GROTA DO CIRILO LITHIUM PROJECT

ARAÇUAÍ AND ITINGA REGIONS, MINAS GERAIS, BRAZIL

NI 43-101 TECHNICAL REPORT ON FEASIBILITY STUDY

FINAL REPORT

Prepared for: Sigma Lithium Resources Corporation

Prepared by:

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IMPORTANT NOTICE

This report was prepared as National Instrument 43-101 Technical Report for Sigma Lithium Resources Corporation (Sigma) by Primero Group Americas Inc. (a subsidiary of Primero Group Ltd), SGS Geological Services, MCB Serviços e Mineração and WorleyParsons Engenharia Ltda. (collectively the Report Authors). The quality of information, conclusions, and estimates contained herein is consistent with the level of effort involved in the Report Authors' services, based on i) information available at the time of preparation, ii) data supplied by outside sources, and iii) the assumptions, conditions, and qualifications set forth in this report. This report is intended for use by Sigma subject to terms and conditions of its individual contracts with the Report Authors. Except for the purposed legislated under Canadian provincial and territorial securities law, any other uses of this report by any third party is at that party's sole risk.

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CERTIFICATE OF AUTHOR

I, Frederic Claridge, P. Eng., do hereby certify that:

1. I am a Senior Technical Director with Advisian, a consulting division of WorleyParsons Canada Infrastructure and Environment, with an office at 4321 Still Creek Drive in Burnaby, British Columbia Canada,
2. This certificate applies to the technical report entitled “Grota Do Cirilo Lithium Project, Araçuaí and Itinga Regions, Minas Gerais, Brazil, NI 43-101 Technical Report on Feasibility Study Final Report”, prepared for Sigma Lithium Resources Corporation (“**Sigma**”), with an effective date of September 16, 2019 (the “**Report**”).
3. I am a graduate from the University of Illinois in Urbana, Illinois, with a Master of Science in Civil Engineering, specializing in Soil Mechanics and Foundations in 1968; and an undergraduate Bachelor of Science degree from the University of Toronto in 1965.
4. I am a registered member of the associations of professional engineers of British Columbia, Canada (EGBC# 107501).
5. I have extensive experience in geotechnical engineering, water resources, waste management and environmental assessment. I have directed geotechnical and water management activities and provided technical assistance for many major mining and civil engineering projects, including large dams and reservoirs, mine waste dumps, tailings impoundments and dry stack facilities. My experience spans Canada, Africa, Asia, Europe, and South America.
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 my professional associations and past relevant work experience, I fulfil the requirements to be a qualified person for the purposes of NI 43-101.
7. I am responsible for Section 18 (except for subsections 18.4.3, 18.4.4.2, 18.6.2, 18.7, 18.8.1.2, 18.13, 18.15, 18.16), subsections 20.1.3, 20.1.4, 20.5, 20.7, 21.4.4, 21.5.6 as well as the applicable parts of Section 1, 2, 3, 25 and 26.
8. I am independent of Sigma, as defined at section 1.5 of NI 43-101.
9. I have no previous involvement with the property that is the subject of the Report.
10. I have read NI 43-101 and the sections of the Report for which I am responsible, and hereby certify that they have been prepared in compliance with NI 43-101.
11. As of the effective date of the Report, to the best of my knowledge, information, and belief, the sections of the Report for which I am responsible contain all scientific and technical information that is required to be disclosed to make the Report not misleading.

____

Frederic Claridge, P.Eng., Senior Technical Director, Advisian Americas, a division of WorleyParsons Canada Services Ltd.

Signed and dated October 18, 2019 in Vancouver, British Columbia

CERTIFICATE OF AUTHOR

I, Lucas Duarte, P. Eng., MSc, PMP do hereby certify that:

1. I am a senior geotechnical engineer based in Montreal, Canada.
2. This certificate applies to the technical report entitled “Grota Do Cirilo Lithium Project, Araçuaí and Itinga Regions, Minas Gerais, Brazil, NI 43-101 Technical Report on Feasibility Study Final Report”, prepared for Sigma Lithium Resources Corporation (“**Sigma**”), with an effective date of September 16, 2019 (the “**Report**”).
3. I graduated in 2006 from *Universidade Federal de Minas Gerais* in Brazil and from *École Nationale des Ponts et Chaussées* in France with a B.Eng. in civil engineering, and I hold a masters degree in geotechnical engineering from Universidade Federal de Minas Gerais in Brazil in 2012.
4. I am a registered member of “*Ordre des Ingénieurs du Québec*” (#5040549).
5. I have worked in the geotechnical field since 2003. My international engineering experience applies to mining facilities, particularly tailings storage facilities, dam design, waste rock containment facilities, open pits and associated structures. I work actively in dam safety management, dam safety inspections, risk assessments, tailings and mine waste disposal operation, as well as economical assessments.
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 and past relevant work experience, I fulfil the requirements to be a qualified person for the purposes of NI 43-101.
7. I have participated in the preparation of this Report in the parts related to the waste rock in parts 3 and 4, and I am responsible for sub-sections 18.4.2, 18.4.4.2, 18.8.1.2 and 26.3.1.1 and the applicable parts of Sections 1, 2, and 3.
8. I am independent of Sigma, as defined at section 1.5 of NI 43-101.
9. I have had no previous involvement with the property that is the subject of the Report.
10. I have read NI 43-101, and the sections of the Report for which I am responsible, and hereby certify that they have been prepared in compliance with NI 43-101.
11. As of the effective date of the Report, to the best of my knowledge, information and belief, the sections of the Report for which I am responsible contain all scientific and technical information that is required to be disclosed to make the Report not misleading.

____
Lucas Duarte, P.Eng., Senior Geotechnical Engineer

Signed and dated this October 18, 2019 in Montreal, Quebec.

CERTIFICATE OF AUTHOR

I, Ara Erzingatzian, P. Eng., do hereby certify that:

1. I am a project/study manager with Primero Group Americas Inc., a division of Primero Group Ltd. with an office at 2000 Peel Street, Suite 905, Montreal, Canada.
2. This certificate applies to the technical report entitled “Grota Do Cirilo Lithium Project, Araçuaí and Itinga Regions, Minas Gerais, Brazil, NI 43-101 Technical Report on Feasibility Study Final Report”, prepared for Sigma Lithium Resources Corporation (“**Sigma**”), with an effective date of September 16, 2019 (the “**Report**”).
3. I graduated in 1989 from Concordia University in Montreal, with a B.Eng. in mechanical engineering.
4. I am a registered member of “Ordre des Ingénieurs du Québec” (120305).
5. I have worked since 1989 in various positions in the mining and metallurgical as well as industrial projects fields as a project manager, study manager, engineering manager, discipline lead and senior mechanical engineer for Bechtel, SNC-Lavalin, WSP, Yara and Primero.
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 and past relevant work experience, I fulfil the requirements to be an independent qualified person for the purposes of NI 43-101.
7. I have visited the Xuxa site on July 1, 2018.
8. I am the study manager of Sigma’s Grota do Cirilo Lithium Project, and I have participated in the preparation of this Report and am responsible for Sections 19, 20 (except for subsection 20.5), 22, 24, the applicable parts of Sections 1, 2, 3, 25 and 26 and sub-sections 18.1, 18.6, 18.10.2, 18.13, 18.15, 18.16, 21.1, 21.2, 21.3, 21.4 (except for subsections 21.4.4 and 21.4.5), 21.4.6.
9. I am independent of Sigma, as defined at section 1.5 of NI 43-101.
10. I have no previous involvement with the property that is the subject of the Report.
11. I have read NI 43-101 and the sections of the Report for which I am responsible, and hereby certify that they have been prepared in compliance with NI 43-101.
12. As of the effective date of the Report, to the best of my knowledge, information and belief, the sections of the Report for which I am responsible contain all scientific and technical information that is required to be disclosed to make the Report not misleading.

____

Ara Erzingatzian, P.Eng., Study Manager, Primero Group Americas Inc.

Signed and dated this October 18, 2019 in Montreal, Quebec.

CERTIFICATE OF AUTHOR

I, Kiedock Kim, P. Eng., do hereby certify that:

1. I am a Lead Process engineer with Primero Group Americas Inc., a division of Primero Group Ltd. with an office at 2000 Peel Street, Suite 905, Montreal, Canada.
2. This certificate applies to the technical report entitled “Grota Do Cirilo Lithium Project, Araçuaí and Itinga Regions, Minas Gerais, Brazil, NI 43-101 Technical Report on Feasibility Study Final Report”, prepared for Sigma Lithium Resources Corporation (“**Sigma**”), with an effective date of September 16, 2019 (the “**Report**”).
3. I graduated with a Bachelor of Science degree in Metallurgical Engineer from Queens University in Kingston, Ontario in 1982, and a Master of Science degree in Mineral Processing from the University of Alberta, in Edmonton in 1985.
4. I am a registered Professional Engineer (#90413477) with the Professional Engineers of Ontario.
5. I have worked as a metallurgist for a total of 30 years since receiving my Master of Science degree.
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 and past relevant work experience, I fulfil the requirements to be a qualified person for the purposes of NI 43-101.
7. I have participated in the preparation of this Report and am responsible for Sections 13, 17, and the applicable parts of sections 1, 2, 3, 25 and 26, and sub-sections 18.7, 21.5, 21.5.1, 21.5.2, 21.5.3, 21.5.4 and 21.5.5.
8. I am independent of Sigma, as defined at section 1.5 of NI 43-101.
9. I have no previous involvement with the property that is the subject of the Report.
10. I have read NI 43-101 and the sections of the Report for which I am responsible, and hereby certify that they have been prepared in compliance with NI 43-101.
11. As of the effective date of the Report, to the best of my knowledge, information and belief, the sections of the Report for which I am responsible contain all scientific and technical information that is required to be disclosed to make the Report not misleading.

____

Kiedock Kim, P.Eng., Lead Process Engineer, Primero Group Americas Inc.

Signed and dated this October 18, 2019 in Montreal, Quebec.

CERTIFICATE OF AUTHOR

I, Marc-Antoine Laporte, P.Geo., M.Sc., of Québec, Québec, do hereby certify:

1. I am a project geologist with SGS Geological Services with a business address at 125 rue Fortin, Suite 100, Quebec, Quebec, G1M 3M2.
2. This certificate applies to the technical report entitled "Grota Do Cirilo Lithium Project, Araçuaí and Itinga Regions, Minas Gerais, Brazil, NI 43-101 Technical Report on Feasibility Study Final Report", prepared for Sigma Lithium Resources Corporation ("**Sigma**"), with an effective date of September 16, 2019 (the "**Report**").
3. I am a graduate of Université Laval (2004 and 2008) in Earth Sciences. I am a member in good standing of Ordre des Géologues du Québec (#1347). I have worked as a geologist continuously since my graduation.
4. 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 and past relevant work experiences, I fulfil the requirement to be a qualified person for the purposes of NI 43-101.
5. My most recent personal inspection of the Project was on September 18-23, 2018.
6. I have participated in the preparation of this Technical Report and am responsible for Sections 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 23 and the applicable parts of sections 1, 2, 25, 26 and 27.
7. I am independent of Sigma as defined by Section 1.5 of NI 43-101.
8. I have no any prior involvement with the property that is the subject of the Report.
9. I have read NI 43-101 and the sections of the Report for which I am responsible, and hereby certify that they have been prepared in compliance with NI 43-101.
10. As of the effective date of the Report, to the best of my knowledge, information and belief, the sections of the Report for which I am responsible contain all scientific and technical information that is required to be disclosed to make the Report not misleading.

____

Marc-Antoine Laporte, P.Geo., Project Geologist, SGS Geological Services

Signed and dated this October 18, 2019 in Quebec City, Quebec.

CERTIFICATE OF AUTHOR

I, Porfírio Cabaleiro Rodriguez, state that:

1. I am a Mining Engineer and Associate Consultant at GE21 Consultoria Mineral, which is located on Avenida Afonso Pena, 3130, Suite 12o, Funcionarios, Belo Horizonte, MG, Brazil - CEP 30130-910.
2. This certificate applies to the technical report entitled "Grota Do Cirilo Lithium Project, Araçuaí and Itinga Regions, Minas Gerais, Brazil, NI 43-101 Technical Report on Feasibility Study Final Report", prepared for Sigma Lithium Resources Corporation ("**Sigma**"), with an effective date of September 16, 2019 (the "**Report**").
3. I am a graduate of the Federal University of Minas Gerais, located in Belo Horizonte, Brazil, and hold a Bachelor of Science Degree in Mine Engineering (1978).
4. I have practised my profession continuously since 1979. I am a professional mining engineer, with more than 39 years relevant experience in ore resource and reserves estimation. I am a member of the Australian Institute of Geoscientists ("AIG") - ("MAIG") #3708.
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 my professional associations and past relevant work experience, I fulfil the requirements to be an independent qualified person for the purposes of NI 43-101.
6. I have visited the Xuxa site from April 17-18, 2019.
7. I am responsible for sections 15, 16 and partially for the sections 1, 2, 3, 21 (including subsections 21.4.5 and 21.5.7), 25 (including subsection 25.1.5) and 26 (including subsection 26.2) of the Technical Report and subsections 18.4.3, 18.6.2 and 18.8.
8. I am independent of Sigma as described in section 1.5 of NI 43-101.
9. I have been engaged by Sigma to prepare their mineral rights documents for the Brazilian Mineral Agency since 2017.
10. I have read NI 43-101 and the sections of the Report for which I am responsible, and hereby certify that they have been prepared in compliance with NI 43-101.
11. At the effective date of the Report, to the best of my knowledge, information, and belief, the part of Report for which I am responsible, contains all scientific and technical information that is required to be disclosed to make the Report not misleading.

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Porfirio Cabaleiro Rodriguez, BSc. (MEng), Senior Director GE21, MAIG #3708

Signed and dated this October 18, 2019 in Belo Horizonte, MG.

ABBREVIATIONS

AMIS	African Mineral Standards
CAPEX	Capital Expenditures
CIM	Canadian Institute of Mining, Metallurgy and Petroleum
DMS	Dense Medium Separation
EPCM	Engineering Procurement Construction Management
FOB	Free on Board
FS	Feasibility Study
HDPE	High Density Polyethylene
HLS	Heavy Liquid Separation
HMI	Human Machine Interface
LOM	Life of Mine
MCB	MCB Serviços e Mineração
MEL	Mechanical Equipment List
MTO	Material Take-off
NPI	Non-Process Infrastructure
NPV	Net Present Value
OPEX	Operating Expenditures
PEP	Project Execution Plan
Primero	Primero Group Americas Inc
Project	Xuxa Lithium Project
Property	Sigma Property
RFQ	Request for Quotation
ROM	Run of Mine
Sigma	Sigma Lithium Resources Corporation
SGS	SGS Geological Services (SGS Canada)
UCS	Unconfined Compressive Strength
UPS	Uninterruptible Power Supply
WBS	Work Breakdown Structure
WP	Worley Parsons Engenharia Ltda

1 SUMMARY

1.1 INTRODUCTION

Sigma Lithium Resource Corporation (Sigma) requested Primero Group Americas Inc. (Primero), a division of Primero Group Ltd, SGS Geological Services (SGS), MCB Serviços e Mineração (MCB), and Worley Parsons Engenharia Ltda (WP) prepare a technical report (the Report) on the Grota do Cirilo Lithium Project (the Project) located in Minas Gerais State, Brazil.

Sigma Mineração S.A. (SMSA) is the Brazilian subsidiary of Sigma and is the owner of the mining rights and the holder of mining concessions ordinance which includes the Xuxa deposit.

The Report supports the disclosure by Sigma in the news release dated October 1, 2019, entitled "Sigma Lithium Announces Bankable Feasibility Study with Forecasted LOM Revenue of US$1.4 billion and EBITDA of US$ 690 million for the high-grade, low-cost Xuxa Deposit". Mineral Resources are reported for four pegmatite bodies, Xuxa, Barreiro, Murial and Lavra do Meio. Mineral Reserves are reported for the Xuxa deposit.

A feasibility study, which is the subject of this Report, has been conducted on the Xuxa deposit. Mineral Resources and Mineral Reserves are reported using the 2014 Canadian Institute of Mining, Metallurgy and Petroleum (CIM) Definition Standards (2014 CIM Definition Standards).

1.2 PROPERTY DESCRIPTION AND LOCATION

The Project is located in Northeastern Minas Gerais State, in the municipalities of Araçuaí and Itinga, approximately 25 km east of the town of Araçuaí and 450 km northeast of Belo Horizonte.

The Project comprises four properties owned by SMSA and is divided into the Northern Complex (the Grota do Cirilo, Genipapo and Santa Clara properties) and the Southern Complex (the São José property).

The Project consists of 27 mineral rights, which include mining concessions, applications for mining concessions, exploration authorizations and applications for mineral exploration authorizations, spread over 191 km^2, which include nine past producing lithium mines and 11 first-priority exploration targets. Granted mining concessions are in good standing with the Brazilian authorities.

The surface rights in the Grota do Cirilo area, the current primary focus of activity, are held by two companies, Arqueana Minérios e Metais (Arqueana) and Miazga Participações S.A. (Miazga). SMSA has entered into two right-of-way agreements with these companies to support Sigma's exploration and development activities within the Grota do Cirilo property, as well as third-party surface owners.

Sigma has been granted a flow of 150 m^3/h from the Jequitinhonha River for all months of the year for a period of 10 years, which is sufficient for life-of mine (LOM) requirements.

The Brazilian Government levies a Compensação Financeira pela Exploração de Recursos Minerais (CFEM) royalty on mineral production. Lithium production is subject to a 2.0% CFEM royalty, payable on the gross income from sales. The Project is subject to two third-party net smelter return (NSR) royalties of 1% each.

To the extent known to the QP, there are no other significant factors and risks that may affect access, title, or the right or ability to perform work on the Project that have not been discussed in this Report.

1.3 ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE AND PHYSIOGRAPHY

The Project is easily accessible from regional paved road BR-367, which runs through the northern part of the Project. Within the Project area, accessibility is provided by a network of maintained arterial and back country service roads. A municipal airport services the town of Araçuaí. The closest major domestic airport is located at Montes Claros, 327 km west of Araçuaí.

The Eastern Brazil region is characterized by a dry, semi-arid and hot climate. It is expected that future mining operations could be conducted year-round. Exploration activities are year-round but can be interrupted by short-term rainfall events.

Mining operations have been previously conducted in the Project area. Existing infrastructure includes power supply and substation, an extensive office block equipped with internet and telephones, accommodation for 40 persons on site, dining hall and kitchen, workshop, on-site laboratory and sample storage building, warehouse and a large store, a fuel storage facility with pumping equipment, and a water pumping facility from the Jequitinhonha river with its reservoir. The main 138 kV transmission line from the Irape hydro power station runs through the northern part of the Project area. The town of Araçuaí can supply basic services. Other services must be sourced from Belo Horizonte or São Paulo.

The topography consists of gently rolling hills with less than 100 m difference in elevation. The Project area typically hosts thorn scrub and savannah. Much of the area has been cleared for agriculture. The primary source of water for this project is the Jequitinhonha River.

1.4 HISTORY

Exploration and mining activities prior to Sigma's project interest were conducted by Companhia Estanìfera do Brazil (CEBRAS), Arqueana Minérios e Metais (Arqueana), Tanex Resources plc (Tanex; a subsidiary of Sons of Gwalia Ltd (Sons of Gwalia)), and RI-X Mineração S.A. (RI-X). CEBRAS produced a tin/tantalite concentrate from open pit mines from 1957 to the 1980s. Arqueana operated small open pit mines from the 1980s to the 2000s, exploiting pegmatite and alluvial gravel material for tin and tantalite. Tanex Resources obtained a project interest from Arqueana, and undertook channel sampling, air-track, and reverse circulation (RC) drilling. The Project was subsequently returned to Arqueana. In 2012, RI-X obtained a controlling interest in Arqueana, and formed a new subsidiary company to Arqueana called Araçuaí Mineração whose name was later changed to SMSA. SMSA completed mapping, data compilation, a ground magnetic survey, channel sampling, and HQ core drilling. A heavy mineral separation (HMS) pilot plant was built during 2014–2015. Lithium-specific mining activities were conducted over at least five deposits in the Northern Complex, and four deposits in the Southern Complex.

In 2017 Sigma purchased a dense media separation (DMS) unit to produce a 6% Li_2O spodumene concentrate. Sigma has completed ground reconnaissance, satellite image interpretation, geological mapping, channel and chip sampling, trenching, core drilling, Mineral Resource and Mineral Reserve estimation, and a feasibility study. Sigma initially focused on a geological assessment of available field data to prioritize the 200 known pegmatites that occur on the various properties for future evaluation. A ranking table that highlighted pegmatite volume, mineralogy and Li_2O and Ta_2O_5 grade was established. Within the more prospective areas, Sigma concentrated its activities on detailed geological and mineralogical mapping of historically mined pegmatites, in particular, on the larger pegmatites.

1.5 GEOLOGICAL SETTING AND MINERALIZATION

The pegmatites in the Project area are classified as lithium–cesium–tantalum or LCT types. The Project area lies in the Eastern Brazilian Pegmatite Province (EBP) that encompasses a very large region of about 150,000 km^2, stretching from the state of Bahia to Rio de Janeiro state.

The pegmatite swarm is associated with the Neoproterozoic Araçuaí orogeny and has been divided into two main types: anatectic (directly formed from the partial melting of the country rock) or residual pegmatite (fluid rich silicate melts resulting from the fractional crystallization of a parent magma). The pegmatites in the Project area are interpreted to be residual pegmatites and are further classified as LCT types.

Pegmatite bodies are typically hosted in a grey biotite–quartz schist and form bodies that are generally concordant with the schist foliation but can also cross-cut foliation. The dikes are sub-horizontal to shallow-dipping sheeted tabular bodies, typically ranging in thickness from a few metres up to 40 m or more, and display a discontinuous, thin, fine-grained chilled margin. Typical pegmatite mineralogy consists of microcline, quartz, spodumene, albite and muscovite. Spodumene typically comprises about 28–30% of the dike, microcline and albite around 30–35%, and white micas about 5–7%. Locally, feldspar and spodumenes crystals can reach as much as 10–20 cm in length. Tantalite, columbite and cassiterite can occur in association with albite and quartz. The primary lithium-bearing minerals are spodumene and petalite. Spodumene can theoretically contain as much as 3.73% Li, equivalent to 8.03% Li_2O, whereas petalite, can contain as much as 2.09% lithium, equivalent to 4.50% Li_2O.

Features of the pegmatites where mineral resources have been estimated include:

- Xuxa: foliation concordant, strikes northwest–southeast, dips to the southeast at 40º to 45º, and is not zoned. The strike length is 1,700 m, averages 12–13 m in thickness and has been drill tested to 259 m in depth. Xuxa remains open to the west, east, and at depth
- Barreiro: foliation discordant, strikes northeast–southwest, dips to the southeast at 30º to 35º, and is slightly zoned with a distinct spodumene zone as well as an albite zone. The pegmatite is about 600 m long (strike), 30–35 m wide, and 800 m along the dip direction. Barreiro remains open to the northeast and at depth
- Murial: foliation discordant, strikes north–south, and has a variable westerly dip, ranging from 25º to 75º. The strike length is about 750 m, with a thickness of 15–20 m, and the down-dip dimension is 200 m. The pegmatite is zoned with a spodumene-rich intermediate zone and a central zone that contains both spodumene and petalite. The southern section of the pegmatite has lower lithium tenors than the norther portion of the dike. Murial remains open to the north, south, and at depth
- Lavra do Meio: foliation concordant, strikes north–south, dips 75º–80º to the east. The strike length is 300 m with an average thickness of 12–15 m and a down-dip distance of 250 m. The pegmatite is zoned and contains both spodumene and petalite and remains open at depth.

1.6 EXPLORATION

Sigma began working on the Project in June 2012, focusing on a geological assessment of available field data to prioritize the 200 known pegmatites that occur on the various properties for future evaluation. A ranking table that highlighted pegmatite volume, mineralogy and Li_2O and Ta_2O_5 grade was established.

Within the more prospective areas, Sigma concentrated its activities on detailed geological and mineralogical mapping of historically mined pegmatites, in particular, on the larger pegmatites, Xuxa and Barreiro. These dikes were channel sampled and subsequently assessed for their lithium, tantalum and cassiterite potential. This work was followed by bulk sampling and drilling. In the southern complex area, Sigma geologists have visited sites of historical workings, and undertaken reconnaissance mapping and sampling activities. The Lavra Grande, Samambaia, Ananias, Lavra do Ramom and Lavra Antiga pegmatites were mined for spodumene and heavy minerals, and in some cases gem-quality crystals were targeted. These pegmatites are considered to warrant additional work.

1.7 DRILLING

Drilling completed by Sigma across the Project area consists of 255 core holes totalling 42,959.76 m. To date, this drilling has concentrated on the Grota do Cirilo pegmatites. Drilling was at HQ core size (63.5 mm core diameter) in order to recover enough material for metallurgical testing. Drill spacing is variable by pegmatite, but typically was at 50 m with wider spacing at the edges of the drill pattern. Drill orientations were tailored as practicable to the strike and dip of the individual pegmatites. The drill hole intercepts range in thickness from approximately 85–95% of true width to near true width of the mineralization.

All core was photographed. Drill hole collars were picked up in the field using a Real Time Kinematic (RTK) global positioning system (GPS) instrument with an average accuracy of 0.01 cm. All drill holes were down-hole surveyed by Sigma personnel using the Reflex EZ-Track and Reflex Gyro instruments. Calibrations of tools were completed in 2017 and 2018.

Sampling intervals were determined by the geologist, marked and tagged based on lithology and mineralization observations. The typical sampling length was 1 m but varied according to lithological contacts between the mineralized pegmatite and the host rock. In general, 1-2 m host rock samples were collected from each side that contacts the pegmatite.

Sigma conducted HQ drilling programs in 2014, 2017, and 2018 on selected pegmatite targets. The drill programs have used industry-standard protocols that include core logging, core photography, core recovery measurements, and collar and downhole survey measurements. There are no drilling, sampling or recovery factors that could materially impact the accuracy and reliability of the results in any of the drill campaigns. Drill results from Grota do Cirilo property support the Mineral Resource estimates and the feasibility study.

1.8 SAMPLE PREPARATION, ANALYSES AND SECURITY

Sampling intervals were determined by the geologist, marked and tagged based on lithology and mineralization observations. The typical sampling length was 1 m but varied according to lithological contacts between the mineralized pegmatite and the host rock. In general, 1 m host rock samples were collected from each side that contacts the pegmatite.

All samples collected by SMSA during the course of the 2012–2018 exploration programs were sent to the SGS Geosol laboratory (SGS Geosol) located in the city of Belo Horizonte, Brazil. A portion of the 2017–2018 sample pulps were prepared by ALS Brazil Ltda. in Vespasiano, Brazil (ALS Vespasiano) and shipped to ALS Canada Inc. Chemex Laboratory (ALS Chemex) in North Vancouver, BC, Canada for cross check validation. A portion of the 2014 samples were resampled by the QP and sent for validation to the SGS Lakefield Laboratory (SGS Lakefield) in Lakefield Canada. All laboratories, including ALS Chemex, ALS Vespasiano, SGS Lakefield and SGS Geosol are ISO/IEC 17025 accredited. The SGS Geosol laboratory is ISO 14001 and 17025 accredited by the Standards Council. All laboratories used for the technical report are independent from SMSA and Sigma and provide services to SMSA pursuant to arm’s length service contracts.

Sample preparation conducted at SGS Geosol consisted of drying, crushing to 75% passing 3 mm using jaw crushers, and pulverizing to 95% passing 150 mesh (106 µm) using a ring and puck mill or a single component ring mill. In 2017, SGS Geosol performed 55-element analysis using sodium peroxide fusion followed by both inductively coupled plasma optical emission spectrometry (ICP-OES) and inductively coupled plasma mass spectrometry (ICP-MS) finish (SGS code ICM90A). This method uses 10 g of the pulp material and returns different detection limits for each element and includes a 10 ppm lower limit detection for Li and a 10,000 ppm upper limit detection for Li. In 2018, SGS Geosol used a 31-element analytical package using sodium peroxide fusion followed by both Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES) and ICP-MS finish (SGS code ICP90A).

Sample preparation at ALS Vespasiano comprised drying, crushing to 70% passing 2 mm using jaw crushers, and pulverizing to 85% passing 200 mesh (75 µm) using a ring and puck mill or a single component ring mill. Lithium and boron were determined by sodium peroxide fusion followed by ICP-AES analysis (ALS Chemex method ME-ICP82b).

The 2017 witness samples collected on the 2014 drill core were analyzed at SGS Lakefield using sodium peroxide fusion followed by both ICP-OES and ICP-MS finish (SGS code ICM90A).

In addition to the laboratory quality assurance quality control (QA/QC) routinely implemented by SGS Geosol and ALS Chemex using pulp duplicate analysis, SMSA developed an internal QA/QC protocol for the Xuxa drilling, which consisted of the insertion of analytical standard reference materials (standards), blanks and core duplicates on a systematic basis with the samples shipped to the analytical laboratories. In 2017, Sigma also sent pulps from selected mineralized intersections to ALS Chemex for reanalysis. No pulp reanalysis was performed by Sigma in 2013 and 2014. A total of 664 pulp samples from the 2017 Xuxa drilling program were sent to ALS Vespasiano for third-party verification.

SMSA inserted standards in sample batches during the 2014 and 2017–2018 sampling programs. During the 2014 campaign, the standard used was made of locally sourced and prepared pegmatite and was not certified. SMSA inserted an uncertified standard into the sample stream for every 25 samples for a total of five uncertified standards inserted. The 2017–2018 campaign used seven certified standards from African Mineral Standards (AMIS), an international supplier of certified reference materials. A total of 88 standards were inserted during the 2017 campaign and 315 were inserted during the 2018 campaign. Results were considered acceptable and no material accuracy issues were noted.

During the 2017–2018 campaign SMSA included insertion of analytical blanks in the sample series as part of their internal QA/QC protocol. The blank samples, which are made of fine silica powder provided by AMIS, are inserted an average of one for every 20 samples by the SMSA geologist and subsequently sent to SGS Geosol. The same procedure was used by SMSA for the 2014 drilling campaign. A total of 647 analytical blanks were analysed during the 2014 and 2017–2018 exploration programs. Results were considered acceptable and no material contamination issues were noted.

SMSA inserted core duplicates every 20th sample in the sample series as part of their internal QA/QC protocol. The sample duplicates correspond to a quarter HQ core from the sample left behind for reference, or a representative channel sample from the secondary channel cut parallel to the main channel. Assay results were considered acceptable between the two sample sets.

Bulk densities of the lithologies were measured by SGS Geosol by pycnometer measurement. Measurements were by lithology with special attention to the lithium bearing pegmatite. Separate measurements were made for the Xuxa and Barreiro deposits.

A total of 188 measurements were made on Xuxa core from 2017–2018. Of the 188 measurements, 24 were made on albite-altered pegmatite, 54 on schist, and 110 on lithium-bearing pegmatite. For Barreiro, a total of 401 measurements were made on core from the 2018 drill program. Of the 401 measurements, 82 were made on albite-altered pegmatite, 177 on schist, and 142 on lithium-bearing pegmatite. For Murial, a total of 134 measurements were made by the same method on core from the 2018 drill program. Of the 134 measurements, 32 were made on the albite-altered pegmatite, 58 on the schist and 44 on the lithium bearing pegmatite. For Lavra do Meio, a total of 51 measurement were made by the same method on core from the 2018 drill program. Of the 51 measurements, nine were made on the albite altered pegmatite, 22 on the schist and 20 on the lithium bearing pegmatite.

In 2017, SGS validated the exploration processes and core sampling procedures used by SMSA as part of an independent verification program. The QP concluded that the drill core handling, logging and sampling protocols are at conventional industry standard and conform to generally accept best practices. The chain of custody was followed by SMSA employees and the sample security procedure showed no flaws. The QP considers that the sample quality is good and that the samples are generally representative. Finally, the QP is confident that the system is appropriate for the collection of data suitable for a Mineral Resource estimate and can support Mineral Reserve estimates and mine planning.

1.9 DATA VERIFICATION

Visits to the Project site were conducted by Marc-Antoine Laporte, P.Geo., M.Sc. from September 11 to September 15, 2017, from July 11 to July 17, 2018 and from September 18 to 23, 2018. These visits enabled the QP to become familiar with the exploration methods used by SMSA, the field conditions, the position of the drill hole collars, the core storage and logging facilities and the different exploration targets.

The database for the Project was first transmitted to SGS by Sigma on September 15, 2017 and was regularly updated by Sigma geologists. The database contains data for: collar locations; downhole surveys; lithologies and lithium assays. Upon importation of the data into the modelling and mineral resources estimation software (Genesis©), SGS conducted a second phase of data validation where all the major discrepancies were removed from the database. Finally, SGS conducted random checks on approximately 5% of the assay certificates, to validate the assay values entered in the database.

Witness samples were taken from previously sampled intervals and the half cores were cut to quarter cores. A total of nine mineralized intervals were sampled to compare the average grade for the two different laboratories. The average for the original samples is 1.61 % Li_2O while the average for the control samples is 1.59 % Li_2O. The average grade difference is 0.02% which makes a relative difference of 1.28% between the original and the control samples.

As additional control sampling, SMSA sent 664 samples from the 2017-2018 Grota do Cirillo drilling campaign to ALS Chemex for analysis using the protocol ME-ICP82b with sodium peroxide fusion. Preparation was done by ALS Vespasiano and the samples were subsequently shipped to Vancouver. The average Li concentration for the original was 6,411.4 ppm Li while the duplicate average was 6,475.9 ppm Li. This indicates a slight bias of the ALS Chemex duplicates which is well within the accepted margin of error.

Following the data verification process and QA/QC review, the QP is of the opinion that the sample preparation, analysis and QA/QC protocol used by SMSA for the Project follow generally accepted industry standards and that the Project data is of a sufficient quality. However, more attention should be put into the blank material selection in the future in order improve the similarity between the batches.

1.10 MINERAL PROCESSING AND METALLURGICAL TESTING

Drill core samples from the Xuxa pegmatite deposit were processed at the SGS Lakefield facility in October 2018. Work conducted included comminution, heavy liquid separation (HLS), REFLUX™ classifier, DMS and magnetic separation.

Drill core samples were selected and combined into six variability (Var) samples for a test work program comprising of mineralogical analyses, grindability, HLS, REFLUX™ classifier, DMS, and magnetic separation testing. Flowsheets for lithium beneficiation were developed in conjunction with the testwork. The goal was to produce spodumene concentrate grading a minimum 6% Li_2O and maximum 1% Fe_2O_3 while maximizing lithium recovery.

Four HLS tests, at four crush sizes (15.9 mm, 12.5 mm, 9.5 mm, and 6.3 mm) were carried out on each of the six variability samples to evaluate the recovery. The 9.5 mm crush size was selected as the optimum crush size for DMS test work, as it results in the highest lithium recovery with minimal fines generation.

The DMS variability samples were each crushed to -9.5 mm and screened into four size fractions: coarse (-9.5/+6.3 mm), fines (-6.3/+1.7 mm), ultrafines (-1.7/+0.5 mm) and hypofines (-0.5 mm). The coarse, fines and ultrafines fractions of each variability sample were then processed separately for lithium beneficiation. The REFLUX™ classifier test work was carried out with a RC-100 unit for mica rejection from the fines and ultrafines fractions only. This test work was conducted at FLSmidth's Minerals Testing and Research Center in Utah, USA.

The coarse and fines REFLUX™ classifier underflow and ultrafines RC underflow of each variability sample were processed separately through DMS. The DMS concentrate from each of these fractions underwent a magnetic separation step at 10,000 Gauss.

The DMS test work flowsheet for the coarse and fines fractions included two passes through the DMS; the first at a lower specific gravity (SG) cut-point (~2.65) to reject silicate gangue and the second at a higher specific gravity (SG) cut-point (~2.90) to generate spodumene concentrate. The coarse DMS middlings were re-crushed to -3.3 mm and a two stage HLS test conducted. The ultrafines DMS test work flowsheet included only a single pass through the DMS circuit at a high SG cut-point (~2.90) to generate spodumene concentrate.

The DMS test results demonstrated that DMS was able to produce spodumene concentrate with >6% Li_2O in most of the tests, for an average recovery of 60.4%.

The Var 3 and Var 4 samples were determined to best represent the deposit.

1.11 MINERAL RESOURCE ESTIMATES

Mineral Resources for the Grota do Cirilo pegmatite were estimated using a computerised resource block model. Three-dimensional wireframe solids of the mineralisation were defined using drill hole Li_2O analytical data.

Data were composited to 1 m composite lengths, based on the north–south width of the block size defined for the resource block model. Compositing starts at the schist-pegmatite contact. No capping was applied on the analytical composite data. The Xuxa models used a 6 m x 3 m x 5 m block size. Murial and Lavra do Meio models used a 5 m x 3 m x 5 m block size and the Barreiro model used a 5 m x 5 m x 5 m block. Average densities were applied to blocks, which varied by pegmatite, from 2.65 t/m^3 at Lavra do Meio to 2.71 t/m^3 at Barreiro.

Variography was undertaken for Xuxa, Barreiro and LDM and the projection and Z-axis rescaling were done according to the mineralization orientation.

The grade interpolation for the Xuxa, Barreiro and Lavra do Meio resource block models were completed using ordinary kriging (OK). The Murial model was estimated using an inverse distance weighting to the second power (ID2) methodology. The interpolation process was conducted using three successive passes with more inclusive search conditions from the first pass to the next until most blocks were interpolated, as follows:

- Pass 1:
- Xuxa: search ellipsoid distance of 75 m (long axis) by 75 m (intermediate axis) and 25 m (short axis) with an orientation of 130° azimuth and -50° dip to the southeast; minimum of seven composites, a maximum of 15 composites and a minimum of three drill holes
- Barreiro: search ellipsoid distance of 55 m (long axis) by 55 m (intermediate axis) and 25 m (short axis) with an orientation of 155° azimuth and -35° dip to the southeast; a minimum of seven composites, a maximum of 15 composites and a minimum of three drill holes
- Murial: 75 m (long axis) by 75 m (intermediate axis) and 35 m (short axis) with an orientation of 95° azimuth and -80° dip to the west; minimum of seven composites, a maximum of 15 composites and a minimum of three drill holes
- Lavra do Meio: 50 m (long axis) by 50 m (intermediate axis) and 25 m (short axis) with an orientation of 280° azimuth and -75° dip to the east; minimum of five composites, a maximum of 15 composites and a minimum of three drill holes

- Pass 2:

- Xuxa: twice the search distance of the first pass; minimum of seven composites, a maximum of 15 composites and a minimum of three drill holes
- Barreiro: twice the search distance of the first pass; a minimum of seven composites, a maximum of 15 composites and a minimum of three drill holes
- Murial: twice the search distance of the first pass; minimum of seven composites, a maximum of 15 composites and a minimum of three drill holes
- Lavra do Meio: twice the search distance of the first pass; minimum of five composites, a maximum of 15 composites and a minimum of three drill holes
- Pass 3:
- Xuxa: 300 m (long axis) by 300 m (intermediate axis) by 100 m (short axis) with a minimum of seven composites, a maximum of 25 composites and a minimum of three drill holes
- Barreiro: 250 m (long axis) by 250 m (intermediate axis) by 100 m (short axis) with a minimum of seven composites, a maximum of 25 composites and no minimum number of drill holes
- Murial: 200 m (long axis) by 200 m (intermediate axis) by 100 m (short axis) with a minimum of seven composites, a maximum of 20 composites and no minimum number of drill holes
- Lavra do Meio: 125 m (long axis) by 125 m (intermediate axis) by 75 m (short axis) with a minimum of five composites, a maximum of 15 composites and no minimum composites required per drill hole.

The estimates and models were validated by statistically comparing block model grades to the assay and composite grades, and by comparing block values to the composite values located inside the interpolated blocks. The estimates were considered reasonable.

Mineral Resources are classified into Measured, Indicated and Inferred categories. The Mineral Resource classification is based on the density of analytical information, the grade variability and spatial continuity of mineralization. The Mineral Resources were classified in two successive stages: automated classification, followed by manual editing of final classification results. Classifications were based on the following:

- Measured Mineral Resources
- Xuxa: the search ellipsoid used was 50 m (strike) by 50 m (dip) by 25 m with a minimum of seven composites in at least three different drill holes
- Barreiro, Murial, and Lavra do Meio: the search ellipsoid was 55 m (strike) by 55 m (dip) by 35 m with a minimum of five composites in at least three different drill holes
- Indicated Mineral Resources
- In all deposits, the search ellipsoid was twice the size of the Measured category ellipsoid using the same composites selection criteria
- Inferred Mineral Resources
- In all deposits, all remaining blocks.

The conceptual economic parameters were used to assess reasonable prospects of eventual economic extraction. A series of economic parameters were estimated to represent the production cost and economic prospectivity of an open pit mining operation in Brazil and came either from SGS Canada or SMSA. These parameters are believed to be sufficient to include all block models in future open pit mine planning, due mostly to the relatively low mining costs in Brazil.

The Mineral Resource estimates for Grota do Cirilo are reported in Table 1-1 to Table 1-4 using a 0.5% Li_2O cut-off. The Mineral Resource estimates are constrained by the topography and are based on the conceptual economic parameters. The estimate has an effective date of January 10, 2019. The QP for the estimate is Mr. Marc-Antoine Laporte, P.Geo., an SGS employee.

Table 1-1 – Xuxa Deposit Mineral Resource Estimate

Cut-off Grade Li_2O (%)	**Category**	**Tonnage (t)**	**Average Grade Li_2O (%)**
0.5	Measured	10,193,000	1.59
0.5	Indicated	7,221,000	1.49
0.5	**Measured + Indicated**	**17,414,000**	**1.55**
0.5	Inferred	3,802,000	1.58

Notes to accompany Table 1.1 Xuxa Deposit Mineral Resource Estimate:

1. Mineral Resources have an effective date of January 10, 2019 and have been classified using the 2014 CIM Definition Standards. The Qualified Person for the estimate is Mr. Marc-Antoine Laporte, P.Geo., an SGS employee.
2. Mineral Resources are reported assuming open pit mining methods, and the following assumptions: lithium concentrate (6% Li_2O) price of US$1,000/t, mining costs of US$2/t for mineralization and waste, US$1.2/t for overburden, crushing and processing costs of US$12/t, general and administrative (G&A) costs of US$4/t, concentrate recovery of 85%, 2% royalty payment, pit slope angles of 55º, and an overall cut-off grade of 0.5% Li_2O.
3. Tonnages and grades have been rounded in accordance with reporting guidelines. Totals may not sum due to rounding.
4. Mineral Resources are reported inclusive of those Mineral Resources converted to Mineral Reserves. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.
5. Long-term Li_2O price of $1,000/tonne assumes processing cost of US$12 and metallurgical recovery of 85%.

Table 1-2 – Barreiro Deposit Mineral Resource Estimate

Cut-off Grade Li_2O (%)	**Category**	**Tonnage (t)**	**Average Grade Li_2O (%)**
0.5	Measured	10,313,000	1.4
0.5	Indicated	10,172,000	1.46
0.5	***Measured + Indicated***	***20,485,000***	***1.43***
0.5	Inferred	1,909,000	1.44

Notes to accompany Table 1.2 Barreiro Deposit Mineral Resource Estimate

1. Mineral Resources have an effective date of January 10, 2019 and have been classified using the 2014 CIM Definition Standards. The Qualified Person for the estimate is Mr. Marc-Antoine Laporte, P.Geo., an SGS employee.
2. Mineral Resources are reported assuming open pit mining methods, and the following assumptions: lithium concentrate (6% Li_2O) price of US$1,000/t, mining costs of US$2/t for mineralization and waste, US$1.2/t for overburden, crushing and processing costs of US$12/t, general and administrative (G&A) costs of US$4/t, concentrate recovery of 85%, 2% royalty payment, pit slope angles of 55º, and an overall cut-off grade of 0.5% Li_2O.
3. Tonnages and grades have been rounded in accordance with reporting guidelines. Totals may not sum due to rounding.
4. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.
5. Long-term Li_2O price of $1,000/tonne assumes processing cost of US$12 and metallurgical recovery of 85%.

Table 1-3 - Murial Deposit Mineral Resource Estimate

Cut-off Grade Li_2O (%)	Category	Tonnage (t)	Average Grade Li_2O (%)
0.5	Measured	4,175,000	1.17
0.5	Indicated	1,389,000	1.04
0.5	**Measured + Indicated**	**5,564,000**	**1.14**
0.5	Inferred	669,000	1.06

Notes to accompany Table 1.3 Murial Deposit Mineral Resource Estimate

1. Mineral Resources have an effective date of January 10, 2019 and have been classified using the 2014 CIM Definition Standards. The Qualified Person for the estimate is Mr. Marc-Antoine Laporte, P.Geo., an SGS employee.
2. Mineral Resources are reported assuming open pit mining methods, and the following assumptions: lithium concentrate (6% Li_2O) price of US$1,000/t, mining costs of US$2/t for mineralization and waste, US$1.2/t for overburden, crushing and processing costs of US$12/t, general and administrative (G&A) costs of US$4/t, concentrate recovery of 85%, 2% royalty payment, pit slope angles of 55º, and an overall cut-off grade of 0.5% Li_2O.
3. Tonnages and grades have been rounded in accordance with reporting guidelines. Totals may not sum due to rounding.
4. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability
5. Long-term Li_2O price of $1,000/tonne assumes processing cost of US$12 and metallurgical recovery of 85%.

Table 1-4 - Lavra do Meio Deposit Mineral Resource Estimate

Cut-off Grade Li_2O (%)	Category	Tonnage (t)	Average Grade Li_2O (%)
0.5	Measured	1,626,000	1.16
0.5	Indicated	649,000	0.93
0.5	**Measured + Indicated**	**2,275,000**	**1.09**
0.5	Inferred	261,000	0.87

Notes to accompany Table 1.4 Lavra do Meio Deposit Mineral Resource Estimate

1. Mineral Resources have an effective date of January 10, 2019 and have been classified using the 2014 CIM Definition Standards. The Qualified Person for the estimate is Mr. Marc-Antoine Laporte, P.Geo., an SGS employee.
2. Mineral Resources are reported assuming open pit mining methods, and the following assumptions: lithium concentrate (6% Li_2O) price of US$1,000/t, mining costs of US$2/t for mineralization and waste, US$1.2/t for overburden, crushing and processing costs of US$12/t, general and administrative (G&A) costs of US$4/t, concentrate recovery of 85%, 2% royalty payment, pit slope angles of 55º, and an overall cut-off grade of 0.5% Li_2O.
3. Tonnages and grades have been rounded in accordance with reporting guidelines. Totals may not sum due to rounding.
4. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.
5. Long-term Li_2O price of $1,000/tonne assumes processing cost of US$12 and metallurgical recovery of 85%.

Factors that can affect Grota do Cirilo Mineral Resource estimates include but are not limited to:

- Changes to the modelling method or approach
- Changes to geotechnical assumptions, in particular, the pit slope angles
- Metallurgical recovery assumption that are based on preliminary test results
- Changes to any of the social, political, economic, permitting, and environmental assumptions considered when evaluating reasonable prospects for eventual economic extraction.

Mineral Resource estimates can also be affected by the market value of lithium and lithium compounds.

1.12 MINERAL RESERVE ESTIMATES

Xuxa Mineral Reserve estimates have an effective date of 5 June 2019 and have been converted from Measured and Indicated Mineral Resources. The key parameters upon which the 5 June 2019 Mineral Reserve estimates were defined are summarized in Table 1-5.

Table 1-5 – Parameters Used in Pit Optimization

Parameter	Value
Lithium concentrate price	US$700/t concentrate
Royalties (CFEM)	2% over revenue
Exchange rate	3.7 BRL/ US$
Costs	
Mining	US$2.15/t mined
Processing	US$10.51 /t ore
G&A	US$3,809,106/ year
Logistics	US$82/t concentrate wet
Plant recovery	60.4%
Concentrate grade	6%
Mining recovery	100%
Dilution	9.3%
Overall Pit slopes	33.6° – 53°

Note: CFEM is the Brazilian government royalty

The total Proven and Probable Mineral Reserves are as presented in Table 1-6.

Table 1-6 – Mineral Reserves

Reserve	Tonnage (t)	Li_2O (%)
Proven	10,270,000	1.45
Probable	3,520,000	1.47
TOTAL	**13,790,000**	**1.46**

Note to accompany Mineral Reserves table:

1. Mineral Reserves have an effective date of 5 June 2019. The Qualified Person for the estimate is Porfirio Cabaleiro Rodriguez, MAIG, an employee of GE21.
2. Mineral Reserves are confined within an optimized pit shell that uses the following parameters: lithium concentrate price: US$700/t concentrate; mining costs: US$2.15/t mined; processing costs: US$10.51/t processed; general and administrative costs: US$3.8 M/a; logistics costs: US$82/t wet concentrate; process recovery of 60.4%; mining dilution of 9%; pit inter-ramp angles that range from 40.5 – 74.8º.
3. Tonnages and grades have been rounded in accordance with reporting guidelines. Totals may not sum due to rounding.

The existing high voltage transmission line at Pit 1 will need to be relocated in Year 2 so as not to interfere with the mining of the pit's northern part. Sigma has been given the legal authority to relocate the line by 150 m.

Sigma has not purchased the surface rights for Pit 2 but has applied to the ANM (Brazilian mining regulatory agency) for the granting of authority to mine the area. Pit 2 will come into operation 1.5 years after plant start-up.

1.13 MINING METHODS

Sigma has undertaken a program of resource drilling for the Xuxa deposit. Most of these drill holes have been geotechnically logged for structural data. The geotechnical data logged from these holes has been analyzed to provide estimates of slope stability, using industry standard empirical techniques.

The mine layout and operation are based on the following criteria:

- Two independent open pits areas: Pit 1 in the north and Pit 2 in the south
- Single access from both pits to the mine infrastructure pad and the processing plant
- Low height ore benches to reduce mine dilution and maximize mine recovery
- Pre-splitting of the ore zone to reduce mine dilution
- Elevated inter-ramp angles for the waste to reduce strip ratio.

The basis for the scheduling includes:

- Six months of pre-stripping to liberate the ore
- Mining of Pit 1 first as this is closer to the processing plant and is also included in the current environmental license process
- Disposal of the waste rock at the start of operation at pile 1 (close to processing plant) and pile 2
- Commence disposal of waste rock at pile 3 after one year and three months from the start of the operation
- Commence mining of Pit 2 from Year 3 onwards
- Mine both pits in conjunction from Year 3 to Year 6 to reduce the drop-down rate and to facilitate the 1.5 Mtpa production rate
- The planned open pit mine life is nine years and three months
- The mining fleet is based on off-highway trucks for the waste movement and road trucks for the ore to be operated by a mining contractor.

1.14 RECOVERY METHODS

The Xuxa concentrator plant is designed to produce a minimum 6.0% Li_2O spodumene concentrate from an ore grade of 1.46% Li_2O (diluted) with an average iron content of 0.97%, using DMS.

1.14.1 Processing Plant Description

The plant throughput capacity is based on a 1.5 Mtpa (dry) of ore fed to the crushing circuit. The wet plant (DMS) is sized for 1.5 Mtpa throughput capacity, while the in-house crushing circuit is sized for 3.0 Mtpa (accounting for a potential additional future DMS plant that would be used to treat a different deposit).

The concentrator plant is designed based on a proven DMS circuit and includes a three-stage conventional crushing and screen circuit, up-flow classification for mica removal, two-stage coarse DMS circuit, two-stage fines DMS circuit, single-stage ultrafines circuit, as well as magnetic separation and optical sorting on the final product stream.

1.14.2 Design Criteria and Utilities Requirements

The data for the feasibility study engineering and design were sourced from metallurgical test-work conducted at SGS Lakefield. Recovery data are based on results from variability samples #3 and #4. The mass balance, process design criteria and process flow diagrams were developed based on these test work data.

The utilities consumption requirements are approximately 6.7 MW for the process plant and 1.5 MW for non-process infrastructure at the process plant.

The raw water consumption for process water is nominal a 23 m^3/hr (make-up raw water requirement).

The process water will be recycled within the plant using a thickener, where all fines slurry streams will be directed and recovered. This water will be pumped to the process water tank and recycled to the circuits.

Consumables will include reagents and operational consumables for the crushing circuit and the DMS plant.

1.15 PROJECT INFRASTRUCTURE

The project infrastructure will be constructed on earthworks pads for the mineral processing plant, the mine operation support units, the open pits of the mines and the areas of waste rock and tailings disposal.

1.15.1 Buildings, Roads, Fuel storage, Power Supply and Water Supply

Access to the processing plant will be by municipal road linking BR367 within the communities of Poço D'antas and Taquaril Seco. The current road will be suitable for truck traffic; however, construction of a new section of the road will be necessary to bypass the plant.

The plant and mine services areas will have administrative buildings such as offices, changeroom, cafeteria, concierge, clinic, fire emergency services and operation support facilities such as workshops and warehouses.

Fuel will be stored and dispensed from a fuel facility located at the mine services area.

Power will be supplied from the existing power grid line. Two main sub-stations (CEMIG and plant) will be installed to supply power to the plant, the mine services area and associated infrastructure.

Raw water will be supplied from the Jequitinhonha River, treated as necessary and reticulated within the plant for process, potable and firewater needs.

1.15.2 Waste Rock and Tailings Disposal and Stockpiles

Waste rock and tailings will be stored in two piles in the initial years of operation. Waste pile 1 will be located near the process area (both in the Olimpio area) and will be used for co-disposal of waste rock and tailings generated from the plant.

Waste pile 2 will be located to the south, in the Gilson area.

Both piles will have 25m wide access ramps with maximum gradients of 10%.

Waste piles 3 and 4 will be located adjacent to the north and south pits respectively. Table 1-7 provides the projected storage requirements.

Table 1-7 – Waste Pile Storage

	Waste Rock m^3	**Tailings m^3**	**Waste & Tailings Total Mt**	**Years - Storage**
Waste pile #1	7,845,000	567,400	17 (Note 1)	1.3
Waste pile #2	456,731 (Note 2)	39,879	1.0	1.3
Waste pile #3	17,399,267	8,582,001	88.26	4.5
Waste pile #4	26,776,556	-	101.14	5.2

Note 1: approximately 6.0 Mt of mine pre-stripping (first 2 quarters of mine production) will be disposed of at waste pile 1

Note 2: 314,072 m^3 will be clear and grub from the process area and mine services area and 142,659 m^3 from the earthworks cut material.

1.15.3 Control Systems and Communication

A process control system (PCS) including a main plant SCADA system will be installed for monitoring and control purposes.

The telecommunications network will consist of the telecommunications network, access control system and RFID.

1.16 MARKET STUDIES AND CONTRACTS

The key information contained in the market study was prepared by Roskill Consulting Group Ltd (Roskill).

1.16.1 Demand and Consumption

The short-, medium- and long-term outlook for lithium consumption appears strong, with overall consumption growth forecast at 15.2% per annum, and demand growth 14.5% per annum, to 2033 in the base-case scenario. Growth will be higher in the shorter-term, at 22.7% per annum to 2023, and then slow to 14.0% per annum from 2023 to 2028, and 9% per annum from 2028 to 2033, as the market matures.

There are, however, considerable upside and downside risks to the outlook for growth in consumption of lithium to 2028, dependant on the global economic growth and the demand of Li-ion battery-powered hybrid and electric vehicles (xEVs).

1.16.2 Supply

At end-2018, global nameplate production capacity for mining lithium totalled 588,540 tpa lithium carbonate equivalent (LCE). Based on announced capacity expansions and new project schedules, lithium mine production capacity is forecast to increase to almost 1.0 Mtpa LCE by 2022. The largest additions to mine capacity are in Australia for mineral-based production and Chile for brine-based production. Additional mine capacity will be required from the mid/late-2020s.

1.16.3 Contracts

Sigma has entered into a binding heads of agreement (the Agreement) for a strategic offtake and funding partnership with Mitsui & Co., Ltd. of Japan (Mitsui) for a significant portion of the funding required for the capital expenditures and project construction.

Pursuant to the Agreement, Mitsui and Sigma have agreed terms on:

- Production pre-payment to Sigma of US$30,000,000 for battery-grade lithium concentrate supply of up to 55,000 t annually over six years, extendable for five years plus an off-take agreement supplementary 25,000 t of product annually
- Advancement of deposit for long-lead items for the project
- Strategic collaboration to leverage Mitsui's considerable global logistics and battery materials marketing expertise as well as an agreement to continue discussions regarding additional funding for further exploration and development of Sigma's mineral properties
- Mitsui's right to participate in Sigma's future capital for production expansion with other deposits conditional to concluding a feasibility study and Mineral Reserves estimates
- Sales prices are set quarterly based on the published price of nominal arms-length chemical-spodumene concentrate above 6% Li_2O (SC6).

Sigma is currently in negotiations with further potential off-take customers for the balance of its annual production. Currently, Sigma has no other agreements in place.

Sigma has no contracts in place in support of operations. Any future contracts are likely to be negotiated and renewed on an annual or biannual basis. Contract terms are expected to be typical of similar contracts in Minas Gerais State.

1.16.4 Price Forecast

Sigma is using the 10-year Roskill forecast for the average spodumene concentrate nominal arms-length sales price of US$733.00 US (cost, insurance and freight (CIF) delivered to Port of Shanghai, China) in the economic assessment.

1.17 ENVIRONMENTAL STUDIES, PERMITTING AND SOCIAL OR COMMUNITY IMPACT

Conselho Estadual de Politica Ambiental (COPAM) granted an Operation License in support of certain SMSA mining concessions on the Grota do Cirilo property on August 25, 1994. The licence was renewed on August 14, 2008 but has subsequently been allowed to lapse as it was not suitable for the new level of mining contemplated by Sigma. Sigma applied and was issued the first phase of the Preliminary License (Licença Previa or LP) and an Installation License (Licença de Instalação or LI) to commence construction at the Xuxa deposit. Mining licenses are for life of mine and environmental licences are timely renewed when due.

Sigma holds approved economic mining plans (Plano de Aproveitamento Econômico or PAE) over the Xuxa, Barreiro, Lavra do Meio, Murial, Maxixe and Nezinho do Chicâo deposits within the Grota do Cirilo property. The PAE for Xuxa was updated and approved in August 2018.

Reclamation plans (referred to as degraded area plans or PRADs) have been developed and implemented for certain past-producing areas within the Grota do Cirilo property. The successful recovery of these areas is managed by SMSA personnel and external consultants in conjunction with the governing regulatory agencies.

Sigma has held regular meetings and consultation sessions with local stakeholders regularly over the last five years. The further development of SMSA mining activities in the Jequitinhonha Valley is viewed by both communities as an important regional economic driver.

1.17.1 Applicable Legal Requirements for Project Environmental Permitting

CONAMA Resolution N° 237 (1997) defines environmental licensing as an administrative procedure by which the competent environmental agency permits the locating, installation, expansion and operation of enterprises and activities that use environmental resources in a manner considered to be effectively or potentially polluting.

The licensing process in Minas Gerais has been developed in accordance with COPAM Regulatory Deliberation N° 217, dated December 6, 2017 and establishes classification criteria based on scale and polluting potential, as well as the locational criteria used to define the modalities of environmental licensing of ventures and activities that use environmental resources in the state of Minas Gerais.

In compliance with CONAMA Resolution 09/90, the environmental licensing of mining projects is always subject to an Environmental Impact Assessment (EIS), followed by an Environmental Impact Report (EIR), which supports the technical and environmental feasibility stage of the project and the granting of a LP and/or a concurrent LP + LI.

1.17.2 Current Project Environmental Permitting Status

A Concurrent Environmental Licensing Type CEL 2 (LP + LI) will be required in support of operations.

The water license for the uptake of 150 m³/h of water from the Jequitinhonha River was approved by the Agencia Nacional das Águas (ANA) in February 2019.

The CEL 2 (LP + LI) for the initial project phase, consisting of the north pit (Pit #1), waste piles 1 and 2 and the plant area was submitted on December 20, 2018 and was followed by the complete presentation of the EIS, the EIR and the Environmental Control Plan (ECP) as well the other documents listed in Basic Guidance Form (BGF). The EIS (Estudo e Relatorio de Impacto Ambiental – EIA-RIMA dated 30 October 2018) and Plano de Controle Ambiental – PCA dated December 2018 were prepared and issued for submittal to the authorities by NEO Soluções Ambientais and ATTO GEO Geologia e Engenheria. Approval was obtained on June 3, 2019.

A second EIS covering Pit #2 and waste piles #3 and #4 will be prepared in 2019 and formally submitted for approval in March 2020 in line with the prescribed permitting timing requirements for the process plant coming online with Pit #1.

1.17.3 Authorization

SMSA is the owner of the mining rights registered under DNPM Nº 824.692/1971, and the holder of Mining Concession Ordinance Nº 1.366, published on October 19, 1984. In 2018 a new Economic Development Plan (EDP) was registered with the National Mining Agency (ANM), which was approved on November 16, 2018.

The approval of the EDP and environmental study involves the technical and legal analysis and formal approval of the proposed project. Upon being granted the LP + LI, the company must install the project, comply with the environmental conditions established in the LP + LI certificate and finally, apply for the Operation License in order to begin operational activities.

The formalization of the environmental licensing process also includes the requesting and granting of the EIA. The environmental intervention process was also duly applied for on the same day, December 20, 2018, under registration Nº 0859842/2018. This will allow Sigma environmental intervention in an approximately 64 ha area.

1.17.4 Land Access

Sigma has a lease agreement with Miazga Participações S.A., owner of the Poço Danta-Paiuí, Poço Danta and Poço Dantas Farms, to carry out mining activities on its properties. These farms include Legal Reserves (LR) which are preserved and registered in the National Rural Environmental Registration System (NRERS), in accordance with Law Nº 12.651, dated May 25, 2012.

1.17.5 Social License Considerations

Sigma understands and accepts the importance of proactive community relations as an overriding principle in its day-to-day operations as well as future development planning. The company therefore structures its community relations activities to consider the concerns of the local people and endeavors to communicate and demonstrate its commitment in terms that can be best appreciated and understood to maintain the social license to operate.

The Jequitinhonha valley is the poorest region in Minas Gerais which is plighted by poverty and is in the lowest quartile the Human Development Index (HDI). Sigma is the largest investment and operation in the area by a factor of ten and the project will be transformational to the local communities. The largest direct economic benefit is that Sigma is subject to a 2% royalty on revenue which is divided between the Federal Government, State Government and Local Government. Secondly a portion of the taxes on local procurement of goods and services is shared with the Local Government. These incomes from the royalty and tax are a most important source of funding for local Government and Sigma is the largest direct contributor in the region. Sigma will be by far the largest employer in the region with an estimated 500 direct jobs being created with 3 to 4 times this number being indirect.

Farming in the area is small-scale subsistence type as the area is semi-arid. There is minimal impact on the neighbouring farms of Grota do Cirilo properties. Sigma and contractor workforce will live in the cities of Araçuaí and Itinga and strict environmental management plans are in place to minimize the environmental footprint of the project. An example is 90% of the process water is re-circulated and there is zero run-off water from the site except during the wet season, when excess water from the pond will be discharged in an overflow channel. The process uses dry stacking technology and no slimes dam will be built. Regular environmental monitoring will be conducted, and results will be shared with the local communities.

Sigma has targeted and continues with consultations/engagements with numerous stakeholders in support of project development of the Project and has hosted visits from representatives of government departments and local academic institutions.

1.17.6 Rehabilitation, Closure Planning and Post-Closure Monitoring

WP established the closure plan and associated costs. The closure plan for the Grota do Cirilo property encompasses the following: dismantling of building and infrastructure, removal of heavy mobile and surface equipment, restoration by reconstituting vegetal cover of the soil and the establishment of the native vegetation, grading and capping with vegetation suppression layer and revegetation of the waste rock and overburden stockpiles, removal of suppressed vegetation along with slope cover and surface drainage for water management, fencing of site, environmental liability assessment studies where there may have been spillages and soil and water contamination and safe disposal, revegetation of the open pit berm areas and fencing around the open pits.

In the post-closure phase, a socioenvironmental and geotechnical monitoring program will be carried out, to support ecosystem restoration or preparation for the proposed future use.

The monitoring program will collect soil and diversity of species on an annual basis, continuing for a five-year period after mine closure.

1.18 CAPITAL AND OPERATING COSTS

1.18.1 Capital Costs

The capital cost (CAPEX) estimate includes the process plant, site infrastructure, mining and Owner’s costs. Pre-production, working capital, sustaining and deferred capital costs were also included.

Equipment costs were obtained with firm price quotations for six long lead mechanical equipment and with budgetary quotations for the remaining equipment packages. In-country (Brazil) quotations were obtained for the installation unit rates and to the extent feasible for equipment supply. Brazilian fabricators were selected for structural steel and platework supply and fabrication.

Material take-offs (MTOs) were generated from the feasibility study designs with the unit rate costs applied per commodity. The CAPEX estimate has an accuracy of ±15% and is summarized in Table 1-8.

Table 1-8 – Capital Cost Estimate Summary

Description	**Capital Cost US$ (Million)**
Processing plant	32.8
Site infrastructure	32.2
Owner's cost	4.6
Contingency	7.5
Recoverable taxes	-6.0
SUBTOTAL CAPITAL COST	71.1
Pre-production and working capital	27.3
Sustaining and deferred capital	15.2

1.18.2 Operating Costs

The operating cost (OPEX) estimate is based on contract mining, build-own-operate (BOO) high-voltage electrical sub-stations and non-process infrastructure substations and contract crushing, as per Sigma's preferred commercial strategy.

The concentrate transport cost has been estimated to be US$22.90M per annum or US$15.30/t of ore per Sigma input based on preliminary quotations. This includes all the transport costs from the site to the Port of Ilhéus, Brazil, port storage and handling fees and CIF shipment to the port of Shanghai, China.

General and administration costs have been estimated to be US$2.64M per annum or US$1.76/t of ore.

Operating cost estimates are summarized in Table 1-9.

Table 1-9 – Operating Cost Estimate Summary

Description	**OPEX US$/t**
Mining cost per tonne of ore mined	21.91
Process cost per tonne of ROM	10.69
G&A cost per tonne of ROM	1.76
Shipping per tonne of ROM	15.30
NPI (included in Process and G&A)	-
TOTAL	49.66

The OPEX costs are inclusive of taxes. The OPEX accuracy is ± 15%.

1.19 ECONOMIC ANALYSIS

Forward-looking information is based on certain factors and assumptions management believes to be reasonable at the time such statements are made, including but not limited to, continued exploration activities, lithium and other metal prices, the estimation of initial and sustaining capital requirements, the estimation of labour and production costs, the estimation of Mineral Reserves and Resources, assumptions with respect to currency fluctuations, the timing and amount of future exploration and development expenditures, receipt of required regulatory approvals, the availability of necessary financing, permitting and such other assumptions and factors as set out herein. Forward-looking information is subject to known and unknown risks, uncertainties and other factors that may cause the actual results, level of Sigma's activities, performance or achievements to be materially different from those expressed or implied by such forward-looking information.

Although the QPs have attempted to identify important factors that could cause actual results to differ materially from the forward-looking information set out in this presentation, there may be other factors that cause results not to be as anticipated, estimated or intended. There can be no assurance that such forward-looking information will prove to be accurate, as actual results and future events could differ materially from those anticipated in such information. Accordingly, readers should not place undue reliance on forward-looking information. Forward-looking information is made as of the date of this presentation and neither the QPs or Sigma undertake to update or revise any forward-looking information that is included herein, except in accordance with applicable securities laws.

The economic analysis was developed using the discounted cash flow method and based on the data and assumptions for capital and operating costs detailed in this report for mining, processing and associated infrastructure. An exchange rate of 3.85 BRL per US$ was used to convert particular components of the cost estimates into US$. No provision was made for the effects of inflation and the base currency was considered on a constant 2019 US$ basis. The evaluation was undertaken on a 100% equity basis. Exploration costs are deemed outside of the project and any additional project study costs have not been included in the analysis. Base case scenario results are presented in Table 1-10.

Table 1-10 – Base Case Economic Analysis Results

Item	Unit	Value
Pre-tax NPV @ 8%	US$	299,074,000
After-tax NPV @ 8%	US$	248,507,000
Pre-tax IRR	%	47.6%
After-tax IRR	%	43.2%
Pre-tax payback period	Years	2.9
After-tax payback period	Years	3.1

Note: NPV = net present value, IRR = internal rate of return.

The main economic assumptions/input parameters used for the base case are shown in Table 1-11.

Table 1-11 – Main Macroeconomic Assumptions

Item	Unit	Value
Spodumene price @ 6.00% Li_2O (CIF China) (Note 1)	US$/t	733
Spodumene price @ 6.00% Li_2O (FOB Ilhéus Port) (Note 2)	US$/t	629
Exchange rate (Note 3)	BRL/US$	3.85
Discount rate	%	8.0%

Note 1: Roskill forecast of average nominal arms-length selling price.
Note 2: China spodumene price minus budgetary estimate shipping cost. .
Note 3: An exchange rate of 4.10 BRL/US$ was used for update of the CAPEX. OPEX was based on 3.85 BRL/US$.

The main technical assumptions for the base case are shown in Table 1-12.

Table 1-12 – Technical Assumptions (base case)

Item	Unit	Value
Total Mineral Reserves (P&P)	t	13,784,000
Annual ROM ore processed	t	1,496,000
Annual Spodumene Concentrate Production	t	220,000
Lithium carbonate equivalent (LCE) production (***Note 1***)	t	33,000
Strip ratio	ratio	9.6: 1
Average Li_2O grade of the Mineral Reserve	%	1.46%
Spodumene recovery rate	%	60.4%
Concentrate grade	% Li_2O	6.00%
Mine life	years	9.2
Cost of spodumene concentrate ex-works	US$/t spodumene conc.	238
Transportation costs (CIF China)	US$/t spodumene conc.	104
Total cash cost (CIF China)	US$/t spodumene conc.	342
Processing costs per tonne ROM	US$/t spodumene conc.	11.03
Mining costs per waste + ore mined	US$/t mined	2.07

Note 1: tonnage based on direct conversion to LCE excluding conversion rate

In the analysis, a 10-year average Roskill forecast of an average nominal arms-length selling price of US$733.00 (CIF Shanghai) for the spodumene concentrate has been assumed.

Figure 1-2 illustrates the after-tax cash flow and cumulative cash flow profiles of the project under the base case scenario.

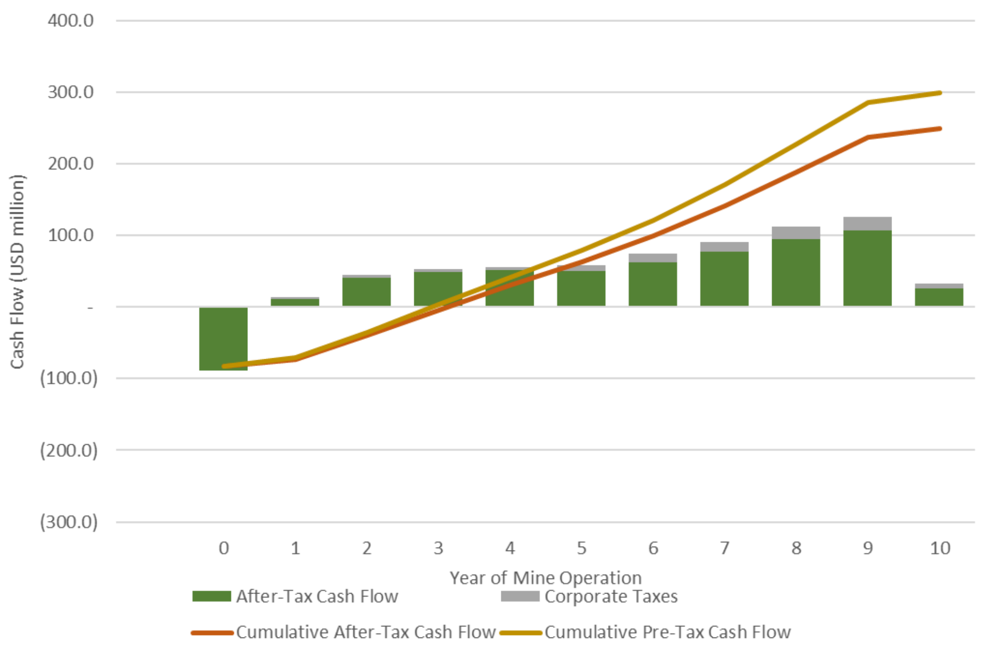


Figure 1-1 - After-Tax Cash Flow and Cumulative Cash Flow

Note: Figure provided by Sigma

The project has been evaluated on pre- and after-tax basis.

Sudene is a government agency tasked with simulating economic development in specific geographies of Brazil. The project will be installed in a Sudene-covered area, where a tax incentive granted to the project indicates a 75% reduction of income tax for 10 years, after achieving at least 20% of its production capacity. The considered Brazilian income tax rate is assumed to be 15.25%, which represents the Sudene tax benefit applied to the Brazilian maximum corporate tax of 34% on taxable income (25% income tax plus 9% social contribution).

The project is expected to benefit from RECAP (IN SRF 605/2006 – a special tax regime for fixed assets acquisition for exporting companies) which grants PIS (Social Integration Program) and COFINS (Social Security Contribution) exemptions on federal sales taxes charged on gross revenues. The economic analysis assumes that the project is granted this exemption.

The project is expected to be exempt from all importation taxes for products for which there is no similar item produced in Brazil *(Ex-Tarifário)*. Assembled equipment where some but not all individual components are produced in Brazil can be considered exempt from import taxes under these terms. The Project royalties include:

- A 2.0% CFEM royalty on gross spodumene revenue, paid to the Brazilian Government. The CFEM royalty amount is split between the Federal Government of Brazil (12%), State Government of Minas Gerais (23%), and Municipal Government of Araçuaí (65%)
- Two 1% NSR royalties

A sensitivity analysis was carried out with the base case (including closure costs) as described above as the midpoint. An interval of ±20% versus base case values was considered using 10% increments. Results are shown in Figure 1-2 to Figure 1-3 for commodity price, exchange rate, initial CAPEX, OPEX, discount rate, and lithium grade. A further sensitivity analysis was conducted on a case excluding closure costs (presented in Section 22).

The Project's NPV (and IRR) are not significantly vulnerable to changes in the pre-production initial capital expenditure nor discount rate considered, as shown by the smoother curves associated with these variables. Note that the Project IRR is independent of the discount rate considered.

The Project's NPV (and IRR) are more sensitive to variation in CIF spodumene price, lithium grade and BRL per US$ exchange rate as shown by the steeper curves associated with these variables. The Project's NPV is significantly positive at the lower limit of the price interval and the examined exchange rate interval. The NPV is also significantly positive at the upper limit of the operating expenses interval.

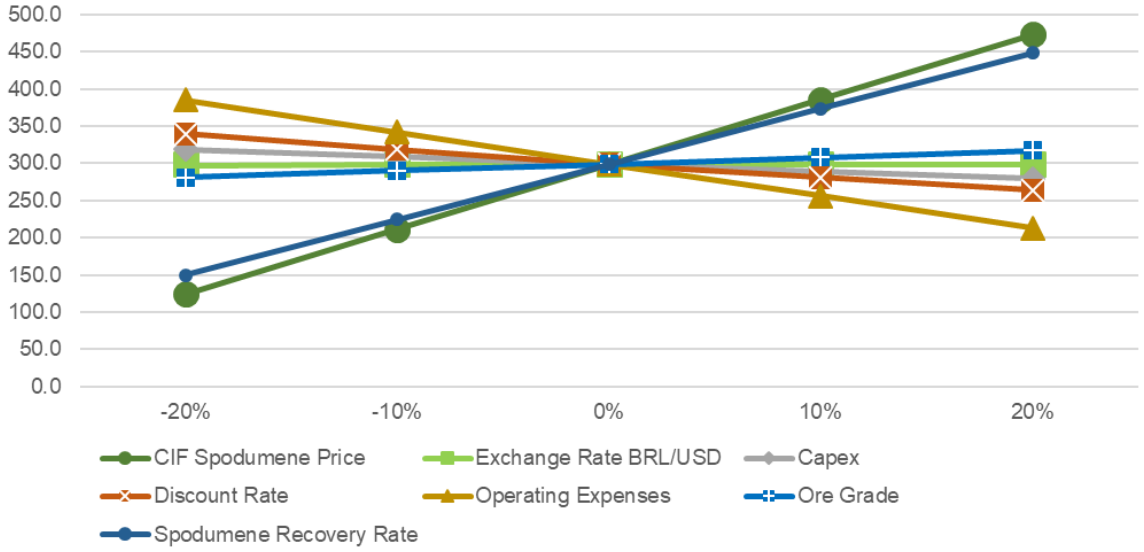


Figure 1-2 – Pre-tax NPV (US$ million)

Note: Figure provided by Sigma

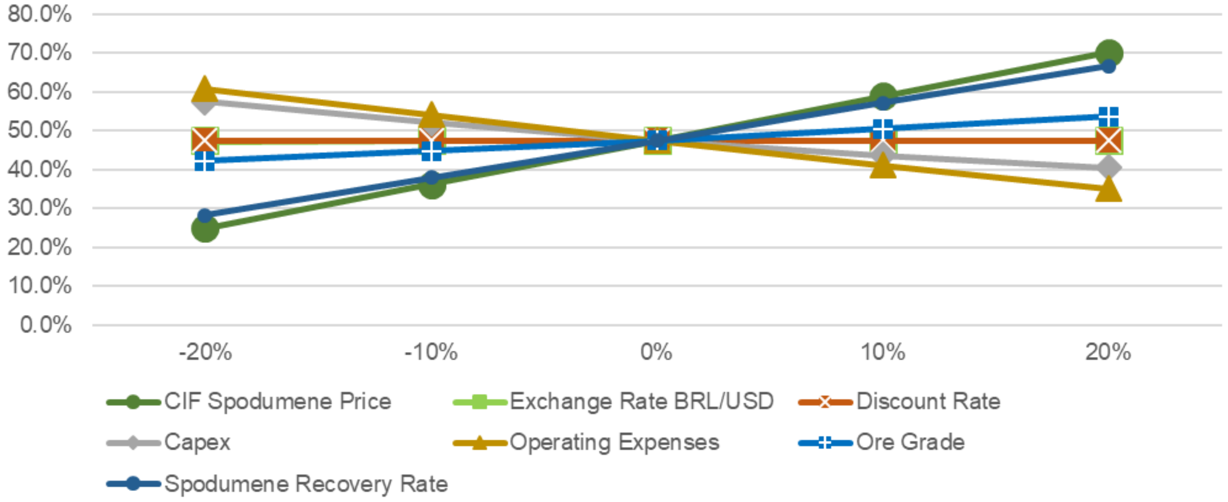


Figure 1-3 – After-tax NPV (US$ million)

Note: Figure provided by Sigma

1.20 INTERPRETATION AND CONCLUSIONS

Mineral Resources are reported for four pegmatite bodies, Xuxa, Barreiro, Murial and Lavra do Meio. Mineral Reserves are reported for the Xuxa deposit. A feasibility study which is the subject of this Report, has been conducted on the Xuxa deposit. The extraction plan in the feasibility study assumes development of two open pits (Pit 1 and Pit 2) and construction of a process plant and related infrastructure to process 1,500,000 dry tonnes of ore per year for a mine life of nine years and three months. Under the assumptions presented in the Report, the mine and process plans are feasible, and the project shows positive economics.

1.20.1 Risk Assessment

Risk assessment sessions were conducted individually and collectively by all parties. These are summarized in the sections below.

Most aspects of the Project are well defined. The key residual risks are summarized below. One of the most significant risks identified for the Project are related to lithium markets.

The following risks are highlighted for the project:

- Lithium market sale price and demand (commercial trends)
- Fluctuations in the exchange rate and inflation
- Delay in obtaining financing: impact to NTP
- Delay in obtaining the license for Pit #2 and waste piles #3 and #4
- More fines generated from mining and crushing: potential negative impact on recovery
- Ongoing geotechnical monitoring system can change some final pit slope parameters: potential increase in strip ratio.

Further details on the risk assessment are provided in Section 25.2.

1.20.2 Opportunities

The following opportunities are identified for the Xuxa project:

- Recovery of Li_2O from hypofines with a flotation circuit
- Potential upgrading of some or all of the Inferred Mineral Resources to higher-confidence categories and eventually conversion to Mineral Reserves.

1.21 RECOMMENDATIONS

The following summarizes the recommendations from the feasibility study. A phased work program is planned. The first phase relates to continued evaluation and exploration of known pegmatite bodies. The second phase consists of mining, process, geotechnical and other supporting studies and needs to be completed early in the execution phase. Completion of Phase 2 work is independent of the work recommended for Phase 1, and can be conducted concurrently with the Phase 1 recommendations.

Phase 1 is estimated at US$6.1M and consists of a 36,000 m drill program to test the Xuxa, Barreiro, Nezinho do Chicao, Murial and Bee areas.

Phase 2 is estimated at US$1,275,000 and consists of:

- Process plant (testing for wet magnetic separation equipment, a middlings recrushing recovery trade-off study): US$60,000
- Mine design (finalize topographic survey; complete density, moisture and blasted swell effect analyses for ore and waste; implement a reconciliation system and grade control program; evaluate underground mining potential for below the open pit levels of the mine, conduct a reserve study for underground mining; implement geotechnical monitoring system): US$345,000
- Geotechnical (supplementary geotechnical and hydrogeological investigations of planned infrastructure sites including at waste pile areas; supplementary geochemical tests (ARD); large-scale waste rock and tailings co-disposal stockpile field test): US$870,000. (Note: further details of the proposed geotechnical, hydrogeological and geochemical program are provided in Section 26.3)

2 INTRODUCTION

Sigma Lithium Resource Corporation (Sigma) requested that Primero Group Americas Inc. (Primero), a division of Primero Group Ltd, SGS Geological Services (SGS), MCB Serviços e Mineração (MCB), Worley Parsons (WP) and 3S Engheneria prepare a technical report (the Report) on the Grota do Cirilo Lithium Project (the Project) located in Minas Gerais State, Brazil (Figure 2-1).

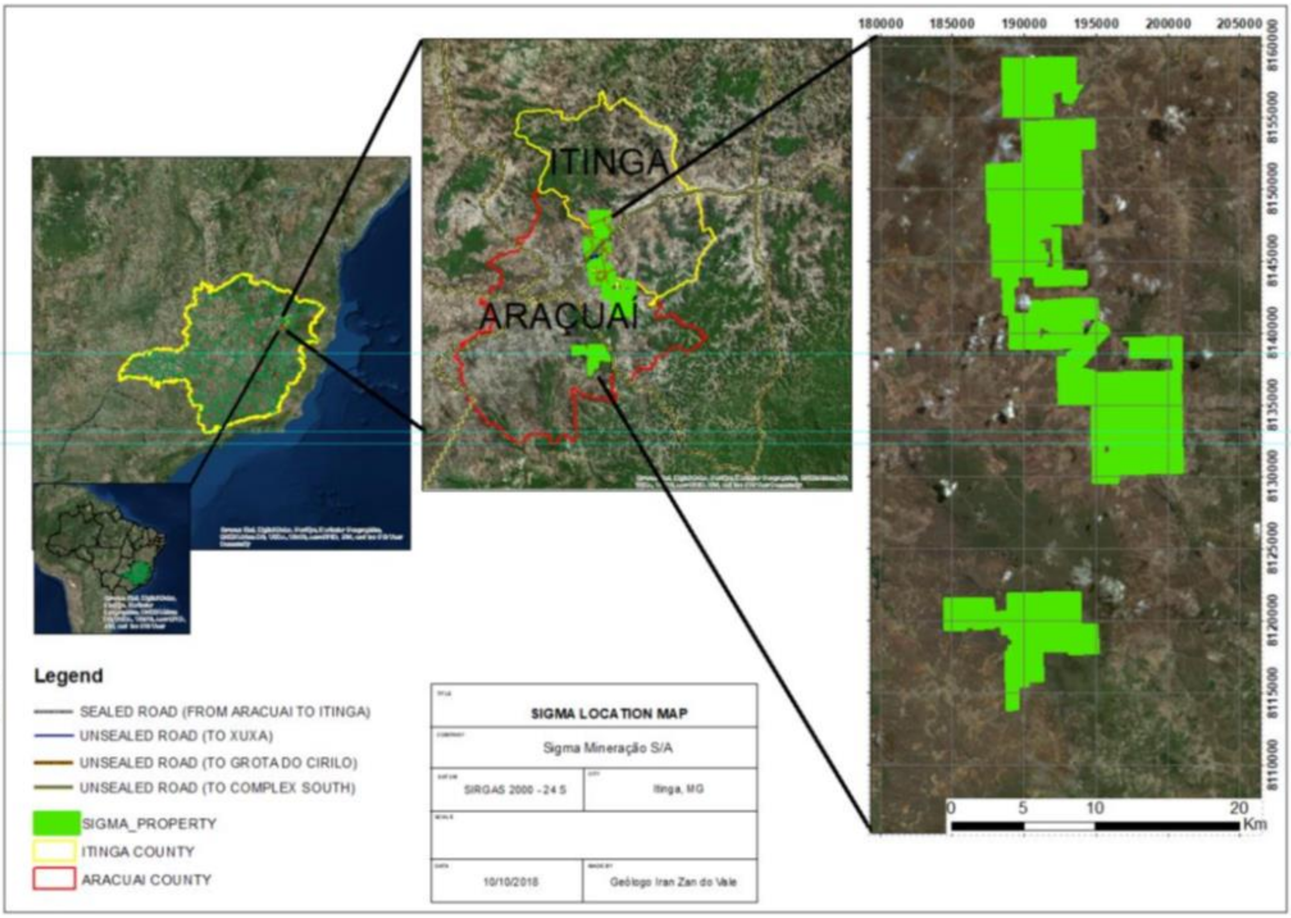


Figure 2-1 - Project Location

The Report summarizes the results of a feasibility study on the Xuxa deposit within the Project area.

2.1 TERMS OF REFERENCE

The Report supports the disclosure by Sigma in the news release dated October 1, 2019, entitled "Sigma Lithium Announces a Positive Feasibility Study with Forecast LOM Net Revenue of US$1.4 Billion and EBITDA of US$ 690 Million for the High-Grade, Low-Cost Xuxa Deposit".

Mineral Resources are reported for four pegmatite bodies, Xuxa, Barreiro, Murial and Lavra do Meio. Mineral Reserves are reported for the Xuxa deposit. A feasibility study, which is the subject of this Report, has been conducted on the Xuxa deposit.

Mineral Resources and Mineral Reserves are reported using the 2014 Canadian Institute of Mining, Metallurgy and Petroleum (CIM) Definition Standards (2014 CIM Definition Standards).

This Report is based, in part, on internal reports and information as listed in Section 27 of this Report. Where sections from reports authored by other consultants have been directly quoted in this Report, they are indicated as such in the Report sections.

2.2 EFFECTIVE DATES

The effective date of the Mineral Resource estimate is January 10, 2019.

The effective date of the Mineral Reserve estimate is June 5, 2019.

The effective date of the financial analysis supporting the Mineral Reserves is September 16, 2019.

The overall effective date of the Report is the date of the financial analysis supporting the Mineral Reserves and is September 16, 2019.

2.3 QUALIFIED PERSONS

This Technical Report was prepared for Sigma by or under the supervision of the following Qualified Persons (QPs):

- Mr. Fred Claridge, P.Eng, Senior Technical Director, WP
- Mr. Lucas Duarte, P. Eng., Senior Geotechnical Engineer
- Mr. Ara Erzingatzian, P.Eng, Study Manager, Primero
- Mr. Kiedock Kim, P.Eng., Lead Process Engineer, Primero
- Mr. Marc-Antoine Laporte, P.Geo., Project Geologist, SGS
- Mr. Porfirio Cabaleiro Rodriguez, MAIG, Senior Director GE21

2.4 SITE VISITS

The following Qualified Persons visited the Project site.

Mr. Ara Erzingatzian visited the Xuxa Lithium Project site on July 1, 2018. The day visit coincided with the Project kick-off meeting with Sigma. The Project plant area as well as the planned Xuxa mine's Pit 1 and the Barreiro deposit location was visited to obtain familiarity with the terrain and to review existing infrastructure (administration building, power lines, roads, overall site access and water intake location at the Jequitinhonha River).

Mr. Marc-Antoine Laporte visited the Project site on September 11–15, 2017, from July 11–17, 2018 and again from 18-23 September 2019. During the 2017 site visit, Mr. Laporte conducted a general review of the logging and QA/QC procedures in place for the 2017 drill program. Drill hole collars were visited, and selected collar positions checked with a hand-held global positioning system (GPS) instrument. An inspection of the drilling equipment and deviation survey methodology and tools was completed. Mr. Laporte took 26 witness (control) samples from the remaining 2014 Xuxa campaign drill core to submit for independent confirmation of the presence of lithium-bearing mineralization. During the July 2018 site visit a general review of the logging and QA/QC procedure was conducted with Sigma geologists to confirm compliance with industry best practices. Drill hole collars at Xuxa, Barreiro and Lavra Do Meio were inspected and selected collar positions checked with a hand-held GPS instrument. An extensive review of the mineralized core from the four main pegmatite was conducted during the first two days of the visit including discussion of the sampling method with technical staff. Inspection of the drilling equipment and deviation survey methodology and tools between the two drilling companies was also completed to check consistency between the drill teams. One day was spent on the Sao Jose property to inspect the different historical mine workings and make recommendations for future drilling. Mr. Laporte visited the site again in September 2019, where he discussed the geological model and information needed to complete the resource estimates on the Xuxa, Barreiro, Murial and Lavra do Meio pegmatites.

Mr. Porfirio Cabaleiro Rodriguez visited the site from April 17-18, 2019. During this visit, he familiarized himself with general aspects of the proposed mine area, and locations for future waste pile areas and the planned plant site area. Mr. Rodriguez observed the possible influence of the Piauí River on the planned pits, and the general aspects of rock behavior based on the observation of excavations.

2.5 UNITS AND CURRENCY

Système International d'unités (SI) metric units are used, including metric tonnes (tonnes, t) for weight.

All currency amounts are stated in US dollars (US$) unless otherwise stated.

2.6 INFORMATION SOURCE

Sigma provided the financial model for the economic study. Primero has reviewed the model and input files for alignment with the Project input data.

The WP engineering team visited the site in November 2018. The site visit focused on assessing the general terrain and local topographic conditions, and the local infrastructure available including access roads, existing transmission line, water gathering system from the Jequitinhonha River, the area around the proposed open pits and the local communities. The characteristics of the surface soil and trenches excavated in the mine area were inspected, including observations of the soil mantle and several meters of the underlying rock mass. In addition, WP witnessed Sigma's lithium pilot plant in operation.

Mr. Rodriguez is currently the senior director of GE21 Consultoria Mineral, a consulting company based in Belo Horizonte, and is taking responsibility for mining sections that were prepared by MCB.

3 RELIANCE ON OTHER EXPERTS

3.1 MARKETING

The QP has fully relied upon, and disclaims responsibility for, marketing information derived from a third-party expert retained by Sigma through the following document:

- Roskill Consulting Group Ltd, 2019: Spodumene Price Forecast for Xuxa DFS: report prepared by Roskill Consulting Group Ltd for Sigma, March 29, 2019.

This information is used in Section 19, the Mineral Reserve estimate in Section 15, and the financial analysis in Section 22.

The QP considers it reasonable to rely on Roskill because the company is independent, privately owned, and has nearly 50 years' experience of research and consulting in metals, minerals and chemical industries, and their end-use industries. Roskill specialises in providing in depth market reports that give a comprehensive analysis of an individual metal or mineral market. These reports cover world supply and demand, the operations of the major producers, end-use market applications, price trends, international trade patterns and forecasts. Roskill also publishes regularly updated cost curves and databases for a number of metals and minerals.

The QP has fully relied upon, and disclaims responsibility for contract and off-take information derived from Sigma through the following document:

- Sigma's announcement on April 10, 2019 of the Sigma and Mitsui Binding Heads of Agreement. (Heads of Agreement - Lithium concentrate offtake dated March 25, 2019)

This information is used in Section 19, and in support of the Mineral Resource estimate in Section 14, the Mineral Reserve estimate in Section 15, and the financial analysis in Section 22.

3.2 ENVIRONMENTAL, PERMITTING AND SOCIAL LICENCE

The QP has fully relied upon, and disclaims responsibility for, environmental, permitting, and social licence information derived from third-party experts retained by Sigma through the following document:

- Environmental Regularization Summary – Xuxa Project - DNPM 824 692 71: report prepared by Harpia Consultoria Ambiental for Sigma, 2019.

This information is used in Section 20, and in support of the Mineral Resource estimate in Section 14, the Mineral Reserve estimate in Section 15, and the financial analysis in Section 22.

This Environmental Regularization Summary by Harpia Consultoria Ambiental is a translation from and is based on an Environmental Impact Assessment (EIS) prepared by NEO Soluções Ambientais and ATTO GEO Geologia e Engenheria for submittal by Sigma to applicable regulatory authorities. The EIS was comprised of:

- Estudo e Relatorio de Impacto Ambiental – EIA-RIMA dated 30 October 2018, and
- Plano de Controle Ambiental – PCA dated December 2018)

This information is used in Section 20, and in support of the Mineral Resource estimate in Section 14, the Mineral Reserve estimate in Section 15, and the financial analysis in Section 22.

The EIS and the Environmental Regularization Summary cover the initial phase of the licensing process (for Pit 1 and waste piles 1 and 2).

3.3 TAXATION

The QP has fully relied upon, and disclaims responsibility for taxation (including amortization, interest rates, depreciation, discounts), levy, royalty, and buy-back options information derived from third-party experts retained by Sigma including the following document:

- Sigma Legal Opinion – SUDENE and RECAP tax incentives: legal opinion prepared by Lefosse Advogados 25 March 2019.

This information is used in Section 22, and in support of the Mineral Reserve estimate in Section 15.

3.4 MINERAL TENURE

The QPs have not reviewed the mineral tenure, nor independently verified the legal status, ownership of the Project area, underlying property agreements or permits. The QPs have fully relied upon, and disclaims responsibility for, information derived from third-party experts retained by Sigma through the following document:

- Friere, W., Costa, B., Soarres, D.R., and Azevedo, M., 2018: Legal Opinion 29/2018: report prepared by William Freire and Partners for Sigma, 10 April 2018, 68 p.

This information is used in Section 4 of the report, and in support of the Mineral Resource estimate in Section 14, the Mineral Reserve estimate in Section 15, and the financial analysis in Section 22.

4 PROPERTY DESCRIPTION AND LOCATION

4.1 PROPERTY DESCRIPTION AND LOCATION

The Project area is located within Zone SE24 of the Americas topographic map reference, and is divided into four properties:

- Grota do Cirilo property: UTM 190,615 m east and UTM 8146,788 m north; WGS 84, Zone 24S
- Genipapo property: UTM 191226 m east and UTM 8155496 m north, WGS 84, Zone 24 K
- Santa Clara: UTM 197682 m east and UTM 8134756 m north, WGS 84, Zone 24 K
- São José property: UTM 190612 m east and UTM 8119190 m north, 84, Zone 24 K.

The property locations are shown in Figure 4-1.

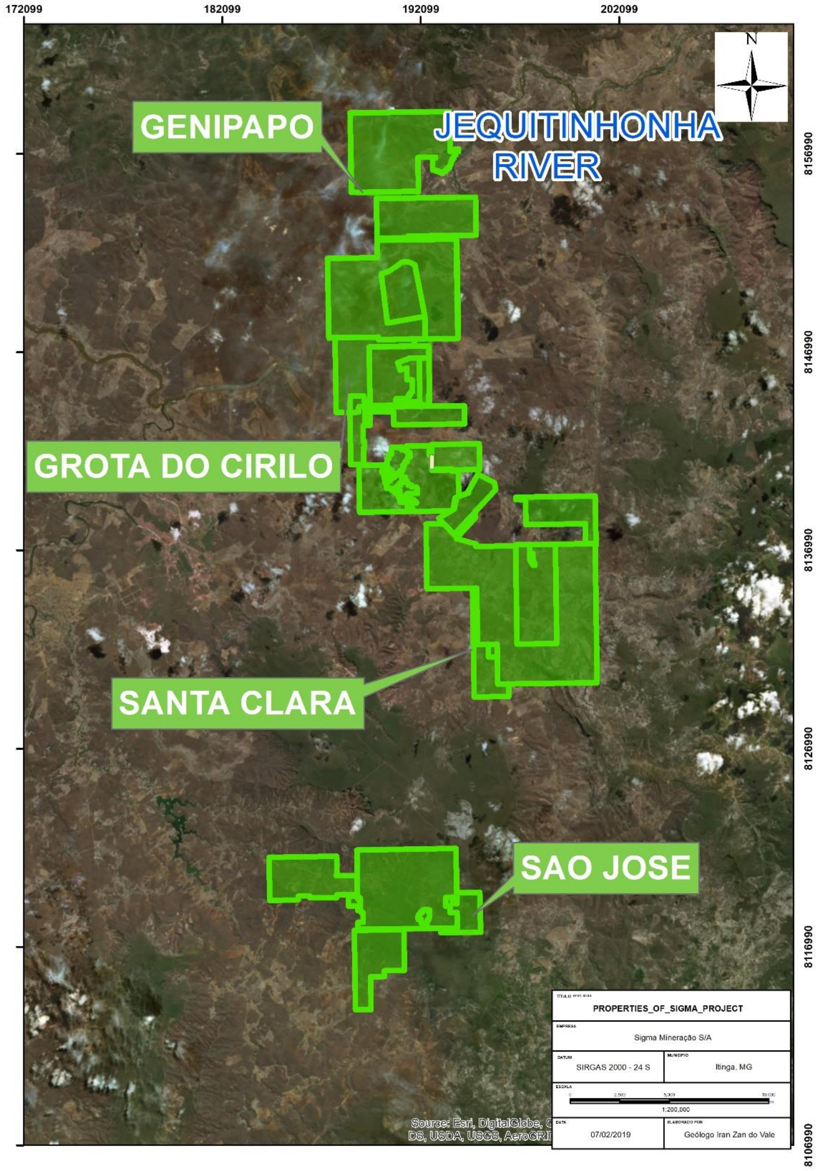


Figure 4-1 - Project Properties - Genipapo, Grota do Cirilo, Santa Clara and São José

4.2 MINERAL TENURE

The legal framework for the development and use of mineral resources in Brazil was established by the Brazilian Federal Constitution, which was enacted on October 5, 1988 (the Brazilian Constitution) and the Brazilian mining code, which was enacted on January 29, 1940 (Decree-law 1985/40, later modified by Decree-law 227, of February 29, 1967, the Brazilian Mining Code).

According to the Brazilian constitution, all mineral resources in Brazil are the property of the Federal Government. The Brazilian constitution also guarantees mining companies the full property of the mineral products that are mined under their respective concessions. Mineral rights come under the jurisdiction of the Federal Government and mining legislation is enacted at the Federal level only. To apply for and acquire mineral rights, a company must be incorporated under Brazilian law, have its management domiciled within Brazil, and its head office and administration in Brazil.

In general, there are no restrictions on foreign investment in the Brazilian mining industry, except for mining companies that operate, or hold mineral rights within a 150 km-wide strip of land parallel to the Brazilian terrestrial borders. In this instance the equity interests of such companies have to be majority Brazilian-owned. Exploration and mining activities in the border zone, and on indigenous lands are regulated by the Brazilian Mining Code and supporting legislation.

The Project consists of 27 mineral rights, mining concessions, applications for mining concessions, exploration authorizations and applications for mineral authorizations covering an area of 19,195.62 ha in four property areas (refer to Figure 4-1). The tenure holdings are summarized in Table 4-1 and tenure outlines are shown in Figure 4-2. The identification numbers used in Figure 4-2 correspond to the identification numbers in the first column of Table 4-1. A summary of the types of concession within each property area is provided in Table 4-2.

Table 4-1 – Mineral Rights Description

ID	Number	Year	Type	Expiry Date	Area (ha)	Associated Property
1	802.401	1972	Mining concession	Life of mine	1,796.5	Genipapo
2	802.400	1972	Mining concession	Life of mine	969.13	Genipapo
3	004.134	1953	Mining concession	Life of mine	494.69	Grota do Cirilo
4	831.891	2017	Application for exploration authorization	N/A*	10.57	Genipapo
5	830.039	1981	Application for mining concession	Life of mine	715.24	Grota do Cirilo
6	824.692	1971	Mining concession	Life of mine	756.21	Grota do Cirilo
7	822.591	1972	Application for mining concession	Life of mine	269.34	Grota do Cirilo
8	824.693	1971	Application for mining concession	Life of mine	380.56	Grota do Cirilo

ID	Number	Year	Type	Expiry Date	Area (ha)	Associated Property
9	810.345	1968	Mining concession	Life of mine	125.54	Grota do Cirilo
10	009.135	1967	Mining concession	Life of mine	312	Grota do Cirilo
11	005.804	1953	Mining concession	Life of mine	9.33	Grota do Cirilo
12	804.541	1971	Application for mining concession	Life of mine	44.89	Grota do Cirilo
13	824.695	1971	Mining concession	Life of mine	1,069.2	Grota do Cirilo
14	805.799	1970	Mining concession	Life of mine	8.29	Grota do Cirilo
15	801.312	1972	Mining concession	Life of mine	2,505.22	Grota do Cirilo
16	831.975	2017	Application for exploration authorization	N/A*	4.03	Grota do Cirilo
17	002.998	1953	Mining concession	Life of mine	327.84	Santa Clara
18	801.870	1978	Mining concession	Life of mine	544.9	Santa Clara
19	801.316	1972	Mining concession	Life of mine	3,727.9	Santa Clara
20	801.315	1972	Mining concession	Life of mine	991.71	Santa Clara
21	813.413	1973	Mining concession	Life of mine	379.31	Santa Clara
22	832.889	2013	Exploration authorization	Renewal in progress	810.23	São José
23	806.856	1972	Mining concession	Life of mine	1,920.4	São José
24	808.869	1971	Mining concession	Life of mine	29	São José
25	804.088	1975	Mining concession	Life of mine	29.22	São José
26	801.875	1978	Mining concession	Life of mine	281.51	São José
27	830.580	1979	Exploration authorization	N/A**	686.89	São José
					19,195.62	

Notes: * The application is still under analysis by the AMN so no expiry date exists at this stage. ** The Final Research Report was submitted in due time and is pending analysis. There is no provision for an administrative decision.

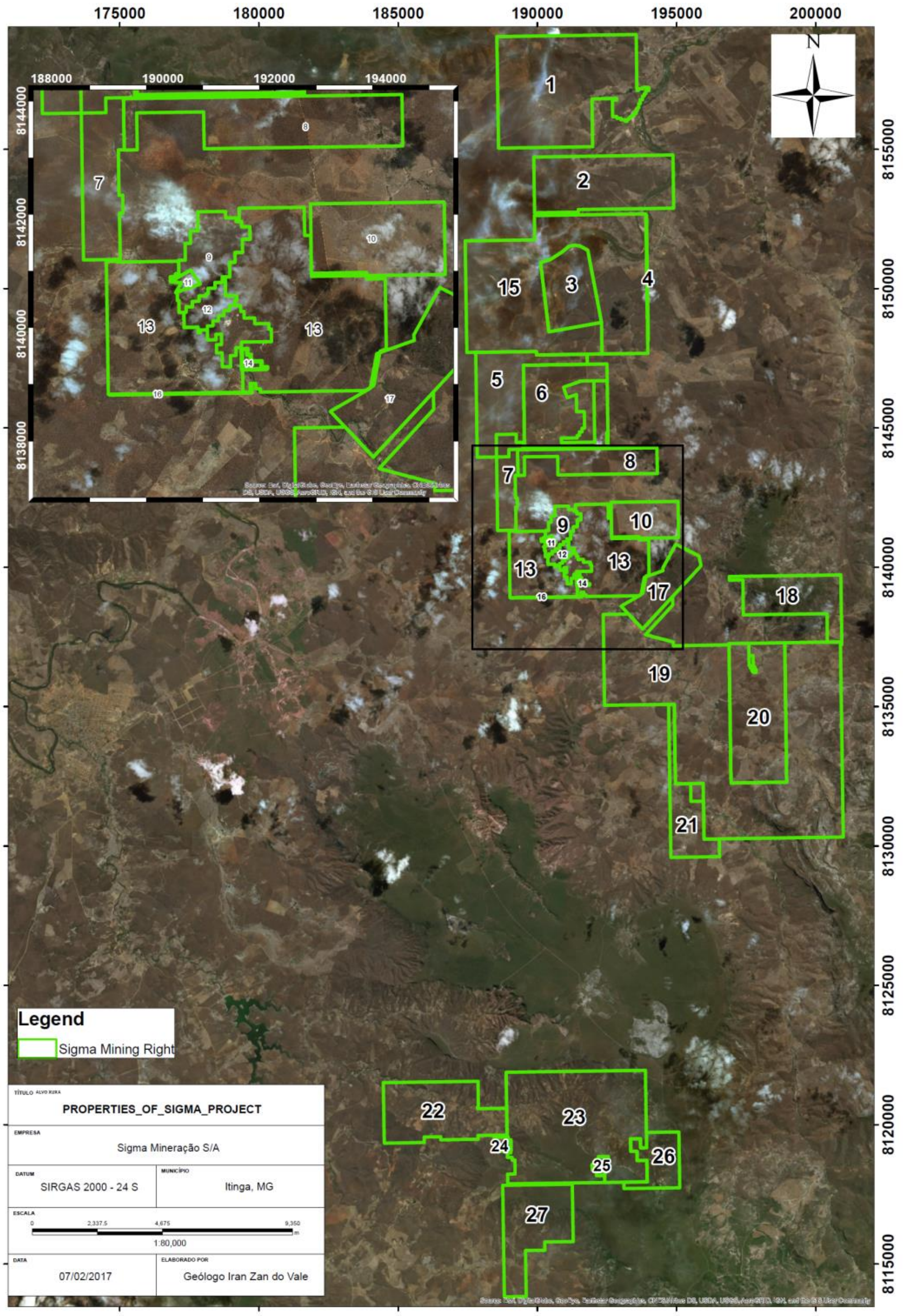


Figure 4-2 - Project Mineral Rights, North and South Complexes

Note: The tenure within the black-white border is an inset figure to show the details of the concessions in the area outlined within the black square.

Table 4-2 - Property Tenure Summary

Property	Area (ha)	Concessions	Historical Workings
Grota do Cirilo	6,694.54	7 mining concessions, 5 exploration authorization applications	Xuxa, Barreiro, Lavra do Meio, Murial and Maxixe
São José	3,757.25	4 mining concessions and 2 exploration authorizations	Samambaia, Lavra Grande, Ananias, Ramom and Lavra Antiga
Genipapo	2,776.20	2 mining concessions and 1 exploration authorization application	Morundu and Lavra Velha
Santa Clara	5,971.66	5 mining concessions	Lavra do Honorato

All concessions have been surveyed on the ground and have been monumented (physical boundary markers are in place). Sigma retains third-party consultants to monitor its concession obligations. The consultants report on both a monthly and a quarterly basis.

The following payments and fees are required to keep concessions current:

- ANM Proceeding 802.401/1972, 802.400/1972, 4.134/1953, 824.692/1971, 810.345/1968, 9.135/1967, 5.804/1953, 824.695/1971, 805.799/1970, 2.998/1953, 801.870/1978, 801.316/1972, 801.315/1972, 813.413/1973, 806.856/1972, 808.869/1971, 804.088/1975, 801.875/1978 (mining concessions): Financial Compensation for the Exploration of Mineral Resources (CFEM) will only be due when there is mineral production in the areas. For the sale of lithium, the value of CFEM is equivalent to 2% of gross sales revenue, less taxes levied on its sale
- ANM Proceeding 830.039/1981, 822.591/1972, 824.693/1971, 804.541/1971 (Requirement of Mining): there is no periodic payment due
- ANM Proceeding 850.580/1979 (Exploration Authorization): there is no periodic payment due
- ANM Proceeding 832.889/2013 (Exploration Authorization, awaiting analysis of the Partial Exploration Report). The annual payments due from annual hectare fees (TAH) have been made. In case of approval of the request for extension, TAH will be assessed annually in December each year at the present value of R$3.937,72 (about $C1,420)
- ANM Proceeding 831.891/2017, 831.975/2017, 831.890/2017, 831.892/2017 (Application for Exploration Authorization). There is no periodic payment due.

Sigma has seven mining concessions that have had Plano de Aproveitamento Econômicos (PAEs) approved, covering the Xuxa, Barreiro, Lavra do Meio, Murial, Maxixe and Nezinho do Chicâo deposits within the Grota do Cirilo property.

4.3 SURFACE RIGHTS

Under Brazilian laws, foreign entities may not own a controlling interest in surface rights. The surface rights in the Grota do Cirilo area, the current primary focus of activity, are held by two companies, Arqueana Minérios e Metais (Arqueana) and Miazga Participações S.A. (Miazga) and certain areas are held under private ownership. The controlling interest in Sigma, the A10 Investment Fund, is also the controlling interest in Arqueana and Miazga. Through these affiliations with Sigma, landowner agreements have been negotiated with these entities to support Sigma's exploration and development activities within the Grota do Cirilo property. As required for reconnaissance exploration purposes, Sigma has negotiated exploration access in the remaining property areas.

4.4 AGREEMENTS

SMSA has entered into two rights-of-way agreements with Arqueana and Miazga. There are no conditions attached to the agreements.

4.5 ROYALTIES AND ENCUMBRANCES

4.5.1 CFEM Royalty

The Brazilian Government is entitled to a Compensação Financeira pela Exploração de Recursos Minerais (CFEM) royalty. The holder of a mining concession for lithium mineral must pay the Brazilian government 2.0% of the gross income from the sale thereof. The only deductions allowed are taxes levied on commercial sales.

4.5.2 Royalty Agreements

There are two net smelter return (NSR) royalties.

The first provides for a net smelter return, calculated at the rate of 1% over the gross revenues of SMSA, less all taxes and costs incurred in the process of extraction, production, processing, treatment, transportation and commercialization of the products sold. SMSA has a purchase option, exercisable anytime, for the price of US$3,800.000. The royalty has a sales option, for the same price, exercisable as follows:

- When SMSA enters into commercial production and has reached a threshold of 40,000 t of mineral products concentrates per year; or
- The original controlling group ceases to have more than 30% of SMSA. The “original controlling group” reference is to the A10 Investment Fund that currently controls 72% of Sigma.

The second royalty provides for an NSR royalty calculated at the rate of 1%, over the gross revenues of SMSA, less taxes and returns. There is no buyout provision for this royalty.

4.6 QP COMMENT

To the extent known, there are no other significant factors and risks that may affect access, title, or the right or ability to perform work on the Project that have not been discussed in this Report.

5 ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE AND PHYSIOGRAPHY

5.1 ACCESSIBILITY

The Project is located in northeastern Minas Gerais State, in the Municipalities of Itinga and Araçuaí, approximately 25 km east of the town of Araçuaí and 450 km northeast of Belo Horizonte.

The Project is well served by a public and private road network, as a result of its proximity to National Road 367. The Project is accessible year-round by a network of arterial and back country service roads.

National route BR 251 accesses the Port of Vitoria in the State of Espirito Santo, some 700 km from the Project site. This port could represent a potential port of export for any spodumene production from the Project. The national road BR116 and BR415 accesses to Ilhéus Port which is 540km from the project and is also an option for Sigma.

5.2 CLIMATE

The region is characterized by a dry, semi-arid and hot climate. It has a temperature mean of 24.5ºC and a low annual average rainfall of 750 mm. There is a pronounced dry season with the driest month being June. The wettest month is November. There is no cold season.

Exploration activities are currently conducted year-round. It is expected that any future mining activities will also be year-round.

5.3 LOCAL RESOURCES AND INFRASTRUCTURE

When Sigma purchased Arqueana Minérios e Metais Arqueana (Arqueana; see discussion in Section 6), had been in operation since the 1970s. In common with many brownfield projects, the Grota do Cirilo property has substantial infrastructure constructed to support mining activities. This includes provision of power supply and a site power substation, an extensive office block equipped with internet and telephones, accommodation for 40 persons on site, dining hall and kitchen, workshop, on-site laboratory and sample storage building, warehouse, core storage, a fuel storage facility with pumping equipment, and a water pumping facility from the Jequitinhonha River with its own reservoir. The main 138kV transmission line from the Irape hydro power station runs through the northern part of the Project area. Figure 5-1 is an aerial photograph showing the infrastructure in the pilot plant/office site area. The Project main office is shown in Figure 5-2. Figure 5-3 is a photograph showing the layout of the original 2014 Sigma pilot plant. Figure 5-4 shows the current pilot plant layout.

Additional information on the infrastructure envisaged is provided in Section 18.

The nearest larger communities are Itinga and Araçuaí with populations of 14,000 and 40,000 respectively. Araçuaí is serviced by the its local airport and by mobile phone network from the principal Brazilian service providers. The closest major domestic airport is located at Montes Claros, 327 km west of Araçuaí.

Figure 5-1 - Aerial View, Current Project Infrastructure

Note: Drone view, flight dated September 2018, image looks northeast, photographic still image by Sigma. The core storage facility (labelled 2 on the image) provides a scale indicator and is about 30 m wide and 45 m long. Due to the elevated perspective view, no other reliable scale indicator can be provided. The infrastructure is located in the tenure numbered “3” in Figure 4-2 and Table 4-2.

Figure 5-2 - Field Office (location 6 in Figure 5-2)

Note: Drone view, flight dated September 2018, image looks east, photographic still image by Sigma. Vehicles provide scale indicator. Due to the elevated perspective view, no other reliable scale indicator can be provided.

Figure 5-3 - SMSA Pilot Plant

Note: Photograph taken by Sigma, 2014. Images shows the heavy mineral pilot plant in operation. At the time, the plant was processing material to recover tantalite and cassiterite. It consisted of a 10 tonne per hour water pulse jig (the green structure), two crushers, a jaw crusher and roll crusher.

Figure 5-4 – First Phase Production Plant

Note: Drone view, flight dated September 2018, image looking east–southeast, photographic still image by Sigma. The core storage facility (silver roof at top right of image) provides a scale indicator and is about 30 m wide and 45 m long. Due to the elevated perspective view, no other reliable scale indicator can be provided.

5.4 PHYSIOGRAPHY

The Project topography consists of gently rolling hills with less than 100 m difference in elevation. The hilltops are covered with a veneer of alluvium, up to 5 m thick, which is not present on the hill slopes where bedrock is frequently exposed.

The Jequitinhonha River and the Araçuaí River join west of the Project and the Jequitinhonha River passes through the Grota do Cirilo property in close proximity to the Sigma offices, as shown in Figure 5-1.

The Project area is characterized by thick thorn scrub and trees of medium height - except where it has been cleared for agriculture. The natural vegetation on the hilltops is typical of savannah grassland (Figure 5-5).

Figure 5-5 - Photo Showing Typical Vegetation Within Project Area

Note: Figure by Sigma, 2018. The photograph looks north. The image is taken in the licence labelled as “6” in Table 4-2 and Figure 4-2. Due to the photographic perspective view, no reliable scale indicator can be provided.

6 HISTORY

6.1 PROJECT HISTORY

The exploration history for the Project is summarized in Table 6-1.

Table 6-1 - Project History

Operator	Year	Comment
Companhia Estanìfera do Brazil (CEBRAS)	1957 – 1980s	Tin production consisting of a, cassiterite/tantalite concentrate with by-products of feldspar and lithium minerals. Mining focused on near surface, weathered zones, excavations ranged from 100–700 m in length. CEBRAS operated a gravity separation plant, consisting of a jaw crusher, a trommel and cone crusher, with sizing screens and jigs to recover tantalite/cassiterite concentrate. Feldspar and the lithium minerals, spodumene, lepidolite, amblygonite and petalite, were handpicked before the jaw crusher.
Arqueana Minérios e Metais (Arqueana)	1980s – 2000s	Produced a 6–6.5%% Li_2O spodumene concentrate and a 3.5-4% Li_2O petalite concentrate. No systematic exploration was conducted. Historic mining occurred primarily where the bedrock had been exposed by erosion, on hill flanks. Following the death of the owner of Arqueana, artisan-level operations continued. The focus was on feldspar, petalite, ornamental-grade tourmaline and quartz. This was further reduced, after some years, to the underground mining of minor amounts of tantalite and gemstone.
Tanex Resources plc (Tanex; a subsidiary of Sons of Gwalia Ltd (Sons of Gwalia)	2000 – 2003	Channel sampling, air-track drilling, 13 reverse circulation (RC) drill holes. Based on a report that has no location maps, it appears that Tanex and Sons of Gwalia drilled two drill holes at Lavra do Meio in 2000. No other mentions of drill hole locations have been found. In addition, Sigma has not been able to locate or any of the collar locations for the Tanex and Sons of Gwalia drilling on the ground.
Arqueana	2003 – 2012	Local workers continue production, but at a reduced rate.
RI-X	2012	Acquires a controlling interest in Arqueana, incorporates SMSA.
Sigma	2012 to date	Completes mapping, data compilation, ground magnetic survey, channel sampling. Drill program in 2014 of 984m to initially investigate the Xuxa and Barreiro prospects. Heavy mineral separation (HMS) pilot plant constructed in 2014–2015, consisting of a jaw crusher, roll crusher, sizing screen and pulse jig. Acquired a dense media pilot plant in 2017 to produce lithium concentrate. Completed drill program of 255 holes (approx. 42,310 m) in the Grota do Cirilo property area, on the Xuxa, Barreiro, Lavra do Meio, Maxixe and Murial prospects. An internal Mineral Resource estimate was completed at Xuxa, Barreiro, Murial and Lavra do Meio. The first public disclosure of a Mineral Resource estimate for Grota de Cirilo was in 2017 which was only for the Xuxa deposit. Updated resources for Xuxa and first-time estimate of Mineral Resources for Barreiro, Lavra do Meio and Murial were released in January 2019

6.2 PRODUCTION

There are no verifiable production records for the Project area: based on the known size of the CEBRAS processing plant, about 500 t/d could have been extracted during CEBRAS operations.

The Arqueana operations are estimated to have produced about 29,700 t of tin–tantalum concentrate by 1995. Other production included potassium feldspar (113,402 t), albite (9,649 t), petalite (31,467 t), amblygonite (2,353 t), spodumene (1,317 t), tourmaline (1,429 t), beryl (91,971 t), epidote (5,603 t), and quartz (29,125 t).

Production from artisan and small-miner activity is unknown. Sigma has had no commercial production from the Project.

7 GEOLOGICAL SETTING AND MINERALIZATION

7.1 REGIONAL GEOLOGY

The Project area lies in the Eastern Brazilian Pegmatite Province (EBP) that encompasses a very large region (about 150,000 km^2) of the States of Bahia, Minas Gerais, and Rio de Janeiro. Approximately 90% of the EBP is located in the eastern part of Minas Gerais state.

The pegmatite swarm is associated with the Neoproterozoic Araçuaí orogeny. Granitic rocks that formed during the Araçuaí orogeny have been separated into five different supersuites, coded as G1, G2, G3, G4 and G5. The granite intrusive events are interpreted to have formed during a collisional episode related to the Gondwana Supercontinent (Trans-Amazonian event). The granite supersuites range in age from pre-collisional (G1 at 630–585 Ma) to post collisional (G4 and G5 at 535–490 Ma). The pegmatite swarm is interpreted to be related to the G4 supersuite, in particular, the Piaui batholith (Soares et al, 2009).

Figure 7-1 is a regional-scale schematic geological plan.

7.2 LOCAL GEOLOGY

Figure 7-2 is an overview plan of the geology of the northern project area.

7.2.1 Biotite–Cordierite Schist

The host rock to the pegmatitic intrusions is a medium-grey coloured biotite–quartz schist, which is interpreted to be a metamorphosed flysch of the Eocambrian Salinas Formation (Quéméneur and Lagache, 1999). The schist typically has millimetre to centimetre-size cordierite porphyroblasts and finely disseminated, stretched, iron-sulphide crystals with a preferred orientation that is sub-parallel to the foliation. Minor intercalations of calcsilicate rocks can occur within the schist.

Where weathered, the schist may display sericite-rich zones and micro-crystalline quartz–calcite intercalations that include dark green, disseminated, sub- to millimetre-sized amphibole and pink garnet crystals.

7.2.2 Pegmatites

Pegmatites are generally divided into two main types:

- Anatectic (directly formed from the partial melting of the country rock)
- Residual pegmatite (fluid rich silicate melts resulting from the fractional crystallization of a parent magma).

The pegmatites in the Project area are interpreted to be residual pegmatites and are further classified as representative of lithium–cesium–tantalum or LCT types.

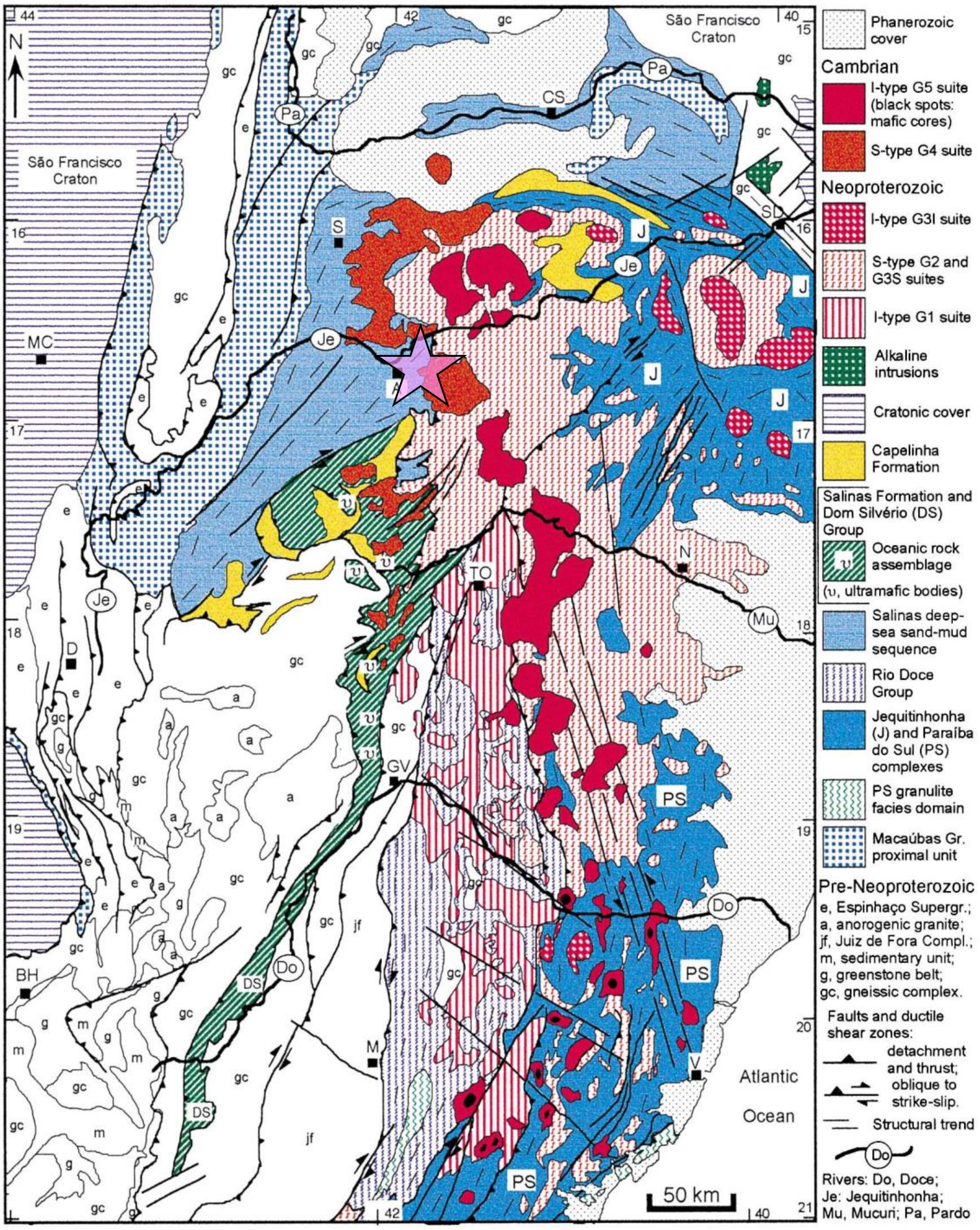


Fig. 7.1 Geologic map of the Araçuaí Belt and adjacent cratonic areas (highlighting the Neoproterozoic and Cambrian units (modified from Pinto et al., 1998). Towns: A, Araçuaí; BH, Belo Horizonte; CS, Candido Sales; D, Diamantina; GV, Governador Valadares; M, Manhuaçu; MC, Montes Claros; N, Nanuque; TO, Teófilo Otoni; S, Salinas; SD, Salto da Divisa; V, Vitória. **A.C. Pedrosa-Soares et al. / Precambrian Research 110 (2001) 307–323**

Figure 7-1 - Regional Geologic Map

Note: Figure modified by Sigma, 2018, after Pedrosa-Soares et al., 2001. Pink star is approximate Project location.

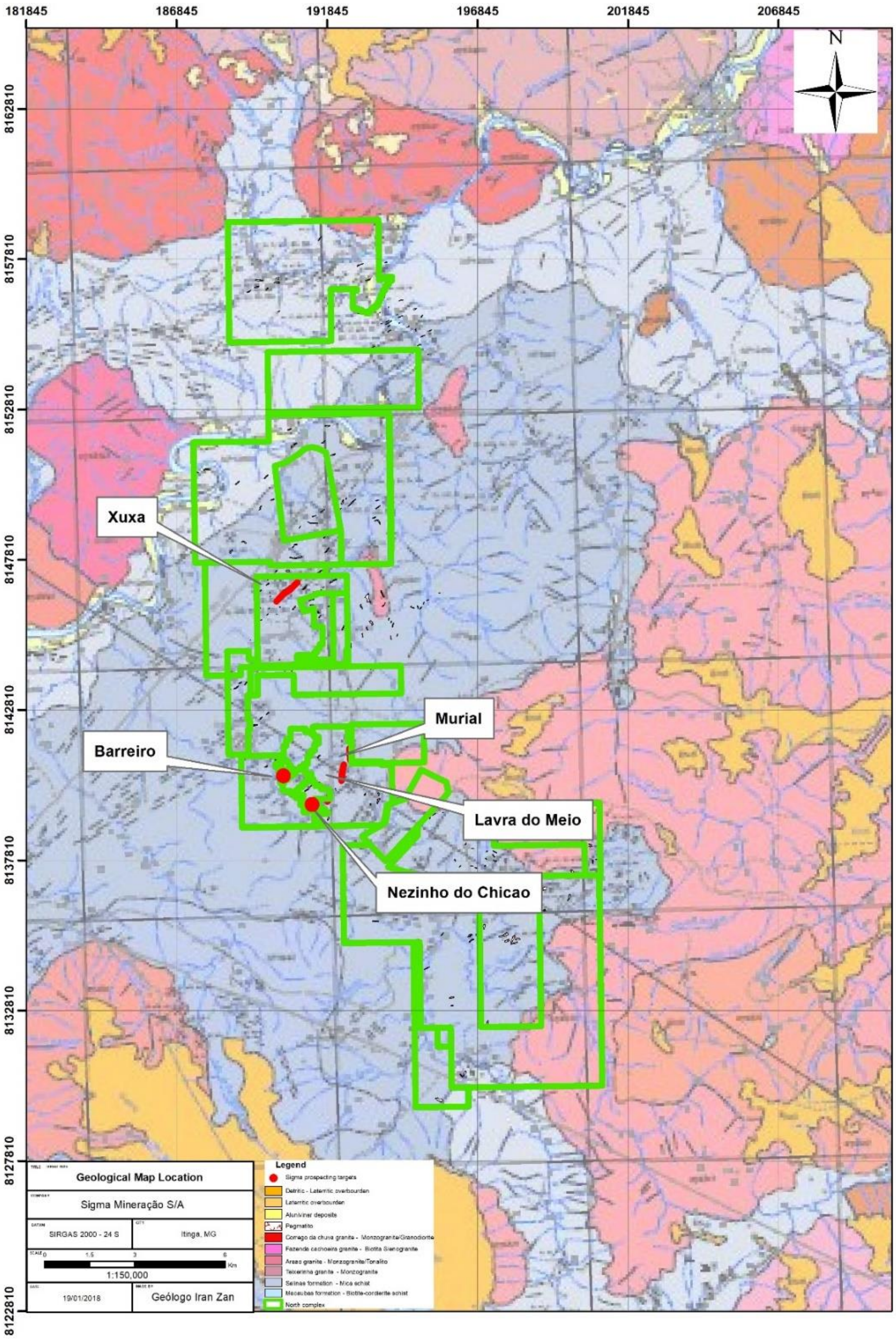


Figure 7-2 - Local Geology Map, Northern Complex

Note: Figure provided by Sigma, 2018.

Pegmatites in the Araçuaí and Itinga district tend to be tabular in shape, with widths, thicknesses and lengths that vary widely. The dikes typically have sharp contacts with the schist host rock and have a discontinuous, thin, fine-grained (chilled margin) border zone. They do not display classic concentric zoning around a quartz core (e.g. Simmons et al, 2003), instead, the Araçuaí and Itinga district dikes display a characteristic layered anisotropic internal fabric (London, 1992).

In the general Project district, pegmatites are typically hosted by a medium-grey, biotite–quartz schist. The pegmatites are generally concordant with the schist foliation, which is coincident with the overall strike of the schists. The pegmatite–schist contacts display recrystallization features such as biotite eyes within cordierite masses, and development of millimetre-sized, black tourmaline needles that are almost always perpendicular to the shale foliation.

Spodumene can form 28–30% of the pegmatite mass, microcline and albite contents range from 30–35%, with microcline content dominant over albite, muscovite comprises about 5–7% and the remainder of the rock mass consists of quartz. The pale green-coloured spodumene crystals are elongate or tabular, ranging from millimetre to centimetres in scale, and have been observed at metre-scale in outcrop. Spodumene cuts the microcline matrix, and intergrowths of spodumene and quartz, sometimes in association with muscovite, are common. Accessory minerals, such as columbite and tantalite form in association with albite and quartz. Late-stage mineralization includes sphalerite and pyrite.

7.3 PROPERTY GEOLOGY

7.3.1 Grota do Cirilo Property

Figure 7-3 is a pegmatite location map for the Grota do Cirilo property, showing the mapped dike swarms and the locations of the Xuxa pegmatite and the five major known historical workings.

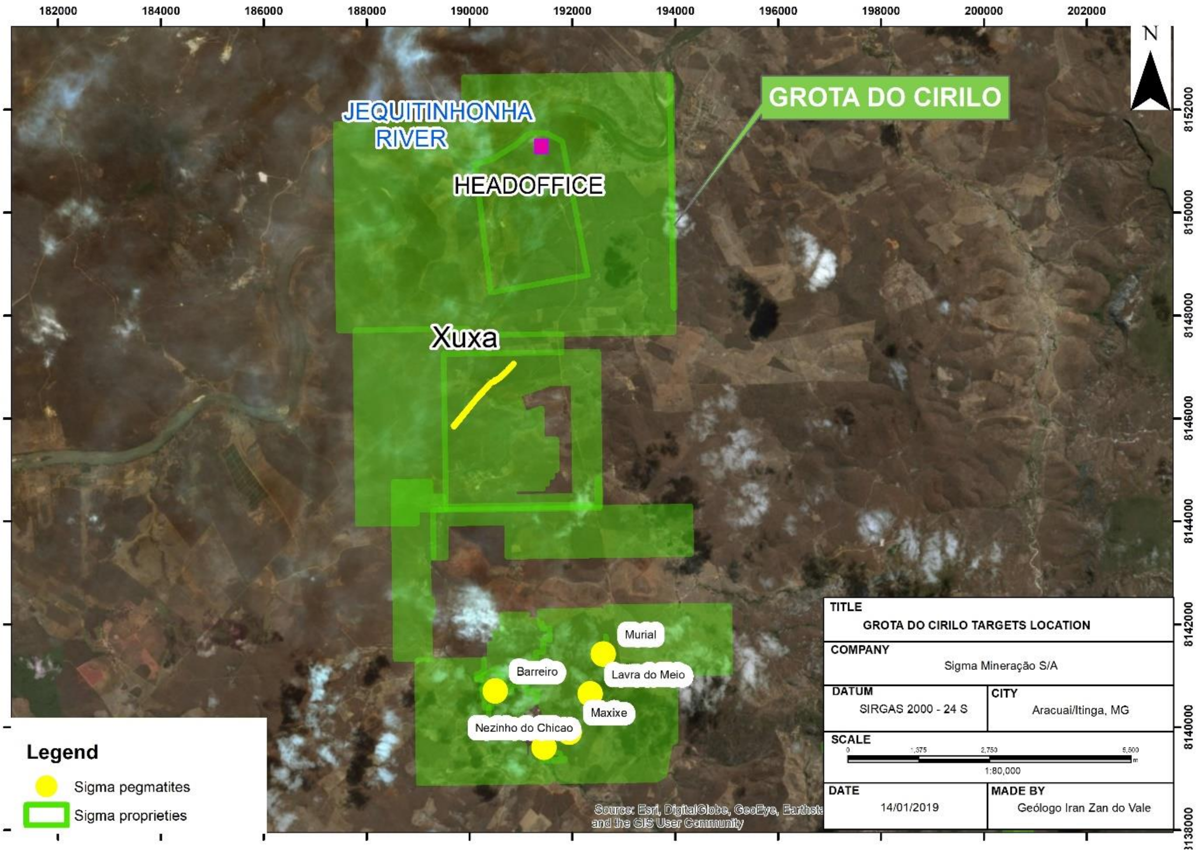


Figure 7-3 - Historic Workings and Pegmatite Dike Swarms within Grota Do Cirilo Property

Note: Figure prepared by Sigma, 2018. Historical workings as yellow dots, and the strike of the Xuxa. Figure also shows location of Sigma's office and camp complex.

7.3.1.1 Xuxa

The host rock for the Xuxa pegmatite body is a biotite–quartz schist with a well-developed crenulation cleavage. Pegmatite xenoliths have been observed within the schist, with sizes ranging from a few centimetres to a metre. The pegmatite/schist contact is frequently hornfelsed.

The pegmatite is concordant with the regional foliation, striking northwest–southeast and dipping at 45–55º to the southeast. Drill data indicate the pegmatite has a strike length of 1,700 m, averages 12–13 m in thickness, and can reach as much as 20 m thick. It has been drill tested to 259 m vertical depth. It remains open to the west, east, and at depth.

Pegmatite mineralogy consists of the following minerals, with their approximate vein content: spodumene (20%), microcline and albite (40–45%), quartz (30%) and muscovite (5%). Spodumene occurs as pale green to colourless, elongated, tabular, crystals that can range in size from millimetre to as much as 80 cm in length and be as wide as 10 cm. The spodumene laths are set in a medium- to very coarse-grained groundmass of colourless albite, translucent quartz and pale grey perthitic microcline. Pale yellow–green medium- to coarse-grained muscovite micas may be present. Poikilitic textures of spodumene and quartz are common. Tantalite–columbite and cassiterite can occur in association with albite.

The Xuxa pegmatite dike is found on both sides of the Piaui River but does not crop out in the river valley. Two drill holes were angled so as to pass under the Piaui River, with one hole drilled from each bank. The drill holes intercepted pegmatite at depth. Core logging showed the spodumene to be weathered and contain replacement textures. The current interpretation is that the Piaui River occupy a fault trace, and that the interpreted fault has thinned the pegmatite body in that location.

Figure 7-4 shows a typical cross section through the Xuxa deposit.

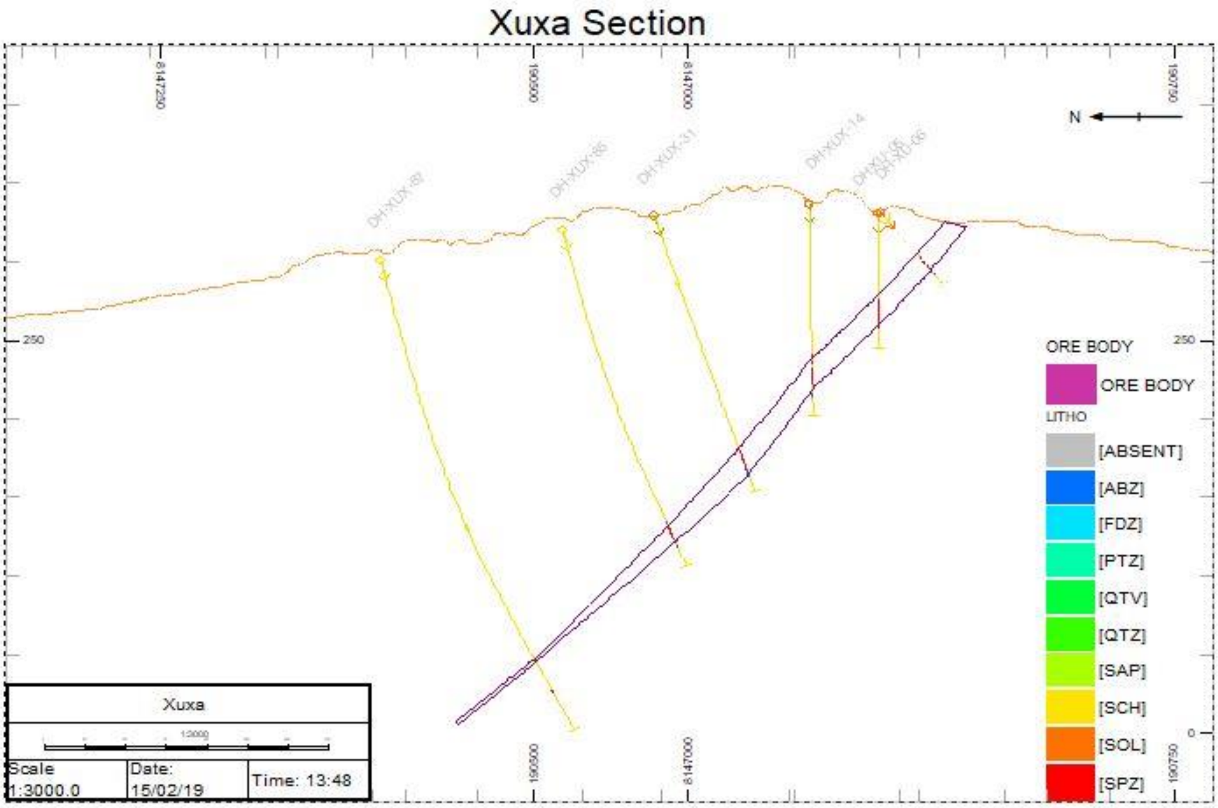


Figure 7-4 - Xuxa Cross Section (looking northeast)

Note: Figure prepared by SGS, 2019

7.3.1.2 Barreiro

The Barreiro pegmatite body is emplaced into biotite–quartz schist. Pale greenish–grey coloured, multi-centimetre-sized microcrystalline quartz–feldspar intercalations have been noted in the schist, with disseminated green, sub- to one-millimetre-sized amphibole and pink garnet crystals. Pegmatite xenoliths can be found within 3 m of the dike edge within the schist and can range from a centimetre to as much as a meter in size.

The pegmatite strikes northeast–southwest and dips to the southeast at 30–35º. Based on drill data, the dike is about 600 m long, 800 m wide, and has an average thickness of 30–35 m. It remains open to the northeast and at depth. The deepest drill hole reached 374 m. The pegmatite is apparently intruded discordant to the host crenulated biotite schist in surface exposures, but at depth, can be concordant, and emplacement may be related to local fracturing.

The dike is slightly zoned into distinct spodumene-rich and albite-rich areas and is divided into an edge (or border), and a central zone. Overall, spodumene is about 20–24% of the dike mass, albite–microcline is approximately 32–40%, and around 10–18% is mica (muscovite).

The border zone is about 45 cm in thickness, and consists of fine-grained albite, quartz and muscovite. Heavy minerals such as cassiterite and tantalite may occur associated with albite units. The central zone is spodumene-rich and consists of albite and spodumene crystals that are typically 10–25 cm in length but can more rarely can attain as much as a metre in length. Spodumene crystals are also present as short, prismatic, elongated laths. The spodumene laths are colourless or pale green, sometimes displaying a poikilitic texture of fine- to medium-grained quartz and/or pale green sericite. Petalite occurs sporadically, as both colourless, translucent to transparent, coarse to very coarse-grained crystalline aggregates. It can also be present as cryptocrystalline, translucent masses.

Figure 7-5 shows a typical cross section through the Barreiro deposit.

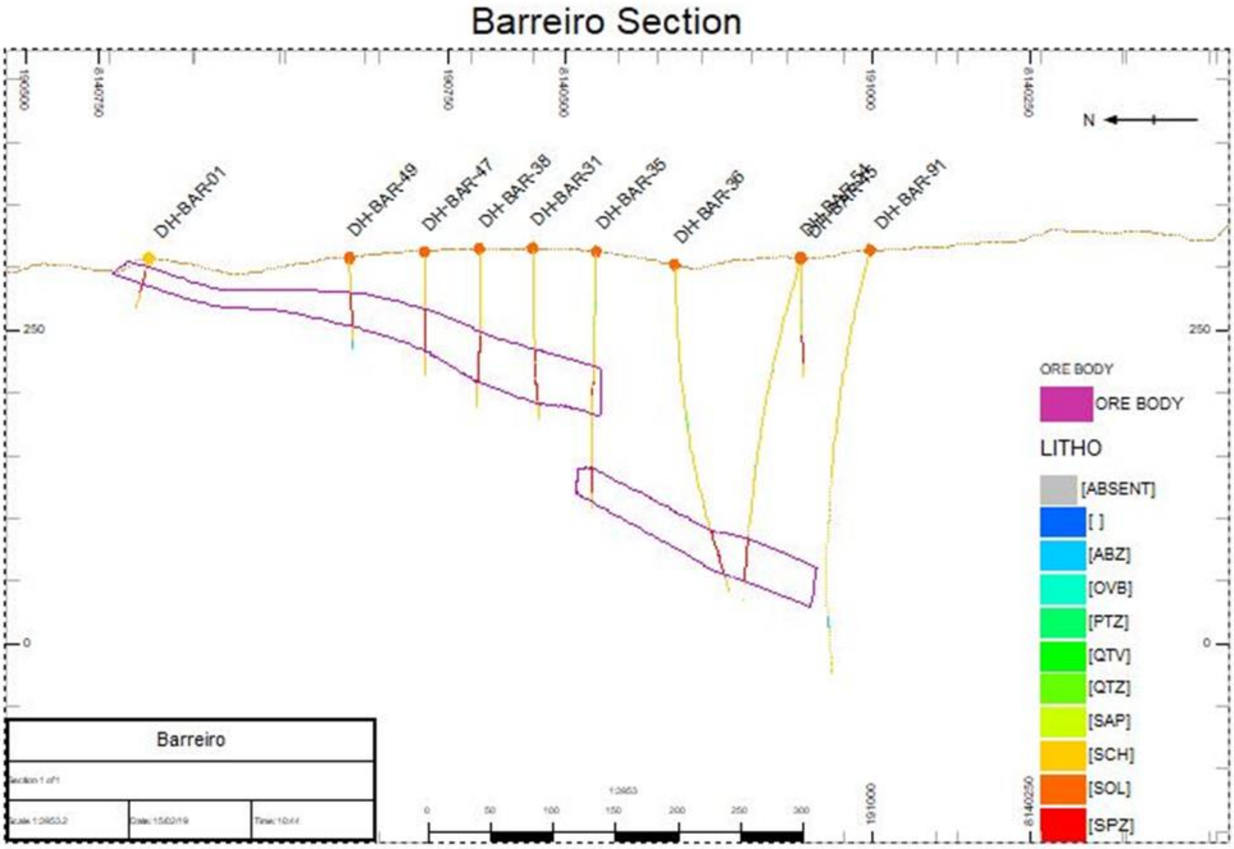


Figure 7-5 - Barreiro Cross Section (looking northeast)

Note: Figure prepared by SGS, 2019

7.3.1.3 Lavra do Meio

The host country rock to the pegmatite dike is a biotite–quartz schist and has similar features to the schist that hosts the Barreiro pegmatite. Garnet and tourmaline have developed near the pegmatite–schist contact.

The dike is concordant with the schist foliation, strikes north–south and dips at 75–80º to the east. Based on drill data, the dike is about 300 m long, 250 m wide, and has an average thickness of 12–15 m. It remains open at depth, with the deepest drill hole reaching 270 m.

The pegmatite mineralization is moderately to highly homogeneous mostly in the centre and deeper part. The upper and lower contact zones are characterized by albite, quartz and mica. In the albite-rich border zone, tantalite and cassiterite can occur interstitial to fan-shaped albite lamellae. In the pegmatite core, medium, to very coarse-grained laths of typically pale green spodumene and coarse to very coarse-grained, colourless, translucent to transparent, petalite crystal aggregates and cryptocrystalline masses occur and compose around 20% of the lithium-bearing minerals. Both spodumene and petalite are set within a micro-fractured, medium to coarse-grained matrix composed of quartz, mica, albite and microcline. The micro-fractures are infilled with pyrolusite.

Figure 7-6 is a cross-section through the Lavra do Meio pegmatite.

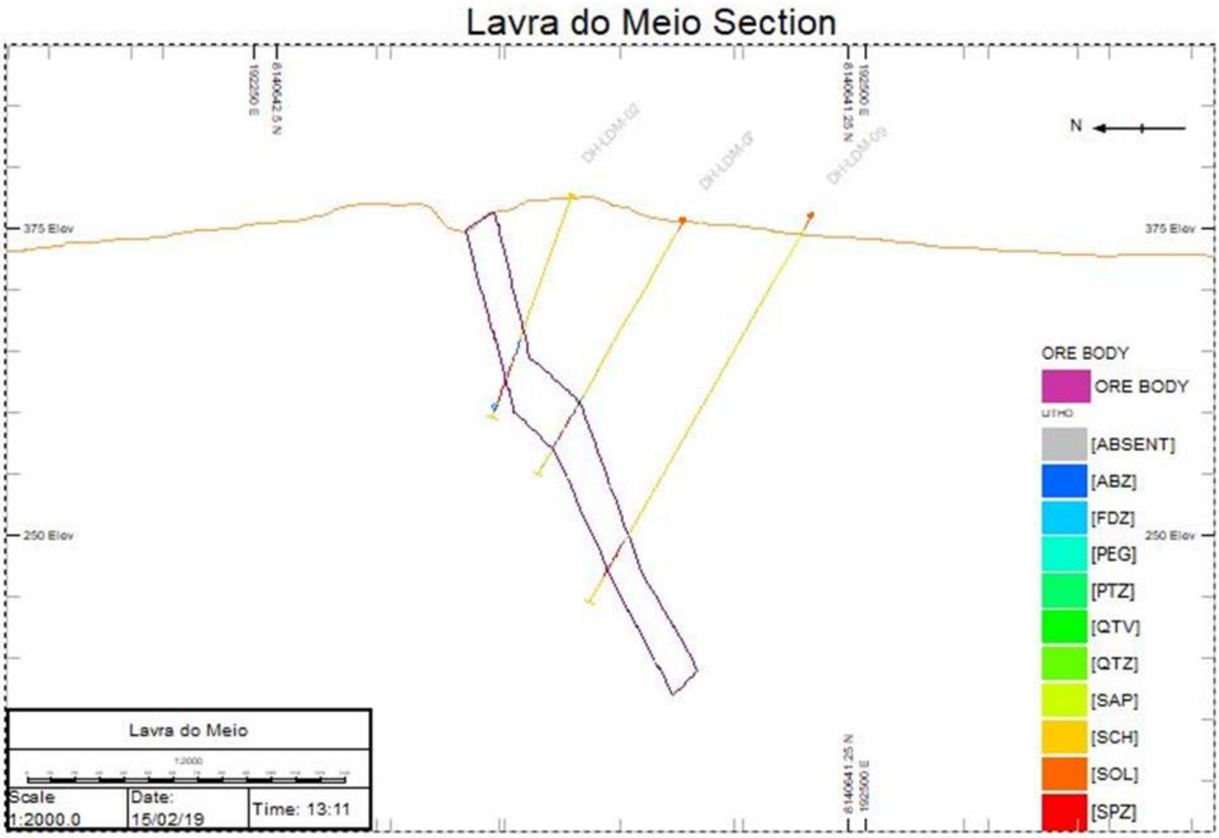


Figure 7-6 - Lavra do Meio Cross Section (looking north)

Note: Figure prepared by SGS, 2019

7.3.1.4 Nezinho do Chicao

The Nezinho do Chicão (Nezinho) pegmatite was discovered in the 1980s by Arqueana. It has been tested by a small pit and a number of exploration trenches (Figure 7-7).

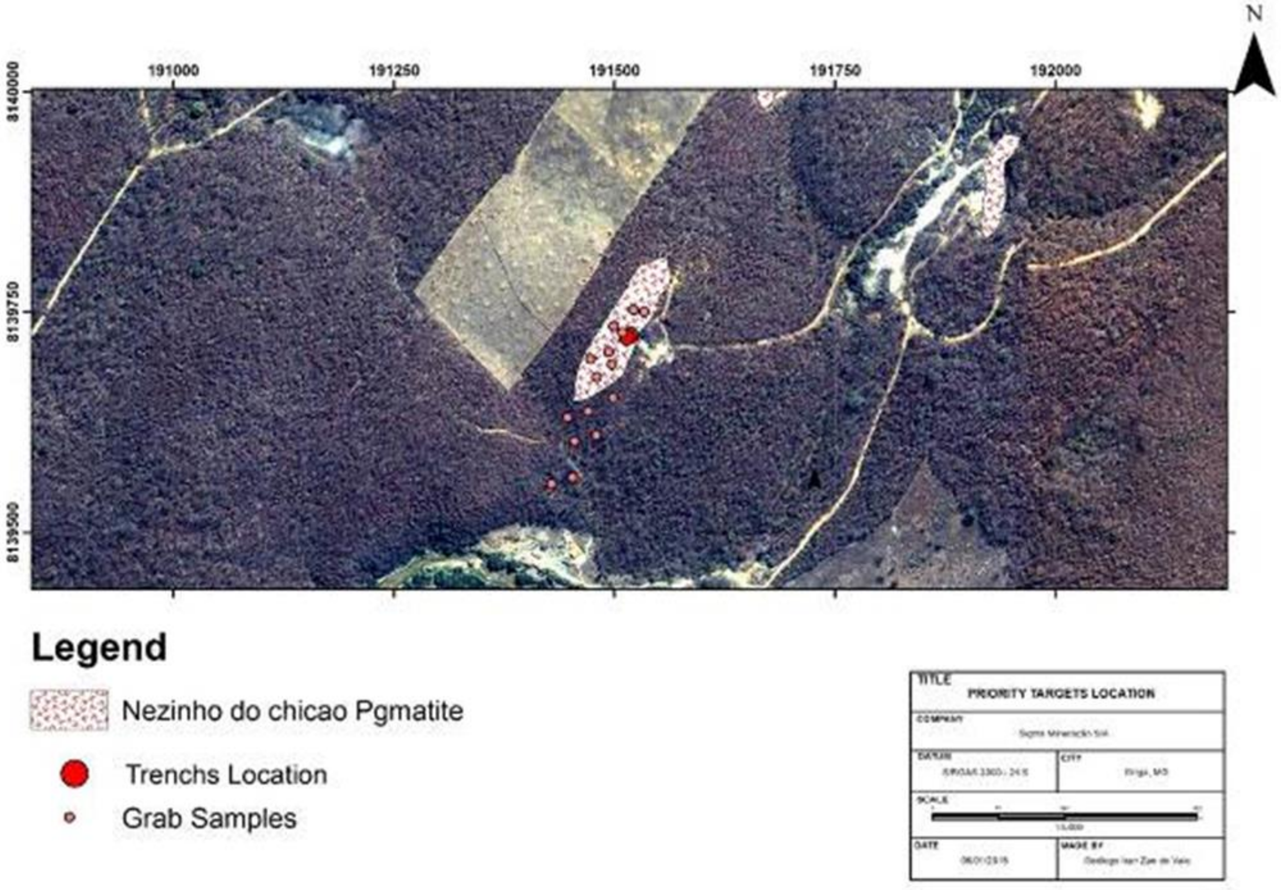


Figure 7-7 - Nezinho Do Chicao Plan Map

Note: Figure prepared by SGS, 2019

The pegmatite is hosted in a biotite–quartz schist, which is similar to the schist described as hosting the Barreiro pegmatite.

The pegmatite body strikes at 215º, dipping at 20–25º to the west. The dike is about 600 m long, 200 m wide and 15–20 m thick. It remains open, with the deepest drill hole reaching 150 m.

7.3.1.5 Murial

A similar biotite–quartz schist to that hosting the Barreiro pegmatite is host to the Murial pegmatite.

The pegmatite is a north–south striking body that has fluctuating westerly dips, ranging from 70–85º in the south of the dike, to a much shallower 25–35º in the north. It is about 750 m long, 200 m wide, and has an average thickness of 15–20 m. It remains open to the north, south, and at depth.

The southern part of the dike generally has lower lithium contents, and the pegmatite has a sub-vertical to nearly vertical orientation. To the north, the lithium concentrations increase, and the dike orientation changes to horizontal to sub-horizontal and becomes more planar in shape.

The pegmatite shows a border, intermediary and central zone. The border zone is enriched in albite, the intermediate zone is typically spodumene-rich, and the central zone contains both spodumene and petalite. The fine-grained border matrix can include tantalite and cassiterite mineralization.

A cross-section through the Murial pegmatite is provided in Figure 7-8.

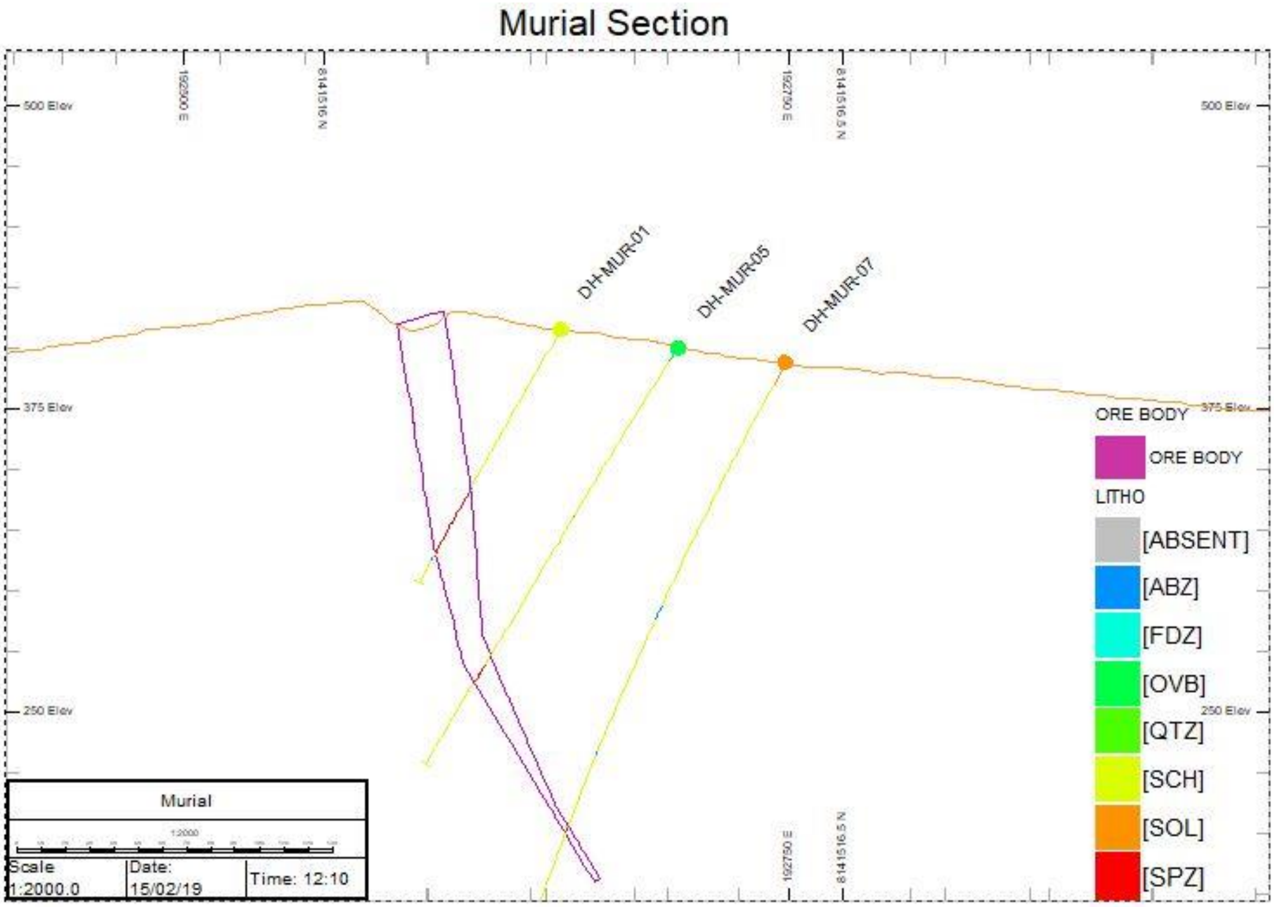
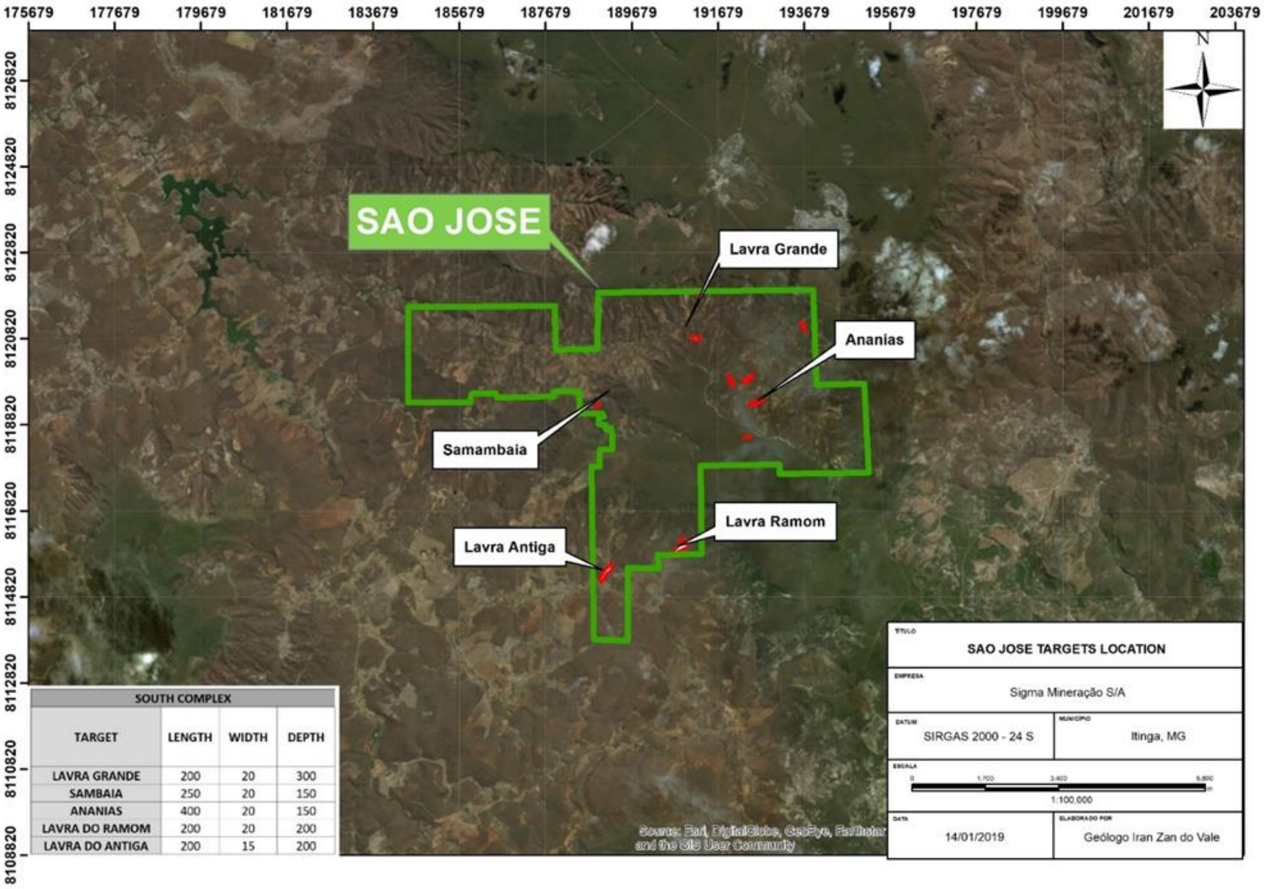


Figure 7-8 - Murial Cross Section (looking north)

Note: Figure prepared by SGS, 2019

7.3.2 Sao Jose Property

The São José property hosts five historical workings: Ramon, Lavra Antiga, Lavra Grande, Samambaia and Ananias (Figure 7-9). The São José area is locally known for gem-quality spodumene crystals that are used in jewelry.



SOUTH COMPLEX			
TARGET	LENGTH	WIDTH	DEPTH
LAVRA GRANDE	200	20	300
SAMBAIA	250	20	150
ANANIAS	400	20	150
LAVRA DO RAMOM	200	20	200
LAVRA DO ANTIGA	200	15	200

Figure 7-9 - Historical Workings within São José Property

Note: Figure prepared by SGS, 2019

7.3.2.1 Lavra Grande

The Lavra Grande pegmatite was mined from underground in two stopes targeting the alteration zone, with petalite as the primary mineralization target. The dike strikes east-west, is about 300 m long, and 20–25 m in width. It is near vertical, dipping at 75–80° to the north. Pegmatite mineralogy consists of spodumene, petalite, feldspar and quartz. Petalite crystals exhibit perfect crystalline habit and are rose in colour.

The country rock is a medium grey biotite-quartz-schist, occasionally exhibiting crenulation cleavage that may encompass, mm to cm sized coliform cordierite porphyroblasts and finely disseminated stretched iron sulphide crystals with a preferred orientation that is sub-parallel to the foliation. The weathered zone of the schist often includes enriched sericite zones and micro-crystalline quartz-calcite intercalations that include disseminated dark green sub to millimetre sized amphibole and pink garnet crystals, all within a gneissose fabric.

7.3.2.2 Lavra Ramon

This area was historically mined using artisanal methods for spodumene and feldspar. The dike consists of a contact (border) zone and a central zone. The contact zone consists of a thin, leukocytic and competent edge, whereas the central zone is predominantly coarse-grained with very large crystals. The Ramon dike has crystals that can be as much as 1–2 m in length, and spodumene can be as much as 50% of the pegmatite mass (Figure 7-10).

Figure 7-10 - Macro Crystals at Lavra Ramon

Note: Figure prepared by SGS, 2019

Preliminary field work suggests the pegmatite is approximately 200 m long, 200 m wide, and 20 m thick and strikes N40ºW and dips 75º to the southeast. Country rock includes shale and gneiss. The strike of the country rock is N45ºW and the dip varies depending on distance to the granitic intrusions.

7.3.2.3 Lavra Antiga

This area was historically mined using artisanal methods for spodumene and feldspar. The dike consists of a contact (border) zone and a central zone. The main minerals are spodumene, feldspar, and quartz. The structure is essentially divided into a contact zone and central zone. The contact zone is characterized by a thin, leukocytic and competent edge and the central zone is predominantly coarse grained with very large crystals.

Preliminary field work suggests the pegmatite is approximately 200 m long, 200 m wide, and 15 m thick and strikes N40ºW and dips 75º to the southeast. The strike of the country rock is N45ºW and the dip varies depending on distance to the granitic intrusions.

7.3.2.4 Samambaia

The Samambaia pegmatite consists of a number of parallel intrusions (stacked pegmatites) with outcrop widths varying from 3–5 m in thickness. Three, parallel, stacked pegmatites can be identified over a 50 m interval in historical workings, with spodumene crystals clearly visible in the side-walls of the excavations. The pegmatite zone is estimated at 250 m long, striking northeast–southwest, and dipping at 45º to the southeast (Figure 7-11).

Figure 7-11 - Samambaia Plan Map

Note: Figure prepared by Sigma, 2019

The dike consists of a contact zone and a central zone. The contact zone consists of fine-grained, whitish, quartz–albite, whereas the central zone comprises spodumene, feldspar and quartz minerals. The central zone rock mass consists of about 25–28% spodumene, 40–45% feldspar, and 8–10% quartz. Country rock includes shale and gneiss. The strike of the country rock is N45ºW and the dip varies depending on distance to the granitic intrusions.

7.3.2.5 Ananias

The historical workings consist of a small pit and a single underground stope. Lithium minerals are visible in the excavation walls. The pegmatite is about 200 m long, 20 m thick, strikes east-west, and dips at 60º to the south (Figure 7-12).

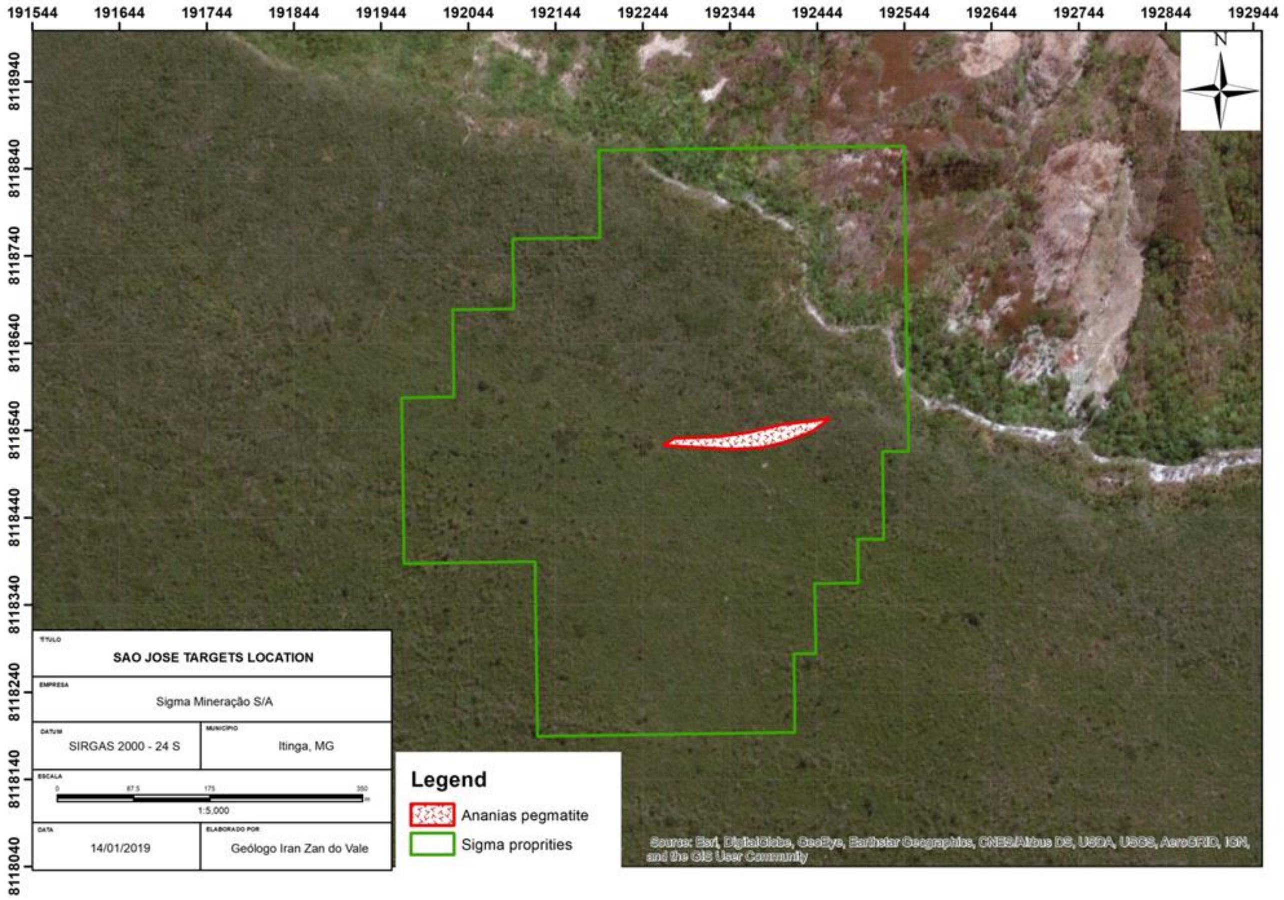


Figure 7-12 – Ananias Plan Map

Note: Figure prepared by SGS, 2019

It consists of a central zone and a contact zone. The central zone primarily consists of 25–28% spodumene, 40–45% feldspar, 8–10% quartz and 10% mica. The contact zone comprises whitish, fine-grained quartz and albite. The dimensions of the pegmatite have not been estimated. The strike of the country rock is N45ºW and the dip varies depending on distance to the granitic intrusions.

7.3.3 Genipapo

Only initial reconnaissance work has been performed on the Genipapo property, which has identified the Ilha Allegre, Jenipapo, Mario Gusmao and Sebastiano Dutra dikes, and small deposits identified by Arqueana as hosting tantalum–niobium–tin mineralization. Additional information is provided in Section 9-6. This area is not a current exploration focus.

7.3.4 Santa Clara

Initial reconnaissance activities have identified the Marculino, Maroto, Jose Gonsales and Bolasha pegmatites as well as areas that Arqueana reported as hosting tantalum–niobium–tin mineralization. Additional information is provided in Section 9-6. This area is not a current exploration focus.

8 DEPOSIT TYPES

The deposits within the Project area are considered to be examples of LCT-type pegmatites.

The following deposit type descriptor for such pegmatites is summarized and abstracted from Bradley and McCauley (2013).

All known LCT pegmatites are associated with convergent-margin or collisional orogens. LCT pegmatite maxima at ca. 2650, 1800, 525, 350, and 100 Ma correspond to times of collisional orogeny and, except for a comparatively minor peak at 100 Ma, to times of supercontinent assembly. The largest known deposits are Archean in age (Viana and al, 2003).

LCT pegmatites represent the most highly differentiated and last to crystallize components of certain granitic melts. Parental granites are typically peraluminous, S-type granites, although some Archean examples are metaluminous, I-type granites. LCT pegmatites are enriched in the incompatible elements lithium, cesium, tin, rubidium, and tantalum, and are distinguished from other rare-element pegmatites by this diagnostic suite of elements. The dikes typically occur in groups, which consist of tens to hundreds of individual pegmatites and cover areas up to a few tens of square kilometres. LCT pegmatites are known to form as far as 10 km from the parental granite and the more distal the pegmatite, frequently the more fractionated. The most highly fractionated rare-element-enriched pegmatites only constitute 1–2% of regional pegmatite populations.

The dikes are commonly late syntectonic to early post-tectonic with respect to enclosing rocks. Most LCT pegmatites intruded metasedimentary rocks, which are often metamorphosed to low-pressure amphibolite to upper greenschist facies.

Individual pegmatites have various forms including tabular dikes, tabular sills, lenticular bodies, and irregular masses. They are significantly smaller than typical granitic plutons, and typically are of the order of tens to hundreds of metres long, and meters to tens of metres wide.

Most LCT pegmatite bodies show some sort of structural control. At shallower crustal depths, pegmatites tend to be intruded along anisotropies such as faults, fractures, foliation, and bedding planes. For example, in more competent rocks such as granites, pegmatites commonly follow fractures whereas pegmatites intruded into schists tend to conform to foliation. In higher-grade metamorphic host rocks, pegmatites are typically concordant with the regional foliation, and form lenticular, ellipsoidal, or tapered cylindrical bodies.

Lithium is mostly found in the silicates spodumene ($LiAlSi_2O_6$), petalite ($LiAlSi_4O_{10}$), and lepidolite (Li-mica, $KLi_2Al(Al,Si)_3O_{10}(F,OH)_2$). Lithium phosphate minerals, mainly montebrasite, amblygonite, lithiophilite, and triphylite, can be present in some LCT pegmatites. Tantalum mineralization predominantly occurs as columbite–tantalite ($[Mn,Fe][Nb,Ta]_2O_6$). Tin is found as cassiterite (SnO_2). Cesium is mined exclusively from pollucite ($CsAlSi_2O_6$).

Most individual LCT pegmatite bodies are concentrically, though irregularly, zoned. However, there are unzoned examples known.

Within an idealized pegmatite, four main zones can be defined (Figure 8-1).

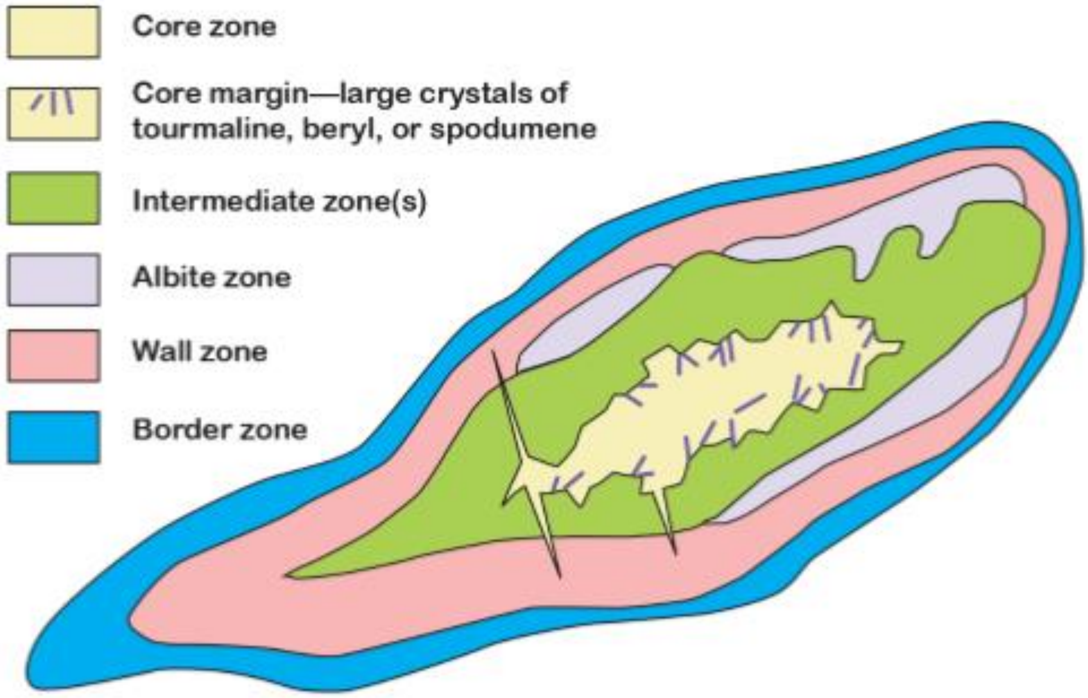


Figure 8-1 - Generalized Schematic Representation LCT Pegmatite

Note: Figure from Bradley and McCauley (2013)

These comprise:

- Border: chilled margin just inside the sharp intrusive contact between pegmatite and country rock. Typically, a few centimetres thick, fine-grained, and composed of quartz, muscovite, and albite;
- Wall: <3 m thick. Largest crystals <30 cm. Main minerals are albite, perthite, quartz, and muscovite. Graphic intergrowths of perthite and quartz are common. Can form economic muscovite concentrations that can be mined. Tourmaline and beryl may be present;
- Intermediate: Term used to refer to everything between the wall and the core. These may be discontinuous rather than complete shells, there may be more than one, or there may be none at all. Major minerals include plagioclase and potassium feldspars, micas, and quartz. Can host beryl, spodumene, elbaite (tourmaline), columbite–tantalite, pollucite (zeolite), and lithium phosphates. Typically, coarser-grained than the wall or border zones;
- Core: Often mono-mineralic quartz in composition. Perthite, albite, spodumene or other lithium aluminosilicates, and (or) montebrasite (lithium phosphate) may occur with the quartz.

LCT pegmatites crystallize from the outside inward. In an idealized zoned pegmatite, first the border zone crystallizes, then the wall zone, then the intermediate zone(s), and lastly, the core and core margin.

The QP considers that exploration programs that use the deposit model set out above would be applicable to the Project area.

9 EXPLORATION

9.1 INTRODUCTION

Sigma began working on the Project in June 2012, focusing on a geological assessment of available field data to prioritize the 200 known pegmatites that occur on the various properties for future evaluation. A ranking table that highlighted pegmatite volume, mineralogy and Li_2O and Ta_2O_5 grade was established.

Within the more prospective areas, Sigma concentrated its activities on detailed geological and mineralogical mapping of historically mined pegmatites, in particular, on the larger pegmatites, Xuxa and Barreiro. These dikes were channel sampled and subsequently assessed for their lithium, tantalum and cassiterite potential. This work was followed by bulk sampling and drilling. A comprehensive description of the work program was provided in Laporte (2018), from which the following information has been summarized and abstracted.

9.2 GRIDS AND SURVEYS

Landinfo, a Denver, Colorado-based company that specialises in satellite imagery, was contracted by SMSA to acquire a high definition satellite image and prepare a digital elevation model (DEM) for the Grota do Cirilo property area. In 2017, a DEM was constructed specifically for the Xuxa pegmatite area, and in 2018, the DEM was extended to include all targets on the Grota do Cirilo property (Figure 9-1).

A 3D topographic survey and mapping of the various historically mined pegmatites was conducted using differential global positioning system (DGPS) instruments and total station equipment.

9.3 GEOLOGICAL MAPPING

Sigma concentrated its activities on detailed geological and mineralogical mapping of historically mined pegmatites.

9.4 CHANNEL MAPPING

Sigma conducted a significant amount of channel sampling at the known historical mines and pegmatite outcrops on the Project from 2012 to 2014. A total of 544 channel samples were collected from 14 pegmatite bodies within the Grota do Cirilo property. Table 9-1 summarizes the channel sampling conducted during this time.

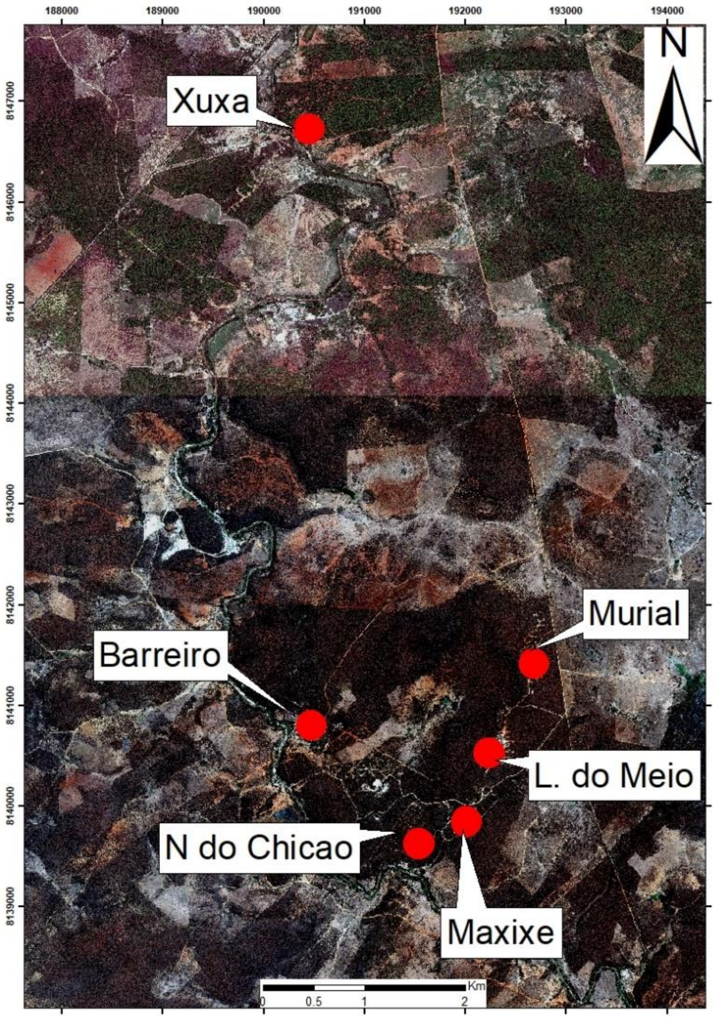


Figure 9-1 - Grota do Cirilo Satellite Image

Note: Figure prepared by Sigma, 2018.

Table 9-1 - Channel Sampling Summary

Property	Prospect	Number of Samples
Grota do Cirilo	Xuxa	5
	Barreiro	151
	Lavra do Meio	72
	Murial	50
Sao Jose	Lavra Grande	40
Total		**318**

The channel samples were collected along and/or across strike, to the stratigraphy, schistosity, mineralization or other visible continuous structure. Individual channel samples were 10 to 15 cm in width, and approximately 5 cm in depth and one metre in length. Sample weights were between 15 to 30 kg. Channels were taken at outcrops, historic trenches, and historic mine workings. Samples were taken from both the pegmatite and the schist host rock. The samples, were bagged, tagged and sent to the SGS Belo Horizonte laboratory for analysis. Check samples were sent to SGS Johannesburg for control purposes.

An example of the channel sampling methodology is provided in Figure 9-2, and is photographed at the Murial workings.

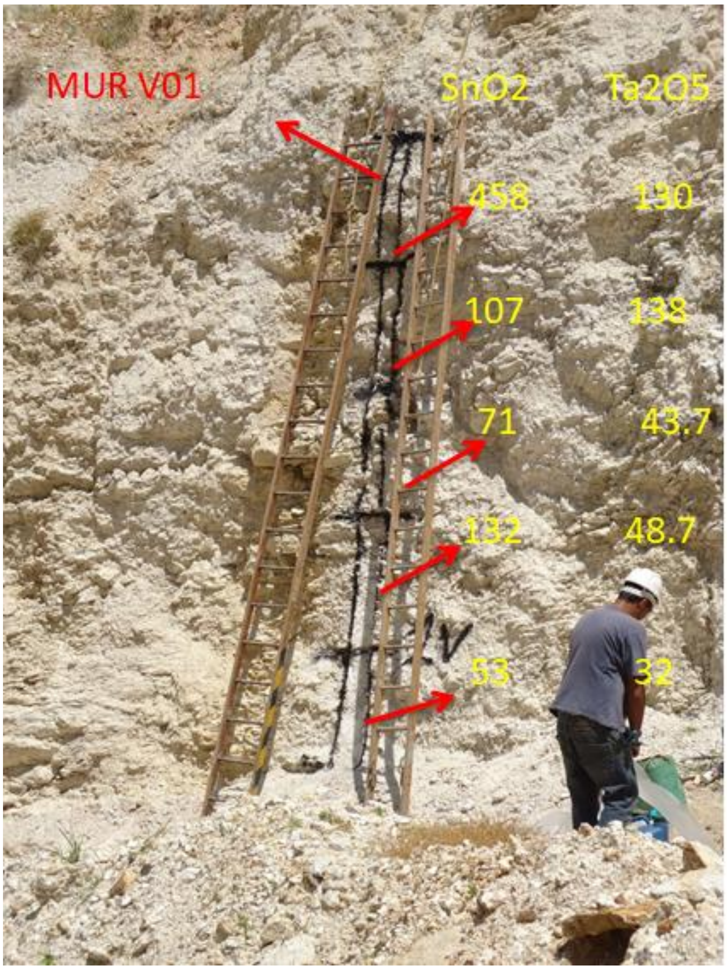


Figure 9-2 - Channel Samples at Murial Mine

Note: Photograph by Sigma, 2018.

9.5 TRENCH SAMPLING

Sigma generally followed up positive channel sampling results with trenching and collection of large bulk (500 to 1,000 kg) samples for evaluation of heavy mineral potential. Table 9-2 summarizes the trenching conducted during this time.

Table 9-2 - Grota do Cirilo Trench Sampling Summary

Area	Number of Trenches
Barreiro	6
Lavra do Meio	3
Nzinho do Chicao	2
Mutamba	5
Gringo	6
Matinha	4
Costelao	5
Arueira	3
Acari	5
Total	**39**

9.6 EXPLORATION POTENTIAL

The Grota do Cirilo property hosts a large swarm of pegmatites, with differing orientations and varying mineralogical compositions. The pegmatites can be separated into two classes:

- Structurally concordant (having dips and strikes comparable to that of the regional foliation of the host schist host (azimuth 300–340° and dip 40–60°). Nearly all of the pegmatites (Costelão, Matinha, Mutamba, Joao Vaqueiro, Arueira, etc.) belong to the concordant class. They form intrusive bodies (dikes), typically being several hundred meters in length and from 3–20 m thick
- Structurally discordant; having dips and strikes that cross-cut schist foliation. The Gringo (azimuth 140–170° dip -15–55°), Barbieri (azimuth 340° dip 90°) and Urubu are examples of discordant pegmatites.

The pegmatites which may support additional exploration activities in the Grota do Cirilo property are outlined in Table 9-3**.**

Table 9-3 - Grota do Cirilo Property Prospects

Prospect	Description
Mutamba	Concordant to wall rock foliation, mainly containing feldspar and heavy minerals, and the outcrop is 240 m in length with a width of 4-7 m, dipping azimuth 320–340° dip -45–55°. Arqueana mined the pegmatite to approximately 5 m depth.
Maxixe	One of the larger of the Arqueana excavations, commencing as an open pit, then being mined from underground. The former open pit is about 150 m long, and 20 m wide. The pegmatite dike strikes at 125–80º, and dips at 30–35º. It is hosted in a medium-grey-coloured, fine-grained, cordierite prorphyroblast-bearing biotite–quartz schist

Prospect	Description
Gringo	Discordant to the regional foliation, with high lithium content (spodumene/petalite). The Gringo outcrop is more than 130 m in length, 2–7 m in width and the observed contact attitudes suggest that it may widen in depth. Arqueana mined the pegmatite to approximately 5 m depth
Matinha	Concordant (or close to concordant) with foliation and is composed mainly of feldspar. The outcrop is 265 m in length, with a maximum width of 23 m, azimuth of 320° and dip -55° and steepens in the northeast to -90°). Arqueana mined the pegmatite to approximately 10–12 m depth.
Costelão and Velho Costelão	The Costelão and Velho Costelão pegmatites are closely located and are parallel in strike. Both are concordant bodies but have different mineralogical composition. Costelão is a Li (ambligonite) type pegmatite, with an outcrop length of 220 m and width of 11 m, az 330° dip -60°. Velho Costelão is smaller in size: the outcrop is 7 m wide, an interpreted length of 100–150 m, az 340°, dip -75°. The north-eastern part of the Costelão body was mined columbite–tantalite, cassiterite, quartz and feldspar. The southwestern portion was exposed in several prospecting trenches and pits. Velho Costelão was mined from two small underground stopes.
Joao Vaqueiro	Concordant to the regional host rocks. It is spodumene/petalite-type pegmatite body. The outcrop has been shown to be more than 15 m thick, azimuth 320° and dip -50°.
Arueira	Concordant to the host rock. This is a lepidolite-type pegmatite that is 250 m in length, 2–5 m in width, striking 320°, and dipping at -50°. The pegmatite was open-pit mined by Arqueana and produced columbite–tantalite, cassiterite, lepidolite, quartz and feldspar.
Soldado	Soldado (Grota Soldado) is famous in the area for its extremely high grades of heavy minerals (columbite–tantalite and cassiterite). It is a slope deposit containing debris and blocks of pegmatite. In 2013, SMSA cleaned two old pits where garimpeiros had worked historically. Large blocks of pegmatite and a number of smaller boulders were found in the basal layer of a Quaternary deposit, but the in-situ pegmatite was not located.
Tamburil	The Tamburil pegmatite outcrop is around 7 m in width and 90 m length dipping at -60° to the east. It is spodumene/petalite-type pegmatite body. It has been open pit mined to a depth of 10 m.
Acari	Located along strike from Tamburil. It is an outcrop 9 m in width and 150 m in length and dips 60° to the east. A well-developed lithium-bearing zone is visible on the south part of the outcrop that consists of a 4 m wide pocket of petalite.
Bee Mine	The Bee Mine is situated close to the Tamburil deposits and 500 m north northeast of Nezinho do Chicão. The pegmatite is exposed in old trench and in a 7 m-deep shaft and shows spodumene crystals. The pegmatite hanging wall and footwall are not exposed in the trench.
Peneira	The pegmatite is about 7–9 m thick and may be as much as 15 m thick. It is about 200–250 m long. It has been mined for columbite–tantalite, cassiterite, quartz and feldspar. Spodumene and petalite form in the intermediate zone, and spodumene comprises about 20% of the pegmatite body. The crystals are about 20–30 cm in length. Petalite is formed associated to the grains and fractures of spodumene in small interstitial portions throughout the body and is a small percentage of the body.

Additional prospects and dikes that may warrant follow-up are provided in Table 9-4 for the Genipapo property and Table 9-5 for the Santa Clara property.

Table 9-4 - Genipapo Property Prospects

Prospect	Description
Ilha Alegre	Located near the main road from Araçuaí-Itaobim, in the proximity of the Taquaral village. The body strikes southwest–northeast. This pegmatite has a composition including feldspar, quartz, mica and black tourmaline, very similar to the Santa Clara pegmatites.
Jenipapo	A dike approximately 10 m thick, concordant to wall rock (strike 325º, dip <75º). The composition is predominantly feldspar with quartz and mica. The body has been investigated by means of a single open pit to a depth of 5 m.
Lavra do Morundu	A vertical pegmatite dyke approximately 30 m thick by 250 m long. It is discordant to the fabric of the country rock. Heavy minerals including cassiterite and tantalite are recognizable in this pegmatite.
Mario Gusmão	A narrow (<5 m thick) dike, concordant to wall rock (strike 330º, dip <65º), composed of feldspar with quartz, mica and abundant black tourmaline. This pegmatite has been mined by means of an open pit to a depth of approximately 10 m.
Sebastiano Dutra	A 10–20 m thick, >150 m long dike, concordant to wall rock (strike 330º, dip <65º). The pegmatite exhibits well defined zoning: (i) feldspar with quartz and coarse mica wall zone; and (ii) feldspar (albite)–mica–quartz with columbite intermediate zone; and (iii) quartz core zone. This pegmatite has been mined for gemstone via several open pits of up to 10 m depth.
Aprigio and Aprigio 2	These two pegmatites are located in proximity to each other and are concordant with the host rock fabric (320-45°). The main minerals are feldspar–quartz–mica (muscovite and lepidolite), and secondary minerals include black tourmaline (afrisite). No heavy minerals were observed.
Apriginho	The Apriginho pegmatite body is approximately 15–20 m wide and 60 m long. The main minerals are 60–70% feldspar, 15% quartz, 10% mica and 5% petalite, with accessory tourmaline. The body has small garimpeiro pits probably prospecting for tourmaline. The body is concordant with the host rock (340-75º).
Tedi	This pegmatitic body is 150 m long, striking north-south. The width of the pegmatite is unknown as the contact zones have not been exposed. The main minerals are feldspar, quartz, mica (muscovite and lepidolite) and the secondary minerals include black tourmaline. Garimpeiro activity was noted during the prospecting visit.
Vicente	Strikes east–west, with an 80º dip concordant to the host rock. In the area there are some small open pits and underground workings. The mineralogical composition of the bodies includes feldspar, quartz, mica and black tourmaline.
Bie	Strikes 320º and dips 90º, concordant with the host rock. The body was mined by means of an open pit 20 m wide and 70 m long. The main minerals are feldspar, quartz, and mica (muscovite and lepidolite) and the secondary minerals include black tourmaline and cassiterite.

Table 9-5 - Santa Clara Property Prospects

Santa Clara Prospect	Description
Honorato and Marculino	The Honorato pegmatite is a 7–10 m wide dike, dipping discordantly to the host rock (strike 125º, dip <50º). An old open pit on the dike is about 150 m long, and 5 m deep. The Marculino pegmatite is located close to the Honorato body, probably dipping in different directions and with a combined length of around 600 m. The Marculino pegmatite has been prospected by means of a number of small pits, most of them now collapsed. The contact of the pegmatite with the host rocks is not visible, but according to pegmatite cleavage direction (az. 325º<40º), it seems to be concordant with the host rocks. The mineral composition of the Marculino and Honorato pegmatites is typical for the Santa Clara area, with 60–70% feldspar, with quartz, mica and black tourmaline. One sample from Honorato pit included small cassiterite crystals.
Maroto and Jose Gonsales	The Maroto pegmatite body strikes north–south and is 300 m in length. The Jose Gonsales pegmatite strikes east–west and is 200 m in length (according to historical map data). The two pegmatites are adjacent to the Marculino dike, on the upper part of the same hill. A large number of old pits and trenches with pegmatite debris were noted.
Bolacha and Antonio Preto	The Bolacha and Antonio Preto pegmatite bodies both strike north–south and are approximately 200 m in length. Prospecting was done by means of a series of pits. The pegmatite contains feldspar, quartz, mica and black tourmaline

In the southern complex area, Sigma geologists have visited sites of historical workings, and undertaken reconnaissance mapping and sampling activities. The Lavra Grande, Samambaia, Ananias, Lavra do Ramom and Lavra Antiga pegmatites were mined for spodumene, petalite, feldspar and heavy minerals, and in some cases gem-quality crystals were targeted. These pegmatites are considered to warrant additional work.

10 DRILLING

10.1 INTRODUCTION

Sigma has conducted a number of drilling campaigns on the project since acquiring the property in 2012. To date, this drilling has concentrated on the Grota do Cirilo pegmatites. Table 10-1 is a drill summary table showing the drilling completed by Sigma until December 2018. No further drilling was done in 2019. A total of 255 core holes (42,959.76 m) was completed.

Table 10-1 - Total Sigma Drill Holes

Pegmatite/Area	Number of Drill Holes	Metres Drilled
Xuxa	93	13,976.15
Barreiro	109	19,658.30
Murial	37	6,595.61
Lavra do Meio	17	2,188.98
Nezinho do Chicao	5	394.22
Maxixe	2	216.50
Total	**255**	**42,959.76**

10.2 DRILL TYPE

All drilling was core drilling at HQ core size (63.5 mm core diameter) to provide quality logging material, and in order to recover sufficient material for future metallurgical testing.

10.3 SIGMA DRILLING CAMPAIGNS

10.3.1 Xuxa

As at 31 December 2018, Sigma had completed a total of 93 diamond drill holes on Xuxa for 13,976.15 m (Table 10-2). All of the drilling is used in support of Mineral Resource estimation.

Table 10-2 - Total Xuxa Drilling

Year	Number of Drill Holes	Metres Drilled
2014	9	649.2
2017	57	7,148.55
2018	27	6,178.40
Total	**93**	**13,976.15**

The 2014 drill program was undertaken by the Brazilian-based company Geosol, core was stored in locally made wooden boxes and transported to the company's core sheds for logging and sampling. The average pegmatite intersection was 13.55 m and an average true thickness of 9.6 m was calculated. The true thickness, based on 2017 drilling, increased to 12.6 m, and was 13 m on average following the 2018 drilling.

Ten percent of the holes at Xuxa have been drilled vertically and the remaining 90% are inclined at between 050º to 090º (average of 75º). The core holes are generally oriented at azimuth 145°, perpendicular to the general orientation of the pegmatite intrusions, and deviate slightly toward the west. Drill spacing is typically 50 m with wider spacing at the edges of the drill pattern. The drill hole intercepts range in thickness from approximately 85% of true width to near true width of the mineralization.

Illustrative intercepts through the deposit, showing examples of drill holes with low-grade intercepts, with high-grade intercepts and with higher-grade intercepts within lower-grade widths, are provided in Table 10-3. Figure 10-1 shows the locations of the drill collars. Figure 10-2 is a longitudinal section showing the general drill orientations.

Table 10-3 - Xuxa Example Drill Intercept Table

Deposit/Area	Hole ID	UTM East (m)	UTM North (m)	Elevation (m)	Azimuth (m)	Dip (º)	Depth (m)	From (m)	To (m)	Thickness (m)	Average Grade (%Li2O)
Xuxa	DH-XUX-01	190537.30	8146787.50	319.40	0.00	-90.00	55.50	21.80	42.30	17.90	1.51
Xuxa	DH-XUX-23	190331.31	8146818.50	308.27	145.00	-75.00	200.09	171.70	187.00	15.30	1.96
Xuxa	DH-XUX-27	190394.98	8146883.16	319.78	145.00	-75.00	203.72	172.31	184.70	12.47	1.44
Xuxa	DH-XUX-33	190200.46	8146523.49	287.05	145.00	-75.00	62.70	41.79	52.80	11.01	1.44
Xuxa	DH-XUX-91	190044.75	8146414.19	294.32	145.00	-75.00	116.55	201.00	214.56	13.56	1.51
Xuxa	DH-XUX-63	189961.97	8146523.56	276.92	145.00	-75.00	236.34	88.76	108.13	19.33	1.85
Xuxa	DH-XUX-63	189961.97	8146523.56	276.92	145.00	-75.00	236.34	136.56	218.36	32.82	1.18
Xuxa	DH-XUX-55	189825.28	8146278.72	288.99	145.00	-75.00	215.25	22.23	226.80	4.57	2.00
Xuxa	DH-XUX-74	190215.25	8146805.98	290.67	145.00	-75.00	230.08	162.07	178.00	15.93	1.81
Xuxa	DH-XUX-74	190215.25	8146805.98	290.67	145.00	-75.00	230.08	162.07	178.00	15.93	1.81

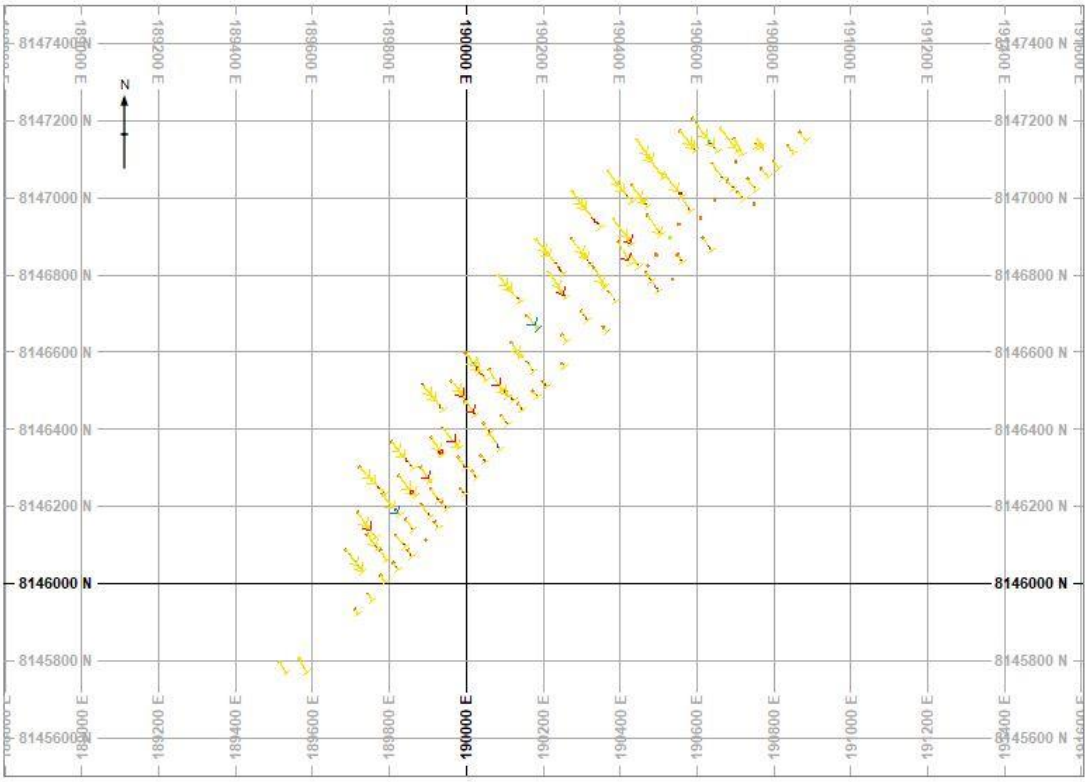


Figure 10-1 - Plan View of the Drilling at Xuxa

Note: Figure prepared by Sigma, 2019.

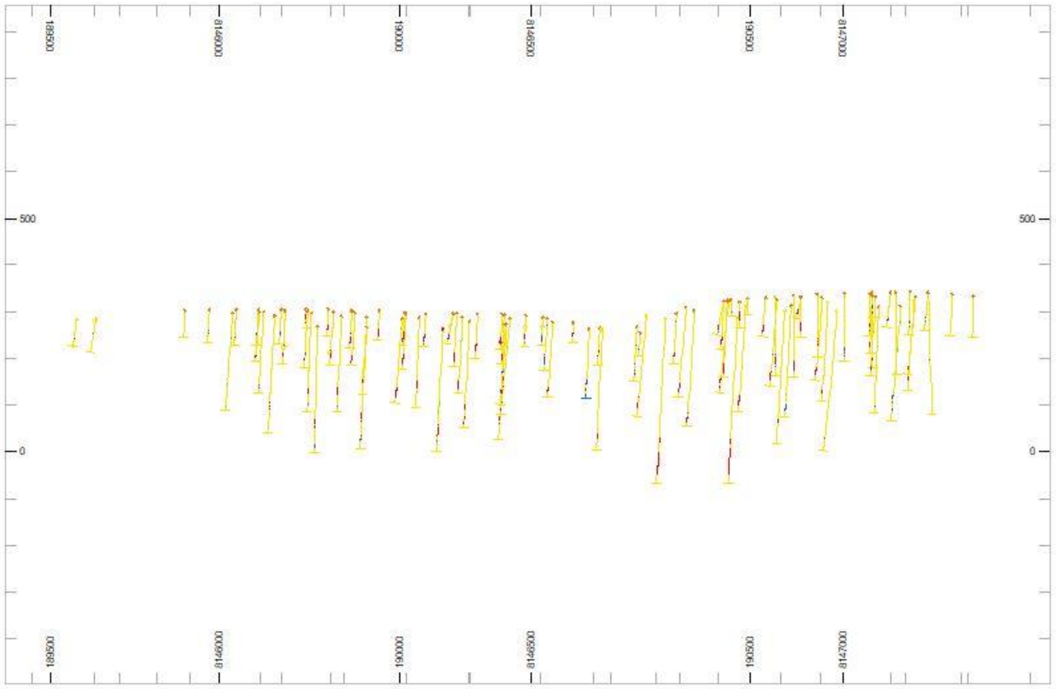


Figure 10-2 - Longitudinal View of the Drilling at Xuxa

Note: Figure prepared by Sigma, 2019.

10.3.2 Barreiro

Drilling from 2014–2018 consisted of 109 HQ drill holes (19,658.3 m). The drilling is summarized by year in Table 10-4. All but five of the drill holes are used in Mineral Resource estimation as five of the drill holes were completed after the database closeout date for estimation.

Table 10-4 - Total Barreiro Drilling

Year	Number of Drill Holes	Metres Drilled
2014	4	181.05
2017	2	233.94
2018	103	19,243.31
Total	**109**	**19,658.3**

The drill holes were generally spaced between 50–100 m apart with 65% of the drilling being vertical and the remaining drill holes were drilled on a N310º azimuth. The drill-hole inclination ranged from 50º to 90º, and the deepest hole reached 350 m below surface. The average pegmatite intersection was about 42.00 m, resulting in a typical true thickness of 30–35 m.

Illustrative intercepts through the deposit, showing examples of drill holes with low-grade intercepts, with high-grade intercepts and with higher-grade intercepts within lower-grade widths, are provided in

Table 10-5. A drill hole location plan for the drilling is provided in Figure 10-3, and a longitudinal view of the drill traces in Figure 10-4.

Table 10-5 - Barreiro Example Drill Intercept Table

Deposit/Area	Hole ID	UTM East (m)	UTM North (m)	Elevation (m)	Azimuth (m)	Dip (º)	Depth (m)	From (m)	To (m)	Thickness (m)	Avera (%Li2
Barreiro	DH-BAR-14	190891.26	8140690.17	330.00	0.00	-90.00	122.07	60.38	97.41	37.03	1.50
Barreiro	DH-BAR-16	190921.72	8140724.46	332.81	0.00	-90.00	110.14	63.92	98.80	34.88	1.20
Barreiro	DH-BAR-44	190653.36	8140575.39	302.01	0.00	-90.00	81.39	28.75	73.68	28.32	1.21
Barreiro	DH-BAR-47	190731.53	8140569.08	311.90	0.00	-90.00	97.40	46.92	80.00	33.08	1.68
Barreiro	DH-BAR-61	190882.14	8140763.39	331.28	0.00	-90.00	122.18	80.98	110.64	39.98	1.41
Barreiro	DH-BAR-65	190939.88	8140520.36	310.21	0.00	-90.00	142.64	100.17	131.08	30.91	1.88
Barreiro	DH-BAR-78	191183.01	8140455.27	322.40	310.00	-75.00	384.74	306.00	338.04	32.04	2.10
Barreiro	DH-BAR-103	191220.25	8140610.83	326.34	310.00	-75.00	315.46	250.88	301.58	50.70	1.60

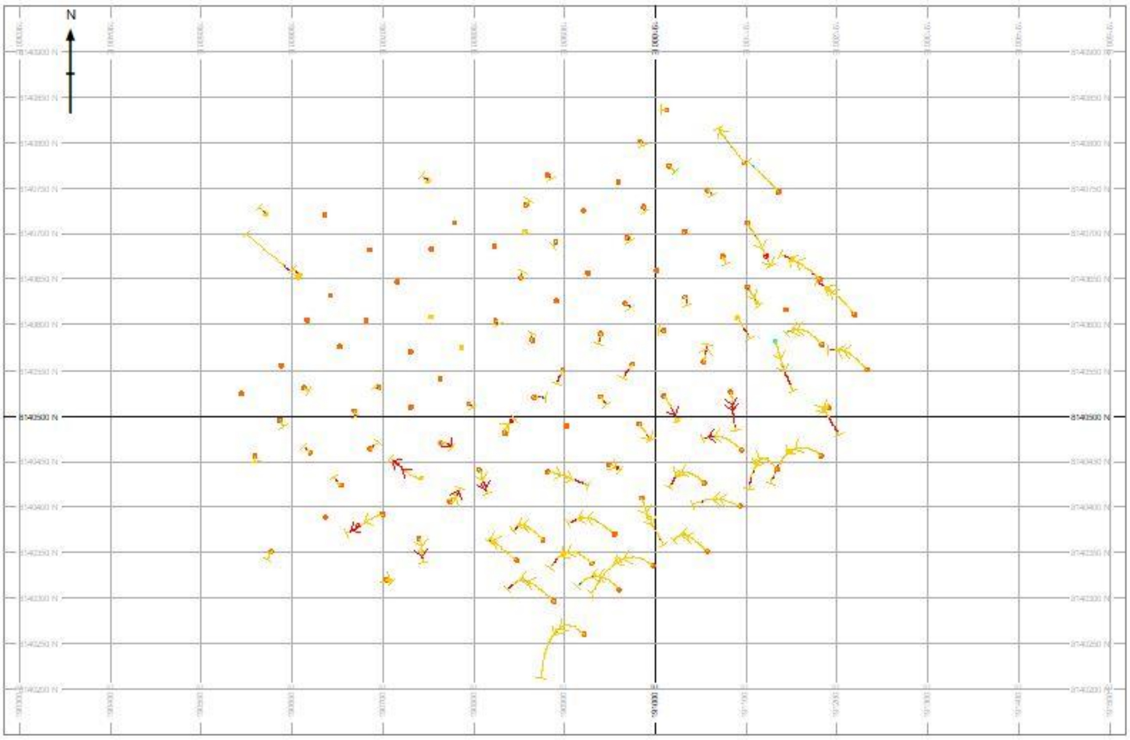


Figure 10-3 - Plan View of the Drilling at Barreiro

Note: Figure prepared by Sigma, 2019.

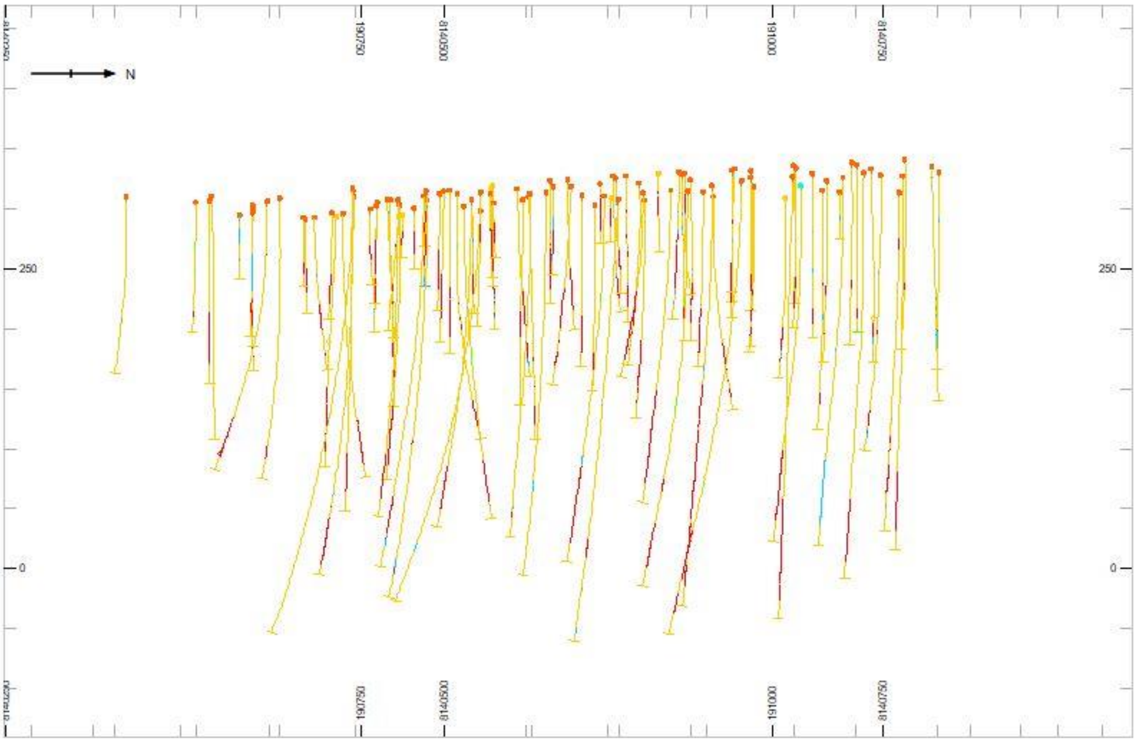


Figure 10-4 - Longitudinal View of the Drilling at Barreiro

Note: Figure prepared by Sigma, 2019.

10.3.3 Lavra do Meio

During 2017–2018, Sigma completed 17 HQ core holes for 2,118.98 m. A drill hole summary table is provided in Table 10-6. All drilling is used in Mineral Resource estimation.

Table 10-6 - Total Lavra do Meio Drilling

Year	Number of Drill Holes	Metres Drilled
2017	2	157.99
2018	15	1,960.99
Total	**17**	**2,118.98**

The core holes drilled at Lavra do Meio are generally vertical, perpendicular to the general orientation of the pegmatite intrusions, and have a variable deviation toward the south. Their spacing is typically 50 m with wider spacing at 75 m at the east and west edges of the drill pattern. The drill holes dips range from -60° to -70° with an average of -60° and the drill hole intercepts range in thickness from approximately 95% of true width to near true width of the mineralization.

Illustrative intercepts through the deposit, showing examples of drill holes with low-grade intercepts, with high-grade intercepts and with higher-grade intercepts within lower-grade widths, are provided in Table 10-7. Drill collar locations are included in Figure 10-5 in plan view, and a longitudinal section showing the drilling is included as Figure 10-6.

Table 10-7 - Lavra do Meio Example Drill Intercept Table

Deposit/Area	Hole ID	UTM East (m)	UTM North (m)	Elevation (m)	Azimuth (m)	Dip (º)	Depth (m)	From (m)	To (m)	Thickness (m)	Avera (%Li2
Lavra do Meio	DH-LDM-02	192380.20	8140642.01	387.61	275.00	-70.00	95.47	67.26	90.12	22.74	1.34
Lavra do Meio	DH-LDM-04	192375.89	8140593.14	379.24	270.00	-70.00	80.32	38.81	66.42	27.61	1.80
Lavra do Meio	DH-LDM-08	192422.20	8140546.98	366.75	270.00	-60.00	150.02	95.50	134.00	38.50	1.30
Lavra do Meio	DH-LDM-14	192434.76	8140482.11	358.15	270.00	-60.00	187.45	149.71	172.54	22.83	1.16
Lavra do Meio	DH-LDM-14	192434.76	8140482.11	358.15	270.00	-60.00	187.45	178.28	181.39	3.11	1.51

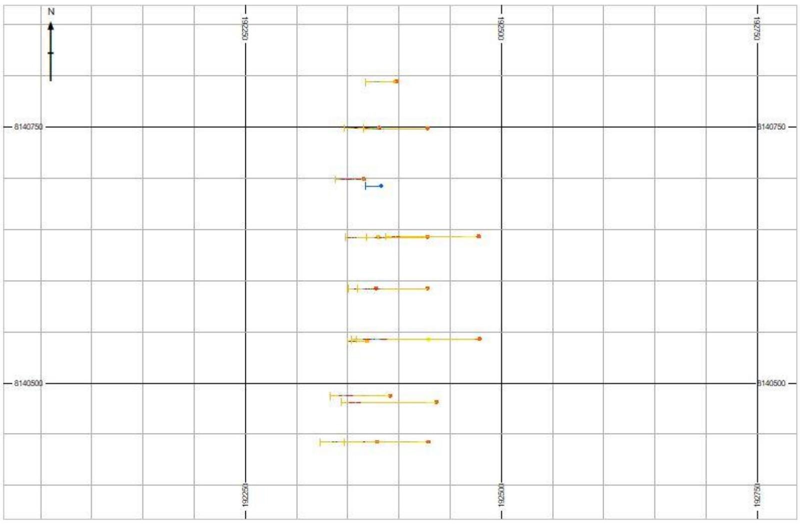


Figure 10-5 - Plan View of the Drilling at Lavra do Meio

Note: Figure prepared by Sigma, 2019.

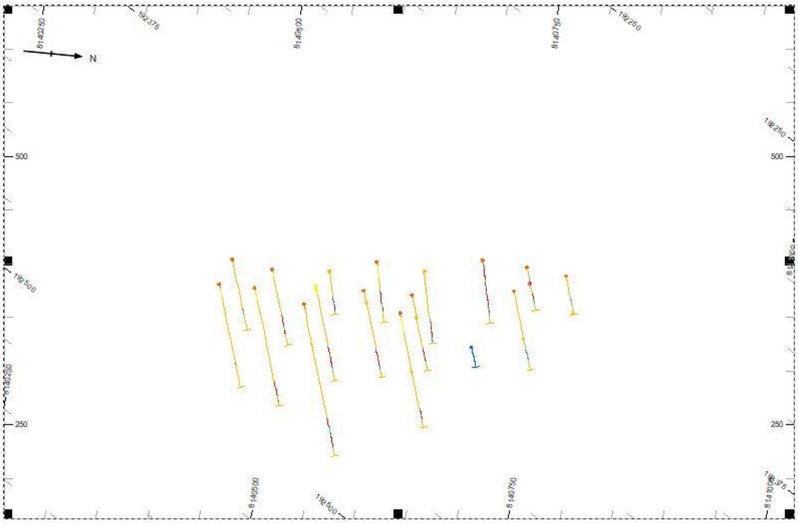


Figure 10-6 - Longitudinal View of the Drilling at Lavra do Meio

Note: Figure prepared by Sigma, 2019.

10.3.4 Murial

Drilling in 2017–2018 totals 6,595.61 m in 37 HQ core holes. A drill hole summary table is provided in Table 10-8. All but three of the drill holes are used in Mineral Resource estimation as three of the drill holes were completed after the database closeout date for estimation.

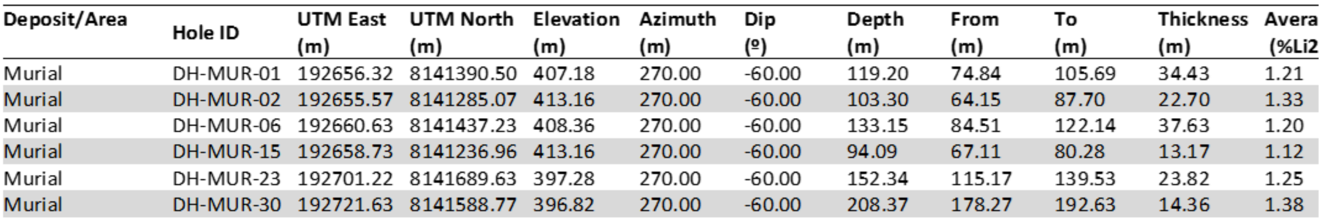
Table 10-8 - Total Murial Drilling

Year	Number of Drill Holes	Metres Drilled
2017	1	119,21
2018	36	6,476.40
Total	**37**	**6,595,61**

The core holes drilled at Murial are generally vertical, perpendicular to the general orientation of the pegmatite intrusions, and deviate toward the south. The spacing is typically 50 m with wider spacing at 100 m at the eastern edge of the drill pattern. The drill holes dips range from 57° to 61° with an average of 60° and the drill hole intercepts range in thickness from approximately 95% of true width to near true width of the mineralization.

Illustrative intercepts through the deposit, showing examples of drill holes with low-grade intercepts, with high-grade intercepts and with higher-grade intercepts within lower-grade widths, are provided in Table 10-9. Drill hole collar locations are provided in Figure 10-7 and Figure 10-8.

Table 10-9 - Murial Example Drill Intercept Table



Deposit/Area	Hole ID	UTM East (m)	UTM North (m)	Elevation (m)	Azimuth (m)	Dip (º)	Depth (m)	From (m)	To (m)	Thickness (m)	Avera (%Li2
Murial	DH-MUR-01	192656.32	8141390.50	407.18	270.00	-60.00	119.20	74.84	105.69	34.43	1.21
Murial	DH-MUR-02	192655.57	8141285.07	413.16	270.00	-60.00	103.30	64.15	87.70	22.70	1.33
Murial	DH-MUR-06	192660.63	8141437.23	408.36	270.00	-60.00	133.15	84.51	122.14	37.63	1.20
Murial	DH-MUR-15	192658.73	8141236.96	413.16	270.00	-60.00	94.09	67.11	80.28	13.17	1.12
Murial	DH-MUR-23	192701.22	8141689.63	397.28	270.00	-60.00	152.34	115.17	139.53	23.82	1.25
Murial	DH-MUR-30	192721.63	8141588.77	396.82	270.00	-60.00	208.37	178.27	192.63	14.36	1.38

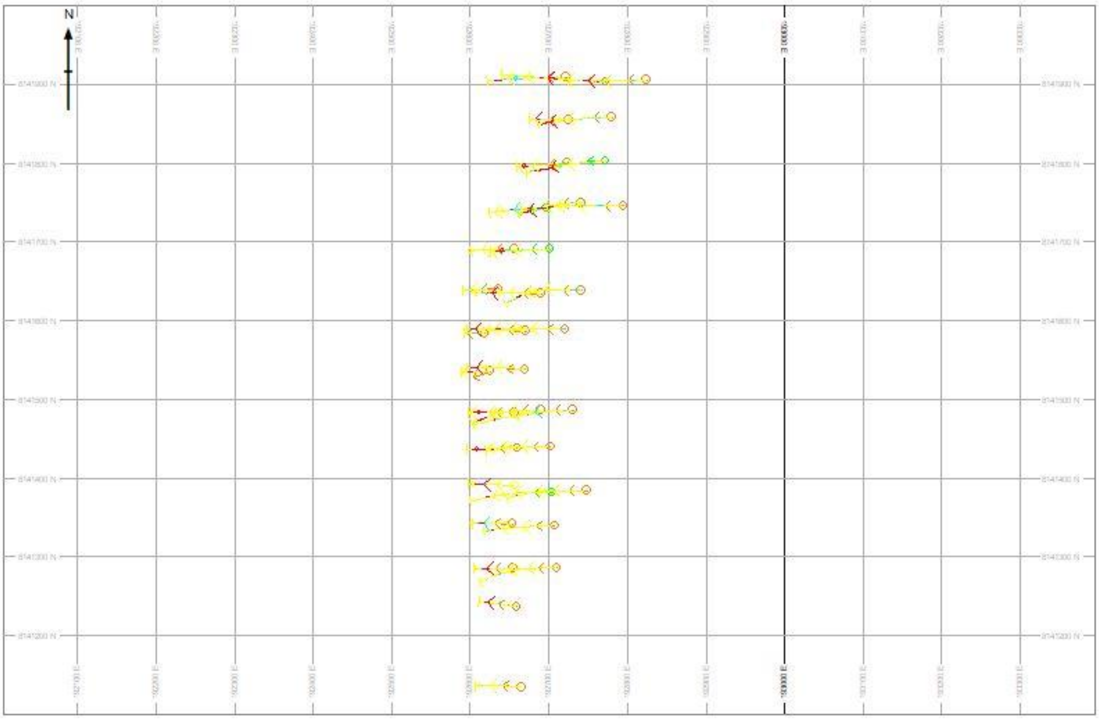


Figure 10-7 - Plan View of the Drilling at Murial

Note: Figure prepared by Sigma, 2019.

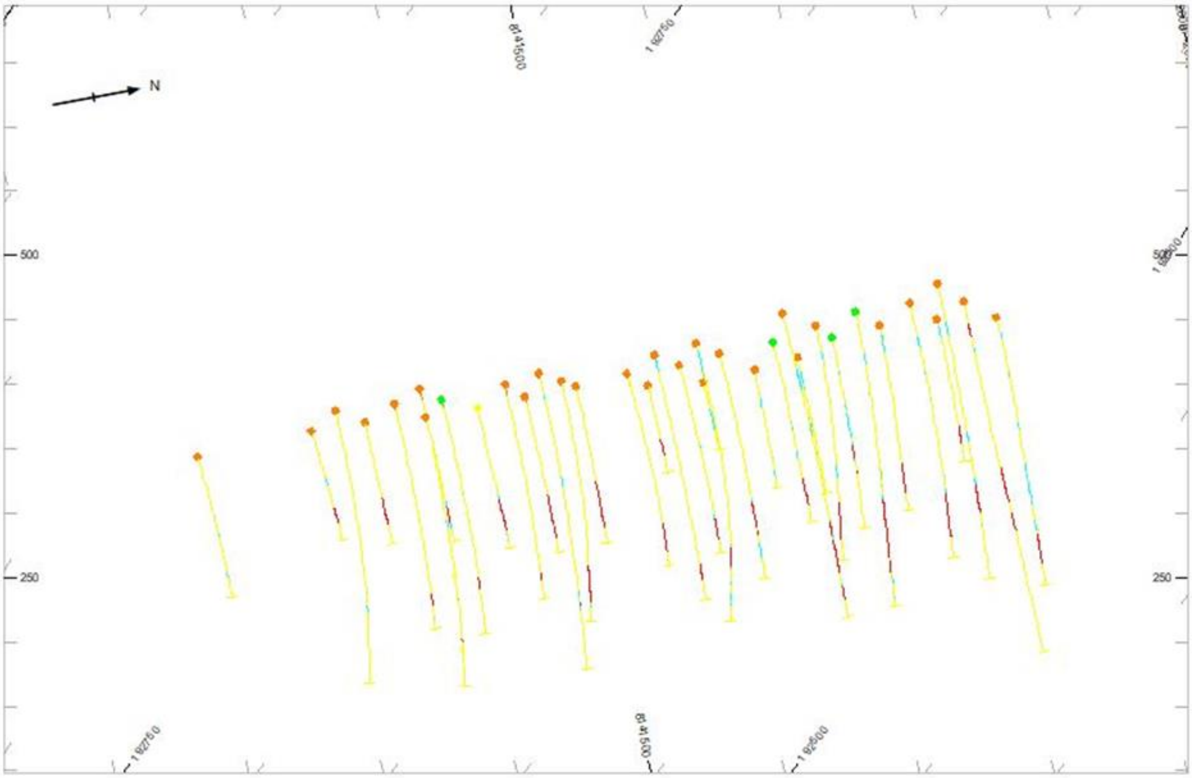


Figure 10-8 - Longitudinal View of the Drilling at Murial

Note: Figure prepared by Sigma, 2019.

10.3.5 Nezinho do Chicao

Five drill holes totalling 394.22 m have been completed at Nezinho do Chicao (Table 10-10).

Table 10-11 provides illustrative intercepts through the deposit, showing examples of drill holes with low-grade and high-grade intercepts. The average grade over the five holes is 1.33% Li_2O. Figure 10-9 shows the collar locations.

Table 10-10 - Total Nezinho do Chicao Drilling

Year	Number of Drill Holes	Metres Drilled
2018	5	394,22
Total	**5**	**394,22**

Table 10-11 - Nezinho do Chicao Example Drill Intercept Table

Deposit/Area	Hole ID	UTM East (m)	UTM North (m)	Elevation (m)	Azimuth (m)	Dip (º)	Depth (m)	From (m)	To (m)	Thickness (m)	Average Grade (%Li2O)
Nezinho do Chicao	DH-NDC-01	191528.73	8139671.55	323.94	270.00	-60.00	61.68	18	45.9	27.9	0.71
Nezinho do Chicao	DH-NDC-02	191576.92	8139671.64	319.93	270.00	-60.00	78.27	41.66	61.91	20.25	1.04
Nezinho do Chicao	DH-NDC-03	191629.63	8139674.62	313.8	270.00	-60.00	101.2	64.87	86.19	21.32	1.32
Nezinho do Chicao	DH-NDC-04	191584.91	8139722.12	320.93	270.00	-60.00	77.44	46.81	63.71	17.53	1.71
Nezinho do Chicao	DH-NDC-05	191577.95	8139626.83	316.12	270.00	-60.00	75.63	43.1	65.65	22.5	1.85

Figure 10-9 - Plan View of the Drilling at Nezinho do Chicao

Note: Figure prepared by Sigma, 2019.

10.3.6 Maxixe

Two drill holes totalling 216.5 m have been completed at Maxixe (Table 10-12). Figure 10-10 shows the collar locations.

Table 10-12 - Total Maxixe Drilling

Year	Number of Drill Holes	Metres Drilled
2017	2	216,50
Total	**2**	**216,50**

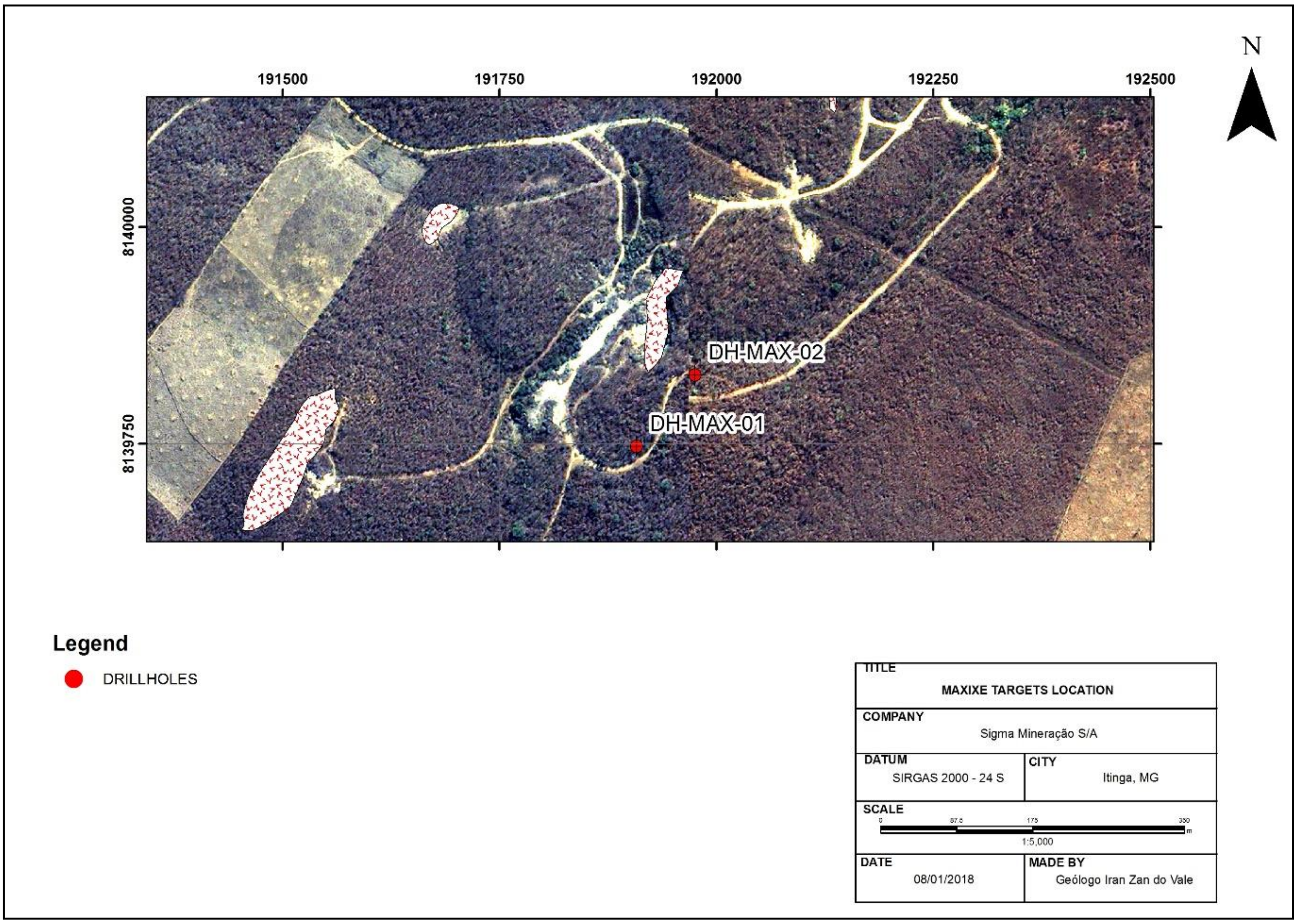


Figure 10-10 - Maxixe Drill Hole Location Plan

Note: Figure prepared by Sigma, 2019.

10.4 DRILL HOLE LOGGING

In each program core logging consisted of recording the following key information into Excel spreadsheets:

- Lithology: description, colour, grain size, unit, code
- Alteration: code, intensity, type
- Mineralization: estimated spodumene %, major minerals (quartz, albite, microcline, amphibolite, muscovite, tantalite/columbite, cassiterite, biotite, tourmaline, cordierite), major mineral percentage
- Structures: veins, faults, shear zones, breccias, mineral lineation, lithological contacts
- Rock quality designation (RQD)
- Recovery
- Magnetic susceptibility.

All core was photographed.

10.5 RECOVERY

Due to the hardness of the pegmatite units, the recovery of the drill core was generally excellent, and was typically 100%.

10.6 DRILL SURVEYS

Drill hole collars were picked up in the field using a Real Time Kinematic (RTK) GPS with an average accuracy of 0.01 cm.

All drill holes were down-hole surveyed by Sigma personnel using the Reflex EZ-Trac and Reflex Gyro instruments. Calibrations of tools were completed in 2017 and 2018.

10.7 QP COMMENT

Sigma conducted HQ drilling programs in 2014, 2017, and 2018 on selected pegmatite targets. The drill programs have used industry-standard protocols that include core logging, core photography, core recovery measurements, and collar and downhole survey measurements. There are no drilling, sampling or recovery factors that could materially impact the accuracy and reliability of the results in any of the drill campaigns.

Information collected during the campaigns can be used to support Mineral Resource estimation at Xuxa, Barreiro, Lavra do Meio and Murial. There are insufficient drill holes to support estimates at Maxixe and Nezinho de Chicao.

11 SAMPLE PREPARATION, ANALYSES AND SECURITY

11.1 INTRODUCTION

The descriptions in this section are based on information supplied by Sigma and observations made during the independent verification programs conducted at the Project site by SGS during September 11–15, 2017 and July 11–16, 2018.

The evaluation of the geological setting and mineralization on the Project is based on observations and sampling from surface (through geological mapping, grab and channel samples) and diamond drilling.

11.2 SAMPLING

11.2.1 Geochemical Sampling

Geochemical samples consisted of rock chip and grab samples taken from areas of outcrop. These were generally about 1 kg in weight.

11.2.2 Channel Sampling

Channel samples were collected by cutting channels with a diamond-disc cutting machine. Typically, the cut channel measured 4 cm in width and 10 cm in depth. Each channel sample was generally 1 m long and cut directly from the outcrop, identified, numbered and then placed in a new plastic bag. Due to the hardness of the pegmatite units, the recovery of the channel material was generally very good, averaging more than 95%.

11.2.3 Trench Sampling

Sigma generally followed up positive channel sampling results with trenching. This work was conducted from 2012 to 2014.

Trenches were typically 1 m wide, 0.5 m deep, and were dug at 2.5 m intervals across the entire pegmatite width from footwall to hanging wall. Full-width pegmatite samples were taken from each trench and aggregated to form 800–1,000 kg trench bulk samples for metallurgical test work.

11.2.4 Core Sampling

Drill core of HQ size was placed in wooden core boxes and delivered daily by the drill contractors to the project core logging facilities at SMSA camp. The drill core was first aligned and measured by the technician and geologist for core recovery. The core recovery measurements were followed by the RQD measurements. After a summary review of the core, it was logged, and sampling intervals were defined by a geologist. Before sampling, the core was photographed using a digital camera and the core boxes were identified with box number, hole ID, and aluminium tags were used to mark the sample intervals.

Sampling intervals were determined by the geologist, marked and tagged based on lithology and mineralization observations. The typical sampling length was 1 m but varied according to lithological contacts between the mineralized pegmatite and the host rock. In general, 1 m host rock samples were collected from each side that contacts the pegmatite. The HQ drill core samples were split into two halves with one half placed in a new plastic bag along with the sample tag; the other half was replaced in the core box with the second sample tag for reference. The third sample tag was archived on site.

Copies of the Excel spreadsheets are stored on external hard drive and backed-up every day for security.

11.2.5 Metallurgical Sampling

HQ size drill core was collected from a portion of the 2017-2018 Xuxa drill program for metallurgical purposes. The first half of the HQ drill core was selected for metallurgical testing. The second half was split in two quarters, one quarter placed in a new plastic bag along with the sample tag and the remaining quarter was replaced in the core box with the second sample tag for reference. The samples were then catalogued and placed in rice bags or pails, for shipping. The sample shipment forms were prepared on site with one copy inserted with the shipment, one copy sent by email to SGS Geosol, and one copy kept for reference. The samples were transported on a regular basis by SMSA driver by pick-up truck directly to the SGS Geosol facilities in Belo Horizonte. At SGS Geosol, the sample shipment was verified, and a confirmation of shipment reception and content was emailed to the Sigma CEO and project geologist.

11.3 DENSITY DETERMINATIONS

Densities were measured by SGS Geosol using pycnometer measurement. Measurements were made by lithology with special attention to the lithium-bearing pegmatite. Separate measurements were made for the Xuxa, Barreiro, LDM and Murial deposits. A total of 188 measurements were made on Xuxa core from 2017-2018. Of the 188 measurements, 24 were made on albite-altered pegmatite, 54 on schist, and 110 on lithium-bearing pegmatite. The average results for Xuxa are presented in Table 11-1.

Table 11-1 - Xuxa Density Test Results Summary

Lithology	Specific Gravity
Albite altered pegmatite	2.61 ± 0.05
Schist	2.77 ± 0.05
Lithium bearing pegmatite	2.70 ± 0.09

For Barreiro, a total of 401 measurements were made on core from the 2018 drill program. Of the 401 measurements, 82 were made on albite-altered pegmatite, 177 on schist, and 142 on lithium-bearing pegmatite. The average results for Barreiro are presented in Table 11-2.

Table 11-2 – Barreiro Density Test Results Summary

Lithology	Specific Gravity
Albite altered pegmatite	2.65 ± 0.04
Schist	2.76 ± 0.05
Lithium bearing pegmatite	2.71 ± 0.08

For Murial, a total of 134 measurement were made by the same method on core from the 2018 drill program. Of the 134 measurements, 32 were made on the albite altered pegmatite, 58 on the schist and 44 on the lithium bearing pegmatite. The average results for Murial are presented in Table 11-3.

Table 11-3 – Murial Density Test Results Summary

Lithology	Specific Gravity
Albite altered pegmatite	2.65 ± 0.04
Schist	2.79 ± 0.05
Lithium bearing pegmatite	2.69 ± 0.08

For Lavra do Meio, a total of 51 measurement were made by the same method on core from the 2018 drill program. Of the 51 measurements, 9 were made on the albite altered pegmatite, 22 on the schist and 20 on the lithium bearing pegmatite. The average results for Lavra do Meio are presented in Table 11-4.

Table 11-4 – Lavra do Meio Density Test Results Summary

Lithology	Specific Gravity
Albite altered pegmatite	2.63 ± 0.05
Schist	2.78 ± 0.06
Lithium bearing pegmatite	2.65 ± 0.06

11.4 ANALYTICAL AND TEST LABORATORIES

All samples collected by SMSA during the course of the 2012–2018 exploration programs relating to the Grota do Cirilo property were sent to SGS Geosol in Belo Horizonte, Brazil.

A portion of the 2017–2018 sample pulps were prepped by ALS Brazil Ltda. in Vespasiano, Brazil (ALS Vespasiano) and shipped to ALS Canada Inc. Chemex Laboratory (ALS Chemex) in North Vancouver, BC, Canada for cross check validation.

A portion of the 2014 samples were resampled by the QP and sent for validation to the SGS Lakefield laboratory (SGS Lakefield) in Lakefield, Canada.

All laboratories, including ALS Chemex, ALS Vespasiano, SGS Lakefield and SGS Geosol are ISO/IEC 17025 accredited. The SGS Geosol laboratory is ISO 14001 and 17025 accredited by the Standards Council. All laboratories used for the technical report are independent of Sigma and SMSA and provide services to Sigma pursuant to arm’s length service contracts.

11.5 SAMPLE PREPARATION AND ANALYSIS

All channel sample and drill core handling were done on site with logging and sampling conducted by employees and contractors of SMSA. Trench samples collected from 2012–2014 were crushed in Sigma’s on-site pilot plant, using a jaw crusher and then roll crushed to reduce the material to below 2 mm size. The heavy minerals were then concentrated on site using a pulse jig (refer to photograph of the pulse jig in Figure 5-3). The Universities of Rio de Janeiro and São Paulo, as well as SGS Lakefield, completed various metallurgical test work on these samples (refer to Section 13).

Channel and drill core samples collected during the 2013, 2014, 2017 and 2018 exploration programs from the Grota do Cirilo property were transported directly by Sigma representatives to SGS Geosol for sample preparation. The submitted samples were pulverized at SGS Geosol to respect the specifications of the analytical protocol and then analysed in the same laboratory. In 2013 and 2014, samples were pulverized at the same facilities, following the same specification as used in 2017.

All samples received at SGS Geosol were inventoried and weighted prior to being processed. Drying was done to samples having excess humidity. Sample material was crushed to 75% passing 3 mm using jaw crushers. One kilogram of material is put on separate bag and reserved for future analysis. Ground material was then split in two using a Jones split riffle to obtain one 2 kg sample reserved for duplicate analysis and one 1 kg samples for primary analysis. One-kilogram sub-samples were then pulverized using a ring and puck mill or a single component ring mill to 95% passing 150 mesh (106 µm) and split into four 250 g samples using a rotative splitter. The balance of the crushed sample (reject) was placed into the original plastic bag. The pulverized samples were finally analysed by SGS Geosol.

SGS Geosol has used two analytical methods for the pulverized samples from the Project. The analytical method used by SGS Geosol for the 2017 program is the 55-element analysis using sodium peroxide fusion followed by both inductively coupled plasma optical emission spectrometry (ICP-OES) and inductively coupled plasma mass spectrometry (ICP-MS) finish (SGS code ICM90A). This method uses 10 g of the pulp material and returns different detection limits for each element and includes a 10 ppm lower limit detection for Li and a 10,000-ppm upper limit detection for Li. For the 2018 program, SGS Geosol used a 31-element analytical package using sodium peroxide fusion followed by both Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES) and ICP-MS finish (SGS code ICP90A). Analytical results were sent electronically to Sigma and results were compiled in an MS Excel spreadsheet by the project geologists.

All samples received at ALS Vespasiano were inventoried, weighed and dried prior to being processed. Sample material was crushed to 70% passing 2 mm using jaw crushers. Crushed material was split to 250 g sub-samples and then pulverized using a ring and puck mill or a single component ring mill to 85% passing 200 mesh (75 µm). The pulverized samples were sent to ALS Chemex using SGS-secured delivery services. Lithium and boron were determined by sodium peroxide fusion followed by ICP-AES analysis (ALS Chemex method ME-ICP82b). The method is a high-precision analytical method for Li to support resource determination in known deposits.

The 2017 witness samples collected on the 2014 drill core were analysed at SGS Lakefield using sodium peroxide fusion followed by both ICP-OES and ICP-MS finish (SGS code ICM90A).

11.6 QUALITY ASSURANCE AND QUALITY CONTROL

In addition to the laboratory quality assurance quality control (QA/QC) routinely implemented by SGS Geosol and ALS Chemex using pulp duplicate analysis, Sigma developed an internal QA/QC protocol for the Grota do Cirilo drilling, which consisted of the insertion of analytical standard reference materials (standards), blanks and core duplicates on a systematic basis with the samples shipped to the analytical laboratories. No pulp reanalysis was performed by Sigma in 2013 and 2014. A total of 664 pulp samples from the 2017–2018 Grota do Cirilo drilling program were sent to ALS Vespasiano for third-party verification.

11.6.1 Analytical Standards

Sigma inserted standards in sample batches during the 2014 and 2017–2018 sampling programs. During the 2014 campaign, the standard used was made of locally sourced and prepared pegmatite and was not certified. Sigma inserted an uncertified standard into the sample stream for every 25 samples for a total of five uncertified standards inserted. The 2017–2018 campaign used seven certified standards from African Mineral Standards (AMIS), an international supplier of certified reference materials (Table 11-5). The recommended lithium values for the AMIS standards range between 0.16 and 2.27% Li_2O. A total of 88 standards were inserted during the 2017 campaign and 345 were inserted during the 2018 campaign. Figure 11-1 to Figure 11-6 show the standard results for AMIS standards submitted as part of the 2017–2018 campaigns.

Table 11-5 - Standard Average Li Values with Analytical Error

Analytical Standards	Li (ppm)	Analytical Error (2σ)
AMIS0341	4,733	799
AMIS0338	1,682	428
AMIS0339	22,700	2,506
AMIS0340	14,060	1462
AMIS0342	1,612	198
AMIS0343	7,150	1525
AMIS0408	15,300	2,360

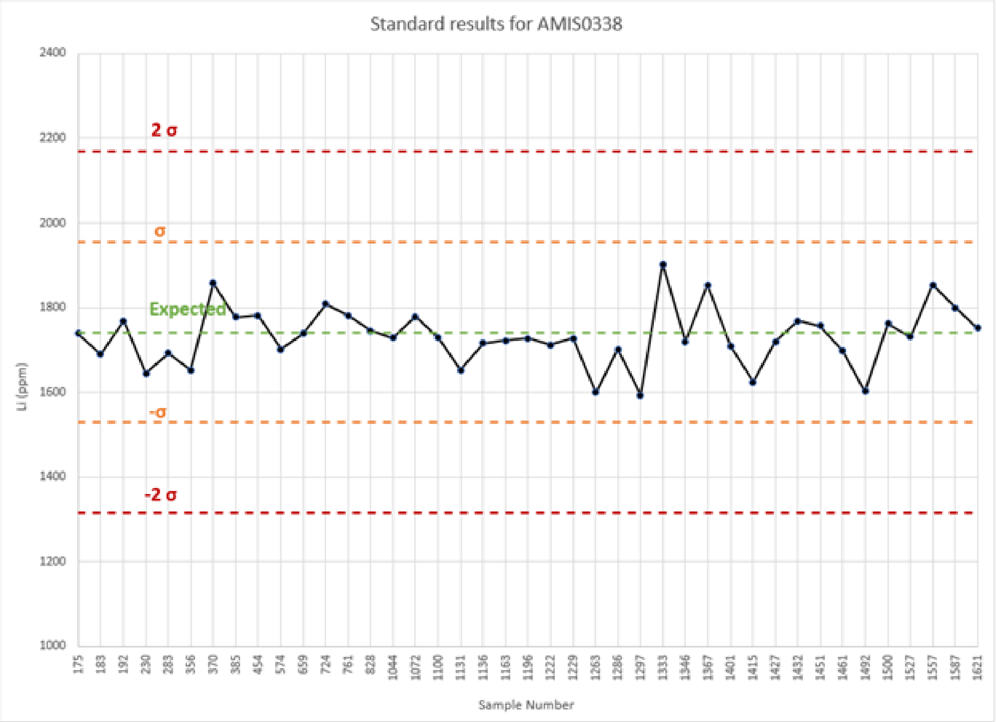


Figure 11-1 - Standard Sample Analysis Results for the 2017–2018 Batch with Standard AMIS0338

Note: Figure prepared by SGS, 2019.

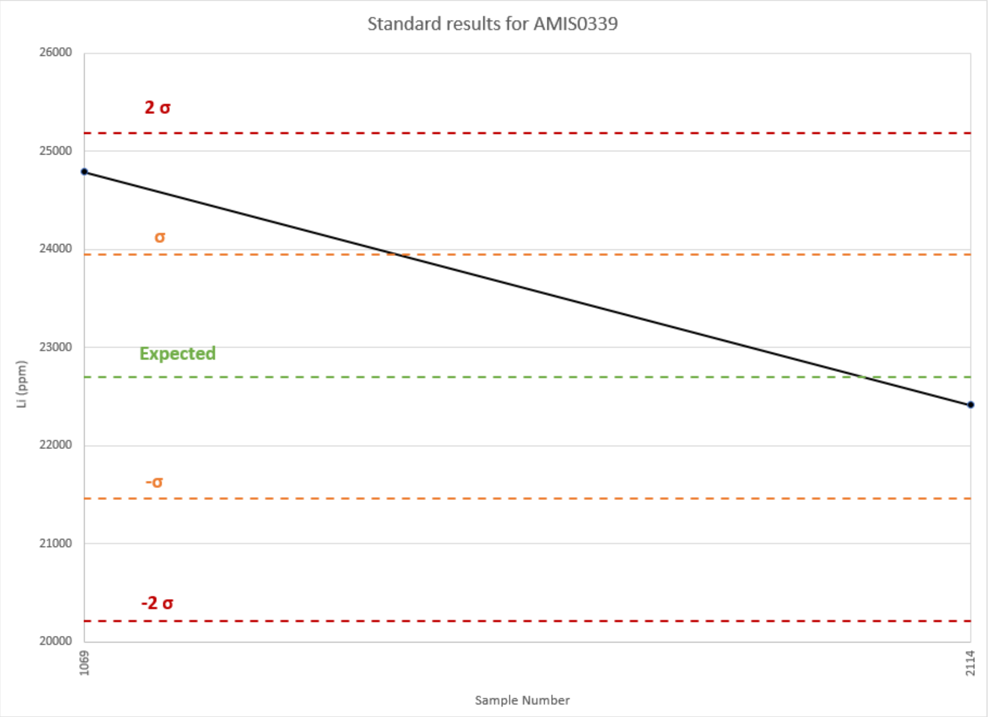


Figure 11-2 - Standard Sample Analyses Results for the 2017–2018 Batch with Standard AMIS0339

Note: Figure prepared by SGS, 2019.

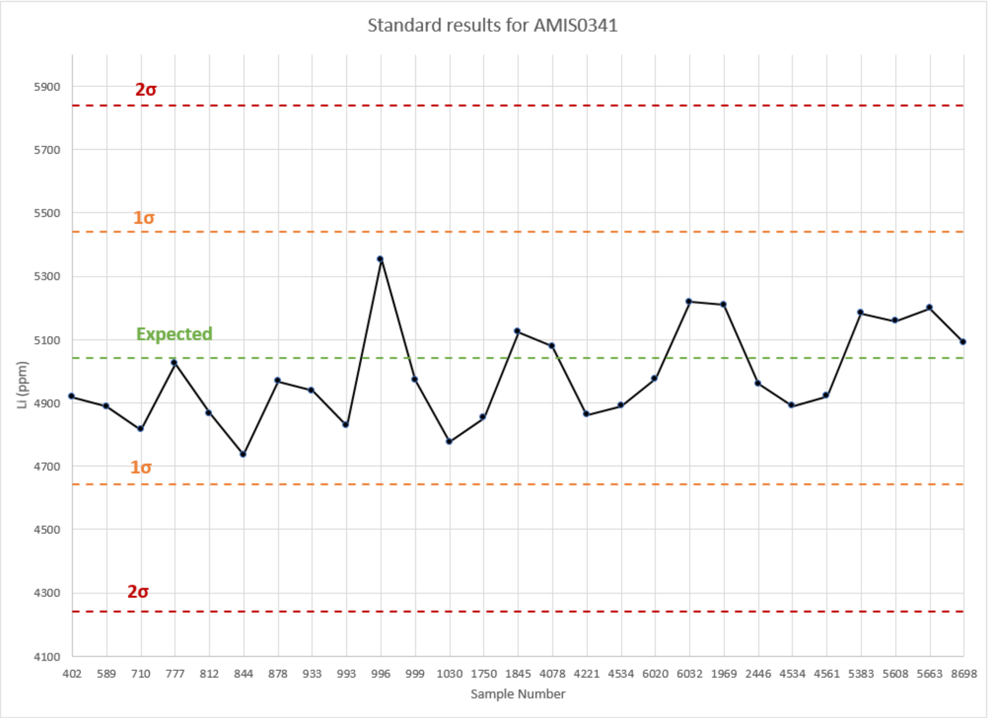


Figure 11-3 - Standard Sample Analyses Results for the 2017–2018 Batch with Standard AMIS0341

Note: Figure prepared by SGS, 2019.

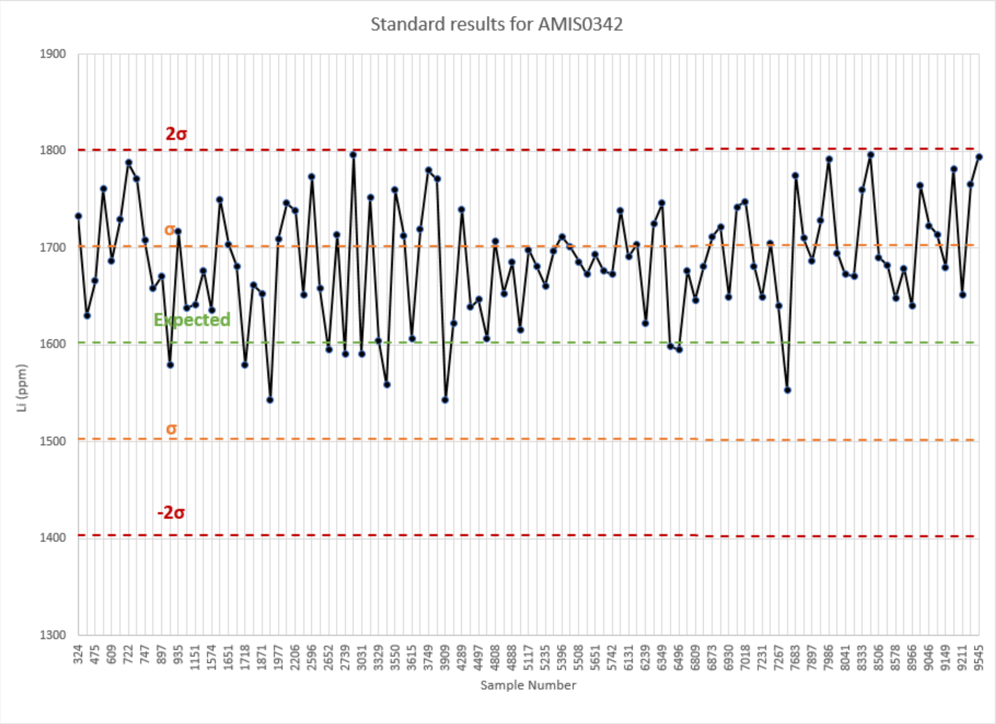


Figure 11-4 - Standard Sample Analyses Results for the 2017–2018 Batch with Standard AMIS0342

Note: Figure prepared by SGS, 2019.

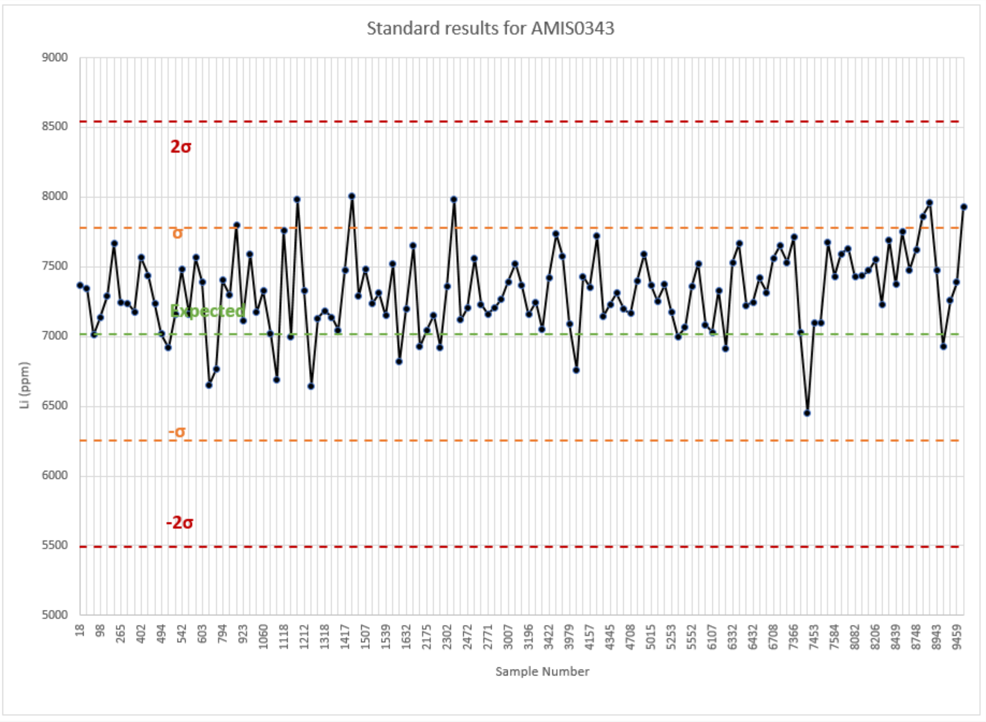


Figure 11-5 - Standard Sample Analyses Results for the 2017–2018 Batch with Standard AMIS0343

Note: Figure prepared by SGS, 2019.

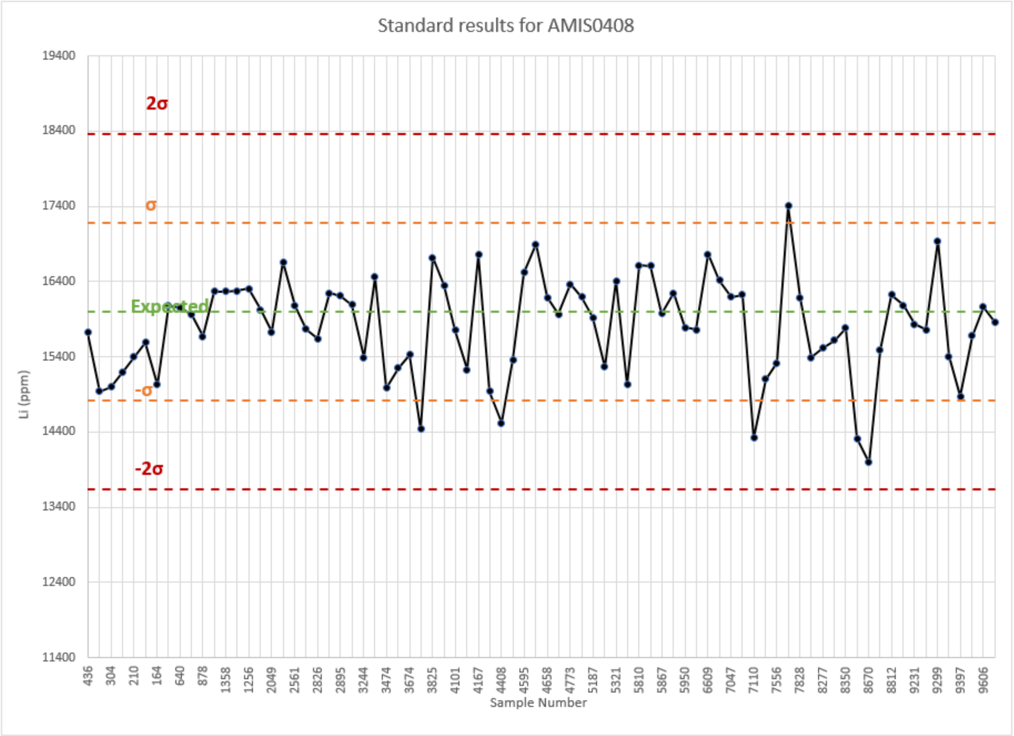


Figure 11-6 - Standard Sample Analyses Results for the 2017–2018 Batch with Standard AMIS0408

Note: Figure prepared by SGS, 2019.

The results for the 2017–2018 batch are mostly within two times the standard deviation of the expected results. Only one result out of the 433 standards fell outside the acceptable limits recommended by AMIS.

11.6.2 Analytical Blanks

During the 2017–2018 campaign Sigma included insertion of analytical blanks in the sample series as part of their internal QA/QC protocol. The blank samples, which are made of fine silica powder provided by AMIS, are inserted an average of one for every 20 samples by the Sigma geologist and subsequently sent to SGS Geosol. The same procedure was used by Sigma for the 2014 drilling campaign but with locally sourced silicate stone.

A total of 647 analytical blanks were analysed during the 2017–2018 exploration programs. From the 647 blanks analysed, the first 43 (five in 2014 and 39 in 2017) yielded results between 50 and 94 ppm. In the last 554 samples only one sample returned with a value over three times the laboratory detection limit of 10 ppm. This discrepancy between the first 43 blanks and the rest is likely due to contamination of the initial blank batch of uncertified material. Because the level of contamination is very low, it is the QP’s opinion that these slightly higher values are inconsequential. Figure 11-7 shows blank sample results from the 2017–2018 exploration program.

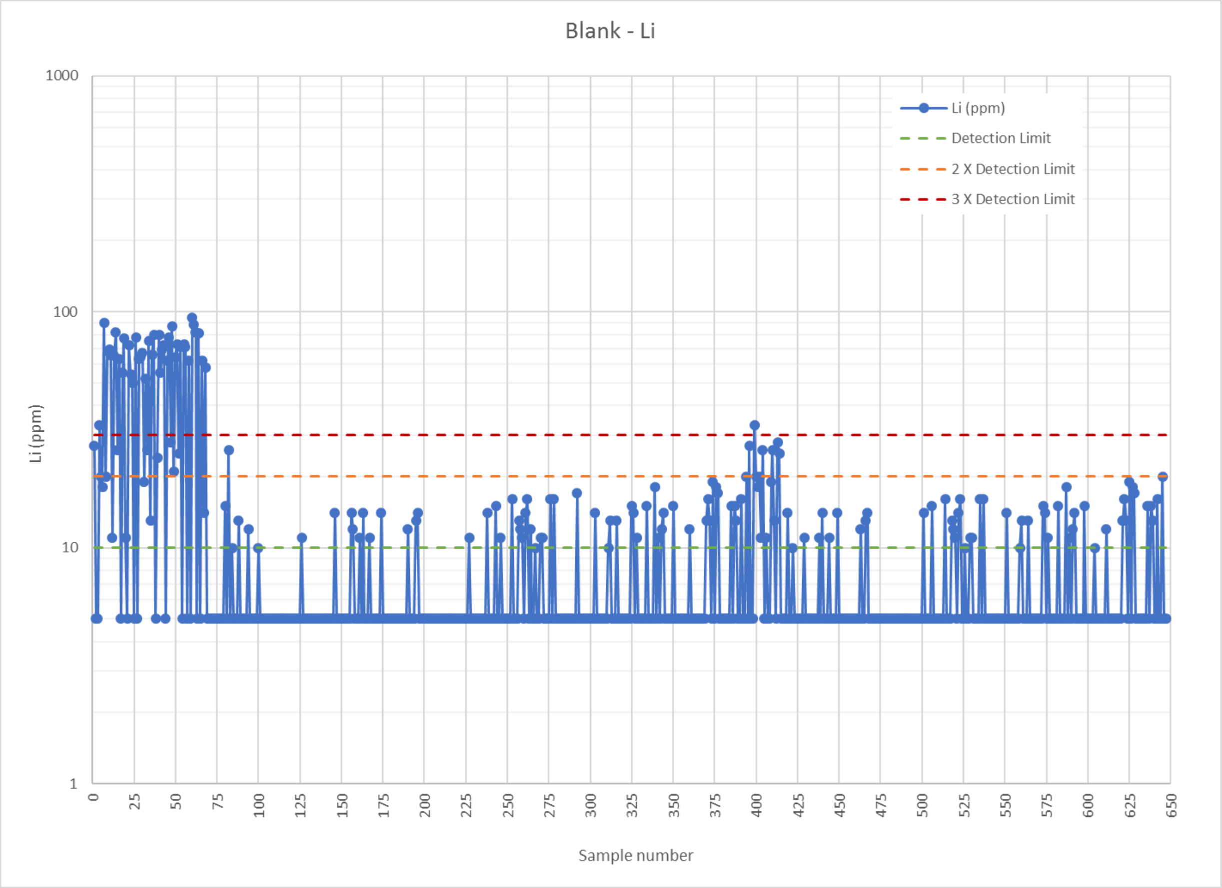


Figure 11-7 - Blank Sample Analyses from the 2017–2018 Campaign

Note: Figure prepared by SGS, 2019.

11.6.3 Core Duplicates

Sigma inserted core duplicates as every 20th sample in the sample series as part of their internal QA/QC protocol. The sample duplicates correspond to a quarter HQ core from the sample left behind for reference, or a representative channel sample from the secondary channel cut parallel to the main channel. A total of 333 duplicate pairs were analyzed and only one sample fell outside the 20% difference line. Figure 11-8 is a scatterplot comparing original and duplicate core pairs. The average value for the original values is 4,431.5 ppm Li and the average value for the duplicate values is 4,433.2 ppm Li. The difference between original and duplicate averages is 1.63 ppm. The correlation coefficient R^2 of 0.9912 suggests a high similarity between the two sets of analyses.

Pulp duplicates analyses were also conducted on 387 sample intervals. The average Li concentration for the original values is 4,547.6 ppm Li and the average value of the duplicates is 4,551.9 ppm Li. The difference between the averages is 4.3 and standard two-tailed paired t-test analysis returned no statistically significant bias. The correlation coefficient R^2 of 0.9896 suggests a high similarity between the two sets of analyses (Figure 11-9).

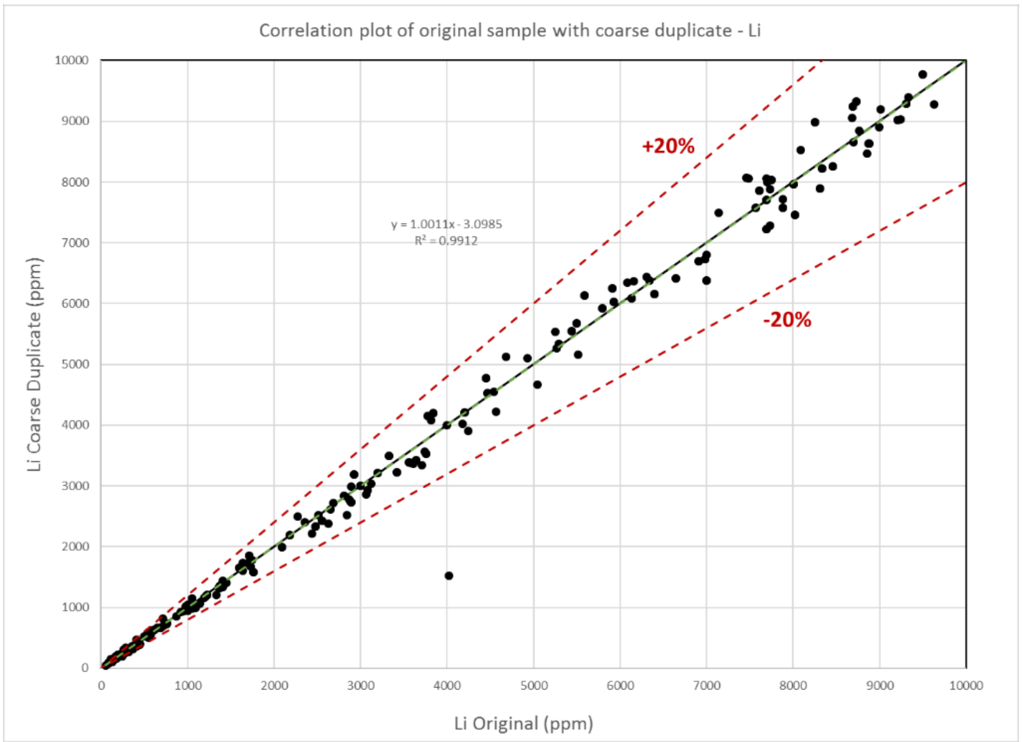


Figure 11-8 - Scatterplot of Core Duplicates

Note: Figure prepared by SGS, 2019.

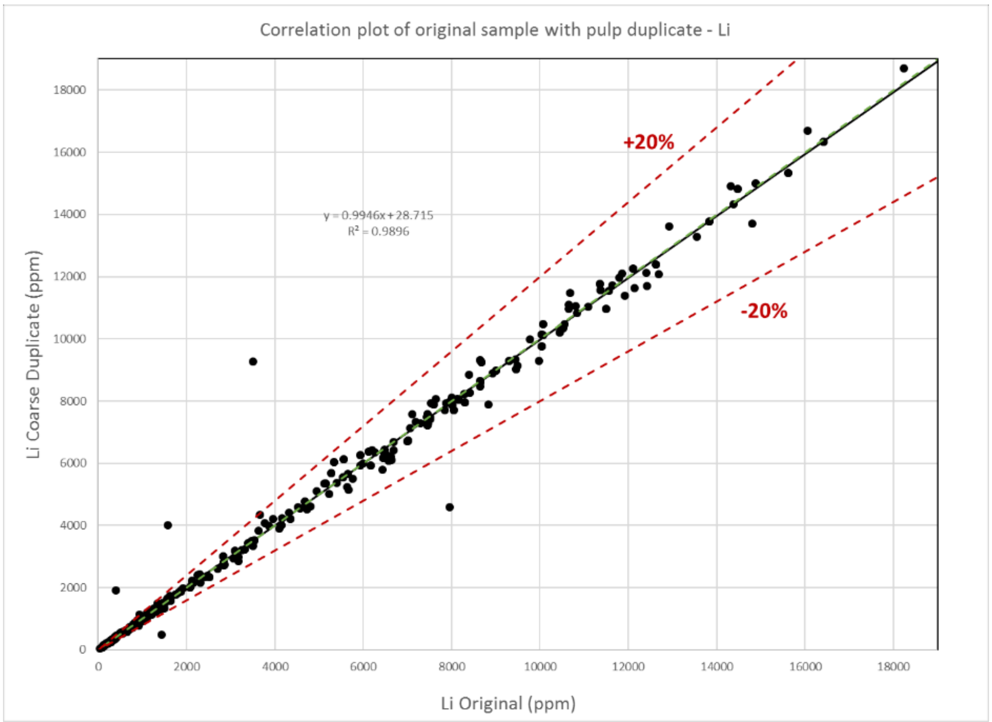


Figure 11-9 - Correlation Between Original Samples and Pulp Duplicates

Note: Figure prepared by SGS, 2019.

11.7 SAMPLE SECURITY

Core was not stored in a secured area; however, access to the area is limited to authorized employees. Samples are placed into bags and numbered with the sample tag inserted in the bag. Sample collection and transportation have always been undertaken by company personnel using company vehicles. Tracking of sample shipments used industry-standard procedures. Chain-of-custody procedures consisted of filling out sample submittal forms that were sent to the laboratory with sample shipments to make certain that all samples were received by the laboratory.

11.8 SAMPLE STORAGE

The remaining drill core is stored at the Project site in metal racks in secure sheds.

11.9 QP COMMENTS

SGS validated the exploration processes and core sampling procedures (2017) used by SMSA as part of an independent verification program.

The QP concluded that the drill core handling, logging and sampling protocols are at conventional industry standard and conform to generally acceptable best practices. The chain of custody was followed by SMSA employees and the sample security procedure showed no flaws.

The QP considers that the sample quality is good and that the samples are generally representative.

Finally, the QP is confident that the system is appropriate for the collection of data suitable for a Mineral Resource estimate.

The descriptions in this section are based on information supplied by Sigma and observations made during the independent verification programs conducted at the Project site by SGS during September 11–15, 2017 and July 11–16, 2018 and September 18-23, 2019.

The evaluation of the geological setting and mineralization on the Project is based on observations and sampling from surface (through geological mapping, grab and channel samples) and diamond drilling.

12 DATA VERIFICATION

A visit to the Project was conducted by Marc-Antoine Laporte, P.Geo., M.Sc. from September 11–15, 2017, and again from July 11–17, 2018. The visits enabled the QP to become familiar with the exploration methods used by SMSA, the field conditions, the position of the drill hole collars, the core storage and logging facilities and the different exploration targets. During the 2017 site visit, the QP collected a total of 26 control samples from witness core stored on site from the 2014 Xuxa deposit drill program.

The data validation was conducted from three fronts:

- Validation of the drilling database;
- Validation of the QA/QC data (see section 11.6);
- Control sampling program.

12.1 DRILLING DATABASE

The database for the Project was first transmitted to SGS by Sigma on September 15, 2017 and regularly updated by Sigma geologists. The database contains data for: collar locations; downhole surveys; lithologies and lithium assays.

Upon importation of the data into the modelling and mineral resources estimation software (Genesis©), SGS conducted a second phase of data validation. At this point all the major discrepancies were removed from the database.

Lastly, SGS conducted random checks on approximately 5% of the assay certificates, to validate the assay values entered in the database.

12.2 WITNESS SAMPLING

During the 2017 site visit, the QP conducted a check sampling program, re-sampling a total of 26 core samples from the 2014 drill program to verify the presence of lithium mineralization on the Xuxa deposit. The samples were taken from previously sampled intervals and the half cores were cut to quarter cores. The samples were analysed at SGS Lakefield for lithium. The sampling was conducted with the help of the Sigma geological team under the supervision of the QP and Mr Don Hains, P.Geo.

Mr Hains is an industrial minerals exploration and economic geologist with more than 30 years of experience in development, use and analysis of industrial minerals properties and materials. He is the author of the CIM Best Practice Guidelines for Reporting of Lithium Brine Resources and Reserves and a co-author of the CIM Best Practice Guidelines for Reporting on Industrial Minerals Resources and Reserves. Sigma had retained Mr Hains to provide input into the drill programs, logging protocols, and the resampling, in support of the QP.

A total of nine mineralized intervals were sampled to compare the average grade for the two different laboratories (Table 12-1). The average for the original samples is 1.61 % Li_2O while the average for the control samples is 1.59 % Li_2O (Table 12-2). The average grade difference is 0.02% which makes a relative difference of 1.28% between the original and the control samples.

Table 12-3, and Figure 12-1 to Figure 12-3 present the results of the control sample statistical analysis. The correlation plot yields a correlation coefficient R2 of 0.6527 and standard two-tailed paired t-test analysis returned no statistically significant bias (p-value = 0.8473 / $\alpha = 0.05$). This gives no reasons to doubt the validity of the SGS Geosol assays results.

Table 12-1 - Witness Sample Mineralized Interval Comparison between SGS Geosol and SGS Lakefield

Drill Hole	Sample Number	From (m)	To (m)	Length (m)	SGS Geosol Li_2O%	SGS Lakefield Li_2O%	Relative Difference (%)
DH-XU-01	AT-2005	23.50	25.00	0	2.0903	1.8834	0.0990
DH-XU-01	AT-2010	30.90	32.00	1.5	1.9138	2.1155	-0.1054
DH-XU-01	AT-2017	39.70	41.00	1.1	0.8754	1.3435	-0.5347
DH-XU-02	AT-2024	81.00	82.40	1.3	2.4264	2.3500	0.0315
DH-XU-02	AT-2030	88.90	90.20	1.4	1.6600	1.6236	0.0219
DH-XU-02	AT-2035	95.60	96.60	1.3	3.0110	2.6661	0.1146
DH-XU-04	AT-2041	86.70	87.70	1	1.9414	1.3021	0.3293
DH-XU-04	AT-2045	91.00	91.90	1	2.3614	2.6376	-0.1170
DH-XU-04	AT-2049	94.40	95.50	0.9	0.7796	1.4412	-0.8487
DH-XU-05	AT-2057	37.60	38.60	1.1	2.0744	1.3400	0.3540
DH-XU-05	AT-2061	42.20	43.40	1	1.1932	1.7088	-0.4322
DH-XU-05	AT-2066	48.80	50.00	1.2	1.8583	1.5099	0.1875
DH-XU-06	AT-2074	54.80	56.00	1.2	0.6470	0.5346	0.1737
DH-XU-06	AT-2082	64.40	65.60	1.2	2.3767	1.1783	0.5042
DH-XU-06	AT-2087	70.70	71.90	1.2	1.0337	1.2453	-0.2047
DH-XU-07	AT-2099	24.40	25.60	1.2	1.3756	1.4929	-0.0853
DH-XU-07	AT-2101	26.70	27.70	1.2	0.2917	0.3189	-0.0930
DH-XU-08	AT-2109	68.30	69.30	1	2.0692	3.2551	-0.5731
DH-XU-08	AT-2113	72.00	73.00	1	3.7001	2.5190	0.3192
DH-XU-08	AT-2120	78.90	79.70	1	2.2454	2.1119	0.0594
DH-XU-09	AT-2131	23.80	24.80	0.8	1.1430	1.1463	-0.0028
DH-XU-09	AT-2137	29.50	30.20	1	2.6732	3.0125	-0.1269
DH-XU-09	AT-2140	31.80	32.60	0.7	0.3346	0.7576	-1.2645
DH-XU-10	AT-2149	35.40	36.10	0.8	0.1102	0.6433	-4.8359
DH-XU-10	AT-2150	36.10	36.90	0.7	1.3525	0.9833	0.2730
DH-XU-10	AT-2152	37.90	38.90	0.8	0.3912	0.2717	0.3054

Table 12-2 - Witness Sample Original vs Control Differences

Element	Count	Original > Control		Original ≤ Control	
		Count	**%**	**Count**	**%**
Li_2O (%)	26	13	50	13	50

Table 12-3 - Witness Sample Original and Control Descriptive Statistics

Data Set	Mean	Minimum	Maximum	Standard Deviation
SGS_Geosol	1.613	0.110	3.700	0.910
SGS_Lakefield	1.592	0.272	3.255	0.807

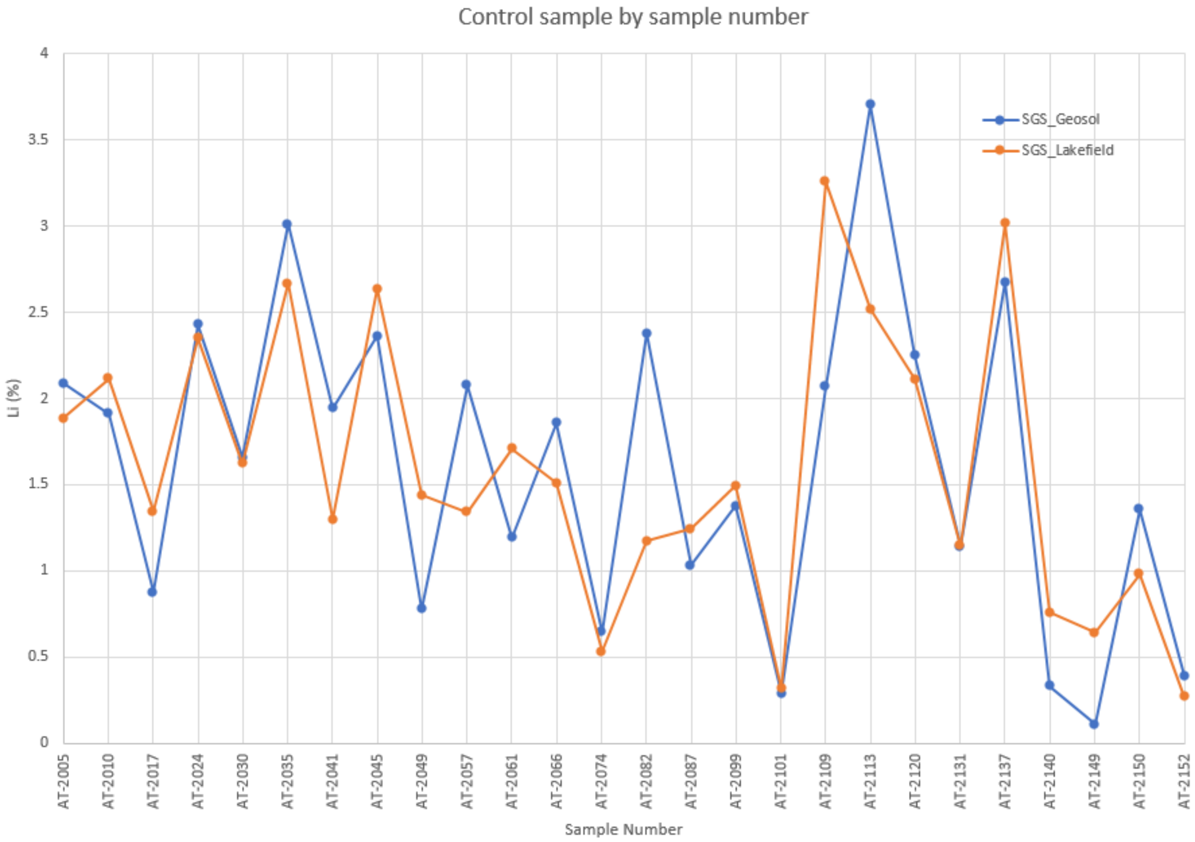


Figure 12-1 - Witness Sample Original vs Control Sample Differences

Note: Figure prepared by SGS, 2019.

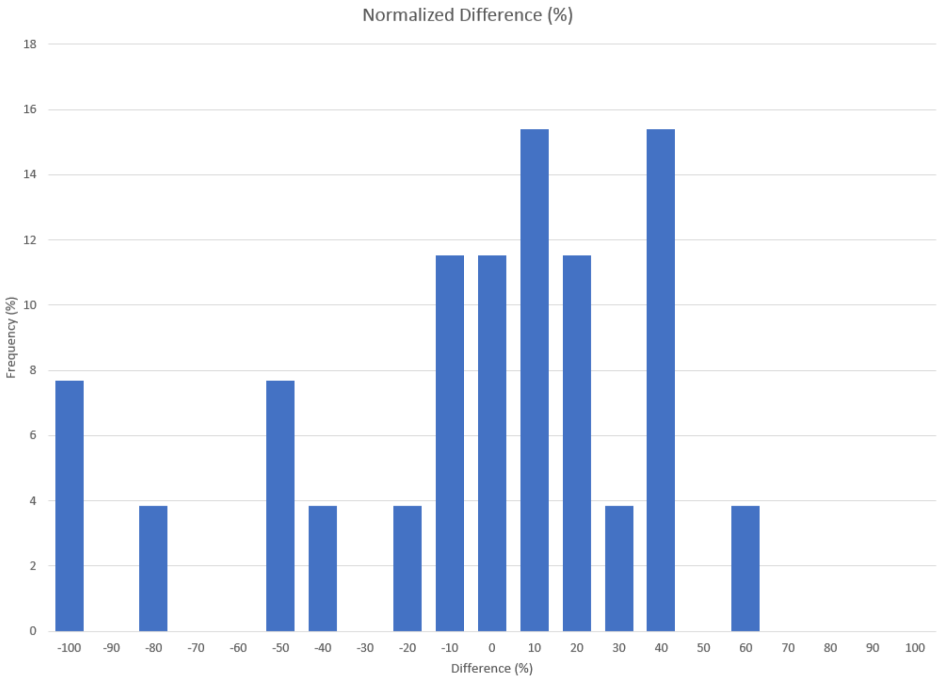


Figure 12-2 - Witness Sample Original vs Control Sample Differences Frequency Distribution

Note: Figure prepared by SGS, 2019.

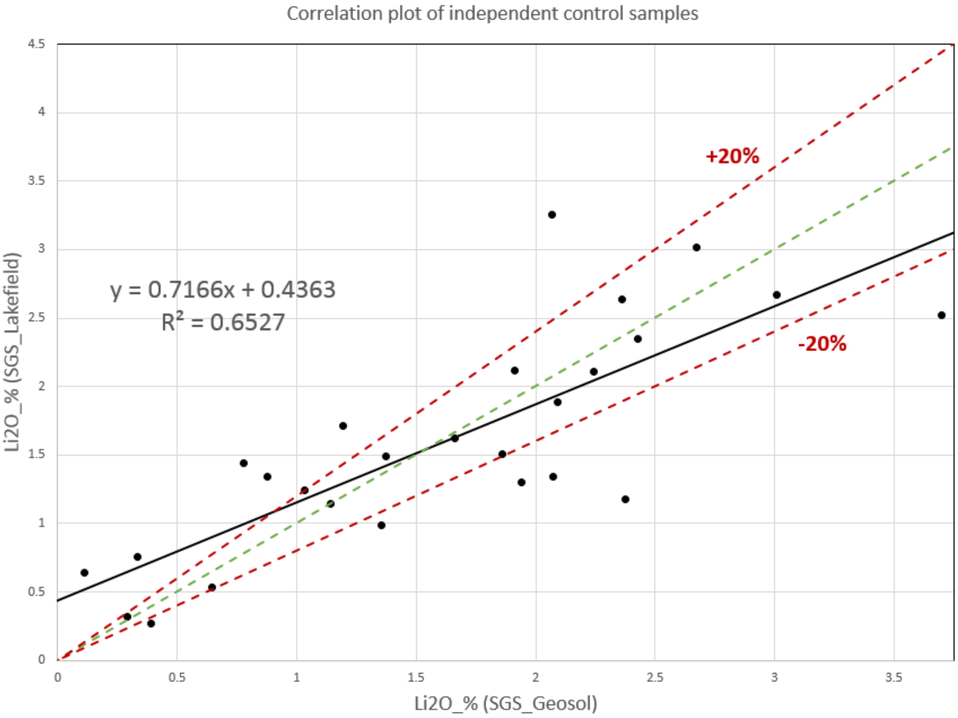


Figure 12-3 - Witness Sample Original vs Control Sample Differences Correlation Analysis

Note: Figure prepared by SGS, 2019.

12.3 CHECK ASSAYS

As additional control sampling, Sigma sent 664 samples from the 2017-2018 Grota do Cirilo drilling campaign to ALS Chemex for check sample analysis using the ALS Chemex protocol ME-ICP82b with sodium peroxide fusion.

Preparation was done by ALS Vespasiano and the samples were subsequently shipped to Vancouver for analysis.

The average lithium concentration for the original samples was 6,411.4 ppm Li and the duplicates averaged 6,475.9 ppm Li. The average difference was 64.5 (1.0%) and standard two-tailed paired t-test analysis returned a p-value of 0.0006 (α = 0.05) (Table 12-4 and Table 12-5). This indicates a slight bias with the ALS Chemex duplicates which is well within the accepted margin of error. Since the correlation coefficient R^2 of 0.9792 suggest a high similarity between the two sets of analyses (Figure 12-4 and Figure 12-5), this bias does not warrant any corrective action. Five outliers were identified, but they were not linked to any statistical drift, and thus, it is inconsequential. The control sample results are therefore deemed acceptable, and the original data can be used in Mineral Resource estimation.

Table 12-4 - Check Assay Original vs Control Samples

		Original > Control		Original ≤ Control	
Element	**Count**	**Count**	**%**	**Count**	**%**
Li_2O (%)	664	375	56	287	44

Table 12-5 - Check Assay Original and Control Descriptive Statistics

Data Set	Mean	Minimum	Maximum	Standard Deviation
SGS_Geosol	6,411.40	50	43,175	5,948.2
ALS	6,475.9	40	44,956	5,989

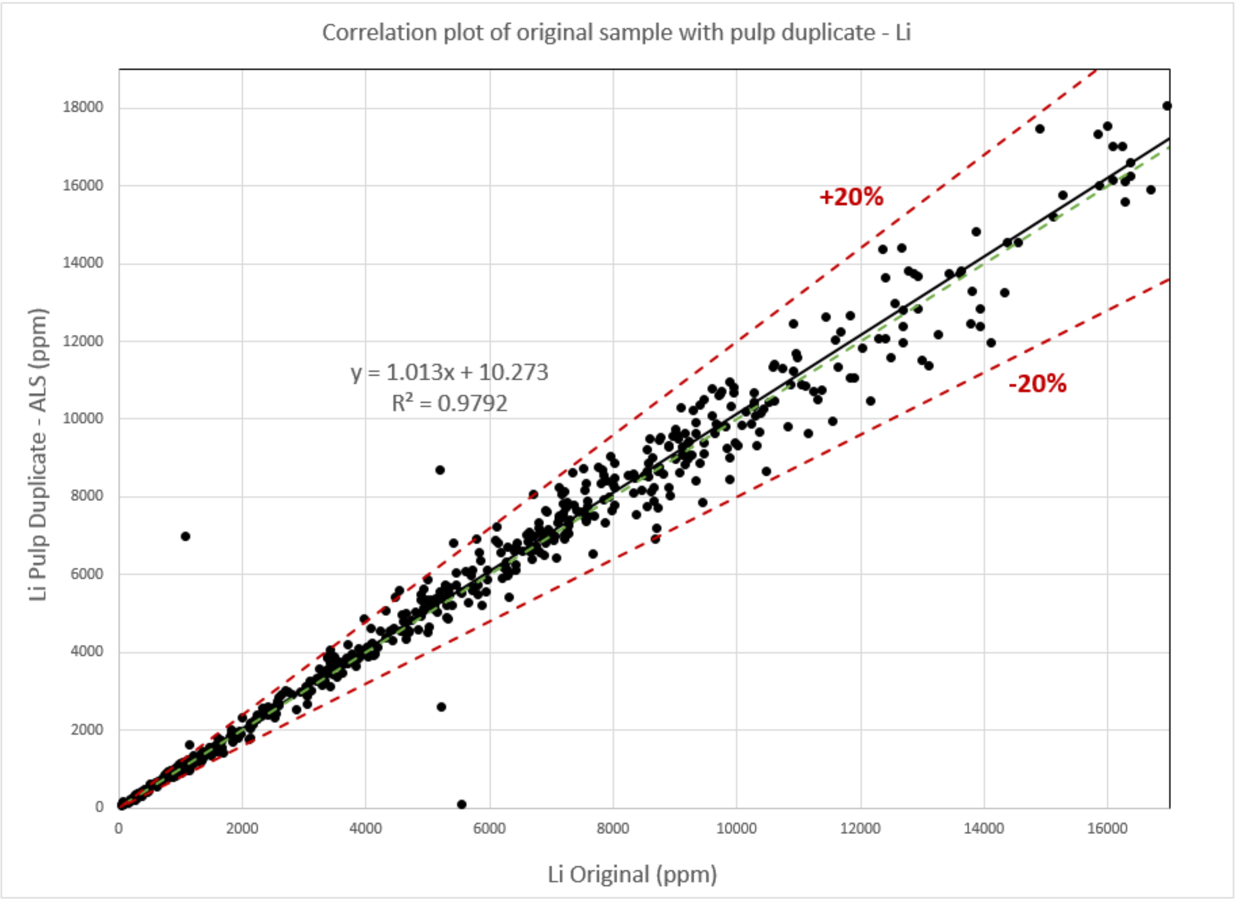


Figure 12-4 - Check Assay Correlation Between Original Samples and Pulp Duplicates

Note: Figure prepared by SGS, 2019.

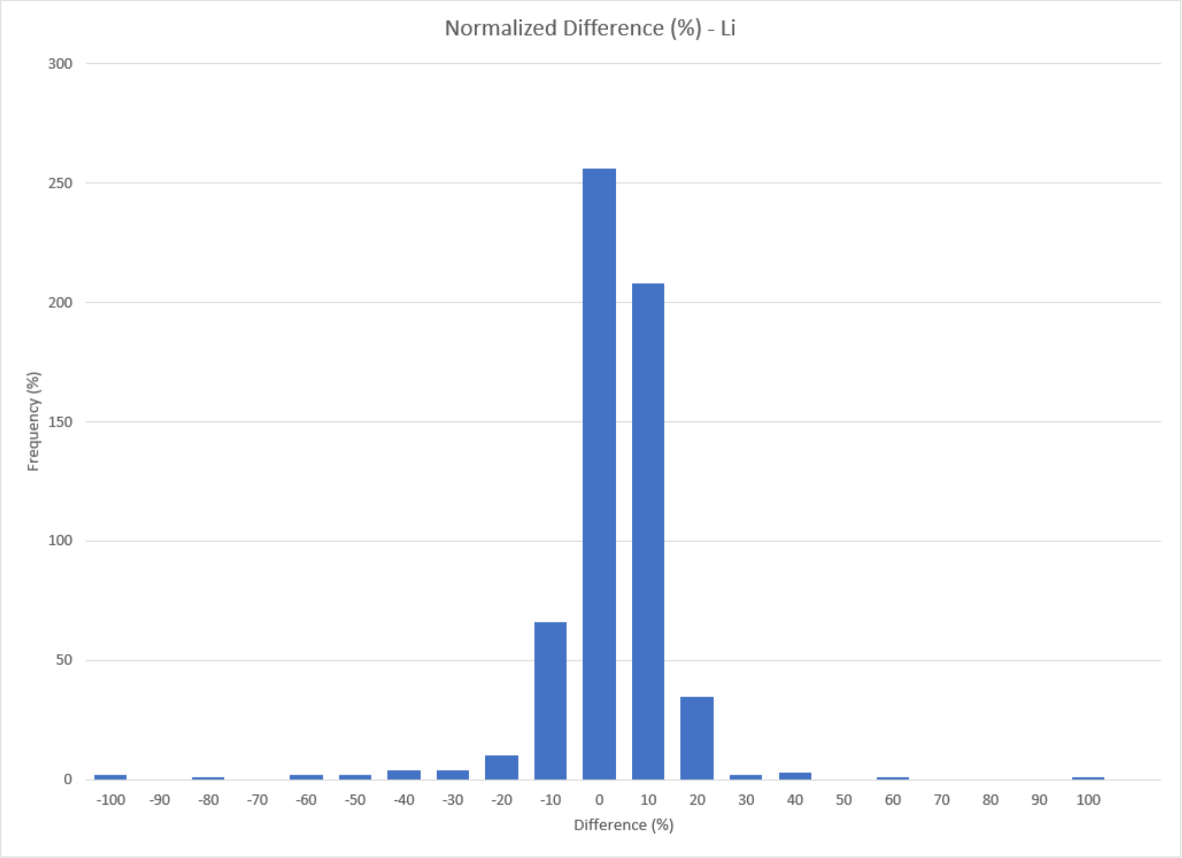


Figure 12-5 - Check Assay Distribution of the Difference Between Original Results and Pulp Duplicates

Note: Figure prepared by SGS, 2019.

12.4 QP COMMENTS

Sigma implemented an internal QA/QC protocol by regularly inserting reference materials (standards and blank) and core duplicates in the samples stream. Sigma also conducted a re-analysis of selected pulps in a second laboratory during 2017–2018, as part of its QA/QC protocol.

SGS completed a review of the sample preparation and analysis (including the QA/QC analytical protocol implemented by SMSA for the Grota do Cirilo property). The QP visited the Project twice, in 2017 and 2018, to review the sample preparation procedures, local infrastructure and in order to conduct an independent sampling program on 2014 drill core.

Following the data verification process and QA/QC review, the QP is of the opinion that the sample preparation, analysis and QA/QC protocol used by Sigma for the Project follow generally accepted industry standards and that the Project data is of a sufficient quality. However, more attention should be put into the blank material selection in future in order improve the similarity between the batches. In addition, density sampling should be more systematic and done every 10 m with a minimum of one sample per lithology to provide better control on the internal variation of the pegmatite deposits.

13 MINERAL PROCESSING AND METALLURGICAL TESTING

Test work was carried out at the SGS Lakefield metallurgical testing facility. This facility is independent of Sigma Resources and is a recognised testing facility, although not certified; this is typical of for metallurgical testing facilities.

Preliminary metallurgical investigation of the Xuxa deposit was first carried out in November 2017 by SGS at Lakefield in Ontario, Canada on a high-grade sample.

Mineral processing testing for the feasibility study commenced in October 2018. Figure 13-1 and Figure 13-2 illustrate overview of Stage 1 test work flowsheet and sample preparation.

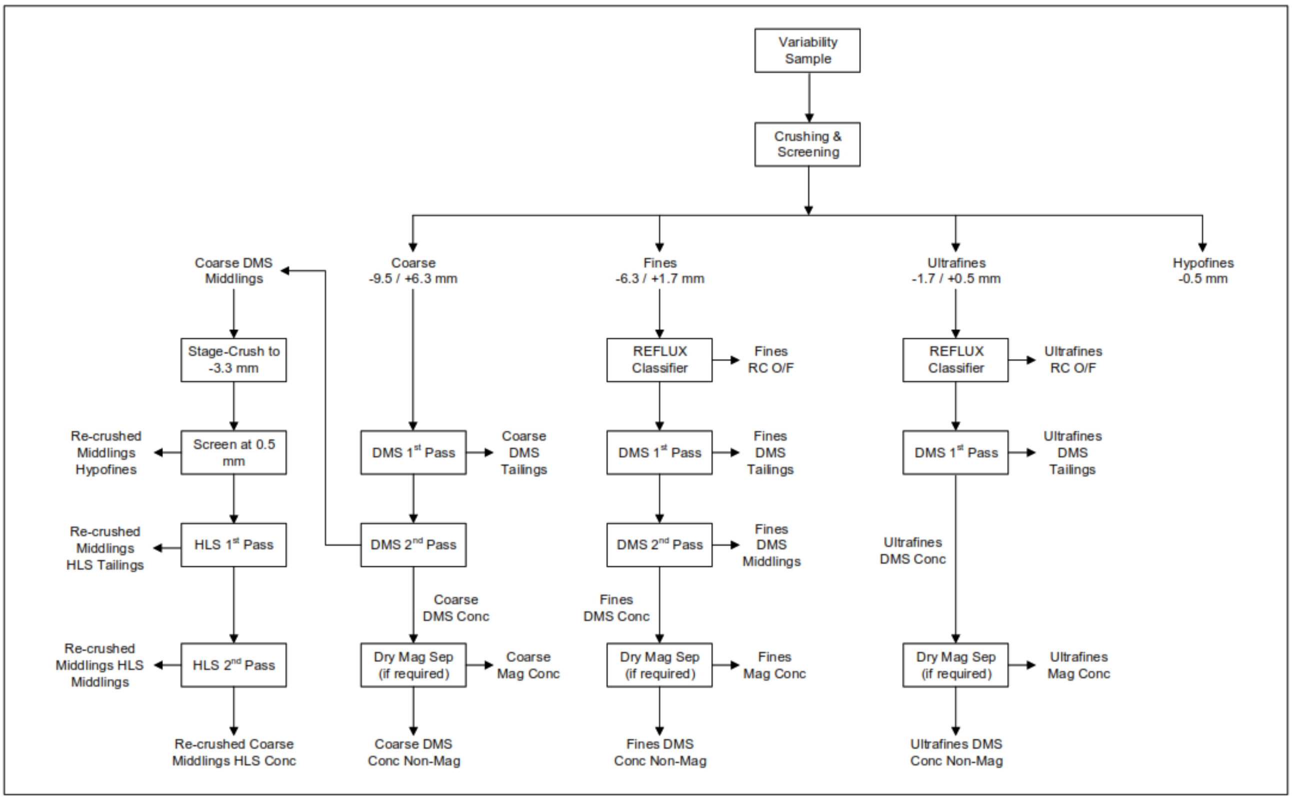


Figure 13-1 - Overview of Typical Stage 1 Test work Flowsheet

Note: Figure prepared by Primero, 2019

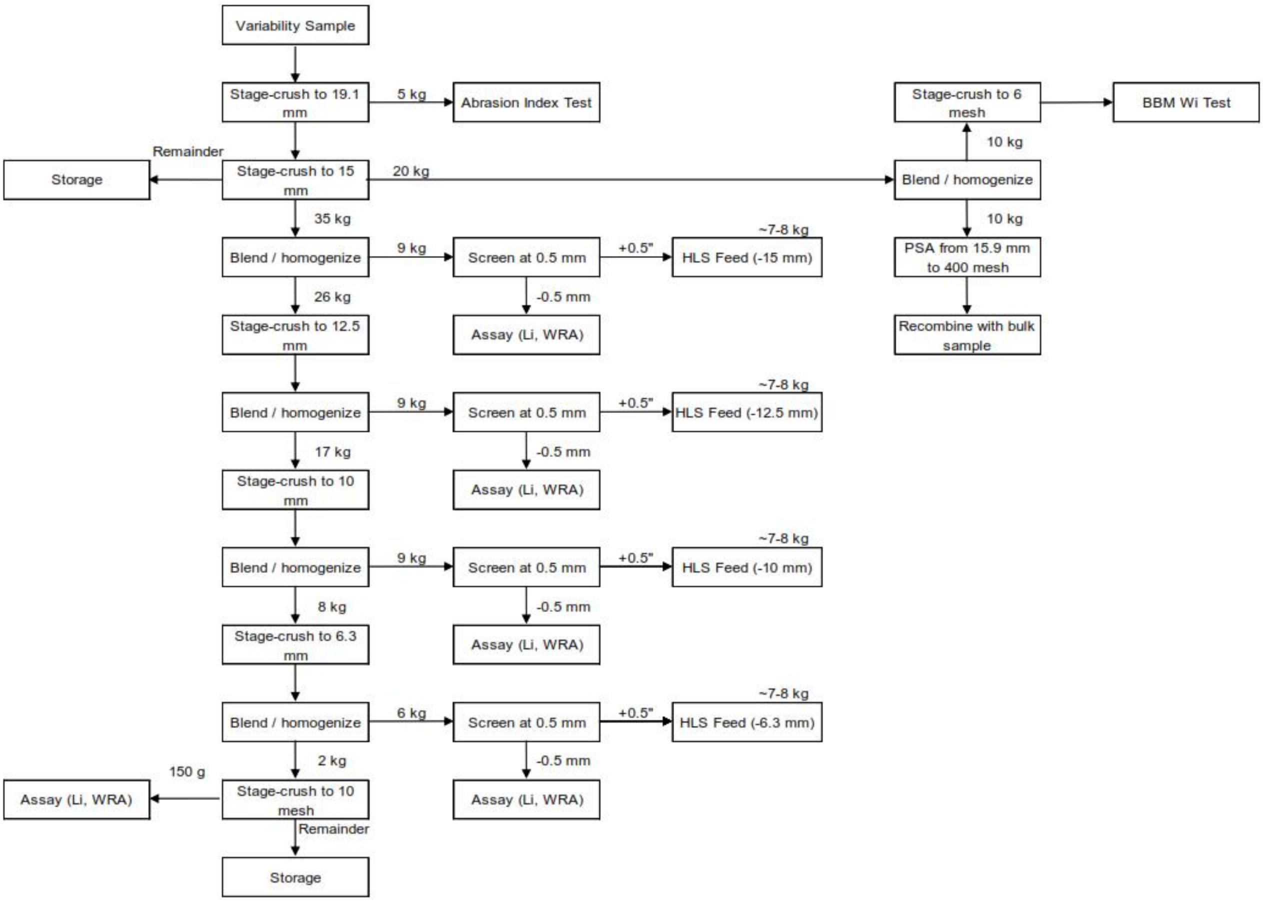


Figure 13-2 – Sample Preparation Diagram for Stage 1 Variability Samples

Note: Figure prepared by Primero, 2019

13.1 TEST MATERIALS

Sample selection was undertaken by Primero, with Sigma reviewing the proposed material choices.

The initial variability sample selection criteria were as follows:

1. High grade Li_2O
2. Low grade Li_2O
3. Later years – high grade
4. Early years – average grade
5. High Fe
6. High schist.

These six variability samples criteria aligned closely with the sample selection criteria outlined in the CIM Best Practice Guidelines (Sub-Committee on Best Practice Guidelines for Mineral Processing, 2011).

Selected drill core samples were sorted into:

- Six ore sorting samples
- Six variability samples (for Stage 1 test work)
- One waste rock sample for environmental test work.

The remaining drill core samples were combined to create the composite sample for Stage 2 test work.

Fourteen samples from a separate shipment were combined to produce six samples of relatively equal weights (~40 kg) for the unconfined compressive strength (UCS) and Bond low-energy impact test work.

Twenty-five drums (5,196 kg) of trench samples were also delivered for pilot plant testing in Stage 3. The fine fraction from the trench samples was used for solid-liquid separation test work.

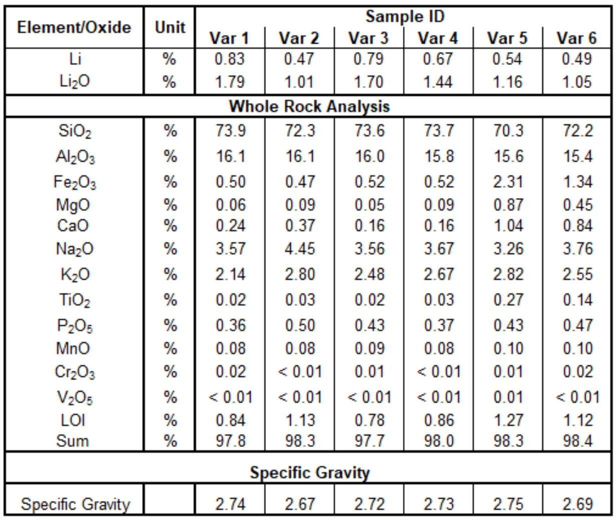
13.2 STAGE 1 TEST WORK

Stage 1 test work was conducted on variability samples, and included feed characterisation, grindability, ore sorting, heavy liquid separation, bulk test work including reflux, further dense media separation work and environmental testing.

13.2.1 Characterization

Table 13-1 presents the head assays of each of the six variability (Var) samples.

Table 13-1 - Chemical Analysis and WRA Results



Element/Oxide	Unit	Sample ID					
		Var 1	Var 2	Var 3	Var 4	Var 5	Var 6
Li	%	0.83	0.47	0.79	0.67	0.54	0.49
Li_2O	%	1.79	1.01	1.70	1.44	1.16	1.05
Whole Rock Analysis							
SiO_2	%	73.9	72.3	73.6	73.7	70.3	72.2
Al_2O_3	%	16.1	16.1	16.0	15.8	15.6	15.4
Fe_2O_3	%	0.50	0.47	0.52	0.52	2.31	1.34
MgO	%	0.06	0.09	0.05	0.09	0.87	0.45
CaO	%	0.24	0.37	0.16	0.16	1.04	0.84
Na_2O	%	3.57	4.45	3.56	3.67	3.26	3.76
K_2O	%	2.14	2.80	2.48	2.67	2.82	2.55
TiO_2	%	0.02	0.03	0.02	0.03	0.27	0.14
P_2O_5	%	0.36	0.50	0.43	0.37	0.43	0.47
MnO	%	0.08	0.08	0.09	0.08	0.10	0.10
Cr_2O_3	%	0.02	< 0.01	0.01	< 0.01	0.01	0.02
V_2O_5	%	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01
LOI	%	0.84	1.13	0.78	0.86	1.27	1.12
Sum	%	97.8	98.3	97.7	98.0	98.3	98.4
Specific Gravity							
Specific Gravity		2.74	2.67	2.72	2.73	2.75	2.69

The lithium grade of the six variability samples were relatively close to expected grade. The average iron content was relatively low at ~0.50% Fe_2O_3 in Var 1 to 4. The iron content was higher in Var 5 and 6 as iron and schist were added to the samples. The average specific gravity was 2.72.

A subsample of the head composite of each variability sample was submitted for mineralogical analysis in four size fractions:

- +300 µm
- -300/+212 µm
- -212/+106 µm
- -106 µm.

The main silicate gangue minerals include quartz (30.9%), plagioclase (34.0%) and K-feldspar (13.6%). Spodumene (10.1%) and petalite (3.6%) are present in moderate and minor levels respectively. The lithium deportment illustrates that ~81% of the lithium is hosted by spodumene, 16.4% by petalite and ~3% by the montebrasite (2.7%).

At all size fractions below 300 µm, the spodumene, petalite and silicate gangue are well liberated. The montebrasite is not as well liberated.

13.2.2 Grindability Test Work

The following comminution tests were carried out on the variability samples:

- Bond abrasion test: used to determine the abrasiveness of a test sample. The index is used by crusher and mill engineers to determine wear rates of liners. Results are provided in Table 13-2.
- Bond ball mill grindability tests: semi-continuous (locked cycle) tests. The Bond ball mill work index is used to determine the power draw or energy consumption to ball mill a test sample. Results are provided in Table 13-2. The sample was characterized as medium hardness relative to the SGS database, with an average BWi of 13.8 kWh/t.
- UCS tests: used to determine the relative strength of material in a crushing environment. Results are provided in Table 13-3. Variability was observed in the average UCS of each the six samples, with values ranging from 50.1–74.4 MPa. The overall average UCS was 64.2 MPa.
- Bond low-energy impact tests: a particle test in which rocks are subjected to increasingly higher energy levels until they fracture. Results are provided in Table 13-3. Variability was observed in the average crusher work indices (CWi) of each the 6 samples, with values ranging from 9.8 kWh/t to 14.6 kWh/t. The sample characterizations ranged from medium to hard, with an overall average CWi of 11.8 kWh/t.

Table 13-2 - Bond Abrasion and Ball Mill Work Index Test Work Summary

Sample Name	Abrasion Index	Bond Ball Mill Work Index (kWh/t)
Var 1	0.440	14.4
Var 2	0.350	14.1
Var 3	0.458	14.9
Var 4	0.381	13.6
Var 5	0.379	12.2
Var 6	0.380	13.6
Average	**0.398**	**13.8**
Min	**0.350**	
Max	**0.458**	

Table 13-3 – Average UCS and CWi

Sample	Average UCS (MPa)	Average CWi (kWh/t)
1	65.2	10.3
2	57.8	10.8
3	50.1	9.8
4	74.4	14.6
5	69.3	12.9
6	68.6	12.6
Average	**64.2**	**11.8**

13.2.3 Ore Sorting Test work

Ore sorting test work on the six samples was carried out by Steinert US at their facility in Kentucky, USA. The objective of this preliminary test work was to evaluate the viability of ore-sorting as a technique for waste rejection from the Xuxa ore, and to investigate the performance of different sensors.

Five samples were pegmatite samples consisting of little or no waste rock, while the sixth sample consisted of waste rock only. The ore sorter machine used for the test work was a Steinert KSS 100 520 FLI XT with four types of sensors: XRT (with 3-D laser), induction, laser (brightness), and colour. The products from the test work were returned to SGS Lakefield for Li and whole rock analysis (WRA).

The ore sorter calibration indicated that all four sensors could be applied to remove waste from the samples. Therefore, different sensors (and combinations of sensors) were tested on the five samples. A summary of the ore sorter test work results is presented in Table 13-4.

Table 13-4 – Summary of Ore Sorter Test work Results

Sample	Product	Sensor	Weight	Assays (%)		Distribution (%)	
			%	Li_2O	Fe_2O_3	Li_2O	Fe_2O_3
1	Product	XRT	92.4	1.43	0.63	88.0	70.6
	Waste + Fines		7.6	2.36	3.17	12.0	29.4
	Feed Head (Calc.)		100	1.50	0.82	100	100
2	Product	Laser	95.5	1.50	0.60	98.9	68.0
	Waste + Fines		4.5	0.34	5.94	1.1	32.0
	Feed Head (Calc.)		100	1.45	0.84	100	100
3	Product	XRT / laser / induction	93.9	1.62	0.66	98.9	57.0
	Waste + Fines		6.1	0.27	7.61	1.1	43.0
	Feed Head (Calc.)		100	1.53	1.09	100	100
4 (1 pass)	Product	Induction	94.4	1.51	0.67	96.8	74.1
	Waste + Fines		5.6	0.84	3.95	3.2	25.9
	Feed Head (Calc.)		100	1.47	0.85	100	100
4 (2 pass)	Product	Induction	97.5	1.50	0.70	99.2	80.2
	Waste + Fines		2.5	0.45	6.79	0.8	19.8
	Feed Head (Calc.)		100	1.47	0.85	100	100
5	Product	XRT / laser / induction	96.2	1.39	0.70	99.2	74.2
	Waste + Fines		3.8	0.28	6.26	0.8	25.8
	Feed Head (Calc.)		100	1.35	0.91	100	100

The relatively low mass and lithium distributions to the waste + fines resulted in only marginal lithium upgrading in the products. However, due to the high iron distributions to the waste + fines, significant Fe_2O_3 downgrading was typically observed in the products. The greatest change was in the test on sample 3 (from 1.09% Fe_2O_3 in the feed to 0.66% Fe_2O_3 in the product), using combination of XRT / laser / induction sensors.

13.2.4 Heavy Liquid Separation

Heavy liquid separation tests were conducted to assess the amenability of the sample to dense media separation (DMS) for spodumene beneficiation, and to determine the optimum crush size for DMS.

Four size fractions were evaluated: 6.3 mm, 9.5 mm, 12.5 mm, and 15.9 mm. A summary of the key data from the HLS test results is presented in Table 13-5.

The Stage 1 HLS tests delivered promising results, with >6% Li_2O concentrate generated in each of the 24 tests. Lithium recoveries in the interpolated 6.0% Li_2O concentrate typically ranged from 40% to 70%, with the significant variation observed between variability samples and at different crush sizes.

Table 13-5 - Summary of HLS Test Results on Variability Samples

	Mass Distribution (%)				**Media SG**				**Li_2O Grade (%)**				**HLS Li Distribution (%)**							
	6% Li_2O Conc (interpolated)				**Required for 6% Li_2O Conc (interpolated)**				**Head (Calc.)**				**6% Li_2O Conc (interpolated)**				**SG 2.50 Floats**			
Crush Size (mm)	**15.9**	**12.5**	**9.5**	**6.3**	**15.9**	**12.5**	**9.5**	**6.3**	**15.9**	**12.5**	**9.5**	**6.3**	**15.9**	**12.5**	**9.5**	**6.3**	**15.9**	**12.5**	**9.5**	**6.3**
Var 1	15.1	18.1	19.3	20.5	2.88	2.87	2.86	2.80	1.66	1.77	1.72	1.71	54.0	60.5	66.6	71.9	5.6	7.7	5.0	5.3
Var 2	6.8	8.7	5.5	8.2	2.88	2.86	2.98	2.83	1.01	1.03	0.92	1.02	39.9	49.0	35.4	48.2	15.4	15.2	15.0	17.0
Var 3	12.9	14.7	14.5	16.1	2.87	2.85	2.88	2.80	1.53	1.59	1.54	1.60	49.9	54.9	56.2	60.2	11.1	11.3	10.4	12.1
Var 4	12.1	11.6	15.9	17.9	2.90	2.91	2.90	2.80	1.51	1.45	1.55	1.50	48.1	48.0	61.4	71.5	5.4	5.2	4.6	4.8
Var 5	6.1	9.3	12.2	11.1	2.99	2.93	2.92	2.92	1.10	1.28	1.28	1.16	33.1	43.7	56.9	57.1	4.6	5.3	4.3	5.7
Var 6	6.0	8.0	7.5	9.7	2.96	2.92	2.95	2.88	1.13	1.06	1.03	1.07	31.6	45.6	44.0	53.2	13.4	13.8	14.4	14.8

Though the recovery of lithium in 6.0% Li_2O spodumene concentrate was maximized at a crush size of 6.3 mm, 9.5 mm was selected as the optimum crush size as it gave the best lithium recovery and had minimal fines generation.

13.2.5 Bulk Test Work

The Stage 1 bulk beneficiation test work program was designed to simulate, as closely as possible, the expected plant flowsheet at laboratory scale. The beneficiation test work consisted primarily of REFLUX Classifier, DMS, and dry magnetic separation test work. Each of the coarse, fines and ultra-fines fractions of a variability sample were separately processed to generate spodumene concentrate.

13.2.5.1 REFLUX™ Classifier Test work Results

In the absence of mineralogical data on each of the products, potassium (K_2O) was considered to be an indicator for the main mica minerals (muscovite and biotite) expected to be present in the samples. The results of the test work appeared to be promising with K_2O upgrading and Li_2O downgrading observed in the overflow products generated from each of the RC feed samples. This indicates that mica was preferentially rejected to the overflow product.

On average, 8.8% of the K_2O and 2.3% of the lithium reported to the fines overflow while 5.3% of the K_2O and 1.4% of the lithium reported to the ultrafines overflow.

13.2.5.2 Coarse Dense Media Separation Test work

An SG of 2.65 was selected as the cut-point for the bulk DMS first pass tests to maximize silicate gangue rejection to the DMS tailings, while minimizing lithium losses. DMS second-pass SG cut-points were recalculated to target a concentrate grade of 6.20% Li_2O. These revised DMS second-pass cut-points for Var 1 –Var 4 are presented in Table 13-6.

Table 13-6 - Coarse Fraction DMS results

Sample	Target Coarse DMS second pass SG Cut-Point	Lithium recovery to second pass sinks (%)	Lithium grade in second pass sinks (%)	Lithium recovery to non-mags (%)	Lithium grade in non-mags (%)
Var 1	2.88	65.7	6.11		
Var 2	2.90	43.4	6.26		
Var 3	2.90	52.2	6.52		
Var 4	2.92	52.2	5.88		
Var 5	2.85	60.9	4.54	57.6	5.64
Var 6	2.90	46.6	5.53	46.0	6.01

The lithium grades in the DMS tailings were relatively high, averaging 0.53% Li_2O across the six variability samples. This was largely due to presence of significant amounts of petalite in the variability samples.

13.2.5.3 Coarse DMS Re-crushing, Screening, and HLS Test work

The DMS middlings of each variability sample were stage-crushed to -3.3 mm and screened at 0.5 mm to produce -3.3 / +0.5 mm HLS feed samples. Due to lack of sample size HLS was used instead of DMS. These samples were submitted for two pass HLS tests, with passes at the same media SGs as those used in the coarse DMS tests on each variability sample. As on-spec concentrate was not generated from the coarse DMS of Var 4 and Var 5, an additional HLS pass was added at a slightly higher SG for these two samples.

Spodumene concentrate grading >6% Li_2O was generated from the HLS tests on the coarse re-crushed middlings of each of the variability samples apart from Var 6 (which graded 5.64% Li_2O). For Var 5, the SG 2.90 HLS sinks product graded >6% Li_2O, an increase over the SG cut-point of 2.85 used in the Var 5 coarse DMS test. Averaged over the six variability samples, the additional lithium recovery to the -3.3 mm middlings HLS concentrate was 13.6%.

Figure 13-3 illustrates the effect of combining the -3.3 mm middlings HLS concentrate with the coarse DMS concentrate on the overall combined concentrate Li_2O grade for each variability sample. In general, due to the lower mass yield to the HLS concentrates compared to the corresponding DMS concentrates, the combined DMS + HLS concentrate Li_2O grades are very similar to those of the coarse DMS concentrates.

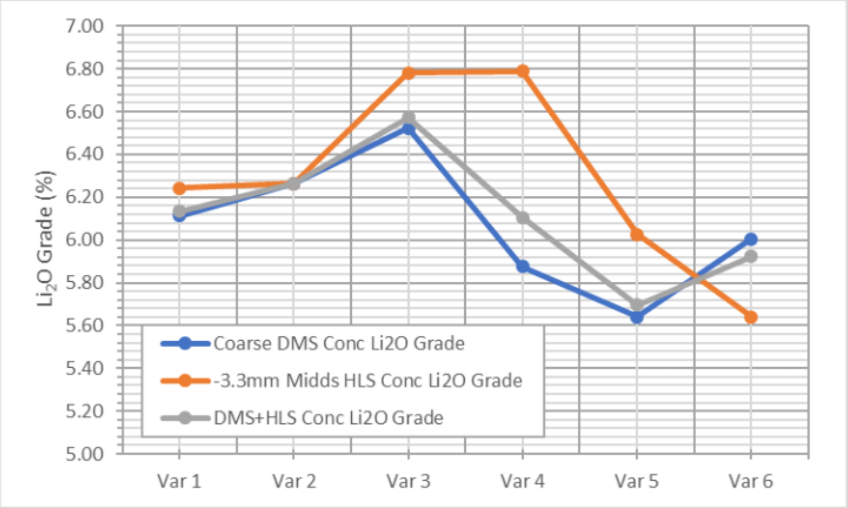


Figure 13-3 - Effect of Combining Coarse DMS and -3.3 mm Midds HLS Concentrates

Note: Figure prepared by SGS Lakefield, 2019.

13.2.5.4 Fines Fraction DMS Test work

DMS first pass SG cut-point (SG 2.65) was used for the fines fractions of each variability sample.

The DMS second pass cut-points selected for the fines fraction DMS test work are presented in Table 13-7.

Table 13-7 - Fines Fraction DMS 2nd Pass SG Cut-Points

Sample	Target Coarse DMS second pass SG Cut-Point	Lithium recovery to second pass sinks (%)	Lithium grade in second pass sinks (%)	Lithium recovery to non-mags (%)	Lithium grade in non-mags (%)
Var 1	2.86	72.8	5.94		
Var 2	2.88	53.5	6.09		
Var 3	2.88	65.6	6.01		
Var 4	2.90	75.1	5.98		
Var 5	2.88	72.4	4.08	69.3	6.01
Var 6	2.88	62.8	4.87	60.4	6.11

13.2.5.5 Ultrafines Fraction DMS Test work

SG cut-points used for the coarse fraction DMS second pass were also used for the single-pass ultrafines DMS test work on the corresponding variability samples. Results are presented in Table 13-8.

Table 13-8 – Ultra-fine Fraction DMS Results

Sample	Target Ultra-fines DMS first pass SG Cut-Point	Lithium recovery to first pass sinks (%)	Lithium grade in first pass sinks (%)	Lithium recovery to non-mags (%)	Lithium grade in non-mags (%)
Var 1	2.88	69.4	6.74	67.3	6.52
Var 2	2.90	42.1	5.81	39.0	5.98
Var 3	2.90	51.7	6.65	48.4	6.48
Var 4	2.92	60.3	6.80	58.2	6.65
Var 5	2.90	59.1	6.24	52.8	6.61
Var 6	2.90	53.5	6.18	50.0	6.07

13.2.6 Overall Flowsheet Test work

13.2.6.1 Size-By-Size Distributions

The trend in lithium grades in the different size fractions was identical for all six variability samples. Lithium was upgraded in the coarse fraction, with the lithium grade declining in each finer size fraction. The lithium grade in the fines fraction was observed to be close to variability sample head grade, and lithium downgrading was observed in the ultrafines and fines fractions.

As a result of the mass distributions and the lithium head grades of each fraction, the greatest proportion of lithium reported to the coarse fraction, followed closely by the fines fraction, and then the ultrafines and hypofines fractions.

13.2.6.2 Overall Flowsheet Test Work Results

On-spec or near-spec combined spodumene concentrate was successfully generated from the bulk processing of each of the variability samples. Apart from Var 3 and Var 5, the combined concentrate from each variability sample graded between 6.00-6.16% Li_2O, indicating that lithium recovery to the concentrate was optimized based on the flowsheet tested.

The iron contents of the Var 1–Var 4 combined spodumene concentrates were each below the 1% Fe_2O_3 target. Only in Var 4 was this target achieved without any dry magnetic separation of the DMS concentrates. For Var 1 and Var 3, dry magnetic separation was required for the ultrafines DMS concentrate, while dry magnetic separation of the fines and ultrafines DMS concentrates was required for Var 2.

Dry magnetic separation of the coarse, fines, and ultrafines DMS concentrates was required for the two high-waste variability samples (Var 5 and Var 6). The combined concentrates generated grades slightly in excess of 1% Fe_2O_3, at 1.10% Fe_2O_3 for Var 5 and 1.06% Fe_2O_3 for Var 6. It is expected that the required slight decrease in iron content of these samples may be achieved by the further optimization of the parameters used in the dry magnetic separation test work.

The combined middlings grades were relatively high for Var 1–Var 4, ranging from 0.91% Li_2O to 1.23% Li_2O. The combined middlings grades for Var 5 and Var 6 were ~0.55% Li_2O. The average lithium distribution to the combined middlings, across the six variability samples, was 5.7%.

The mass yields and lithium losses to the mica overflow (combined REFLUX™ classifier overflow) and magnetic concentrate products were relatively low for each variability sample. The mass yield to the mica overflow averaged 1.6%, with an average lithium distribution of 0.8%. The median mass to the combined magnetic concentrate was 0.5%, with a median lithium distribution of 1.1%. The main outlier was the Var 5 (high Fe) magnetic concentrate, which accounted for 4.1% of the feed mass and 3% of the feed lithium.

The mass yield to the hypofines fractions ranged from 14.0% for Var 1 to 23.3% for Var 5, with an average of 17.3%. Lithium distribution to the hypofines fraction ranged from 11.4% for Var 1 to 16.0% for Var 5, with an average of 13.9%. The lithium grades of the hypofines fractions were slightly lower than the head grades of the corresponding variability sample.

13.2.7 Geochemical (Environmental) Testing

In addition to the geochemical test work conducted at SGS Geosol on 20 samples as detailed in Section 20.1.4, the metallurgical test work program at SGS Lakefield included geochemical testing which included a sample which was a blend of waste rock and DMS tailings, in a ratio of 10:1. Environmental tests were conducted on three samples: waste rock; DMS tailing identified as "ENV Test Tailings"; and a waste rock/DMS tailing composite identified as "Untested/DMS Tls Blend". The purpose of the environmental program was to assess the acid rock drainage (ARD), contaminant release, and geotechnical characteristics associated with the samples tested.

Geochemical test results for the DMS tailing and humidity cell testing of the waste rock/tailing composite are available.

Semi-quantitative XRD analyses determined that the waste rock was predominantly composed of silicates with minor to trace amounts of iron-sulphide and iron-oxide minerals. Moderate to minor contributions of aluminium, iron, calcium, magnesium, potassium, and sodium were also identified by elemental analysis.

Ontario Schedule 4 limits were used in analysing the results of the waste rock toxicity characteristic leaching procedure (TCLP) leachate. All of the typically controlled parameters were well within the limits specified for this test procedure. Since the TCLP is a highly aggressive extraction procedure, the limits applicable to this test procedure are much higher than those used for synthetic precipitation leaching procedure (SPLP) or shake flask extraction (SFE) leachates. Results of the waste rock SPLP and SFE leachate analyses reported all parameters at concentrations well within the World Bank guidelines.

For the sample tested at SGS Lakefield, modified acid–base accounting (ABA) of the waste rock and the waste rock/tailings composite suggested that these samples are unlikely to generate acidity due to sulphide oxidation. However, as stated in Section 20.1.4, the results of the ABA tests on the other waste rock samples are reported as either non acid-generating or in the uncertain range.

Analysis of the waste rock/tailings composite humidity cell leachates reported all World Bank (WB) controlled parameters well within the specified guidelines. Testing was stopped after 20 weeks of leaching. The depletion rates calculated for this test cell indicated that, if the current depletion rates continue, the waste rock/tailings composite may be expected to retain fast reacting carbonate neutralization potential available upon exhaustion of the samples sulphide content. The test results for that sample indicated no expected acid generation.

Results of the particle size distribution analysis indicated that the DMS tailing sample was comprised entirely of coarse-grained particles (gravel and sand size). While the waste rock was also comprised predominantly of coarse particle sizes, this sample also reported a significant silt size fraction.

13.3 STAGE 2 (COMPOSITE SAMPLE)

The remaining drill core sample after variability sample tests was grouped to form a “composite sample”. This sample contained a significant proportion of material classified as “later year” samples. The composite sample was subjected to feed characterisation, abrasion and beneficiation test work.

The combined spodumene concentrate graded 6.13% Li_2O and 1.27% Fe_2O_3 with 48% lithium recovery.

The combined results do not consider the processing of re-crushed DMS middlings.

The iron grade in the spodumene concentrate was <1% Fe_2O_3 in the coarse fraction but increased in the finer fractions (up to 2.34% Fe_2O_3 in the ultrafines fraction).

13.4 STAGE 3 (PILOT PLANT SAMPLE)

The samples for Stage 3 pilot plant, with calculated head grade of 1.64% Li_2O, were trench samples from the north pit. These samples had an average head grade of 1.42% Li_2O. The samples were subjected to feed characterisation, beneficiation, solid-liquid separation, optical sorting and iron removal test work.

The DMS test results indicate the production of a concentrate (at SG 2.80) grading 6.32% Li_2O and 0.71% Fe_2O_3 with 71.9% lithium recovery in 19.9% of the feed mass.

The bulk pilot plant samples results indicated that a concentrates grade of 6.41% Li_2O with 73.1% lithium recovery, iron content was 0.69% Fe_2O_3 could be achieved without the need for any dry magnetic separation.

The combined tailings grade was relatively low at 0.25% Li_2O, and 7.5% of the total lithium reported to this product. Some of this lithium may be in the form of petalite.

13.5 RECOVERY AND BASIS OF ASSUMPTIONS

Var 3 and Var 4 samples were determined to best represent the deposit. The global recovery was based on the average of the recoveries of these samples and estimated at 60.4% for the DMS circuit, which includes coarse, fines and ultrafines material as summarized in Table 13-9.

Table 13-9 – Estimates of DMS Circuit Recovery

DMS Circuit	Detailed Estimate
Coarse (-9.5+6.3 mm)	24.7%
Fines (-6.3+1.7 mm)	26.1%
Ultrafines (-1.7+0.5 mm)	9.6%
Global DMS Recovery	**60.4%**

The global DMS recovery is the sum of recoveries of the DMS sub-circuits. For the detailed recovery estimate, recoveries were calculated from individual laboratory results in a spreadsheet that simulates the plant design flowsheet. The stream tonnages were derived from the mass balance, and the mass splits and grades of the streams were obtained from laboratory results. Some of internal stream data had to be calculated (or estimated) from historical operational data from existing operations.

14 MINERAL RESOURCE ESTIMATES

The Mineral Resource estimates are reported using the 2014 CIM Definition Standards. The mineral resource estimation work for the Project was conducted by Mr. Marc-Antoine Laporte, M.Sc., P.Geo. The 3D modelling, geostatistics, and grade interpolation of the block model was conducted using the Genesis© software developed by SGS. The Mineral Resource estimation process was reviewed internally by Maxime Dupere, P.Geo, from SGS. Due to the distances between the Xuxa, Barreiro, Lavra do Meio and Murial pegmatites, they are treated as separate estimates and separate block models were constructed for each zone.

The Mineral Resource estimates are based on the drill hole database (lithology logs and assays) using HQ drill core and are limited by the topographic surface. Due to the lack of control on the channel sampling from the previous exploration campaigns, the channel assay results were not used for purposes of resource estimation and mapping was used only to control the pegmatite wireframe.

14.1 XUXA DEPOSIT

14.1.1 Exploratory Data Analysis

The final database used for the Xuxa pegmatite Mineral Resource estimation was transmitted to SGS by SMSA on December 13, 2018 in Microsoft® Excel format and Datamine format and this date was used as a cut-off for the resource estimate. The database validation steps are discussed in Section 12. The database comprises 93 drill holes with entries for:

- Down hole surveys (n = 4,680)
- Assays (n = 2,386)
- Lithologies (n = 1,180).

The database was validated upon importation in Genesis©, which enabled the correction of minor discrepancies between the table entries, surveys, and lithologies.

Vertical sections were generated oriented N55°W (305º azimuth) following the drilling pattern and perpendicular to the general trend of the pegmatite unit. In general, the sections are spaced at 50 m intervals. Figure 14-1 is a drill collar layout plan.

The topographic surface that was used by SGS was a 1 m precision DEM (refer to Section 9.2).

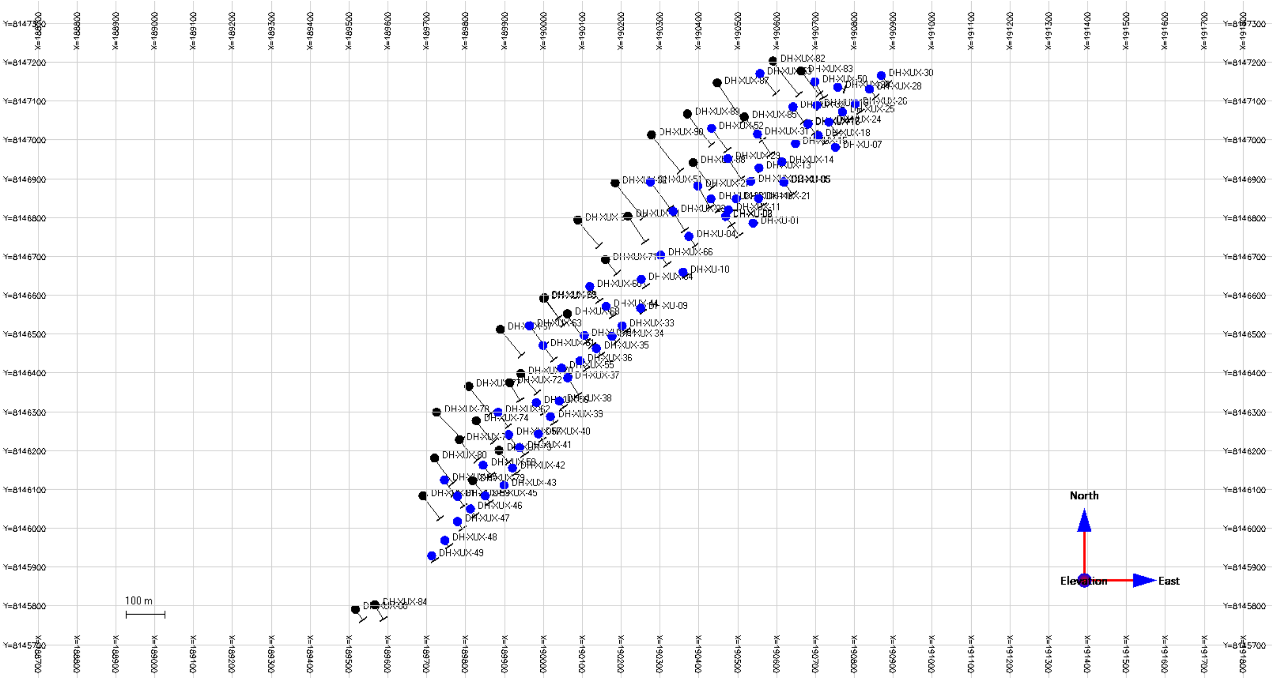


Figure 14-1 - Xuxa Drill Hole Collar Locations

(2017 collars shown in blue and 2018 collars shown in black)

Note: Figure prepared by SGS, 2019. Figure north is to top of figure.

14.1.2 Analytical Data

There is a total of 2,386 assay intervals in the database that were used for Mineral Resource estimation; 1,247 assays are contained inside the interpreted mineralized solids. Most of the drill holes defining the mineralized solids have been sampled continuously. Table 14-1 shows the range of Li_2O values from the analytical data within the interpreted mineralized shapes.

Table 14-1 - Xuxa Assay Statistics Inside Mineralized Solids

	Li_2O (%)
Count	1,247
Mean	1.48
Std. Dev.	0.84
Min	0.03
Median	1.51
Max	4.63

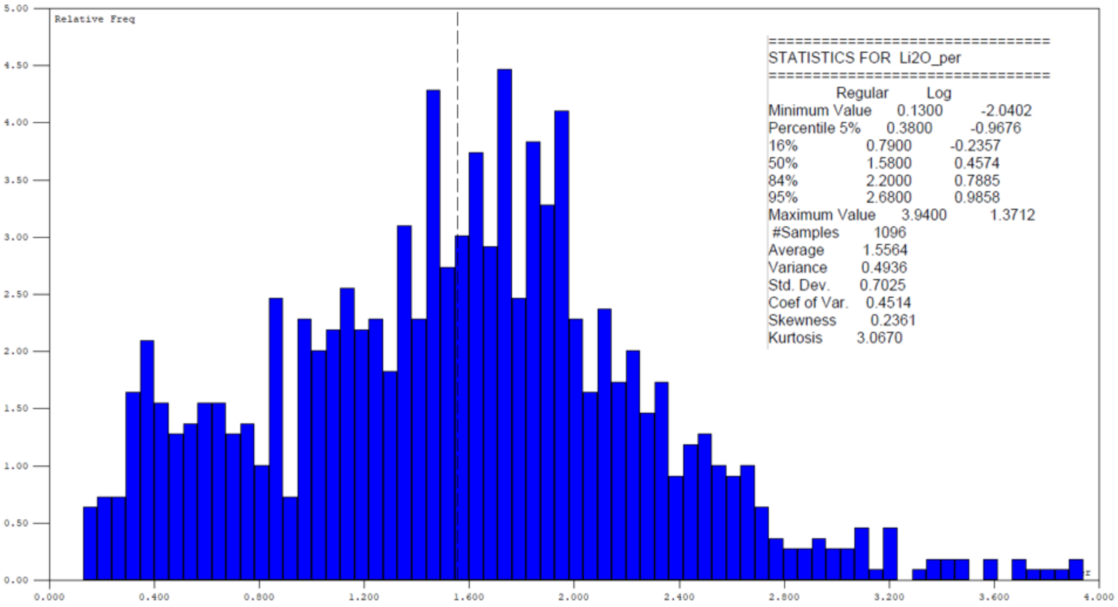
14.1.3 Composite Data

Block model grade interpolation was conducted on composited analytical data. A 1 m composite length was selected based on the north–south width of the 5 m by 3 m by 5 m block size defined for the resource block model. Compositing began at the bedrock-overburden contact. No capping was applied on the analytical composite data.

Table 14-2 shows the grade statistics of the analytical composites used for the interpolation of the resource block model and Figure 14-2 is an example histogram.

Table 14-2 - Xuxa 1 m Composite Statistics

	Li_2O (%)
Count	**1,096**
Mean	**1.56**
Std. Dev.	**0.70**
Min	**0.13**
Median	**1.58**
Max	**3.94**



```
================================
STATISTICS FOR  Li2O_per
================================
                 Regular        Log
Minimum Value     0.1300       -2.0402
Percentile 5%     0.3800       -0.9676
16%               0.7900       -0.2357
50%               1.5800        0.4574
84%               2.2000        0.7885
95%               2.6800        0.9858
Maximum Value     3.9400        1.3712
 #Samples         1096
Average           1.5564
Variance          0.4936
Std. Dev.         0.7025
Coef of Var.      0.4514
Skewness          0.2361
Kurtosis          3.0670
```

Figure 14-2 - Xuxa 1 m Composite Histogram

Note: Figure prepared by SGS, 2019.

14.1.4 Density

Density determinations are outlined in Section 11.3. An average density value of 2.7 t/m^3 was determined for the mineralized pegmatite. This value was used for the calculation of the tonnages from the volumetric estimates of the resource block model.

14.1.5 Geological Interpretation

SGS conducted the interpretation of the 3D wireframe solids of the mineralization based on the drill hole data and surface mapping done by SMSA geologists. For the purpose of modelling, sections (looking northeast) were generated every 50 m, with intermediate sections where necessary to tie in the solids. The modelling was first completed on sections to define mineralized shapes using the lithology and lithium analytical data. A minimum grade of 0.3% Li_2O over a minimum drill hole interval length of 1.5 m was generally used as guideline to define the width of mineralized shapes (refer to Figure 7-4). The final 3D wireframe model (solid) was constructed by linking the defined mineralized shapes based on the geological interpretation.

The linked interpretation shows one pegmatite body, with a strike orientation of 075º azimuth and a dip averaging -50º to the northwest. The pegmatite body was modelled as one envelope with two principal zones on the east and west side of the Piaui Corrego creek that are linked by a thinner zone extrapolated below the river level. A fault following the Piaui river possibly partially split the pegmatite and induced a slight sinistral displacement between the east and west zones. Additional drilling should be conducted to quantify the fault location and impact on the pegmatite location.

The mineralized solids were clipped directly on the DEM surface and the average depth of soil overburden is 2.9 m. Between the soil and the rock there is a semi consolidated saprolite that is quite variable in thickness from 1 to 17 m. Figure 14-3 shows the final 3D wireframe solids in isometric view with the drill holes pierce points.

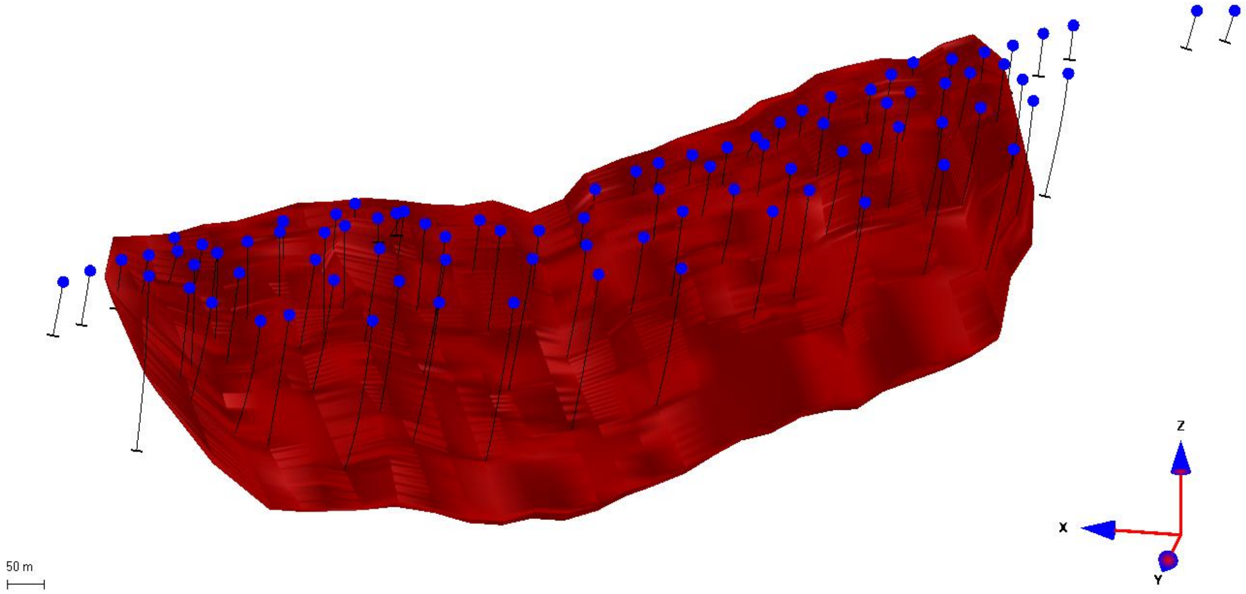


Figure 14-3 - Xuxa Pegmatite Solid (looking southeast)

Note: Figure prepared by SGS, 2019.

14.1.6 Resource Block Modeling

A block size of 5 m by 3 m by 5 m (vertical) was selected for the Xuxa resource block model based on the drill hole spacing and the width and general geometry of mineralization. No rotation was applied to the block model. The 5 m vertical dimension corresponds to the bench height of a potential small open pit mining operation. The 5 m northeast–southwest dimension corresponds to about a tenth of the minimum drill spacing and accounts for the variable geometry of the mineralization in that direction.

The 3 m northwest–southeast block dimension accounts for the minimum width of the mineralization modelled at Xuxa. The resource block model contains 156,706 blocks located inside (> 1%) the mineralized solids, for a total volume of 7,872,275 m^3. Table 14-3 summarizes the block model limit parameters.

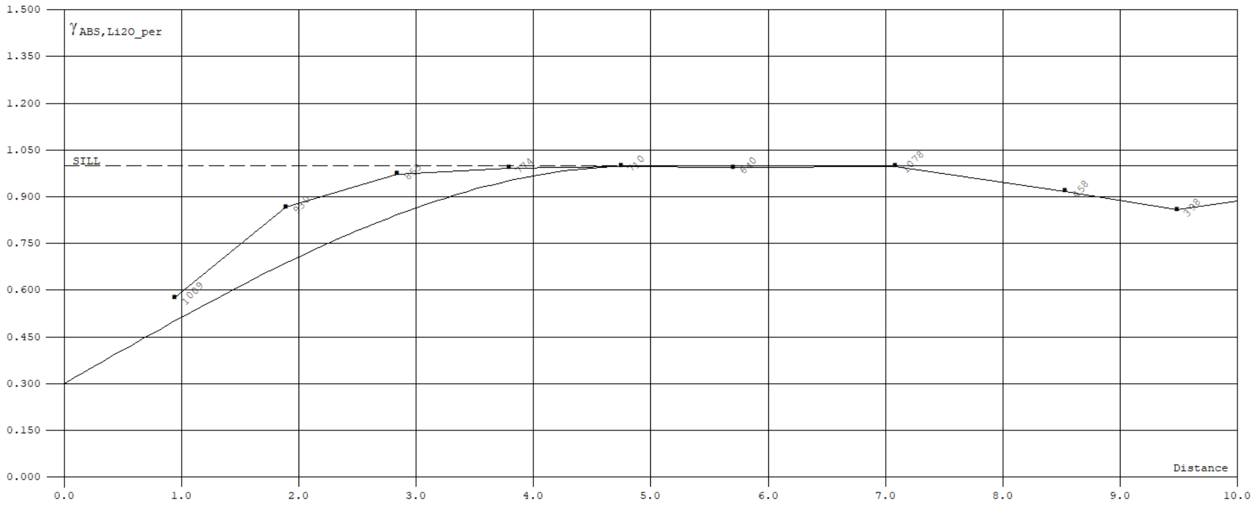
Table 14-3 - Xuxa Resource Block Model Parameters

Direction	Block Size (m)	Number of Blocks	Coordinates (Local Grid) Min (m)	Coordinates (Local Grid) Max (m)
East–west (x)	5	249	189,710	190,950
North–south (y)	3	420	8,145,922	8,147,176
Elevation (z)	5	71	50	350

14.1.7 Variography

In order to determine the continuity and distribution of the Li$_2$O grades, the 1 m composites were submitted to a variographic study. The variographic analysis helped determine the search ellipses criteria and define the kriging parameters for the block interpolation process.

The composites show a normal distribution with a relatively high standard deviation of 0.70 Li_2O%. This prevented the use of a single correlogram model. Instead, two were generated, one for short distances and one for long distances. The short-distance correlogram was computed on untransformed composites. The long-distance correlogram was computed on transformed composites. The transformations involved projection of the composites and rescaling of the Z axis. This was to ensure a constant planar area of composite that could be used to identified long distance thin structure in the mineralized zone. Multiple iterations of variographic analyses were conducted on the transformed composites, each involved different Z axis slicing. The resulting correlogram is shown in Figure 14-4.



```
Variable  : Li2O_per                  Date     : 09-10-2018
Variogram : Absolute                  File     : Variography_XUXA_Combined.gsd

Direction :   General
Azimuth   :      0.00
Dip       :      0.00
Tolerance :    180.00
Lag Dist  :      1.10

Gamma = N(0.3000) + S(0.4850, 40.0/40.0/2.6, 315.0/-50.0/0.0) + S(0.1150, 145.0/145.0/2.6, 315.0/-50.0/0.0)
      + S(0.1000, 145.0/145.0/3.0, 315.0/-50.0/0.0)
```

Figure 14-4 - Xuxa Combined Correlogram

Note: Figure prepared by SGS, 2019.

The transformation process is omnidirectional by nature, so no preferred orientation and dip were identified during the modelling process. However, projection and Z-axis rescaling were done according to the mineralization orientation of 315º azimuth and -50º dip. The long-distance model is therefore optimal in this preferred orientation.

14.1.8 Block Model Interpolation

The grade interpolation for the Xuxa resource block model was completed using ordinary kriging (OK). The interpolation process was conducted using three successive passes with more inclusive search conditions from the first pass to the next until most blocks were interpolated.

Variable search ellipse orientations were used to interpolate the blocks. The general dip of the mineralized pegmatite was modelled on each section and then interpolated in each block. During the interpolation process, the search ellipse was orientated based on the interpolation direction of each block, hence better representing the local dip and orientation of the mineralization.

The first pass was interpolated using a search ellipsoid distance of 75 m (long axis) by 75 m (intermediate axis) and 25 m (short axis) with an orientation of 075º azimuth and -50º dip which represents the general geometry of the pegmatite in the Xuxa deposit. Using search conditions defined by a minimum of seven composites, a maximum of 15 composites and a minimum of three drill holes, 35% of the blocks were estimated. For the second pass, the search distance was twice the search distance of the first pass and composites selection criteria were kept the same as for the first pass. A total of 88% of the blocks were interpolated following the second pass. Finally, the search distance of the third pass was increased to 300 m (long axis) by 300 m (intermediate axis) by 100 m (short axis) with a minimum of seven composites, a maximum of 25 composites and a minimum of three drill holes. The purpose of the last interpolation pass was to interpolate the remaining unestimated blocks mostly located at the edges of the block model, representing 12% of the blocks.

Internal dilution in included in the interpolation process and is estimated by the QP to be at 1% of the overall volume (78,900 m^3). 35,000 m^3 can be calculated from the drill log information but their lateral extension can be variable due to the 50 m drill spacing so 1% is considered reasonable by the QP.

Figure 14-5 illustrates the three search ellipsoids used for the different interpolation passes. Figure 14-6 shows the results of the block model interpolation in longitudinal view.

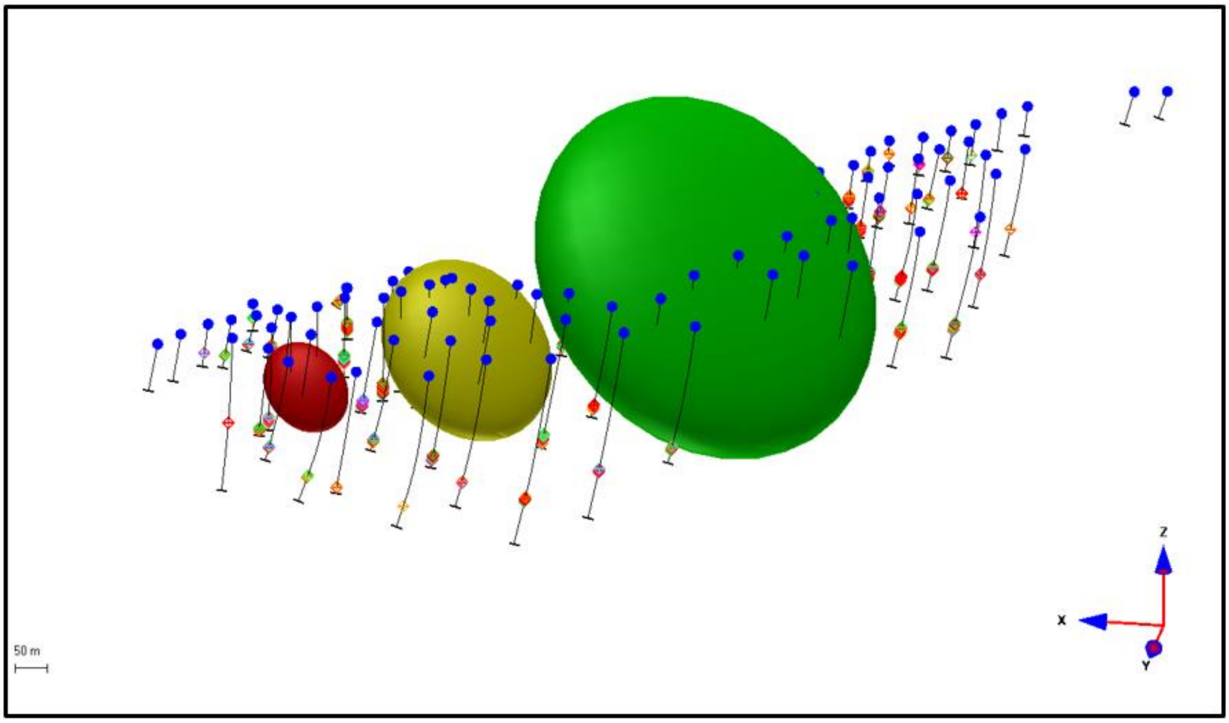


Figure 14-5 - Isometric View of Xuxa Search Ellipsoids

Note: Figure prepared by SGS, 2019.

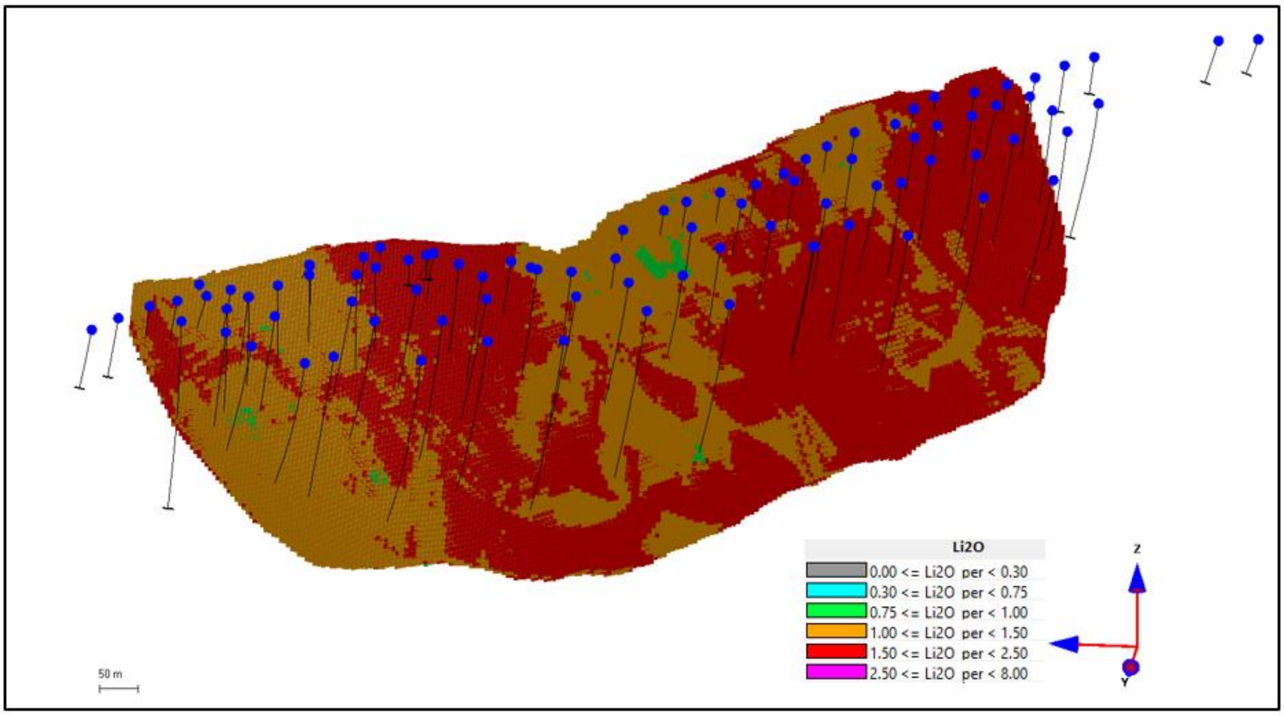
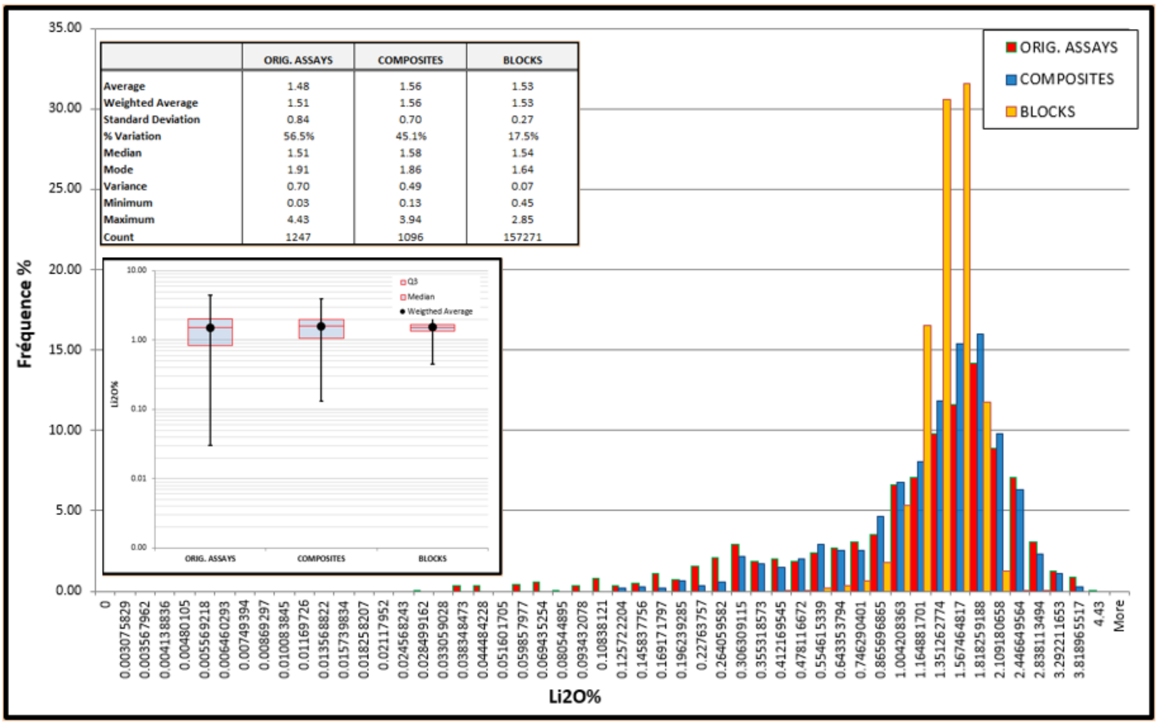


Figure 14-6 - Isometric View of the Xuxa Interpolated Block Model

Note: Figure prepared by SSG, 2019.

14.1.9 Model Validation

To validate the interpolation process, the block model grades were compared statistically to the assay and composite grades. The distribution of the assays, composites and blocks are normal (gaussian) and show similar average values with decreasing levels of variance (Figure 14-7). The assays and composites have average values of 1.48 and 1.56% Li_2O with variances of 0.70 and 0.49% Li_2O. The interpolated blocks have an average value of 1.53% Li_2O with a variance of 0.07% Li_2O.



	ORIG. ASSAYS	COMPOSITES	BLOCKS
Average	1.48	1.56	1.53
Weighted Average	1.51	1.56	1.53
Standard Deviation	0.84	0.70	0.27
% Variation	56.5%	45.1%	17.5%
Median	1.51	1.58	1.54
Mode	1.91	1.86	1.64
Variance	0.70	0.49	0.07
Minimum	0.03	0.13	0.45
Maximum	4.43	3.94	2.85
Count	1247	1096	157271

Figure 14-7 - Statistical Comparison of Xuxa Assay, Composite and Block Data

Note: Figure prepared by SGS, 2019.

Furthermore, the block values were compared to the composite values located inside the interpolated blocks. This enables a test for possible over- or under-estimation of the grade by the search parameters by testing the correlation between the two values. A correlation of determination of 0.55 (R^2) was established between the blocks and the composites (Figure 14-8), which is lower than expected and represents a higher level of smoothing than expected, but it is still considered by the QP to be acceptable for this type of deposit.

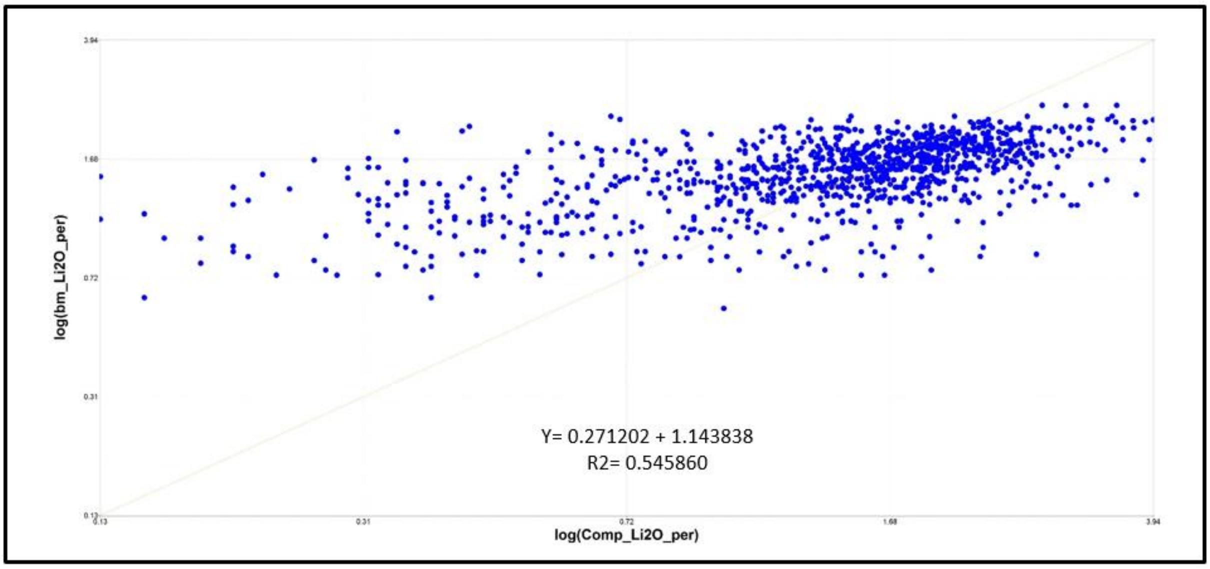


Figure 14-8 - Comparison Xuxa Block Values Versus Composites Inside Blocks

Note: Figure prepared by SGS, 2019.

14.1.10 Mineral Resources Classification

Mineral Resources are classified into Measured, Indicated and Inferred categories. The Mineral Resource classification is based on the density of analytical information, the grade variability and spatial continuity of mineralization. The Mineral Resources were classified in two successive stages: automated classification, followed by manual editing of final classification results.

The first classification stage was conducted by applying an automated classification process which selects around each block a minimum number of composites from a minimum number of holes located within a search ellipsoid of a given size and orientation:

- Measured Mineral Resources: the search ellipsoid used was 50 m (strike) by 50 m (dip) by 25 m with a minimum of seven composites in at least three different drill holes
- Indicated Mineral Resources: the search ellipsoid was twice the size of the Measured category ellipsoid using the same composites selection criteria
- Inferred Mineral Resources: all remaining blocks.

Figure 14-9 is a plan view showing the final classifications. Because the upper section of the deposit is tested by only one drill hole, it was classified as Inferred, as was the lower section of the deposit.

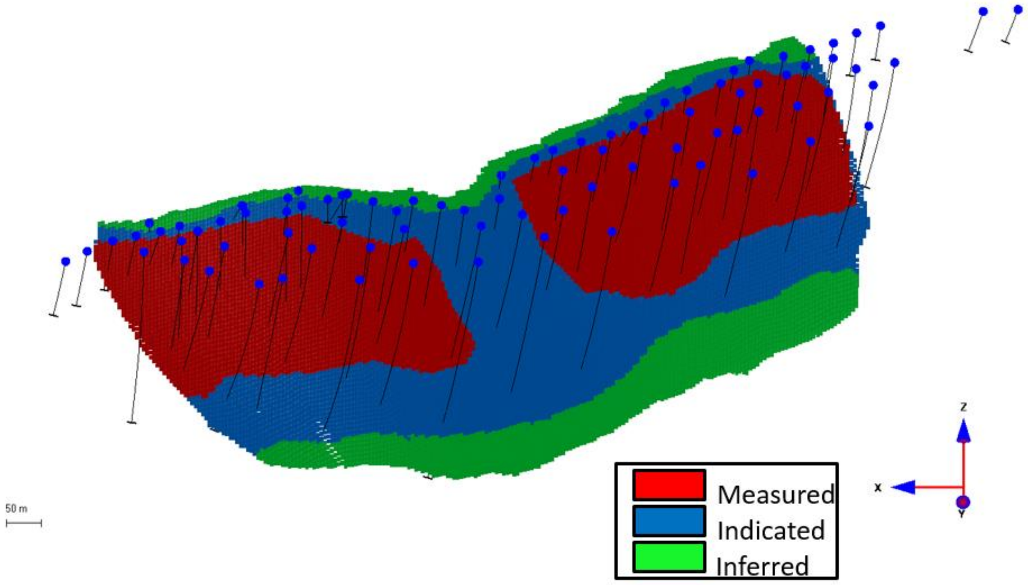


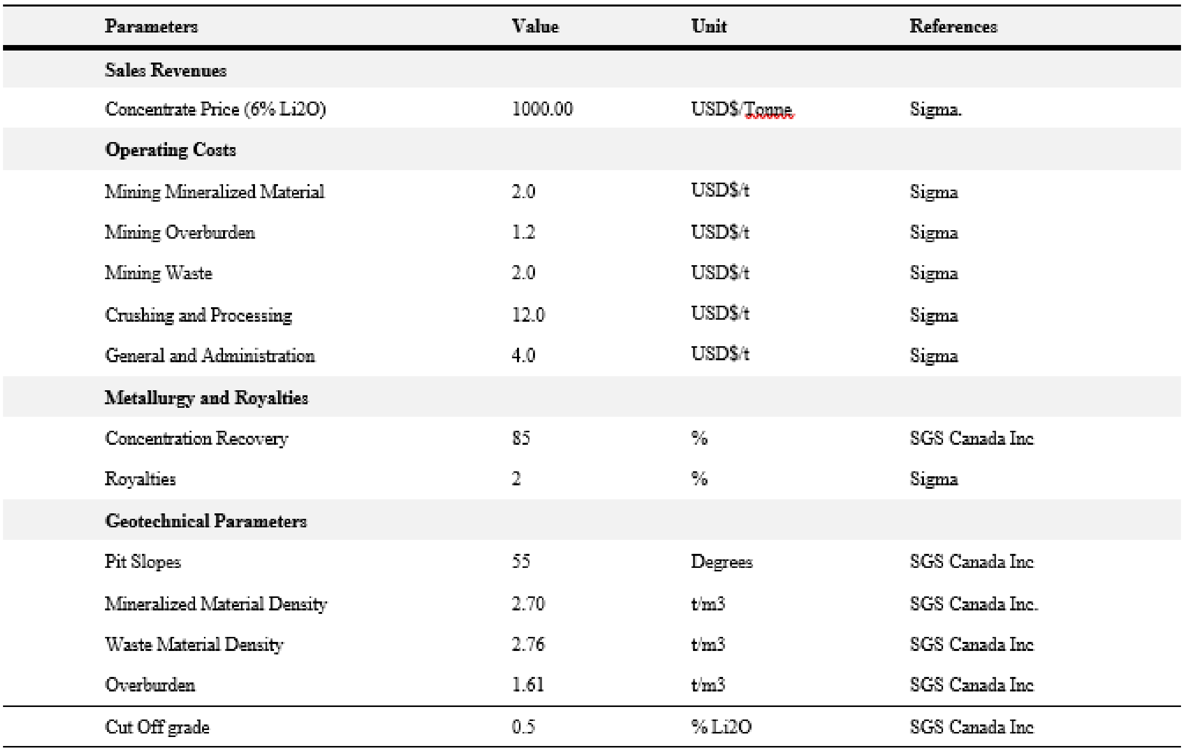
Figure 14-9 - Xuxa Block Model Classification

Note: Figure prepared by SGS, 2019.

14.1.11 Reasonable Prospects of Eventual Economic Extraction

The conceptual economic parameters were used to assess reasonable prospects of eventual economic extraction. A series of economic parameters were estimated to represent the production cost and economic prospectivity of an open pit mining operation in Brazil. They are detailed in Table 14-4 and came either from SGS Canada or SMSA. These parameters are believed to be sufficient to include all block models in future open pit mine planning mostly due to the relatively low mining costs in Brazil.

Table 14-4 - Xuxa Parameters for Reasonable Prospects for Eventual Economic Extraction



Parameters	Value	Unit	References
Sales Revenues			
Concentrate Price (6% Li2O)	1000.00	USD$/Tonne	Sigma.
Operating Costs			
Mining Mineralized Material	2.0	USD$/t	Sigma
Mining Overburden	1.2	USD$/t	Sigma
Mining Waste	2.0	USD$/t	Sigma
Crushing and Processing	12.0	USD$/t	Sigma
General and Administration	4.0	USD$/t	Sigma
Metallurgy and Royalties			
Concentration Recovery	85	%	SGS Canada Inc
Royalties	2	%	Sigma
Geotechnical Parameters			
Pit Slopes	55	Degrees	SGS Canada Inc
Mineralized Material Density	2.70	t/m3	SGS Canada Inc.
Waste Material Density	2.76	t/m3	SGS Canada Inc
Overburden	1.61	t/m3	SGS Canada Inc
Cut Off grade	0.5	% Li2O	SGS Canada Inc

Note: Concentration recovery (flotation test) are based on preliminary results from SGS Lakefield laboratory and may change at the completion of the test. Overburden density was taken from the average value of saprolitic soil as defined by Tan (2003)

14.1.12 Mineral Resource Statement

The Mineral Resource estimate is reported in Table 14-5 using a 0.5% Li_2O cut-off. The Mineral Resources are constrained by the topography and based on the conceptual economic parameters detailed in Table 14-4. The estimate has an effective date of January 10, 2019. The QP for the estimate is Mr. Marc-Antoine Laporte, P.Geo., an SGS employee.

Table 14-5 - Xuxa Deposit Mineral Resource Estimate

Cut-off Grade Li_2O (%)	Category	Tonnage (t)	Average Grade Li_2O (%)
0.5	Measured	10,193,000	1.59
0.5	Indicated	7,221,000	1.49
0.5	**Measured + Indicated**	**17,414,000**	**1.55**
0.5	Inferred	3,802,000	1.58

Notes to accompany Mineral Resource table:

1. Mineral Resources have an effective date of January 10, 2019 and have been classified using the 2014 CIM Definition Standards. The Qualified Person for the estimate is Mr. Marc-Antoine Laporte, P.Geo., an SGS employee.
2. Mineral Resources are reported assuming open pit mining methods, and the following assumptions: lithium concentrate (6% Li_2O) price of US$1,000/t, mining costs of US$2/t for mineralization and waste, US$1.2/t for overburden, crushing and processing costs of US$12/t, general and administrative (G&A) costs of US$4/t, concentrate recovery of 85%, 2% royalty payment, pit slope angles of 55º, and an overall cut-off grade of 0.5% Li_2O.
3. Tonnages and grades have been rounded in accordance with reporting guidelines. Totals may not sum due to rounding.
4. Mineral Resources are reported inclusive of those Mineral Resources converted to Mineral Reserves. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.
5. Long-term Li_2O price of $1,000/tonne assumes processing cost of US$12 and metallurgical recovery of 85%.

Factors that can affect Mineral Resource estimates include but are not limited to:

- Changes to the modelling method or approach
- Changes to geotechnical assumptions, in particular, the pit slope angles
- Metallurgical recovery assumption that are based on preliminary test results
- Changes to any of the social, political, economic, permitting, and environmental assumptions considered when evaluating reasonable prospects for eventual economic extraction
- Internal schist dilution is estimated to 1% (78,900 m^3) but can be variable depending of the lateral extension of the schist zone between the 50m drill spacing
- Mineral Resource estimates can be affected by the market value of lithium and lithium compounds or the modification of the Brazilian taxation regime or environmental policies.

14.2 BARREIRO DEPOSIT

14.2.1 Exploratory Data Analysis

The final database used for the Barreiro pegmatite mineral resource estimation was transmitted to SGS by SMSA on December 13, 2018 in Microsoft® Excel format and Datamine format. The database validation steps are discussed in Section 12. The database comprises 104 drill holes with entries for:

- Down hole surveys (n = 5,917)
- Assays (n = 4,707)
- Lithologies (n = 808).

The database was validated upon importation in Genesis©, which enabled the correction of minor discrepancies between the table entries, surveys, and lithologies.

Vertical sections were generated oriented northwest following the drilling pattern and the general trend of the pegmatite unit. In general, the sections are spaced at 50 m intervals. Figure 14-10 is a drill collar layout plan.

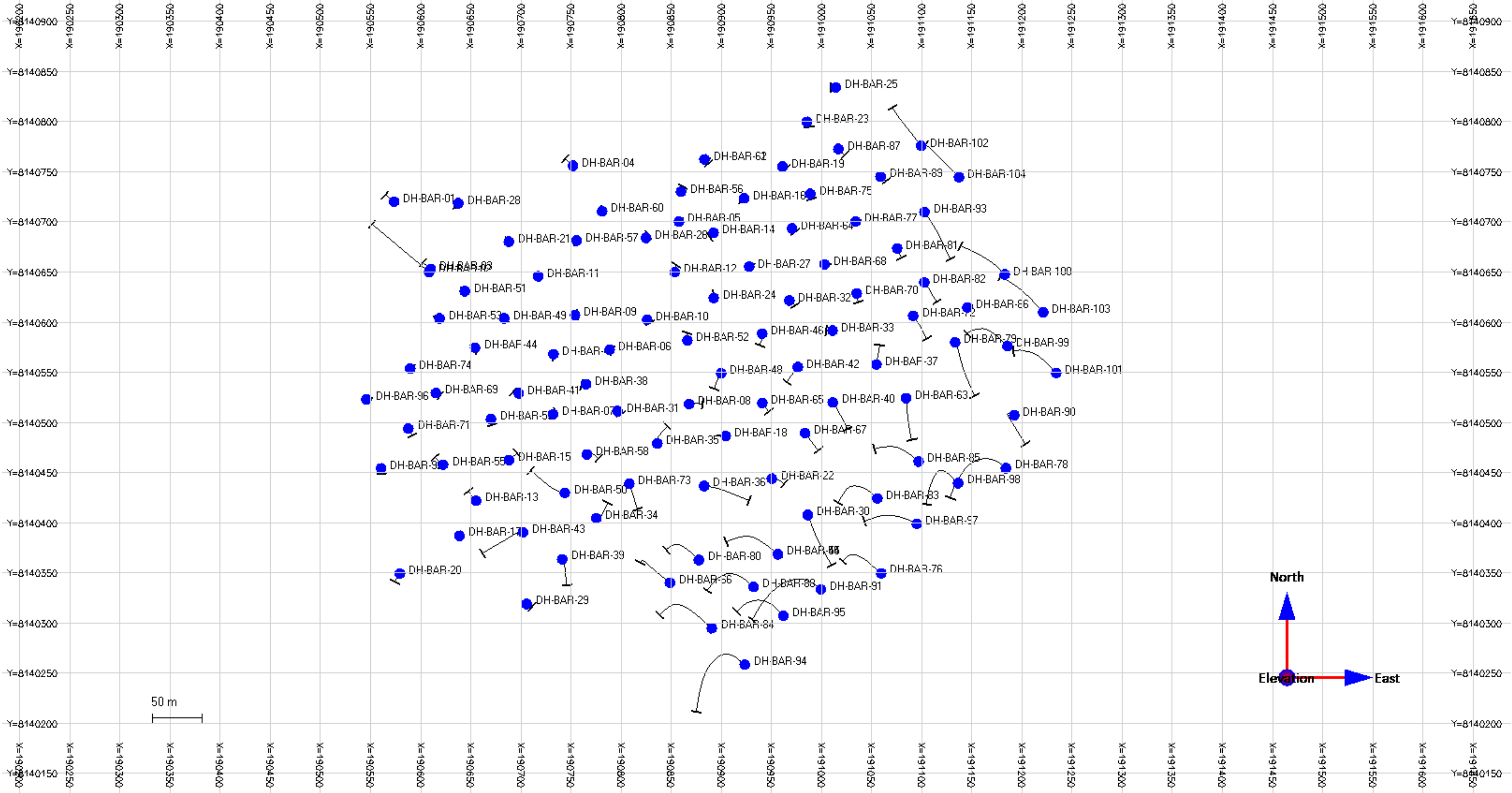


Figure 14-10 - Barreiro Drillhole Collar Locations

Note: Figure prepared by SGS, 2018. Figure north is to top of figure.

The topographic surface that was used by SGS was a 1 m precision DEM (refer to Section 9.2).

14.2.2 Analytical Data

There is a total of 4,707 assay intervals in the database that were used for the Barreiro Mineral Resource estimate; 3,125 assays are contained inside the interpreted mineralized solids. Most of the drill holes defining the mineralized solids have been sampled continuously. Table 14-6 shows the range of Li_2O values from the analytical data inside the mineralized solids.

Table 14-6 - Barreiro Assay Statistics Inside Mineralized Solids

	Li_20 (%)
Count	3.125
Mean	1.42
Std. Dev.	1.04
Min	0.02
Median	1.32
Max	7.62

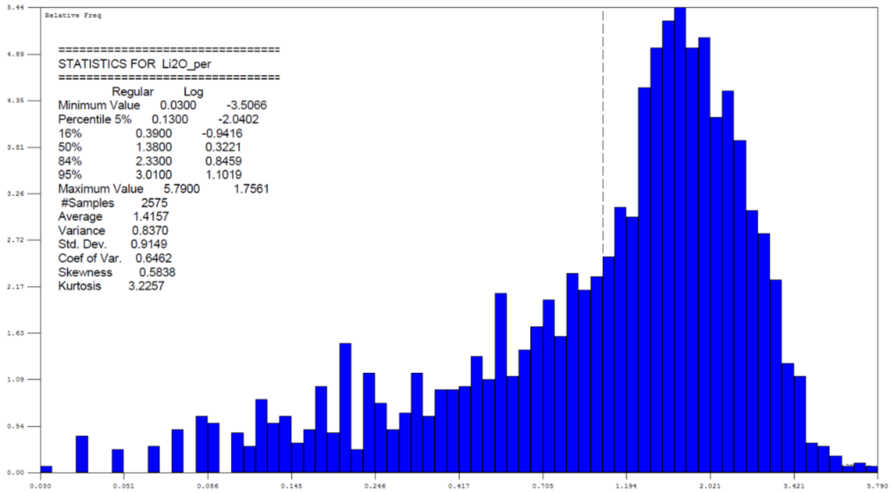
14.2.3 Composite Data

Block model grade interpolation was conducted on composited analytical data. A 1 m composite length was selected based on the north–south width of the 5 m by 5 m by 5 m block size defined for the resource block model. Compositing starts at the bedrock-overburden contact. No capping was applied on the analytical composite data.

Table 14-7 shows the statistics of the analytical composites used for the interpolation of the resource block model. Figure 14-11 shows an example histogram.

Table 14-7 - Barreiro 1 m Composite Statistics

	Li_20 (%)
Count	2,575
Mean	1.42
Std. Dev.	0.91
Min	0.03
Median	1.38
Max	5.79



```
================================
STATISTICS FOR  Li2O_per
================================
              Regular       Log
Minimum Value    0.0300      -3.5066
Percentile 5%    0.1300      -2.0402
16%            0.3900      -0.9416
50%            1.3800       0.3221
84%            2.3300       0.8459
95%            3.0100       1.1019
Maximum Value    5.7900       1.7561
 #Samples       2575
Average        1.4157
Variance       0.8370
Std. Dev.      0.9149
Coef of Var.    0.6462
Skewness        0.5838
Kurtosis       3.2257
```

Figure 14-11 - Barreiro 1 m Composite Histogram

Note: Figure prepared by SGS, 2018.

14.2.4 Density

Density determinations are outlined in Section 11.3. An average density value of 2.71 t/m^3 was determined for the mineralized pegmatite. This value was used for the calculation of the tonnages from the volumetric estimates of the resource block model.

14.2.5 Geological Interpretation

SGS conducted the interpretation of the 3D wireframe solids of the mineralization based on the drill hole data and surface mapping done by SMSA geologists. For the purpose of modelling, sections (looking northeast) were generated every 50 m, with intermediate sections where necessary to tie in the solids. The modelling was first completed on sections to define mineralized shapes using the lithology and lithium analytical data. A minimum grade of 0.3% Li_2O over a minimum drill hole interval length of 1.5m was generally used as guideline to define the width of mineralized shapes. The final 3D wireframe model (solid) was constructed by linking the defined mineralized shapes based on the geological interpretation.

The linked interpretation shows one pegmatite body, with an orientation of azimuth 155° and a dip averaging -35° to the southeast. The pegmatite body was modelled with two envelopes split by a major fault that can be traced on surface. Some drill holes show a possible north–south deformation zone that also affects the deposit and possibly connects the two zones (either totally or partially). This interpretation will require additional drill testing.

The mineralized solids were clipped directly on the DEM surface and the average depth of soil overburden is 3.15 m. Between the soil and the rock there is a semi-consolidated saprolite intersected in a few holes that is quite variable in thickness from 1 m to 3 m. Figure 14-12 shows the 3D wireframe solids of the Xuxa pegmatite in isometric view with the drill hole pierce points.

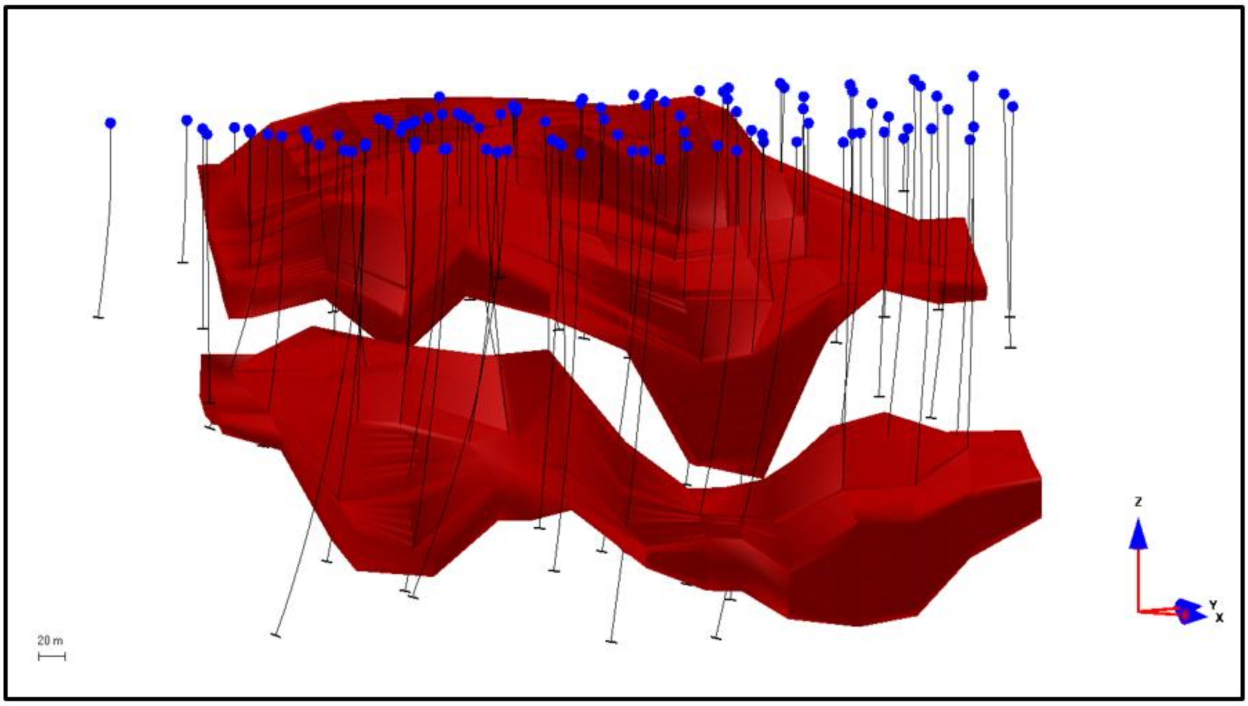


Figure 14-12 - Sectional Interpretation of the Barreiro Pegmatite Unit (looking north)

Note: Figure prepared by SGS, 2018.

14.2.6 Resource Block Modelling

A block size of 5 m (northeast–southwest) by 5 m (northwest–southeast) by 5 m (vertical) was selected for the Barreiro resource block model based on drill hole spacing and width and general geometry of mineralization. No rotation is applied to the block model. The 5 m vertical dimension corresponds to the bench height of a potential small open pit mining operation. The 5 m northeast–southwest dimension corresponds to about a tenth of the minimum drill spacing and accounts for the variable geometry of the mineralization in that direction. The 5 m northwest–southeast block dimension accounts for the minimum width of the mineralization modelled at Barreiro. The resource block model contains 89,259 blocks located inside the mineralized solids, for a total volume of 8,605,468 m^3. Table 14-8 summarizes the block model limit parameters.

Table 14-8 - Barreiro Resource Block Model Parameters

Direction	Block Size (m)	Number of Blocks	Coordinates (Local Grid) Min (m)	Coordinates (Local Grid) Max (m)
East–west (x)	5	171	190,450	191,300
North–south (y)	5	141	8,140,150	8,140,850
Elevation (z)	5	91	-100	350

14.2.7 Variography

In order to determine the continuity and distribution of the Li_2O grades, the 1 m composites were submitted to a variographic study. The variographic analysis helped determine the search ellipses criteria and define the kriging parameters for the block interpolation process.

The composites show a normal distribution with a relatively high standard deviation of 0.91 Li_2O%. This prevented the use of a single correlogram model. Instead, two were generated, one for short distances and one for long distances. The short-distance correlogram was computed on untransformed composites. The long-distance correlogram was computed on transformed composites. The transformations involved projection of the composites and rescaling of the Z axis. This was to ensure a constant planar area of composite that could be used to identified long distance thin structure in the mineralized zone. Multiple iterations of variographic analyses were conducted on the transformed composites, each involved different Z axis slicing. The resulting correlogram is shown as Figure 14-13.

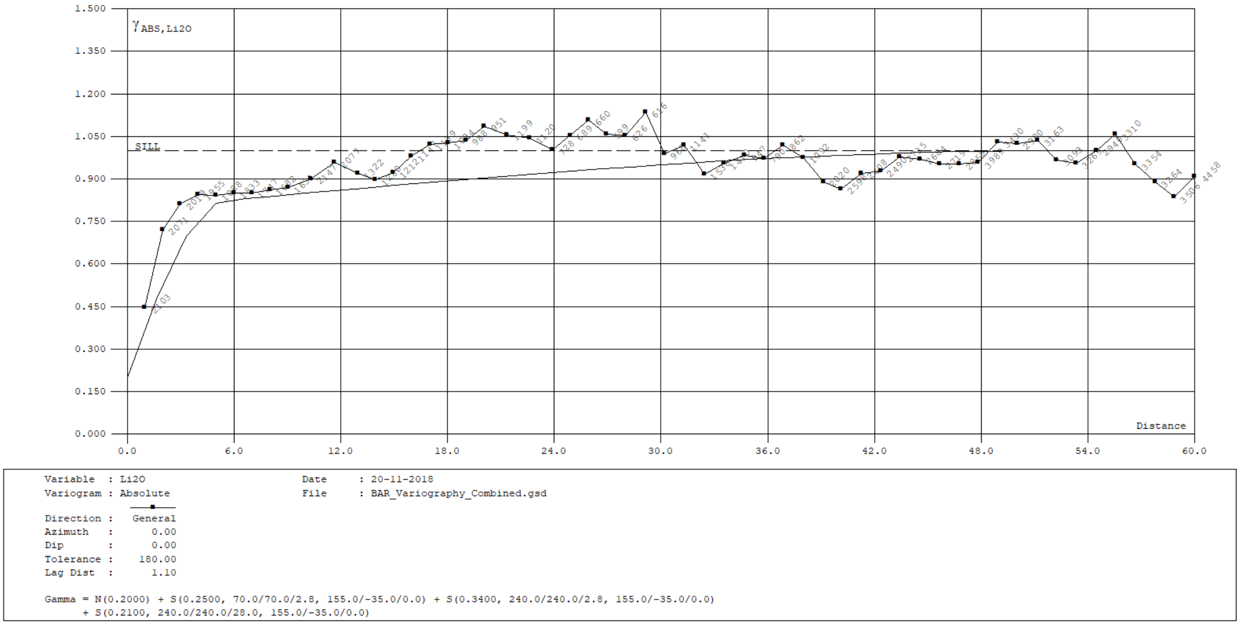


Figure 14-13 - Barreiro Combined Correlogram

Note: Figure prepared by SGS, 2018.

The transformation process is omnidirectional by nature, so no preferred orientation and dip were identified during the modelling process. However, projection and Z-axis rescaling were done according to the mineralization orientation of 155º of azimuth and -35º dip. The long-distance model is therefore optimal in this preferred orientation.

14.2.8 Block Model Interpolation

The grade interpolation for the Barreiro resource block model was completed using OK. The interpolation process was conducted using three successive passes with more inclusive search conditions from the first pass to the next until most blocks were interpolated.

Variable search ellipse orientations were used to interpolate the blocks. The general dip of the mineralized pegmatite was modelled on each section and then interpolated in each block. During the interpolation process, the search ellipse was orientated following the interpolation direction of each block, hence better representing the dip and orientation of the mineralization.

The first pass was interpolated using a search ellipsoid distance of 55 m (long axis) by 55 m (intermediate axis) and 25 m (short axis) with an orientation of 155° azimuth, and -35° dip to the southeast which represents the general geometry of the pegmatites in the deposit. Using search conditions defined by a minimum of seven composites, a maximum of 15 composites and a minimum of three holes, 62% of the blocks were estimated. For the second pass, the search distance was twice the search distance of the first pass and composites selection criteria were kept the same as for the first pass. A total of 95% of the blocks were interpolated following the second pass. Finally, the search distance of the third pass was increased to 250 m (long axis) by 250 m (intermediate axis) by 100 m (short axis) with a minimum of seven composites, a maximum of 25 composites and no minimum number of drill holes. The purpose of the last interpolation pass was to interpolate the remaining unestimated blocks mostly located at the edges of the block model, representing 5% of the blocks.

Figure 14-14 illustrates the three search ellipsoids used for the different interpolation passes. Figure 14-15 show the results of the block model interpolation in longitudinal view.

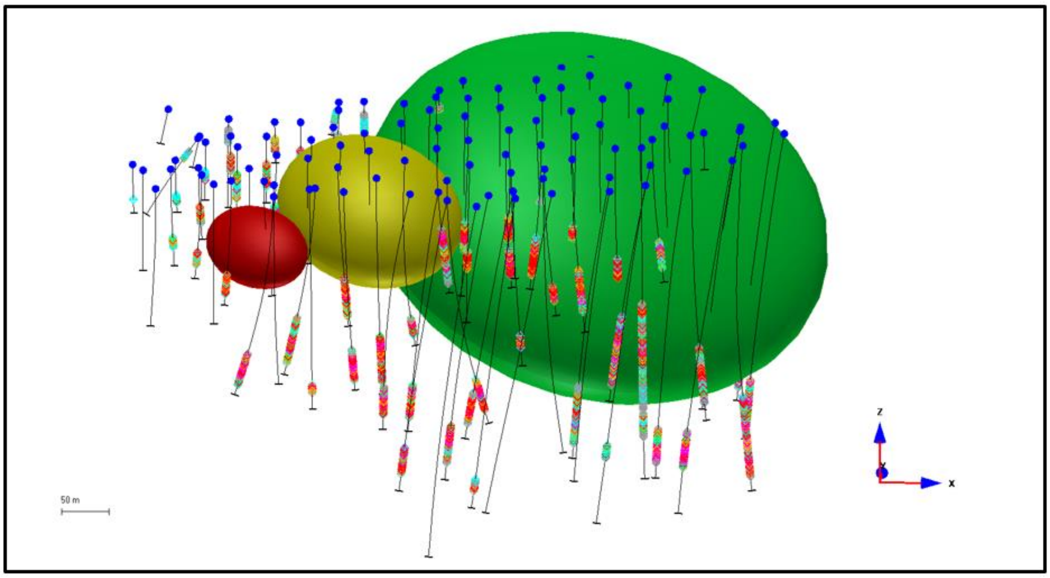


Figure 14-14 - Isometric View of Barreiro Search Ellipses

Note: Figure prepared by SGS, 2018.

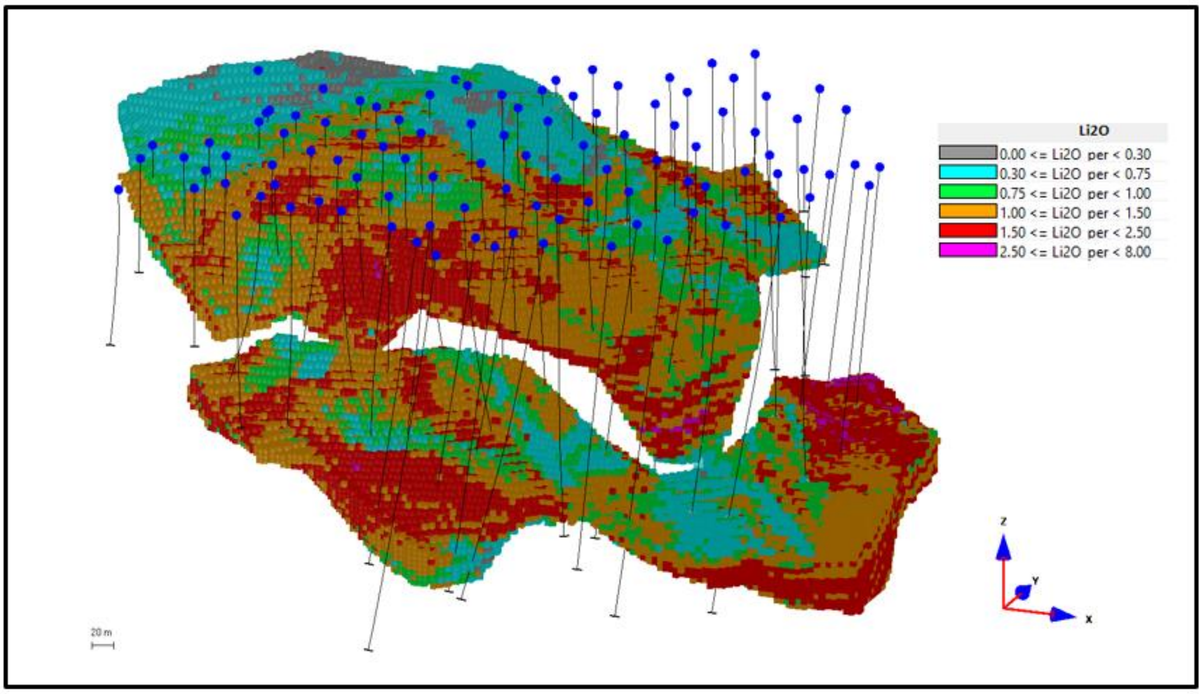
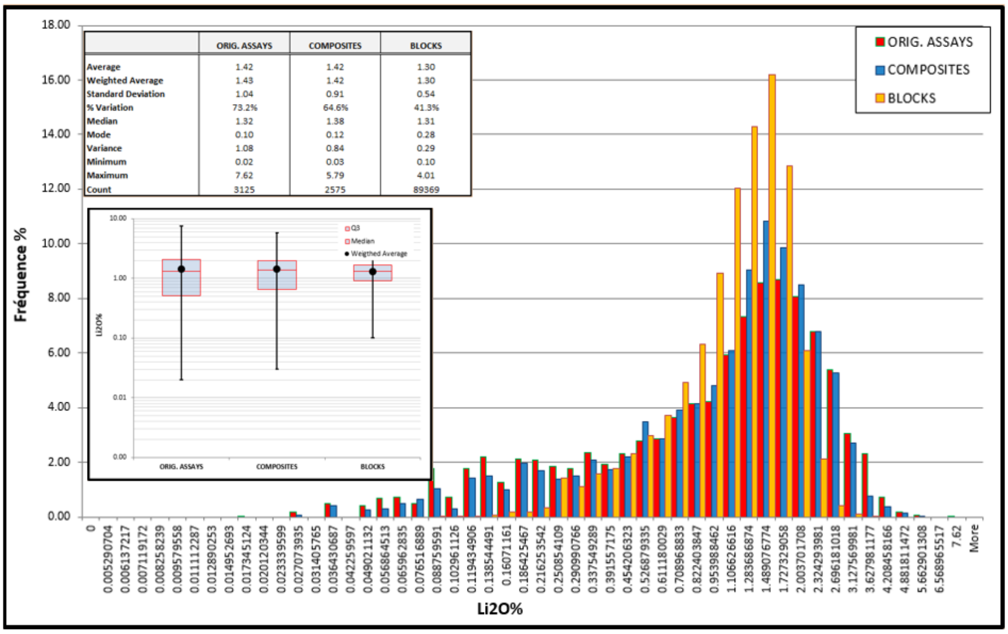


Figure 14-15 - Isometric View of the Barreiro Interpolated Block Model

Note: Figure prepared by SGS, 2018. Legend shows Li_2O grades as greater than the first number, and less than the second in each colour range.

14.2.9 Model Validation

In order to validate the interpolation process, the block model grades were compared statistically to the assay and composite grades. The distribution of the assays, composites and blocks are normal (gaussian) and show similar average values with decreasing levels of variance (Figure 14-16).



	ORIG. ASSAYS	COMPOSITES	BLOCKS
Average	1.42	1.42	1.30
Weighted Average	1.43	1.42	1.30
Standard Deviation	1.04	0.91	0.54
% Variation	73.2%	64.6%	41.3%
Median	1.32	1.38	1.31
Mode	0.10	0.12	0.28
Variance	1.08	0.84	0.29
Minimum	0.02	0.03	0.10
Maximum	7.62	5.79	4.01
Count	3125	2575	89369

Figure 14-16 - Statistical Comparison of Barreiro Assay, Composite and Block Data

Note: Figure prepared by SGS, 2018.

The assays and composites have average values of 1.42% and 1.42% Li_2O respectively with variances of 1.08 and 0.84% Li_2O. The interpolated blocks have an average value of 1.30% Li_2O with a variance of 0.29% Li_2O.

Furthermore, the block values were compared to the composite values located inside the interpolated blocks. This enables to test for possible over- or under-estimation of the grade by the search parameters by testing the local correlation between the two values. A correlation of determination of 0.66 (R2) was established between the blocks and the composites (Figure 14-17) which is typical and considered acceptable for this type of deposit.

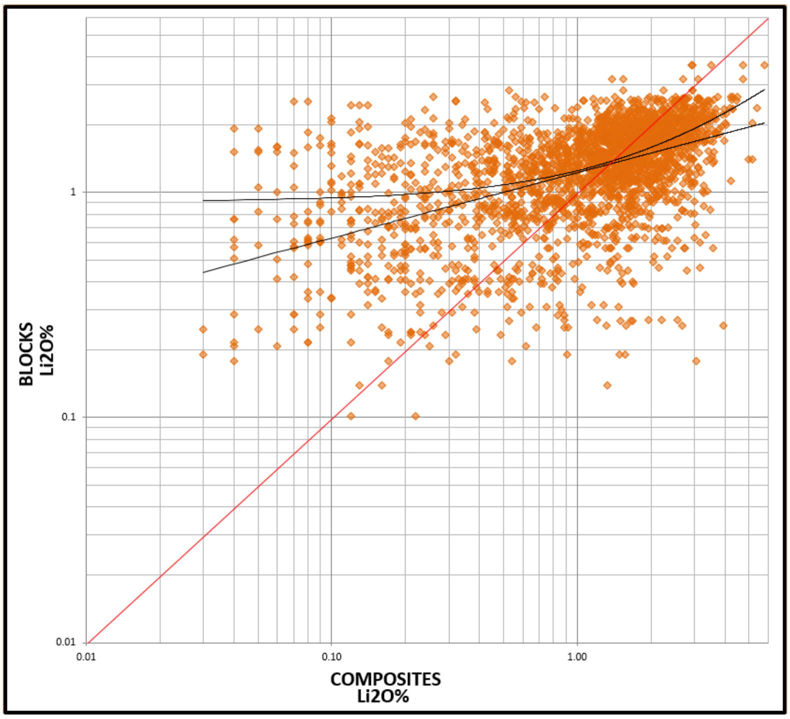


Figure 14-17 - Barreiro Block Values Versus Composites Inside Those Blocks

Note: Figure prepared by SGS, 2018.

14.2.10 Mineral Resources Classification

Mineral Resources are classified into Measured, Indicated and Inferred categories. The Mineral Resource classification is based on the density of analytical information and the grade variability and spatial continuity of mineralization. The Mineral Resources were classified in two successive stages: automated classification, followed by manual editing of final classification results.

The first classification stage was conducted by applying an automated classification process which selects around each block a minimum number of composites from a minimum number of holes located within a search ellipsoid of a given size and orientation:

- Measured Mineral Resources: the search ellipsoid was 55 m (strike) by 55 m (dip) by 35 m with a minimum of five composites in at least three different drill holes;
- Indicated Mineral Resources: the search ellipsoid was twice the size of the Measured category ellipsoid using the same composites selection criteria;
- Inferred Mineral Resources: all remaining blocks.

Figure 14-18 is a plan view showing the final classifications.

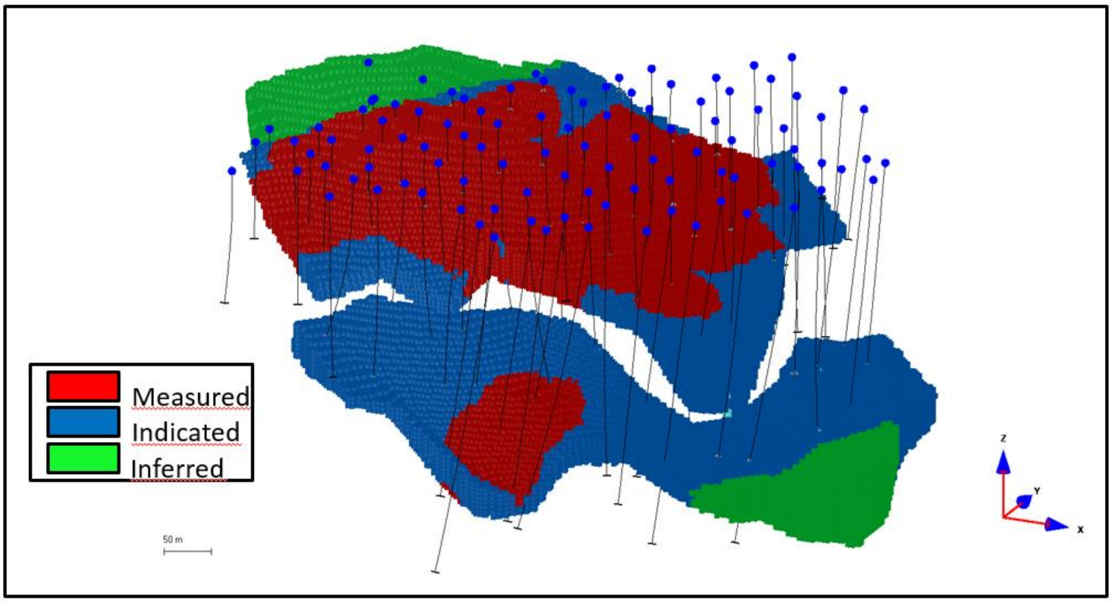


Figure 14-18 - Barreiro Block Model Classification

Note: Figure prepared by SGS, 2018.

14.2.11 Reasonable Prospects of Eventual Economic Extraction

The conceptual economic parameters were used to assess reasonable prospects of eventual economic extraction. A series of economic parameters were estimated to represent the production cost and economic prospectivity of an open pit mining operation in Brazil. They are detailed in Table 14-9 and came either from SGS Canada or SMSA. These parameters are believed to be sufficient to include all block models in future open pit mine planning mostly due to the relatively low mining costs in Brazil but need to be confirmed.

Table 14-9 - Barreiro Parameters for Reasonable Prospects of Eventual Economic Extraction

Parameters	Value	Unit	References
Sales Revenues			
Concentrate Price (6% Li2O)	1000.00	USD$/Tonne	Sigma.
Operating Costs			
Mining Mineralized Material	2.0	USD$/t	Sigma
Mining Overburden	1.2	USD$/t	Sigma
Mining Waste	2.0	USD$/t	Sigma
Crushing and Processing	12.0	USD$/t	Sigma
General and Administration	4.0	USD$/t	Sigma
Metallurgy and Royalties			
Concentration Recovery	85	%	SGS Canada Inc
Royalties	2	%	Sigma
Geotechnical Parameters			
Pit Slopes	55	Degrees	SGS Canada Inc
Mineralized Material Density	2.71	t/m3	SGS Canada Inc.
Waste Material Density	2.76	t/m3	SGS Canada Inc
Overburden	1.61	t/m3	SGS Canada Inc
Cut Off grade	0.5	% Li2O	SGS Canada Inc

Note: Concentration recovery (flotation test) are based on preliminary results from SGS Lakefield laboratory and may change at the completion of the test. Overburden density was taken from the average value of saprolitic soil as defined by Tan (2003).

14.2.12 Mineral Resource Statement

The Mineral Resource estimate is reported in Table 14-10 using a 0.5% Li_2O cut-off. The Mineral Resources are constrained by the topography and based on the conceptual economic parameters detailed in Table 14-10. The estimate has an effective date of January 10, 2019. The QP for the estimate is Mr Marc-Antoine Laporte, P.Geo., an SGS employee.

Table 14-10 - Barreiro Deposit Mineral Resource Estimate

Cut-off Grade Li_2O (%)	Category	Tonnage (t)	Average Grade Li_2O (%)
0.5	Measured	10,313,000	1.4
0.5	Indicated	10,172,000	1.46
0.5	**Measured + Indicated**	**20,485,000**	**1.43**
0.5	Inferred	1,909,000	1.44

Notes to accompany Mineral Resource table:

1. Mineral Resources have an effective date of January 10, 2019 and have been classified using the 2014 CIM Definition Standards. The Qualified Person for the estimate is Mr Marc-Antoine Laporte, P.Geo., an SGS employee.
2. Mineral Resources are reported assuming open pit mining methods, and the following assumptions: lithium concentrate (6% Li_2O) price of US$1,000/t, mining costs of US$2/t for mineralization and waste, US$1.2/t for overburden, crushing and processing costs of US$12/t, general and administrative (G&A) costs of US$4/t, concentrate recovery of 85%, 2% royalty payment, pit slope angles of 55º, and an overall cut-off grade of 0.5% Li_2O.
3. Tonnages and grades have been rounded in accordance with reporting guidelines. Totals may not sum due to rounding.
4. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.
5. Long-term Li_2O price of $1,000/tonne assumes processing cost of US$12 and metallurgical recovery of 85%.

Factors that can affect Mineral Resource estimates include but are not limited to:

- Changes to the modelling method or approach
- Changes to geotechnical assumptions, in particular, the pit slope angles
- Metallurgical recovery assumption that are based on preliminary test results
- Changes to any of the social, political, economic, permitting, and environmental assumptions considered when evaluating reasonable prospects for eventual economic extraction
- Mineral Resource estimates can also be affected by the market value of lithium and lithium compounds.

14.3 MURIAL DEPOSIT

14.3.1 Exploratory Data Analysis

The final database used for the Murial pegmatite Mineral Resource estimation was transmitted to SGS by SMSA on December 13, 2018 in Microsoft® Excel format and Datamine format. The database validation steps are discussed in Section 12. The database comprised 34 drill holes with entries for:

- Down hole surveys (n = 2,002)
- Assays (n = 1,750)
- Lithologies (n = 327).

The database was validated upon importation in Genesis©, which enabled the correction of minor discrepancies between the table entries, surveys, and lithologies.

Vertical sections were generated oriented east-west following the drilling pattern and the general trend of the pegmatite unit. In general, the sections are spaced at 50 m intervals. Figure 14-19 is a drill collar location plan.

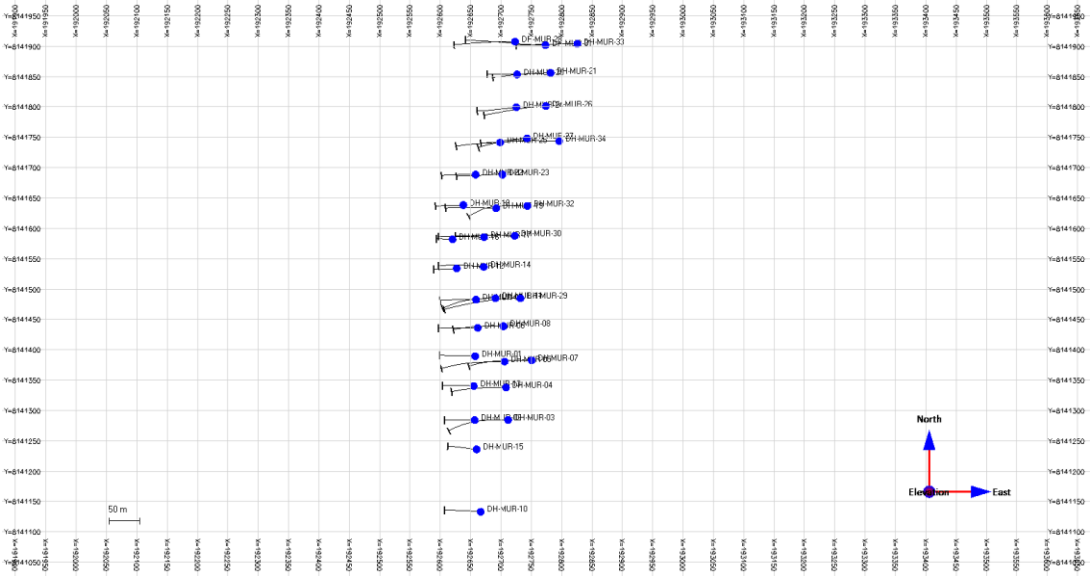


Figure 14-19 - Murial Drill Hole Collar Locations

Note: Figure prepared by SGS, 2018. Figure north is to top of figure.

The topographic surface that was used by SGS was a 1 m precision DEM (refer to Section 9.2).

14.3.2 Analytical Data

There is a total of 1,750 assay intervals in the database used for mineral resource estimation; 728 assays are contained inside the mineralized solids. Most of the drill hole intervals defining the mineralized solids have been sampled continuously. Table 14-11 shows the range of Li_2O values from the analytical data.

Table 14-11 - Murial Assay Statistics Inside Mineralized Solids

	Li_2O (%)
Count	728
Mean	1.17
Std. Dev.	0.82
Min	0.02
Median	1.16
Max	4.28

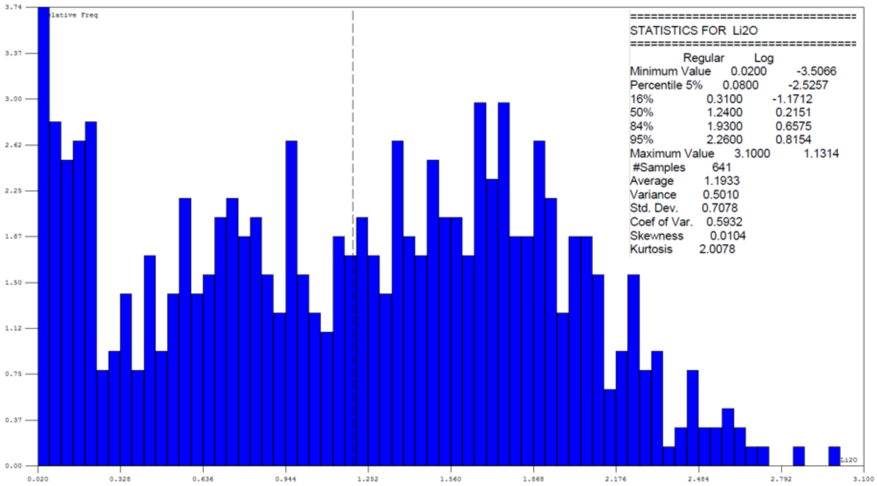
14.3.3 Composite Data

Block model grade interpolation was conducted on composited analytical data. A 1 m composite length was selected based on the north–south width of the 5 m by 3 m by 5 m block size defined for the resource block model. Compositing starts at the bedrock-overburden contact. No capping was applied on the analytical composite data.

Table 14-12 shows the statistics of the analytical composites used for the interpolation of the resource block model. Figure 14-20 shows an example histogram.

Table 14-12 - Murial 1 m Composite Statistics

	Li_2O (%)
Count	641
Mean	1.19
Std. Dev.	0.71
Min	0.02
Median	1.24
Max	3.10



```
==================================
STATISTICS FOR  Li2O
==================================
              Regular       Log
Minimum Value      0.0200        -3.5066
Percentile 5%      0.0800        -2.5257
16%              0.3100        -1.1712
50%              1.2400         0.2151
84%              1.9300         0.6575
95%              2.2600         0.8154
Maximum Value      3.1000         1.1314
 #Samples       641
Average        1.1933
Variance       0.5010
Std. Dev.      0.7078
Coef of Var.    0.5932
Skewness        0.0104
Kurtosis       2.0078
```

Figure 14-20 - Murial 1 m Composite Histogram

Note: Figure prepared by SGS, 2018.

14.3.4 Density

Density determinations are outlined in Section 11.3. An average density value of 2.69 t/m^3 was determined for the mineralized pegmatite. This value was used for the calculation of the tonnages from the volumetric estimates of the resource block model.

14.3.5 Geological Interpretation

SGS conducted the interpretation of the 3D wireframe solids of the mineralization based on the drill hole data and surface mapping done by SMSA geologists. For the purpose of modelling, sections (looking north) were generated every 50 m, with intermediate section where necessary to tie in the solids. The modelling was first completed on sections to define mineralized shapes using the lithology and lithium analytical data. A minimum grade of 0.3% Li_2O over a minimum drill hole interval length of 1.5 m was generally used as guideline to define the width of mineralized shapes. The final 3D wireframe model (solid) was constructed by linking the defined mineralized shapes based on the geological interpretation (refer to Figure 7-8).

The linked interpretation shows one pegmatite body, with an orientation of 95º and a dip averaging -80º to the west. The pegmatite body was modelled with one envelope that starts sub-vertical on the west side and flattens to around 35º dip on the eastern side, probably due to local folding. Additional drilling will be required to support the model interpretation.

The mineralized solids were clipped directly on the DEM surface and the average depth of soil overburden thickness is about 4 m. No saprolite zone was logged by Sigma geologists. Figure 14-21 shows the final 3D wireframe solids in isometric view with the drill hole pierce points.

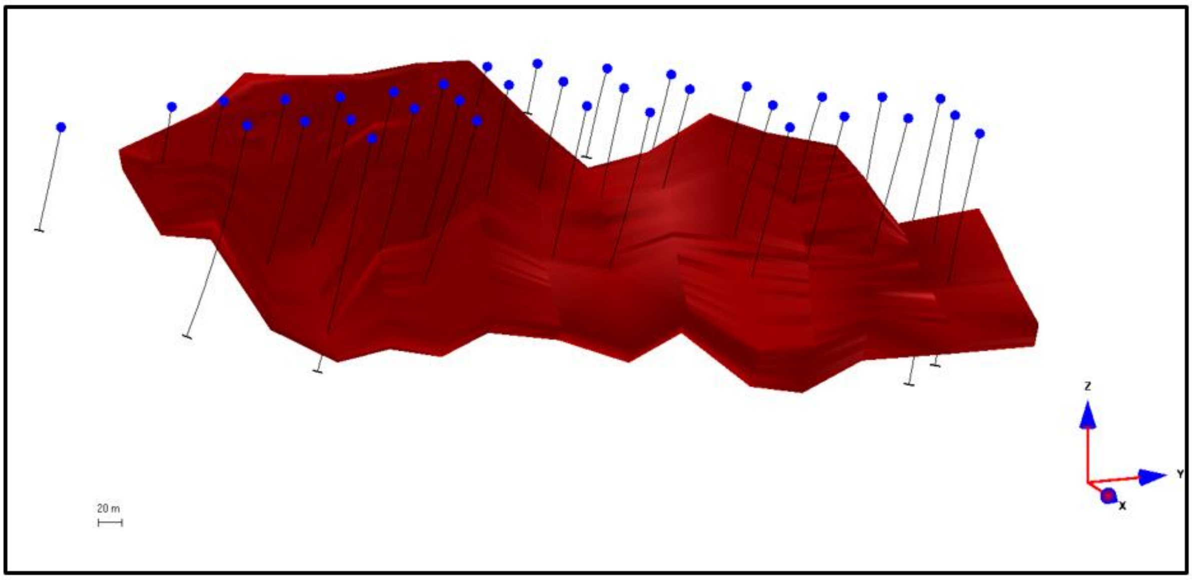


Figure 14-21 - Murial Pegmatite Solid (looking west)

Note: Figure prepared by SGS, 2018.

14.3.6 Resource Block Modeling

A block size of 5 m by 3 m by 5 m (vertical) was selected for the Murial resource block model based on drill hole spacing and the width and general geometry of mineralization. No rotation was applied to the block model. The 5 m vertical dimension corresponds to the bench height of a potential small open pit mining operation. The 5 m northeast–southwest dimension corresponds to about a tenth of the minimum drill spacing and accounts for the variable geometry of the mineralization in that direction. The 3 m northwest–southeast block dimension accounts for the average minimum width of the mineralization modelled at Murial. The resource block model contains 47,117 blocks located inside the mineralized solids, for a total volume of 2,633,891 m^3. Table 14-13 summarizes the block model limit parameters.

Table 14-13 - Murial Resource Block Model Parameters

Direction	Block Size (m)	Number of Blocks	Coordinates (Local Grid) Min (m)	Coordinates (Local Grid) Max (m)
East–west (x)	5	63	192,518	192,828
North–south (y)	3	282	8,141,157	8,142,000
Elevation (z)	5	61	61	431

14.3.7 Block Model Interpolation

The grade interpolation for the Murial resource block model was completed using an inverse distance weighting to the second power (ID2) methodology. The inverse squared distance weighting method assigns a grade to each block in the block model, without the necessity of a sample being within the block volume. With the ID2 method, the grade, thickness or any other value for the sample is adjusted by the inverse of the distance to the sample, squared. All adjusted sample weights are summed, then divided by the sum of the inverse distances. Closer samples are given greater weight than samples farther away.

The interpolation process was conducted using three successive passes with more inclusive search conditions from the first pass to the next until most blocks were interpolated.

Variable search ellipse orientations were used to interpolate the blocks. The general dip of the mineralized pegmatite was modelled on each section and then interpolated in each block. During the interpolation process, the search ellipse was orientated based on the interpolation direction of each block, hence better representing the local dip and orientation of the mineralization.

The first pass was interpolated using a search ellipsoid distance of 75 m (long axis) by 75 m (intermediate axis) and 35 m (short axis) with an orientation of 95° azimuth and -80° dip to the east which represents the general geometry of the pegmatites in the deposit. Using search conditions defined by a minimum of seven composites, a maximum of 15 composites and a minimum of three drill holes, 53% of the blocks were estimated. For the second pass, the search distance was twice the search distance of the first pass and composites selection criteria were kept the same as for the first pass. A total of 82% of the blocks were interpolated following the second pass.

Finally, the search distance of the third pass was increased to 200 m (long axis) by 200 m (intermediate axis) by 100 m (short axis) with a minimum of seven composites, a maximum of 20 composites and no minimum number of drill holes. The purpose of the last interpolation pass was to interpolate the remaining unestimated blocks mostly located at the edges of the block model, representing 18% of the blocks.

Figure 14-22 illustrates the three search ellipsoids used for the different interpolation passes.

Figure 14-23 show the results of the block model interpolation in longitudinal view.

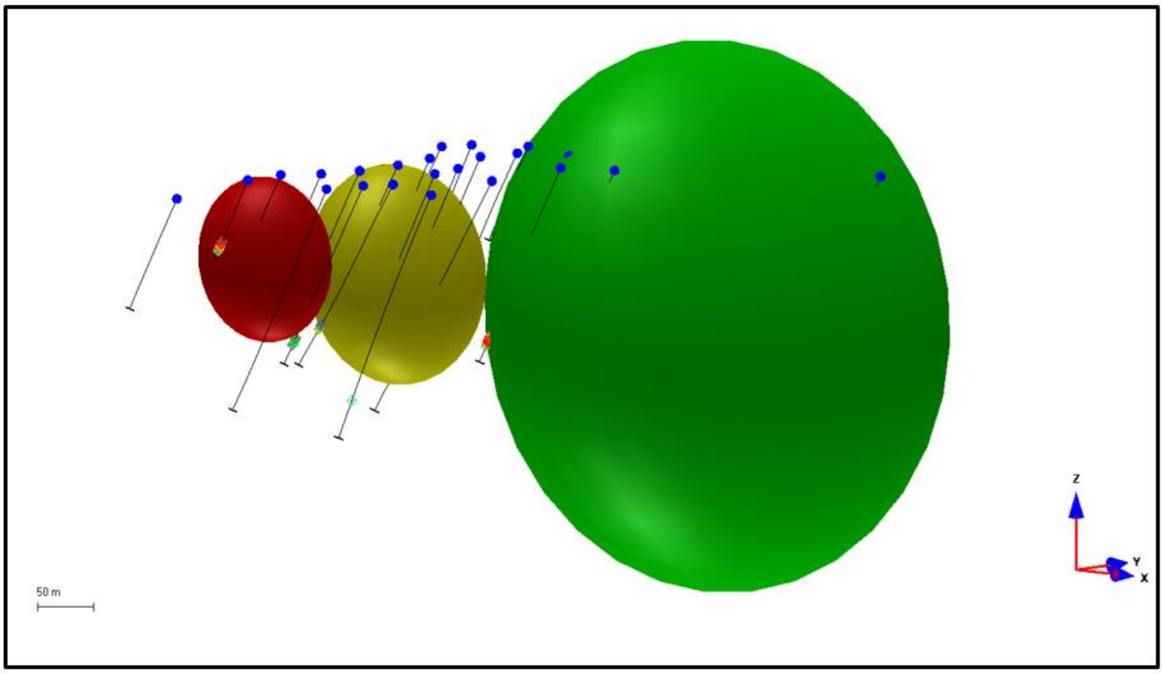


Figure 14-22 - Isometric View of Murial Search Ellipsoids

Note: Figure prepared by SGS, 2018.

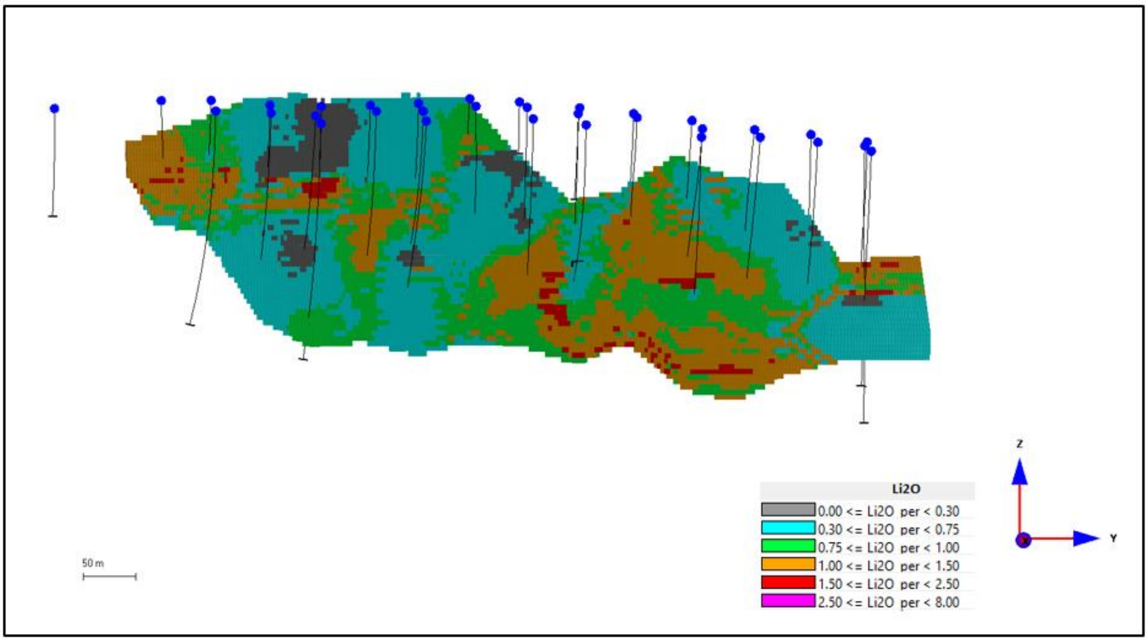
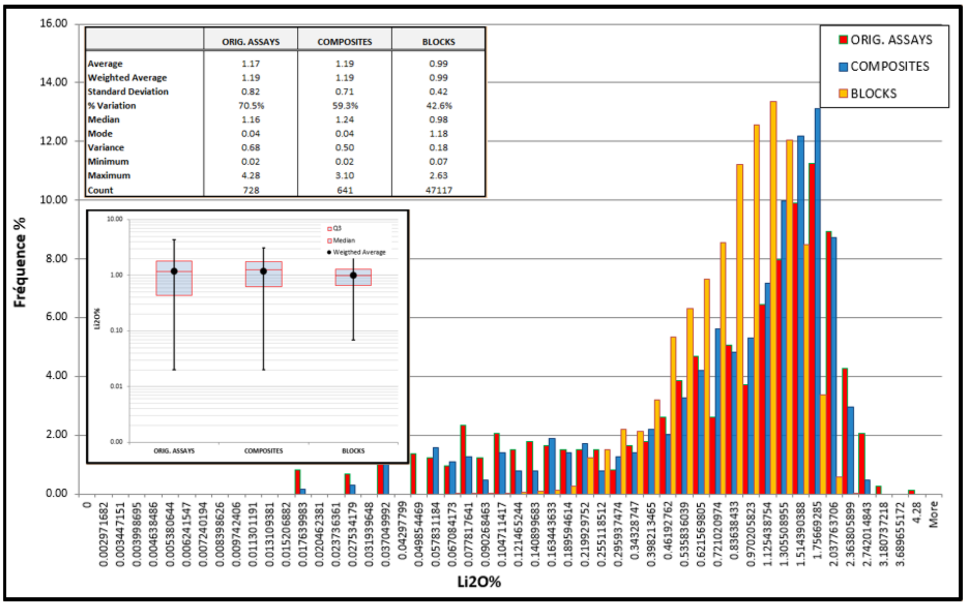


Figure 14-23 - Isometric View of Murial Interpolated Block Model

Note: Figure prepared by SGS, 2018.

14.3.8 Model Validation

In order to validate the interpolation process, the block model grades were compared statistically to the assay and composite grades. The distribution of the assays, composites and blocks are normal (gaussian) and show similar average values with decreasing levels of variance (Figure 14-24).



	ORIG. ASSAYS	COMPOSITES	BLOCKS
Average	1.17	1.19	0.99
Weighted Average	1.19	1.19	0.99
Standard Deviation	0.82	0.71	0.42
% Variation	70.5%	59.3%	42.6%
Median	1.16	1.24	0.98
Mode	0.04	0.04	1.18
Variance	0.68	0.50	0.18
Minimum	0.02	0.02	0.07
Maximum	4.28	3.10	2.63
Count	728	641	47117

Figure 14-24 - Statistical Comparison of Murial Assay, Composite and Block Data

Note: Figure prepared by SGS, 2018.

The assays and composites have average values of 1.17 and 1.19% Li_2O with variances of 0.68 and 0.50% Li_2O. The interpolated blocks have an average value of 0.99% Li_2O with a variance of 0.18% Li_2O.

Furthermore, the block values were compared to the composite values located inside the interpolated blocks. This enables a test for possible over- or under-estimation of the grade by the search parameters by testing the correlation between the two values. A correlation of determination of 0.10 (R^2) was established between the blocks and the composites (Figure 14-25). This relatively low but can be explained by the high level of internal variance in the deposit and is considered acceptable.

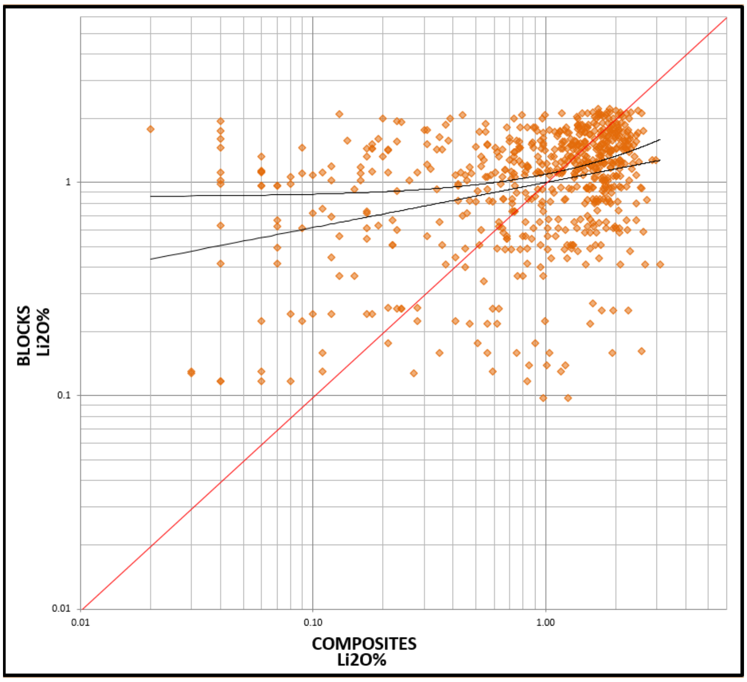


Figure 14-25 - Murial Block Values Versus Composites Inside Those Blocks

Note: Figure prepared by SGS, 2018.

14.3.9 Mineral Resources Classification

The Mineral Resources are classified into Measured, Indicated and Inferred categories. The Mineral Resource classification is based on the density of analytical information, the grade variability and spatial continuity of mineralization. The Mineral Resources were classified in two successive stages: automated classification, followed by manual editing of final classification results.

The first classification stage is conducted by applying an automated classification process which selects around each block a minimum number of composites from a minimum number of drill holes located within a search ellipsoid of a given size and orientation.

- Measured Mineral Resources: the search ellipsoid was 55 m (strike) by 55 m (dip) by 35 m with a minimum of five composites in at least three different drill holes.
- Indicated Mineral Resources: the search ellipsoid was twice the size of the Measured category ellipsoid using the same composites selection criteria.
- Inferred Mineral Resources: all remaining blocks were considered to be in the Inferred category

Figure 14-26 is a plan view showing the final classifications.

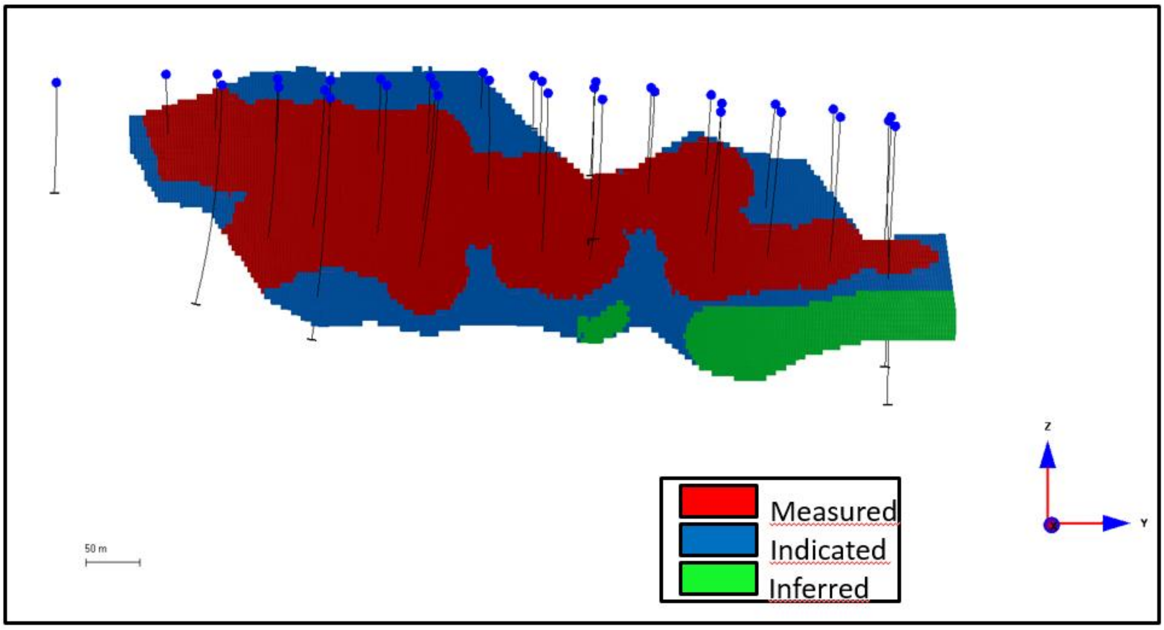


Figure 14-26 - Murial Block Model Classification

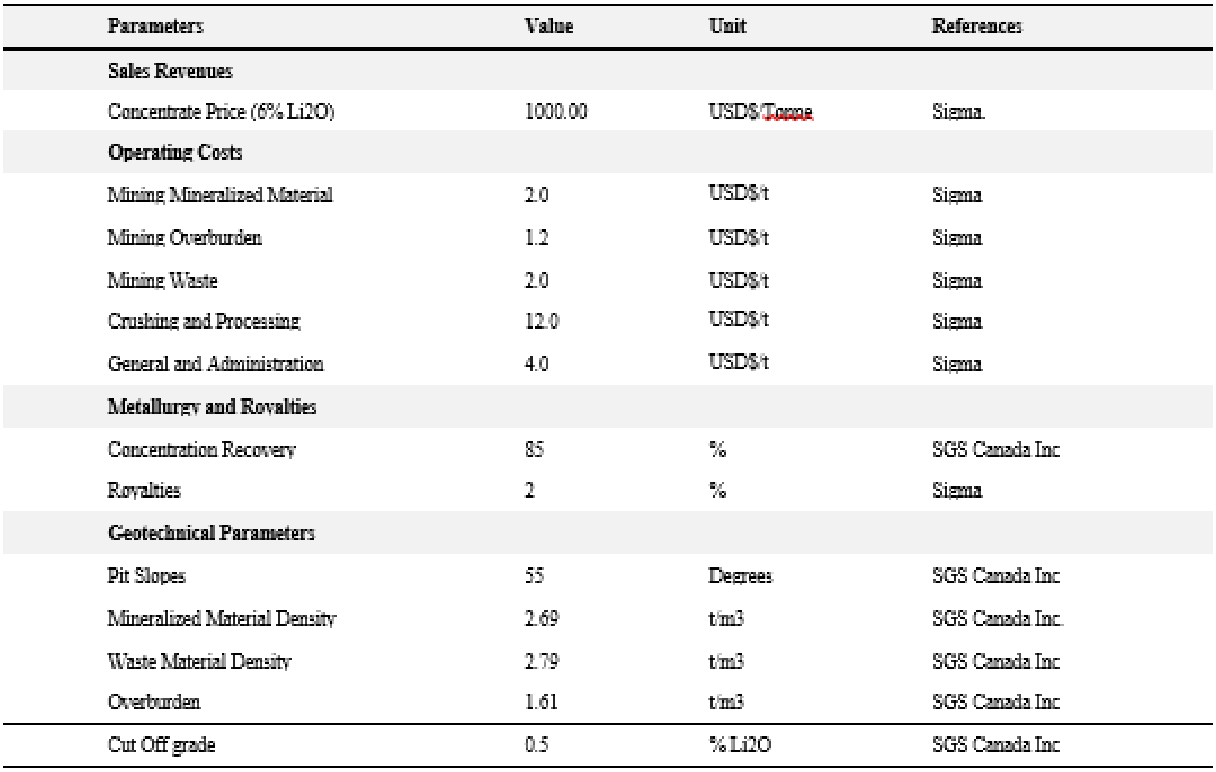
Note: Figure prepared by SGS, 2018.

The lower east side of the deposit only has one observation point and so is classified as Inferred Mineral Resources.

14.3.10 Reasonable Prospects for Eventual Economic Extraction

The conceptual economic parameters were used to assess reasonable prospects of eventual economic extraction. A series of economic parameters were estimated to represent the production cost and economic prospectivity of an open pit mining operation in Brazil. They are detailed in Table 14-14 and came either from SGS Canada or SMSA. These parameters are believed to be sufficient to include all block models in future open pit mine planning mostly due to the relatively low mining costs in Brazil but need to be confirmed.

Table 14-14 - Murial Parameters for Reasonable Prospect for Eventual Economic Extraction



Parameters	Value	Unit	References
Sales Revenues			
Concentrate Price (6% Li2O)	1000.00	USD$/Tonne	Sigma.
Operating Costs			
Mining Mineralized Material	2.0	USD$/t	Sigma
Mining Overburden	1.2	USD$/t	Sigma
Mining Waste	2.0	USD$/t	Sigma
Crushing and Processing	12.0	USD$/t	Sigma
General and Administration	4.0	USD$/t	Sigma
Metallurgy and Royalties			
Concentration Recovery	85	%	SGS Canada Inc
Royalties	2	%	Sigma
Geotechnical Parameters			
Pit Slopes	55	Degrees	SGS Canada Inc
Mineralized Material Density	2.69	t/m3	SGS Canada Inc.
Waste Material Density	2.79	t/m3	SGS Canada Inc
Overburden	1.61	t/m3	SGS Canada Inc
Cut Off grade	0.5	% Li2O	SGS Canada Inc

Note: Concentration recovery (flotation test) are based on preliminary results from SGS Lakefield laboratory and may change at the completion of the test. Overburden density was taken from the average value of saprolitic soil as defined by Tan (2003).

14.3.11 Mineral Resource Statement

The Mineral Resource estimate is reported using a 0.5% Li_2O cut-off. The Mineral Resources are constrained by the topography and are based on the conceptual economic parameters detailed in Table 14-15. The estimate has an effective date of January 10, 2019. The QP for the estimate is Mr Marc-Antoine Laporte, P.Geo., an SGS employee.

Table 14-15 - Murial Deposit Mineral Resource Estimate

Cut-off Grade Li_2O (%)	Category	Tonnage (t)	Average Grade Li_2O (%)
0.5	Measured	4,175,000	1.17
0.5	Indicated	1,389,000	1.04
0.5	**Measured + Indicated**	**5,564,000**	**1.14**
0.5	Inferred	669,000	1.06

Notes to accompany Mineral Resource table:

1. Mineral Resources have an effective date of January 10, 2019 and have been classified using the 2014 CIM Definition Standards. The Qualified Person for the estimate is Mr Marc-Antoine Laporte, P.Geo., an SGS employee.
2. Mineral Resources are reported assuming open pit mining methods, and the following assumptions: lithium concentrate (6% Li_2O) price of US$1,000/t, mining costs of US$2/t for mineralization and waste, US$1.2/t for overburden, crushing and processing costs of US$12/t, general and administrative (G&A) costs of US$4/t, concentrate recovery of 85%, 2% royalty payment, pit slope angles of 55º, and an overall cut-off grade of 0.5% Li_2O.
3. Tonnages and grades have been rounded in accordance with reporting guidelines. Totals may not sum due to rounding.
4. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.
5. Long-term Li_2O price of $1,000/tonne assumes processing cost of US$12 and metallurgical recovery of 85%.

Factors that can affect Mineral Resource estimates include but are not limited to:

- Changes to the modelling method or approach
- Changes to geotechnical assumptions, in particular, the pit slope angles
- Metallurgical recovery assumptions that are based on preliminary test results
- Changes to any of the social, political, economic, permitting, and environmental assumptions considered when evaluating reasonable prospects for eventual economic extraction
- Mineral Resource estimates can also be affected by the market value of lithium and lithium compounds.

14.4 LAVRA DO MEIO DEPOSIT

14.4.1 Exploratory Data Analysis

The final database used for the Lavra do Meio pegmatite mineral resource estimation was transmitted to SGS by SMSA on December 13, 2018 in Microsoft® Excel format and Datamine format. The database validation steps are discussed in Section 12. The database comprised 17 drill holes with entries for:

- Down hole surveys (n = 717)
- Assays (n = 656)
- Lithologies (n = 119).

The database was validated upon importation in Genesis©, which enabled the correction of minor discrepancies between the table entries, surveys, and lithologies.

Vertical sections were generated oriented east-west following the drilling pattern and the general trend of the pegmatite unit. In general, the sections are spaced at 50 m intervals. Figure 14-27 is a drill collar location plan.

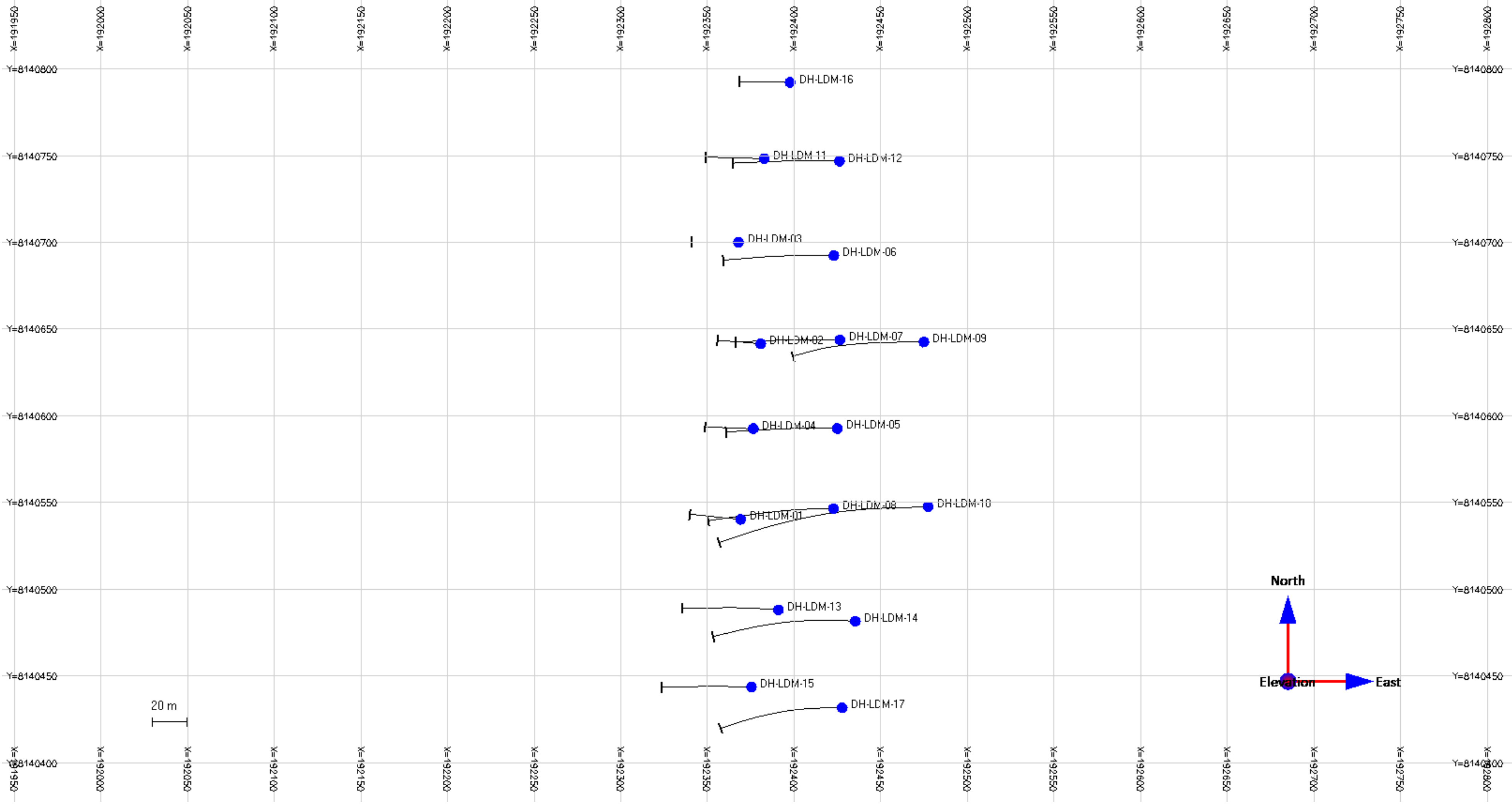


Figure 14-27 - Lavra Do Meio Drill Hole Collar Locations

Note: Figure prepared by SGS, 2018. Figure north is to top of figure.

The topographic surface that was used by SGS was a 1 m precision DEM (refer to Section 9.2).

14.4.2 Analytical Data

There is a total of 656 assay intervals in the database used for the Mineral Resource estimate; 405 assays are contained inside the interpreted mineralized solids. Most of the drill holes defining the mineralized solids have been sampled continuously.

Table 14-16 shows the range of Li_2O values from the analytical data.

Table 14-16 - Lavra do Meio Assay Statistics Inside Mineralized Solids

	Li_20 (%)
Count	405
Mean	1.13
Std. Dev.	1.01
Min	0.02
Median	0.94
Max	6.15

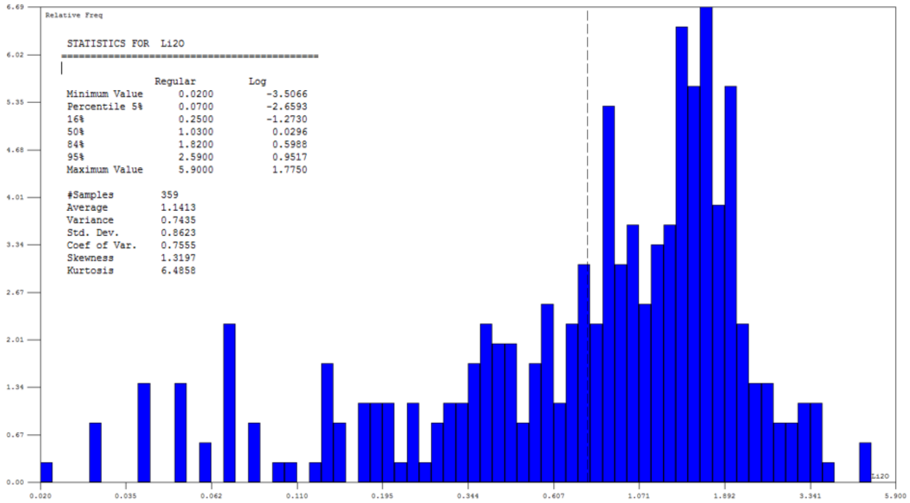
14.4.3 Composite Data

Block model grade interpolation was conducted on composited analytical data. A 1 m composite length was selected based on the north–south width of the 5 m by 3 m by 5 m block size defined for the resource block model. Compositing starts at the bedrock-overburden contact. No capping was applied on the analytical composite data.

Table 14-17 shows the grade statistics of the analytical composites used for the interpolation of the resource block model and Figure 14-28 shows the related histogram for Li_2O.

Table 14-17 - Lavra do Meio 1 m Composite Statistics

	Li_20 (%)
Count	359
Mean	1.14
Std. Dev.	0.86
Min	0.02
Median	1.04
Max	5.90



```
STATISTICS FOR  Li2O
==============================================
|
                  Regular          Log
Minimum Value      0.0200        -3.5066
Percentile 5%      0.0700        -2.6593
16%                0.2500        -1.2730
50%                1.0300         0.0296
84%                1.8200         0.5988
95%                2.5900         0.9517
Maximum Value      5.9000         1.7750

#Samples        359
Average         1.1413
Variance        0.7435
Std. Dev.       0.8623
Coef of Var.    0.7555
Skewness        1.3197
Kurtosis        6.4858
```

Figure 14-28 - Lavra do Meio 1 m Composite Histogram

Note: Figure prepared by SGS, 2018.

14.4.4 Density

Density determinations are outlined in Section 11.3. An average density value of 2.65 t/m^3 was determined for the mineralized pegmatite. This value was used for the calculation of the tonnages from the volumetric estimates of the resource block model.

14.4.5 Geological Interpretation

SGS conducted the interpretation of the 3D wireframe solids of the mineralization based on the drill hole data and surface mapping done by SMSA geologists. For the purpose of modelling, sections (looking north) were generated every 50 m, with intermediate sections where necessary to tie in the solids. The modelling was first completed on sections to define mineralized shapes using the lithology and lithium analytical data. A minimum grade of 0.3% Li_2O over a minimum drill hole interval length of 1.5 m was generally used as a guideline to define the width of the mineralized shapes. The final 3D wireframe model (solid) was constructed by linking the defined mineralized shapes based on the geological interpretation (refer to Figure 7-6).

The linked interpretation shows one pegmatite body, with a strike orientation of azimuth 280° and a dip averaging -75° to the east. The pegmatite body was modelled as two envelopes split by a major fault that can be traced on surface. Some drill holes show a possible north–south deformation zone that also affects the deposit and possibly connects the two zones (either totally or partially). This interpretation will require additional drill testing.

The mineralized solids were clipped directly on the DEM surface and the average depth of soil overburden is 5.7 m. No saprolite zone was logged by the Sigma geologists.

Figure 14-29 shows the final 3D wireframe solids in isometric view with the drill hole pierce points.

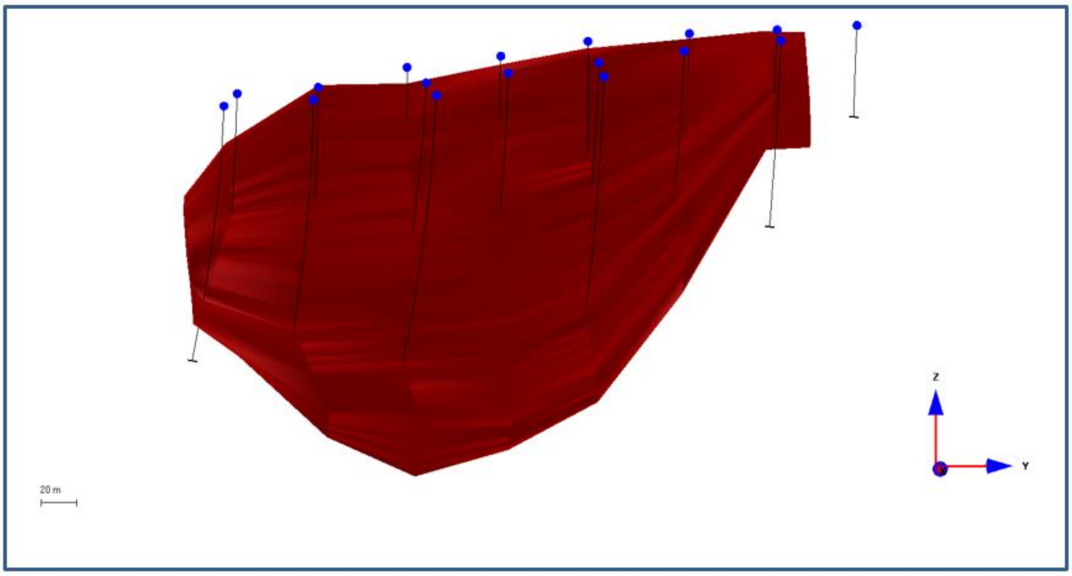


Figure 14-29 - Lavra do Meio Pegmatite Solid (looking west)

Note: Figure prepared by SGS, 2018.

14.4.6 Resource Block Modeling

A block size of 5 m (northeast–southwest) by 3 m (northwest–southeast) by 5 m (vertical) was selected for the Lavro do Meio resource block model based on drill hole spacing, width and general geometry of mineralization. No rotation was applied to the block model. The 5 m vertical dimension corresponds to the bench height of a potential small open pit mining operation. The 5 m northeast–southwest dimension corresponds to about a tenth of the minimum drill spacing and accounts for the variable geometry of the mineralization in that direction. The 5 m northwest–southeast block dimension accounts for the minimum width of the mineralization modelled at Lavro do Meio. The resource block model contains 19,088 blocks located inside the mineralized solids, for a total volume of 1,048,241 m^3. Table 14-18 summarizes the block model limit parameters.

Table 14-18 - LDM Resource Block Model Parameters

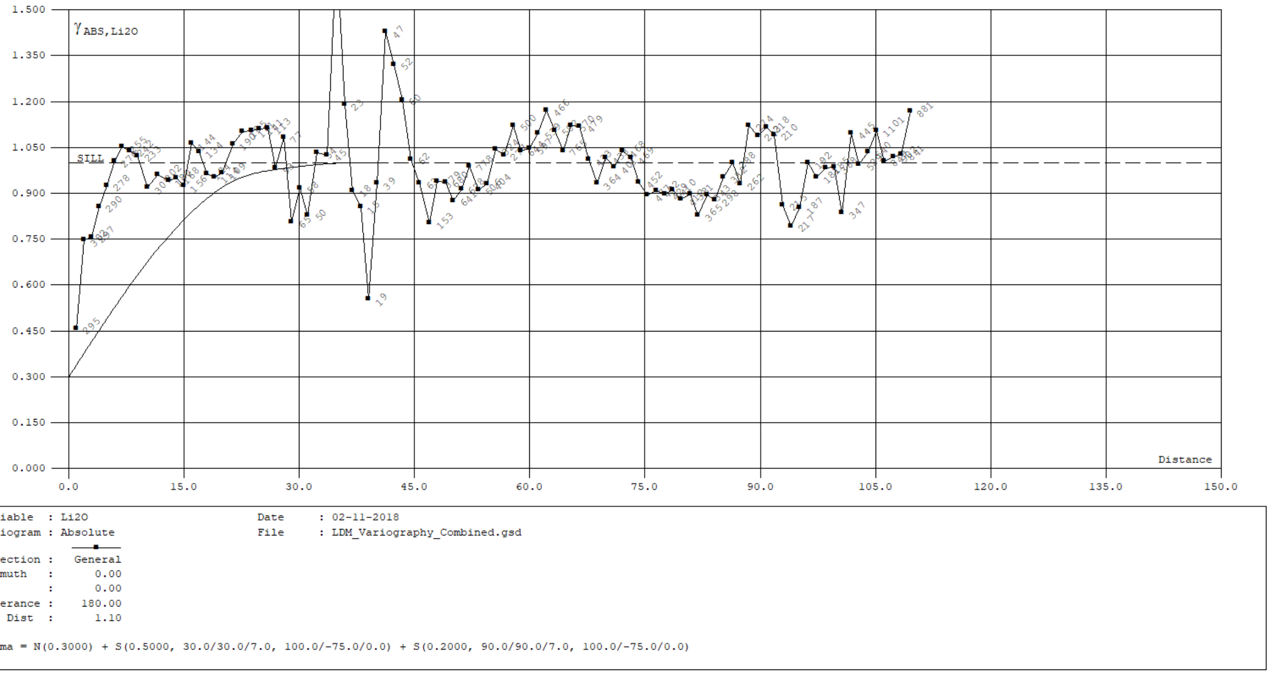
Direction	Block Size (m)	Number of Blocks	Coordinates (Local Grid) Min (m)	Coordinates (Local Grid) Max (m)
East–west (x)	5	76	192,225	192,600
North–south (y)	3	226	8,140,250	8,140,925
Elevation (z)	5	57	110	390

14.4.7 Variography

In order to determine the continuity and distribution of the Li_2O grades, the 1 m composites were submitted to a variographic study. The variographic analysis helped determine the search ellipses criteria and define the kriging parameters for the block interpolation process.

The composites show a normal distribution with a relatively high standard deviation of 0.86 Li_2O%. This prevented the use of a single correlogram model. Instead, two were generated, one for short distances and one for long distances.

The short-distance correlogram was computed on untransformed composites. The long-distance correlogram was computed on transformed composites. The transformations involve projection of the composites and rescaling of the Z axis. This was to ensure a constant planar area of composite that could be used to identified long distance thin structure in the mineralized zone. Multiple iterations of variographic analyses were conducted on the transformed composites, each involved different Z slicing. The resulting correlogram is shown in Figure 14-30.



```
Variable   : Li2O                         Date     : 02-11-2018
Variogram  : Absolute                     File     : LDM_Variography_Combined.gsd

Direction  :   General
Azimuth    :      0.00
Dip        :      0.00
Tolerance  :    180.00
Lag Dist   :      1.10

Gamma = N(0.3000) + S(0.5000, 30.0/30.0/7.0, 100.0/-75.0/0.0) + S(0.2000, 90.0/90.0/7.0, 100.0/-75.0/0.0)
```

Figure 14-30 - Lavra do Meio Combined Correlogram

Note: Figure prepared by SGS, 2018.

The transformation process is omnidirectional by nature, so no preferred orientation and dip were identified during the modelling process. However, projection and Z-axis rescaling were done according to the mineralization orientation of 100º of azimuth and -75º dip. The long-distance model is therefore optimal in this preferred orientation.

14.4.8 Block Model Interpolation

The grade interpolation for the resource block model was completed using OK. The interpolation process was conducted using three successive passes with more inclusive search conditions from the first pass to the next until most blocks were interpolated.

Variable search ellipse orientations were used to interpolate the blocks. The general dip of the mineralized pegmatite was modelled on each section and then interpolated in each block. During the interpolation process, the search ellipse was orientated based on the interpolation direction of each block, hence better representing the dip and orientation of the mineralization.

The first pass was interpolated using a search ellipsoid distance of 50 m (long axis) by 50 m (intermediate axis) and 25 m (short axis) with an orientation of 280º azimuth and -75º dip to the east which represents the general geometry of the pegmatites in the Lavra do Meio deposit. Using search conditions defined by a minimum of five composites, a maximum of 15 composites and a minimum of three drill holes, 54% of the blocks were estimated. For the second pass, the search distance was twice the search distance of the first pass and composites selection criteria were kept the same as for the first pass. A total of 91% of the blocks were interpolated following the second pass. Finally, the search distance of the third pass was increased to 125 m (long axis) by 125 m (intermediate axis) by 75 m (short axis) with a minimum of five composites, a maximum of 15 composites and no minimum composites required per drill hole. The purpose of the last interpolation pass was to interpolate the remaining unestimated blocks mostly located at the edges of the block model, representing 9% of the blocks.

Figure 14-31 illustrates the three search ellipsoids used for the different interpolation passes. Figure 14-32 shows the results of the block model interpolation in longitudinal view.

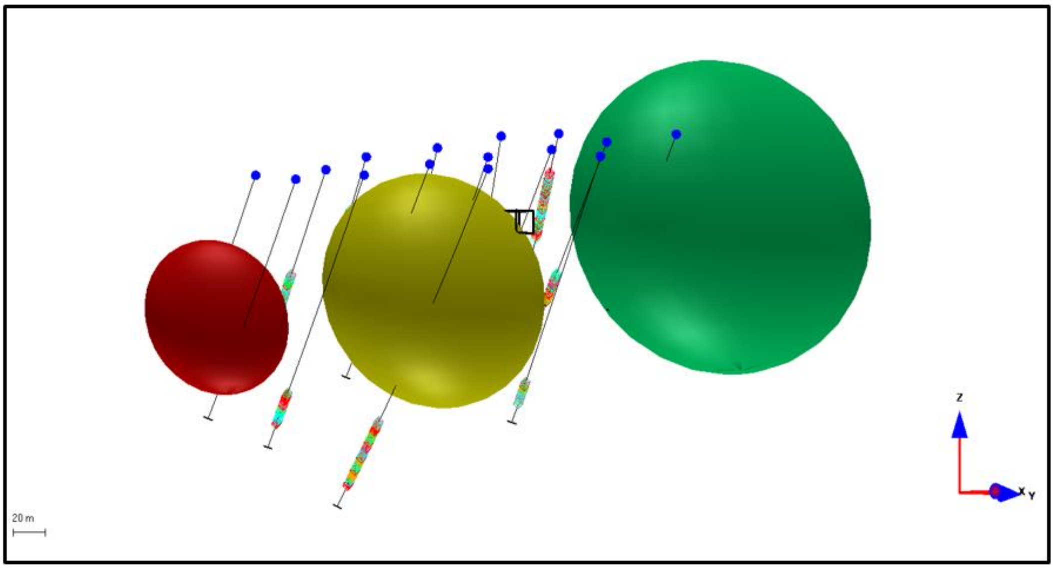


Figure 14-31 - Isometric View of Lavra do Meio Search Ellipses

Note: Figure prepared by SGS, 2018.

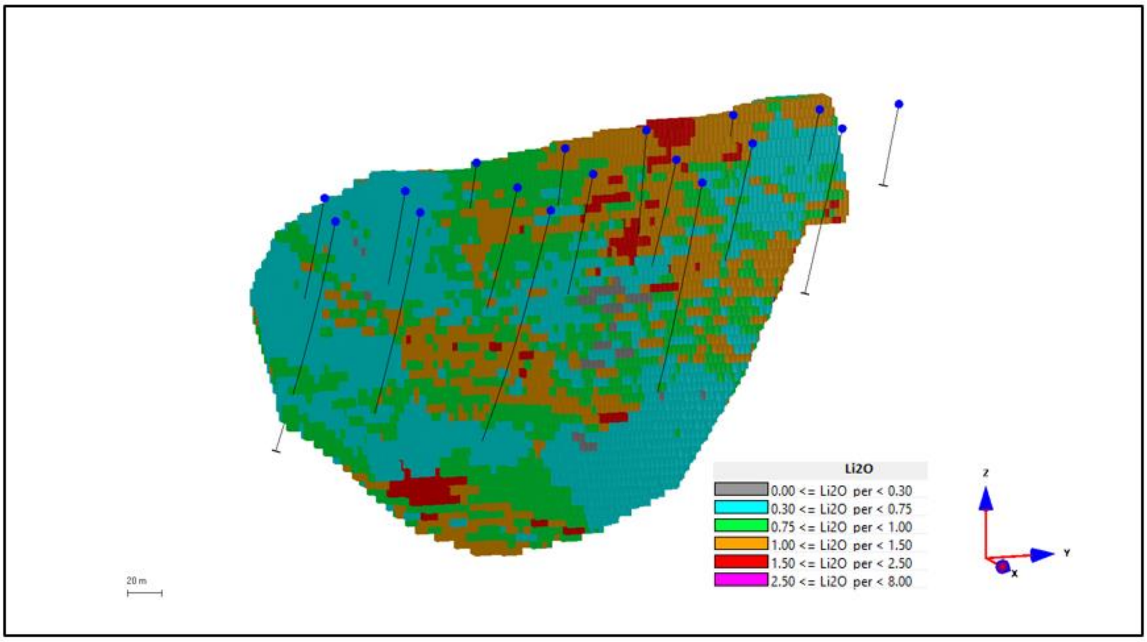
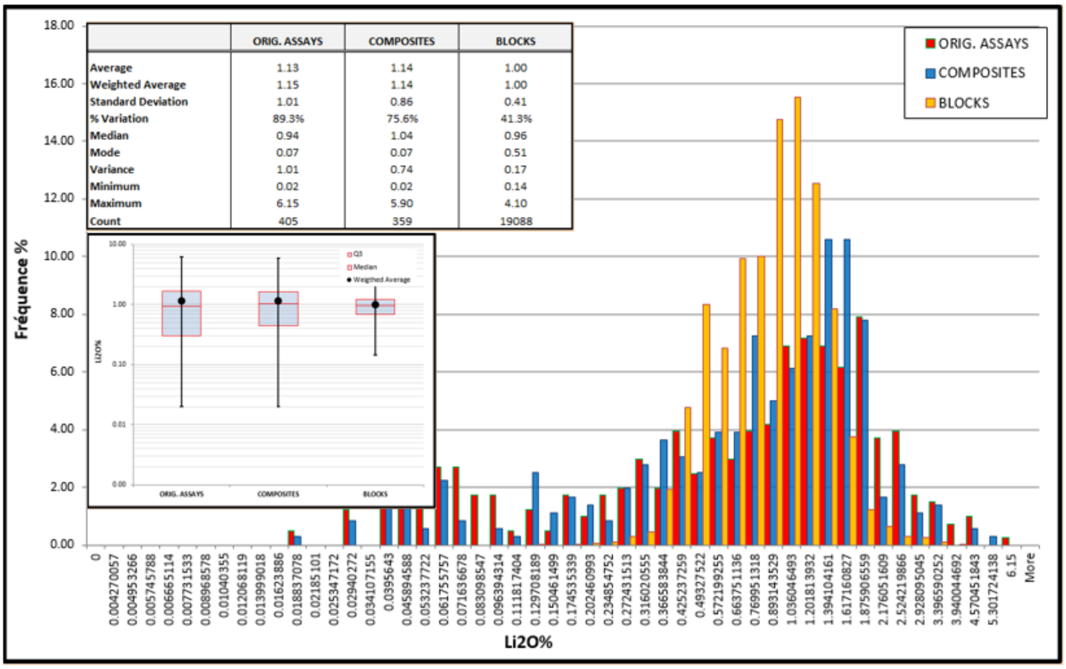


Figure 14-32 - Isometric View of Lavra Do Meio Interpolated Block Model

Note: Figure prepared by SGS, 2018.

14.4.9 Model Validation

To validate the interpolation process, the block model grades were compared statistically to the assay and composite grades. The distribution of the assays, composites and blocks are normal (gaussian) and show similar average values with decreasing levels of variance (Figure 14-33).



	ORIG. ASSAYS	COMPOSITES	BLOCKS
Average	1.13	1.14	1.00
Weighted Average	1.15	1.14	1.00
Standard Deviation	1.01	0.86	0.41
% Variation	89.3%	75.6%	41.3%
Median	0.94	1.04	0.96
Mode	0.07	0.07	0.51
Variance	1.01	0.74	0.17
Minimum	0.02	0.02	0.14
Maximum	6.15	5.90	4.10
Count	405	359	19088

Figure 14-33 - Statistical Comparison of Lavro Do Meio Assay, Composite and Block Data

Note: Figure prepared by SGS, 2018.

The assays and composites have respective averages of 1.13% Li_2O and 1.14% Li_2O with variances of 1.01 and 0.74. The interpolated blocks have and average value of 1% Li_2O with a variance of 0.17.

Furthermore, the block values were compared to the composite values located inside the interpolated blocks. This enables a test for possible over- or under-estimation of the grade by the search parameters by testing the correlation between the two values. A correlation of determination of 0.63 (R2) was established between the blocks and the composites (Figure 14-34) which is typical and considered acceptable for this type of deposit by the QP.

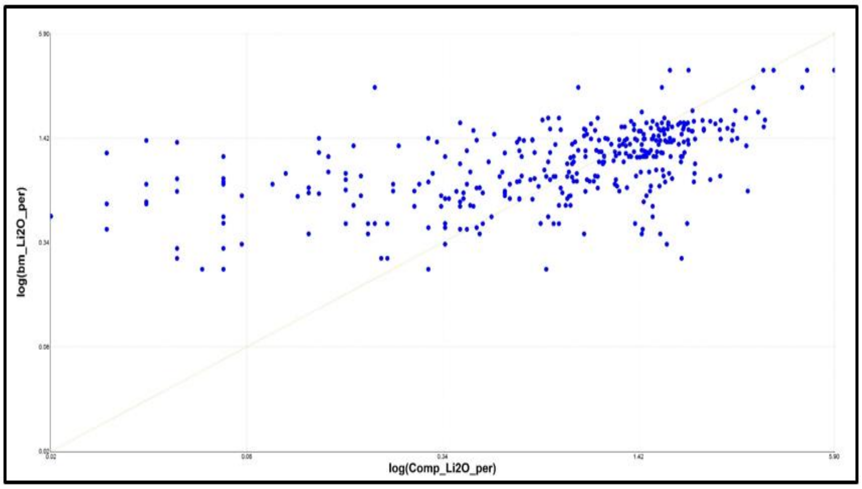


Figure 14-34 - Lavra Do Meio Block Values Versus Composites Inside Those Blocks

Note: Figure prepared by SGS, 2018.

14.4.10 Mineral Resources Classification

The Mineral Resources are classified into Measured, Indicated and Inferred categories. The Mineral Resource classification is based on the density of analytical information, the grade variability and spatial continuity of mineralization. The Mineral Resources were classified in two successive stages: automated classification, followed by manual editing of final classification results.

The first classification stage was conducted by applying an automated classification process which selects around each block a minimum number of composites from a minimum number of holes located within a search ellipsoid of a given size and orientation.

Classification parameters were:

- Measured Mineral Resources: the search ellipsoid was 55 m (strike) by 55 m (dip) by 35 m with a minimum of five composites in at least three different drill holes
- Indicated Mineral Resources: the search ellipsoid was twice the size of the Measured category ellipsoid using the same composites selection criteria
- Inferred Mineral Resources: all remaining blocks.

Figure 14-35 illustrates the block model classification.

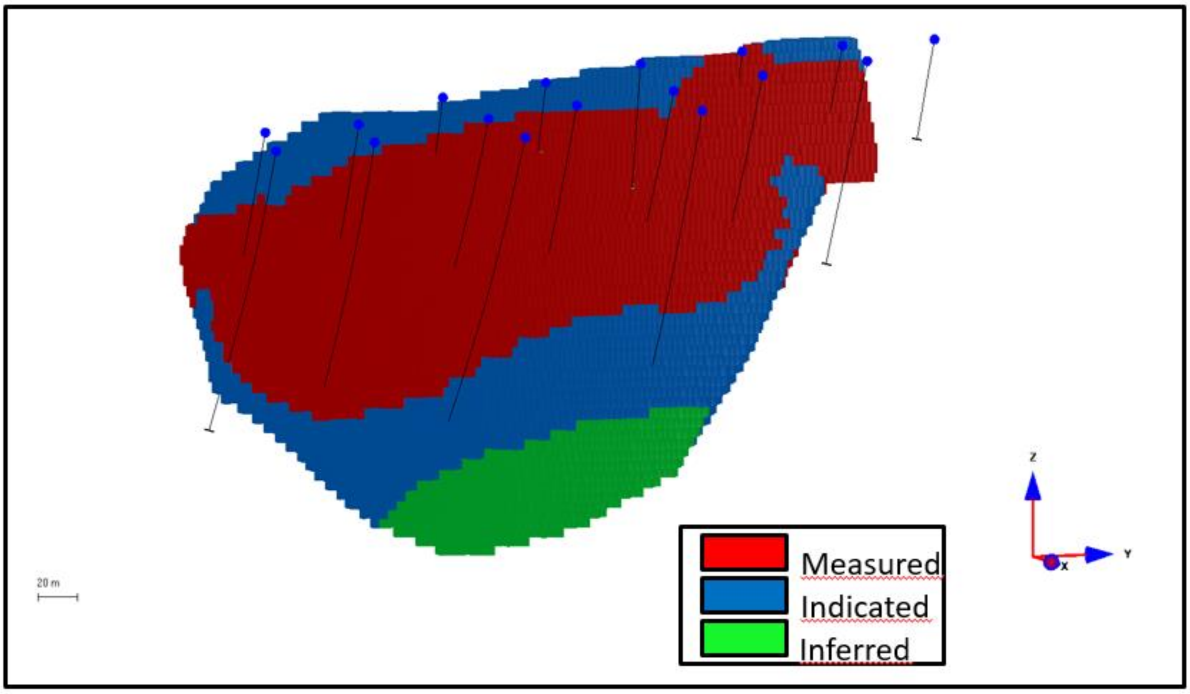


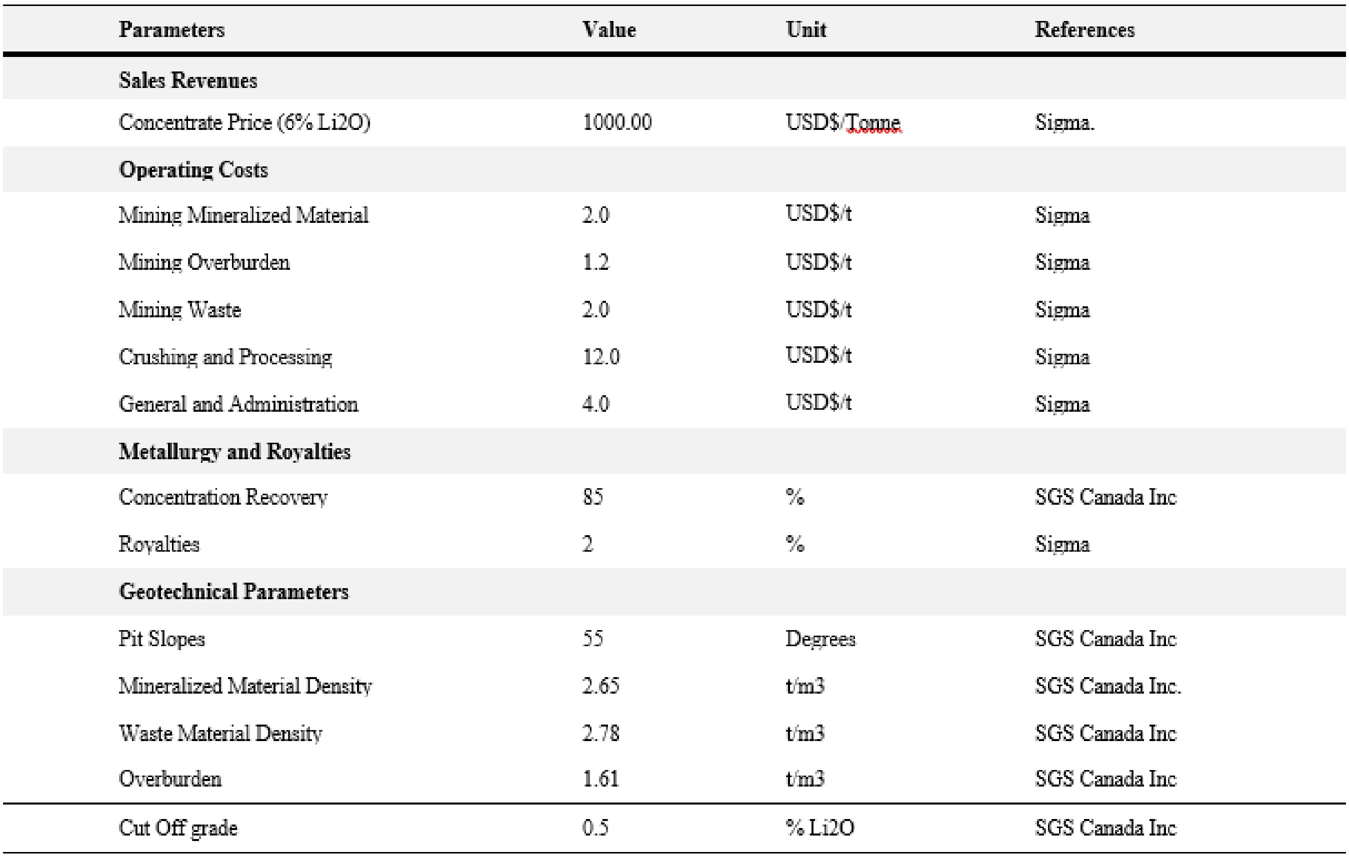
Figure 14-35 - Lavra Do Meio Block Model Classification

Note: Figure prepared by SGS, 2018.

14.4.11 Reasonable Prospects of Eventual Economic Extraction

The conceptual economic parameters were used to assess reasonable prospects of eventual economic extraction. A series of economic parameters were estimated to represent the production cost and economic prospectivity of an open pit mining operation in Brazil. They are detailed in Table 14-19 - and came either from SGS Canada or SMSA. These parameters are believed to be sufficient to include all block models in future open pit mine planning mostly due to the relatively low mining costs in Brazil but need to be confirmed.

Table 14-19 - Lavro do Meio Parameters for Reasonable Prospect for Eventual Economic Extraction



Parameters	Value	Unit	References
Sales Revenues			
Concentrate Price (6% Li2O)	1000.00	USD$/Tonne	Sigma.
Operating Costs			
Mining Mineralized Material	2.0	USD$/t	Sigma
Mining Overburden	1.2	USD$/t	Sigma
Mining Waste	2.0	USD$/t	Sigma
Crushing and Processing	12.0	USD$/t	Sigma
General and Administration	4.0	USD$/t	Sigma
Metallurgy and Royalties			
Concentration Recovery	85	%	SGS Canada Inc
Royalties	2	%	Sigma
Geotechnical Parameters			
Pit Slopes	55	Degrees	SGS Canada Inc
Mineralized Material Density	2.65	t/m3	SGS Canada Inc.
Waste Material Density	2.78	t/m3	SGS Canada Inc
Overburden	1.61	t/m3	SGS Canada Inc
Cut Off grade	0.5	% Li2O	SGS Canada Inc

Note: Concentration recovery (flotation test) are based on preliminary results from SGS Lakefield laboratory and may change at the completion of the test. Overburden density was taken from the average value of saprolitic soil as defined by Tan (2003)

14.4.12 Mineral Resource Estimation

The Mineral Resource estimate is reported in Table 14-20 using a 0.5% Li_2O cut-off. The Mineral Resources are constrained by the topography and based on the conceptual economic parameters detailed in Table 14-19. The estimate has an effective date of January 10, 2019. The QP for the estimate is Mr Marc-Antoine Laporte, P.Geo., an SGS employee.

Table 14-20 - Lavra do Meio Deposit Mineral Resource Estimate

Cut-off Grade Li_2O (%)	Category	Tonnage (t)	Average Grade Li_2O (%)
0.5	Measured	1,626,000	1.16
0.5	Indicated	649,000	0.93
0.5	**Measured + Indicated**	**2,275,000**	**1.09**
0.5	Inferred	261,000	0.87

Notes to accompany mineral resource table:

1. Mineral Resources have an effective date of January 10, 2019 and have been classified using the 2014 CIM Definition Standards. The Qualified Person for the estimate is Mr Marc-Antoine Laporte, P.Geo., an SGS employee.
2. Mineral Resources are reported assuming open pit mining methods, and the following assumptions: lithium concentrate (6% Li_2O) price of US$1,000/t, mining costs of US$2/t for mineralization and waste, US$1.2/t for overburden, crushing and processing costs of US$12/t, general and administrative (G&A) costs of US$4/t, concentrate recovery of 85%, 2% royalty payment, pit slope angles of 55º, and an overall cut-off grade of 0.5% Li_2O.
3. Tonnages and grades have been rounded in accordance with reporting guidelines. Totals may not sum due to rounding.
4. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.
5. Long-term Li_2O price of $1,000/tonne assumes processing cost of US$12 and metallurgical recovery of 85%.

Factors that can affect the Mineral Resource estimates include but are not limited to:

- Changes to the modelling method or approach
- Changes to geotechnical assumptions, in particular, the pit slope angles
- Metallurgical recovery assumption that are based on preliminary test results
- Changes to any of the social, political, economic, permitting, and environmental assumptions considered when evaluating reasonable prospects for eventual economic extraction.
- Mineral Resource estimates can also be affected by the market value of lithium and lithium compounds.

The QP is not aware of any environmental, legal, title, taxation, socioeconomic, marketing, political or other relevant factors that would materially affect the estimation of Mineral Resources that are not discussed in this Report.

15 MINERAL RESERVE ESTIMATES

15.1 INTRODUCTION

The Mineral Reserve estimate for the Xuxa deposit was reported using the 2014 CIM Definition Standards.

Mineral Reserves amenable to open pit mining methods were estimated through an open pit optimization exercise using the Measured and Indicated Mineral Resources in the block model provided by SGS.

Mineral Reserves were reported within detailed engineered pit designs and life-of-mine (LOM) plans based on two pit shells.

The Mineral Reserves inside the engineered pit designs were reported using estimated cut-off grades (COG) and ore type, based on a lithium concentrate (CIF) China price of US$700/t and a R$:US$ exchange rate of 3.7.

Proven and Probable Mineral Reserves with an effective date of 5 June 2019 are estimated to be 13.79 Mt at 1.46% Li_2O grade.

There will be four waste rock disposal areas. Waste piles 1, 2 and 3 will be used to dispose of waste from Pit 1, and waste pile 4 will be used for waste disposal for Pit 2. Waste piles 1 and 3 will also be used for co-disposal of waste rock as well as crushed tailings from the process plant.

MCB notes:

- The environmental license permit for Pit 1, the processing plant and waste piles 1 and 2 was received by Sigma on June 3, 2019
- The environmental impact assessment study and the environmental licensing process for waste piles 3 and 4 and for the mining of Pit 2 has commenced. Work is anticipated to be completed by March 2020, after which the application for the environment license will be filed. The approval process for this second license is expected to take about 12 months.

A high voltage transmission line will need to be moved by 150 m, so as not to interfere with the final Pit 1 design. Sigma already has the legal authority to relocate the power line.

Sigma does not own the surface rights in the Pit 2 area but has applied to the ANM for the right to mine.

To align with the expected timing of the granting of the environmental permits, mining is planned to start with Pit 1 with being dumped at waste piles 1 and 2 during pre-stripping and the first year of operation. Mining of Pit 2 will start 1.5 years after Pit 1. Current open pit life of mine is estimated at nine years and three months.

The envisaged site layout plan is shown in Figure 15-1 including the pits, waste piles, access roads, the mining services infrastructure area and the processing plant area.

Figure 15-1 – Site General Layout

Note: Figure prepared by MCB, 2019.

Test work and processing results indicate that the Mineral Reserves are all amenable to processing using DMS technology.

15.2 MINERAL RESERVE STATEMENT

The Mineral Reserves per are presented in Table 15-1.

Table 15-1 - Mineral Reserve Statement

Pit	Tonnage (t)	Li_2O (%)
Pit 1		
Proven Mineral Reserve	4,650,000	1.36
Probable Mineral Reserve	1,060,000	1.42
Pit 2		
Proven Mineral Reserve	5,610,000	1.56
Probable Mineral Reserve	2,406,000	1.52
Total		
Proven Mineral Reserve	**10,270,000**	**1.45**
Probable Mineral Reserve	**3,520,000**	**1.47**
Total Proven and Probable Mineral Reserves	**13,790,000**	**1.46**

Note to accompany Mineral Reserves table:

1. CIM (2014) definitions were followed for Mineral Reserves
2. Mineral Reserves have an effective date of 5 June 2019. The Qualified Person for the estimate is Porfirio Cabaleiro Rodriguez, MAIG, an employee of GE21.
3. Mineral Reserves are confined within an optimized pit shell that uses the following parameters: lithium concentrate price: US$700/t concentrate; mining costs: US$2.15/t mined; processing costs: US$10.51/t processed; general and administrative costs: US$3.8 M/a; logistics costs: US$82/t wet concentrate; process recovery of 60.4%; mining dilution of 9%; pit inter-ramp angles that range from 40.5–74.8º.
4. Tonnages and grades have been rounded in accordance with reporting guidelines. Totals may not sum due to rounding.

Estimated waste tonnages for Pit 1 and Pit 2 are 65 Mt and 74 Mt respectively.

15.3 MINERAL RESERVE ESTIMATION

15.3.1 Reserve Block Model

The mining engineering work related to the pit optimizations and engineered pit designs was carried out using the block models prepared by SGS in January 2019 for the Xuxa deposit. A parent block size of 5 m x 3 m x 6 m (X, Y, Z) was used for the Xuxa deposit.

The models contain blocks coded with the following information:

- Lithium (Li_2O) grade
- Iron grade
- Block proportion of ore
- Resource category (Measured, Indicated, and Inferred)
- Density

LOM final designs have been compiled for the open pits and these were the basis of estimating the Mineral Reserves for the Xuxa deposit.

15.3.2 Open Pit Optimization

The open pit optimizations were carried out by means of the Lerchs–Grossmann (L-G) 3D algorithm in NPVS software (version 4.23.242.0). Using mining costs, processing costs, selling costs, lithium recovery values and an overall pit slope, the pit optimizer determines an ultimate pit shell that delineates the volume of material that can be extracted to maximize value.

A series of pit optimizations were produced using a range of lithium selling prices (revenue factors) in order to produce an industry standard pit-by-pit graph. This process was used to evaluate the sensitivity of the pit optimizations to changes in mineral selling prices, as well as to evaluate the effect of the pit size and stripping ratios on the project net present value (NPV). The optimization process produces a series of nested pit shells that prioritize the mining of the most economic material. Less profitable material (lower grade and / or high strip ratio) is, by definition only mined in later pit shells as the input commodity selling price is increased.

From these results, appropriate pit shells for the deposit were selected as a basis for the engineered pit designs and Mineral Reserve estimates. All pit optimizations were run using reasonable and relevant economic, cost, recovery, pit slope assumptions, and on diluted lithium grades. Only resource blocks classified as either Measured or Indicated were allowed to drive the pit optimizer for Mineral Reserve reporting purposes.

15.3.3 Dilution and Extraction

Total dilution is calculated as the sum of planned and unplanned dilution:

- Planned dilution: non-ore material (below cut-off grade) that lies within the designed boundaries (mining lines) as determined by the selectivity of mining method, the continuity of the orebody along strike and along dip and the complexity of the orebody shape
- Unplanned dilution: additional non-ore material (below cut-off grade) which is derived from rock outside the boundaries (mining lines), incorporated due to blast induced over-break and/or the difficulty to separate ore/waste during mining excavation

Resources for the Xuxa deposit were estimated including a proportion of dilution in the resource block grades. This internal dilution consists of schist material that is sometimes present internal to the geological wireframe (Figure 15-2).

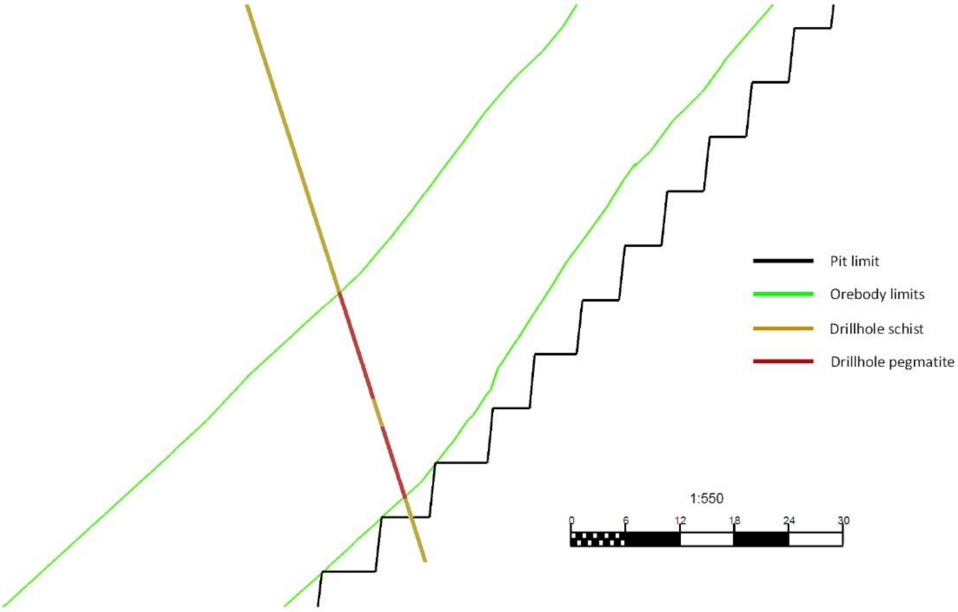


Figure 15-2 – Internal Dilution

Note: Figure prepared by MCB, 2019.

Based on the drill hole spacing the proportion of planned dilution was increased by 1% (as defined by SGS). Unplanned dilution used for Mineral Reserve was 8.3% based on an operational shape for the mining operation.

Due to the plunge of the orebody (ranging from 40-47°), a dilution of 0.5 m on each side of the orebody was included to account for unplanned dilution during operations.

Mining recovery is usually a percentage estimate of in situ ore recovered after mining has taken place. One of the main drivers of the project was to maximize the mining recovery (extraction). Mining recovery were estimated to be 100%.

15.3.4 Cost Parameters for Pit Optimization

The key pit optimization parameters used to derive the economic pit shells for the deposits are summarized in Table 15-2. The optimizations were based on parameters and cost data projected for the project and based on current quotations for the project.

Table 15-2 - Pit Optimization Parameters

Modifying Factor	Value
Lithium concentrate price	US$700/t concentrate
Royalties (CFEM) (Note 1)	2% over revenue
Exchange rate	3.7 BRL/ US$
Costs	
Mining fixed (loading, blasting, services)	1.09t/ material
Mining haulage	Figure 15-3
Processing (including ore retreat and tailings disposal)	US$10.51/t ore
G&A	US$3,809,000/ year
Logistics	US$82/t concentrate wet
Plant recovery	60.4%
Concentrate grade	6%
Mining recovery	100%
Dilution	9.3%
Weathered rock pit design parameters	
Face angle	50°
Bench height	12 m
Berm width	4 m
Inter ramp angle	40.5°
Fresh rock pit design parameters	
Face angle	84°
Bench height	24 m
Berm width	4 m
Inter ramp angle	74.8°
Ore pit design parameters	
Face angle	84°
Bench height	6 m
Berm width	4 m
Interramp angle	52.3°
Ramp width	25 m

Note 1: CFEM is the Brazilian government royalty

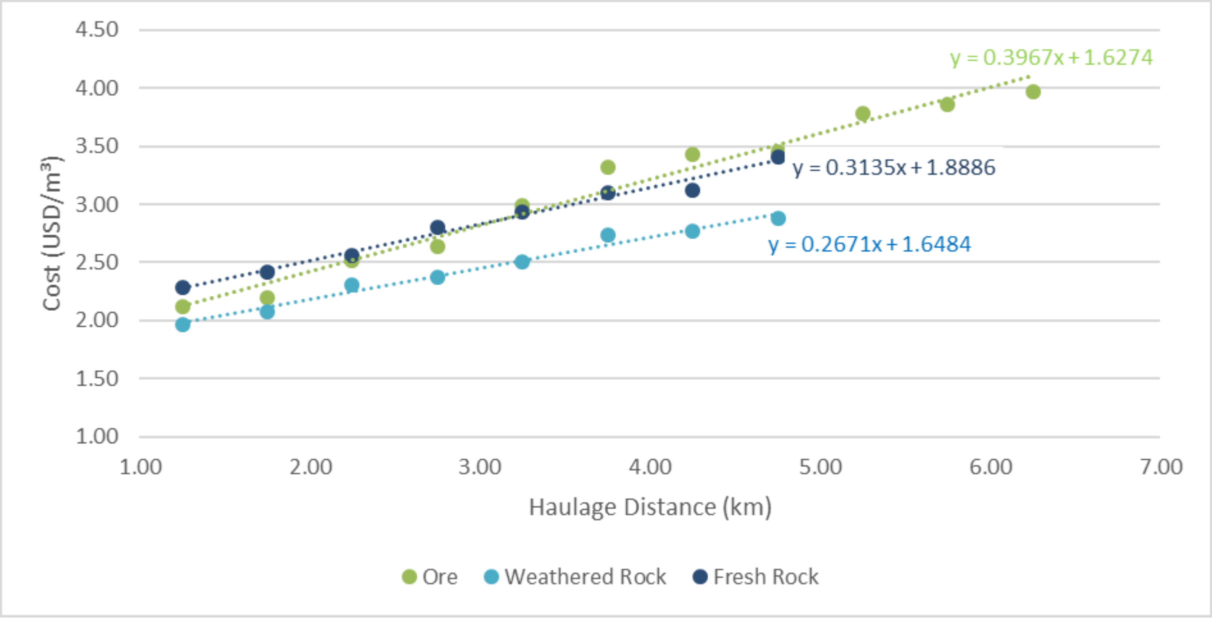


Figure 15-3 – Haulage Cost Profile for Waste and Ore Estimated by the Contractor

Note: Figure prepared by MCB, 2019

Mining costs were based on the mining contract rates quoted for this project and on current mine scheduling and transportation profiles submitted to the contractor.

15.3.5 Pit Optimization Mill Recovery

Test work indicated that a marketable concentrate of spodumene is achievable with a metallurgical recovery of 60.4% based on samples collected on site and test work conducted by SGS Lakefield. The concentrate will have a 6% Li_2O grade.

15.3.6 Pit Optimization Results

A series of pit shells were run using lithium selling prices ranging from 20% to 100% of estimated selling price at an R$ / US$ exchange rate of 3.7 and using the other parameters listed in the sections above. The results of the pit optimization are presented in Figure 15-4.

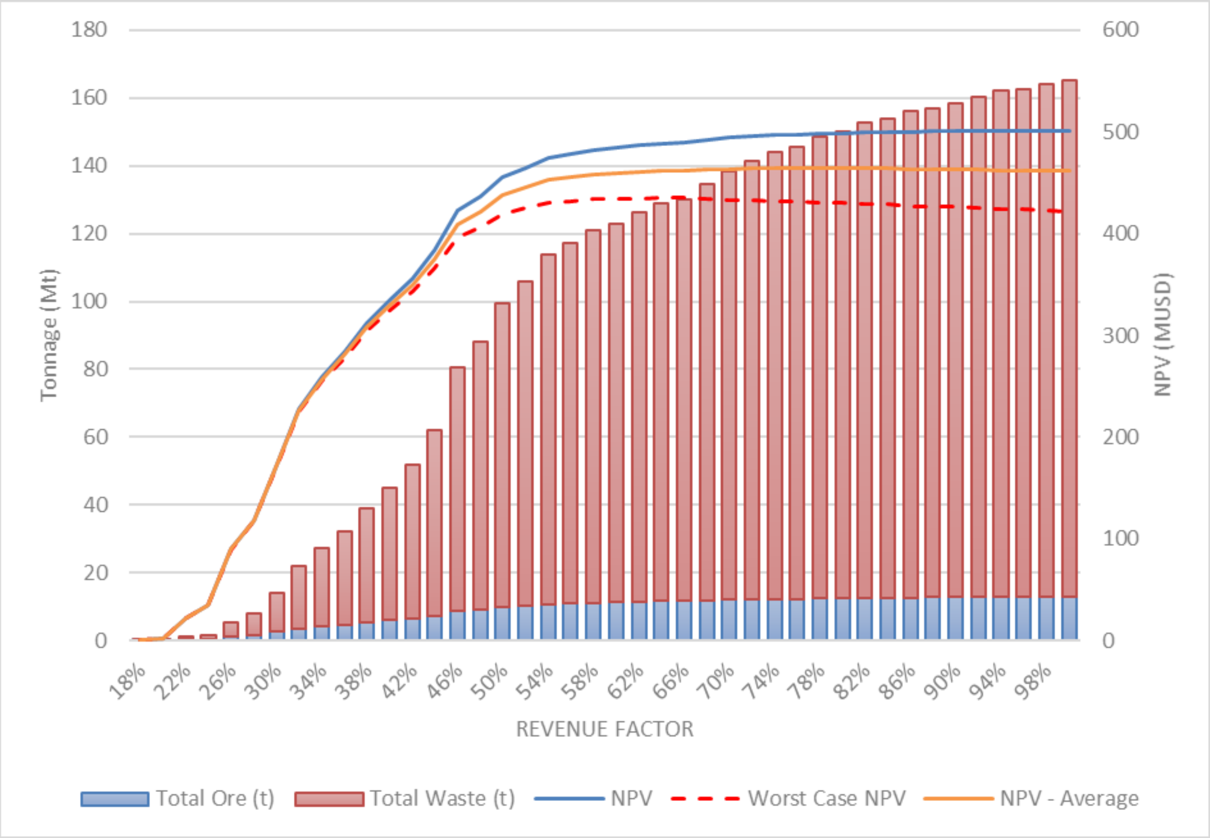


Figure 15-4 – Pit Optimization Results

Note: Figure prepared by MCB, 2019.

Although there are shells with better results, considering that the main driver of the project was to maximize the ore recovery, the 100% revenue factor (RF) price shell was selected as the base case.

15.4 FACTORS THAT MAY AFFECT THE MINERAL RESERVE ESTIMATES

The main factors that may impact the Mineral Reserve estimates are as follows:

- Metal prices and exchange rate assumptions
- Mining, process, and operating costs
- Recovery assumptions

The QP is not aware of any environmental, legal, title, taxation, socioeconomic, marketing, political or other relevant factors that would materially affect the estimation of Mineral Reserves that are not discussed in this Report.

A sensitivity analysis was conducted considering the 100% pit shell for each scenario with ranges in selling price, metallurgical recovery and total costs. Total costs include mining costs, processing costs, logistics costs (CIF China) and royalties. Table 15-3 shows the ranges used for this sensitivity analysis. The base case is highlighted.

Table 15-3 - Sensitivity Parameters

Item	Unit	-15%	Base Case	+15%
Selling price	US$/t concentrate	595	700	805
Processing recovery	%	51.3%	60.4%	69.5%
Total costs	US$/t concentrate	305	359	413

Table 15-4 sensitivity analysis results (ROM tonnage and project NPV) are based on the 100% revenue factor pit shell.

Table 15-4 - Sensitivity Analysis Results Relative to Base Case

Variable	Range	-15%	+15%
ROM tonnes	Selling price	-2.8%	2.3%
	Processing recovery	-2.1%	2.2%
	Total costs	2.7%	-2.1%
NPV	Selling price	-28.4%	28.8%
	Processing recovery	-24.6%	24.9%
	Total costs	13.8%	-9.5%

Table 15-4 shows that the concentrate selling price has the highest impact on the project economics, followed by the processing recoveries. Although the table shows that variations in the key parameters will have little impact on the ROM tonnage, the NPV is very sensitive to the variations of project assumptions.

16 MINING METHODS

16.1 OPEN PIT MINING

The initial nine years and three months LOM is planned for using open pit mining but there may be upside potential in the future to extend the LOM using underground mining methods.

16.2 MINE OPERATION AND LAYOUT

The proposed mining operations are based on the use of hydraulic excavators and a haul truck fleet engaged in conventional open pit mining techniques. Details of the pit slope design parameters are provided in Section 16.3.

Excavated material will be loaded to trucks and hauled to either the ROM pad or the waste pile. Ore excavation and haulage will be monitored by quality control personnel employed by the Geology department and details of material movement will be recorded by a radio dispatch system. Weathered material is considered to be free dig with transitional material to be lightly blasted to loosen it for digging. Fresh rock will be typically blasted on 6 m benches for the ore domain and 12 m benches for the waste domain.

In order to reduce dilution and maximize mine recovery, a controlled blasting (pre-splitting) technique will be used for the ore domain to reduce back-break and better control dilution. In badly fractured rock, unloaded guide holes may be drilled between the loaded holes.

The orebody is located in the south side of the pit walls for both pits. The benches follow the ore to maximize mine recovery. A higher dilution rate is expected in the deposit footwall given the project driver of maximizing mining recovery. The north side of the pit will be in waste (schist). The goal is to reduce waste development, thus overall slope angles for this zone are much higher.

16.3 GEOTECHNICAL ASSUMPTIONS

16.3.1 Introduction

The geotechnical study to define the parameters for the North and South pits was based on the works already developed in the region, geological information collected during the geological campaign stages, geotechnical data obtained from samples of 93 drill holes, uniaxial compression tests (UWC) of 8 composites samples and indirect tensile tests of 22 samples, to estimate the resistance parameters per the methodology developed by Bieniawski for the definition of rock mass rating (RMR). Pit slope parameters for both pits are included in Table 15-2.

16.3.2 Geotechnical Considerations

The geotechnical characterization logging over 65 drill holes (total length: 3,548 m) was used for generating a geotechnical model used for a statistical analysis of the RMR.

Figure 16-1 to Figure 16-3 show the location of the vertical sections of the geotechnical model for RMR statistical analysis. The vertical drill hole sections show the weathering grade model and correlated histogram with resulting RMR values.

Based on information from the drill holes geotechnical characterization, fault zones or deep weathering zones that could locally affect slope stability, were not detected.

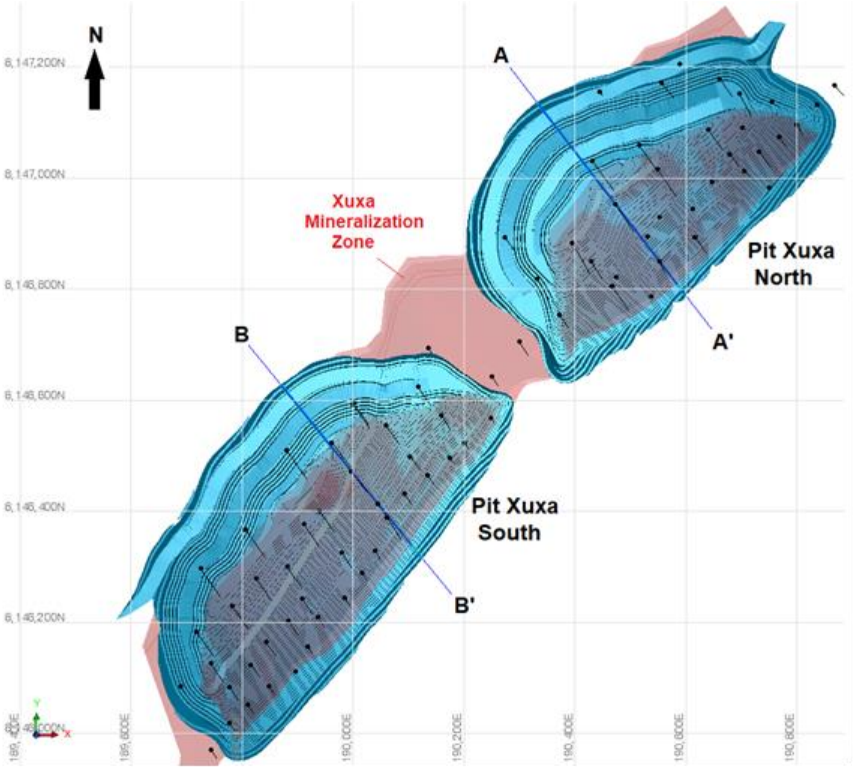


Figure 16-1 – Location of Geotechnical Sections

Note: Figure prepared by MCB, 2019.

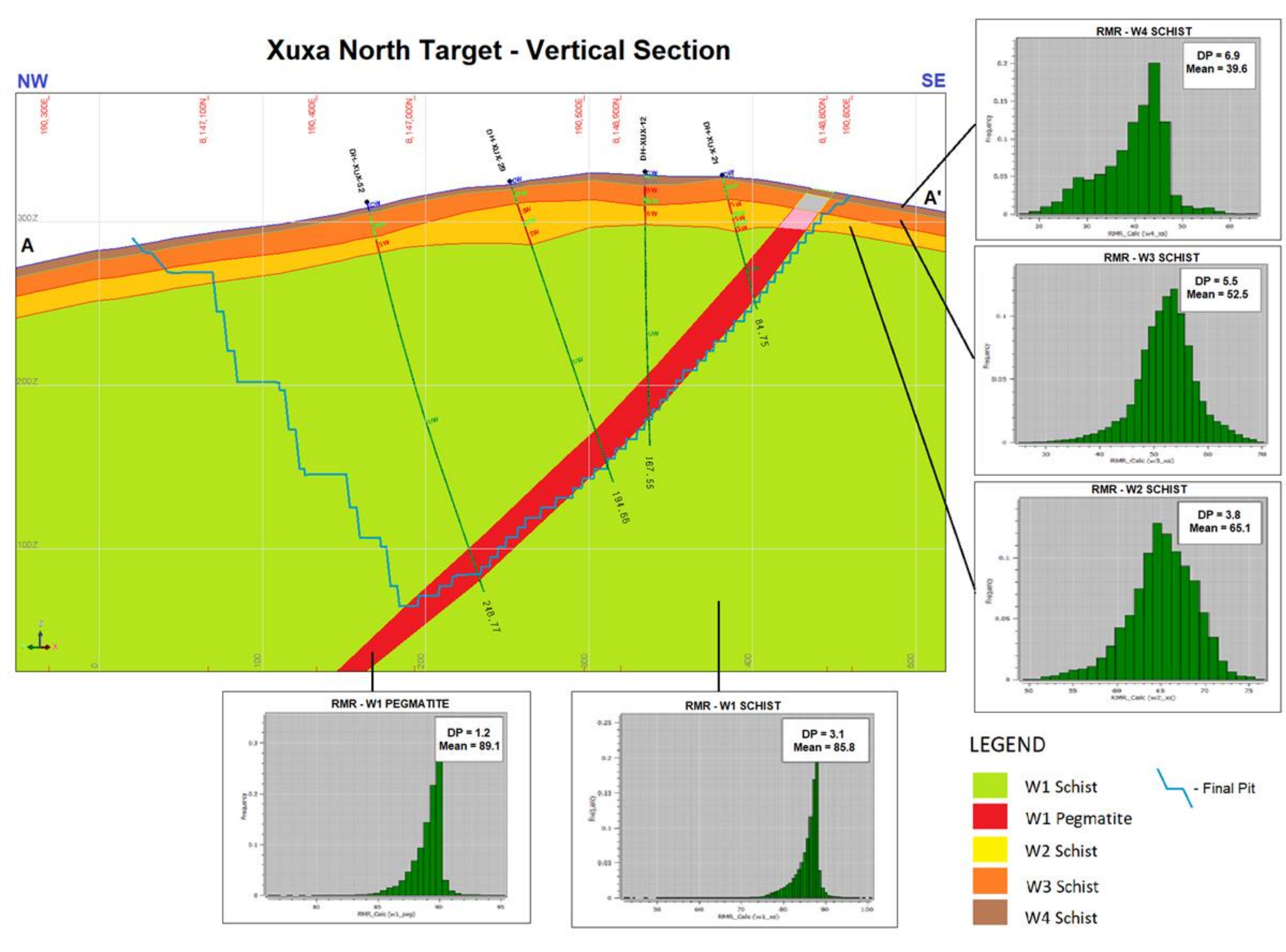


Figure 16-2 – Weathering Grade Vertical Drill Holes Section - Xuxa North Target

Note: Figure prepared by MCB, 2019.

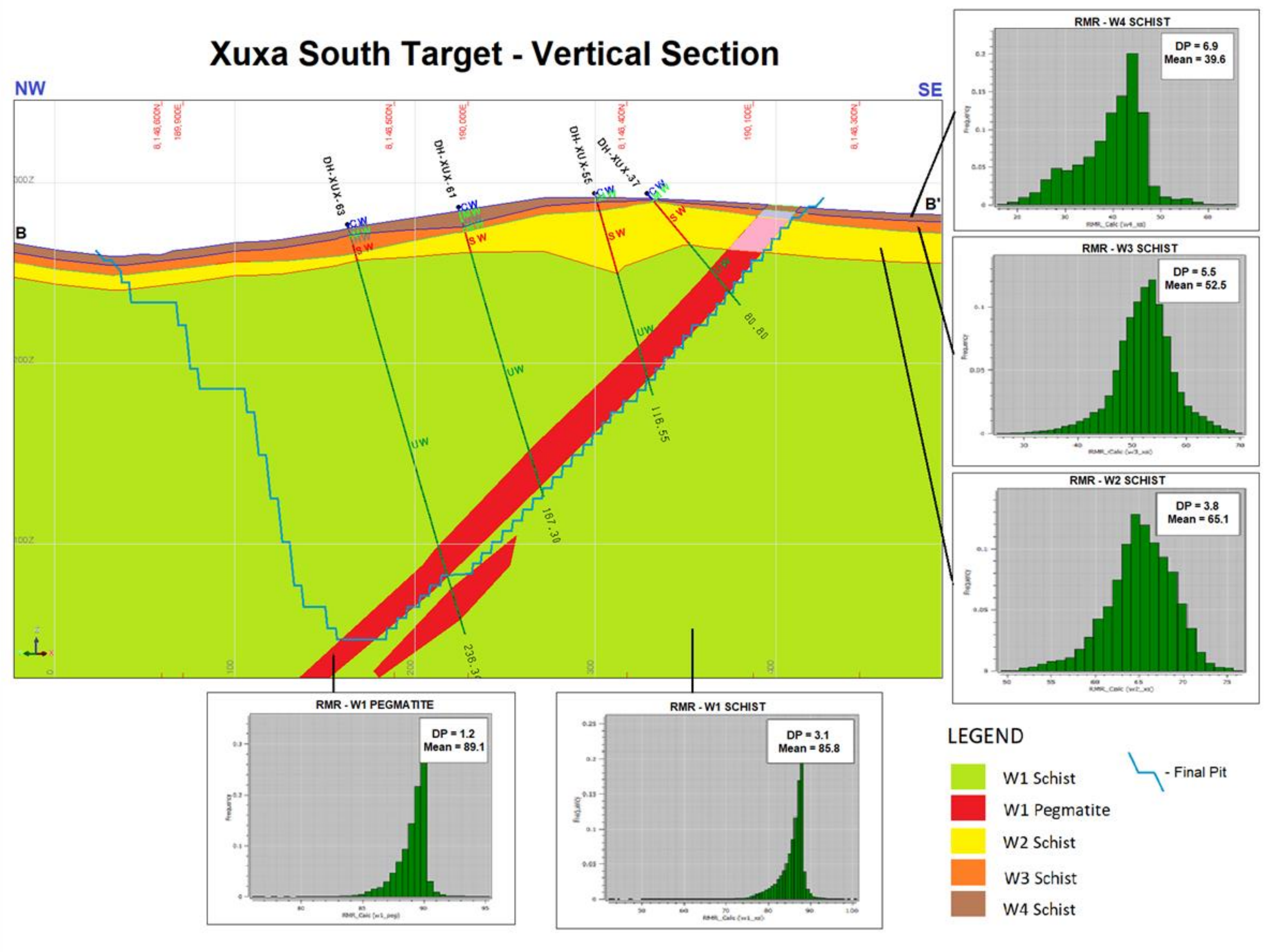


Figure 16-3 – Weathering Grade Vertical Drill Holes Section - Xuxa South Target

Note: Figure prepared by MCB, 2019.

The rock mass is defined as biotite-schist but based on close verification of the drill cores as well as of exposures in outcrops or in already implanted mines in the region, it does not exhibit sufficiently developed schist to define a preferential plane of weakness. In general, it exhibits an incipient schistosity not constituting a significant anisotropy in the rock mass. Zones with more intense schistosity are isolated and usually located in contact with the pegmatite or in areas with more severe shear or disturbance features. These features of the host rock that exhibit a massive aspect with low fracturing level, with low fracture level generally standard F1 / F2 with average spacing greater than 0.30 m, allow the adoption of steep face angles close to 90º and the use of benches with heights greater than 20 m.

To obtain the strength parameters and geotechnical indices for the rock mass in the region of Pits #1 and 2, drill cores samples representative of the different lithotypes were selected.

Table 16-1 presents the relationship between the collected samples and the depth of the holes and provides a geological description of each selected type.

Seven samples were sent for tests, four from the hanging wall and three from the foot wall. The schistosity orientation was identified, even for the samples in which the schist was incipient.

Table 16-1 – Sample Plan of Geotechnical Tests

Hanging Wall (HW) Foot Wall (FW)	ID-Furo	From (m)	To (m)	Interval (cm)	ID-Sample (geotechnical)	ID Sample Lab (geotechnical)	ENSAIO per Lithology	Recommended number of geotechnical tests (rapturas) in Laboratory	Lithology (original logged)	Foliation (angle to core axis)	Lithological Description
HW	DH-XUX-053	62.10	62.57	47	GT-0039	LT_01_CP_05	1	1	SCH	50°	**biotite-quartz-schist:** medium grey colour, compact, fine grained-matrix, compact, mainly composed of fine-grained quartz and biotite; showing a well-developed xistosity; presence of disseminated sub- to millimetric pyrite-aggregates, stretched sub-parallel with foliation; showing "spotted"-texture, caused by sub- to mm biotite aggregates, stretched sub-parallel with foliation.
HW	DH-XUX-053	76.83	77.31	48	GT-0040	LT_01_CP_01		1	SCH	60°	
HW	DH-XUX-053	97.34	98.26	92	GT-0041	LT_01_CP_04		1	SCH	50°	
HW	DH-XUX-053	135.66	136.24	58	GT-0042	LT_01_CP_03		1	SCH	50°	
HW	DH-XUX-053	173.91	174.82	91	GT-0046	LT_01_CP_02		1	SCH	45°	
HW	DH-XUX-023	133.43	134.06	63	GT-0048	LT_02_CP_01	2	1	SCH	without	**biotite-quartz-schist**: medium- to dark grey colour, extremely compact, very fine to fine-grained matrix, without to poorly developed schistosity, mainly composed of very fine- to fine-grained quartz and biotite; presence of disseminated fine-grained pyrite.
HW	DH-XUX-023	134.51	135.09	58	GT-0049	LT_02_CP_03 /LT_02_CP_05		2	SCH	without	
HW	DH-XUX-023	144.27	145.16	89	GT-0050	LT_02_CP_04		2	SCH	50°	
HW	DH-XUX-023	151.66	152.11	45	GT-0051	LT_02_CP_02		1	SCH	55°	
HW	DH-XUX-053	209.00	209.33	33	GT-0043	LT_03_CP_02	3	1	SCH	without	**calc-silicate-schist / rock (CS):** grey to pale green colour, compact, without foliation, fine to very fine-grained matrix, mainly composed of quartz, calcite and chlorite; showing diffuse layering/banding caused by mineral variation, probably representing a relict original cross-bedding; sometimes presenting sub- to mm amphibole-spotting; showing disseminated sub-millimetric pyrite-aggregates, especially within pale green coloured layers/bands; angel of banding to core-axis ~45° - 50°.
HW	DH-XUX-053	212.38	213.08	70	GT-0044	LT_03_CP_04 /LT_03_CP_05		2	SCH	without	
HW	DH-XUX-053	214.00	214.76	76	GT-0045	LT_03_CP_01		1	SCH	without	
HW	DH-XUX-053	216.61	216.86	25	GT-0047	LT_03_CP_03		1	SCH	without	
HW	DH-XUX-065	94.65	95.13	48	GT-0052	LT_04_CP_05	4	1	SCH	60°	**cordierite-biotite-quartz-schist**: medium-grey colour, compact, fine-grained matrix, well developed schistosity; mainly composed of fine-grained quartz and biotite; presence of "spotted"-texture, caused by sub- to mm biotite-aggregates, stretched sub-parallel with foliation; showing mm to cm
HW	DH-XUX-065	97.93	98.23	30	GT-0053	LT_04_CP_02		1	SCH	60°	

Hanging Wall (HW) Foot Wall (FW)	ID-Furo	From (m)	To (m)	Interval (cm)	ID-Sample (geotechnical)	ID Sample Lab (geotechnical)	ENSAIO per Lithology	Recommended number of geotechnical tests (rapturas) in Laboratory	Lithology (original logged)	Foliation (angle to core axis)	Lithological Description
HW	DH-XUX-065	102.09	102.55	46	GT-0054	LT_04_CP_01		1	SCH	60°	cordierite porphyroblasts representing mm to cm oval/rounded compact porphyroblasts and fine- to medium-grained porpyroblasts presenting a cauliflower-aspect, caused by fine-grained cordierite-aggregates; presence of disseminated fine-grained pyrite-aggregates, stretched sub-parallel with foliation.
HW	DH-XUX-065	103.28	103.71	43	GT-0055	LT_04_CP_03		1	SCH	70°	
HW	DH-XUX-065	103.94	104.65	71	GT-0056	LT_04_CP_04		1	SCH	55°	
FW	DH-XUX-067	267.27	267.74	47	GT-0058	LT_05_CP_02 /LT_05_CP_04	5	2	SCH	without	**calc-silicate-schist/rock**: greenish to greyish colour, compact, very fine- to fine-grained matrix, mainly composed of quartz, calcite and chlorite; presence of disseminated sub-millimetric pyrite; without foliation (rock); presenting diffuse layering/banding deformation (folding); diffuse layers/bands are caused by mineral variation/distribution, probably representing an original cross-bedding.
FW	DH-XUX-067	270.74	271.16	42	GT-0059	LT_05_CP_05		1	SCH	without	
FW	DH-XUX-067	271.16	271.54	38	GT-0060	LT_05_CP_01		1	SCH	without	
FW	DH-XUX-067	271.74	272.20	46	GT-0061	LT_05_CP_03		1	SCH	without	
FW	DH-XUX-073	119.25	119.75	50	GT-0062	LT_06_CP_01	6	1	SCH	55°	**cordierite-biotite-quartz-schist**: medium-grey colour, extremely compact, poorly developed schistosity, fine-grained matrix, mainly composed of quartz and biotite; showing mm to cm oval rounded cordierite-porphyroblast and fine-grained aggregates of cordierite, presenting a cauliflower-structure; presence of accessory minerals like sub-millimetric transparent euhedral garnet crystals; sometimes disseminated fine-grained pyrite can be observed.
FW	DH-XUX-074	120.03	120.36	33	GT-0063	LT_06_CP_02		1	SCH	45°	
FW	DH-XUX-075	120.36	120.61	25	GT-0064	LT_06_CP_03		1	SCH	45°	
FW	DH-XUX-076	120.98	121.22	24	GT-0065	LT_06_CP_04		1	SCH	45°	
FW	DH-XUX-077	121.86	122.18	32	GT-0066	LT_06_CP_05		1	SCH	50°	
FW	DH-XUX-074	210.04	210.45	41	GT-0067	LT_07_CP_01	7	1	SCH	70°	**biotite-quartz-schist**: medium- to pale grey colour, extremely compact, poorly developed schistosity; fine-grained matrix, mainly composed of quartz and biotite; often showing frequently alteration of pale grey quartz-rich bands/layers with medium-grey to dark-grey biotite-rich layers/bands; presence of disseminated fine-grained pyrite, stretched sub-parallel with foliation.
FW	DH-XUX-074	212.48	213.00	52	GT-0068	LT_07_CP_02		1	SCH	45°	
FW	DH-XUX-074	252.83	253.61	78	GT-0069	LT_07_CP_03 /LT_07_CP_04		2	SCH	55°	
FW	DH-XUX-073	109.29	109.73	44	GT-0070	LT_07_CP_05		1	SCH	45°	

Table 16-2 summarizes the results of the uniaxial compressive strength tests (values in red were not used in calculations of the mean).

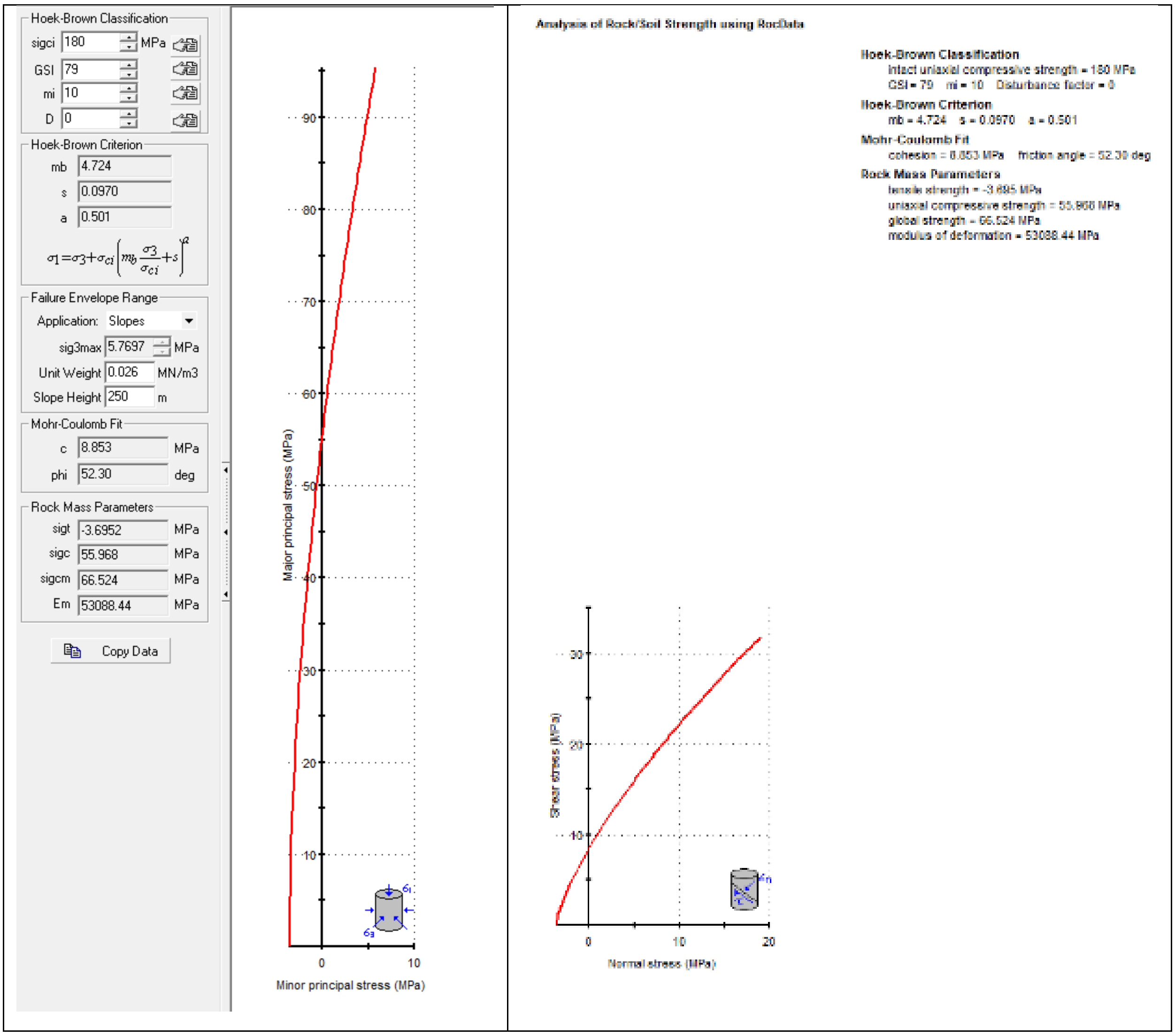
Table 16-2 – UCS Test Results

Lithology	Code	Height (mm)	Diameter (mm)	Resistance (MPa)	Young's Modulus (GPa)	Poisson Ratio
1	LT_01_CP_01	166.65	62.70	107.14	34.26	0.433
	LT_01_CP_02	166.50	62.95	84.76	34.59	0.334
	LT_01_CP_03	166.70	62.95	152.38	33.40	-
	LT_01_CP_04	166.60	62.85	87.12	29.40	0.327
	LT_01_CP_05	166.60	62.80	128.28	36.26	0.364
	Mean			**111.94**	**33.58**	**0.342**
2	LT_02_CP_01	164.35	62.70	167.64	38.78	0.344
	LT_02_CP_02	164.50	62.75	221.39	58.68	0.222
	LT_02_CP_03	169.10	62.65	163.20	37.25	0.310
	LT_02_CP_04	169.45	62.75	164.18	39.04	0.412
	LT_02_CP_05	165.60	62.70	184.63	39.73	0.298
	Mean			**180.21**	**42.69**	**0.294**
3	LT_03_CP_01	166.50	63.10	142.93	40.26	0.226
	LT_03_CP_02	166.55	63.00	213.31	60.81	0.282
	LT_03_CP_03	166.40	63.10	158.55	50.34	0.217
	LT_03_CP_04	166.55	63.05	120.97	41.65	0.312
	LT_03_CP_05	166.60	63.10	154.49	48.24	0.291
	Mean			**158.05**	**48.26**	**0.266**
4	LT_04_CP_01	167.20	63.25	63.25	31.12	0.342
	LT_04_CP_02	168.25	63.20	62.59	32.39	0.231
	LT_04_CP_03	168.30	63.25	72.70	36.63	0.217
	LT_04_CP_04	168.25	63.20	76.15	38.60	0.220
	LT_04_CP_05	168.70	63.25	74.34	41.30	0.301
	Mean			**69.80**	**36.01**	**0.262**
5	LT_05_CP_01	166.30	63.05	149.79	42.69	0.330
	LT_05_CP_02	164.40	63.05	293.68	54.73	0.274
	LT_05_CP_03	164.40	63.10	136.84	47.14	0.406
	LT_05_CP_04	164.30	63.05	228.59	53.31	0.241
	LT_05_CP_05	164.30	63.05	129.71	42.05	0.350
	Mean			**187.72**	**47.98**	**0.299**
6	LT_06_CP_01	165.50	63.10	76.09	26.60	0.223
	LT_06_CP_02	165.45	63.15	83.73	32.35	0.491
	LT_06_CP_03	165.45	63.10	59.94	23.57	0.336
	LT_06_CP_04	168.80	62.90	59.49	26.11	0.447
	LT_06_CP_05	165.45	62.85	50.07	21.57	0.354
	Mean			**63.31**	**25.90**	**0.407**
7	LT_07_CP_01	168.80	63.10	159.27	55.37	0.237
	LT_07_CP_02	168.75	63.10	71.56	39.74	0.297
	LT_07_CP_03	168.65	62.35	133.89	36.09	0.368
	LT_07_CP_04	168.75	62.35	141.97	36.86	-
	LT_07_CP_05	168.75	62.85	82.14	28.17	0.479
	Mean			**117.77**	**39.25**	**0.301**

Based on the results from the uniaxial compressive strength tests and the elastic modulus, it can be stated that the expected behavior of the rock mass is well characterized. The gathered information and performed tests are more than sufficient for the characterization and geomechanical classification of the rock mass in the area of implantation of Pit #1 and Pit #2.

Twenty indirect tensile tests were performed using the Brazilian Method to determine the tensile strength or cohesion values of Pit #1 and Pit #2. The results from the two series of 10 ruptures resulted in average yield strengths of 11.3 MPa for Series 1 and 14.9 MPa for Series 2. All failure modes were valid, and the saturation condition was dry. The results show a variation that can be considered as adequate for the performed tests and representative for the tensile strength values of the rock mass for Pit #1 and Pit #2.

From the data and information obtained from the samples' description and laboratory assays, a geomechanical classification (RMR (Bieniawski) and Q (Barton)) was obtained for the rock massif using Geo & Soft's CLASROCK 32 software. The resulting Q index (Barton) was 183.33 (extremely good), the RMW (Bieniawski) was 79 (Good 80-61) with a Geological Strength Index (GSI) of 79. The resulting geomechanical classification for the area is Bieniawski Class II rock mass with a Q-Value of 183.33. The geotechnical index was obtained using the Rocscience ROCdata software for the expected behaviour simulation and shown in Figure 16-4.



Hoek-Brown Classification
sigci 180 MPa
GSI 79
mi 10
D 0

Hoek-Brown Criterion
mb 4.724
s 0.0970
a 0.501

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

Failure Envelope Range
Application: Slopes
sig3max 5.7697 MPa
Unit Weight 0.026 MN/m3
Slope Height 250 m

Mohr-Coulomb Fit
c 8.853 MPa
phi 52.30 deg

Rock Mass Parameters
sigt -3.6952 MPa
sigc 55.968 MPa
sigcm 66.524 MPa
Em 53088.44 MPa

Analysis of Rock/Soil Strength using RocData

Hoek-Brown Classification
intact uniaxial compressive strength = 180 MPa
GSI = 79 mi = 10 Disturbance factor = 0

Hoek-Brown Criterion
mb = 4.724 s = 0.0970 a = 0.501

Mohr-Coulomb Fit
cohesion = 8.853 MPa friction angle = 52.30 deg

Rock Mass Parameters
tensile strength = -3.695 MPa
uniaxial compressive strength = 55.968 MPa
global strength = 66.524 MPa
modulus of deformation = 53088.44 MPa

Figure 16-4 – RocData Software Results

Note: Figure prepared by MCB, 2019.

Simulations of expected behavior for the North and South slopes for the evaluation of slope stability using Rocscience PHASE 2 software were performed using stress x strain analysis, the most appropriate methodology for the expected conditions. Since the weathered portion is restricted to the first two banks of the pits with predominant exposure of healthy rock, no circular type instability processes are expected justifying the adoption of this methodology to verify the expected behavior of the rock mass.

Geotechnical sections were used for the simulations, as shown in Figure 16-5 and Figure 16-6, and the results obtained for the two sections that present the most severe conditions expected for each of the pits are presented in sequence.

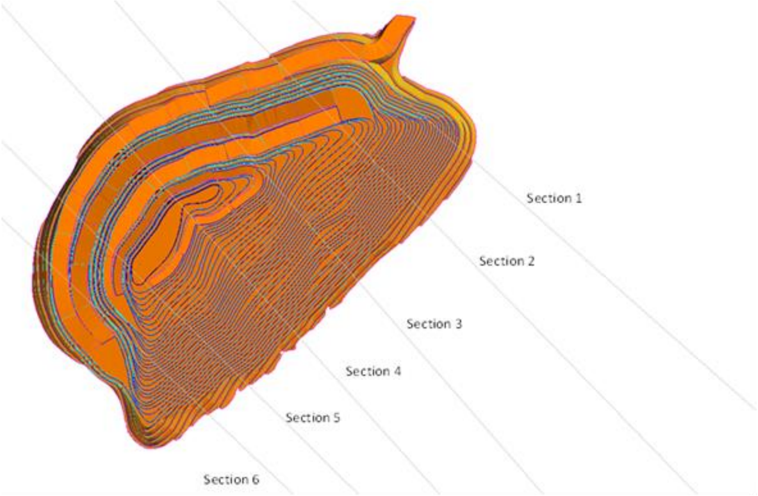


Figure 16-5 – Pit 1: Section Locations

Note: Figure prepared by MCB, 2019.

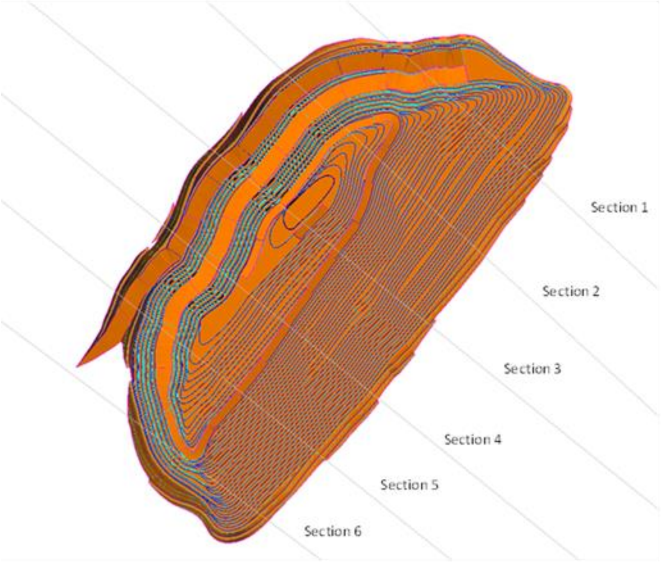


Figure 16-6 – Pit 2: Section Locations

Note: Figure prepared by MCB, 2019.

In summary, based on the characterization and geomechanical classification work, the following resistance parameters and geotechnical indices were defined for stability analyses:

- Class: 2 (Bieniawski system)
- RMR: 79
- RMS: 106 MPa (rock mass strength)
- MRMR: 63 (mining RMR - Laubscher)
- DRMS: 92.7 MPa (design rock mass strength - Laubscher)

Parameters used in mathematical modelling simulations included:

- Internal friction angle: weathered rock mass 30°
- Internal friction angle: fresh rock mass 52°
- Modulus of elasticity: weathered rock mass 1 GPa
- Modulus of elasticity: fresh rock mass 53 GPa
- Cohesion: weathered rock mass 0.5 Mpa
- Cohesion: fresh rock mass 8.85 Mpa
- Tensile strength: weathered rock mass 0.5 MPa
- Tensile strength: fresh rock mass 3.70 MPa

Safety factors for a critical section of each pit were included in Figure 16-7 and Figure 16-8.

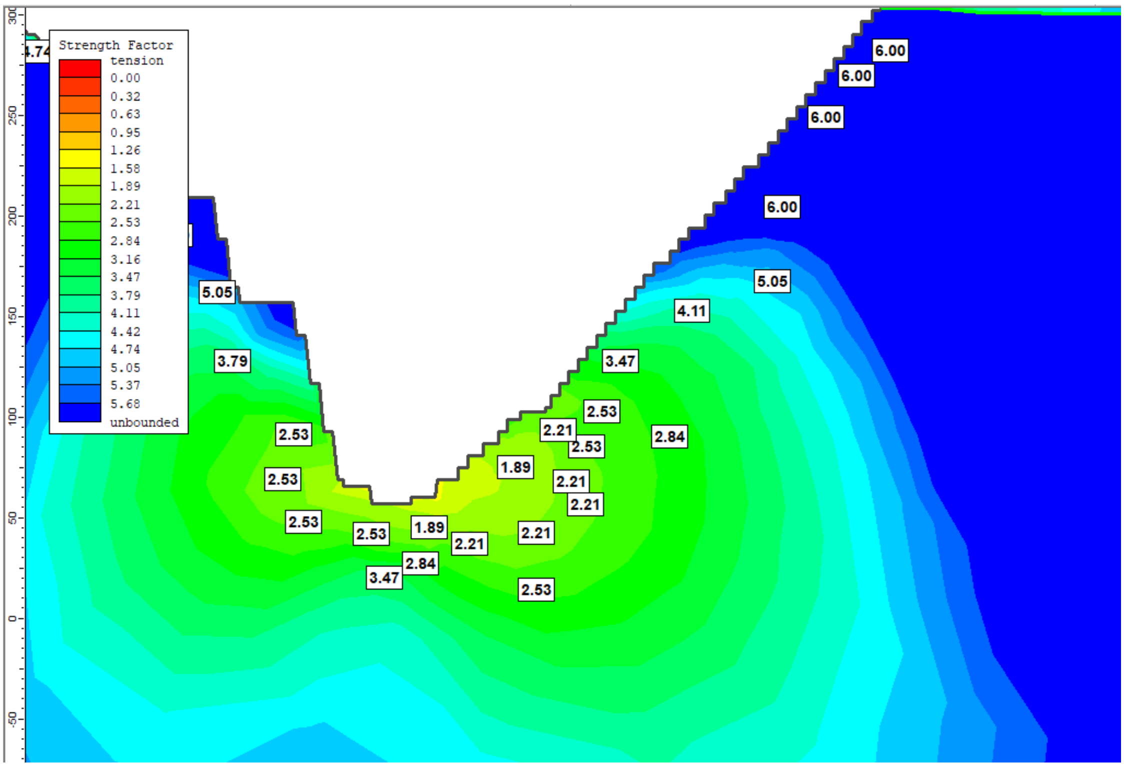


Figure 16-7 – Safety Factors – Section 3 Pit 1

Note: Figure prepared by MCB, 2019.

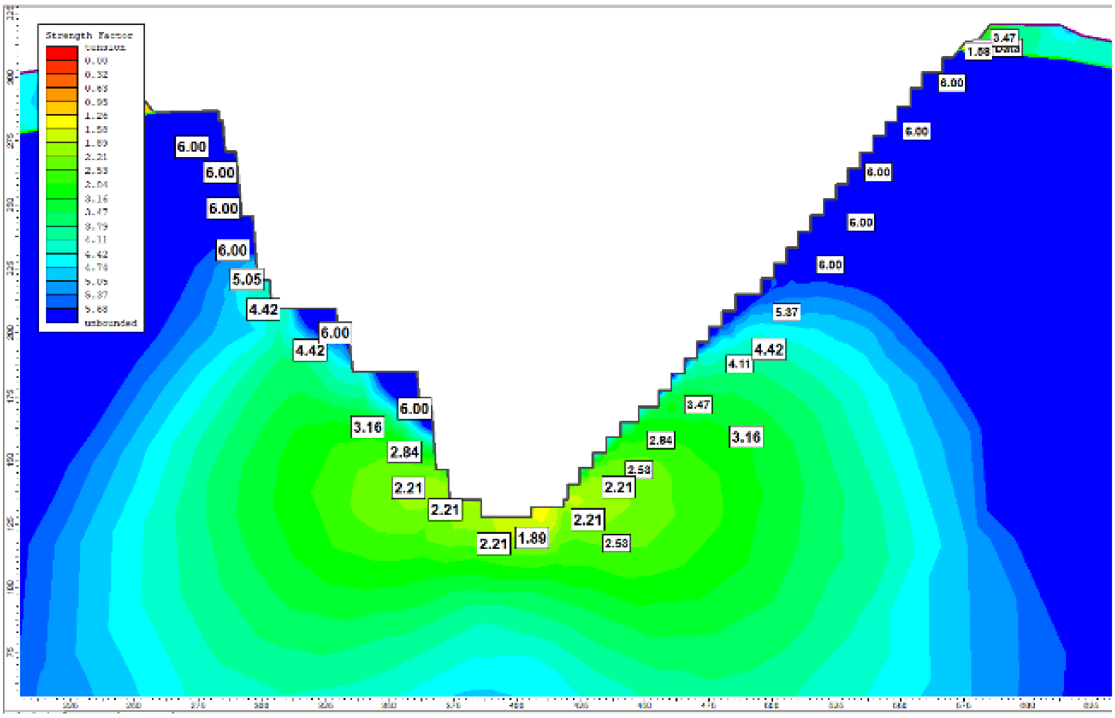


Figure 16-8 – Safety Factors – Section 3 Pit 2

Note: Figure prepared by MCB, 2019.

Values obtained from the simulations indicate adequate stability conditions for both pits for the proposed geometry.

During the operation phase, a geotechnical monitoring system will be implanted to continually collect and analyse data and, if necessary, issue alerts of abnormal movements in the pit walls.

16.4 ENGINEERED PIT DESIGNS

The engineered pit designs were completed using the pit optimization shells as a guide in order to maximize the value and lithium recovered inside the ultimate pits. The resulting pit designs include practical geometry that required in an operational mine, such as the haul road to access all the benches, recommended pit slopes with geotechnical berms, proper benching configuration, and smoothed pit walls. The last benches of both pits have a half-ramp design to reduce the amount of stripping necessary to mine the ore from those benches. The resulting engineered pit designs were used to estimate the Mineral Reserves as stated in Table 15-1.

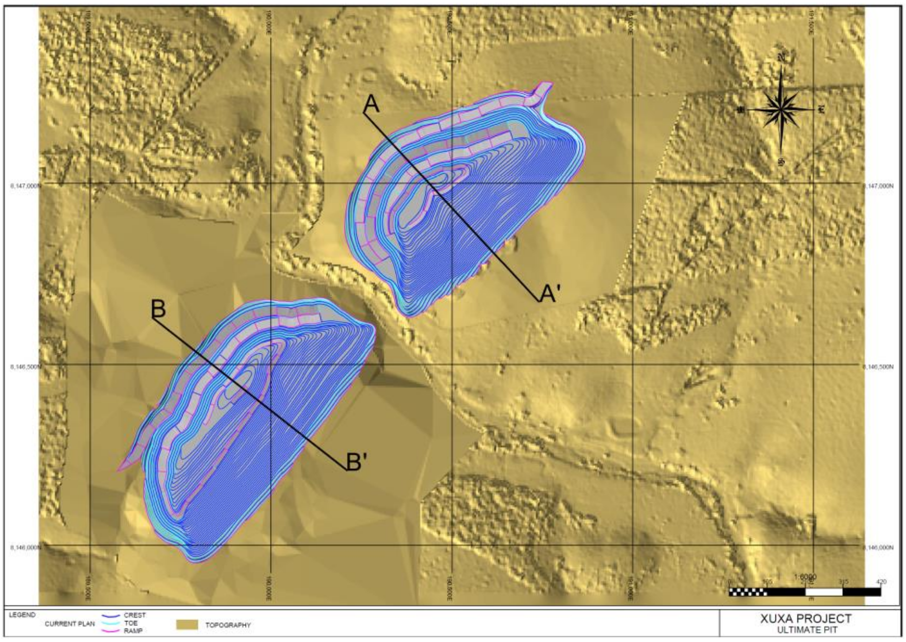


Figure 16-9 - Final Pit Designs – 3D View

Note: Figure prepared by MCB, 2019.

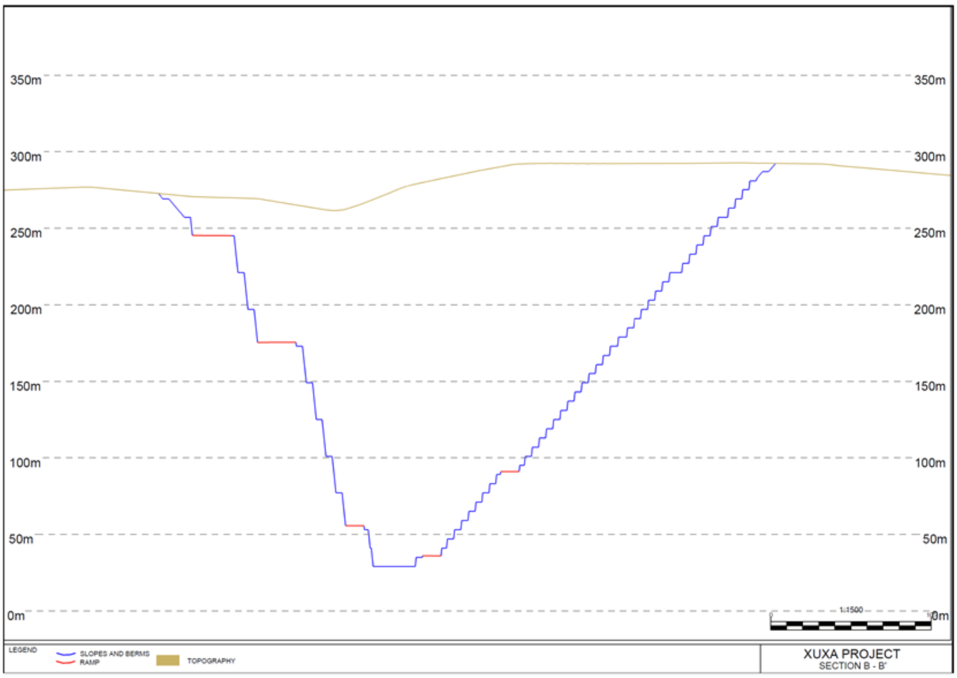


Figure 16-10 - Final Pit Designs – Section View (A-A')

Note: Figure prepared by MCB, 2019

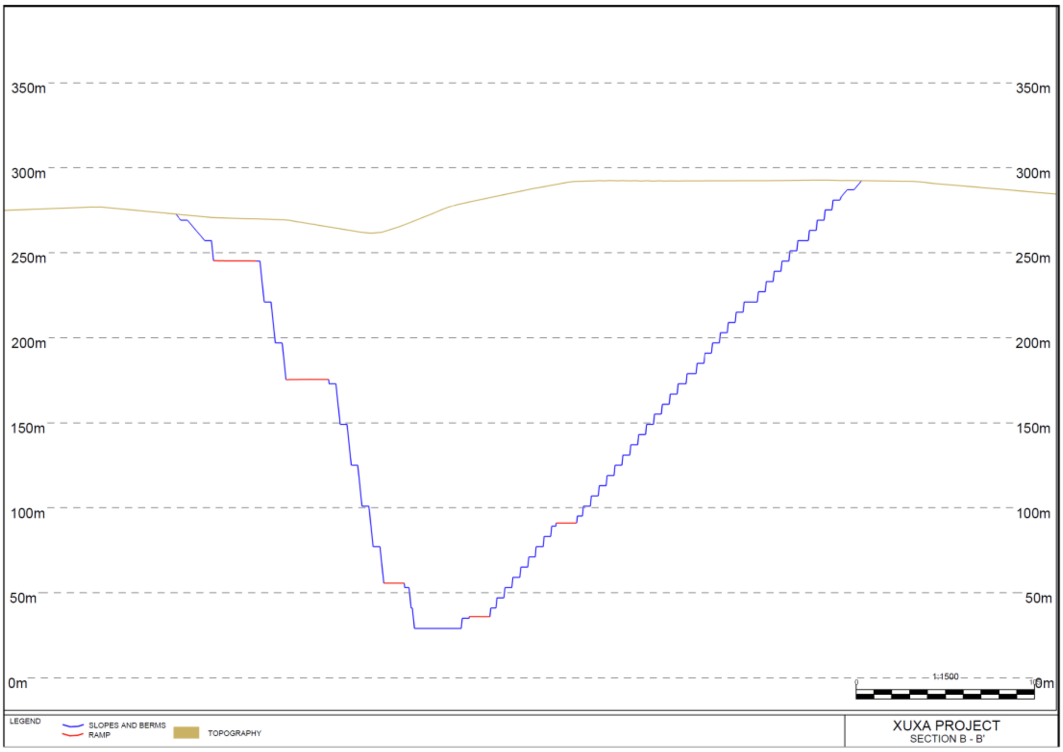


Figure 16-11 - Final Pit Designs – Section View (B-B’)

Note: Figure prepared by MCB, 2019.

16.5 MINE SCHEDULING

Four pushbacks were designed for each pit for mine scheduling, using the following criteria:

- Six months of pre-stripping with a maximum of 6 Mt of waste
- Mining starts at Pit 1 as this is closer to the processing plant and is also included in the current environmental license process
- Waste piles 1 and 2 are used in the first five quarters of the operation
- Waste pile 1 will be used for co-disposal of waste and tailings
- Waste pile 2 will mainly be used for soil disposal
- Waste pile 3 will be available from Quarter 6 onwards
- Pit 2 and waste pile 4 start operation from Year 3 onwards
- Mine both pits in conjunction from Year 3 to Year 6 to reduce the drop-down rate and to facilitate the 1.5 Mtpa ore goal
- Process plant ramp up (in Year 1, month 7): 25% month 7, 60% month 8 and 100% for month 9 onwards
- 125 kt of ROM per month/375 kt of ROM per quarter/1.5 Mtpa of ROM per year
- Maximum 5 Mt of waste per quarter / 20 Mt of waste per year.

Table 16-3 shows the mine scheduling considering the operational design.

Table 16-3 - Operational Mine Scheduling

Period		ROM (kt)	Li_2O (%)	Fe (%)	Waste (kt)	Plant (kt)	Li_2O (%)	Fe (%)
Y1	M1	6.8	1.17	0.78	985.8			
	M2	6.4	1.21	0.80	987.1			
	M3	6.8	1.27	0.81	928.9			
	M4	16.7	1.21	0.71	1,087.5			
	M5	17.0	1.30	0.52	1,049.0			
	M6	15.0	1.35	0.52	946.2			
	M7	89.5	1.32	0.67	1,255.1	31.3	1.26	0.65
	M8	94.1	1.35	0.64	1,266.9	75.0	1.30	0.66
	M9	93.5	1.23	0.74	1,665.1	125.0	1.34	0.65
	M10	126.6	1.50	0.62	1,147.7	125.0	1.27	0.72
	M11	127.6	1.40	0.69	1,241.9	125.0	1.49	0.62
	M12	120.7	1.25	0.74	1,197.0	125.0	1.39	0.69
Y2	M1	124.2	1.54	0.69	1,519.7	125.0	1.27	0.74
	M2	126.0	1.37	0.74	1,546.1	125.0	1.53	0.70
	M3	128.1	1.36	0.74	1,599.4	125.0	1.37	0.74
	M4	126.9	1.39	0.74	1,562.6	125.0	1.36	0.74
	M5	125.5	1.43	0.75	1,594.1	125.0	1.39	0.74
	M6	124.0	1.35	0.82	1,572.6	125.0	1.43	0.75
	M7	125.0	1.29	0.85	1,529.0	125.0	1.34	0.82
	M8	125.4	1.30	0.80	1,575.3	125.0	1.29	0.85
	M9	125.0	1.41	0.81	1,506.8	125.0	1.30	0.80
	M10	126.4	1.33	0.85	1,574.1	125.0	1.41	0.81
	M11	126.4	1.28	0.88	1,581.4	125.0	1.33	0.85
	M12	135.7	1.31	0.89	1,343.3	125.0	1.28	0.88
Y3	Q1	377.0	1.37	0.88	4,498.5	375.0	1.35	0.88
	Q2	368.1	1.41	0.88	4,833.7	375.0	1.40	0.88
	Q3	369.6	1.44	0.89	4,683.2	375.0	1.43	0.88
	Q4	355.3	1.38	0.96	4,797.0	375.0	1.40	0.93
Y4		1,452.8	1.39	0.77	16,979.9	1,500.0	1.39	0.78
Y5		1,578.2	1.38	1.02	18,024.3	1,500.0	1.38	1.01
Y6		1,462.8	1.42	1.02	19,084.5	1,500.0	1.42	1.02
Y7		1,522.3	1.53	1.02	17,899.4	1,500.0	1.52	1.02
Y8		1,471.8	1.60	1.06	10,065.5	1,500.0	1.60	1.06
Y9		1,530.1	1.58	1.08	4,254.5	1,500.0	1.58	1.08
Y10		1,056.4	1.55	1.10	1,002.5	1,177.4	1.55	1.10
TOTAL		**13,783.7**	**1.46**	**0.96**	**138,385.6**	**13,783.7**	**1.46**	**0.96**

16.6 MINING FLEET

The open pit mining activities were assumed to be primarily undertaken by a contractor-operated fleet.

The proposed plant processing rate allowed a total ore material movement of under 2 Mtpa, which is suitable for small equipment such as on-highway trucks. This is a cost-effective option since most of this equipment is assembled in Brazil, therefore its capital cost is reduced due to the exemption from import taxes. Operating costs can also be reduced because spare parts for the equipment can be easily bought, and operational and maintenance services can be readily provided.

Small excavator and loading equipment are also suitable for ore selectivity, whilst maintaining productivity in 6-m operational benches.

Off-highway trucks were considered for the waste rock given a production of around 18 Mtpa.

For waste rock, an excavator of 15 m^3 (Hitachi 2500 or similar) was selected to load 150-t class trucks (CAT 785 or similar). For ore, a 4.6 m^3 excavator (CAT 374 or similar) was selected to work with a 40-t truck (Actros 8x4 or similar). The same support equipment class was defined for both.

The proposed mining fleet, and peak fleet numbers, is summarized in Table 16-4.

Table 16-4 - Major Open Pit Equipment Requirements

Description	Equipment Type	Class	Number of Units
Loading	Hydraulic excavator	CAT 374	2
	Hydraulic excavator	Hitachi 2500	2
	Wheel loader	980	1
Hauling	Highway truck	40-tonnes	6
	Off-highway truck	150-tonnes	11
Drilling	Drill	Rotary drill	4
Blasting	Explosive truck	Anfo load truck	1
Support	Motor grader	16 ft. Class	2
	Track dozer	D9-class	3
	Water truck	25,000-L class	3
	Small excavator	CAT 336	2
	Fuel and lubricant truck	Fuel and lube truck	1
	Flatbed truck	Flatbed truck with crane	1
	RC drill		1
	Light vehicle	L200	8
	Light tower	Light + genset	7
	Pumps + senerator set		1

16.6.1 Drill and Blasting

One blast will be required per day. The drill and blast requirements will include:

- Ore
- Bench height: 6 m
- Burden and spacing: 3.0 m x 3.3 m
- Hole diameter: 4 inches
- Powder factor: 0.297 kg/t

- Waste
- Bench height: 12 m
- Burden and spacing: 5.0 m x 6.0 m
- Hole diameter: 6 inches
- Powder factor: 0.244 kg/t

The anticipated drilled meters, number of rock drills and total ANFO/emulsion requirements are provided in Table 16-5 .

Table 16-5 - Drill and Blasting Data

Year	Total number of drilled meters (km)	Number of drills required (unit)	Total ANFO/Emulsion required (kg)
Y1/Q1	43.42	2	662,418
Y1/Q2	44.67	2	671,819
Y1/Q3	66.33	3	932,413
Y1/Q4	64.65	3	876,507
Y02	316.28	4	4,394,670
Y03	308.05	4	4,267,810
Y04	307.46	4	4,258,805
Y05	308.05	4	4,267,810
Y06	307.90	4	4,265,622
Y07	308.03	4	4,267,504
Y08	199.74	3	2,599,149
Y09	81.62	1	1,114,090
Y10	13.22	1	203,678

16.7 PIT DEWATERING

In the pits, drainage will be directed through the benches to the bottom bench. The design assumes a sump pumping to an elevation that is a maximum of 250 m above the pit base. When necessary, it may discharge the water into the waste pile ponds that will be located near each pit. The pit sump system will have to be reestablished for each sinking cut. Water from the pits will be used for haul road dust suppression.

Groundwater is not expected inside the pit limits, however, a monitoring programme will be implemented as stated in section 18.4.1.3. If there is any groundwater, it will not be possible to separate the surface runoff in the base of the pit from groundwater. Any water that cannot be diverted would have to be pumped from the sump at the base of the pit, or from diversion sumps on haul ramps.

Each waste pile will have its own sedimentation pond that will collect runoff from the waste piles and, eventually, pumped water from the pits. The ramps and benches will be constructed in order to facilitate the drainage to this pond. Cleaning of this ponds will occur during the dry season and whenever possible this cumulated water will also be used for dust suppression.

16.8 MANPOWER

The mine personnel will work three shifts with four crews to provide 24/7 coverage. The effective hours worked for the production are approximately 21.7 hours per day.

The production and maintenance will be carried out by contractors. Total manpower for the mine is presented in Table 16-6 for the peak and correspond to 273 people.

Table 16-6 - Manpower Peak Numbers

Company	**Area**	**Position**	**Peak Number**
Sigma	Technical Services	Chief Mining and Production Engineer	1
Sigma	Technical Services	Mining Supervisor	2
Sigma	Technical Services	Chief Geology	1
Sigma	Technical Services	Geology Supervisor	1
Sigma	Technical Services	Field Geologist	2
Sigma	Technical Services	Surveyor	2
Sigma	Technical Services	Geology Assistant	2
Contractor	Operation	Drivers	102
Contractor	Operation	Operators	44
Contractor	Administrative	Contract Manager	1
Contractor	Administrative	Administrative Clerk	1
Contractor	Administrative	Supply Analyst	2
Contractor	Administrative	Buyer	1
Contractor	Administrative	Driver	9
Contractor	Administrative	Industrial Electrician	4
Contractor	Administrative	Pump Mechanic	4
Contractor	Administrative	Watchman	4
Contractor	Administrative	Operator (support equipment)	4
Contractor	Production	Production Engineer	1
Contractor	Production	Production Clerk	4
Contractor	Production	Production Controller	1
Contractor	Production	Topographer	1
Contractor	Production	Topography Assistant	2
Contractor	Production	Drill and Blast Clerk	2
Contractor	Maintenance	Maintenance Clerk	1
Contractor	Maintenance	Maintenance Controller	1
Contractor	Maintenance	Mechanic Specialist	6
Contractor	Maintenance	Mechanic	12
Contractor	Maintenance	Maintenance Assistant	12
Contractor	Maintenance	Electrician	5
Contractor	Maintenance	Lubrification Operator	8
Contractor	Maintenance	Lubrication Assistant	8
Contractor	Maintenance	Tire repairer	6
Contractor	Maintenance	Welder	2
Contractor	Maintenance	Washer	2
Contractor	HSEQ	Occupational Physician	1
Contractor	HSEQ	Occupational Health and Safety Engineer	1
Contractor	HSEQ	Occupational Health and Safety Technician	3
Contractor	Exploration	Operator	6
Contractor	Exploration	Drilling Technician	1
TOTAL			**273**

17 RECOVERY METHODS

17.1 PROCESSING PLANT DESCRIPTION

The concentrator plant will be located approximately 5 km from the open pit mine pits. The spodumene concentrate will be produced by DMS. The DMS plant is designed to produce a minimum 6.0% Li_2O spodumene concentrate from ore grade of 1.46% Li_2O (diluted), with an average iron content of 0.97%.

The plant throughput capacity is based on 1.5 Mtpa (dry) of ore fed to the crushing circuit. As an option, an in-house crushing circuit of 3.0 Mtpa could be installed which would allow for upside potential if the Mineral Resources from the remaining deposits in Section 14 can be converted to Mineral Reserves. Figure 17-1 shows the planned layout for the in-house crushing system and DMS plant.

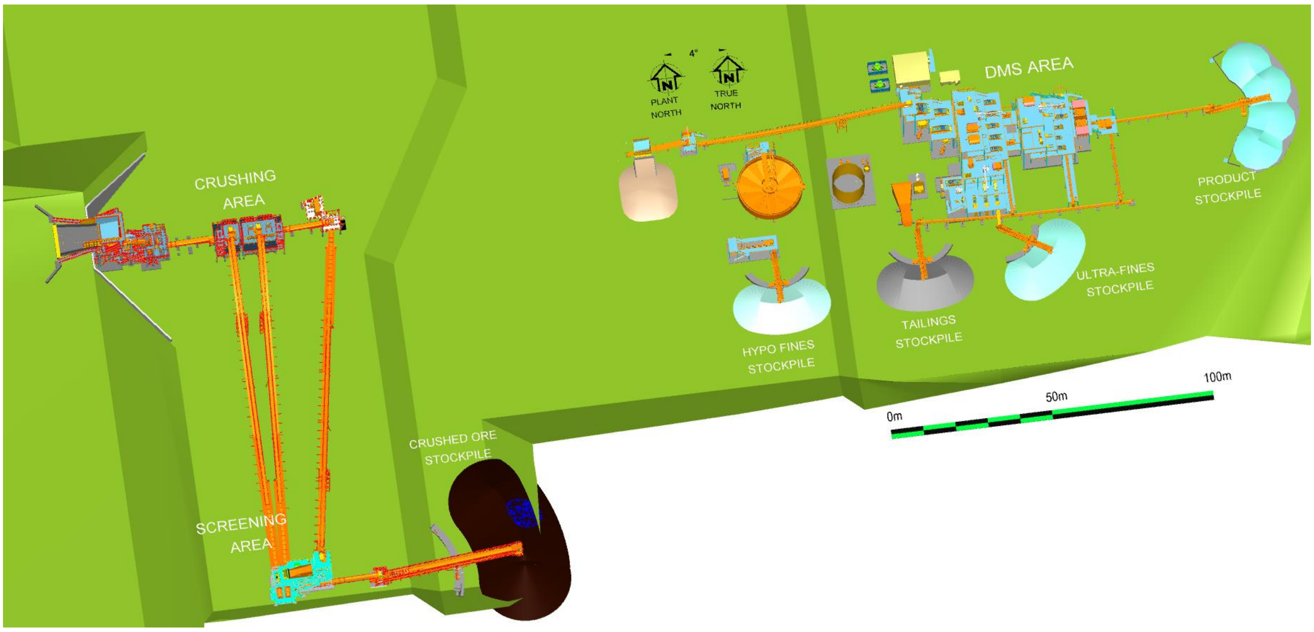


Figure 17-1 – Process Plant: In-house Crushing and DMS Plant

Note: Figure prepared by Primero, 2019.

The spodumene concentrator process plant is designed based on a proven DMS circuit and includes the following:

- A three-stage conventional crushing and screening circuit
- DMS screening and mica removal via up-flow classification
- Two-stage DMS circuit for coarse fraction
- Two-stage DMS circuit for fines fraction with a magnetic separation step
- Single-stage DMS circuit for ultra-fines fraction
- Thickening, filtration (belt filter) and dry stacking of hypofines fraction with the waste
- Optical sorting and / or magnetic separation on the concentrate
- Tailings from the DMS plant trucked for co-disposal with the waste rock.

Ore trucked from the mine will be dumped directly into the feed bin for the primary crusher at the process plant and crushed in three stages using a jaw crusher, a secondary cone crusher and two tertiary cone crushers. Crushed ore will be fed to a double-deck screen, where ore will be separated into three fractions. The oversize (-150 mm + 60 mm) will be sent to the secondary crusher for further crushing and recycled back to the screen. The middlings (-60 mm + 9.5 mm) will be fed to tertiary crushing. The undersize fraction (-9.5 mm) will be sent to the crushed ore stockpile for feed to the wet plant.

The wet plant will consist principally of a two-stage DMS circuit for coarse fractions, two-stage DMS circuit for fines fraction and a single-stage DMS circuit for the ultra-fines fraction.

The sinks from the secondary stage coarse DMS and the secondary stage fines DMS (which includes a wet magnetic separation step) will report to the DMS product stockpile for truck loading and transport.

The floats from the primary stage coarse DMS cyclone, primary stage fines cyclones and secondary fines cyclone as well as those from the ultra-fines cyclone will report to a tailings pile.

The sinks from the ultra-fines DMS will report to the ultra-fines product stockpile for blending with coarse/fine spodumene product for sale.

A DMS tails thickener and filtration system will be used prior to stockpiling of -0.5 mm hypo-fines with the waste pile.

Figure 17-2 is a block flow diagram for the crushing circuit and the DMS plant. Figure 17-3 represents a simplified process flowsheet.

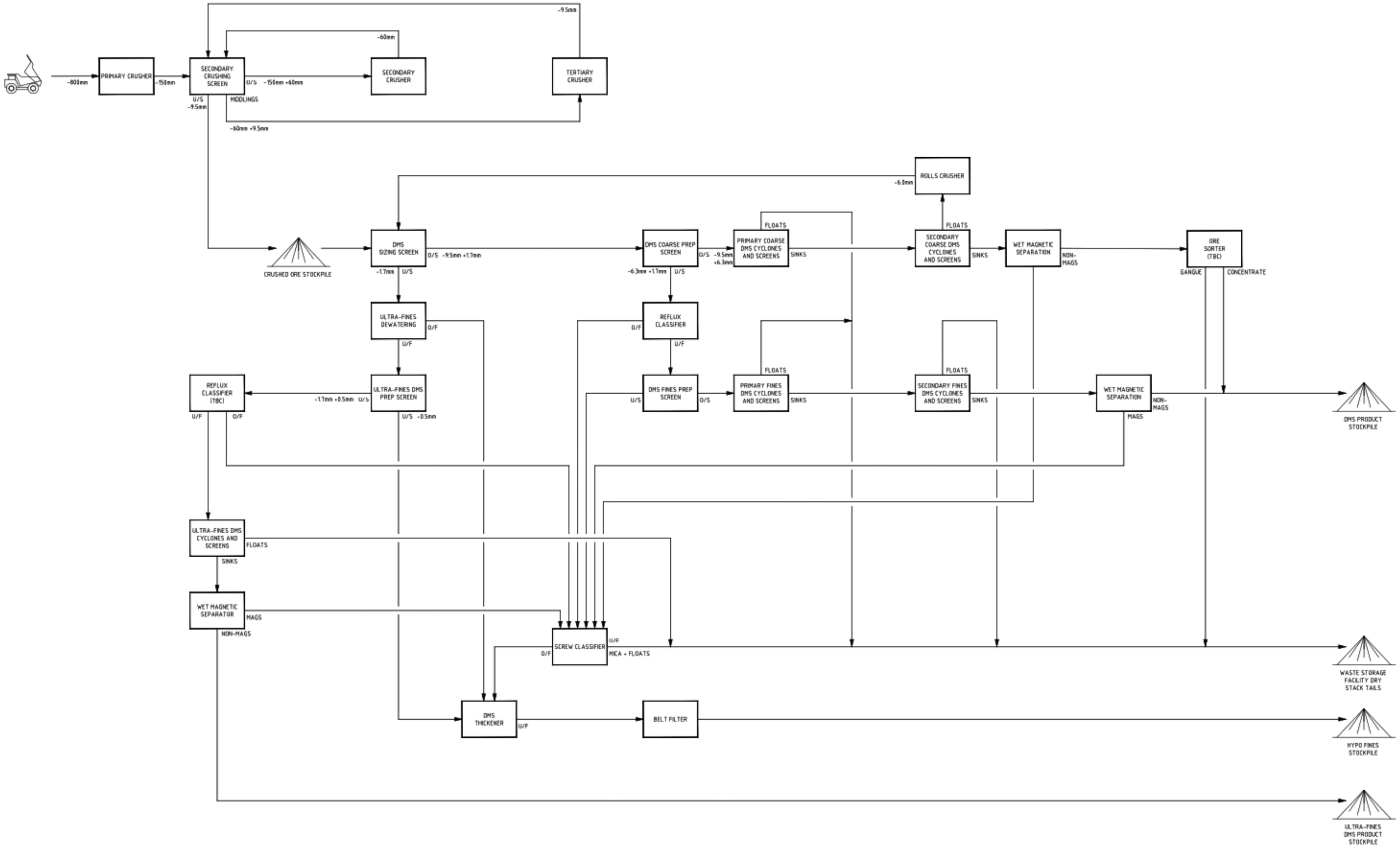


Figure 17-2 – Block Flow Diagram for Crushing Circuit and DMS Plant

Note: Figure prepared by Primero, 2019.

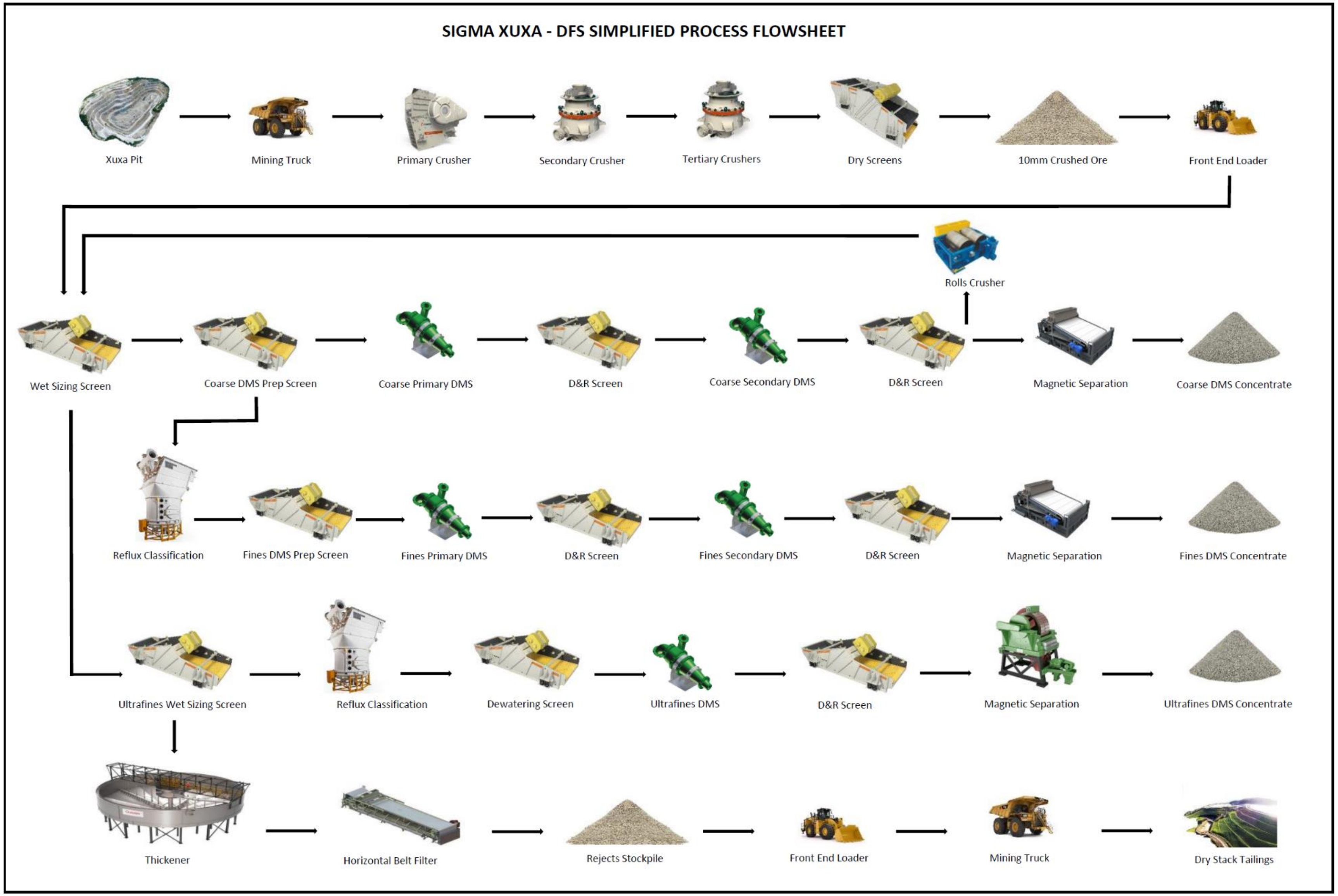


Figure 17-3 - Simplified Process Flowsheet

Note: Figure prepared by Sigma, 2019

17.2 CRUSHING FACILITIES

For commercial reasons, contract crushing will be implemented with a nominal throughput capacity of 1.5Mtpa. The contract crushing assumption is based on Metso's proposal which includes one portable jaw crusher unit (NW106) and two portable cone crushing and screening units (NW200 HPS) including all conveyors up to the crushed ore stockpile, based on particle size distribution criteria dictated by the DMS circuit. There will be a truck dump station for direct dumping of the trucks into the feed chute.

The crushed ore will be stockpiled upstream of the wet-plant feed. The stockpile is sized for nominal four days storage with a capacity for seven days storage.

17.3 DMS PLANT

Crushed ore from the crushed ore stockpile will be transported to the DMS feed inlet for where it will be conveyed to a sizing screen to remove the -1.7 mm material which will be sent to the ultra-fines DMS circuit. The -9.5+1.7 mm material will report to the DMS coarse sizing screen where it will be screened at 6.3 mm to produce:

- -9.5+6.3 mm coarse product which reports to the primary coarse DMS
- -6.3+1.7 mm fines product which reports to the primary fines DMS via a REFLUX™ classifier

Figure 17-4 shows the plant layout in relation to the planned stockpile areas.

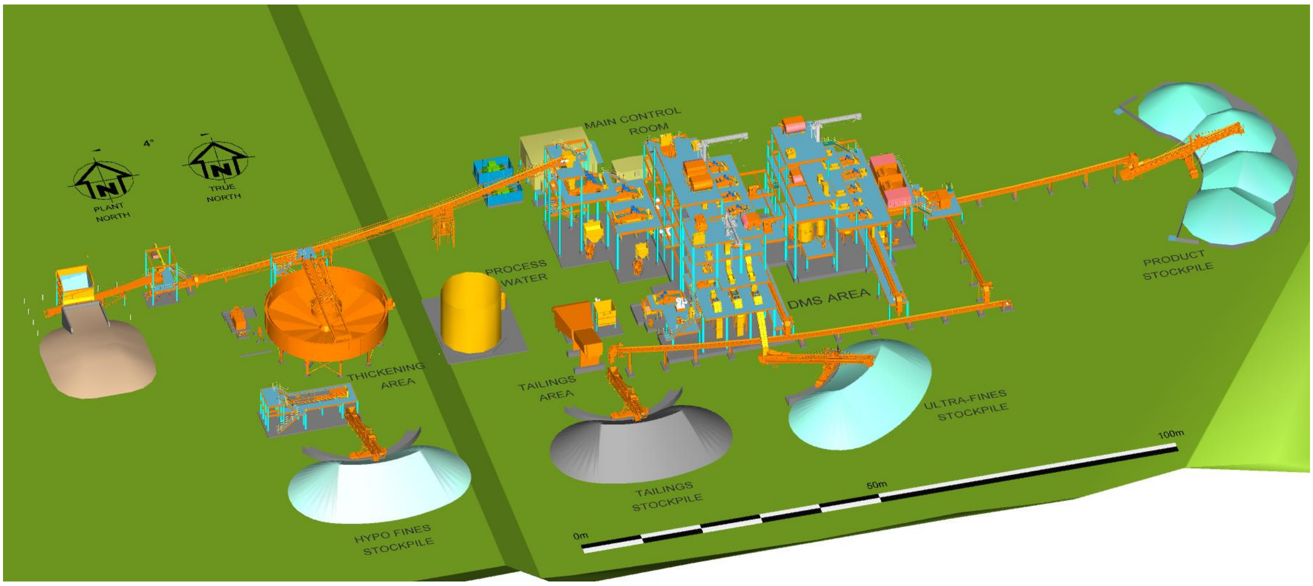


Figure 17-4 – Xuxa DMS Plant and Product Stockpiles

Note: Figure prepared by Primero, 2019.

The coarse and fine DMS circuits will consist of primary and secondary DMS cyclones to efficiently separate spodumene from the gangue material in order to produce a 6.0% Li_2O or higher concentrate grade. Mica will be removed from the fines stream by a REFLUX™ classifier, prior to feeding the DMS fines preparation screen.

Prior to feeding the primary DMS cyclones, each ore stream (coarse and fine) will be mixed with ferrosilicon slurry and pumped to the respective coarse and fine primary DMS cyclones. The ferrosilicon slurry density will be carefully controlled to enable the gravity separation of spodumene from minerals with a lower SG. Spodumene has a higher SG than most other gangue minerals and consequently the spodumene will report to the DMS cyclone underflow (sinks), with the gangue material reporting to DMS cyclone overflow (floats).

17.3.1 Primary DMS Circuit (Coarse and Fines)

The primary DMS circuit will have two sets of DMS cyclones (coarse and fines). They both will share the same SG (2.65) ferrosilicon medium.

The floats from the primary coarse DMS cyclones will be sent to tailings, while the underflow streams (sinks) will report to the secondary coarse DMS cyclones.

The primary fines DMS circuit feed will be processed through a REFLUX™ classifier, which aims to remove a portion of the mica. This mica stream will be dewatered and report to tailings, while the REFLUX™ classifier underflow will report to the primary fines DMS cyclones. The floats from the primary fines DMS cyclones will be sent to tailings, while the underflow streams (sinks) will report to the secondary fines DMS cyclones.

17.3.2 Secondary DMS Circuit (Coarse and Fines)

The secondary DMS circuit will have two sets of DMS cyclones (coarse and fines DMS cyclones). They will both share the same SG (2.90) ferrosilicon medium.

The floats from the secondary coarse DMS stage will be re-crushed through a rolls crusher and transferred back to the sizing screen. The floats stream from the secondary fines DMS cyclone will report to a waste pile.

The sinks from the secondary coarse DMS cyclones and those from the secondary fines DMS cyclones will be sent to the DMS product stockpile via a magnetic separator for iron removal to meet the product iron content criteria, and via an ore sorter for removal of high SG gangue such as schist which cannot be separated from the spodumene in the DMS circuit. This will be the final spodumene concentrate product at 6% Li_2O.

17.3.3 Ultra-fines DMS Circuit

The ultra-fines (-1.7mm+0.5mm) material from the sizing screen will be dewatered via a hydro-cyclone and screened further by a subsequent ultra-fines DMS preparation screen. The -1.7 mm material will report to the ultra-fines single stage DMS circuit processing. The floats will report to a waste pile.

17.4 THICKENING, FILTRATION AND HYPOFINES STACKING

The ultra-fines dewatering cyclone overflow, the ultra-fines preparation screens undersize (-0.5 mm), the screw classifier overflow and other screen underflows will report to the DMS tails thickener for dewatering. The underflow will be discharged to a belt filter and the filter cake will report to a stockpile of -0.5 mm hypo fines which will then report to a waste pile.

17.5 TAILINGS DISPOSAL SYSTEM

The floats from the primary coarse and fines DMS cyclones, the secondary fines cyclone, and the ultra-fines DMS cyclone, as well as the underflow from the screw classifier (mica and floats) will be screened to 12% moisture and co-disposed with mine waste in a waste pile.

17.6 BASIS OF DESIGN AND MASS BALANCE

Data for the 2019 Feasibility Study are based on the metallurgical test-work data. Recovery data are based on the data from Var 3 and Var 4.

The engineering and design were developed to a feasibility level based on the mass balance, process design criteria and process flow diagrams which incorporate the results of the laboratory test-work.

The operating parameters used as a basis for design are summarized in Table 17-1.

Table 17-1 – Operating Parameters

Parameter	Value
Operating days/annum	365
Operating hours/day	24
Calendar hours	8,760
Shifts/day (crushing & sorting)	2
Shifts/day (wet Plant)	3
Hours/shift	8

The design basis and mass balance based on the test work results are summarized in Table 17-2.

Table 17-2 – Design Basis and Mass Balance Summary

Parameter	Units	Value	Source	Comment
Total ore processing rate	dry tonnes per year	1,500,000	1	Client
	wet tonnes per year	1,530,612	4	Calculation
Spodumene ore grade (no dilution)	% Li_2O	1.61	4	Calculation
Spodumene ore grade (incl. dilution)	% Li_2O	1.46	1	MCB Mar 20th 2019
Ore moisture	% w/w	2	1	Client
Dilution factor	% w/w	9.3	1	MCB and SGS Canada Mar 20th 2019
Crushing Plant				
Dilute ore stockpile	days	2	1	Client
Total ore fed to crusher incl. dilution	dry tonnes per year	1,500,000	1	Client
	wet tonnes per year	1,530,612	4	Calculation
Crusher overall availability	%	47.7	1	Client
Crusher operating hours	hours per year	4,176	1	Client
Nominal ore crushing rate	dry tonnes per day (16 hr /d crush)	5,747	4	Calculation
Nominal ore crushing rate	dry tonnes per hour	359	4	Calculation
	wet tonnes per hour	367	4	Calculation
Sized for nominal ore crushing rate	dry tonnes per year	3,000,000	1	Client
	wet tonnes per year	3,061,224	4	Calculation
Sized for nominal crusher hours at 3.0 MTPA	Hours per year	6,325	1	Client
Sized for nominal ore crushing rate	dry tonnes per day (16 hr/d crush)	7,589	4	Calculation
Sized for nominal ore crushing rate	dry tonnes per hour	474	4	Calculation
	wet tonnes per hour	484	4	Calculation
Design ore crushing rate	dry tonnes per hour	522	4	Calculation
	wet tonnes per hour	532	4	Calculation

Wet Plant	Units	Value	Source	Comment
DMS plant feed stockpile	days	7	1	Client
Feed rate to wet plant	dry tonnes per year	1,500,000	1	Client
	wet tonnes per year	1,530,612	4	Calculation
Wet plant overall availability	%	85	6	Industry Standard
Wet plant operating hours	hour per year	7,446	6	Industry Standard
Nominal wet plant feed rate	dry tonnes per day (24 h/d)	4,835	4	Calculation
Nominal wet plant feed rate	dry tonnes per hour	202	4	Calculation
	wet tonnes per hour	206	4	Calculation
Design wet plant size	dry tonnes per hour	242	4	Calculation
	wet tonnes per hour	247	4	Calculation
Reflux Classifier mica rejection rate	%w/w	5	3	SGS 2019 Test work
DMS coarse prep screen oversize (-9.5+6.3mm)	%w/w Mass	35.0	3	SGS 2019 Test work
DMS coarse prep screen undersize (-6.3+1.7mm)	%w/w Mass	35.0	3	SGS 2019 Test work
DMS sizing screen undersize (-1.7+0.5mm)	%w/w Mass	15.0	3	SGS 2019 Test work
Ultra-fines dewatering cyclone undersize (-0.5 mm hypofines)	%w/w Mass	15.0	3	SGS 2019 Test work
Wet plant spodumene conc. grade	%w/w Li_2O	6.0	7	Industry Standard
Li_2O Recovery				
Li_2O recovery (DMS)	%	60.4	4	Calculated
Li_2O recovery – Coarse DMS	%	24.7	4	Calculated from SGS Lakefield 2019 Test work
Li_2O recovery – Fines DMS	%	26.1	4	Calculated from SGS Lakefield 2019 Test work
Li_2O recovery – Ultra-fines DMS	%	9.6	4	Calculated from SGS Lakefield 2019 Test work
Stockpiles				
Coarse & Fines spodumene	dry tonnes per year	186,738	4	Calculation
	wet tonnes per year	212,202	4	Calculation
Ultra-fines spodumene	dry tonnes per year	29,202	4	Calculation
	wet tonnes per year	33,184	4	Calculation
Total spodumene concentrate production	dry tonnes per year	215,939	4	Calculation
	wet tonnes per year	245,386	4	Calculation
Hypofines stockpile	dry tonnes per year	251,077	4	Calculation
	wet tonnes per year	285,315	4	Calculation
Process tails – tonnage	dry tonnes per year	1,032,983	4	Calculation
	wet tonnes per year	1,173,845	4	Calculation

Operating hours assumptions for main facilities are stated in Table 17-3 and key equipment in

Table 17-4.

Table 17-3 – Operating Hours for Main Facilities

Facilities	Calendar Hours (h/a)	Operating Hours (h/a)	Overall utilization (%)
Crushing and conveying	8,760	4,176	47.7%
Dense medium separation circuit	8,760	7,446	85
Tails filter plant and conveyor	8,760	7,446	85

Table 17-4 – Key Equipment and Capacity

Equipment name	Capacity (nominal/design)	Specification
Primary crusher	532.4 tph / 638.8 tph	Jaw crusher
Secondary crusher	437.0 tph / 524.4 tph	Cone crusher
Tertiary crusher (2 units)	187.0 tph / 244.4 tph *per unit*	Cone crusher
DMS screens		Sizing; coarse and fines prep; primary and secondary sinks and floats (coarse, fines, ultrafines); secondary sinks and floats (coarse, fines); degrit; static drain: Reflux underflow
DMS centrifuges		
Thickener	Design slurry flowrate: 1,941 m^3/h	High-rate: 20m-diameter
Belt filter	Design slurry flowrate: 33.8 m^3/h	Horizontal vacuum belt filter: 7 m^2
Optical sorter	Design: 12.1 t/h	Achievable feed size range: max 35mm / 80m. Two-way optical sorter, sorting width – 2m with high resolution double camera system. Color sorting.
Reflux classifier	Solids flowrate: 75 tph / 90 tph	

17.7 UTILITIES REQUIREMENTS

The power consumption requirements are approximately 6.7 MW for the processing plant and 1.5 MW for non-process infrastructure at the process plant.

The raw water consumption for process water is a nominal 23 m^3/hr (make-up raw water requirement).

The process water will be recycled within the plant with a thickener, where all fines slurry streams will be directed and recovered and pumped to the process water tank and recycled to the circuits as needed.

Consumables will include reagents and operational consumables for the crushing circuit and the DMS plant.

Reagents will include ferrosilicon and flocculant.

- Ferrosilicon: a consumption rate of 530 g/t
- Flocculant: Flomin 905 VHM (Magna Floc 10 equivalent) have a consumption rate of 10 g/t.

In the crushing circuit, consumables will include liners for all the crushers and the screen panels. In the DMS plant, maintenance items will be necessary for cyclones, pumps, screens and belt filters.

18 PROJECT INFRASTRUCTURE

The mine and the concentrator infrastructure will be located at Sigma's Xuxa property. Much of the mining non-process infrastructure at the mine services area will be included in the contract mining scope. The main infrastructure will include:

- Two open pit mines and four waste stockpiles
- Raw water supply (underground pipeline) to site
- Electrical supply infrastructure to provide power to the site and related substations
- BR367 access road to the plant and municipal road deviation
- Bridge over the Piauí River spanning Pit 1 and Pit 2
- Road transport (including haul roads) for waste rock and ore to and from the mine
- Workshops and fueling services
- Plant and mine facilities including warehouse, laboratory

18.1 XUXA GENERAL SITE PLAN

The overall site plan shows the mine pits, process plant, waste rock disposal areas, mining services as well the main access road and the rerouted municipal roads (Figure 18-1). There is an existing operations base west of the BR367 highway. The Xuxa site, which is approximately 4 km from the main highway, is accessible via an existing road from highway BR367. This road will be widened by 4 m. The existing municipal road located to the west of the Olimpio area, will be blocked from public traffic. A municipal road will be added to contour the plot and located within the plot limits. For scaling, refer to Figure 18-2.

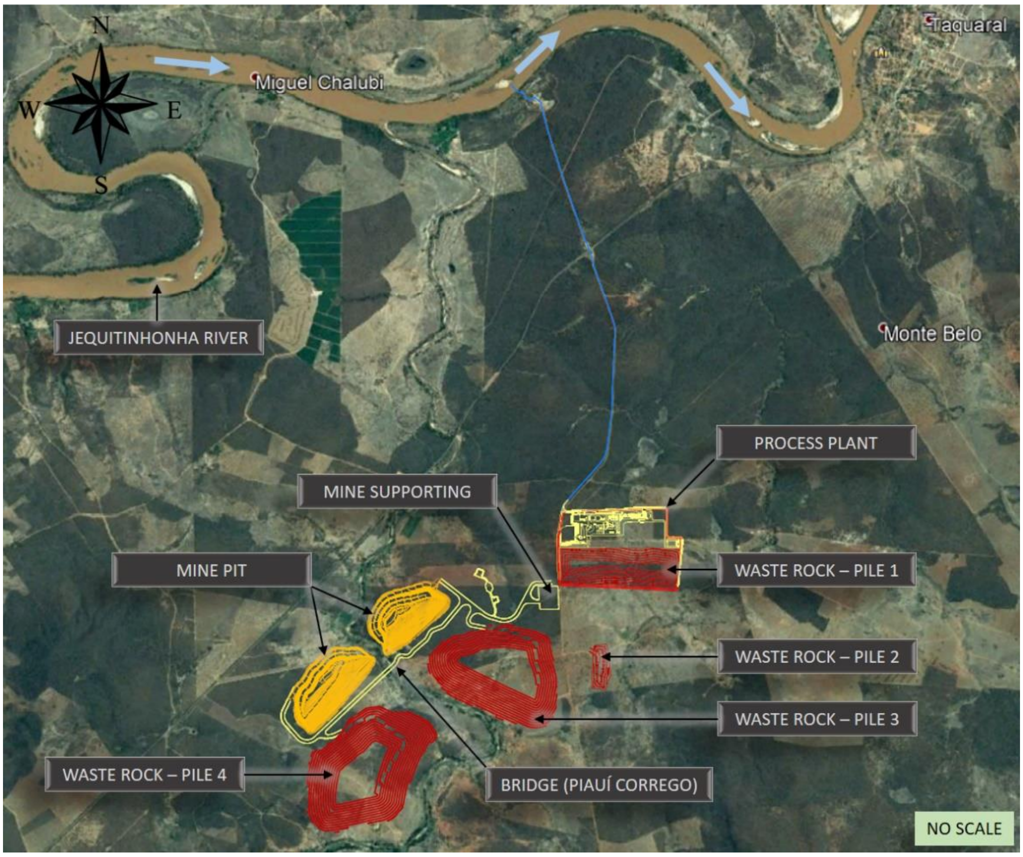


Figure 18-1– Sigma Lithium Project General Layout Plan for Xuxa

Note: Figure prepared by WP, 2019.

The planned locations for the processing plant and related infrastructure including the ROM pad are shown on Figure 18-2.

All mining activities will be concentrated within the areas of mine pits 1 and 2, the Olimpio (waste rock pile 1 and process plant area) and Gilson (waste rock pile 2 area) plots and waste piles 3 and 4.

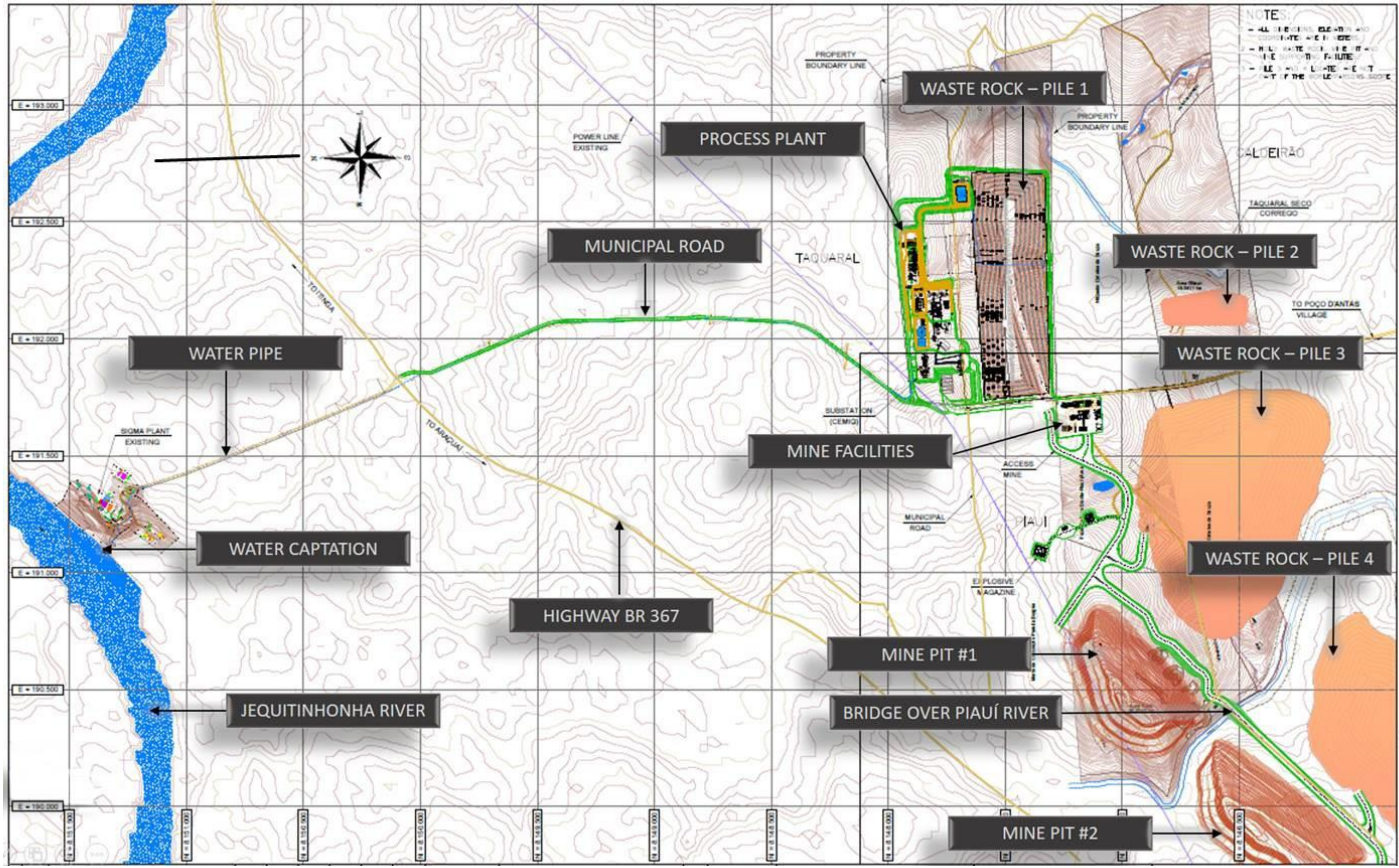


Figure 18-2 – Overall Site Plan

Note: Figure prepared by WP, 2019. Grid squares are 500 m x 500 m.

18.2 ROADS

The existing municipal road will need to be upgraded to be suitable for the trucks traveling to the port for product export. The road will consist of a platform of embankment of 11.0 m of width, a track of 8.0 m of width, rainfall drainage in ditches. The pavement will consist of a sub-base, base and primary gravel top-layer. An access bypass will be built at the junction with the BR367, in accordance with Departamento Nacional de Infraest de Transportes (DNIT) standards.

A 2.6 km long municipal road will be built by the municipality to bypass the plant and allow access to local communities. It will be built within the boundaries of the property and be suitable for light vehicle traffic. The road will have a platform of embankment of 8.0 m width and a track of 7.0 m.

18.2.1 Haul Roads and Bridge

Haul roads and associated drainage for pits and waste piles and to the ROM pad will be built. Gravel roads will be constructed in support of mining operations. Haul roads are planned to be 25 m wide inside the pits and 29 m wide outside the pit.

A bridge is planned to cross over the Piaui River for access between Pit 1 and Pit 2. The concrete bridge will have a span of 30.0 m and 12.0 m of free lane for the 150 t class trucks (CAT 785 or similar).

The planned bridge location is shown in Figure 18-3.

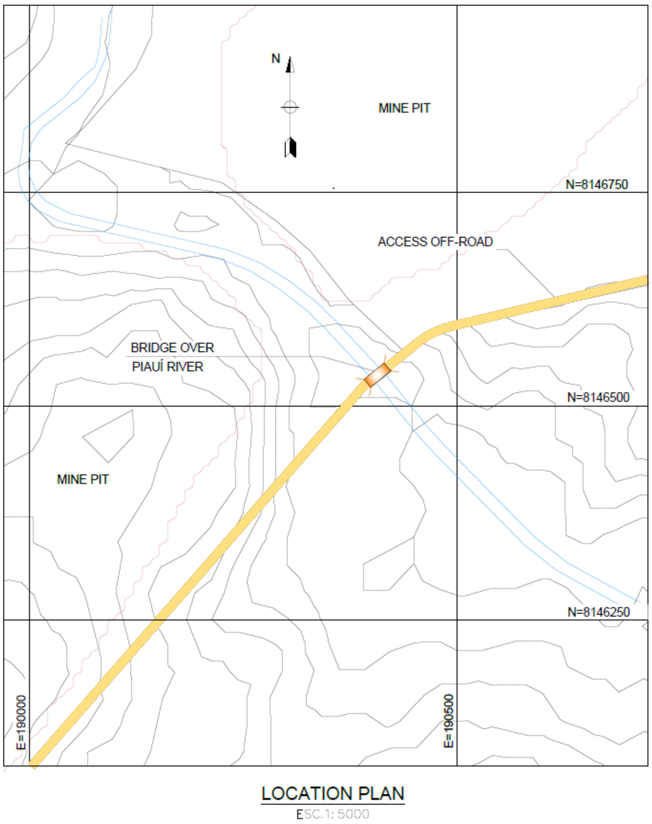


Figure 18-3 – Bridge Location

Note: Figure prepared by WP, 2019.

For the road drainage system, concrete ditches are provided on the sides of the right-of way and rip-rap rock structures for energy dissipation and discharge.

18.3 EARTHWORKS AND BURIED SERVICES

Earthmoving will include grading and levelling in the process plant, the mine support area and the access roads to the process plant and mine. The slopes used will be 1:1 (H:V) for the cuts and 1.5:1 (H:V) for earth fills. About 600,000 m^3 of excess fill material will need to be stored in waste pile 1.

18.4 WATER BALANCE (STORM WATER, WATER TREATMENT)

18.4.1 Hydrology and Hydrogeology

18.4.1.1 Hydrology

For the process plant, waste pile 1 and 2 areas as well as for the mine area including waste piles 3 and 4 areas, hydrological studies were completed with the objective of establishing the flow rates for surface drainage control structure and waste pile designs. Hydrological studies assumed 100- and 500-year return periods, with a 50% probability of occurrence. A minimum permissible velocity of 0.5 m/s was assumed, to avoid deposition of solids in the channels. Soil type and characteristics of land use were identified via satellite imagery and a technical site visit. Topographic information was provided by Sigma.

At the mine area, after each precipitation event, monitoring of river sections downstream of the ponds for erosive processes should be carried out.

18.4.1.2 Piauí River Flood Study

The flood line indicates that the flood areas along the Piauí River, in the planned bridge area, are basically contained in the greater waterway channel. Flood modelling in the area of the planned bridge was conducted using a 100-year return period.

18.4.1.3 Hydrogeology

A detailed hydrogeological investigation is recommended to clarify water table surface elevation, continuity of water bearing zone and to evaluate subsurface (water bearing zone/aquifer) hydrogeological parameters to better understand the condition and plan for mining activities. The investigation should include a baseline study of the pre-mining conditions, including the following:

- Gathering and review of historical data, if available, such as 3D geologic model from mineral exploration drilling, strike and dip direction of open fracture sets in cores and cross sections at the study site and water quality data for surface water/ groundwater/ springs
- Identify potential contaminant sources
- Determine physical and geochemical parameters to be monitored as part of baseline and regular monitoring program
- Installation of six baseline monitoring wells plus an additional well for a pumping test
- Conduct a pumping test of minimum 72 hours to estimate key hydrogeological parameters of the subsurface in the mine pit area and to evaluate dewatering options: a pumping well (larger diameter than monitoring wells) will be drilled as well as two monitoring wells for drawdown monitoring (these two are included in the total of six baseline monitoring wells)
- Estimation of hydraulic conductivities for monitoring wells using slug tests
- Determine local and regional groundwater flow directions and local gradients
- Collect groundwater samples for select parameters to set up baseline groundwater chemistry from monitoring wells
- Develop a hydrogeological model for the site.

The metasedimentary schist host rock is likely to have low primary permeability/porosity. As a result, if it is possible to install monitoring in existing core-holes, the screens should be places where open fractures are present below the water table. Monitoring wells should be installed both upgradient of the active mine site area and down gradient from the waste piles. To identify groundwater flow direction, a minimum of three monitoring wells are required.

A hydrogeological monitoring program should be employed during the mining operation and will likely include:

- Develop monitoring well network based on baseline study results, geologic setting and potential sources of contaminants (inorganic and organic)
- Regular groundwater sampling for select parameters and record of water levels; and measure field parameters (electrical conductivity, pH and temperature) for each monitoring well
- Sample analysis and comparison of the results with Brazilian environmental guidelines
- Environmental report preparation.

18.4.2 Overview

To avoid damage to the access and interior roads, a surface drainage system will be implemented. Contact water from the process plant, non-process plant and mine services, tailings and waste piles (Olímpio and Gilson areas), the open pit area and the access road will be sent to the sedimentation ponds. All drainage from plant, mine services area and waste rock / tailings disposal pile in the Olimpio area will be collected in settling pond #1. Drainage of the waste rock pile in the Gilson area will be collected in settling pond #2. For waste piles 3 and 4, the graded surface will be sloped to allow for rainwater to be discharged by gravity out of the waste piles, where it will be picked up by gutters and/or other drainage devices to settling ponds 3 or 4.

Process plant water will be taken from the Jequitinhonha River at a maximum rate of 150 m^3/h (refer to discussion in Section 18.11), and the plant will also use water recycled from the sedimentation ponds. Recycling will be maximized to reduce intake water consumption and to allow for water collection at various stages of the process for reuse. Water recovery will also lower intake water consumption by recycling drainage water collected in the sedimentation ponds. Figure 18-4 is a balance projection for operations. Some of the recycled water will also be used for dust suppression.

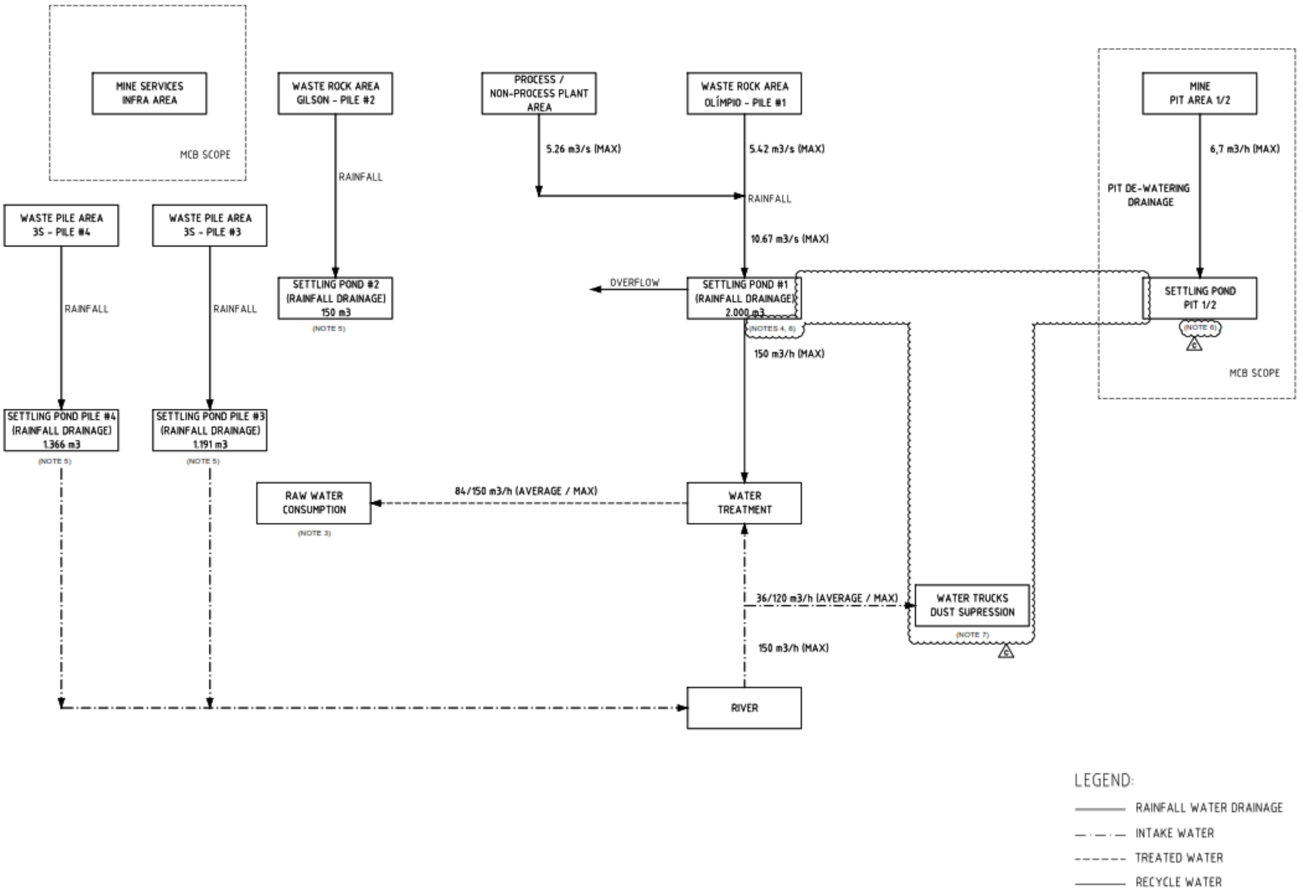


Figure 18-4 – Water Balance

Note: Figure prepared by WP, 2019.

18.4.3 Open Pit Dewatering

In the open pits, the drainage will be directed to the benches at the deepest levels that will be developed to receive all the pit drainage. Deeper benches will serve as sumps and solids containment basins. Each pit will have its own sedimentation pond. Water from these ponds will be used to fill water trucks in the dry season and may also be pumped to the sediment ponds in the waste pile area.

When necessary, a diesel portable dewatering pump mounted on skids will be used to pump the water in the waste pile sediment ponds.

18.4.4 Waste piles

18.4.4.1 Waste Piles 1 and 2

Runoff will be directed from higher ground around the waste piles.

For the waste piles where tailings and waste will be co-disposed, precipitation falling directly on the waste piles will be managed in order to maintain a dry working area to place the tailings, to mitigate erosion of the tailings, and manage turbidity in runoff prior to water recycling to the process plant.

Tailings placement will be restricted during and immediately after precipitation events and surface accumulations of water will be allowed to runoff and evaporate. Surface runoff will be facilitated by sloping the pile surface to essentially match the underlying topography, with an overall slope of 2–3% towards the southeast.

Runoff water will be collected in an engineered saucer-shaped low from where it will be gravity drained through a pipe in the perimeter lane and discharged to a sedimentation pond located adjacent to the southeast corner of the pile. Once construction of the pile is completed, a final protective cover will be placed to facilitate revegetation and minimize erosion, at which point the sedimentation pond may be decommissioned.

For the waste piles which will receive waste rock only, ponds will be built to receive all pile drainage and eventually drainage from the pits. Drainage in the ramps of the waste piles will be built to direct water bench to bench and peripherical trenches will be built to direct rainfall water to the ponds ensuring solids containment if solids are carried from the waste piles to the containment basins. These ponds will be cleaned during dry seasons. Accumulated water will be used to fill the water trucks or may be discharged if the water is within the applicable aquatic guidelines.

18.4.4.2 Waste Piles 3 and 4

The graded surface will be sloped to allow for rainwater to be discharged by gravity out of the pile, where it will be picked up by gutters and/or other drainage devices to settling ponds 3 and 4.

18.4.5 Water Treatment Plants

The primary water treatment plant will be conventional and will remove sand, suspended solids and sludge. Treated water will be sent for storage in a primary 3,600 m^3 capacity storage tank. The water intakes and proposed treatments are summarized in Figure 18-5.

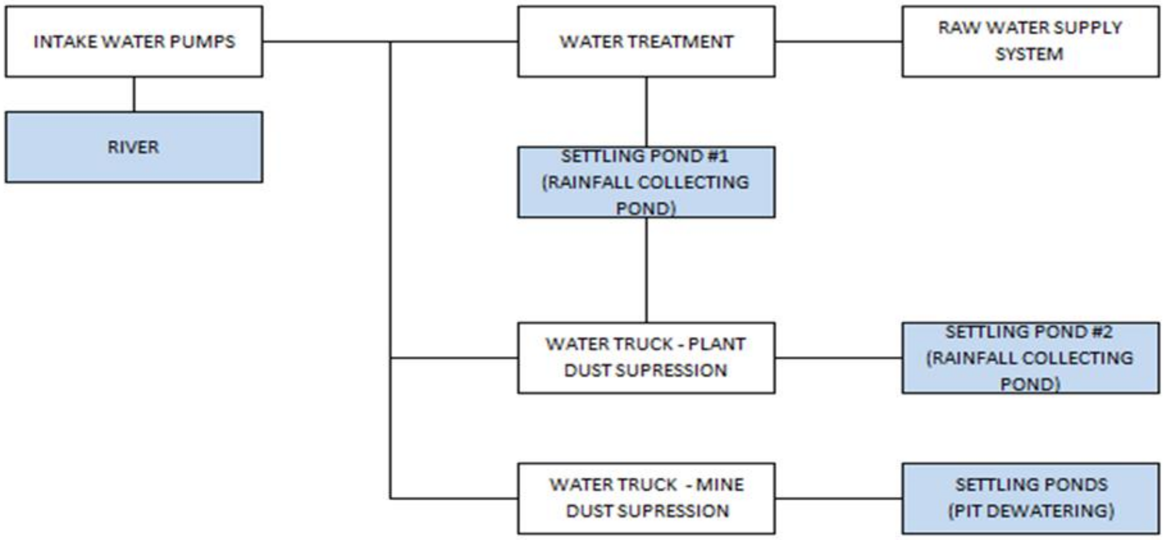


Figure 18-5 – Intake Water / Water Treatment

Note: Figure prepared by WP, 2019.

18.5 SEWAGE

There will be a sewage treatment station located in the plant area and one in the mine service area. These will treat all sewage collected from the buildings in mine service area and at the plant non-process infrastructure. In the mine pit areas, portable toilets will be used.

The sewage system is designed to treat all domestic effluent from the process plant area (24 m^3/day, equivalent to 200 persons) and the mine services area (42 m^3/day equivalent to 350 persons).

The treated wastewater from the sewage treatment will need to be disinfected to be able to be piped to a drainage system (compliance to CONSEMA 128 and CONAMA 430). The sludge coming from the treated water will be trucked off site for disposal by specialized contractors.

18.6 BUILT INFRASTRUCTURE

The main processing facilities will consist of unclad steel structures supporting the processing equipment. Floor layouts will allow for access and maintenance around the equipment and will be generally open grating; where required, checkered plate or elevated concrete slabs are used. Switch-rooms (housing the various motor control centres (MCCs)) will be prefabricated and pre-wired, with the wiring tested in the factory before despatch, to minimise site work.

18.6.1 Non-Process Infrastructure

All buildings in the administrative areas will be built as modular structures, with painted metal panels, thermal insulation and metal tiles. The buildings will be provided with all electrical, hydraulic and communication facilities. Containers will be used for laboratories and electrical substation (switch-rooms).

Operational support facilities, such as workshops, warehouses and others, will be of conventional construction consisting of metal structure sheds and masonry offices.

Utilities such as raw water, potable water and fire water will be provided for these buildings. A fire detection and protection system consisting of firewater hydrants, monitors and hose reels, foam systems for protection of diesel installations, gaseous extinguishing systems and portable fire extinguishers will be installed.

Table 18-1 summarizes the planned built non-process infrastructure requirements.

Table 18-1 – Infrastructure Summary Table

Item	Comment
PROCESS PLANT	
Administrative building	703 m²; prefabricated modular construction
Gate house	712 m²; prefabricated modular construction
Kitchen and canteen	560 m²; kitchen, concrete structure 313 m²; canteen; prefabricated modular construction
Plant workshop and warehouse	The workshop building will be 1,113 m². The warehouse will have 219 m² of covered area and 319 m² of open area. Single conventional metal structure building.
Laboratories	488 m²; metal shed. Will have containers for the physical laboratory (44 ft), chemical laboratory (44 ft) and an office (22 ft).
First aid clinic, fire station.	129 m²; first aid clinic; prefabricated modular construction 102 m²; fire station; prefabricated modular construction Covered parking for the ambulance and fire truck.
Change room	389 m²; separate areas for male/female; prefabricated modular construction
Truck weigh station	Will consist of a road scale located in the plant area, and will weigh the spodumene concentrate product trucks leaving the plant and weigh diesel tank trucks that will supply diesel storage facilities in the mine area

Item	Comment
	Trucks will be weighed when they enter and exit the plant. It is estimated that 35 spodumene product trucks will be weighed per day and 3–4 diesel trucks per week. The scale will be sized for "bitrem" trucks
Truck scale control room	25 m²; prefabricated modular construction and located near the truck scale.
Truck driver rest area	75 m²; prefabricated modular construction
Security cabin	16 m²; prefabricated modular construction
Waste management	127 m²; prefabricated modular construction

18.6.2 Mining Infrastructure

The contract mining contractor will provide their own design and install the facilities for the mining services area, except for the diesel storage and dispensing facilities.

A conceptual mining services area layout was generated for estimation purposes; however, this layout will be fully designed by the selected mining contractor.

Table 18-1 summarizes the planned built non-process infrastructure requirements.

Table 18-2 – Infrastructure Summary Table

Item	Comment
MINE	
Mine workshop	Maintenance will be carried out by the mining contractor. The team will be assisted on a technical basis by the original equipment manufacturer (OEM). Stores facility for items such as hydraulic hoses, filters, hydraulic components, drifters. The workshop area will be equipped with an overhead crane, storage area for area for empty and full gas bottles, offices, mess room, change room, storage facilities.
Heavy vehicle workshop	Trackless workshop. Will be equipped with 2 service bays and two ramps for all daily, weekly and monthly maintenance. Includes a bay for tracked equipment. Will be equipped with fire hydrant points and chemical extinguishers, grinding equipment and vehicle repair tools, store area, workbenches, lockers, tools and tool crib
Boiler shop	Will handle minor emergency rebuilds for equipment, piping repairs, general steelwork maintenance, box-front exchange and stores holding
Electromechanical workshop	Will include the machining and subassembly (mechanical) workshop and the electrical and instrumentation workshop. The mechanical workshop will handle service exchange, sub-assembly services, refurbishment of components and small stores holding. It will be equipped with hydraulic bench press, workbenches, grinding equipment, drilling machine, lathe machines, bandsaw and tools as required.

Item	Comment
	The electrical and instrumentation workshop facility will handle service exchange of motors, sub-assembly services, refurbishment of components and testing. It will be equipped with electrical test bench for equipment, electrical motor testing equipment, motor vehicle testing equipment, electrical cable store and small tools as required
Tire shop	Store and replace tires.
Truck wash	Designed to cater for washing of trackless machines. Wash bay will be equipped with a high-pressure water cleaner, a silt trap to separate the grit and an oily wastewater treatment station. Facility will include chemical extinguishers, high pressure water cleaning equipment, oil separator ans small tools
Magazines and emulsion plant	Explosives, detonators and emulsion will be trucked to site under a contract supply arrangement. Facilities will be located close to the Pit 1. Distances from the magazines and the emulsion plant will be in accordance to the Brazilian regulation for the storage of explosives (R105 Brazilian Army code). The emulsion will be stored in a vertical silo.

18.7 STOCKPILES

18.7.1 ROM stockpile

The ROM pad area will be located at the feed of the primary crushing circuit and will be built up of first category fill material compacted to 95%. The ROM will be delivered in 40-t trucks directly from the mine. The truck will dump the material at the handling area which will then be piled using a front-end loader. The ROM stockpile will occupy an area of about 5,900 m^2 of the ROM pad and have an approximate base of 48 m x 12 m and a maximum height of 10 m for a capacity of 45,000 t or 10 days plant feed. The additional approximately 8,200 m^2 of the ROM pad area will be used for ROM handling with trucks and front-end loaders. A front-end loader will feed the primary crusher.

Excavated channels will be used for rainwater drainage of the ROM pad area and will discharge to the ditches of the perimeter access road which connect to the overall plant rainwater drainage collection system.

18.7.2 Crushed Ore Stockpile

Crushed ore will be stockpiled at the end of the crushing circuit. There will be no concrete pad at the base. The stockpile is designed for seven days storage capacity. The crushed ore will be loaded into the DMS feed bin via front end loaders, to feed the DMS circuit.

18.7.3 DMS Product Stockpile

The DMS product stockpile will be fed by a radial stacker and sized for one day for a storage of 720 t. The concentrate will be loaded into product transport trucks with front end loaders for transport to the port.

18.7.4 Hypofines Stockpile (in-plant)

The hypofines stockpile will be fed by a radial stacker and be sized for one day’s storage of 890 t. There will be no concrete pad beneath the stockpile. Hypofines will be loaded into mine trucks by front end loaders and transported to a waste pile.

18.7.5 Ultrafines Stockpile (in-plant)

Ultrafines spodumene concentrate product will be stockpiled by a radial stacker and be sized for one day's storage of 105 t. It will have a concrete pad.

18.7.6 Waste Storage – Dry Stack Tailings Stockpile (in-plant)

The tailings stockpile will be fed by a radial stacker, placed on grade and sized for a storage capacity of 3,600 t. There will be no concrete pad beneath the stockpile. The tailings will be loaded into mine trucks by front end loaders and transported to a waste pile for co-disposal.

18.8 WASTE ROCK AND DRY TAILINGS CO-DISPOSAL

About 6.6 Mm^3 of waste rock and 1 Mt of tailing will need to be stored on an annual basis. Waste amounts and disposal locations are summarized in Table 18-3.

Table 18-3 – Waste Pile Storage

	Waste rock m^3	**Tailings m^3**	**Waste / Tailings Total Mt**	**Years - storage**
Pile # 1	7,845,000	567,400	16.3 / 0.7 (Note 1)	1.3
Pile # 2	456,731 (Note 2)	39,879	1.0	1.3
Pile # 3	17,399,267	8,582,001	88.26	4.5
Pile # 4	26,776,556	-	101.14	5.2

Note 1: approximately 6.0 Mt of mine pre-stripping (first two quarters of mine production) will be disposed of at waste pile 1
Note 2: 314,072 m^3 will be clear and grub from the process area and mine services area and 142,659 m^3 from the earthworks cut material.

Co-disposal of waste rock and tailings is planned for waste piles 1, 2 and 3. Waste pile #4 is meant to be storage of waste rock only.

Clear and grub from the process area and mine services area will be disposed at waste pile #2. Part of the total earthworks cut material (~600,000 m^3) will be disposed of at waste pile 1.

18.8.1.1 Waste Piles 1 and 2

For the co-disposal waste piles, it is planned to co-dispose the tailings centrally within the mine waste pile, which is anticipated to be relatively coarse and hence will exhibit relatively high strength properties and enhanced slope stability and resistance to erosion, in comparison with the performance of the tailings if disposed in a separate deposit. The ratio of the mass of waste rock to tailings is approximately 10:1, which will facilitate central containment of the tailings within the waste rock. The waste rock and tailings will be stacked in piles, which will consist of two zones:

- Zone 1: Central zone comprising near surface soil from the open pit (if not used for landfill construction), and fine (-0.5mm) filtered tailings and coarse (+0.5mm) tailings
- Zone 2: External areas consisting of coarse rock ranging from gravel to boulder sizes of the sterile pit material, which will confine the central zone and ensure the stability of the pile.

Pile 1 will be located near the process area and be sized approximately at 1,050 m (east–west), 325 m (north–south), and 70 m high.

Pile 2 will be located to the south and will be about 350 x 125 x 28 m in dimension.

Both waste piles will have 25 m wide access ramps with a maximum gradient of 10%. The pile slopes will have a 1V: 1.6H inclination with berms every 10 m. The width of the berms will be 4 m. All materials will be spread in horizontal layers and compacted with appropriate equipment.

The thickness of the waste rock layers should not exceed approximately 80 cm. The larger blocks should be pushed to the face of the embankment to create a barrier that will prevent material falling along the slope surfaces of the embankment during construction operations. The material in Zone 1 should be compacted in layers not exceeding 20 cm in thickness.

Site preparation activities to be completed in advance of waste deposition at each pile will include the following:

- Clearing, removal of organic or excessively soft soil, general levelling and any other site preparation required for drainage and erosion control
- Execution of the perimeter access lane surrounding the pile
- Execution of surface drainage ditches in the adjacent ground to direct rainwater to the perimeter drainage channels

Before the beginning of the next phase, complementary investigations and geotechnical tests in the areas of the waste rock and tailings storage shall be done, to confirm the basic assumptions adopted in the feasibility study.

The methodology for the disposal of waste rock and tailings will include:

- Waste rock fill pile 1
- Compaction of waste pile 1
- Primary peripheral lining for pile 1
- Granular base pile 1
- Structural concrete for the water drainage in steps
- Regularization concrete for water drainage in steps
- Structural concrete for running through boxes

A diligent QA and monitoring program shall be implemented to ensure adequate compaction is achieved throughout the construction.

18.8.1.2 Waste Piles 3 and 4

Stability analysis was done for waste piles 3 and 4 for dry conditions and with a water table within pile loadings conditions. A transition material between fine and coarse must be designed and produced by crushing. Tailings and fine material will be arranged in the center portion of the pile while waste rock from the pits will be placed so as to confine the fine material. The volume ratio of waste to tailings will be 12:1. The volume ratio of waste rock to tailings will be 10:1. Average pile slopes (bank to bank) will be approximately 1V:1.7H. Truck access ramps for unloading material on the pile will have two lanes with a maximum slope of 8% and a minimum width of 25m. There will be a 10 m lane for drainage and vehicular access for inspections (monitoring) and maintenance around the waste piles. Piles will have bank slopes of about 30°, bank height of 10 m, berm widths of 6 m and drainage systems every 300 m to ensure minimum infiltration and that the water table remains low, including during intense rainfall occurrences.

Foundation soils will be regularized by removing surface organic matter material as well as the underlying soil that has low shear strength, which may affect the pile stability. A 1.0 m soil excavation throughout the area has been considered for the purposes of the feasibility study. The graded surface will be sloped to allow for rainwater to be discharged by gravity out of the waste pile, where it will be picked up by gutters and/or other drainage devices.

A monitoring program will be instituted which should include the following elements:

- Regular visual observation
- Survey points installed on the benches of the rockfill slope at a spacing of between 50-100 m.
- A reliable benchmark will be installed in stable ground outside of the waste piles for reference in estimating settlement of the waste piles.

18.9 FUEL

Fuel will be trucked to site under a contract supply arrangement. The diesel storage facility will be located on the same terrace as the maintenance workshops and will store diesel fuel for distribution to mine site heavy and light mobile equipment as well as for the plant mobile equipment and vehicles. The facility is designed for ease of access and supply and distribution of diesel fuel. The capacity of the storage facility will be sufficient to supply the site for five days with three aboveground tanks with a total storage of 165 m^3. The storage tanks will be located in a concrete containment bunded area.

18.10 POWER SUPPLY

18.10.1 Site Power Supply

Power will be supplied by a CEMIG, a State power company. The CEMIG network offers a stable power supply in accordance with local interconnection rules and ONS (National System Operator) procedures.

The power will be supplied from an intersection of an existing 138 kV overhead transmission line. This line will supply a new CEMIG substation (intersection substation), which will supply the main Sigma substation that will be located adjacent to the CEMIG substation. The incoming power will be transformed to 4,160 Vac and connected to the main switchroom for plant distribution including for the process plant, non-process infrastructure and mining.

The primary main distribution voltage will be 4,160 Vac, 3 phase, 60 Hz. The secondary distribution voltage will be 440 Vac, 3 phase, 60 Hz for all loads. For small loads and lighting power, the voltage will be 220 Vac, 3 phase and for offices and working stations power will be 127 Vac, 1 phase, 60 Hz.

Emergency power will be supplied by diesel generator sets.

The existing 13.8 kV Taquaral Seco Transmission Line located in the Olimpio area (plant area) will be relocated by CEMIG around the site perimeter to an existing line pole.

18.10.2 Process Plant

The contract crushing equipment will be supplied via a cable from the plant substation switchgear to a 4.16/0.44 kV transformer. The transformer will be connected to a skid mounted outdoor 440 V MCC for distribution to the contract crushing equipment. The contract crushing load is estimated at 1.1 MW, including auxiliary electrical loads (Table 18-4).

Table 18-4 – Total Process Plant Power Demand

Area	Demand (contract crushing)
Crushing/Screening/Stockpile	1.1 MW
DMS/Reagents/Tailings	3.5 MW
Total Process Plant Demand	**4.6 MW**

18.11 WATER SUPPLY

The primary water source will be from the Jequitinhonha River.

Sigma has been granted a flow of 150 m^3/h for all months of the year by the Agencia Nacional das Águas (ANA) for a period of 10 years, which is sufficient for LOM requirements. There will be a day storage tank of 3,600 m^3 at the plant. Two pumps, one operating and one on standby, will supply make-up water/raw water to the following consumers for subsequent reticulation:

- Process water tank
- Fire water tank
- Potable water treatment / potable water tank
- Mine services
- Non-Process plant.

Potable water treatment will be supplied directly from the primary water treatment plant. Raw water will be used in the workshops and for the truck-wash system make-up.

Process water will be recirculated as much as possible to minimize make-up water requirements.

18.12 COMPRESSED AIR

Compressed air will be required by the process plant, utilities area, workshops and laboratory. Plant and instrument air will be supplied by rotary screw compressors. Instrument air will be further dried prior to use.

For the mine and at the mine workshop, compressors will be provided as required by the mining contractor.

18.13 CONTROL SYSTEMS

A process control system (PCS) will monitor all plant equipment and instruments, and control of all drives not associated with a vendor programmable logic controller (PLC). Plant PLC processor racks will be located in switchrooms with the exception of vendor package PLCs which may be located in field control panels. The main plant supervisory control and data acquisition (SCADA) system hardware will consist of a redundant master–follower input/output (I/O) server pair of rack-mounted SCADA computers located in communications rack in or near the plant control room. The computers and the control room network equipment will be powered by a rack mount uninterruptible power supply (UPS). A fibre-optic network will connect with locations outside of the switchroom/control room buildings. There will be two control rooms within process plant: the crushing control room and the main control room. The crushing control room will be located adjacent to the crushing switchroom, while the main control room will be located next to the DMS switchroom.

18.14 COMMUNICATION SYSTEMS

The communications system will consist of:

- Telecommunications network and internet services
- Access control
- Extruded cabling.

18.15 CAMPS AND ACCOMMODATION

There will be no constriction or operations camp for the Project considering the proximity of nearby towns.

18.16 PORT FACILITIES

Sigma will use the port facilities located at Port of Ilhéus for solid bulk storage port operations. The Port of Ilhéus is certified by Bureau Veritas Quality and is fully functional with trained professionals and cargo handling equipment.

The product will be received and unloaded, stored in a segregated and dedicated warehouse or yard that will be free of contamination, and when required, will be uploaded to a ship.

The Port of Ilhéus will manage reporting of reception and loading, command of the ship and/or its agents, co-ordinate cargo loading and include port operation insurance.

A proposal was submitted to Sigma by Intermarítima Portos e Logística S/A for an average ship loading rate of 5,000 tpd with a tolerance of 10%. Figure 18-6 shows the inland land transport routing from the Xuxa site to the Port of Ilhéus.

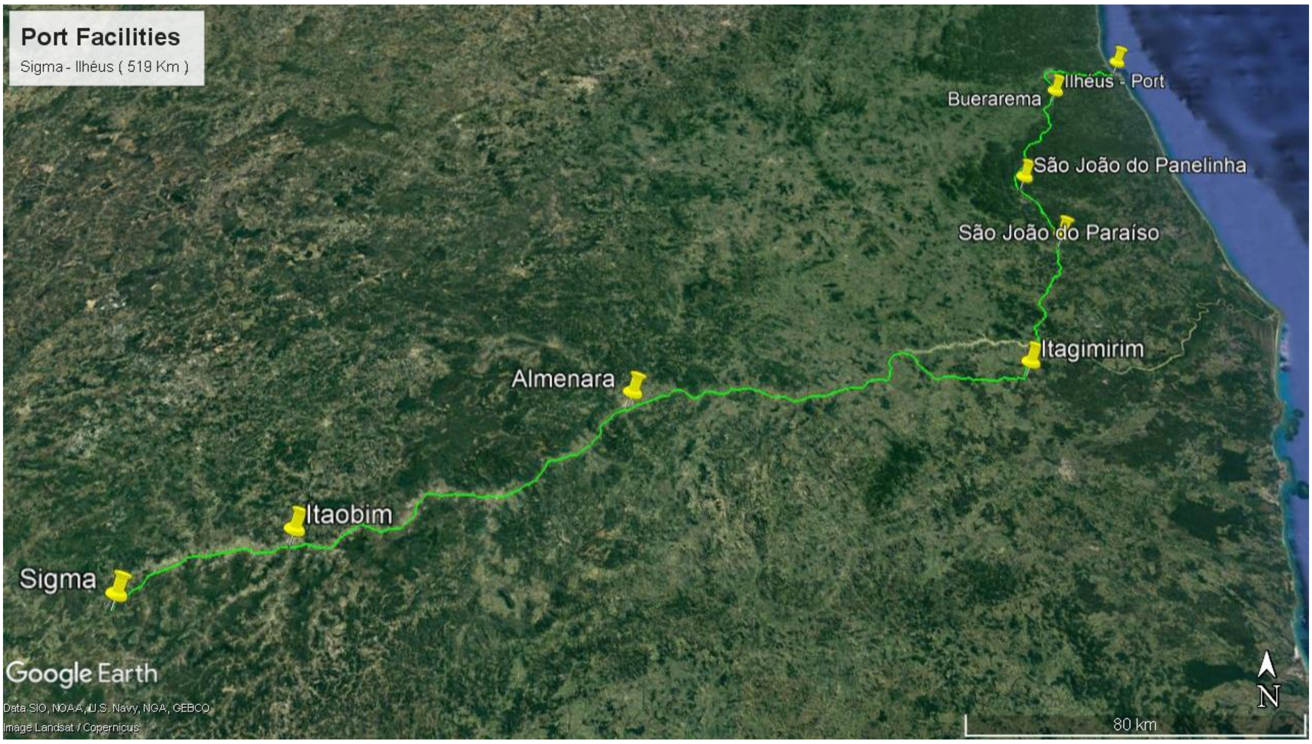


Figure 18-6 – Product Transport Routing from Xuxa to Ilhéus

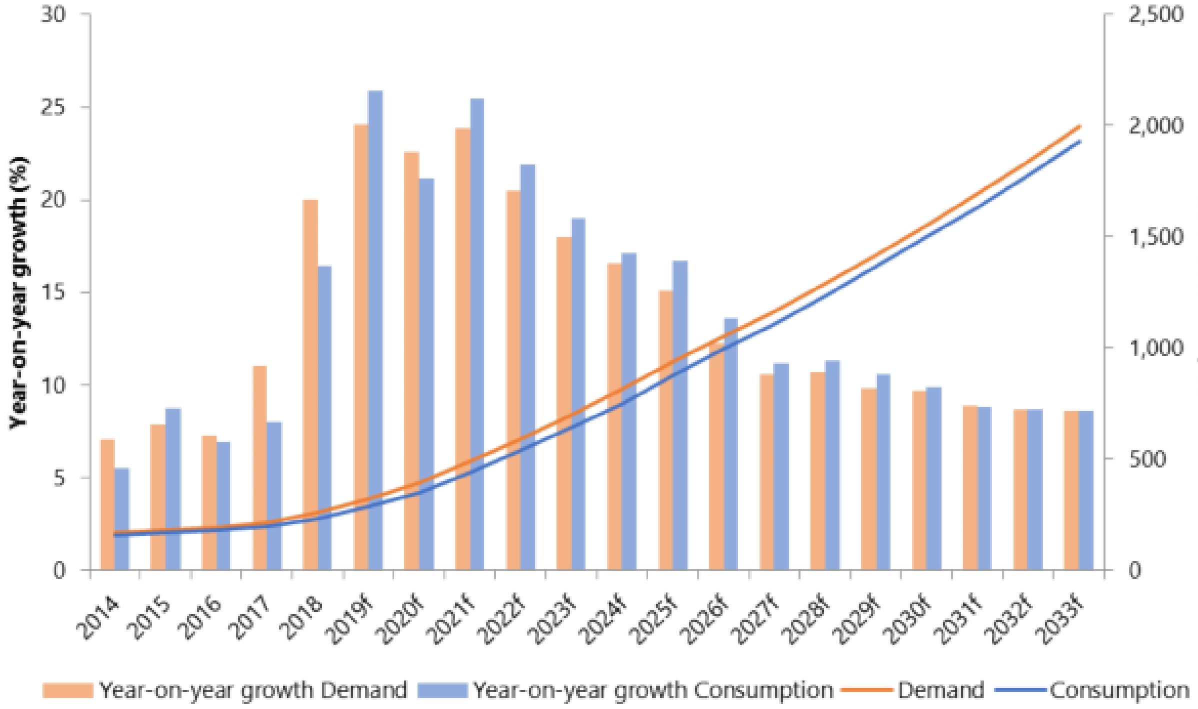
Note: Figure provided by Sigma, 2019

19 MARKET STUDIES AND CONTRACTS

Information in this section on marketing and price assumptions is summarized from Roskill (2019).

19.1 LITHIUM DEMAND AND CONSUMPTION

Demand for lithium rose by 20% in 2018 to reach over 261,100 t lithium carbonate equivalent (LCE), 3% above Roskill's mid-2018 forecast of 253,500 t LCE. Consumption of lithium in 2018 was estimated at 231,300 t LCE. Growth in consumption of lithium since 2000 has been led by the rechargeable battery industry which has accounted for 67% of the total rise in consumption since 2000. The rechargeable battery sector accounted for 50% of lithium consumption in 2018 and became the largest lithium consumer in 2008. The short-, medium- and long-term outlook for lithium consumption appears strong, as shown in Figure 19-1.



Source: Roskill forecast

Figure 19-1 - World Consumption and Demand Forecast for Lithium, 2014–2033

Note: Figure prepared by Roskill, 2019

19.1.1 Usage by Product Type

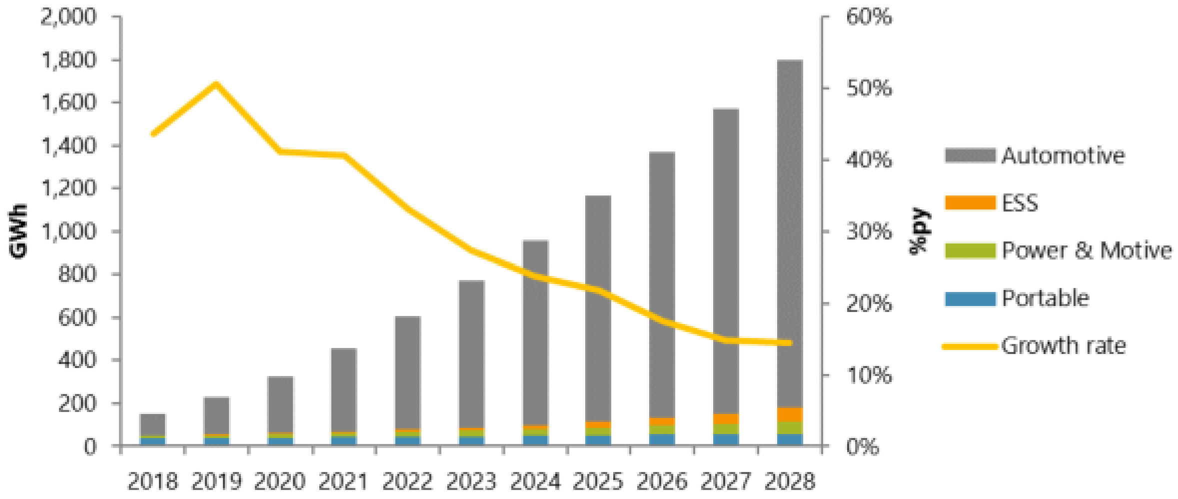
Lithium carbonate is the most widely consumed lithium product, used in rechargeable batteries, ceramics, glass-ceramics, glass, metallurgical powders, aluminium and other uses. Battery-grade carbonate and hydroxide together represented 50% of total consumption by product in 2018, reflecting the importance of the rechargeable battery market. A small amount of battery-grade metal is used in rechargeable batteries, but its main use is in primary batteries, with all battery uses for lithium at 52% of total product consumption.

19.1.2 Demand by Country/Region

China is the largest consumer of lithium, accounting for around 40% of total consumption in 2018. Chinese consumption has increased by 11.3% per annum since 2003, principally through rapid expansion of its battery sector. Japan and South Korea represent 15% of the global market for lithium respectively.

19.1.3 Lithium-ion Battery Market Trend

Roskill's baseline outlook for consumption of lithium-ion batteries forecasts growth of 28% per annum from 2018 to 2028 (Figure 19-2).

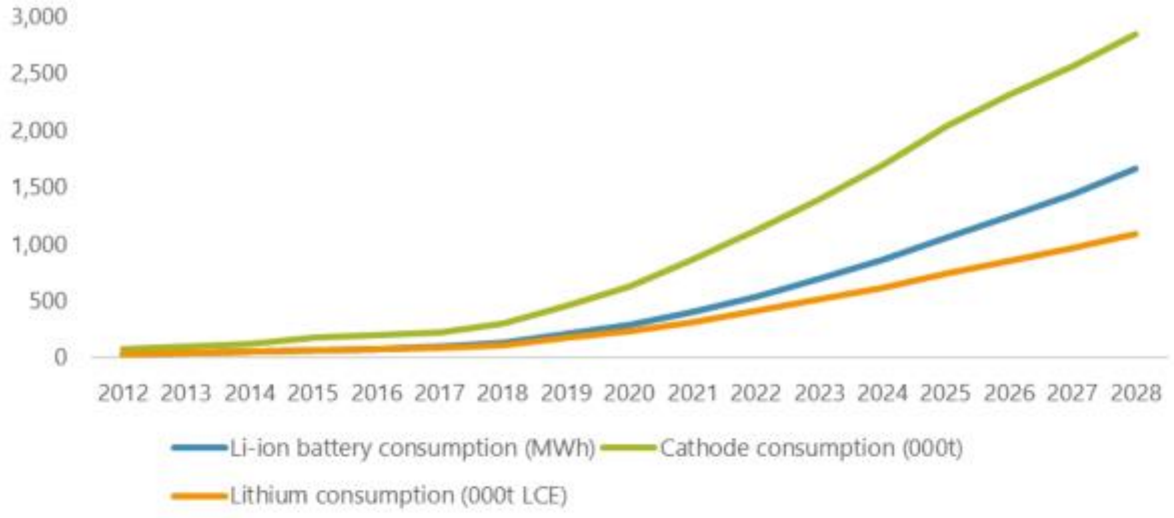


Source: Roskill

Figure 19-2 - World Li-ion Battery Use by Market, 2018–2028 (GWh)

Note: Figure prepared by Roskill, 2019

The forecast for lithium-ion battery, cathode and lithium consumption is shown in Figure 19-3.

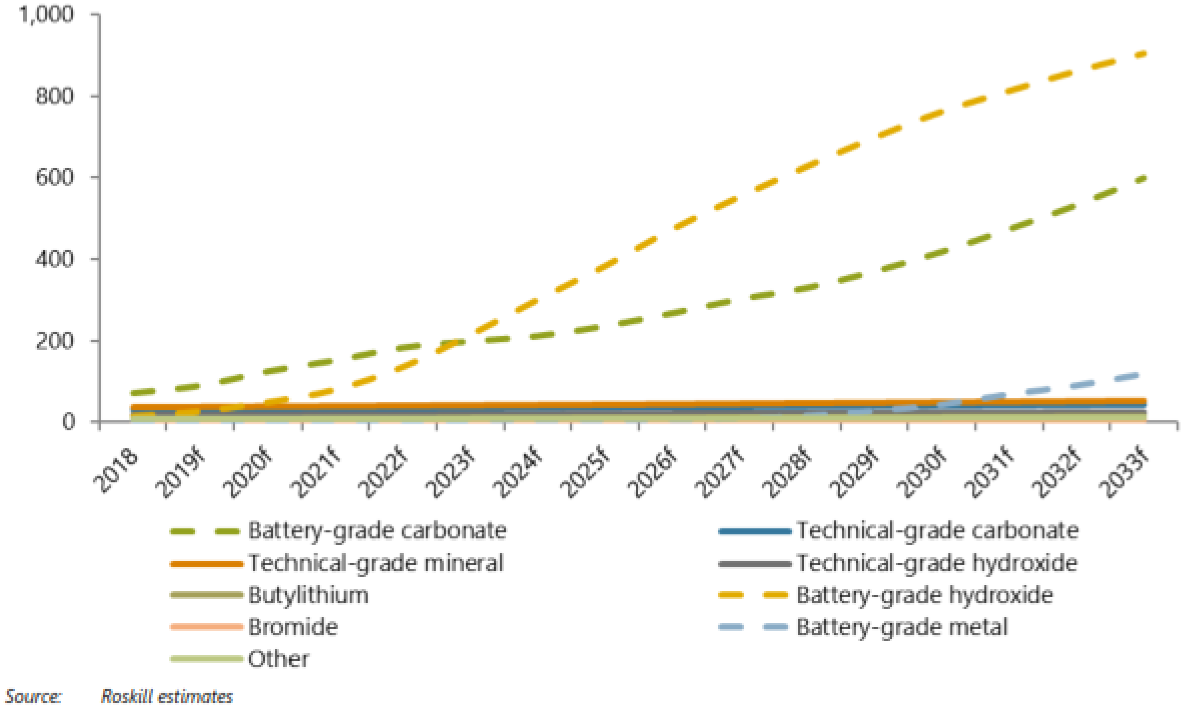


Source: Roskill

Figure 19-3 - Forecast Li-ion battery, cathode and lithium consumption, base-case, 20012-2028

Note: Figure prepared by Roskill, 2019

The short-, medium- and long-term outlook for lithium consumption appears strong. There are considerable upside and downside risks to the outlook for growth in consumption of lithium to 2028. The low-case (pessimistic) scenario foresees slower global economic growth affecting demand. In this scenario, growth in consumption of lithium is forecast at 11.1% per annum. In the high-case (optimistic) scenario, growth in consumption of lithium is forecast to increase by 19.2% per annum to reach 3.2 Mt LCE in 2028. The forecast consumption of lithium by product is shown in Figure 19-4.

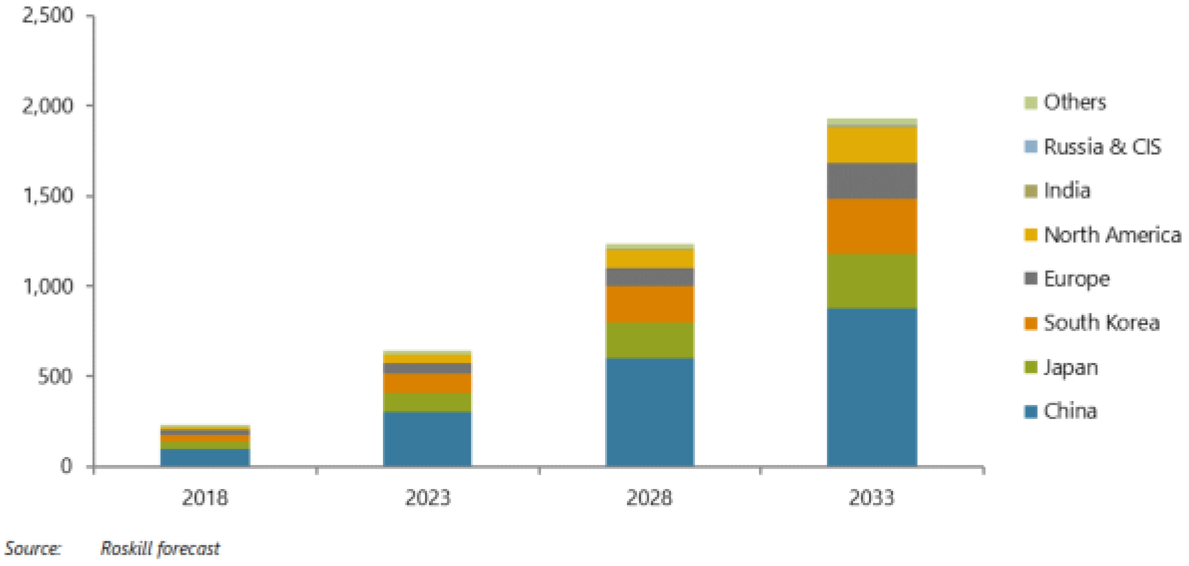


Source: Roskill estimates

Figure 19-4 - World forecast consumption of lithium by product, 2018-2033 (000t LCE)

Note: Figure prepared by Roskill, 2019

The consumption of lithium by country/region is shown in Figure 19-5.



Source: Roskill forecast

Figure 19-5 - World outlook for consumption of lithium by country/region, 2018–2033 (t LCE).

Note: Figure prepared by Roskill, 2019

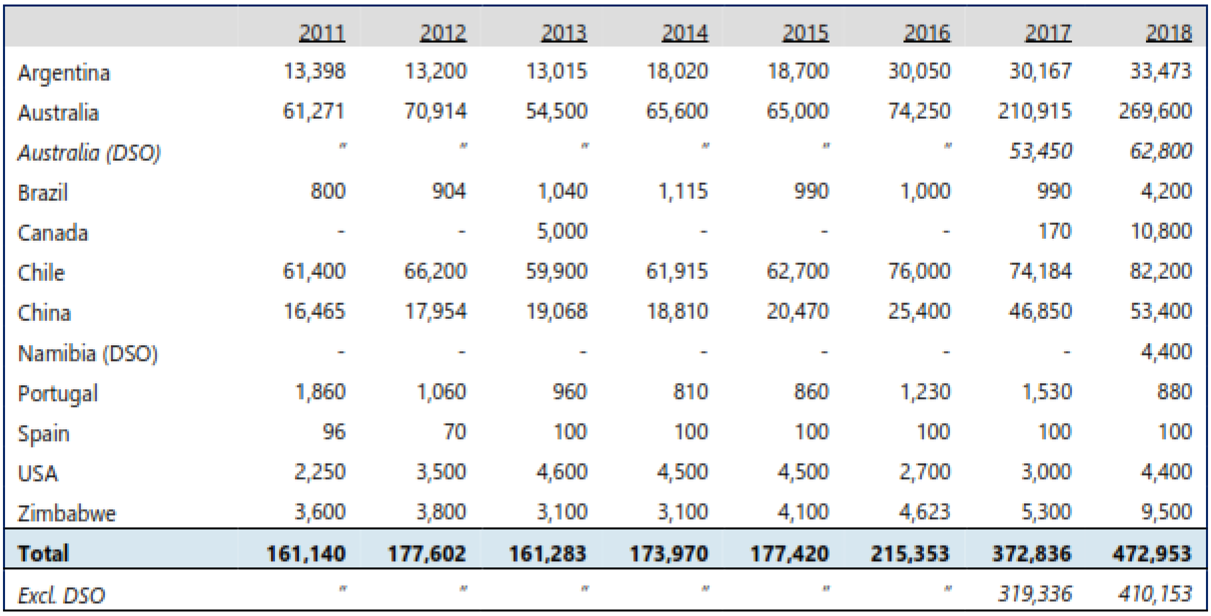
19.2 LITHIUM PRODUCTION

19.2.1 Production

Based on United States Geological Survey (USGS) data, the countries that have major lithium inventories include Chile, China, Australia, Argentina, Bolivia, and the USA.

Since 2000, growth in "mine" (mineral mining and brine extraction) output has averaged 10% per annum, driven largely by increasing production at operations in Australia, Chile, China and Argentina. Table 19-1 is a summary of lithium production by country. Output in 2018 is expected to move significantly higher again.

Table 19-1 – World Mine Production of Lithium by Country, 2010–2018 (t LCE)

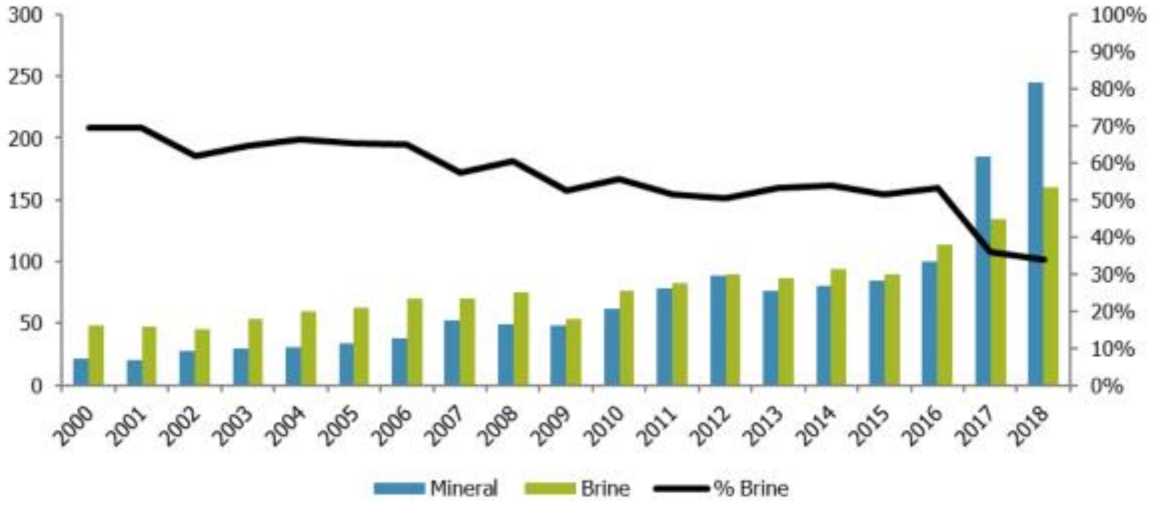


	2011	2012	2013	2014	2015	2016	2017	2018
Argentina	13,398	13,200	13,015	18,020	18,700	30,050	30,167	33,473
Australia	61,271	70,914	54,500	65,600	65,000	74,250	210,915	269,600
Australia (DSO)	″	″	″	″	″	″	*53,450*	*62,800*
Brazil	800	904	1,040	1,115	990	1,000	990	4,200
Canada	-	-	5,000	-	-	-	170	10,800
Chile	61,400	66,200	59,900	61,915	62,700	76,000	74,184	82,200
China	16,465	17,954	19,068	18,810	20,470	25,400	46,850	53,400
Namibia (DSO)	-	-	-	-	-	-	-	4,400
Portugal	1,860	1,060	960	810	860	1,230	1,530	880
Spain	96	70	100	100	100	100	100	100
USA	2,250	3,500	4,600	4,500	4,500	2,700	3,000	4,400
Zimbabwe	3,600	3,800	3,100	3,100	4,100	4,623	5,300	9,500
Total	**161,140**	**177,602**	**161,283**	**173,970**	**177,420**	**215,353**	**372,836**	**472,953**
Excl. DSO	″	″	″	″	″	″	*319,336*	*410,153*

Source: Roskill estimates

Note: DSO = direct shipping ore.

Since 2000, the dominance of lithium production from brine operations has been gradually falling (Figure 19-6). As Australian mineral production increased significantly in 2017 and 2018, the share of mine production held by brine producers dropped to 35% and 32% respectively.



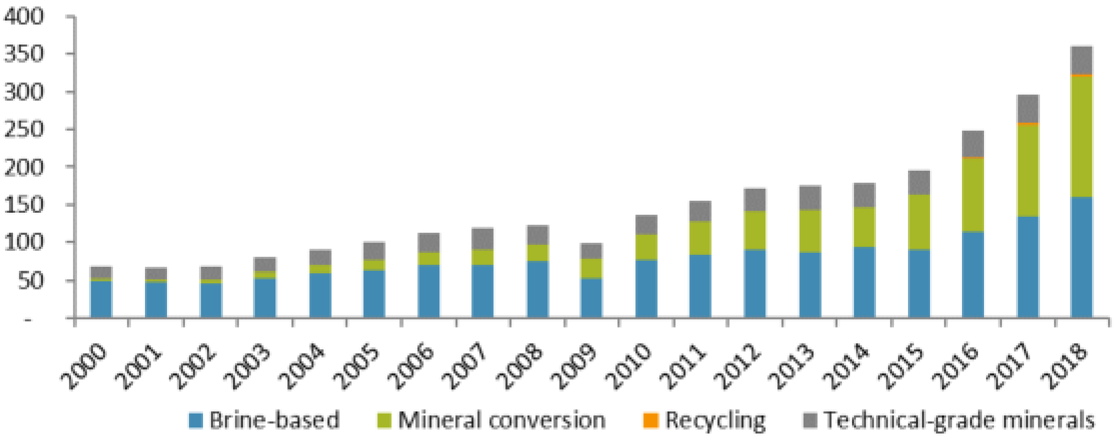
Source: Roskill estimates

Note: Mineral excludes DSO produced in Australia and Namibia

Figure 19-6 - World refined production of lithium by type, 2000-2018 (000t LCE)

Note: Figure prepared by Roskill, 2019

The supply of refined lithium compounds is from brine-based production, mineral conversion, and a small amount of recycling, with the remainder of mine output sold as technical-grade minerals (Figure 19-7). Total output of these refined products is estimated at 308,200 t LCE in 2018, up from 240,200 t LCE in 2017. The "big-5" producers (Albemarle, SQM, Ganfeng, Tianqi and Livent) accounted for 71% of refined product output.



Source: Roskill estimates

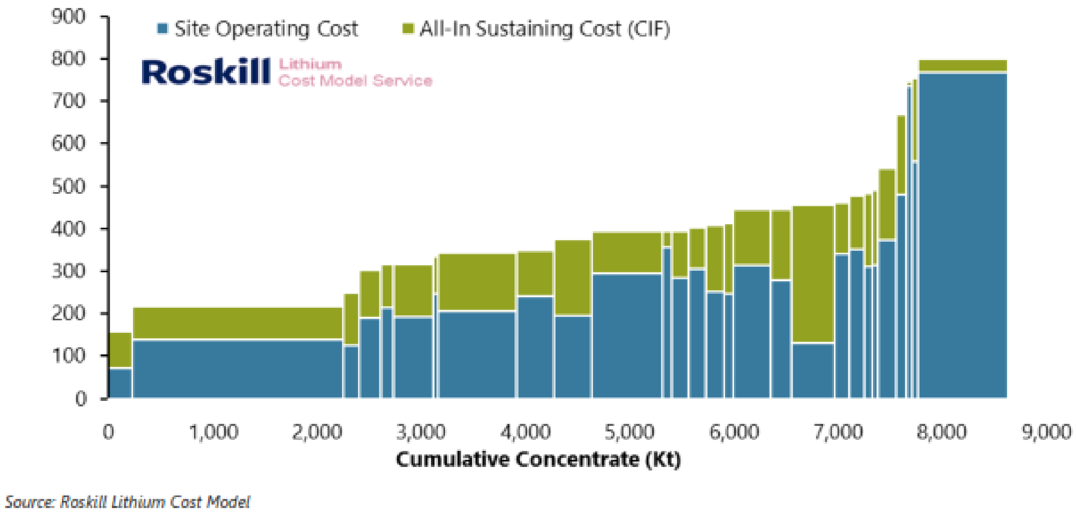
Note: Negligible impact of recycled output to 2018

Figure 19-7 - World refined production of lithium by type, 2000-2018 (000t LCE)

Note: Figure prepared by Roskill, 2019

19.2.2 Production Costs

Production costs for mineral concentrate varied significantly in 2018 (Figure 19-8), with production at Talison Greenbushes in Western Australia at around US$200/t cost, insurance and freight (CIF) China compared to spodumene equivalent costs for direct-shipping ore (DSO) produced at Wodgina, also in Australia, at around US$800/t CIF.



Source: Roskill Lithium Cost Model

Figure 19-8 - Mineral Concentrate Cost Curve, 2018–2040 (US$/t CIF)

Note: Figure prepared by Roskill, 2019

19.2.3 Forecast Mine Capacity

At the end-of 2018, global nameplate production capacity for mining lithium totalled 611,390 tpa LCE. The largest additions to mine capacity in the short-term are in Australia (mineral-based) and Chile (brine-based). Overall, existing and potential new producers could raise total mine capacity to 1.7 Mtpa LCE by 2023 and 1.85 Mtpa LCE by 2025 (Figure 19-9). Significant volumes of additional mining capacity will be required in the mid-2020s to match consumption growth later in the decade and into the 2030s. It is likely that capacity expansions at existing producers or projects approaching commissioning will account for a portion of additional supply, though a significant number of new projects will also be required longer-term to meet consumption growth.

Source: Roskill forecasts
Note: Capacity not adjusted for financing, construction and commissioning/ramp-up delays

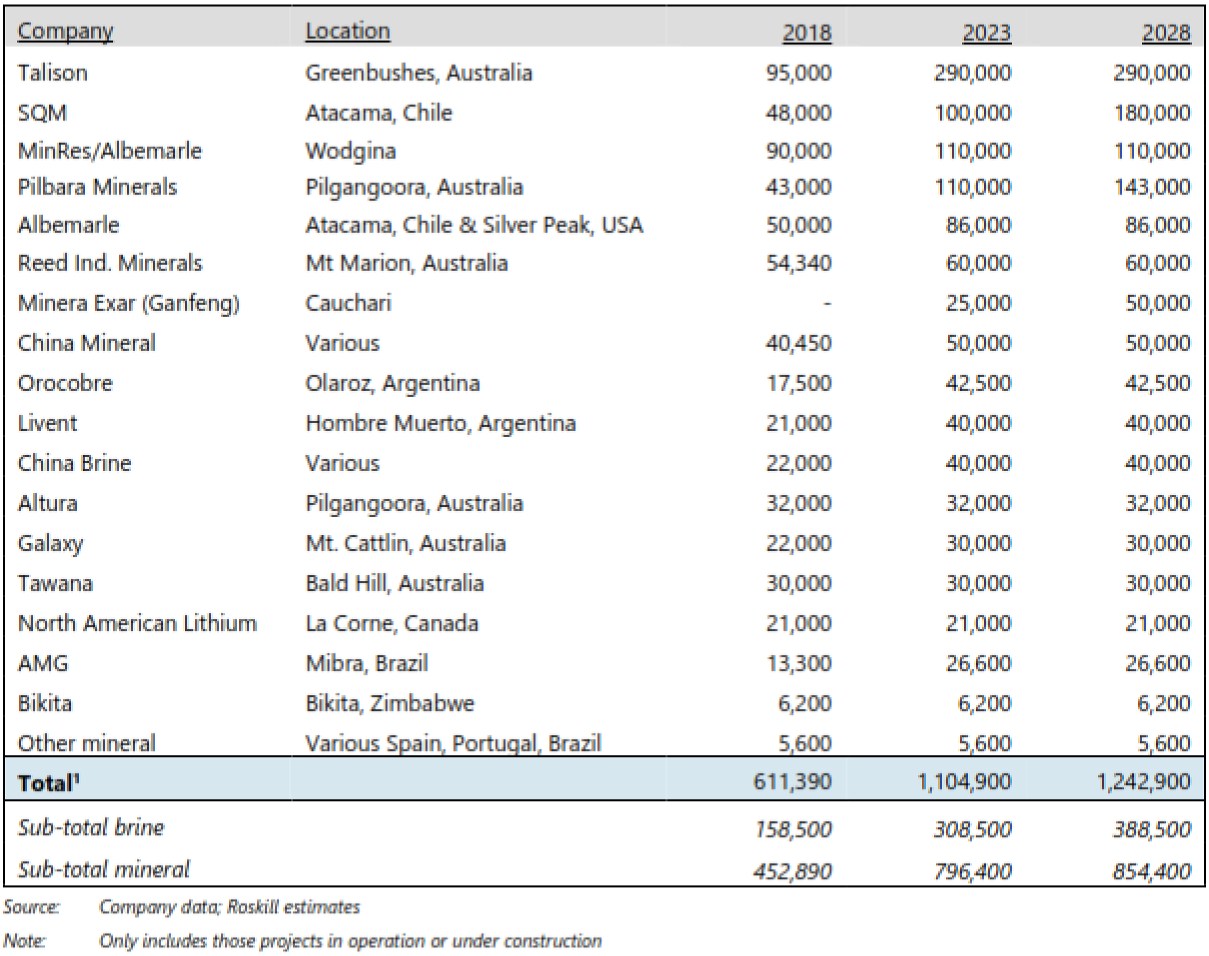
Figure 19-9 - World Forecast Mine Capacity for Lithium, 2014–2023 (000t LCE)

Note: Figure prepared by Roskill, 2019

Existing producers (including those that started production in 2018) are adding around 0.5 Mtpa LCE of mine capacity by 2023 and a further 0.15 Mtpa LCE of capacity by 2028, based on announced plans. Talison could contribute 0.2 Mtpa LCE, tripling its 2018 capacity by 2023, with most other producers doubling their facilities capability.

The existing, expanded and under construction lithium nameplate capacity by company is summarized in Table 19-2.

Table 19-2 - World Forecast, Expanded And Under Construction Lithium Nameplate Capacity by Company, 2010–2018 (t LCE)



Company	Location	2018	2023	2028
Talison	Greenbushes, Australia	95,000	290,000	290,000
SQM	Atacama, Chile	48,000	100,000	180,000
MinRes/Albemarle	Wodgina	90,000	110,000	110,000
Pilbara Minerals	Pilgangoora, Australia	43,000	110,000	143,000
Albemarle	Atacama, Chile & Silver Peak, USA	50,000	86,000	86,000
Reed Ind. Minerals	Mt Marion, Australia	54,340	60,000	60,000
Minera Exar (Ganfeng)	Cauchari	-	25,000	50,000
China Mineral	Various	40,450	50,000	50,000
Orocobre	Olaroz, Argentina	17,500	42,500	42,500
Livent	Hombre Muerto, Argentina	21,000	40,000	40,000
China Brine	Various	22,000	40,000	40,000
Altura	Pilgangoora, Australia	32,000	32,000	32,000
Galaxy	Mt. Cattlin, Australia	22,000	30,000	30,000
Tawana	Bald Hill, Australia	30,000	30,000	30,000
North American Lithium	La Corne, Canada	21,000	21,000	21,000
AMG	Mibra, Brazil	13,300	26,600	26,600
Bikita	Bikita, Zimbabwe	6,200	6,200	6,200
Other mineral	Various Spain, Portugal, Brazil	5,600	5,600	5,600
Total[1]		611,390	1,104,900	1,242,900
Sub-total brine		*158,500*	*308,500*	*388,500*
Sub-total mineral		*452,890*	*796,400*	*854,400*

Source: Company data; Roskill estimates

Note: Only includes those projects in operation or under construction

Overall, existing producers could raise refined capacity to 816,440 tpa LCE by 2023 and 936,440 tpa LCE by 2028. Recycling could add significantly to lithium refining capacity in the mid-term.

Unless further brownfield expansion occurs, a significant number of new projects will also be required longer-term to meet consumption growth. A long list of lithium mine projects is under evaluation (amongst which are Nemaska Lithium, new lithium projects emerging in Argentina since 2016, several brine projects under evaluation in South America, including Lithium Power International, Minera Salar Blanco and Wealth Minerals who have secured development licenses to the Maricunga project in Chile. Keliber are raising finance for their project in Finland. European Metals at Cinovec, European Lithium at Wolfsburg and Sigma at Xuxa are at feasibility stage. Rio Tinto was aiming to complete a revised feasibility study on the Jadar deposit during 2018. In Canada, Critical Elements released a feasibility study on the Rose project in 2017, but the main project backer (Helm of Germany) have withdrawn from the project. Galaxy is expected to release a feasibility study on the James Bay project in 2019, with Sayona at Authier and Avalon at Separation Rapids expected to further the feasibility of their projects during 2019.

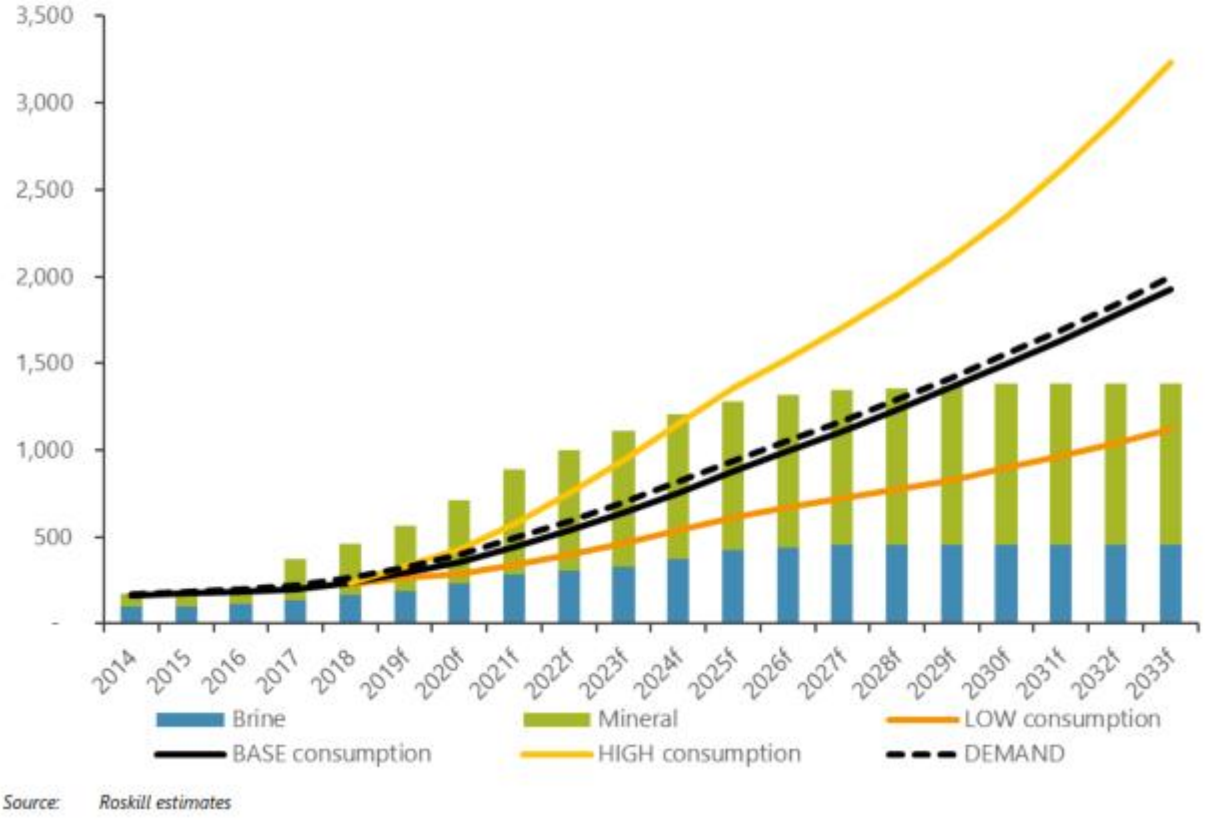
Mine projects at the feasibility study and financing stage, not included in the capacity table above, could add 382,550 tpa of capacity by the early 2020s. Not all projects at pre-feasibility study stage have a defined capacity but could add similar capacity. These projects could close the forecast long-term supply gap to base-case and high-case consumption, if existing and 2018 new producers are unable to expand.

Existing producers could raise refined capacity to 816,440 tpa LCE by 2023 and 936,440 tpa LCE by 2028, but thereafter there has yet to be any significant developments announced. Significant volumes of additional refining capacity will be required in the mid-2020s.

In total, the major producers would account for 80-85% of mined output through integrated supply, or captive or off-take agreements with mine operators, in 2023, higher than their 70% share in 2018 but falling to 75% in 2028. Other suppliers currently accounting for 5-10% of mine and refined supply increasing to 20% market share by 2028 with 250,000 t LCE, with the majority coming from Australian spodumene producers.

The greatest uncertainty is other companies' contribution to supply entering the market in 2019–2023. In the long-term, their contribution is necessary unless further expansion occurs at existing producers above. Their fortunes therefore largely rest on the ability of these off-takers to sell/use lithium compounds.

Roskill expects refined output to increase ahead of consumption as in a rapidly growing market (Figure 19-10). Nevertheless, the market is at risk of oversupply in the late 2010s and early 2020s given the size of expansions and the number of new mine and refined producers entering the market. Given a history of underperformance on delivering supply to market, lithium's past problems may well cancel out predicted shorter-term oversupply.



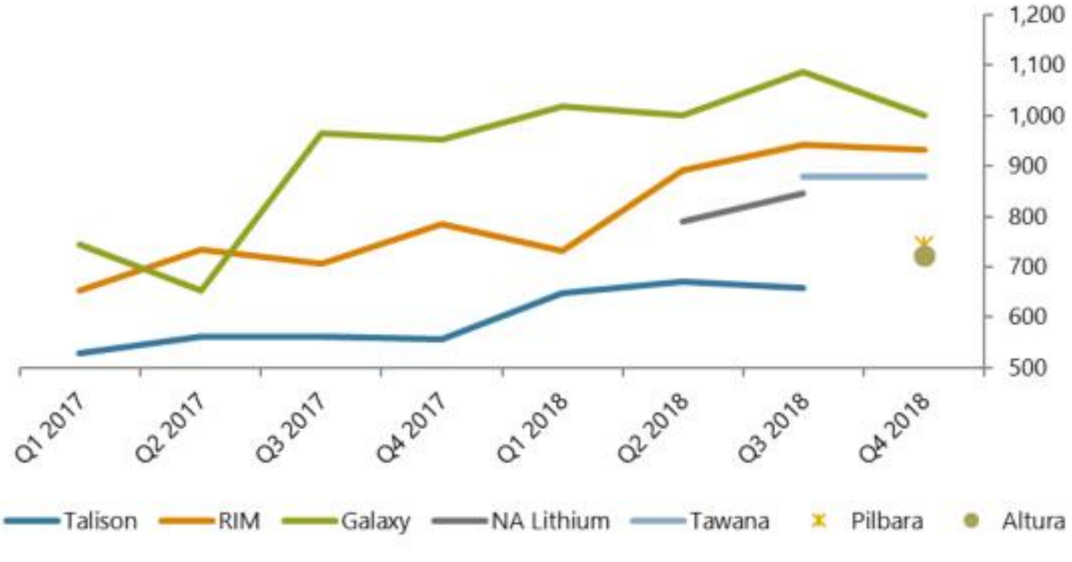
Source: Roskill estimates

Figure 19-10 - World Forecast Mine Supply for Lithium, 2014–2023 (000t LCE)

Note: Figure prepared by Roskill, 2019

19.3 LITHIUM PRICES

Lithium product prices respond to variations in supply, demand, and the perceived supply/demand balance, costs and economic factors. Most commonly referenced currency for transactions is in US$. The variance in price between suppliers can be seen in the value of shipments to China over the last two years in Figure 19-11.

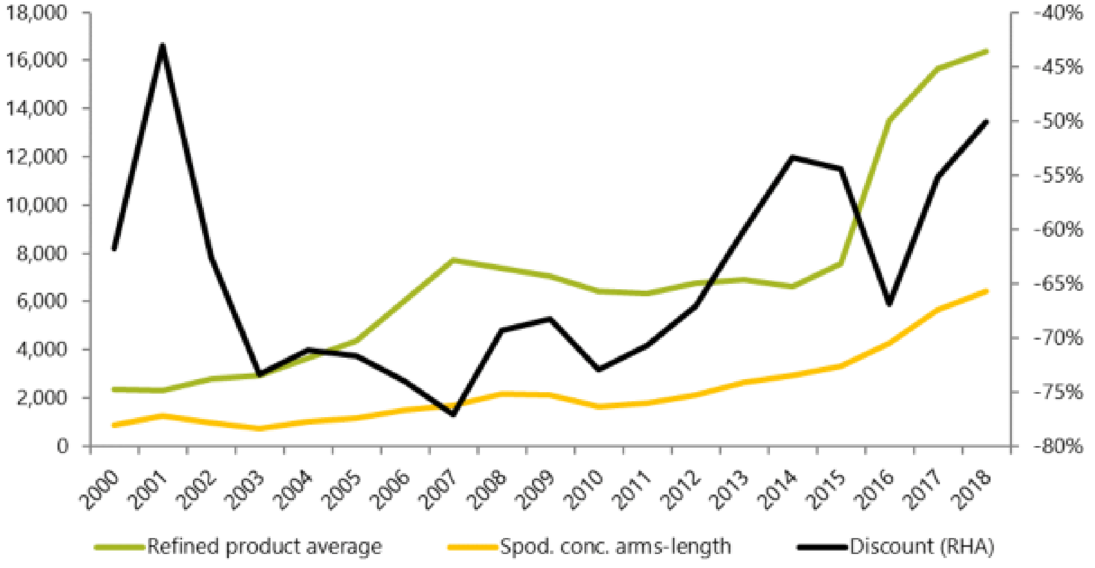


Source: China Customs and Company Financials/Reports

Figure 19-11 - Chemical Grade Spodumene Concentrate Prices by Supplier, Q1 2017– Q4 2018 (US$/t CIF China)

Note: Figure prepared by Roskill, 2019

Chemical grade spodumene concentrate prices compared to refined lithium products are shown in Figure 19-12.



Source: China Customs, Global Trade Tracker, Roskill
Note: Spodumene concentrate CIF China price includes 12% losses during the conversion process, although this varies from plant to plant

Figure 19-12 Prices for Chemical-Grade Spodumene Concentrate and Comparison to Refined Lithium Products 2000–2018 (US$/t LCE)

Note: Figure prepared by Roskill, 2019

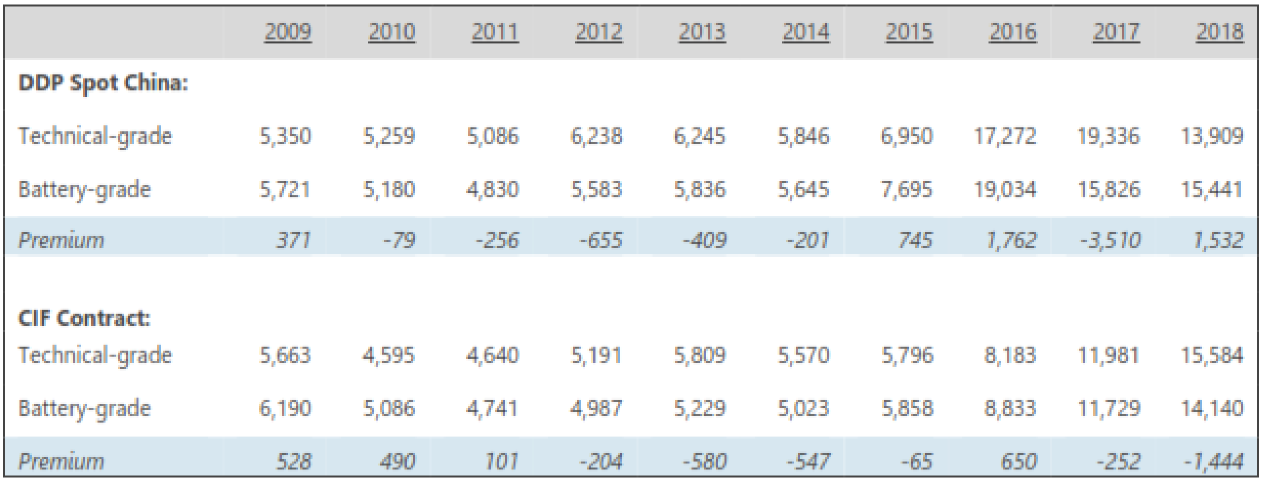
19.3.1 Outlook

Lithium carbonate is the main product produced and consumed in the lithium market, although lithium hydroxide use is growing at a faster rate. Battery-grade lithium carbonate accounted for around 70% of carbonate use in 2018. With this considered, the price of lithium carbonate is the best indicator of changes in market balance, as well as being the benchmark by which most other lithium products are priced.

19.3.2 Battery-Grade Lithium Carbonate

The average value of imports (CIF) of lithium carbonate into key battery-grade markets from Chile and Argentina can be used as a guide to yearly average contract prices for battery-grade lithium carbonate from South American suppliers (Table 19-3). There has essentially been no consistent premium for battery-grade carbonate.

Table 19-3–Comparison: Battery-Grade and Technical-Grade Lithium Carbonate Avg Annual Contract and Spot Price, 2009–18 (US$/t)



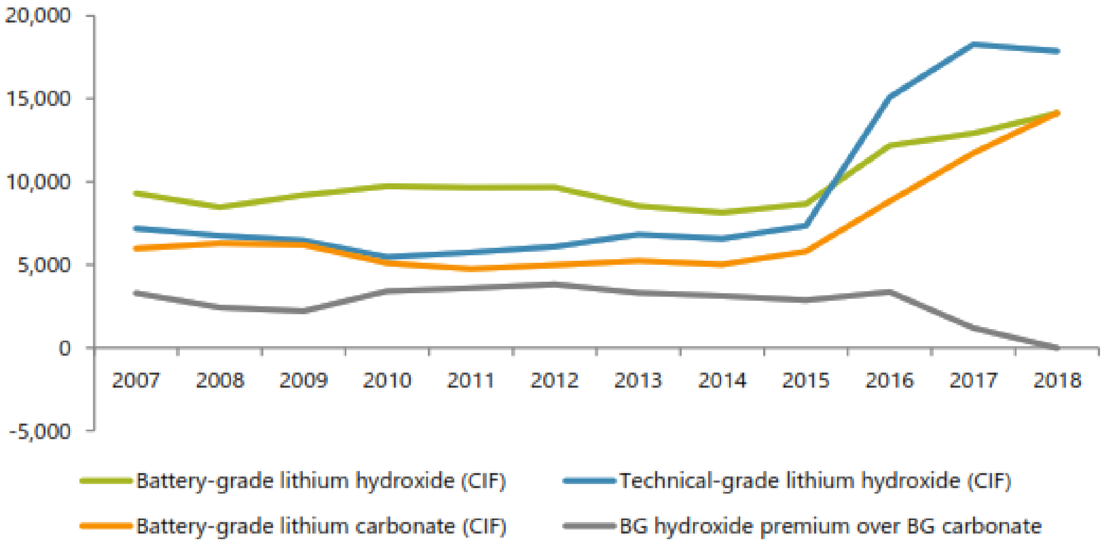
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
DDP Spot China:										
Technical-grade	5,350	5,259	5,086	6,238	6,245	5,846	6,950	17,272	19,336	13,909
Battery-grade	5,721	5,180	4,830	5,583	5,836	5,645	7,695	19,034	15,826	15,441
Premium	*371*	*-79*	*-256*	*-655*	*-409*	*-201*	*745*	*1,762*	*-3,510*	*1,532*
CIF Contract:										
Technical-grade	5,663	4,595	4,640	5,191	5,809	5,570	5,796	8,183	11,981	15,584
Battery-grade	6,190	5,086	4,741	4,987	5,229	5,023	5,858	8,833	11,729	14,140
Premium	*528*	*490*	*101*	*-204*	*-580*	*-547*	*-65*	*650*	*-252*	*-1,444*

Source: Roskill (contract); Asian Metal (spot)

19.3.3 Battery-Grade Lithium Carbonate

Battery-grade hydroxide contract prices show a larger variance by destination than carbonate. This also weighs down the average price, which based on South Korea and Taiwan would be closer to US$18,500/t in 2018.

Battery-grade lithium hydroxide carries a premium to lithium carbonate of over US$1,000/t in the Chinese spot market and had carried a larger premium on a CIF contract basis until 2017 (Figure 19-13).



Source: Battery-grade lithium hydroxide CIF = Weighted average of Japan, Korea and Taiwan imports; Industrial-grade lithium hydroxide = see above; battery-grade Lithium carbonate CIF = see above

Figure 19-13 - Average Annual Contract Prices Battery Grade Lithium Hydroxide & Lithium Carbonate (2007–2018 (US$/tCIF))

Note: Figure prepared by Roskill, 2019

19.3.4 Chemical-Grade Spodumene Concentrate

Per Roskill, marginal costs of concentrate production are expected to remain between US$500–800/t LCE through 2028, if the very high cost of production from lepidolite and DSO at the upper end of the cost curve is justified by a lack of supply from other, cheaper, sources, in which case it could fall to US$400-500/t.

Roskill provided price forecasts through to 2032 for spodumene concentrate prices for the three categories of 6% spodumene lithium concentrate pricing structures, as described below. The world's largest spodumene concentrate producer Talison Lithium in Australia practices inter-company pricing (as that company is 51% owned by Tianqui and 49% owned by Albermarle).

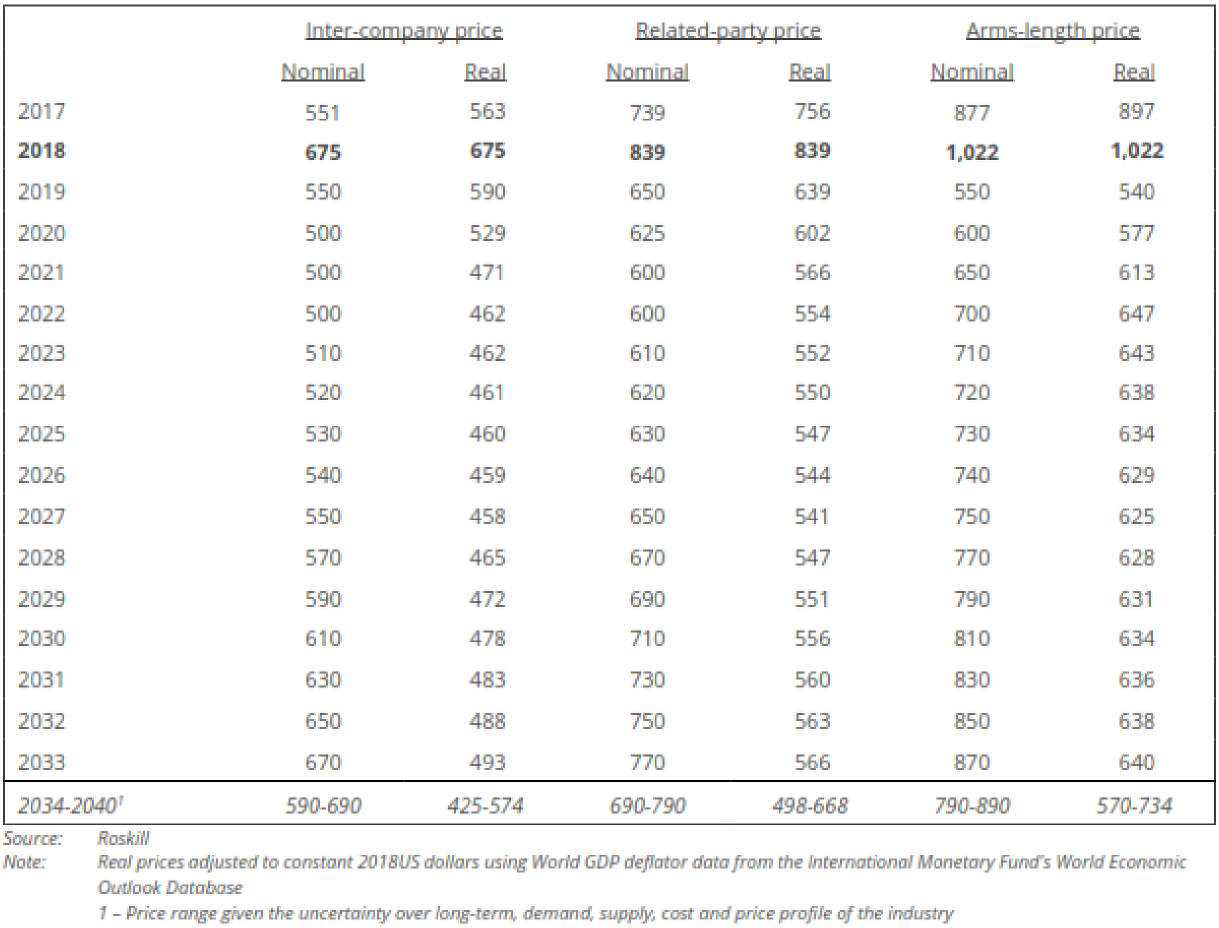
The three-tier pricing forecast published by Roskill is based on the following:

- **Inter-company priced**: Talison Lithium to Tianqi Lithium and Albemarle; and, NA Lithium to CATL.
- **Related-party priced**: Reed Industrial Minerals to Ganfeng Lithium; Pilbara Minerals to Ganfeng Lithium and General Lithium; and, Altura Mining to Optimum Nano and Lionergy.
- **Arms-length priced**: Galaxy Lithium to Blossom Lithium, Shandong Ruifu and General Lithium; AMG to General Lithium; and, Altura to Burwill Holdings.

Prices for all contracts peaked in 2018, within a range of US$560-1,050 / tonne reflecting Talison to Tianqi/Albemarle inter-company shipments at the lower end and Galaxy to third party customers at arm's length at the high end. Related-party contracts fell in the middle of these two end-members and remain the benchmark average to 2032. Related- party contracts are expected to fall to US$600/t by 2021 before steadily increasing into the late-2020s. Arms-length sales are expected to show a premium to related-party sales of around US$100/t, with inter-company contracts at US$100/t discount. However, if lithium carbonate and hydroxide prices increase at a greater rate going forward, the chemical-grade spodumene price could increase towards the high case scenario, and vice versa.

Spodumene concentrate pricing inputs for the FS as provided by Roskill in August 2019 are stated in Table 19-4.

Table 19-4 - Annual Average Price Forecast Trend for Chemical Grade Spodumene, 2017–2040 (US$/t CIF)



	Inter-company price		Related-party price		Arms-length price	
	Nominal	Real	Nominal	Real	Nominal	Real
2017	551	563	739	756	877	897
2018	**675**	**675**	**839**	**839**	**1,022**	**1,022**
2019	550	590	650	639	550	540
2020	500	529	625	602	600	577
2021	500	471	600	566	650	613
2022	500	462	600	554	700	647
2023	510	462	610	552	710	643
2024	520	461	620	550	720	638
2025	530	460	630	547	730	634
2026	540	459	640	544	740	629
2027	550	458	650	541	750	625
2028	570	465	670	547	770	628
2029	590	472	690	551	790	631
2030	610	478	710	556	810	634
2031	630	483	730	560	830	636
2032	650	488	750	563	850	638
2033	670	493	770	566	870	640
2034-2040[1]	*590-690*	*425-574*	*690-790*	*498-668*	*790-890*	*570-734*

Source: *Roskill*
Note: *Real prices adjusted to constant 2018US dollars using World GDP deflator data from the International Monetary Fund's World Economic Outlook Database*
1 – Price range given the uncertainty over long-term, demand, supply, cost and price profile of the industry

Arms-length sales are expected to show a premium to related-party sales of around US$100/t, with inter-company contracts at a US$100/t discount. If lithium carbonate and hydroxide prices increase at a greater rate, the chemical grade spodumene price could increase towards the high case scenario, and vice versa.

For the Reserves definition, a spodumene concentrate price of US$700.00 (CIF Shanghai) has been used based on Sigma input and in line with Roskill early years prices.

For the economic analysis in Section 22, a 10-year average Roskill nominal arms-length forecast of an average nominal selling price of US$733.00 (CIF Shanghai) for the spodumene concentrate has been assumed.

19.3.5 Price Risk Factors

A number of key factors are likely to affect global commodity markets and, therefore, may impact lithium prices over the coming years, outside of cost/supply/demand fundamentals. Further, some risk factors unique to the lithium market may also impact the price in the future. Those key factors that underpin the forecasts presented above are presented below:

- Global economic growth: the world economy remains fragile, albeit since 2016 there has been an improvement in sentiment if not substance. Chinese growth is slowing and impacting world markets, but not as severely as predicted. While some recovery has been seen in Europe, this remains threatened by uncertainty in certain economies, reforms, and the impact of the increasing calls to halt austerity programs. In North America, cheap shale gas and increased oil output was contributing to growth, and the election of Donald Trump as President has further improved domestic sentiment towards more rapid US gross domestic product (GDP) growth; however, this may be short-lived with protectionism of US industry potentially damaging in the long-run. A

Chinese recession before 2020 cannot be ruled out, especially as debt levels continue to soar and this was the catalyst for the last recession in the west in 2008–2009, and with it, potential demand destruction in lithium and lower prices as witnessed between 2008 and 2011. Roskill has adjusted its baseline demand forecasts for all markets to show low/high scenarios should economic growth proceed at lower or higher levels than currently forecast.

- Changes to the cost of production (energy and raw materials)
- Changes to the cost of production (labour): of particular importance for the lithium market is the fact that China, which has historically enjoyed growth underpinned by comparatively low wages, is forecast to see a continued increase in wages over the coming decade. This may be countered by mechanised equipment, requiring less workers, however this equipment will also come at higher costs, increasing the up-front and working capital expenditure required.
- Changes to freight costs: the dry bulk sector is in the midst of a heavy trough with rates sinking to historic lows at end 2015. The fall was driven by the wide availability of dry bulk tonnage, with many vessels laid-up, and waning demand in the Asia–Pacific region pushing down freight rates. There has been a small recovery in the dry bulk sector in 2017, but this has yet to materially impact costs of lithium, which are approaching historic highs. If lithium prices were to collapse, and freight rates increase as they did in the late 2000s/early 2010s, then freight would have a more pronounced impact on lithium prices, especially spodumene concentrate and DSO. The vast majority of refined lithium product is shipped by container; containerised freight rates are more variable than bulk freight and are not significant compared to the current price of lithium; however, if the latter was to fall and the former rise then freight rates would have a more pronounced impact on refined lithium products.
- Changes to exchange rates: any companies that face costs denominated in their local currency but sell their products in US denominated contracts will be negatively affected by a weakening of the dollar and/or strengthening of their own currency, though most mining companies routinely hedge against exchange rate risk. A weakened renminbi (RMB) should favour domestic China producers and a weakened US$ dollar vice versa.
- Capital availability: since the global financial crisis, financial losses on the equity markets have dampened enthusiasm for equity deals, many of which have fallen through. The lack of availability financing and investor interest has disproportionately affected the mining industry, which is highly capital-intensive, and has pushed up the average cost of capital paid by companies. As a result, potential new lithium projects, exploration programs and expansion plans could sustain delays or cancellations if sentiment in the wider mining sector worsens for example as a result of another global downturn.
- Stockpiling and technological developments could also have an impact on the product price.

19.4 CONTRACTS AND OFF-TAKE AGREEMENTS

19.4.1 Off-take Agreements

Sigma has entered into a binding heads of agreement (the Agreement) for a strategic offtake and funding partnership with Mitsui & Co., Ltd. of Japan (Mitsui) for a significant portion of the funding required for the capital expenditures and construction of the Xuxa mine.

Pursuant to the Agreement, Mitsui and Sigma have agreed terms on:

- Production pre-payment to Sigma of US$30,000,000 for battery-grade lithium concentrate supply of up to 55,000 tonnes annually over six years, extendable for five years
- Offtake rights of a supplementary 25,000 tonnes of products over a period of six years, extendable for five years
- Advancement of deposit for long-lead items in support of meeting Sigma's Project construction schedule
- Strategic collaboration to leverage Mitsui's considerable global logistics and battery materials marketing expertise as well as an agreement to continue discussions regarding additional funding for further exploration and development of Sigma's vast mineral properties
- Mitsui's right to participate in Sigma's future capital expenditure financings and offtake rights for production expansion with other deposits conditional to concluding a feasibility study and Mineral Reserve estimates
- Selling price is based on quarterly published nominal arms-length price for chemical spodumene concentrate.

Sigma is currently in negotiations with further potential off-take customers for the balance of its annual production.

19.4.2 Operations Contracts

Sigma has no contracts in place in support of operations. Any future contracts are likely to be negotiated and renewed on an annual or biannual basis. Contract terms are expected to be typical of similar contracts in Minas Gerais State.

Contracts under negotiation include the following:

19.4.2.1 Outsourcing of the Mining Contract

Mining contractors are preparing all-in cost per tonne of ore mined offers, which will include drilling and blasting, mining of both waste rock and ore, dump development and supply all the necessary mining infrastructure. The contract is planned for a 10-year period. Outsourcing of mining is very common in the lithium industry.

19.4.2.2 Outsourcing of Substations

The construction and maintenance of the two main incoming substations and three smaller non-process plant substations is currently under negotiations. This contract is planned for a 10-year period.

19.4.2.3 Outsourcing of Crushing Plant

The outsourcing of the three-stage crushing plant to produce material of +0.5mm to -9.5mm is being negotiated. Outsourcing of the crushing is very common in the lithium industry.

19.4.2.4 Road transport contract

Proposals have been requested for the transport by truck of 20,000 t of concentrate per month to the Port of Ilhéus. The contract is planned for a two-year period.

19.4.2.5 Contract with the Port of Ilhéus

A five-year contract for storing and loading of 20,000 t of concentrate from the Port of Ilhéus is being negotiated with the local port authority.

19.4.2.6 Power contract with CEMIG

Discussions have commenced to sign a power supply contract with CEMIG.

20 ENVIRONMENTAL STUDIES, PERMITTING AND SOCIAL OR COMMUNITY IMPACT

Harpia Consultoria Ambiental provided the write-up and translation included in this section based on the Estudo e Relatorio de Impacto Ambiental or EIS (EIA-RIMA dated 30 October 2018 and Plano de Controle Ambiental – PCA dated December 2018). These documents were prepared and issued for submittal to the authorities by NEO Soluções Ambientais and ATTO GEO Geologia e Engenheria.

20.1 ENVIRONMENTAL CONSIDERATIONS

20.1.1 Environmental Permitting

In compliance with CONAMA Resolution 09/90, the environmental licensing of mining projects is always subject to an EIS, followed by an Environmental Impact Report (EIR), which supports the technical and environmental feasibility stage of the project and the granting of a Preliminary License (Licença Previa or LP) and/or a concurrent Preliminary Licence with an Installation License (Licença de Instalação or LI), collectively referred to as the (LP + LI).

The licensing process in Minas Gerais was developed in accordance with COPAM Regulatory Deliberation N° 217, dated December 6, 2017, which sets out the criteria that must be addressed based on the size of a planned mine, and its likelihood of generating environmental damage. Sigma has applied for an environmental license for approval of open-pit mining activities in respect of metallic minerals, except iron ore, with the following parameters:

- A gross production of 240,000 tpa
- 40 ha for tailings/waste piles
- Dry and wet mineral processing plants with a capacity of 1,500,000 tpa.

A water usage license for the project of 150 m^3 per hour has been granted.

The process of Concurrent Environmental Licensing Type CEL 2 LP and LI was submitted on December 20, 2018, as confirmed by receipt N°. 0859841/2018, and was followed by the presentation of an EIS, EIR and an Environmental Control Plan (ECP).

The permit for the first phase of both the Preliminary License (LP) and the Installation License (LI) (i.e. for Pit 1, processing plant and waste piles 1 and 2) was obtained on June 3, 2019.

An updated economic plan (Plano de Aproveitamento Economico (PAE)) was approved by the ANM in August 2018. With these licences, construction and plant installation at the Xuxa project is approved. Sigma is currently finalising the application for the environmental licenses for pit 2 and waste piles 3 & 4 which will be required in 2022.

Table 20-1 summarizes the granted Operations Licences, Environmental Operating Authorizations, and water leases within the Grota do Cirilo property. As indicated in the table, some of the licenses are under renewal, or are in the process of being updated.

Table 20-1 - Granted Licences and Leases

Number	Area	License Scope	Project Phase	License Phase	Permit Period		Status
					Begin	End	
0135/1994	931.012/1983 "Mining Group"	Operation License	Production		Aug. 25.1994	April 03 2003	Expired; renewed in 2008
0029/2008	931.021/1983 "Mining Group"	Operation License	Production	Renewal	Aug. 14.2008	Aug. 14.2014	Expired, and voluntarily not renewed
05782/2016	Faz. Monte Belo	Environmental Operating Authorization	Feasibility (pilot stage production)		Oct. 05.2016	Oct.20.2020	Valid
08190/2017	Faz. Barreiro Barreiro	Environmental Operating Authorization	Feasibility (pilot stage production)		Nov. 14.2017	Nov. 14.2021	Valid
07137/2016	Faz. Maxixe Lavra do Meio	Environmental Operating Authorization	Feasibility (pilot stage production)		Nov. 29.2016	Nov. 29.2020	Valid
08190/2017	Faz. Monte Belo	Environmental Operating Authorization	Feasibility (pilot stage production)		Nov.11.2017	Nov.11.2021	Valid
36073/2016	Faz. Monte Belo	Water Usage License for Small Volumes	Feasibility (pilot stage production)		Oct. 05.2016	Oct. 05.2019	Valid
43150/2016	Faz. Maxixe	Water Usage License for Small Volumes	Feasibility (pilot stage production)		Nov. 29.2016	Nov. 29.2019	Valid
1064/2017	Faz. Monte Belo	Water Usage License for Small Volumes	Feasibility (pilot stage production)		May 24.2017	May 24 2027	Valid
02500.001337 / 2019-47	Faz. Monte Belo	Water Usage License	Stage production		Jan 14 2019	Jan 14 2029	Valid
281/2019	Grota Cirilo	Environmental Preliminary License	Production		June 3 2019	June 3 2027	Valid
218/2019	Grota Cirilo	Environmental Installation License	Production		June 3 2019	June 3 2027	Valid

Sigma has developed Reclamation of Degraded Areas Plans (PRADs) and implemented them for certain past-producing areas within the Grota do Cirilo property. The plans are managed by Sigma personnel and external consultants in conjunction with the governing regulatory agencies. PRAD documentation was submitted to the Superintendência Regional do Meio Ambiente – Jequitinhonha (SUPRAM) for approval, and Sigma was granted approval to conduct the activities outlined in the PRAD on May 18, 2017 (per OF SUPRAM JEQ Nr 363/2017). SUPRAM has reviewed the work done under the PRAD, and on March 22, 2018 provided approval under OF. DREG.SUPRAM Jequitinhonha no. 3012/2018.

The PRADs are subject to periodic reviews and updates in response to new techniques, review of rehabilitation alternatives, adjustments for new mining activities and the restart of operations within previously mined areas.

Reviews conducted by third-party consultants William Freire and Neo Ambiental indicate that the existing environmental liabilities are related to small-scale artisanal mining that has not caused major environmental damage. Sigma is of the opinion that no rehabilitation of these areas is currently required, as rehabilitation would be conducted after Sigma's mining activities at these deposits has been completed.

20.1.2 Baseline Studies

A summary of the baseline studies completed is provided in Table 20-2.

Table 20-2 - Baseline Studies

Area	Comment
Land use	The current land uses include agriculture and subsistence farming.
Flora	Flora zones includes savanna, riparian forests, seasonal forests and pasture lands. Most of the biotic zones have been disturbed by man and are in the process of regeneration.
Archaeology and cultural heritage	No archaeological sites, indigenous lands or *quilombo* communities were identified in the Itinga municipal district. The Governmental Archaeological Agency inspected the proposed mine area and conformed that there is no archaeological sites
Special Areas	No special areas were identified. The project site is not located within a Conservation Unit
Fauna	Studies conducted included avifauna (birds), herpetofauna (reptiles and amphibians), terrestrial mastofauna (large and medium sized mammals) and ichthyofauna (fish). A low number of endemic and specialist species were recorded in the field, demonstrating that the remaining natural areas have little capacity for the harboring of species that cannot withstand man-generated changes in their habitats.
Climate	The climate is continental-dry and warm, and has two clearly defined and distinct seasons, one dry, coinciding with winter in the southern hemisphere and the other wet, coinciding with summer
Water	The Project is located in the Jequitinhonha River basin, spatially occupying the sub-basins of the Ribeirão Piauí and the Córrego Taquaral, which are direct tributaries of the Jequitinhonha River.
Soils	Three major soil types were identified, consisting of latosols and podzolic soils
Geomorphology	The general area is of low hills and fluvial flood plains
Caves	No cave systems were identified.
Social setting	Itinga municipality, existing local infrastructure, health status, and education status.

Additional studies should be completed, and would include evaluation of greenhouse gases, additional tests on the Jequitinhonha River and responses of the water to water treatment plans, noise and vibration baselines, and particulate matter baseline studies.

20.1.3 Water Considerations

All water drained and collected to settling ponds, will be recycled to water treatment and then to the process plant, or used in water trucks to spray the roads in the dry season. During the wet season, excess water from the pond will be discharged in an overflow channel. The rainfall water/effluent quality from the settling pond will meet the Brazilian Regulations parameters, according to CONAMA 430 - Section II and/or groundwater analysis. For the analysis of surface water, CONAMA 357/2005 shall be followed; for groundwater, CONAMA 396/2008 and CONAMA 420/2009.

20.1.4 Acid Rock Drainage

A preliminary assessment was conducted to identify the potential for acid rock drainage (ARD), with an emphasis on standard static tests, including modified acid base accounting (ABA), and kinetic tests, specifically the humidity cell test.

ABA tests were conducted at SGS Geosol on a total of 20 samples from five drill holes.

Using net neutralization potential (NNP) criteria, 15 samples out of the 20 samples tested are in the uncertain range, and the remaining five samples tested were non-acid generating.

The neutralization potential ratio (NPR), which is based on the ratio between acid generation potential (AP) and neutralization potential (NP), was evaluated. Thirteen samples were non-acid generating, but four samples had $1<NPR<2$ suggesting potential for acid generation.

In addition to the above test work on 20 samples, SGS Lakefield conducted a single humidity cell test. The tested sample had ten-parts waste rock (schist) and one-part DMS tailings. Findings include:

- The pH fluctuated between 6.55 and 7.31, which is in a circumneutral pH range (6.5–8.3). In general, measured alkalinity values were much greater than measured acidity, which is indicative of dominant buffering capacity conditions
- The electrical conductivities of weekly collected effluent ranged from 32 to 95 µS/cm, which is indicative of low ionic constituents of water
- Some heavy metals and toxic elements, such as As and U, were detected by analysis of effluent chemistry, but their corresponding concentrations were generally much lower than is permitted by the Canadian guideline for drinking water
- The ABA test result on the humidity cell sample suggested 5.15 kg CaCO3/t for NP and 2.5 kg CaCO3/t for AP. Based on the ABA test result and the depletion rate calculation over the course of the humidity cell, the sulphide content in the waste depleted at a faster rate than the sample NP, which suggests negligible acid or metals release for this composite sample
- It was concluded that localized ARD generation may occur due to the presence of pyrite and reactive sulphur bearing minerals in the waste rock and tailings.
- Supplementary laboratory tests are planned in accordance with the Canadian Mine Environment Neutral Drainage (MEND) procedures for acid rock drainage (ARD) definition and control for waste rock, tailings (+0.5 mm and -0.5 mm) and combined waste and +0.5 mm tailings as follows:
- Waste rock: modified ABA tests on new set of samples, net acid generation testing (NAG) and humidity cell kinetic testing (4 cell tests: mix of samples with ARD generating conditions, mix of samples with uncertain conditions, +0.5 mm tailings and -0.5 mm tailings)
- Tailings (+0.5 mm and -0.5 mm): modified ABA tests
- Combined waste and +0.5 mm tailings: XRF and XRD analyses.

20.2 PERMITTING CONSIDERATIONS

Sigma has obtained all major licenses and permits except for the final operation license (LO) as stated in sub-section 20.1.1.

20.2.1 Authorizations

20.2.1.1 Federal

SMSA is the owner of the mining rights registered under DNPM Nº 824.692/1971, and the holder of Mining Concession Ordinance Nº 1.366, published on October 19, 1984. In 2018 a new Economic Development Plan (EDP) was registered with the National Department of Mineral Production (DNPM) and the National Mining Agency (ANM), which was approved on November 16, 2018.

20.2.1.2 State

The environmental licensing process for the project was formalized on December 20, 2018, in accordance with protocol 0859841/2018, under type CEL 2 (LP + LI), in accordance with DN 217/20171.

In order to formalize the Concurrent Environmental Licensing process CEL 2 LP and LI, the EIS, EIR and ECP, listed in Basic Guidance Form (BGF) Nº 0751216/2018 A were submitted as required.

The approval process involves a technical and legal analysis conducted by the environmental regulator. Upon being granted the LP + LI, the company must build the project, comply with the environmental conditions established in the LP + LI certificate and finally, apply for the Operation License in order to begin operational activities.

The formalization of the environmental licensing process also includes the requesting and granting of the environmental intervention authorization.

20.2.1.3 Environmental Intervention Authorization - EIA

The environmental intervention process was applied for on December 20, 2018, under registration Nº 0859842/2018.

The purpose of this authorization is to allow for environmental intervention in an area of about 63.9 ha of native vegetation, classified as part of the "Atlantic Forest Biome". Current legislation (Federal Law 11.428 / 2006) establishes a mining enterprise as a public utility, and therefore allows for intervention in the form of the removal of vegetation that is in the middle stage of regeneration and the cutting of protected species, provided the proper environmental and forestry compensation is applied. The compensations listed in Table 20-3 will therefore apply to the project:

Table 20-3 – Applicable Environmental Compensation

Compensation	Situation	Legislation
Environmental	Ventures of significant environmental impact.	SNUC Law Nº 9.985/2000, dated 18 July 2000.
Atlantic Forest	Mining ventures that depend on the removal of vegetation in the advanced and medium stages of regeneration, inserted in the Atlantic Forest biome.	DN COPAM N°73/2004, dated 8 September 2004, Law Nº 11.428, dated 22 December 2006 and IEF Ordinance Nº 30, dated 03 February 2015.
Mining	Mining venture that depends on the removal of native vegetation.	Law N° 20.922, dated 16 October 2013 and IEF Ordinance Nº 27, dated 07 April 2017.
Protected Species	Compensation for the Removal of Protected Species (Yellow Ipê - Law N° 20.308 (2012)	Law N° 20.308 (2012)

20.2.1.4 Water Usage Permit

Sigma has been granted a permit for 150 m^3/h of water from the Jequitinhonha river for all months of the year by the Agencia Nacional das Águas (ANA) for a period of 10 years. The process was formalized in February 2019 under registration number 02501.004570/2018-91.

20.2.2 Municipal

The project must comply with municipal legislation and the declarations issued by the Itinga town council.

20.2.3 Surface Rights

Sigma has a lease agreement with Miazga, owner of the Poço Danta-Paiuí, Poço Danta and Poço Dantas Farms, to carry out mining activities on its properties. These farms include Legal Reserves (LR) which are preserved and registered in the National Rural Environmental Registration System (NRERS), in accordance with Law Nº 12.651, dated May 25, 2012. The location of the properties and the respective Legal Reserves are:

- The Poço Danta-Piauí Farm has a total area of 86.5415 ha, of which 17.3083 ha is designated a Legal Reserve (LR), preserved for the native species of the region, and which shall not be less than 20% of the total property. The reserve will not be affected by the proposed mine.
- The Poço Danta Farm has a total area of 97.3467 ha, of which 19.4693 ha is designated a Legal Reserve (LR), preserved for the native species of the region, 20% of the total property. The reserve will not be affected by the planned mine.
- The Poço Dantas Farm has a total area of 80.00 ha, of which 16.00 ha is designated a Legal Reserve (LR), preserved for the native species of the region, 20% of the total property. The reserve will not be affected by the proposed mine.

Figure 20-1 shows the locations of the farms and protected areas.

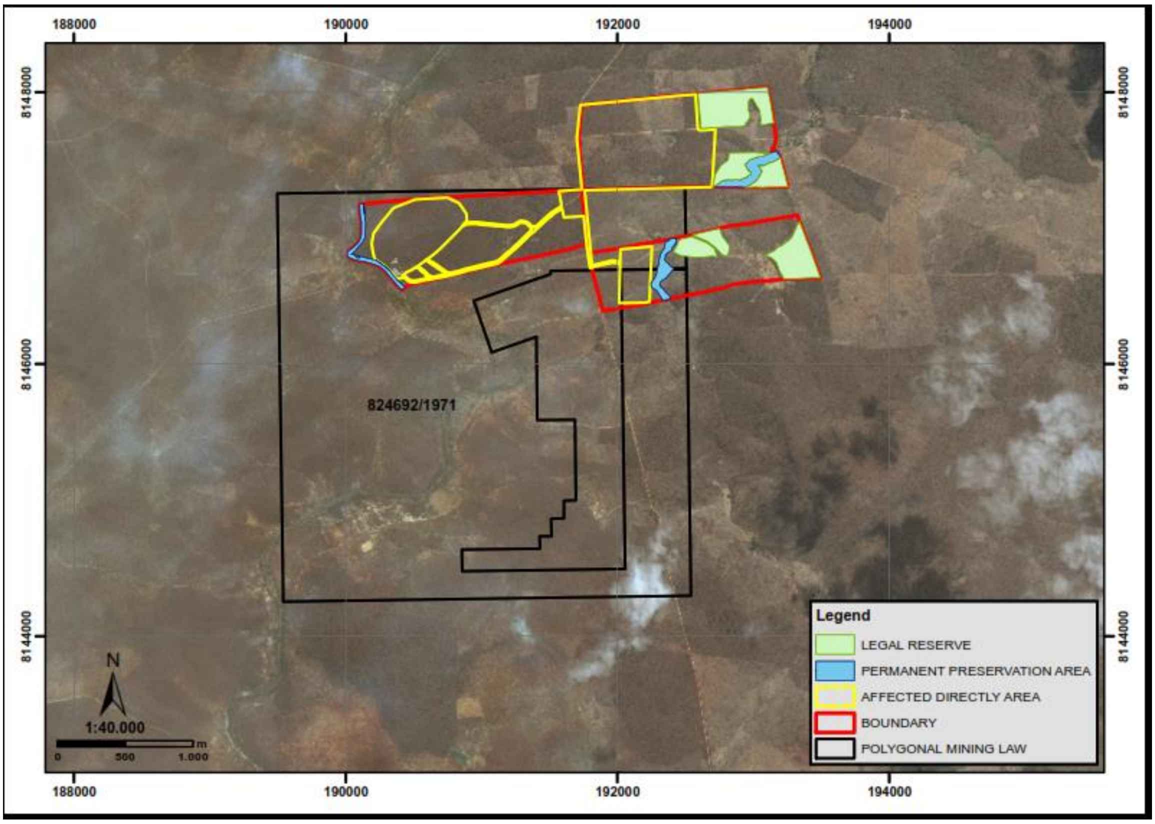


Figure 20-1 - Location of Areas of Interest and Properties

Note: Figure prepared by Neo Ambiental, 2019

20.3 SOCIAL CONSIDERATIONS

20.3.1 Project Social Setting

The project is located in the properties known as Poço Dantas Farm, Poço Danta Farm and Poço Danta-Piauí Farm, in the rural area of Itinga. Research by the Brazilian Institute of Geography and Statistics (IBGE) (2010) indicates that Itinga has a population of 14,407 inhabitants.

There are few "neighboring" communities. The closest significant communities to the project are: Ponte do Piauí, Poço Dantas and Taquaral Seco, located 0.40 km, 0.71 km, and 1.50 km, respectively. Slightly further away, but still potentially affected by planned mining activities, is the district of Taquaral de Minas (4.27 km).

The areas surrounding the project are sparsely populated, with little vehicular traffic. The villages are mainly concentrated along BR 367 and in the municipal district of Araçuaí, which has approximately 40,000 inhabitants. The main economic activities of the region are agriculture and small livestock farming.

20.3.2 Sigma Consultations

Sigma maintains an excellent relationship with the communities throughout the municipalities of Itinga and Araçuaí, having held regular meetings and consultation sessions with local stakeholders over the last five years. The development of mining activities by Sigma in the Jequitinhonha Valley is viewed by both communities as an important economic driver in the region, which has been significantly impoverished by regular droughts afflicting the semi-arid region.

As part of its engagement in promoting the development of the region, SMSA has sponsored the creation of a regional multi-jurisdictional commission and held a symposium for this commission to discuss regional development joint initiatives at its operational headquarters in Itinga on December 13, 2017. Three Minas Gerais state attorneys, one Federal state attorney, two officers from the Ministry of Defense, two officers from Departmento de Ciência e Tecnologia Aeroespacial (DCTA), and one director from IBRAM in Minas Gerais State, were in attendance.

In support of local community relationships, Sigma was formally recognized in the local business environment by the mayor of Itinga on December 30, 2017.

Sigma held six meetings in 2018 with representatives from communities within the Grota do Cirilo area to discuss the Project. These meetings provided opportunities for Sigma to understand community expectations for the Project. Meetings were held as follows:

- October 12 and October 24, 2018: community of Taquarl Seco
- October 13 and October 25, 2018: community of Piaui-Poco Dantas
- October 14 and October 26, 2018: community of Ponte Piuai

The meetings indicate that Sigma has had a positive community impact and the general opinion of the local communities is that Sigma has already generated more employment opportunities and improved some of the local infrastructure.

20.4 EVALUATION OF ENVIRONMENTAL IMPACTS AND MITIGATION ACTIONS

Table 20-4 provides a summary of planned environmental impact minimizing measures.

Table 20-4 – Environmental Impact Minimization Measures

Minimization Measures	Objectives
Program for the management and control of water resources and effluents	The program aims to adopt environmental control measures through the treatment of domestic and industrial effluents originating from the implementation and operation of the venture.
Program for the implementation of a system of drainage erosion control	The objective is to establish measures to conserve soil and water, through the implementation of a rainwater drainage system employing specialized techniques.
Program for controlling atmospheric emissions and noise and vibration levels	This program aims to promote, by technical means, the prevention and control of atmospheric emissions and the levels of noise and vibrations from mining activities.
Solid Waste Management Program	To establish proper procedures for the management of the solid waste generated during the installation and operation of the mine, by reducing the generation, handling, packaging, storage, transportation, treatment and final disposal of the same, in accordance with current regulations.
Reuse of tailings program	The objective of this report is to describe the feasibility of the use of the tailings/waste generated by the process of exploitation of pegmatite of the Sigma mining venture.
Environmental Education Program – EEP	The EEP has the general aim of mobilizing and raising the awareness of employees and the community located in the Area of Indirect Influence (AII) of the venture, regarding the importance of environmental conservation, through activities that seek to raise awareness of the topics addressed.
Program of prioritization and professional training of human resources and local suppliers	Create strategies of human resource training to provide opportunities for growth and development for the internal workers of the company and the region through courses focused on the importance of the enterprise, in partnership with the public and private educational institutions of the region.
Accident prevention and public health program	Adopt measures to ensure the integrity, health and safety of employees, as well as comply with Regulatory Standard NR-22, which establishes obligations upon employers to coordinate, establish and implement measures of employee safety and health.
Social communication program	To promote practices of social and environmental responsibility, based on ethics and the transparency of information related to the enterprise. Develop continuous and transparent communication between the company, the local community and inspection agencies.
PPA and Legal Reserve maintenance program	To guarantee the conservation of the Permanent Preservation Areas (PPA) and Legal Reserve (LR) and provide compensation to avoid the loss of flora species, mainly aquatic macrophytes, to sow propagules, to protect the water body and to care for fauna by offering suitable areas for their survival.
Program for the rescue and prevention of flight of local wildlife	The Fauna Rescue Program aims to avoid the mortality of the fauna and allow animals to continue occupying the region, as well as to contribute to the scientific research into the fauna during the removal of the vegetation by the mining project.

Minimization Measures	**Objectives**
Endangered and threatened species rescue program	The objective is to rescue matrices of endangered species, whether endemic or of great socioeconomic importance in the area. These should be housed in a greenhouse (seedling nursery) for future reintroduction in the areas to be recovered.
Management and environmental supervision plan	The Plan should ensure that programs related to all types of activities are developed in a rigorous manner in compliance with legislation.
REHABILITATION MEASURES	**AIMS**
Degraded Area Recovery Plan (DARP)	The main objective of this plan is to restore areas that will be affected by the mining process in the area, through the application of recovery techniques, such as the planting of vegetation, seeking a harmony between the environment and human beings.
COMPENSATION MEASURES	**AIMS**
Environmental compensation	Repair to an equivalent degree, based on the negative environmental impacts that cannot be mitigated. "Environmental compensation may only be used if a *sine qua non* condition is met, which is the full demonstration of the partially or totally irrecoverable nature of the adversely affected environment.*"*
Mine closure plan	The closure plan is based on assessments of available technical information and local conditions throughout the life of the venture.

20.5 WASTE AND WATER MANAGEMENT

Provision has been made for the waste rock and tailings piles for storage of waste rock from the mining pit and the tailings from the process plant.

Co-disposal of waste rock and tailings is planned for waste piles 1 and 3. These waste rock and tailings piles will be designed to rigorous geotechnical and environmental standards.

There are several options for the management and closure rehabilitation of these facilities. These include capping with a stable cover that minimises potential for erosion and supports revegetation (refer to Section 20.7). For water management refer to Section 20.1.3.

20.6 RELATIONS WITH STAKEHOLDERS

Sigma understands and accepts the importance of proactive community relations as an overriding principle in its day-to-day operations as well as future development planning. The company therefore structures its community relations activities to consider the concerns of the local people and endeavors to communicate and demonstrate its commitment in terms that can be best appreciated and understood to maintain the social license to operate.

The Jequitinhonha valley is the poorest region in Minas Gerais which is plighted by poverty and is in the lowest quartile the Human Development Index (HDI). Sigma will be the largest investment and operation in the area by a factor of ten and the project will be transformational to the local communities. The largest direct economic benefit is that Sigma is subject to a 2% royalty on revenue which is divided between Federal Government, State Government and Local Government. Secondly a portion of the taxes on local procurement of goods and services is shared with the Local Government.

These incomes from the royalty and tax is a most important source of funding for local Government and Sigma will be the largest direct contributor in the region. Sigma will be by far the largest employer in the region with an estimated 500 direct jobs being created with three to four times this number being indirect.

Farming in the area is small scale subsistence type as the area is semi-arid. There will be minimal impact on the farms neighbouring the Grota do Cirilo property. It is envisaged that Sigma employees and the contractor workforce will live in the cities of Araçuaí and Itinga.

Strict environmental management plans will be in place to minimize the project environmental footprint. An example is that 90% of the process water will be re-circulated and there will be zero run-off water from the site, except during the wet season, where excess water from the pond will be discharged in an overflow channel. The process will use dry stacking technology and no slimes dam will be built. Regular environmental monitoring will be conducted, and results will be shared with the local communities.

Sigma has identified and continues with consultations/engagements with numerous stakeholders in support of the project development which include the following:

- Communities
- Local municipal authorities of Intinga and Araçuaí
- Religious leaders in Itinga and Araçuaí
- The University of UNIP and Youth leaders in Araçuaí
- Regional Town Hall meeting with General Public and Commercial Society
- Consultations with local communities of Taquarl Seco, Poco Dantes and Paiu
- Local Environmental authority of Araçuaí and Itinga
- Regulatory and Government institutions

- Federal Department of Mines (ANM) in Brasilia
- Minas Gerais Department of Mines (ANM) in Belo Horizonte
- State Environmental Regulator (Supram) in Belo Horizonte
- Regional Supram regulator in Diamantina
- FINEPA (Financiadora de Estudos e Projectos) in Rio de Janeiro
- INDI the Minas Gerais Agency responsible for the Promotion of Investment and Exports

Sigma has sponsored a number of local sporting and community invents in Araçuaí and Itinga. The company has donated materials for the building and repairing of roads in Itinga and continues to be supportive of community needs. There have been numerous site visits from representatives of various governmental regulator bodies, governmental agencies as well as from various regional and state Universities.

20.7 REHABILITATION AND CLOSURE PLANNING

The rehabilitation and closure plan consists of three main stages:

1. Decommissioning planning
2. Execution of decommissioning
3. Implementation of the socio-environmental and geotechnical follow-up and monitoring actions of the post-closing.

Closure planning will include provision for dismantling and removal of buildings and infrastructure. Where possible, material will be sold for scrap. Heavy vehicles and equipment are planned to be sold for scrap. Waste piles will be graded as needed, capped with a vegetation suppression layer and revegetated with herbaceous-shrub species. A final protective cover can be placed over the pile to facilitate revegetation and minimize erosion, at which point the sedimentation pond may be decommissioned. A cap layer of soil will be placed and seeded on the open pit berm areas. A fence will be built around the open pits, and all mine haul roads will be blocked off.

Sigma has confirmed that there are no requirements for reclamation bonds.

20.7.1 Decommissioning Planning

The decommissioning planning comprises the following basic activities:

- Study of alternative uses or dismantling of the buildings, materials and equipment
- Study of the local environment
- Preparation of the Closure Plan.

20.7.2 Execution of Decommissioning

The Xuxa pit will be closed after its planned mine life of just over nine years. However, as Sigma is actively working on mining studies to assess other deposits in the Grota do Cirilo area, it is likely that the process plant could remain operational after the Mineral Reserves at the Xuxa deposit are exhausted. The following assumptions were considered for the execution of the decommissioning (Table 20-5).

Table 20-5 – Environmental Impact Minimization Measures

Area	Activity
Dismantling buildings and infrastructure	All facilities and equipment will be deactivated, dismantled, demolished and removed from the development area, except for the equipment described below The donation or reuse of the facilities by the local public authority or nearby communities or properties is not foreseen Due to outsourcing of the mine operation, the support infrastructure is not included in this decommissioning plan, except for the sewage treatment plant, the diesel supply unit and the potable water reservoir tank For transportation cost calculation, we are considering that the scrap will be sold to companies located in Belo Horizonte-MG or equivalent distance at most The materials whose sales price as scrap are less than the cost of transport to the scrap companies or that have no buyer market will be placed in the pond #1 or in mine pit #1 (north), provided they comply with environmental legislation The CEMIG substation, and its access, will not be decommissioned The Sigma substations will be decommissioned, and the electro-centre will be sold as scrap The electro-centres, transformers and other substation equipment will be sold as steel or iron scrap. For these items the separation between steel / iron and copper will not be made. The insulating oil of the transformers will be delivered, against payment, to a company specialized in the treatment and disposal of this type of oil The removal of primary coating of the accesses are not considered in this decommissioning plan; Buildings built in masonry will be demolished and the demolition waste (concrete, masonry material) will be placed in the pond #1 or in mine pit #1 (north). The rebars will not be separated from the concrete Modular buildings will be disassembled, and the panels will be placed in the pond #1 or in mine pit #1 (north) Items that will be sold as scrap: air conditioning, ventilation equipment, steel structures, metallic tiles, above ground Carbon Steel piping Underground piping for water and sewage, as well as rainwater drainage systems will not be removed; Above ground PVC piping will be placed in the pond #1 or in mine pit #1 (north)
Heavy mobile and surface equipment	Mechanical equipment will be sold as scrap by weight, therefore, it will not be necessary to verify the operating and safety conditions before removal The equipment will not be dismantled for removal, except for equipment whose dimensions do not allow transportation in a single piece, which must be dismantled or cut Fuel tanks will be cleaned internally for residual diesel removal and will be sold as scrap The tanks and other FRP (Fiberglass Reinforced Polymer) equipment that make up the Water Treatment Station will be placed in the pond #1 or in mine pit #1 (north), after being reduced to smaller pieces The sewage treatment plants will be drained and washed with calcium hypochlorite solution for disinfection. The FRP components will be placed in the pond #1 or in mine pit #1 (north) and the mechanical and electrical equipment will be sold as scrap All fluids will be removed from the equipment prior to transportation and classified as lubricants, oil insulation and other fluids containing contaminants that will be destined to specialized companies that will reprocess and/or incinerate these products The desiccant material used in the compressed air dryers will be removed and placed in the pond #1 or in one of the mine pits Electric cables and trays will be removed and sold as scrap. The conduits shall be removed and placed in the pond #1 or in mine pit #1 (north) The fiber optic cables will be removed and placed in the pond #1 or in mine pit #1 (north) Concrete posts will be removed and placed in the pond #1 or in mine pit #1 (north), the luminaires will be sold as scrap and the lamps sold and companies specialized in reprocessing and discarding of lamps Telecommunication equipment, access control and instruments will be sold as scrap Due to outsource mine operation, the mine operating equipment / heavy mobile equipment are not included in this decommissioning plan.
Restoration	Restoration shall be executed according to the specific characteristics of the land where the project is located. The objective will be to reconstitute the vegetal cover of the soil and the establishment of the native vegetation after the operation of the enterprise.

Area	Activity
	In the post-closure phase, the monitoring program should be carried out, to follow the conditions of physical and biological stabilization of the areas to ensure the adequate restoration of the ecosystem
Waste rock & dry tailing co-disposal stockpiles / waste rock disposal stockpiles / overburden pile	The waste piles will be graded as needed, capped with a vegetation suppression layer and revegetated with herbaceous-shrub species. A final protective cover can be placed over the pile to facilitate revegetation and minimize erosion, at which point the sedimentation pond may be decommissioned
Water management	The removal of the suppressed vegetation and the topsoil, topographic review and slope cover and surface drainage should be specified and performed.
Site safety	To ensure site safety a fence must be built around the mine pit and to block the mine haul road. This fence may be made of barbed wire.
New & used controlled products	Not applicable. Use of controlled products in mine operation is not part of the Closure Planning.
Soils and contaminated materials	For areas of the mine support facilities and processing plant, it is recommended to carry out environmental liability assessment studies, particularly in locations of fuel tanks, substations, among others, where there may be spillage and consequent contamination of soil and water. If necessary, a company specializing in safety disposal could be hired.
Open pit	For revegetation of the open pit berm areas, a cap layer of soil shall be placed and seeded. A fence shall be built around the open pit.
Financial guarantee (reclamation bonds)	Sigma has confirmed that there are no requirements for reclamation bonds.

20.7.3 Monitoring Program and Post-closure Monitoring

In the post-closure phase, a socioenvironmental and geotechnical monitoring program will be carried out, to support ecosystem restoration or preparation for the proposed future use.

The monitoring program will collect soil and diversity of species on an annual basis, continuing for a five-year period after mine closure.

21 CAPITAL AND OPERATING COSTS

21.1 BASIS OF ESTIMATE

The capital cost estimate (CAPEX) and operating cost estimate (OPEX) were developed to provide substantiated costs for the feasibility study and to provide Sigma with the overall risk and opportunity profile to a level of confidence to enable a decision to proceed with the project's execution, to set up partnerships and off-take agreements and for financing.

The estimate parameters are as follows:

- Estimate accuracy plant capital costs: +15% / -15%
- Estimate accuracy infrastructure capital costs: +15% / -15%
- Estimate accuracy operating costs: +15% / -15%
- Estimate period: 1Q19
- Estimate currency: US$

21.2 WORK BREAKDOWN STRUCTURE

A work breakdown structure was developed for the project. The first level structure includes:

- 000 – Management and project general
- 100 – Site overall
- 200 – Crushing and screening plant
- 300 – Processing plant
- 600 – Infrastructure
- 700 – Mining
- 800 – Owner project costs
- 900 – Sustaining and future capital

21.3 ESTIMATE PLAN

MCB (for mining), WP (for Non-Process Infrastructure (NPI) and geotechnical) and Sigma submitted CAPEX and OPEX estimates to Primero for incorporation into the overall project CAPEX and OPEX estimate.

For installation contracts for the process plant, Primero provided scope definition, battery limits, equipment lists and material take-offs (MTOs) to WP for WP to prepare and issue requests for quotation (RFQs) with standard WP terms and conditions (T&Cs) to local contractors. Installation costs (unit rates and productivity) and the construction schedule were based on the contractors' proposals.

For procurement packages, the objective was to maximize Brazilian supply and fabrication content. WP provided input to the bidders' list in Primero's procurement package register (for the process plant portion).

21.3.1 Currency Conversion

Where estimated costs for the CAPEX and OPEX were priced in local currencies, the exchange rates in Table 21-1 were used to convert to the base estimate currency US$.

Table 21-1 – Quoted Currency Exchange Rates

Code	Description	Rate
US$	US Dollars	1.000
EUR	Euro	0.870
AUD	Australian Dollars	1.399
BRL	Brazilian Real (Note 1)	3.850
CAD	Canadian Dollars	1.310

Note 1: and exchange rate of 4.10 BRL to US$ was used to update affected portions of the CAPEX to account for adjustment in exchange rates.

21.4 CAPITAL COSTS

21.4.1 Capital Cost Estimate

A summary of the capital cost estimate for the project is shown in Table 21-2.

Table 21-2 – Capital Cost Estimate Summary

Area	Direct (US$)	Indirect (US$)	Contingency (US$)	Recoverable (US$)	Total (US$)
PROCESSING PLANT					
010 - Engineering, Procurement and Management	0	6,511,000	977,000	-210,000	7,279,000
015 - Commissioning	0	1,096,000	165,000	-31,000	1,230,000
030 - Vendor Representatives	0	180,000	27,000	-3,000	204,000
040 - Construction Indirects - Contractors	0	2,035,000	306,000	-47,000	2,294,000
200 - Process Plant Overall	260,000	0	25,000	-49,000	236,000
220 - Contract Crushing	846,000	0	130,000	-120,000	856,000
310 - DMS	14,042,000	0	1,716,000	-2,206,000	13,552,000
314 - Ultrafines DMS	2,611,000	0	308,000	-403,000	2,515,000
340 - Concentrate Handling	1,053,000	0	115,000	-117,000	1,051,000
350 - Tails Handling	3,800,000	0	383,000	-582,000	3,601,000
370 - Process Plant Services	388,000	0	46,000	-50,000	385,000
Subtotal Processing Plant	23,000,000	9,822,000	4,198,000	-3,818,000	33,203,000
SITE INFRASTRUCTURE					
010 - Engineering, Procurement and Management	0	4,154,000	57,000	-76,000	4,135,000
020 - Subconsultants	0	109,000	2,000	0	111,000
040 - Construction Indirects - Contractors	0	1,952,000	29,000	-69,000	1,912,000
120 - Bulk Earthworks	7,401,000	0	877,000	-253,000	8,026,000
370 - Process Plant Services	550,000	0	35,000	-85,000	501,000
390 - Plant Buildings	752,000	0	80,000	-33,000	800,000
600 - Infrastructure	5,411,000	0	393,000	-814,000	4,990,000
620 - Water & Sewerage	3,342,000	0	357,000	-318,000	3,381,000
630 - Infrastructure General	2,183,000	0	400,000	-78,000	2,505,000
650 - Substation	43,000	0	5,000	-2,000	46,000
660 - Buildings - Admin	3,788,000	0	123,000	-129,000	3,782,000

Area	Direct (US$)	Indirect (US$)	Contingency (US$)	Recoverable (US$)	Total (US$)
700 - Mining	67,000	0	2,000	-14,000	55,000
720 - Mine Establishment	1,626,000	0	163,000	-72,000	1,717,000
750 - Mine Infrastructure	72,000	0	2,000	-10,000	64,000
770 - Mine Mobile Equipment - LME	198,000	0	22,000	-8,000	212,000
780 - Fuels	511,000	0	47,000	-35,000	522,000
Subtotal Site Infrastructure	25,944,000	6,215,000	2,594,000	-1,996,000	32,759,000
OWNERS COST					
810 - Owners Project Costs	0	3,889,000	584,000	-136,000	4,337,000
811 - Owners Temporary Infrastructure		299,000	45,000	-5,000	339,000
840 - Spares	0	454,000	62,000	-89,000	428,000
Subtotal Owners Cost	0	4,642,000	691,000	-230,000	5,104,000
SUBTOTAL CAPITAL COST	**48,944,000**	**20,679,000**	**7,483,000**	**-6,044,000**	**71,066,000**
PRE-PRODUCTION AND WORKING CAPITAL					
730 - Mining Pre-Production	12,713,000	0	1,145,000	-563,000	13,294,000
820 - Plant & Pre-Production	0	2,738,000	411,000	-110,000	3,039,000
830 - Working Capital	0	9,534,000	1,431,000	0	10,964,000
Subtotal Pre-Production and Working Capital	12,713,000	12,272,000	2,987,000	-673,000	27,297,000
SUBTOTAL INITIAL CAPITAL COST	**61,657,000**	**32,951,000**	**10,470,000**	**-6,717,000**	**98,363,000**
SUSTAINING AND DEFERRED CAPITAL					
910 - Sustaining Capital	0	1,275,000	192,000	0	1,467,000
920 - Deferred Capital	4,711,000	828,000	535,000	-238,000	5,835,000
930 - Closure Cost	0	7,838,000	107,000	0	7,945,000
Subtotal Sustaining and Deferred Capital	**4,711,000**	**9,941,000**	**834,000**	**-238,000**	**15,247,000**

The average contingency for the capital cost and for the initial capital cost is 11% totalling US$10.47 million.

A summary of the CAPEX broken down by foreign currency is included in Table 21-3.

Table 21-3 – CAPEX Split by Currency

Currency	Local Pricing	US$ Equivalent	Percentage
AUD	211,000	142,000	0%
BRL	204,603,000	49,903,000	70%
CAD	122,000	91,000	0%
EUR	682,000	749,000	1%
US$	20,181,000	20,181,000	28%
Total		71,066,000	100%

A summary of the applicable taxes is shown in Table 21-4.

Table 21-4 – Tax Summary

DESCRIPTION	ICMS (US$)	ISS (US$)	PIS/CONFINS (US$)
Process plant	1,879,000	652,000	1,932,000
Infrastructure	571,000	982,000	1,417,000
Owners	50,000	194,000	179,000
Subtotal	2,499,000	1,828,000	3,528,000
Pre-production and working capital	30,000	688,000	643,000
Sustaining and deferred capital	0	225,000	209,000

21.4.2 Summary of Key Quantities

A summary of the key quantities for the process plant are presented in Table 21-5.

Table 21-5 – Process Plant Key Quantity Summary

Type	Unit	Total
Steelwork	t	607
Platework	t	285
Concrete	m^3	2608
Cable	m	48,502
Equipment	num	184

A summary of the key quantities for the Earthworks and NPI portion of works is included in Table 21-6.

Table 21-6 – Earthworks and NPI key Quantity Summary

DESCRIPTION	Quantity	Unit
Mechanical equipment	143	t
Pipe AC	121	t
Pipe HDPE/PVC	7,822	m
Electrical/instrumentation cables	95,567	m
Conduits	1,616	un
Lighting fixture	730	un
Flex conduits	20,075	m
Reinforcement	181	t
Covering/side cover	4,831	m^2
Concrete 30/40 MPa	2,317	m^3
Distance of material transport - DMT until 5km	20,000	m^3
Excavation + DMT-civil	55,000	m^3
Steel (for covering)	123	t
Piauí creek bridge	58,730	m^3
Excavation - geotechnical	134,536	m^3
Modular buildings	1,947	m^2
Compaction - earthworks	167,321	m^3
Excavation - earthworks	1,301,587	m^3
Regularization	256,246	m^2
Vegetal suppression - earthworks	942,214	m^2
Mechanical equipment	2,941	m

21.4.3 Basis of Process Plant Estimate

21.4.3.1 Summary Table

The process plant capital cost estimate was assembled in accordance with Table 21-7.

Table 21-7 – Capital Cost Estimate Basis – Process Plant

Description	Responsible	Data Requirement
CAPITAL COST ESTIMATE		
Direct Costs		
Supply and fabrication	Primero	Quoted (for equipment, structural steel and platework) *Firm quotes for long lead equipment (six). Multiple budget quotes including for electrical equipment and instrumentation.*
Installation	WP	Quoted (equipment, platework and structural steel) *Unit rates from WP budgetary pricing RFQs based on Primero MTOs and equipment list.*
Bulks supply and installation	WP	Quoted (for concrete and electrical supply & installation) *Unit rates obtained by WP from budgetary pricing RFQs based on Primero MTOs.* *Piping supply and installation factored form similar projects for process plant.*
Civil	WP	Quoted *Unit rates obtained from WP from budgetary pricing RFQs.*
Process Infrastructure	WP	Provided from WP
Freight	Primero	Calculated *Pricing obtained from major procurement locations to site.*
Commissioning	Primero	Calculated *Built up from historic data*
Indirect Costs		
Indirect labour rates	WP	Quoted *Multiple quotes*
Engineering	Primero	Calculated *Detailed deliverables list and hours* estimate
Offsite and site management	Primero	Calculated *Built up by resource from detailed project schedule*
Temporary facilities	Primero/WP	Calculated/Quoted *Duration build up from detailed project schedule for EPCM and Client facilities.* *Contractors facilities quoted by WP*
Construction plant	WP	Quoted *Contractor plant included in quotes by WP*
Contingency	Primero	Calculated *Assessed on supply and installation separately. Compared against detailed risk analysis.*
Foreign exchange	Primero	Calculated *Estimate built in US$ based on currency applied conversion rates (Table 21-1)*
Escalation	N/A	Not included
Owners costs	Sigma	Calculated *Information provided by Sigma*
Training	Primero	Estimated
First fills and consumables	Primero	Calculated
Spares	Primero	Calculated
Taxes	Sigma	Estimated *Refer to Table 21-9 for tax rates applied*
Import duties	N/A	Not included

As a basis for the CAPEX build-up, engineering and design were advanced to a feasibility level with approval of key deliverables obtained from Sigma including for the design basis, process design criteria, block flow diagram, process flow diagram, mass balance basis of design, project execution plan, schedule, site conditions, site plans and general arrangements.

Equipment lists, bulk lists and MTOs were generated. The project implementation schedule was developed, and the critical path defined. Risk assessments were conducted.

21.4.3.2 Estimate Area Facility and Commodity Coding

The estimate was developed based on the project WBS structure and Primero's standard commodity coding structure for mineral projects.

21.4.3.3 Contingency

Contingencies do not include allowances for scope changes, escalation or exchange rate fluctuations. Specific items were covered by allowances and not by contingency. Contingency was assigned to each estimate line item and is based on the inputs in Table 21-8.

Table 21-8 – Contingency Requirements

Category	Contingency
SCOPE CATEGORY – Contingent sum attributed to quantities and scale	
Detailed take-off from detailed design drawings, detailed model and lists	7.5%
General take off from sketches, plot plans, general model, general arrangement drawings, process and instrumentation diagrams and single line diagrams	10%
Estimated from plot plans, GA's and previous experience	12.5%
Factored from previous projects / ratios	20%
Allowance	25%
SUPPLY COST – Contingent sum attributed to supply and freight costs	
Awarded contract, purchase order and fixed price quotation	5%
Budget quotation	10%
In-house database	12.5%
Estimated value	15%
Factored value	20%
Allowance	25%
INSTALLATION COST – Contingent sum attributed to installation costs	
Awarded contract, purchase order and fixed price quotation	5%
Budget quotation	10%
In-house database	12.5%
Estimated value	15%
Factored value	20%
Allowance	25%

Contingency was calculated for each estimate line item according to the above categorisation based on the following formula:

[A] = [0.4B + 0.4C + 0.2D]

Where:

[A] = Contingency %
[B] = Scope Category %
[C] = Supply Cost Category %
[D] = Installation Cost Category %

21.4.3.4 Tax

21.4.3.4.1 Taxation

Recoverable taxes were considered as shown in the summary Table 21-4. The basis of these exemptions is that Sigma may benefit from the Federal special tax regime of acquisition of capital goods by Brazilian exporters (RECAP regime).

To qualify for the RECAP regime, the project needs to meet the requirements as stated in the RECAP regime. Currently, Sigma is not in a position to attest whether the company complies or would be able to comply with all the legal requirements in order to be granted the regime by the Federal Revenue Service.

Sigma may also benefit from the Federal tax incentive applicable to companies headquartered in the Northeast region of Brazil (SUDENE incentive) whereby Sigma applies for the tax incentive consisting of a fixed reduction of 75% of the corporate income tax calculated based on the so-called "exploitation profit'. An application has been filed by Sigma with SUDENE. Sigma will need to obtain a Constitutive Report by submitting a new request once the Xuxa project is fully implemented and the project has fully achieved its 20% capacity.

The estimate was built on a cost basis excluding taxes. Taxes were then applied as per Table 21-9.

Table 21-9 – Summary of Tax applied to the CAPEX

Description	**Supply**		**Install**	
Tax Applicable	ICMS	PIS/COFINS	ISS	PIS/COFINS
Mechanical	12.00%	9.25%	5.00%	4.65%
Concrete	0.00%	0.00%	3.00%	3.65%
Platework	12.00%	9.25%	5.00%	4.65%
Structural	12.00%	9.25%	5.00%	4.65%
E&I	12.00%	9.25%	5.00%	4.65%
Indirects	12.00%	9.25%	5.00%	3.65%

As agreed with Sigma, the VAT tax (Imposto sobre Circulação de Mercadorias e Serviços *(*ICMS)), and federal taxes on gross revenues (PIS/COFINS) are assumed to be recoverable taxes. The project is expected to benefit from RECAP (IN SRF 605/2006 – a special tax regime for fixed assets acquisition for exporting companies) which grants PIS (Social Integration Program) and COFINS (Social Security Contribution) exemptions on federal sales taxes charged on gross revenues. City tax on services (Imposto Sobre Serviços (ISS)) is assumed to be not recoverable.

Law 13.137/15 increased the standard PIS and COFINS rates levied on the import of goods, from a combined rate of 9.25% (1.65% PIS and 7.6% COFINS) to 11.75% (2.1% PIS and 9.65% COFINS). According to Law 13.137/15, taxpayers are allowed to recognize PIS and COFINS input credits based on the increased rates (under the non-cumulative regime). Other sectors that were already subject to increased PIS and COFINS rates for imports under special regimes (such as cosmetics, machinery, pharmaceuticals and tires) are now subject to combined rates as high as 20%, depending on the harmonized code for the products. The PIS and COFINS rates on imported services remains unchanged (i.e. combined rate of 9.25%).

PIS/COFINS can be 100% exempt for exporting companies under a Tax Benefit ruled by Normative Instruction from the Federal Revenue (Instrução Normativa SRF) number 605, called RECAP.

RECAP exemption applies to:

- PIS/COFINS over gross revenue over fixed assets goods sold to a client who has applied to RECAP
- PIS/COFINS over importation of fixed assets for a company that who has applied to RECAP.

21.4.3.5 Estimate Clarifications and Exclusions

The estimate basis was based on the Project Execution and Contracting Plan as defined in Section 24. The Project implementation schedule as defined in Section 24, formed the basis for input into the CAPEX and OPEX. Table 21-7 states the assumptions and exclusions made to complete the estimate.

No allowance was made in the estimate for withholding tax.

Inflation, escalation and import duties are excluded.

21.4.4 Basis of Estimate – NPI and Earthworks

The estimate for the NPI and earthworks portion was developed by WP. The following clarifications apply:

- Costs for spare parts for the start-up phase was estimated at 5% of the mechanical equipment cost
- Freight costs for equipment and materials were based on supplier's proposals or from the WP data base. Freight was estimated at 7% of net value.
- For concrete, freight costs were included in the contractor's unit rates
- Unit rates were based on proposals received for civil construction and electromechanical assembly services or WP's database
- R$ 200.00 / m^2 was used for estimating the cost of furniture
- The Xuxa mine closure cost was based on the Decommissioning Plan 209011-00146-GE-PLN-0001-RB
- The estimate for the relocation of the Taquaral Seco Transmission Line in the Olimpio area was provided by Sigma
- Estimates for bulk materials were based on WP database
- Pricing for construction and electromechanical assembly were based on submitted proposals
- Allowances: design allowances were allocated as applicable. Minor changes in scope, estimates of omissions, proposals quality, budget prices, market conditions were included in contingency. Allowances were subsequently incorporated into the contingency allocations.

Table 21-10 shows the allowance allocations by discipline as applied to a commodity.

Table 21-10 - Allowances

ITEM	DESCRIPTION	%	%	%	%	%
1	Buildings	0%				
2	Civil	0%	5%	10%	15%	
3	Electrical	0%	10%	15%		
4	Auxiliary equipment	0%				
5	Geotechnical-waste rock		10%			
6	Instrumentation	0%	5%	10%	15%	
7	Mechanical	0%				
8	Drainage					20%
9	Earthworks	0%	5%	10%	15%	
10	Piping	0%		10%	15%	20%

Estimated costs for waste piles 3 and 4 and the related ponds' excavation including clear and grub and drainage were provided by Sigma.

21.4.4.1 Taxes

The following taxes were applied for the NPI and geotechnical scope:

- Services (installation):
  - Earthworks: ISS = 5.0% and PIS / COFINS = 3.65%
  - Civil Construction: ISS = 3.0% and PIS / COFINS = 3.65%
  - Modular Buildings: ISS = 3.0% and PIS / COFINS = 3.65%
  - Electromechanical Assembly: ISS = 5.0% and PIS / COFINS = 3.65%

- Bulk Materials (supply): ICMS: 12.0%; PIS/COFINS: 9.25%

- Equipment (electromechanical):
  - ICMS: tax between 8.8% and 18.0% based on the submitted proposals
  - PIS/COFINS: taxes between 3.65% and 9.25% based on the submitted proposals

21.4.4.2 Estimate Clarifications and Exclusions

The following items will be excluded from the CAPEX cost estimate per Sigma instructions:

- Switchroom buildings (HV and 3 NPI switchrooms): considered in the OPEX.
- CCTV: there will be no CCTV

21.4.5 Basis of Estimate – Mining

Considering that the mining fleet and all the mining infrastructure including workshops and administrative buildings are the mining contractor's responsibility, the capital cost for mining is limited to the pre-stripping phase and the mine site roads construction.

Waste during the pre-stripping will be disposed on waste piles 1 and 2, with soil being directed only to pile 2. Pile 1 will also be used for co-disposal of crushed tailings. Mined ore during the pre-stripping phase will be stocked on the ROM pad near the crushing area.

Site preparation will be part of the main site earthworks contract and includes the following roads and pads:

- Road access from the processing plant to Pit 1
- Road access to mine facilities terrace
- Mine facilities terrace
- Magazines roads and terraces

This service includes all activities necessary to build the roads and terraces, including paving (when necessary) and drainage structures. The estimated capital cost for the pre-stripping phase is provided in Table 21-11.

Table 21-11 - Estimated Capital Cost during Pre-Stripping (in thousand US$)

Area	Y1Q1	Y1Q2
Infrastructure		
Infrastructure maintenance	81	81
Site preparation/ roads	1,314	
Loading		
Soil	195	29
Schist	58	334
Weathered schist	810	777
Ore	12	30
Haulage		
Soil	689	103
Schist	173	996
Weathered schist	2,738	2,627
Ore	24	51
Waste Spreading		
Soil	116	17
Schist	25	142
Weathered schist	459	440
Blasting		
Waste	63	362
Ore	12	28
Drilling		
Waste	31	179
Ore	6	16
TOTAL CAPEX (000 US$)	**6,807**	**6,213**

Before Pit 2 starts operation, it is necessary to build a road to the area and the waste pile. This cost is estimated as a deferred cost of US$1,978,000.

21.4.6 Basis of Estimate – Owner's cost

The Owner's cost as provided by Sigma is summarized in the Table 21-12. This cost covers the period from the beginning of construction to the commencement of production.

Table 21-12 – Owner's Cost (in US$)

Description	Cost (US$)
Labor expense (includes all salary, benefits, and burdens)	898,000
Traveling	37,000
Restaurant - outsourced	28,000
IT - software ERP maintenance	-
IT - outsourced	-
Shared services (Cleaning, etc.)	59,000
Occupational Health and Safety	11,000
Investor relations - travelling, events	319,000
Legal expenses (Luana, William, Silverio)	109,000
Communications	19,000
Admin installation / D&O annual insurance	187,000
General admin - other expenses	47,000
Ground transportation	40,000
General admin - auditing, tax, accounting	280,000
Admin vehicles maintenance/gas	11,000
Survey specialist	-
Rent	139,000
Consultants	156,000
Environmental conditional tasks	100,000
Environmental compensation	520,000
Plant insurance	288,000
Mine insurance	31,000
Environmental land acquisition (one-off)	130,000
Fixed assets (one-off)	65,000
Environmental tax – SNUC – to go to production	0
Environmental fees CEL2 (LP + LI) (PHASE 2)	260,000
Other expenses (Y1 only)	47,000
Total	3,781,000

21.5 OPERATING COSTS

21.5.1 Operating Cost Summary – Process Plant

The processing plant operating cost estimate includes crushing and DMS circuits and is based on a ±15% level of accuracy, utilizing indicative quotations where possible, and otherwise Primero database estimates and recent experience in the lithium industry. The basis is for crushing to be contracted out.

The processing OPEX includes operating and maintenance labour, power, fuel and indirect charges associated with the processing plant. Based on these cost assumptions, inclusions and exclusions, it is estimated that the OPEX will be approximately $10.69/t of ore feed or $74.23/t of spodumene concentrate produced (Table 21-13).

Table 21-13 – Plant OPEX Processing Cost Summary

DESCRIPTION	OPEX US$/ t
Mine	21.91
Process	10.69
G&A	1.76
Shipping	15.30
NPI (included in process and G&A)	-
TOTAL	49.66

21.5.2 Operating Cost Summary

The OPEX cost summary breakdown is presented in Table 21-14.

Table 21-14 – Plant OPEX Processing Cost Summary Breakdown

Unit cash cost analysis	US$ 000 per / year	US$/t rom	US$/t concentrate
Tonnes per annum		**1,500,000 tpa**	**215,939 tpa**
Plant			
- Crushing Contractor	3,183	2.12	14.74
- Labour	1,789	1.19	8.28
- Operating consumables	1,784	1.19	8.26
- Power	1,972	1.31	9.13
- Power Substation Rental	1,864	1.24	8.63
- Maintenance supplies	2,020	1.35	9.36
- Lease mobile equipment	3,416	2.28	15.82
Total	**16,028**	**10.69**	**74.23**
Transportation and G&A			
- Concentrate transport	22,782	15.30	104.34
- General and administration	2,637	1.76	12.21
Total	**25,419**	**17.06**	**116.55**
Plant			
- Variable	10,217	6.81	
- Fixed	5,811		
Total	**16,028**		

21.5.2.1 Basis of Estimate (Production)

The basis of the data sources, assumptions, cost inclusions and cost exclusions for the process operating costs is as follows.

21.5.2.1.1 Contract Crushing

A budgetary proposal was received from Metso Brazil for contract crushing and was used in the OPEX for the feasibility study. Metso's scope includes one portable jaw crusher unit (NW106) and two portable cone crushing and screening units (NW200 HPS) as well as all conveyors up to the crushed ore stockpile. The scope includes site assembly, personnel for operations and maintenance, spare parts and wear items, accommodation and meals. Metso costs of $2.12/t and $3.18 M per year were used.

Grading, foundations, power supply as well as lifting equipment are excluded from the Metso operating cost estimate but captured in the project CAPEX. The power consumption cost is covered in the process OPEX cost.

21.5.2.1.2 Labour

An allowance has been made for production, maintenance and management personnel associated with running the processing plant. The plant will be operating seven days a week with the following schedules:

- The crushing plant is based upon three shifts of eight hours per day operation (based on Metso input)
- The DMS plant is based upon three shifts of eight hours per day operation

Personnel requirements are provided in Table 21-15 (the summary excludes the labour for contract crushing which is covered in the contractor's unit rate). The manning levels reflect previous experiences at similar lithium operations and the Brazilian labor law. Further rationalization may be possible once is in steady-state operation.

Table 21-15 – Labour Summary

Labor	Total Number Employed
Administration Department	**1**
Operations manager	1
Plant Operations	**30**
Chief Metallurgist	1
Shift supervisor	4
Store man	4
DMS operator	4
Utility operator	5
Journeyman (mechanic & electrician)	8
Mobile operator	4
Mining and Geology	**6**
Mining engineer	2
Geologist	2
Surveyor	2
Metallurgy and Chemistry Laboratory	**6**
Met tech	2
Assayer	4
HSE and Environment	**2**
HSE and sustainability coordinator	1
Environment supervisor	1
Maintenance	**8**
Maintenance chief	1
Mechanical maintenance supervisor	1
Mechanics	2
Electricians	2
Assistant electricians	2
TOTAL LABOR EMPLOYED	**53**
By Location	
Administration	1
Plant	30
Mining and geology	6
Metallurgy and chemistry laboratory	6
HSE and environment	2
Maintenance	8

Operating labor cost is estimated to be US$1.35 M per annum or US$0.90/t ore.

21.5.2.1.3 Operating Consumables

The consumables are split into two areas: DMS plant and reagents. In the DMS plant, costs for cyclones, pumps, screens and belt filter replacement are included in maintenance supply cost estimates.

Consumables for the crushing circuit are covered in the contract crushing contractor cost.

21.5.2.1.4 Reagents

The reagents will include ferrosilicon and flocculant.

- Ferrosilicon: costs are estimated on a consumption rate of 530 g/t (based on industry standards and Primero data base) and indicative cost of US$1,368/t provided by DMS Powder (Pty) Ltd
- Flocculant: Flomin 905 VHM (Magna Floc 10 equivalent) costs are estimated on a consumption rate of 10 g/t (based on test work) and an indicative cost of US$4,056/kg provided by SNF Brazil
- These costs include the costs of delivery
- No allowance has been made for first-fill consumable inventory stocks (these are included in CAPEX as part of Owner's cost). Assumptions are based upon Primero's recent lithium experience at a similar processing facility and quotes from the in-country sources.

Operating consumables cost is estimated to be US$1.78 M per annum or US$1.19/t ore.

21.5.2.1.5 Power Cost

The OPEX was based on 6 US cents per kWh, based on the cost estimate provided by Sigma.

Power consumption was determined based on calculated plant utilization and the mechanical equipment list on an 80% load factor in operation. The estimated installed power for the processing plant is 6.7 MW; an allowance of 256 kW has also been made for lighting, heating and ancillary buildings. This includes the power consumed in the crushing circuit (for contracting crushing).

Overall, power consumption is expected to be 32.7 GWh per annum for a total annual power cost of US$1.97 M or US$1.31/t ore.

21.5.2.1.6 Power Substation Rental Cost

The contracting strategy for the two main HV substations (CEMIG (Itinga 1) and Sigma plant (138kV / 4.16 kV)) will be based on a build, own and operate (and maintain) or BOO basis. A budgetary cost as submitted to Sigma by Ecogen for BOO has been retained in the feasibility study as a component of the OPEX. The rental cost is US$1.86 M per annum or US$1.24/t ore.

The scope will include design, supply, installation, commissioning, operation and maintenance of the two substations and transmission lines from the existing grid line.

The CEMIG substation will be donated to CEMIG.

21.5.2.1.7 Maintenance Materials

Maintenance supply costs have been allowed on a 2.3% per annum of direct capital equipment cost. Laboratory supply costs have been allocated a lump sum of US$200,000.

Overall, maintenance cost is estimated to be US$2.02 M per annum or US$1.35/t ore.

21.5.2.1.8 Lease of Mobile Equipment

The mobile equipment will be leased. The lease costs of mobile equipment for light vehicles for supervisors, heavy equipment for feeding ore, service trucks for maintenance and minibuses for personnel transport have been estimated at US$3.42 M per annum or US$2.28/t of ore.

21.5.2.1.9 Concentrate Transport

Concentrate transport cost has been estimated at US$22.90 M per annum or $15.30/t of ore per Sigma input based on preliminary estimates. This includes the cost from the site to the Port of Ilhéus in Brazil and to the final port of Shanghai, China.

21.5.2.1.10General & Administration

General and administration costs have been estimated at US$2.64 M per annum or $1.76/t of ore per Sigma provided input.

21.5.3 Indirect Production Costs

Indirect processing and site administration costs have been included for the processing plant. These costs cover such matters as communications and information technology (IT), engineering, environmental and rehabilitation consultants and services, cleaning contractors, staff training, amenities, fringe benefits and similar for processing and maintenance personnel, health and safety, insurances, and rates, leases and licenses.

21.5.4 Pre-production Costs

Pre-production costs have been included in the CAPEX. These are costs normally associated with the plant and incurred prior to and during commissioning, including early employment of operations personnel and associated recruitment, training and mobilization, first fill consumables and stock of reagents, maintenance spares and associated indirect costs incurred during this period.

21.5.5 Qualifications and Exclusions

The operating cost estimate is presented with the following qualifications and exclusions:

- General Qualifications
- Costs for labour and salaries were provided by Sigma based on current Brazilian standards
- OPEX costs for mining, crushing contractor, power substation BOO, concentrate transport (road transport, port and shipping), power and mobile equipment rental were obtained by Sigma and provided to Primero
- No contingency allowance for OPEX
- General and Administration:
- Benefits and overheads are included in Sigma provided salary overheads
- Workforce assumed to be local: no allowance for flights to site
- Security personnel costs included as per client input
- Training cost is included in the pre-production CAPEX
- Mining
- Start-up stockpile re-handling costs excluded (in mining cost)
- The Owner's mining and geology team are included in the OPEX (labour)
- Ore Handling
- Plant OPEX includes feeding of primary crusher
- Concentrate
- Concentrate packaging not allowed for – based on bulk truck transport
- Concentrate transport includes land transport to Port of Ilhéus, port handling and shipping CIF Port of Shanghai
- Tailings storage
- Tailings storage transport costs to waste pile included in OPEX.
- Environmental
- Rehabilitation costs are included in deferred CAPEX

- Consumables
- Reagents and consumables quoted FOB at supplier's location in Brazil
- Allowance of 20% transport to site from the supplier's location in Brazil
- Diesel costs as advised by Sigma
- Utilities
- Power cost as advised by Sigma
- Mobile Equipment
- Plant mobile equipment costs include fuel and maintenance
- Leasing costs considered (not rental)
- Maintenance
- An allowance of 2.3% of installed capital cost was made to cover all maintenance costs
- Exclusions
- Exchange rate variations
- Escalation from the date of estimate
- Project financing costs (covered in economic model)
- Interest charges (covered in economic model)
- Local / regional government rates and charges (covered in Owner's G&A)
- Subsidies to local community (covered in Owner's G&A)
- Marketing costs: no specific budget allocated to this item, not required
- Government monitoring and compliance: outset licensing costs included, no ongoing costs
- Overtime allowances: not applicable
- Union fees: not applicable (2017 Labor reform law)
- Contract labour excluded (weightometer checks, lab QA, plant audits, met audits, chemical suppliers): not required
- For the laboratory, the following costs are excluded: grade control and exploration analytical costs, external assaying charges, metallurgical and environmental testing costs, external laboratory costs
- Water supply costs from river (not applicable)

21.5.6 Operating Cost Summary – NPI

Table 21-16 shows the summary of costs in NPI's scope.

Table 21-16 – OPEX Summary NPI (over LOM)

OPEX	Total (R$)
Mechanical - Spare Parts	953,000
Rent: CEMIG Substation, Sigma and 3X Electrocenters	64,584,000
Environmental and Social Programs	9,000,000
Maintenance Team - Infrastructure	10,530,000
Insurances	8,130,000
Costs with Compensation Areas	-
Property Security	5,547,000
Energy	8,445,000
TOTAL VALUE (R$)	**107,189,000**

The items listed in the NPI OPEX summary table are distributed as follows:

- Spare parts: included in Plant OPEX
- Rental of HV substations - CEMIG and Sigma: included in overall OPEX
- Social, environmental and economic programs: included by Sigma in Owner's CAPEX
- Building maintenance: included in overall OPEX
- Insurance: included in Owner's cost CAPEX
- Property security: included in overall OPEX (personnel)
- Energy: included in overall OPEX
- Contingency: not retained.

21.5.6.1 Basis of NPI OPEX

- Building maintenance team was estimated by WP. These have been included in the overall plant labor: summary (refer to Table 21-15 and Table 21-16)
- Insurance costs were estimated as 0.6% of the overall CAPEX as informed by Sigma
- Security cost provided by Sigma: R$ 51,360.00/mth. R$ 616,320.00/year. Included in overall OPEX
- Annual power consumption: 434.39 MWh, rate per Sigma: R$ 180.00 per MWh: included in overall OPEX.

21.5.7 Operating Cost Summary – Mining

The mining contractor will develop and operate the project based on the following. Contractor will be responsible for:

- Operating of all mining equipment from pre-stripping to end of LOM
- Building mining infrastructure and buildings for the mine services area as described in Section 18
- Maintenance of all mining equipment including a site maintenance team
- Loading, hauling and dumping the tailings from the process plant, re-handling of ore from the ROM stockpiles to the crusher (for the feasibility study, the costs for rehandling are included in the processing OPEX costs)
- Contractor will also be responsible for keeping the road accesses in good condition.

During operations, Sigma will be responsible for the supply of power, water, explosives, detonators and diesel (estimated costs included in the contract mining OPEX unit rates).

The mining operating cost was estimated based on the following assumptions and costs:

- Operation start-up 6 months after start of pre-stripping
- Soil from Pit 1 to be disposed at waste pile 2
- Waste from Pit 1 first five quarters (including pre-stripping) to be disposed at waste pile 1
- Waste from Pit 1 sixth quarter onwards to be disposed at waste pile 3
- Waste from Pit 2 to be disposed at waste pile 4
- Pit 2 start of operation in Year 3
- Haulage distances were estimated considering the stated routes for a mining cycle simulation and a detailed cost analysis
- Mine infrastructure costs are distributed throughout the years on the operating cost.

Table 21-17 shows the estimation of mining operating cost considering the operational mine scheduling presented in Section 16.

Tailings disposal, ore from stockpile to crushing circuit and crushed ore feed to the DMS will be in the mining contractor's scope. However, for the feasibility study, these costs are included in the processing costs.

Table 21-17 - Mining Operating Cost

	Unit	**Y1**		**Y2**	**Y3**	**Y4**	**Y5**	**Y6**	**Y7**	**Y8**	**Y9**	**Y10**	**TOTAL**
		Q3	**Q4**										
Ore	kt	277	375	1,519	1,470	1,453	1,578	1,463	1,522	1,472	1,530	1,056	**13,715**
Waste Soil	kt	32	30	447	752	0	0	0	0	0	0	0	**1,261**
Waste Schist	kt	449	366	4,816	3,325	1,035	2,310	1,777	0	0	0	0	**12,301**
Waste Weathered schist	kt	3,706	3,191	13,242	14,736	15,945	15,714	17,307	17,899	10,065	4,254	1,002	**117,061**
Plant feed	kt	231	375	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,177	**13,783**
Infra/ Demob													
Infrastructure maintenance	000 US$	73	73	290	290	290	290	290	290	290	290	218	**2,687**
Demob	000 US$											187	**187**
Services													
Loading													
Soil	000 US$	11	10	151	254								**426**
Schist	000 US$	1,286	1,107	4,595	5,113	5,533	5,453	6,005	6,211	3,493	1,476	348	**40,619**
Weathered schist	000 US$	145	118	1,556	1,074	334	746	574					**4,548**
Ore	000 US$	151	204	827	800	791	859	796	829	801	833	575	**7,466**
Haulage													
Soil	000 US$	38	36	509	757								**1,340**
Schist	000 US$	3,833	3,300	13,056	13,291	15,721	15,494	15,610	18,512	10,964	4,681	1,204	**115,666**
Weathered schist	000 US$	490	400	4,995	3,352	1,074	2,396	1,792					**14,500**
Ore	000 US$	260	399	1,797	1,740	1,772	1,925	1,796	2,048	2,025	2,105	1,493	**17,359**
Waste Spreading													
Soil	000 US$	6	6	90	151								**254**
Schist	000 US$	546	470	2,187	2,434	2,634	2,596	2,859	2,957	1,663	703	166	**19,214**
Weathered schist	000 US$	82	67	987	682	212	474	364					**2,868**
Blasting													
Waste	000 US$	1,393	1,199	4,978	5,539	5,994	5,907	6,506	6,729	3,784	1,599	377	**44,005**
Ore	000 US$	144	194	787	761	752	817	758	788	762	793	547	**7,104**
Drilling													
Waste	000 US$	689	593	2,462	2,740	2,964	2,921	3,218	3,328	1,871	791	186	**21,763**
Ore	000 US$	79	107	433	420	415	450	418	435	420	437	302	**3,915**

22 ECONOMIC ANALYSIS

22.1 CAUTIONARY STATEMENT

Forward-looking information is based on certain factors and assumptions management believes to be reasonable at the time such statements are made, including but not limited to, continued exploration activities, lithium and other metal prices, the estimation of initial and sustaining capital requirements, the estimation of labour and production costs, the estimation of Mineral Reserves and Resources, assumptions with respect to currency fluctuations, the timing and amount of future exploration and development expenditures, receipt of required regulatory approvals, the availability of necessary financing, permitting and such other assumptions and factors as set out herein. Forward-looking information is subject to known and unknown risks, uncertainties and other factors that may cause the actual results, level of Sigma's activities, performance or achievements to be materially different from those expressed or implied by such forward-looking information.

Although the QPs have attempted to identify important factors that could cause actual results to differ materially from the forward-looking information set out in this presentation, there may be other factors that cause results not to be as anticipated, estimated or intended. There can be no assurance that such forward-looking information will prove to be accurate, as actual results and future events could differ materially from those anticipated in such information. Accordingly, readers should not place undue reliance on forward-looking information. Forward-looking information is made as of the date of this presentation and neither the QPs or Sigma undertake to update or revise any forward-looking information that is included herein, except in accordance with applicable securities laws.

22.2 METHODOLOGY USED

An economic analysis was developed using the discounted cash flow method and was based on the data and assumptions for capital and operating costs detailed in this report for mining, processing and associated infrastructure. An exchange rate of 3.85 BRL per US$ was used to convert particular components of the cost estimates into US$. For the CAPEX, an adjustment on the exchange rate was made to 4.10 BRL per US$ (as reflected also in the project CAPEX). No provision was made for the effects of inflation and the base currency was considered on a constant 2019 US$ basis. The evaluation was undertaken on a 100% equity basis. Exploration costs are deemed outside of the project and any additional project study costs have not been included in the analysis.

Base case scenario results are detailed in Table 22-1.

Table 22-1 – Base Case Scenario Results

Item	Unit	Value
Pre-tax NPV @ 8%	US$	299,074,000
After-tax NPV @ 8%	US$	248,507,000
Pre-tax IRR	%	47.6%
After-tax IRR	%	43.2%
Pre-tax payback period	Years	2.9
After-tax payback period	Years	3.1

A sensitivity analysis reveals that the project's viability will not be significantly vulnerable to variations in initial capital expenditures, within the margins of error associated with the feasibility study estimates. However, the project's viability remains most vulnerable to sensitivities in spodumene prices and spodumene recovery rate.

22.3 ASSUMPTIONS/BASIS

The following macro-economic and technical assumptions were used for the economic assessment.

22.3.1 Macro-Economic Assumptions

The main macro-economic assumptions used in the base case scenario are detailed in Table 22-2. The price forecasts for spodumene concentrate 6.0% Li_2O were based on projections from Roskill. The sensitivity analysis considers a range of ±20% versus base case.

Table 22-2 – Main Macroeconomic Assumptions

Item	Unit	Value
Spodumene price @ 6.00% Li_2O (CIF China) (Note 1)	US$/t	733
Spodumene price @ 6.00% Li_2O (FOB Ilhéus Port) (Note 2)	US$/t	629
Exchange rate (Note 3)	BRL/US$	3.85
Discount rate	%	8.0%

Note 1: Roskill forecast of average nominal arms-length selling price.
Note 2: China spodumene price minus budgetary estimate shipping cost. .
Note 3: An exchange rate of 4.10 BRL/US$ was used for update of the CAPEX. OPEX was based on 3.85 BRL/US$.

An exchange rate of 3.85 BRL per US$ was used to convert the BRL cost projections into US$. For the CAPEX, an adjustment to 4.10 BRL per US$ was made (reflected in the estimated CAPEX). The sensitivity of base case financial results to exchange rate variations was examined. Cost components which include US$ content originally converted to BRL currency using the base case exchange rate were adjusted accordingly.

22.3.2 Technical Assumptions

The main technical assumptions used in the base case are given in Table 22-3.

Table 22-3 – Main Technical Assumptions

Item	Unit	Value
Total Mineral Reserves (P&P)	t	13,784,000
Annual ROM ore processed	t	1,496,000
Annual spodumene concentrate production	t	220,000
LCE production (***Note 1***)	t	33,000
Strip ratio	ratio	9.6: 1
Average Li_2O grade of the reserve	%	1.46%
Spodumene recovery rate	%	60.4%
Concentrate grade	% Li_2O	6.00%
Mine life	years	9.2
Cost of spodumene concentrate ex-works	US$/t spodumene conc.	238
Transportation costs (CIF China)	US$/t spodumene conc.	104
Total cash cost (CIF China)	US$/t spodumene conc.	342
Processing costs per tonne ROM	US$/t ROM	11.03
Mining costs per waste + ore mined	US$/t mined	2.07

Note 1: tonnage based on direct conversion to LCE excluding conversion rate

22.3.3 Taxes and Royalties

The project was evaluated on a pre- and after-tax basis. It must be noted that there are many potential complex factors that affect the taxation of a mining project. The taxes, depletion, and depreciation calculations in the economic analysis are simplified and only intended to give a general indication of the potential tax implications at the project level.

Sudene is a government agency tasked with simulating economic development in specific geographies of Brazil. The project is to be installed in a Sudene-covered geographic area, where a tax incentive granted to the project indicates a 75% reduction of income tax for 10 years, after achieving at least 20% of its production capacity. The considered Brazilian income tax rate is assumed to be 15.25%, which represents the Sudene tax benefit applied to the Brazilian maximum corporate tax of 34% on taxable income (25% income tax plus 9% social contribution).

The project is expected to benefit from RECAP (IN SRF 605/2006 – a special tax regime for fixed assets acquisition for exporting companies) which grants PIS and COFINS exemptions of a total of 11.25%. The economic analysis assumes with reasonable basis that the project is granted this exemption.

The project is expected to be exempt from all importation taxes for products which there is no similar item produced in Brazil *(Ex-Tarifário)*. Assembled equipment where some but not all individual components are produced in Brazil can be considered exempt from import taxes under these terms.

The project royalties will include:

- A 2.0% CFEM royalty on gross spodumene revenue, paid to the Brazilian Government. The CFEM royalty amount is split between the Federal Government of Brazil (12%), State Government of Minas Gerais (23%), and Municipal Government of Araçuaí (65%).
- Two 1% NSR royalties.

22.4 FINANCIAL MODEL

Figure 22-1 illustrates the after-tax cash flow and cumulative cash flow profiles of the project under the base case scenario with a discount rate of 8%. The intersection of the after-tax cumulative cash flow with the horizontal zero line represents the payback period, measured from the start-up of the plant. The NPV, IRR and payback period values on a pre- and after-tax basis are stated in Table 22-1.

The indicated pre pre-production initial capital expenditures were estimated at US$71.1 million which includes the DMS plant, non-process infrastructure, and Owner's cost.

The estimated project and mine closure costs are approximately US$7,944,000 and are considered in the base case of the economic study. A sensitivity analysis was conducted excluding closure costs and is presented in sub-section 22.4.1.

Sunk costs were not considered in the determination of cash flows and economic indicators but were considered as opening balances for the purpose of determining tax liabilities.

The cash flow profile in Table 22-5 shows the capital cost and provides an estimated capital spending schedule over the pre-production period of the project. Working capital requirements were estimated based on 60 days accounts receivable, 25 days inventory, and 25 days accounts payable and other current liabilities.

The total gross revenue derived from the sale of spodumene concentrate 6.00% Li_2O was estimated at US$1,482.1 million, an average revenue of US$108/t ROM, and total operating costs (excluding royalty payments and any sales discounts) were estimated at US$665.0 million at an average cost of US$48.3/t ROM.

Net operating margin (gross revenue less realization and operating costs) was estimated at US$690.4 million.

Table 22-4 – Xuxa Estimated Revenue and Operating Costs for 1.5 Mtpa Production

Item	Total US$ M	LOM Avg. US$/t
Gross Revenue		
Lithium Concentrate	1,482	733
Less: Realization Costs		
Royalties	52	26
Mitsui Prepay Repayment	48	24
Freight & Insurance & Storage	211	104
Total Realization Costs	311	154
Net Sales Revenue Less Freight & Storage	1,171	579
Less: Site Operating Costs		
Mining	302	149
Processing	152	75
Selling, General & Administration	26	13
Total Site Operating Costs	480	238
Net Operating Margin	690	341
% Net Operating Margin of Net Sales	*59%*	*59%*
Less: Depreciation, Interest, and Taxes		
Depreciation	116	57
Interest & Post-Interest Royalty	17	8
Taxes	89	44
Total: Depreciation, Interest, and Taxes	222	110
Net Income	469	232

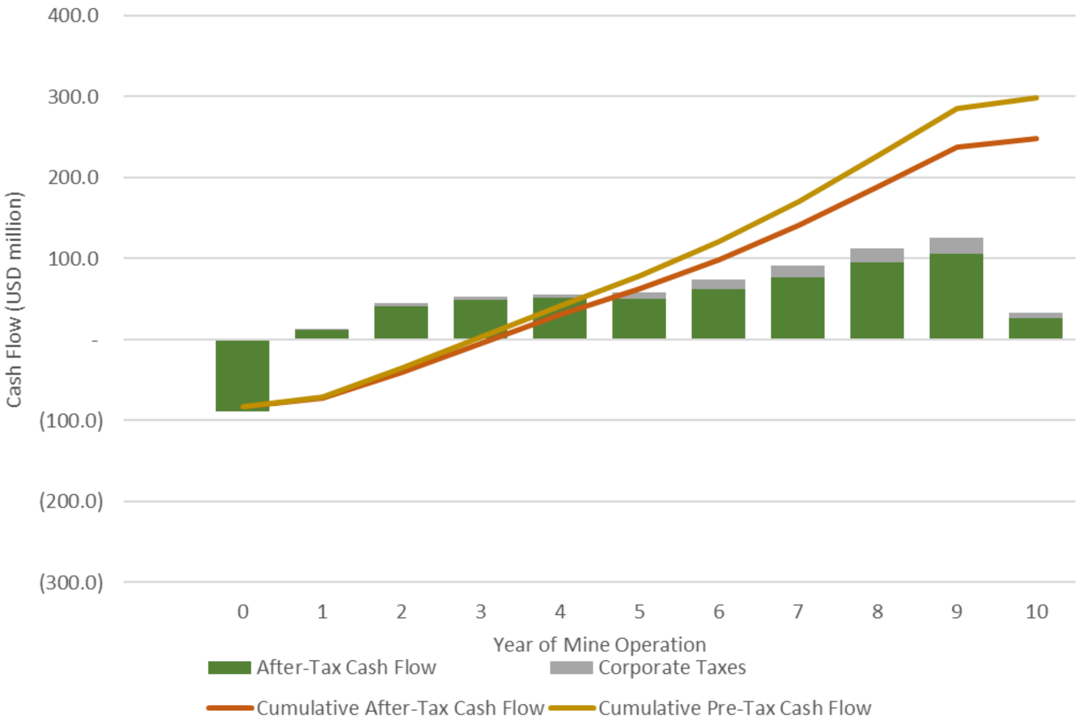


Figure 22-1 – After-Tax Cash Flow and Cumulative Cash Flow Profiles

Note: Figure provided by Sigma, 2019

Table 22-5 – After-Tax Cash Flow and Cumulative Cash Flow Profiles

Consolidated P&L - Xuxa	[Units]		2019E	2020E	2021E	2022E	2023E	2024E	2025E	2026E	2027E	2028E	2029E	2030E
Net Revenues	[USD]		-	-	119,449,229	130,540,756	131,490,325	136,861,688	141,692,700	156,806,079	170,302,693	178,060,142	180,214,367	36,423,685
Growth (Y.o.Y)	[%]					9.3%	0.7%	4.1%	3.5%	10.7%	8.6%	4.6%	1.2%	(79.8%)
Spodumene Revenue	[USD]		-	-	132,579,070	144,094,287	145,091,637	152,174,580	156,431,294	164,301,769	177,068,264	185,140,847	187,387,420	37,874,738
CFEM Royalty	[USD]		-	-	(2,651,581)	(2,881,886)	(2,901,833)	(3,043,492)	(3,128,626)	(3,286,035)	(3,541,365)	(3,702,817)	(3,747,748)	(757,495)
Land Owner Royalty	[USD]		-	-	-	-	-	(1,491,311)	(1,533,027)	(1,610,157)	(1,735,269)	(1,814,380)	(1,836,397)	(371,172)
NSR #1	[USD]		-	-	(1,086,460)	(1,197,346)	(1,208,679)	(1,270,789)	(1,309,442)	(1,378,497)	(1,488,937)	(1,563,508)	(1,588,909)	(322,385)
Offtake Financing Partner Discounts	[USD]		-	-	(9,391,800)	(9,474,300)	(9,490,800)	(9,507,300)	(8,767,500)	(1,221,000)	-	-	-	-
COGS	[USD]		-	-	(75,895,980)	(77,122,781)	(74,742,622)	(77,892,579)	(79,827,031)	(79,007,465)	(74,218,630)	(60,695,245)	(51,078,280)	(14,530,213)
Growth (Y.o.Y)	[%]					1.6%	(3.1%)	4.2%	2.5%	(1.0%)	(6.1%)	(18.2%)	(15.8%)	(71.6%)
% Total Net Revenues	[%]				(63.5%)	(59.1%)	(56.8%)	(56.9%)	(56.3%)	(50.4%)	(43.6%)	(34.1%)	(28.3%)	(39.9%)
Mining Costs	[USD]		-	-	(38,754,243)	(39,555,452)	(37,724,479)	(39,706,621)	(41,300,864)	(39,863,964)	(33,577,304)	(19,573,275)	(10,270,382)	(1,681,623)
Processing Costs	[USD]		-	-	(15,860,213)	(16,089,528)	(15,696,281)	(16,133,818)	(16,167,707)	(15,977,470)	(16,008,141)	(16,034,745)	(16,059,082)	(7,969,873)
Transportation Costs	[USD]		-	-	(21,281,523)	(21,477,802)	(21,321,862)	(22,052,139)	(22,358,460)	(23,166,030)	(24,633,185)	(25,087,225)	(24,748,817)	(4,878,718)
Gross Profit	[USD]		-	-	43,553,249	53,417,974	56,747,703	58,969,109	61,865,669	77,798,614	96,084,062	117,364,897	129,136,086	21,893,472
Growth (Y.o.Y)	[%]					22.6%	6.2%	3.9%	4.9%	25.8%	23.5%	22.1%	10.0%	(83.0%)
SG&A and Other Expenses	[USD]		-	-	(2,637,436)	(2,637,436)	(2,637,436)	(2,637,436)	(2,637,436)	(2,637,436)	(2,637,436)	(2,637,436)	(2,637,436)	(2,637,436)
Growth (Y.o.Y)	[%]													
% Total Net Revenues	[%]		–	–	(2.2%)	(2.0%)	(2.0%)	(1.9%)	(1.9%)	(1.7%)	(1.5%)	(1.5%)	(1.5%)	(7.2%)
EBITDA	[USD]		-	-	40,915,813	50,780,538	54,110,267	56,331,673	59,228,233	75,161,178	93,446,626	114,727,461	126,498,650	19,256,036
Growth (Y.o.Y)	[%]			n.a		24.1%	6.6%	4.1%	5.1%	26.9%	24.3%	22.8%	10.3%	(84.8%)
EBITDA Margin	[%]		–	–	34.3%	38.9%	41.2%	41.2%	41.8%	47.9%	54.9%	64.4%	70.2%	52.9%
Consolidated Depreciation	[USD]		-	(78,362)	(23,367,048)	(26,212,478)	(27,283,986)	(27,504,078)	(5,288,211)	(2,442,781)	(1,371,273)	(1,088,757)	(1,073,152)	(333)
EBIT	[USD]		-	(78,362)	17,548,765	24,568,060	26,826,281	28,827,595	53,940,022	72,718,398	92,075,353	113,638,704	125,425,499	19,255,703
EBIT Margin	[%]				14.7%	18.8%	20.4%	21.1%	38.1%	46.4%	54.1%	63.8%	69.6%	52.9%
Consolidated Interest Expenses	[USD]		-	-	-	(390,000)	(4,215,000)	(2,940,000)	(1,665,000)	(390,000)	(390,000)	(390,000)	(390,000)	(390,000)
EBT	[USD]		-	(78,362)	17,548,765	24,178,060	22,611,281	25,887,595	52,275,022	72,328,398	91,685,353	113,248,704	125,035,499	18,865,703
EBT Margin	[%]				14.7%	18.5%	17.2%	18.9%	36.9%	46.1%	53.8%	63.6%	69.4%	51.8%
NSR #2 EBT Royalty	[USD]		-	-	(175,488)	(241,781)	(226,113)	(258,876)	(522,750)	(723,284)	(916,854)	(1,132,487)	(1,250,355)	(188,657)
Consolidated Income Tax	[USD]		-	-	(2,352,222)	(3,687,154)	(3,448,220)	(3,947,858)	(7,971,941)	(11,030,081)	(13,982,016)	(17,270,427)	(19,067,914)	(6,414,339)
Effective Tax Rate (% of EBT)	[%]				(13.4%)	(15.3%)	(15.3%)	(15.3%)	(15.3%)	(15.3%)	(15.3%)	(15.3%)	(15.3%)	(34.0%)
Net Income	[USD]		-	(78,362)	15,021,055	20,249,125	18,936,948	21,680,861	43,780,331	60,575,033	76,786,483	94,845,790	104,717,230	12,262,707
Net Margin	[%]				12.6%	15.5%	14.4%	15.8%	30.9%	38.6%	45.1%	53.3%	58.1%	33.7%
Consolidated Unlevered Free Cash Flow - Xuxa	**[Units]**		**2019E**	**2020E**	**2021E**	**2022E**	**2023E**	**2024E**	**2025E**	**2026E**	**2027E**	**2028E**	**2029E**	**2030E**
Net Revenues	[USD]		-	-	119,449,229	130,540,756	131,490,325	136,861,688	141,692,700	156,806,079	170,302,693	178,060,142	180,214,367	36,423,685
EBITDA	[USD]		-	-	40,915,813	50,780,538	54,110,267	56,331,673	59,228,233	75,161,178	93,446,626	114,727,461	126,498,650	19,256,036
EBIT	[USD]		-	(78,362)	17,548,765	24,568,060	26,826,281	28,827,595	53,940,022	72,718,398	92,075,353	113,638,704	125,425,499	19,255,703
(+) Taxes on EBIT	[USD]		-	-	(2,352,222)	(3,746,629)	(4,091,008)	(4,396,208)	(8,225,853)	(11,089,556)	(14,041,491)	(17,329,902)	(19,127,389)	(6,546,939)
NOPAT	[USD]		-	(78,362)	15,196,543	20,821,431	22,735,273	24,431,387	45,714,168	61,628,842	78,033,862	96,308,802	106,298,110	12,708,764
(+) Depreciation	[USD]		-	78,362	23,367,048	26,212,478	27,283,986	27,504,078	5,288,211	2,442,781	1,371,273	1,088,757	1,073,152	333
(-) Capex	[USD]		-	(88,863,470)	(11,381,721)	(4,286,030)	(1,130,065)	-	-	-	-	-	-	(7,944,075)
(+/-) Δ WK	[USD]		-	-	(15,980,992)	(1,752,799)	(321,831)	(669,926)	(540,031)	(1,300,005)	(2,345,911)	(2,201,456)	(1,012,815)	21,133,532
After-Tax FCFF	[USD]		-	(88,863,470)	11,200,877	40,995,080	48,567,363	51,265,540	50,462,348	62,771,617	77,059,223	95,196,102	106,358,447	25,898,555
Pre-Tax FCFF	[USD]		-	***(88,863,470)***	***13,553,100***	***44,741,710***	***52,658,371***	***55,661,748***	***58,688,201***	***73,861,173***	***91,100,715***	***112,526,005***	***125,485,835***	***32,445,494***
Discount Period			0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0
Discount Factor			1.0	0.9	0.9	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.5	0.4
After-Tax Discounted Cash Flow	[USD]	-	-	(82,280,991)	9,602,947	32,543,217	35,698,462	34,890,465	31,799,839	36,626,636	41,632,701	47,621,752	49,264,540	11,107,446
After-Tax Cumulative Cash Flows	[USD]		-	(82,280,991)	(72,678,044)	(40,134,827)	(4,436,366)	30,454,099	62,253,938	98,880,574	140,513,275	188,135,027	237,399,566	248,507,013
Pre-Tax DCF	[USD]		-	(82,280,991)	11,619,599	35,517,412	38,705,475	37,882,450	36,983,522	43,097,285	49,218,882	56,291,018	58,124,222	13,915,316
Pre-Tax Cumulative Cash Flows	[USD]		-	(82,280,991)	(70,661,392)	(35,143,981)	3,561,494	41,443,944	78,427,466	121,524,751	170,743,633	227,034,650	285,158,872	299,074,188
Pre-Tax Payback Period	[Years]	2.9												
After-Tax Payback Period	[Years]	3.1												

22.5 SENSITIVITY ANALYSIS

A sensitivity analysis was carried out with the base case (including cost for mine closure) as described above as the midpoint. An interval of ± 20% versus base case values was considered with increments of 10%.

The sensitivity analysis assesses the impact on the Project's net present value (NPV) and internal rate of return (IRR), on both a pre-tax and after-tax basis, of changes in CIF spodumene price, lithium grade, BRL to US$ exchange rate, pre-production initial capital expenditure, operating expenses and discount rate.

As seen in Figure 22-2, Figure 22-3, Figure 22-4, and Figure 22-5, the Project's NPV and IRR are not significantly vulnerable to changes in the pre-production initial capital expenditure nor discount rate considered, as shown by the smoother curves associated with these variables. Note that the Project IRR is independent of the discount rate considered.

The Project's NPV and IRR are more sensitive to variation in CIF spodumene price and recovery rates as shown by the steeper curves associated with these variables.

The Project's NPV is significantly positive at the lower limit of the price interval and the recovery rate interval examined. The Project's NPV is also significantly positive at the upper limit of the operating expenses interval examined.

22.5.1 Pre-Tax Analysis

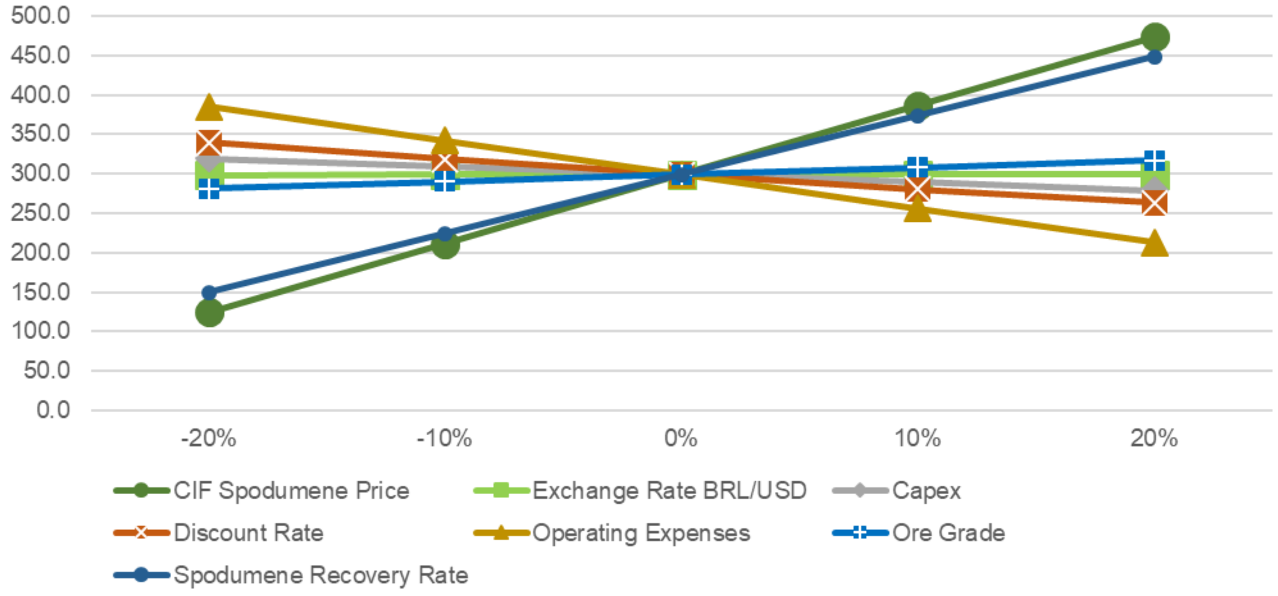


Figure 22-2 – Pre-Tax NPV (US$ million)

Note: Figure provided by Sigma, 2019

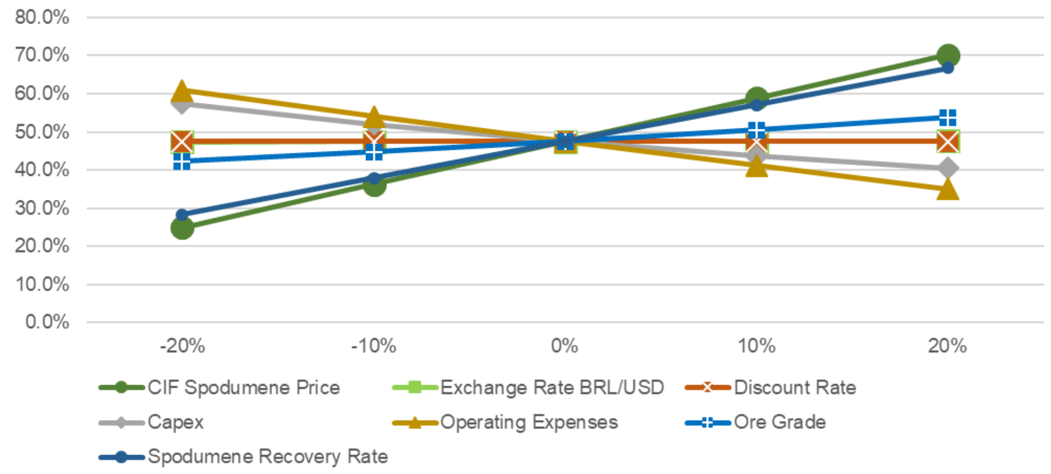


Figure 22-3 – Pre-Tax IRR

Note: Figure provided by Sigma, 2019

22.5.2 After Tax Analysis

Table 22-6 – After-Tax NPV Sensitivity Input Assumptions for Each Scenario (+20% and -20%)

Input Assumption	Unit	-20%	-10%	Base	+10%	+20%
CIF Spodumene Price LOM Avg	US$/t	586	660	733	806	879
CIF Spodumene Price 2021	*US$/t*	*520*	*585*	*650*	*715*	*780*
Recovery Rate	%	48	54	60	66	73
Total Opex (Note 1)	US$ M	(532)	(599)	(665)	(732)	(798)
Discount Rate	%	6.4	7.2	8.0	8.8	9.6
Total Capex	US$ M	(91)	(102)	(114)	(125)	(136)
Ore Grade	%	1.17	1.31	1.46	1.60	1.75
Exchange Rate BRL / US$ (Note 1)	BRL/US$	3.28	3.69	4.10	4.51	4.92

Note 1: An exchange rate of 4.10 BRL/US$ was used for update of the CAPEX. OPEX was based on 3.85 BRL/US$.

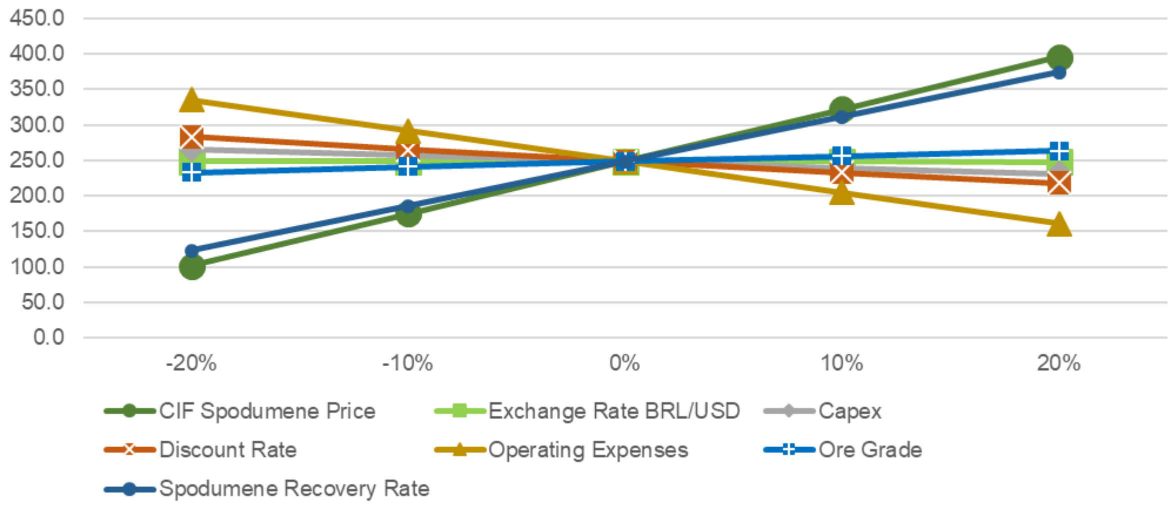


Figure 22-4 – After-Tax NPV (US$ million)

Note: Figure provided by Sigma, 2019

Table 22-7 – After-Tax NPV Sensitivity Analysis for Each Scenario

After Tax NPV (US$ M)	**Unit**	**-20%**	**-10%**	**Base**	**+10%**	**+20%**
CIF Spodumene Price LOM Avg	US$ M	102	175	249	322	395
Recovery Rate	US$ M	123	186	249	311	374
Total Opex	US$ M	335	292	249	205	161
Discount Rate	US$ M	283	265	249	233	218
Total Capex	US$ M	266	257	249	240	231
Ore Grade	US$ M	233	241	249	256	264
Exchange Rate BRL / US$	US$ M	235	243	249	253	257

Note: All NPVs were calculated using all-in Initial, Sustaining and Deferred CAPEX of US$ 113.6 million, which is the sum of the Initial CAPEX and the non-financeable Sustaining and Deferred CAPEX of US$ 15.2 million.

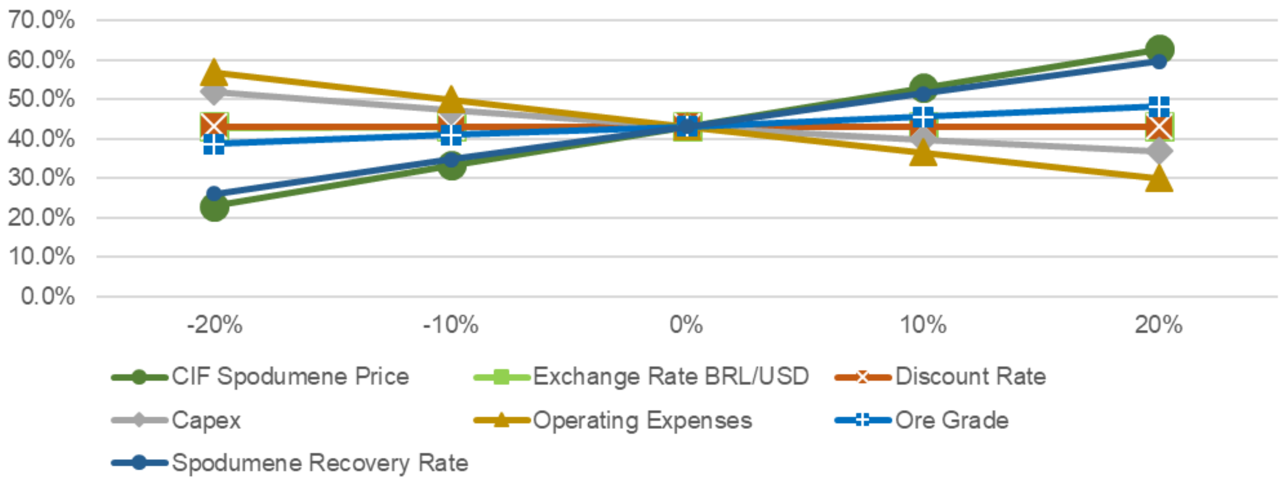


Figure 22-5 – After-Tax IRR

Note: Figure provided by Sigma, 2019

Table 22-8 – Combined Sensitivity of Xuxa NPV to Prices and Discount Rate

After-Tax NPV (US$ M)		**Spodumene Price CIF US$/t**				
		586	**660**	**733**	**806**	**879**
Discount Rate	6.4%	123	203	283	363	444
	7.2%	112	188	265	342	419
	8.0%	102	175	249	322	395
	8.8%	93	163	233	303	374
	9.6%	84	151	218	286	353

Note: All NPVs were calculated using all-in Initial, Sustaining and Deferred CAPEX of US$ 113.6 million, which is the sum of the Initial CAPEX and the non-financeable Sustaining and Deferred CAPEX of US$ 15.2 million.

Table 22-9 – After-Tax IRR Sensitivity to Spodumene Price (CIF)

	Spodumene Price CIF US$ / t				
	586	**660**	**733**	**806**	**879**
After-Tax IRR %	22.9	33.2	43.2	52.9	62.7

22.5.3 Sensitivity Analysis (excluding closure costs)

A sensitivity analysis was conducted on the case excluding closure costs. Pre-tax and after-tax NPV and IRRs for this case are shown in Figure 22-6 through Figure 22-9.

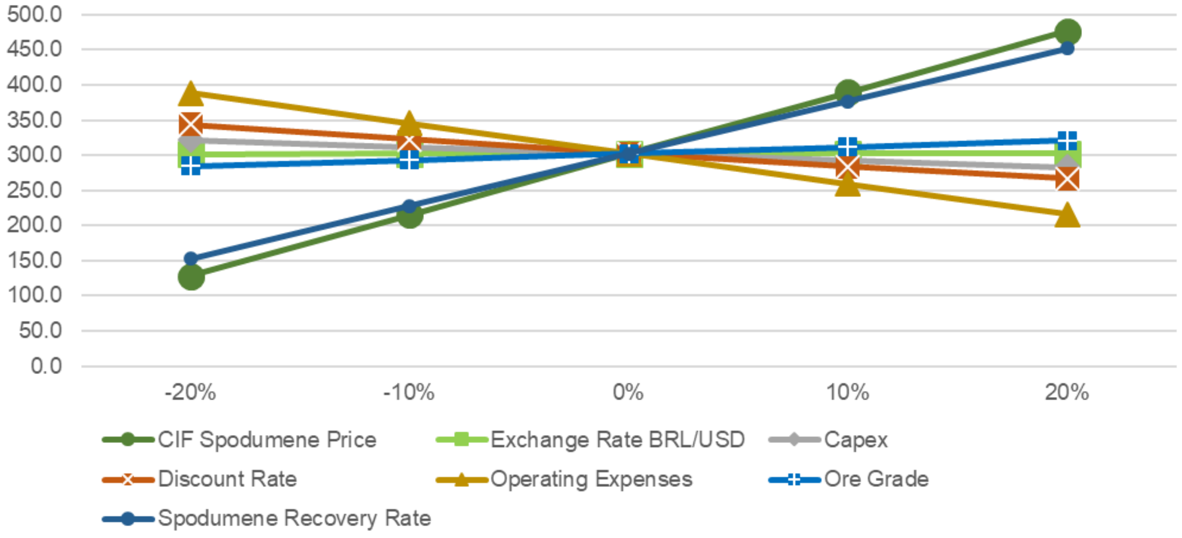


Figure 22-6 – Pre-Tax NPV (US$ million) – excluding closure costs

Note: Figure provided by Sigma, 2019

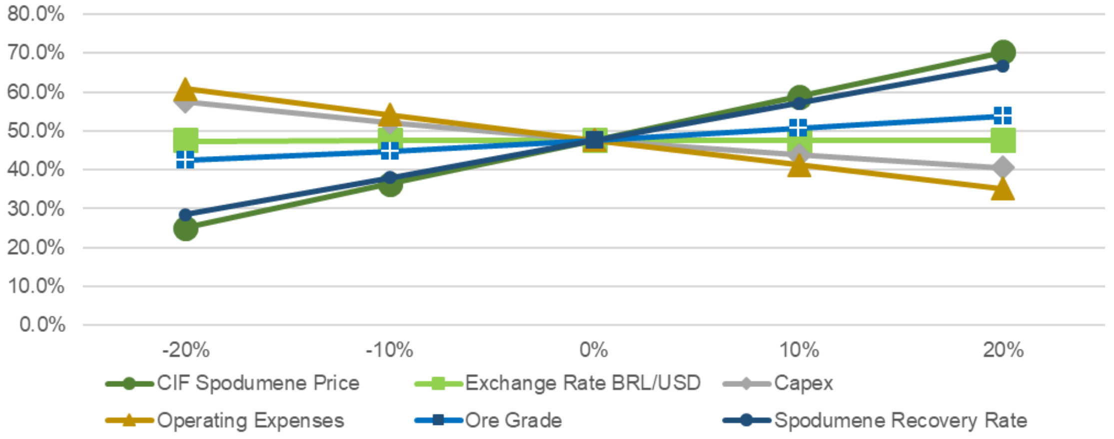


Figure 22-7 – Pre-Tax IRR – excluding closure costs

Note: Figure provided by Sigma, 2019

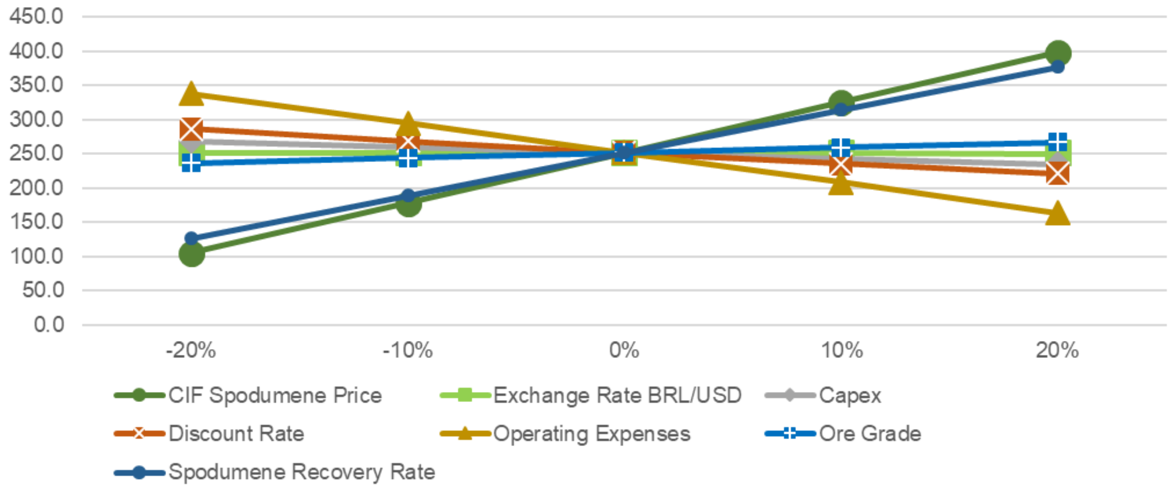


Figure 22-8 – After-Tax NPV (US$ million) – excluding closure costs

Note: Figure provided by Sigma, 2019

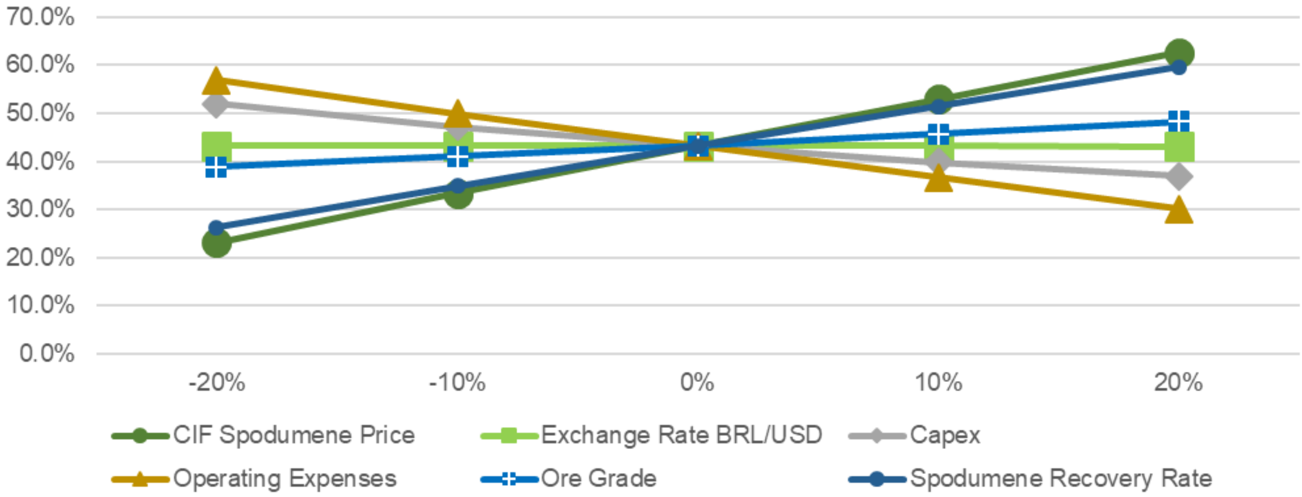


Figure 22-9 – After-Tax IRR – excluding closure costs

Note: Figure provided by Sigma, 2019

23 ADJACENT PROPERTIES

This section is not relevant to this Report.

24 OTHER RELEVANT DATA AND INFORMATION

24.1 SCHEDULE

The project implementation schedule was developed in conjunction with MCB, Primero and Sigma.

Project approval and kick-off is dictated by two major milestones, namely the approval of the Environmental Construction License and confirmation of project financing. To progress the project prior to meeting these two milestones, a contract is planned to be awarded for the front-end engineering and design (FEED) for the process plant. This approach will allow process design to progress sufficiently to confirm selection of major long-lead equipment and associated pricing. Once these two milestones are met, orders can be placed, and detailed engineering can commence to reduce risks to Sigma and its stakeholders while maintaining progress.

The schedule for the engineering and design itself is based on a detailed deliverables list with estimated hours and rationalised using Primero's past experience from similar projects. This includes all engineering, drafting, procurement services and management.

Procurement and fabrication lead times included are based on competitive tenders issued to the market for all major equipment and fabricated bulks. Allowances have also been made for delivery times to site.

Initial site mobilisation for the bulk earthwork's construction is dictated by the completion of the bulk earthworks design. Full site establishment for all other site installation works can commence as soon as the bulk earthworks have progressed sufficiently enough, and the areas are handed over. The schedules for the various construction contracts have been based on installation man-hours and site durations received from suitably qualified contractors via competitive tendering. The durations, sequencing and site manning levels were all rationalised and adjusted according to construction experience of similar projects within the same area.

Commissioning of the process plant has been based on previous experience commissioning plants of similar process design and size.

24.1.1 Key Dates

The project implementation key dates are shown Table 24-1.

Table 24-1 – Key Dates Summary

Activity	Date (weeks)
FEED design commences	-9w
Bulk earthworks design commences	-5w
Environmental construction license	-1w
Project financing complete, project go	0
Site mobilisation	9w
Concrete commences	17w
SMP commences	31w
Construction complete	58w
Start of dry commissioning	58w
Start of ore commissioning	64w
Commissioning complete	66w

24.1.2 Schedule Basis

The schedule is based on the following:

- Offsite: nominal 40-hour week, no work on public holidays
- Sigma approval period (preferred supplier list, process design and general arrangement drawings only): five working days unless otherwise noted herein
- Onsite construction labour: 190 hrs per month per person. Two shifts considered in certain areas for acceleration. 13 days per fortnight, 10 hours / day, three weeks on, one week off
- Onsite expatriate labour: 13 days per fortnight, 10 hours / day, six weeks on, two weeks off
- No site activities during public holidays.

24.2 PROJECT EXECUTION PLAN

This section describes the project execution plan (PEP) which forms the basis of this feasibility study. The PEP will be firmed up in the next phase (FEED).

24.2.1 Mission Statement

The project delivery objectives will need to align those of Sigma's business and project objectives as follows:

- Meet or exceed Sigma's health, safety, environmental, community and project development standards
- Conform to statutory requirements and Sigma's commitments regarding licenses and approvals

24.2.2 Scope

The Owner's team has the overall responsibility of managing project implementation. The Owner's scope of services will include the following:

- Obtaining and management of the necessary Federal, State and local permits and approvals
- Preparation of overarching standards, site rules and procedures
- Overall site health, safety and environmental management
- Scope preparation, tendering and award, contract administration and closeout of each of the contracts listed in Section 24.2.4.
- Detailed overview of the engineering ensuring the Sigma requirements are satisfied
- Interface management between the consultant sub-contractors
- Interface with the Sigma corporate office
- Establishment of the operations and mining teams, including the mining operations sub-contractor
- Procurement of spare parts (operating, insurance) (based on spare parts list provided by the suppliers)
- Training and operational readiness

24.2.3 Criteria and WBS

24.2.3.1 Project Standards and WBS

The design, engineering and project execution will be carried out in accordance with Brazilian Standards and ASME/ANSI and IEC as applicable and as stated in the design criteria. A WBS for the Project has been developed.

24.2.4 Contracting Strategy

The Sigma Owner's team will be responsible for tendering and award of the major contracts listed in Table 24-2.

Table 24-2 – Major Contracts List

Package Description
Engineering, Procurement & Construction Management - Overall
Engineering, Procurement and Commissioning – Process Plant
HV Power line feed and sub-stations
Contract crushing
Contract mining

24.2.4.1 Engineering, Procurement and Construction Management - Overall

Sigma will engage a suitably qualified engineering, procurement and construction management (EPCM) contractor. The EPCM contractor shall act as an agent of Sigma in all project management and construction activities. The EPCM contractor shall be responsible for the following services:

- Overall project management and construction management (including overall reporting consolidation)
- Overall management of the construction site including health, safety and environmental management.
- Engineering, procurement and construction of all non-process infrastructure

In addition to this, the EPCM contractor will tender and award several sub-contracts to suitably qualified consultants and construction contractors.

24.2.4.2 Engineering, Procurement and Commissioning – Process Plant

The Owner's team will award the engineering, procurement and commissioning of the spodumene processing facility to a suitably qualified engineering consultant with specific experience in designing and delivering processing facilities.

The selected consultant will carry out process plant commissioning to ensure commissioning, ramp-up and full name-plate production is achieved within the shortest possible time.

24.2.4.3 HV Power Line Feed and Sub-Stations

Power will be sourced via a 125 m extension from an existing 138 kV overhead transmission line. A suitable contractor will be engaged to construct the new 138k V overhead transmission line, switchyard and 4.16 kV sub-station on a BOO arrangement.

CEMIG will be required to carry out the final connection between the existing 138 kV line and the newly constructed line.

24.2.4.4 Contract Crushing

The Owner's team will award the contract crushing services to a suitably qualified OEM provider. The crushing facility will be solely managed, operated and maintained by the crushing contractor in order to meet the monthly production requirements.

The crushing contractor will mobilise, install and commission the crushing circuit. The process plant engineering, procurement and commissioning consultant will be responsible for installing minor concrete pads and provision of electrical power supply for the crushing facility.

24.2.4.5 Contract Mining

A suitable mining contractor will be engaged to carry out mining operations throughout the LOM. The mining contractor will mobilise to site approximately six months prior to the commissioning of the process plant in order to carry out site establishment, construction of haul roads and pre-stripping activities. With the exception of diesel fuel storage and distribution, the mining contractor will be responsible for providing all mine services infrastructure in order to operate and maintain the mining fleet and ancillary equipment. This will include, but not be limited to, the heavy vehicle equipment workshops, light vehicle workshops, tyre change facility and general maintenance workshops and warehousing.

24.2.5 Construction

24.2.5.1 Construction Management

The EPCM contractor will have ownership of the site during construction and shall be responsible for all sub-contractors on site and be responsible for health and safety at site.

24.2.5.2 Construction Facilities

The EPCM contractor will set-up temporary construction facilities for their own construction management personnel as well as the Owner's team. The Owner's team will relocate into the new permanent administration building as soon as installation has been completed.

Each construction sub-contractor will be responsible for providing its own construction facilities at designated areas including laydown areas.

24.2.5.3 Construction Power

Until the newly installed substation is energised, all construction power will be supplied via diesel generators. All contractors will be responsible for fuelling their own generators.

24.2.5.4 Construction Security

The contractor will install a security fence around the perimeter of the site as well as a security hut and boom gate at the entrance to the site for personnel and visitors sign-in and sign-out and for inspection of vehicle loads leaving the site. A sheltered warehouse will be provided and managed by the EPCM contractor for any equipment requiring indoor storage.

24.2.5.5 Accommodation

No on-site accommodation has been considered. The Owner's team and the EPCM contractor will source accommodation locally in the neighbouring towns within reasonable traveling distance to site. All construction contractors will be responsible for providing their own accommodation off-site.

25 INTERPRETATION AND CONCLUSIONS

25.1 CONCLUSIONS

This Report outlines the requirements and parameters for the development of an open pit mine consisting of two pits (Pit 1 and Pit 2) and the concentrator plant and related infrastructure to process 1,500,000 dry tonnes of ore per year for a LOM of nine years and three months.

25.1.1 Mineral Resource

Mineral Resource estimates are reported for the Xuxa, Barreiro, Lavra do Meio and Murial pegmatites in the Grota do Cirilo property area. Based on the information and reviews presented in this Report, the QP notes that:

- Information from experts retained by Sigma supports that the mining tenure held is valid and is sufficient to support declaration of Mineral Resources
- Surface rights to allow exploration-stage activities have been obtained, in addition, these surface rights will support project evaluation such as DMS pilot plant test work in the Grota do Cirilo property area
- Royalties are payable to third parties and the Brazilian government
- To the extent known to the QP, there are no other significant factors and risks that may affect access, title, or the right or ability to perform work on the property that have not been discussed in this Report
- The known deposits within the Project area are considered to be examples of LCT pegmatites
- 11 pegmatites in the Geniapapo and six pegmatites in the Santa Clara area were considered to have exploration potential; however, no current exploration is planned in this area due to the current focus on the Grota do Cirilo property area
- Sigma has completed ground reconnaissance, satellite image interpretation, geological mapping, channel and chip sampling, trenching, core drilling, and Mineral Resource estimation a total of 255 core holes (42,301.15) m was completed in 2014, and 2017–2018. The drilling used conventional methods. Core was logged and photographed. Collar surveys were performed. Core recovery is considered acceptable.
- Most drill holes intersect the mineralized zones at an angle, and the drill hole intercept widths reported for the Project are shorter than true widths
- Sample security procedures met industry standards at the time the samples were collected. Current sample storage procedures and storage areas are consistent with industry standards
- Sample preparation and lithium analyses are performed by accredited laboratories that are independent of Sigma. Sample preparation and analytical methods are appropriate for lithium determination
- SGS validated the exploration processes and core sampling procedures (2017) used by SMSA as part of an independent verification program. The drill core handling, logging and sampling protocols are at conventional industry standard and conform to generally accept best practices. The sample quality is good and that the samples are generally representative. The system is appropriate for the collection of data suitable for a Mineral Resource estimate
- The sample preparation, analysis and QA/QC protocol used by Sigma for the Project follow generally accepted industry standards and that the Project data is of a sufficient quality. However, more attention should be put into the blank material selection in the future in order improve the similarity between the batches
- Mineral Resources were estimated using OK, and were classified using the 2014 CIM Definition Standards

- Mineral Resources can be affected by the market value of lithium and lithium compounds or the modification of the Brazilian taxation regime environmental policies

The Mineral Resource estimates are reported using a 0.5% Li_2O cut-off. The Mineral Resources are constrained by the topography and based on the conceptual economic parameters stated in the notes below. The estimate has an effective date of January 10, 2019. The QP for the estimate is Mr. Marc-Antoine Laporte, P.Geo., an SGS employee.

25.1.2 Process Plant

Spodumene concentrate with a minimum grade of 6.0% Li_2O was achieved by a metallurgical testing program at SGS Canada in Lakefield.

The metallurgical test work showed that spodumene can be recovered via a DMS circuit, which includes coarse, fines and ultrafines DMS unit operations, with a global recovery of 60.4%.

The spodumene plant is designed to process 1,500,000 dry tonnes of ore per year to produce a total of 215,939 dry tonnes of spodumene concentrate of 6.0% Li_2O based on a Li_2O recovery of 60.4%.

The flowsheet includes three-stage conventional crushing, grinding, magnetic separation, DMS, thickening, filtering and spodumene and concentrate storage and shipping. The QP concludes that the project is technically feasible to proceed to detailed engineering and construction.

25.1.3 Infrastructure

The necessary non-process infrastructure for the plant that will need to be installed includes: the main high voltage electrical substations, the main site access roads (municipal), administrative buildings including medical clinic, mess hall and kitchen, warehouse and maintenance building, utilities storage and reticulation (compressed air, process potable and fire-water).

25.1.4 Water Management

The water management infrastructure is considered to be sufficiently sized to manage the expected surface runoff volumes.

25.1.5 Mining

Based on current Mineral Reserves and mine planning, the Xuxa LOM production schedule extends for 10 years, with a total of 2 Mt of lithium concentrate anticipated to be produced during this period.

Mining operations are based on the use of hydraulic excavators and a haul truck fleet engaged in conventional open pit mining techniques. Excavated material will be loaded in trucks and hauled to either the ROM pad or the waste piles. Controlled blasting (pre-splitting) technique will be used for the ore domain to reduce back-break and to better control dilution.

The risks to the Xuxa Project LOM plan and operations are currently considered to be low, with outcomes being sensitive to negative commercial trends that might develop in respect of the lithium price, exchange rate, and the inflationary effect on labour and consumables. With respect to the mining operation, the production rate and size of the pit may impose some challenges in terms of mining.

Based on the geotechnical results obtained, the pit slopes geometry is adequate to the rock mass geomechanical conditions and that the safety factors obtained are much higher the minimums recommended for this type of project. Adjustments and improvements to the geotechnical parameters may be possible when active mining operations commence.

25.1.5.1 Waste and tailings

During the LOM, the estimated waste tonnage will be 65 Mt and 74 Mt from Pit 1 and Pit 2 respectively. About 9.6 Mt of tailings will be produced from the process plant. Three waste piles (piles 1, 2 and 3) will be used for co-disposal of waste rock and tailings with pile 4 to be used for disposal of waste rock only.

The tailings will be filtered to a dry consistency and placed as a solid waste confined within waste rock shells that will ensure the short and long-term stability of the waste piles.

25.1.6 Geotechnical

A preliminary site geotechnical investigation was carried out. Due to access restrictions, only a limited number of boreholes and test-pits were executed in the periphery of the process plant facilities and the results were used to provide preliminary geotechnical design parameters.

A detailed hydrogeological investigation is recommended to clarify water table elevation, continuity of water bearing zone and evaluate subsurface (water-bearing zone/aquifer) hydrogeological parameters to better understand the condition and plan for mining activities. The investigation should include a baseline study of the pre-mining conditions.

25.1.7 Environment

Sigma has applied and received the LP + LI to commence construction at the Xuxa deposit. Sigma holds approved PAEs over the Xuxa, Barreiro, Lavra do Meio, Murial, Maxixe and Nezinho do Chicâo deposits within the Grota do Cirilo property. Licenses are timely renewed when due.

The PAE for Xuxa was updated and approved in August 2018. The portion of the EIS that applied to the Xuxa deposit area was updated and submitted in December 2018 in support of the licence application for Pit #1 and waste piles #1 and #2, approval of which was obtained on June 3, 2019. The EIS for mine Pit #2 and waste piles #3 and #4 will be prepared in 2019 and submitted in March 2020 in line with the prescribed permitting timing requirements for the process plant coming online with Pit #1.

25.1.7.1 ARD

The preliminary conclusion from the ARD testing on 20 samples at SGS Geosol is that any acidic drainage release is likely to be localized and of relatively minor concentration. ABA results suggest that more than half of the samples (13 samples) are non-acid producers. The remaining samples may be potentially acid producers. Further review is required to conclude on representivity, characteristics and occurrence frequency as well as additional testing.

In addition, a single humidity cell test was conducted at SGS Lakefield. The test showed non-acidic effluent over a 20-week period. The humidity cell test has determined that the sulphide content in the sample is depleting at a faster rate than the sample NP.

25.1.8 CAPEX

The capital cost (CAPEX) estimate includes the process plant, site infrastructure, mining and Owner's costs. Pre-production, working capital, sustaining and deferred capital costs were also included.

Equipment costs were obtained with firm price quotations for six long lead mechanical equipment and with budgetary quotations for the remaining equipment packages. In-country (Brazil) quotations were obtained for the installation unit rates and to the extent feasible for equipment supply. Brazilian fabricators were selected for structural steel and platework supply and fabrication.

Material take-offs (MTOs) were generated from the feasibility study designs with the unit rate costs applied per commodity. The CAPEX estimate has an accuracy of ±15% and is summarized in Table 25-1.

Table 25-1 – CAPEX Summary

Area	**Direct (US$)**	**Indirect (US$)**	**Contingency (US$)**	**Recoverable (US$)**	**Total (US$)**
PROCESSING PLANT					
Subtotal Processing Plant	23,000,000	9,822,000	4,198,000	-3,818,000	33,203,000
SITE INFRASTRUCTURE					
Subtotal Site Infrastructure	25,944,000	6,215,000	2,594,000	-1,996,000	32,759,000
OWNERS COST					
Subtotal Owners Cost	0	4,642,000	691,000	-230,000	5,104,000
SUBTOTAL CAPITAL COST	**48,944,000**	**20,679,000**	**7,483,000**	**-6,044,000**	**71,066,000**
PRE-PRODUCTION AND WORKING CAPITAL					
730 - Mining Pre-Production	12,713,000	0	1,145,000	-563,000	13,294,000
820 - Plant & Pre-Production	0	2,738,000	411,000	-110,000	3,039,000
830 - Working Capital	0	9,534,000	1,431,000	0	10,964,000
Subtotal Pre-Production and Working Capital	12,713,000	12,272,000	2,987,000	-673,000	27,297,000
SUBTOTAL INITIAL CAPITAL COST	**61,657,000**	**32,951,000**	**10,470,000**	**-6,717,000**	**98,363,000**
SUSTAINING AND DEFERRED CAPITAL					
910 - Sustaining Capital	0	1,275,000	192,000	0	1,467,000
920 - Deferred Capital	4,711,000	828,000	535,000	-238,000	5,835,000
930 - Closure Cost	0	7,838,000	107,000	0	7,945,000
Subtotal Sustaining and Deferred Capital	**4,711,000**	**9,941,000**	**834,000**	**-238,000**	**15,247,000**

Note 1: deferred Capital costs are comprised of the Pit 2 haul roads, balance pile 1 excavation, bridge between Pit 1 and Pit 2, waste piles 3 and 4 excavation (clear& grub, excavation, ponds cuts) and closure costs.

25.1.9 OPEX

The operating cost (OPEX) estimate is based on contract mining, build-own-operate (BOO) high-voltage electrical sub-stations and non-process infrastructure substations and contract crushing, as per Sigma's preferred commercial strategy.

The concentrate transport cost has been estimated to be US$22.90M per annum or US$15.30/t of ore per Sigma input based on preliminary quotations. This includes all the transport costs from the site to the Port of Ilhéus, Brazil, port storage and handling fees and CIF shipment to the port of Shanghai, China.

General and administration costs have been estimated to be US$2.64M per annum or US$1.76/t of ore.

Operating cost estimates are summarized in Table 25-2.

Table 25-2 – Operating Cost Estimate Summary

DESCRIPTION	**OPEX US$/ t contract crushing**
Mine	21.91
Process	10.69
G&A	1.76
Shipping	15.30
NPI (included in Process and G&A)	-
TOTAL	49.66

25.1.10 Economics

The economic analysis was developed using the discounted cash flow method and based on the data and assumptions for capital and operating costs detailed in this report for mining, processing and associated infrastructure. An exchange rate of 3.85 BRL per US$ was used to convert particular components of the cost estimates into US$. An exchange rate of 4.10 BRL/US$ was used as a further update of the CAPEX.

No provision was made for the effects of inflation and the base currency was considered on a constant 2019 US$ basis. The evaluation was undertaken on a 100% equity basis. Exploration costs are deemed outside of the Project and any additional project study costs have not been included in the analysis.

Base case scenario results are presented in Table 25-3.

Table 25-3 – Base Case Economic Study Results

Item	**Unit**	**Value**
Pre-tax NPV @ 8%	US$	299,074,000
After-tax NPV @ 8%	US$	248,507,000
Pre-tax IRR	%	47.6%
After-tax IRR	%	43.2%
Pre-tax payback period	Years	2.9
After-tax payback period	Years	3.1

The Project’s NPV and IRR are not significantly vulnerable to changes in the pre-production initial capital expenditure nor discount rate considered. The Project’s NPV and IRR are more sensitive to variation in CIF spodumene price and BRL per US$ exchange rates.

The Project's NPV is significantly positive at the lower limit of the price interval and the exchange rate interval examined. The Project's NPV is also significantly positive at the upper limit of the operating expenses interval examined.

25.2 RISK EVALUATION

Risk assessment sessions were conducted individually and collectively by all parties.

Most aspects of the project are well defined. The risks are grouped by licensing, cost (CAPEX and OPEX), schedule, operations, markets and social/environmental categories. One of the most significant risks identified for the Project is related to lithium markets.

The following risks are highlighted for the project:

- Lithium market sale price and demand (commercial trends)
- Delay in obtaining financing: impact to notice to proceed (NTP)
- Delay in obtaining the power permit and CEMIG substation energization: impact on plant start-up date
- Delay in obtaining the license for Pit #2 and waste piles #3 and #4
- Fluctuations in the exchange rate and inflation
- Labour strikes at the Port and at site (construction and operation)
- Tax exemptions and import not confirmed
- Increased demands from the local community once in operation
- More fines generated from mining and crushing: potential negative impact on recovery
- Additional testing required for geotechnical (for foundations, earthworks and for waste rock storage areas), hydrogeology to validate assumptions
- The production rate and size of the pit may impose challenges for operations
- Waste rock/tailings disposal: additional testing required to conclude on potential for acid drainage in the waste rock and tailings storage areas: although the tests performed indicate that acid drainage will probably not exist, this is still a possibility and needs to be investigated to assess need for lining and for specific drainage design to avoid soil/ground-water contamination
- Waste rock/tailings disposal: in the next phase, complementary investigations and geotechnical tests in the areas of the waste rock and tailings storage, could change the basic assumptions adopted in the feasibility study. In this case, deeper excavation than foreseen may be required
- Waste generation: the continuous geotechnical monitoring system to be implemented during mining operation can indicate local changes to geotechnical parameters, and potential increase of waste
- If some or all of the Inferred Mineral Resources can be upgraded to higher-confidence categories and eventually converted to Mineral Reserves, the total amount of waste generated from mining this material would require an increase in the storage capacity of the waste piles resulting in bigger pile requirements.
- Waste rock/tailings disposal: additional testing is required to conclude against potential for tailings liquefaction during waste and filtered tailings disposal. Large-scale field testing must be conducted using filtered tailings and waste material. The field test will include compaction of 3 to 4 m, sampling and conducting CPTU tests. It is known that tailings compaction will prevent liquefaction but requires testing for higher elevation and for confirmation. Changes in the elevation or the design could be necessary based on the test results.

25.3 OPPORTUNITIES

The following opportunities are identified for the Xuxa project:

- Recovery of Li_2O from hypofines with a flotation circuit
- Recovery of Li_2O from petalite
- Potential upgrading of some or all of the Inferred Mineral Resources to higher-confidence categories and eventually conversion to Mineral Reserves
- Potential for future underground mining of the Xuxa pegmatite if a trade-off study supports the concept
- Exchange rate may work in the Project’s favour.

26 RECOMMENDATIONS

The following summarizes the recommendations from the feasibility study. A phased work program is planned. The first phase relates to continued evaluation and exploration of known pegmatite bodies. The second phase consists of mining, process, geotechnical and other supporting studies and needs to be completed early in the execution phase. Completion of Phase 2 work is independent of the work recommended for Phase 1 and can be conducted concurrently with the Phase 1 recommendations.

26.1 PHASE 1 (GEOLOGY AND RESOURCE)

The overall estimated cost for the drill program for Phase 1 is estimated at US$6.1M and consists of a 36,000 m drill program to test the Xuxa, Barreiro, Nezinho do Chicao, Murial and Bee areas. This is not included as a project cost.

Sigma intends to continue its infill and exploration evaluation of the pegmatites within the Grota do Cirilo area with a 36,000 m drill program as follows:

- Xuxa: 4,400 m to potentially support expansion of the Mineral Resource at depth, and potentially support category upgrades
- Barreiro: infill drilling, and step-out drilling to the north, 9,600 m
- Nezinho do Chicao: 12,800 m
- Murial: step-out drilling to the north, 4,400 m
- Bee mine: 4,800 m

Drilling will be completed with HQ size core tools with total depths between 150–300 m. Core sampling will be conducted on 1 m intervals. The all-in program costs, including drilling, logging, and assays, is estimated at US$170/m.

26.2 PHASE 2

Phase 2 recommendations will be implemented in the project execution phase, prior to commencement of operations, and are estimated to be a total of US$1,275,000, consisting of:

- Process plant (testing for wet magnetic separation equipment, a middlings recrushing recovery trade-off study): US$60,000
- Mine design (finalize topographic survey; complete density, moisture and blasted swell effect analyses for ore and waste; implement a grade control program; evaluate underground mining potential for below the open pit levels of the mine, conduct a reserve study for underground mining; implement geotechnical monitoring system): US$345,000
- Geotechnical (supplementary geotechnical investigations of planned infrastructure sites including at waste pile areas; supplementary geochemical tests (ARD); large-scale waste rock and tailings co-disposal stockpile field test): US$870,000.

26.2.1 Recommendations – processing plant

The following activities are recommended:

- Further determination of the characteristic of the waste material diluting the ore going to the plant including Fe_2O_3 and further development of Fe_2O_3 model. To be obtained from the grade control program from mining. No additional cost.

- Testing by Vendor for the selection and sizing of the wet magnetic separators for coarse product. 3 samples required (low, avg, high: 200 kg each): US$40,000
- Implement best practice for mine drill and blast process to minimize fines generation which will have a negative impact on the process plant: Sigma has sourced expertise: no additional cost.
- Conduct a trade off study for the potential recovery of Li_2O from the DMS fines middlings by re-crushing versus current approach of sending it to the tailings - need samples (200 kg/test work): estimated cost US$20,000.

26.2.2 Recommendations - mining

Mining recommendation include:

- Perform a detailed topographical survey in the area (including road from highway to plant): estimated cost US$35,000
- Perform analyses for apparent density (dry and wet density), blasted swell effects and natural moisture for ore and the waste for mining activities: estimated cost US$10,000
- Implement grade control program including procedures, drilling and software: estimated cost US$110,000
- Plan and implement a robust reconciliation system, in addition to grade control program, including plant feed sampling procedures, software reporting system development: estimated cost US$ 40,000
- Conduct a conceptual scoping level study (PEA) for potential underground mining of the remaining resource including inferred resources located under the open pit, to define the open pit/underground mine limit to allow the development of a geotechnical campaign program to support future underground mine project: estimated cost US$100,000
- Implement a geotechnical monitoring system including installation of clinometers, prims and piezometers to continually collect and analyse data during operations to alert, if necessary, abnormal movements in the pit walls. A topography total station will be required (cost covered in topography service per Sigma): estimated cost US$50,000

26.2.3 Recommendations – geotechnical, hydrogeological and geochemical

26.2.3.1 Geotechnical

A supplementary geotechnical investigation program needs to be performed for the all areas of Xuxa during the detailed engineering phase: waste piles areas, mine services area, process and non-process plant areas and access roads (approximately 40 holes): estimated cost US$90,000.

26.2.3.2 Waste rock/tailings disposal

Additional testing is required to conclude against the potential for tailings liquefaction during waste and filtered tailings disposal. Large-scale field testing must be conducted using filtered tailings and waste material: estimated cost US$520,000.

26.2.4 Hydrogeological

Additional hydrogeological investigation as defined is Sections 18.4.1.3 (Hydrogeology) will be required comprising:

- Six monitoring wells plus a pumping well for an estimated length of 1,000m for the baseline study
- One pumping test of minimum 72 hours: one pumping well to a depth of 150m, plus two monitoring wells to the same depth: it is noted that in order to estimate the key parameters transmissivity (T) and storativity (S) from a pumping test, it is necessary to measure drawdowns/water levels from the monitoring wells.

In summary, the installation of seven wells in total is proposed. Four wells are specifically considered for the baseline study and three additional monitoring wells for the pumping test: the total cost of this program is estimated at US$225,000.

This estimate is based on a unit cost of US$175 per meter for a typical 100 m deep monitoring well installation, including the cost of labor, mob-demob, drilling and well installation material including well installation materials and water sample collection and chemistry tests. In addition, the pumping test is estimated to cost US$50,000. This work must be done in the early stages of the detailed engineering phase.

26.2.5 Geochemical

Geochemical investigation per Section 20.1.4 for ARD will be required (ABA, NAG and humidity kinetic testing on waste rock; ABA for tailings; XRF and XRD analysed on combined waste and tailings): the estimated cost for these tests is US$35,000. This work must be completed before the start of detailed engineering.

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