:

- Environment Quality Act (L.R.Q., c. Q-2):
  - Regulation respecting the application of section 32 of the Environment Quality Act (R.R.Q., c. Q-2, r. 2);
  - Regulation respecting the application of the Environment Quality Act (R.R.Q., c. Q-2, r. 3);
  - Clean Air Regulation (R.R.Q., c. Q-2, r. 4.1);
  - Regulation respecting industrial depollution attestations (R.R.Q., c. Q-2, r.5);
  - Regulation respecting pits and quarries (R.R.Q., c. Q-2, r. 7);
  - Regulation respecting sanitary conditions in industrial or other camps (R.R.Q., c. Q-2, r. 11);
  - Regulation respecting solid waste (R.R.Q., c. Q-2, r. 13);
  - Regulation respecting the declaration of water withdrawals (R.R.Q., c. Q-2, r. 14);
  - Regulation respecting the landfilling and incineration of residual materials (R.R.Q., c. Q-2, r.19);
  - Regulation respecting waste water disposal systems for isolated dwellings (R.R.Q., c. Q-2, r. 22);

  - Regulation respecting environmental impact assessment and review (R.R.Q., c. Q-2, r. 23);
  - Regulation respecting hazardous materials (R.R.Q., c. Q-2, r. 32);
  - Protection Policy for Lakeshores, Riverbanks, Littoral Zones and Floodplains (c. Q-2, r. 35);
  - Water Withdrawal and Protection Regulation (R.R.Q., c. Q-2, r. 35.2);
  - Land Protection and Rehabilitation Regulation (R.R.Q., c. Q-2, r. 37);
  - Regulation respecting the quality of drinking water (R.R.Q., c. Q-2, r. 40);
  - Regulation respecting the charges payable for the use of water (R.R.Q., c. Q-2, r. 42.1);
  - Transportation of Dangerous Substances Regulation (L.R.Q., c.-24.2, r.43);
  - Regulation respecting environmental standards for heavy vehicles (R.R.Q., c. Q-2, r.33).
- Act respecting the conservation and development of wildlife (LRQ, c. C-61.1);
  - Regulation respecting wildlife habitats (R.R.Q., c. C-61.1, r. 18);
- Act respecting threatened or vulnerable species (LRQ, c. E-12.01);
  - Regulation respecting threatened or vulnerable wildlife species and their habitats (R.R.Q., c-E-12.01, r. 2);
  - Regulation respecting threatened or vulnerable plant species and their habitats (R.R.Q., c-E-12.01, r. 3);
- Act respecting the lands in the domain of the State (L.R.Q., c. T-8.1);
- Watercourses Act (L.R.Q., c. R-13);
  - Regulation respecting the water property in the domain of the State (R.R.Q., c. R-13, r.1);
- Sustainable Forest Development Act (L.R.Q., c. A-18.1);
  - Regulation respecting standards of forest management for forests in the domain of the State (R.R.Q., c. A-18.1, r.7);
- Building Act (L.R.Q., c. B-1.1);
  - Regulation respecting the application of the Building Act (R.R.Q., c. B-1.1, r.1);
  - Construction Code (R.R.Q., c. B-1.1, r.2);
  - Safety Code (R.R.Q., B1-1, r.3);
- Petroleum Products Act (L.R.Q., c. P-30.01);
  - Petroleum Products Regulation (R.R.Q., P-30.01, r. 1);
- Cultural Heritage Act (L.R.Q., c. P-9.002);
- Act respecting land use planning and development (L.R.Q., c. A-19.1);
- Act respecting occupational health and safety (L.R.Q., c. S-2.1);
  - Regulation respecting occupational health and safety in mines (R.R.Q., c. S-2.1, r. 14);
- Soil protection and contaminated sites rehabilitation policy;
- Instruction note 98-01 on noise.

Permits and Authorizations

Following the environmental assessment and the obtaining of the environmental decree authorizing the project, several applications for authorizations and permits for the construction and operations will be submitted to the various competent authorities.

The main authorizations and permits considered are:

- Certificates of Authorization (CA) under the EQA for the construction and operations of the plant and their associated infrastructure;
- Application for CA under the EQA for the implementation of supply or treatment system for drinking water or wastewater as well as for construction of aqueducts and sewers;
- Authorization for a device or equipment for preventing, decreasing, or stopping the release of noise and atmospheric emissions;
- Depollution attestation in industrial environment under section 31.11 of the EQA and under Regulation respecting Industrial Depollution Attestations;
- A forest intervention permit from MERN for deforestation activities under Sustainable Forest Development Act and under regulation respecting standards of forest management for forests in the domain of State.

20.7.2.3 Federal Permitting Process

Canadian Environmental Assessment Act (CEAA)

The Canadian Environmental Assessment Act (2012) (Government of Canada, 2018) and its regulations establish the legislative basis for federal environmental assessments in most regions of Canada.

The CEAA (2012) applies to projects designated by the Regulations Designating Physical Activities. A project may also be designated by the Minister of the Environment if he or she believes that the implementation of the project may cause significant environmental effects or public concern about these effects.

Canadian Metals project is not subject to a federal environmental assessment under the CEAA (2012) and the Regulations Designating Physical Activities. However, Canadian Metals could have to get permits from the federal authorities in pursuance to the following acts:

THE FISHERIES ACT (SCH. I, P.I, IT.6 AND SCH. II, IT. 5)

The Fisheries Act deals with the proper management and control of the fisheries, the conservation and protection of fish and their habitat, and prevention of pollution. It involves the following authorizations, requirements, and orders:

- Section 22 (1): At every obstruction, where the Minister determines it to be necessary, the owner or occupier thereof shall, when required by the Minister, provide a sufficient flow of water over the spillway or crest, with connecting sluices into the river below, to permit the safe and unimpeded descent of fish.

- Section 22 (2): The owner or occupier of any obstruction shall make such provision as the Minister determines to be necessary for the free passage of both ascending and descending migratory fish during the period of construction thereof.
- Section 22 (3): The owner or occupier of any obstruction shall permit the escape into the river-bed below the obstruction of such quantity of water, at all times, as will, in the opinion of the Minister, be sufficient for the safety of fish and for the flooding of the spawning grounds to such depth as will, in the opinion of the Minister, be necessary for the safety of the ova deposited thereon.
- Section 32: No person shall kill fish by any means other than fishing.
- Section 35 (1) No person shall carry on any work, undertaking or activity that results in the harmful alteration or disruption, or the destruction, of fish habitat.

Exception:

- 35 (2) A person may carry on a work, undertaking or activity without contravening subsection (1) if:
    - (a) the work, undertaking or activity is a prescribed work, undertaking or activity, or is carried on in or around prescribed Canadian fisheries waters, and the work, undertaking or activity is carried on in accordance with the prescribed conditions.
    - (b) the carrying on of the work, undertaking or activity is authorized by the Minister and the work, undertaking or activity is carried on in accordance with the conditions established by the Minister.
    - (c) the carrying on of the work, undertaking or activity is authorized by a prescribed person or entity and the work, undertaking or activity is carried on in accordance with the prescribed conditions.
    - (d) the harmful alteration or disruption, or the destruction, of fish habitat is produced as a result of doing anything that is Authorized, otherwise permitted or required under this act.
    - (e) the work, undertaking or activity is carried on in accordance with the regulations.
  - Section 36 (5) (a to e): Site-specific regulations by the Governor in Council Authorizing the deposit of deleterious substances. Deleterious substances are defined as substances that, if added to water, would alter or degrade the quality of that water so that it is deleterious to fish.
  - Section 37 (2): Ministerial order requiring modifications, additions or restrictions to, or the closing of work that does or could result in the harmful alteration, disruption or destruction of fish habitat, or the deposit of deleterious substances.

According to the details available now, the project is not subject to an authorization by Fisheries and Oceans Canada (DFO).

THE MIGRATORY BIRDS CONVENTION ACT (SCH. I, P.I, IT.7.1)

The Migratory Birds Convention Act, 1994, provides for the implementation in Canada of the 1916 Convention between the United Kingdom and the United States of America for the Protection of Migratory Birds in Canada and the United States. The Convention may be amended from time to time. Under section 12 (1) (h) of the Act:

"for prohibiting the killing, capturing, injuring, taking or disturbing of migratory birds or the damaging, destroying, removing or disturbing of nests."

THE SPECIES AT RISK ACT (S.C. 2002, C. 29)

The Species at Risk Act (SARA) was created to prevent wildlife species from becoming extinct. The Act protects species at risk and their critical habitats. SARA also contains provisions to help manage species of special concern to prevent them from becoming endangered or extinct.

Once a species is listed under the Species at Risk Act, it becomes illegal to kill, harass, capture, or harm it in any way. Critical habitats are also protected from destruction. The Act also requires that recovery strategies, action plans, and management plans be developed by the competent minister for all listed species. Under section 33:

"No person shall damage or destroy the residence of one or more individuals of a wildlife species that is listed as an endangered species or a threatened species, or that is listed as an extirpated species if a recovery strategy has recommended the reintroduction of the species into the wild in Canada."

OTHER PERMITS

The following Canadian laws and regulations must be respected by the project:

- Canadian Environmental Protection Act (L.C. 1999, ch. 33);
- Fisheries Act (L.R.C., 1985, ch. F-14);
- Species at Risk Act (L.C.2002, ch.29);
- Explosives Act (L.R.C. 1985, ch. E-17);
- Transportation of Dangerous Goods Act, 1992 (L.C. 1992, ch. 34);
- Transportation of Dangerous Goods Regulations (SOR/2001-286) (DORS/2001-286);
- Hazardous Products Act (L.R.C. 1985, ch. H-3);
- Environmental Emergency Regulations (DORS/2003-307);
- Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations.

20.7.2.4 Timeline

Table 44: Project Timeline

Phase	Activity	Timeline
Pre-feasibility	Site selection	2017
	Technical and financial study	July 2018
Project notice to MDDELCC	Submission	March 2018
Feasibility	Feasibility study	March 2019
Environmental Impact Study	Submission	April 2019
	Environmental decree authorizing the project	April 2020
Construction	Starting period	April 2020
	Ending period	October 2021
Exploitation	Starting period	October 2021

20.8 Water Management

Quarry

The components of a water management system may include embankments, ditches and culverts, pipelines, and storage tanks associated with fresh water supply, diversion of uncontaminated water, and collection/treatment and discharge of non-compliant water.

A system of ditches, diversion, and canalization berms will be put in place to bring the runoff water to the sedimentation basin.

Industrial Process Plant

Potable water is required for domestic use by the plant workforce, support services, fire protection, and furnace component cooling circuits. City water will be used for indirect cooling of the closed cooling-water circuits and systems.

The total make-up water consumption expected is 1,450 m^3/day (60 m^3/h). The water treatment system must be designed in order to ensure potable water for human consumption and treatment of the water used in the furnace circuits.

20.9 Site Closure

Quarry

The closure plan of Langis quarry will be carried out in accordance with the quarry and sand pit regulations. The following situations will be taken into account:

- Revegetation of the degraded areas;
- Physical stability of the quarry components;
- Open-pit quarry workings;
- Rock and overburden piles;
- Water Management systems.

The closure plan shall include, among other things:

- A description of the quarry site and the activities that will be carried out there;
- A description of the restoration work to be completed to return the quarry site to a satisfactory state;
- A monitoring program as well as an estimation of the rehabilitation costs.

Industrial Process Plant

Once the plant is dismantled, the site will be rehabilitated. Wherever possible, materials will be reused or recycled. The project closure plan will focus mainly on the following elements:

- The secondary roads and pathways will be scarified;
- The buildings and surface infrastructure will be dismantled. The surfaces will then be covered with topsoil and revegetated;
- Measures will be put in place to secure the area as per regulatory obligations.

21. Capital and Operating Cost

This section provides a breakdown of overall capital and operating cost estimates of the quarry pit and the metallurgical (smelters) plant at Baie-Comeau. Crushed silica transportation process between both locations is also included.

The economic link between both operations is a result of Langis silica being provided at cost to the metallurgical plant in Baie-Comeau. In this section, unit-cost estimates in absolute and relative terms as all-in and cash-cost breakdowns for the different intermediate product as well as end products of the smelter are also provided.

Capital budget and production cost estimates have been based on CAN$ with all quotes, and estimations received in US$ are converted at the exchange rate:

US$0.75 = CAN$1.00

CAN$1.33 = US$1

The currency was based on a long-term projection averages for years 2018, 2019, 2020, and 2021 according to the Economy Forecast Agency (EFA).

The presented capital cost estimate for the Langis Pre-Feasibility Study project has an accuracy of ±25%, corresponding to the level of engineering effort executed for a pre-feasibility project level.

21.1 Capital Cost Estimate

This section provides a cost estimate breakdown for the expected capital budgets in connection with the development of the Langis exploration activity, the quarry pit development, the quarry plant, as well as the metallurgical plant operation in Baie-Comeau to produce FeSi75 standard product to be sold to the market.

The capital cost breakdown is provided under the assumption of a stand-alone operation for each site of the integrated quarrying and smelting project.

Individual components of the capital budget are classified as either direct capital costs, indirect capital costs, or other costs. The classifications are defined as follows:

- Direct costs include estimates for mechanical, electrical, and production equipment, labour, and materials for erection of plant elements that is required to deliver the fixed assets;
- Indirect costs include all project-specific cost items that are incurred in order to support direct field cost items, e.g. engineering design, EPCM, project management, site management and supervision during construction, heavy lifts and commission, as well as temporary on-site support facilities;
- Other costs include an allowance for contingencies, owner's cost, fees for insurances, bonds, and guarantees, such as technical, financial, tax, and legal advisors.

The capital cost of the project is the cost for the initial development of the project. Table 45 summarizes the capital cost estimate.

The estimated consolidated direct capital requirements for CME's integrated Langis project, which encompasses the development of the Langis silica deposit as well as downstream smelter operation in Baie-Comeau, is expected to amount to approximately CAN$311M within a range of ±25%. Included in the estimation is approximately CAN$220M of direct and CAN$91M of indirect costs.

Table 45: Summary of Capital Cost Estimate

Capex Item	Cost in CAN$
Direct Costs	
Quarry Development / Pre-stripping	$250,000
Quarry Infrastructure	$821,000
Metallurgical Plant Buildings	$50,422,496
Metallurgical Plant Process	$135,921,510
Metallurgical Plant Infrastructure	$32,884,236
TOTAL DIRECT	**$220,299,241**
Indirect Costs	
Owner's Costs	$8,029,992
Freight	$5,867,813
Heavy Lift (250-T Crane)	$620,000
Construction Indirect Costs	$11,509,212
Supplier Engineering	$10,000,000
EPCM	$21,922,824
Contingency	$32,884,236
TOTAL INDIRECT	**$90,834,078**
TOTAL DIRECT & INDIRECT	**$311,133,319**

The contingency is estimated at 15% of the direct costs and accounts for project uncertainties related to events that might lead to revisions or cost overruns for individual capital components during the various project execution stages, including early-stage planning, detailed design and engineering, procurement, construction, and commissioning.

The overall estimation bandwidth is within the aforementioned range of ±25% in accordance with the current pre-feasibility stage of the project and deemed sufficient to evaluate project economics to derive at a sensible go/no-go decision for the integrated project.

Table 46: Cost by Cost Type

	COST BY COST TYPE					
	HOURS	CAN$				
Cost type Description	INSTALLATION	INSTALLATION	EQUIPMENT	MATERIALS	SUB-C	TOTAL
Allowance	388,042.22	49,572,706.24	4,465,146.98	14,441,637.58	92,411,060.59	160,890,551.38
Budget Quote	7,315.87	958,378.69	92,641,688.70	1,941,734.01	5,916,492.43	101,458,293.83
Estimated	156,710.92	22,382,739.08	4,641,244.32	21,268,967.41	491,523.99	48,784,474.79
Total	552,069.00	72,913,824.00	101,748,080.00	37,652,339.00	98,819,077.00	311,133,320.00

Table 47: Contingency by Cost Type

Allowance	20%
Budget Quote	10%
Estimated	15%
Average	15%

21.1.1 Direct Capital Costs

The direct capital cost includes the costs for the two areas of operations—the Langis Quarry at Saint-Vianney and the metallurgical plant in Baie-Comeau.

21.1.1.1 Langis Quarry Direct Capital Costs

The development of the Langis silica quarry as outlined in section 16 leads to the following fixed asset and capital equipment requirements with associated capital budget estimates as disclosed in Table 48.

Table 48: Capital Estimate for Langis Quarry Operation

Nr.	Capex Item	Cost in CAN$
1	Quarry development / pre-stripping	$250,000
2	Quarry infrastructure	$821,000
	TOTAL	**$1,071,000**

The capital expenditure estimate for the silica deposit operation located in close proximity to the village Saint-Vianney, Quebec, is based on a pre-feasibility level of engineering effort for the operations design.

21.1.1.2 Baie-Comeau Quarry Direct Capital Costs

The estimates for major fixed capital investment items and project development expenses for the proposed two (2) submerged arc furnace (SAF) at the smelter at Baie-Comeau are presented in the Table 50.

Table 49: Cost by WBS

	COST BY WBS					
	Installation		Equipment	Materials	Other	
Description	Hours	Cost	Cost	Cost	Cost	Total
METALLURGICAL PLANT—GENERAL AREA						
EARLY WORKS	15,937	$2,884,904	$-	$712,000	$-	$3,596,904
METALLURGICAL PLANT—PROCESS AREAS						
RAW MATERIALS RECEPTION & STORAGE	14,688	$1,964,797	$2,590,000	$2,441,907		$6,996,704
RAW MATERIALS RECLAIM, WEIGHING & DOSING	68,854	$9,069,514	$15,776,585	$4,356,262		$29,202,360
SMELTING	183,206	$23,862,272	$76,084,000	$10,650,366	$440,000	$111,036,638
OFF-GAS TREATMENT & HEAT RECOVERY—GENERAL AREA	16,042	$2,218,528	$397,250	$2,247,177		$4,862,955
TAPPING AND CASTING	32,515	$4,451,508	$878,750	$3,290,719	$100,000	$8,720,977
FINAL PRODUCT HANDLING & PACKAGING	26,106	$3,506,886	$923,750	$2,126,223		$6,556,859
UTILITIES & SERVICES	185,888	$23,672,604	$4,727,745	$10,577,885	$7,445,000	$46,423,234
NON-PRODUCING ASSETS	8,835	$1,282,811	$370,000	$1,249,800		$2,902,611
Total Direct						**$220,299,242**
PROJECT INDIRECTS						
Site Construction Indirect					$12,129,212	$12,129,212
EPCM Services			$10,000,000		$21,922,824	$31,922,824
Freight to site					$5,867,813	$5,867,813
OWNER'S COSTS					$8,029,992	$8,029,992
Contingency					$32,884,236	$32,884,236
Total Indirect						**$90,834,077**
Total Direct & Indirect	**552,069**	**$72,913,824**	**$111,748,080**	**$37,652,339**	**$88,819,077**	**$311,133,319**

Table 50: Capex by Disciplines

	Cost in CAN$				
Disciplines	**Installation**	**Equipment**	**Material**	**Other**	**Total**
Civil & Earthworks	$11,158,606		$712,000		$11,870,606
Concrete Works	$7,869,268				$7,869,268
Structural Steel Works	$6,989,970	$4,727,745	$6,798,169		$18,515,884
Buildings & Architectural	$11,067,013	$2,960,000	$11,827,685	$7,445,000	$33,299,698
Mechanical Works	$17,183,460	$94,060,335	$18,314,485	$10,540,000	$140,098,280
Piping Works	$7,433,156				$7,433,156
Electrical Works	$7,587,989				$7,587,989
Instrumentation & Control Works	$3,624,362				$3,624,361
Sub-Total Direct cost	$72,913,824	$101,748,080	$37,652,339	$17,985,000	$230,299,242
Freight (5%)				$5,867,813	$5,867,813
Construction Indirect (5%)				$12,129,212	$12,129,212
EPCM (10%)				$21,922,824	$21,922,824
Sub-Total Indirect				$75,889,849	$39,919,849
TIC—TOTAL					**$270,219,091**
Owner's Cost (2.5% of TIC)				$8,029,992	$8,029,99
Contingency (20%)				$32,884,236	$32,884,236
TPC—TOTAL					$311,133,319

21.1.1.2.1 Labour

The craft labour wage rate was established for each trade using Quebec Industrial Collective Agreement for heavy industry valid up to April 30th, 2017, with a 2% escalation. The weighted average crew rate used for the PFS, was $132/hour. That rate is all inclusive (including salaries, fringe benefits, tools, etc.).

During the construction period, the labour will work 40 hours per week on basis of 8 hours per day, 5 days per week.

21.1.1.2.2 Material Handling and Furnaces Technology Supplier

The furnaces Technology Supplier budget quote represents almost half of the direct cost. This budget quote includes the material handling system (excluding dust extraction system), furnaces, crushing and sizing, off-gas treatment system, electrical and instrumentation scope of supply, as well as engineering and support during construction.

The capital estimate for the downstream operation is based on a thorough bottom-up assessment of the pre-feasibility engineering design of the Baie-Comeau smelter, as outlined in section 17. The capital budgeting process is based on a direct cost proposal from Tenova Pyromet for two 35-MW SAF smelters as well as widespread engineering techniques, usually applied in industrial projects of this scale once a technical feasible layout has been identified. The layout design is a fundamental step for budgeting purposes, as it builds the basis for underlying construction parameters such as earthworks, area requirements for light-and heavy industrial structures, warehouses, office and administrative spaces, associated concrete and steel-consumption, as well as total man-hour needs and others. In addition, the process modelling, mass, and energy balances are important input factors as they determine equipment needs that impact building dimensions and handling system requirements for raw materials as well as intermediate by-products and final products.

The recommended and project-specific smelter layout has been developed considering the most adequate engineering solutions for all envisioned plant subsystems. A similar conceptual engineering process is also applied to all mechanical equipment, steel structures, civil works, and earthworks. The expected earth excavation volume for the plant was derived from the actual topography of the plot in Baie-Comeau. The investment budget for electrical equipment is calculated from the pre-feasibility design. The bottom-up capital budget estimate provides accuracy even at this pre-feasibility project stage.

All equipment and material costs outside of Canada were included as FOB (Free on Board) and exclusive of taxes and duties. A freight and packaging mark-up for the main packages and any spare parts has been included in the respective line items in the cost development sheet. Equipment-related transportation costs need further evaluation as part of a more detailed procurement and supply-chain analysis.

The working assumption for the PFS is that fixed capital equipment imports fall under the “Economic Action Plan 2015” initiative that intends to eliminate all tariffs on machinery and equipment imports.

Hence, the import duties for foreign machinery imports have been set to zero in accordance with the "Duty-Free Manufacturing Tariff Regime" initiative. CME intends to commence this work-stream in the next project development stages.

21.1.2 Indirect Capital Costs

Indirect capital costs include, but are not limited to:

- Owner's costs;
- EPCM costs;
- 15% contingency;
- Temporary facilities;
- Commissioning and start-up.

The contingency is applied to the direct capital costs to accommodate for any project uncertainties related to events that might lead to revisions or cost overruns for individual capital components during the various project execution stages such as early-stage planning, detailed design and engineering, procurement, construction, and commissioning.

21.1.3 Sustaining Capital Cost Estimate

Sustaining capital costs are the capital expenditures during the life of the assets that are required to maintain or upgrade the existing asset and maintain production throughput.

Sustaining capital cost estimates are summarized in the table below.

Table 51: Summary of Sustaining Capital Cost Estimate

Area	Years 1-5	Years 6-10	Years 11-15	Years 16-20	Years 21-25	Years 25-28
Quarry Pit Operations	Operation will be contracted and sustaining capital will be included in contracted strategy.					
Smelter Operations	$2,570,000	$4,000,000	$4,000,000	$4,000,000	$4,000,000	$4,000,000

21.2 Operating Cost Estimate

21.2.1 Scope and Methodology

Operating costs for the project were estimated and calculated on an annual basis. A summary of the operating costs is shown in the followings tables. The operation has been divided into six (6) areas, namely:

- Quarry pit;
- Beneficiation;
- G&A quarry site;
- Transportation from Saint-Vianney to Baie-Comeau;

- Smelter operations, mainly raw material and energy costs;
- G&A smelter operations.

Operating costs are presented as a total annual cost in CAN$ and on a per-unit based on cost per tonne of SiO_2 production at the Saint-Vianney quarry site as well as cost per tonne of final FeSi75 product.

The summary of the annual operating costs, cost per tonne of SiO_2 and cost per tonne of FeSi75 for a typical year of operations are shown in the following table.

Table 52: Summary of Annual Operating Costs per Area

Operating Cost Breakdown (28-year Project Life)	Annual Average	Average Costs (CAN$/t FeSi75)
Energy	26,226,570	364.00
Raw Materials and Supplies	31,582,115	438.33
Transport SiO_2 (Langis to Baie-Comeau)	9,078,426	126.00
G&A all area	7,285,797	101.12
Quarry Operation	5,034,203	69.87
Labour Metallurgical Plant	11,744,311	163.00
Total	**90,952,284**	**1,262.00**

Calculations in the table above are based on 72,051 tonnes of FeSi75 production.

21.2.2 Labour Cost and Manpower Requirements

The manpower requirement for Canadian Metals at the two main sites for a typical year of operation is shown in the table below.

Table 53: Summary of Manpower Requirements

Area	Manpower, persons per year
Quarry Pit / Beneficiation	1 + Contractor (~20)
Transportation	Contractor (~12)
Smelter	137
TOTAL	**137 + ~35**

The labour requirements and qualification levels, as outlined above and under the respective sections of this Technical Report, present the total requirement of manpower for the project.

Gross labour costs (base salary plus benefits) structure was considered for the purposes of the PFS. The proposed structure reflects all applicable ancillary costs incurred by an employer in this region, including all relevant fringe benefits such as social security contributions, vacation, and statutory holiday payments. As the reviewed ranges for salaries in the region have been fairly large and the actual salary payments will turn out to be a function of the regional labour market dynamics as of the time when staffing commences, the financial model benchmark has been set to the upper-end of the provided ranges.

For the estimation of the operation costs for labour, the salaries and benefit structure that have been applied are presented in Appendix B. The following table presents the summary of the manpower required to run the metallurgical plant.

Table 54: Manpower for Metallurgical Plant

TOTAL MANPOWER	137	Total CAN$/year	$11,750,694
TOTAL PER TONNE SiO_2 PROCESSED ($/tonne)			90.60
TOTAL PER TONNE FeSi75 ($/tonne)			163.09

21.2.3 Quarry Operating Cost

The quarry operating cost estimate was prepared by GoldMinds on the basis of two budget quotes from different contractors. The costs are based on operating the quarry equipment, the manpower associated with operating the equipment, the cost for explosives, as well as dewatering, road maintenance, and other activities. The cost to quarry one tonne of SiO_2 is $21.79.

21.2.3.1 General and Administration Quarry Site Operating Costs

General and Administration (G&A) quarry site costs include the operation of all the services, manpower, and infrastructure required to support the operations. The costs included is estimated at $801,000 per year.

21.2.4 Transportation from Saint-Vianney to Baie-Comeau

Langis silica transportation costs include everything from loading at Langis Quarry to unloading at Metallurgical Plant in Baie-Comeau. Transportation costs were quoted by two (2) different shipment companies. The silica will be loaded at the quarry and transported directly to the metallurgical plant to avoid handling operations that could breakdown lumps into fines. To achieve this goal, silica will be shipped into either half-height containers or dump trailers. Full containers or dump trailers will be stored near port of Matane and then ferried or barged to port of Baie-Comeau where their empty counterparts will be stored. Transportation will be interrupted during thawing season due to load restrictions on roads.

The table below shows the summary of transportation costs for a typical year of operation.

Table 55: Annual Operating Costs for Transportation

	Annual Cost in CAN$	Unit Cost in CAN$/t SiO_2	Unit Cost in CAN$/t FeSi
Material Handling and Haulage	$9,078,426	70	126

All costs associated with the transportation and logistics within the smelter as well as the market are incorporated in the overall smelter operating cost structure.

21.2.5 Smelter Operating Costs

Smelter operating costs were estimated for the annual tonnage as described in section 17 of this Technical Report. The various processing steps are detailed in section 17 but the main ones are raw materials handling, smelting, casting, crushing, and packaging. The summary of the operating costs for the smelter is shown in Table 52.

21.2.5.1 G&A Costs

General and Administrative (G&A) costs for the smelter area include office costs, legal and professional costs, as well as general site costs such as recruitment, security, safety and training, first aid, community relations, travel and accommodation, and freight.

The G&A costs exclude the labour portion of the respective costs, which is included under the Labour area.

The G&A costs for the smelter operations as described above are estimated at $6,484,797.

21.2.5.2 Raw Materials and Consumables

Table 56 below details the raw materials used in the smelter operations, annual tonnages, and costs on a per-tonne basis.

Table 56: Raw Materials Quantities and Costs

Cost Item	Annual Requirement in MTPY	Average Costs (CAN$/t FeSi75)
Langis Silica	129,692	205.20
Carbon Reductant—Colombian Coal	83,839	214.88
Iron Ore—Hematite	25,218	52.73
Wood Chips	72,051	90

Electrode Paste	3,603	52.67
Other Consumables		27.99
Total		**643.47**

Table 57: Source for the different Prices used

Cost Item	Price Source
Langis Silica	4 different quotes for contracting the quarry operation + 2 quotes for the transport between the quarry and the smelter
Carbon Reductant—Colombian Coal	3 quotes
Iron Ore—Hematite	Estimation based on market price
Wood Chips	Quote from the “Association des producteurs de copeaux de bois du Québec”
Electrode Paste	Different online sources

21.2.5.3 Power and Utilities

Apart from the processed resources in the SAF, the biggest cost driver is the applicable electricity rate, as the process is highly energy intensive. In that respect, the project clearly exhibits a competitive advantage when compared to other locations of incumbent smelter sites.

A preliminary estimate for a combined power and energy rate was conducted by the provincial utility, namely Hydro-Québec, and based on the smelters’ anticipated average power utilization. The result of this preliminary combined power and energy rate is CAN¢4.584/kWh. CME’s integrated smelter project is expected to be eligible for a rate reduction under Quebec’s economic development rate for large power consumers (L-rate discount).

22. Economic Analysis

The economic/financial assessment of the Langis project of Canadian Metals Inc. is based on Q1-2018 price projections in U.S. and Canadian currency and cost estimates in Canadian currency. An exchange rate of US$0.75 per CAN$ was assumed to convert US$ market price projections and particular components of the cost estimates into CAN$. No provision was made for the effects of inflation. The evaluation was carried out on a 100%-equity basis. Current Canadian tax regulations were applied to assess the corporate tax liabilities while the new regulations in Quebec (Bill 55, December 2013) were applied to assess the mining tax liabilities.

The financial indicators under base case conditions are indicated in the table below.

Table 58: Base Case Financial Results

Base Case Financial Results	Unit	Value
Pre-Tax (P-T) NPV @ 8%	M CAN$	525.6
After-Tax (A-T) NPV @ 8%	M CAN$	388.8
P-T IRR	%	24.5
A-T IRR	%	22.0
P-T Payback Period	years	3.8
A-T Payback Period	years	4.0

A sensitivity analysis reveals that the project's viability will not be significantly vulnerable to variations in capital and operating costs, within the margins of error associated with Preliminary Feasibility Study (PFS) estimates. However, the project's viability remains more vulnerable to the US$/CAN$ exchange rate and the larger uncertainty in future market prices.

22.1 Assumptions

22.1.1 Macro-Economic Assumptions

The main macro-economic assumptions used in the base case are given in

Table 59. The price forecasts for ferrosilicon (FeSi75), silica fume, and silica slag were provided by Canadian Metals. Canadian Metals also provided a local selling price for the silica product at the quarry site. Details on the derivation of these price forecasts are given in section 19 of this report. The sensitivity analysis examines a range of prices 30% above and below this base case forecast.

Table 59: Macro-Economic Assumptions

Item	Unit	Base Case Value
Ferrosilicon Price (Ex-Works Metallurgical Plant)	US$/tonne	1819†
Silica Fume Price (Ex-Works Metallurgical Plant)	US$/tonne	250
Silica Slag Price (Ex-Works Metallurgical Plant)	US$/tonne	100
Silica Product Price (Ex-Works Quarry)	CAN$/tonne	32.50
Exchange Rate	US$/CAN$	0.750
Discount Rate	% per year	8
Discount Rate Variants	% per year	6 and 10

† FeSi75: $1.10/lb (2205 lb/t) (75%)

An exchange rate of US$0.75 per CAN$ was used to convert the US$ market price projections into Canadian currency. The sensitivity of base case financial results to variations in the exchange rate was examined. Those cost components which include U.S. content originally converted to Canadian currency using the base case exchange rate were adjusted accordingly.

According to the definition of “Mineral Resource” in Subsection 248(1) of the Income Tax Act, paragraph (d) 3 states that a sandstone deposit, which is the subject of this report, is a mineral resource; thus, the current Canadian tax system applicable to Mineral Resource Income was used to assess the project’s annual tax liabilities. These consist of federal and provincial corporate taxes as well as provincial mining taxes. The federal and provincial corporate tax rates currently applicable over the project’s operating life are 15.0% and 11.5% (decreasing by 0.1% annually from 11.9% in 2016 to 11.5% in 2020) of taxable income, respectively. The marginal tax rates applicable under the mining tax regulations in Quebec (Bill 55, December 2013) are 16%, 22%, and 28% of taxable income, depending on the profit margin. For taxation purposes, the project is divided into two (2) separate entities, the Langis Quarry Operation (subject to corporate and mining taxes) and the Metallurgical Plant in Baie-Comeau (subject to corporate taxes only). A processing allowance rate of 10% is assumed for mining tax purposes, as the quarry operation produces a crushed silica product that is shipped to the Metallurgical Plant. As the Metallurgical Plant operation represents an independent industrial process, it is assumed that the Quebec “Tax Holiday for Large Investment Projects” program is applicable. This program provides up to 15% of the project’s total capital expenditure in the form of annual corporate tax credits.

The assessment was carried out on a 100%-equity basis. Apart from the base case discount rate of 8.0%, two (2) variants of 6.0 and 10.0% were used to determine the Net Present Value (NPV) of the project. These discount rates represent possible costs of equity capital.

22.1.2 Royalty and Income and Benefit Agreements

This project incorporates an “NSR” royalty agreement. This agreement calls for annual payments of 3% of Ex-Works Metallurgical Plant sales. The quarry operation is not subject to any agreement with local First Nations communities.

22.1.3 Technical Assumptions

The main technical assumptions used in the base case are given in Table 60.

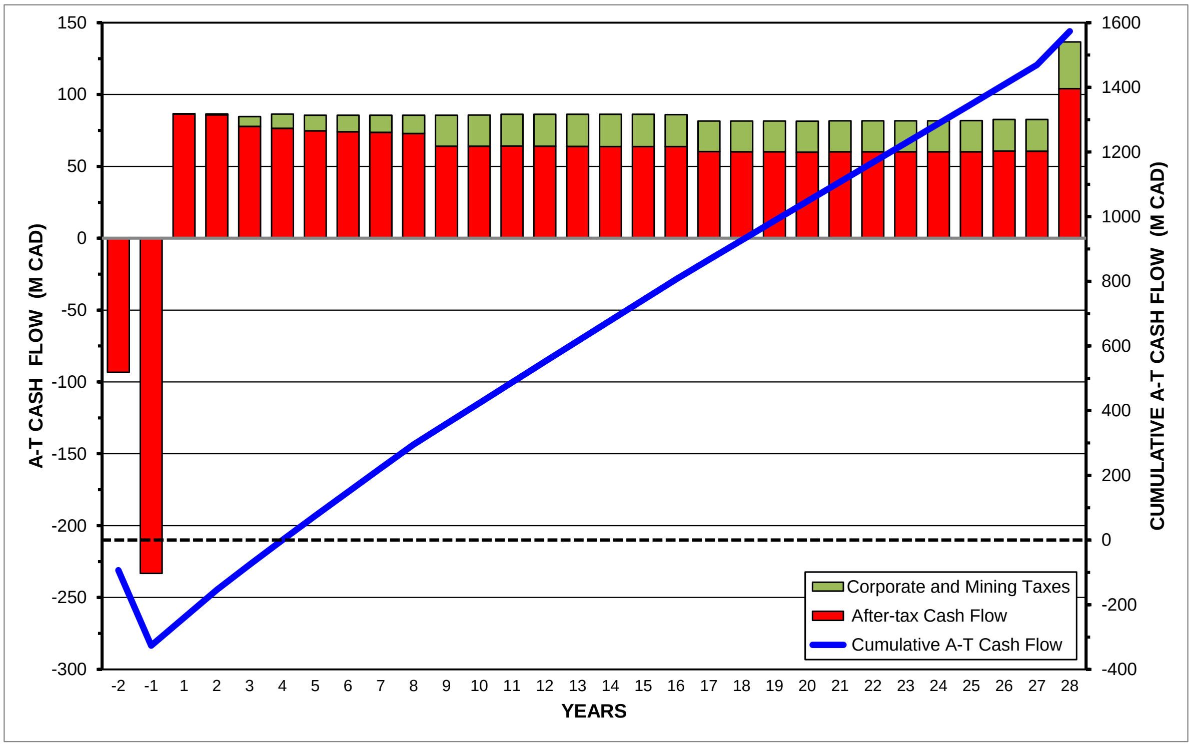
Table 60: Technical Assumptions

Item	Unit	Base Case Value
Open-Pit Resource Quarried	k tonnes	6,293
Average Head Grade at Process Plant	% SiO_2	99.0
Design Processing Rate	k tonnes/year	225.0
Average Stripping Ratio	w : o	0.407
Quarry Life	years	28
Process Recovery	%	75.0
Average Processed Product Grade	% SiO_2	99.0
Quantity of Processed Product Shipped to Metallurgical Plant (years 1-16/17-28)	k tonnes/year	129.7 / 123.8
Average Quantity of Excess Processed Product Sold on Local Market (years 1-15/16-28)	k tonnes/year	46.9 / 35.1
Ferrosilicon Production (years 1-16/17-28)	tonnes/year	72.1 / 68.8
Silica Fume Production (years 1-16/17-28)	tonnes/year	13.6 / 13.0
Slag Production (years 1-16/17-28)	tonnes/year	5.3 / 5.0
Average Quarry Production Costs	($/tonne RoM)	22.40
Average Quarry G&A Costs	($/tonne RoM)	3.56
Transport Costs to Metallurgical Plant	($/tonne Si product)	70.00
Metallurgical Plant Costs (includes G&A costs)	($/tonne Si product)	1,055.36

22.2 Financial Model and Results

Figure 109 illustrates the after-tax cash flow and cumulative cash flow profiles of the project for base case conditions. Note that the total height of a particular bar (i.e., after-tax cash flow plus corporate and mining taxes) represents in fact the before-tax cash flow. The intersection of the after-tax cumulative cash flow curve with the horizontal dashed line represents the payback period.

Figure 109: After-tax Cash Flow and Cumulative Cash Flow Profiles



A summary of the evaluation results is given in Table 61 and Table 62 and gives the cash flow statement for both base case conditions.

The summary and cash flow statement indicate that the total pre-production (initial) capital costs were evaluated at $311.1M. The sustaining capital requirement was evaluated at $21.0M. Quarry closure costs in the form of trust fund payments at the start of quarry production were estimated at an additional $0.525M.

The cash flow statement shows a capital cost breakdown by area and provides an estimated capital spending schedule over the 2-year pre-production period of the project. Working capital requirements were estimated at two (2) months of total annual operating costs. Since operating costs vary annually over the quarry life, additional amounts of working capital are injected or withdrawn as required.

The total revenue derived from the sale of the Metallurgical Plant and Quarry products was estimated at $5,030.4M ($4,798.62M for ferrosilicon, $124.3M for silica fume, $19.3M for slag, and $88.1M for excess quarry products). The total operating costs were estimated at $2,500.5M (excluding royalty payments).

The financial results indicate a pre-tax Net Present Value (**NPV**) of $525.6M at a discount rate of 8.0%. The pre-tax Internal Rate of Return (**IRR**) is 24.5% and the payback period is 3.8 years.

The after-tax NPV is $388.8M at a discount rate of 8.0%. The after-tax IRR is 22.0% and the payback period is 4.0 years.

Table 61: Project Evaluation Summary—Base Case

Item	Unit	Value
Total Ferrosilicon Sales	M CAN$	4,798.6
Total Silica Fume Sales	M CAN$	124.3
Total Slag Sales	M CAN$	19.3
Total Quarry Sales	M CAN$	88.1
Total Revenue	M CAN$	5,030.4
Total Operating Costs	M CAN$	2,500.5
Total Royalty Payments	M CAN$	150.9
Initial Capital Costs (excludes Working Capital)	M CAN$	311.1
Sustaining Capital Costs	M CAN$	21.0
Quarry Rehabilitation Trust Fund Payments	M CAN$	0.525
Total Pre-tax Cash Flow	M CAN$	2,085.8
Pre-tax NPV @ 6%	M CAN$	727.3
Pre-tax NPV @ 8%	M CAN$	525.6
Pre-tax NPV @ 10%	M CAN$	381.6
Pre-tax IRR	%	24.5
Pre-tax Payback Period	Years	3.8
Total After-tax Cash Flow	M CAN$	1,573.3
After-tax NPV @ 6%	M CAN$	543.7
After-tax NPV @ 8%	M CAN$	388.8
After-tax NPV @ 10%	M CAN$	277.5
After-tax IRR	%	22.0
After-tax Payback Period	Years	4.0

Table 62: Cash Flow Statement—Base Case

LANGIS PROJECT PFS – Canadian Metals Inc.

All monetary values in CAD except where specified otherwise

Exchange Rate (USD per CAD) 0.750

			2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	
Year			**-2**	**-1**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**Total**
Mineralisation (t)				0	236,175	247,263	243,083	236,230	244,821	235,498	235,498	235,498	235,498	235,498	229,242	229,242	229,242	229,242	229,242	187,086	187,086	187,086	187,086	187,086	224,080	224,080	224,080	224,080	224,080	235,449	235,449	235,449	**6,293,447**
Grade (% SiO_2)					98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	**98.96**
Waste (t)				0	66,337	33,771	331,075	13,178	150,725	134,593	134,593	134,593	134,593	134,593	45,673	45,673	45,673	45,673	45,673	84,801	84,801	84,801	84,801	84,801	113,318	113,318	113,318	113,318	113,318	23,791	23,791	23,791	**2,558,381**
Total Material Mined (t)				0	302,512	281,034	574,158	249,408	395,546	370,091	370,091	370,091	370,091	370,091	274,915	274,915	274,915	274,915	274,915	271,886	271,886	271,886	271,886	271,886	337,397	337,397	337,397	337,397	337,397	259,240	259,240	259,240	**8,851,828**
Stripping Ratio (w : o)					0.281	0.137	1.362	0.056	0.616	0.572	0.572	0.572	0.572	0.572	0.199	0.199	0.199	0.199	0.199	0.453	0.453	0.453	0.453	0.453	0.506	0.506	0.506	0.506	0.506	0.101	0.101	0.101	**0.407**
	Process Recovery (%)	75.0%																															
Total Production (t)	Grade (% SiO_2)	98.96%			177,131	185,447	182,312	177,173	183,616	176,624	176,624	176,624	176,624	176,624	171,931	171,931	171,931	171,931	171,931	140,314	140,314	140,314	140,314	140,314	168,060	168,060	168,060	168,060	168,060	176,587	176,587	176,587	**4,720,085**
Less Handling & Transport Losses (t)		0.00%			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Net Production for Metallurgical Plant Use and Sales (t)					**177,131**	**185,447**	**182,312**	**177,173**	**183,616**	**176,624**	**176,624**	**176,624**	**176,624**	**176,624**	**171,931**	**171,931**	**171,931**	**171,931**	**171,931**	**140,314**	**140,314**	**140,314**	**140,314**	**140,314**	**168,060**	**168,060**	**168,060**	**168,060**	**168,060**	**176,587**	**176,587**	**176,587**	**4,720,085**
Product for Metallurgical Plant (t)					129,692	129,692	129,692	129,692	129,692	129,692	129,692	129,692	129,692	129,692	129,692	129,692	129,692	129,692	129,692	129,692	123,836	123,836	123,836	123,836	123,836	123,836	123,836	123,836	123,836	123,836	123,836	123,836	**3,561,107**
Product for Sale at Quarry (t)					47,439	55,755	52,620	47,481	53,924	46,932	46,932	46,932	46,932	46,932	42,239	42,239	42,239	42,239	42,239	10,623	16,478	16,478	16,478	16,478	44,223	44,223	44,223	44,223	44,223	52,751	52,751	52,751	**1,158,979**
FeSi75 Production (t)	Tonnes FeSi75 / t Product	0.556			72,051	72,051	72,051	72,051	72,051	72,051	72,051	72,051	72,051	72,051	72,051	72,051	72,051	72,051	72,051	72,051	68,798	68,798	68,798	68,798	68,798	68,798	68,798	68,798	68,798	68,798	68,798	68,798	**1,978,393**
Microsilica Production (t)	Tonnes Microsilica / t Product	0.105			13,583	13,583	13,583	13,583	13,583	13,583	13,583	13,583	13,583	13,583	13,583	13,583	13,583	13,583	13,583	13,583	12,969	12,969	12,969	12,969	12,969	12,969	12,969	12,969	12,969	12,969	12,969	12,969	**372,955**
Slag Production (t)	Tonnes Slag / t Product	0.041			5,282	5,282	5,282	5,282	5,282	5,282	5,282	5,282	5,282	5,282	5,282	5,282	5,282	5,282	5,282	5,282	5,044	5,044	5,044	5,044	5,044	5,044	5,044	5,044	5,044	5,044	5,044	5,044	**145,044**
Langis Quartz Fines Production (t)	Tonnes Langis Quartz Fines / t ore	0.192			45,257	47,382	46,581	45,268	46,914	45,127	45,127	45,127	45,127	45,127	43,928	43,928	43,928	43,928	43,928	35,850	35,850	35,850	35,850	35,850	42,939	42,939	42,939	42,939	42,939	45,118	45,118	45,118	**1,205,982**
Excess Silica Product (t)					47,439	55,755	52,620	47,481	53,924	46,932	46,932	46,932	46,932	46,932	42,239	42,239	42,239	42,239	42,239	10,623	16,478	16,478	16,478	16,478	44,223	44,223	44,223	44,223	44,223	52,751	52,751	52,751	**1,158,979**
Low Grade Quarry Production (t)	Tonnes Low Grade Product / t ore	0.055			13,026	13,638	13,407	13,029	13,503	12,989	12,989	12,989	12,989	12,989	12,644	12,644	12,644	12,644	12,644	10,319	10,319	10,319	10,319	10,319	12,359	12,359	12,359	12,359	12,359	12,986	12,986	12,986	**347,115**
FeSi75 Sales ($)	Price – Ex-Works Met. Plant (USD/t)	1,819.13			174,759,701	174,759,701	174,759,701	174,759,701	174,759,701	174,759,701	174,759,701	174,759,701	174,759,701	174,759,701	174,759,701	174,759,701	174,759,701	174,759,701	174,759,701	174,759,701	166,869,670	166,869,670	166,869,670	166,869,670	166,869,670	166,869,670	166,869,670	166,869,670	166,869,670	166,869,670	166,869,670	166,869,670	**4,798,591,251**
Microsilica Sales ($)	Price – Ex-Works Met. Plant (USD/t)	250.00			4,527,541	4,527,541	4,527,541	4,527,541	4,527,541	4,527,541	4,527,541	4,527,541	4,527,541	4,527,541	4,527,541	4,527,541	4,527,541	4,527,541	4,527,541	4,527,541	4,323,132	4,323,132	4,323,132	4,323,132	4,323,132	4,323,132	4,323,132	4,323,132	4,323,132	4,323,132	4,323,132	4,323,132	**124,318,234**
Slag Sales ($)	Price – Ex-Works Met. Plant (USD/t)	100.00			704,313	704,313	704,313	704,313	704,313	704,313	704,313	704,313	704,313	704,313	704,313	704,313	704,313	704,313	704,313	704,313	672,515	672,515	672,515	672,515	672,515	672,515	672,515	672,515	672,515	672,515	672,515	672,515	**19,339,183**
Langis Quartz Fines Sales ($)	Price – Ex-Works Quarry (USD/t)	24.38			1,470,854	1,539,908	1,513,875	1,471,196	1,524,699	1,466,639	1,466,639	1,466,639	1,466,639	1,466,639	1,427,674	1,427,674	1,427,674	1,427,674	1,427,674	1,165,135	1,165,135	1,165,135	1,165,135	1,165,135	1,395,527	1,395,527	1,395,527	1,395,527	1,395,527	1,466,334	1,466,334	1,466,334	**39,194,408**
Excess Silica Product Sales ($)	Price – Ex-Works Quarry (USD/t)	24.38			1,541,782	1,812,052	1,710,165	1,543,123	1,752,528	1,525,285	1,525,285	1,525,285	1,525,285	1,525,285	1,372,781	1,372,781	1,372,781	1,372,781	1,372,781	345,233	535,530	535,530	535,530	535,530	1,437,259	1,437,259	1,437,259	1,437,259	1,437,259	1,714,392	1,714,392	1,714,392	**37,666,804**
Low Grade Quarry Production Sales ($)	Price – Ex-Works Quarry (USD/t)	24.38			423,353	443,228	435,735	423,451	438,851	422,139	422,139	422,139	422,139	422,139	410,924	410,924	410,924	410,924	410,924	335,358	335,358	335,358	335,358	335,358	401,671	401,671	401,671	401,671	401,671	422,052	422,052	422,052	**11,281,240**
Total Sales ($)					183,427,542	183,786,742	183,651,330	183,429,324	183,707,633	183,405,617	183,405,617	183,405,617	183,405,617	183,405,617	183,202,933	183,202,933	183,202,933	183,202,933	183,202,933	181,837,281	173,901,341	173,901,341	173,901,341	173,901,341	175,099,774	175,099,774	175,099,774	175,099,774	175,099,774	175,468,094	175,468,094	175,468,094	**5,030,391,120**
Total Revenue ($)	Base Case				183,427,542	183,786,742	183,651,330	183,429,324	183,707,633	183,405,617	183,405,617	183,405,617	183,405,617	183,405,617	183,202,933	183,202,933	183,202,933	183,202,933	183,202,933	181,837,281	173,901,341	173,901,341	173,901,341	173,901,341	175,099,774	175,099,774	175,099,774	175,099,774	175,099,774	175,468,094	175,468,094	175,468,094	5,030,391,120
Total Revenue ($)	Indexed for Sensitivity				**183,427,542**	**183,786,742**	**183,651,330**	**183,429,324**	**183,707,633**	**183,405,617**	**183,405,617**	**183,405,617**	**183,405,617**	**183,405,617**	**183,202,933**	**183,202,933**	**183,202,933**	**183,202,933**	**183,202,933**	**181,837,281**	**173,901,341**	**173,901,341**	**173,901,341**	**173,901,341**	**175,099,774**	**175,099,774**	**175,099,774**	**175,099,774**	**175,099,774**	**175,468,094**	**175,468,094**	**175,468,094**	**5,030,391,120**
Quarrying Costs ($)	$/t quarry product				5,044,716	4,986,836	7,362,980	4,606,669	5,906,380	5,595,624	5,595,624	5,595,624	5,595,624	5,595,624	4,742,021	4,742,021	4,742,021	4,742,021	4,742,021	4,262,567	4,262,567	4,262,567	4,262,567	4,262,567	5,202,483	5,202,483	5,202,483	5,202,483	5,202,483	4,679,469	4,679,469	4,679,469	140,959,458
Beneficiation Costs ($)	$/t material processed	0.00			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G&A Quarry Site Costs ($)	$/year	801,000			765,081	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	22,392,081
Transport Costs to Metallurgical Plant ($)	$/t quarry product	70.00			9,078,426	9,078,426	9,078,426	9,078,426	9,078,426	9,078,426	9,078,426	9,078,426	9,078,426	9,078,426	9,078,426	9,078,426	9,078,426	9,078,426	9,078,426	9,078,426	8,668,554	8,668,554	8,668,554	8,668,554	8,668,554	8,668,554	8,668,554	8,668,554	8,668,554	8,668,554	8,668,554	8,668,554	249,277,468
Metallurgical Plant Costs ($)	$/t final FeSi75 product	1,055.36			76,039,743	76,039,743	76,039,743	76,039,743	76,039,743	76,039,743	76,039,743	76,039,743	76,039,743	76,039,743	76,039,743	76,039,743	76,039,743	76,039,743	76,039,743	76,039,743	72,606,710	72,606,710	72,606,710	72,606,710	72,606,710	72,606,710	72,606,710	72,606,710	72,606,710	72,606,710	72,606,710	72,606,710	2,087,916,414
G&A Metallurgical Plant Site Costs ($)	$/t year	0			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Royalty Payments ($)	NSR (Sales FOB Metallurgical Plant)	3.00%			5,502,826	5,513,602	5,509,540	5,502,880	5,511,229	5,502,169	5,502,169	5,502,169	5,502,169	5,502,169	5,496,088	5,496,088	5,496,088	5,496,088	5,496,088	5,455,118	5,217,040	5,217,040	5,217,040	5,217,040	5,252,993	5,252,993	5,252,993	5,252,993	5,252,993	5,264,043	5,264,043	5,264,043	150,911,734
Total Operating Costs ($)	Base Case				96,430,792	96,419,608	98,791,689	96,028,719	97,336,779	97,016,962	97,016,962	97,016,962	97,016,962	97,016,962	96,157,278	96,157,278	96,157,278	96,157,278	96,157,278	95,636,854	91,555,871	91,555,871	91,555,871	91,555,871	92,531,740	92,531,740	92,531,740	92,531,740	92,531,740	92,019,776	92,019,776	92,019,776	2,651,457,154
Total Operating Costs ($)	Indexed for Sensitivity				**96,430,792**	**96,419,608**	**98,791,689**	**96,028,719**	**97,336,779**	**97,016,962**	**97,016,962**	**97,016,962**	**97,016,962**	**97,016,962**	**96,157,278**	**96,157,278**	**96,157,278**	**96,157,278**	**96,157,278**	**95,636,854**	**91,555,871**	**91,555,871**	**91,555,871**	**91,555,871**	**92,531,740**	**92,531,740**	**92,531,740**	**92,531,740**	**92,531,740**	**92,019,776**	**92,019,776**	**92,019,776**	**2,651,457,154**
Operating Profit ($)					**86,996,750**	**87,367,134**	**84,859,640**	**87,400,606**	**86,370,854**	**86,388,655**	**86,388,655**	**86,388,655**	**86,388,655**	**86,388,655**	**87,045,655**	**87,045,655**	**87,045,655**	**87,045,655**	**87,045,655**	**86,200,426**	**82,345,470**	**82,345,470**	**82,345,470**	**82,345,470**	**82,568,034**	**82,568,034**	**82,568,034**	**82,568,034**	**82,568,034**	**83,448,318**	**83,448,318**	**83,448,318**	**2,378,933,966**
Quarry Pre-production Capital Expenditure ($)																																	
QUARRY DEVELOPMENT – Pre-stripping			0	250,000																													250,000
QUARRY EQUIPMENT			0	0																													0
QUARRY INFRASTRUCTURE			347,970	811,930																													1,159,900
METALLURGICAL PLANT – BUILDINGS			21,370,916	49,865,470																													71,236,386
METALLURGICAL PLANT – PROCESS			57,608,556	134,419,964																													192,028,520
METALLURGICAL PLANT – INFRASTRUCTURE			13,937,554	32,520,959																													46,458,513
Total	Base Case		93,264,996	217,868,323																													311,133,319
Total	Indexed for Sensitivity		93,264,996	217,868,323																													311,133,319
Residual Value ($)	Process Plant	15.0%																														-39,489,736	-39,489,736
Working Capital ($)	Months of Annual Operating Costs	2.00		15,154,661	-3,660	396,024	-459,385	216,618	-51,793	0	0	0	0	-142,267	0	0	0	0	-79,909	-640,484	0	0	0	156,653	0	0	0	0	-87,169	0	0	-14,459,289	0
Sustaining Capital Expenditure ($)																																	
Quarry					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Metallurgical Plant					150,000	300,000	600,000	720,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	20,970,000
Total Sustaining Capital Expenditure	Base Case				150,000	300,000	600,000	720,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	20,970,000
Total Sustaining Capital Expenditure	Indexed for Sensitivity				150,000	300,000	600,000	720,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	20,970,000
Total Capital Expenditure ($)			**93,264,996**	**233,022,984**	**146,340**	**696,024**	**140,615**	**936,618**	**748,207**	**800,000**	**800,000**	**800,000**	**800,000**	**657,733**	**800,000**	**800,000**	**800,000**	**800,000**	**720,091**	**159,516**	**800,000**	**800,000**	**800,000**	**956,653**	**800,000**	**800,000**	**800,000**	**800,000**	**712,831**	**800,000**	**800,000**	**-53,149,025**	**292,613,583**
Trust Fund Rehabilitation Payments ($)			**0**	**262,500**	**131,250**	**131,250**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**525,000**
Federal Corporate Income Tax	Proportions of Total Taxes	61.0%	0	0	88,390	196,370	6,854,125	9,569,196	10,646,811	11,273,095	11,648,104	11,888,854	12,054,321	12,175,378	12,351,521	12,426,106	12,487,428	12,538,794	12,582,379	12,514,179	11,968,097	11,995,955	12,020,184	12,041,330	12,087,020	12,103,265	12,117,556	12,130,156	12,141,287	12,261,789	12,270,521	18,201,734	312,633,945
Provincial Corporate Income Tax		37.7%	0	0	0	133,424	0	134,123	91,568	92,795	92,334	642,521	9,245,333	9,337,204	9,471,548	9,528,209	9,574,834	9,613,926	9,647,125	9,594,679	9,175,895	9,197,163	9,215,672	9,231,834	9,266,826	9,279,252	9,290,188	9,299,833	9,308,355	9,400,731	9,407,419	13,954,677	193,227,468
Quebec Mining Tax		1.3%	0	0	211,154	287,417	61,049	262,699	189,508	196,636	200,646	203,453	205,419	206,794	311,904	312,578	313,050	313,380	313,611	171,981	172,095	172,174	172,229	172,268	213,658	213,677	213,691	213,700	213,706	356,324	356,328	356,330	6,587,461
Total Corporate Income and Mining Taxes ($)	Total	100.0%	**0**	**0**	**299,544**	**617,210**	**6,915,174**	**9,966,018**	**10,927,888**	**11,562,526**	**11,941,085**	**12,734,828**	**21,505,072**	**21,719,376**	**22,134,973**	**22,266,894**	**22,375,312**	**22,466,101**	**22,543,115**	**22,280,839**	**21,316,086**	**21,365,292**	**21,408,086**	**21,445,432**	**21,567,504**	**21,596,194**	**21,621,435**	**21,643,689**	**21,663,349**	**22,018,844**	**22,034,268**	**32,512,741**	**512,448,875**
PRE-TAX CASH FLOW			**-93,264,996**	**-233,285,484**	**86,719,160**	**86,539,861**	**84,719,026**	**86,463,987**	**85,622,647**	**85,588,655**	**85,588,655**	**85,588,655**	**85,588,655**	**85,730,923**	**86,245,655**	**86,245,655**	**86,245,655**	**86,245,655**	**86,325,564**	**86,040,910**	**81,545,470**	**81,545,470**	**81,545,470**	**81,388,817**	**81,768,034**	**81,768,034**	**81,768,034**	**81,768,034**	**81,855,203**	**82,648,318**	**82,648,318**	**136,597,343**	**2,085,795,383**
Cumulative B-T CF			-93,264,996	-326,550,480	-239,831,320	-153,291,459	-68,572,434	17,891,554	103,514,200	189,102,856	274,691,511	360,280,167	445,868,822	531,599,745	617,845,400	704,091,054	790,336,709	876,582,363	962,907,927	1,048,948,837	1,130,494,307	1,212,039,776	1,293,585,246	1,374,974,063	1,456,742,097	1,538,510,131	1,620,278,166	1,702,046,200	1,783,901,403	1,866,549,721	1,949,198,039	2,085,795,383	
Payback period work area				1.00	1.00	1.00	1.00	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
AFTER-TAX CASH FLOW			**-93,264,996**	**-233,285,484**	**86,419,616**	**85,922,650**	**77,803,851**	**76,497,969**	**74,694,759**	**74,026,129**	**73,647,571**	**72,853,827**	**64,083,584**	**64,011,547**	**64,110,681**	**63,978,761**	**63,870,343**	**63,779,554**	**63,782,448**	**63,760,071**	**60,229,383**	**60,180,178**	**60,137,384**	**59,943,385**	**60,200,530**	**60,171,840**	**60,146,599**	**60,124,345**	**60,191,855**	**60,629,475**	**60,614,051**	**104,084,602**	**1,573,346,507**
Cumulative A-T CF			-93,264,996	-326,550,480	-240,130,864	-154,208,214	-76,404,362	93,606	74,788,366	148,814,495	222,462,066	295,315,893	359,399,476	423,411,023	487,521,705	551,500,465	615,370,808	679,150,362	742,932,810	806,692,881	866,922,265	927,102,443	987,239,827	1,047,183,211	1,107,383,742	1,167,555,582	1,227,702,181	1,287,826,526	1,348,018,380	1,408,647,855	1,469,261,906	1,573,346,507	
Payback period work area				1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

FINANCIAL INDICATORS	Lag from t=-3 to pre-prod. start (months)	12		
Pre Tax	Lag from t=0 to prod. start (months)	0		
Payback Period (years)			**3.8**	
Total Cash Flow ($)			**2,085,795,383**	
Net Present Value ($)	Discount Rate	6.0%	**727,276,748**	
Net Present Value ($)	Discount Rate	8.0%	**525,596,925**	
Net Present Value ($)	Discount Rate	10.0%	**381,554,086**	
Internal Rate of Return			**24.5%**	
After Tax				Effective Tax Rates
Payback Period (years)			**4.0**	
Total CashFlow ($)			**1,573,346,507**	24.6%
Net Present Value ($)	Discount Rate	6.0%	**543,677,358**	25.2%
Net Present Value ($)	Discount Rate	8.0%	**388,832,363**	26.0%
Net Present Value ($)	Discount Rate	10.0%	**277,533,159**	27.3%
Internal Rate of Return			**22.0%**	

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22.3 Sensitivity Analysis

A sensitivity analysis has been carried out, with the base case described above as a starting point, to assess the impact of changes in total pre-production capital expenditure (“**CAPEX**”), operating costs (“**OPEX**”), product prices (“**PRICE**”) and the US$/CAN$ exchange rate (“**FX RATE**”) on the project’s NPV @ 8.0% and IRR. Each variable was examined one-at-a-time (product prices are varied together). An interval of ±30% with increments of 10.0% was used for the first three (3) variables. US$/CAN$ exchanges rates of 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, and 0.95 (relative variations of -13.33, -6.67, 0.0, 6.67, 13.33, 20.0, and 26.67, respectively) were used. The U.S. content associated with the capital cost estimate was adjusted accordingly for each exchange rate assumption.

The before-tax results of the sensitivity analysis, as shown in the next two figures, indicate that, within the limits of accuracy of the cost estimates in this study, the project’s before-tax viability does not seem significantly vulnerable to the underestimation of capital and operating costs, taken one at-a-time. As seen in Figure 110, the NPV is more sensitive to variations in Opex than Capex, as shown by the steeper slope of the Opex curve. As expected, the NPV is most sensitive to variations in price and the US$/CAN$ exchange rate. The NPV becomes marginal at the lower limit of the price interval but remains positive at the upper limit of the exchange rate interval examined. A break-even NPV (i.e., 8% equal to zero) is achieved at a price variation of about -31% (prices are varied together), which corresponds to prices of approximately $1,245, $170, and $69 for FeSi75, silica fume, and slag, respectively.

Figure 110: Pre-tax NPV @ 8 %: Sensitivity to Capital Expenditure, Operating Cost, Price, and US$/CAN$ Exchange Rate

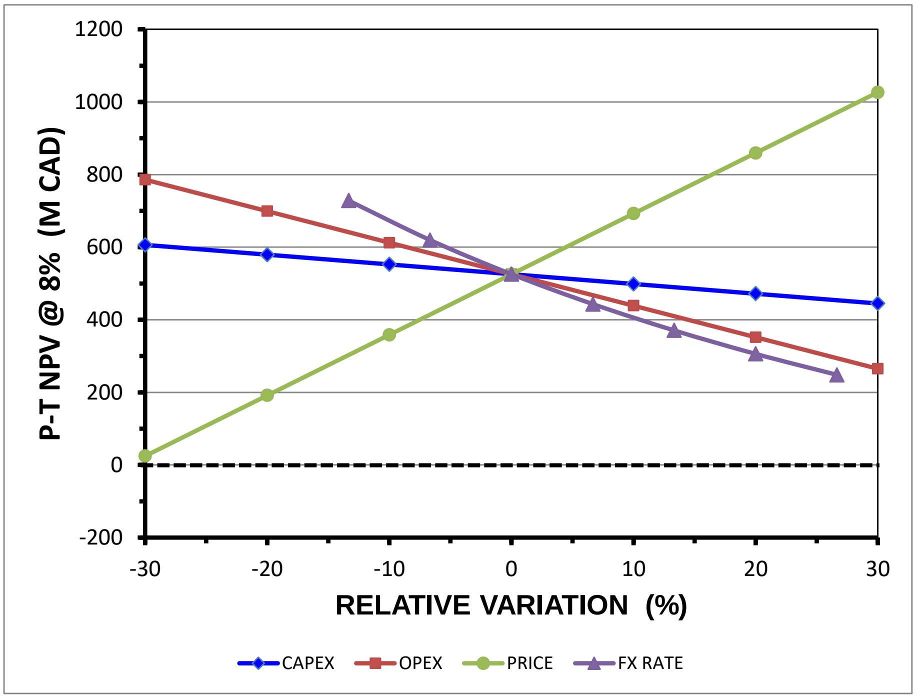
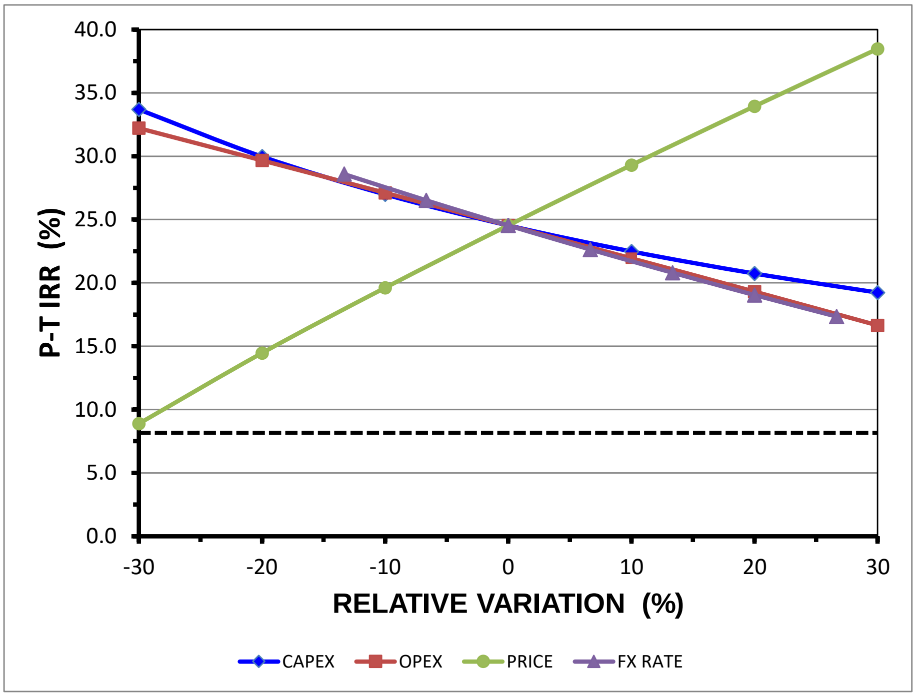


Figure 111, showing variations in internal rate of return, provides the same conclusions. The horizontal dashed line represents the base case discount rate of 8%. The IRR is more sensitive to variations in Opex than Capex for positive variations but is equally sensitive to both variables for negative variations.

Figure 111: Pre-tax IRR: Sensitivity to Capital Expenditure, Operating Cost, Price, and US$/CAN$ Exchange Rate



The same conclusions can be made from the after-tax results of the sensitivity analysis as shown in the next two figures. Figure 112 indicates that the project's after-tax viability is mostly vulnerable to a price forecast reduction and change in the US$/CAN$ exchange rate, while being less affected by the under-estimation of capital and operating costs. The NPV becomes nil at the lower limit of the price interval but remains positive at the upper limit of the exchange rate interval examined. Thus, the break-even NPV (i.e., 8% equal to zero) is achieved at a price variation of about -30% (prices are varied together), which corresponds to prices of $1,275, $175, and $70 for FeSi75, silica fume, and slag, respectively.

Figure 112: After-tax NPV @ 8 %: Sensitivity to Capital Expenditure, Operating Cost, Price, and US$/CAN$ Exchange Rate

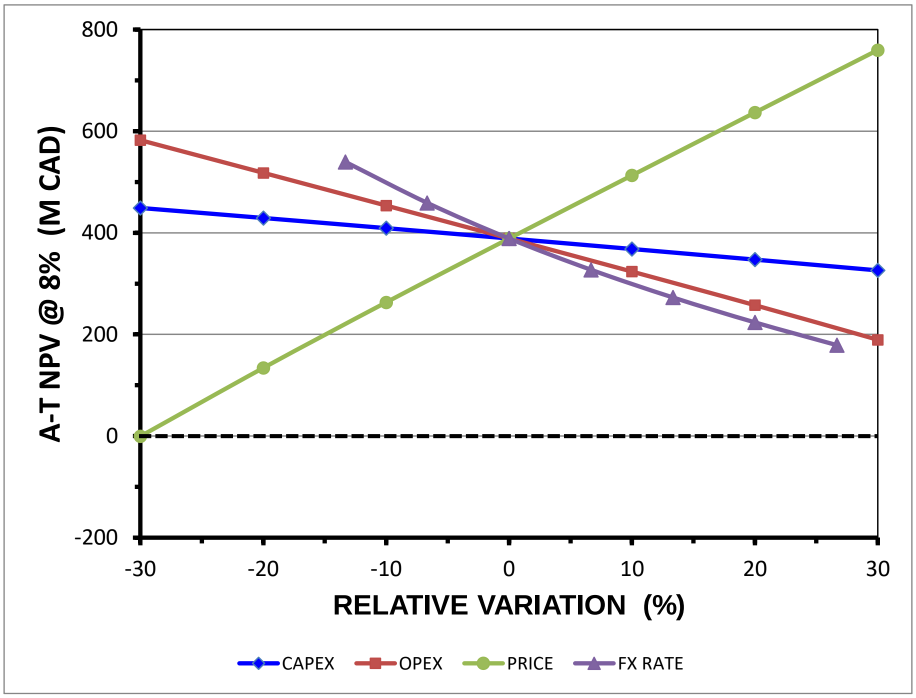
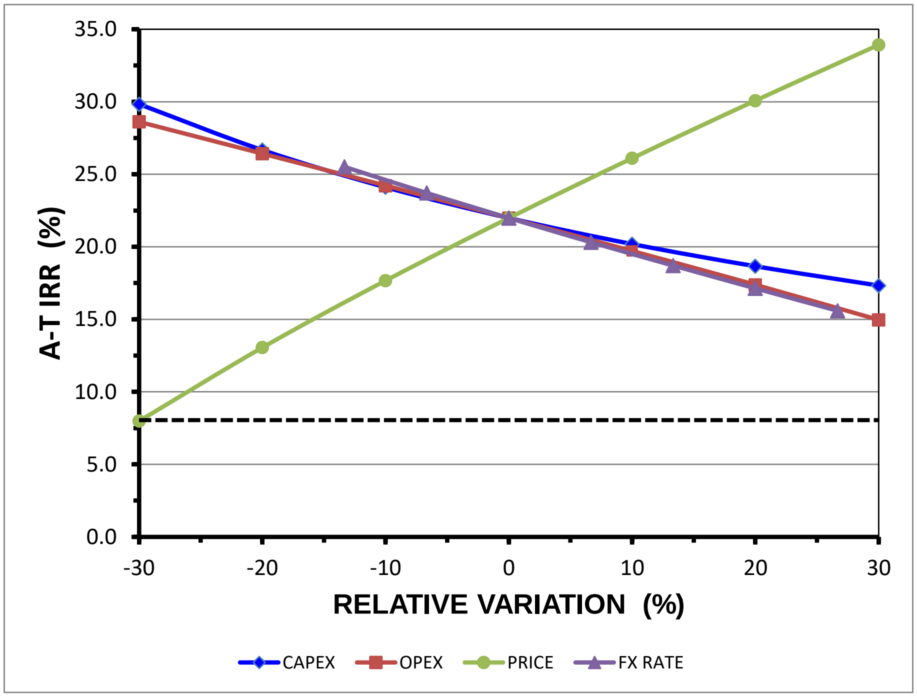


Figure 113, showing variations in IRR, provides the same conclusions.

Figure 113: After-tax IRR: Sensitivity to Capital Expenditure, Operating Cost, Price, and US$/CAN$ Exchange Rate



22.4 Important Caution Regarding the Economic Analysis

The economic analysis contained in this report is preliminary in nature. It incorporates inferred mineral resources that are considered geologically too speculative to have the economic considerations applied to them that would enable them to be categorized as mineral reserves.

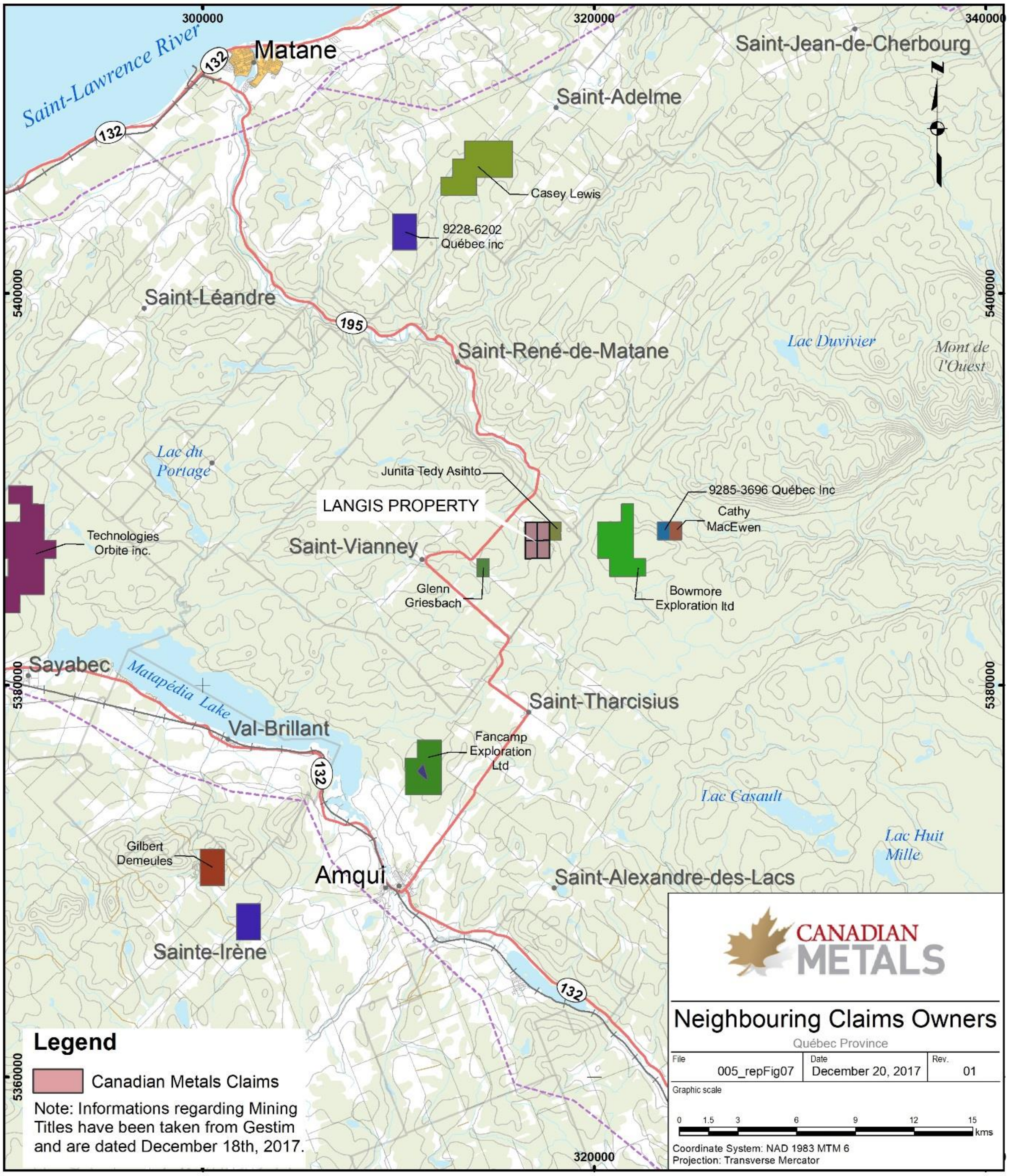
23. Adjacent Properties

23.1 Langis Quarry

There are few properties adjacent to the Langis Property. One is directly adjacent to the territory referred to in this Technical Report, and few more are located in a radius of 8 km surrounding the Property. This information appears in Figure 114. The properties adjacent to the Langis Property have been retrieved from GESTIM database of the *Ministère des Ressources Naturelles du Québec*, which enables to consult the Public Register of Real and Immovable Mining Rights.

Junita Tedy Asihto owns the segment right next to Langis Property, located at top east, where no work of any kind has been undertaken in the last two years. Further east, Bowmore Exploration Ltd. has done research and examination on rocky outcrops in 2015; however, nothing was reported for 2016. Continuing in the same direction, activity regarding the development of partnership for quartzite and silica occurred on land registered under the number 9285-3696 Québec Inc. Right east to this last one, no work has been reported for 2016 and 2017 by Cathy MacEwen. Finally, it is the same situation for Glenn Griesbach, west of the Langis Property. A quarry operated by Beton Provincial Ltee is located on claim CDC2501566, owned by Fancamp Exploration Ltd.

Figure 114: Top View—Territory of Langis Property and Surrounding Lands, Saint-Vianney



Situations may have changed, and the reader should only rely on the news from the owners of the adjacent properties.

Table 63: Adjacent Properties Ownership

Claims (CDC number)	Owner	Status (January 2018)	Colour
2501562 to 2501569	Fancamp Exploration Ltd.	Active	Orange
2462374	Glenn Griesbach	Active	Red
2387521 to 2387524	Canadian Metals Inc.	Active	Blue
2435621	Junita Tedy Asihto	Active	Yellow
2402524 to 2402533	Bowmore Exploration	Active	Green
2352188	9285-3696 Québec Inc.	Active	Pale Blue
2441547	Cathy MacEwen	Active	Pink

23.2 Baie-Comeau Smelter

The FeSi smelter is located in a heavy industrial facility; this allows the implementation of projects requiring large volumes of raw materials to handle and can tolerate impacts by noise and dust. The smelter site is located in a prohibited/restricted exploration area.

24. Other Relevant Data and Information

24.1 Project Execution Strategy and Schedule

The project execution strategy after the pre-feasibility study completion includes a detailed plan for putting the project in operation considering the quickest and most cost-effective way.

The main milestones include feasibility study (FS), Environmental Baseline Studies and Environmental Impact Assessment (EIA), geotechnical and hydrogeological work, front-end engineering, detailed engineering, procurement, construction, commissioning and start-up, and ramp-up production.

It is expected that the above listed items will be completed for three (3) years.

24.1.1 Feasibility Study (FS)

The feasibility study stage is expected to start right after the completion of the current pre-feasibility study in July 2018 and be completed in nine (9) months by the end of March 2019.

During the feasibility study, CIMA+ will perform further engineering work to design the quarry and the metallurgical plant at a ±10% of capital costs.

Major part of the feasibility study will be a detailed metallurgical test program designed specifically to firm up the process flow sheet, optimize process performance, and confirm the metallurgical design. Such test program should include:

- **Mineralogy**—a general X-Ray Diffraction (XRD) mineralogy analysis of the Langis samples and the reference sample will be accomplished to characterize the crystalline phases;
- **Characterization of heating properties of quartz**—characterize three different properties of the quartz: thermal shock stability, melting properties, and phase transformation. The results will be compared with published results for other quartz sources. As for most other tests of furnace raw materials, the tests will give relative differences between investigated materials:
    - **Thermal stability by shock heating**—too much fines in the charge will decrease gas permeability of the charge mixture, which again can lead to unstable furnace operation. To avoid decrepitation of lumpy quartz, fines generation is therefore regarded as critical for good operation of Si and FeSi furnaces;
    - **Melting properties by Sessile drop test**—melting properties will be investigated in CO atmosphere. Melting properties of quartz are determined by kinetics and the measured values will thus vary with the experimental condition;
    - **Phase transformation during heat treatment**—during heating, quartz will transform to other SiO_2 modifications with cristobalite as the stable high-temperature phase and amorphous silica as an intermediate phase. The rates of quartz/cristobalite transformation and amorphous silica formation vary with quartz sources. Specific surface area will increase during these transformations. Reactions with SiO_2 are expected to be affected by phase transformations. Rate for the phase transformation is thus expected to be of importance for the performance of furnaces for Si production;

  - **Simulation of Si production process in medium scale**—a test that simulates conditions in industrial Si furnaces is a new test under development;
  - **Pilot scale ferrosilicon production**—pilot scale silicon process, both with an open off-gas system and a semi-closed furnace with opportunity to monitor and analyze the off-gas continuously, the last with focus on NOx. The equipment and the experiment should be designed to investigate relative differences between selected parameters for the testing. Raw materials as quartz can be one of these and the experiment will indicate behaviour of the quartz in the furnace. The results from the pilot plant testing will define reactions and behavior of the quartz from the casted cross sections as well as the quality of the produced alloy, silicon yield, and indications of furnace performance from the observations of personnel operation the pilot furnace.

Other important areas of consideration during the feasibility study will include:

- Engage with a plant equipment supplier to provide detailed feasibility level of design on the metallurgical plant alone;
- Investigate the option to increase the capacity of the selected SAF units and conduct a trade-off study to compare the increased production capacity vs. the increased capital and operating costs for the production;
- Investigate the option to produce Metallurgical Silicon (mgSi) as final product as a pose to FeSi75 or be capable to produce both products.

24.1.2 Environmental Impact Assessment (EIA)

The EIA work is expected to start at a feasibility study level beginning of 2019 to be able to conduct baseline studies and field work during the favourable warmer seasons of the year.

The baseline studies will include reviews of the project timeline, environmental settings, methodology described, economic and social benefits, air, noise, flora and fauna studies, as well as modelling, etc.

Based on the baseline studies, a detailed Environmental Impact Statement (EIS) document will be produced and presented to the provincial and federal governments for review. It is expected that the project will receive environmental release within one (1) year during spring 2019.

24.1.3 Geotechnical, Hydrology, and Hydrogeological Studies, Front-End Engineering

During the feasibility study, detailed field work will be conducted. This includes evaluation of the quarry, as well as metallurgical plant geotechnical, surface, and underground water conditions to complete the quarry pit and smelter design. Based on the work, detailed reports will be generated, which will become a basis of the quarry pit design and define the civil and structural requirements as well as the water management for the smelter area, building on the feasibility study results and executing a front-end engineering.

24.1.4 Detailed Engineering, Procurement, and Construction

After completing the above milestones, detailed engineering will be conducted for the Langis project. Based on the work, the necessary equipment will be procured, build, and transported to site.

The above work is expected to start in the second quarter of 2019 and be completed by the end of 2020.

The construction period will start in parallel with some of the engineering and procurement periods, when equipment is available in the second quarter of 2020, and is expected to be completed by the end of 2021.

The detailed project development schedule is presented in Appendix D.

25.Interpretation and Conclusions

25.1 Geology and Mineral Resources

The Langis Val-Brillant sandstones with their Lower White sandstones, which are 15 to 35 metres thick, are found to be fairly uniform in term of chemistry and meet the specifications indicated to the authors for ferrosilicon plant feed. The deposit is dissected by numerous faults, the most important being NNE-SSW or NE-SW oriented thrust faults with a steep dip to the north and uprising of the northwest block relative to the southeast block with apparently not much effect on the quality of the material. Horizontal movement is also present along these faults.

Inclined holes drilled in 2017 have shown that the grades are not affected by the displacement faults; however, two major faults were highlighted in location and width of ferruginous alteration aside the plane. For that reason, these tow faults with their perimeters have been modelled as waste and excluded from the resource model.

As there are vertical displacements caused by some fault movements, follow-up with 3D mapping of the face will be necessary should a specific strata selection be made in the white material. The strata with higher iron content can easily be observed in the face visually and therefore set apart, if required.

The new drilling has allowed the transformation of Inferred mineral resources to Indicated and Measured mineral resources in a positive manner.

25.2 Mining Methods

The pit optimization analysis was done using the MineSight® Economic Planner (MSEP) module of MineSight® Version 11.0. The optimizer uses the 3D Lerchs-Grossmann algorithm to determine the economic pit limits based on input of costs and revenue per block. The optimization was limited to proximity of 10 m from the Property limits. As per NI 43-101 guidelines regarding the Standards of Disclosure for Mineral Projects, only blocks classified in the Measured and Indicated categories drove the pit optimizer for this study. Inferred resource blocks are treated as waste, bearing no economic value.

The cost and operating parameters that were used are preliminary estimates for developing the economic pit and should not be confused with the operating costs subsequently developed for the PFS and presented in section 21.

The pit designed for the Langis Deposit consists of only one (1) phase in size and grade. The final pit is approximately 350 m long with minimum and maximum width at surface of 100 and 225 m respectively, and a maximum pit depth from surface of 47 m. The total footprint of the quarry is expected to be around 118,000 m^2. The overburden thickness varies between 2 to 3 m with an average of 2.5 m.

The pit considers a single permanent access ramp located on the east side. The deepest part of the open pit is at an elevation of 200 m at a depth of 47 m below original surface. The open-pit design is constrained by the Property limits to the west.

The open-pit design includes 6.3 Mt of Probable & Proven Mineral Reserves at a grade of 99% SiO_2. In order to access these reserves, 0.8 Mt of overburden and 2.6 Mt of waste rock will need to be removed.

This results in a stripping ratio (waste to ore) of 0.41. Table 64 presents the open-pit reserves for the Langis deposit.

Table 64: Open-Pit Mineral Reserves

Category	Tonnage	SiO_2 Grade (%)
Proven	3.5 Mt	99.0
Probable	2.8 Mt	99.0
Proven & probable	6.3 Mt	99.0

Source: GoldMinds Geoservices Inc.

25.3 Processing and Metallurgy

Various metallurgical test programs were undertaken by Canadian Metals and executed in different laboratory testing facilities with special expertise of production of FeSi. *Centre de Technologie Minérale et de Plasturgie* (CTMP) performed various chemical and physical analyses on the samples under the supervision of Genivar, as the goal was to establish the characteristics of the Langis sandstone in relation to various potential commercial uses.

From the initial test results in 2013, Canadian Metals Inc. retained that the Langis Property sandstone can provide suitable material for ferrosilicon production. This lead to a pilot smelting testing at MINTEK in 2015.

Based on the various tests performed over the years for different samples of Langis quartzite in various reputable testing facilities, the general conclusion is that commercial production of ferrosilicon can be achieved using Langis silica products.

This report design is based on the metallurgical processes to utilize the Langis silica as a raw material to produce Ferrosilicon75 (FeSi75) standard along with microsilica (silica fumes) as final plant products to be sold to the market. The Langis silica deposit will be quarried and recovered for use as a feedstock into a downstream ferrosilicon smelter in Baie-Comeau, Quebec, from where it will be shipped to its final destination.

After the silica is quarried by the means of open-pit quarry type of operations, previously detailed in section 16 of this report, the process steps at the quarry site will consist of blasting, crushing, and screening the silica before its transportation to the metallurgical facility (smelter) by truck. Silica that is too fine for use in the smelter can be marketed to local industries, while the coarser material will be used directly in the smelter.

The smelter at Baie-Comeau will produce ferrosilicon by a pyrometallurgical process that combines silica from the Langis quarry with a carbon source (coal), iron ore, and wood chips in a 2 x 35 MW Submerged Arc Furnaces (SAF) in which the above listed raw materials are smelted into ferrosilicon. Molten ferrosilicon is tapped from the furnace into ladles and then poured into molds to cool and solidify into large ingots. The ingots are removed from the mold after they have cooled sufficiently, then crushed and classified into the required size fraction for sale.

The raw materials required for the production of FeSi75 are listed and described as follows:

- Silica (quartzite)—Langis silica;
- Reducing agent—coal;
- Iron supplement—iron ore;
- Wood chips;
- Electrode paste—Søderberg paste.

25.4 Infrastructure

Both the Langis Quarry and the Metallurgical Plant are located near municipalities, thus eliminating the need for worker campsite accommodations.

The Langis Quarry site has existing access to public roads, connection to the electrical grid, and cellular communications coverage.

Public services and road access do not currently exist for the Metallurgical Plant in Baie-Comeau; however, the city of Baie-Comeau made commitments to provide water and sewer services to the industrial park. Highway 389 is scheduled to be re-routed through the industrial park and the work began in February 2017.

25.5 Environmental and Social Aspects

The project under study is based on two distinct but complementary components: an open quarry and an industrial complex with the process plant.

The quarry mainly consists of the development and extraction of a silica (SiO_2) deposit. The deposit is easily accessible by existing roads.

A production of 130,000 tonnes of coarse silica per year will require approximately 165,000 tonnes per year to be extracted and processed at the Langis quarry. The life of the project is expected to be 28 years. The quarry project notably includes the following activities: standard drilling/blasting, excavation, dump trucks, stockpiling, and crushing. The water for dust control will come from a sedimentation basin.

The quarry will supply the industrial complex producing silicon. The process plant will mainly consist of an electric arc smelting plant where silica is mixed with hematite, coal, electrode paste, and wood chips for the production of ferrosilicon (FeSi). This process required two electric arc furnaces (70 MW). Electricity will come from hydropower and will be provided through the Hydro-Québec grid (Rate L). Process water will come from the city water supply system.

The base case configuration assumes an annual production of about:

- 72,051 tonnes of FeSi;
- 12,384 tonnes of silica fume, a by-product of the smelting process;
- 4,128 tonnes of slag.

Raw materials will be brought to the plant by road, water, and railway. Final products may go through the same transportation modes but will be highly dependent on clients’ locations and needs.

The two main project components have different locations, both in eastern Quebec. The quarry is located in the municipality of Saint-Vianney in the Bas-Saint-Laurent region, while the silicon plant will be located in Baie-Comeau in the Côte-Nord region.

The quarry is located in a forested area with a low human activity density. The proposed exploitation area covered by the quarry is 9.34 ha.

The silicon plant footprint is about 12 ha. It is located north of an industrial park within the municipality of Baie-Comeau. The site is underdeveloped, mainly forested, and the existing industrial and commercial features are located to the south.

25.6 Capital and Operating Costs

The estimated consolidated direct capital requirements for CME's integrated Langis project, which encompasses the development of the Langis silica deposit as well as the proposed first phase of the downstream smelter operation in Matane, is expected to amount to approximately CAN$311.1M within a range of ±25%. Included in the estimation is approximately CAN$220.3M of direct and CAN$90.8M of indirect costs.

Table 65: Summary of Capital Cost Estimate

Capex Item	Cost in CAN$
Direct Costs	
Quarry Development / Pre-Stripping	$250,000.00
Quarry Infrastructure	$821,000.00
Metallurgical Plant—Buildings	$50,422,495.53
Metallurgical Plant—Process	$135,921,509.69
Metallurgical Plant—Infrastructure	$32,884,236.21
TOTAL DIRECT	**$220,299,241.43**
Indirect Costs	
Owner's Costs	$8,029,992.00
Freight	$5,867,813.25
Heavy Lift (250-T Crane)	$620,000.00
Construction Indirect Costs	$11,509,212.07
EPCM	$21,922,824.14

Contingency	$32,884,236.21
TOTAL INDIRECT	**$90,834,077.68**
TOTAL DIRECT & INDIRECT	**$311,133,319.11**

The operating costs for the project were estimated and calculated on an annual basis. A summary of the operating costs is shown in the followings table.

The operating costs are presented as a total annual cost in CAN$ and on a per-unit basis on a cost per tonne of SiO_2 production at the Saint-Vianney quarry site as well as on a cost per tonne of final FeSi75 product.

The summary of the annual operating costs and the cost per tonne of SiO_2 and FeSi75 for an average year of operations are shown in the table below.

Table 66: Summary of Annual Operating Costs per Area

Area	Annual Cost in CAN$	Unit Cost	Unit Cost
		(CAN$/t SiO_2)	(CAN$/t FeSi)
Labour	$11,750,693.76	$90.60	$163.09
Power	$26,396,120.18	$203.53	$364.00
Materials, Consumables, Supplies	$46,491,423.61	$358.48	$645.26
Other	$6,484,590.00	$50.00	$90.00
TOTAL	**$91,122,827.55**	**$702.61**	**$1,264.70**

25.7 Economic Analysis

An economic analysis based on the production and cost parameters of the project has been carried out and the results are shown in Table 67. In the analysis used were Ex-Works Metallurgical Plant selling prices of US$1,819 per tonne for ferrosilicon, US$250 per tonne for silica fume, and US$100 per tonne for silica slag. A US$/CAN$ exchange rate of 0.750 was assumed.

Table 67: Summary of the Life of Project Production, Revenues, and Costs

Description	Units	
Production—Mineralization	k tonnes	6,293
Production—Silica Product Feed to FeSi Plant	k tonnes	3,561
Production—Excess Silica Product Sold	k tonnes	1,159

Revenue	M CAN$	5,030.4
Initial Capital Costs (excludes working capital)	M CAN$	311.1
Sustaining Capital Costs	M CAN$	21.0
Operating Costs (excludes royalty payments)	M CAN$	2,500.5
Royalty Payments	M CAN$	150.9
Closure Costs	M CAN$	0.525
Total Pre-Tax Cash Flow	M CAN$	2,085.8
Total After-Tax Cash Flow	M CAN$	1,573.3

The financial indicators associated with the economic analysis are summarized in Table 68.

This study has been compiled according to widely accepted industry standards. Nevertheless, there is no certainty that the conclusions reached in this study will be realized.

Table 68: Summary of Financial Indicators

Base Case Results	Unit	Value
Pre-Tax (P-T) NPV @ 8 %	M CAN$	525.6
After-Tax (A-T) NPV @ 8 %	M CAN$	388.8
P-T IRR	%	24.5
A-T IRR	%	22.0
P-T Payback Period	years	3.8
A-T Payback Period	years	4.0

25.8 Opportunities and Risks

25.8.1 Opportunities

25.8.1.1 Mineral Processing and Metallurgy

- Optimize process flow sheet.
- Optimize raw materials structure, quantity ratios, and raw materials supply chain.
- Potential of producing metallurgical silicon (mgSi) instead or along with the ferrosilicon 75 (FeSi75).
- Optimize final products types, volumes, and specifications from the quarry plant and from the smelter.
- Work with SAF smelter equipment provider to optimize processes, materials, and supplies.

25.8.1.2 Transportation and Logistics

- Optimize raw materials and final products transportation regimes and structures.

25.8.2 Risk Assessment

Any industrial project contains inherent risks that must be considered from the perspective of the potential operator/investor. The following table presents a risk assessment in an attempt to quantify these risks with the relevant matrices shown. A more detailed and extensive project risk assessment should be undertaken in future project stages to identify and outline mitigation strategies for operation, market, and technical risks.

Table 69: Risk Definitions

#	RISK EVENT	IMPACT/ CONSEQUENCE	EXISTING MITIGATIONS	L (1-5)	C (1-5)	SUM	RISK RATING
1	Product Sales Price	Can potentially improve or reduce considerably the project economics	Average sales price selected (not aggressive, not conservative), based on projections of a reputable provider.	2	5	10	***MEDIUM***
2	CAN$ to US$ Exchange Rate	Can potentially improve or reduce considerably the project economics	Acceptable FX Rate selected, based on current and general historical comparison between CAN$ and US$.	2	5	10	***MEDIUM***
3	Project Operating Costs	Facilitate Costs Review and properly complete Cost Reduction Process	Numerous potentials to improve the Capital Cost structure during the next stage of Project development.	2	4	8	***MEDIUM***
4	Project Capital Costs	Facilitate Costs Review and properly complete Cost Reduction Process	Numerous potentials to improve the Capital Cost structure during the next stage of Project development.	2	3	6	***MEDIUM***
5	Project Schedule	Successful completion of the report	Not an aggressive schedule assumed for the purposes of the PFS.	1	4	4	***LOW***
6	Environmental Study	Successful completion of the Impact Study	Not an aggressive schedule assumed for the purposes of the PFS.	1	3	3	***LOW***
7	Metallurgical Testing	Successful completion of the metallurgical testing campaign	Already some testing done and there is a good level of confidence in the previous results.	1	3	3	***LOW***

26.Recommendations

26.1 Geology and Mineral Resources

In GMG opinion, the actual resource appears sufficient for the contemplated project of CME. Most of the recommendations of 2016 have been realized and place the Property in good position for the next step. Our suggestions are now:

- Realize a feasibility with the current Measured and Indicated resources within the crown land;
- Negotiate to acquire the surface right with inferred resources to the west of the existing quarry where there is an open face and it is technically ready for quarrying. Once acquisition or agreement with neighbour is done and should additional resources be required for the project, then drill on regular grid of 60 x 60 m ($250k $350k). The author suggests the acquisition at evaluation and a reasonable percentage factor associated with a limited royalty per tonne for a fixed amount;
- As part of the additional drilling proposed above, proceed with a hydrogeological study to better understand the groundwater behaviour in the quarry area and how quarrying will affect the water table (100k);
- As part of the additional drilling requested above, proceed with more geotechnical data gathering to better define rock mass properties to increase confidence in mining parameters used and reduce rock waste removal.

26.2 Mining

In GMG opinion, trial quarrying with the current BEX and the next step of a feasibility study will allow CME to:

- Adjust the drilling and blasting pattern to minimize fines and control the number of oversize rocks that need to be re-handled to minimize damage to quarrying equipment;
- Compile and analyze the on-going abrasion tests and Bond index tests to better define the energy required for crushing the material;
- Review quarry plans with new drilling information to optimize ore to waste ratio and reduce dilution;
- Provide optimized quarrying plans to contractors to refine quarrying costs.

26.3 Metallurgy and Process

For the next stage of project development, namely the Feasibility Study, CIMA+ recommends several very important steps and tasks regarding the metallurgical testing and design in order to firm up and optimize the process design to ensure optimal metallurgical plant performance that will produce the optimal final products and thus maximize the project economics. Those steps and measures are:

- Develop a strategy and recipe for a detailed metallurgical test program to optimize process performance and confirm the metallurgical design. Such test program should include:
  - **Mineralogy**—a general X-Ray Diffraction (XRD) mineralogy analysis of the Langis samples and the reference sample will be accomplished to characterize the crystalline phases;

  - **Characterization of heating properties of quartz**—characterize three different properties of the quartz: thermal shock stability, melting properties, and phase transformation. The results will be compared with published results for other quartz sources. As for most other tests of furnace raw materials, the tests will give relative differences between investigated materials:
    - **Thermal stability by shock heating**—too much fines in the charge will decrease gas permeability of the charge mixture, which again can lead to unstable furnace operation. To avoid decrepitation of lumpy quartz, fines generation is therefore regarded as critical for good operation of Si and FeSi furnaces;
    - **Melting properties by Sessile drop test**—melting properties will be investigated in CO atmosphere. Melting properties of quartz are determined by kinetics and the measured values will thus vary with the experimental conditions;
    - **Phase transformation during heat treatment**—during heating, quartz will transform to other SiO_2 modifications with cristobalite as the stable high-temperature phase and amorphous silica as an intermediate phase. The rates of quartz/cristobalite transformation and amorphous silica formation vary with quartz sources. Specific surface area will increase during these transformations. Reactions with SiO_2 are expected to be affected by phase transformations. Rate for the phase transformation is thus expected to be of importance for the performance of furnaces for Si production;
  - **Simulation of Si production process in medium scale**—a test that simulates conditions in industrial Si furnaces is a new test under development;
  - **Pilot scale ferrosilicon production**—pilot scale silicon process, both with an open off-gas system and a semi-closed furnace with opportunity to monitor and analyze the off gas continuously, the last with focus on NOx. The equipment and the experiment should be designed to investigate relative differences between selected parameters for the testing. Raw materials as quartz can be one of these and the experiment will indicate behaviour of the quartz in the furnace. The results from the pilot plant testing will define reactions and behavior of the quartz from the casted cross sections as well as the quality of the produced alloy, Silicon yield, and indications of furnace performance from the observations of personnel operation the pilot furnace;

- Engage with a plant equipment supplier to provide detailed feasibility level of design on the metallurgical plant alone;
- Investigate the option to increase the capacity of the selected SAF units and conduct a trade-off study to compare the increased production capacity vs. the increased capital and operating costs for the production;
- Investigate the option to produce Metallurgical Silicon (mgSi) as final product as a pose to FeSi75 or be capable to produce both products.

The proposed budget to execute the above listed activities is expected to be in the range of $500k to $750k, and the work will be included in the feasibility study.

26.4 Infrastructure, Environmental, and Social Aspects

The table below describes what the recommended timeline from environmental and social point of view should include.

Table 70: Project Development Timeline

Phase	Activity	Timeline
Pre-feasibility	Site selection	2017
	Technical and financial study	July 2018
Project notice to MDDELCC	Submission	March 2018
Feasibility	Feasibility study	March 2019
Environmental Impact Study	Submission	April 2019
	Environmental decree authorizing the project	April 2020
Construction	Starting period	April 2020
	Ending period	October 2021
Exploitation	Starting period	October 2021

Detailed studies should be undertaken to assess the biophysical, biological, and social aspects of the project.

Site closure plan should be carried out as well based on the points described below.

Quarry

The closure plan of Langis quarry will be carried out in accordance with the quarry and sand pit regulations. The following situations will be taken into account:

- Revegetation of the degraded areas;
- Physical stability of the quarry components;
- Open-pit quarry workings;
- Rock and overburden piles;
- Water Management systems.

The closure plan shall include, among other things:

- A description of the quarry site and the activities that will be carried out there;
- A description of the restoration work to be completed to return the quarry site to a satisfactory state;
- A monitoring program as well as an estimation of the rehabilitation costs.

Industrial Process Plant

When the plant is dismantled, the site will be rehabilitated. Wherever possible, materials will be reused or recycled. The project closure plan will focus mainly on the following elements:

- The secondary roads and pathways will be scarified;
- The buildings and surface infrastructure will be dismantled. The surfaces will then be covered with topsoil and revegetated;
- Measures will be put in place to secure the area as per regulatory obligations.

26.5 Recommended Work Program and Estimated Cost

CIMA+ recommends that CME undertakes a detailed feasibility study (FS) as the next stage of project development, including:

- Use of the current Measured and Indicated resources within the crown land;
- Negotiations to acquire the surface right with Inferred resources to the west of the existing quarry where there is an open face and it is technically ready for quarrying. Once the acquisition or agreement with the neighbour is done and should additional resources be required for the project, then drill on regular grid of 60 x 60 m;
- Hydrogeological study to better understand the surface and groundwater behaviour in the quarry area and how quarrying will affect the water table;
- Geotechnical study to better define rock mass properties to increase confidence in mining parameters used and reduce rock waste removal;
- Development of a strategy and recipe for a detailed metallurgical test program to optimize process performance and confirm the metallurgical design including mineralogy, characterization of heating properties of quartz, thermal stability by shock heating, melting properties by Sessile drop test, phase transformation during heat treatment, and simulation of Si production process in medium scale. In addition, detailed pilot-scale ferrosilicon production should be part of the metallurgical test program, part of the FS;
- Engaging with a plant equipment supplier to provide detailed feasibility level of design on the metallurgical plant alone;
- Investigation of the option to increase the capacity of the selected SAF units and conduct a trade-off study to compare the increased production capacity vs. the increased capital and operating costs for the production;
- Investigation of the option to produce Metallurgical Silicon (mgSi) as final product as a pose to FeSi75 or be capable to produce both products.

The Feasibility Study including all the supporting metallurgical test programs and field work is expected to be completed within one (1) year.

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DV 87-01—RAPPORTS DES REPRESENTANTS REGIONAUX 1986. 1987, Par RIVE, M, RACICOT, D, GOBEIL, A, VALLIERES, A, LACHANCE, S, DUQUETTE, G, MARCOUX, P. 292 pages. 5 microfiches, page 227. DV 86-04—RAPPORTS DES REPRESENTANTS REGIONAUX 1985. 1986, Par RIVE, M. RACICOT, D, GOBEIL, A, VALLIERES, A, LACHANCE, S, DUQUETTE, G, MARCOUX, P. 238 pages. 1 CARTE (ECHELLE 1/13 500 000). 5 microfiches, page 179.

DV 83-05—RAPPORT DES GEOLOGUES RESIDENTS—1982. 1983, Par RIVE, M, LATULIPPE, M, GOBEIL, A, VALLIERES, A, DUQUETTE, G, MARCOUX, P. 135 pages. 3 microfiches, page 108.

DPV 868—RAPPORTS DES GEOLOGUES RESIDENTS POUR L'ANNEE 1981. 1982, Par RIVE, M, LATULIPPE, M, GOBEIL, A, LAMARCHE, R Y, DUQUETTE, G, MARCOUX, P. 144 pages. 3 microfiches, page 114.

DPV 814—RAPPORTS DES GEOLOGUES RESIDENTS POUR L'ANNEE 1980. 1981, Par RIVE, M, LATULIPPE, M, GOBEIL, A, LAMARCHE, R Y, DUQUETTE, G, MARCOUX, P. 120 pages. 3 microfiches, pages 92 et 93.

GM 68026—ETUDE DE CARACTERISATION DE LA SILICE DU DEPOT LANGIS. 2013, Par CHARLTON, J D, PAGANON, M D, FORBES, E. 380 pages.

GM 57849—RAPPORT DES TRAVAUX DE PROSPECTION, ETUDE DE LA SILICE DU VAL BRILLANT. 1999, Par HEBERT, Y. 19 pages. 9 cartes. 3 microfiches.

GM 46546—SONDAGE STRATIGRAPHIQUE, CANTON LANGIS. 1988, Par. 1 page. 1 carte. 1 microfiche.

GM 45933—RESULTATS D'ANALYSES, PROJET LANGIS. 1987, Par METRICLAB [1980] INC. 8 pages. 1 carte. 1 microfiche.

GM 42388—RAPPORT SUR LA SILICE DE MATANE. 1985, Par LABREQUE, P C, MARLEAU, R A. 40 pages. 3 cartes. 2 microfiches.

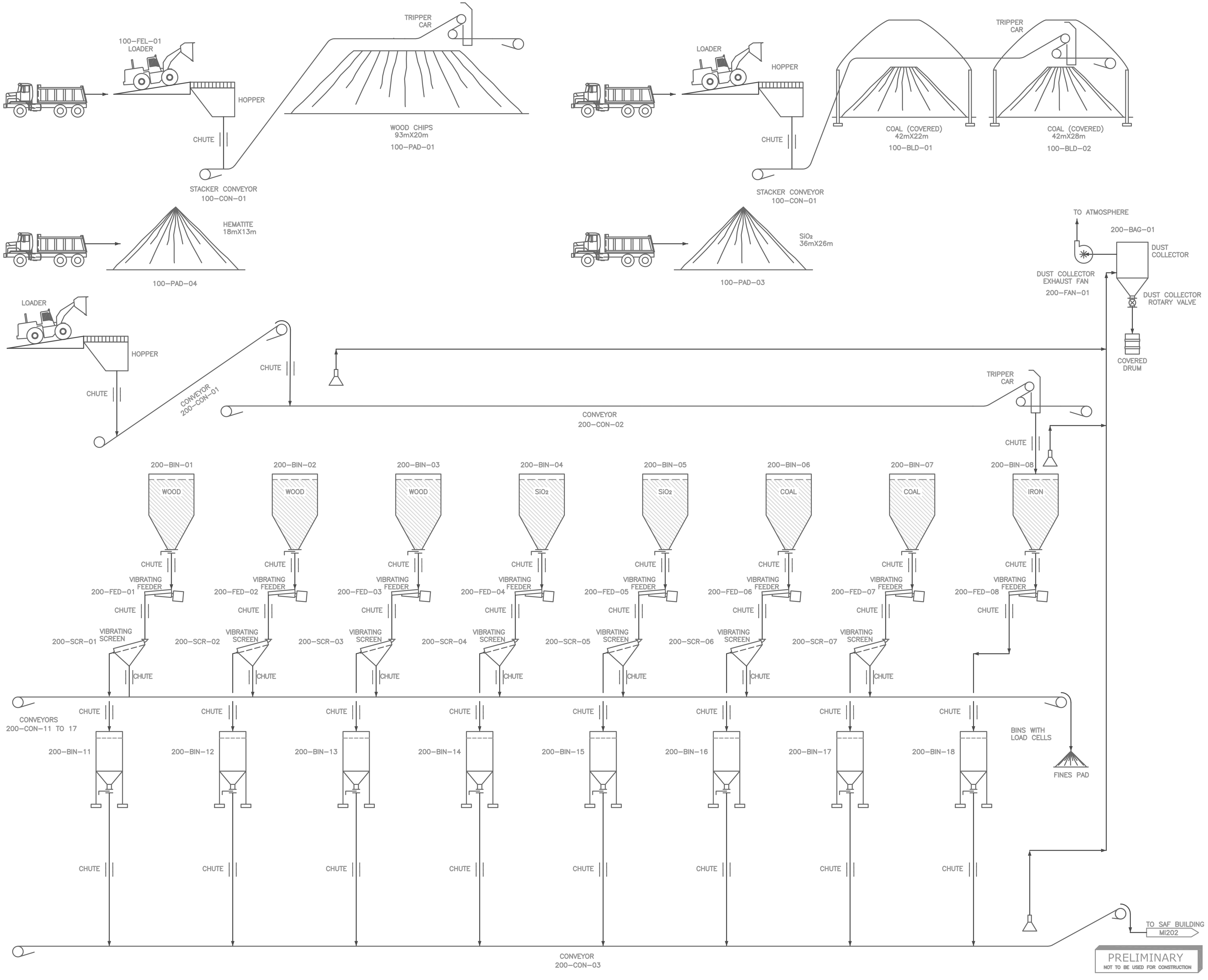
GM 42387—ETUDE ENVIRONNEMENTALE DU PROJET DE MISE EN PRODUCTION DU GITE DE SILICE DE MATANE. 1984, Par ARLEAU, R A. 76 pages. 3 cartes. 3 microfiches.

GM 40477—RAPPORT SUR LA SILICE DE MATANE, CANTONS DE LANGIS & TESSIER. 1983, Par MARLEAU, RA, CLOUTIER, G H. 247 pages. 4 cartes. 6 microfiches.

GM 36008—A COMPARATIVE STUDY IN REGARD TO OTHER COMMERCIAL SILICA/SANDS OF NORTHEASTERN AMERICA. 1979, Par MARLEAU, R A, CLOUTIER, G H, BELANGER, P, PLUMPTON, A J. 89 pages. 5 cartes. 3 microfiches.

Appendix A:

Drawings



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REVISION

No.	Date	Description	By
A	18-03-12	ÉMIS POUR INFORMATION	M.A.B.

NOTE

NOTE TO USER

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1:100 = 0 1 2

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PROJECT

CANADIAN METALS INC.
LANGIS PROJECT
PRE-FEASABILITY STUDY

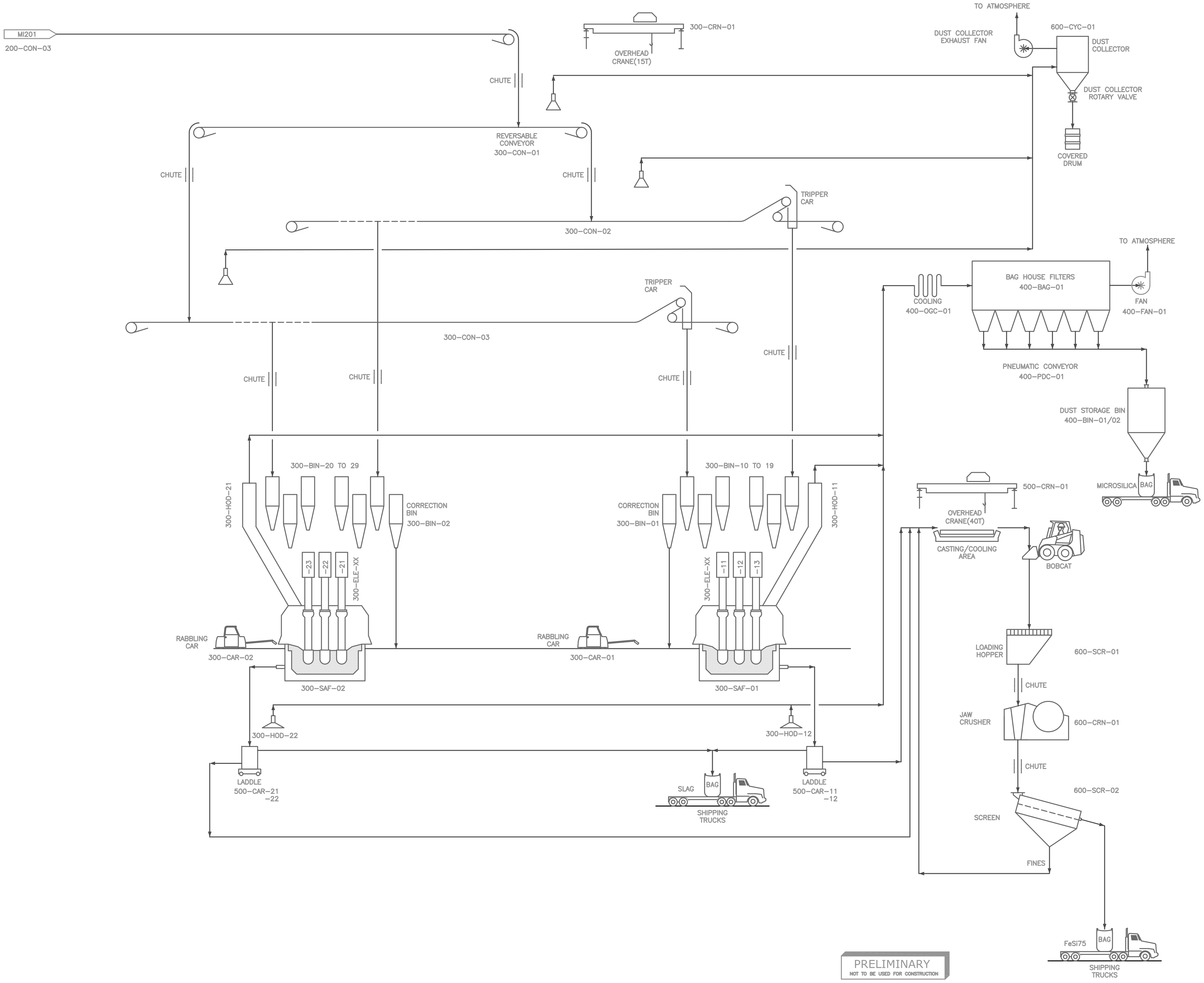
DRAWING TITLE

CANADIAN METALS
PRE-FEASABILITY STUDY
SIMPLIFIED FLOWSHEET

Drawn : PAUL LATREILLE	CIMA+ File no. : FILE No.	Customer no. : CUSTOMER No.
Prepared : PAUL LATREILLE	Scale : 1:1	Drawing no. : MI201
Verified : MICHEAL TREMBLAY	Date : 2018-02-12	Of : 1-2
Speciality : PROCESS		

CAD FILE. = MI201.DWG

ACAD2000 – LAYERS AICQ–2002



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REVISION

No.	Date	Description	By
A	18–03–12	ÉMIS POUR INFORMATION	M.A.B.

NOTE

NOTE TO USER

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1:100 = 0 1 2

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DRAWING TITLE

CANADIAN METALS
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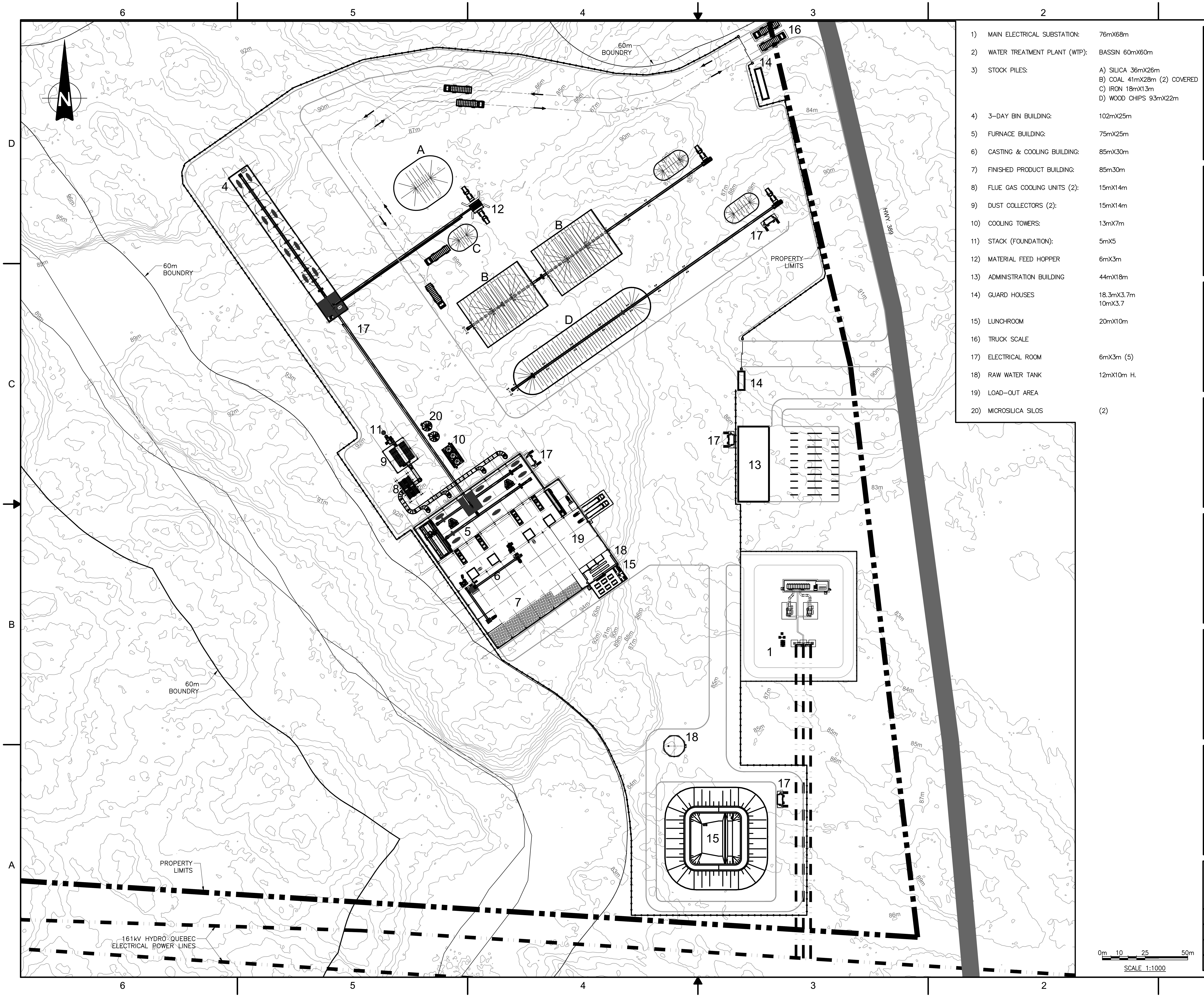
SIMPLIFIED FLOWSHEET

Drawn : PAUL LATREILLE	CIMA+ File no. : FILE No.	Customer no. : CUSTOMER No.
Prepared : PAUL LATREILLE	Scale : 1:1	Drawing no. : MI202
Verified : MICHEAL TREMBLAY	Date : 2018–02–12	Of : 2–2
Speciality : PROCESS		

CAD FILE. = MI202.DWG

ACAD2000 – LAYERS AICQ–2002



1)	MAIN ELECTRICAL SUBSTATION:	76mX68m
2)	WATER TREATMENT PLANT (WTP):	BASSIN 60mX60m
3)	STOCK PILES:	A) SILICA 36mX26m B) COAL 41mX28m (2) COVERED C) IRON 18mX13m D) WOOD CHIPS 93mX22m
4)	3-DAY BIN BUILDING:	102mX25m
5)	FURNACE BUILDING:	75mX25m
6)	CASTING & COOLING BUILDING:	85mX30m
7)	FINISHED PRODUCT BUILDING:	85m30m
8)	FLUE GAS COOLING UNITS (2):	15mX14m
9)	DUST COLLECTORS (2):	15mX14m
10)	COOLING TOWERS:	13mX7m
11)	STACK (FOUNDATION):	5mX5
12)	MATERIAL FEED HOPPER	6mX3m
13)	ADMINISTRATION BUILDING	44mX18m
14)	GUARD HOUSES	18.3mX3.7m 10mX3.7
15)	LUNCHROOM	20mX10m
16)	TRUCK SCALE	
17)	ELECTRICAL ROOM	6mX3m (5)
18)	RAW WATER TANK	12mX10m H.
19)	LOAD-OUT AREA	
20)	MICROSILICA SILOS	(2)

REVISION

No.	Date	Description	By
B	18-04-XX	ISSUED POUR PRE-FEASABILITY STUDY	X.X.
A	18-03-14	ISSUED FOR INFORMATION	P.L.

NOTE

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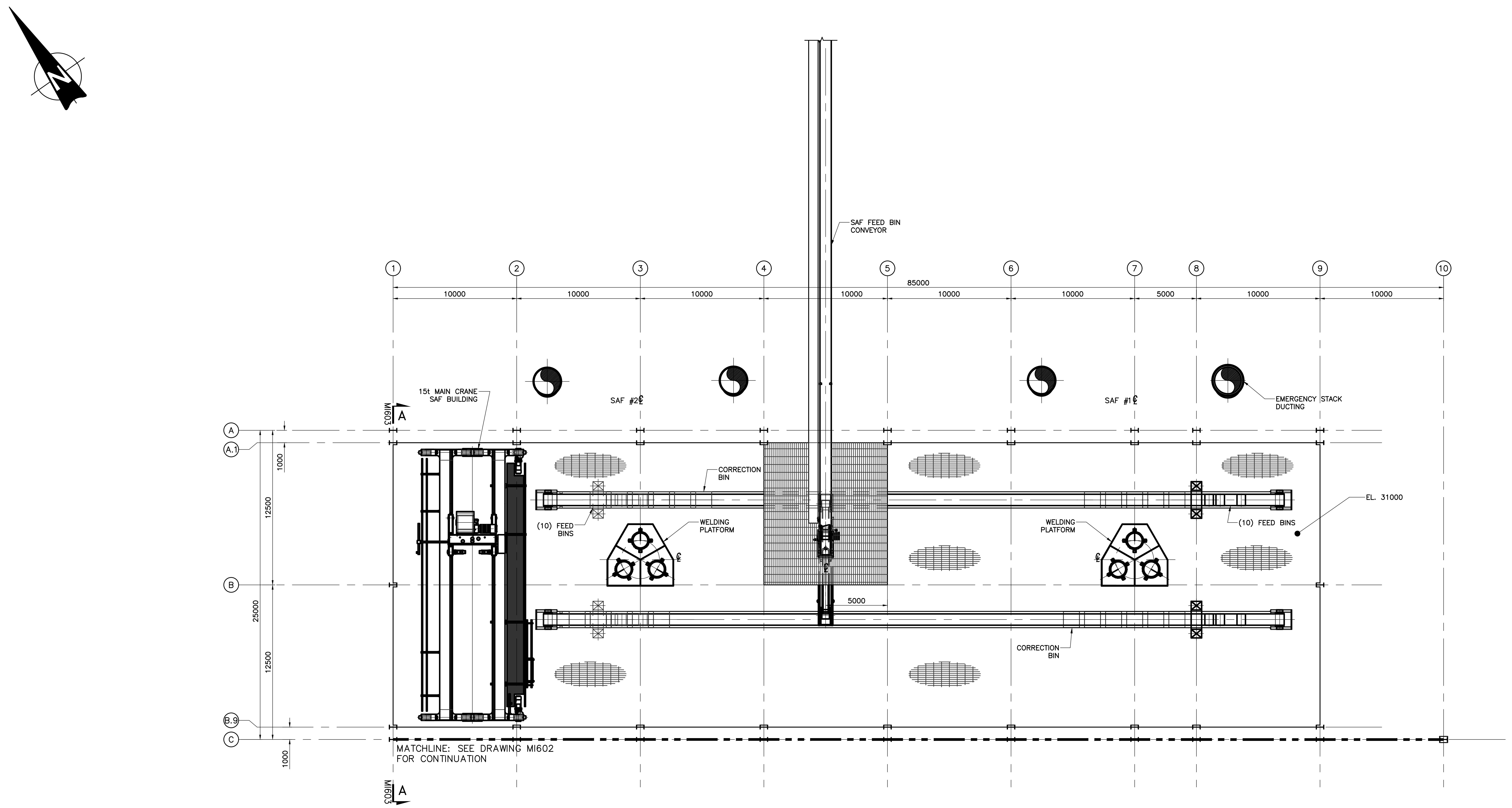
DRAWING TITLE

PLAN VIEW
PROCESS FACILITIES
SITE LAYOUT

Drawn : PAUL LATREILLE
CIMA+ File no. : FILE No.
Customer no. : CUSTOMER No.
Prepared : PAUL LATREILLE
Scale : SCALE
Drawing no. : MI302
Verified : MICHEAL TREMBLAY
Date : 2018-02-14
Of : 1-1
Speciality : MECHANICAL

CAD FILE. = MI302.DWG

ACAD2000 - LAYERS AICQ-2002



PLAN VIEW
EL: 31000

REVISION

No.	Date	Description	By
A	18-04-XX	ISSUED POUR PRE-FEASABILITY STUDY	X.X.

NOTE

NOTE TO USER

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1:25 = 0 .5
1:50 = 0 1
1:100 = 0 1 2

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PROJECT

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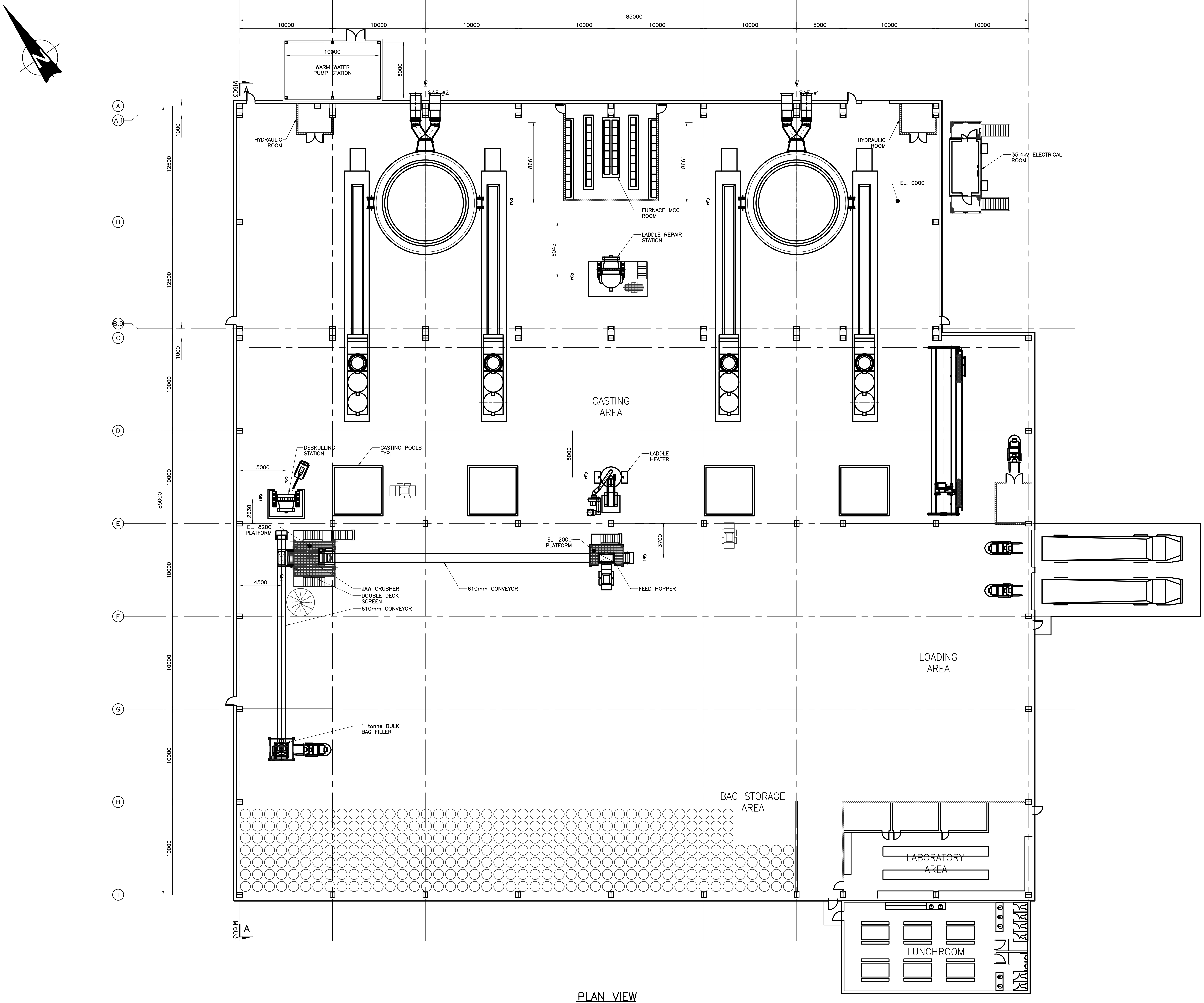
PRE-FEASABILITY STUDY

DRAWING TITLE
35MW ARC FURNACES
FEED BIN FLOOR
PLAN VIEW

Drawn : PAUL LATREILLE	CIMA+ File no. : FILE No.	Customer no. : CUSTOMER No.
Prepared : PAUL LATREILLE	Scale : 1=200	Drawing no. : MI601
Verified : MICHEAL TREMBLAY	Date : 2018-02-19	Of : 1—1
Speciality : MECHANICAL		

CAD FILE. = MI601.DWG

ACAD2000 — LAYERS AICQ—2002



PLAN VIEW
EL:

REVISION

No.	Date	Description	By
A	18-04-XX	ISSUED POUR PRE-FEASABILITY STUDY	X.X.

NOTE

NOTE TO USER

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1:50 = 0 1
1:100 = 0 1 2

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PRE-FEASABILITY STUDY

DRAWING TITLE
35MW ARC FURNACES, CASTING AND
COOLING & FINISHED PRODUCT BLDG'S
GROUND FLOOR PLAN VIEW

Drawn : PAUL LATREILLE	CIMA+ File no. : FILE No.	Customer no. : CUSTOMER No.
Prepared : PAUL LATREILLE	Scale : 1=200	Drawing no. : MI602
Verified : MICHEAL TREMBLAY	Date : 2018-02-19	Of : 1-1
Speciality : MECHANICAL		

CAD FILE. = MI602.DWG

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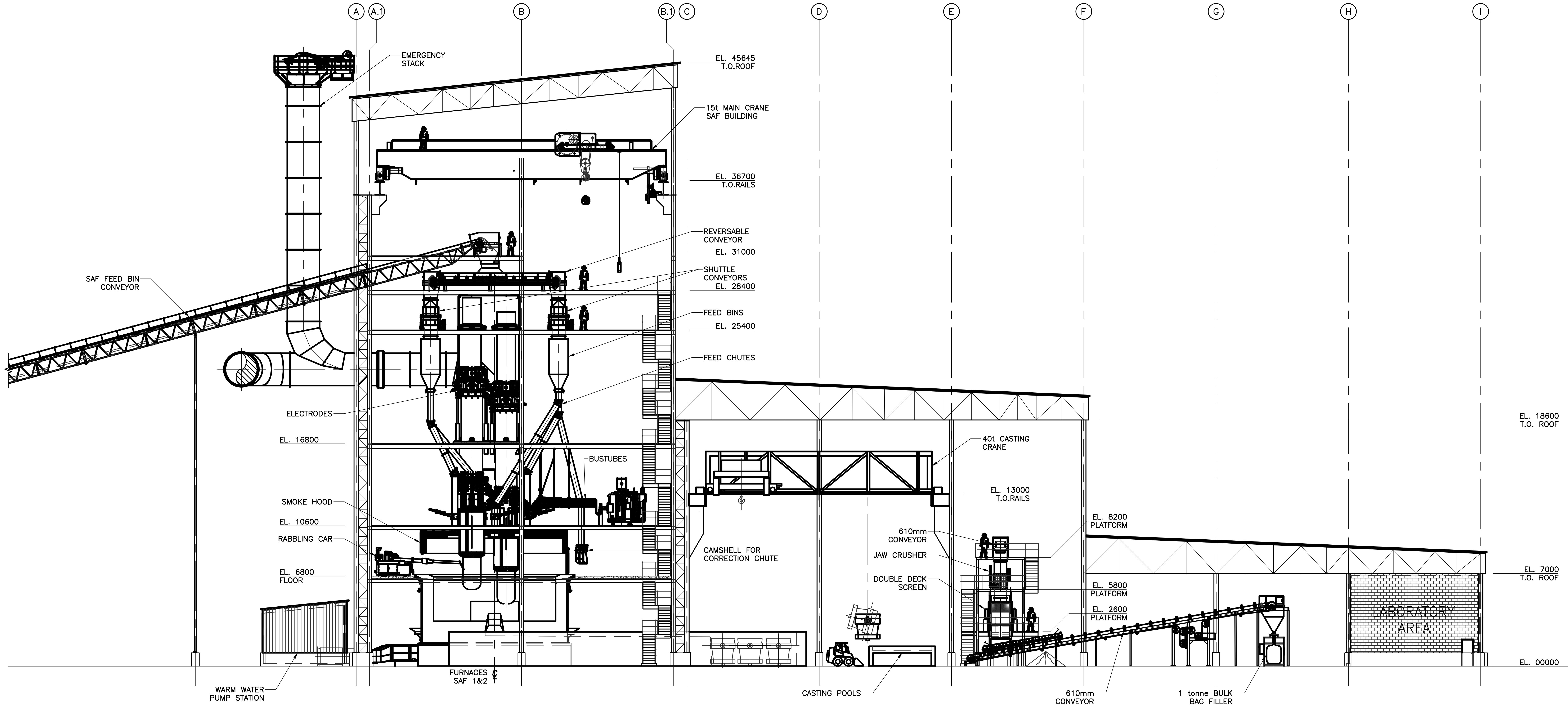

SECTION A–A
EL:

REVISION

A	18–04–XX	ISSUED POUR PRE–FEASABILITY STUDY	X.X.
No.	Date	Description	By

NOTE

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1:50 = 0 1
1:100 = 0 1 2

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DRAWING TITLE
35MW ARC FURNACES, CASTING AND
COOLING & FINISHED PRODUCT BLDG'S
SECTION A–A

Drawn : PAUL LATREILLE	CIMA+ File no. : FILE No.	Customer no. : CUSTOMER No.
Prepared : PAUL LATREILLE	Scale : 1=200	Drawing no. : MI603
Verified : MICHEAL TREMBLAY	Date : 2018–03–07	Of : 1–1
Speciality : MECHANICAL		

CAD FILE. = MI603.DWG

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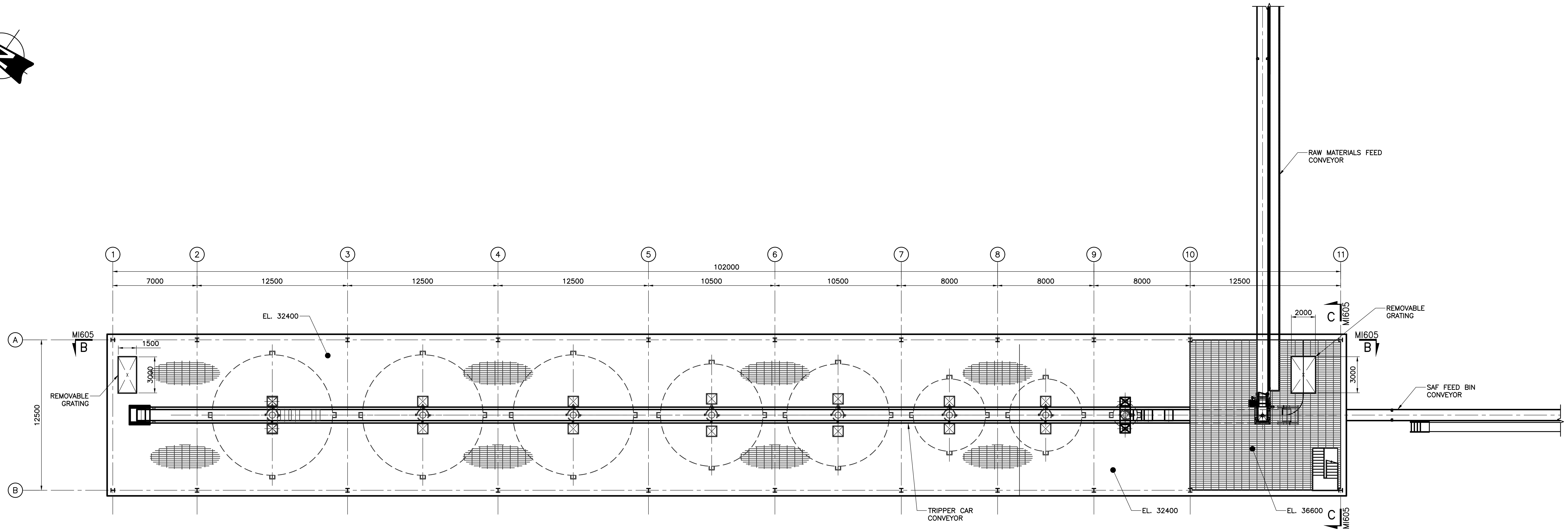
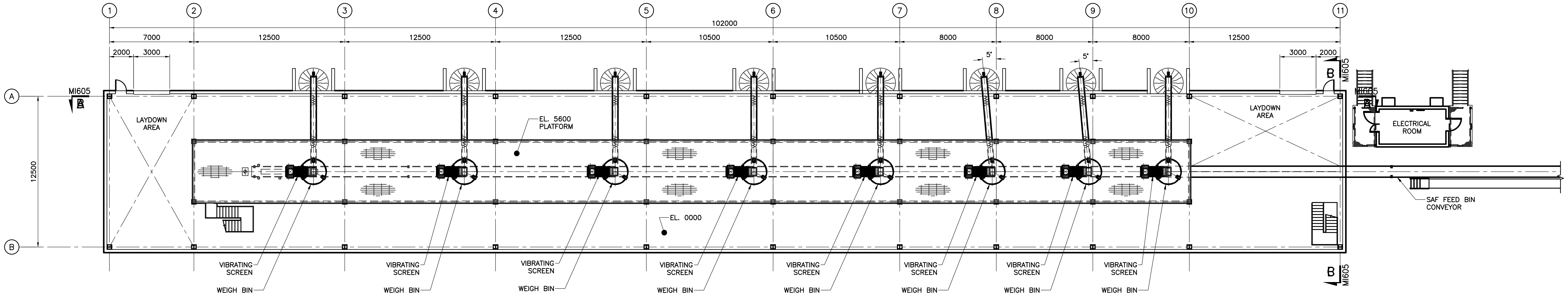


TRIPPER CONVEYOR PLAN VIEW
EL: 36600



CONVEYOR LOADING PLAN VIEW
EL: 5600 PLATFORM

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REVISION

No.	Date	Description	By
A	18–04–XX	ISSUED POUR PRE–FEASABILITY STUDY	X.X.

NOTE

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1:50 = 0 1
1:100 = 0 1 2

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PROJECT

CANADIAN METALS INC.
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PRE-FEASABILITY STUDY

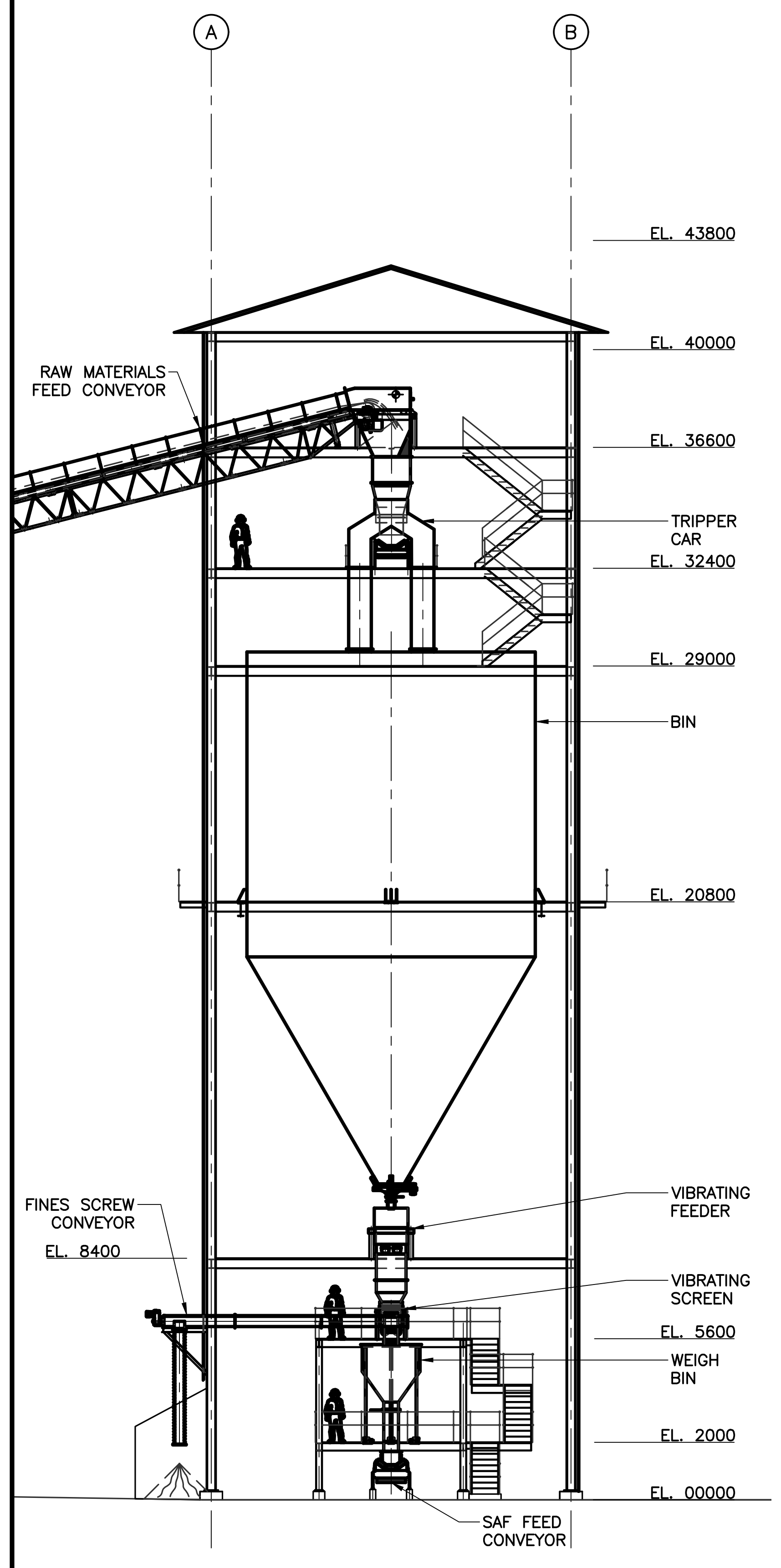
DRAWING TITLE

LOADING & BIN HOUSE BUILDING
PLAN VIEW

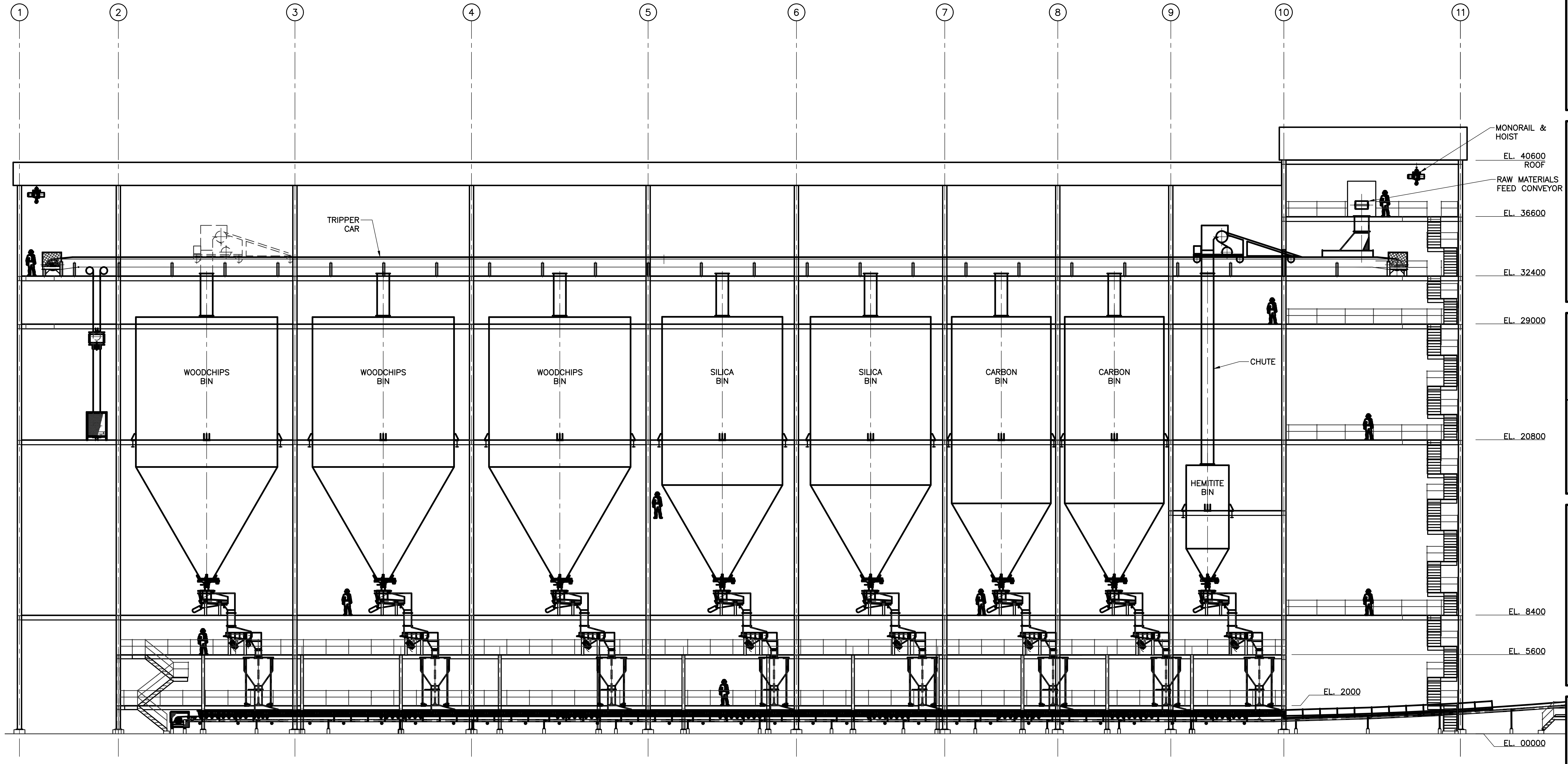
Drawn : PAUL LATREILLE	CIMA+ File no. : FILE No.	Customer no. : CUSTOMER No.
Prepared : PAUL LATREILLE	Scale : 1=200	Drawing no. : MI604
Verified : MICHEAL TREMBLAY	Date : 2018–03–07	Of : 1–1
Speciality : MECHANICAL		

CAD FILE. = MI604.DWG

ACAD2000 – LAYERS AICQ–2002



SECTION C–C
EL:



SECTION B–B
EL:

REVISION

No.	Date	Description	By
A	18–04–XX	ISSUED POUR PRE–FEASABILITY STUDY	X.X.

NOTE

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PROJECT

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LANGIS PROJECT
PRE-FEASABILITY STUDY

DRAWING TITLE

LOADING & BIN HOUSE BUILDING
SECTIONS B–B & C–C

Drawn : PAUL LATREILLE
CIMA+ File no. : FILE No.
Customer no. : CUSTOMER No.
Prepared : PAUL LATREILLE
Scale : 1=200
Drawing no. : MI605
Verified : MICHEAL TREMBLAY
Date : 2018–03–07
Of : 1–1
Speciality : MECHANICAL

CAD FILE. = MI605.DWG

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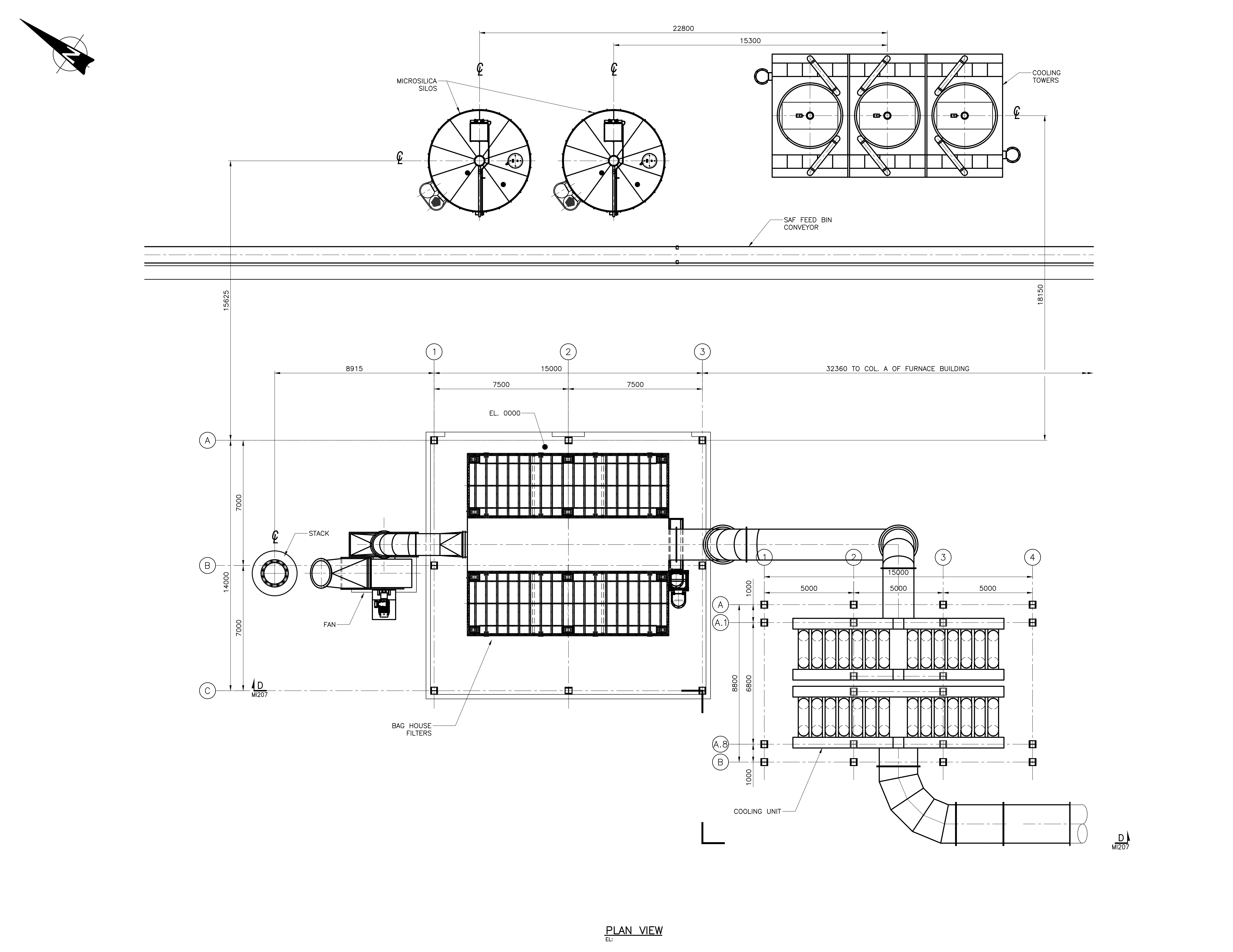

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No.	Date	Description	By
A	18-04-XX	ISSUED POUR PRE-FEASABILITY STUDY	X.X.

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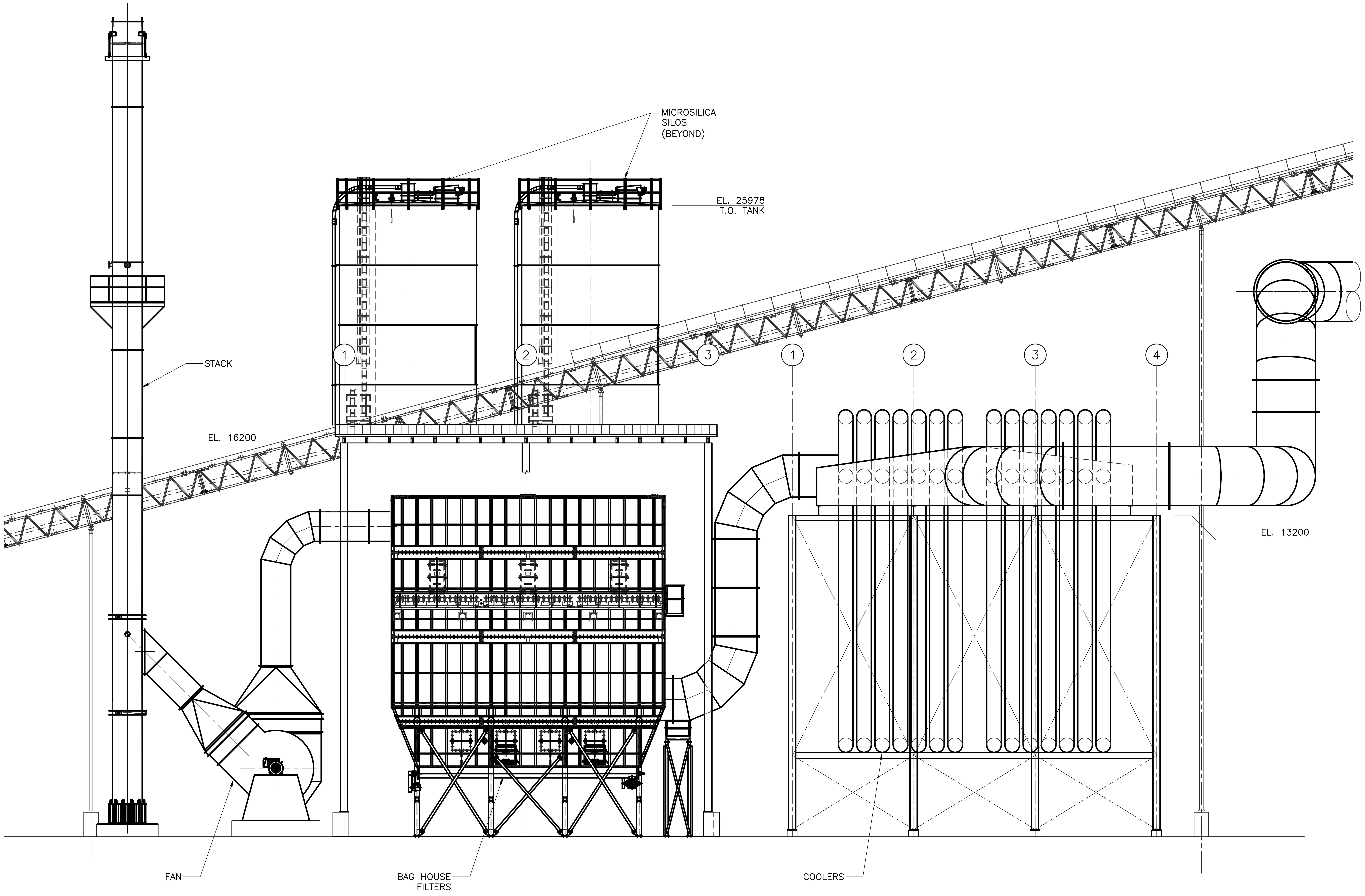
DRAWING TITLE

OFF-GAS TREAMENT BUILDING
PLAN VIEW

Drawn : PAUL LATREILLE	CIMA+ File no. : FILE No.	Customer no. : CUSTOMER No.
Prepared : PAUL LATREILLE	Scale : 1=100	Drawing no. : MI606
Verified : MICHEAL TREMBLAY	Date : 2018-03-29	Of : 1-1
Speciality : MECHANICAL		

CAD FILE. = MI606.DWG

ACAD2000 – LAYERS AICQ–2002



SECTION D–D
EL:

REVISION

No.	Date	Description	By
A	18–04–XX	ISSUED POUR PRE–FEASABILITY STUDY	X.X.

NOTE

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DRAWING TITLE

OFF–GAS TREAMENT BUILDING
SECTION D–D

Drawn : PAUL LATREILLE	CIMA+ File no. : FILE No.	Customer no. : CUSTOMER No.
Prepared : PAUL LATREILLE	Scale : 1=100	Drawing no. : MI607
Verified : MICHEAL TREMBLAY	Date : 2018–03–07	Of : 1–1
Speciality : MECHANICAL		

CAD FILE. = MI607.DWG

ACAD2000 – LAYERS AICQ–2002

Appendix B:

Labour Table

MAN POWER COST

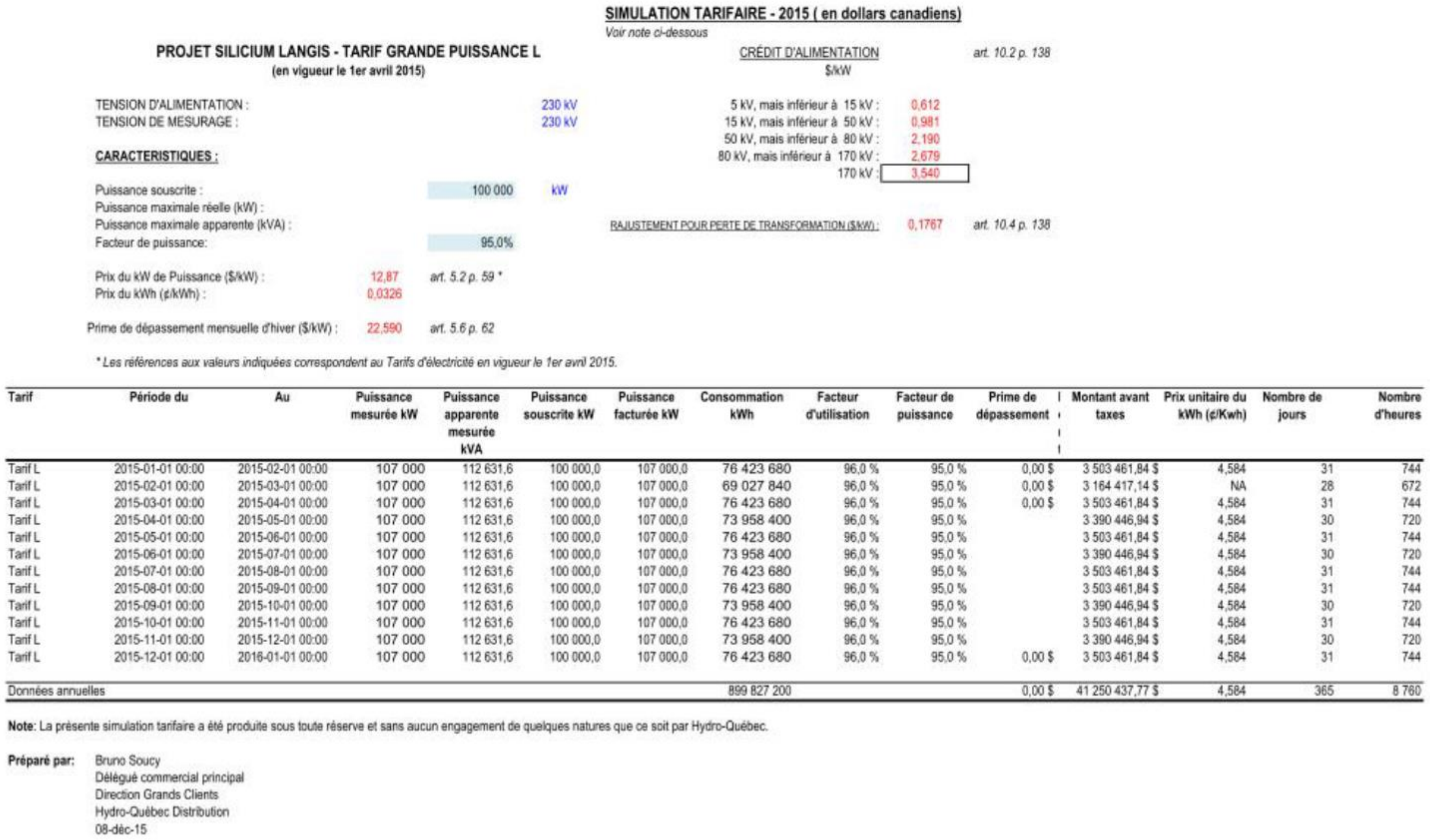
PRE-FEASIBILITY STUDY

PROCESS FACILITIES Hourly Staff	TOTAL REQUIRED	SELECTED BASE RATE	BASE HOURS PER YEAR	YEARLY RATE	VACATIONS	FRINGE BENEFITS	YEARLY COST	TOTAL ANNUAL COSTS
Furnace Operation					*6%*	*30%*		
STAFF:								
Plant Superintendent	1			$ 110 000	6 600	33 000	$ 149 600	$ 149 600
Senior Metallurgist	1			$ 105 000	6 300	31 500	$ 142 800	$ 142 800
Metallurgist	1			$ 80 000	4 800	24 000	$ 108 800	$ 108 800
Metallurgical technician	1			$ 63 000	3 780	18 900	$ 85 680	$ 85 680
General Op. Foreman	1			$ 85 000	5 100	25 500	$ 115 600	$ 115 600
Chief chemist	1			$ 80 000	4 800	24 000	$ 108 800	$ 108 800
Lab technicians (Assay Lab)	4			$ 63 000	3 780	18 900	$ 85 680	$ 342 720
Sample prep	4			$ 50 000	3 000	15 000	$ 68 000	$ 272 000
Plant trainer	1			$ 80 000	4 800	24 000	$ 108 800	$ 108 800
Clerk	1			$ 42 000	2 520	12 600	$ 57 120	$ 57 120
HOURLY:								
Shift supervisor	4	32,00	2 184	$ 69 888	4 193	20 966	$ 95 048	$ 380 191
Furnace Operator	36	29,00	2 184	$ 63 336	3 800	19 001	$ 86 137	$ 3 100 931
Control room	incl furnace operator							
Furnace feed	incl furnace operator							
Casting	incl furnace operator							
Unloading raw materials	4	26,00	2 184	$ 56 784	3 407	17 035	$ 77 226	$ 308 905
FeSiO2 crushing	4	26,00	2 184	$ 56 784	3 407	17 035	$ 77 226	$ 308 905
Product shipment	4	26,00	2 184	$ 56 784	3 407	17 035	$ 77 226	$ 308 905
Helpers/labour	8	22,00	2 184	$ 48 048	2 883	14 414	$ 65 345	$ 522 762
Production Loader Operator	8	27,00	2 184	$ 58 968	3 538	17 690	$ 80 196	$ 641 572
								$ -
MAINTENANCE STAFF:								
Mill Mechanical foreman	1			$ 85 000	5 100	25 500	$ 115 600	$ 115 600
Mill Maintenance planner	2			$ 70 000	4 200	21 000	$ 95 200	$ 190 400
Electrical foreman	1			$ 85 000	5 100	25 500	$ 115 600	$ 115 600
MAINTENANCE HOURLY:								
Mechanical leader	4	29,00	2 184	$ 63 336	3 800	19 001	$ 86 137	$ 344 548
Electrcial leader	4	31,00	2 184	$ 67 704	4 062	20 311	$ 92 077	$ 368 310
Mechanics	12	26,00	2 184	$ 56 784	3 407	17 035	$ 77 226	$ 926 715
Electricians	6	28,00	2 184	$ 61 152	3 669	18 346	$ 83 167	$ 499 000
Instrument Technician	2	31,00	2 184	$ 67 704	4 062	20 311	$ 92 077	$ 184 155
Helpers	2	22,00	2 184	$ 48 048	2 883	14 414	$ 65 345	$ 130 691
Sub-Total Hydromet	***118***							**$ 9 939 108**
TOTAL PER TONNE SiO2 PROCESSED ($/t)								**76,64**

ADMINISTRATION Yearly Staff	TOTAL REQUIRED	SELECTED BASE RATE	BASE HOURS PER YEAR	YEARLY RATE	VACATIONS	FRINGE BENEFITS	YEARLY COST	TOTAL ANNUAL COSTS
Administration					*6%*	*30%*		
General Manager	1			$ 120 000	7 200	36 000	$ 163 200	$ 163 200
Administrative Superintendant	1			$ 105 000	6 300	31 500	$ 142 800	$ 142 800
Accountant	1			$ 77 000	4 620	23 100	$ 104 720	$ 104 720
Clerk	1			$ 42 000	2 520	12 600	$ 57 120	$ 57 120
Administrative Assistant	1			$ 57 000	3 420	17 100	$ 77 520	$ 77 520
Human Resources Officer	1			$ 90 000	5 400	27 000	$ 122 400	$ 122 400
Regional Public Relation Coordinator	1			$ 85 000	5 100	25 500	$ 115 600	$ 115 600
First Aid Attendant	2			$ 52 000	3 120	15 600	$ 70 720	$ 141 440
IT Technologist	2			$ 55 000	3 300	16 500	$ 74 800	$ 149 600
Health and Safety	1			$ 90 000	5 400	27 000	$ 122 400	$ 122 400
Senior Environmental Engineer	1			$ 105 000	6 300	31 500	$ 142 800	$ 142 800
Environmental Monitor	1			$ 63 000	3 780	18 900	$ 85 680	$ 85 680
Purchasing Officer	1			$ 85 000	5 100	25 500	$ 115 600	$ 115 600
Warehouse Supervisor	1			$ 65 000	3 900	19 500	$ 88 400	$ 88 400
Warehouse crew	2			$ 43 000	2 580	12 900	$ 58 480	$ 116 960
Surface crew operator and logistic	1	22,00	2 184	$ 48 048	2 883	14 414	$ 65 345	$ 65 345
Sub-Total Administration	**19**							**$ 1 811 585**
TOTAL PER TONNE SiO2 PROCESSED ($/t)								**13,97**
TOTAL MAN POWER	**137**							**$ 11 750 694**
TOTAL PER TONNE SiO2 PROCESSED (($/tonne)								90,60
TOTAL PER TONNE FeSi75 (($/tonne)								163,09

Appendix C:

Hydro-Québec Power Rates Simulation



SIMULATION TARIFAIRE - 2015 (en dollars canadiens)

Voir note ci-dessous

PROJET SILICIUM LANGIS - TARIF GRANDE PUISSANCE L

(en vigueur le 1er avril 2015)

TENSION D'ALIMENTATION : 230 kV
TENSION DE MESURAGE : 230 kV

CARACTERISTIQUES :

Puissance souscrite : 100 000 kW
Puissance maximale réelle (kW) :
Puissance maximale apparente (kVA) :
Facteur de puissance: 95,0%

Prix du kW de Puissance ($/kW) : 12,87 *art. 5.2 p. 59 **
Prix du kWh (¢/kWh) : 0,0326

Prime de dépassement mensuelle d'hiver ($/kW) : 22,590 *art. 5.6 p. 62*

CRÉDIT D'ALIMENTATION *art. 10.2 p. 138*

$/kW	
5 kV, mais inférieur à 15 kV :	0,612
15 kV, mais inférieur à 50 kV :	0,981
50 kV, mais inférieur à 80 kV :	2,190
80 kV, mais inférieur à 170 kV :	2,679
170 kV :	3,540

RAJUSTEMENT POUR PERTE DE TRANSFORMATION ($/kW) : 0,1767 *art. 10.4 p. 138*

** Les références aux valeurs indiquées correspondent au Tarifs d'électricité en vigueur le 1er avril 2015.*

Tarif	Période du	Au	Puissance mesurée kW	Puissance apparente mesurée kVA	Puissance souscrite kW	Puissance facturée kW	Consommation kWh	Facteur d'utilisation	Facteur de puissance	Prime de dépassement	Montant avant taxes	Prix unitaire du kWh (¢/Kwh)	Nombre de jours	Nombre d'heures
Tarif L	2015-01-01 00:00	2015-02-01 00:00	107 000	112 631,6	100 000,0	107 000,0	76 423 680	96,0 %	95,0 %	0,00 $	3 503 461,84 $	4,584	31	744
Tarif L	2015-02-01 00:00	2015-03-01 00:00	107 000	112 631,6	100 000,0	107 000,0	69 027 840	96,0 %	95,0 %	0,00 $	3 164 417,14 $	NA	28	672
Tarif L	2015-03-01 00:00	2015-04-01 00:00	107 000	112 631,6	100 000,0	107 000,0	76 423 680	96,0 %	95,0 %	0,00 $	3 503 461,84 $	4,584	31	744
Tarif L	2015-04-01 00:00	2015-05-01 00:00	107 000	112 631,6	100 000,0	107 000,0	73 958 400	96,0 %	95,0 %		3 390 446,94 $	4,584	30	720
Tarif L	2015-05-01 00:00	2015-06-01 00:00	107 000	112 631,6	100 000,0	107 000,0	76 423 680	96,0 %	95,0 %		3 503 461,84 $	4,584	31	744
Tarif L	2015-06-01 00:00	2015-07-01 00:00	107 000	112 631,6	100 000,0	107 000,0	73 958 400	96,0 %	95,0 %		3 390 446,94 $	4,584	30	720
Tarif L	2015-07-01 00:00	2015-08-01 00:00	107 000	112 631,6	100 000,0	107 000,0	76 423 680	96,0 %	95,0 %		3 503 461,84 $	4,584	31	744
Tarif L	2015-08-01 00:00	2015-09-01 00:00	107 000	112 631,6	100 000,0	107 000,0	76 423 680	96,0 %	95,0 %		3 503 461,84 $	4,584	31	744
Tarif L	2015-09-01 00:00	2015-10-01 00:00	107 000	112 631,6	100 000,0	107 000,0	73 958 400	96,0 %	95,0 %		3 390 446,94 $	4,584	30	720
Tarif L	2015-10-01 00:00	2015-11-01 00:00	107 000	112 631,6	100 000,0	107 000,0	76 423 680	96,0 %	95,0 %		3 503 461,84 $	4,584	31	744
Tarif L	2015-11-01 00:00	2015-12-01 00:00	107 000	112 631,6	100 000,0	107 000,0	73 958 400	96,0 %	95,0 %		3 390 446,94 $	4,584	30	720
Tarif L	2015-12-01 00:00	2016-01-01 00:00	107 000	112 631,6	100 000,0	107 000,0	76 423 680	96,0 %	95,0 %	0,00 $	3 503 461,84 $	4,584	31	744
Données annuelles							899 827 200			0,00 $	41 250 437,77 $	4,584	365	8 760

Note: La présente simulation tarifaire a été produite sous toute réserve et sans aucun engagement de quelques natures que ce soit par Hydro-Québec.

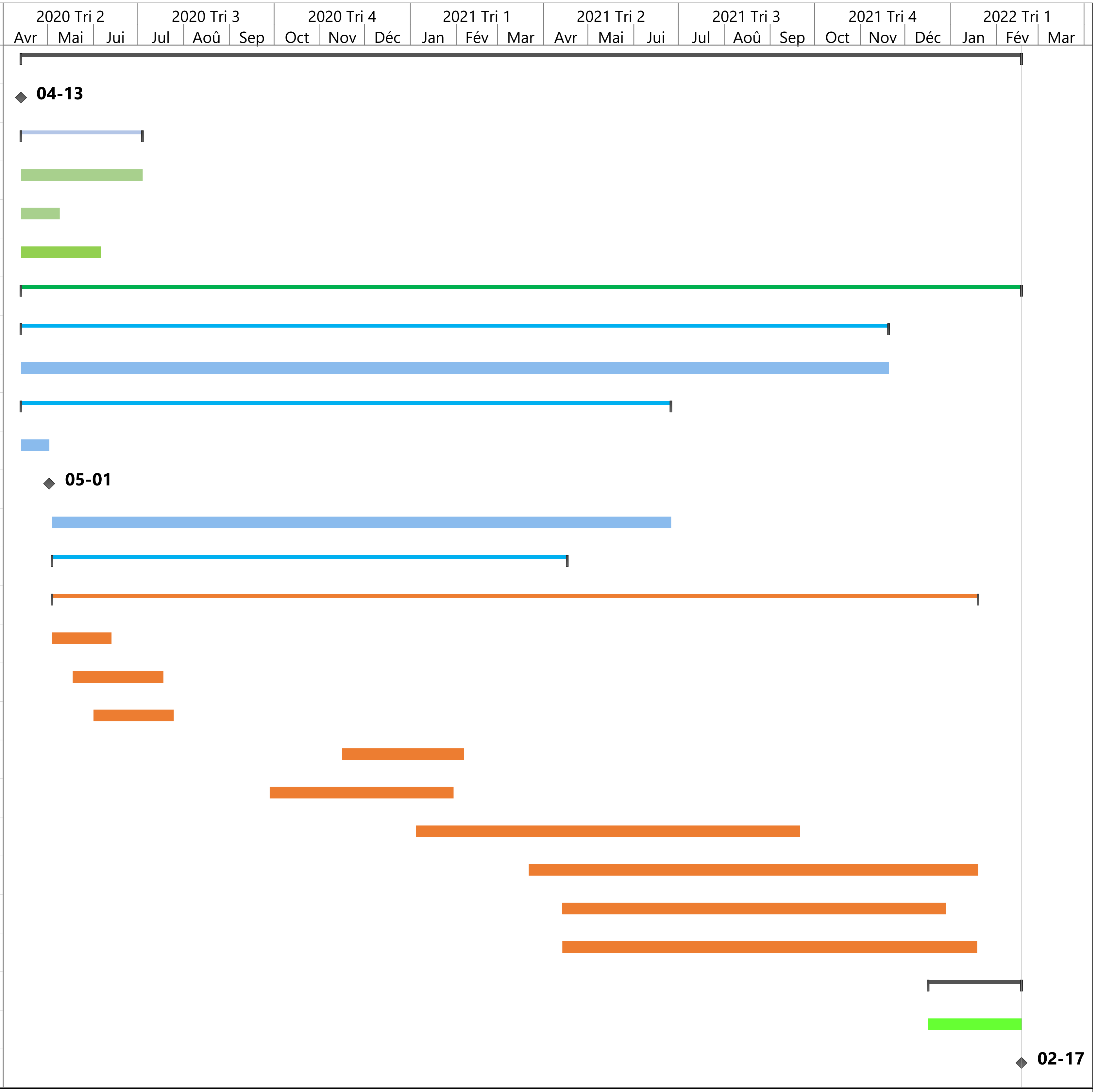
Préparé par: Bruno Soucy
Délégué commercial principal
Direction Grands Clients
Hydro-Québec Distribution
08-déc-15

These rates were used as a base of estimate only.

Appendix D:

Schedules

N°	N°	Nom de la tâche	Durée	Début	Fin
1	**1**	**TOTAL PROJECT DURATION**	**84.68 sm**	**Lun 20-04-13**	**Jeu 22-02-17**
2	2	Green LIGHT - PROJECT START	0 sm	Lun 20-04-13	Lun 20-04-13
3	**3**	**Geotechnical & Front End Engineering**	**10.5 sm**	**Lun 20-04-13**	**Ven 20-07-03**
4	4	Geotechnical Works	52.5 jours	Lun 20-04-13	Ven 20-07-03
5	5	Project Scheduling & WBS Package Definition	17.5 jours	Lun 20-04-13	Ven 20-05-08
6	6	Contract Definition with Main OEM	35 jours	Lun 20-04-13	Ven 20-06-05
7	**7**	**PROJECT PERIOD**	**84.68 sm**	**Lun 20-04-13**	**Jeu 22-02-17**
8	**8**	**Detailed Engineering & Procurement**	**73.5 sm**	**Lun 20-04-13**	**Ven 21-11-19**
9	9	Detailed Engineering	367.5 jours	Lun 20-04-13	Ven 21-11-19
10	**10**	**Main OEM Equipement Supplier**	**55.13 sm**	**Lun 20-04-13**	**Ven 21-06-25**
11	11	Final Negotiations with Main OEM	13.13 jours	Lun 20-04-13	Ven 20-05-01
12	12	Main OEM Contract Award	0 sm	Ven 20-05-01	Ven 20-05-01
13	13	Main OEM Engineering	262.5 jours	Lun 20-05-04	Ven 21-06-25
14	**14**	**Secondary Equipment Definition & Sourcing**	**43.75 sm**	**Lun 20-05-04**	**Ven 21-04-16**
16	**16**	**Construction**	**78.25 sm**	**Lun 20-05-04**	**Mer 22-01-19**
17	17	Surveying	26.25 jours	Lun 20-05-04	Ven 20-06-12
18	18	Initial Site Work	39.38 jours	Lun 20-05-18	Ven 20-07-17
19	19	Underground Work	35 jours	Lun 20-06-01	Ven 20-07-24
20	20	Foundation Contract	52.5 jours	Lun 20-11-16	Ven 21-02-05
21	21	Steel Fabrication	78.75 jours	Lun 20-09-28	Ven 21-01-29
22	22	Steel Erection	161.88 jours	Mar 21-01-05	Lun 21-09-20
23	23	Mecanical Erection of OEM Equipment	190 jours	Lun 21-03-22	Mer 22-01-19
24	24	Mechanical Erection of Secondary Equipment	161.88 jours	Mar 21-04-13	Mar 21-12-28
25	25	Electrical & Instrumentation Installation	175 jours	Mar 21-04-13	Mar 22-01-18
26	**26**	**VPO & Start-Up**	**7.88 sm**	**Jeu 21-12-16**	**Jeu 22-02-17**
27	27	VPO & Equipment Testing	39.38 jours	Jeu 21-12-16	Jeu 22-02-17
28	28	Continuous Operation of System	0 sm	Jeu 22-02-17	Jeu 22-02-17



Projet : Project Schedule REV G
Date : Lun 18-05-28

Tâche		Récapitulatif du projet		Tâche manuelle		Début uniquement	[	Échéance	⬇
Fractionnement		Tâche inactive		Durée uniquement		Fin uniquement	]	Avancement	
Jalon	◆	Jalon inactif	◇	Report récapitulatif manuel		Tâches externes		Progression manuelle	
Récapitulative		Récapitulatif inactif		Récapitulatif manuel		Jalons externes	◆		

Appendix E:

Fiscal Model

LANGIS PROJECT PFS – Canadian Metals Inc.

PURPOSE: List the main assumptions on whitch the present Tax Model is based.

1.0 General assumptions

1.1- Project

a) It is assumed that the Project will be exploited by a Corporation;

b) It is assummed that each Financial Period of the Corporation will end on December 31;

c) It is assumed that construction would be in 2017 (year-2) and 2018 (year -1);

d) It is assumed that the Project would come into operation in 2019 (corresponding to year 1);

e) In the present Model it is assumed that no interest is paid. If interest was paid, it would be deductible for income tax purposes but not for mining taxes;

f) In the present Model it is understood that a royalty is paid. Such royalty is deductible for income tax purposes but not for mining taxes;

g) For mining taxes, it is assumed that Restauration Trust Fund payments will start in year #2 (and not in year -1), a timimg that allows for better deductibility of these payments, because a "loss" cannot be carried forward to another year.
N.B.: We understand that the Quebec Mining Association has written to Ressources Naturelles Québec in respect of this problem and we assume that a solution permitting full deductibility will be found.

h) It is assumed that closing costs will be equal to the amounts paid into the Restauration Trust Fund and that closing costs will be paid in year 26;

i) It is assumed the Restauration Trust Fund will be recuperated in same year 26.

1.2 - Income tax (federal & Quebec)

a) It is assumed that the general Corporation tax rate will apply;

b) It is assumed that the Project qualifies as a "mineral resource" for the purpose of the federal and Quebec income tax calculation;

c) It is assumed that the corporate federal tax rate of 15% that is currently applicable wil remain unchanged during the Project's operating life;

d) It is assumed that the Quebec corporate tax rate, currently at 11.9% will decrease by 0.1% per year from 2017 to 2020, thus reaching 11.5% and remaining unchanged for the rest of the Project's life.

e) It is assumed that the Quebec capital tax will remained eliminated;

f) Tax depreciation: The "half-year rule" is considered in the simulation. This rule implies that, in the year in which an asset is acquired, only half of the otherwise allowed depreciation can be claimed;

g) It is assumed there are no losses from prior years and no accumulated Canadian Exploration Expenses ("CEE");

h) Mine development costs (pre-production stripping):
NOTE #1: Under 2013 federal Budget changes, mine development cost are now deemed to be Canadian Development Expenses ("CDE") instead of Canadian Exploration Expenses as previously provided, subject to transitional rules.
This implies that "Mine development costs" will be depreciable at 30% on a declining-balance basis, instead of at a rate of 100%.
NOTE #2: Since it is assumed that construction of the mine would be from 2016 and 2017, the impact of the new rules and its transitional rules on the MODEL is as follows:
Mine Development costs incurred in 2016 (if any): 60% CEE and 40% CDE;
Mine Development costs incurred in 2017 (if any): 30% CEE and 70% CDE;
Mine Development costs incurred in 2018 (if any): 0% CEE and 100% CDE.

i) Depreciable assets acquired during the construction stage of a new mine (referred to as Class 41 A-1 assets):
NOTE #1: Under the 2013 federal Budget changes, restrictions have been proposed in the rate of depreciation of mining assets acquired before the start of production of a new mine.
Under the pre-Budget rules, depreciation is calculated on a two (2) step basis:
a) Basic depreciation of 25% calculated on a declining-balance basis; and
b) If there is still a tax profit after all deductions have been taken, including the basic depreciation, then an additional depreciation is allowed, up to the lower of:
- the profit immediately before that additional depreciation; and
- 100% of the not yet depreciated basis.

NOTE #2: The "additional depreciation" will be gradually eliminated, as follows:
Additional depreciation taken in 2017: 90% of the not yet depreciated basis
Additional depreciation taken in 2018: 80% of the not yet depreciated basis
Additional depreciation taken in 2019: 60% of the not yet depreciated basis
Additional depreciation taken in 2020: 30% of the not yet depreciated basis
Additional depreciation taken in 2021: 0% of the not yet depreciated basis
NOTE #3: Thus, by 2021, the "additional depreciation" will have been eliminated; only the basic 25% rate will apply.

1.3 - Mining Taxes

a) The mining Regime discussed in the DEPARTMENT OF FINANCE interpretation bulletin 2013-3 (May 6, 2013) and in Bill 55 has beeen implemented into the Legislation.
This means that the MODEL REFLECTS:
1- The new mandatory minimum royalty of 4 %, calculated on the output value at the mine shaft head ("OVMSH") (1% for first annual OVMSH of $80 million);
2- As discussed in more detail hereafter in paragraph f), the proposed more generous processing allowance (10% instead of 7%);
3- The proposed increased limitations for calculating the processing allowance (max. of 75 % of "profit" and 30% of OVMSH;

4- The increased tax rates, respectively 22% and 28%, when the "PROFIT MARGIN" exceeds the proposed 35% limitation (hereafter referred to as the "SURTAX");

NOTE: We are assuming that all sales would be subject to the Mining Tax.
NOTE: In this Model, we are assuming a processing allowance rate of 20%.

b) It is assumed that the current basic rate of 16% and the PROPOSED SURTAXES will remain constant during the life of the Project;

c) Insurance payments are not deductible for Mining Tax purposes. No specific amount is however considered in this respect in the present Mining tax calculation.

d) General administrative expenditures are not deductible for Mining Tax purposes. Only payments in direct relation to the mining operation are allowed. We have assumed that 10% of "General and Administration Costs" would not be deductible for mining Tax purposes (example: insurance expenses)

e) Operating expenses may include royalties and payments related to a Benefit Agreement. Such payments, if paid, would be not deductible for Mining Tax purposes, but wouild be deductible for income tax purposes.

2.0 Specific assumptions concerning income tax calculation

2.1 Pre-production Capital Expenditure

a) Income tax treatment of pre-production expenditures	**2019** year-3	**2020** year-2	**2021** year-1
1-CEE (PRE-PRODUCTION EXP. & DEV.)			
Proportion considered as CEE, per Budget:	0%	0%	0%
MINE DEVELOPMENT : Pre-stripping	0	0	0
2-CDE (PRE-PRODUCTION EXP. & DEV.)			
Proportion considered as CDE, per Budget:	100%	100%	100%
MINE DEVELOPMENT : Pre-stripping	0	0	250 000
MINE DEVELOPMENT : Pre-stripping	**0**	**0**	**250 000**
3- CLASS 41 A-1			
Mine site:			
MINE EQUIPMENT	0	0	0
MINE INFRASTRUCTURE	0	347 970	811 930
MET BUILDINGS	0	21 370 916	49 865 470
MET PROCESS	0	57 608 556	134 419 964
MET INFRASTRUCTURE	0	13 937 554	32 520 959
TOTAL OF CLASS 41A-1 PRE-PRODUCTION EXPENDITURES:	**0**	**93 264 996**	**217 618 323**
4- CLASS 41B			
None during construction (see however section 2.2)	0	0	0
TOTAL OF ALL PRE-PRODUCTION EXPENDITURES:	**0**	**93 264 996**	**217 868 323**
Pre-production expendítues indexed for sensitivity (as per cash flow sheet)	0	93 264 996	217 868 323
b) Mining Taxes: classification of pre-production expenditures			
1- EXPLORATION (PRE-BUDGET 2010)	0	0	0
Assumed to be nil for the simulation			
2- EXPLORATION (POST-BUDGET 2010)	0	0	0
Assumed to be nil for the simulation			
3- DEVELOPMENT (PRE-PRODUCTION)			
i) Mine Development	0	0	250 000
4- DEVELOPMENT (POST-PRODUCTION)			
None during construction	0	0	0
5- DEPRECIABLE ASSETS			
MINE EQUIPMENT	0	0	0
MINE INFRASTRUCTURE	0	347 970	811 930
MET BUILDINGS	0	21 370 916	49 865 470
MET PROCESS	0	57 608 556	134 419 964
MET INFRASTRUCTURE	0	13 937 554	32 520 959
TOTAL OF PRE-PRODUCTION DEPRECIABLE ASSETS	**0**	**93 264 996**	**217 618 323**
TOTAL OF ALL PRE-PRODUCTION EXPENDITURES:	**0**	**93 264 996**	**217 868 323**
Pre-production expendítues indexed for sensitivity (as per cash flow sheet)	0	93 264 996	217 868 323
c) Determination of processiong assets (for purpose of processing allowance)			
It is assumed that 90% of ore process elements will qualify as "processing assets"			
Processing assets acquired:	0	0	0
Qualifying assets (per assumption):	90%	90%	90%
Processing assets:	0	0	0

LANGIS PROJECT PFS – Canadian Metals Inc.

All monetary values in CAD except where specified otherwise

Exchange Rate (USD per CAD)		0.750

			2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	
Year			**-2**	**-1**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**Total**
Mineralisation (t)				0	236,175	247,263	243,083	236,230	244,821	235,498	235,498	235,498	235,498	235,498	229,242	229,242	229,242	229,242	229,242	187,086	187,086	187,086	187,086	187,086	224,080	224,080	224,080	224,080	224,080	235,449	235,449	235,449	**6,293,447**
Grade (% SiO_2)					98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	98.96	**98.96**
Waste (t)				0	66,337	33,771	331,075	13,178	150,725	134,593	134,593	134,593	134,593	134,593	45,673	45,673	45,673	45,673	45,673	84,801	84,801	84,801	84,801	84,801	113,318	113,318	113,318	113,318	113,318	23,791	23,791	23,791	**2,558,381**
Total Material Mined (t)				0	302,512	281,034	574,158	249,408	395,546	370,091	370,091	370,091	370,091	370,091	274,915	274,915	274,915	274,915	274,915	271,886	271,886	271,886	271,886	271,886	337,397	337,397	337,397	337,397	337,397	259,240	259,240	259,240	**8,851,828**
Stripping Ratio (w : o)					0.281	0.137	1.362	0.056	0.616	0.572	0.572	0.572	0.572	0.572	0.199	0.199	0.199	0.199	0.199	0.453	0.453	0.453	0.453	0.453	0.506	0.506	0.506	0.506	0.506	0.101	0.101	0.101	**0.407**
	Process Recovery (%)	75.0%																															
Total Production (t)	Grade (% SiO_2)	98.96%			177,131	185,447	182,312	177,173	183,616	176,624	176,624	176,624	176,624	176,624	171,931	171,931	171,931	171,931	171,931	140,314	140,314	140,314	140,314	140,314	168,060	168,060	168,060	168,060	168,060	176,587	176,587	176,587	**4,720,085**
Less Handling & Transport Losses (t)		0.00%			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Net Production for Metallurgical Plant Use and Sales (t)					**177,131**	**185,447**	**182,312**	**177,173**	**183,616**	**176,624**	**176,624**	**176,624**	**176,624**	**176,624**	**171,931**	**171,931**	**171,931**	**171,931**	**171,931**	**140,314**	**140,314**	**140,314**	**140,314**	**140,314**	**168,060**	**168,060**	**168,060**	**168,060**	**168,060**	**176,587**	**176,587**	**176,587**	4,720,085
Product for Metallurgical Plant (t)					129,692	129,692	129,692	129,692	129,692	129,692	129,692	129,692	129,692	129,692	129,692	129,692	129,692	129,692	129,692	129,692	123,836	123,836	123,836	123,836	123,836	123,836	123,836	123,836	123,836	123,836	123,836	123,836	**3,561,107**
Product for Sale at Quarry (t)					47,439	55,755	52,620	47,481	53,924	46,932	46,932	46,932	46,932	46,932	42,239	42,239	42,239	42,239	42,239	10,623	16,478	16,478	16,478	16,478	44,223	44,223	44,223	44,223	44,223	52,751	52,751	52,751	**1,158,979**
FeSi75 Production (t)	Tonnes FeSi75 / t Product	0.556			72,051	72,051	72,051	72,051	72,051	72,051	72,051	72,051	72,051	72,051	72,051	72,051	72,051	72,051	72,051	72,051	68,798	68,798	68,798	68,798	68,798	68,798	68,798	68,798	68,798	68,798	68,798	68,798	**1,978,393**
Microsilica Production (t)	Tonnes Microsilica / t Product	0.105			13,583	13,583	13,583	13,583	13,583	13,583	13,583	13,583	13,583	13,583	13,583	13,583	13,583	13,583	13,583	13,583	12,969	12,969	12,969	12,969	12,969	12,969	12,969	12,969	12,969	12,969	12,969	12,969	**372,955**
Slag Production (t)	Tonnes Slag / t Product	0.041			5,282	5,282	5,282	5,282	5,282	5,282	5,282	5,282	5,282	5,282	5,282	5,282	5,282	5,282	5,282	5,282	5,044	5,044	5,044	5,044	5,044	5,044	5,044	5,044	5,044	5,044	5,044	5,044	**145,044**
Langis Quartz Fines Production (t)	Tonnes Langis Quartz Fines / t ore	0.192			45,257	47,382	46,581	45,268	46,914	45,127	45,127	45,127	45,127	45,127	43,928	43,928	43,928	43,928	43,928	35,850	35,850	35,850	35,850	35,850	42,939	42,939	42,939	42,939	42,939	45,118	45,118	45,118	**1,205,982**
Excess Silica Product (t)					47,439	55,755	52,620	47,481	53,924	46,932	46,932	46,932	46,932	46,932	42,239	42,239	42,239	42,239	42,239	10,623	16,478	16,478	16,478	16,478	44,223	44,223	44,223	44,223	44,223	52,751	52,751	52,751	**1,158,979**
Low Grade Quarry Production (t)	Tonnes Low Grade Product / t ore	0.055			13,026	13,638	13,407	13,029	13,503	12,989	12,989	12,989	12,989	12,989	12,644	12,644	12,644	12,644	12,644	10,319	10,319	10,319	10,319	10,319	12,359	12,359	12,359	12,359	12,359	12,986	12,986	12,986	**347,115**
FeSi75 Sales ($)	Price – Ex-Works Met. Plant (USD/t)	1,819.13			174,759,701	174,759,701	174,759,701	174,759,701	174,759,701	174,759,701	174,759,701	174,759,701	174,759,701	174,759,701	174,759,701	174,759,701	174,759,701	174,759,701	174,759,701	174,759,701	166,869,670	166,869,670	166,869,670	166,869,670	166,869,670	166,869,670	166,869,670	166,869,670	166,869,670	166,869,670	166,869,670	166,869,670	**4,798,591,251**
Microsilica Sales ($)	Price – Ex-Works Met. Plant (USD/t)	250.00			4,527,541	4,527,541	4,527,541	4,527,541	4,527,541	4,527,541	4,527,541	4,527,541	4,527,541	4,527,541	4,527,541	4,527,541	4,527,541	4,527,541	4,527,541	4,527,541	4,323,132	4,323,132	4,323,132	4,323,132	4,323,132	4,323,132	4,323,132	4,323,132	4,323,132	4,323,132	4,323,132	4,323,132	**124,318,234**
Slag Sales ($)	Price – Ex-Works Met. Plant (USD/t)	100.00			704,313	704,313	704,313	704,313	704,313	704,313	704,313	704,313	704,313	704,313	704,313	704,313	704,313	704,313	704,313	704,313	672,515	672,515	672,515	672,515	672,515	672,515	672,515	672,515	672,515	672,515	672,515	672,515	**19,339,183**
Langis Quartz Fines Sales ($)	Price – Ex-Works Quarry (USD/t)	24.38			1,470,854	1,539,908	1,513,875	1,471,196	1,524,699	1,466,639	1,466,639	1,466,639	1,466,639	1,466,639	1,427,674	1,427,674	1,427,674	1,427,674	1,427,674	1,165,135	1,165,135	1,165,135	1,165,135	1,165,135	1,395,527	1,395,527	1,395,527	1,395,527	1,395,527	1,466,334	1,466,334	1,466,334	**39,194,408**
Excess Silica Product Sales ($)	Price – Ex-Works Quarry (USD/t)	24.38			1,541,782	1,812,052	1,710,165	1,543,123	1,752,528	1,525,285	1,525,285	1,525,285	1,525,285	1,525,285	1,372,781	1,372,781	1,372,781	1,372,781	1,372,781	345,233	535,530	535,530	535,530	535,530	1,437,259	1,437,259	1,437,259	1,437,259	1,437,259	1,714,392	1,714,392	1,714,392	**37,666,804**
Low Grade Quarry Production Sales ($)	Price – Ex-Works Quarry (USD/t)	24.38			423,353	443,228	435,735	423,451	438,851	422,139	422,139	422,139	422,139	422,139	410,924	410,924	410,924	410,924	410,924	335,358	335,358	335,358	335,358	335,358	401,671	401,671	401,671	401,671	401,671	422,052	422,052	422,052	**11,281,240**
Total Sales ($)					183,427,542	183,786,742	183,651,330	183,429,324	183,707,633	183,405,617	183,405,617	183,405,617	183,405,617	183,405,617	183,202,933	183,202,933	183,202,933	183,202,933	183,202,933	181,837,281	173,901,341	173,901,341	173,901,341	173,901,341	175,099,774	175,099,774	175,099,774	175,099,774	175,099,774	175,468,094	175,468,094	175,468,094	**5,030,391,120**
Total Revenue ($)	Base Case				183,427,542	183,786,742	183,651,330	183,429,324	183,707,633	183,405,617	183,405,617	183,405,617	183,405,617	183,405,617	183,202,933	183,202,933	183,202,933	183,202,933	183,202,933	181,837,281	173,901,341	173,901,341	173,901,341	173,901,341	175,099,774	175,099,774	175,099,774	175,099,774	175,099,774	175,468,094	175,468,094	175,468,094	5,030,391,120
Total Revenue ($)	Indexed for Sensitivity				**183,427,542**	**183,786,742**	**183,651,330**	**183,429,324**	**183,707,633**	**183,405,617**	**183,405,617**	**183,405,617**	**183,405,617**	**183,405,617**	**183,202,933**	**183,202,933**	**183,202,933**	**183,202,933**	**183,202,933**	**181,837,281**	**173,901,341**	**173,901,341**	**173,901,341**	**173,901,341**	**175,099,774**	**175,099,774**	**175,099,774**	**175,099,774**	**175,099,774**	**175,468,094**	**175,468,094**	**175,468,094**	5,030,391,120
Quarrying Costs ($)	$/t quarry product				5,044,716	4,986,836	7,362,980	4,606,669	5,906,380	5,595,624	5,595,624	5,595,624	5,595,624	5,595,624	4,742,021	4,742,021	4,742,021	4,742,021	4,742,021	4,262,567	4,262,567	4,262,567	4,262,567	4,262,567	5,202,483	5,202,483	5,202,483	5,202,483	5,202,483	4,679,469	4,679,469	4,679,469	140,959,458
Beneficiation Costs ($)	$/t material processed	0.00			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G&A Quarry Site Costs ($)	$/year	801,000			765,081	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	801,000	22,392,081
Transport Costs to Metallurgical Plant ($)	$/t quarry product	70.00			9,078,426	9,078,426	9,078,426	9,078,426	9,078,426	9,078,426	9,078,426	9,078,426	9,078,426	9,078,426	9,078,426	9,078,426	9,078,426	9,078,426	9,078,426	9,078,426	8,668,554	8,668,554	8,668,554	8,668,554	8,668,554	8,668,554	8,668,554	8,668,554	8,668,554	8,668,554	8,668,554	8,668,554	249,277,468
Metallurgical Plant Costs ($)	$/t final FeSi75 product	1,055.36			76,039,743	76,039,743	76,039,743	76,039,743	76,039,743	76,039,743	76,039,743	76,039,743	76,039,743	76,039,743	76,039,743	76,039,743	76,039,743	76,039,743	76,039,743	76,039,743	72,606,710	72,606,710	72,606,710	72,606,710	72,606,710	72,606,710	72,606,710	72,606,710	72,606,710	72,606,710	72,606,710	72,606,710	2,087,916,414
G&A Metallurgical Plant Site Costs ($)	$/t year	0			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Royalty Payments ($)	NSR (Sales FOB Metallurgical Plant)	3.00%			5,502,826	5,513,602	5,509,540	5,502,880	5,511,229	5,502,169	5,502,169	5,502,169	5,502,169	5,502,169	5,496,088	5,496,088	5,496,088	5,496,088	5,496,088	5,455,118	5,217,040	5,217,040	5,217,040	5,217,040	5,252,993	5,252,993	5,252,993	5,252,993	5,252,993	5,264,043	5,264,043	5,264,043	150,911,734
Total Operating Costs ($)	Base Case				96,430,792	96,419,608	98,791,689	96,028,719	97,336,779	97,016,962	97,016,962	97,016,962	97,016,962	97,016,962	96,157,278	96,157,278	96,157,278	96,157,278	96,157,278	95,636,854	91,555,871	91,555,871	91,555,871	91,555,871	92,531,740	92,531,740	92,531,740	92,531,740	92,531,740	92,019,776	92,019,776	92,019,776	2,651,457,154
Total Operating Costs ($)	Indexed for Sensitivity				**96,430,792**	**96,419,608**	**98,791,689**	**96,028,719**	**97,336,779**	**97,016,962**	**97,016,962**	**97,016,962**	**97,016,962**	**97,016,962**	**96,157,278**	**96,157,278**	**96,157,278**	**96,157,278**	**96,157,278**	**95,636,854**	**91,555,871**	**91,555,871**	**91,555,871**	**91,555,871**	**92,531,740**	**92,531,740**	**92,531,740**	**92,531,740**	**92,531,740**	**92,019,776**	**92,019,776**	**92,019,776**	**2,651,457,154**
Operating Profit ($)					**86,996,750**	**87,367,134**	**84,859,640**	**87,400,606**	**86,370,854**	**86,388,655**	**86,388,655**	**86,388,655**	**86,388,655**	**86,388,655**	**87,045,655**	**87,045,655**	**87,045,655**	**87,045,655**	**87,045,655**	**86,200,426**	**82,345,470**	**82,345,470**	**82,345,470**	**82,345,470**	**82,568,034**	**82,568,034**	**82,568,034**	**82,568,034**	**82,568,034**	**83,448,318**	**83,448,318**	**83,448,318**	**2,378,933,966**
Quarry Pre-production Capital Expenditure ($)																																	
QUARRY DEVELOPMENT – Pre-stripping			0	250,000																													250,000
QUARRY EQUIPMENT			0	0																													0
QUARRY INFRASTRUCTURE			347,970	811,930																													1,159,900
METALLURGICAL PLANT – BUILDINGS			21,370,916	49,865,470																													71,236,386
METALLURGICAL PLANT – PROCESS			57,608,556	134,419,964																													192,028,520
METALLURGICAL PLANT – INFRASTRUCTURE			13,937,554	32,520,959																													46,458,513
Total	Base Case		93,264,996	217,868,323																													311,133,319
Total	Indexed for Sensitivity		93,264,996	217,868,323																													311,133,319
Residual Value ($)	Process Plant	15.0%																														-39,489,736	-39,489,736
Working Capital ($)	Months of Annual Operating Costs	2.00		15,154,661	-3,660	396,024	-459,385	216,618	-51,793	0	0	0	0	-142,267	0	0	0	0	-79,909	-640,484	0	0	0	156,653	0	0	0	0	-87,169	0	0	-14,459,289	0
Sustaining Capital Expenditure ($)																																	
Quarry					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Metallurgical Plant					150,000	300,000	600,000	720,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	20,970,000
Total Sustaining Capital Expenditure	Base Case				150,000	300,000	600,000	720,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	20,970,000
Total Sustaining Capital Expenditure	Indexed for Sensitivity				150,000	300,000	600,000	720,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	20,970,000
Total Capital Expenditure ($)			**93,264,996**	**233,022,984**	**146,340**	**696,024**	**140,615**	**936,618**	**748,207**	**800,000**	**800,000**	**800,000**	**800,000**	**657,733**	**800,000**	**800,000**	**800,000**	**800,000**	**720,091**	**159,516**	**800,000**	**800,000**	**800,000**	**956,653**	**800,000**	**800,000**	**800,000**	**800,000**	**712,831**	**800,000**	**800,000**	**-53,149,025**	**292,613,583**
Trust Fund Rehabilitation Payments ($)			**0**	**262,500**	**131,250**	**131,250**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**525,000**
Federal Corporate Income Tax	Proportions of Total Taxes	61.0%	0	0	88,390	196,370	6,854,125	9,569,196	10,646,811	11,273,095	11,648,104	11,888,854	12,054,321	12,175,378	12,351,521	12,426,106	12,487,428	12,538,794	12,582,379	12,514,179	11,968,097	11,995,955	12,020,184	12,041,330	12,087,020	12,103,265	12,117,556	12,130,156	12,141,287	12,261,789	12,270,521	18,201,734	312,633,945
Provincial Corporate Income Tax		37.7%	0	0	0	133,424	0	134,123	91,568	92,795	92,334	642,521	9,245,333	9,337,204	9,471,548	9,528,209	9,574,834	9,613,926	9,647,125	9,594,679	9,175,895	9,197,163	9,215,672	9,231,834	9,266,826	9,279,252	9,290,188	9,299,833	9,308,355	9,400,731	9,407,419	13,954,677	193,227,468
Quebec Mining Tax		1.3%	0	0	211,154	287,417	61,049	262,699	189,508	196,636	200,646	203,453	205,419	206,794	311,904	312,578	313,050	313,380	313,611	171,981	172,095	172,174	172,229	172,268	213,658	213,677	213,691	213,700	213,706	356,324	356,328	356,330	6,587,461
Total Corporate Income and Mining Taxes ($)	Total	100.0%	**0**	**0**	**299,544**	**617,210**	**6,915,174**	**9,966,018**	**10,927,888**	**11,562,526**	**11,941,085**	**12,734,828**	**21,505,072**	**21,719,376**	**22,134,973**	**22,266,894**	**22,375,312**	**22,466,101**	**22,543,115**	**22,280,839**	**21,316,086**	**21,365,292**	**21,408,086**	**21,445,432**	**21,567,504**	**21,596,194**	**21,621,435**	**21,643,689**	**21,663,349**	**22,018,844**	**22,034,268**	**32,512,741**	**512,448,875**
PRE-TAX CASH FLOW			**-93,264,996**	**-233,285,484**	**86,719,160**	**86,539,861**	**84,719,026**	**86,463,987**	**85,622,647**	**85,588,655**	**85,588,655**	**85,588,655**	**85,588,655**	**85,730,923**	**86,245,655**	**86,245,655**	**86,245,655**	**86,245,655**	**86,325,564**	**86,040,910**	**81,545,470**	**81,545,470**	**81,545,470**	**81,388,817**	**81,768,034**	**81,768,034**	**81,768,034**	**81,768,034**	**81,855,203**	**82,648,318**	**82,648,318**	**136,597,343**	**2,085,795,383**
Cumulative B-T CF			-93,264,996	-326,550,480	-239,831,320	-153,291,459	-68,572,434	17,891,554	103,514,200	189,102,856	274,691,511	360,280,167	445,868,822	531,599,745	617,845,400	704,091,054	790,336,709	876,582,363	962,907,927	1,048,948,837	1,130,494,307	1,212,039,776	1,293,585,246	1,374,974,063	1,456,742,097	1,538,510,131	1,620,278,166	1,702,046,200	1,783,901,403	1,866,549,721	1,949,198,039	2,085,795,383	
Payback period work area				1.00	1.00	1.00	1.00	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
AFTER-TAX CASH FLOW			**-93,264,996**	**-233,285,484**	**86,419,616**	**85,922,650**	**77,803,851**	**76,497,969**	**74,694,759**	**74,026,129**	**73,647,571**	**72,853,827**	**64,083,584**	**64,011,547**	**64,110,681**	**63,978,761**	**63,870,343**	**63,779,554**	**63,782,448**	**63,760,071**	**60,229,383**	**60,180,178**	**60,137,384**	**59,943,385**	**60,200,530**	**60,171,840**	**60,146,599**	**60,124,345**	**60,191,855**	**60,629,475**	**60,614,051**	**104,084,602**	**1,573,346,507**
Cumulative A-T CF			-93,264,996	-326,550,480	-240,130,864	-154,208,214	-76,404,362	93,606	74,788,366	148,814,495	222,462,066	295,315,893	359,399,476	423,411,023	487,521,705	551,500,465	615,370,808	679,150,362	742,932,810	806,692,881	866,922,265	927,102,443	987,239,827	1,047,183,211	1,107,383,742	1,167,555,582	1,227,702,181	1,287,826,526	1,348,018,380	1,408,647,855	1,469,261,906	1,573,346,507	
Payback period work area				1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

FINANCIAL INDICATORS	Lag from t=-3 to pre-prod. start (months)	12		
Pre Tax	Lag from t=0 to prod. start (months)	0		
Payback Period (years)			**3.8**	
Total Cash Flow ($)			**2,085,795,383**	
Net Present Value ($)	Discount Rate	6.0%	**727,276,748**	
Net Present Value ($)	Discount Rate	8.0%	**525,596,925**	
Net Present Value ($)	Discount Rate	10.0%	**381,554,086**	
Internal Rate of Return			**24.5%**	
After Tax				Effective
Payback Period (years)			**4.0**	Tax Rates
Total CashFlow ($)			**1,573,346,507**	24.6%
Net Present Value ($)	Discount Rate	6.0%	**543,677,358**	25.2%
Net Present Value ($)	Discount Rate	8.0%	**388,832,363**	26.0%
Net Present Value ($)	Discount Rate	10.0%	**277,533,159**	27.3%
Internal Rate of Return			**22.0%**	