TECHNICAL REPORT

ON THE

GROTA DO CIRILO LITHIUM PROJECT

ARAÇUAÍ AND ITINGA REGIONS, MINAS GERAIS, BRAZIL

190,615 mE, 8146,788 mN

Prepared for

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CERTIFICATE OF AUTHOR
MARC-ANTOINE LAPORTE P.GEO

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

1. I am a senior geologist with SGS Canada Inc (Geological Services) with a business address at 125 rue Fortin, Suite 100, Quebec City, Quebec, G1M 3M2.
2. This certificate applies to the Technical Report entitled "*Technical Report on the Grota do Cirilo Lithium Project, Aracuai and Itinga Regions, Minas Gerais, Brazil.*" with an effective date of 18th January 2024.
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 the 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 an independent qualified person for the purposes of NI 43-101.
5. My most recent personal inspection of the Project was from November 22-24, 2023.
6. I have read NI 43-101 and I have participated in the preparation of this Technical Report and am responsible for Sections 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13.2.7, 13.3.7, 14, 23 and the applicable parts of sections 1, 2, 25, 26 and 27, each of which has been prepared in accordance with NI 43-101.
7. I am independent of Sigma Lithium Corporation as defined by Section 1.5 of the Instrument. I don't have any prior involvement with the property that is the subject of the technical report.
8. As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the sections of the technical report for which I am responsible contain all scientific and technical information that is required to be disclosed to make the technical report not misleading.

Signed and dated this 19th day of March 2024 at Quebec City, Quebec.

"Signed and sealed" Marc-Antoine Laporte, P.Geo., M.Sc.

Marc-Antoine Laporte, P.Geo., Senior Geologist
SGS Canada Inc

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JARRETT QUINN P.ENG.

I, Jarrett Quinn, P.Eng., Ph.D., of Montréal, Québec, do hereby certify:

1. I was a Consulting Process Engineer for Primero Group Americas Inc. with a business address at 1450 - 1801 McGill College, Montréal, Québec, H3A 2N4 at the effective date of the report.
2. This certificate applies to the Technical Report entitled "*Technical Report on the Grota do Cirilo Lithium Project, Aracuai and Itinga Regions, Minas Gerais, Brazil.*" with an effective date of 18th January 2024.
3. I am a graduate of McGill University (B.Eng. 2004, M.Eng. 2006, and Ph.D. 2014) in Metallurgical Engineering. I am a member in good standing of the Ordre des Ingénieurs du Québec (#5018119). I have worked as a metallurgist since 2006.
4. I have read the definition of Qualified Person set out in the National Instrument 43-101 (Instrument) and certify that by reason of my education, affiliation with a professional association and past relevant work experiences, I fulfil the requirement to be an independent qualified person for the purposes of NI 43-101.
5. I have read NI 43-101 and have participated in the preparation of this Technical Report. I am responsible for Section 13 (Mineral Processing and Metallurgical Testing) excluding sections 13.2.7 and 13.3.7 and am responsible for Chapter 17 (Recovery Methods), which have been prepared in accordance with NI 43-101.
6. I am independent of Sigma Lithium Resources Corporation as defined by Section 1.5 of the Instrument. I do not have prior involvement with the properties that are the subject of the technical report.
7. As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the sections of the technical report for which I am responsible contain all scientific and technical information that is required to be disclosed to make the technical report not misleading.

Signed and dated this 19th day of March 2024 at Montréal, Quebec.

"Signed and sealed" Jarrett Quinn P.Eng.

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Jarrett Quinn, P.Eng. (OIQ #5018119), Ph.D., Consulting Process Engineer,
Primero Group Americas Inc.

CERTIFICATE OF AUTHOR
PORFÍRIO CABALEIRO RODRIGUEZ FAIG

I, Porfirio Cabaleiro Rodriguez, FAIG., do hereby certify:

1. I am a Mining Engineer and Director for GE21 Consultoria Mineral, located at Avenida Afonso Pena, 3130 − 12º andar, Belo Horizonte, MG, Brazil, CEP 30.130-910.
2. This certificate applies to the Technical Report entitled "*Technical Report on the Grota do Cirilo Lithium Project, Aracuai and Itinga Regions, Minas Gerais, Brazil.*" with an effective date of 18th January 2024.
3. I am a graduate in Mining Engineering from the Federal University of Minas Gerais, in Belo Horizonte, Brazil. I have worked as a Mining Engineer for more than 42 years.
4. I am a Fellow of the Australian Institute of Geoscientists (FAIG #3708).
5. I have read the definition of Qualified Person set out in the National Instrument 43-101 (Instrument) and certify that by reason of my education, affiliation with a professional association and past relevant work experiences, I fulfil the requirement to be an independent qualified person for the purposes of NI 43-101.
6. I visited the site between 25-29 July ,2022.
7. I have read NI 43-101 and have participated in the preparation of this Technical Report and am responsible for Sections 15, 16, 18.4, 18.8, 19, 20, 21.1, 21.2, 21.3 and 24, and the applicable parts of 1 and 25, each of which has been prepared in accordance with NI 43-101.
8. I am independent of Sigma Lithium Corporation as defined by Section 1.5 of the Instrument. I do not have prior involvement with the properties that are the subject of the technical report.
9. As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the sections of the technical report for which I am responsible contain all scientific and technical information that is required to be disclosed to make the technical report not misleading.

Signed and dated this 19th day of March 2024 at Belo Horizonte, Minas Gerais State.

"Signed and sealed" Porfirio Cabaleiro Rodriguez, BSc. (MEng), FAIG

____

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

CERTIFICATE OF AUTHOR
HOMERO DELBONI JR

I, Homero Delboni Jr, B.E., M.Eng.Sc., Ph.D., of São Paulo, Brazil, do hereby certify:

1. I am a Senior Consultant of Mineral Processing Solutions Ltda., Alameda Casa Branca, 755 cj. 161, Sao Paulo, SP 01408-001 Brazil.
2. This certificate applies to the Technical Report entitled "Technical Report on the Grota do Cirilo Lithium Project, Aracuai and Itinga Regions, Minas Gerais, Brazil" with an effective date of 31st January 2024.
3. I graduated with a Bachelor of Engineering Degree in Mining and Minerals Processing from The University of Sao Paulo (Brazil) in 1983, concluded a Masters in Engineering in Minerals Processing in The University of Sao Paulo (Brazil) in 1989 and obtained a Ph.D. in Minerals Processing Engineering at The University of Queensland – Julius Kruttschnitt Mineral Research Centre, Brisbane (Australia) in 1999.
4. I am a Member (#112813) and Chartered Professional in Metallurgy of the Australian Institute of Mining and Metallurgy – MAusIMM – CP (Metallurgy). I have worked as a Minerals Processing engineer for a total of 39 years since my graduation from university.
5. I have read the definition of Qualified Person set out in the National Instrument 43-101 (Instrument) and certify that by reason of my education, affiliation with a professional association and past relevant work experiences, I fulfil the requirement to be an independent qualified person for the purposes of NI 43-101.
6. I have read NI 43-101 and I have participated in the preparation of this Technical Report, and I am responsible for Section 18, excluding sub-sections 18.4.2, 18.4.4.2, 18.8 and 18.8.8.1.2, which have been prepared in compliance with NI 43-101.
7. I am independent of Sigma Lithium Corporation as defined by Section 1.5 of the Instrument. I do not have prior involvement with the properties that are the subject of the technical report.
8. As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the sections of the technical report for which I am responsible contain all scientific and technical information that is required to be disclosed to make the technical report not misleading.

Signed and dated this March 19, 2024, at São Paulo, SP - Brazil.

"Signed and sealed" Homero Delboni Jr, B.E., M.Eng.Sc., Ph.D., MAusIMM

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Homero Delboni Jr, B.E., M.Eng.Sc., Ph.D., MAusIMM – CP (Metallurgy) Senior Consultant, Mineral

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CERTIFICATE OF AUTHOR
WILLIAM VAN BREUGEL P.ENG.

I, William van Breugel, P. Eng. of Christopher Lake, Saskatchewan hereby certify that:

1. I am an Associate Mining Engineer for SGS Canada Inc, with an office located at 235 Ajawan Street, Christopher Lake, Saskatchewan, Canada.
2. This certificate applies to the Technical Report entitled "*Technical Report on the Grota do Cirilo Lithium Project, Aracuai and Itinga Regions, Minas Gerais, Brazil.*" with an effective date of 18th January 2024.
3. I graduated from the University of Waterloo in 1990 (BASc (Hons). Geological Engineering). I am a member of good standing of the Association of Professional Engineers and Geoscientists of Saskatchewan (License #22452). I have worked as a mining engineer for over 33 years since my graduation from university. I have worked on precious metals, base metals, industrial commodities, and diamond projects including mine operations and property evaluations. I am a "Qualified Person" for purposes of National Instrument 43-101 (the "Instrument").
4. I have read the definition of Qualified Person set out in the National Instrument 43-101 (Instrument) and certify that by reason of my education, affiliation with a professional association and past relevant work experiences, I fulfil the requirement to be an independent qualified person for the purposes of NI 43-101.
5. I have read NI 43-101 and have participated in the preparation of this Technical Report and am responsible for Section 21 (excluding sections 21.1, 21.2 and 21.3) and Section 22, and the applicable parts of sections 1, 3, and 25, each of which has been prepared in accordance with NI 43-101.
6. I am independent of Sigma Lithium Corporation as defined by Section 1.5 of the Instrument. I do not have prior involvement with the properties that are the subject of the technical report.
7. As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the sections of the technical report for which I am responsible contain all scientific and technical information that is required to be disclosed to make the technical report not misleading.

Signed and dated this 19th day of March 2024 at Christopher Lake, Saskatchewan.

"Signed and sealed" William van Breugel, P.Eng.

William van Breugel, P.Eng.

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
GE21	GE21 Mineral Consultants
HDPE	High Density Polyethylene
HLS	Heavy Liquid Separation
HMI	Human Machine Interface
LOM	Life of Mine
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	Grota do Cirilo Lithium Project
Promon	Promon Engenharia Ltda
Property	Sigma Property
RFQ	Request for Quotation
ROM	Run of Mine
SC	Spodumene Concentrate
Sigma	Sigma Lithium Corporation
SGS	SGS Geological Services (SGS Canada)
UCS	Unconfined Compressive Strength
UPS	Uninterruptible Power Supply
WBS	Work Breakdown Structure

1 SUMMARY

1.1 INTRODUCTION

Sigma Lithium Corporation (Sigma) requested SGS Geological Services (SGS) to prepare an updated NI 43-101 Technical Report (the Report) on Sigma's Grota do Cirilo project located in Minas Gerais State, Brazil.

This report contains an updated Mineral Resource Estimate for the Nezinho do Chicao, Lavra do Meio and Murial pegmatites and the maiden Mineral Resource Estimate for the Maxixe, Tamboril and Elvira pegmatites.

There has been no change in the Mineral reserves or financial analysis from previous reports.

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, Barrerio, Murial, Lavra do Meio and Nezinho do Chicao deposits.

The Report supports the disclosure by Sigma in the news release dated the 31st of January 2024.

Mineral Resources and Mineral Reserves (MRMR) are reported using the 2014 Canadian Institute of Mining, Metallurgy and Petroleum (CIM) Definition Standards (2014 CIM Definition Standards) and adhere, as best as possible, to the 2019 CIM Estimation of Mineral Resources & Mineral Reserves Best Practice Guidelines (2019 CIM MRMR Guidelines).

1.2 PROPERTY DESCRIPTION AND LOCATION

The Project is located in the northeastern Minas Gerais State, in the municipalities of Araçuaí and Itinga, approximately 25 km east of the town of Araçuaí and 600 km northeast of Belo Horizonte.

The Project is comprised of 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 29 mineral rights, which include mining concessions, applications for mining concessions, exploration permits and applications for mineral explorations authorizations, spread over 185 km^2, and includes nine past producing lithium mines and 11 first-priority exploration targets. Granted mining concessions are in good standing with the Brazilian authorities.

Certain surface rights in the Xuxa area, the current primary focus of mining activity, are held by two companies, Arqueana Minérios e Metais (Arqueana), Miazga Participações S.A. (Miazga) and Tatooine Investimentos S.A. (Tatooine). 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 with third-party surface owners in the Project area.

SMSA has a mining easement (Servidão Mineral) with a total of 413.3 hectares and aims to cover the areas of waste and tailings piles, production plant, all access roads (internal), electrical substation, installation of fueling station and support structures. The Servidão Mineral was published in the Official Gazette of the Federal Government. It contemplates the mining and processing activities of the Xuxa deposit and processing plant (ANM Process No. 824.692/1971).

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 one third-party net smelter return (NSR) royalties of 1%.

To the extent known to the QPs, 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 federal paved road BR-367, which runs through the northern part of the Project. Within the Project area, accessibility is provided by municipal roads. A municipal airport services the town of Araçuaí for private flights. The closest major domestic airports are located at the municipality of Vitória da Conquista, 273 km east of the Project and at the municipality of Montes Claros, 329 km west of the Project.

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 towns of Araçuaí and Itinga can supply certain services. Other services may 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 west, east, 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.

Nezinho do Chicao:

- The pegmatite body strikes nearly north-south (020º) and dips at 40-75º to the southeast. The dike is about 1,600 m long, 200 m down-dip and 20-30 m thick. It remains open to the north, south and at depth. The NDC pegmatite is a high-grade mix of spodumene and petalite with a variable ratio depending on the thickness of the zone.

1.6 EXPLORATION

The development of the Project started in the second quarter of 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, drilling and metallurgical test work. 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 458 core holes totalling 82,455 m. To date, this drilling has concentrated on the Grota do Cirilo pegmatites. Drilling was completed using 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 every year since 2017.

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, 2018, 2020, 2021 and 2022 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 and Mineral Reserve (MRMR) estimates for the Xuxa Definitive Feasibility Study (DFS) and the Barreiro/NDC Pre-Feasibility Study (PFS) update.

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 2014–2023 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 and 2020-2023 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). The 2020-2022 samples were assayed by SGS Geosol with a 31-element analytical package using sodium peroxide fusion followed by both Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) and ICP-MS finish (SGS code ICP90A) For Li, the lower limit of detection is 10 ppm, and the upper limit of detection is 15,000 ppm (1.5% Li).

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 and 2021, 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 729 pulp samples from the 2017, 2018, 2020 and 2021 Xuxa, Barreiro, Murial and Lavra do Meio drilling programs were sent to ALS Vespasiano for third-party verification.

SMSA inserted standards in sample batches during the 2014, 2017–2018 and 2020-2022 sampling programs. The 2017–2018 campaign used seven certified standards from African Mineral Standards (AMIS), an international supplier of certified reference materials while the 2020-2022 campaign used four certified AMIS standards. A total of 88 standards were inserted during the 2017 campaign and 315 were inserted during the 2018 campaign, with a further 73 standards submitted in the 2021 campaign and 210 samples submitted in 2021-2022. Results were considered acceptable, and no material accuracy issues were noted.

During the 2017–2018 and 2020-2022 campaigns 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 939 analytical blanks were analysed during the 2014, 2017–2018 and 2020-2022 exploration programs. Results were considered acceptable, and no material contamination issues were noted.

SMSA inserted coarse 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, Barreiro, Murial, Lavra do Meio and NDC deposits.

A total of 219 measurements were made on Xuxa core from 2017–2021. Of the 219 measurements, 26 were made on albite-altered pegmatite, 69 on schist, and 121 on lithium-bearing pegmatite. For Barreiro, a total of 471 measurements were made on core from the 2018 and 2021 drill programs. Of the 471 measurements, 94 were made on albite-altered pegmatite, 206 on schist, and 164 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. For NDC, a total of 292 lithium-bearing samples had density measurements calculated, comprising 196 spodumene samples and 96 petalite samples.

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.

As additional QAQC, 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.

Sigma sent 65 samples from the 2021 Barreiro drilling campaign to ALS Chemex for check sample analysis using the ALS Chemex protocol ME-ICP82b with sodium peroxide fusion.

The average lithium concentration for the original samples was 6,518.0 ppm Li and the duplicates averaged 6,559.7 ppm Li, with an average difference of 41.7 ppm or 0.6%. The correlation coefficient R^2 of 0.9854 suggests a strong correlation and a high similarity between the two sets of samples.

Sigma sent 304 samples from the 2021-2022 NDC drilling campaign to ALS Chemex for check sample analysis using the ALS Chemex protocol ME-ICP82b with sodium peroxide fusion.

The average lithium grade for the original samples was 1.38% Li_2O and the duplicates averaged 1.39% Li_2O. The correlation coefficient R^2 of 0.98 suggests a strong correlation and a high similarity between the two sets of samples.

A total of 216 coarse duplicates and 216 pulp duplicates from NDC were submitted for analysis from the 2021 and 2022 drill programs. For the coarse duplicates, the average of the original samples was 1.44% Li_2O, while the duplicates averaged 1.42% Li_2O, while the original pulp samples averaged 1.43% Li_2O, with the pulp duplicates also averaging 1.43% Li_2O.

Overall, 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, from September 18 to 23, 2018, from October 18 to 21, 2021 and from May 30 to June 1, 2022. 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 transmitted to SGS by Sigma as comma separated values (csv) files 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 SGS proprietary modelling and mineral resources estimation software (Genesis©), SGS conducted a second phase of data validation where any discrepancies were identified and removed from the database, after consultation and verification with Sigma geologists. Finally, SGS conducted random checks on approximately 5% of the assay certificates, to validate the assay values entered in the database.

Witness sampling was undertaken in 2017 on previously sampled mineralized intervals, with the remaining half core cut to quarter core, and the samples submitted to the SGS Lakefield lab for analysis. 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.

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.

1.10 MINERAL PROCESSING AND METALLURGICAL TESTING

1.10.1 Xuxa

Drill core samples from the Xuxa deposit were processed at the SGS Lakefield facility in 2018 and 2022, samples from the Barreiro deposit were tested between November 2020 and May 2021, and samples from the Nezinho do Chicao deposit in 2022. Work conducted on the Xuxa deposit samples included comminution, heavy liquid separation (HLS), REFLUX™ classifier, dense media separation (DMS) and magnetic separation. The Barreiro deposit test work program included sample characterization, grindability testing, HLS and DMS metallurgical test work. The Nezinho do Chicao deposit test work program included sample characterization, mineralogical analyses, HLS, DMS, and magnetic separation. Xuxa

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 test work. 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 resulted 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 mm/+6.3 mm), fines (-6.3 mm/+1.7 mm), ultrafines (-1.7 mm/+0.5 mm) and hypofines (-0.5 mm). The coarse, fines and ultrafines fractions of each variability sample were processed separately for lithium beneficiation. The REFLUX™ classifier (RC) 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, fines and ultrafines RC underflow streams of each variability sample were processed separately through DMS. The DMS concentrate from each fraction underwent dry magnetic separation 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 pass at a higher SG cut-point (ca. ~2.90) to generate spodumene concentrate. The coarse DMS middlings were re-crushed to -3.3 mm and a two stage HLS test was conducted. The ultrafines DMS test work flowsheet included both a single pass and a double pass DMS circuit at a high SG cut-point (~2.90) to generate spodumene concentrate.

The DMS test results demonstrated the ability to produce spodumene concentrate with >6% Li_2O in most of the tests. Based on the test work results, a lithium recovery of 60.4% was selected for plant design.

1.10.2 Barreiro

Four variability and one composite sample were tested for Barreiro, with the goals of the program to provide preliminary process information on the metallurgical performance of mineralized material from the Barreiro deposit. The test work program was developed based on the flowsheet developed for the Xuxa deposit. The aim of the test work program was to produce chemical grade spodumene concentrate (>6% Li_2O) with low iron content (<1% Fe_2O_3), while maximizing lithium recovery.

Two sets of HLS tests were undertaken. The first set was conducted using the Composite to test optimal crush size (i.e., top size of 15.9 mm, 12.5 mm, 10.0 mm, and 6.3 mm). HLS tests were then performed on each variability sample at the optimum crush size. The fine fraction (i.e., -0.5 mm) was screened out from each sub-sample and the oversize fraction was submitted for HLS testing. A crush size of -10 mm was determined to be optimal and variability HLS testing was undertaken at this crush size. Interpolated stage recoveries (6% Li_2O concentrate) for the four variability samples ranged from 56.0% to 77.3%.

In all four variability samples, HLS tests produced >6% Li_2O spodumene concentrate with low iron content (<1.0% Fe_2O_3).

Pilot-scale DMS test work was operated on the composite sample. Dry magnetic separation was undertaken on the DMS feed. DMS test work results showed combined spodumene concentrate grade of 6.11% Li_2O and stage recovery of 59.5% for a global recovery of 50.9%.

1.10.3 Nezinho do Chicao

Three variability samples and one composite sample were tested for Nezinho do Chicao (NDC), with the goal of the program to provide process information on the metallurgical performance of mineralized material from the NDC deposit. The test work program was developed based on the flowsheet developed for the Barreiro deposit. The aim of the test work program was to produce chemical grade spodumene concentrate (>5.5% Li_2O) with low iron content (<1% Fe_2O_3), while maximizing lithium recovery.

HLS tests were undertaken across four different crush sizes (i.e., top size of 15.9 mm, 12.5 mm, 9.5 mm, and 6.3 mm) to determine the optimum crush size, for each ore (high grade, medium grade and low grade). The fine fraction (i.e., -0.5 mm) was screened out from each sub-sample and the oversize fraction was submitted for HLS testing. A crush size of -9.5mm was determined to be optimal and variability HLS testing was undertaken at this crush size. Interpolated stage recoveries (5.5% Li_2O concentrate) for the three variability samples ranged from 58.7% to 61.4%, and the master composite a nominal 57.8%, for the 9.5mm crushed process step 1.54% Li_2O head grade.

Pilot-scale DMS test work was operated on the composite sample. Dry magnetic separation was undertaken on the DMS feed. DMS test work results showed combined spodumene concentrate grade with petalite 5.50% Li_2O and stage recovery of 58.7% for a global recovery of 50.6%.

1.11 MINERAL RESOURCE ESTIMATES

Mineral Resources for the Grota do Cirilo project 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 model used a 5 m x 3 m x 5 m block size and while the Barreiro, Murial, Lavra do Meio, Nezhino do Chicao, Maxixe, Tamboril and Elvira models 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, NDC and Murial models and the projection and Z-axis rescaling were done according to the mineralization orientation.

The grade interpolation for the Xuxa, Barreiro, NDC and Murial resource block models were completed using ordinary kriging (OK). The Lavra do Meio, Maxixe, Tamboril and Elvira models wer estimated using an inverse distance weighting to the second power (ID^2) 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.

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.

Conceptual economic parameters were used to assess the 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 combined Mineral Resource estimate for the Grota do Cirilo project is reported in Table 1-1, while the individual MREs for the different pegmatites are reported in Table 1-2 to Table 1-9 using a 0.3% Li_2O cut-off. The Mineral Resource estimates are constrained by the topography and are based on the conceptual economic parameters. The Xuxa estimate has an effective date of the 10th january 2019, the Barreiro estimate has an effective date of the 10th February 2022, and the NDC, Murial, Lavra do Meio, Maxixe, Tamboril and Elvira estimates have an effective date of the 18th January 2024. The QP for the estimates is Mr. Marc-Antoine Laporte, P.Geo., an SGS employee.

Table 1-1: Grota do Cirilo Complete Mineral Resource Estimate 18th January 2024

Cut-off Grade Li_2O (%)	Category	Tonnage (t)	Average Grade Li_2O (%)	LCE (Kt)
0.3	Measured	45.2	1.41	1,576
0.3	Indicated	49.1	1.39	1,688
0.3	**Measured + Indicated**	**94.3**	1.40	**3,265**
0.3	Inferred	14.6	1.37	495

Notes to accompany Mineral Resource table:

1. Mineral Resources have an effective date of the 18th January, 2024 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. All Resources are presented undiluted and in situ, constrained by continuous 3D wireframe models, and are considered to have reasonable prospects for eventual economic extraction.
3. Mineral Resources are reported assuming open pit mining methods, and the following assumptions: lithium concentrate (6% Li_2O) price of US$1,300/t, mining costs of US$2.2/t for mineralization and waste, crushing and processing costs of US$10.7/t, general and administrative (G&A) costs of US$4/t, concentrate recovery of 60%, 2% royalty payment, pit slope angles of 55º, and an overall cut-off grade of 0.3% Li_2O.
4. Tonnages and grades have been rounded in accordance with reporting guidelines. Totals may not sum due to rounding.
5. Mineral resources which are not mineral reserves do not have demonstrated economic viability. An Inferred Mineral Resource has a lower level of confidence than that applying to a Measured and Indicated Mineral Resource and must not be converted to a Mineral Reserve. It is reasonably expected that the majority of Inferred Mineral Resources could be upgraded to Indicated Mineral Resources with continued exploration.
6. The results from the pit optimization are used solely for the purpose of testing the “reasonable prospects for economic extraction” by an open pit and do not represent an attempt to estimate mineral reserves. The results are used as a guide to assist in the preparation of a Mineral Resource statement and to select an appropriate resource reporting cut-off grade.
7. The estimate of Mineral Resources may be materially affected by environmental, permitting, legal, title, taxation, socio-political, marketing, or other relevant issues.

Table 1-2: NDC Deposit Mineral Resource Estimate

Cut-off Grade Li_2O (%)	Category	Tonnes (Mt)	Average Grade Li_2O (%)	Contained LCE (Kt)
0.3	Measured	2.4	1.58	94
0.3	Indicated	31.2	1.43	1,103
0.3	**Measured + Indicated**	**33.6**	**1.45**	**1,205**

Table 1-3: Murial Deposit Mineral Resource Estimate

Cut-off Grade Li_2O (%)	Category	Tonnage (Mt)	Average Grade Li_2O (%)	LCE (Kt)
0.3	Measured	10.1	1.31	327
0.3	Indicated	3.4	1.07	90
0.3	**Measured + Indicated**	**13.5**	**1.25**	**417**
0.3	Inferred	2.6	1.29	83

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

Cut-off Grade Li_2O (%)	Category	Tonnage (Mt)	Average Grade Li_2O (%)	LCE (Kt)
0.3	Measured	3.0	1.16	86
0.3	Indicated	1.2	1.20	36
0.3	**Measured + Indicated**	**4.2**	**1.17**	**122**
0.3	Inferred	0.02	1.34	0.7

Table 1-5: Maxixe Deposit Mineral Resource Estimate

Cut-off Grade Li_2O (%)	Category	Tonnage (Mt)	Average Grade Li_2O (%)	LCE (Kt)
0.3	Measured	-	-	-
0.3	Indicated	-	-	-
0.3	**Measured + Indicated**	**-**	**-**	**-**
0.3	Inferred	1.6	1.35	53.4

Table 1-6: Tamboril Deposit Mineral Resource Estimate

Cut-off Grade Li_2O (%)	Category	Tonnage (Mt)	Average Grade Li_2O (%)	LCE (Kt)
0.3	Measured	-	-	-
0.3	Indicated	-	-	-
0.3	**Measured + Indicated**	**-**	**-**	**-**
0.3	Inferred	0.7	1.05	18.1

Table 1-7: Elvira Deposit Mineral Resource Estimate

Cut-off Grade Li_2O (%)	Category	Tonnage (Mt)	Average Grade Li_2O (%)	LCE (Kt)
0.3	Measured	-	-	-
0.3	Indicated	-	-	-
0.3	**Measured + Indicated**	**-**	**-**	**-**
0.3	Inferred	2.1	1.16	60.2

Notes to accompany Mineral Resource tables:

1. Mineral Resources have an effective date of the 18th January, 2024 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. All Resources are presented undiluted and in situ, constrained by continuous 3D wireframe models, and are considered to have reasonable prospects for eventual economic extraction.
3. Mineral Resources are reported assuming open pit mining methods, and the following assumptions: lithium concentrate (6% Li_2O) price of US$1,300/t, mining costs of US$2.2/t for mineralization and waste, crushing and processing costs of US$10.7/t, general and administrative (G&A) costs of US$4/t, concentrate recovery of 60%, 2% royalty payment, pit slope angles of 55º, and an overall cut-off grade of 0.3% Li_2O.
4. Tonnages and grades have been rounded in accordance with reporting guidelines. Totals may not sum due to rounding.
5. Mineral resources which are not mineral reserves do not have demonstrated economic viability. An Inferred Mineral Resource has a lower level of confidence than that applying to a Measured and Indicated Mineral Resource and must not be converted to a Mineral Reserve. It is reasonably expected that the majority of Inferred Mineral Resources could be upgraded to Indicated Mineral Resources with continued exploration.
6. The results from the pit optimization are used solely for the purpose of testing the “reasonable prospects for economic extraction” by an open pit and do not represent an attempt to estimate mineral reserves. There are no mineral reserves on the Property. The results are used as a guide to assist in the preparation of a Mineral Resource statement and to select an appropriate resource reporting cut-off grade.
7. The estimate of Mineral Resources may be materially affected by environmental, permitting, legal, title, taxation, socio-political, marketing, or other relevant issues.

Table 1-8: Xuxa Deposit Mineral Resource Estimate

Cut-off Grade Li_2O (%)	Category	Tonnage (Mt)	Average Grade Li_2O (%)	LCE (Kt)
0.3	Measured	10.2	1.59	401
0.3	Indicated	7.2	1.49	266
0.3	**Measured + Indicated**	**17.4**	**1.55**	**667**
0.3	Inferred	3.8	1.58	149

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. All Resources are presented undiluted and in situ, constrained by continuous 3D wireframe models, and are considered to have reasonable prospects for eventual economic extraction.
3. 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 0.3% Li_2O.
4. Tonnages and grades have been rounded in accordance with reporting guidelines. Totals may not sum due to rounding.
5. Mineral resources which are not mineral reserves do not have demonstrated economic viability. An Inferred Mineral Resource has a lower level of confidence than that applying to a Measured and Indicated Mineral Resource and must not be converted to a Mineral Reserve. It is reasonably expected that the majority of Inferred Mineral Resources could be upgraded to Indicated Mineral Resources with continued exploration.
6. The results from the pit optimization are used solely for the purpose of testing the "reasonable prospects for economic extraction" by an open pit and do not represent an attempt to estimate mineral reserves. The results are used as a guide to assist in the preparation of a Mineral Resource statement and to select an appropriate resource reporting cut-off grade.
7. The estimate of Mineral Resources may be materially affected by environmental, permitting, legal, title, taxation, socio-political, marketing, or other relevant issues.

Table 1-9: Barreiro Deposit Mineral Resource Estimate

Cut-off Grade Li_2O (%)	Category	Tonnage (t)	Average Grade Li_2O (%)	LCE (Kt)
0.3	Measured	19.5	1.38	665
0.3	Indicated	6.1	1.29	195
0.3	**Measured + Indicated**	**25.6**	**1.36**	**861**
0.3	Inferred	3.8	1.38	132

Notes to accompany Mineral Resource table::

1. Mineral Resources have an effective date of February 11, 2022 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. All Resources are presented undiluted and in situ, constrained by continuous 3D wireframe models, and are considered to have reasonable prospects for eventual economic extraction.
3. Mineral Resources are reported assuming open pit mining methods, and the following assumptions: lithium concentrate (6% Li_2O) price of US$1,500/t, mining costs of US$2.2/t for mineralization and waste, crushing and processing costs of US$10/t, general and administrative (G&A) costs of US$4/t, concentrate recovery of 60.7%, 2% royalty payment, pit slope angles of 52-55º, and an overall cut-off grade of 0.3% Li_2O.
4. Tonnages and grades have been rounded in accordance with reporting guidelines. Totals may not sum due to rounding.

5. Mineral resources which are not mineral reserves do not have demonstrated economic viability. An Inferred Mineral Resource has a lower level of confidence than that applying to a Measured and Indicated Mineral Resource and must not be converted to a Mineral Reserve. It is reasonably expected that the majority of Inferred Mineral Resources could be upgraded to Indicated Mineral Resources with continued exploration.
6. The results from the pit optimization are used solely for the purpose of testing the “reasonable prospects for economic extraction” by an open pit and do not represent an attempt to estimate mineral reserves. The results are used as a guide to assist in the preparation of a Mineral Resource statement and to select an appropriate resource reporting cut-off grade.
7. The estimate of Mineral Resources may be materially affected by environmental, permitting, legal, title, taxation, socio-political, marketing, or other relevant issues.

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

1.12.1 Xuxa Mineral Reserves

Xuxa Mineral Reserve estimates have an effective date of 26th of June 2021 and have been converted from Measured and Indicated Mineral Resources. The key parameters upon which the 26 June 2021 Mineral Reserve estimates were defined are summarized in Table 1-6.

Table 1-10: Parameters Used in Xuxa Pit Optimization

Item			Unit	Value
Revenue	Sales Price		US$/t conc.*	$1500.00
	Ore	Density	g/cm³	fixed in model
		Grade	% Li_2O	fixed in model
	Mining	Mine Recovering	%	fixed in model
		Dilution		fixed in model
	Block Model Dimensions	Block Dimensions	Unit	value
		X x Y x Z	m	5 x 3 x 5
	General Angle	Soil	º	34
		Saprolite		37.5
		Fresh Rock		Sector 1 – 72º Sector 2 – 50º
	Processing	Metallurgical Recovery**	%	60.7
		Mass Recovery***	%	Calculated in block
		Concentrated Grade	% Li_2O	6.0
		Cut-off	% Li_2O	0.5
Costs		Mining	US$/t mined	$2.20
		Processing	US$/t ore	$10.70
		G&A (Adjusted for OPEX)		$4.00
		Sale (2% cost of sale)	US$/t product	$14.66
		Royalties (CFEM 2%)		$14.66

Note: * conc. = concentrate, ** based on DMS Tests, *** Including 15% fines losses - FOB Mine

Proven and Probable Mineral Reserves are as presented in Table 1-7.

Table 1-11: Xuxa Mineral Reserves

Sigma FS Xuxa 5 x 3 x 5 (m) Block Dimensions 97% Mine Recovery, 3.75% Dilution (Effective date: 6/26/2021)			
Classification	**Tonnage (Mt)**	**Li_2O(%)**	**LCE(Kt)**
Proven	8.34	1.55	319.7
Probable	3.46	1.54	131.8
Total	11.80	1.55	451.5

Notes to accompany Mineral Reserves table:

1. *Mineral Reserves were estimated using Geovia Whittle 4.3 software and following the economic parameters listed below:*
2. *Sale price for Lithium concentrate at 6% Li_2O = US$1,500/t concentrate FOB Mine*
3. *Exchange rate US$1.00 = R$5.00.*
4. *Mining costs: US$2.20/t mined.*
5. *Processing costs: US$10.7/t ore milled.*
6. *G&A: US$4.00/t ROM (run of mine).*
7. *Mineral Reserves are the economic portion of the Measured and Indicated Mineral Resources.*
8. *97% Mining Recovery and 3.75% Mining Dilution*
9. *Final slope angle: 34° to 72° based on Geotechnical Document presented in Section 16.*
10. *Inferred Mineral Resources with the Final Operational Pit is 0.68 Mt grading at 1.52% Li_2O. The Inferred Mineral Resources are not included in the Mineral Reserves.*
11. *Strip Ratio = 16.6 t/t (waste+Inferred mineral resources)/mineral reserves.*
12. *The Qualified Person for the estimate is Porfírio Cabaleiro Rodriguez, BSc. (MEng), FAIG, an employee of GE21..*

1.12.2 Barreiro Mineral Reserves

The Barreiro Mineral Reserve estimates have an effective date of February 24, 2022 and have been converted from Measured and Indicated Mineral Resources. The key parameters upon which the February 24, 2022 Mineral Reserve estimates were defined are summarized in Table 1-8.

Table 1-12: Parameters Used in Barreiro Pit Optimization

Item			Unit	Value
Revenue	Sales Price		US$/t conc.*	$1,500
	Ore	Density	g/cm^3	Block model
		Grade	% Li_2O	Block model
	Mining	Mine Recovering	%	Block model
		Dilution		Block model
	Block Model Dimensions	Block Dimensions	Unit	value
		X x Y x Z	m	5 x 5 x 5
	General Angle	Overburden	º	Sector 1 – 35º Sector 2 – 37º
		Fresh Rock		Sector 1 – 55º Sector 2 – 52º
	Processing	Metallurgical Recovery**	%	60.0
		Mass Recovery***	%	Calculated in block
		Concentrated Grade	% Li_2O	6.0
		Cut-off	% Li_2O	0.5
Costs		Mining	US$/t mined	$2.19 (Ore)/$1.88 (Waste)
		Processing	US$/t ore	$10.70
		G&A (Adjusted for OPEX)		$4.00
		Sale (2% cost of sale)	US$/t product	$14.66
		Royalties (CFEM 2%)		$14.66

Note: * conc. = concentrate, ** based on DMS Tests, *** Including 15% fines losses - FOB Mine

Proven and Probable Mineral Reserves are as presented in Table 1-9.

Table 1-13: Barreiro Mineral Reserves

Sigma PFS Barreiro 5 x 5 x 5 (m) Block Dimensions 97% Mine Recovery, 3.00% Dilution (Effective date: 2/24/2022)			
Classification	**Tonnage (Mt)**	**Li_2O(%)**	**LCE(Kt)**
Proven	16.93	1.38	576.8
Probable	4.83	1.29	153.1
Total	**21.76**	**1.36**	**729.9**

Notes to accompany Mineral Reserves table:

1. *Mineral Reserves were estimated using Geovia Whittle 4.3 software and following the economic parameters listed below:*
2. *Sale price for Lithium concentrate at 6% Li_2O = US$1,500/t concentrate FOB Mine.*
3. *Exchange rate US$1.00 = R$5.00.*
4. *Mining costs: US$2.19/t mined.*
5. *Processing costs: US$10.7/t ore milled.*
6. *G&A: US$4.00/t ROM (run of mine).*
7. *Mineral Reserves are the economic portion of the Measured and Indicated Mineral Resources.*
8. *97% Mine Recovery and 3% Mine Dilution*
9. *Final slope angle: 35° to 55° based on Geotechnical Document presented in Section 16.*
10. *Inferred Mineral Resources with the Final Operational Pit is 0.59 Mt grading at 1.32% Li_2O. The Inferred Mineral Resources are not included in the Mineral Reserves.*
11. *Strip Ratio = 12.5 t/t (waste+Inferred mineral resource)/mineral reserve.*
12. *The Qualified Person for the estimate is Porfírio Cabaleiro Rodriguez, BSc. (MEng), FAIG, an employee of GE21.*

1.12.3 Nezinho do Chicao Mineral Reserves

Nezinho do Chicao (NDC) Mineral Reserve estimates have an effective date of 31st October 2022 and have been converted from Measured and Indicated Mineral Resources, as prepared by SGS Geological Services (SGS Canada). The key parameters upon which the Mineral Reserve estimates were defined are summarized in Table 1-10.

Table 1-14: Parameters Used in NDC Pit Optimization

<table>
<tr><th colspan="3">Item</th><th>Unit</th><th>Value</th></tr>
<tr><td rowspan="18">Revenue</td><td rowspan="2">Financial Parameters</td><td>Sales Price</td><td>US$/t conc</td><td>3500</td></tr>
<tr><td>Discount rate</td><td>%</td><td>10</td></tr>
<tr><td rowspan="2">ROM</td><td>Density</td><td>g/cm³</td><td>model</td></tr>
<tr><td>Grades</td><td>% Li₂O</td><td>model</td></tr>
<tr><td rowspan="2">Mining</td><td>Mining Recovery</td><td rowspan="2">%</td><td>model</td></tr>
<tr><td>Dilution</td><td>model</td></tr>
<tr><td rowspan="4">Block Model</td><td>Block dimensions</td><td>Unit</td><td>Value</td></tr>
<tr><td>X</td><td rowspan="3">m</td><td>5</td></tr>
<tr><td>Y</td><td>3</td></tr>
<tr><td>Z</td><td>5</td></tr>
<tr><td rowspan="2">Overall Slope Angle</td><td>Overburden</td><td rowspan="2">º</td><td>35</td></tr>
<tr><td>Fresh Rock</td><td>52</td></tr>
<tr><td rowspan="4">Processing</td><td>Metallurgical Recovery DMS**</td><td>%</td><td>60.7</td></tr>
<tr><td>Mass Recovery</td><td>%</td><td>Calculated for each block</td></tr>
<tr><td>Concentrate Grade</td><td>% Li₂O</td><td>6</td></tr>
<tr><td>Cut-off Grade (fixed by program)</td><td>% Li₂O</td><td>0.5</td></tr>
<tr><td colspan="2" rowspan="5">Costs</td><td>Mining</td><td>US$/t mined</td><td>2.43</td></tr>
<tr><td>Processing</td><td rowspan="2">US$/t ROM</td><td>10.7</td></tr>
<tr><td>G&A</td><td>4</td></tr>
<tr><td>Sales (2% sales cost)</td><td rowspan="2">US$/t product</td><td>14.66</td></tr>
<tr><td>Royalties (CFEM 2%)</td><td>14.66</td></tr>
</table>

Note: * conc. = concentrate, ** based on DMS Tests, *** Including 15% fines losses - FOB Mine

Proven and Probable Mineral Reserves are as presented in Table 1-11.

Table 1-15: Nezinho do Chicao Mineral Reserves

Sigma PFS Nezinho do Chicão 5 x 3 x 5 (m) Block Dimensions 94% Mine Recovery, 3% Dilution (Effective date: 10/30/2022)			
Classification	**Tonnage (Mt)**	**Li_2O(%)**	**LCE(Kt)***
Proven	2.17	1.53	82.1
Probable	19,02	1.44	677.3
Total	**21.19**	**1.45**	**759.4**

*Lithium Carbonate Equivalent

Notes to accompany Mineral Reserves table:

1. *Mineral Reserves were estimated using Geovia Whittle 4.3 software and following the economic parameters listed below:*
2. *Sale price for Lithium concentrate at 6% Li_2O = US$3,500/t concentrate FOB Mine.*
3. *Mining costs: US$2.43/t mined.*
4. *Processing costs: US$10.7/t ore milled.*
5. *G&A: US$4.00/t ROM (run of mine).*
6. *Exchange rate US$1.00 = R$5.30.*
7. *Mineral Reserves are the economic portion of the Measured and Indicated Mineral Resources.*
8. *94% Mine Recovery and 3% Mine Dilution*
9. *Final slope angle: 35° to 52° based on Geotechnical Study conducted by Itaaçu.*
10. *Strip Ratio = 16.01 t/t (waste)/mineral reserve.*
11. *The Competent Person for the estimate is Porfírio Cabaleiro Rodriguez, BSc. (MEng), FAIG, an employee of GE21.*

1.13 MINING METHODS

Sigma has undertaken a program of resource drilling for the Xuxa, Barreiro and NDC deposits. Most 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.

1.13.1 Xuxa

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

- Two independent open pits areas: Pit 1 in the north (Xuxa Pit #1) and Pit 2 in the south (Xuxa Pit #2)
- Single access from both pits to the mine infrastructure pad and the processing plant
- Pit wall 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
- Pit 1 and Pit 2 mined in conjunction from Year 1 to Year 8 to reduce the drop-down rate and to facilitate the 1.5 Mtpa production rate
- The planned open pit mine life is eight years
- The mining fleet is based on road trucks operated by a mining contractor.

1.13.2 Barreiro

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

- A single open pit on the Barreiro pegmatite
- Low height mineralized material benches to reduce mine dilution and maximize mine recovery
- Pre-splitting of the mineralized material to reduce mine dilution
- Elevated inter-ramp angles for the waste to reduce strip ratio

The basis for the scheduling includes:

- Pit wall pre-stripping the pit to liberate mineralized material
- Pit push-backs in years 4 to 6 to expand and allow deepening of the pit
- Mining at a rate of 1.80 Mtpa
- The planned open pit mine life is 12 years
- The mining fleet is based on road trucks operated by a mining contractor.

1.13.3 Nezinho do Chicao

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
- Low height mineralized material benches to reduce mine dilution and maximize mine recovery
- Pit wall pre-splitting of the mineralized material to reduce mine dilution
- Elevated inter-ramp angles for the waste to reduce strip ratio

The basis for the scheduling includes:

- Mining at a rate of 1.80 Mtpa
- The planned open pit mine life is 12 years

The mining fleet is based on road trucks operated by a mining contractor.

1.14 RECOVERY METHODS

The processing plant was designed to produce a target 6.0% Li_2O spodumene concentrate from an ore grade of 1.46% Li_2O (diluted) DMS.

A second DMS concentrator plant would be constructed to process Barreiro ore. This plant would produce a minimum 6.0% Li_2O spodumene concentrate from an ore grade of 1.39% Li_2O (diluted).

With the integration and proposed new development of the NDC mine, the wholistic mining strategy and operational strategy will be designed around a combined Phase 2 & 3 process facility.

Compared to Xuxa and Barreiro ores, the NDC ore does not respond as well due to different lithium deportment and mineralogy, so when processed the target concentrate grade drops to a nominal 5.5% contained lithium concentrate as spodumene and petalite from an ore grade of 1.44% Li_2O (diluted).

1.14.1 Processing Plant Description

The throughput capacity for the Phase 1 processing plant is based on 1.7 Mtpa (dry) of ore fed to the crushing circuit, while the proposed expansion for the Phase 2 & 3 is based on a nominal capacity of 3.9Mtpa.

The processing plants are designed based on a proven DMS circuit and include conventional three-stage crushing and screen circuit, up-flow classification for mica removal, two-stage coarse DMS circuit, two-stage fines DMS circuit, two-stage ultrafines circuit, as well as magnetic separation on the fines and ultrafines DMS concentrate final product streams.

When NDC ore is treated through the extension of the processing plant, a third DMS circuit is proposed, to recover additional lithium units as petalite from the spodumene DMS float stream. The sinks from this circuit reports to the tailings, while the floats (petalite) report to the spodumene stockpile.

Front-End Engineering Design (FEED) was completed for the processing plant. Xuxa design data is based on feasibility-level metallurgical test work conducted at SGS Canada Inc. in Lakefield, Ontario. The mass balance, process design criteria and process flow diagrams were developed based on these test work data.

Design of the combined Barreiro and NDC concentrator is based on PFS-level test work conducted by SGS Canada Inc. in Lakefield, Ontario.

1.14.2 Design Criteria and Utilities Requirements

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

The Phase 1 raw water consumption for process water is nominal a 35 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 Xuxa project infrastructure has been 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.

If developed, the Phase 2 & 3 project will utilise the infrastructure developed for the Xuxa project.

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

Access to the processing plant will be by municipal roads linking to the federal road BR367. The current municipal road will be suitable for truck traffic. Sigma constructed a new section of the municipal road to bypass the plant, duly authorized by the municipality of Itinga.

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

At Xuxa, waste rock will be stored in five waste piles in the vicinity of the Xuxa pits. Geotechnical studies determined an optimal bench height of 20 m, with a face angle of 38°. The access ramps will be 12 m wide, with a maximum gradient of 10%.

Table 1-12 shows the capacities of the Xuxa waste piles.

Table 1-16 – Xuxa Waste Pile Storage

Designed Pile	Volume (Mm^3)	Area (ha)
Pile 1	16.2	35.9
Pile 2	15.1	34.1
Pile 3	1.8	8.7
Pile 4	35.9	55.8
Pile 5	2.4	8.3
TOTAL	***71.4***	**142.8**

The Barreiro waste will be stored in a single waste pile close to the Barreiro pit. The waste pile parameters are the same as the Xuxa parameters – a 20 m bench height, 38° face angle, 12 m access ramp and a maximum gradient of 10%.

Table 1-13 show the capacity of the Barreiro waste pile.

Table 1-17: Barreiro Waste Pile Storage

Waste Pile	Value
Volume (Mm^3)	110.9
Area (ha)	122.7
Maximum height (m)	220

The NDC waste will be stored in a single waste stockpile adjacent to the NDC pit. The waste pile parameters are the same as those for Xuxa and Barreiro, namely a 20 m bench height, 38° face angle, 12 m access ramp and a maximum gradient of 10%.

Table 1-14 show the capacity of the NDC waste pile.

Table 1-18: NDC Waste Pile Capacity and Surface Area

Waste Pile	Value
Volume (Mm^3)	162.5
Area (ha)	158.8
Maximum height (m)	225

The tailings stockpile will be fed by a radial stacker from the process plant. The tailings will then be loaded into mine trucks by front end loaders and transported to a tailings pile for storage.

1.15.3 Control Systems and Communication

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

The telecommunications network will consist of the telecommunications network, access control system and radio frequency identification (RFID).

1.16 MARKET STUDIES AND CONTRACTS

The key information contained in the market study regarding lithium demand, supply and price forecasts are summarized from Benchmark Mineral Intelligence (2022).

1.16.1 Demand and Consumption

Lithium's demand growth profile increased dramatically in 2022, driven by structural changes in the automotive industry with manufactures increasingly transitioning towards electric vehicles ("EVs"). Benchmark Mineral Intelligence estimates that 2022 will end in a deficit position with total base-case battery demand expected to end the year at 591 GWh, translating to 475 kt of lithium carbonate equivalent ("LCE") demand, up from 348kt LCE in 2022. Total lithium demand in 2022 expected to be 613 kt of LCE vs 482 kt in 2021.

Benchmark Mineral Intelligence estimates that the supply-demand balance will tighten further going forward, with 2023 forecasted to have a base case demand from battery end-use of 630 kt LCE, a 33% increase from 2022. This deficit position is expected to continue to increase, reaching a net deficit position of 159 kt LCE by 2030 and 2,580 kt LCE by 2040.

Benchmark Mineral Intelligence estimates global EV penetration will reach 12.4% in 2022, up from 8.0% in 2021, as global EV sales continue to accelerate, particularly from Europe and China. This figure is expected to climb to 21% by 2025 and reach 74% by 2040.

1.16.2 Supply

Benchmark Mineral Intelligence expects lithium supply to increase over the 634 kt LCE of total supply estimated in 2022, given the robust commodity price outlook for lithium.

In the longer term, Benchmark Mineral Intelligence forecasts that the total lithium supply will reach 2.1 Mt LCE by 2030 and 3.0Mt LCE by 2040. Benchmark Mineral Intelligence's supply forecast includes expansions from existing mines as well as new entrants developing pre-production projects.

1.16.3 Price Forecast

Tight market supply combined with rapidly improving demand for lithium chemicals is expected to put continued strong upward pressure on prices. Benchmark Mineral Intelligence's base case forecast expects prices to continue to rise through 2023 as demand outstrips supply with real lithium hydroxide and spodumene 6% prices hitting US$55,900/t and US$5,100/t in 2023, respectively. Benchmark then expects prices to stabilize at higher levels in 2024 and begin to decline to more stable levels in a balanced supply-demand market in 2025.

1.16.4 Contracts

1.16.4.1 Operational Contracts

In June, 2022, SMSA entered into a Letter of Intent with Fagundes Construção e Mineração S.A. ("Fagundes") to provide mining services to SMSA for its pre-stripping phase, as well as its operational phase, including the supply of all equipment for such works. The definitive agreement was signed in June 2023. In August 2022, SMSA entered into a Letter of Intent with IBQ Indústrias Químicas S.A. ("Enaex") for the supply of explosives and the handling of such explosives for SMSA's mining works. The definitive agreement was signed in December 2023. Fagundes and Enaex are currently the ultimate service providers and suppliers for all mining activities of SMSA.

In May 2023, SMSA entered into an agreement with Multilift Logística Ltda. ("Multilift"), to provide services pertaining storage and port handling. In June and December 2023, SMSA also entered into agreements pertaining transport of goods to the ports with G7 Log Transported Ltda. ("G7") and D'Granel Transportes e Comércio Ltda. ("D'Granel"), respectively.

Any future contracts are likely to be negotiated and renewed on an annual or bi-annual basis. Contract terms are expected to be typical of similar contracts in Minas Gerais State.

1.16.4.2 Construction contracts

SMSA has signed an agreement for the EPCM of the Production Plant and associated infrastructure with Promon. The detail engineering is progressing according to priority and both companies started issuing construction drawings according to the schedule baseline. Procurement services according to the Procurement Plan defined in the FEED. Construction Management includes general scheduling, managing all items, generating weekly dash boards, preparing presentations with critical points, preventive and corrective actions in order to reach the project deadlines.

In April 2022, SMSA signed an agreement for the civil construction of the Phase 1 Greentech Plant with engineering firm Tucumann Engenharia e Empreendimentos Ltda. The scope of work includes all civil construction works and services for the implementation of the Project, including the supply of materials, commissioning, provision of documentation, topographic survey services, excavations, shallow foundations, concrete structures, buildings, paving, streets, urbanization and landscaping and rainwater drainage and spare parts.

In March 2022, SMSA signed an agreement for the construction of a substation and the displacement of an existing transmission line with Tecnova Engenharia Ltda. The scope of work includes all civil construction, electromechanical and electrical assembly works and services for the implementation of the including, the civil project, the electrical project, the electromechanical project, the supply and installation of materials, structures and equipment, as well as commissioning, supply of documentation as built of the civil, electromechanical and electrical works, considering all the technical information informed by CEMIG.

In July 2022, SMSA signed an agreement for the construction of a laboratory with SGS Geosol. The scope of work includes all work for the management of the assembly of the SMSA's internal laboratory and implementation, including the electrical project, the electromechanical project (including, but not limited to, the drawings, layouts, technical specifications, bills of materials, calculation memorials and documents), hydraulic design, supply and installation of materials, structures and equipment, as well as commissioning, start-up, supply of "as built" documentation of the projects, electromechanical, hydraulic and electrical, and all other services necessary for the execution of the scope of work.

In July 2022, SMSA signed an agreement for the electromechanical assembly of the Phase 1 Greentech Plant with PAREX Engenharia S.A. The scope of work includes all assembly of the Phase 1 Greentech Plant, and the supply of materials for such scope of works.

SMSA is in negotiation with respect to the construction contracts for Phase 2.

1.17 ENVIRONMENTAL STUDIES, PERMITTING AND SOCIAL OR COMMUNITY IMPACT

Conselho Estadual de Politica Ambiental (COPAM) granted an Operation License (LO) to SMSA for commercial production and sale in March 2023 for the Xuxa's Pit #1 (North Pit) and in April 2023 for the Xuxa's Pit #2 (South Pit)..

On August 17, 2022, Sigma applied for the permitting of the environmental license for the Barreiro mine and waste piles. The environmental license for the subsequent phases will solely contemplate the license of the deposits and of its waste piles.

SMSA 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 project. The PAE for Xuxa was updated and approved in August 2018, while the PAE for Barreiro was updated and approved in July 2022.

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 Study (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 Licence (LP), a concurrent Preliminary and Installation License (LP + LI), and/or a concurrent Preliminary, Installation and Operational License (LP + LI + LO).

1.17.2 Xuxa Project Environmental Permitting Status

SMSA has a definitive water license for the uptake of 150 m³/hr of water from the Jequitinhonha River approved by the Agencia Nacional das Águas (ANA) in January 2019. The water usage license is valid for 10 years, which is expected to be sufficient for the life-of mine (LOM) requirements for mining and product processing from Xuxa.

The LP + LI for the first phase of the project, consisting of Xuxa's Pit #1, waste piles #1 and #2 and the construction of the processing plant was submitted on December 20, 2018 followed by the EIS, the EIR and other mandatory documents. The EIS and Environmental Control Plan (Plano de Controle Ambiental – PCA) dated December 2018 were prepared by NEO Soluções Ambientais and ATTO GEO Geologia e Engenharia. The LP+LI for Xuxa Pit #1, Piles #1 and #2 and the processing plant was obtained on June 3, 2019.

A second EIS covering Xuxa's Pit #2 and waste piles #3, #4 and #5 was formally approved in July 2022. On November 16, 2022, SMSA filed its request for the permitting of the operational license (LO) for Xuxa's Pit#1 and areas and processing plant, which was obtained in March 2023; and, on January 23, 2023, SMSA filed its request for the permitting of Xuxa's Pit #2 areas. The operational license (LO) for Xuxa's Pit #2 and waste piles #3, #4 and #5 was obtained in April 2023.

On August 17, 2022, SMSA applied for the environmental license for the Barreiro Mine and waste piles.

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 PAE was registered with the National Mining Agency (ANM), which was approved on November 16, 2018.

The approval of the PAE and environmental study involves the technical and legal analysis and formal approval of the proposed project. With the granted LP + LI, SMSA has commenced the installation of the project, complied and continues to comply with the environmental conditions established in the LP + LI certificate and finally, applied for and obtained the Operation License for Xuxa Pit #1 as well as for Xuxa Pit #2 (Phase 1) and for Increase of Production Plant.

The formalization of the environmental licensing process also included the filing of an Environmental Impact Study (Estudo de Impacto Ambiental or EIA) and an Environmental Impact Report (Relatório de Impacto Ambiental or RIMA).

1.17.4 Land Access

Sigma entered into right-of-way agreements with Miazga and third-party surface rights owners of the Project, to carry out mining activities on its properties. These farms include Legal Reserves (LR) which are preserved and registered in the Sistema Nacional de Cadastro Ambiental Rural (SICAR), in accordance with Law Nº 12.651, dated May 25, 2012.

SMSA has a mining easement (Servidão Mineral) with a total of 413.3 hectares and aims to cover the areas of waste and tailings piles, production plant, all access roads (internal), electrical substation, installation of fueling station and support structures. The Servidão Mineral was published in the Official Gazette of the Federal Government. It contemplates the mining and processing activities of the Xuxa deposit (ANM Process No. 824.692/1971).

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 considered one of the poorest region in Minas Gerais which is plighted by poverty and is in the lowest quartile the Human Development Index (HDI). Sigma is one of the largest investors and operators in the area and the project will be transformational to the local communities. The largest direct economic benefit is that Sigma is subject to a 2% CFEM 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. Studies identified that 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

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.

1.17.7 Increase of Production Plant (UTM)

On June 16, 2023, Sigma filed at SUPPRI (the Priority Projects Superintendence of Minas Gerais) the environmental studies, including, among others, the Environmental Control Report (Relatório de Controle Ambiental - RCA) for the permitting of the LP+LI+LO for the increase of Volumes of Production Plant for the production of 3,700,000 t/year. The construction, installation and operation license was obtained in January 26, 2024.

1.17.8 Barreiro Environmental Work to Date

On August 17, 2022, the Company filed at SUPPRI (the Priority Projects Superintendence of Minas Gerais) the environmental studies, including, among others, the EIS and EIR (Barreiro EIS/EIR) for the permitting of the LP+LI+LO for the Barreiro deposit and its waste piles. Once the EIS/EIR is approved by the environmental authorities, SMSA will be authorized to commence the construction, installation and operation of the Barreiro deposit.

1.17.9 NDC Environmental Work to Date

The EIS and EIR for NDC deposit, jointly with other mandatory documents, will be submitted to –SUPPRI for the permitting of the LP+LI+LO.

The environmental licensing process began in December 2022 and was formalized on August 10, 2023, with the presentation of technical studies for the production of 1,700,000 t/year for open pit mining and 182. 2 ha for waste piles.

1.18 CAPITAL AND OPERATING COSTS

1.18.1 Capital Cost Estimate

The capital cost estimate (CAPEX) was developed to provide substantiated costs for the FEED study of Phase 1 and the PFS-level study of Phase 2 & 3 processing plant and to provide Sigma with an overall risk and opportunity profile to enable a Phase 1 production decision and to advance off-take agreements and project financing.

The total CAPEX for Phase 1 including the Estimated Vat Tax Incentive is US$130.6 M.

The total Capex for Phase 2 & 3 is US$154.9 M (this is including the Owner's cost, working capital, contingency and excluding the Sustaining Capital).

The CAPEX estimate has an accuracy of ±25% and is summarized in Table 1-15 (Phase 1) and Table 1-16 (Phase 2 & 3).

Table 1-19 – Capital Cost Estimate Summary Phase 1

AREA	TOTALS (USD)		
	DIRECTS + INDIRECTS (USD)	CONTINGENCY (USD)	TOTAL (USD)
001 MINE	7,856,938	605,014	8,461,952
002 PLANT	64,841,255	4,992,777	69,834,032
002.003 AUTOMATION/DIGITALIZATION	3,852,981	296,680	4,149,661
003 ENVIRONMENTAL	14,418,492	1,121,428	15,539,921
004 EPCM & ENGINEERING SERVICES	17,867,543	1,375,801	19,243,344
005 SUBSTATION & UTILITY POWER SUPPLY	6,888,863	530,442	7,419,305
Total Construction Capital Cost	111,873,091	8,625,462	120,498,553
006 OWNERS PROJECT COSTS	8,901,677	890,168	9,791,844
007.001 Working Capital and Spares	6,137,293	–	6,137,293
Total Construction Capital Cost (ex VAT Tax Incentive)	126,912,061	9,515,630	136,427,691
009 Estimated VAT Tax Incentive	(5,859,000)	–	(5,859,000)
Total Construction Capital Cost	121,053,061	9,515,630	130,568,691
008 Sustaining and Deferred Capital	3,200,000	246,400	3,446,400

Table 1-20: Capital Cost Estimate Summary Phase 2 & 3

AREA	TOTALS		
	(USD)		
MEGA PLANT	DIRECTS + INDIRECTS	CONTINGENCY	TOTAL
	(USD)	(USD)	(Excluding recoverables)
			(USD)
000 MEGA (Excluding Sustaining Capital)	144,429,471	10,473,002	154,902,473
000 MEGA (Including Sustaining Capital)	157,499,471	11,479,392	168,978,863
001 MINE	2,096,208	161,408	2,257,616
002 PLANT	89,536,397	6,718,807	96,255,204
003 ENVIRONMENTAL	15,252,504	1,174,443	16,426,946
004 EPCM & ENGINEERING SERVICES	21,672,011	1,668,745	23,340,755
005 SUBSTATION & UTILITY POWER SUPPLY	663,829	51,115	714,943
006 OWNERS PROJECT COSTS	9,071,230	698,485	9,769,715
007 WORKING CAPITAL & SPARES	6,137,293	0	6,137,293
008 SUSTAINING & DEFERRED CAPITAL	13,070,000	1,006,390	14,076,390

Note: The Phase 2 & 3 substation costs are included in the Xuxa CAPEX estimate

1.18.2 Operating Cost Estimate

The processing plant operating cost estimate includes the operation of a three-stage crushing and screening circuit and DMS circuits (two stages for coarse, fine and ultra fines material classes).

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 variable OPEX for the Phase 1 concentrator will be $5.3/t of ore feed and US$7.5M of fixed OPEX. The estimated variable OPEX for the Phase 2 & 3 concentrator is $4.8/t of ore feed and US$6.7M of fixed OPEX.

Operating cost estimates are summarized in Table 1-17 (Phase 1) and Table 1-18 (Phase 2 & 3)

Table 1-21: Phase 1 Operating Cost Estimate Summary

DESCRIPTION	OPEX (US$)
Mining (US$/t material mined)	$2.1
Process (US$/t ore feed)	$10.4
G&A (US$/t ore feed)	$5.3
Shipping (US$/t SC)	$120

Table 1-22: Phase 2 & 3 Operating Cost Estimate Summary

DESCRIPTION	OPEX (US$)
Barreiro Mining (US$/t material mined)	$2.68
NDC Mining (US$/t material mined)	$1.98
Phase 2 & 3 Process (US$/t ore feed)	$7.1
Phase 2 & 3 G&A (US$/t ore feed)	$2.7
Shipping (US$/t SC)	$120

1.19 ECONOMIC ANALYSIS

1.19.1 Economic Assumptions

Three levels of economic analyses were undertaken for the Project, contemplating the mining of the Mineral Reserves of:

- the Xuxa deposit (Phase 1)

- the Barreiro and NDC deposits (Phase 2 & 3) and
- both Phase 1 and Phase 2 & 3 (Phase 1, 2 & 3)

The Phase 1, 2 & 3 analysis has been selected as the best growth and integrated plan for the Grota Do Cirilo Project.

The economic analyses contemplate the production of spodumene concentrate (SC) at grades of 5.5% Li_2O, in line with the current lithium market conditions.

The base case scenario after-tax net present value (NPV) results are detailed in Table 1-19 below. The discount rate assumed for the after-tax NPVs is 8%.

A sensitivity analysis reveals that the Project's viability will not be significantly vulnerable to variations in capital expenditures, within the margins of error associated with the DFS and study estimates for Phase 1 and Phase 2 & 3, respectively. In contrast, the Project's economic returns remain most sensitive to changes in spodumene prices, feedstock grades and recovery rates.

Table 1-23 – Base Case After-Tax NPVs

MODELLED CASE	UNIT	@ 5.5% SC
Phase 1	US$ M	$5,699
Phase 2 & 3	US$ M	$9,587
Phase 1, 2 & 3	**US$ M**	**$15,289**

Phase 1, Phase 2 & 3 and Phase 1, 2 & 3 were 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 analyses 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 stimulating 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). For Phase 2 & 3, the Sudene tax incentive is expected to be renewed after the 10th anniversary of achieving at least 20% of their production capacities.

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%).

- A 1.0% NSR royalty with permissible deductions from gross spodumene revenue including the CFEM royalty, any commercial discounts, transportation costs and taxes paid.

1.19.2 Phase 1 DFS Economic Analysis

The Phase 1 economic analysis is based on an eight-year operation sourcing feedstock ore from the Xuxa deposit's Mineral Reserve of 11.8 Mt grading at 1.55% Li_2O. Phase 1 is expected to generate run-rate production of 270 ktpa of lithium concentrate, delivering US$990 million of annual free cash flow, at a 5.5% SC grade.

The base case scenario results are detailed in Table 1-20 below.

Table 1-24: Phase 1 Base Case Scenario Results

ITEM	UNIT	@ 5.5% SC
After-Tax NPV @ 8%	US$ M	$5,699
After-Tax IRR	%	1,282%
After-Tax Payback Period	Years	0.1

The key technical assumptions used in the base case are highlighted below in Table 1-21.

Table 1-25: Key Phase 1 Technical Assumptions

ITEM	UNIT	@ 5.5% SC
Total Ore Processed (ROM)	Mt	11.8
Annual ROM Ore Processed	Mt	1.5
Run-Rate SC Production	Ktpa	270
Run-Rate LCE Production (Note 1)	Ktpa	37
Strip Ratio	Ratio	16.4: 1
Average Li_2O Grade	%	1.55%
Spodumene Recovery Rate	%	65.0%
Spodumene Concentrate Grade	% Li_2O	5.5%
Operating Life	Years	8
Total Cash Cost Ex. Royalties (@ Mine Gate)	US$/t SC	$288
Total Cash Cost Incl. Royalties (@ Mine Gate)	US$/t SC	$419
Transportation Costs (CIF China)	US$/t SC	$120
Total Cash Cost (CIF China)	US$/t SC	$539
AISC (CIF China)	US$/t SC	$541
Mining Costs	US$/t Material Mined	$2.06
Processing Costs	US$/t ROM	$10.38
G&A Costs	US$/t ROM	$5.29

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

The total gross revenue derived from the sale of spodumene concentrate is estimated at US$10.6 billion, an average revenue of US$4,909/t 5.5% SC with total operating costs (including royalty payments and commercial discounts) of US$1.3 billion at an average cost of US$581/t 5.5% SC. The resulting after-tax earnings margin (gross revenue less realization, operating costs and taxes) was estimated at US$7.9 billion.

A sensitivity analysis for Phase 1 was carried out with the base case as the midpoint. An interval of ±20% versus base case values was considered with increments of 10%.

Phase 1 after-tax NPV is not significantly vulnerable to changes in BRL to US$ exchange rate, CAPEX, OPEX, or discount rate considered. In contrast, Phase 1 after-tax NPV is more sensitive to variation in spodumene price, lithium grade, and spodumene recovery rates.

Phase 1 after-tax IRR is not significantly vulnerable to changes in OPEX. In contrast, Phase 1 after-tax IRR is more sensitive to variation in spodumene price, lithium grade, spodumene recovery rates, BRL to US$ exchange rate and CAPEX. Note that the Phase 1 after-tax IRR is independent of the discount rate considered.

1.19.3 Phase 2 & 3 PFS Economic Analysis

The Phase 2 & 3 PFS economic analysis is based on a twelve-year operation sourcing feedstock ore from the Barreiro deposit's Mineral Reserve of 21.8 Mt grading at 1.37% Li_2O and the NDC deposit's Mineral Reserve of 21.2 Mt grading at 1.45% Li_2O. Phase 2 & 3 is expected to generate run-rate production of 496 ktpa of lithium concentrate, delivering US$1,179 M of annual free cash flow, at a 5.5% SC grade.

The base case scenario results are detailed in Table 1-22 below.

Table 1-26: Phase 2 & 3 Base Case Scenario Results

ITEM	UNIT	@ 5.5% SC
After-Tax NPV @ 8%	US$ M	$9,587
After-Tax IRR	%	1,207%
After-Tax Payback Period	Years	0.1

The key technical assumptions used in the base case are highlighted below in Table 1-23.

Table 1-27: Key Phase 2 & 3 Technical Assumptions

ITEM	UNIT	@ 5.5% SC
Total Ore Processed (ROM)	Mt	42.9
Annual ROM Ore Processed	Mt	3.3
Run-Rate SC Production	Ktpa	496
Run-Rate LCE Production (Note 1)	Ktpa	67
Phase 2 Strip Ratio	Ratio	12.5: 1
Phase 3 Strip Ratio	Ratio	16.0: 1
Phase 2 Average Li_2O Grade	%	1.36%
Phase 3 Average Li_2O Grade	%	1.45%
Phase 2 Spodumene Recovery Rate	%	57.9%
Phase 3 Spodumene Recovery Rate	%	50.6%
Spodumene Concentrate Grade	% Li_2O	5.5%
Operating Life	Years	12
Total Cash Cost ex. Royalties (@ Mine Gate)	US$/t SC	$292
Total Cash Cost incl. Royalties (@ Mine Gate)	US$/t SC	$394
Transportation Costs (CIF China)	US$/t SC	$120
Total Cash Cost (CIF China)	US$/t SC	$514
AISC (CIF China)	US$/t SC	$516
Mining Costs	US$/t Material Mined	$2.25
Processing Costs	US$/t ROM	$7.06
G&A Costs	US$/t ROM	$2.68

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

The total gross revenue derived from the sale of spodumene concentrate is estimated at US$21.5 billion, an average revenue of US$3,610/t 5.5% SC with total operating costs (including royalty payments and commercial discounts) of US$3.4 billion at an average cost of US$569/t 5.5% SC. The resulting after-tax earnings margin (gross revenue less realization, operating costs and taxes) was estimated at US$15.3 billion.

A sensitivity analysis for Phase 2 & 3 was carried out with the base case as described above as the midpoint. An interval of ±20% versus base case values was considered with increments of 10%.

Phase 2 & 3 after-tax NPV is not significantly vulnerable to changes in BRL to US$ exchange rate, CAPEX, OPEX, or discount rate considered. In contrast, Phase 2 & 3 after-tax NPV is more sensitive to variation in spodumene price, lithium grade, and spodumene recovery rates.

Phase 2 & 3 after-tax IRR is not significantly vulnerable to changes in OPEX. In contrast, Phase 2 & 3 after-tax IRR is more sensitive to variation in spodumene price, lithium grade, spodumene recovery rates, BRL to US$ exchange rate and Capex. Note that the Phase 2 & 3 after-tax IRR is independent of the discount rate considered.

1.19.4 Phase 1, 2 & 3 Economic Analysis

The Phase 1, 2 & 3 economic analysis is based on a thirteen-year operation sourcing feedstock ore from the Xuxa deposit's Mineral Reserve of 11.8 Mt grading at 1.55% Li_2O, Barreiro deposit's Mineral Reserve of 21.8 Mt grading at 1.37% Li_2O and the NDC deposit's Mineral Reserve of 21.2 Mt grading at 1.45% Li_2O. Phase 1, 2 & 3 is expected to generate run-rate production of up to 766 ktpa of lithium concentrate, delivering US$1,788 million of annual free cash flow, at a 5.5% SC grade.

The base case scenario results are detailed in Table 1-24 below.

Table 1-28: Phase 1, 2 & 3 Base Case Scenario Results

ITEM	UNIT	@ 5.5% SC
After-Tax NPV @ 8%	US$ M	$15,289
After-Tax IRR	%	1,273%
After-Tax Payback Period	Years	0.1

The key technical assumptions used in the base case are highlighted below in Table 1-25.

Table 1-29: Key Phase 1, 2 & 3 Technical Assumptions

ITEM	UNIT	@ 5.5% SC
Total Ore Processed (ROM)	Mt	54.7
Annual ROM Ore Processed	Mt	4.2
Run-Rate SC Production	ktpa	766
Run-Rate LCE Production (Note 1)	ktpa	104
Phase 1 Strip Ratio	ratio	16.4: 1
Phase 2 Strip Ratio	ratio	12.5: 1
Phase 3 Strip Ratio	ratio	16.0: 1
Phase 1 Average Li_2O Grade	%	1.55%
Phase 2 Average Li_2O Grade	%	1.36%
Phase 3 Average Li_2O Grade	%	1.45%
Phase 1 Spodumene Recovery Rate	%	65.0%
Phase 2 Spodumene Recovery Rate	%	57.9%
Phase 3 Spodumene Recovery Rate	%	50.6%
Spodumene Concentrate Grade	% Li_2O	5.5%
Operating Life	years	13
Total Cash Cost ex. Royalties (@ Mine Gate)	US$/t SC	$289
Total Cash Cost incl. Royalties (@ Mine Gate)	US$/t SC	$401
Transportation Costs (CIF China)	US$/t SC	$120
Total Cash Cost (CIF China)	US$/t SC	$521
AISC (CIF China)	US$/t SC	$523
Mining Costs	US$/t Material Mined	$2.20
Processing Costs	US$/t ROM	$7.78
G&A Costs	US$/t ROM	$3.24

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

the total gross revenue derived from the sale of spodumene concentrate is estimated at US$32.1 billion, an average revenue of US$3,956/t 5.5% SC with total operating costs (including royalty payments and commercial discounts) of US$4.6 billion at an average cost of US$572/t 5.5% SC. The resulting after-tax earnings margin (gross revenue less realization, operating costs and taxes) was estimated at US$23.3 billion.

A sensitivity analysis for Phase 1, 2 & 3 was carried out with the base case as described above as the midpoint. An interval of ±20% versus base case values was considered with increments of 10%.

Phase 1, 2 & 3 after-tax NPV is not significantly vulnerable to changes in BRL to US$ exchange rate, CAPEX, OPEX, or discount rate considered. In contrast, Phase 1, 2 & 3 after-tax NPV is more sensitive to variation in spodumene price, lithium grade, and spodumene recovery rates.

Phase 1, 2 & 3 after-tax IRR is not significantly vulnerable to changes in OPEX. In contrast, Phase 1, 2 & 3 after-tax IRR is more sensitive to variation in spodumene price, lithium grade, spodumene recovery rates, BRL to US$ exchange rate and Capex. Note that the Phase 1, 2 & 3 after-tax IRR is independent of the discount rate considered.

1.20 INTERPRETATION AND CONCLUSIONS

Mineral Resources are reported for eight pegmatite bodies, Xuxa, Barreiro, Murial, Lavra do Meio, Nezinho do Chicao, Maxixe, Tamboril and Elvira. Mineral Reserves are reported for the Xuxa, Barreiro and NDC deposits.

1.20.1 Risk Assessment

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 the license for Barreiro Pit
- 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
- The production rate and size of the pit may impose challenges for operations
- 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

1.20.2 Opportunities

The following opportunities are identified for the Grota do Cirilo Project:

- Recovery of Li_2O from hypofines with a flotation circuit
- Sales of hypofines as DSO
- Recovery of Li_2O from petalite
- Sale of plant rejects to the ceramics industry
- 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 at both Phase 1 and Phase 2 projects.
- Exchange rate may work in the Project's favour.

1.21 RECOMMENDATIONS

The following summarizes the recommendations from this report.

1.21.1 Geology and Resources

The QPs recommend that additional exploration drilling be conducted to the northwest of Barreiro and also to the east of Maxixe/Tamboril to potentially increase resources. The overall cost for the drill program is estimated to be US$3M.

2 INTRODUCTION

Sigma requested SGS Geological Services (SGS) to prepare an updated NI 43-101 Technical Report (the Report) on Sigma's Grota do Cirilo project located in Minas Gerais State, Brazil.

This report contains an updated Mineral Resource Estimate for the Nezinho do Chicao, Lavra do Meio and Murial pegmatites and the maiden Mineral Resource Estimate for the Maxixe, Tamboril and Elvira pegmatites.

There has been no change in the Mineral reserves or financial analysis from previous reports.

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, Barrerio, Murial, Lavra do Meio and Nezinho do Chicao deposits.

The Report supports the disclosure by Sigma in the news release dated the 31st of January 2024.

Mineral Resources and Mineral Reserves (MRMR) are reported using the 2014 Canadian Institute of Mining, Metallurgy and Petroleum (CIM) Definition Standards (2014 CIM Definition Standards) and adhere, as best as possible, to the 2019 CIM Estimation of Mineral Resources & Mineral Reserves Best Practice Guidelines (2019 CIM MRMR Guidelines).

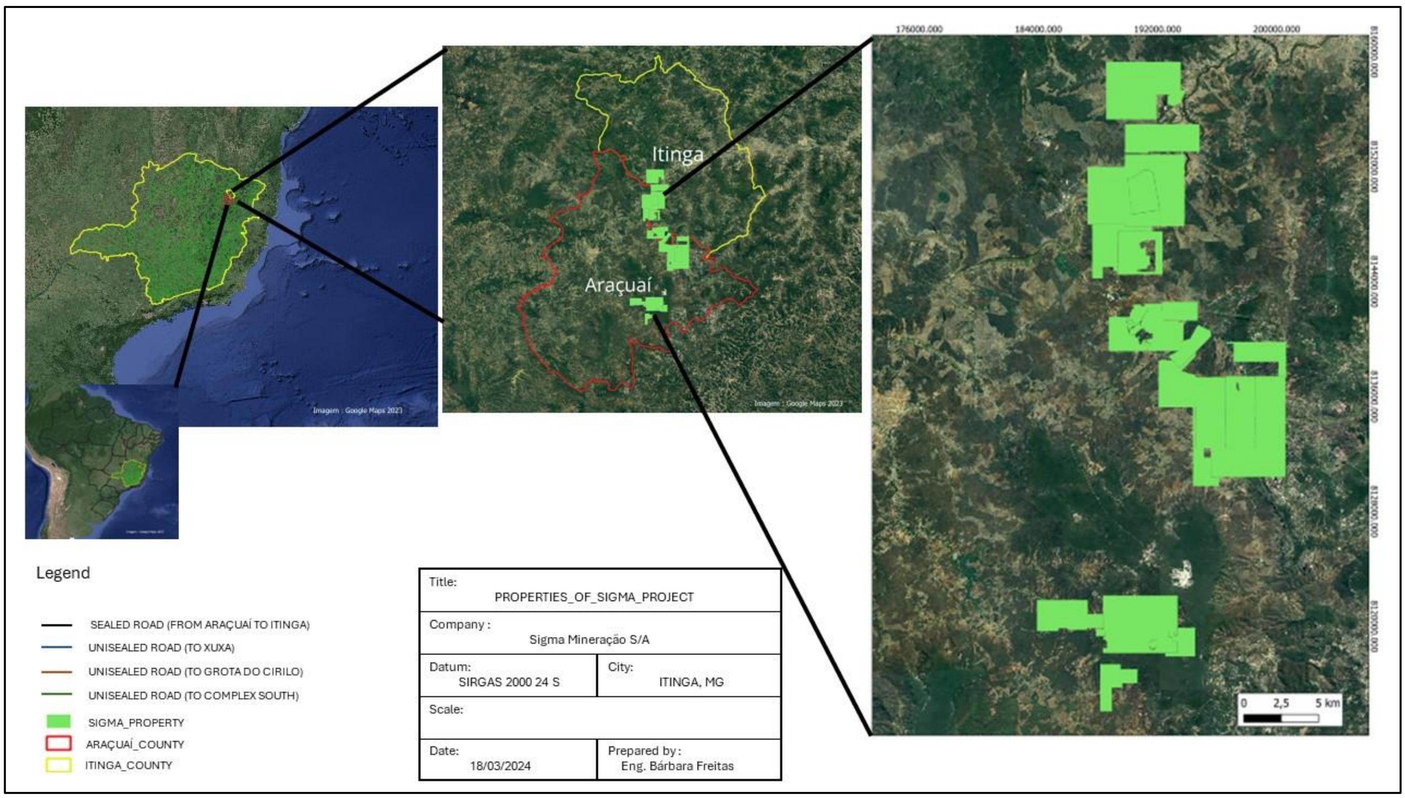


Figure 2-1: Project Location

2.1 TERMS OF REFERENCE

Mineral Resources are reported for eight pegmatite bodies, Xuxa, Barreiro, Nezinho do Chicao, Murial, Lavra do Meio, Maxixe, Tamboril and Elvira. Mineral Reserves are reported for the Xuxa, Barreiro and Nezinho do Chicao deposits. A feasibility study has been conducted on the Xuxa deposit and a pre-feasibility level study has been conducted on the Barreiro and Nezinho do Chicao deposits.

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 Xuxa Mineral Resource estimate is the 10th January 2019.

The effective date of the Xuxa Mineral Reserve estimate is the 21st June 2021

The effective date of the Barreiro Mineral Resource estimate is the 24th February 2022.

The effective date of the Barreiro Mineral Reserve estimate is the 24th February 2022.

The effective date of the financial analysis supporting the Barreiro Mineral Reserve is the 24th February 2022.

The effective date of the NDC Mineral Resource estimate is the 18th January 2024.

The effective date of the NDC Mineral Reserve estimate is the 31st October 2022.

The overall effective date of the financial analysis supporting the NDC Mineral Reserves is the 31st October 2022.

The effective date of the Murial Mineral Resource estimate is the 18th January 2024.

The effective date of the Lavra do Meio Mineral Resource estimate is the 18th January 2024.

The effective date of the Maxixe Mineral Resource estimate is the 18th January 2024.

The effective date of the Tamboril Mineral Resource estimate is the 18th January 2024.

The effective date of the Elvira Mineral Resource estimate is the 18th January 2024.

2.3 QUALIFIED PERSONS

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

- Mr. Marc-Antoine Laporte, P.Geo., Senior Geologist, SGS
- Mr. Jarrett Quinn, P.Eng., Consulting Process Engineer, Primero Group Americas
- Mr. Porfirio Cabaleiro Rodriguez, FAIG, Senior Director GE21
- Mr. Homero Delboni, MAusIMM (CP), Senior Consultant, Mineral Processing Solutions Ltda
- Mr. William van Breugal, P.Eng, Associate Mining Engineer, SGS

2.4 SITE VISITS

The following Qualified Persons visited the Project site.

Mr. Marc-Antoine Laporte visited the Project site on September 11–15, 2017, from July 11–17, 2018, from September 18-23, 2018, from October 18-21, 2021, from May 30 to June 1 2022 and from November 22-24, 2023. 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 2018, where he discussed the geological model and information needed to complete the resource estimates on the Xuxa, Barreiro, Murial and Lavra do Meio pegmatites. On his site visit in 2021, Mr. Laporte reviewed logging, QAQC and the drilling program underway at the Barreiro deposit. He also discussed the geological model and the information needed to update the MRE for Barreiro.

Mr. Porfirio Cabaleiro Rodriguez visited the site from April 17-18, 2019, and from 25-29 July 2022. During these visit, he familiarized himself with general aspects of the proposed mine areas, 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 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.

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:

- Benchmark Mineral Intelligence, Q3 - 2022: Lithium Forecast, Q3 - 2022.

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 Benchmark Mineral Intelligence because the company is independent, privately owned, and is an industry leader in battery metals reporting. Benchmark Mineral Intelligence, founded in 2014, is a London-based IOSCO-regulated Price Reporting Agency and specialist information provider for the lithium-ion battery to EV supply chain. Benchmark Mineral Intelligence 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. Benchmark Mineral Intelligence also publishes regularly updated cost curves and databases for a number of metals and minerals.

3.2 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.

3.3 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.
- Vetor Ambiental updated the report for the Phase 1 Project in 2020 and for Phase 2 in 2021.

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 for Phase 1 Xuxa by Harpia Consultoria Ambiental is a translation from and is based on an Environmental Impact Assessment (EIA) prepared by NEO Soluções Ambientais, ATTO GEO Geologia e Engenheria and Vetor Ambiental and submitted by Sigma to applicable regulatory authorities.

Similarly, the Environmental Regularization Summary for Phase 2 Barreiro is based on an Environmental Impact Assessment (EIA) prepared by Vetor Ambiental and submitted by Sigma to applicable regulatory authorities.

The EIS was comprised of:

- Estudo e Relatorio de Impacto Ambiental Phase 1 North Pit – EIA-RIMA dated 30 October 2018

- Plano de Controle Ambiental Phase 1 North Pit– PCA dated December 2018
- Estudo e Relatorio de Impacto Ambiental Phase 1 south pit – EIA-RIMA dated 28 August 2020, and
- Plano de Controle Ambiental Phase 1 south pit – PCA dated 28 August 2020
- Estudo e Relatorio de Impacto Ambiental Phase 2 Barreiro t – EIA-RIMA dated 20 February 2022, and
- Plano de Controle Ambiental Phase 2 Barreiro – PCA dated 15 March, 2022

The Phase 2 Barreiro Environmental Regularization Summary is based on an EIA-RIMA and PCA which was prepared by Vetor Ambiental.

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 EIA and the Environmental Regularization Summary for Phase 1 cover the licensing process for Xuxa North & South pits and waste piles 1 ,2 ,3 ,4 and 5. The EIS and the Environmental Regularization Summary for Phase 2 cover the licensing process for Barreiro pit and waste pile 1.

3.4 COST ESTIMATION AND FINANCIAL ANALYSIS

As this report is a resource update, the economic background and analysis for existing reserves at the Xuxa, Barreiro and Nezinho Do Chicao deposits is unchanged from previous reports. The QP has relied upon previous QP's assessment for these deposits in this report.

The QP has studied the previous cost estimates and conducted an audit of the previously published financial model. Cost estimates were suitably applied in the financial model. The audit found no errors or inconsistencies in the financial model.

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.

Updated and new reserve estimates for the Nezinho do Chicao, Lavra do Meio, Murial , Maxixe, Tamboril and Elvira pegmatites will require updated capital, operating and commodity price estimates in future reports.

3.5 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 disclaim 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 191,226 m east and UTM 8,155,496 m north, WGS 84, Zone 24 K
- Santa Clara: UTM 197,682 m east and UTM 8,134,756 m north, WGS 84, Zone 24 K
- São José property: UTM 190,612 m east and UTM 8,119,190 m north, 84, Zone 24 K.

The property locations are shown in Figure 4-1.

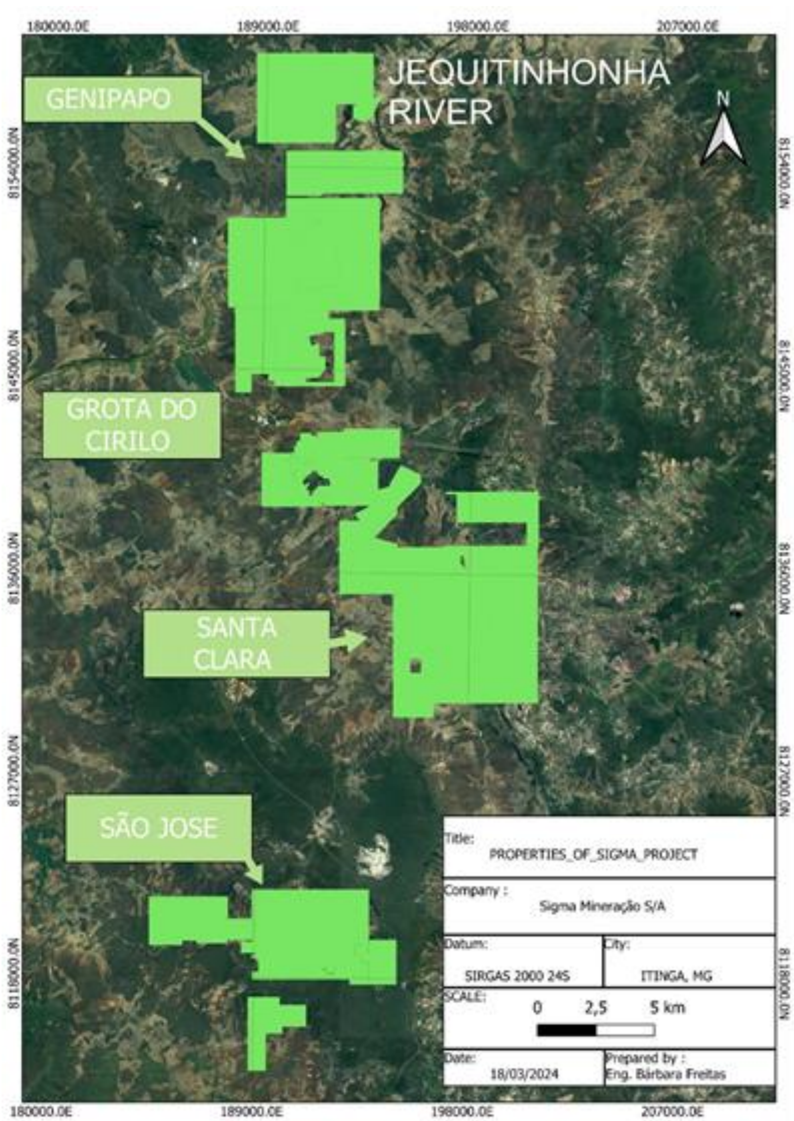


Figure 4-1: Project Properties - Genipapo, Grota do Cirilo, Santa Clara and São José

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 are regulated by the Brazilian Mining Code and supporting legislation.

The Project consists of 29 mineral rights, mining concessions, applications for mining concessions and exploration permits covering an area of 19,683 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	1,796.54	Genipapo
2	802.400	1972	Mining concession (*)	Life of mine	969.13	Genipapo
3	4.134	1953	Mining concession (*)	Life of mine	494.69	Grota do Cirilo
4	831.891	2017	Exploration Permit	03/10/2026 **	10.57	Genipapo
5	830.039	1981	Mining Application	Life of mine	658.2	Grota do Cirilo
6	824.692	1971	Mining concession	Life of mine	756.21	Grota do Cirilo
7	810.345	1968	Mining concession (*)	Life of mine	125.54	Grota do Cirilo
8	9.135	1967	Mining concession (*)	Life of mine	312	Grota do Cirilo
9	5.804	1953	Mining concession (*)	Life of mine	9.33	Grota do Cirilo
10	804.541	1971	Mining Application	Life of mine	44.89	Grota do Cirilo
11	824.695	1971	Mining concession (*)	Life of mine	1,069.21	Grota do Cirilo
12	805.799	1970	Mining concession (*)	Life of mine	8.29	Grota do Cirilo
13	801.312	1972	Mining concession (*)	Life of mine	2,505.22	Grota do Cirilo
14	831.975	2017	Exploration Permit	05/04/2026 **	4.03	Grota do Cirilo
15	2.998	1953	Mining concession (*)	Life of mine	327.84	Santa Clara
16	801.870	1978	Mining concession	Life of mine	544.9	Santa Clara
17	801.316	1972	Mining concession (*)	Life of mine	3,727.89	Santa Clara
18	801.315	1972	Mining concession (*)	Life of mine	991.71	Santa Clara
19	813.413	1973	Mining concession (*)	Life of mine	379.31	Santa Clara
20	832.889	2013	Extension Exploration Permit	01/11/2025 **	810.23	São José
21	806.856	1972	Mining concession (*)	Life of mine	1,920.42	São José
22	808.869	1971	Mining concession (*)	Life of mine	29	São José
23	804.088	1975	Mining concession	Life of mine	29.22	São José
24	801.875	1978	Mining concession	Life of mine	281.51	São José
25	830.580	1979	Exploration Permit	N/A***	686.89	São José
26	832.244	2021	Exploration Permit	04/02/2025	1.53	Grota do Cirilo
27	832.245	2021	Exploration Requirement	N/A***	0.25	Grota do Cirilo
28	832.246	2021	Exploration Permit	04/02/2025	2.16	Grota do Cirilo
29	830.081	2022	Exploration Permit	18/04/2025	1.16	Grota do Cirilo
	830,124	2024	Exploration Requirement	N/A***	1405.51	Grota do Cirilo

* Mining rights covered by the Mining Group 931.021/83. **Deadline for submission to the ANM of the final research report

*** The Final Research Report was submitted in due time and is pending analysis. There is no provision for an administrative decision. - Exploration permits 832.244, 832.245, 832.246 and 830.081 are too small to be shown in Figure 4-2.

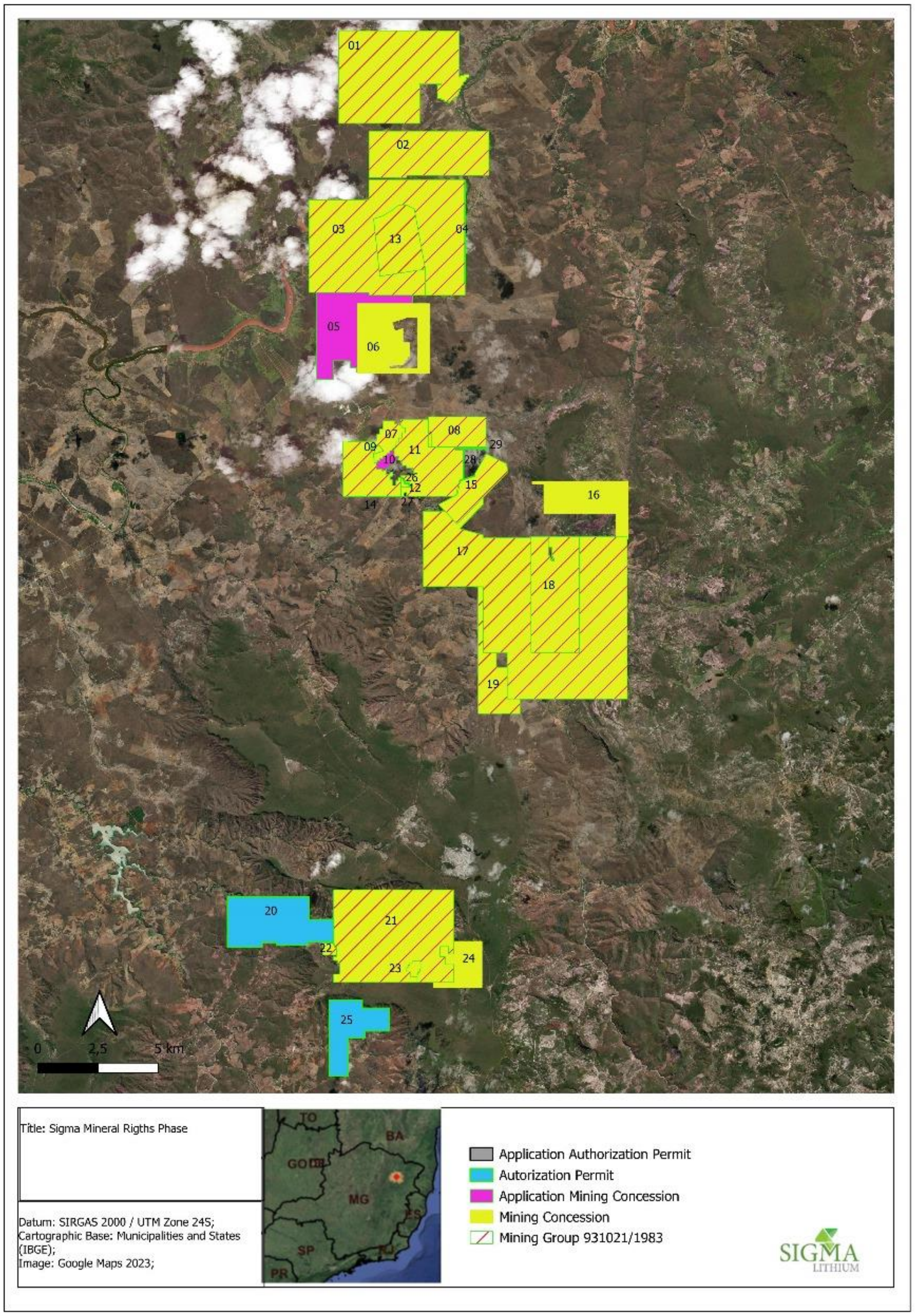


Figure 4-2: Project Mineral Rights, North and South Complexes

Table 4-2: Property Tenure Summary

Property	Area (ha)	Concessions	Historical Workings
Grota do Cirilo	6,904	7 mining concessions, 2 Application for mining concession, 4 exploration permits, 2 exploration requirement	Xuxa, Barreiro, Lavra do Meio, Murial and Maxixe
São José	3,537	4 mining concessions and 2 exploration permits	Samambaia, Lavra Grande, Ananias, Ramom and Lavra Antiga
Genipapo	3,271	3 mining concessions and 1 exploration permit	Morundu and Lavra Velha
Santa Clara	5,972	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, 801.312/1972, 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, 804.541/1971 (Mining Application): there is no periodic payment due
- ANM Proceeding 850.580/1979 (Exploration permit with Final report delivered): there is no periodic payment due
- ANM Proceeding 832.889/2013, (Extension Exploration Permit): The annual payments due at the annual fees per hectare (TAH) were made, totaling the amount of R$4,318.54 (about $US827)
- ANM Process 831.891 / 2017, 831.975 / 2017, (Original Exploration Permit): The annual payments due at the annual fees per hectare (TAH) were made, totaling the amount of R$ 51.83 (about $US9.80)
- The TAH is due in January, for permits granted from July to December of the previous year, and in July, for permits granted from January to June of the present year. Currently the TAH is R$3.55/hectare for original exploration permits and R$5.33/hectare for renewed exploration permits

Sigma has seven mining concessions that have had the PAE 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 Arqueana, Miazga and Tatooine and certain areas are held under private ownership. Sigma has negotiated the right of access in these 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

The royalty provides for an NSR royalty calculated at the rate of 1%, over the gross revenues of SMSA, less all taxes and royalties payable to government authorities, any discounts or sales commissions paid, and any insurance or freight cost borne by SMSA. There is no buyout provision for this royalty.

The Project was also subject to an NSR Royalty of 1% to another third-party – Mr. Amilcar de Melo Afgouni ("Amilcar Royalty"). Under the agreement, SMSA had the option to repurchase the Amilcar Royalty, exercisable at any time, for US$3,800. Mr. Afgouni had the option to require the repurchase of the Amilcar Royalty for the same price, exercisable: (i) if SMSA commences commercial production and reaches production of 40,000 tons of lithium concentrate per year; or (ii) if the original controlling group of Sigma Holdings ceases to have an indirect interest of at least 30% in SMSA on a fully diluted basis. SMSA exercised its repurchase option in April 13, 2023 and the fair value of the royalty agreement call option of US$3,800 as at June 30, 2022.

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 600 km northeast of Belo Horizonte.

The Project is well served by a public and private road network, as a result of its proximity to the federal road BR367. The Project is accessible year-round by a network of arterial and back country service roads.

National route BR251 accesses the Port of Vitória in the State of Espirito Santo, approximately 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 approximately 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

The Grota do Cirilo property has substantial infrastructure constructed by Arqueana (former owner of certain mining rights) 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 local municipal airport and by mobile phone network from the principal Brazilian service providers. The two closest major domestic airport are located in the municipality of Montes Claros, 329 km west of the Project and at the municipality of Vitória da Conquista, 273 km east of the Project.

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: Lithium Metallurgical Test 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 in 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: 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, SMSA 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.
SMSA	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. A feasibility study for Xuxa was issued on the 18th of October 2019 with the Phase 1 mineral reserve statement. A pre-feasibility study for Phase 2 Barreiro was completed in February 2022 and a prefeasibility study for phase 3 at Nezinho do Chicão (NDC) was completed in October 2022. A Front-End Engineering Design (FEED) was completed at Xuxa Phase 1, in October 2020 and construction was immediately commenced thereafter. The construction was complete by the end of October 2022 and Xuxa has commenced commercial production.

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 commenced commercial production from the Project in 2023.

7 GEOLOGICAL SETTING AND MINERALIZATION

7.1 REGIONAL GEOLOGY

The project area lies within the Eastern Brazilian Pegmatite Province (EBPP), spanning an extensive region of approximately 150,000 km^2 across the states of Bahia, Minas Gerais, Espírito Santo and Rio de Janeiro. Approximately 90% of the EBPP is in the eastern part of Minas Gerais state, where mining activities targeting crystal gem-bearing pegmatites have been ongoing since the 17th century (Paes et al., 2016).

The pegmatite units are part of the Araçuaí Orogen that developed during the late Neoproterozoic to Cambrian. Its tectonic evolution is characterized by a series of events typical of collisional orogens, beginning with the formation of the precursor basin rift that evolved to a passive margin, during the Tonian and Cryogenian (ca. 900 to 650 Ma). Subsequent stages witness the emergence of a continental magmatic arc (ca. 630-585 Ma) and supracrustal sequences linked to the arc, followed by syn-collisional anatexis (ca. 575-540 Ma) and by extensive post-collisional magmatism (530-480 Ma). One notable aspect of the Araçuaí Orogen is the enduring succession of granite production events encompassing approximately 630 to 480 Ma, which stand out as the predominant records of its evolutionary history. These rocks, including associated pegmatites, have been categorized into five supersuites representing different plutonic assemblages related to distinct petrogenetic processes (Pedrosa-Soares et al., 2009). These are identified as G1 (pre-collisional, ca. 630–580Ma), G2 (syn-collisional, ca. 585–540 Ma), G3 (late collisional to post-collisional, ca. 545–500 Ma), G4 (late collisional to post-collisional, ca. 530–490 Ma) and G5 (post-collisional, ca. 530–480 Ma) (Pedrosa-Soares et al., 2007).

The significant pegmatite populations within the EBPP crystallized from ca. 630 Ma to ca. 490 Ma and could be categorized into two types: anatectic or residual. Most anatectic pegmatites formed during the collisional stage of the Araçuaí orogen. They are commonly associated with migmatites and granulites, and may bear deposits of kaolinite, K-feldspar, mica, corundum, and quartz (e.g., Correia-Neves et al. 1986; Morteani et al. 2000; Netto et al. 2001; De Campos et al. 2004; Horn 2007). Residual pegmatites, on the other hand, form through magmatic differentiation and originate from parent granites formed during the syn-collisional (G2) and post-collisional (G4 and G5) stages (Pedrosa-Soares et al., 2011).

The interaction between these two types of pegmatites, along with their host rocks and parent granitoids, as well as considerations of geographical distribution and mineralogical enrichment, have delineated the pegmatitic populations into eleven distinct districts within the EBPP (Pedrosa-Soares et al., 2011): Araçuaí, Ataléia, Conselheiro Pena, Espera Feliz, Padre Paraíso, Pedra Azul, São José da Safira, Caratinga, Santa Maria de Itabira, Malacacheta, and Espírito Santo.

The Araçuaí Pegmatite district encompasses the most important lithium ore deposits within the entire province, prominently situated in the Itinga, Coronel Murta, and Curralinho pegmatitic fields. (Sá 1977; Afgouni & Sá1978; Sá & Ellert 1981; Correia-Neves et al. 1986; Romeiro & Pedrosa-Soares 2005; Pedrosa-Soares & Siga Jr. 1987, 1990, 2011; Paes et al. 2016). The Itinga field features Li-rich pegmatites which host the Sigma Lithium project areas.

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

7.2 LOCAL GEOLOGY

Most pegmatites in the Araçuaí district are formed through the crystallization of residual melts originating from post-collisional G4 granites (Pedrosa-Soares & Siga Jr. 1987; Pedrosa-Soares et al., 2011; Paes et al. 2016). The G4 granites are S-type, sub-alkaline to alkaline, and consists of balloon-like zoned plutons composed of biotite granite cores and roots, grading into two-mica and muscovite-garnet leucogranite towards the borders, capped by pegmatoid cupolas (Pedrosa-Soares et al., 2011). These granites, as well as the related lithium-rich pegmatites, are hosted by the Salinas Formation along the regional foliation and fracture systems, dipping to SE and NW (Correia-Neves et al. 1986; Pedrosa-Soares et al. 1987; Costa 1989). The metasedimentary rocks within this Formation consist of a succession of wackes and pelites with conglomerate rock and layers of calc-silicate rock, metamorphosed in the greenschist to amphibolite facies. Its deposition occurred around 580 Ma, according to U-Pb detrital zircon ages which correspond to the maximum depositional age of the unit (Peixoto et al. 2015; Peixoto et al., 2018; Costa 2018; Deluca et al. 2019).

The Araçuaí district pegmatites exhibit a range of sizes, with the most significant comprising from medium to very large and are typically tabular or lenticular. They are external pegmatites that are embedded within the host rocks of the parent granites belonging to the S-type G4 Supersuite (Pedrosa-Soares et al., 2011a). The pegmatite populations in this district are concentrated in the Itinga fields, notable for their lithium abundance, and the Coronel Murta fields, distinguished by their boron-rich nature and no associated petalite (Pedrosa-Soares et al., 2011).

Pegmatites of these fields belong to a category enriched in rare elements (B, Be, Cs, Li, Sn, Ta), characteristic of lithium-cesium-tantalum (LCT) type pegmatites. LCT-type pegmatites are the main hard rock ore deposits for lithium, yielding key lithium silicates like spodumene, petalite, and lepidolite, alongside several associated minerals such as lithium phosphates (e.g., amblygonite, montebrasite, lithophyllite/triphyllite), tantalum oxides, cassiterite, and pollucite (e.g., Černý & Ercit, 2005). Enrichment in lithium-cesium-tantalum is predominantly, though not exclusively, associated with S-type granites derived from muscovite-rich metasedimentary rocks. The peraluminous character is indicated by the occurrence of muscovite, tourmaline, garnet, and occasionally, topaz, andalusite, and gahnite (Cerný 1991b in London 2008).

According to Černý (1982), lithium-bearing pegmatites typically display zoning in both grain size and mineral composition, with lithium minerals concentrating in the inner zones or cores of essentially granitic pegmatites. However, non-zoned, complex pegmatites containing spodumene are also common. In this regard, the Itinga field pegmatites exhibit unusually high concentrations of lithium minerals such as spodumene, petalite, lepidolite, and/or amblygonite, distinguishing them into two main groups based on mineralogical characteristics and zoning patterns. The first group comprises pegmatitic bodies with simple zoning to non-zoned (homogeneous), typically tabular in shape, and exceptionally rich in spodumene while lacking significant occurrences of tourmaline and petalite. Conversely, the second group includes pegmatites with complex zoning, forming lenticular bodies rich in Li, B, Na, Cs, Ta, and/or Cs. These pegmatites are mineralized with an assemblage including spodumene, petalite, lepidolite, amblygonite-montebrasite, albite, cleavelandite, elbaite, cassiterite, tantalite, and/or pollucite (Pedrosa-Soares et al., 2011; Pedrosa-Soares et al., 2022). Furthermore, there are bodies with simple zoning to non-zoned that are mined for dimension stones due to their ornamental value (Correia Neves et al., 1986; Pedrosa-Soares et al., 2009).

The cordierite-biotite-quartz schists of the Salinas Formation, which envelop the main pegmatites within the Itinga Pegmatitic field, exhibit variable concentrations of andalusite, cordierite, and sillimanite, and calc-silicate rock layers are often intercalated. These rocks are characterized by a parallel or locally subparallel schistosity, oriented NE-SW and dipping moderately to steeply towards NW (Paes et al., 2010a). Pegmatites intrude along two distinct striking surfaces with medium to high-angle dips: the NW-dipping schistosity and the SE-dipping fracture cleavage. Pegmatites emplaced along the NW-dipping schistosity are referred to as concordant bodies, while those hosted by the SE-dipping fracture cleavage are discordant (Pedrosa-Soares et al., 2022). The presence of low-pressure metamorphic silicates such as andalusite and cordierite, along with occurrences of petalite in certain pegmatites and quantitative geothermobarometric data, suggest a relatively shallow crustal depth (5 to 10 km) for metamorphism in the Itinga field (Pedrosa-Soares et al., 2011).

More specifically, within the Sigma Lithium project areas, the pegmatites are commonly hosted by a medium-grey, biotite-quartz schist. Typically, these pegmatites are concordant with the schist foliation which also corresponds to the overall strike of the schist-rich units of the Salinas Formation. At the interfaces between the pegmatite and schist, recrystallization features are evident, including eye-like biotite within cordierite masses, as well as the formation of millimeter-sized black tourmaline needles, which are almost invariably perpendicular to the main schistosity.

Concerning the mineralogical composition of the deposit, spodumene typically constitutes 28–30% of the pegmatite mass, while microcline and albite contents range from 30–35%, with microcline predominating over albite. Muscovite accounts for about 5–7% of the rock mass, with the remaining portion consisting of quartz. The pale green spodumene crystals exhibit elongated or tabular forms, varying in size from millimeters to centimeters, and have been observed up to meter-scale in outcrops. Spodumene cuts the microcline matrix, and intergrowths of spodumene and quartz, occasionally accompanied by muscovite, are commonly observed. Accessory minerals such as columbite and tantalite are found in association with albite and quartz. Late-stage mineralization may include sphalerite and pyrite.

Figure 7-2 is a regional-scale schematic geological plan.

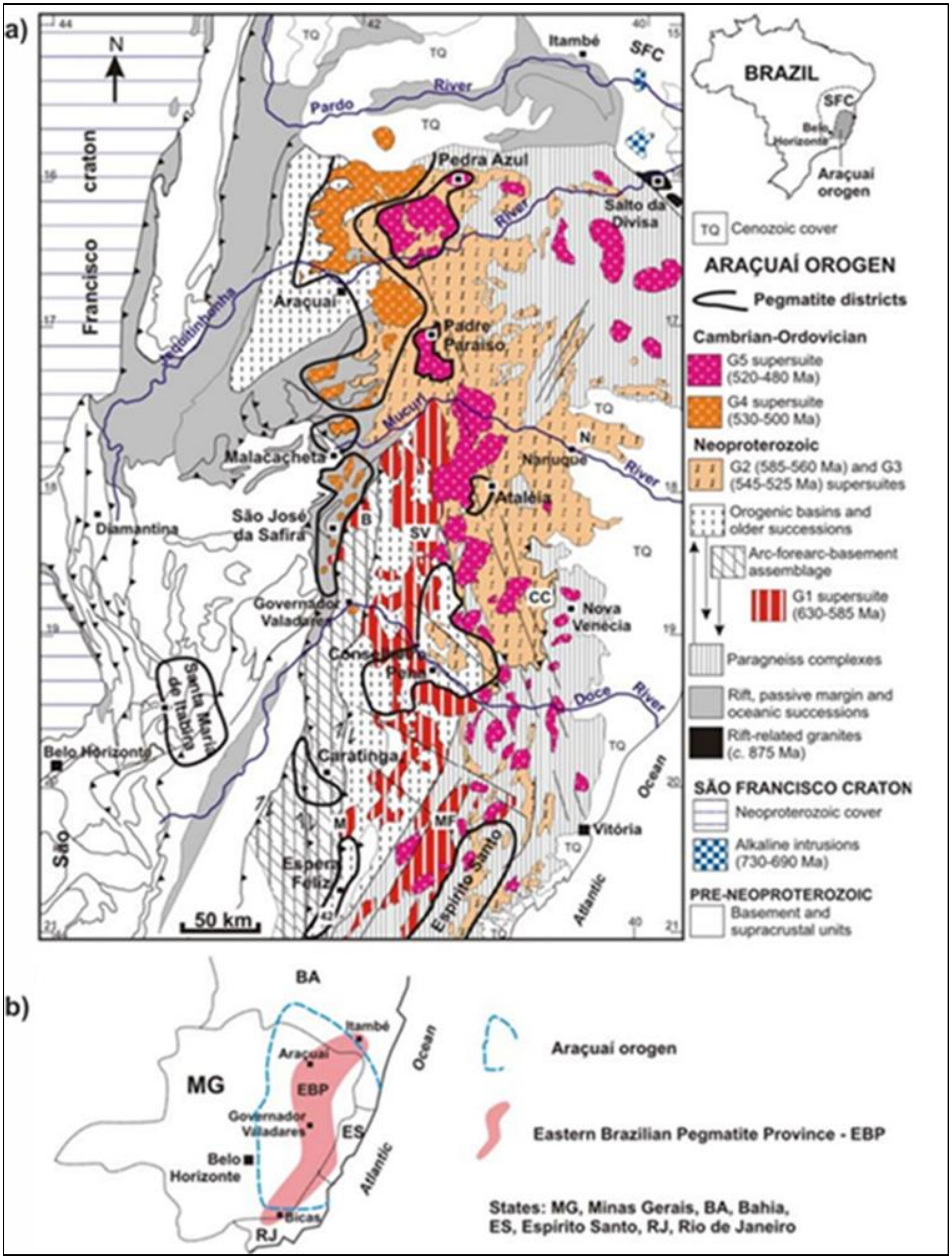


Figure 7-1: Regional Geologic Map (after Pedrosa-Soares et al., 2008)

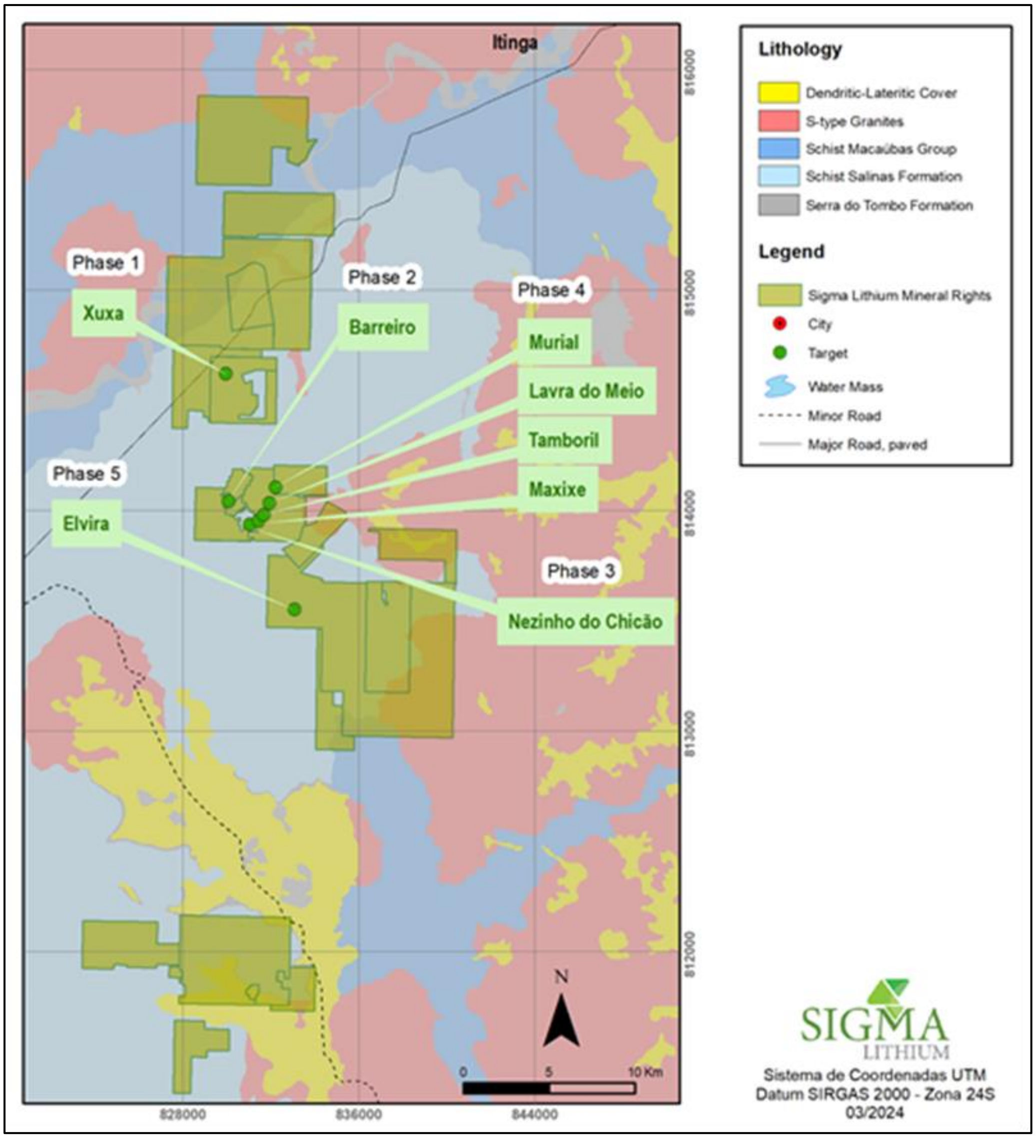


Figure 7-2: Local Geology Map, Itinga Pegmatite Field, Aracuai District

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.

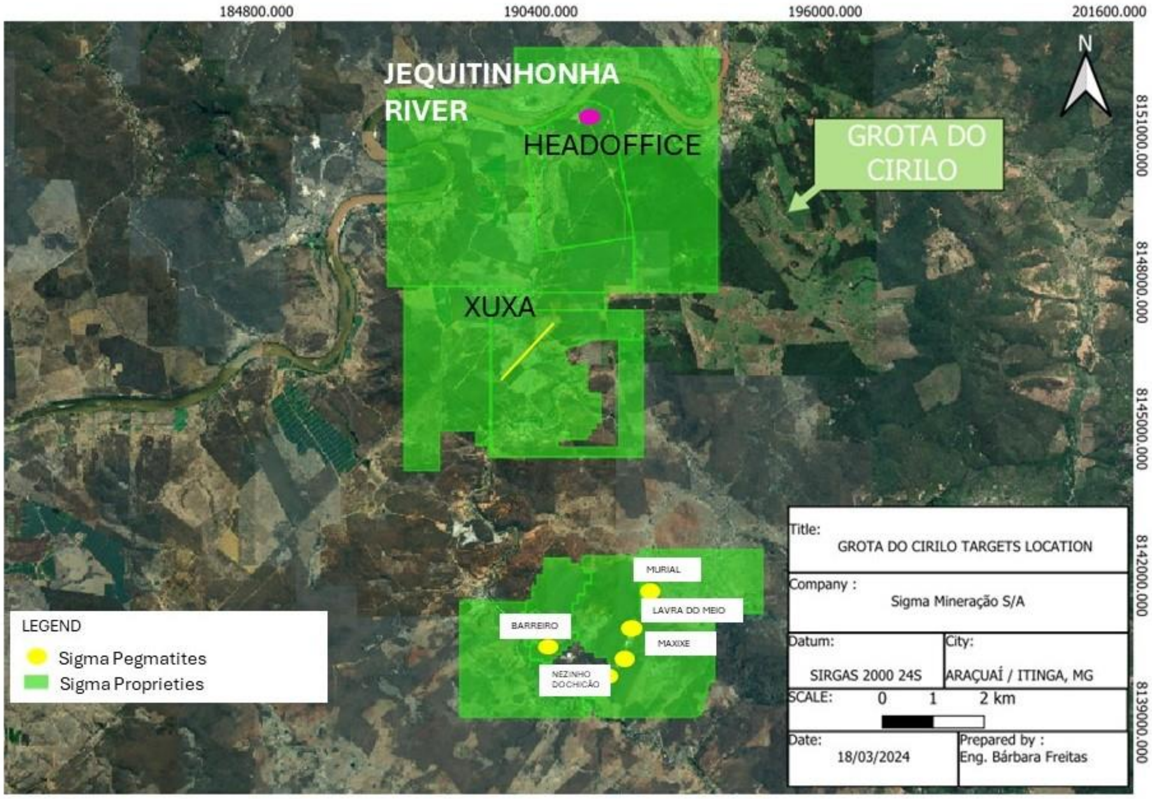


Figure 7-3: Historic Workings and Pegmatite Dike Swarms within Grota Do Cirilo Property

Note: 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 to pass below 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.

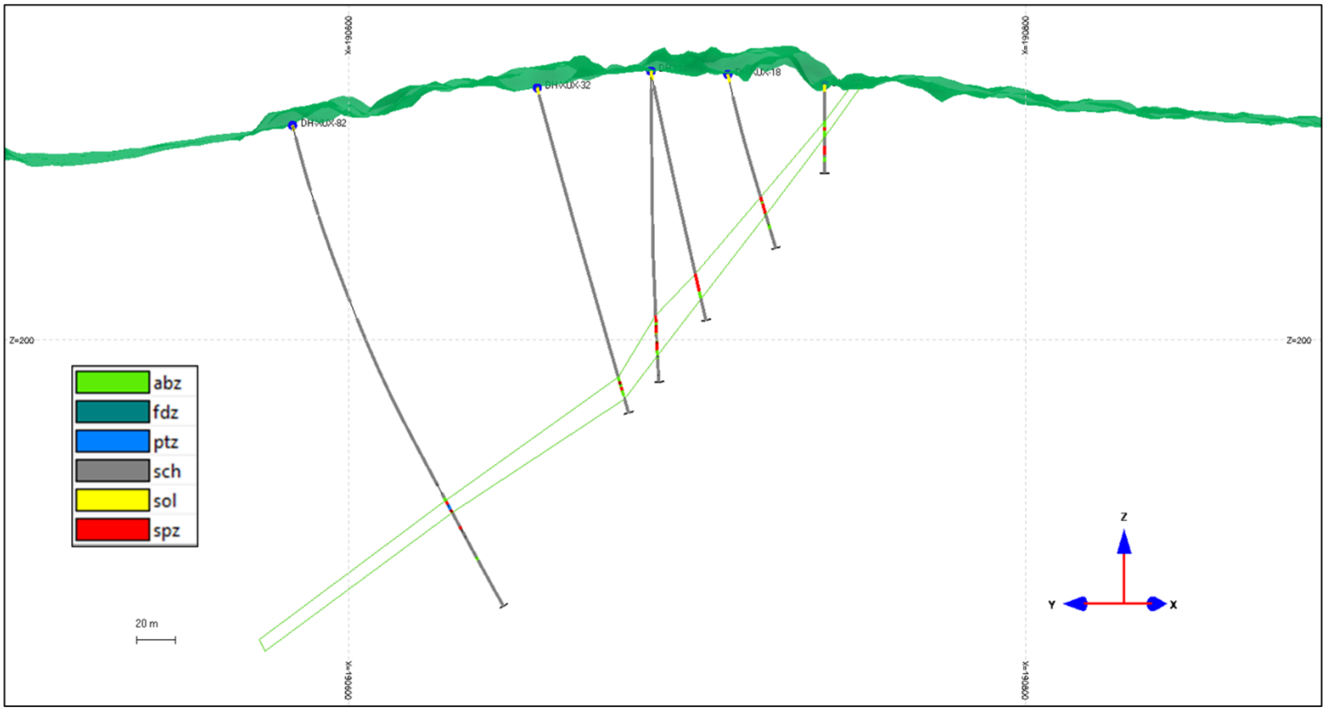


Figure 7-4: Xuxa Cross Section (looking northeast)

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 metre 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.

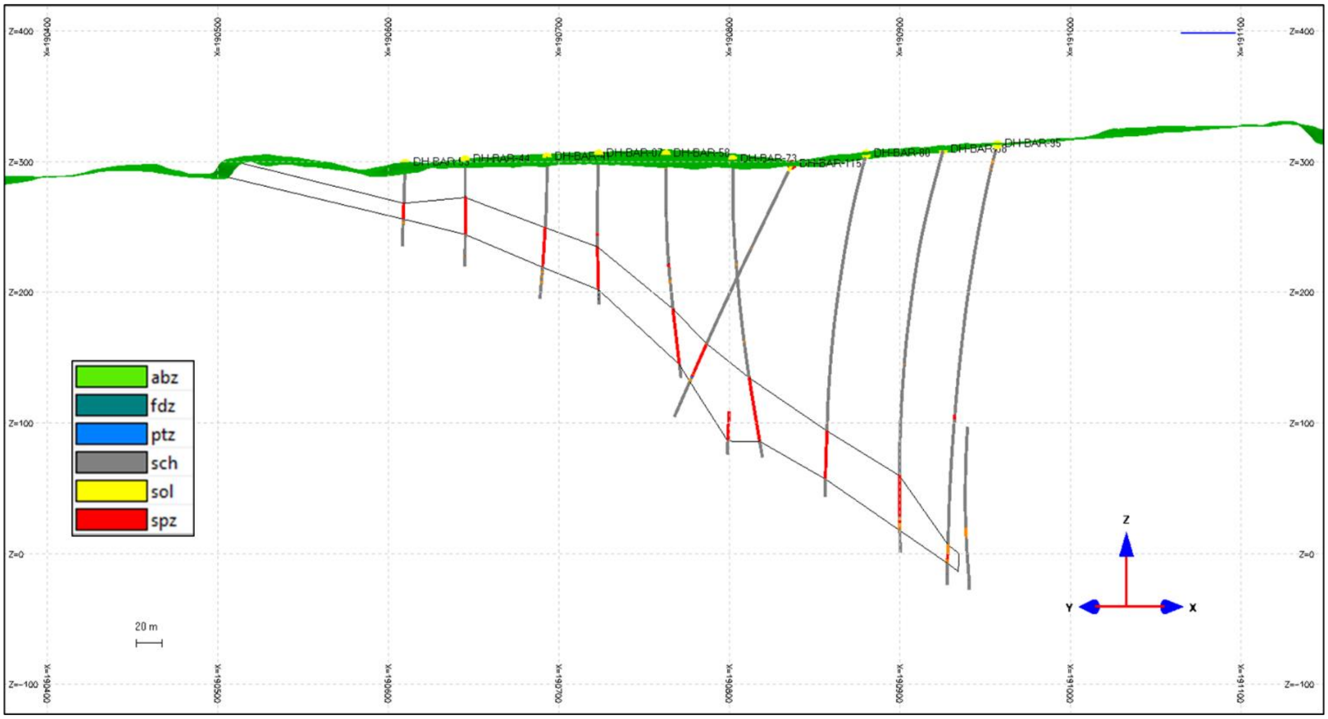


Figure 7-5: Barreiro Cross Section (looking northeast)

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 600 m long, 250 m wide, and has an average thickness of 12–15 m. It extends to a depth of approximately 300 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.

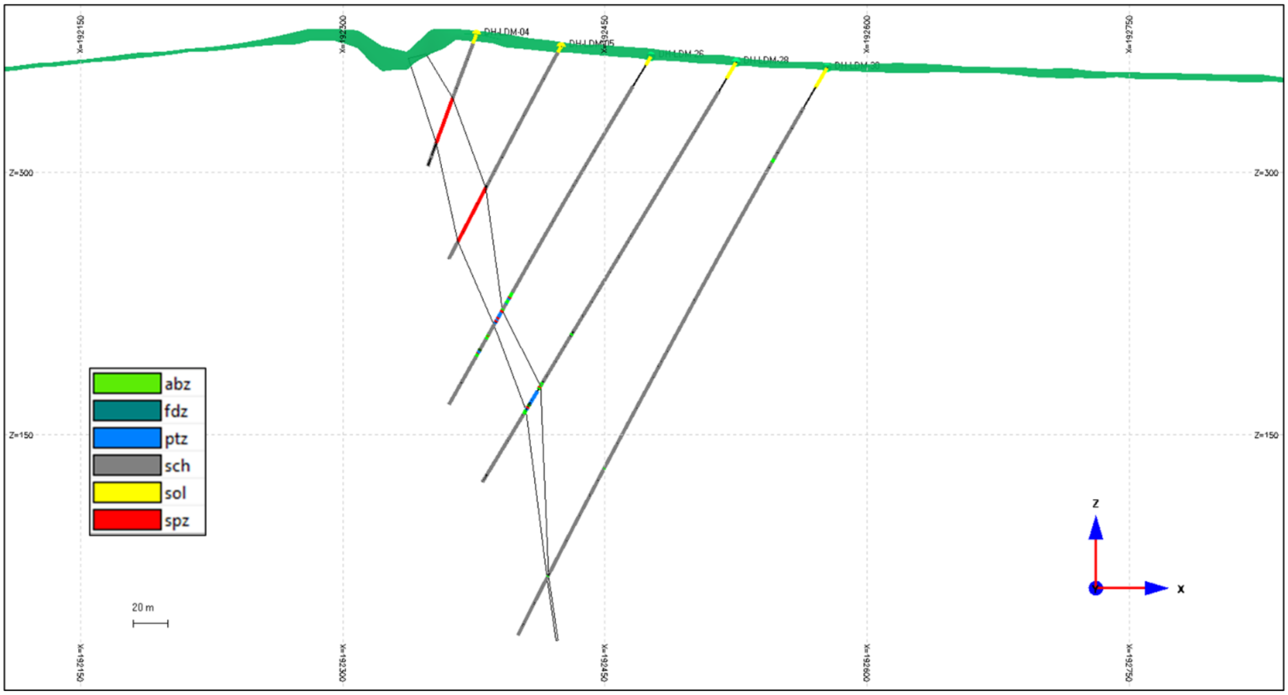


Figure 7-6: Lavra do Meio Cross Section (looking north)

7.3.1.4 Nezinho do Chicao

The Nezinho do Chicão (NDC) pegmatite was discovered in the 1980s by Arqueana. An intensive drilling campaign commenced in 2020 and 131 drill holes totalling 25,671 m have been completed at Nezinho do Chicao to the 18th January 2024.

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 nearly north-south (020º) and dips at 40-75º to the southeast. The dike is about 1,600 m long, 200 m wide and 20-30 m thick. It remains open to the north, south and at depth, with the deepest drill hole reaching 350 m.

The pegmatite shows a classic border, intermediate and central zones. The border zone tends to be more albite rich and the highest spodumene content is generally in the central zone. The NDC pegmatite is a high-grade mix of mainly spodumene but also containing some petalite with a variable ratio depending on the thickness of the zone, although petalite can be found throughout the deposit.

Figure 7-7 is a cross-section through the Nezinho do Chicão pegmatite.

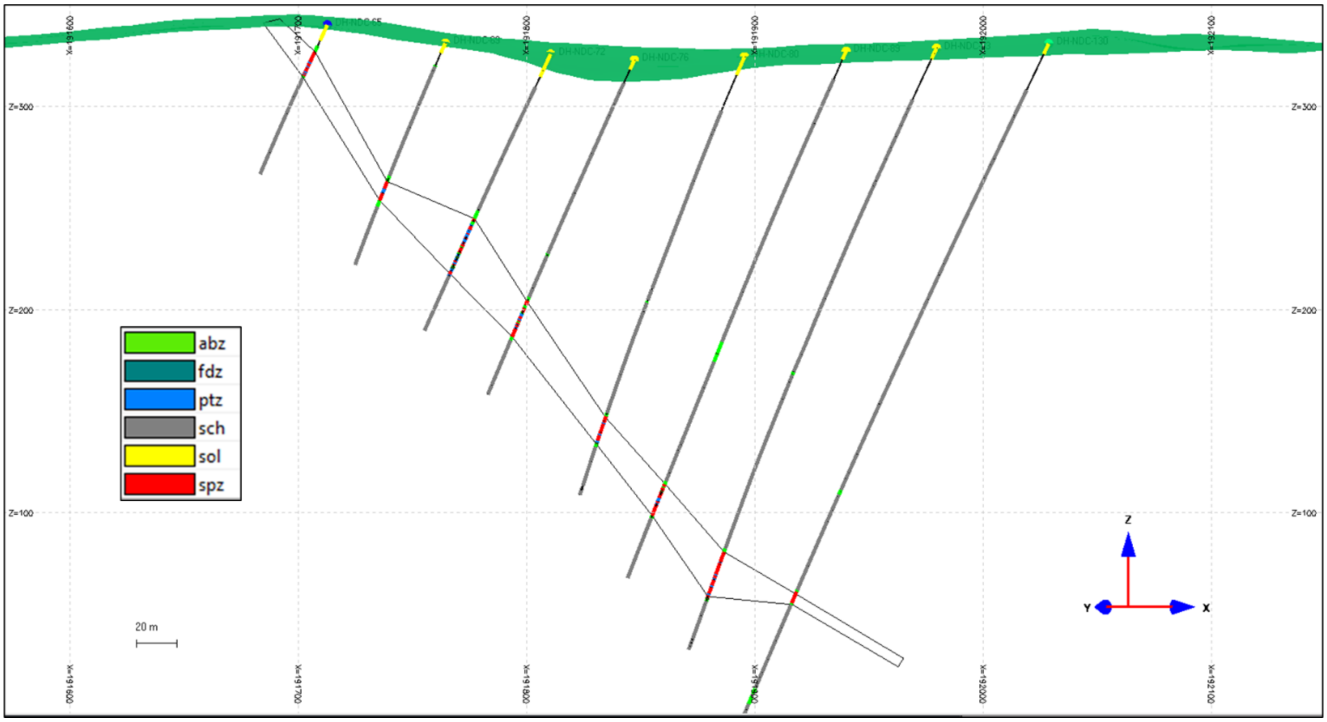


Figure 7-7: Nezinho Do Chicao Cross Section (looking northeast)

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 1,200 m long, 840 m wide, and has an average thickness of 15–20 m. It remains open to the west, east 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.

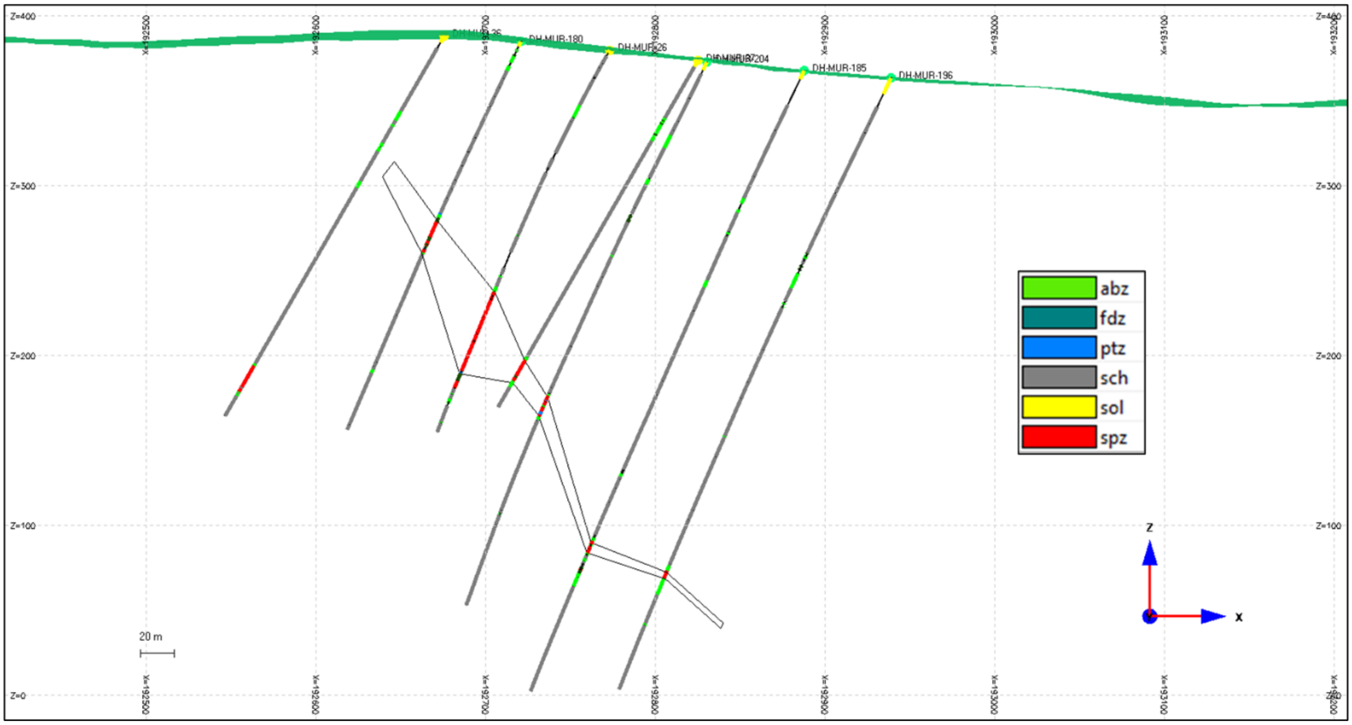


Figure 7-8: Murial Cross Section (looking north)

7.3.1.6 Maxixe and Tamboril

The Maxixe and Tamboril pegmatites are in the hangingwall of the Nezinho do Chicao pegmatite and are southwest and along strike from Lavra do Meio. The pegmatites are very similar geologically to both NDC and LDM.

The host country rock to the pegmatite dikes 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 contacts.

The dikes are concordant with the schist foliation, striking approximately north–south and dipping at 60º to the east. Based on drill data, Maxixe is about 400 m long, 170 m wide, and has an average thickness of 10-12 m. It extends to a depth of approximately 300 m and is open at depth and to the north. Tamboril is about 260 m long, 160 m wide, and has an average thickness of about 8 m. It extends to a depth of approximately 250 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 7-9 is a cross-section through the Maxixe and Tamboril pegmatites.

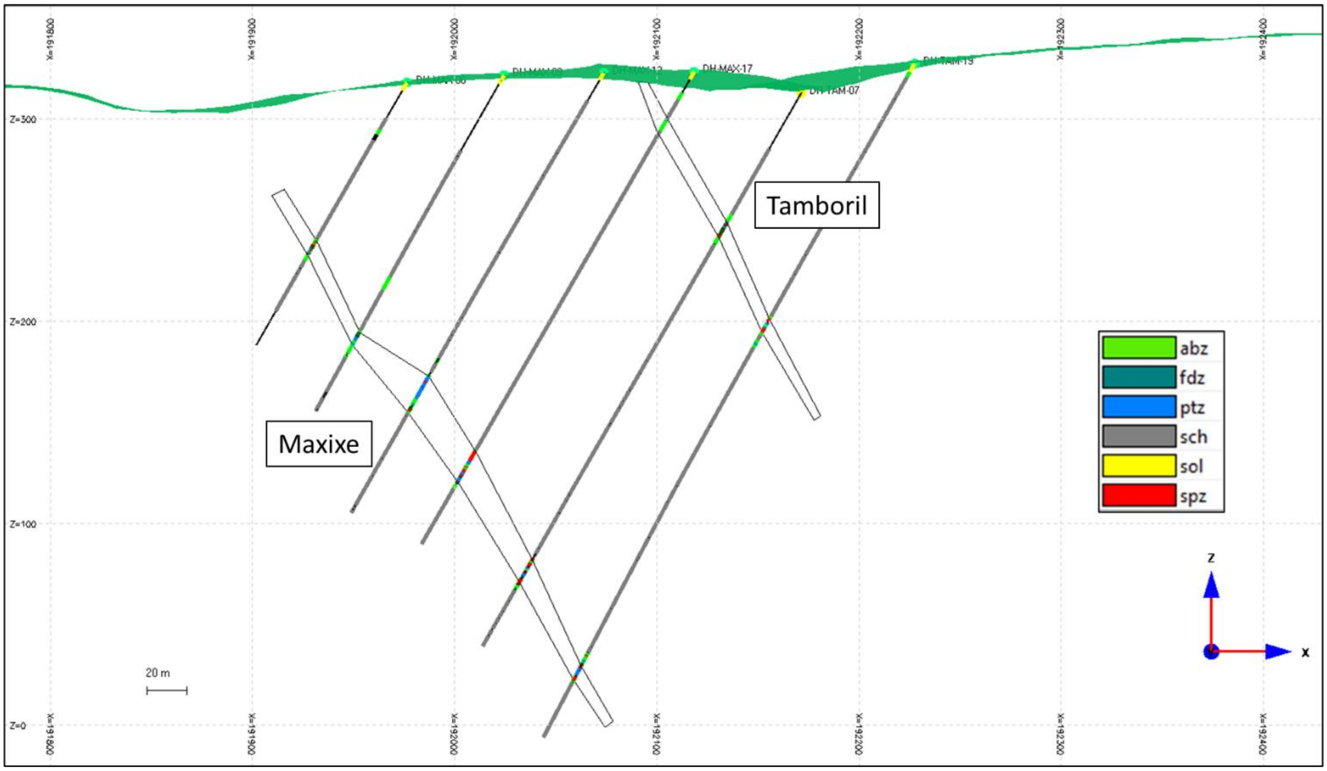


Figure 7-9: Maxixe and Tamboril Cross Section (looking north)

7.3.2 Sao Jose Property

The São José property hosts five historical workings: Ramon, Lavra Antiga, Lavra Grande, Samambaia and Ananias (Figure 7-10). The São José area is locally known for gem-quality spodumene crystals that are used in jewellery.

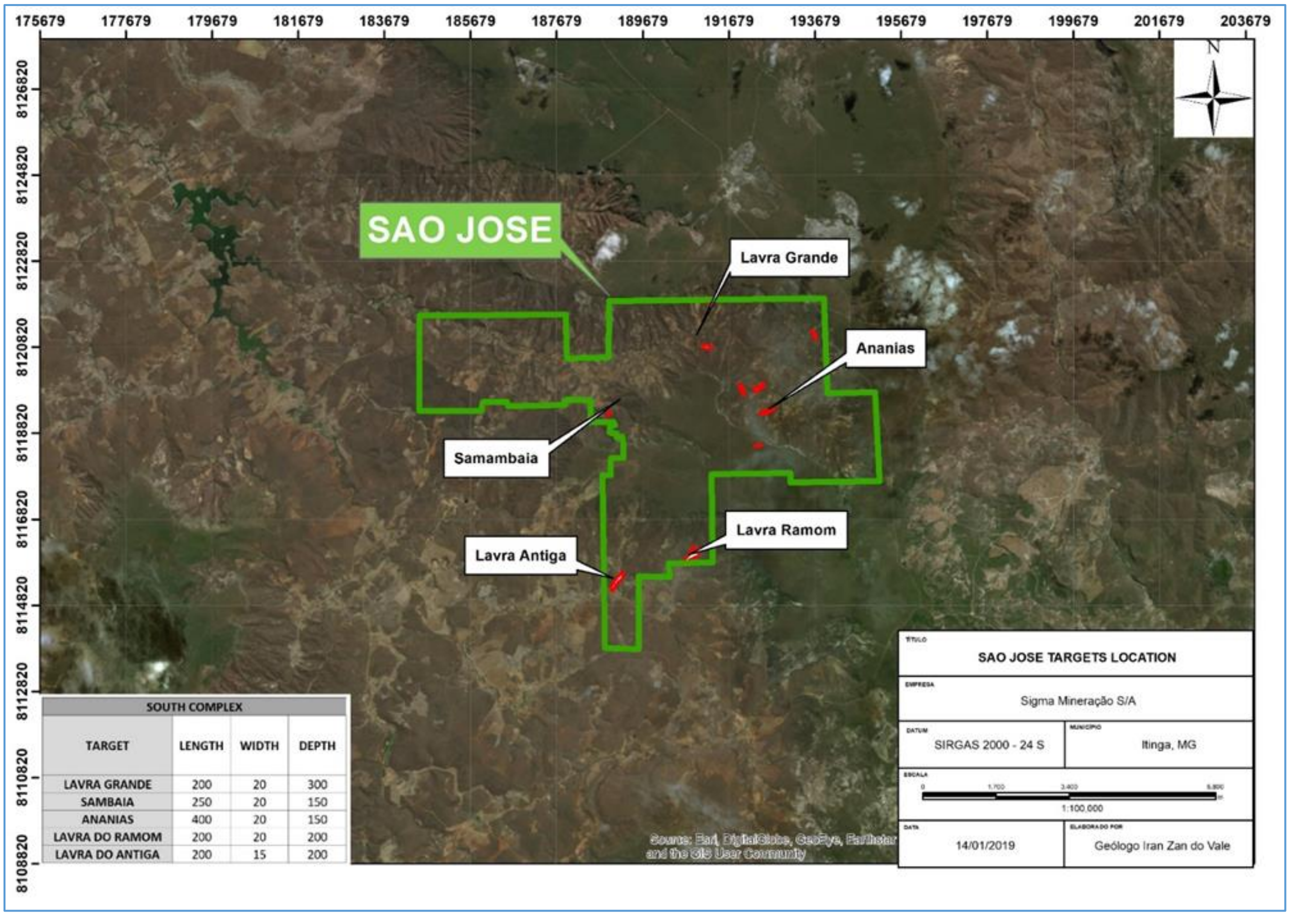


Figure 7-10: Historical Workings within São José Property

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 7-11).

Figure 7-11: Macro Crystals at Lavra Ramon

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 7-12).

Figure 7-12: Samambaia Plan Map

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 7-13).

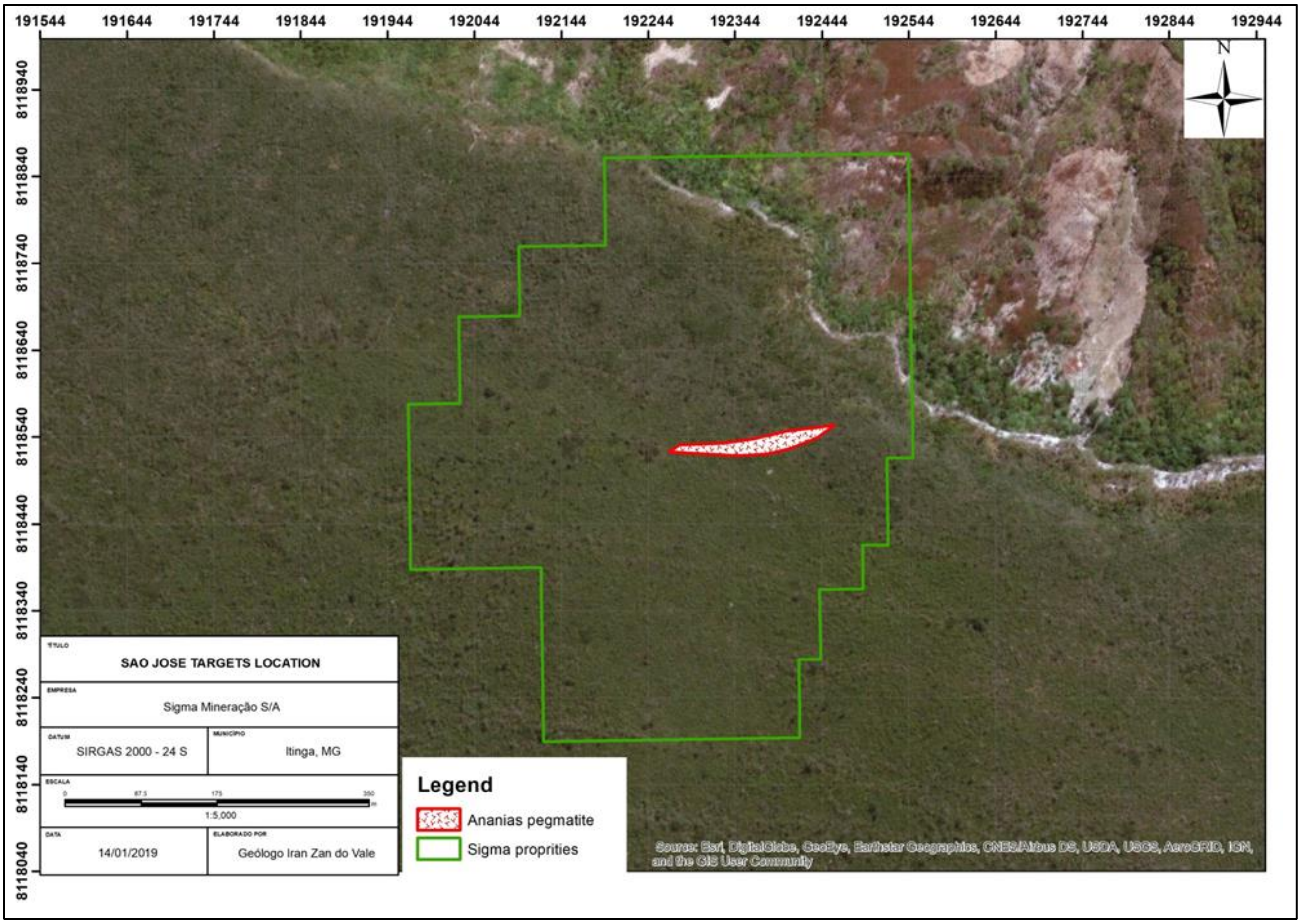


Figure 7-13: Ananias Plan Map

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.

7.3.4.1 Elvira

Three main pegmatites have been identified in the José Gonçalves area and have been initially named Elvira 1, Elvira 2 and Elvira 3.

In these pegmatites, the host biotite-quartz schist has foliation discordant to the pegmatite bodies and the foliated host contains andalusite in the contacts close to the pegmatite "pinch" zone. Cordierite ranging from fine to medium grained is present, related to meta-psammitic zones, together with a greater amount of quartz, which may contain groupings of garnet with fine grain and whitish colour. These characteristics can also be identified in the shale that hosts mineralized pegmatites such as Barreiro, Nezinho do Chicão and Murial, which are hosted in the same regional group of foliated rocks, the Salinas Formation.

The main Elvira pegmatite body, Elvira 1, strikes nearly east-west and dips at 40-75º to the southeast. Elvira 1 is about 520 m long, 185 m wide and up to 18 m thick. It remains open to the northeast, and at depth, with the deepest drill hole reaching 229.5 m.

The pegmatite contains spodumene mineralization, together with quartz, albite and muscovite ranging from medium to very coarse grained. There is a greater amount of coarse-grained to very coarse-grained feldspar and coarse-grained muscovite at the edges of the pegmatite body. Petalite crystallization occurs in the shallowest portion of the pegmatite and has also been identified in mineral groupings arranged in the rock.

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 metres 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).

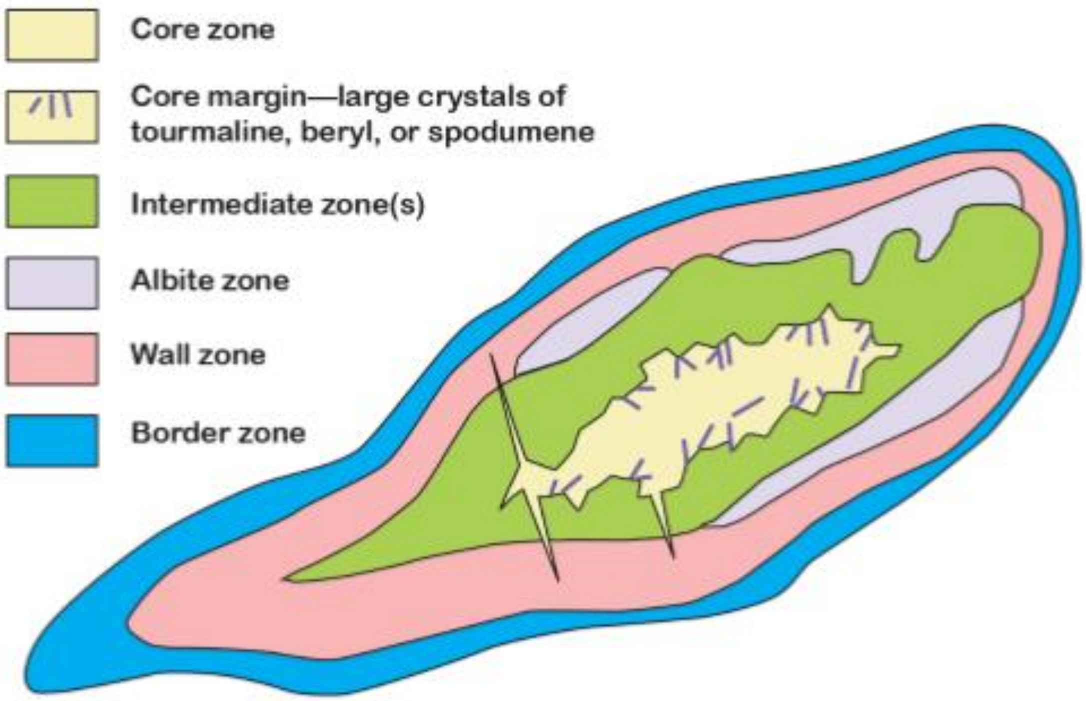


Figure 8-1: Generalized Schematic Representation LCT Pegmatite

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

Work commenced on the Project in the second quarter of 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.

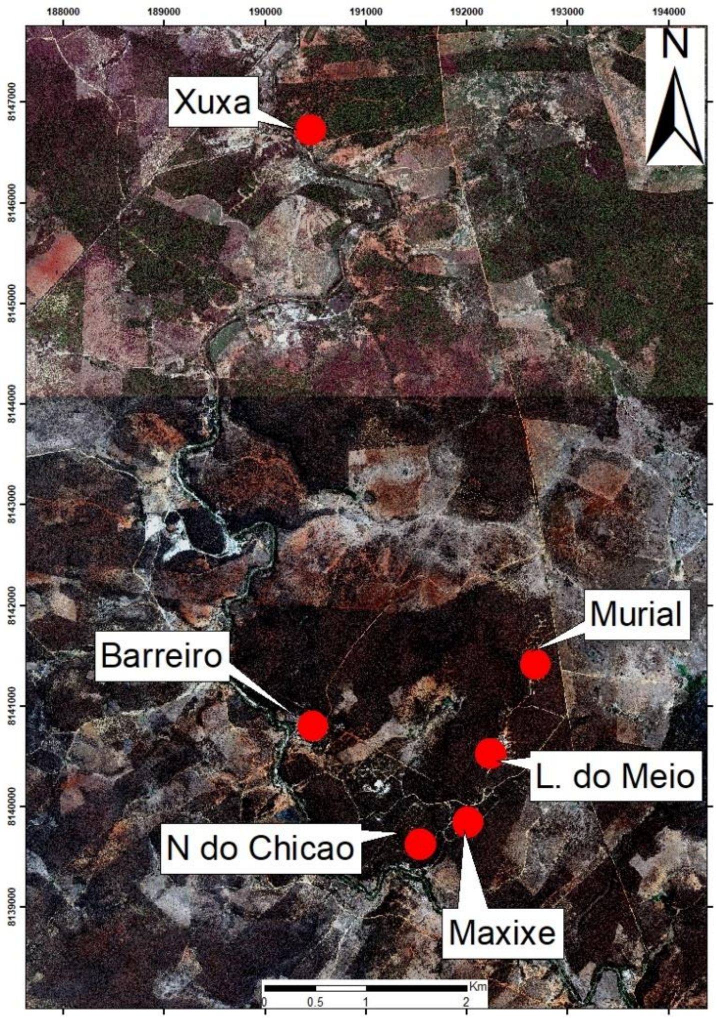


Figure 9-1: Grota do Cirilo Satellite Image

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.

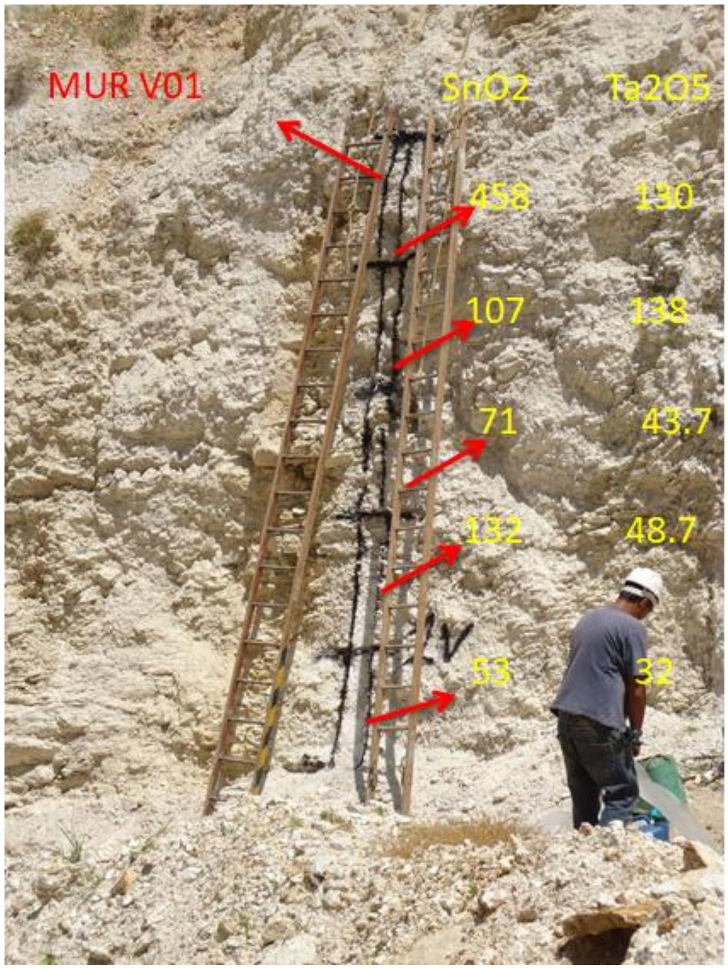


Figure 9-2: Channel Samples at Murial Mine

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
Nezinho 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 the pegmatites (Costelão, Matinha, Mutamba, Joao Vaqueiro, Arueira, etc.) belong to the concordant class. They form intrusive bodies (dikes), typically being several hundred metres 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
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. 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.

Prospect	Description
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.
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
IIha 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.
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, SMSA 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

SMSA has conducted several drilling campaigns on the project since acquiring the property in 2012. To date, this drilling has concentrated primarily on the Grota do Cirilo pegmatites, although in 2023 14 holes were drilled on the Elvira prospect on the Santa Clara property. Table 10-1 is a drill summary table showing the drilling completed by SMSA until the 18th January 2024. A total of 647 core holes (131,982 m) were completed.

Table 10-1: Total Sigma Drill Holes to 18th January 2024

Pegmatite/Area	Number of Drill Holes	Metres Drilled
Xuxa	100	15,531
Barreiro	136	26,976
Murial	177	42,547
Lavra do Meio	44	9,192
Nezinho do Chicao	131	25,671
Maxixe	26	6,711
Tamboril	19	3,582
Elvira	14	1,772
Total	**647**	**131,982**

10.2 DRILL TYPE

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

10.3 SIGMA DRILLING CAMPAIGNS

10.3.1 Xuxa

As of October 31st 2022, SMSA had completed a total of 100 diamond drill holes on Xuxa for 15,531 m (Table 10-2). All of the drilling to the end of 2018 was used in support of Mineral Resource estimation. The seven holes drilled in 2021 were confirmation drill holes and are not included in the current resource statement.

Table 10-2: Total Xuxa Drilling

Year	Number of Drill Holes	Metres Drilled
2014	9	649
2017	57	7,149
2018	27	6,178
2021	7	1,555
Total	**100**	**15,531**

The 2014 drill program was undertaken by a Brazilian-based company named 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 2017-2018 drilling, increased to 13.6 metres.

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

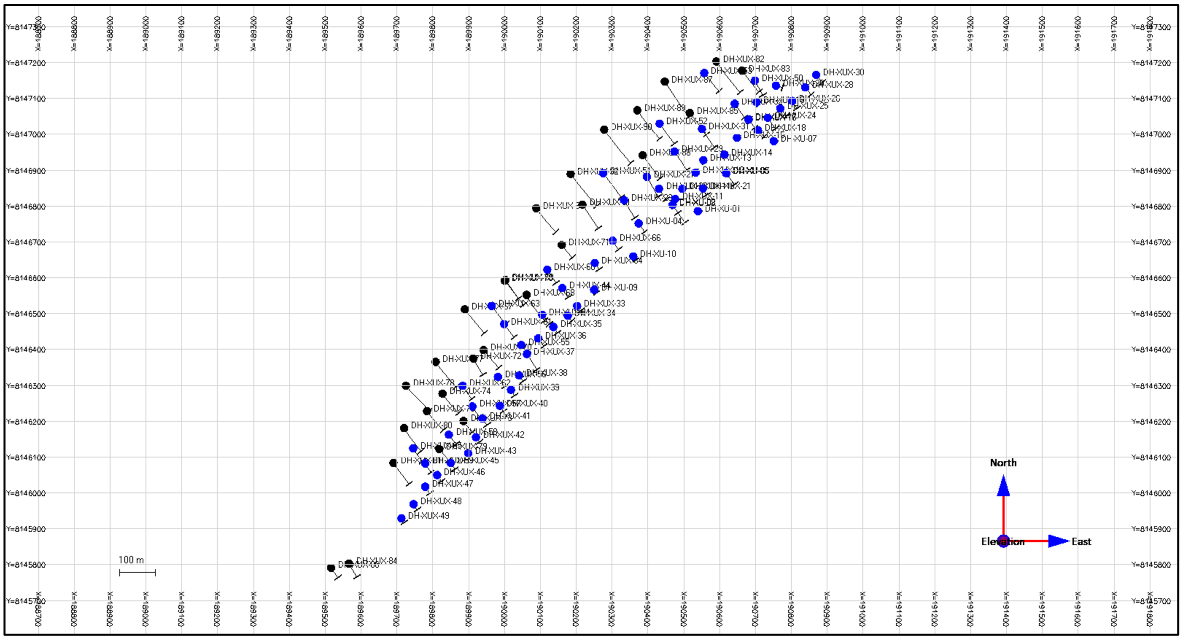


Figure 10-1: Plan View of the Drilling at Xuxa (2017 blue collars and 2018 black collars)

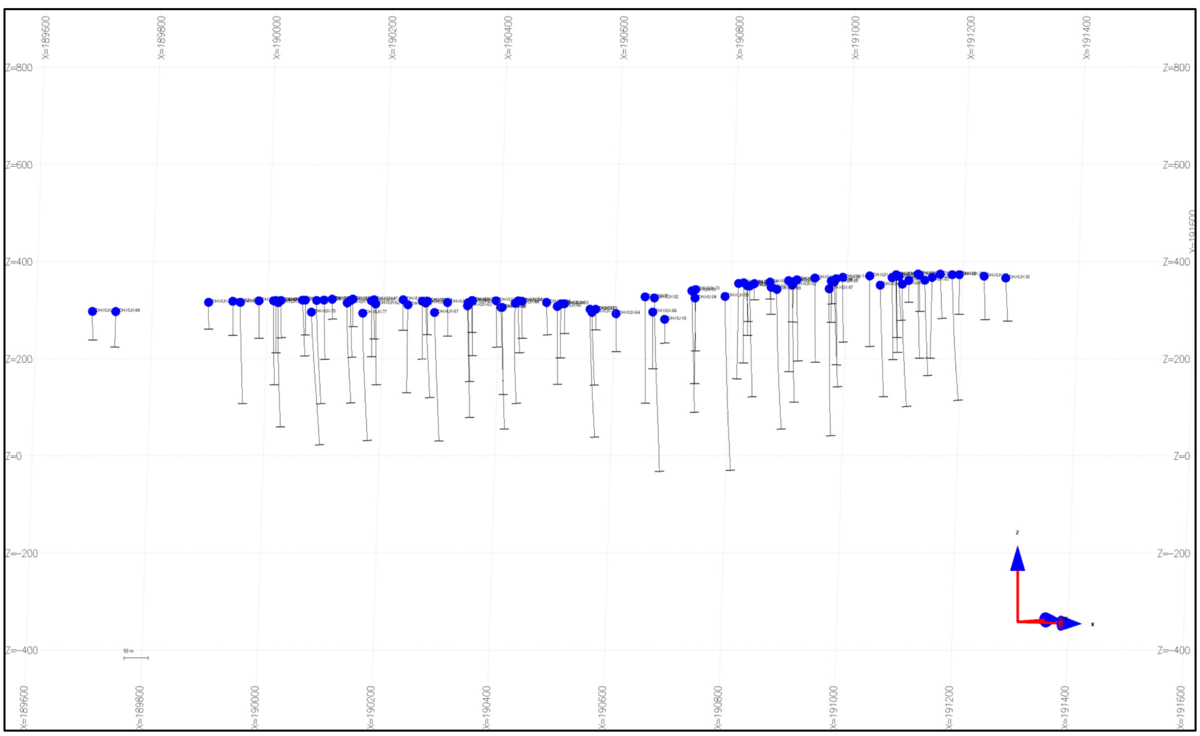


Figure 10-2: Longitudinal View of the Drilling at Xuxa

10.3.2 Barreiro

Drilling from 2014–2021 consisted of 136 HQ drill holes (26,976 m). The drilling is summarized by year in Table 10-4. All of the drill holes are used in Mineral Resource estimation.

Table 10-4: Total Barreiro Drilling

Year	Number of Drill Holes	Metres Drilled
2014	4	181
2017	2	234
2018	103	19,243
2021	27	7,318
Total	**136**	**26,976**

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 m, resulting in a typical true thickness of 35-40 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

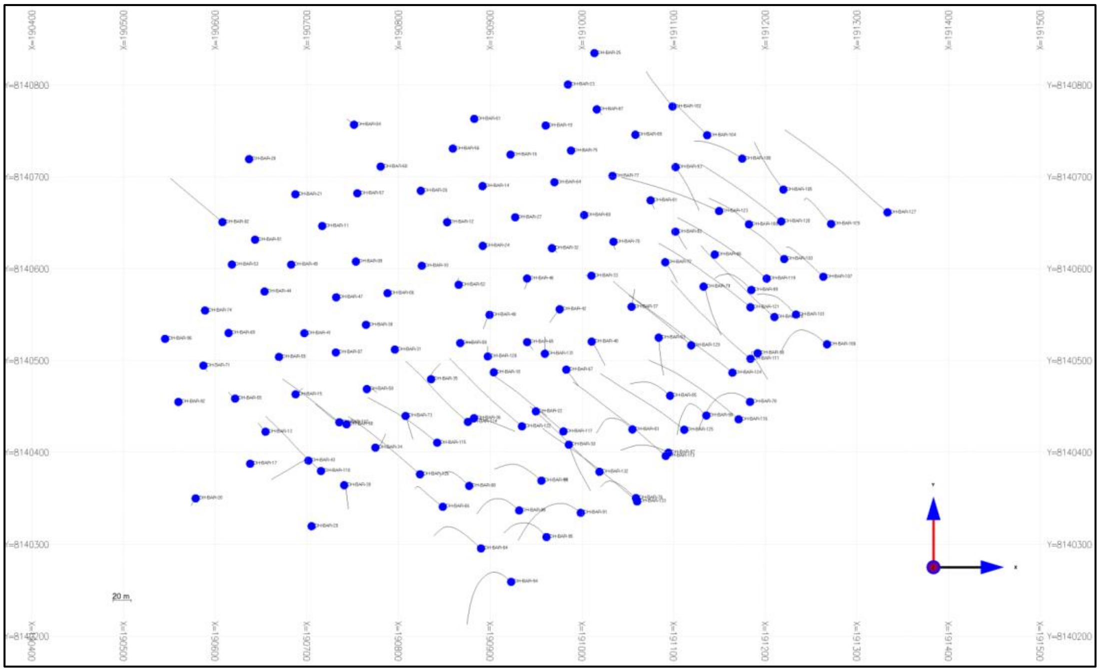


Figure 10-3: Plan View of the Drilling at Barreiro

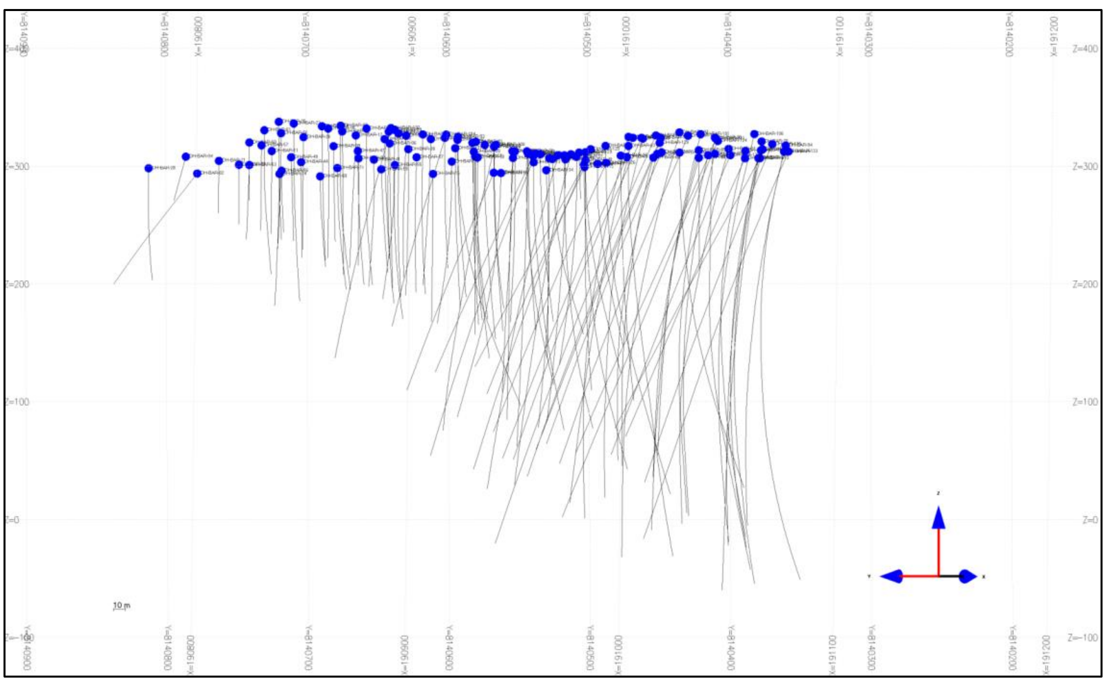


Figure 10-4: Longitudinal View of the Drilling at Barreiro

10.3.3 Lavra do Meio

During 2017–2018, SMSA completed 17 HQ core holes for 2,119 m, while another 27 holes for 7,073 m were completed as part of the 2023 drill program. 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	158
2018	15	1,961
2023	27	7,073
Total	**44**	**9,192**

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

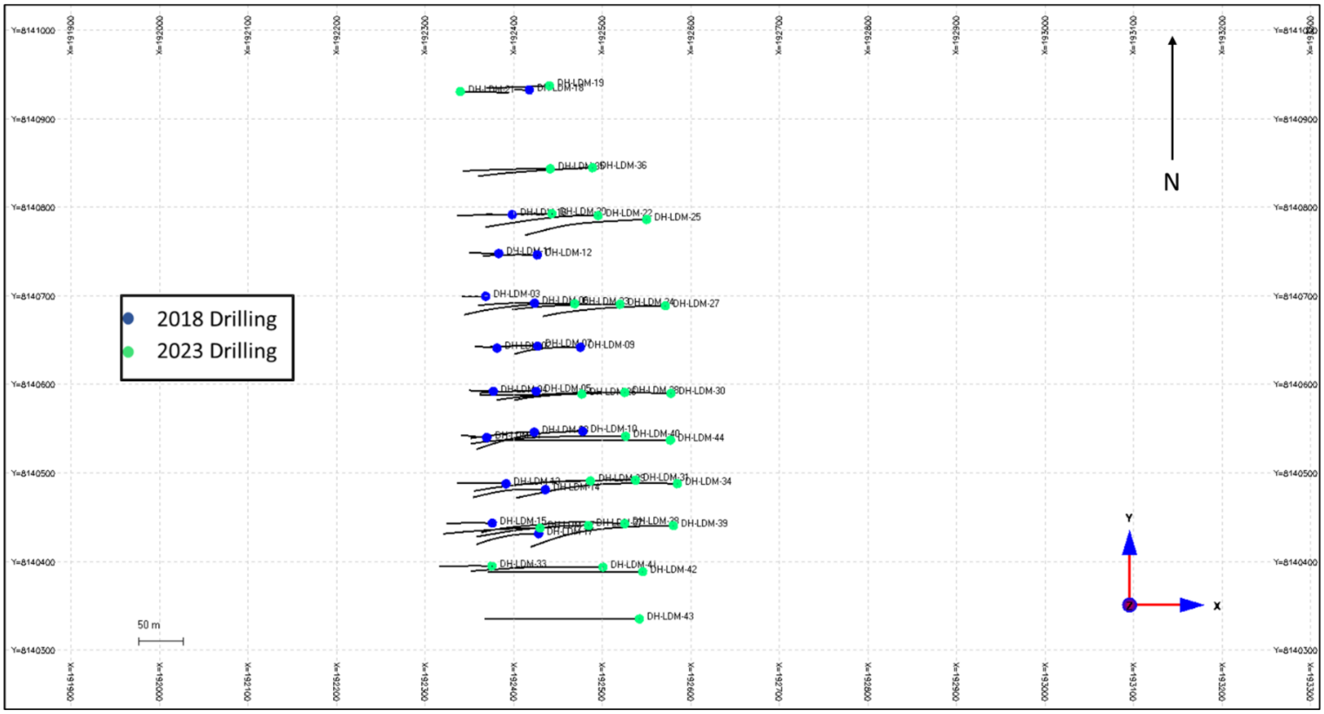


Figure 10-5 – Plan View of the Drilling at Lavra do Meio

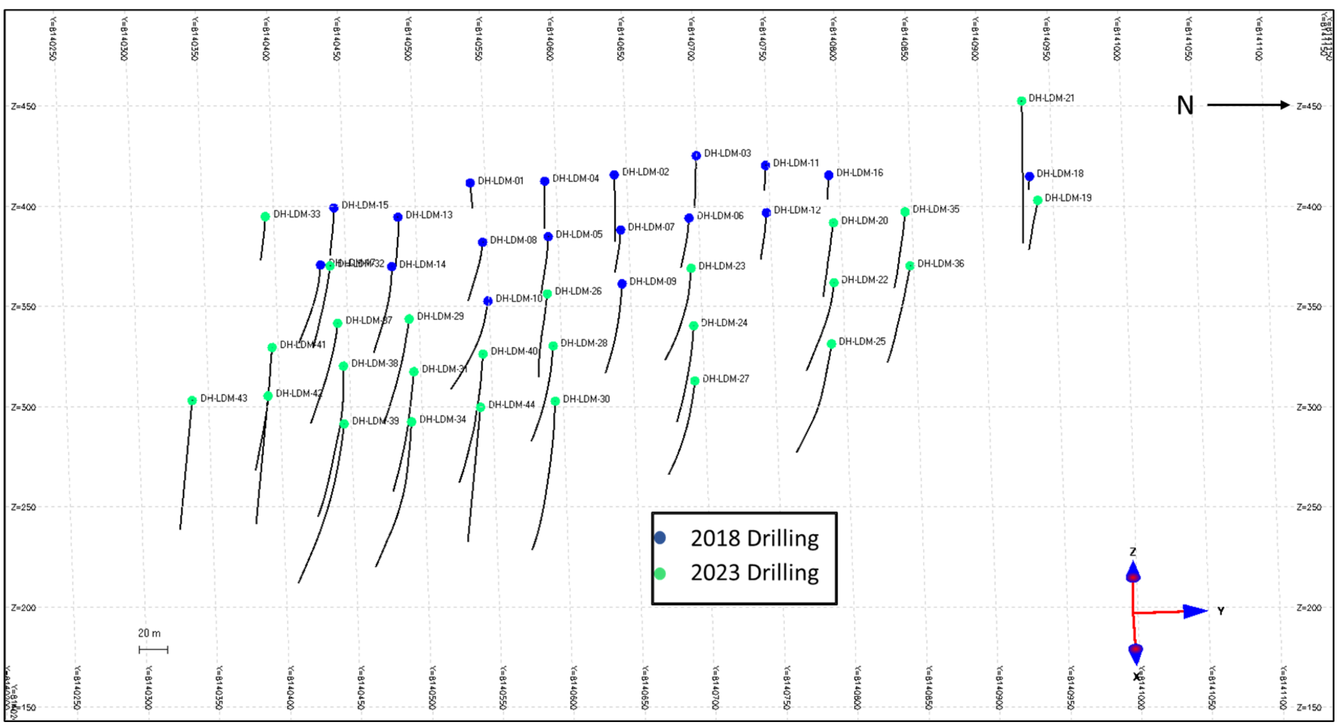


Figure 10-6: Longitudinal View of the Drilling at Lavra do Meio

10.3.4 Murial

Drilling from 2017 to the end of 2023 totals 17,528 m in 79 HQ core holes. A drill hole summary table is provided in Table 10-8. Only the drill holes from 1 to 34 were used in the 2018 Mineral Resource estimation, while the later 2018 results and the 2022 results will be used for the next MRE update.

Table 10-8: Total Murial Drilling

Year	Number of Drill Holes	Metres Drilled
2017	1	119
2018	34	5,765
2022	49	12,793
2023	93	23,870
Total	**177**	**42,547**

The core holes drilled at Murial in 2017 and 2018 were drilled predominantly at an angle of -60 to the west, perpendicular to the orientation of the southernmost pegmatite intrusion. The 2022 and 2023 drilling extends the mineralization northward and is drilled generally vertical, which is perpendicular to the general orientation of the pegmatite intrusions there which are more flat-lying. The spacing is typically 50 m with some spacing at 100 m at the northern portion of the drill pattern. The drill holes dips range from 57° to 90° 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

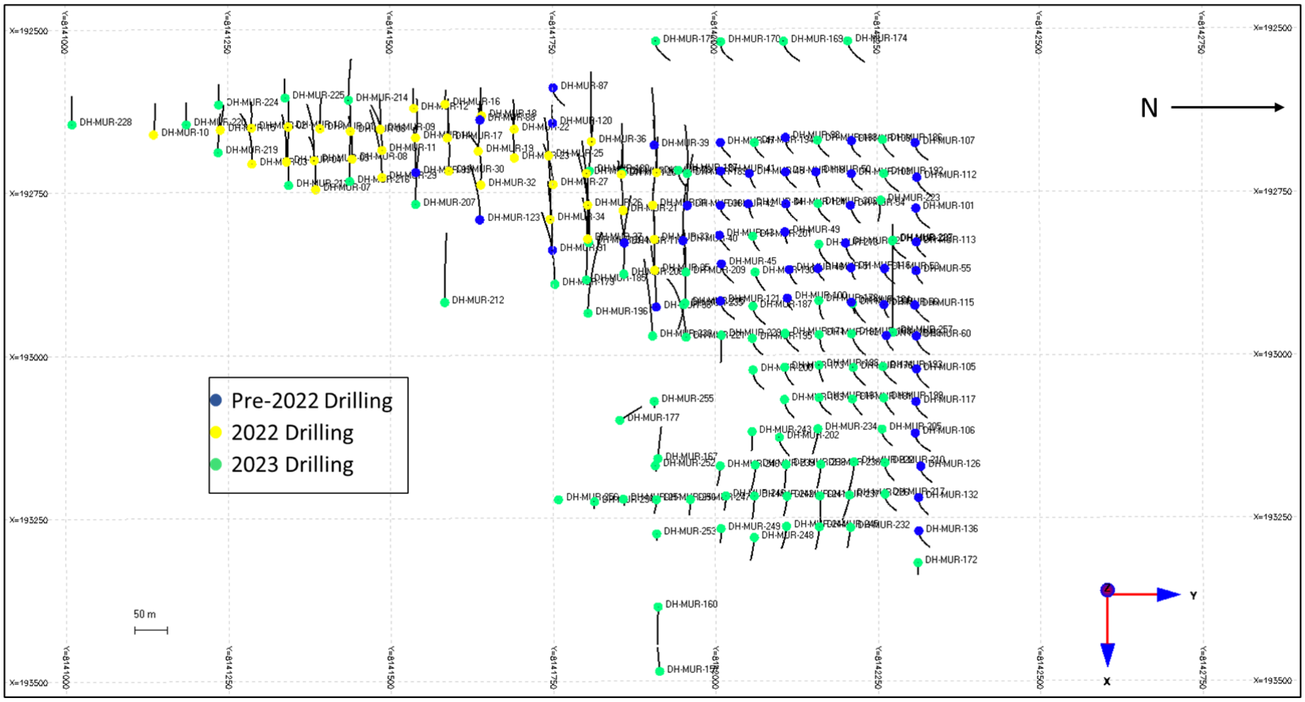


Figure 10-7: Plan View of the Drilling at Murial

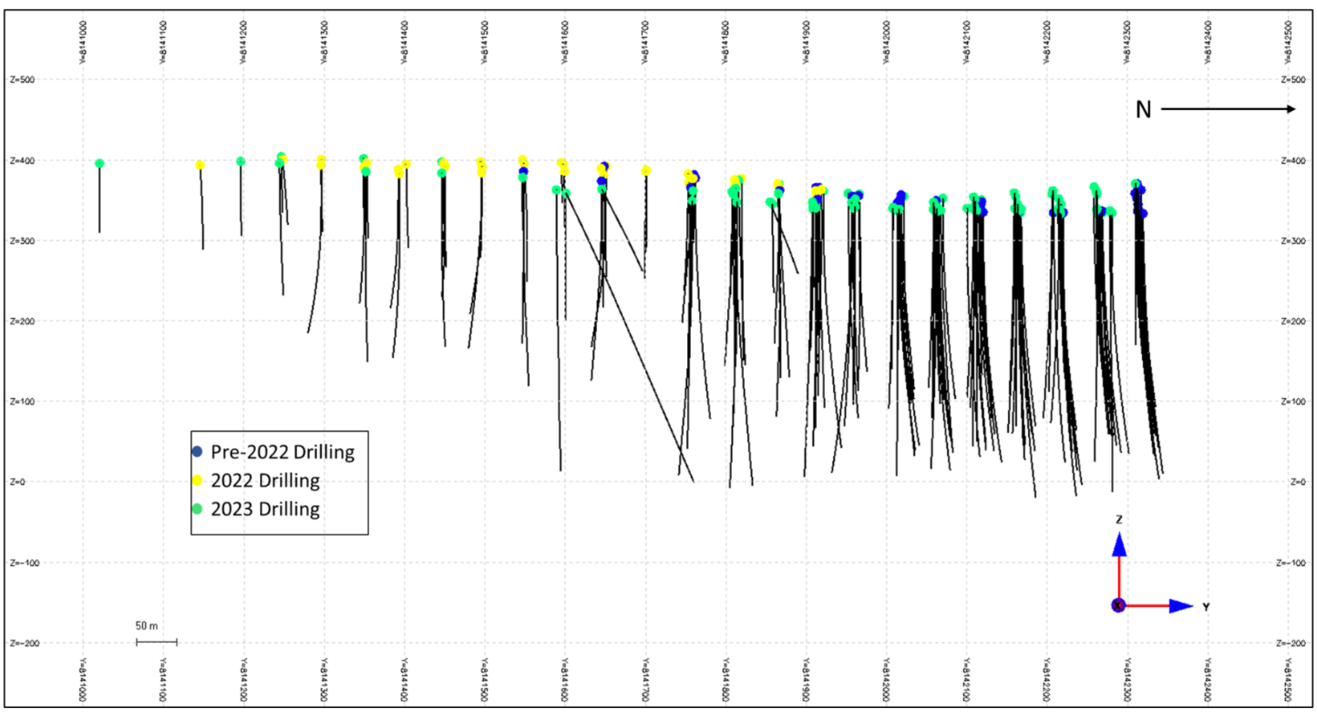


Figure 10-8: Longitudinal View of the Drilling at Murial

10.3.5 Nezinho do Chicao

One hundred and thirty-one drill holes totalling 22,014 m have been completed at Nezinho do Chicao to the end of 2023 (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 1.49% Li_2O. Due the cut-off date, the assay results of holes 118, 120 and 123 were not available for the October 31 2022 MRE update.

Two of the holes at NDC have been drilled vertically and the remaining are inclined between 060º to 090º (average of 65º). The core holes are generally oriented at azimuth 295°, perpendicular to the general orientation of the pegmatite intrusions. Drill spacing is typically 100 m with wider spacing at the edges of the drill pattern. The drill hole intercepts range in thickness from approximately 90% of true width to near true width of the mineralization.

Figure 10-9 shows the collar locations and Figure 10-10 is a longitudinal view of the drilling.

Table 10-10: Nezinho do Chicao Drilling to December 1, 2021

Year	Number of Drill Holes	Metres Drilled
2018	5	394
2021-2022	**118**	**21,916**
2023	**8**	**3,361**
Total	**131**	**25,671**

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

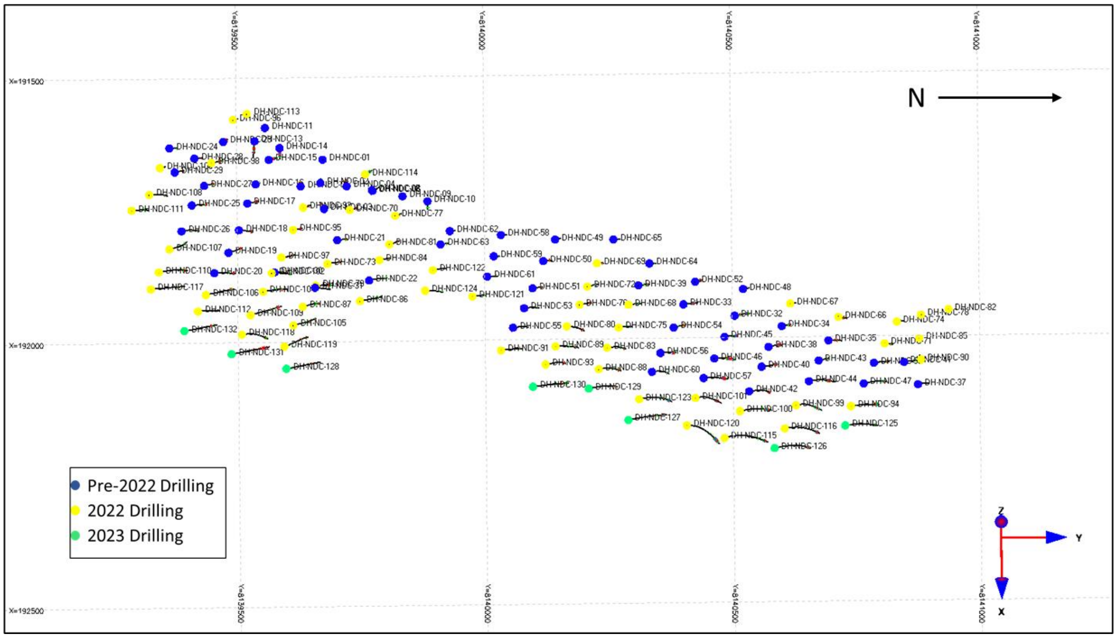


Figure 10-9: Plan View of the Drilling at Nezinho do Chicao

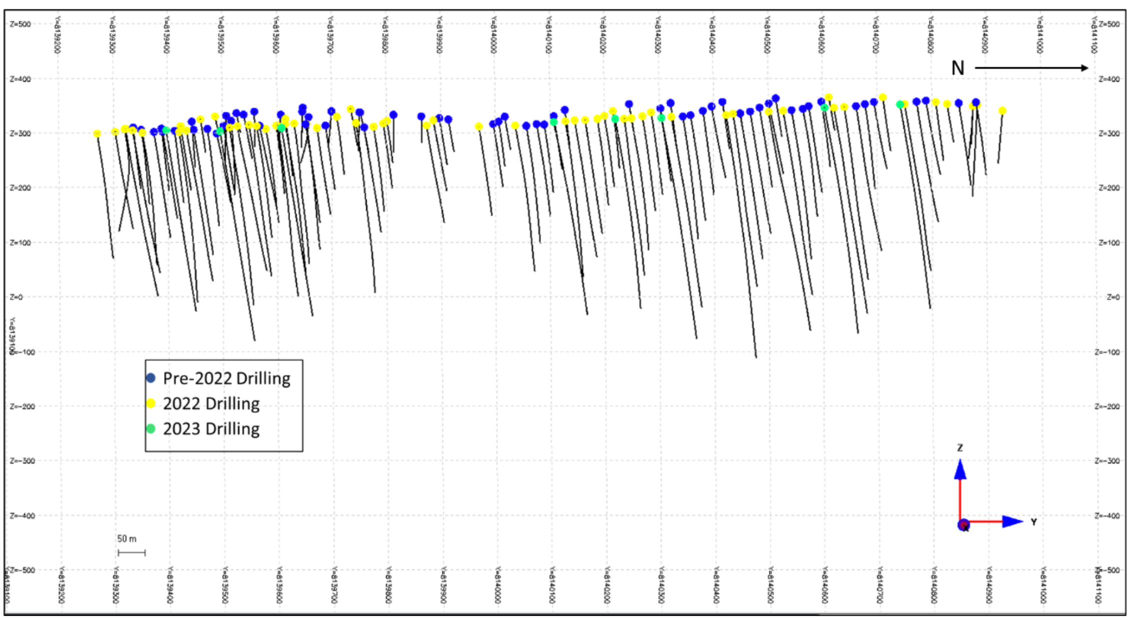


Figure 10-10: Longitudinal View of the Drilling at Nezinho do Chicao

10.3.6 Maxixe

Two drill holes totalling 217 m were completed at Maxixe in 2017, followed by 24 drillholes for 6,494 m in 2023. (Table 10-12).

One of the holes at Maxixe was drilled at 070° and the remaining are inclined at 060°. The core holes are oriented at azimuth 270°, perpendicular to the general orientation of the pegmatite intrusions. Drill spacing is typically 50 m with wider spacing in the centre and on the edges of the drill pattern. The drill hole intercepts range in thickness from approximately 90% of true width to near true width of the mineralization.

Figure 10-11 shows the collar locations and Figure 10-12 is a longitudinal view of the drilling.

Table 10-12: Total Maxixe Drilling

Year	Number of Drill Holes	Metres Drilled
2017	2	217
2023	24	6,494
Total	**26**	**6,711**

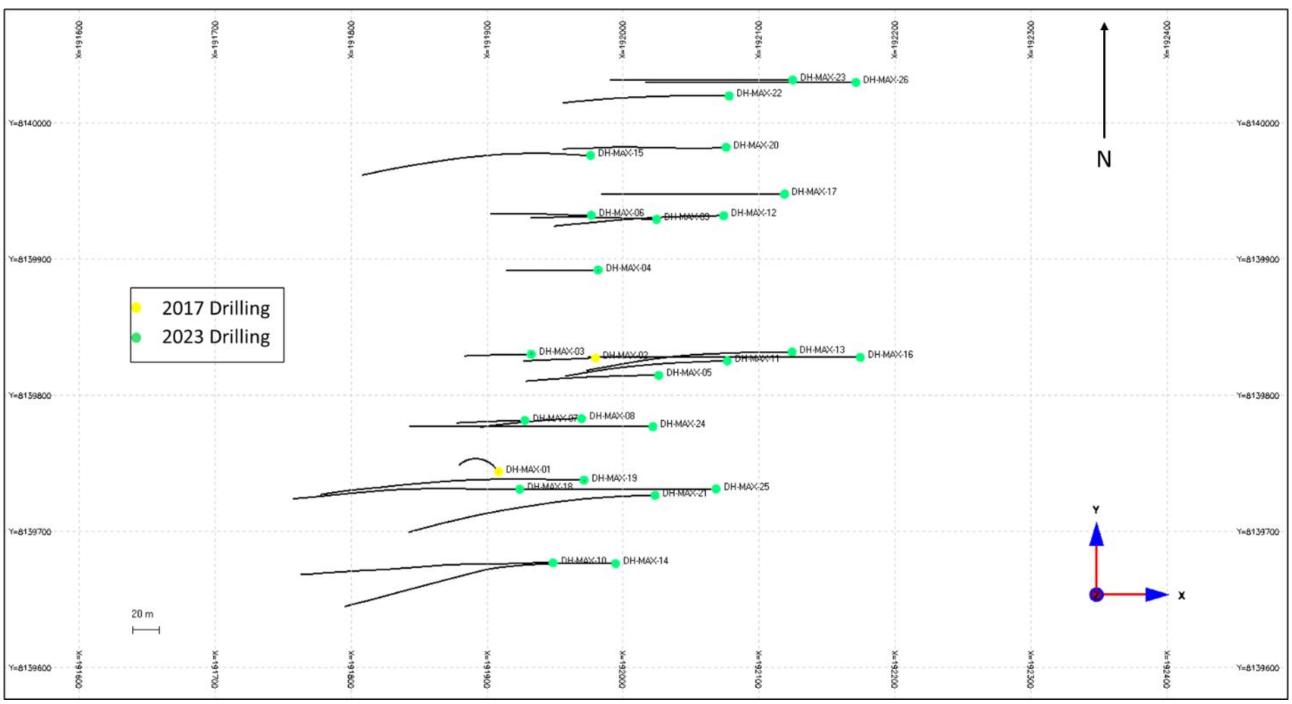


Figure 10-11: Plan View of the Drilling at Maxixe

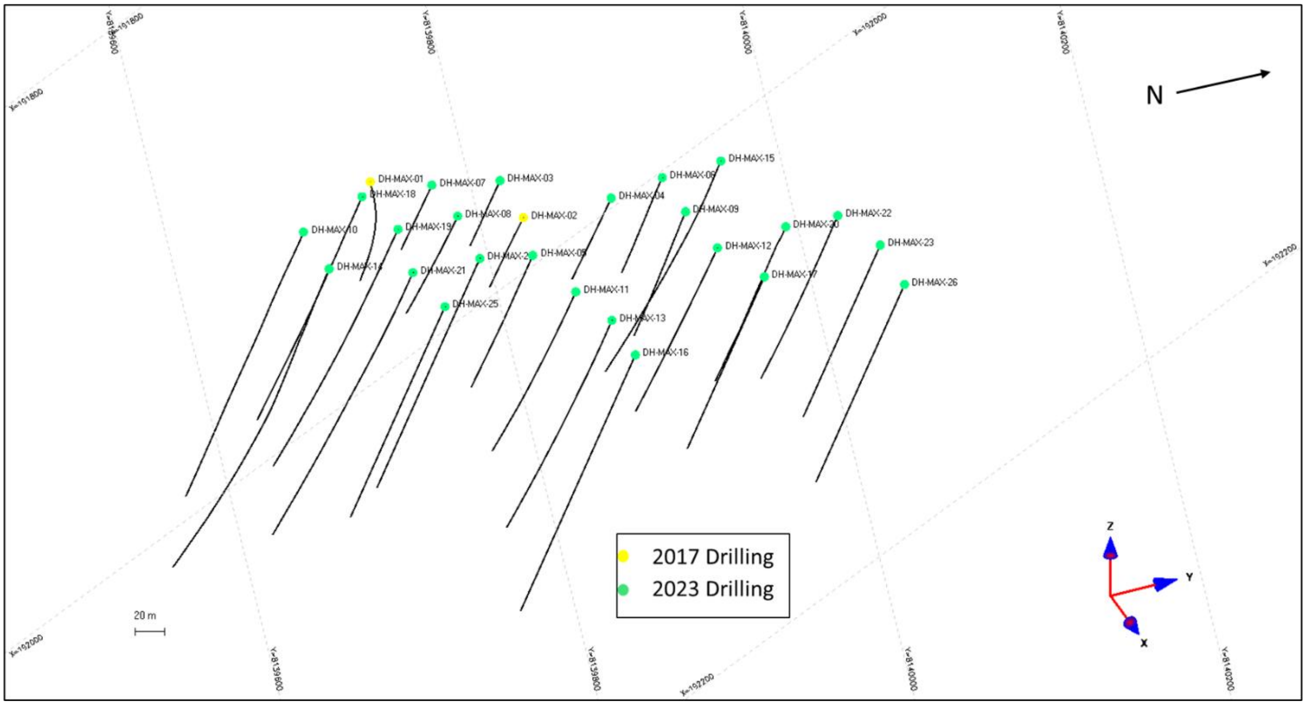


Figure 10-12: Longitudinal View of the Drilling at Maxixe

10.3.7 Tamboril

Eleven drill holes totalling 1,560 m were completed at Maxixe in 2022, with a further eight holes for 2,022 m completed in 2023. (Table 10-13). All the holes are inclined at 060° and oriented at an azimuth of 270°, perpendicular to the general orientation of the pegmatite intrusions. Drill spacing is typically 50 m with wider spacing in the centre and on the edges of the drill pattern. The drill hole intercepts range in thickness from approximately 90% of true width to near true width of the mineralization.

Figure 10-13 shows the collar locations and Figure 10-14 is a longitudinal view of the drilling.

Table 10-13: Total Tamboril Drilling

Year	Number of Drill Holes	Metres Drilled
2022	11	1,560
2023	8	2,022
Total	19	3,582

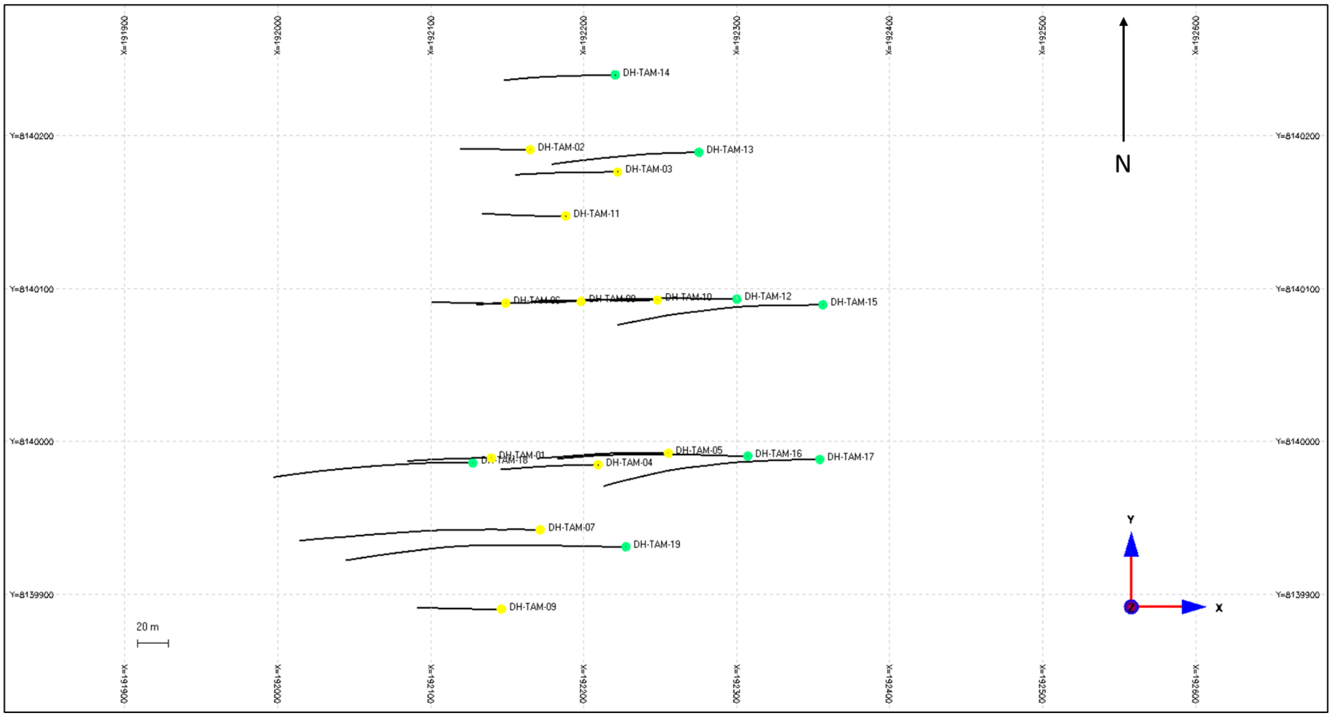


Figure 10-13: Plan View of the Drilling at Tamboril

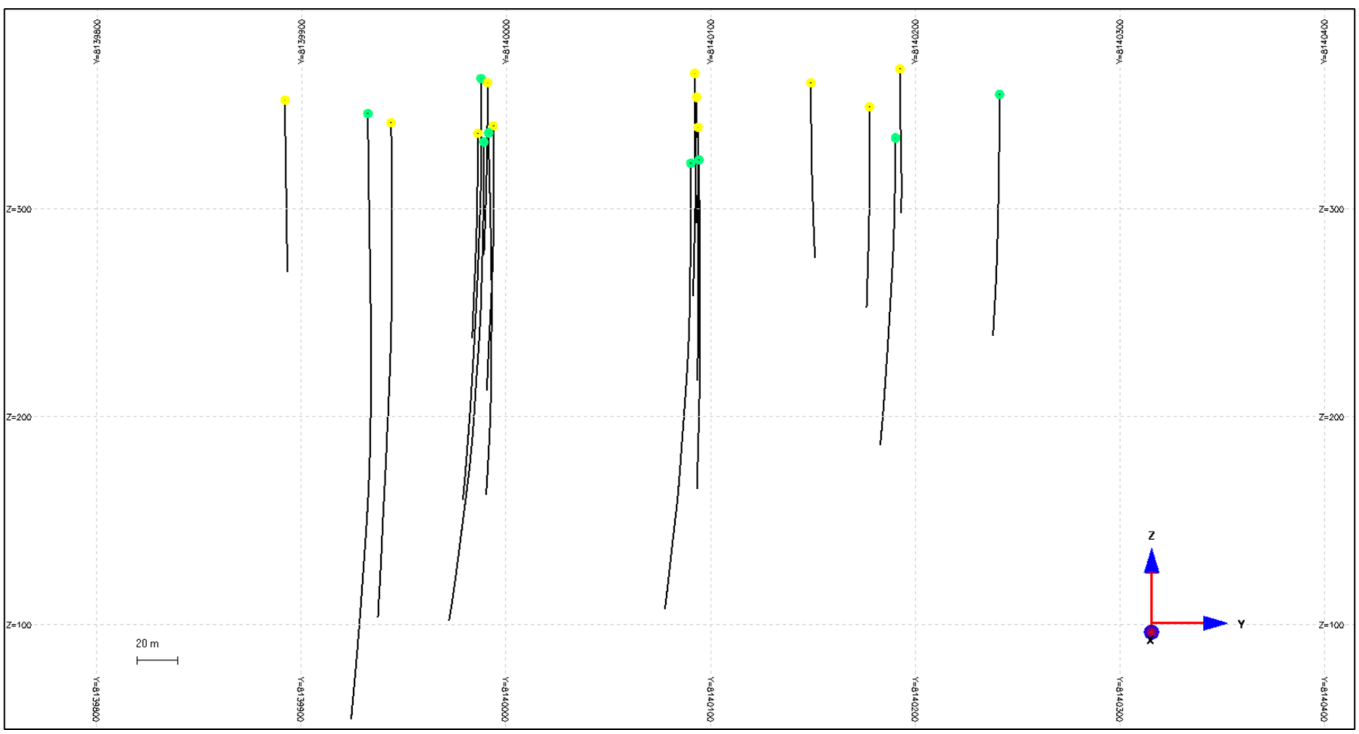


Figure 10-14: Longitudinal View of the Drilling at Tamboril

10.3.8 Elvira

Nine drill holes totalling 1,234 m were completed at Elvira in 2023. (Table 10-14). All the holes are inclined at 060° and oriented at an azimuth of 340°, perpendicular to the general orientation of the pegmatite intrusions. Drill spacing is typically 100 m. The drill hole intercepts range in thickness from approximately 90% of true width to near true width of the mineralization.

Figure 10-15 shows the collar locations and Figure 10-16 is a longitudinal view of the drilling.

Table 10-14: Total Elvira Drilling

Year	Number of Drill Holes	Metres Drilled
2023	9	1,234
Total	9	1,234

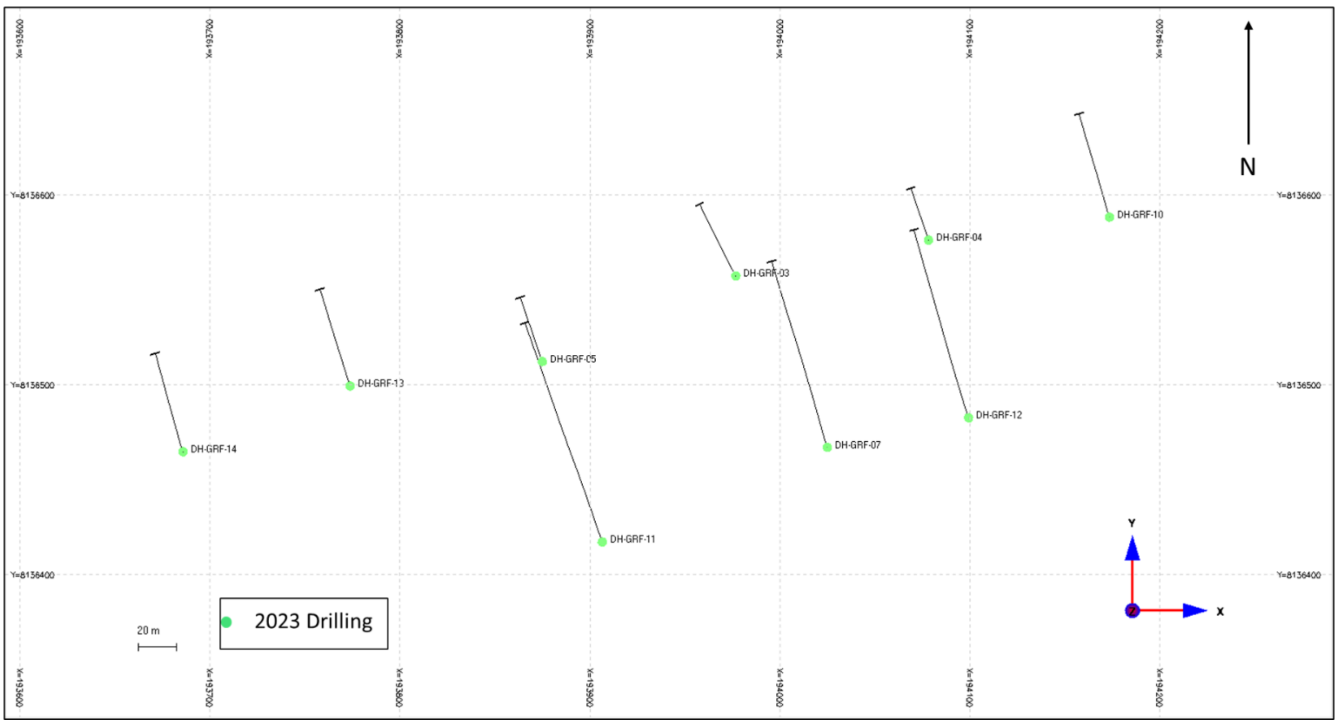


Figure 10-15: Plan View of the Drilling at Elvira

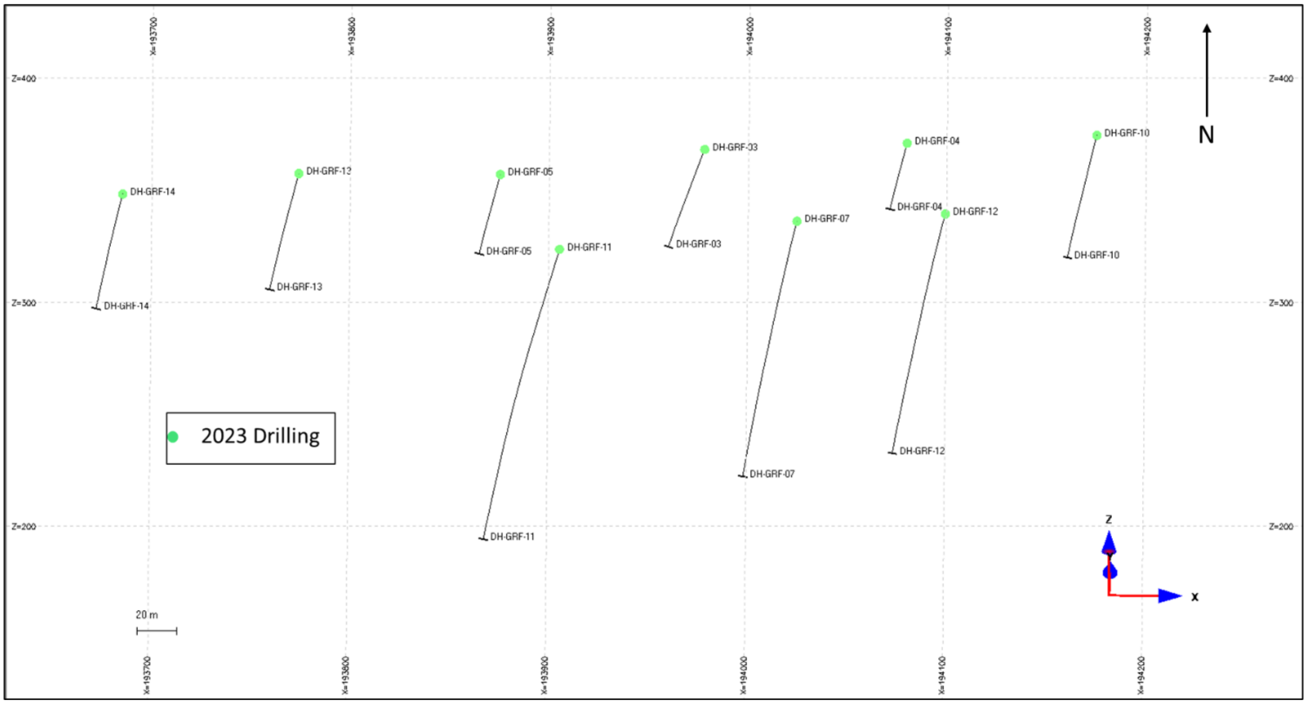


Figure 10-16: Longitudinal View of the Drilling at Elvira

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 dry and wet.

10.5 RECOVERY

Due to the hardness of the pegmatite units, the recovery of the drill core was generally excellent, and was typically close to 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 every year on a regular basis.

10.7 QP COMMENT

SMSA conducted HQ drilling programs in 2014, 2017, 2018, 2021, 2022 and 2023 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, Murial, Nezinho do Chicao, Maxixe, Tamboril and Elvira.

11 SAMPLE PREPARATION, ANALYSES AND SECURITY

11.1 INTRODUCTION

The descriptions in this section are based on information supplied by SMSA and observations made during the independent verification programs conducted at the Project site by SGS during September 11–15, 2017, July 11–17, 2018, September 18-23, 2018, October 18-21, 2021, and May 30 to June 01, 2022

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

SMSA 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 and 2020-2021 Xuxa drill programs 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 Sigma's representative and the project geologist.

For the 2020-2021 Barreiro metallurgical test work, SGS Lakefield utilized the 713 samples from Barreiro that they had on hand to produce four variability samples and one composite sample. After reviewing drill collar, survey, assay, and lithological data associated with the samples, they determined their sample selection criteria. Of the 713 samples on hand, 15 were discounted as they fell outside the known mineralization. The remaining 698 samples were divided into four variability samples based on lithium grade and petalite content. Sub-samples from each variability sample would then be blended to create a master composite.

A PFS-level metallurgical test work program was undertaken on samples from the NDC deposit from April 2022 to December 2022 at SGS Lakefield. The aim of the NDC sample selection process for the metallurgical test work program was to select three variability samples (High, Medium, and Low-Grade) of at least 500 kg. Sub-samples from each variability sample were then be blended to create a master composite which was tested to produce 6% Li_2O concentrate, and recoveries measured. Three thousand seven hundred forty-seven (3747) individual assays were available at SGS Lakefield for production of the variability samples.

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, Lavra do Meio, Nezinho do Chicao, Murial, Maxixe and Tamboril deposits.

A total of 220 measurements were made on Xuxa core from 2017-2021. Of the 220 measurements, 26 were made on albite-altered pegmatite, 69 on schist, and 121 on lithium-bearing pegmatite.

For Barreiro, a total of 470 measurements were made on core from the 2018 and 2021 drill program. Of the 470 measurements, 94 were made on albite-altered pegmatite, 206 on schist, and 164 on lithium-bearing pegmatite.

From the 2022-2023 Murial exploration program, a total of 1,365 samples from 112 drillholes had density measurements calculated. Of those samples, there were 161 spodumene samples and 49 petalite samples. A weighted average of the core metres logged as spodumene-bearing and petalite-bearing was used to calculate the overall average density of the deposit.

From the 2023 Lavra do Meio exploration program, a total of 197 samples from 25 drillholes had density measurements calculated. Of those samples, there were 25 spodumene samples and 13 petalite samples. A weighted average of the core metres logged as spodumene-bearing and petalite-bearing was used to calculate the overall average density of the deposit.

From the 2022-2023 NDC exploration program, a total of 140 samples from 11 drillholes had density measurements calculated. Of those samples, there were 25 spodumene samples and 15 petalite samples. A weighted average of the core metres logged as spodumene-bearing and petalite-bearing was used to calculate the overall average density of the deposit.

From the 2023 Maxixe exploration program, a total of 149 samples from 20 drillholes had density measurements calculated. Of those samples, there were 18 spodumene samples and 11 petalite samples. A weighted average of the core metres logged as spodumene-bearing and petalite-bearing was used to calculate the overall average density of the deposit.

From the 2022-2023 Tamboril exploration program, a total of 95 samples from 17 drillholes had density measurements calculated. Of those samples, there were 15 spodumene samples and 6 petalite samples. A weighted average of the core metres logged as spodumene-bearing and petalite-bearing was used to calculate the overall average density of the deposit.

From the 2023 Elvira exploration program, a total of 31 samples from five drillholes had density measurements calculated. Of those samples, there were six spodumene samples and three petalite samples. A weighted average of the core metres logged as spodumene-bearing and petalite-bearing was used to calculate the overall average density of the deposit.

Table 11-1 shows the average specific gravity results for the lithium-bearing pegmatite for each of the deposits.

Table 11-1: Specific Gravity of Lithium-Bearing Pegmatites

Deposit	Specific Gravity g/cm^3
Xuxa	2.70
Barreiro	2.71
Murial	2.68
Lavra do Meio	2.67
Nezinho do Chicao	2.67
Maxixe	2.62
Tamboril	2.68
Elvira	2.65

11.4 ANALYTICAL AND TEST LABORATORIES

All samples collected by SMSA during the course of the 2012–2022 exploration programs relating to the Grota do Cirilo property were sent to SGS Geosol in Belo Horizonte, Brazil.

A portion of the 2017–2022 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 pursuant to 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 SMSA'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, 2018, 2020, 2021 and 2022 exploration programs from the Grota do Cirilo property were transported directly by SMSA 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 2018-2022 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, SMSA 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 SMSA in 2013 and 2014.

11.6.1 2014 Sampling Program

11.6.1.1 Analytical Standards

SMSA inserted standards in sample batches during the 2013-2014 sampling program. 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.

11.6.1.2 Analytical Blanks

During the 2013-2014 campaign Sigma included insertion of analytical blanks in the sample series as part of their internal QA/QC protocol. The blanks were sourced from a local silicate stone.

11.6.2 2017-2018 Sampling Campaign

11.6.2.1 Analytical Standards

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 11-2: 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

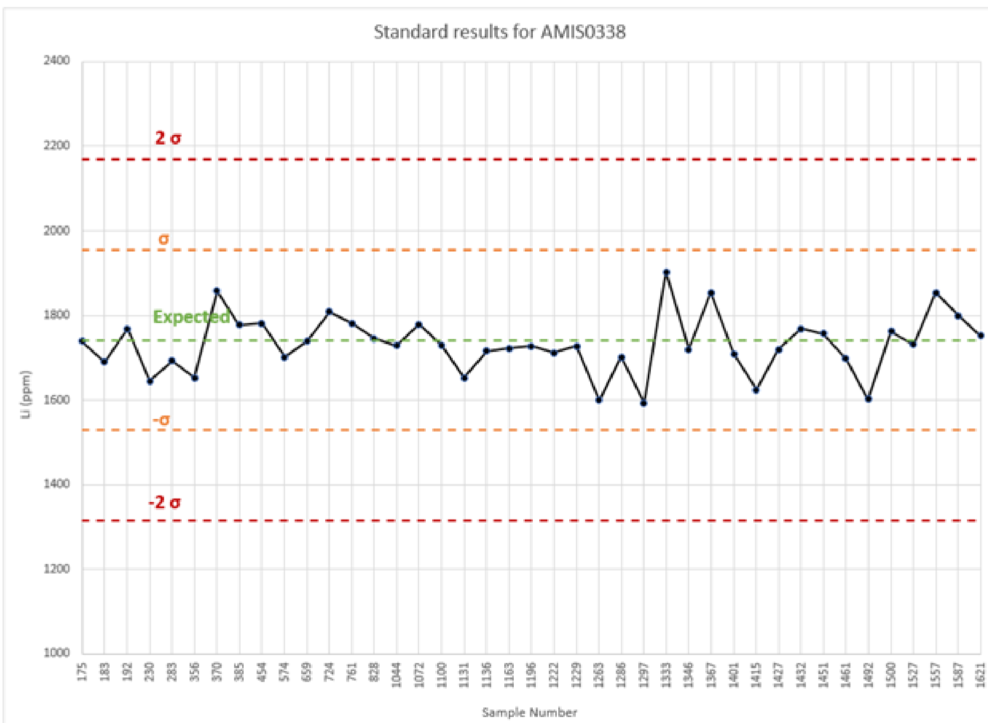


Figure 11-1: Standard Sample Analysis Results for the 2017–2018 Batch with Standard AMIS0338

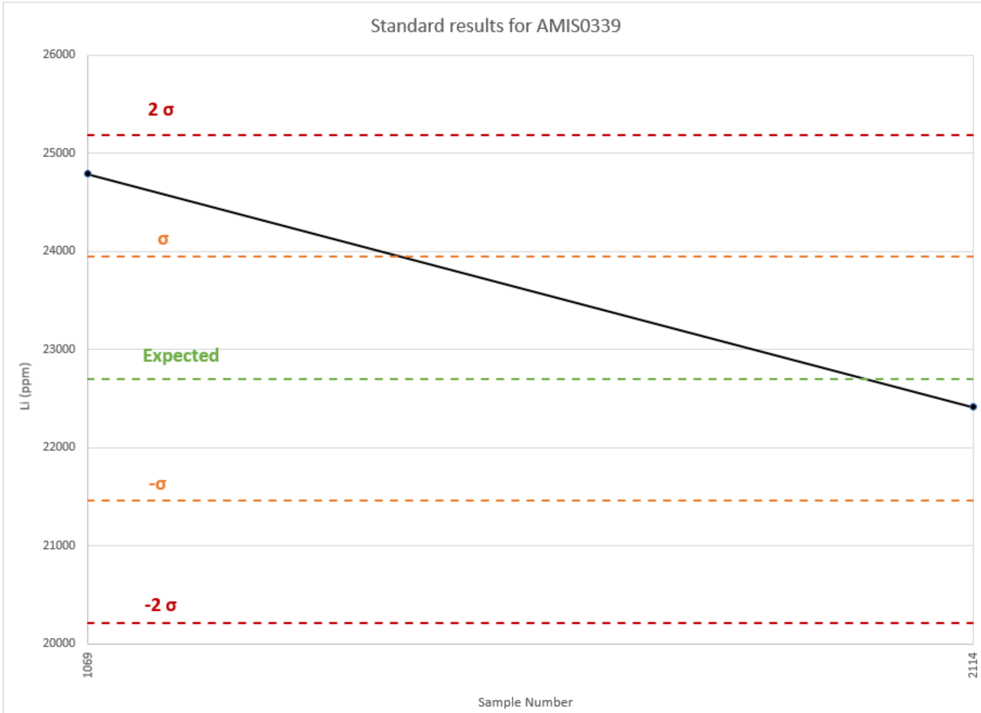


Figure 11-2: Standard Sample Analyses Results for the 2017–2018 Batch with Standard AMIS0339

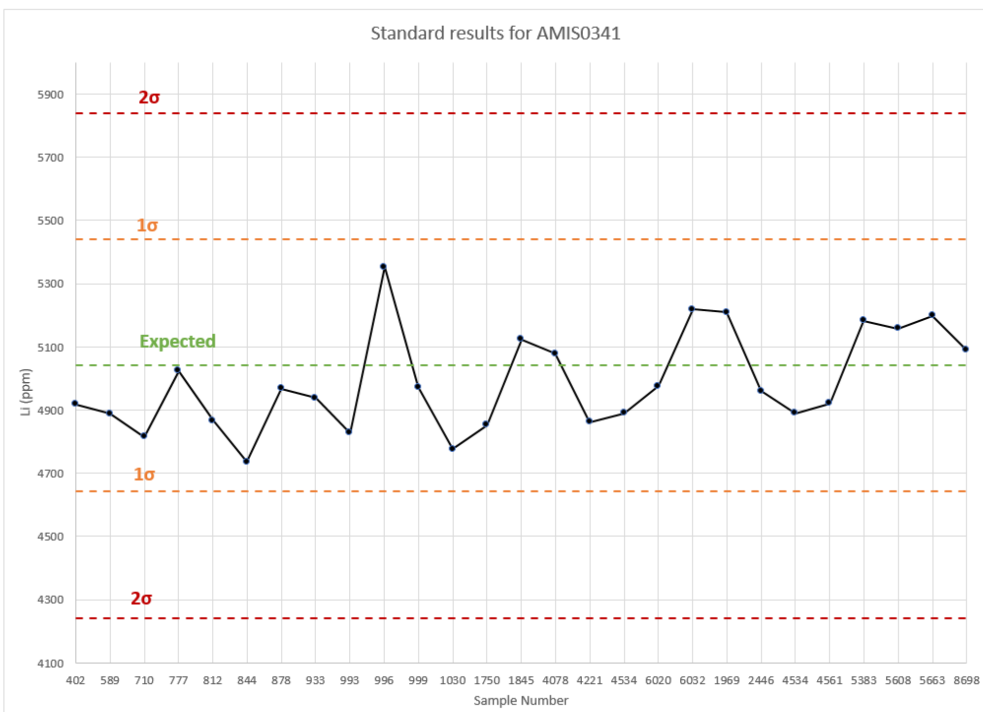


Figure 11-3: Standard Sample Analyses Results for the 2017–2018 Batch with Standard AMIS0341

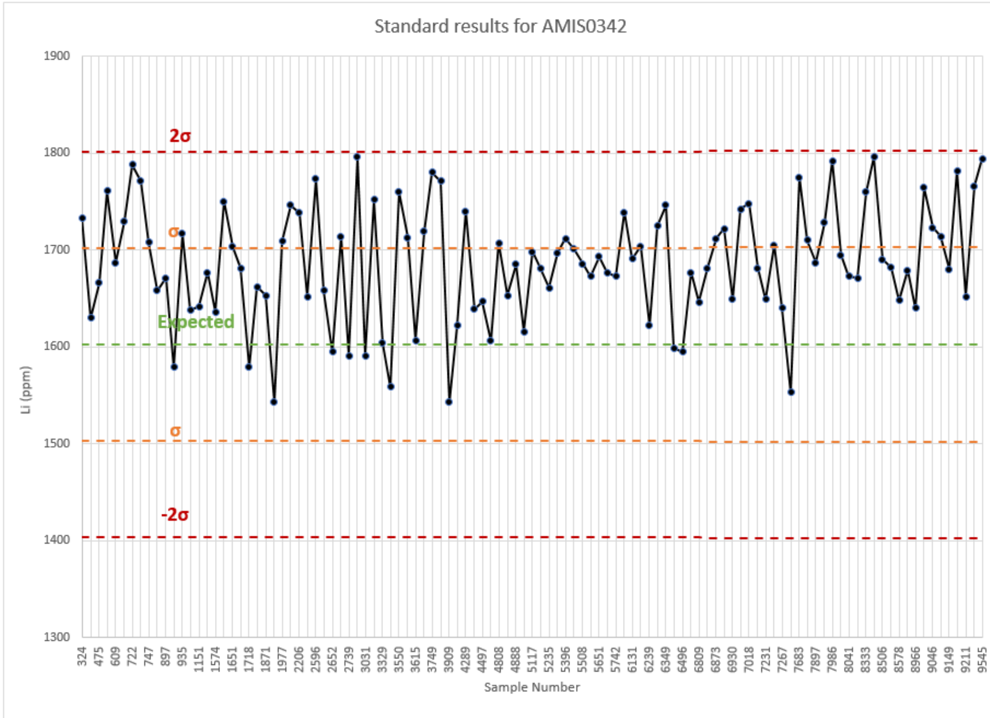


Figure 11-4: Standard Sample Analyses Results for the 2017–2018 Batch with Standard AMIS0342

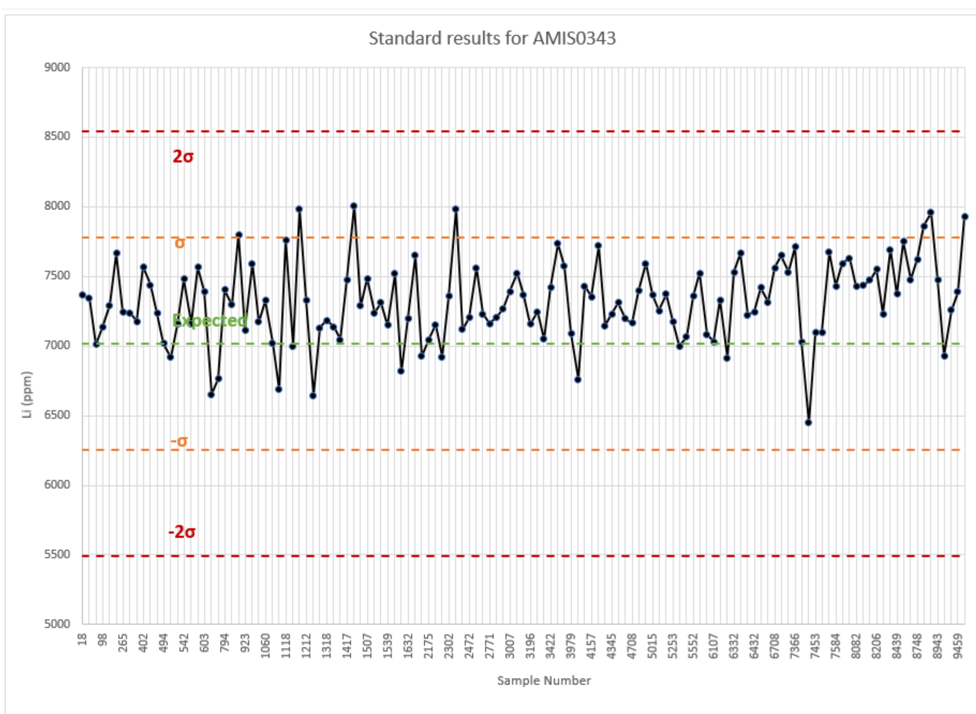


Figure 11-5: Standard Sample Analyses Results for the 2017–2018 Batch with Standard AMIS0343

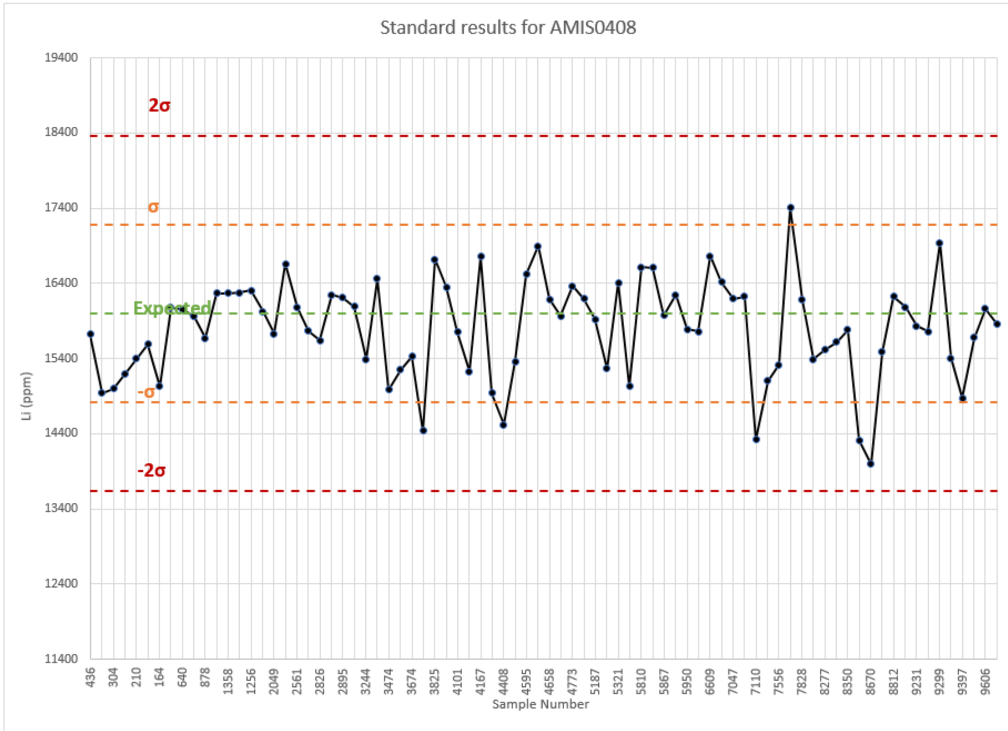


Figure 11-6: Standard Sample Analyses Results for the 2017–2018 Batch with Standard AMIS0408

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

11.6.2.2 Analytical Blanks

During the 2017–2018 campaign SMSA included the 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, were inserted an average of one for every 20 samples by the Sigma geologist and subsequently sent to SGS Geosol.

A total of 647 analytical blanks were analysed during the 2017–2018 exploration programs. From the 647 blanks analysed, the first 39 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 39 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.

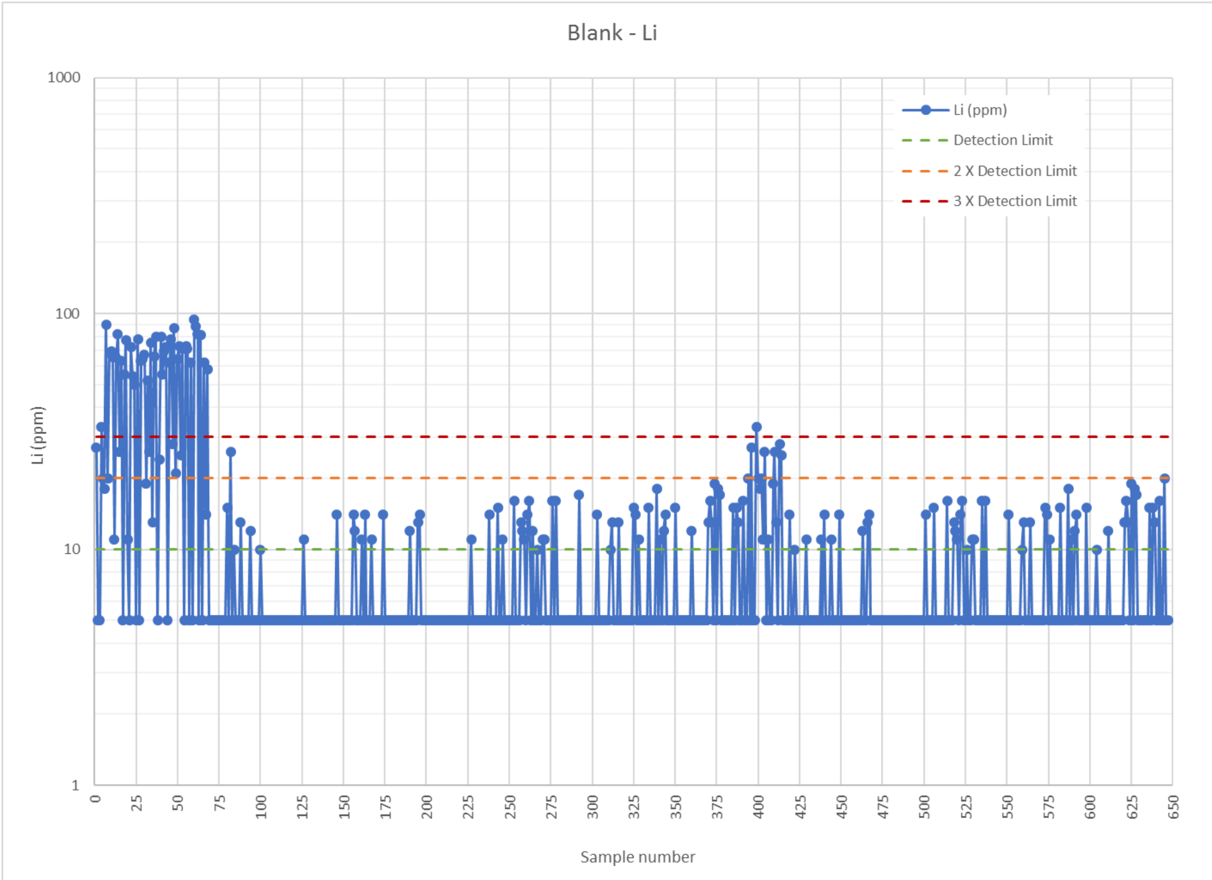


Figure 11-7: Blank Sample Analyses from the 2017–2018 Campaign

11.6.2.3 Core Duplicates

SMSA 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).

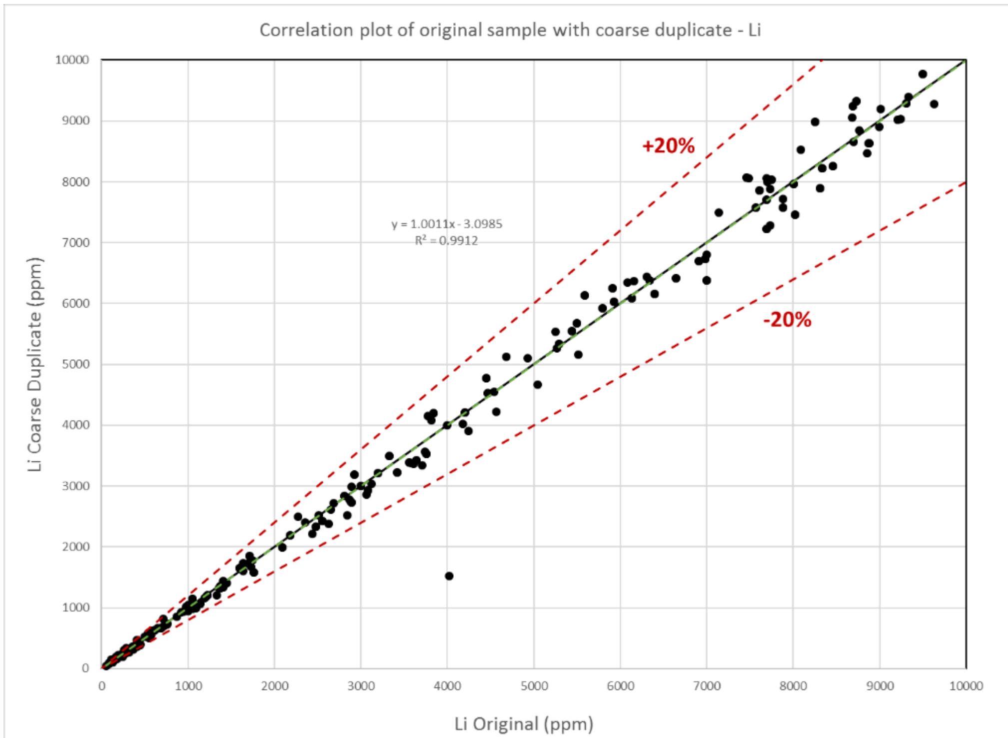


Figure 11-8: Scatterplot of Core Duplicates

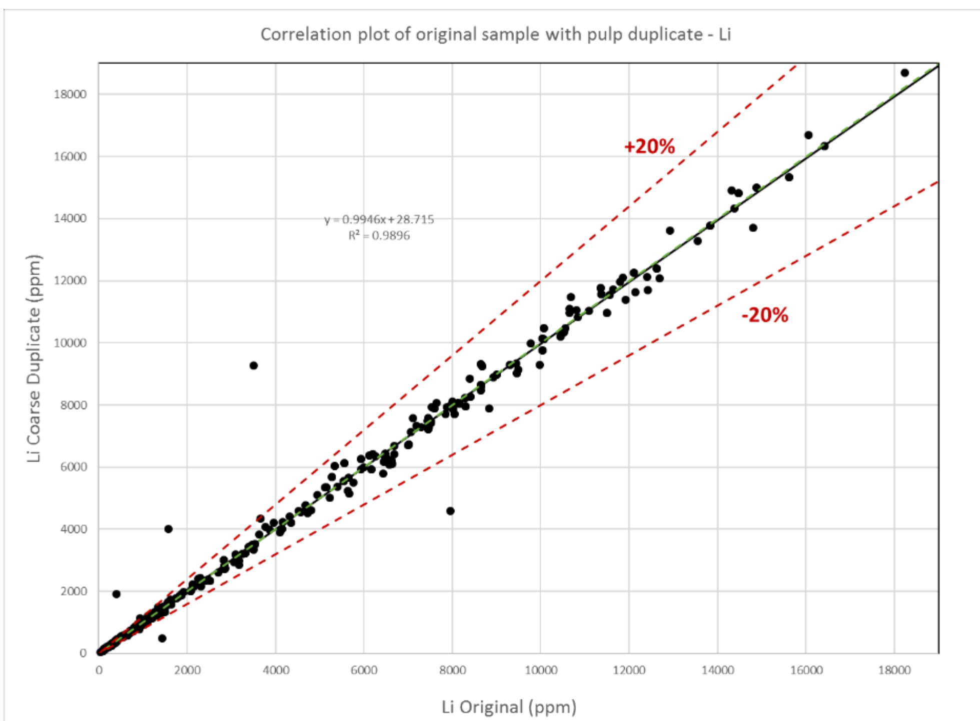


Figure 11-9: Correlation Between Original Samples and Pulp Duplicates

11.6.2.4 Check Assays

As additional QAQC, SMSA 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 ($\alpha = 0.05$) (Table 11-6 and Table 11-7). This indicates a slight bias with the ALS Chemex duplicates which is well within the accepted margin of error. Since the correlation coefficient R2 of 0.9792 suggest a high similarity between the two sets of analyses (Figure 11-10 and Figure 11-11), 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 11-3: Check Assay Original vs Control Samples

ELEMENT	COUNT	ORIGINAL > CONTROL		ORIGINAL ≤ CONTROL	
		Count	%	**Count**	%
Li_2O (%)	664	375	56	287	44

Table 11-4: 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

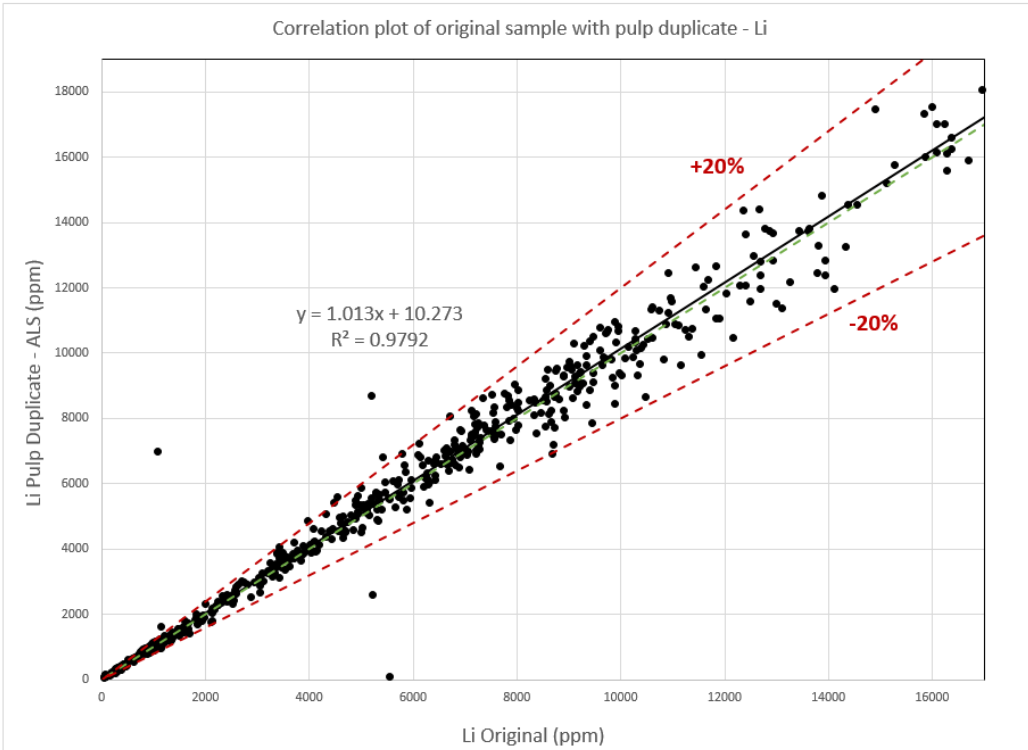


Figure 11-10: Check Assay Correlation Between Original Samples and Pulp Duplicates

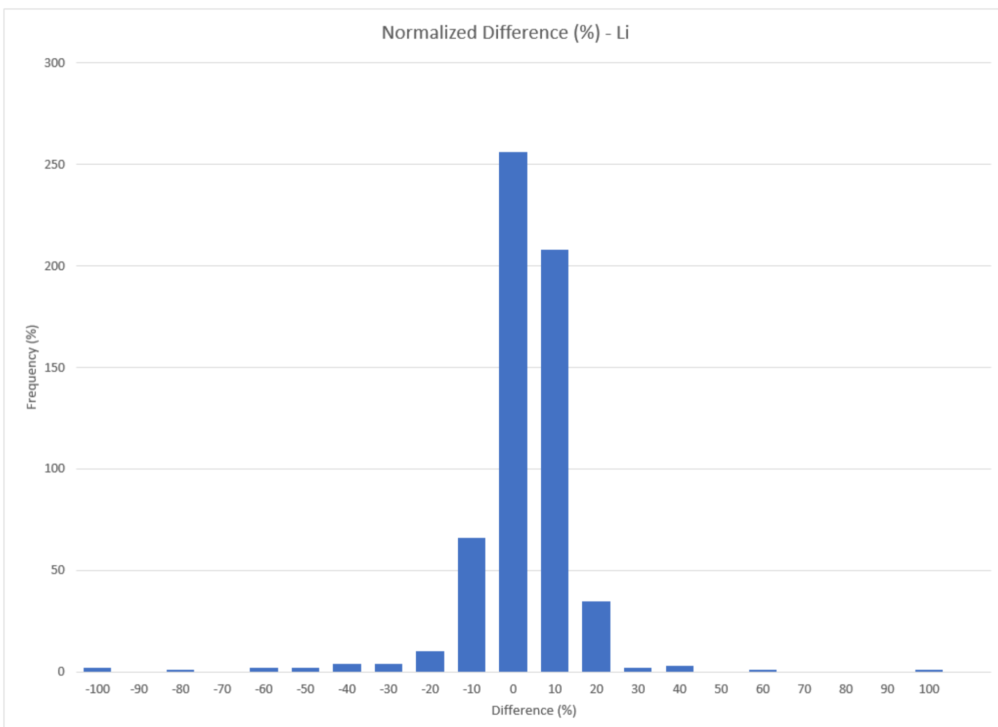


Figure 11-11: Check Assay Distribution of the Difference Between Original Results and Pulp Duplicates

11.6.3 2021 Barreiro Sampling Campaign

For the 2021 drilling and sampling campaign, SMSA's QAQC protocol utilized the inclusion of coarse duplicates, pulp duplicates, standards, blanks and check samples.

For every batch of 24 core samples from an individual hole, there was one coarse duplicate, one pulp duplicate, one standard, one blank and two check samples inserted.

For every batch of 50 core samples from an individual hole, there was one coarse duplicate, one pulp duplicate, two standards, two blanks and three check samples inserted.

11.6.3.1 Analytical Standards

The 2021 campaign used four certified standards from African Mineral Standards (AMIS), an international supplier of certified reference materials (Table 11-8). The recommended lithium values for the AMIS standards used range between 0.16% and 1.50% Li. A total of 73 standards were inserted during the 2021 campaign. Figure 11-12 to Figure 11-15 show the standard results for AMIS standards submitted as part of the 2021 campaign.

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

Analytical Standard	Li (ppm)	Analytical Error (2σ)
AMIS0341	5,041	222
AMIS0342	1,603	199
AMIS0343	7,150	1,525
AMIS0408	16,000	2,400

Note: All concentrations and standard deviations are reported for fusion dissolution of the samples, as this was the assay technique used for the Sigma core samples.

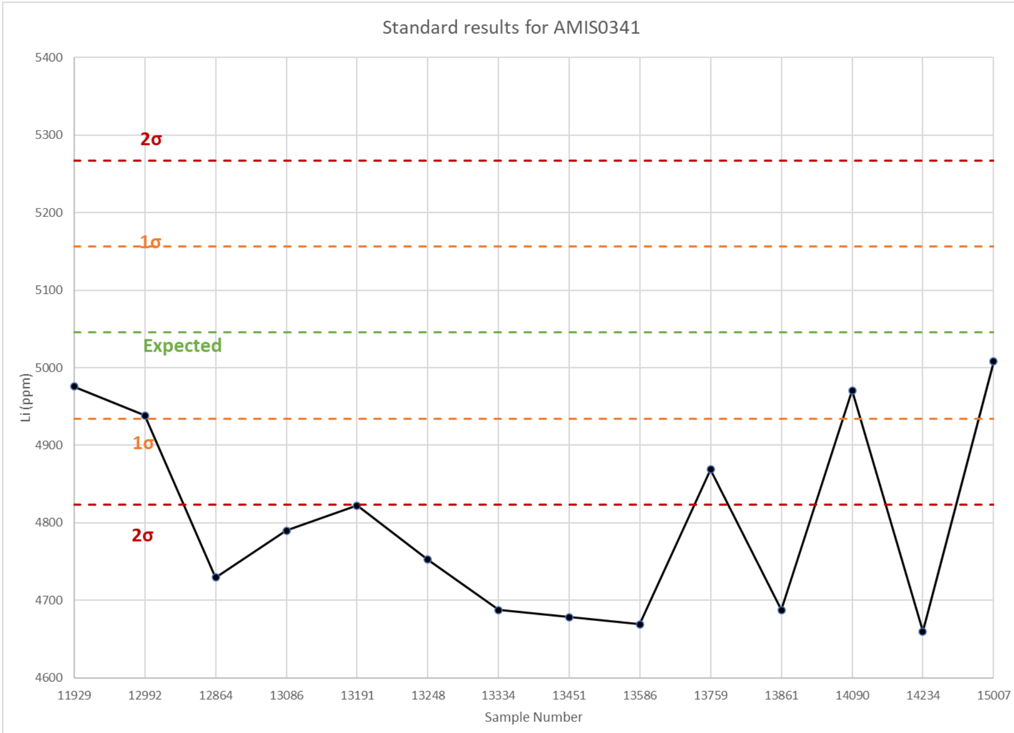


Figure 11-12: Standard Sample Analysis Results for the 2021 Batch with Standard AMIS0341

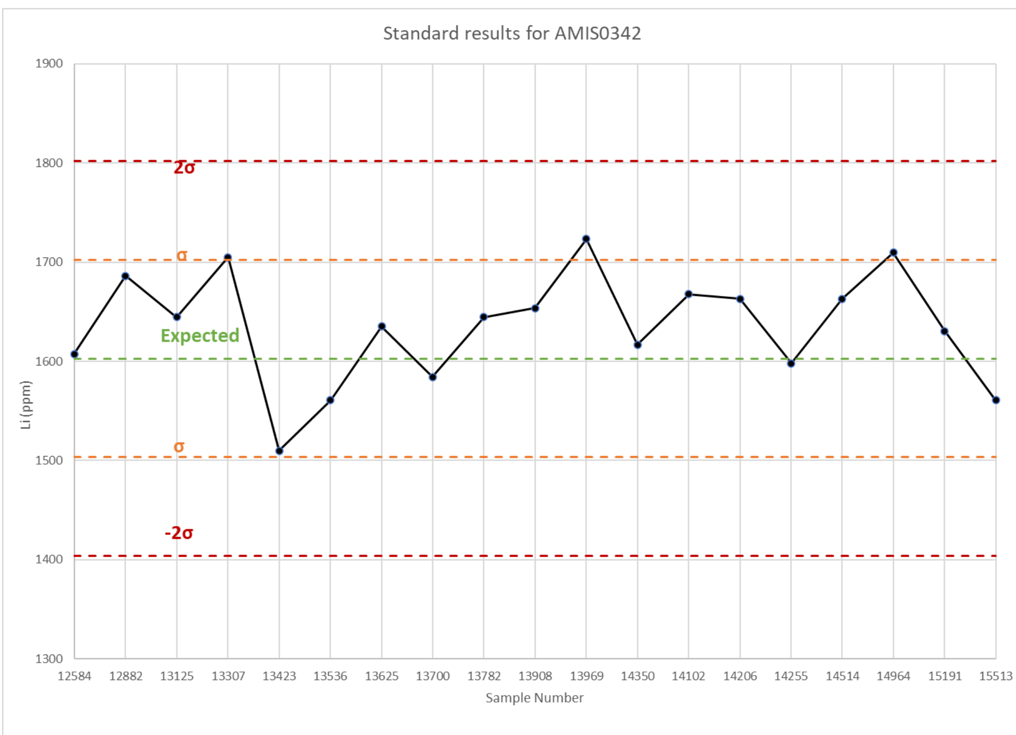


Figure 11-13: Standard Sample Analysis Results for the 2021 Batch with Standard AMIS0342

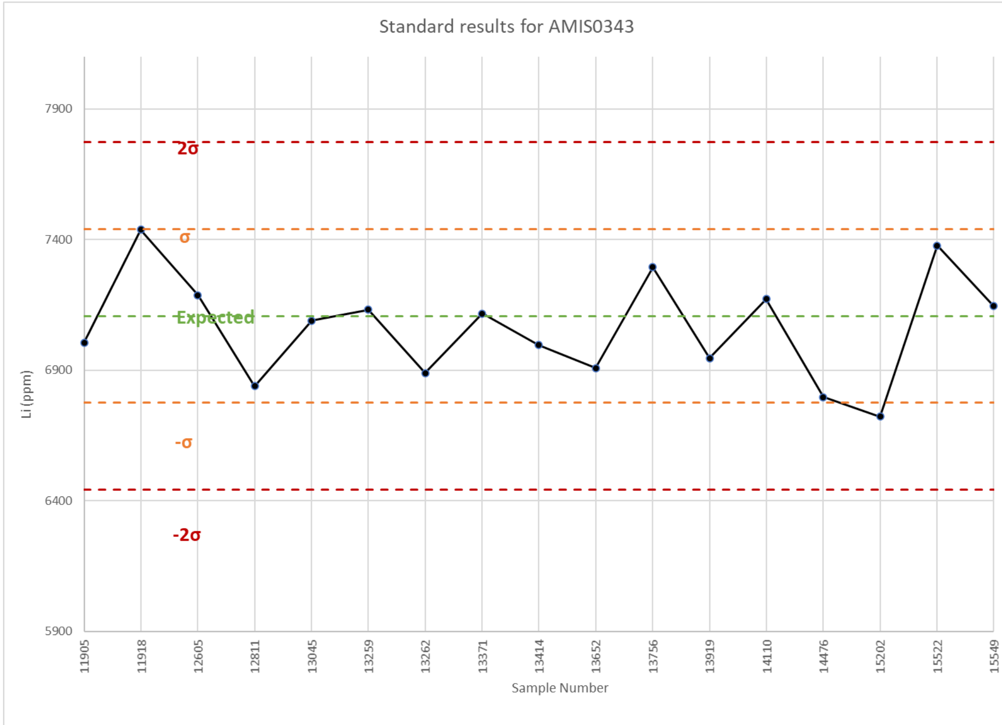


Figure 11-14: Standard Sample Analysis Results for the 2021 Batch with Standard AMIS0343

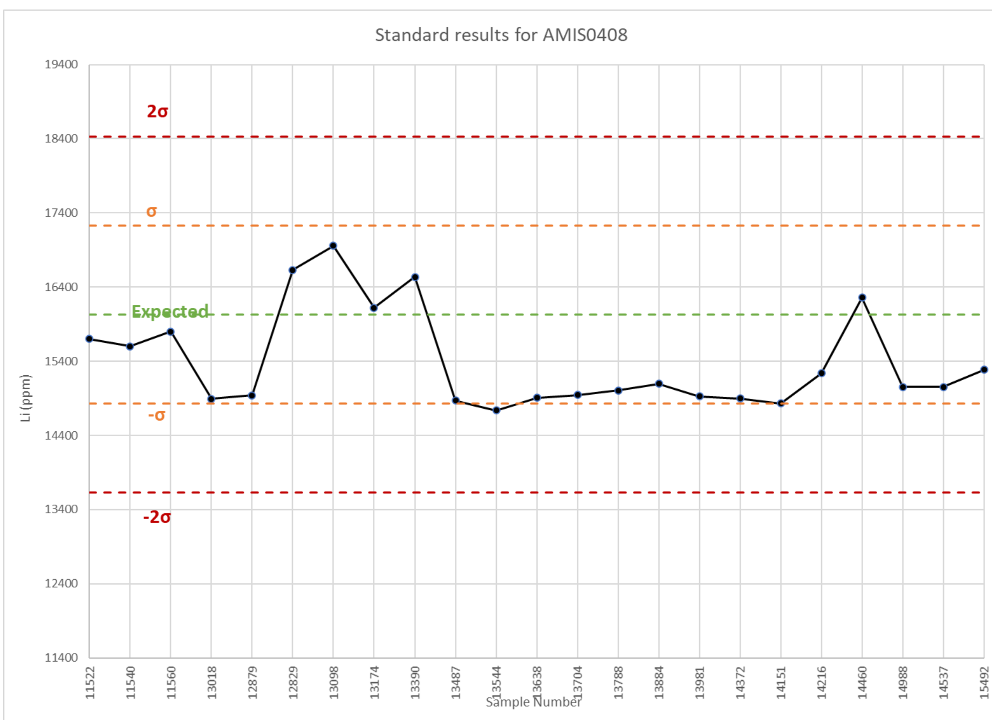


Figure 11-15: Standard Sample Analysis Results for the 2021 Batch with Standard AMIS0408

The results for AMIS0342, AMIS0343 and AMIS0408 all fall within two standard deviations of the mean, although the distribution of AMIS0408 tends to show a slight negative bias compared to the other two standards. This is probably due to a change at the lab in upper limits of detection for the assay techniques used by Sigma, where the upper limit of detection was lowered from 10% Li to 1.5% Li_2O, resulting in the majority of the samples showing as "over limit" and being re-assayed using a four-acid acid digestion and AAS finish.

The results for AMIS0341 are consistently below the two standard deviations for fusion dissolution but are within the limits for a four-acid digestion dissolution.

Overall, the results of the standards analysis are within industry-acceptable standards.

11.6.3.2 Analytical Blanks

A total of 74 analytical blanks were analysed during the 2021 exploration program. Of the 74 blanks, three were above the lower limit of detection of 10 ppm Li and only one was over two standard deviations. Figure 11-16 shows blank sample results from the 2021 exploration program.

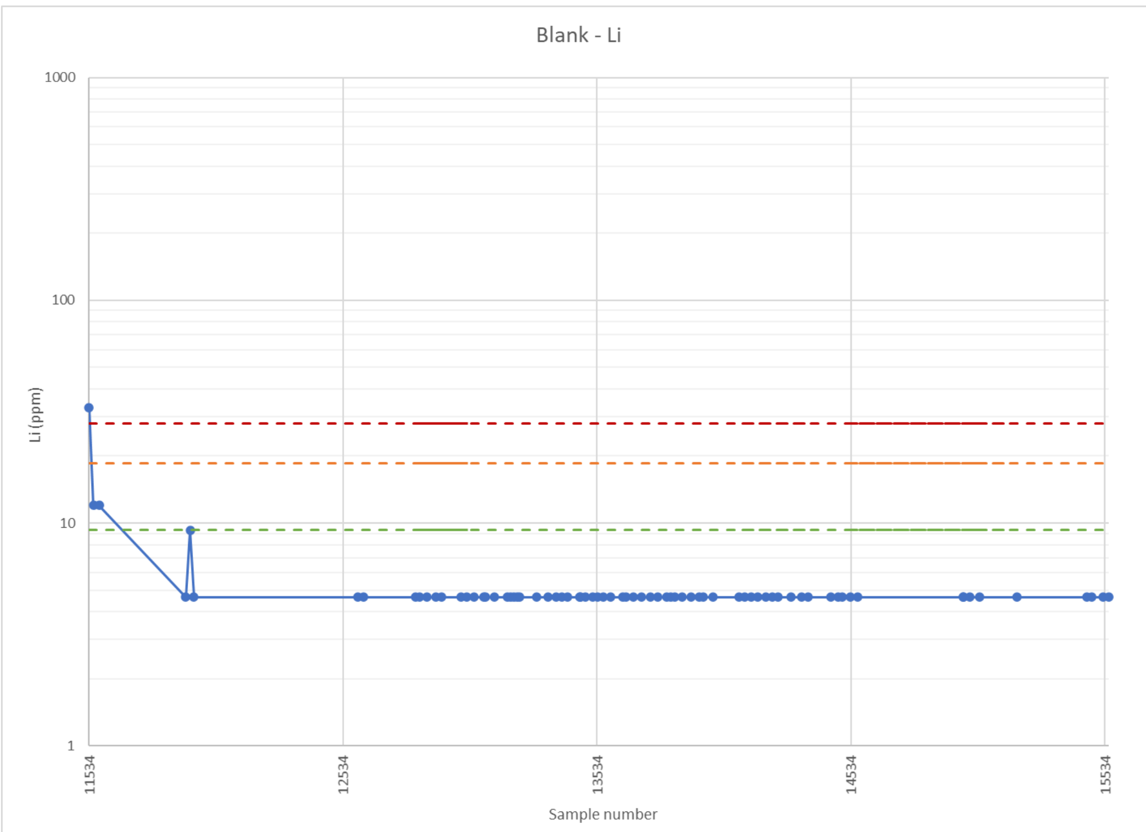


Figure 11-16: Blank Sample Analyses from the 2021 Campaign

11.6.3.3 Coarse Duplicates

The coarse duplicates consist of coarse samples collected immediately after the primary or secondary crushing of the sample, but prior to pulverization. They are designed to evaluate the precision of the physical preparation of the samples, focussing on the splitting of the material.

A total of 56 duplicate pairs were analyzed and only one sample fell outside the 20% difference line. Figure 11-17 is a scatterplot comparing original and duplicate core pairs. The average value for the original values is 6,420.9 ppm Li and the average value for the duplicate values is 6,278.3 ppm Li. The difference between original and duplicate averages is 142.6 ppm. The correlation coefficient R^2 of 0.978 suggests a strong correlation and a high similarity between the two sets of samples.

11.6.3.4 Pulp Duplicates

The pulp duplicates are duplicate samples collected immediately after the sample is pulverized. The purpose of the pulp duplicate is to evaluate the level of homogenization in the sample preparation.

A total of 56 pulp duplicates were submitted for analysis for the 2021 program. Figure 11-18 is a scatterplot comparing original and duplicate core pairs. The average Li concentration for the original values is 6,420.9 ppm Li and the average value of the duplicates is 6,422.1 ppm Li. The difference between the averages is 1.2 ppm and standard two-tailed paired t-test analysis returned no statistically significant bias. The correlation coefficient R^2 of 0.9961 suggests a strong correlation and a high similarity between the two sets of samples.

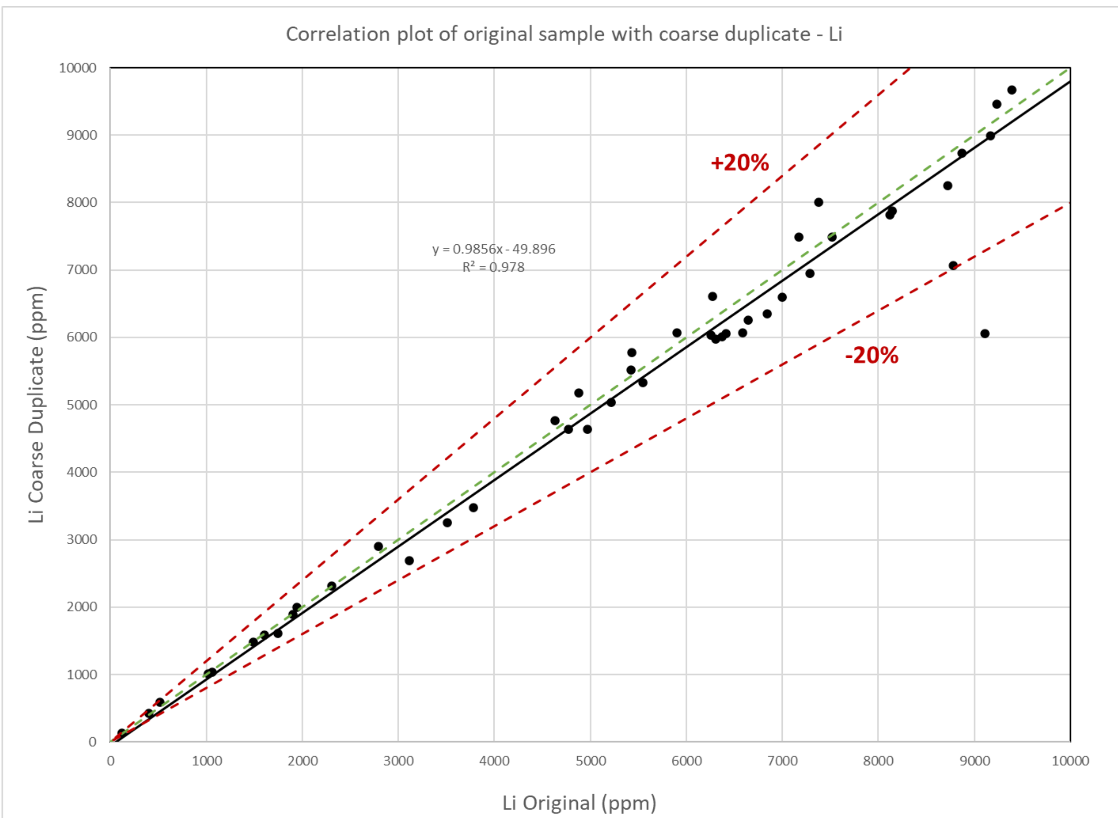


Figure 11-17: Correlation Between 2021 Original Samples and Coarse Duplicates

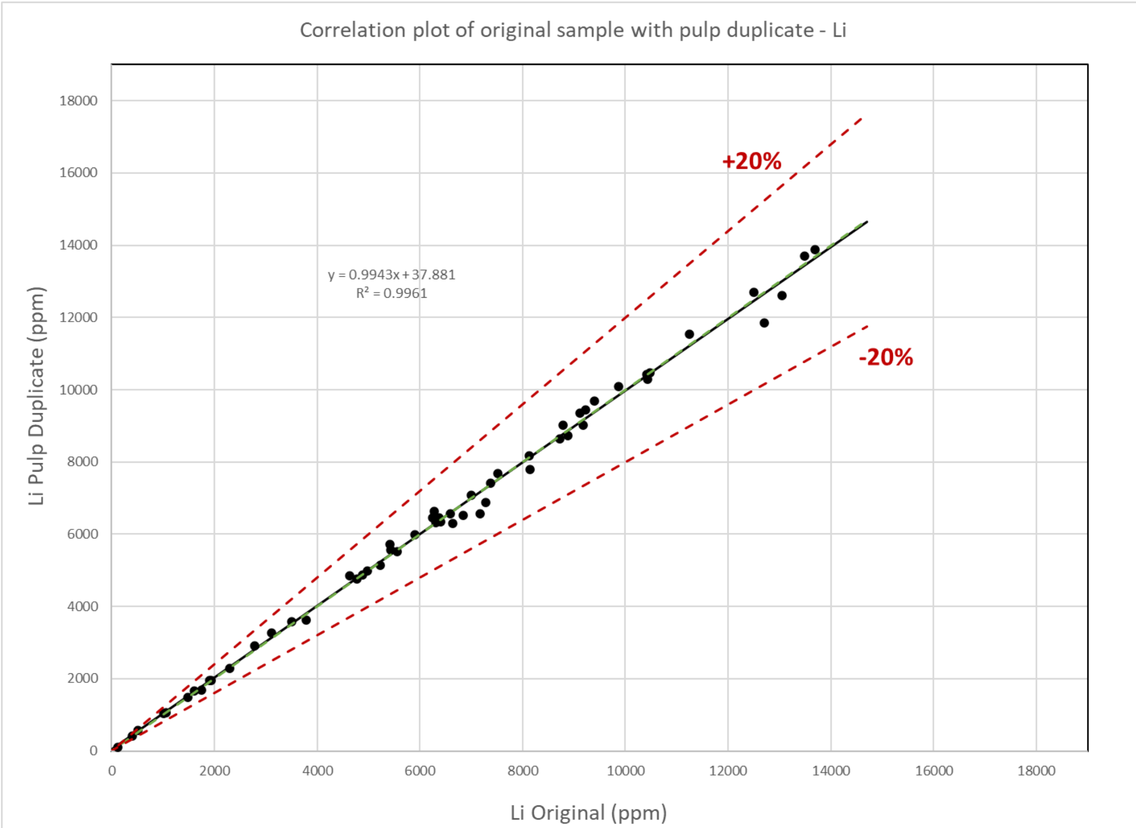


Figure 11-18: Correlation Between 2021 Original Samples and Pulp Duplicates

11.6.3.5 Check Assays

As additional QAQC, SMSA sent 65 samples from the 2021 Barreiro drilling campaign to ALS Chemex for check sample analysis using the ALS Chemex protocol ME-ICP82b with sodium peroxide fusion.

The average lithium concentration for the original samples was 6,518.0 ppm Li and the duplicates averaged 6,559.7 ppm Li, with an average difference of 41.7 ppm or 0.6%. The correlation coefficient R^2 of 0.9854 suggests a strong correlation and a high similarity between the two sets of samples. Consequently, the control sample results are deemed acceptable, and the original data can be used in Mineral Resource estimation.

Figure 11-19 shows the correlation between the original SGS assays, and the ALS check assays, while Figure 11-20 shows the frequency distribution between the original and duplicate assays.

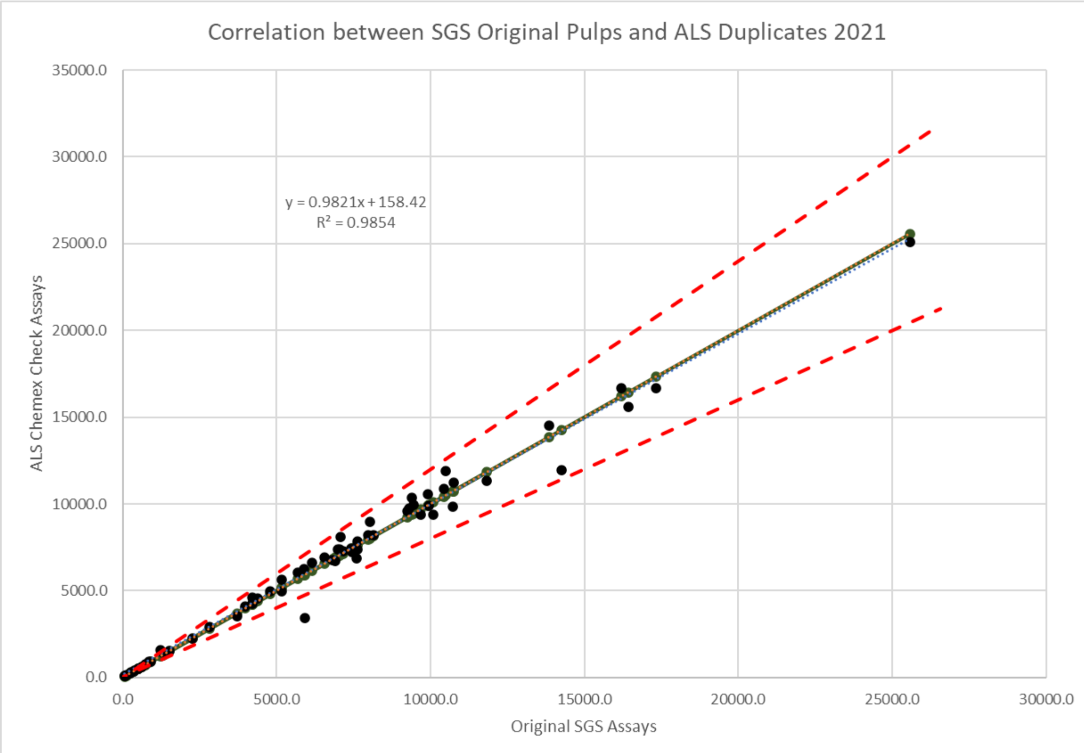


Figure 11-19: 2021 Check Assay Correlation Between SGS Originals and ALS Duplicates

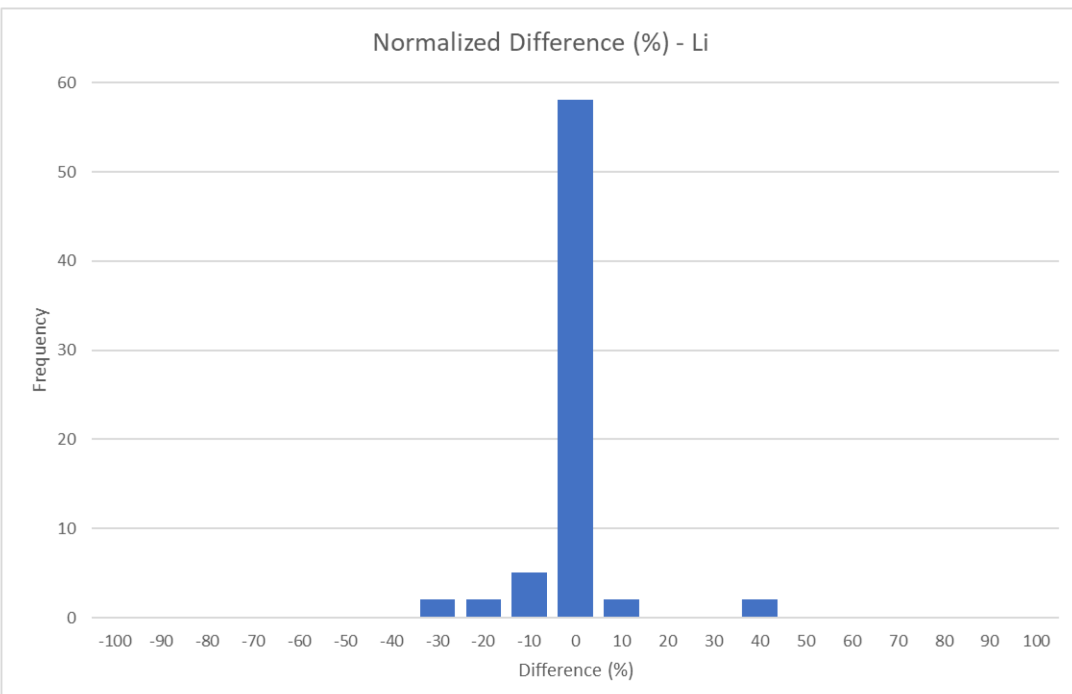


Figure 11-20: Check Assay Distribution of the Difference Between SGS Originals and ALS Duplicates

11.6.4 2021-2022 NDC Sampling Campaign

For the 2021-2022 NDC drilling and sampling campaign, SMSA's QAQC protocol utilized the inclusion of coarse duplicates, pulp duplicates, standards, blanks and check samples.

For every batch of 24 core samples from an individual hole, there was one coarse duplicate, one pulp duplicate, one standard, one blank and two check samples inserted.

For every batch of 50 core samples from an individual hole, there was one coarse duplicate, one pulp duplicate, two standards, two blanks and three check samples inserted.

11.6.4.1 Analytical Standards

The 2021-2022 NDC campaign used four certified standards from African Mineral Standards (AMIS), an international supplier of certified reference materials (Table 11-6). The recommended lithium values for the AMIS standards used range between 0.16% and 1.60% Li. A total of 210 standards were inserted during the 2021-2022 NDC campaign. Figure 11-21 to Figure 11-24 show the standard results for AMIS standards submitted as part of the 2021-2022 NDC campaign.

Table 11-6: Standard Average Li Values with Analytical Error

Analytical Standard	Li (ppm)	Analytical Error (2σ)
AMIS0341	5,041	222
AMIS0342	1,603	199
AMIS0343	7,150	1,525
AMIS0408	16,000	2,400

Note: All concentrations and standard deviations are reported for fusion dissolution of the samples, as this was the assay technique used for the Sigma core samples.

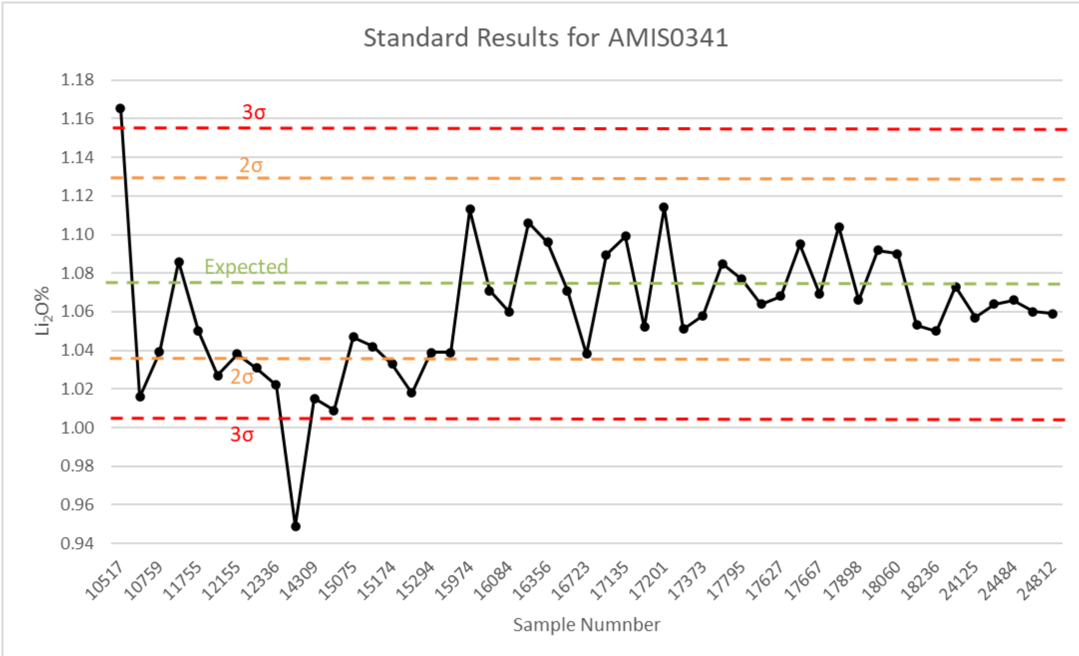


Figure 11-21: Standard Sample Analysis Results for the 2021-2022 NDC Batch with Standard AMIS0341

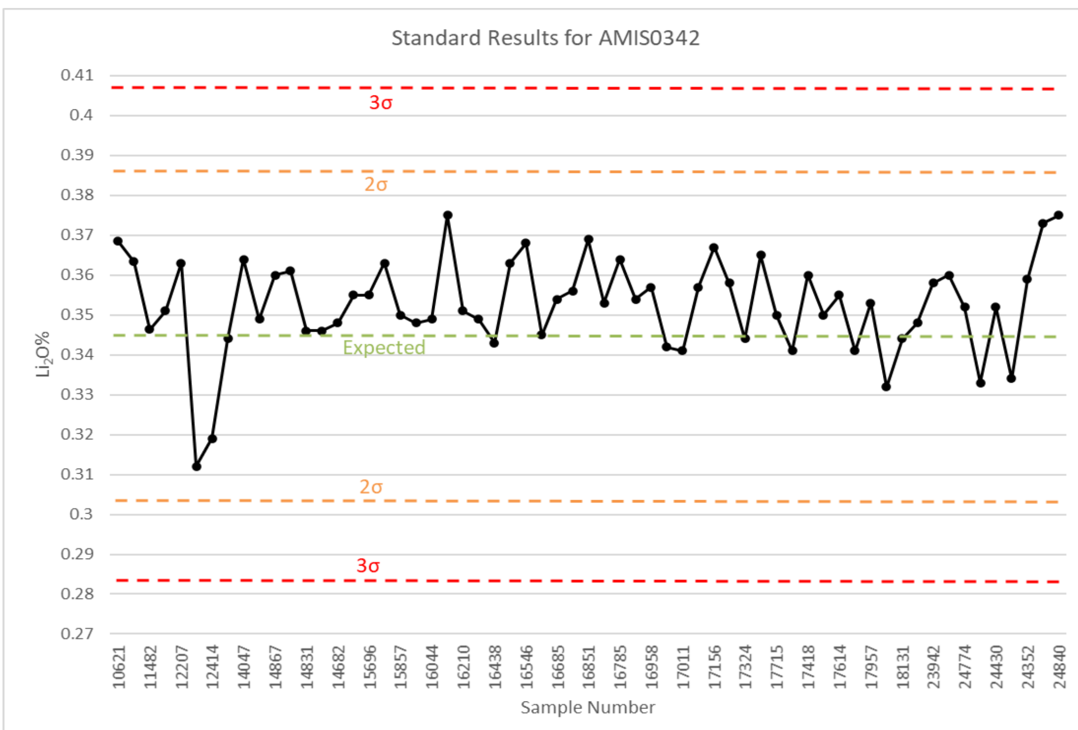


Figure 11-22: Standard Sample Analysis Results for the 2021-2022 NDC Batch with Standard AMIS0342

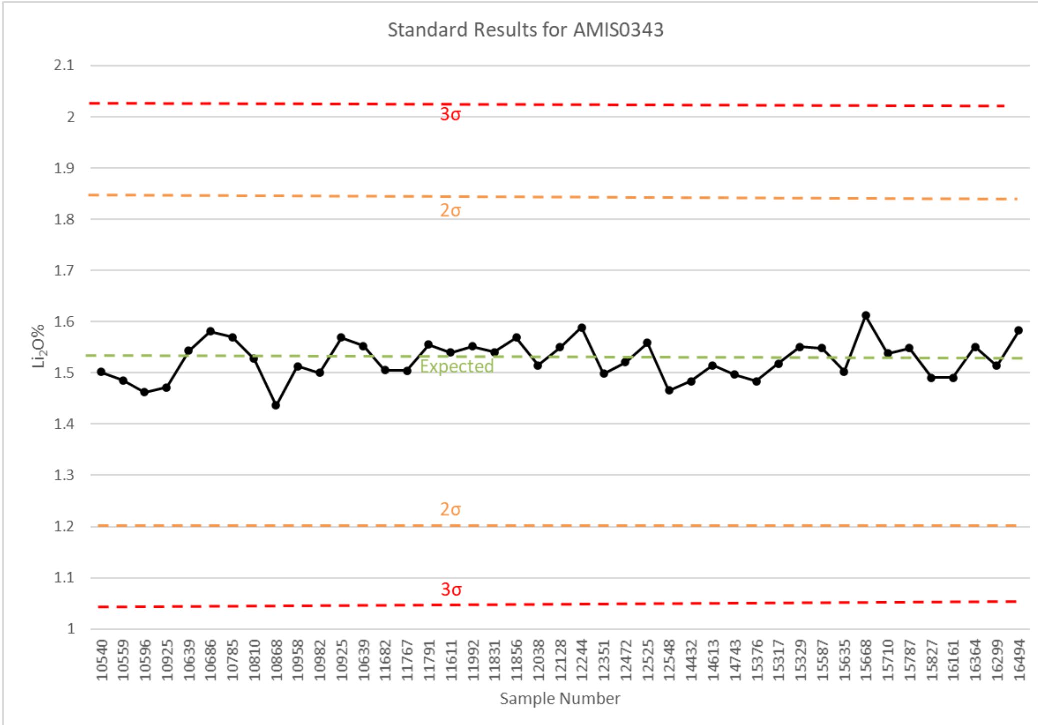


Figure 11-23: Standard Sample Analysis Results for the 2021-2022 NDC Batch with Standard AMIS0343

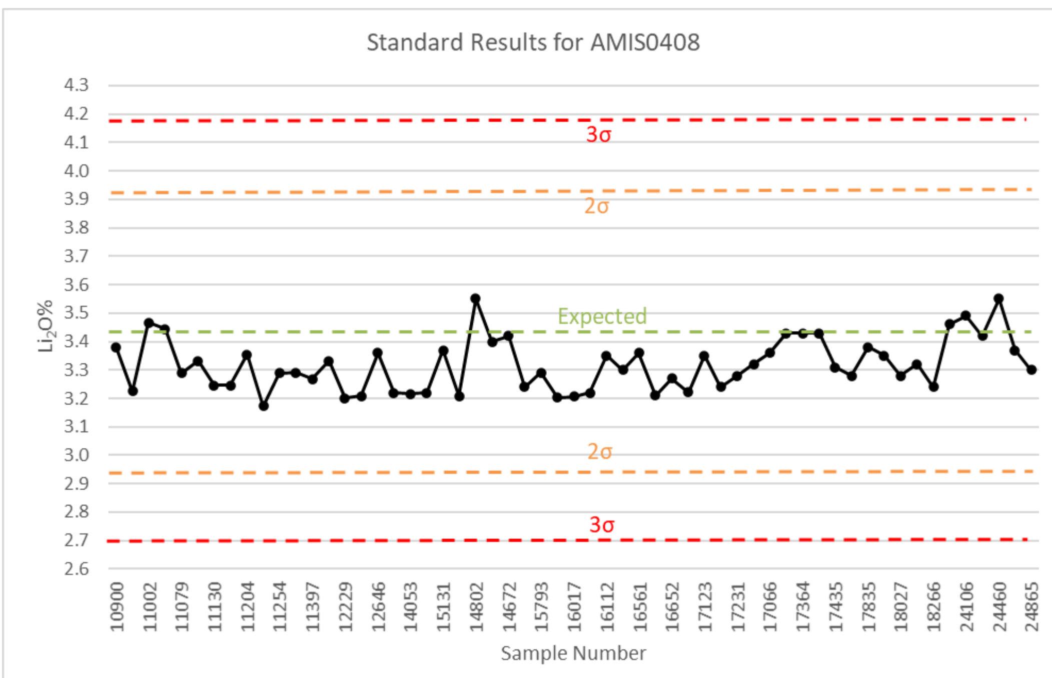


Figure 11-24: Standard Sample Analysis Results for the 2021-2022 NDC Batch with Standard AMIS0343

11.6.4.2 Analytical Blanks

A total of 218 analytical blanks were analysed during the 2021-2022 NDC exploration program. Of the 218 blanks, 30 were above the lower limit of detection of 0.002% Li_2O and 19 were over two times the detection limit. Figure 11-25 shows blank sample results from the 2021-2022 exploration program.

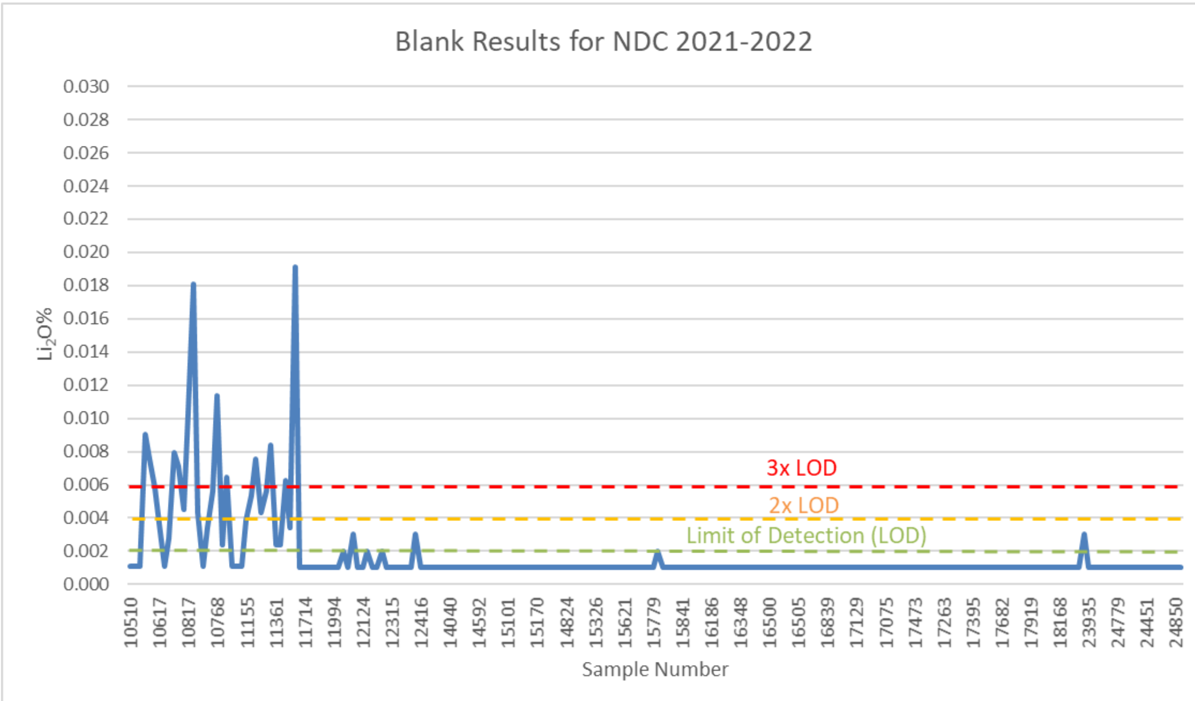


Figure 11-25: Blank Sample Analyses from the 2021-2022 NDC Campaign

11.6.4.3 Coarse Duplicates

A total of 216 duplicate pairs were analyzed, with three samples falling outside the 20% difference line. Figure 11-26 is a scatterplot comparing original and duplicate core pairs. The average value for the original values is 1.44% Li_2O and the average value for the duplicate values is 1.42% Li_2O. The difference between original and duplicate averages is 0.02% Li_2O. The correlation coefficient R^2 of 0.98 suggests a strong correlation and a high similarity between the two sets of samples.

11.6.4.4 Pulp Duplicates

A total of 216 pulp duplicates were submitted for analysis for the 2021-2022 NDC program, with one sample falling outside the 20% difference line. Figure 11-27 is a scatterplot comparing original and duplicate core pairs. The average value for the original values is 1.43% Li_2O and the average value for the duplicate values is 1.43% Li_2O. The difference between original and duplicate averages is 0.00% Li_2O. The correlation coefficient R^2 of 0.98 suggests a strong correlation and a high similarity between the two sets of samples.

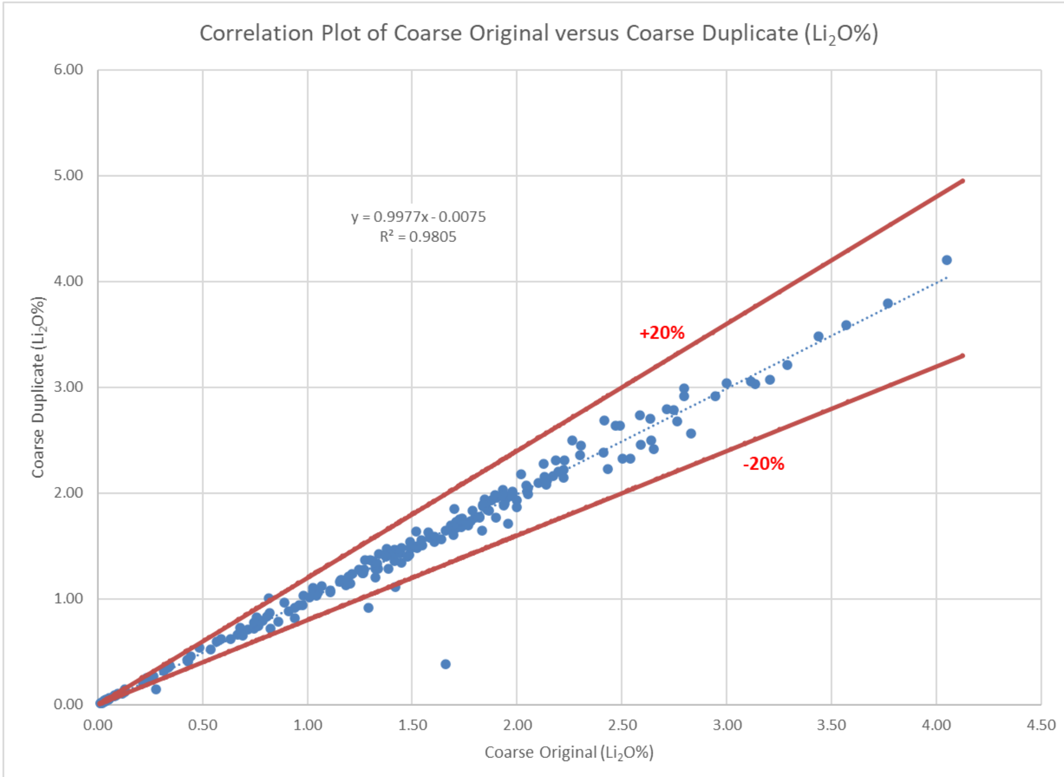


Figure 11-26: Correlation Between 2021-2022 NDC Original Samples and Coarse Duplicates

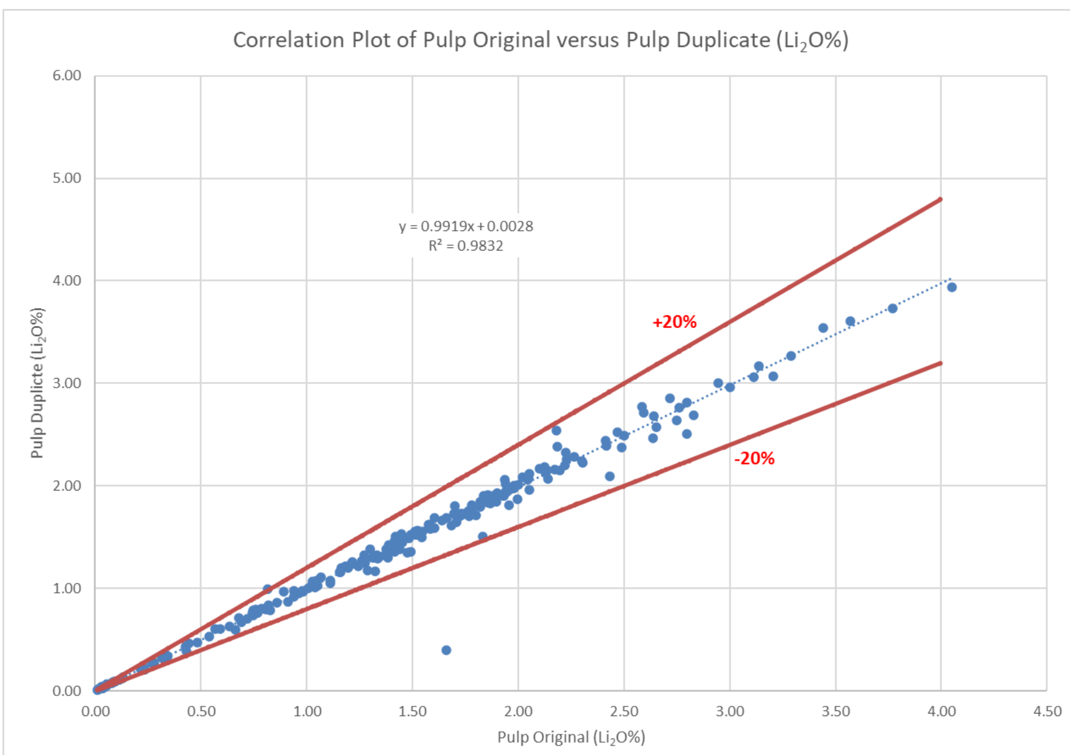


Figure 11-27: Correlation Between 2021-2022 NDC Original Samples and Pulp Duplicates

11.6.4.5 Check Assays

As additional QAQC, Sigma sent 304 samples from the 2021-2022 NDC drilling campaign to ALS Chemex for check sample analysis using the ALS Chemex protocol ME-ICP82b with sodium peroxide fusion.

The average lithium grade for the original samples was 1.38% Li_2O and the duplicates averaged 1.39% Li_2O. The correlation coefficient R^2 of 0.98 suggests a strong correlation and a high similarity between the two sets of samples. Consequently, the control sample results are deemed acceptable, and the original data can be used in Mineral Resource estimation.

Figure 11-28 shows the correlation between the original SGS assays, and the ALS check assays.

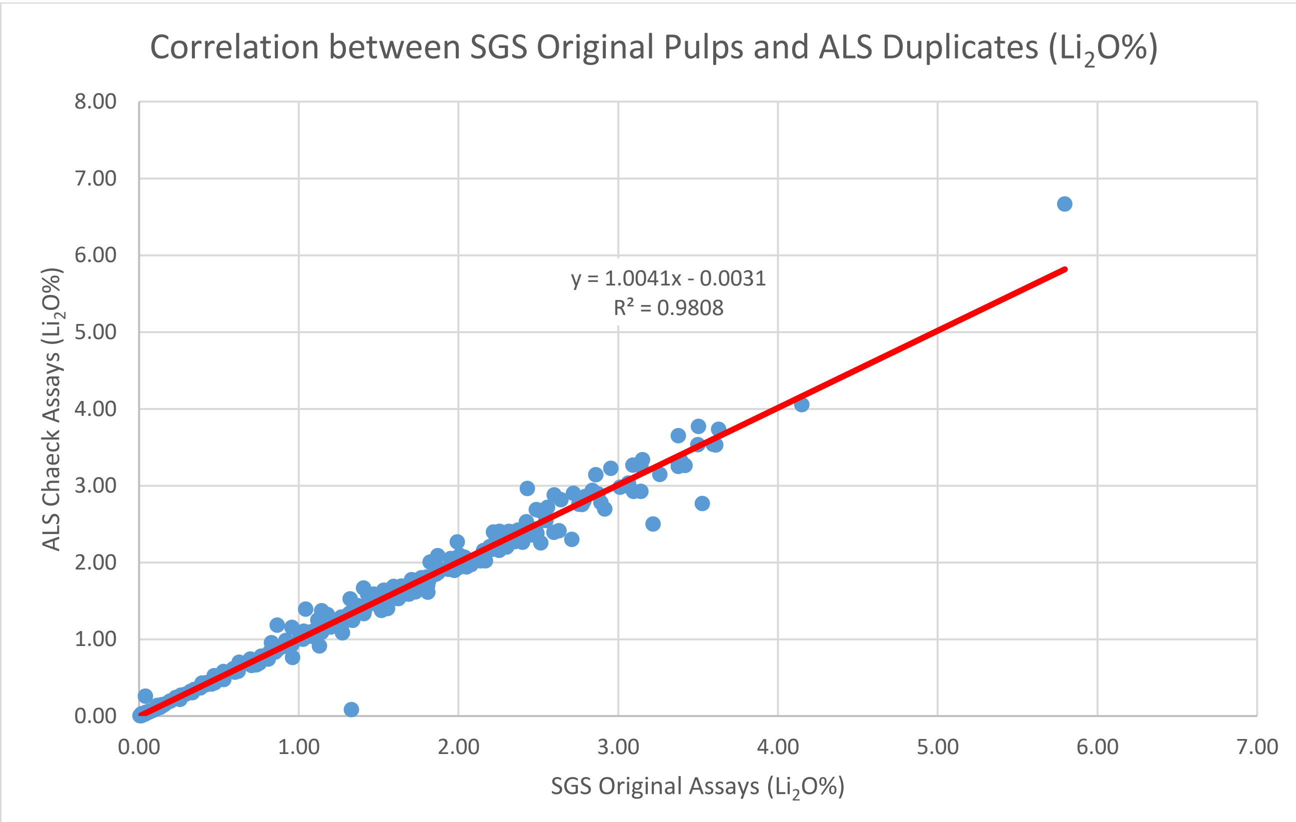


Figure 11-28: 2021-2022 NDC Check Assay Correlation Between SGS Originals and ALS Duplicates

11.6.5 2022-2023 Murial Sampling Campaign

11.6.5.1 Analytical Standards

The 2023 Murial campaign used four certified standards from African Mineral Standards (AMIS), an international supplier of certified reference materials (Table 11-7). The recommended lithium values for the AMIS standards used range between 0.16% and 1.60% Li. A total of 326 standards were inserted during the 2023 Murial campaign. Figure 11-29 to Figure 11-32 show the standard results for AMIS standards submitted as part of the 2023 Murial campaign.

Table 11-7: Standard Average Li Values with Analytical Error

Analytical Standard	Li (ppm)	Analytical Error (2σ)
AMIS0341	5,041	49
AMIS0342	1,603	160
AMIS0408	16,000	61
AMIS0565	5,348	56

Note: All concentrations and standard deviations are reported for fusion dissolution of the samples, as this was the assay technique used for the Sigma core samples.

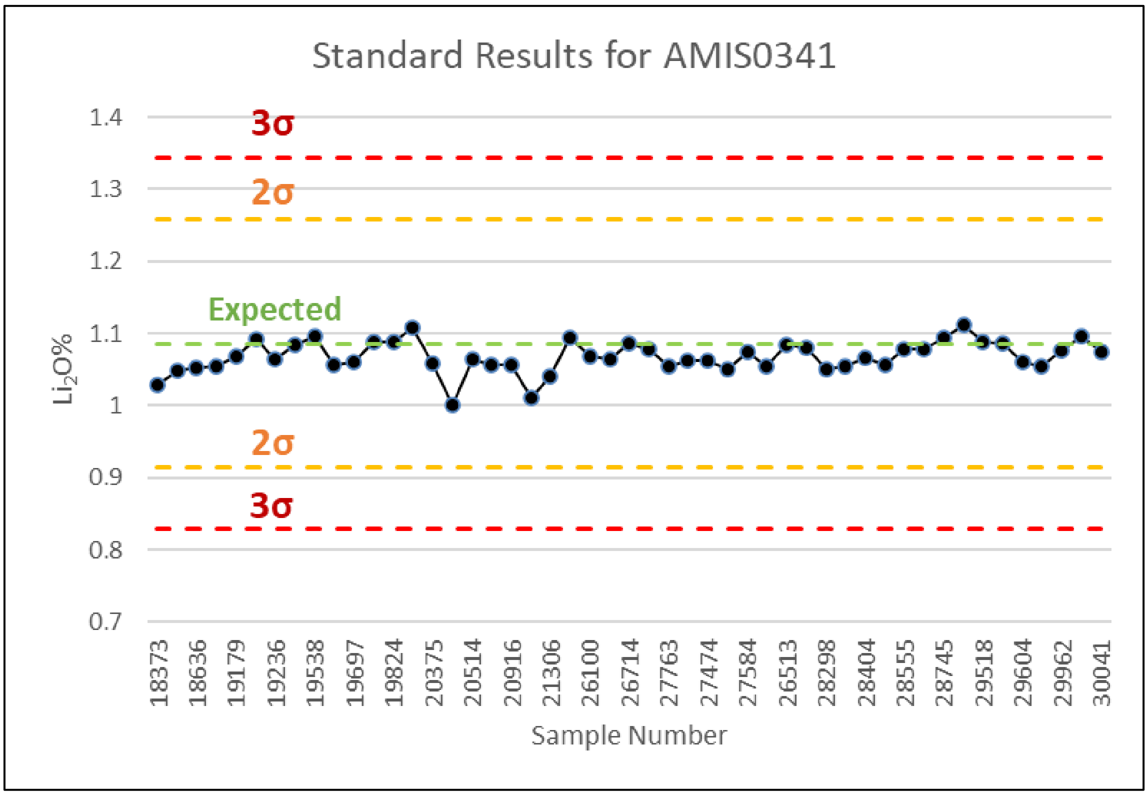


Figure 11-29: Standard Sample Analysis Results for the 2022-2023 Murial Batch with Standard AMIS0341

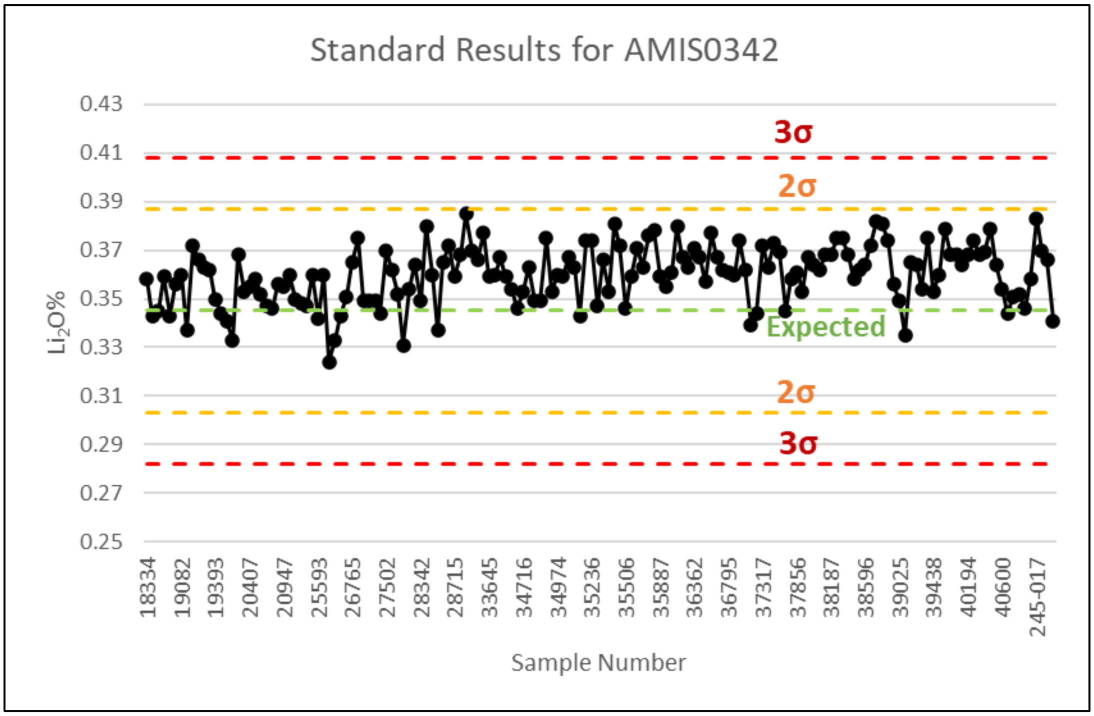


Figure 11-30: Standard Sample Analysis Results for the 2022-2023 Murial Batch with Standard AMIS0342

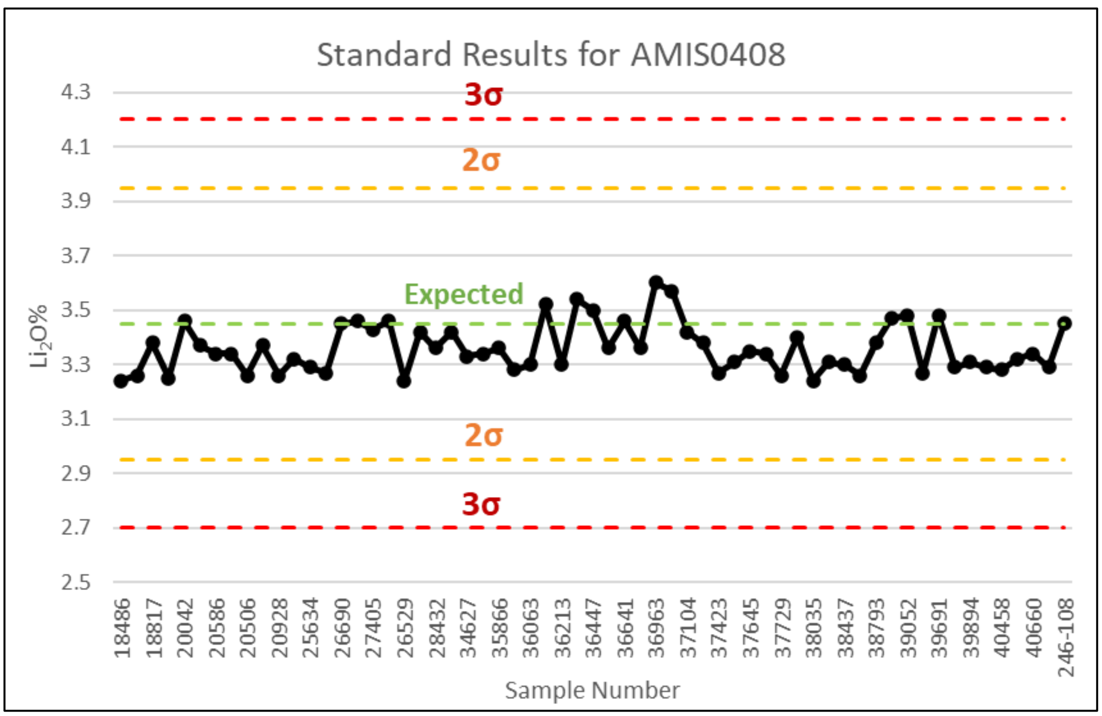


Figure 11-31: Standard Sample Analysis Results for the 2022-2023 Murial Batch with Standard AMIS0408

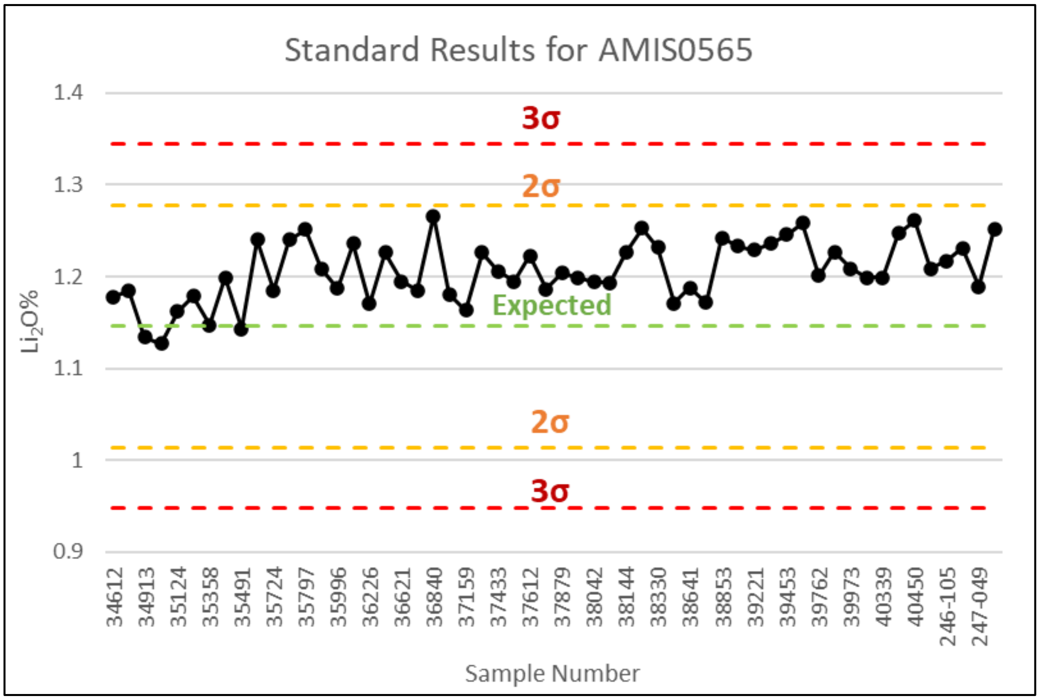


Figure 11-32: Standard Sample Analysis Results for the 2022-2023 Murial Batch with Standard AMIS0565

11.6.5.2 Analytical Blanks

A total of 329 analytical blanks were analysed during the 2022-2023 Murial exploration program. Of the 329 blanks, five were above the lower limit of detection of 0.002% Li_2O and two were over two times the detection limit. Figure 11-33 shows blank sample results from the 2022-2023 exploration program.

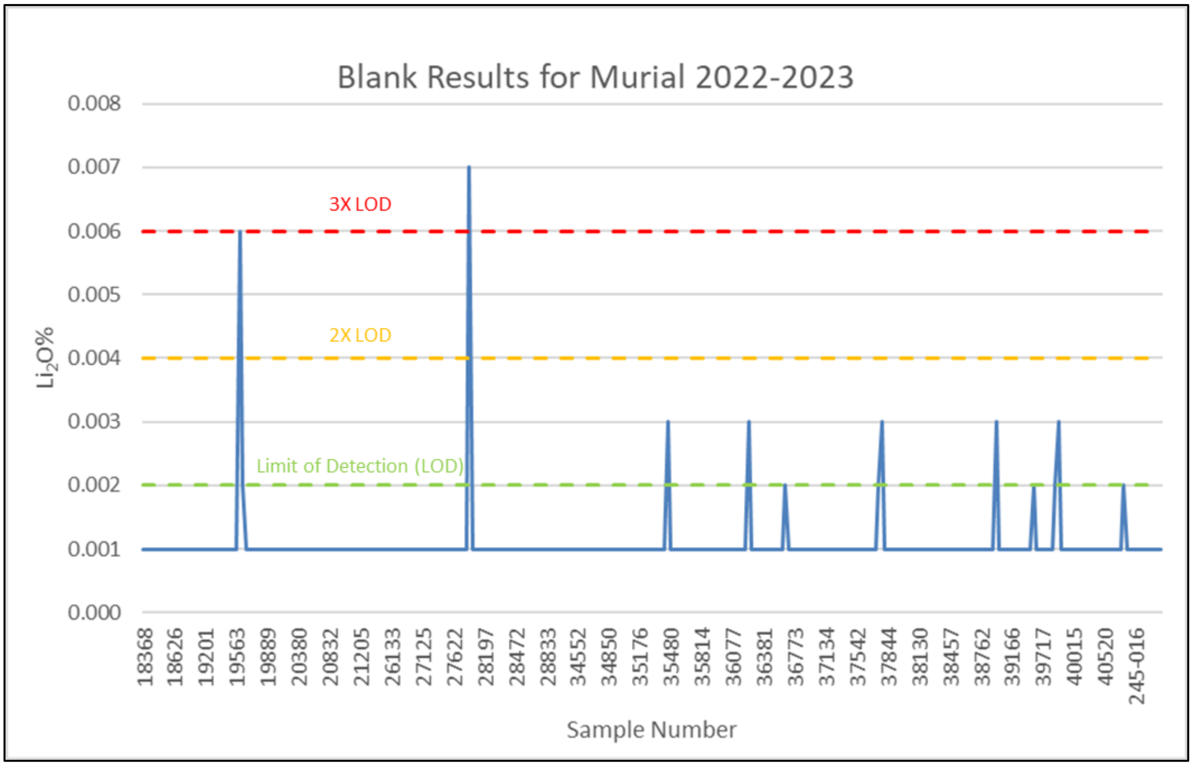


Figure 11-33: Blank Sample Analyses from the 2022-2023 Murial Campaign

11.6.5.3 Coarse Duplicates

A total of 254 duplicate pairs were analyzed, with no samples falling outside the 20% difference line. Figure 11-34 is a scatterplot comparing original and duplicate core pairs. The average value for the original values is 1.02% Li_2O and the average value for the duplicate values is 1.01% Li_2O. The difference between original and duplicate averages is 0.1% Li_2O. The correlation coefficient R^2 of 0.99 suggests a strong correlation and a high similarity between the two sets of samples.

11.6.5.4 Pulp Duplicates

A total of 254 duplicate pairs were analyzed, with no samples falling outside the 20% difference line. Figure 11-35 is a scatterplot comparing original and duplicate core pairs. The average value for the original values is 1.02% Li_2O and the average value for the duplicate values is 1.01% Li_2O. The difference between original and duplicate averages is 0.1% Li_2O. The correlation coefficient R^2 of 0.997 suggests a strong correlation and a high similarity between the two sets of samples.

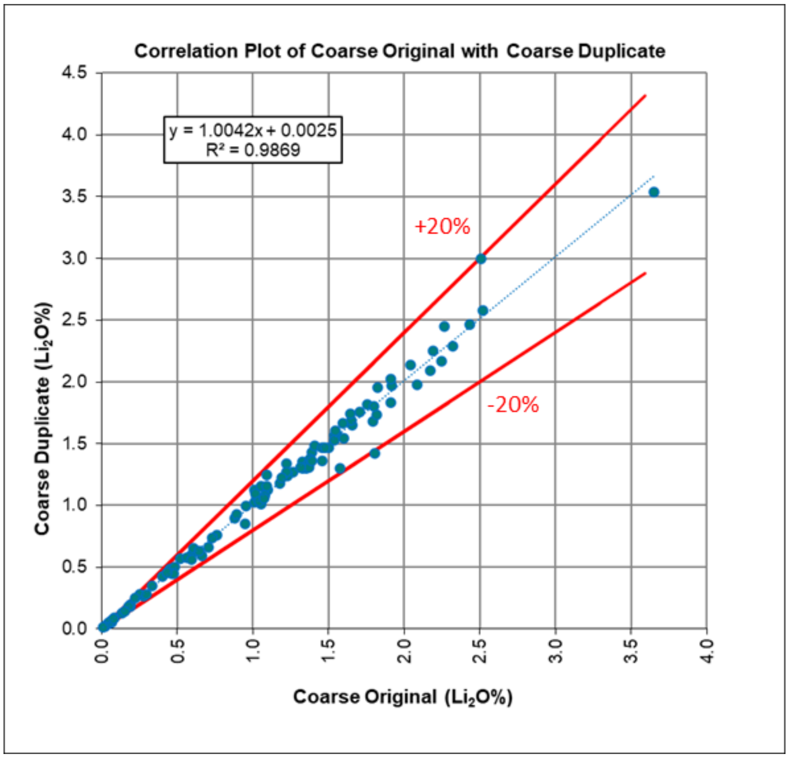


Figure 11-34: Correlation Between 2022-2023 Murial Original Samples and Coarse Duplicates

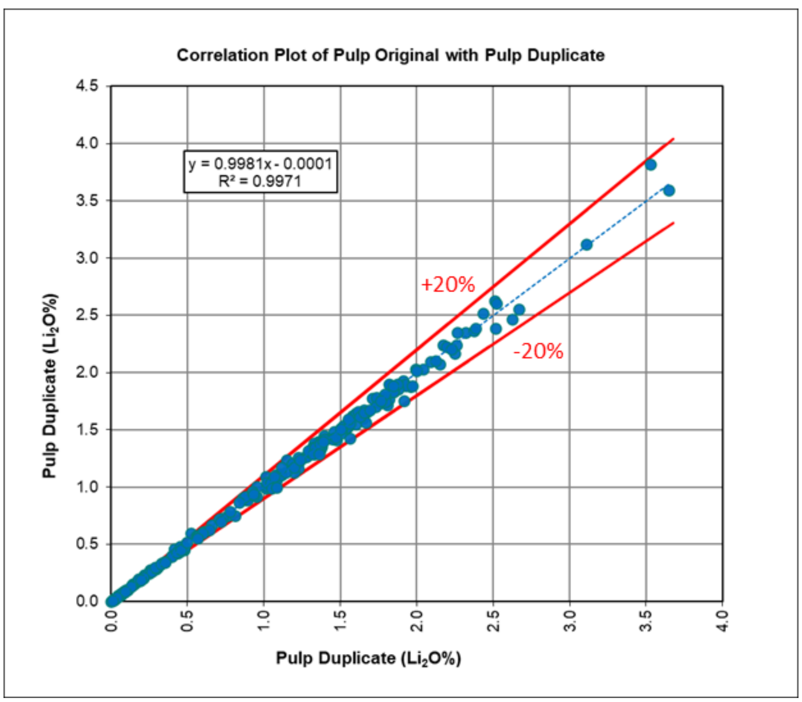


Figure 11-35: Correlation Between 2022-2023 Murial Original Samples and Pulp Duplicates

11.6.5.5 Check Assays

As additional QAQC, Sigma sent 414 samples from the 2022-2023 Murial drilling campaign to ALS Chemex for check sample analysis using the ALS Chemex protocol ME-ICP82b with sodium peroxide fusion.

The average lithium grade for the original samples was 0.58% Li_2O and the duplicates averaged 0.59% Li_2O. The correlation coefficient R^2 of 0.997 suggests a strong correlation and a high similarity between the two sets of samples. Consequently, the control sample results are deemed acceptable, and the original data can be used in Mineral Resource estimation.

Figure 11-36 shows the correlation between the original SGS assays, and the ALS check assays.

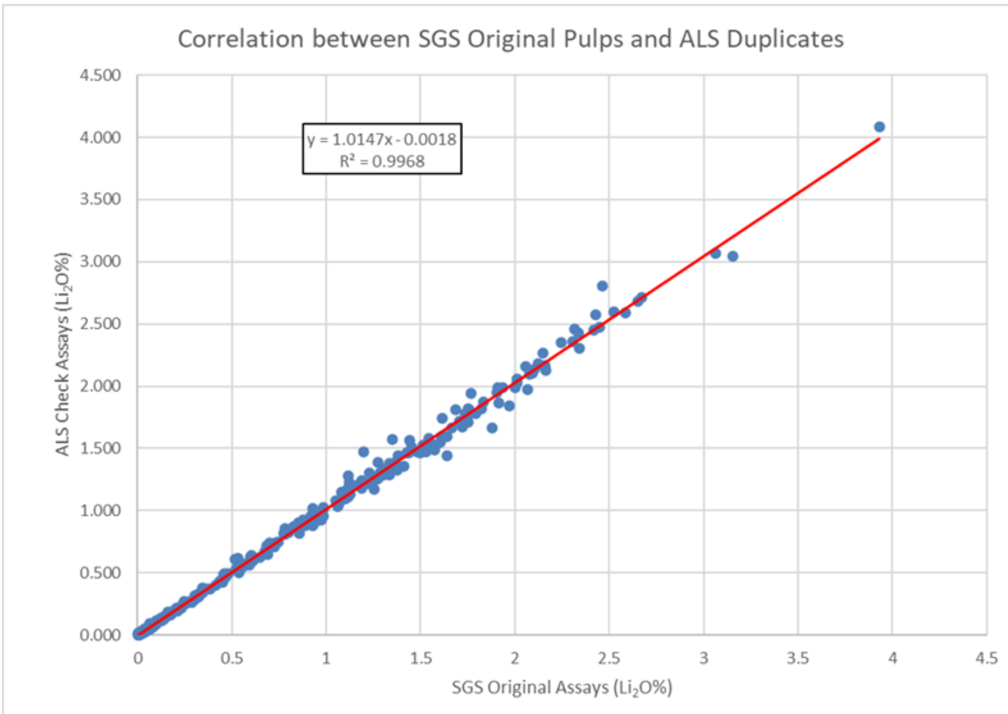


Figure 11-36: 2022-2023 Murial Check Assay Correlation Between SGS Originals and ALS Duplicates

11.6.6 2023 Sampling Campaign

The 2023 sampling campaign encompasses the QAQC for the Lavra do Meio, Maxixe, Tamboril, Nezinho do Chicao and Elvira exploration programs.

11.6.6.1 Analytical Standards

The 2023 campaign used three certified standards from African Mineral Standards (AMIS), an international supplier of certified reference materials (Table 11-8). The recommended lithium values for the AMIS standards used range between 0.16% and 1.60% Li. A total of 87 standards were inserted during the 2023 campaign. Figure 11-37 to Figure 11-39 show the standard results for AMIS standards submitted as part of the 2023 campaign.

Table 11-8: Standard Average Li Values with Analytical Error

Analytical Standard	Li (ppm)	Analytical Error (2σ)
AMIS0342	1,603	40
AMIS0408	16,000	24
AMIS0565	5,348	23

Note: All concentrations and standard deviations are reported for fusion dissolution of the samples, as this was the assay technique used for the Sigma core samples.

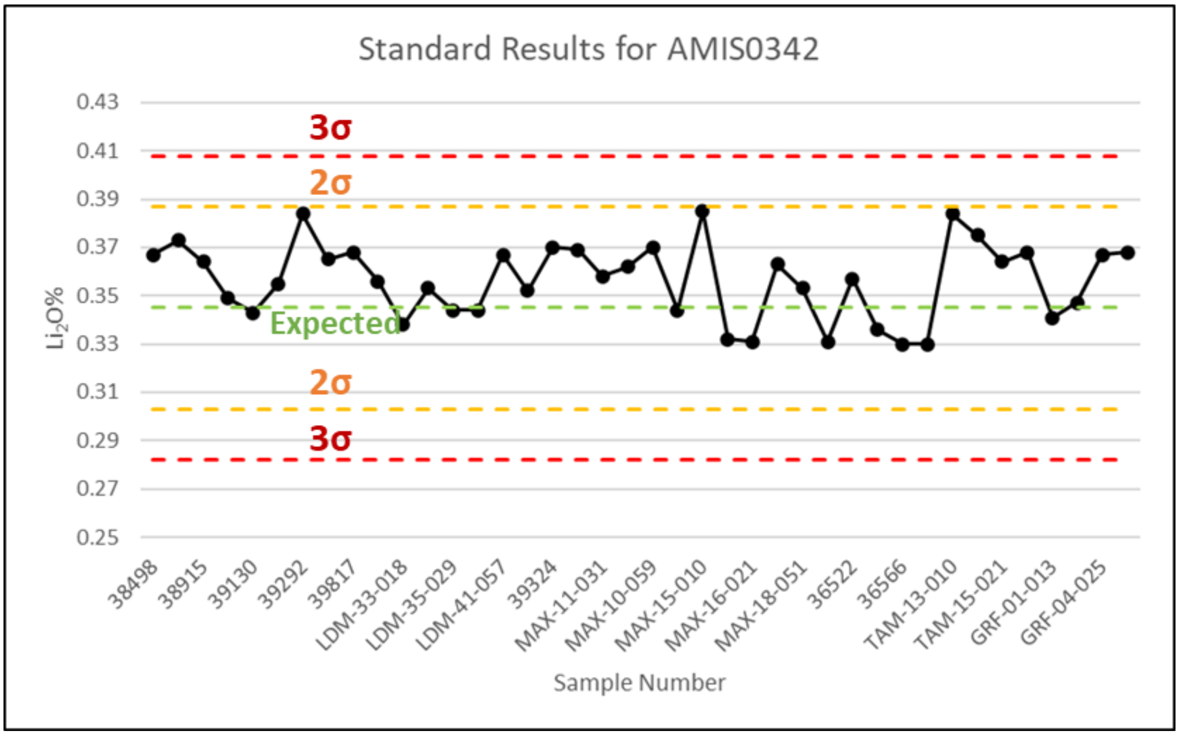


Figure 11-37: Standard Sample Analysis Results for the 2023 I Batch with Standard AMIS0342

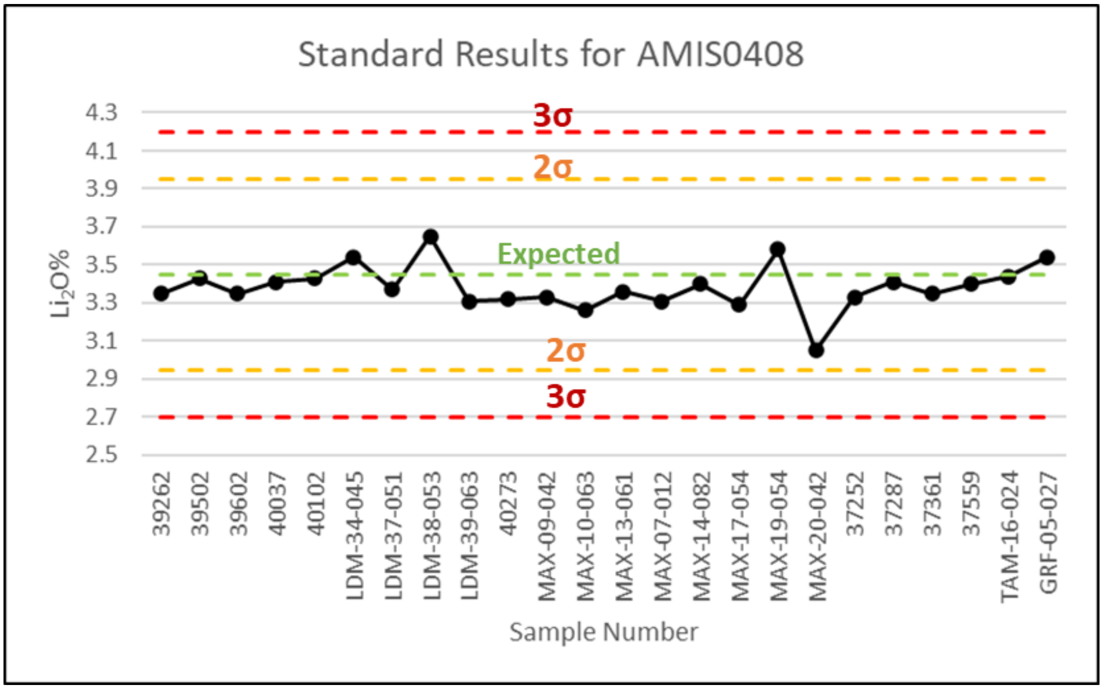


Figure 11-38: Standard Sample Analysis Results for the 2023 Batch with Standard AMIS0408

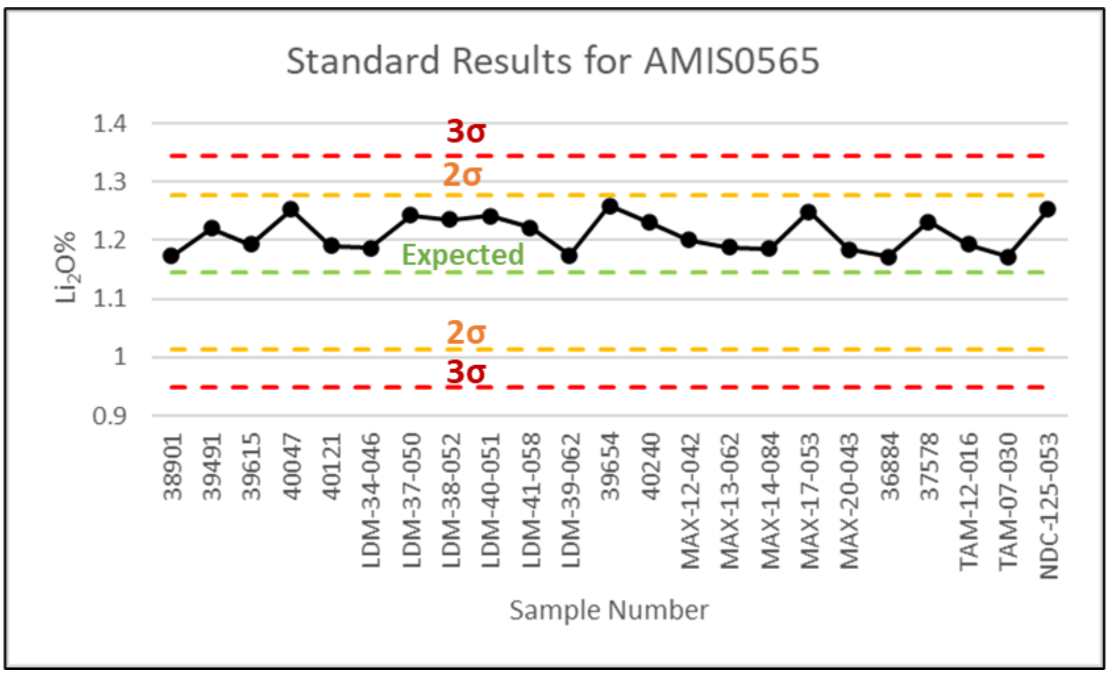


Figure 11-39: Standard Sample Analysis Results for the 2023 Batch with Standard AMIS0565

11.6.6.2 Analytical Blanks

A total of 100 analytical blanks were analysed during the 2023 exploration program. Of the 100 blanks, five were above the lower limit of detection of 0.002% Li_2O. Figure 11-40 shows blank sample results from the 2023 exploration program.

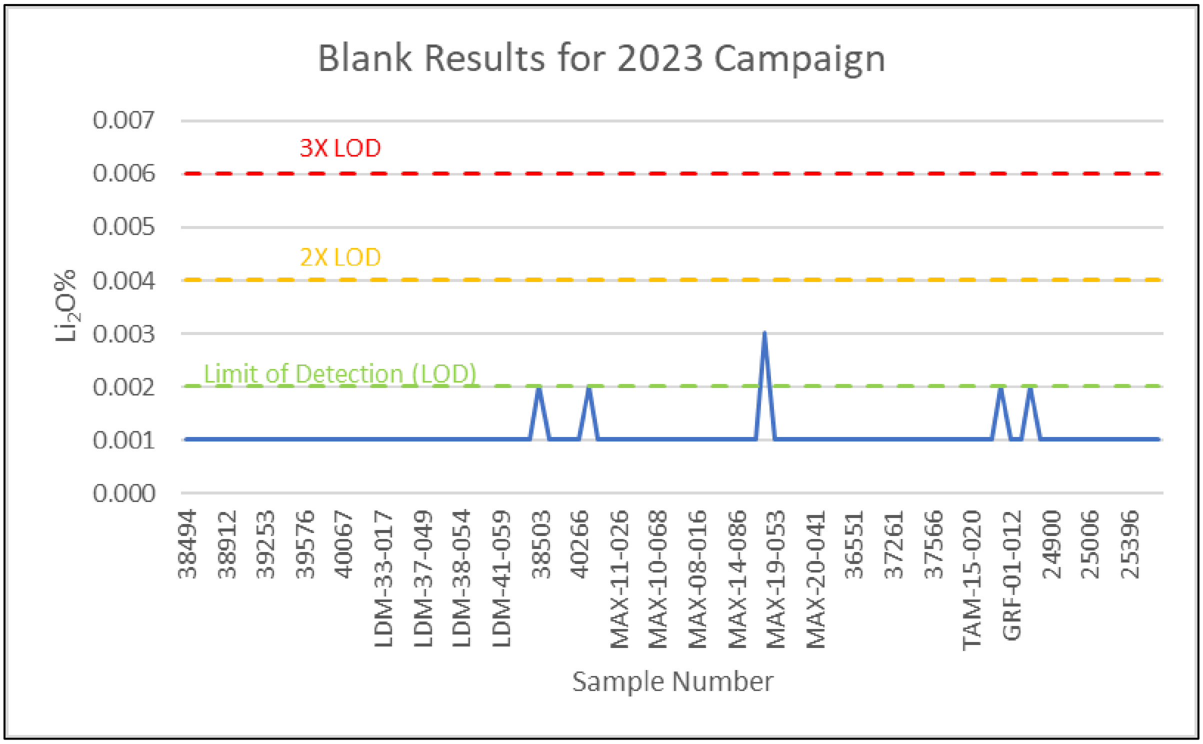


Figure 11-40: Blank Sample Analyses from the 2023 Campaign

11.6.6.3 Coarse Duplicates

A total of 57 duplicate pairs were analyzed, with no samples falling outside the 20% difference line. Figure 11-41 is a scatterplot comparing original and duplicate core pairs. The average value for the original values is 1.42% Li_2O and the average value for the duplicate values is 1.44% Li_2O. The difference between original and duplicate averages is 1.4% Li_2O. The correlation coefficient R^2 of 0.998 suggests a strong correlation and a high similarity between the two sets of samples.

11.6.6.4 Pulp Duplicates

A total of 254 duplicate pairs were analyzed, with no samples falling outside the 20% difference line. Figure 11-42 is a scatterplot comparing original and duplicate core pairs. The average value for the original values is 1.43% Li_2O and the average value for the duplicate values is 1.44% Li_2O. The difference between original and duplicate averages is 0.7% Li_2O. The correlation coefficient R^2 of 0.998 suggests a strong correlation and a high similarity between the two sets of samples.

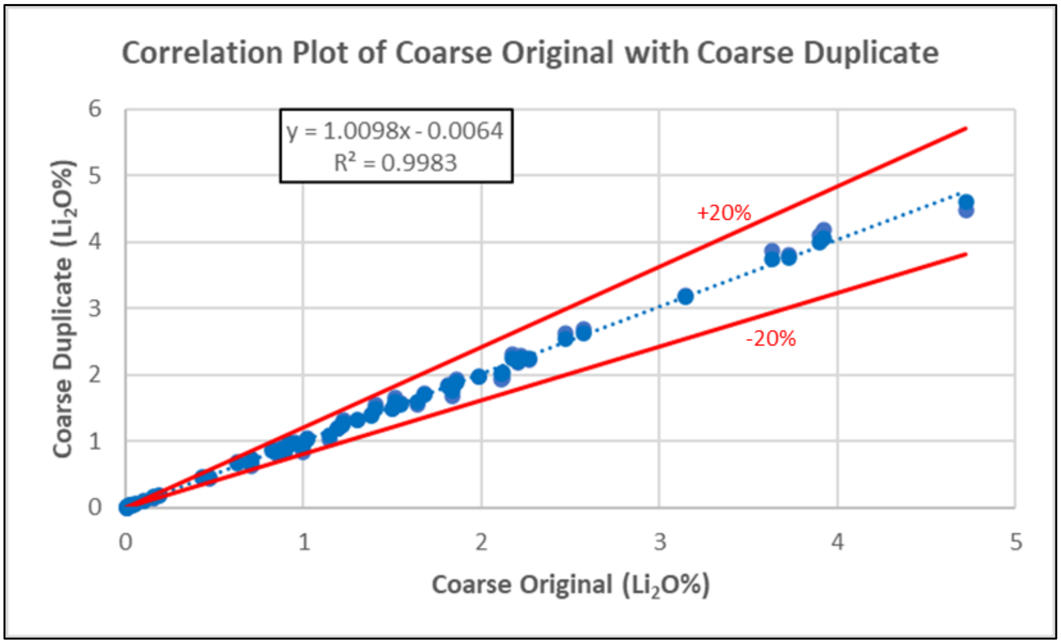


Figure 11-41: Correlation Between 2023 Original Samples and Coarse Duplicates

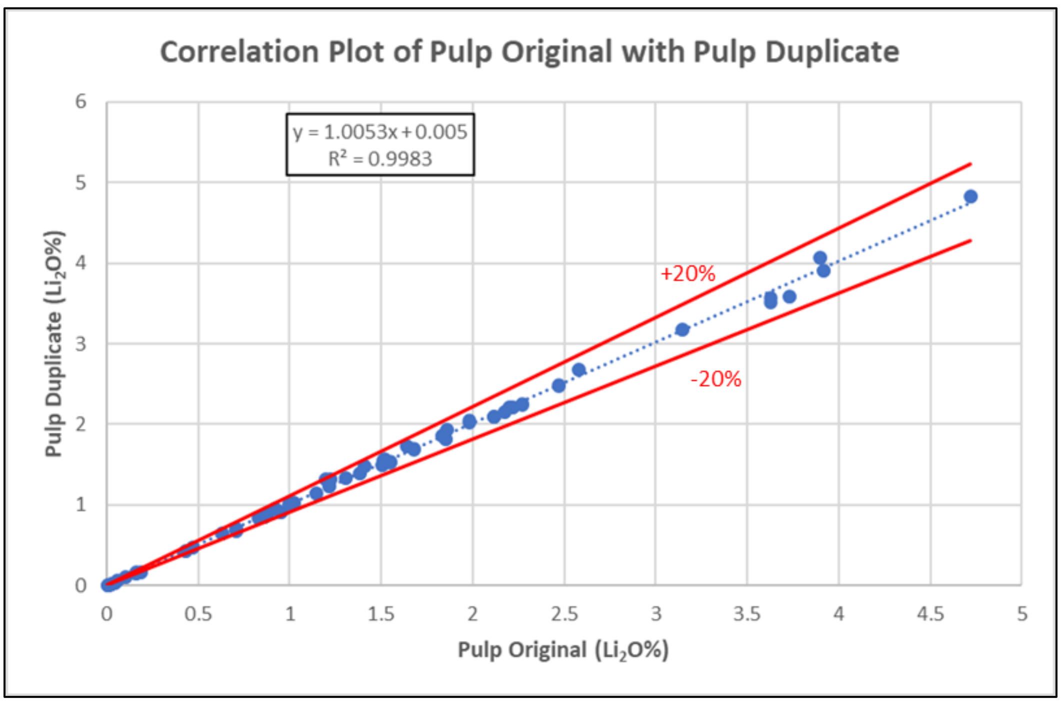


Figure 11-42: Correlation Between 2023 Original Samples and Pulp Duplicates

11.6.6.5 Check Assays

As additional QAQC, Sigma sent 22 samples from the 2023 drilling campaign to ALS Chemex for check sample analysis using the ALS Chemex protocol ME-ICP82b with sodium peroxide fusion.

The average lithium grade for the original samples was 0.39% Li_2O and the duplicates averaged 0.40% Li_2O. The correlation coefficient R^2 of 0.999 suggests a strong correlation and a high similarity between the two sets of samples. Consequently, the control sample results are deemed acceptable, and the original data can be used in Mineral Resource estimation.

Figure 11-43 shows the correlation between the original SGS assays, and the ALS check assays.

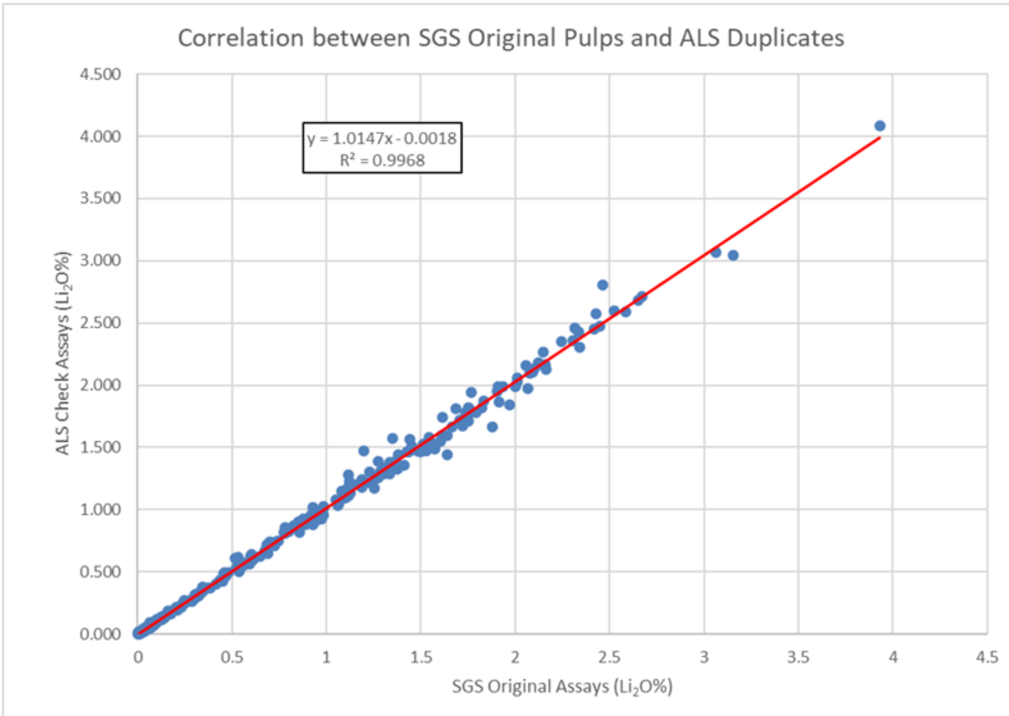


Figure 11-43: 2023 Check Assay Correlation Between SGS Originals and ALS Duplicates

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. Laboratories are inspected regularly by SMSA geologists.

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 used by SMSA in 2017, 2018, 2021-2022 and 2023 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, July 11–17, 2018, September 18-23, 2018, October 18-21, 2021, May 30 to June 01, 2022 and from November 22-24, 2023.

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, again from July 11–17, 2018, from September 18-23 2018, October 18-21, 2021 and May 30 to June 1 2022. 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.

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 R^2 of 0.6527 and standard two-tailed paired t-test analysis returned no statistically significant bias (p-value = 0.8473 / α = 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

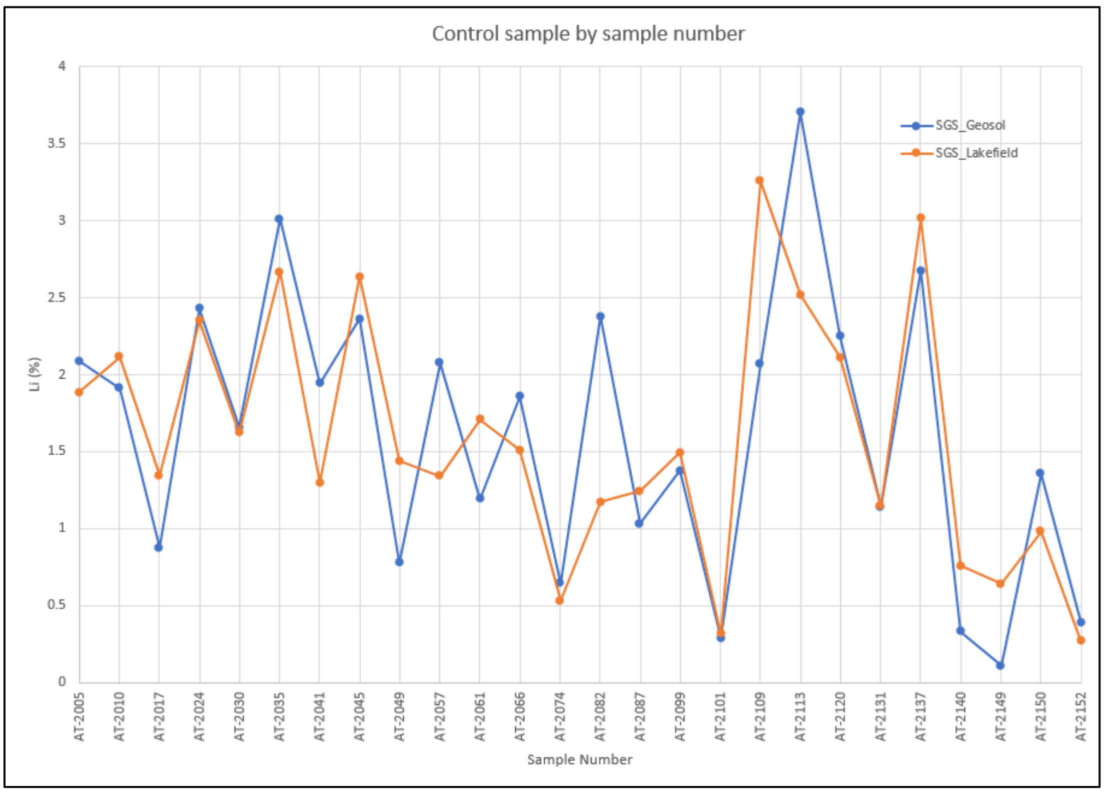


Figure 12-1: Witness Sample Original vs Control Sample Differences

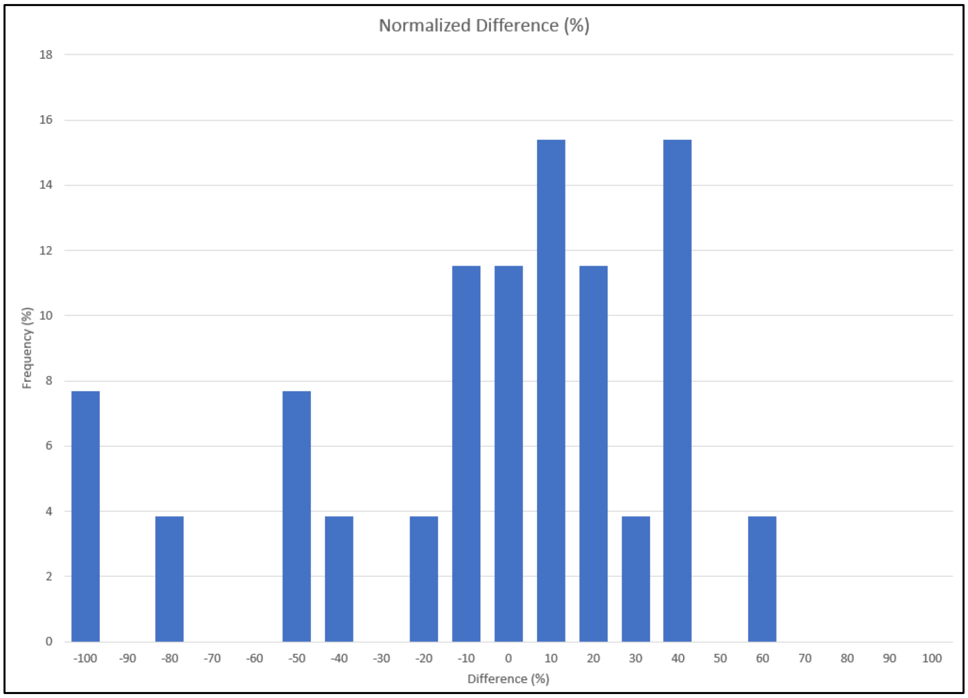


Figure 12-2: Witness Sample Original vs Control Sample Differences Frequency Distribution

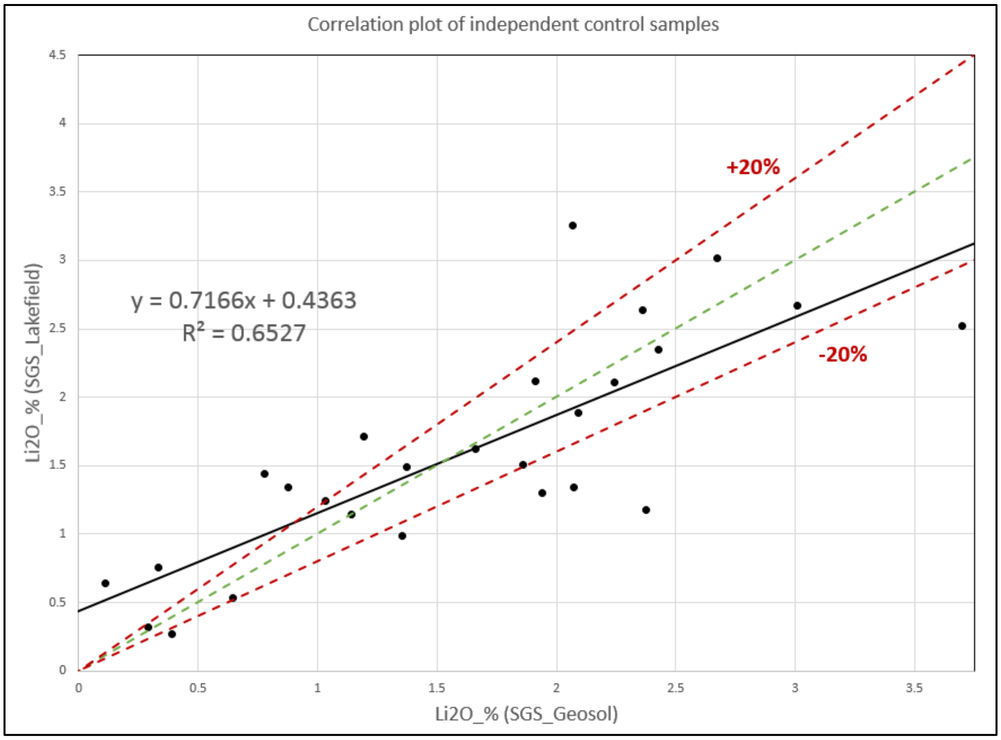


Figure 12-3: Witness Sample Original vs Control Sample Differences Correlation Analysis

12.3 QP COMMENTS

SMSA implemented an internal QA/QC protocol by regularly inserting reference materials (standards and blank) and core duplicates in the samples stream.

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 in 2017, twice in 2018, once in 2021, 2022 and 2023 to review the sample preparation procedures and local infrastructure.

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.

13 MINERAL PROCESSING AND METALLURGICAL TESTING

Preliminary metallurgical test work for the Xuxa deposit was undertaken in November 2017 by SGS Canada Inc. in Lakefield, Ontario, Canada on a high-grade sample. Mineral processing testing for the Xuxa feasibility study commenced in October 2018.

Preliminary metallurgical test work for the Phase 2 Barreiro deposit was first carried out in November 2020 by SGS Canada Inc. in Lakefield, Ontario, Canada on 4 variability samples and a master composite.

13.1 XUXA METALLURGICAL TEST WORK (2018-19)

13.1.1 Stage 1 Testing

Figure 13-1 and Figure 13-2 give an overview of the Xuxa Stage 1 test work flowsheet and sample preparation, respectively. 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 and environmental testing.

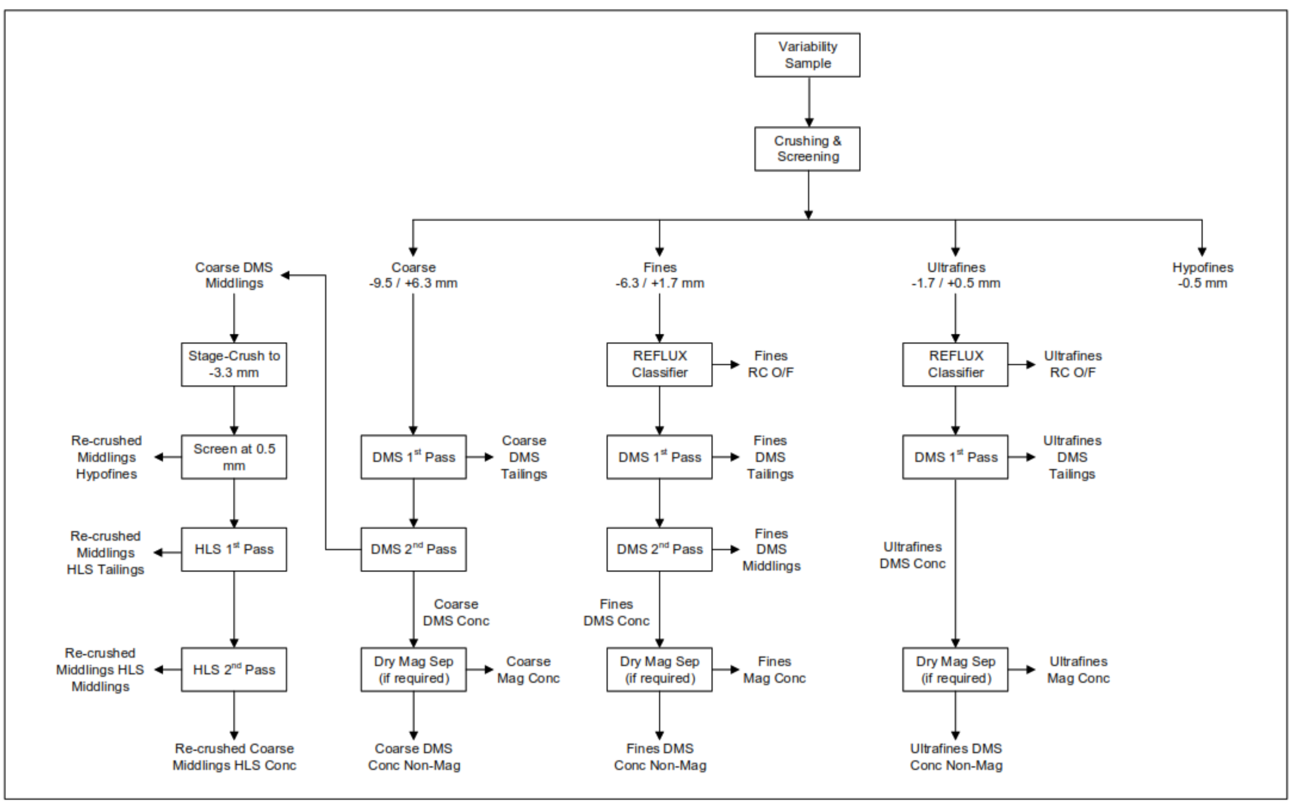


Figure 13-1: Overview of Typical Stage 1 Test work Flowsheet

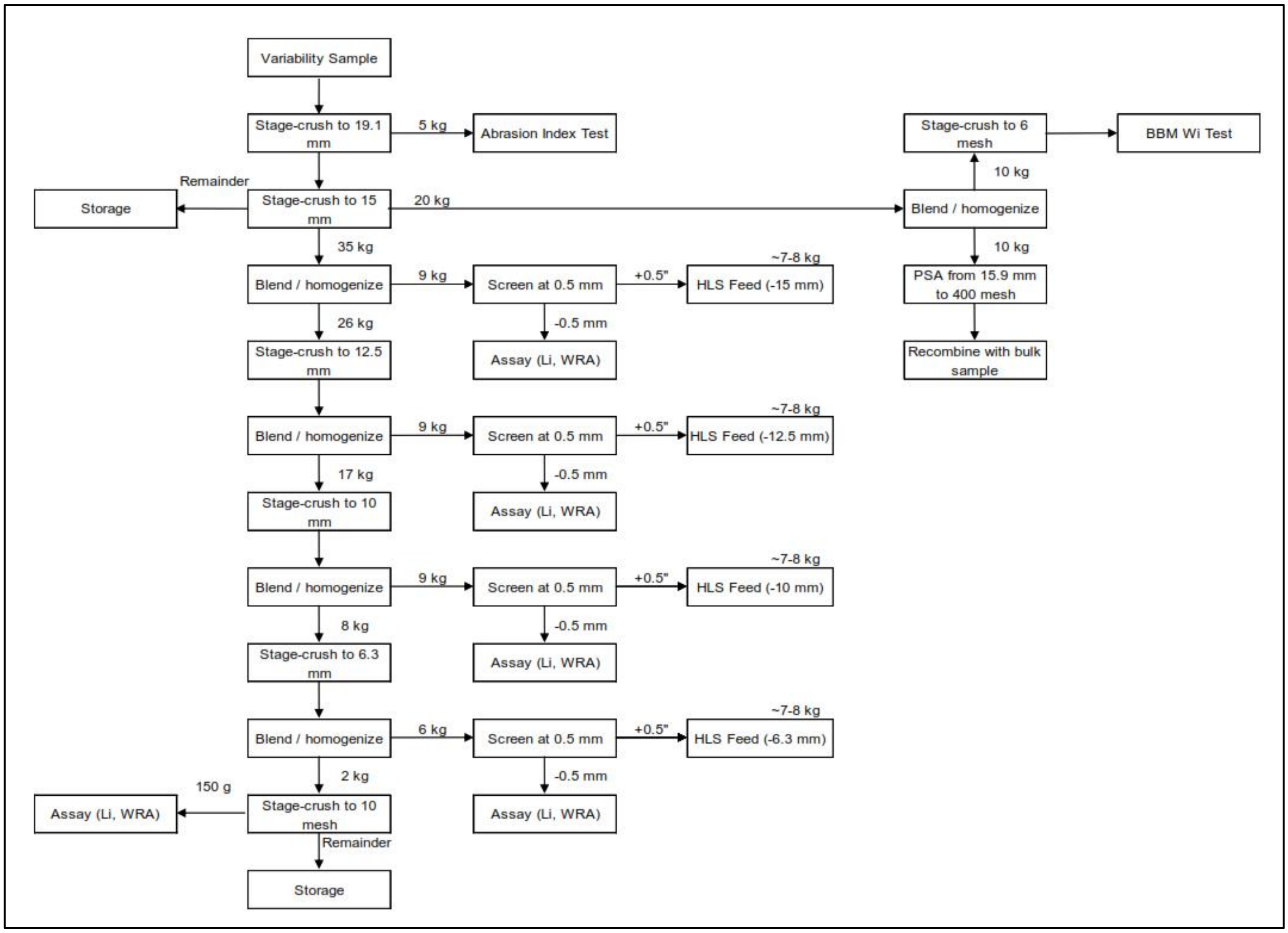


Figure 13-2: Sample Preparation Diagram for Stage 1 Variability Samples

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.

The 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.

13.1.1.1 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.

13.1.1.2 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.
- Uniaxial Compression Test (UCS) : 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	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)
Var 1	65.2	10.3
Var 2	57.8	10.8
Var 3	50.1	9.8
Var 4	74.4	14.6
Var 5	69.3	12.9
Var 6	68.6	12.6
Average	**64.2**	**11.8**

13.1.1.3 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 and fines resulted in only marginal lithium upgrading. However, due to the high iron distributions to the waste and fines, significant iron rejection was typically observed. 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.

13.1.2 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 to minimize fines generation.

13.1.3 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 ultrafines fractions of a variability sample were separately processed to generate spodumene concentrate.

13.1.3.1 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.

13.1.3.2 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 0.48% Li_2O across the six variability samples (Table 13-7). This was largely due to presence of significant amounts of petalite in the variability samples.

Table 13-7: DMS Tailings Grades

SAMPLE	DMS TAILINGS GRADE, % LI_2O
Var 1	0.47
Var 2	0.46
Var 3	0.65
Var 4	0.40
Var 5	0.52
Var 6	0.63

13.1.3.3 Coarse DMS Recrushing, 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 mm / +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 and HLS concentrate Li_2O grades are very similar to those of the coarse DMS concentrates.

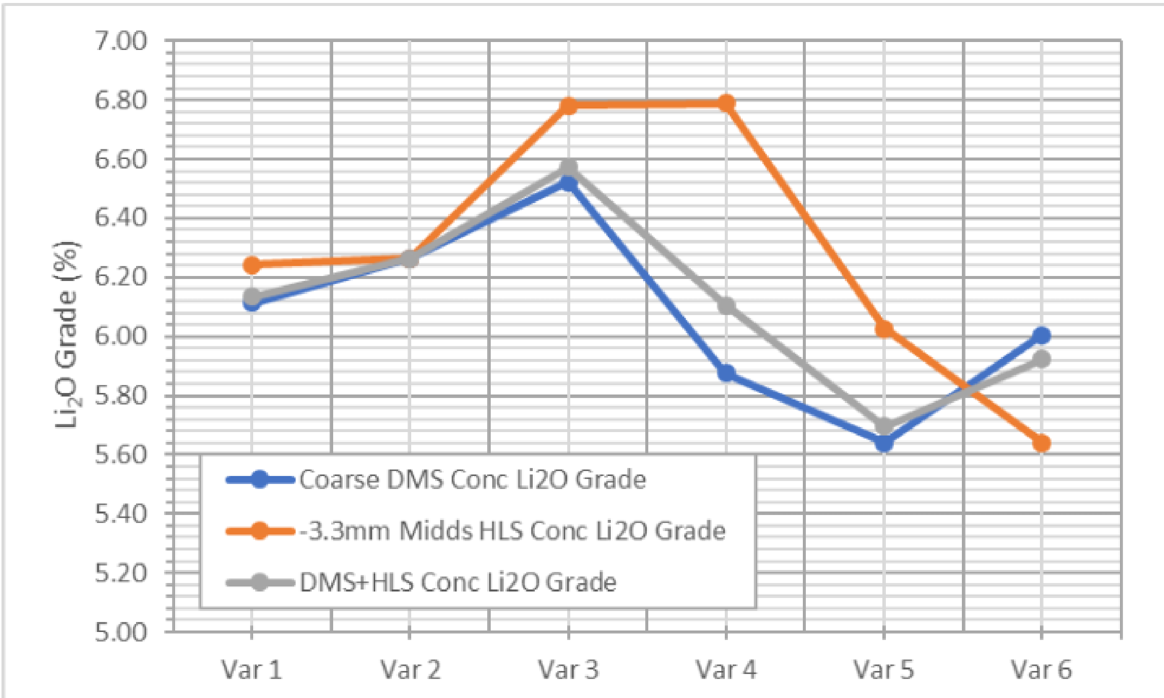


Figure 13-3: Effect of Combining Coarse DMS and -3.3 mm Middlings HLS Concentrates

13.1.3.4 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 13-8.

Table 13-8: 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

13.1.3.5 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 13-9: Ultra-fine Fraction DMS Results

Sample	Target Ultrafines 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

13.1.4 Overall Flowsheet Test Work

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.

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% and 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.

13.1.5 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 on 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 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.

13.1.6 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 fines and ultrafines fractions were passed through the Reflux classifier prior to DMS. Dry magnetic separation was undertaken on the fines and ultrafines DMS concentrates. The combined spodumene concentrate graded 6.16% Li_2O and 0.85% Fe_2O_3 with 46.2% lithium recovery. The combined results do not consider the processing of re-crushed DMS middlings.

13.1.7 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.

13.2 XUXA METALLURGICAL TEST WORK (2020-2021)

13.2.1 Sample Selection and Test Work Objectives

During the 2018 sample selection for the metallurgical test work, samples of pegmatite from outside the Xuxa resource model were incorporated in variability samples Var 2, Var 3, and Var 6. This created a bias by adding a higher concentration of petalite into the samples compared to the average abundance in the main Xuxa pegmatite (Figure 13-4). To be more representative of the deposit, a new sample selection based on mineralogy, average Li_2O grade and spatial distribution was completed by SGS in 2021, followed by a new metallurgical drilling program to select representative samples. SMSA completed nine (9) metallurgical drill holes, recovering 500 kg of material for the new test work. SGS Lakefield used the same parameters as they had for the 2018 metallurgical test work.

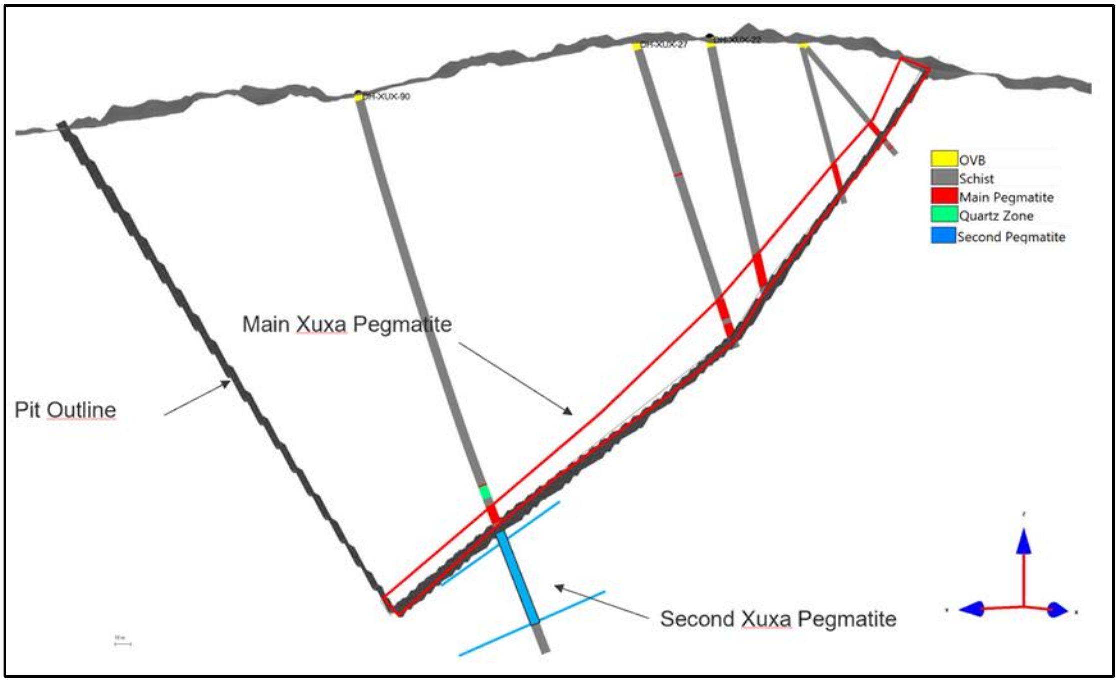


Figure 13-4: Xuxa Main Pegmatite and Second Pegmatite Sampled in 2018

Along with the sample selection, a statistical analysis of the petalite and spodumene distribution was completed throughout the deposit. Results were used to control the sample selection variable tolerance level of the main lithium barring minerals. The analysis was based on detailed mineralogical logging by SMSA's mineralogist along with XRD analysis from the metallurgical samples.

Results show an average petalite distribution of 1.6% throughout the deposit (with 4.5% standard deviation) and 15.8% distribution for spodumene (with 7.8% standard deviation). SGS applied the same interpolation parameters used for the resource estimation and the block model distribution for petalite is shown in Figure 13-5 and spodumene in Figure 13-6. The overall exercise confirmed the geological observation and interpretation and is consistent with the test results.

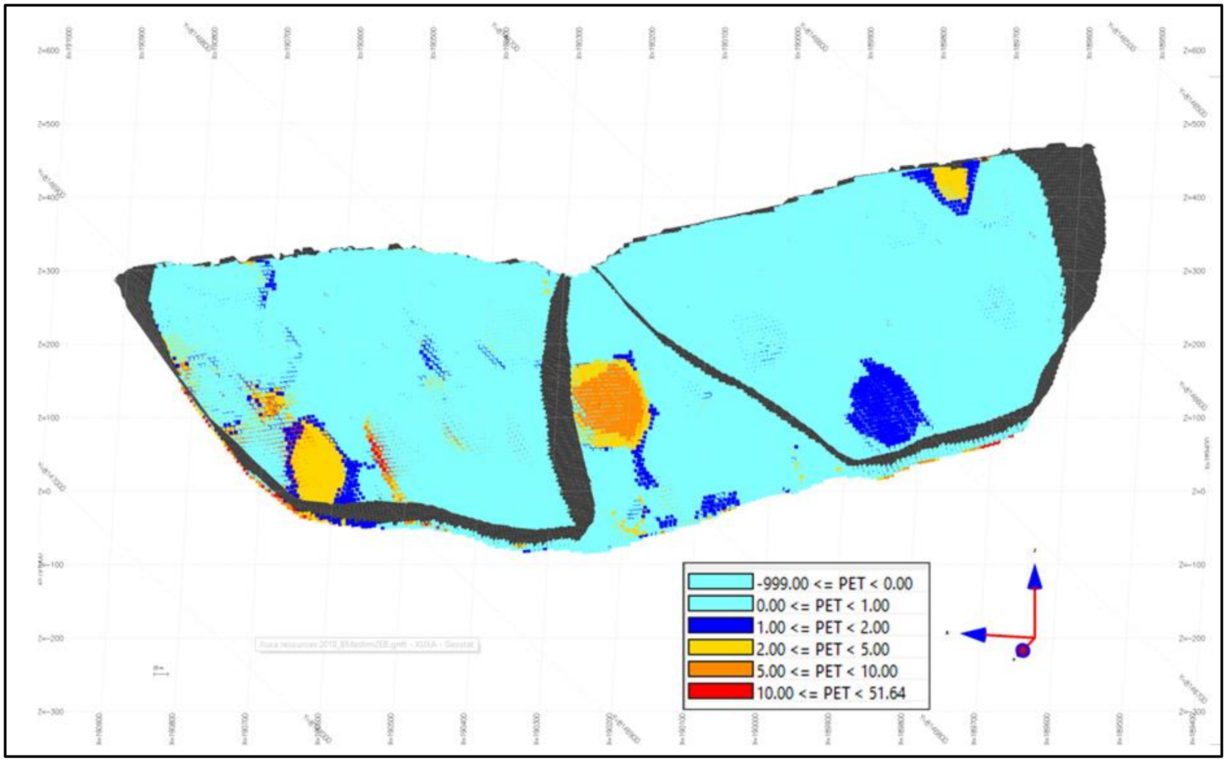


Figure 13-5: Petalite Distribution (%) in Xuxa Block Model (Plan View Looking North)

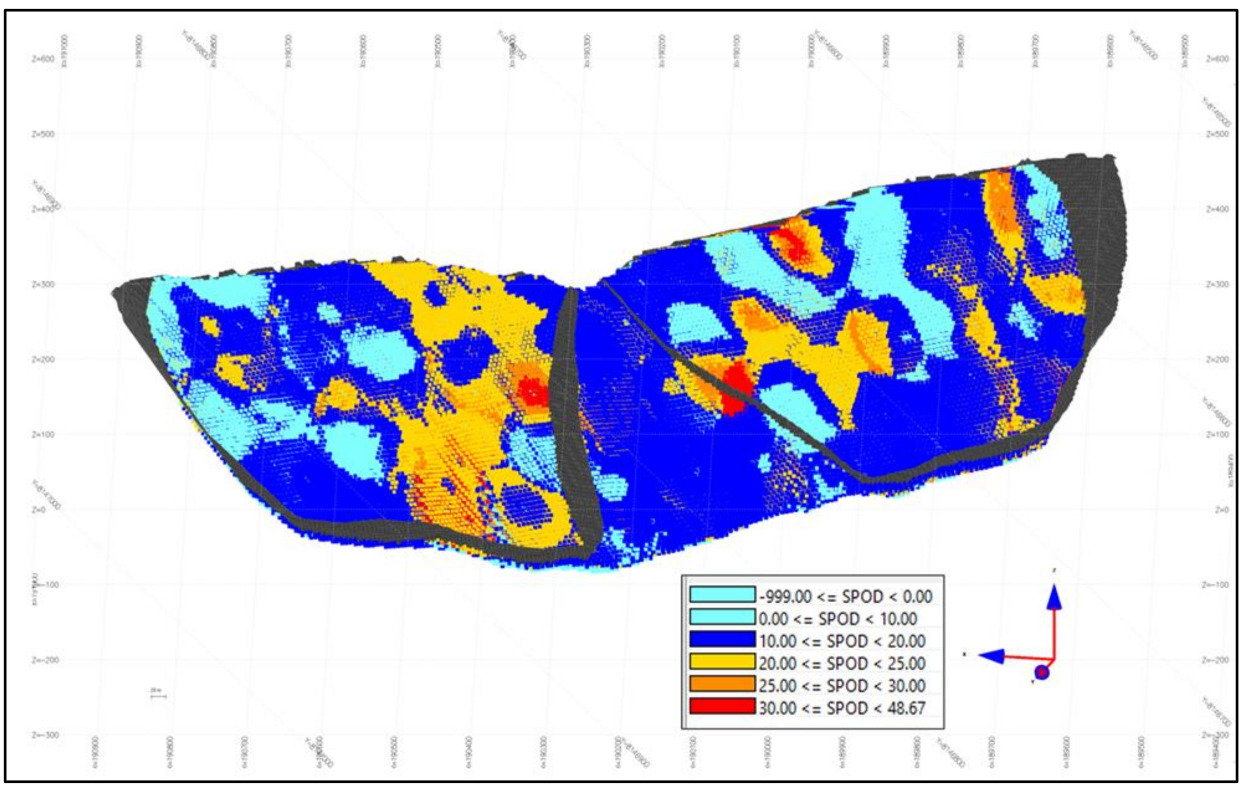


Figure 13 6: Spodumene Distribution (%) in Xuxa Block Model (Plan View Looking North)Sample

13.2.2 Preparation and Characterization

Chemical analyses of the three variability samples are shown in Table 13-10 (calculated head grades based on pegmatite and schist components). The head grades of the variability samples ranged from 1.27% Li_2O for Variability sample 6 (Var 6) to 1.74% Li_2O in the Var 3 sample. Var 2 and Var 3 contained 3% dilution (schist) while Var 6 contained 10% dilution. Var 6 had elevated concentrations of iron (0.94% Fe_2O_3) and potassium (3.40% K_2O) relative to Var 2 and Var 3.

Table 13-10: Variability sample assays

ELEMENT / OXIDE	SAMPLE		
	Var 2	Var 3	Var 6
	Composition, %		
Li	0.77	0.81	0.59
Li_2O	1.66	1.74	1.27
Si_2O	73.5	73.0	72.5
Al_2O_3	16.4	16.4	15.9
Fe_2O_3	0.57	0.56	0.94
MgO	0.13	0.13	0.30
CaO	0.20	0.32	0.39
Na_2O	3.39	3.62	3.44
K_2O	2.69	2.44	3.40
P_2O_5	0.35	0.47	0.40

Table 13-11 shows the semi-quantitative mineralogy based on X-Ray Diffraction (XRD) results for the variability samples. Spodumene content ranged from 13.4% to 17.7%. Muscovite content ranged from 6.0% to 6.5%. Lithium bearing minerals included spodumene, cookeite, and petalite.

Table 13-11: Semi-quantitative XRD analysis of the variability samples

Mineral	Sample		
	Var 2	Var 3	Var 6
	Composition, %		
Albite	28.0	28.2	28.5
Quartz	29.9	28.2	29.1
Spodumene	17.7	16.1	13.4
Microcline	12.2	9.8	15.5
Muscovite	6.5	6.1	6.0
Cookeite	3.5	2.0	1.9
Petalite	0.5	6.4	0.7
Biotite	0.4	0.3	1.4

13.2.3 Heavy Liquid Separation

HLS tests were performed on each variability sample at a crush size of -9.5 mm. Interpolated lithium recoveries at 6% Li_2O concentrate grade are presented in Table 13-12. Interpolated lithium stage recoveries ranged from 63.3% to 79.8%. Global recoveries include lithium losses to the hypofines (-0.5 mm) fraction and ranged from 49.9% to 66.1%.

Table 13-12: HLS Interpolated stage and global lithium recoveries (6% Li_2O concentrate) for each variability sample

Recovery	Interpolated Lithium Recovery, %		
	Var 2	Var 3	Var 6
Stage	79.8	63.3	75.2
Global	66.1	49.9	64.6

Size-by-size analysis was undertaken for each variability HLS test. The size fractions were: coarse (-9.5 mm / +6.4 mm), fines (-6.4 mm / +1.7 mm), and ultrafines (-1.7 mm / +0.5 mm). Detailed size-by-size HLS mass balances are shown in Table 13-13 to Table 13-15.

Lithium recovery was generally seen to increase in the finer size fractions, which is likely due to a higher degree of spodumene liberation. HLS tests produced >6% Li_2O spodumene concentrate. Combined spodumene concentrate iron content ranged from 1.21% to 1.63% Fe_2O_3 (interpolated values for 6% Li_2O concentrate). Magnetic separation was only performed on the Var 6 HLS products. Magnetic separation decreased iron content of the concentrate from 1.63% to 0.83% Fe_2O_3 (interpolated values for 6% Li_2O concentrate) (Table 13-16).

Table 13-13: Variability Sample 2 Global HLS Results

Combined HLS Products	HL SG	Weight		Assays (%)										Distribution (%)								
	g/cm³	g	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5
Spodumene Conc.	2.85	1349	13.5	3.07	6.60	64.0	25.0	1.24	0.12	0.19	0.43	0.32	0.73	63.6	11.7	21.5	24.9	12.3	11.5	1.7	1.6	23.5
Spodumene Conc. (int.*)	2.81	1546	15.5	2.79	6.00	63.6	24.8	1.34	0.18	0.22	0.56	0.82	0.70	66.1	13.4	24.5	30.8	21.5	15.5	2.5	4.7	25.7
Spodumene Conc.	2.80	1569	15.7	2.75	5.93	63.6	24.8	1.35	0.18	0.22	0.58	0.88	0.70	66.4	13.6	24.9	31.5	22.5	16.0	2.6	5.1	26.0
Middlings	-2.85 +2.65	1547	15.5	0.39	0.85	70.2	17.9	1.42	0.37	0.42	2.25	3.26	0.41	9.3	14.7	17.7	32.8	45.6	29.6	10.0	18.7	15.0
Middlings (int.)	-2.84 +2.65	1350	13.5	0.33	0.71	71.5	17.1	1.34	0.34	0.41	2.36	3.11	0.40	6.8	13.1	14.8	26.9	36.5	25.5	9.2	15.5	12.8
Tailings 1	-2.65+2.50	4835	48.5	0.07	0.14	78.0	12.5	0.26	0.03	0.13	4.62	3.27	0.28	5.0	51.2	38.6	18.6	10.3	29.6	64.5	58.5	32.1
Tailings 2	-2.50	254	2.6	1.29	2.77	72.9	17.1	0.34	0.11	0.10	1.64	2.90	0.18	5.0	2.5	2.8	1.3	2.1	1.2	1.2	2.7	1.1
Hypofines (-0.5 mm)		1984	19.9	0.56	1.21	73.5	15.3	0.76	0.19	0.31	3.94	2.53	0.60	17.1	19.8	19.4	22.4	29.7	28.2	22.6	18.6	28.3
Head (calc.)		9969	100.0	0.64	1.37	73.9	15.7	0.68	0.13	0.22	3.52	2.71	0.43	100	100	100	100	100	100	100	100	100

*int = Interpolated based on production of 6% Li_2O concentrate

Table 13-14: Variability Sample 3 Global HLS Results

Combined HLS Products	HL SG	Weight		Assays (%)										Distribution (%)								
	g/cm³	g	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5
Spodumene Conc.	2.85	1286	12.9	2.84	6.12	65.3	23.7	1.20	0.11	0.46	0.52	0.39	0.87	48.9	11.6	18.6	22.3	11.5	18.3	1.8	2.0	20.9
Spodumene Conc. (int.*)	2.84	1343	13.5	2.79	6.00	65.5	23.5	1.21	0.12	0.48	0.56	0.43	0.85	49.9	12.2	19.2	23.6	13.3	19.9	2.1	2.4	21.3
Spodumene Conc.	2.80	1533	15.3	2.60	5.6	66.3	22.8	1.2	0.2	0.5	0.7	0.6	0.8	53.4	14.0	21.4	27.6	19.4	25.1	2.9	3.4	22.7
Middlings	-2.85 +2.65	1536	15.4	0.56	1.20	71.1	17.2	1.36	0.33	0.68	2.34	2.72	0.50	11.5	15.1	16.2	30.3	41.7	32.0	9.9	16.9	14.3
Middlings (int.)	-2.84 +2.65	1478	14.8	0.53	1.14	71.1	17.2	1.36	0.32	0.67	2.37	2.78	0.50	10.4	14.5	15.5	29.0	39.8	30.4	9.6	16.6	13.9
Tailings 1	-2.65+2.50	4238	42.4	0.13	0.27	75.2	14.0	0.29	0.02	0.15	5.24	3.20	0.37	7.2	44.0	36.2	17.6	6.4	19.5	60.9	54.7	29.5
Tailings 2	-2.50	565	5.7	1.49	3.22	74.5	16.9	0.42	0.07	0.11	0.89	1.75	0.18	11.3	5.8	5.8	3.5	3.2	1.9	1.4	4.0	1.9
Hypofines (-0.5 mm)		2360	23.6	0.67	1.44	72.3	16.1	0.77	0.19	0.39	4.02	2.35	0.76	21.2	23.5	23.2	26.3	37.2	28.3	26.0	22.4	33.4
Feed (Calc.)		9985	100	0.75	1.61	72.6	16.4	0.69	0.12	0.33	3.65	2.48	0.54	100	100	100	100	100	100	100	100	100

*int = Interpolated based on production of 6% Li_2O concentrate

Table 13-15: Variability Sample 6 Global HLS Results

Combined HLS Products	HL SG	Weight		Assays (%)										Distribution (%)								
	g/cm³	g	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5
Spodumene Conc.	2.90	1209	12.1	2.95	6.35	64.2	24.9	1.49	0.29	0.36	0.44	0.27	0.37	61.5	10.7	18.9	17.7	12.8	11.7	1.6	0.9	11.1
Spodumene Conc. (int.*)	2.86	1345	13.5	2.79	6.00	64.4	24.3	1.63	0.36	0.45	0.54	0.42	0.39	64.6	11.9	20.6	21.6	17.9	16.3	2.1	1.7	13.0
Spodumene Conc.	2.85	1369	13.7	2.76	5.94	64.4	24.2	1.66	0.37	0.47	0.55	0.45	0.39	65.1	12.2	20.9	22.3	18.7	17.1	2.2	1.8	13.4
Middlings	-2.90 +2.65	1901	19.1	0.45	0.98	70.6	16.4	2.40	0.74	0.91	2.33	2.84	0.42	14.8	18.5	19.6	44.9	51.8	46.0	12.9	15.9	19.8
Middlings (int.)	-2.86+2.65	1764	17.7	0.39	0.83	71.0	16.2	2.36	0.72	0.88	2.41	2.92	0.41	11.7	17.3	17.9	40.9	46.7	41.4	12.4	15.2	17.9
Tailings 1	-2.65+2.50	4995	50.1	0.09	0.20	76.0	13.6	0.23	0.03	0.15	4.52	4.29	0.35	7.9	52.4	42.9	11.4	4.8	20.0	65.6	63.2	43.4
Tailings 2	-2.50	128	1.3	0.75	1.62	68.8	17.6	0.43	0.11	0.13	1.70	7.12	0.40	1.7	1.2	1.4	0.5	0.5	0.5	0.6	2.7	1.3
Hypofines (-0.5 mm)	-	1745	17.5	0.47	1.01	71.5	15.7	1.49	0.47	0.47	3.81	3.34	0.56	14.1	17.2	17.2	25.6	30.1	21.8	19.3	17.2	24.4
Feed (Calc.)		9977	100	0.58	1.25	72.7	15.9	1.02	0.27	0.38	3.45	3.40	0.40	100	100	100	100	100	100	100	100	100

*int = Interpolated based on production of 6% Li_2O concentrate

Table 13-16: Variability Sample 6 Global HLS Results with magnetic separation

Combined HLS Products	HL SG	Weight		Assays (%)										Distribution (%)								
	g/cm³	g	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5
Spodumene Conc.	2.80	1323	13.3	2.88	6.20	66.6	24.4	0.74	0.03	0.10	0.02	0.46	0.16	65.6	12.2	20.3	9.6	1.3	3.4	0.1	1.8	5.1
Spodumene Conc. (int.*)	2.79	1403	14.1	2.79	6.00	66.7	24.1	0.83	0.06	0.14	0.09	0.58	0.16	66.2	12.9	21.2	12.1	4.3	5.9	0.5	2.7	5.9
Spodumene Conc.	2.70	2164	21.7	1.92	4.13	67.0	21.7	1.67	0.42	0.51	0.75	1.67	0.24	71.5	20.0	29.5	35.6	33.3	29.7	4.8	10.6	12.9
HLS Middling	-2.80+2.65	1469	14.7	0.32	0.69	72.8	15.2	2.15	0.65	0.78	2.61	2.71	0.39	8.2	14.7	14.0	31.0	34.7	30.6	11.3	11.7	14.2
Middlings (int.*)	-2.79+2.65	1389	13.9	0.32	0.68	73.1	15.0	2.09	0.62	0.76	2.65	2.66	0.39	7.6	14.0	13.1	28.5	31.7	28.1	10.9	10.9	13.4
Mag Sep Conc.	-2.95+2.80	318	3.2	0.46	0.98	52.8	21.1	7.01	2.47	2.75	1.54	3.55	1.46	2.5	2.3	4.2	21.9	28.7	23.4	1.5	3.3	11.6
Tailings 1	-2.65+2.50	4995	50.0	0.09	0.20	76.0	13.6	0.23	0.03	0.15	4.52	4.29	0.35	7.9	52.3	42.8	11.3	4.8	20.1	66.8	63.2	43.4
Tailings 2	-2.50	128	1.3	0.75	1.62	68.8	17.6	0.43	0.11	0.13	1.70	7.12	0.40	1.7	1.2	1.4	0.5	0.5	0.5	0.6	2.7	1.3
Hypofines (-0.5 mm)	-	1748	17.5	0.47	1.01	71.5	15.7	1.49	0.47	0.47	3.81	3.34	0.56	14.2	17.2	17.2	25.6	30.0	22.0	19.7	17.2	24.5
Head (Calc.)		9980	100	0.58	1.25	72.7	15.9	1.02	0.27	0.37	3.39	3.40	0.40	100	100	100	100	100	100	100	100	100

*int = Interpolated based on production of 6% Li_2O concentrate

13.2.4 Dense Media Separation

DMS testing was performed on the variability samples on the coarse (-9.5 mm / +6.4 mm), fines (-6.4 mm / +1.7 mm) and ultrafines (-1.7 mm / +0.5 mm) size fractions separately. Dry magnetic separation was performed on each of the concentrate streams.

DMS feed was pre-screened at 0.5 mm to remove fine particles. The density of the circulating media was controlled to produce the desired SG cut-points and tracer tests were conducted prior to testing to ensure that the media SG was at the desired target.

Each size fraction underwent two DMS passes. The first pass was operated at a lower density to reject silicate gangue minerals (SG of 2.65). The first pass sink product was repassed through the DMS at a higher density cut-point to produce spodumene concentrate. The SG cut-points for the second pass were chosen based on interpolated HLS data for the production of 6% Li_2O spodumene concentrate. Cut-points for Var 6 were based on HLS and magnetic separation results. Target SG cut-points ranged from 2.78 to 2.89.

13.2.4.1 DMS Results

Table 13-17 summarizes the DMS and magnetic separation results for each sample by size fraction. The results show that 6% Li_2O concentrate was generally produced (other than the fines fraction for Var 6 which produced 5.92% Li_2O concentrate). In all cases, magnetic separation was able to effectively lower the iron content of the concentrate to <1% Fe_2O_3. Lithium stage recoveries by size fraction ranged from 45.7% to 79.7%.

Table 13-17: DMS and magnetic separation results by size fraction

SAMPLE	COARSE			FINES			ULTRAFINES		
	% Li_2O	% Fe_2O_3	Li Rec.*, %	% Li_2O	% Fe_2O_3	Li Rec.*, %	% Li_2O	% Fe_2O_3	Li Rec.*, %
Var 2	6.09	0.69	67.0	6.24	0.66	66.9	6.91	0.70	67.1
Var 3	6.41	0.60	49.3	6.28	0.60	58.0	7.10	0.60	45.7
Var 6	6.03	0.74	70.9	5.92	0.72	79.7	6.78	0.70	69.3

*Stage lithium recovery

Combined DMS and magnetic separation stage results for the three variability samples are shown in Table 13-18, Table 13-19, and Table 13-20. Lithium stage recoveries for Var 2, Var 3, and Var 6 were 66.9%, 53.2% and 74.7%, respectively. Each combined concentrate graded >6% Li_2O with low iron content (<1% Fe_2O_3) after magnetic separation.

Lithium deportment to the middlings stream was relatively high for sample Var 3 at 17.6%, compared to 9.9% and 12.7% in Var 2 and Var 6 respectively.

Mass rejection to the tailings stream (SG -2.65) ranged from 46.2% to 58.1% with lithium losses ranging from 9.8% to 24.8%.

The Var 6 feed sample contained 10% dilution (schist) compared to 3% in the other two samples. Iron content in the Var 6 DMS concentrate was relatively high at 1.92% Fe_2O_3. Magnetic separation was able to reduce iron content to 0.71% Fe_2O_3 with a 2.6% lithium loss to the magnetic concentrate.

Table 13-18: Var 2 Combined DMS stage results

Product	Weight		Assays (%)										Distribution (%)								
	kg	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5
DMS Conc. Non-Mag	73.7	16.3	2.92	6.29	66.6	24.7	0.68	0.04	0.06	0.50	0.32	0.13	66.9	14.8	24.5	16.6	4.65	4.20	2.22	1.98	6.0
DMS Conc. Mag	7.83	1.73	1.18	2.54	52.0	24.6	5.96	1.05	1.35	1.07	4.20	2.67	2.9	1.2	2.6	15.6	12.93	10.5	0.5	2.7	13.4
DMS Middling	120	26.5	0.26	0.57	77.1	13.4	1.06	0.30	0.36	3.55	1.87	0.36	9.9	27.9	21.7	42.3	57.08	42.4	25.5	18.7	27.5
DMS Tailings	251	55.4	0.26	0.56	73.9	15.2	0.30	0.06	0.17	4.78	3.66	0.33	20.3	56.0	51.3	25.4	25.3	42.9	71.8	76.5	53.1
Head (calc.)	452	100	0.71	1.53	73.2	16.5	0.66	0.14	0.22	3.69	2.65	0.35	100	100	100	100	100	100	100	100	100
DMS Conc.	81.5	18.0	2.75	5.93	65.2	24.7	1.18	0.14	0.18	0.56	0.69	0.37	69.8	16.1	27.1	32.2	17.6	14.7	2.7	4.7	19.4

Table 13-19: Var 3 Combined DMS stage results

Product	Weight		Assays (%)										Distribution (%)								
	kg	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5
DMS Conc. Non-Mag	34.9	13.8	2.99	6.43	67.7	23.7	0.58	0.01	0.06	0.56	0.30	0.23	53.2	12.8	19.9	12.3	1.46	2.49	2.10	1.65	7.24
DMS Conc. Mag	4.90	1.94	1.79	3.85	54.6	22.5	4.42	0.84	3.72	0.83	2.24	3.37	4.47	1.45	2.65	13.1	13.3	22.0	0.44	1.73	14.6
DMS Middling	66.1	26.1	0.52	1.12	74.8	14.9	1.13	0.30	0.57	3.17	1.92	0.48	17.6	26.7	23.6	45.1	62.8	45.7	22.5	19.9	28.3
DMS Tailing	147	58.1	0.33	0.71	74.2	15.3	0.33	0.05	0.17	4.74	3.33	0.38	24.8	59.0	53.9	29.6	22.5	29.8	74.9	76.8	49.9
Head (calc.)	253	100	0.78	1.67	73.0	16.5	0.65	0.12	0.33	3.67	2.52	0.45	100	100	100	100	100	100	100	100	100
DMS Conc.	39.8	15.8	2.84	6.11	66.1	23.5	1.05	0.12	0.51	0.59	0.54	0.62	57.7	14.2	22.5	25.4	14.7	24.5	2.5	3.4	21.9

Table 13-20: Var 6 Combined DMS stage results

Product	Weight		Assays (%)										Distribution (%)								
	kg	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5
DMS Conc. Non-Mag	53.3	17.4	2.82	6.06	67.1	23.8	0.72	0.05	0.16	0.63	0.44	0.21	74.7	16.1	25.6	12.1	2.80	6.51	3.17	2.66	9.7
DMS Conc. Mag	12.4	4.04	0.45	0.94	53.6	20.1	7.10	2.58	3.34	1.61	3.09	1.35	2.77	2.98	5.03	27.7	36.3	30.8	1.90	4.34	14.6
DMS Middling	99	32.4	0.26	0.55	77.1	12.9	1.38	0.43	0.54	3.55	1.85	0.36	12.7	34.4	26.0	43.1	48.4	40.1	33.5	20.9	31.3
DMS Tailing	142	46.2	0.14	0.30	73.2	15.2	0.38	0.08	0.21	4.58	4.49	0.36	9.8	46.5	43.4	17.1	12.5	22.6	61.5	72.1	44.4
Head (calc.)	306	100	0.66	1.41	72.6	16.1	1.04	0.29	0.44	3.44	2.87	0.37	100	100	100	100	100	100	100	100	100
DMS Conc.	65.7	21.4	2.37	5.10	64.5	23.1	1.92	0.52	0.76	0.81	0.94	0.42	77.5	19.1	30.6	39.9	39.1	37.4	5.1	7.0	24.3

Table 13-21, Table 13-22, and Table 13-23 show the combined global DMS mass balances for Var 2, Var 3, and Var 6, respectively.

After dry magnetic separation, combined concentrate grades ranged from 6.06% to 6.43% Li_2O with lithium recoveries ranging from 46.1% to 64.2%. Mass reporting to the hypofines (-0.5 mm) fraction ranged from 14.0% to 18.4% with lithium losses ranging from 11.0 to 14.1%.

For magnetic separation on the DMS concentrate samples, combined results showed 9.6% mass rejection and decrease in overall lithium recovery of 2.9% for variability sample 2, 12.3% mass rejection and decrease in overall lithium recovery of 4.5% for variability sample 3, and 18.9% mass rejection and decrease in overall lithium recovery of 2.6% for variability sample 6.

Table 13-21: Var 2 Combined Global DMS results

Product	Weight		Assays (%)										Distribution (%)								
	kg	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5
DMS Conc. Non-Mag	73.7	14.0	2.92	6.29	66.6	24.7	0.68	0.04	0.06	0.50	0.32	0.13	59.6	12.8	21.1	13.4	3.82	3.39	1.89	1.70	4.69
DMS Conc. Mag	7.83	1.49	1.18	2.54	52.0	24.6	5.96	1.05	1.35	1.07	4.20	2.67	2.6	1.1	2.2	12.6	10.62	8.5	0.4	2.4	10.5
DMS Middling	120	22.8	0.26	0.57	77.1	13.4	1.06	0.30	0.36	3.55	1.87	0.36	8.8	24.0	18.7	34.2	46.9	34.2	21.7	16.1	21.6
DMS Tailings	251	47.7	0.26	0.56	73.9	15.2	0.30	0.06	0.17	4.78	3.66	0.33	18.1	48.19	44.21	20.6	20.82	34.62	61.10	65.80	41.66
Hypofines (-0.5 mm)	73.4	14.0	0.54	1.16	73.1	16.18	0.97	0.19	0.33	3.97	2.67	0.59	11.0	14.0	13.8	19.2	17.8	19.3	14.9	14.0	21.6
Head (calc.)	525	100	0.69	1.48	73.2	16.4	0.71	0.15	0.24	3.73	2.65	0.38	100	100	100	100	100	100	100	100	100
DMS Conc.	81.5	15.5	2.75	5.93	65.2	24.7	1.18	0.14	0.18	0.56	0.69	0.37	62.2	13.8	23.3	26.0	14.4	11.9	2.3	4.1	15.2

Table 13-22: Var 3 Combined Global DMS results

Product	Weight		Assays (%)										Distribution (%)								
	kg	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5
DMS Conc. Non-Mag	34.9	11.5	2.99	6.43	67.7	23.7	0.58	0.01	0.06	0.56	0.30	0.23	46.1	10.6	16.5	9.49	1.13	1.95	1.72	1.38	5.45
DMS Conc. Mag	4.90	1.61	1.79	3.85	54.6	22.5	4.42	0.84	3.72	0.83	2.24	3.37	3.88	1.20	2.21	10.1	10.29	17.2	0.36	1.44	11.0
DMS Middling	66.1	21.7	0.52	1.12	74.8	14.9	1.13	0.30	0.57	3.17	1.92	0.48	15.2	22.2	19.6	34.8	48.7	35.8	18.5	16.6	21.3
DMS Tailings	147	48.3	0.33	0.71	74.2	15.3	0.33	0.05	0.17	4.74	3.33	0.38	21.5	49.1	44.9	22.9	17.4	23.3	61.6	64.3	37.5
Hypofines (-0.5 mm)	51.3	16.9	0.59	1.26	72.6	16.2	0.95	0.18	0.45	3.93	2.42	0.72	13.3	16.8	16.7	22.7	22.4	21.8	17.9	16.3	24.8
Head (calc.)	304	100	0.74	1.60	73.0	16.4	0.70	0.13	0.35	3.72	2.50	0.49	100	100	100	100	100	100	100	100	100
DMS Conc.	39.8	13.1	2.84	6.11	66.1	23.5	1.05	0.12	0.51	0.59	0.54	0.62	50.0	11.9	18.8	19.6	11.4	19.2	2.1	2.8	16.4

Table 13-23: Var 6 Combined Global DMS results

Product	Weight		Assays (%)										Distribution (%)								
	kg	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5
DMS Conc. Non-Mag	53.3	14.2	2.82	6.06	67.1	23.8	0.72	0.05	0.16	0.63	0.44	0.21	64.2	13.1	21.0	9.6	2.25	5.35	2.54	2.14	7.21
DMS Conc. Mag	12.4	3.3	0.45	0.97	53.6	20.1	7.10	2.58	3.34	1.61	3.09	1.35	2.38	2.43	4.12	21.9	29.1	25.4	1.50	3.50	10.9
DMS Middling	99	26.4	0.26	0.55	77.1	12.9	1.40	0.43	0.54	3.55	1.85	0.36	10.9	28.0	21.3	34.0	38.8	33.0	26.8	16.7	23.4
DMS Tailings	142	37.7	0.14	0.30	73.2	15.2	0.38	0.08	0.21	4.58	4.49	0.36	8.42	37.9	35.5	13.5	10.0	18.6	49.2	57.9	33.1
Hypofines (-0.5 mm)	69.2	18.4	0.48	1.02	72.9	15.9	1.23	0.31	0.42	3.82	3.13	0.56	14.1	18.5	18.1	21.1	19.7	17.8	20.0	19.7	25.4
Head (calc.)	376	100	0.62	1.34	72.7	16.1	1.07	0.29	0.43	3.51	2.92	0.41	100	100	100	100	100	100	100	100	100
DMS Conc.	65.7	17.5	2.37	5.10	64.5	23.1	1.92	0.52	0.76	0.81	0.94	0.42	66.6	15.5	25.1	31.5	31.4	30.7	4.1	5.6	18.1

13.2.5 Comparison of the 2019 and 2021 Results

Table 13-24 compares the results obtained in the 2019 and 2021 variability test work program. Combined concentrate grade for variability sample 2 increased from 6.16% Li_2O to 6.29% Li_2O while global lithium recovery increased from 46.1% to 59.6%. Combined concentrate grade for variability sample 3 increased from 6.33% Li_2O to 6.43% Li_2O while global lithium recovery decreased from 56.1% to 46.1%. Combined concentrate grade for variability sample 6 decreased from 6.12% Li_2O to 6.06% Li_2O while global lithium recovery increased from 50.5% to 64.2%.

Table 13-24: Summary of 2019 and 2021 DMS and magnetic separation concentrate grade and global recovery (including hypofines fraction)

SAMPLE	STREAM	2019		2021	
		% LI_2O	GLOBAL LITHIUM RECOVERY, %	% LI_2O	GLOBAL LITHIUM RECOVERY, %
Var 2	Coarse Fraction Fines Fraction Ultrafines Fraction	6.26 6.09 5.98	22.9 17.8 5.4	6.09 6.24 6.91	20.5 29.2 9.9
	Combined	6.16	46.1	6.29	59.6
Var 3	Coarse Fraction Fines Fraction Ultrafines Fraction	6.57 6.01 6.48	27.8 22.3 6.1	6.41 6.28 7.10	13.8 25.8 6.50
	Combined	6.33	56.1	6.43	46.1
Var 6	Coarse Fraction Fines Fraction Ultrafines Fraction	6.14 6.11 6.07	21.3 20.3 8.9	6.03 5.92 6.78	23.3 32.0 8.98
	Combined	6.12	50.5	6.06	64.2

13.2.6 Xuxa Recovery and Basis of Assumptions

During the 2019 test work program, 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 13-25. The global recovery of 60.4% Li_2O was reconfirmed in the 2021 results.

Table 13-25: 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%

13.2.7 Impact of Lower Recovery Grade on Recovery

The changing market conditions have necessitated the evaluation of a lower product grade and its impact on recovery. An independent DMS expert has evaluated the Xuxa test work date to determine the affect of reducing the product grade on recovery.

The following HLS and compost test work was used as the basis of the estimation

- 6 HLS variability samples
- 3 Pilot composite samples

This set of data was then used in the calculations to determine the impact of decreasing the product grade from 6% to 5.5% on Li_2O recovery and yield. Both Li_2O recovery and product yield calculations are on a global basis i.e., relative to the fresh feed inclusive of the fines. It has been assumed that the fines do not contribute to the product and have been assigned a zero yield.

13.2.7.1 Increase in Li_2O Recovery

The comparative results for a 9.5 mm top size are shown in Figure 13-7. The results for the variability and composite samples are shown separately.

For a 6% product grade, the median results from the variability and composite samples were similar. When reducing the product grade to 5.5%, the variability samples resulted in a higher recovery compared to the composite samples.

The relative increase in Li_2O recovery is shown in Figure 13-8.

The median values for the composite and variability samples are 4.6 and 9.8% respectively.

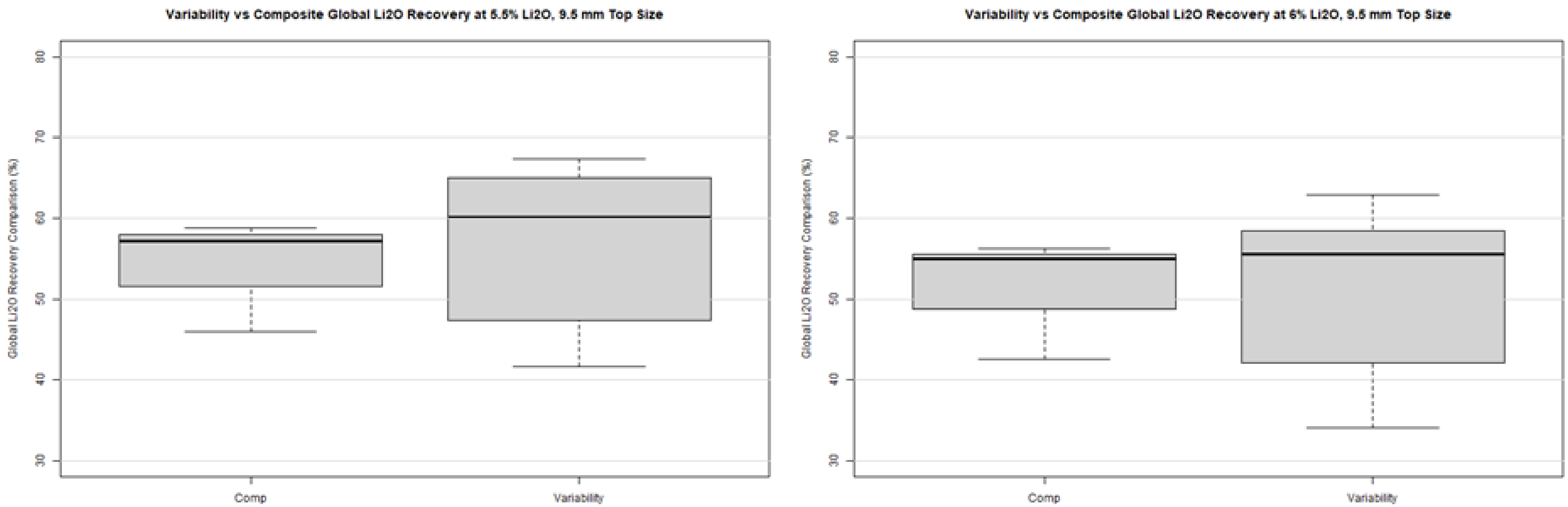


Figure 13-6: Comparative Results for 5.5% and 6.0% Li_2O Global Recovery for 9.5 mm Top Size

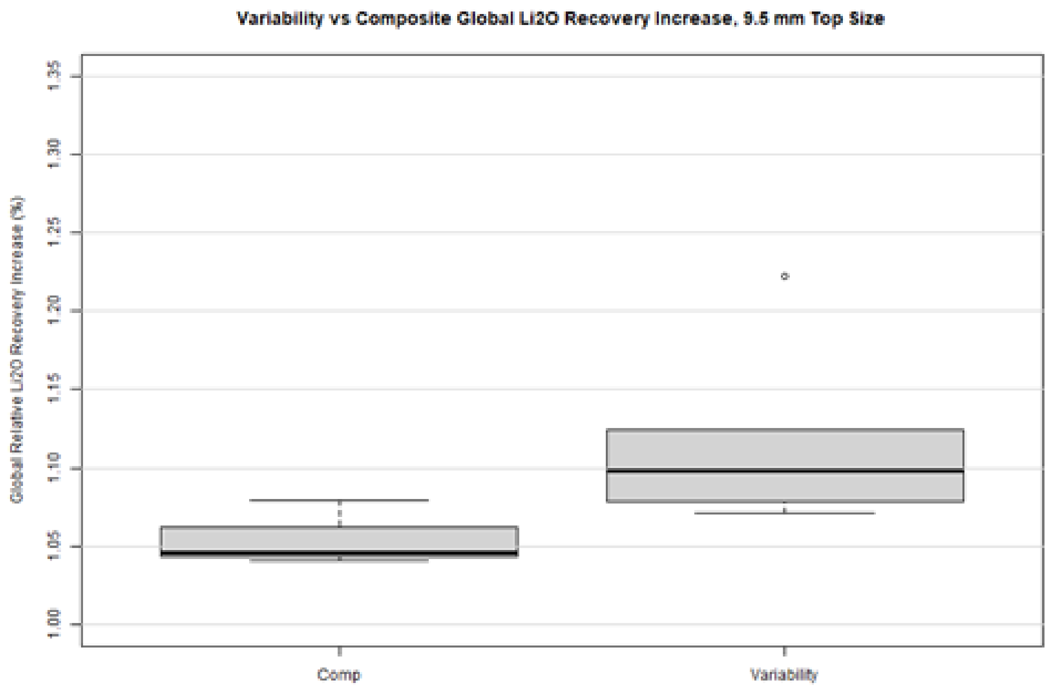


Figure 13-7: Relative Increase in Global Li_2O Recovery for 9.5 mm Top Size

13.2.7.2 Increase in Li_2O Yield

The comparative results for a 9.5 mm top size are shown in Figure 13-9. The results for the variability and composite samples are shown separately.

For both 6% and 5.5%, the variability samples gave a higher yield compared to the composite samples.

The relative increase in yield is shown in Figure 13-10.

The median values for the composite and variability samples are 14.1 and 19.8% respectively.

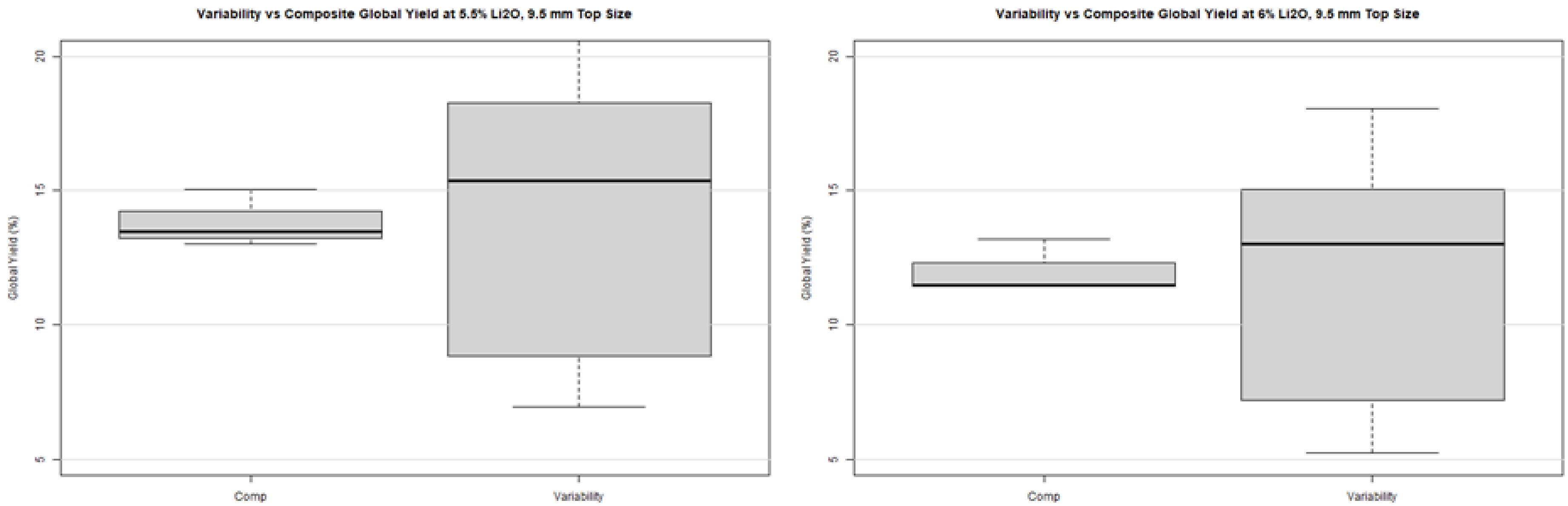


Figure 13-8: Comparative Results for 5.5% and 6.0% Li_2O Global Yield for 9.5 mm Top Size

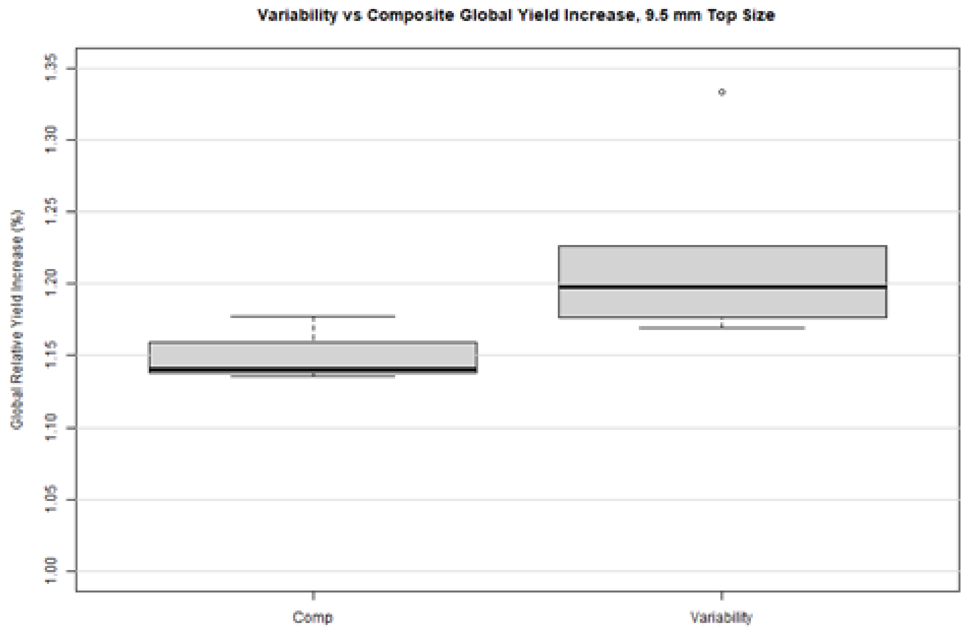


Figure 13-9: Relative Increase in Global Li_2O Yield for 9.5 mm Top Size

13.2.7.3 Recommendation

The relative increases are summarized in Table 13-26.

Table 13-26: Summary of Global Recovery and Yield at 5.5% Li_2O for 9.5 mm Top Size

	Variability	Composite	Overall
Global Li_2O Recovery (%)	9.8	4.6	7.9
Global Yield (%)	19.8	14.1	17.7

Note: the overall percentage assumes an equal weighting between the variability and composite results.

It is estimated that recovery will increase by between 4.6% and 9.8% when product grade is dropped to 5.5%, so it is a fair and conservative assumption to assume the lower end of range.

It is recommended that for a product grade of 5.5% a global recovery of 65% can be assumed.

13.3 BARREIRO METALLURGICAL TEST WORK (2020-21)

13.3.1 Overview

A scoping-level metallurgical test work program was undertaken on samples from the Barreiro deposit from November 2020 to May 2021 and a PFS-level metallurgical test work program was undertaken from May 2021 to August 2021 at SGS Canada Inc. (Lakefield, Ontario). Four variability and one composite sample were tested. The test work program included:

- Sample preparation and characterization
- Grindability testing

- Heavy liquid separation (HLS)

The goals of the program were to provide preliminary process information on the metallurgical performance of ore samples from the Barreiro deposit. The test work program was developed based on previous test work and flowsheet developed for the Xuxa deposit. The aim of the test work program was to produce chemical-grade spodumene concentrate (>6% Li_2O) with low iron content (<1% Fe_2O_3), while maximizing lithium recovery.

13.3.2 Sample Selection

The aim of the Barreiro sample selection process for the metallurgical test work program was to select four variability samples of at least 100 kg. Sub-samples from each variability sample would then be blended to create a master composite. Seven hundred and thirteen (713) individual samples were available at SGS Canada Inc. (Lakefield, ON) for production of the variability samples. Figure 13-11 depicts the lithium (Li_2O) grades and the localization within the Barreiro deposit of the drill hole intervals used for producing the variability samples.

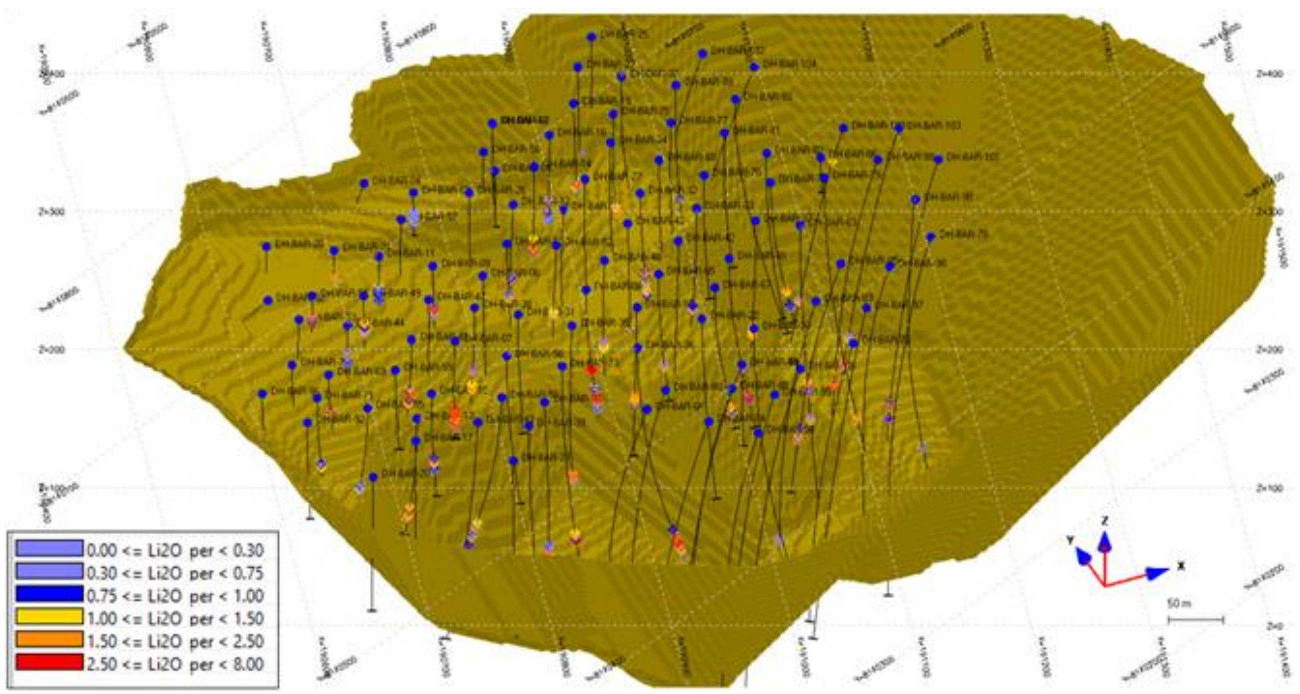


Figure 13-10: Lithium (Li_2O) Grade and Localization of the Drill Holes used to produce the Barreiro Variability Samples

Inadequate attention to sample selection can compromise the adequacy of the metallurgical test work results. This in turn could ultimately limit the ability of the full-scale metallurgical plant design to handle changes in ore composition over the life of the mine. When the samples selected for testing are fully representative of the orebody and of the mine plan, it is easier to predict and reconcile the expected plant performance.

The database received by SGS contained information related to collars, surveys, assays and lithology. In addition, a very detailed table of lithium mineralogy including the petalite content of the rock was included in the database. We also added the geology (rock type) as number variables to handle contents of each. To begin, SGS enhanced the database by including variables to facilitate the sample selection process including the 'TotPet_per' variable that represents the percentage of lithium contained in petalite. In terms of metallurgical performance, this is critical information as petalite is a lithium-bearing mineral which is non-recoverable by Dense Media Separation (DMS). Based on discussions with SGS metallurgy and the resource QP, it was decided to select samples with varying lithium and petalite grades as shown in Table 13-26.

The target lithium grades and petalite content were based on statistical analysis of the full database using declustering and standard tools (e.g., histograms, averages, medians). To begin, fifteen (15) of the seven hundred and thirteen (713) available samples were rejected because they came from outside the mineralized bodies. The 'TotPet_per' ranges from 0% (no lithium in petalite) to 100% (all the lithium is in petalite). The 'TotPet_per' average was 12% for the deposit. The remaining 698 samples were separated into the four variability samples that are representative of the deposit and meet the sample selection objectives (Table 13-27).

The masses of the selected samples are shown in Table 13-27. The master composite was recommended to contain 28.5% of variability sample 1, 24.5% of sample 2, 23.5% of sample 3 and 23.5% of sample 4.

Table 13-27: Description of Barreiro Variability Samples

Variability Sample	Description	1 m Intervals	Mass, kg
1	Average lithium grade and high petalite	142	233.8
2	High lithium grade and normal petalite	172	297.1
3	Average lithium grade and normal petalite	212	366.3
4	Low grade and normal petalite	172	268.6
	Total:	698	1165.8

In conclusion, we have succeeded in producing four variability samples with the material available that reached the objectives related to material type and the required quantity to carry out metallurgical test work.

13.3.3 Test Work Results

13.3.3.1 Sample Preparation and Characterization

Chemical analysis of the four variability samples and the composite sample are shown in Table 13-28. The head grades of the variability samples ranged from 0.88% Li_2O in the Variability sample 4 (Var 4) to 2.09% Li_2O in the Var 2 sample. The Var 3 and Composite samples have the lithium content closest to the average lithium grade of the deposit (approximately 1.4% Li_2O).

Table 13-28: Variability Sample and Composite Sample Assays

Element / Oxide	Sample				
	Var 1	Var 2	Var 3	Var 4	Composite
	Composition, %				
Li	0.51	0.97	0.63	0.41	0.69
Li_2O	1.10	2.09	1.35	0.88	1.48
Si_2O	73.1	73.8	74.3	73.3	73.7
Al_2O_3	16.3	16.6	15.9	16.2	16.3
Fe_2O_3	0.30	0.23	0.22	0.31	0.26
CaO	0.11	0.08	0.09	0.10	0.08
Na_2O	3.73	3.49	3.88	4.17	3.75
K_2O	2.58	2.15	2.58	2.93	2.64
P_2O_5	0.50	0.49	0.54	0.54	0.48
MnO	0.10	0.10	0.08	0.10	0.08
Ta_2O_5	0.01	<0.01	0.01	<0.01	0.01
SnO_2	0.02	0.01	0.02	0.03	0.02

Table 13-29 shows the semi-quantitative X-ray Diffraction (XRD) results for the four variability samples and the composite sample. Spodumene content ranged from 7.8% to 20.9%.

Table 13-29: Semi-quantitative XRD analysis of the four variability samples and the composite sample

Mineral	Sample				
	Var 1	Var 2	Var 3	Var 4	Composite
	Composition, %				
Albite	32.6	28.8	32.4	33.0	31.4
Quartz	31.0	29.9	30.8	31.4	29.7
Spodumene	10.3	20.9	13.2	7.8	14.4
K-feldspar	12.3	10.4	12.2	12.5	10.5
Mica	6.1	4.9	6.1	9.8	7.8
Cookeite	4.2	2.5	2.5	2.3	2.8
Petalite	2.0	1.6	1.9	2.0	2.2
Ferrisicklerite	0.9	1.0	0.9	1.2	1.1
Beryl	0.6	-	-	-	-

Based on the semi-quantitative XRD analysis, the amount of lithium contained in spodumene was estimated for each sample (Table 13-30). Lithium present in spodumene ranged from 69.4% to 87.3%. The non-spodumene lithium-bearing minerals present were cookeite, petalite, and ferrisicklerite. Cookeite and petalite are low SG minerals (<2.7) which are unlikely to be recovered to the DMS concentrate. Ferrisicklerite has a relatively high SG (3.2 – 3.4) and is likely to report to the concentrate.

Table 13-30: Estimates of Lithium Deportment to Spodumene

Mineral	Lithium Deportment, %				
	Var 1	Var 2	Var 3	Var 4	Composite
Spodumene	73.2	87.3	81.0	69.4	79.9

13.3.3.2 Grindability Tests

Bond ball mill work index (BWi) and Abrasion index (Ai) tests were undertaken on subsamples of the Composite sample and Variability sample 3, respectively.

The Composite sample was classified as moderately hard with a BWi of 15.3 kWh/t. Figure 13-12 shows the BWi of the composite sample as compared to the SGS database. The sample falls into the 62nd percentile of hardness.

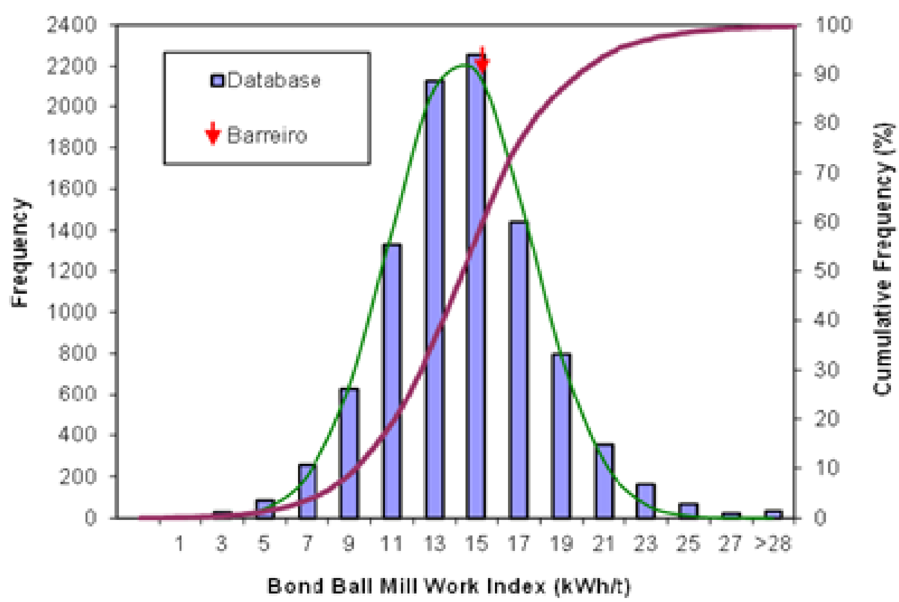


Figure 13-11: BWi of the Composite Sample compared to the SGS Database

Variability sample 3 was classified as moderately abrasive with an Ai of 0.450 g. Figure 13-13 shows the Ai of the Var 3 sample as compared to the SGS database. The sample falls into the 71st percentile of abrasivity.

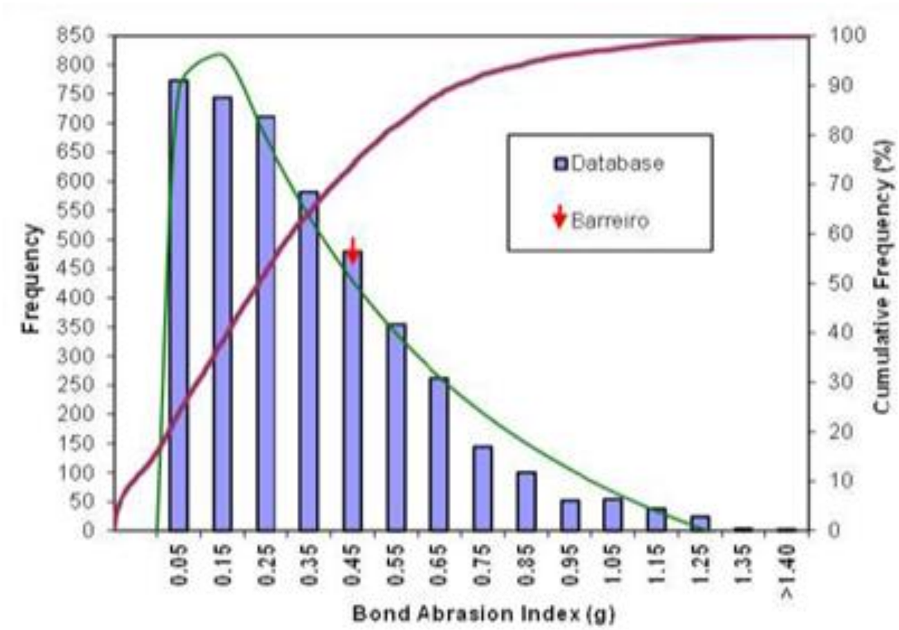


Figure 13-12: Ai of Var 3 compared to the SGS Database

13.3.4 Heavy Liquid Separation

Two sets of HLS tests were undertaken. The first set was conducted on a sub-sample of the Composite to test optimal crush size (i.e., top size of 15.9 mm, 12.5 mm, 10.0 mm, and 6.3 mm). HLS tests were then performed on each variability sample at the optimum crush size. The fine fraction (i.e., -0.5 mm) was screened out from each sub-sample and the oversize fraction was submitted for HLS testing with a heavy liquid comprised of methylene iodide diluted with acetone. Each HLS test included specific gravity (SG) cut points of 2.95, 2.90, 2.85, 2.80, 2.70, 2.65, 2.60, 2.50, and 2.45.

13.3.4.1 HLS: Composite Sample Optimal Crush Size

Grade - recovery curves (stage and global) for the HLS tests to determine optimal crush size are presented in Figure 13-14 and Figure 13-15, respectively.

Lithium stage and global recoveries were estimated (interpolated) for 6.0% Li_2O concentrate and generally increased with decreasing particle size most likely due to increased spodumene liberation (Table 13-31). Estimated lithium stage recovery for the production of 6.0% Li_2O concentrate ranged from 55.4% for the -15.9 mm crush size to 70.2% for the -6.3 mm crush size.

Table 13-31: HLS Interpolated stage and global lithium recoveries (6% Li_2O concentrate) for each crush size

Recovery	Estimated Lithium Recovery, %			
	-15.9 mm	-12.5 mm	-10 .0 mm	-6.3 mm
Stage	55.4	62.4	66.1	70.2
Global	49.6	55.1	56.1	56.1

Global lithium recoveries while producing a 6% Li_2O spodumene concentrate were maximized at both 6.3 mm and 10.0 mm crush size. The 10 mm crush size was selected for the variability HLS tests to maximize recovery and to correspond with previous test work and process design for the Xuxa lithium DMS operation.

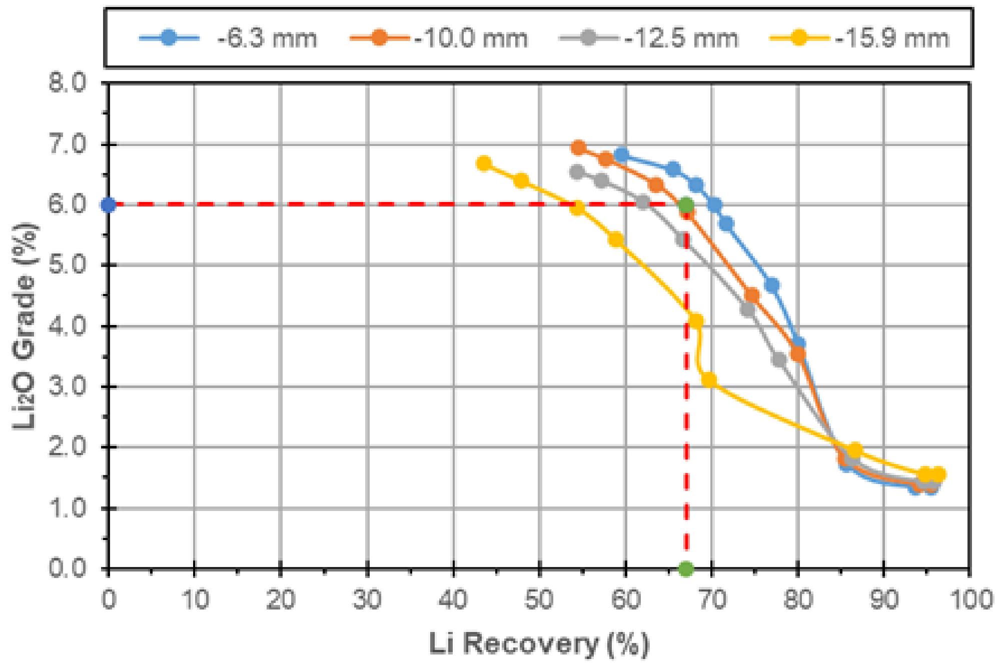


Figure 13-13: Cumulative Lithium Grade - Stage Recovery Curves for HLS Tests

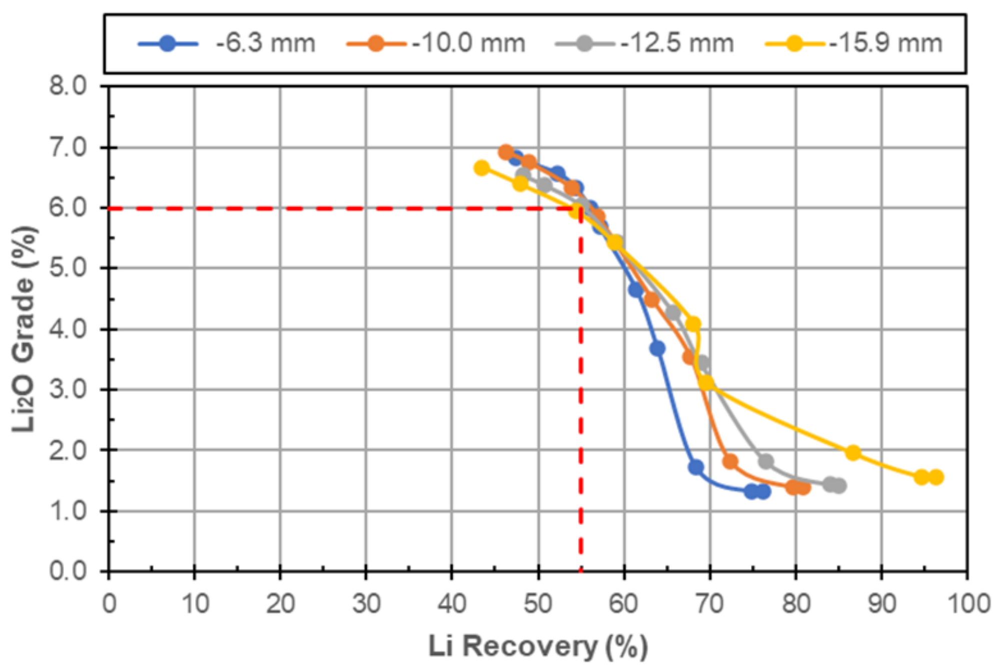


Figure 13-14: Cumulative Lithium Grade – Global Recovery Curves for HLS Tests

Tests results showed that a significant amount of lithium (16% to 27.8%) reported to the HLS tailings (-2.65 SG). To further investigate the lithium losses, XRD analysis was undertaken on certain samples from the HLS test with -10.0 mm crush size (SG 2.60 sink, SG 2.50 sink, SG 2.45 sink, and SG 2.45 float samples). XRD results are shown in Table 13-32. The samples contain low concentrations of spodumene (<2%) and elevated concentrations of petalite (concentrating to 67% in the 2.45 floats stream). Other lithium-bearing minerals present were cookeite, triphylite, and tiptopite.

Table 13-32: Semi-Quantitative XRD Analysis for Selected Samples (-10 mm crush size)

MINERAL	SINK 2.60	SINK 2.50	SINK 2.45	FLOAT 2.45
	COMPOSITION, %			
Albite	40.9	43.0	11.0	2.5
Quartz	48.6	11.1	7.9	5.9
K-feldspar	3.9	36.4	43.2	10.9
Petalite	0.7	3.9	23.9	67.0
Muscovite	1.6	2.2	6.3	3.8
Cookeite	1.5	1.2	4.2	3.5
Spodumene	1.4	0.8	1.9	2.0
Kaolinite	0.8	0.5	0.7	1.4
Analcime	-	-	-	1.9
Triphylite	0.5	0.9	0.2	-
Tiptopite	-	-	0.7	-
Zabuyelite	-	-	-	1.1
TOTAL	100	100	100	100

13.3.4.2 HLS: Variability Samples

HLS tests were performed on each variability sample at the chosen crush size of -10 mm. Interpolated lithium recoveries at 6% Li_2O concentrate grade are presented in Table 13-33. Interpolated lithium stage recoveries ranged from 56.0% to 77.3%. The highest lithium stage recovery was obtained with the Var 2 sample, estimated to be 77.3%. Global recoveries include lithium losses to the hypofine (-0.5 mm) fraction and ranged from 50.0% to 67.2%.

Table 13-33: HLS Interpolated Stage and Global Combined Lithium Recoveries (6% Li_2O concentrate) for each Variability Sample

Recovery	**Interpolated Lithium Recovery, %**			
	Var 1	**Var 2**	**Var 3**	**Var 4**
Stage	56.0	77.3	63.9	61.9
Global	50.0	67.2	53.9	55.0

Size-by-size analysis was undertaken for each variability HLS test. Size fractions were chosen to generate fairly equal mass distributions (and to mimic the Xuxa test work and process design). The size fractions chosen were: coarse (-10.0 mm / +6.4 mm), fines (-6.4 mm / +1.7 mm), and ultrafines (-1.7 mm / +0.5 mm). Detailed size-by-size HLS mass balances are shown in Table 13-34 to Table 13-37.

In all four variability samples, the SG cut points were fairly similar for the different size fractions. Lithium recovery was generally seen in the fines fraction (-6.4 mm / +1.7 mm) increased with finer size fraction, which is likely due to a higher degree of spodumene liberation in the finer size fractions. HLS tests produced >6% Li_2O spodumene concentrate with low iron content (<1.0% Fe_2O_3) from each variability sample.

Table 13-34: Variability Sample 1 Global HLS Results

Fraction	Global HLS Fractional Analysis Combined HLS Products	HL SG	Weight		Assays (%)									Distribution (%)							
		g/cm3	g	%	LI	LI2O	SIO2	AI2O3	Fe2O3	CaO	Na2O	K2O	P2O5	LI	SIO2	AI2O3	Fe2O3	CaO	Na2O	K2O	P2O5
-10.0 mm / +6.4 mm	HLS Sp Concentrate (interpolated)	2.81	314	3.14	2.79	6.00	66.6	23.9	0.49	0.04	0.48	0.37	0.66	13.7	2.9	4.6	4.1	1.2	0.4	0.4	4.2
-6.4 mm / +1.7 mm	HLS Sp Concentrate (interpolated)	2.83	542	5.4	2.79	6.00	64.3	25.1	0.71	0.07	0.51	0.72	0.89	23.7	4.8	8.3	10.2	3.7	0.7	1.5	9.9
-1.7 mm / +0.5 mm	HLS Sp Concentrate (interpolated)	2.81	288	2.9	2.79	6.00	60.4	27.0	1.01	0.23	0.39	1.46	1.28	12.6	2.4	4.7	7.7	6.2	0.3	1.6	7.6
-10.0 mm / +6.4 mm	HLS Middling interpolated	-2.81+2.65	478	4.8	0.69	1.49	71.4	17.5	1.04	0.17	2.69	2.22	0.58	5.16	4.7	5.1	13.2	7.6	3.5	4.1	5.7
-6.4 mm / +1.7 mm	HLS Middling interpolated	-2.83+2.65	596	6.0	0.52	1.11	68.9	19.8	0.73	0.13	2.37	3.38	0.50	4.82	5.6	7.2	11.5	7.4	3.8	7.7	6.0
-1.7 mm / +0.5 mm	HLS Middling interpolated	-2.81+2.65	217	2.2	0.34	0.74	66.9	20.9	0.68	0.14	1.86	4.36	0.48	1.17	2.0	2.8	3.9	2.9	1.1	3.6	2.1
-10.0 mm / +6.4 mm	HLS Tailing (-2.65 SG)	-2.65	1655	16.6	0.30	0.66	73.6	15.3	0.22	0.07	4.68	3.40	0.44	7.90	16.7	15.4	9.5	11.3	20.8	21.5	15.1
-6.4 mm / +1.7 mm	HLS Tailing (-2.65 SG)	-2.65	3122	31.2	0.29	0.61	75.6	14.2	0.19	0.08	4.44	2.77	0.37	13.95	32.4	26.9	16.1	24.0	37.2	33.1	23.4
-1.7 mm / +0.5 mm	HLS Tailing (-2.65 SG)	-2.65	1552	15.5	0.26	0.55	77.6	13.1	0.18	0.07	4.22	2.59	0.31	6.20	16.5	12.4	7.5	10.4	17.6	15.4	9.8
-0.5 mm	Var 1 -500 micron		1236	12.4	0.56	1.21	70.8	17.0	0.50	0.22	4.40	2.31	0.64	10.8	12.0	12.8	16.4	25.2	14.6	10.9	16.2
	Head (calc.)		10000	100	0.64	1.37	72.9	16.4	0.38	0.11	3.72	2.61	0.49	100	100	100	100	100	100	100	100
Var 1, Global Rec.	HLS Concentrate		1145	11.4	2.79	6.00	64.0	25.2	0.72	0.10	0.47	0.81	0.93	50.0	10.0	17.6	21.9	11.1	1.5	3.6	21.7
	HLS Middling interpolated		1292	12.9	0.55	1.19	69.48	19.1	0.84	0.15	2.40	3.12	0.52	11.2	12.3	15.0	28.6	17.9	8.3	15.4	13.9
	HLS Tailing		6328	63.3	0.28	0.61	75.55	14.2	0.20	0.08	4.45	2.89	0.37	28.0	65.6	54.6	33.1	45.8	75.6	70.1	48.2
	Var 1 -500 micron		1236	12.4	0.56	1.21	70.80	17.0	0.50	0.22	4.40	2.31	0.64	10.8	12.0	12.8	16.4	25.2	14.6	10.9	16.2

Table 13-35: Variability Sample 2 Global HLS Results

Frac.	Global HLS Fractional Analysis Combined HLS Products	HL SG	Weight		Assays (%)									Distribution (%)							
		g/cm3	g	%	LI	LI2O	SIO2	AI2O3	Fe2O3	CaO	Na2O	K2O	P2O5	LI	SIO2	AI2O3	Fe2O3	CaO	Na2O	K2O	P2O5
-10 mm / +6.4 mm	HLS Sp Concentrate (interpolated)	2.83	653	6.53	2.79	6.00	67.1	24.1	0.36	0.03	0.69	0.36	0.23	19.8	5.9	9.5	7.5	2.3	1.3	1.1	3.2
-6.4 mm / +1.7 mm	HLS Sp Concentrate (interpolated)	2.81	1129	11.3	2.79	6.00	65.4	24.7	0.43	0.05	0.68	0.65	0.58	34.3	10.0	16.8	15.7	7.1	2.2	3.4	14.4
-1.7 mm / +0.5 mm	HLS Sp Concentrate (interpolated)	2.80	434	4.3	2.79	6.00	61.6	26.6	0.70	0.08	0.46	1.36	0.94	13.2	3.6	7.0	9.8	4.7	0.6	2.7	9.0
-10 mm / +6.4 mm	HLS Middling interpolated	-2.83+2.65	439	4.4	0.71	1.53	72.9	17.1	0.47	0.07	3.14	2.02	0.75	3.39	4.3	4.5	6.6	4.0	4.0	4.1	7.2
-6.4 mm / +1.7 mm	HLS Middling interpolated	-2.81+2.65	548	5.5	0.51	1.09	72.7	16.9	0.49	0.08	2.98	2.51	0.56	3.02	5.4	5.6	8.7	5.5	4.8	6.3	6.8
-1.7 mm / +0.5 mm	HLS Middling interpolated	-2.803+2.65	194	1.9	0.31	0.66	75.7	15.3	0.44	0.08	2.40	2.72	0.41	0.65	2.0	1.8	2.7	2.0	1.4	2.4	1.7
-10 mm / +6.4 mm	HLS Tailing (-2.65 SG)	-2.65	1283	12.8	0.23	0.49	74.8	14.6	0.24	0.08	4.71	3.42	0.35	3.17	13.0	11.3	10.0	13.9	17.7	20.3	9.8
-6.4 mm / +1.7 mm	HLS Tailing (-2.65 SG)	-2.65	2368	23.7	0.27	0.57	77.9	13.2	0.20	0.06	4.40	2.77	0.35	6.86	25.1	18.7	15.0	20.2	30.5	30.3	18.1
-1.7 mm / +0.5 mm	HLS Tailing (-2.65 SG)	-2.65	1242	12.4	0.20	0.42	80.1	11.5	0.19	0.06	4.30	2.34	0.27	2.64	13.5	8.6	7.5	10.5	15.6	13.4	7.5
-0.5 mm	Var 2 -500 micron		1710	17.1	0.70	1.51	73.3	15.9	0.30	0.13	4.36	2.01	0.59	13.0	17.0	16.3	16.5	29.7	21.8	15.9	22.2
	Head (calc.)		10000	100	0.92	1.98	73.6	16.6	0.31	0.07	3.41	2.17	0.45	100	100	100	100	100	100	100	100
Var 2, Global Rec.	HLS Concentrate		2216	22.2	2.79	6.00	65.2	24.9	0.46	0.05	0.64	0.70	0.55	67.2	19.6	33.2	33.0	14.1	4.2	7.2	26.7
	HLS Middling interpolated		1181	11.8	0.55	1.18	73.25	16.8	0.47	0.07	2.95	2.36	0.60	7.1	11.8	11.9	18.0	11.5	10.2	12.9	15.7
	HLS Tailing		4893	48.9	0.24	0.51	77.61	13.1	0.21	0.07	4.45	2.83	0.33	12.7	51.6	38.6	32.5	44.7	63.8	64.0	35.4
	Var 2 -500 micron		1710	17.1	0.70	1.51	73.30	15.9	0.30	0.13	4.36	2.01	0.59	13.0	17.0	16.3	16.5	29.7	21.8	15.9	22.2

Table 13-36: Variability Sample 3 Global HLS Results

Frac.	Global HLS Fractional Analysis Combined HLS Products	HL SG	Weight		Assays (%)									Distribution (%)							
		g/cm3	g	%	Li	Li2O	SiO2	Al2O3	Fe2O3	CaO	Na2O	K2O	P2O5	Li	SiO2	Al2O3	Fe2O3	CaO	Na2O	K2O	P2O5
-10.0 mm / +6.4 mm	HLS Sp Concentrate (interpolated)	2.865	328	3.28	2.79	6.00	67.2	24.0	0.32	0.03	0.63	0.35	0.22	15.3	3.0	4.8	3.3	1.1	0.5	0.4	1.3
-6.4 mm / +1.7 mm	HLS Sp Concentrate (interpolated)	2.83	544	5.4	2.79	6.00	65.0	24.8	0.52	0.11	0.63	0.57	0.74	25.3	4.8	8.3	8.8	6.4	0.8	1.2	7.4
-1.7 mm / +0.5 mm	HLS Sp Concentrate (interpolated)	2.82	285	2.8	2.79	6.00	60.5	27.0	0.80	0.18	0.42	1.35	1.51	13.3	2.4	4.7	7.0	5.3	0.3	1.4	7.9
-10.0 mm / +6.4 mm	HLS Middling interpolated	-2.865+2.65	552	5.5	0.70	1.50	71.8	17.8	0.53	0.12	3.37	2.10	0.75	6.41	5.4	6.0	9.1	6.7	4.5	4.3	7.6
-6.4 mm / +1.7 mm	HLS Middling interpolated	-2.83+2.65	780	7.8	0.47	1.02	72.2	17.5	0.49	0.09	3.27	2.59	0.67	6.16	7.7	8.4	11.8	7.8	6.2	7.5	9.7
-1.7 mm / +0.5 mm	HLS Middling interpolated	-2.82+2.65	316	3.2	0.26	0.57	75.7	15.2	0.49	0.08	2.23	2.87	0.43	1.39	3.3	2.9	4.8	2.8	1.7	3.4	2.5
-10.0 mm / +6.4 mm	HLS Tailing (-2.65 SG)	-2.65	1402	14.0	0.20	0.43	73.3	15.5	0.25	0.07	5.21	3.87	0.44	4.65	14.0	13.3	10.9	9.8	17.8	20.2	11.4
-6.4 mm / +1.7 mm	HLS Tailing (-2.65 SG)	-2.65	2516	25.2	0.20	0.42	75.1	14.4	0.23	0.08	4.95	3.31	0.42	8.28	25.8	22.2	17.8	20.0	30.4	31.1	19.7
-1.7 mm / +0.5 mm	HLS Tailing (-2.65 SG)	-2.65	1330	13.3	0.16	0.35	78.1	12.6	0.19	0.07	4.67	2.74	0.33	3.61	14.2	10.3	7.7	9.5	15.2	13.6	8.0
	Var 3 -500 mic Frac.		1948	19.5	0.48	1.03	72.8	16.0	0.31	0.15	4.72	2.33	0.68	15.6	19.4	19.1	18.7	30.7	22.4	16.9	24.5
	Head (calc.)		10000	100	0.60	1.29	73.2	16.3	0.32	0.10	4.10	2.68	0.54	100	100	100	100	100	100	100	100
Var 3, Global Rec.	HLS Concentrate		1157	11.6	2.79	6.00	64.6	25.2	0.54	0.09	0.56	0.73	0.73	53.9	10.2	17.8	19.1	12.7	1.6	3.0	16.7
	HLS Middling interpolated		1648	16.5	0.53	1.14	72.84	17.2	0.51	0.09	2.99	2.56	0.61	14.0	16.4	17.3	25.7	17.3	12.5	15.2	19.8
	HLS Tailing		5248	52.5	0.20	0.43	75.49	14.3	0.23	0.06	4.77	3.42	0.38	16.5	54.1	45.8	38.4	39.3	63.4	64.8	39.1
	Var 3 -500 mic Frac.		1948	19.5	0.50	1.08	72.89	16.1	0.31	0.13	4.55	2.40	0.64	15.6	19.4	19.1	18.7	30.7	22.4	16.9	24.5

Table 13-37: Variability Sample 4 Global HLS Results

Size Fraction	Global HLS Fractional Analysis Combined HLS Products	HL SG	Weight		Assays (%)									Distribution (%)							
		g/cm3	g	%	Li	Li2O	SiO2	Al2O3	Fe2O3	CaO	Na2O	K2O	P2O5	Li	SiO2	Al2O3	Fe2O3	CaO	Na2O	K2O	P2O5
-10 mm / +6.4 mm	HLS Sp Concentrate (interpolated)	2.85	276	2.8	2.79	6.00	66.0	24.1	0.63	0.04	0.69	0.71	0.21	17.4	2.5	4.2	4.5	1.4	0.5	0.6	1.3
-6.4mm / +1.7 mm	HLS Sp Concentrate (interpolated)	2.84	386	3.9	2.79	6.00	63.2	24.9	0.95	0.09	0.59	1.11	0.79	24.4	3.3	6.0	9.6	4.3	0.6	1.4	6.8
-1.7 mm / +0.5 mm	HLS Sp Concentrate (interpolated)	2.85	210	2.1	2.79	6.00	58.8	27.0	1.44	0.19	0.37	1.71	1.64	13.3	1.7	3.6	7.9	4.7	0.2	1.2	7.8
-10 mm / +6.4 mm	HLS Middling interpolated	-2.848+2.65	562	5.6	0.53	1.14	71.8	17.9	0.55	0.07	3.25	2.56	0.59	6.76	5.5	6.3	8.1	4.8	4.6	4.6	7.5
-6.4mm / +1.7 mm	HLS Middling interpolated	-2.84+2.65	745	7.5	0.37	0.81	72.3	17.6	0.59	0.09	2.66	3.09	0.64	6.32	7.3	8.2	11.4	8.5	4.9	7.4	10.8
-1.7 mm / +0.5 mm	HLS Middling interpolated	2.8	363	3.6	0.23	0.49	71.1	18.3	0.61	0.08	1.59	4.04	0.37	1.86	3.5	4.2	5.8	3.4	1.4	4.7	3.0
-10 mm / +6.4 mm	HLS Tailing (-2.65 SG)	-2.65	1734	17.3	0.14	0.30	74.6	14.3	0.24	0.07	4.64	3.88	0.34	5.54	17.6	15.6	11.1	14.7	20.1	21.7	13.2
-6.4mm / +1.7 mm	HLS Tailing (-2.65 SG)	-2.65	2834	28.3	0.14	0.31	75.6	14.1	0.23	0.06	4.86	3.45	0.35	9.20	29.2	25.1	17.2	21.9	34.4	31.5	22.2
-1.7 mm / +0.5 mm	HLS Tailing (-2.65 SG)	-2.65	1529	15.3	0.12	0.26	77.9	12.9	0.21	0.05	4.59	2.98	0.28	4.17	16.2	12.3	8.4	8.5	17.5	14.7	9.8
	Var 4 -500 micron		1360	13.6	0.36	0.77	71.0	17.1	0.45	0.17	4.65	2.76	0.57	11.1	13.2	14.6	16.0	27.7	15.8	12.1	17.5
	Head (calc.)		10000	100	0.44	0.95	73.4	16.0	0.38	0.08	4.01	3.10	0.44	100	100	100	100	100	100	100	100
Var 4, Global Rec.	HLS Concentrate		872	8.7	2.79	6.00	63.4	24.9	0.94	0.08	0.55	1.15	0.77	55.0	7.5	13.8	22.1	10.4	1.2	3.2	15.9
	HLS Middling interpolated		1670	16.7	0.41	0.88	72.25	17.7	0.56	0.07	2.56	3.17	0.54	14.9	16.3	18.7	25.3	16.7	10.9	16.8	21.3
	HLS Tailing		6098	61.0	0.14	0.30	76.29	13.7	0.22	0.05	4.61	3.51	0.31	18.9	63.0	53.0	36.6	45.1	72.0	67.9	45.3
	Var 4 -500 micron		1360	13.6	0.37	0.80	71.37	16.9	0.44	0.14	4.53	2.81	0.54	11.1	13.2	14.6	16.0	27.7	15.8	12.1	17.5

13.3.5 Dense Media Separation

The DMS test work was performed on the Composite sample on the coarse (-10 mm / +6.4 mm), fine (-6.4 mm / +1.7 mm) and ultrafine (-1.7 mm / +0.5 mm) size fractions separately. Dry magnetic separation at 10,000 gauss was performed on the feed prior to DMS test work.

DMS feed was pre-screened at 500 µm to remove fine particles. The density of the circulating media was controlled to produce the desired SG cut-points and tracer tests were conducted prior to testing to ensure that the SG was at the desired target.

Each size fraction underwent two DMS passes. The first pass was operated at a lower density to reject silicate gangue minerals (SG of 2.65). The first pass sink product was repassed through the DMS at a higher density cut-point to produce spodumene concentrate. The cut-points for the second pass were based on interpolated HLS data for the production of 6% Li_2O spodumene concentrate. The coarse, fine, and ultrafine density target cut-points were 2.84, 2.82, and 2.82, respectively. SG cut-points for each DMS pass were selected based on the variability sample HLS results.

13.3.5.1 DMS Results

DMS and magnetic separation stage results for the coarse, fines and ultrafines fractions are shown in Table 13-38, Table 13-39, and Table 13-40, respectively.

Coarse DMS concentrate grade was slightly below target at 5.72% Li_2O with lithium stage-recovery of 58.1%. Mass pull to the concentrate was 14.8% and iron content of the concentrate was 0.34% Fe_2O_3. A significant proportion of the lithium in the coarse fraction (22.0%) reported to the middlings stream which graded 0.95% Li_2O. The tailings contained 0.54% Li_2O which accounted for 50% of the mass of the coarse fraction and contained 18.6% of the lithium.

The fines fraction DMS produced concentrate grading 6.20% Li_2O with a stage recovery of 60.5% in 13.2% of the mass. Sixteen percent (16.0%) of the lithium reported to the middlings, which had a grade of 1.12% Li_2O and a mass yield of 19.4%. The fines DMS tailings graded 0.45% with 21.9% lithium stage-losses in 65.9% of the mass. Dry magnetic separation did show some success in rejecting iron, with the magnetic concentrate upgraded to 3.55 % Fe_2O_3 with lithium losses of only 1.65%.

For the ultrafines fraction, relatively high-grade spodumene concentrate was produced (6.48% Li_2O) with 58.6% lithium stage-recovery and a relatively low mass yield of 11.5%. The middlings graded 1.03% Li_2O and accounted for 13.2% of the lithium. The ultrafines DMS tailings had a mass yield of 68.5% and accounted for 23.3% of the lithium.

Table 13-38 : Coarse fraction DMS stage results

Product	Weight		Assays (%)											Distribution (%)									
	kg	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO
Concentrate	22.0	14.8	2.66	5.72	67.3	24.1	0.34	0.01	0.04	0.73	0.38	0.28	0.09	58.1	13.7	21.4	16.7	3.32	6.66	2.74	2.10	8.46	17.0
Middling	50.5	33.8	0.44	0.95	77.1	14.3	0.44	0.02	0.10	4.04	1.43	0.55	0.11	22.0	35.9	29.2	49.7	15.2	38.2	34.8	18.1	38.1	47.6
Tailings	75.0	50.3	0.25	0.54	71.5	15.8	0.11	0.05	0.09	4.84	4.12	0.45	0.03	18.6	49.6	47.9	18.5	56.6	51.1	62.0	77.5	46.4	19.3
Mag Conc.	1.7	1.11	0.80	1.72	53.6	23.3	4.11	1.00	0.33	1.42	5.59	3.10	1.14	1.31	0.82	1.55	15.2	24.9	4.12	0.40	2.31	7.03	16.1
Coarse (calc.)	149	100	0.68	1.45	72.6	16.6	0.30	0.04	0.09	3.93	2.67	0.49	0.08	100	100	100	100	100	100	100	100	100	100

Table 13-39 : Fines fraction DMS stage results

Product	Weight		Assays (%)											Distribution (%)									
	kg	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO
Concentrate	38.1	13.2	2.88	6.20	66.5	25.0	0.34	0.01	0.06	0.49	0.35	0.28	0.10	60.5	12.0	20.7	19.9	1.9	6.48	1.72	1.72	19.6	4.62
Middling	55.8	19.4	0.52	1.12	77.7	14.5	0.38	0.02	0.06	2.91	1.64	0.49	0.08	16.0	20.5	17.6	32.6	5.5	9.48	14.98	11.8	50.3	5.41
Tailings	190	65.9	0.21	0.45	74.1	14.4	0.09	0.08	0.15	4.72	3.42	0.02	0.37	21.9	66.5	59.6	25.0	78.9	79.7	82.6	83.5	8.35	84.3
Mag Conc.	4.1	1.4	0.73	1.57	54.0	24.1	3.55	0.68	0.37	1.96	5.68	2.87	1.14	1.65	1.05	2.15	22.4	13.7	4.30	0.74	3.00	21.7	5.66
Fines (calc.)	288	100	0.63	1.36	73.5	16.0	0.23	0.07	0.12	3.77	2.70	0.19	0.29	100	100	100	100	100	100	100	100	100	100

Table 13-40 : Ultrafines fraction DMS stage results

Product	Weight		Assays (%)											Distribution (%)									
	kg	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO
Concentrate	14.1	11.5	3.01	6.48	64.6	26.6	0.40	0.01	0.03	0.30	0.61	0.43	0.07	58.6	10.2	19.9	20.6	3.32	4.47	0.99	2.91	14.4	12.1
Middling	19.8	16.2	0.48	1.03	80.1	13.2	0.41	0.01	0.07	2.20	1.81	0.36	0.04	13.2	17.8	13.9	29.8	4.68	14.70	10.2	12.2	17.0	9.73
Tailings	84.1	68.5	0.20	0.43	76.5	13.6	0.06	0.04	0.09	4.52	2.97	0.32	0.02	23.3	72.0	60.9	18.5	79.3	80.1	88.8	84.7	64.1	20.6
Mag Conc.	4.8	3.9	0.73	1.58	1.02	20.78	1.77	0.11	0.01	0.03	0.15	0.39	0.98	4.86	0.05	5.30	31.1	12.7	0.71	0.04	0.24	4.48	57.6
Ultrafines (calc.)	123	100	0.59	1.26	72.8	15.3	0.22	0.03	0.08	3.49	2.40	0.34	0.07	100	100	100	100	100	100	100	100	100	100

Table 13-41 and Table 13-42 show the overall and combined DMS mass balances for the composite sample. The combined concentrate graded 6.11% Li_2O and 0.35% Fe_2O_3, with a global lithium recovery of 50.8%. Dry magnetic separation prior to the DMS test work was mainly used to reject mica. A slightly higher lithium distribution was observed in the fines fraction (26.5%) as compared to 14.1% for the coarse and 10.2% for the ultrafines fraction, which was largely associated with the higher mass of the fines fraction.

Roughly 15% of the lithium reported to the middling (2nd Pass DMS floats) which graded 1.4% Li_2O. In order to maximize the overall lithium recovery, the coarse and fines middlings were combined, re-crushed and processed by HLS. The material was screened at 3.3 mm. The coarse fraction was stage-crushed to -3.3 mm. All the material was then screened at 0.5 mm. A sub-sample of the -3.3 mm / +0.5 mm fraction was submitted for a single pass HLS test at SG 2.90. The -0.5 mm material was subsampled and assayed. The results of the re-crushed HLS test were incorporated into the DMS mass balance (Table 13-43).

At an SG cut-point of 2.90, the HLS test produced a spodumene concentrate grading 5.61% Li_2O recovering an additional 3.4% lithium. The combined DMS and re-crushed concentrate graded 6.08% Li_2O and the global combined lithium recovery increased from 51.1% to 54.4% with re-crushing (stage recovery of 63.8%).

Table 13-41: Global DMS results by size fraction

	Product	Weight		Assays (%)											Distribution (%)									
		kg	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO
Coarse	DMS Conc.	22.0	3.30	2.66	5.72	67.3	24.1	0.34	0.01	0.04	0.73	0.38	0.28	0.09	14.1	3.04	4.95	4.03	0.57	1.19	0.63	0.48	2.67	1.73
	DMS Middling	50.5	7.56	0.44	0.95	77.1	14.3	0.44	0.02	0.10	4.04	1.43	0.55	0.11	5.35	8.00	6.74	12.0	2.62	6.85	7.96	4.18	12.0	4.85
	DMS Tailings	75.0	11.2	0.25	0.54	71.5	15.8	0.11	0.05	0.09	4.84	4.12	0.45	0.03	4.52	11.0	11.1	4.44	9.74	9.16	14.2	17.9	14.6	1.97
	Mag Con	1.65	0.25	0.52	1.12	77.7	14.5	0.38	0.02	0.06	2.91	1.64	0.49	0.08	0.21	0.26	0.22	0.34	0.09	0.13	0.19	0.16	0.35	0.12
Fines	DMS Conc.	38.1	5.71	2.88	6.20	66.5	25.0	0.34	0.01	0.06	0.49	0.35	0.28	0.10	26.5	5.21	8.89	6.97	0.99	3.10	0.73	0.77	4.63	3.33
	DMS Middling	55.8	8.4	0.52	1.12	77.7	14.5	0.38	0.02	0.06	2.91	1.64	0.49	0.08	7.00	8.91	7.56	11.4	2.90	4.54	6.34	5.31	11.9	3.90
	DMS Tailings	190	28.4	0.21	0.45	74.1	14.4	0.09	0.08	0.15	4.72	3.42	0.02	0.37	9.59	28.9	25.6	8.74	41.6	38.2	35.0	37.6	1.97	60.9
	Mag Con	4.10	0.61	0.73	1.57	54.0	24.1	3.55	0.68	0.37	1.96	5.68	2.87	1.14	0.72	0.46	0.92	7.84	7.24	2.06	0.31	1.35	5.11	4.09
Ultrafines	DMS Conc.	14.1	2.11	3.01	6.48	64.6	26.6	0.40	0.01	0.03	0.30	0.61	0.43	0.07	10.2	1.87	3.49	3.03	0.37	0.57	0.16	0.50	2.62	0.86
	DMS Middling	19.8	2.97	0.48	1.03	80.1	13.2	0.41	0.01	0.07	2.20	1.81	0.36	0.04	2.30	3.27	2.45	4.38	0.52	1.88	1.71	2.08	3.10	0.69
	DMS Tailings	84.1	12.6	0.20	0.43	76.5	13.6	0.06	0.04	0.09	4.52	2.97	0.32	0.02	4.06	13.2	10.7	2.72	8.74	10.27	14.9	14.5	11.7	1.47
	Mag Con	4.79	0.72	0.73	1.58	1.0	20.8	1.8	0.11	0.01	0.03	0.15	0.4	0.98	0.85	0.01	0.93	4.56	1.39	0.09	0.01	0.04	0.82	4.11
	Hypofines	108	16.2	0.56	1.21	71.3	16.4	0.51	0.08	0.15	4.26	2.42	0.61	0.13	14.6	15.8	16.5	29.6	23.2	21.9	18.0	15.1	28.5	12.0
	Head (calc.)	668	100	0.62	1.34	72.9	16.0	0.28	0.06	0.11	3.83	2.58	0.35	0.17	100	100	100	100	100	100	100	100	100	100
	Head (direct)			0.69	1.48	73.7	16.3	0.26	0.03	0.08	3.75	2.64	0.48	0.08										

Table 13-42: Global combined DMS results

Product	Weight		Assays (%)											Distribution (%)									
	kg	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO
DMS Conc.	74.2	11.1	2.84	6.11	66.4	25.0	0.35	0.01	0.05	0.53	0.41	0.31	0.09	50.8	10.1	17.3	14.0	1.93	4.87	1.52	1.76	9.93	5.92
DMS Middlings	126	18.9	0.48	1.04	77.8	14.2	0.41	0.02	0.08	3.25	1.58	0.49	0.09	14.6	20.2	16.7	27.7	6.04	13.3	16.0	11.6	27.0	9.45
DMS Tailings	349	52.3	0.22	0.46	74.1	14.5	0.08	0.07	0.12	4.70	3.46	0.19	0.21	18.2	53.2	47.3	15.9	60.1	57.6	64.0	70.0	28.3	64.3
Mag Con	10.5	1.58	0.70	1.50	33.6	21.1	2.24	0.32	0.16	1.23	2.53	1.37	0.90	1.77	0.73	2.08	12.7	8.72	2.28	0.51	1.55	6.27	8.31
Hypofines	108	16.2	0.56	1.21	71.3	16.4	0.51	0.08	0.15	4.26	2.42	0.61	0.13	14.6	15.8	16.5	29.6	23.2	21.9	18.0	15.1	28.5	12.0
Head (calc.)	668	100	0.62	1.34	72.9	16.0	0.28	0.06	0.11	3.83	2.58	0.35	0.17	100	100	100	100	100	100	100	100	100	100
Head(direct)			0.69	1.48	73.7	16.3	0.26	0.03	0.08	3.75	2.64	0.48	0.08										

Table 13-43: Global combined DMS results with middlings re-crush

Product	Weight		Assays (%)											Distribution (%)									
	kg	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO
DMS Concentrate	74.2	11.1	2.84	6.11	66.4	25.04	0.35	0.01	0.05	0.53	0.41	0.31	0.09	51.0	10.2	17.3	13.8	1.85	4.30	1.53	1.75	10.1	6.07
Expected DMS Re-crush Conc.	5.42	0.81	2.61	5.61	63.7	25.2	0.85	0.04	0.15	0.59	0.33	1.12	0.19	3.42	0.71	1.28	2.44	0.54	0.97	0.13	0.10	2.68	0.92
Expected DMS Re-crush Tail	84.0	12.6	0.33	0.72	77.5	14.1	0.43	0.03	0.07	3.34	1.74	0.43	0.05	6.80	13.4	11.0	19.2	6.40	7.10	11.04	8.44	15.8	3.99
DMS Midllings	19.8	2.97	0.48	1.03	80.1	13.2	0.41	0.01	0.07	2.20	1.81	0.36	0.04	2.30	3.29	2.45	4.30	0.49	1.66	1.72	2.07	3.16	0.71
DMS Tailings	349	52.3	0.22	0.46	74.1	14.5	0.08	0.07	0.12	4.70	3.46	0.19	0.21	18.2	53.5	47.3	15.6	57.7	50.9	64.5	69.7	28.8	65.9
Mag Con	10.5	1.58	0.70	1.50	33.6	21.1	2.24	0.32	0.16	1.23	2.53	1.37	0.90	1.78	0.73	2.08	12.5	8.37	2.02	0.51	1.54	6.39	8.51
Re-crush Undersize	13.7	2.05	0.46	0.99	75.8	15.2	0.42	0.05	0.15	4.13	1.55	0.65	0.13	1.52	2.14	1.94	3.03	1.70	2.46	2.22	1.22	3.93	1.59
Re-crush Undersize	3.04	0.46	0.41	0.88	15.7	0.8	0.03	0.09	3.08	2.26	0.46	0.07	0.02	0.30	0.10	0.02	0.05	0.68	11.2	0.27	0.08	0.09	0.05
Hypofines	108	16.2	0.56	1.21	71.3	16.4	0.51	0.08	0.15	4.26	2.42	0.61	0.13	14.7	15.9	16.5	29.0	22.3	19.4	18.1	15.0	29.0	12.3
Head (calc.)	667	100	0.62	1.33	72.5	16.0	0.28	0.06	0.13	3.81	2.59	0.34	0.17	100	100	100	100	100	100	100	100	100	100
Head (direct)			0.62	1.34	72.9	16.0	0.28	0.06	0.11	3.83	2.58	0.35	0.17										
DMS and Re-crush Conc.	79.6	11.9	2.82	6.08	66.2	25.0	0.39	0.01	0.06	0.53	0.40	0.36	0.10	54.4	10.9	18.6	16.2	2.39	5.27	1.66	1.85	12.8	6.99

Table 13-44 gives a summary of the final concentrate grades and recoveries for the DMS test work.

Table 13-44: Summary of DMS concentrate grade and recovery

STREAM	GRADE, % Li_2O	STAGE RECOVERY, %
Coarse Fraction	5.72	58.1
Fines Fraction	6.20	60.5
Ultrafines Fraction	6.48	58.6
Combined Without Re-crush	6.11	59.5
Combined With Re-crush	6.08	63.8

The DMS concentrate was analyzed using XRD to determine semi-quantitative mineralogy. The results are presented in Table 13-45. The primary lithium-bearing mineral in the DMS concentrate was spodumene with minor amounts of cookeite and ferrisicklerite.

Table 13-45: DMS concentrate semi-quantitative XRD analysis

MINERAL	COMPOSITION, %
Spodumene	74.8
Quartz	14.4
Albite	4.5
Muscovite	3.6
Cookeite	2.2
Ferrisicklerite	0.3
Magnetite	0.2

13.3.6 Barreiro recovery and basis of assumptions

The Barreiro plant mass balance was produced based on stage recoveries achieved during pilot-scale DMS operation on the composite sample:

- Coarse fraction stage lithium recovery of 58.1%
- Fines fraction stage lithium recovery of 60.5%
- Ultrafines fraction stage lithium recovery of 58.6%

Mass reporting to the hypofines fraction was 16% with associated lithium loss of 13.8%.

Barreiro plant design is based on producing a target 6.0% Li_2O spodumene concentrate with global lithium recovery of 50.9%.

13.3.7 Impact of Lower Recovery Grade on Recovery

The project has 5 samples on which HLS test work was done:

- 4 variability samples
- 1 composite samples

This set of data was then used in the calculations to determine the impact of decreasing the product grade from 6% to 5.5% on Li2O recovery and yield. Both Li2O recovery and product yield calculations are on a global basis i.e., relative to the fresh feed inclusive of the fines. It has been assumed that the fines do not contribute to the product and have been assigned a zero yield.

Table 13-46 shows the summary of global recovery and yield between 6% and 5.5% Li_2O product grade.

Table 13-46: Barreiro Global Recovery and Yield between 6% and 5.5% Li_2O Product Grade

		6.0% Li_2O		5.5 % Li_2O		Relative (5.5% vs 6.0%)	
Size	**ID**	**Yield**	**Li_2O Recovery**	**Yield**	**Li_2O Recovery**	**Yield**	**Li_2O Recovery**
9.5	Var 1	11.22	49.18	12.7	51.02	1.04	1.13
9.5	Var 2	22.86	68.96	26	71.89	1.04	1.14
9.5	Var 3	12.35	56.92	14.05	59.33	1.04	1.14
9.5	Var 4	8.56	54.19	9.76	56.66	1.05	1.14
9.5	Comp	13.5	57.29	15.67	60.98	1.06	1.16
Overall Median Value						**1.04**	**1.14**
Overall Relative Increase (%)						**4.26**	**13.74**

Given the narrow relative recovery range between the 6 samples the median of the data set was used. The global recovery at 6% is assumed to be 50.9%, using this relative increase the recovery at 5.5% is assumed to be 57.9%.

13.4 NEZINHO DO CHICAO TEST WORK (2022)

13.4.1 Overview

A PFS-level metallurgical test work program was undertaken on samples from the NDC deposit from April 2022 to December 2022 at SGS Canada Inc. (Lakefield, Ontario). Three variability composites and compositing of a Master Composite sample were tested. The test work program included:

- Sample preparation and characterization
- Mineralogical analyses
- Heavy liquid separation (HLS)
- Dense media separation (DMS) in a pilot plant
- Magnetic Separation

The goals of the program were to provide a preliminary indication of the lithium beneficiation performance with ore from the NDC deposit in Minas Gerais, Brazil. The test work program was developed based on previous test work and flowsheet developed for the Xuxa and Barreiro deposit. The aim of the test work program was to produce a combined spodumene and petalite concentrate grading ≥5.5% Li_2O with low iron content (<1% Fe_2O_3), while maximizing lithium recovery.

13.4.2 Sample Selection

The aim of the NDC sample selection process for the metallurgical test work program was to select three variability samples (High, Medium, and Low-Grade) of at least 500 kg. Sub-samples from each variability sample would then be blended to create a master composite. Three thousand seven hundred forty-seven (3747) individual assays were available at SGS Canada Inc. (Lakefield, ON) for production of the variability samples. Figure 13-16 depicts the lithium (Li_2O) grades and the localization within the NDC deposit of the drill hole intervals used for producing the variability samples.

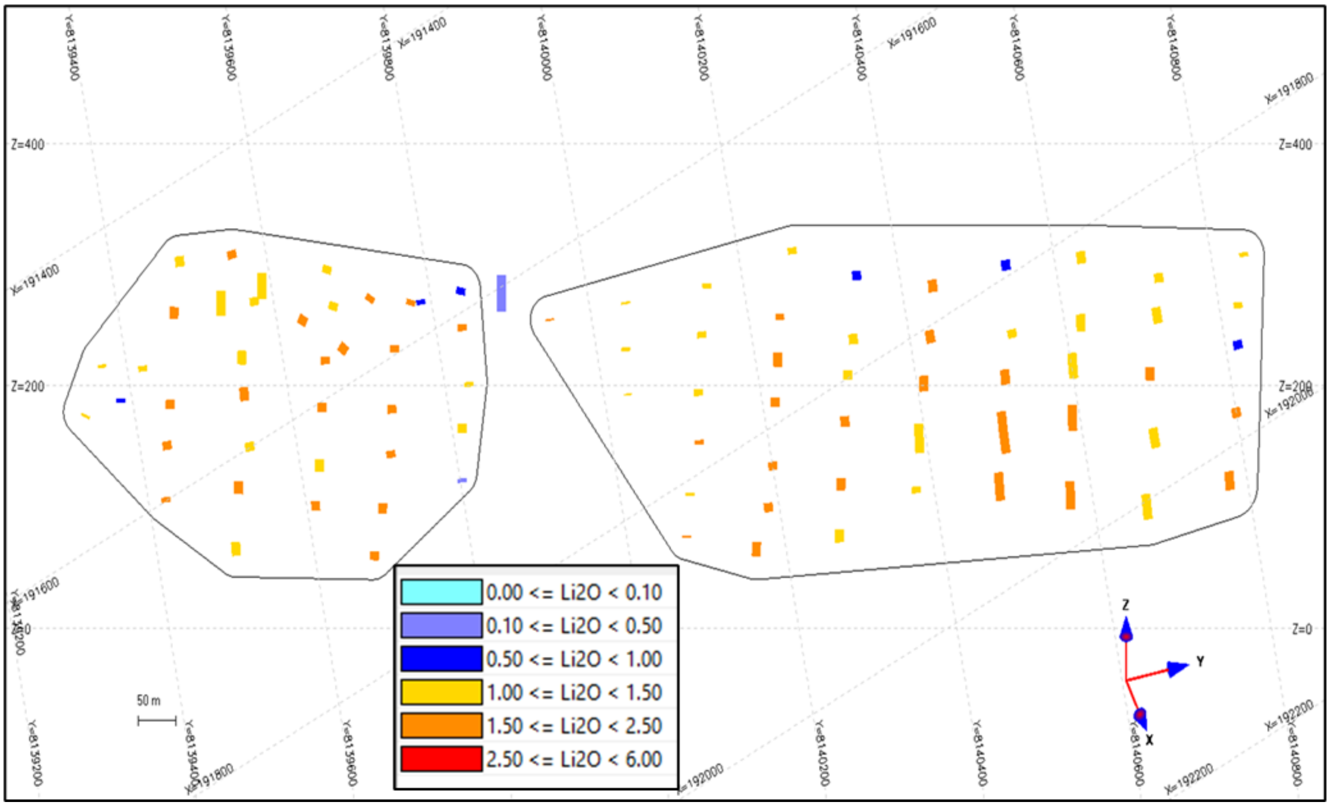


Figure 13-15: Lithium (Li_2O) Grade and Localization of the Drill Holes used to produce the NDC Variability Samples

13.4.3 Test Work Results

13.4.3.1 Sample Preparation and Characterization

Chemical analysis of the three variability samples and the Master composite sample are shown in Table 13-47. The head grades of the variability samples ranged from 1.08% Li_2O in the Low-Grade sample to 1.78% Li_2O in the High-Grade sample. The iron content varied from 0.54% to 1.06% Fe_2O_3 and was highest in the Low-Grade sample.

Table 13-47: Variability Sample and Composite Sample Assays

Element / Oxide	Sample			
	High-Grade	Med-Grade	Low-Grade	Master Comp
	Composition, %			
Li	0.83	0.70	0.50	0.64
Li2O	1.78	1.51	1.08	1.38
SiO2	72.9	72.4	71.4	73.8
Al2O3	16.3	16.5	16.3	16.3
Fe2O3	0.58	0.54	1.06	0.50
MgO	0.04	0.04	0.29	0.10
CaO	0.08	0.08	0.16	0.11
Na2O	3.59	4.01	4.31	4.01
K2O	2.21	2.51	2.66	2.59
TiO2	< 0.01	< 0.01	0.08	0.02
P2O5	0.44	0.33	0.37	0.40
MnO	0.13	0.1	0.08	0.09

Table 13-48 shows the semi-quantitative X-ray Diffraction (XRD) analysis for the three variability samples and the Master composite sample. Spodumene content ranged from 10.3% to 14.1%.

Table 13-48: Semi-quantitative XRD analysis of the three variability samples and the Master composite sample

Element / Oxide	Sample			
	High-Grade	Med-Grade	Low-Grade	Master Comp
	Composition, %			
Albite	29.9	32.7	34.7	32.5
Quartz	26.4	26.2	26.1	27.8
Spodumene	14.1	13.7	10.3	11.4
Orthoclase	6.2	8.5	9.7	7.8
Muscovite	8.7	8.4	7.0	9.2
Petalite	10.5	7.7	5.8	7.7
Cookeite	3.6	2.3	3.5	2.9
Biotite	-	-	1.8	-
Siderite	0.5	0.4	0.6	0.7
Beryl	-	-	0.6	-
Chalcopyrite	0.1	-	-	-
Total	100	100	100	100

Based on the semi-quantitative XRD analysis, the amount of lithium contained in spodumene was estimated for each sample (Table 13-49). Lithium present in spodumene ranged from 65.0% to 68.5% and in petalite ranged from 23.2% to 29.0%. The lithium bearing mineral cookeite was highest in the Low-Grade sample along with minor amounts of beryl.

Table 13-49: Estimates of Lithium Deportment to Spodumene and Petalite

Element / Oxide	Sample			
	High-Grade	Med-Grade	Low-Grade	Master Comp
	Composition, %			
Spodumene	65.0	71.6	68.5	66.9
Petalite	29.0	24.1	23.2	27.1
Total	94.1	95.7	91.7	93.9

13.4.4 Heavy Liquid Separation

Two sets of HLS tests were undertaken. The first set was conducted on the Master Composite sample to test optimal crush size for DMS at four size fractions (i.e., top size of (-15.9/+0.5 mm, -12.5/+0.5 mm, -9.5/+0.5 mm, and -6.3/+0.5 mm). The determined optimal crush size was then used to perform three additional HLS tests with each variability sample, which were also analyzed in three size fractions denoted as coarse, fine, and ultrafine (-9.5/+4.0 mm, -4.0/+1.7 mm, -1.7/+0.5mm, respectively). The -0.5 mm fraction was screened out from each sub-sample but is factored into the overall metallurgical mass balance. The oversize fraction was submitted for HLS testing with a heavy liquid comprised of methylene iodide diluted with acetone. Each HLS test included specific gravity (SG) cut points of 2.95, 2.90, 2.85, 2.80, 2.70, 2.65, 2.60, 2.50, and 2.45.

13.4.4.1 HLS: Master Composite Sample Optimal Crush Size

Grade - recovery curves for the HLS tests to determine optimal crush size are presented in Figure 13-17 and Figure 13-18, for stage and global, respectively.

Lithium stage and global recoveries were estimated (interpolated) for 6.0% Li_2O concentrate and increased with decreasing particle size most likely due to increased spodumene liberation (Table 13-50). Estimated lithium stage recovery for the production of 6.0% Li_2O concentrate ranged from 39.1% for the -15.9 mm crush size to 57.3% for the -6.3 mm crush size.

Table 13-50: HLS Interpolated stage and global lithium recoveries (6% Li_2O concentrate) for each crush size

Recovery	Estimated Lithium Recovery, %			
	-15.9 mm	-12.5 mm	-9.5 mm	-6.3 mm
Stage	39.1	44.8	53.9	57.3
Global	36.1	39.2	46.4	46.6

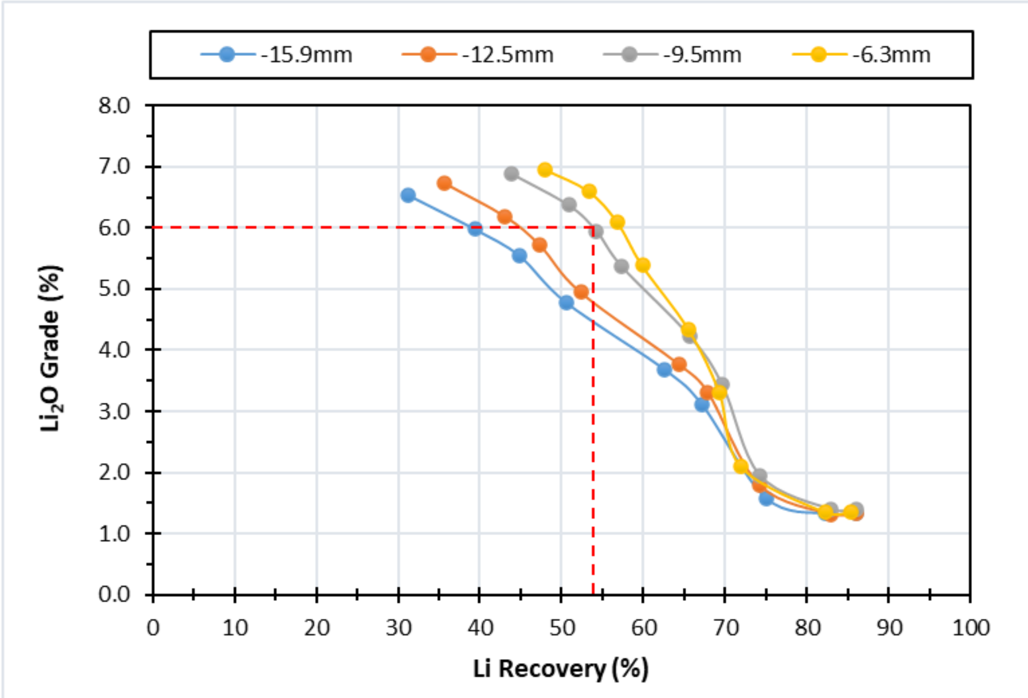


Figure 13-16: Master Composite Cumulative Lithium Grade - Stage Recovery Curves for HLS Tests

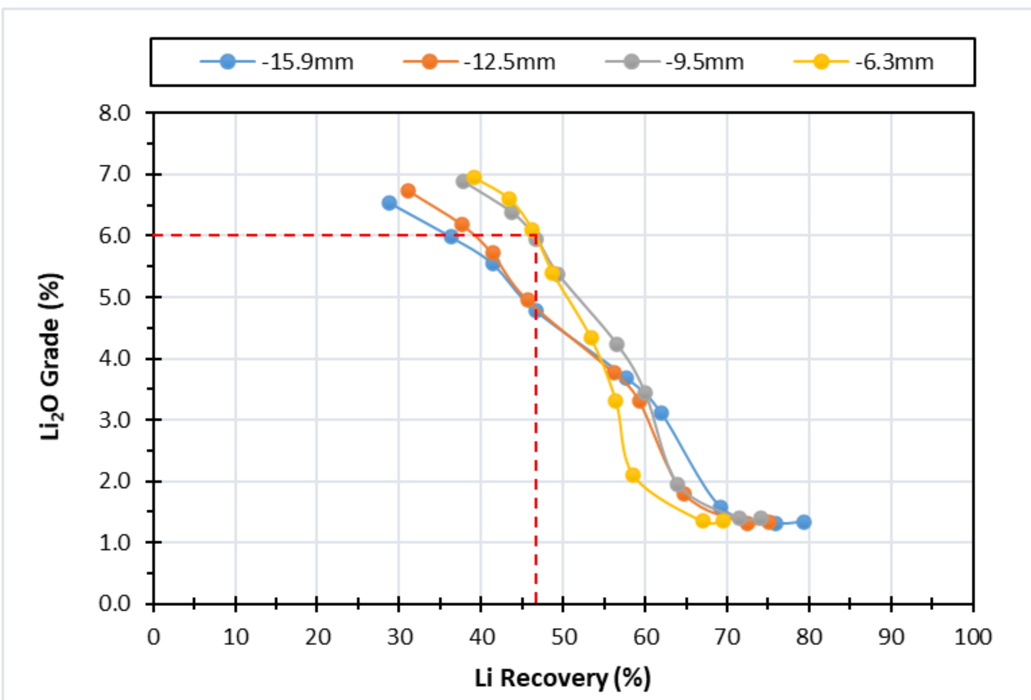


Figure 13-17: Master Composite Cumulative Lithium Grade - Global Recovery Curves for HLS Tests

The HLS grade vs. recovery results with the Master Composite determined the optimal crush size to be -9.5 mm. The stage and global lithium recoveries at the coarser crush sizes of -15.9 mm and -12.5 mm were considerably lower than that at -9.5 mm. Although the stage lithium recovery at -6.3 mm was higher than that of -9.5 mm, high lithium loss to the -0.5 mm fraction at -6.3 mm led the global lithium recovery to fall below the performance at -9.5 mm (Table 13-51). A -9.5 mm crush size correspond with previous test work and process design for the Xuxa lithium DMS operation.

The petalite was concentrated in the SG 2.45 floats, which contained 11.9 % to 12.9% of the total lithium distribution, and 4.1% to 4.6% of the mass distribution.

Table 13-51: Summary of Master Composite HLS Tests with Dry Magnetic Separation for Optimum Crush Size

Crush Size	Non Mag Spod. Conc. - 6.0% Li2O (Int.)				Petalite Conc. (SG 2.45)				-0.5 mm Fraction	
	HLS SG	Assay (%)	Distribution (%)		Assay (%)		Distribution (%)		Distribution (%)	
		Fe2O3	Mass	Li	Li2O	Fe2O3	Mass	Li	Mass	Li
-15.9 mm	2.89	0.36	8.9	36.9	4.07	0.07	4.6	12.9	9.3	7.7
-12.5 mm	2.85	0.37	9.5	40.0	4.15	0.05	4.2	12.2	15	12.7
-9.5 mm	2.80	0.35	11.8	47.9	4.11	0.05	4.3	12.0	17.6	13.9
-6.3 mm	2.78	0.37	11.4	47.4	4.11	0.04	4.1	11.9	23.2	18.6

13.4.4.2 HLS: Variability Samples

HLS tests were performed on the High, Medium, and Low-Grade variability samples was performed at the optimum crush size of -9.5 mm, and the results were analyzed on a global and stage basis to determine the best SG cut-points for DMS. The targeted overall lithium recovery in the combined spodumene and petalite concentrate is 5.5% Li_2O. The SG cut-point of the petalite concentrate was reduced to 2.40 in the tests to improve the petalite concentrate grade and overall lithium recovery in the combined concentrate. Detailed size-by-size HLS mass balances are shown in Table 13-52 to Table 13-55.

The global results revealed that combined spodumene and petalite concentrates grading 5.5% Li_2O with lithium recoveries between 51.9% and 55.6% could be produced at a crush size of -9.5 mm from all three variability samples. The interpolated SG of the spodumene concentrate from the full distribution was 2.82 for the High and Medium-Grade samples and 2.86 for the Low-Grade sample. The global HLS spodumene concentrates graded between 5.70% and 5.95% Li_2O with global lithium distributions between 42.7% and 47.7%. The HLS petalite concentrates graded between 3.85% and 4.54% Li_2O with lithium distributions between 7.8% and 9.4% at the lower SG of 2.40. The combined spodumene and petalite concentrates all graded <1.0% Fe_2O_3, however, the Low-Grade sample was very close to the Fe_2O_3 limit. Magnetic separation was shown to reduce the iron level of the combined Low-Grade HLS concentrate to 0.38% Fe_2O_3.

The HLS spodumene concentrate, middlings, tailings, and petalite concentrate from the Medium-Grade sample underwent XRD analysis to calculate the mineral balance (Table 13-55). The spodumene concentrate contained 70.7% spodumene and quartz, muscovite, and albite were the major contaminant. The petalite losses were high in the HLS tailings (69.1%), while most of the unconcentrated spodumene reported to the HLS middlings (24.0%).

Table 13-52: High-Grade Variability Sample HLS Results

Fraction	Combined HLS Products	HL SG	Weight		Assays (%)									Distribution (%)							
		g/cm^3	g	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	CaO	Na_2O	K_2O	P_2O_5	Li	SiO_2	Al_2O_3	Fe_2O_3	CaO	Na_2O	K_2O	P_2O_5
-9.5 mm / +4 mm	HLS Sp Concentrate (interpolated)	2.81	837	18.0	2.56	5.50	67.75	22.88	0.44	0.02	1.03	0.55	0.38	48.5	16.6	24.5	21.2	6.4	5.3	4.6	17.3
-4 mm / +1.7 mm	HLS Sp Concentrate (interpolated)	2.75	403	18.8	2.56	5.50	64.79	24.37	0.69	0.13	0.87	1.15	0.77	54.6	16.5	28.4	31.5	26.5	5.0	9.6	36.1
-1.7	HLS Sp Concentrate (interpolated)	2.75	273	15.2	2.56	5.50	62.71	24.68	1.02	0.18	0.76	1.34	1.33	46.7	12.9	24.0	32.5	32.9	3.8	9.3	42.5
-9.5 mm / +4 mm	HLS Middlings (interpolated)	-2.81+2.65	823	17.7	0.97	2.09	73.08	16.88	0.63	0.07	2.89	1.68	0.68	18.2	17.6	17.8	29.7	18.2	14.6	13.5	30.5
-4 mm / +1.7 mm	HLS Middlings (interpolated)	-2.75+2.65	184	8.6	0.70	1.51	70.10	18.35	0.83	0.11	2.53	2.96	0.69	6.9	8.2	9.8	17.4	10.4	6.5	10.9	14.8
-1.7	HLS Middlings (interpolated)	-2.75+2.65	162	9.0	0.64	1.38	69.77	18.49	0.93	0.10	2.47	3.32	0.58	7.1	8.5	10.7	17.5	10.9	7.1	13.2	11.1
-9.5 mm / +4 mm	HLS Tailings	-2.65+2.40	2920	62.7	0.44	0.94	74.36	15.08	0.30	0.08	4.54	2.90	0.34	29.0	63.7	56.4	49.1	75.1	81.1	82.8	54.7
-4 mm / +1.7 mm	HLS Tailings	-2.65+2.40	1498	70.0	0.37	0.79	76.36	13.76	0.31	0.08	4.24	2.76	0.31	29.6	72.2	59.8	53.5	66.1	89.2	83.0	54.0
-1.7	HLS Tailings	-2.65+2.40	1298	72.4	0.39	0.84	77.12	13.50	0.33	0.06	3.89	2.55	0.31	34.4	75.0	62.5	50.0	55.7	89.7	81.5	47.8
-9.5 mm / +4 mm	HLS Petalite Conc.	-2.40	197	4.2	2.08	4.48	77.10	16.70	0.25	0.03	0.25	0.04	0.03	9.3	4.5	4.2	2.8	1.8	0.3	0.1	0.3
-4 mm / +1.7 mm	HLS Petalite Conc.	-2.40	104	4.9	2.09	4.50	76.70	16.80	0.22	0.03	0.33	0.05	0.03	11.7	5.0	5.1	2.6	1.6	0.5	0.1	0.4
-1.7	HLS Petalite Conc.	-2.40	93	5.2	2.07	4.46	76.10	16.90	0.29	0.04	0.38	0.04	0.06	13.0	5.3	5.6	3.1	2.5	0.6	0.1	0.7
Global Recovery	HLS Sp Concentrate (interpolated)	2.82	1385	13.8	2.69	5.80	66.03	23.82	0.59	0.08	0.84	0.63	0.65	42.7	12.4	20.2	18.4	13.1	4.0	3.6	13.5
	HLS Middlings (interpolated)	-2.82 +2.65	1099	11.0	0.79	1.69	72.27	17.10	0.74	0.09	2.87	2.24	0.69	9.9	10.8	11.5	18.4	11.6	10.8	9.8	11.4
	HLS Tailings	-2.65+2.40	5716	57.2	0.41	0.88	75.51	14.38	0.31	0.08	4.32	2.79	0.33	26.8	58.7	50.3	39.7	56.4	84.2	63.6	28.2
	HLS Petalite Conc	-2.4	394	3.9	2.08	4.48	76.76	16.77	0.25	0.03	0.30	0.04	0.04	9.42	4.11	4.05	2.24	1.57	0.41	0.07	0.22
	-0.5 mm fines		1406	14.1	0.69	1.49	73.30	16.20	0.67	0.10	0.13	4.10	2.20	11.1	14.0	14.0	21.2	17.4	0.6	23.0	46.6
	Spod Conc + Petalite Conc		1779	17.8	2.55	5.50	68.42	22.24	0.51	0.07	0.73	0.51	0.51	52.1	16.5	24.2	20.6	14.7	4.4	3.6	13.7

Table 13-53: Medium-Grade Variability Sample HLS Results

Fraction	Combined HLS Products	HL SG	Weight		Assays (%)									Distribution (%)							
		g/cm^3	g	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	CaO	Na_2O	K_2O	P_2O_5	Li	SiO_2	Al_2O_3	Fe_2O_3	CaO	Na_2O	K_2O	P_2O_5
-9.5 mm / +4 mm	HLS Sp Concentrate (interpolated)	2.81	829	15.9	2.56	5.50	67.80	22.90	0.38	0.03	1.02	0.59	0.22	52.5	14.9	21.7	16.4	6.9	4.0	3.7	10.5
-4 mm / +1.7 mm	HLS Sp Concentrate (interpolated)	2.77	330	15.8	2.56	5.50	65.31	24.23	0.58	0.06	0.87	1.01	0.50	56.4	14.0	23.5	24.5	13.8	3.8	6.3	24.7
-1.7	HLS Sp Concentrate (interpolated)	2.79	227	14.8	2.56	5.50	61.36	25.94	1.00	0.20	0.70	1.75	1.15	55.1	12.3	24.0	31.2	33.1	2.9	10.1	43.2
-9.5 mm / +4 mm	HLS Middlings (interpolated)	-2.81+2.65	1410	27.1	0.69	1.48	75.78	15.05	0.50	0.09	3.64	1.36	0.37	24.2	28.3	24.2	36.3	29.8	24.0	14.4	30.7
-4 mm / +1.7 mm	HLS Middlings (interpolated)	-2.77+2.65	495	23.7	0.43	0.93	77.46	13.61	0.65	0.08	2.96	1.71	0.36	14.7	25.0	19.9	40.3	26.7	18.6	15.0	26.3
-1.7	HLS Middlings (interpolated)	-2.79+2.65	392	25.5	0.35	0.75	78.91	13.42	0.62	0.08	2.23	2.21	0.29	13.1	27.2	21.5	33.6	21.6	15.6	21.5	18.8
-9.5 mm / +4 mm	HLS Tailings	-2.65+2.40	2971	57.1	0.31	0.66	72.10	16.09	0.31	0.09	5.24	3.72	0.35	22.6	56.7	54.6	47.3	62.7	73.0	82.6	60.4
-4 mm / +1.7 mm	HLS Tailings	-2.65+2.40	1213	58.1	0.24	0.51	73.50	15.23	0.24	0.08	5.04	3.75	0.29	19.6	58.1	54.6	36.3	60.7	77.9	80.7	51.9
-1.7	HLS Tailings	-2.65+2.40	889	57.8	0.26	0.55	74.12	14.80	0.30	0.07	5.16	3.28	0.27	21.7	58.0	53.7	36.6	45.6	81.9	72.6	39.4
-9.5 mm / +4 mm	HLS Petalite Conc.	-2.40	128	2.5	2.13	4.58	76.70	16.70	0.28	0.05	0.20	0.11	0.03	6.8	2.6	2.4	1.9	1.5	0.1	0.1	0.2
-4 mm / +1.7 mm	HLS Petalite Conc.	-2.40	83	4.0	2.07	4.46	77.10	16.80	0.25	0.04	0.25	0.05	0.02	11.8	4.2	4.1	2.6	2.2	0.3	0.1	0.2
-1.7	HLS Petalite Conc.	-2.40	56	3.7	2.13	4.58	76.50	16.80	0.32	0.04	0.30	0.04	0.05	11.5	3.8	3.9	2.5	1.6	0.3	0.1	0.5
Global Recovery	HLS Sp Concentrate (interpolated)	2.82	1306	13.1	2.65	5.70	66.22	23.80	0.51	0.06	0.86	0.72	0.43	47.7	11.9	18.8	15.9	9.9	2.8	3.7	18.9
	HLS Middlings (interpolated)	-2.82 +2.65	2358	23.6	0.59	1.28	76.54	14.56	0.55	0.09	3.23	1.58	0.36	19.4	24.7	20.8	31.0	23.4	18.9	14.4	28.4
	HLS Tailings	-2.65+2.40	5073	50.7	0.28	0.60	72.79	15.66	0.29	0.08	5.18	3.65	0.32	19.7	50.6	48.1	34.8	48.5	65.4	71.5	54.0
	HLS Petalite Conc	-2.4	268	2.7	2.11	4.54	76.78	16.75	0.28	0.04	0.24	0.08	0.03	7.83	2.82	2.72	1.78	1.40	0.16	0.08	0.28
	-0.5 mm fines		1168	11.7	0.59	1.27	72.60	16.60	0.65	0.13	4.64	2.44	0.01	9.5	11.6	11.7	18.0	17.7	13.5	11.0	0.4
	Spod Conc + Petalite Conc		1574	15.7	2.55	5.50	68.02	22.59	0.47	0.06	0.76	0.62	0.37	55.6	14.7	21.5	17.7	11.3	3.0	3.8	19.2

Table 13-54: Low-Grade Variability Sample HLS Results

Fraction	Combined HLS Products	HL SG	Weight		Assays (%)									Distribution (%)							
		g/cm^3	g	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	CaO	Na_2O	K_2O	P_2O_5	Li	SiO_2	Al_2O_3	Fe_2O_3	CaO	Na_2O	K_2O	P_2O_5
-9.5 mm / +4 mm	HLS Sp Concentrate (interpolated)	2.81	572	11.0	2.56	5.50	67.40	23.26	0.39	0.03	1.00	0.59	0.35	51.4	10.3	15.3	9.1	3.5	2.4	2.4	9.8
-4 mm / +1.7 mm	HLS Sp Concentrate (interpolated)	2.78	238	13.0	2.56	5.50	64.88	24.26	0.59	0.06	0.94	0.88	0.92	60.5	11.4	19.6	19.6	10.7	3.2	5.3	31.1
-1.7	HLS Sp Concentrate (interpolated)	2.76	164	13.3	2.56	5.50	62.85	25.54	0.54	0.10	0.83	1.34	1.01	62.3	11.3	21.4	22.8	16.2	3.0	8.8	35.6
-9.5 mm / +4 mm	HLS Middlings (interpolated)	-2.81+2.65	995	19.2	0.60	1.29	70.67	17.08	1.50	0.26	3.06	2.47	0.63	21.2	18.8	19.5	61.0	47.6	12.8	17.5	30.1
-4 mm / +1.7 mm	HLS Middlings (interpolated)	-2.78+2.65	274	15.0	0.47	1.00	69.86	17.70	1.44	0.22	2.80	2.92	0.56	13.4	14.2	16.7	47.3	34.7	10.0	16.8	22.7
-1.7	HLS Middlings (interpolated)	-2.76+2.65	168	13.6	0.34	0.73	72.53	16.76	0.98	0.17	2.74	2.85	0.42	9.1	13.2	14.5	35.9	25.4	8.8	15.9	15.8
-9.5 mm / +4 mm	HLS Tailings	-2.65+2.40	3513	67.9	0.17	0.38	73.20	15.73	0.21	0.07	5.69	3.21	0.36	21.7	68.9	63.5	29.4	47.7	84.3	80.2	60.9
-4 mm / +1.7 mm	HLS Tailings	-2.65+2.40	1284	70.2	0.13	0.29	76.04	14.05	0.21	0.07	5.16	2.92	0.26	18.0	72.4	62.1	32.5	53.9	86.8	78.9	50.1
-1.7	HLS Tailings	-2.65+2.40	867	70.1	0.13	0.27	76.94	13.65	0.20	0.07	5.27	2.61	0.25	17.6	72.5	60.9	37.2	55.0	87.4	75.1	47.8
-9.5 mm / +4 mm	HLS Petalite Conc.	-2.40	128	2.5	1.75	3.77	75.60	16.80	0.19	0.07	1.36	0.13	0.04	7.9	2.6	2.5	1.0	1.7	0.7	0.1	0.2
-4 mm / +1.7 mm	HLS Petalite Conc.	-2.40	60	3.3	1.85	3.98	75.80	17.00	0.22	0.05	1.02	0.17	0.09	11.6	3.3	3.5	1.6	1.7	0.8	0.2	0.8
-1.7	HLS Petalite Conc.	-2.40	38	3.0	1.81	3.90	74.40	16.90	0.50	0.10	1.11	0.13	0.10	10.9	3.0	3.3	4.1	3.4	0.8	0.2	0.8
Global Recovery	HLS Sp Concentrate (interpolated)	2.86	817	8.2	2.76	5.95	64.20	24.39	0.99	0.10	0.66	0.70	0.94	44.1	7.3	12.0	9.1	5.2	1.2	2.1	19.1
	HLS Middlings (interpolated)	-2.86 +2.65	1824	18.2	0.54	1.15	68.75	17.70	2.05	0.30	2.65	3.01	0.60	19.1	17.4	19.5	42.2	35.0	11.2	20.0	27.3
	HLS Tailings	-2.65+2.40	5664	56.6	0.16	0.34	74.42	15.03	0.21	0.07	5.51	3.05	0.32	17.5	58.6	51.4	13.1	26.5	72.4	63.1	45.2
	HLS Petalite Conc	-2.4	225	2.3	1.79	3.85	75.45	16.87	0.25	0.07	1.23	0.14	0.06	7.86	2.36	2.29	0.63	1.01	0.64	0.12	0.35
	-0.5 mm fines		1470	14.7	0.40	0.86	70.30	16.70	2.11	0.34	4.25	2.74	0.22	11.5	14.4	14.8	34.9	32.2	14.5	14.7	8.0
	Spod Conc + Petalite Conc		1042	10.4	2.55	5.50	66.63	22.77	0.83	0.09	0.78	0.58	0.75	51.9	9.7	14.3	9.8	6.2	1.9	2.2	19.5

Table 13-55: Mineral Mass Balance for Medium-Grade HLS

Product	Weight		Assays (%)					Distribution (%)				
	grams	%	Spodumene	Petalite	Quartz	Muscovite	Albite	Spodumene	Petalite	Quartz	Muscovite	Albite
Combined Conc.	1235	14.0	70.7	0.77	11.17	7.23	6.30	75.7	1.08	6.10	13.60	2.77
Combined Middling	2256	25.5	12.27	0.97	44.5	9.93	25.73	24.0	2.49	44.5	34.1	20.65
Combined Tail	5073	57.4	0.00	11.93	21.9	6.73	42.43	0.0	69.14	49.2	52.0	76.58
Petalite Conc	268	3.0	1.30	89.2	2.1	0.67	0.0	0.30	27.3	0.2	0.3	0.0
Head (cal.)	8832	100	13.05	9.91	25.6	7.44	31.8	100	100	100	100	100

13.4.5 Dense Media Separation

The DMS test work was performed on the Master Composite sample crushed to -9.5mm, then screened into coarse (-9.5 mm / +4.0 mm), fine (-4.0 mm / +1.7 mm) and ultrafine (-1.7 mm / +0.5 mm) size fractions separately.

DMS feed was pre-screened at 500 µm to remove fine particles. The density of the circulating media was controlled to produce the desired SG cut-points and tracer tests were conducted prior to testing to ensure that the SG was at the desired target.

Each size fraction underwent two DMS passes. The first pass was operated at a lower density to reject silicate gangue minerals (SG of 2.65). The first pass sink product was repassed through the DMS at a higher density cut-point to produce spodumene concentrate. The floats from each first pass were then run through a DMS step at a SG cut-point of 2.40 to produce a “petalite” concentrate, which reports to the float.

The cut-points for the second pass were based on interpolated HLS data for the production of 6% Li_2O spodumene concentrate. The coarse, fine, and ultrafine density target cut-points were 2.83, 2.79, and 2.79, respectively. SG cut-points for each DMS pass were selected based on the variability sample HLS results.

To maximize spodumene/lithium recovery additional circulation of the middlings (2nd stage float) was integrated by returning back to the 2nd stage DMS feed, post re-crush (- 4mm / + 0.5mm).

The DMS middling concentrate and spodumene concentrate were then magnetically separated (dry) at 10,000 gauss to produce a final spodumene concentrate, with low iron content.

13.4.5.1 DMS Results

The result from this work is presented in Table 13-56, Table 13-57, and Table 13-58.

The coarse fraction DMS concentrate grade was slightly below target at 5.29% Li_2O with lithium stage recovery of 54.3%. Mass pull to the concentrate was 15.8% and iron content of the concentrate was 0.52% Fe_2O_3. A proportion of the lithium in the coarse fraction (12.5%) reported to the middlings stream which graded 0.95% Li_2O. The tailings contained 27.1% of the contained Li at a grade of 0.69% Li_2O and accounted for 60.5% of the mass of the coarse fraction. The fraction of Li recovered from the petalite circuit was 4.4% with a contained Li_2O of 3.96%.

The fines fraction DMS produced concentrate grading 5.40% Li_2O with a staged recovery of 57.9% in 15.5% of the mass. Lithium reported to the middlings, was then split into magnetics and non-magnetics, which graded on average to 1.23% Li_2O and a mass yield of 1.6%. The fines DMS tailings graded 0.56% Li_2O with 23.30% lithium global losses 60.2% of the mass. Dry magnetic separation did show some success in rejecting iron, with the magnetic concentrate upgraded to 8.78% Fe_2O_3 with lithium losses of only 1.5%. The fraction of Li recovered from the petalite circuit was 9.4% with a contained Li_2O of 3.94%.

For the ultrafines fraction, relatively high-grade spodumene concentrate was produced 5.70% Li_2O with 55.6% lithium stage recovery on a mass yield of 13.4%. The middlings graded 0.47% Li_2O and accounted for 5.2% of the lithium, in 15.1% of the mass. The ultrafines DMS tailings graded 0.39% Li_2O, had a mass yield of 58.6% and accounted for 16.5% of the lithium. The fraction of Li recovered from the petalite circuit was 18.1% with a contained Li_2O of 2.45%.

Table 13-56: Coarse fraction DMS stage results

Product	Weight		Assays (%)											Distribution (%)									
	kg	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO
DMS Conc Non-mag	52.22	15.8	2.46	5.29	68.3	22.6	0.52	0.03	0.08	1.14	0.61	0.30	0.09	54.3	14.7	21.7	17.8	5.2	13.6	4.5	3.9	13.2	19.4
DMS Conc Middling	4.21	1.3	0.66	1.42	56.4	22.2	4.81	1.49	0.66	1.15	5.23	1.73	0.66	1.2	1.0	1.7	13.3	20.8	9.0	0.4	2.7	6.1	11.5
DMS Conc Mag	1.18	0.36	1.01	2.17	47.4	19.0	8.37	1.53	0.67	1.13	4.84	7.39	3.32	0.5	0.2	0.4	6.5	6.0	2.6	0.1	0.7	7.3	16.1
DMS Middling	67.30	20.3	0.44	0.95	76.2	14.4	0.65	0.15	0.13	3.83	1.88	0.43	0.10	12.5	21.1	17.9	28.7	33.5	28.5	19.7	15.3	24.3	27.8
DMS Tailings	200.40	60.5	0.32	0.69	74.3	15.3	0.25	0.05	0.07	4.90	3.19	0.29	0.03	27.1	61.3	56.5	32.9	33.3	45.6	75.0	77.3	48.8	24.8
Petalite Concentrate	5.7	1.7	1.84	3.96	75.6	17.0	0.19	0.06	0.04	0.82	0.35	0.06	0.02	4.4	1.8	1.8	0.7	1.1	0.7	0.4	0.2	0.3	0.5
Coarse Fraction (calc.)	331.0	100	0.71	1.54	73.4	16.4	0.46	0.09	0.09	3.96	2.50	0.36	0.07	100	100	100	100	100	100	100	100	100	100

Table 13-57: Fines fraction DMS stage results

Product	Weight		Assays (%)											Distribution (%)									
	kg	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO
DMS Conc Non-mag	12.0	15.5	2.51	5.40	67.1	23.6	0.56	0.02	0.03	0.88	0.75	0.42	0.08	57.9	14.1	22.7	17.6	3.3	4.9	3.6	4.5	16.2	14.0
DMS Conc Middling	1.3	1.6	0.57	1.23	51.1	30.6	1.90	0.33	0.56	0.88	7.40	0.70	0.22	1.4	1.1	3.1	6.3	5.7	9.6	0.4	4.6	2.8	4.0
DMS Conc Mag	0.8	0.99	1.00	2.15	44.7	20.0	8.78	1.39	0.85	1.13	5.20	7.96	3.53	1.5	0.6	1.2	17.7	14.7	8.9	0.3	2.0	19.6	39.5
DMS Middling	14.2	18.3	0.24	0.52	79.6	12.1	0.67	0.18	0.12	3.24	1.88	0.35	0.07	6.5	19.7	13.7	24.9	35.2	23.3	15.6	13.3	15.9	14.5
DMS Tailings	46.8	60.2	0.26	0.56	74.7	14.9	0.26	0.06	0.08	4.99	3.21	0.30	0.04	23.3	60.9	55.6	31.8	38.5	51.0	79.1	74.6	44.8	27.2
Petalite Concentrate	2.7	3.4	1.83	3.94	75.2	17.2	0.24	0.07	0.06	1.06	0.80	0.08	0.02	9.4	3.5	3.7	1.7	2.6	2.2	1.0	1.1	0.7	0.8
Fines Fraction (calc.)	77.8	100	0.67	1.44	73.8	16.1	0.49	0.09	0.09	3.79	2.59	0.40	0.09	100	100	100	100	100	100	100	100	100	100

Table 13-58: Ultrafines fraction DMS stage results

Product	Weight		Assays (%)											Distribution (%)									
	kg	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO
DMS Conc Non-mag	8.2	13.4	2.65	5.70	66.8	24.1	0.52	0.02	0.03	0.58	0.76	0.54	0.07	55.6	12.0	20.8	15.7	3.7	4.2	2.1	4.3	17.0	9.4
DMS Conc Middling	0.9	1.5	0.74	1.59	49.3	33.3	1.28	0.07	0.41	0.73	7.80	0.49	0.16	1.7	1.0	3.1	4.2	1.4	6.3	0.3	4.8	1.7	2.3
DMS Conc Mag	0.7	1.2	1.56	3.36	38.9	21.0	8.67	0.67	1.49	0.77	4.79	11.10	4.99	2.9	0.6	1.6	23.4	11.3	18.8	0.2	2.4	31.3	59.8
DMS Middling	9.3	15.1	0.22	0.47	80.8	11.4	0.55	0.11	0.09	2.76	1.97	0.31	0.06	5.2	16.4	11.1	18.7	23.2	14.3	11.1	12.4	11.0	9.0
DMS Tailings	35.8	58.6	0.18	0.39	76.2	13.9	0.25	0.06	0.08	5.07	2.75	0.25	0.03	16.5	59.9	52.4	32.8	49.0	49.0	79.0	67.1	34.3	17.5
Petalite Concentrate	6.2	10.2	1.14	2.45	74.2	16.6	0.23	0.08	0.07	2.67	2.15	0.20	0.02	18.1	10.1	10.9	5.2	11.3	7.4	7.2	9.1	4.8	2.0
Ultrafines Fraction (calc.)	61.1	100	0.64	1.38	74.6	15.5	0.45	0.07	0.10	3.76	2.40	0.43	0.10	100	100	100	100	100	100	100	100	100	100

The master composite (-9.5mm) was also run through two bulk DMS trials as per the flowsheet description above, with the SG cuts listed:

- Trial 1: DMS SG target for each size fraction; 2.83 (coarse), 2.79 (fines), 2.79 (ultrafines), petalite 2.40
- Trial 2: DMS SG target for each size fraction; 2.87 (coarse), 2.81 (fines), 2.81 (ultrafines), petalite 2.37

The global results for this scope, for the master composite are presented in for each size fraction and combined respectively, for Trial 1 and Trial 2.

13.4.5.1.1 Trial 1 Results

For details on each size fractions coarse, fines and ultrafines DMS response refer to Table 13-59, Table 13-60 and Table 13-61 respectively. The following is the summary for the global combined results.

It will be generally noted that the Li_2O concentration for all size fractions did not reach >6.0% but did have a Li_2O:Fe ratio of >9.5:1. The overall performance for the "flowsheet" based on the results is summarized in Table 13-60.

The global performance, combining the three products was a DMS concentrate grade being below target at 5.36% Li_2O with lithium global recovery of 47.4%. Mass pull to the concentrate was 12.8% and iron content of the concentrate was 0.53% Fe_2O_3. The proportion of the lithium (9.2%) that reported to the middlings stream graded 0.83% Li_2O, 0.64% Fe_2O_3 and was considered worth upgrading. The DMS tailings consisted of 21.7% of the contained Li at a grade of 0.63% Li_2O and accounted for 49.9% of the mass of the coarse fraction.

The total global performance with the addition of the petalite recovery stream equated to a Li_2O recovery of 53.3%, in 15.3% of the mass with a nominal grade of 5.02% Li_2O and 0.47% Fe_2O_3.

The staged performance with the addition of the petalite recovered stream, equates to a Li_2O recovery of 61.9% in 18.5% of the DMS feed mass, with a nominal grade of 5.02%.

13.4.5.1.2 Trial 2 Results

For details on each size fractions coarse, fines, ultrafines DMS response refer the tables presented, Table 13-62, Table 13-63 and Table 13-64 respectively. The following is the summary for the global combined results. It will be generally noted that the Li_2O concentration for all size fractions did not reach >6.0% but did have a Li_2O:Fe ratio of >9.5:1.

The overall performance for the "flowsheet" based on the results is summarized in Table 13-63.

The global performance, combining the three products was a DMS concentrate grade being below target at 5.88% Li_2O with lithium global recovery of 45.5%. Mass pull to the concentrate was 11.2% and very low iron content of the concentrate was 0.36% Fe_2O_3. The proportion of the lithium (11.5%) that reported to the middlings stream graded 0.92% Li_2O, 0.75% Fe_2O_3 and was considered worth upgrading. The DMS tailings consisted of 22.3% of the contained Li at a grade of 0.64% Li_2O and accounted for 50.5% of the mass of the coarse fraction.

The total performance with the addition of the petalite recovery stream equated to a Li_2O recovery of 50.6%, in 13.1% of the mass with a nominal grade of 5.57% Li_2O and 0.34% Fe_2O_3.

The staged performance with the addition of the petalite recovered stream, equates to a Li_2O recovery of 58.7% in 15.8% of the DMS feed mass, with a nominal grade of 5.57%.

Table 13-59: DMS Global results (Master Composite) – 1st Trial

	Product	Weight		Assays (%)											Distribution (%)									
		kg	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO
-9.5 +4 mm	DMS Conc Non-mag	52.2	9.20	2.46	5.29	68.3	22.6	0.52	0.03	0.08	1.14	0.61	0.30	0.09	33.8	8.6	12.8	8.4	2.2	6.5	2.65	2.24	6.85	9.22
	DMS Conc Middling	4.2	0.74	0.66	1.42	56.4	22.2	4.81	1.49	0.66	1.15	5.23	1.73	0.66	0.7	0.6	1.0	6.3	8.8	4.3	0.22	1.55	3.18	5.45
	DMS Conc Mag	1.2	0.21	1.01	2.17	47.4	19.0	8.37	1.53	0.67	1.13	4.84	7.39	3.32	0.3	0.1	0.2	3.0	2.5	1.2	0.06	0.40	3.81	7.67
	DMS Middling	67.3	11.86	0.44	0.95	76.2	14.4	0.65	0.15	0.13	3.83	1.88	0.43	0.10	7.78	12.3	10.5	13.53	14.10	13.58	11.5	8.9	12.65	13.21
	DMS Tailings	200.4	35.32	0.32	0.69	74.3	15.3	0.25	0.05	0.07	4.90	3.19	0.29	0.03	16.85	35.8	33.2	15.50	14.00	21.78	43.8	45.0	25.40	11.80
	Petalite Concentrate	5.7	1.00	1.84	3.96	75.6	17.0	0.19	0.06	0.04	0.82	0.35	0.06	0.02	2.7	1.0	1.0	0.3	0.5	0.4	0.2	0.1	0.1	0.2
-4+1.7 mm	DMS Conc Non-mag	12.0	2.12	2.51	5.40	67.1	23.6	0.56	0.02	0.03	0.88	0.75	0.42	0.08	7.94	1.94	3.08	2.09	0.34	0.56	0.47	0.63	2.21	1.89
	DMS Conc Middling	1.3	0.22	0.57	1.23	51.1	30.6	1.90	0.33	0.56	0.88	7.40	0.70	0.22	0.19	0.16	0.42	0.74	0.58	1.10	0.05	0.66	0.39	0.54
	DMS Conc Mag	0.8	0.14	1.00	2.15	44.7	20.0	8.78	1.39	0.85	1.13	5.20	7.96	3.53	0.2	0.08	0.17	2.09	1.50	1.02	0.04	0.28	2.68	5.34
	DMS Middling	14.2	2.51	0.24	0.52	79.6	12.1	0.67	0.18	0.12	3.24	1.88	0.35	0.07	0.90	2.72	1.87	2.95	3.58	2.65	2.05	1.88	2.18	1.95
	DMS Tailings	46.8	8.25	0.26	0.56	74.7	14.9	0.26	0.06	0.08	4.99	3.21	0.30	0.04	3.20	8.40	7.55	3.76	3.92	5.81	10.41	10.56	6.14	3.67
	Petalite Concentrate	2.7	0.47	1.83	3.94	75.2	17.2	0.24	0.07	0.06	1.06	0.80	0.08	0.02	1.29	0.5	0.5	0.20	0.26	0.25	0.1	0.2	0.09	0.10
-1.7+0.5 mm	DMS Conc Non-mag	8.2	1.45	2.65	5.70	66.8	24.1	0.52	0.02	0.03	0.58	0.76	0.54	0.07	5.72	1.32	2.14	1.32	0.23	0.38	0.21	0.44	1.94	1.13
	DMS Conc Middling	0.9	0.16	0.74	1.59	49.3	33.3	1.28	0.07	0.41	0.73	7.80	0.49	0.16	0.17	0.11	0.32	0.36	0.09	0.57	0.03	0.49	0.19	0.28
	DMS Conc Mag	0.7	0.13	1.56	3.36	38.9	21.0	8.67	0.67	1.49	0.77	4.79	11.10	4.99	0.3	0.07	0.17	1.97	0.69	1.70	0.03	0.25	3.57	7.21
	DMS Middling	9.3	1.63	0.22	0.47	80.8	11.4	0.55	0.11	0.09	2.76	1.97	0.31	0.06	0.53	1.80	1.14	1.57	1.42	1.29	1.14	1.28	1.25	1.09
	DMS Tailings	35.8	6.31	0.18	0.39	76.2	13.9	0.25	0.06	0.08	5.07	2.75	0.25	0.03	1.69	6.56	5.39	2.77	3.00	4.44	8.09	6.92	3.91	2.11
	Petalite Concentrate	6.2	1.09	1.14	2.45	74.2	16.6	0.23	0.08	0.07	2.67	2.15	0.20	0.02	1.86	1.1	1.1	0.44	0.69	0.67	0.7	0.9	0.54	0.24
	Hypofines (-0.5 mm)	97.5	17.2	0.54	1.16	71.7	16.4	1.08	0.31	0.21	4.20	2.53	0.54	0.14	13.8	16.8	17.3	32.7	41.6	31.8	18.2	17.3	22.9	26.9
	Head (calc.)	567	100	0.67	1.44	73.3	16.3	0.57	0.13	0.11	3.95	2.51	0.40	0.09	100	100	100	100	100	100	100	100	100	100
	Combined Feed (Dir.)			0.64	1.38	73.8	16.3	0.50	0.10	0.11	4.01	2.59	0.40	0.09										

Table 13-60: DMS Global results (Master Composite) Combined – 1st Trial

Product	Weight		Assays (%)											Distribution (%)									
	kg	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO
DMS Concentrate Non-mag	72.5	12.8	2.49	5.36	67.9	22.9	0.53	0.03	0.07	1.03	0.65	0.35	0.09	47.4	11.8	18.0	11.8	2.75	7.43	3.34	3.31	11.00	12.24
DMS Combined Mag Conc.	9.1	1.6	0.80	1.73	51.4	23.8	5.17	1.12	0.71	1.04	5.70	3.49	1.49	1.9	1.1	2.3	14.5	14.1	9.9	0.4	3.6	13.8	26.5
DMS Middling	90.8	16.0	0.39	0.83	77.2	13.7	0.64	0.15	0.12	3.63	1.89	0.41	0.09	9.2	16.9	13.5	18.1	19.1	17.5	14.7	12.1	16.1	16.2
DMS Tailings	283	49.9	0.29	0.63	74.6	15.1	0.25	0.05	0.07	4.94	3.14	0.29	0.03	21.7	50.76	46.17	22.0	20.92	32.03	62.26	62.43	35.45	17.58
Petalite Concentrate	14.6	2.6	1.54	3.31	74.9	16.9	0.22	0.07	0.06	1.65	1.20	0.12	0.02	5.9	2.62	2.66	1.0	1.43	1.28	1.07	1.23	0.78	0.57
Hypofines (-0.5 mm)	97.5	17.2	0.54	1.16	71.7	16.4	1.08	0.31	0.21	4.20	2.53	0.54	0.14	13.8	16.8	17.3	32.7	41.6	31.8	18.2	17.3	22.9	26.9
Head (calc.)	567	100	0.67	1.44	73.3	16.3	0.57	0.13	0.11	3.95	2.51	0.40	0.09	100	100	100	100	100	100	100	100	100	100
DMS Spod Concentrate before Mag	81.5	14.4	2.30	4.95	66.1	23.0	1.04	0.15	0.14	1.03	1.21	0.70	0.24	49.3	13.0	20.3	26.3	16.9	17.4	3.8	6.9	24.8	38.7
DMS Spod+Petalite Conc.	87.0	15.3	2.33	5.02	69.1	21.9	0.47	0.03	0.06	1.14	0.74	0.31	0.08	53.3	14.5	20.7	12.8	4.2	8.7	4.4	4.5	11.8	12.8

Table 13-61: DMS Stage results (Master Composite) Combined – 1st Trial

Product	Weight		Assays (%)											Distribution (%)									
	kg	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO
DMS Concentrate Non-mag	72.5	15.4	2.49	5.36	67.9	22.9	0.53	0.03	0.07	1.03	0.65	0.35	0.09	55.0	14.2	21.8	17.5	4.7	10.9	4.1	4.0	14.3	16.7
DMS Combined Mag Conc.	9.1	1.9	0.80	1.73	51.4	23.8	5.17	1.12	0.71	1.04	5.70	3.49	1.49	2.2	1.3	2.8	21.5	24.2	14.6	0.5	4.4	17.9	36.2
DMS Middling	90.8	19.3	0.39	0.83	77.2	13.7	0.64	0.15	0.12	3.63	1.89	0.41	0.09	10.7	20.3	16.3	26.8	32.7	25.7	18.0	14.6	20.8	22.2
DMS Tailings	283	60.2	0.29	0.63	74.6	15.1	0.25	0.05	0.07	4.94	3.14	0.29	0.03	25.2	61.0	55.8	32.7	35.9	47.0	76.1	75.5	46.0	24.0
Petalite Concentrate	14.6	3.1	1.54	3.31	74.9	16.9	0.22	0.07	0.06	1.65	1.20	0.12	0.02	6.8	3.2	3.2	1.4	2.5	1.9	1.3	1.5	1.0	0.8
Head (calc.)	470	100	0.70	1.50	73.6	16.2	0.46	0.09	0.09	3.90	2.50	0.38	0.08	100	100	100	100	100	100	100	100	100	100
DMS Spod Concentrate before Mag	81.5	17.4	2.30	4.95	66.1	23.0	1.04	0.15	0.14	1.03	1.21	0.70	0.24	57.2	15.6	24.6	39.0	29.0	25.5	4.6	8.4	32.2	53.0
DMS Spod+Petalite Conc.	87.0	18.5	2.33	5.02	69.1	21.9	0.47	0.03	0.06	1.14	0.74	0.31	0.08	61.9	17.4	25.0	19.0	7.2	12.8	5.4	5.5	15.3	17.5

Table 13-62: DMS Global results (Master Composite) – 2nd Trial

Size	Product	Weight		Assays (%)											Distribution (%)									
		kg	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO
-9.5 +4 mm	DMS Conc Non-mag	44.7	7.89	2.69	5.79	68.0	23.8	0.38	0.03	0.09	0.83	0.42	0.32	0.10	31.6	7.3	11.6	5.5	1.8	6.3	1.65	1.32	7.00	7.45
	DMS Conc Mag	2.9	0.51	0.95	2.04	53.0	23.5	5.32	1.18	0.54	0.94	5.03	0.36	2.67	0.7	0.4	0.7	5.0	4.7	2.4	0.12	1.03	0.51	12.92
	DMS Middling	77.3	13.62	0.46	0.99	75.4	14.6	0.76	0.21	0.14	3.78	1.96	0.48	0.11	9.34	14.0	12.2	18.95	22.12	16.81	13.0	10.7	18.14	14.16
	DMS Tailings	200.4	35.32	0.32	0.69	74.3	15.3	0.25	0.05	0.07	4.90	3.19	0.29	0.03	16.85	35.8	33.3	16.17	13.66	21.80	43.7	45.0	28.43	10.01
	Petalite Concentrate	5.7	1.00	1.84	3.96	75.6	17.0	0.19	0.06	0.04	0.82	0.35	0.06	0.02	2.7	1.0	1.0	0.3	0.5	0.4	0.2	0.1	0.2	0.2
-4+1.7 mm	DMS Conc Non-mag	13.2	2.32	2.80	6.03	66.3	24.0	0.33	0.02	0.03	0.67	0.56	0.42	0.08	9.69	2.10	3.43	1.40	0.36	0.61	0.39	0.52	2.71	1.76
	DMS Conc Mag	1.9	0.33	0.91	1.96	48.4	27.2	4.21	0.61	0.64	0.90	6.38	0.17	3.51	0.45	0.22	0.55	2.53	1.55	1.85	0.07	0.84	0.16	10.91
	DMS Middling Non-mag	10.2	1.80	0.29	0.62	81.8	11.1	0.24	0.02	0.06	3.33	1.44	0.28	0.03	0.8	2.01	1.23	0.79	0.28	0.95	1.51	1.04	1.40	0.51
	DMS Middling Mag	3.0	0.53	0.38	0.82	60.9	21.4	3.26	1.03	0.41	2.04	5.00	0.29	0.77	0.30	0.44	0.70	3.19	4.26	1.93	0.27	1.07	0.43	3.89
	DMS Tailings	46.8	8.25	0.26	0.56	74.7	14.9	0.26	0.06	0.08	4.99	3.21	0.30	0.04	3.20	8.40	7.56	3.93	3.83	5.82	10.38	10.57	6.87	3.12
	Petalite Concentrate	2.7	0.47	1.83	3.94	75.2	17.2	0.24	0.07	0.06	1.06	0.80	0.08	0.02	1.29	0.5	0.5	0.21	0.26	0.25	0.1	0.2	0.10	0.09
-1.7+0.5 mm	DMS Conc Non-mag	5.5	0.96	2.91	6.26	66.1	24.6	0.28	0.01	0.02	0.46	0.37	0.54	0.07	4.18	0.87	1.46	0.49	0.07	0.17	0.11	0.14	1.44	0.64
	DMS Con Mag	1.3	0.22	1.68	3.62	48.4	27.2	4.21	0.61	0.64	0.90	6.38	0.17	3.51	0.56	0.15	0.37	1.72	1.06	1.26	0.05	0.57	0.11	7.42
	DMS Middling Non-mag	10.9	1.93	0.31	0.67	83.9	9.7	0.25	0.02	0.06	2.73	1.30	0.27	0.01	0.9	2.20	1.15	0.88	0.30	1.02	1.33	1.00	1.44	0.18
	DMS Middling Mag	1.4	0.25	0.50	1.08	54.6	26.7	2.51	0.59	0.40	1.51	6.50	0.18	0.78	0.19	0.19	0.41	1.15	1.15	0.89	0.10	0.65	0.13	1.85
	DMS Tailings	39.4	6.94	0.22	0.47	76.1	14.0	0.27	0.06	0.09	4.96	2.79	0.27	0.03	2.28	7.20	5.98	3.43	3.22	5.51	8.68	7.73	5.20	1.97
	Petalite Concentrate	2.6	0.46	1.57	3.38	74.8	17.0	0.30	0.08	0.06	1.45	1.10	0.14	0.03	1.08	0.5	0.5	0.25	0.28	0.24	0.2	0.2	0.18	0.13
	Hypofines (-0.5 mm)	97.5	17.2	0.54	1.16	71.7	16.4	1.08	0.31	0.21	4.20	2.53	0.54	0.14	13.8	16.8	17.3	34.1	40.6	31.8	18.2	17.4	25.6	22.8
	Head (calc.)	567	100	0.67	1.44	73.4	16.2	0.55	0.13	0.11	3.96	2.50	0.36	0.11	100	100	100	100	100	100	100	100	100	100
	Combined Feed (Dir.)			0.64	1.38	73.8	16.3	0.50	0.10	0.11	4.01	2.59	0.40	0.09										

Table 13-63: DMS Global results (Master Composite) Combined – 2nd Trial

Product	Weight		Assays (%)											Distribution (%)									
	kg	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO
DMS Concentrate Non-mag	63.4	11.17	2.73	5.88	67.5	23.9	0.36	0.03	0.07	0.76	0.44	0.36	0.09	45.50	10.27	16.44	7.38	2.26	7.04	2.15	1.98	11.15	9.85
DMS Combined Mag Conc.	6.0	1.06	1.09	2.35	50.6	25.4	4.74	0.88	0.59	0.92	5.73	0.26	3.11	1.73	0.73	1.67	9.24	7.28	5.55	0.25	2.44	0.77	31.25
DMS Middling	102.9	18.14	0.43	0.92	76.2	14.1	0.75	0.20	0.14	3.54	1.99	0.43	0.12	11.5	18.84	15.73	24.96	28.10	21.60	16.20	14.42	21.54	20.59
DMS Tailings	286.6	50.51	0.30	0.64	74.6	15.1	0.25	0.05	0.07	4.92	3.14	0.29	0.03	22.33	51.37	46.80	23.52	20.71	33.12	62.72	63.31	40.49	15.10
Petalite Concentrate	11.0	1.93	1.77	3.82	75.3	17.0	0.23	0.07	0.05	1.03	0.64	0.08	0.02	5.11	1.98	2.03	0.81	1.00	0.85	0.50	0.49	0.45	0.41
Hypofines (-0.5 mm)	97.5	17.19	0.54	1.16	71.7	16.4	1.08	0.31	0.21	4.20	2.53	0.54	0.14	13.83	16.80	17.33	34.08	40.64	31.84	18.18	17.36	25.59	22.81
Head (calc.)	567.3	100.00	0.67	1.44	73.4	16.2	0.55	0.13	0.11	3.96	2.50	0.36	0.11	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
DMS Concentrate before Mag Sep	69.4	12.24	2.59	5.57	66.0	24.0	0.74	0.10	0.12	0.78	0.90	0.35	0.36	47.23	11.01	18.10	16.63	9.54	12.60	2.40	4.42	11.92	41.09
DMS Spod+Petalite Conc.	74.3	13.1	2.59	5.57	68.6	22.9	0.34	0.03	0.07	0.80	0.47	0.32	0.08	50.6	12.3	18.5	8.2	3.3	7.9	2.7	2.5	11.6	10.3

Table 13-64: DMS Stage results (Master Composite) Combined – 2nd Trial

Product	Weight		Assays (%)											Distribution (%)									
	kg	%	Li	Li_2O	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO	Li	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	P_2O_5	MnO
DMS Concentrate Non-mag	63.4	13.5	2.73	5.88	67.5	23.9	0.36	0.03	0.07	0.76	0.44	0.36	0.09	52.8	12.3	19.9	11.2	3.8	10.3	2.6	2.4	15.0	12.8
DMS Combined Mag Conc.	6.0	1.3	1.09	2.35	50.6	25.4	4.74	0.88	0.59	0.92	5.73	0.26	3.11	2.0	0.9	2.0	14.0	12.3	8.1	0.3	2.9	1.0	40.5
DMS Middling	102.9	21.9	0.43	0.92	76.2	14.1	0.75	0.20	0.14	3.54	1.99	0.43	0.12	13.3	22.6	19.0	37.9	47.3	31.7	19.8	17.4	29.0	26.7
DMS Tailings	287	61.0	0.30	0.64	74.6	15.1	0.25	0.05	0.07	4.92	3.14	0.29	0.03	25.9	61.7	56.6	35.7	34.9	48.6	76.7	76.6	54.4	19.6
Petalite Concentrate	11.0	2.3	1.77	3.82	75.3	17.0	0.23	0.07	0.05	1.03	0.64	0.08	0.02	5.9	2.4	2.5	1.2	1.7	1.2	0.6	0.6	0.6	0.5
Head (calc.)	470	100	0.70	1.50	73.7	16.2	0.43	0.09	0.09	3.92	2.50	0.32	0.10	100	100	100	100	100	100	100	100	100	100
DMS Concentrate before Mag Sep	69.4	14.8	2.59	5.57	66.0	24.0	0.74	0.10	0.12	0.78	0.90	0.35	0.36	54.8	13.2	21.9	25.2	16.1	18.5	2.9	5.3	16.0	53.2
DMS Spod+Petalite Conc.	74.3	15.8	2.59	5.57	68.6	22.9	0.34	0.03	0.07	0.80	0.47	0.32	0.08	58.7	14.7	22.3	12.4	5.5	11.6	3.2	3.0	15.6	13.3

13.4.6 NDC recovery and basis of assumptions

Pilot-scale DMS test work was operated on the composite sample. Dry magnetic separation was undertaken on the DMS feed. DMS test work results showed combined spodumene concentrate grade with petalite included to produce a 5.50% Li_2O and stage recovery of 58.7% for a global recovery of 50.6%. Mass balance was produced based on global recoveries achieved during Trial #2 pilot-scale DMS operation on the composite sample:

- Coarse fraction stage lithium recovery of 31.6%
- Fines fraction stage lithium recovery of 9.69%
- Ultrafines fraction stage lithium recovery of 4.18%

Mass reporting to the hypofines fraction was 17.2% with associated lithium loss of 13.8%.

14 MINERAL RESOURCE ESTIMATES

The Mineral Resource Estimates (MRE) are reported using the 2014 CIM Definition Standards and the 2019 CIM Guidelines. 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.

This MRE comprises an update of the Murial, Lavra do Meio (LDM) and Nezinho do Chicao (NDC) resources, together with the maiden resource estimate for the Maxixe, Tamboril and Elvira pegmatites.

The Murial and LDM MREs were last updated in 2019, while the NDC resource was updated in 2023.

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 NEZINHO DO CHICAO DEPOSIT

14.1.1 Exploratory Data Analysis

The final database used for the Nezinho do Chicao (NDC) pegmatite Mineral Resource estimation was transmitted to SGS by SMSA on the 11th January 2024 in Microsoft Excel 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 comprised 131 drill holes, with assay data available for all holes. The database entries comprise:

- Drill hole collars (n=131)
- Down hole surveys (n = 7,625)
- Assays (n = 5,527)
- Lithologies (n = 2,811).

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 at an azimuth of 25° following the drilling pattern and perpendicular to the general trend of the pegmatite unit. In general, the sections are spaced at 100 m intervals, with drill holes spaced at approximately 50 m intervals on each section. Figure 14-1 shows the drill collar layout plan.

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

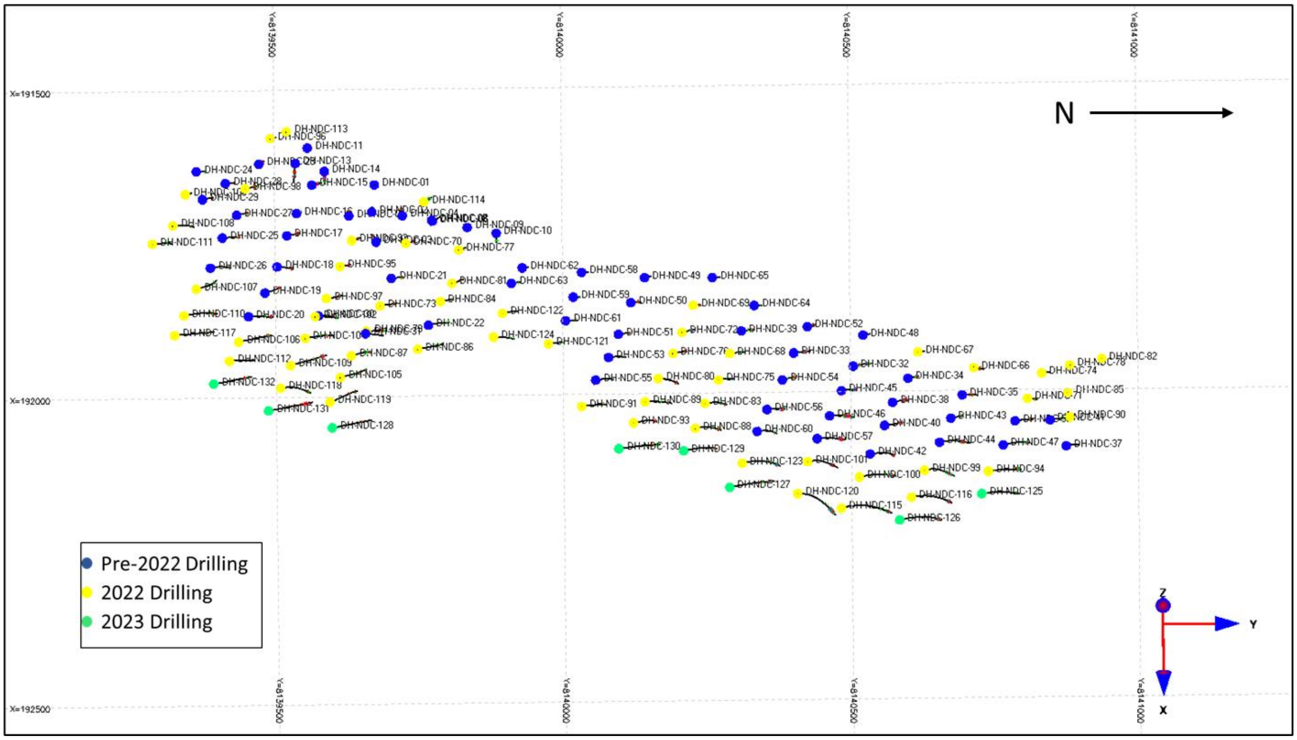


Figure 14-1: NDC Drill Hole Collar Locations

14.1.2 Analytical Data

There is a total of 5,527 assay intervals in the database that were used for Mineral Resource estimation; 3,207 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: NDC Assay Statistics Inside Mineralized Solids

	Li_2O (%)
Count	3,207
Mean	1.46
Std. Dev.	0.84
Min	0.02
Median	1.42
Max	5.79

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 5 m by 5 m by 5 m block size defined for the resource block model. Compositing began at the top of the mineralized wireframe and continued to the end of the mineralized wireframe. No capping was applied on the analytical composite data.

Composite lengths ranged from 0.50 m to 1.135 m, with an average length of 0.999 m. The grade ranged from 0.0% Li_2O to 4.72% Li_2O, with an average grade of 1.47% Li_2O.

Table 14-2 shows the grade statistics of the analytical composites used for the interpolation of the resource block model.

Table 14-2: NDC 1 m Composite Statistics

	Li_2O (%)
Count	**2,607**
Mean	**1.47**
Std. Dev.	**0.70**
Min	**0.00**
Median	**1.45**
Max	**4.72**

14.1.4 Density

Density determinations are outlined in Section 11.3. An average density value of 2.67 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 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 two main pegmatite bodies, with a strike orientation of 018º azimuth and a dip averaging -50º to the northeast. The pegmatite body was modelled as two envelopes separated by an 80 m wide zone with no significant lithium mineralization indicated in drilling. Small satellite zones of mineralization were modelled in the hangingwall of both the north and south main pegmatite zones, together with a small footwall pegmatite modelled on the northern main pegmatite.

The mineralized solids were clipped directly on the DEM surface. Figure 14-2 shows the final 3D wireframe solids in isometric view with the drill holes pierce points.

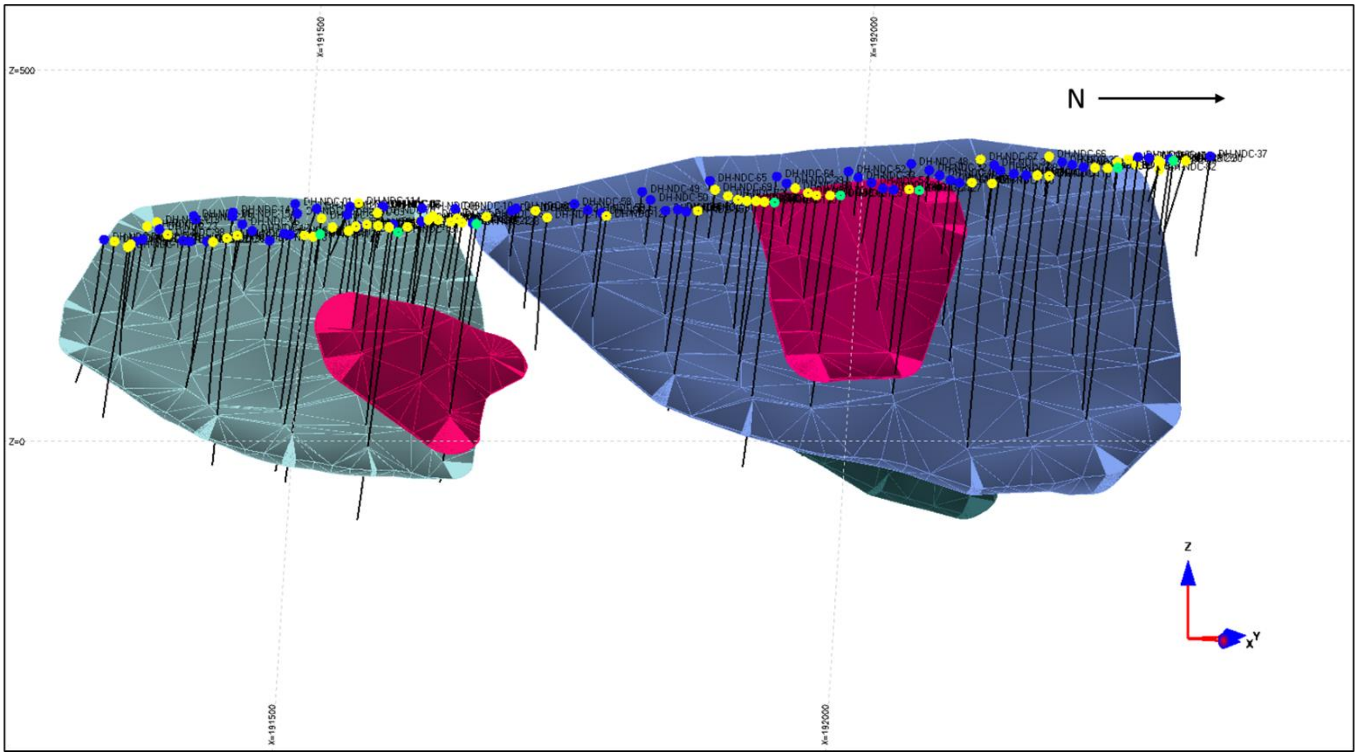


Figure 14-2: NDC Pegmatite Solid (looking west-northwest)

14.1.6 Resource Block Modeling

A block size of 5 m by 5 m by 5 m (vertical) was selected for the NDC 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 5% 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 NDC. The resource block model contains 150,441 blocks located inside (> 1%) the mineralized solids, for a total volume of 12,630,752 m^3. Table 14-3 summarizes the block model limit parameters.

Table 14-3: NDC Resource Block Model Parameters

Direction	Block Size (m)	Number of Blocks	Coordinates Min (m)	Coordinates Max (m)
East–west (x)	5	**308**	191,152	192,687
North–south (y)	**5**	**458**	8,138,971	8,141,256
Elevation (z)	5	**163**	**-228**	**582**

14.1.7 Variography

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 data was plotted as a correlogram, which normalises the data to a sill value of 1.0.

The resulting correlogram is shown as Figure 14-3.

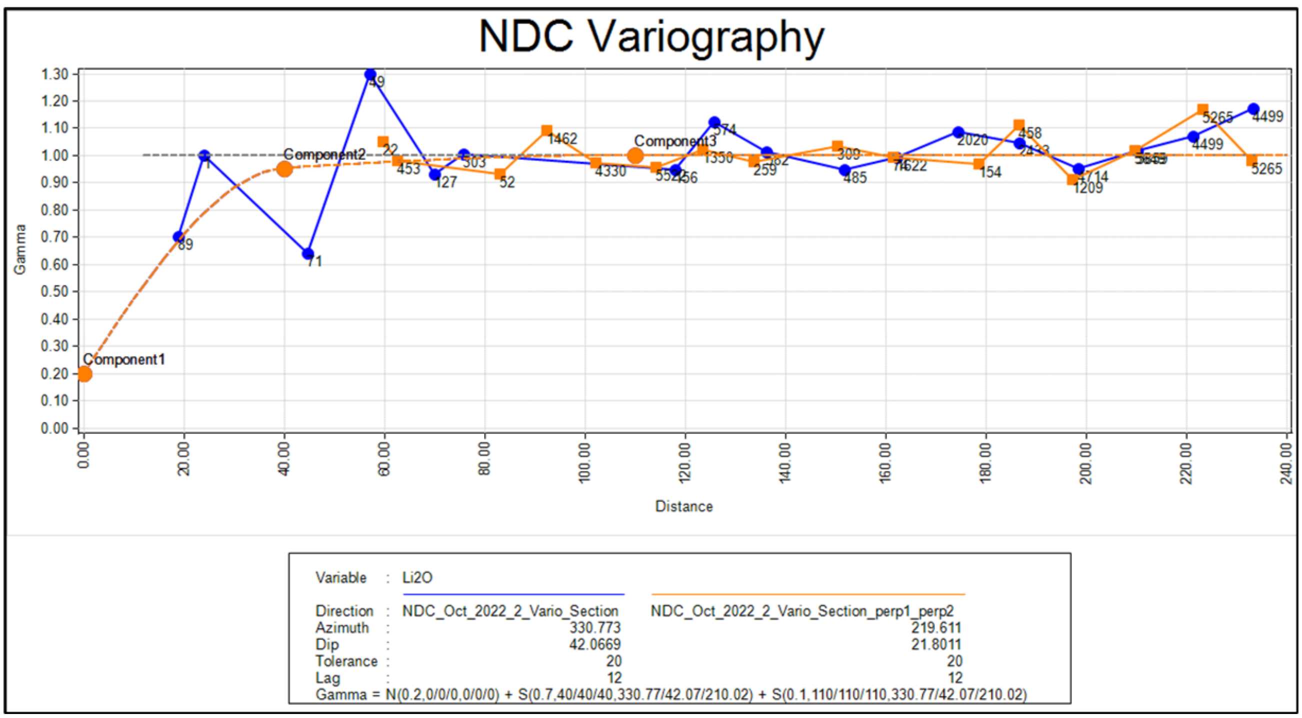


Figure 14-3: NDC Combined Correlogram

14.1.8 Block Model Interpolation

The grade interpolation for the NDC 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.

Separate search ellipses were developed for the north, south and north footwall pegmatites, based on their respective orientations. However, each set of ellipses had the same set of ranges.

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 110º azimuth and -50º dip for the north pegmatite and 115° azimuth and -40° dip for the south pegmatite and the north footwall pegmatite. 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. 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). The purpose of the last interpolation pass was to interpolate the remaining un-estimated blocks mostly located at the edges of the block mode.

Figure 14-5 illustrates the three search ellipsoids used for the different interpolation passes for the NDC north pegmatite.

Figure 14-6 shows the results of the block model interpolation in longitudinal view.

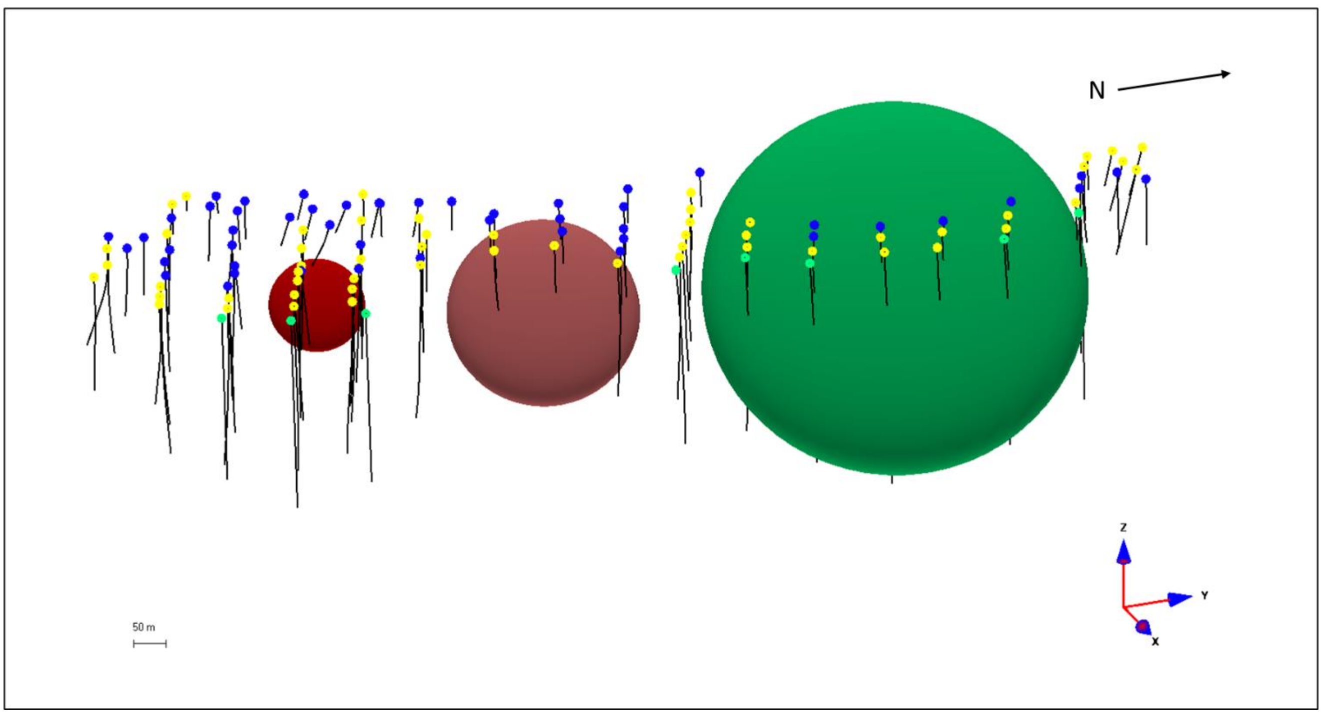


Figure 14-4: Isometric View of NDC North Search Ellipsoids

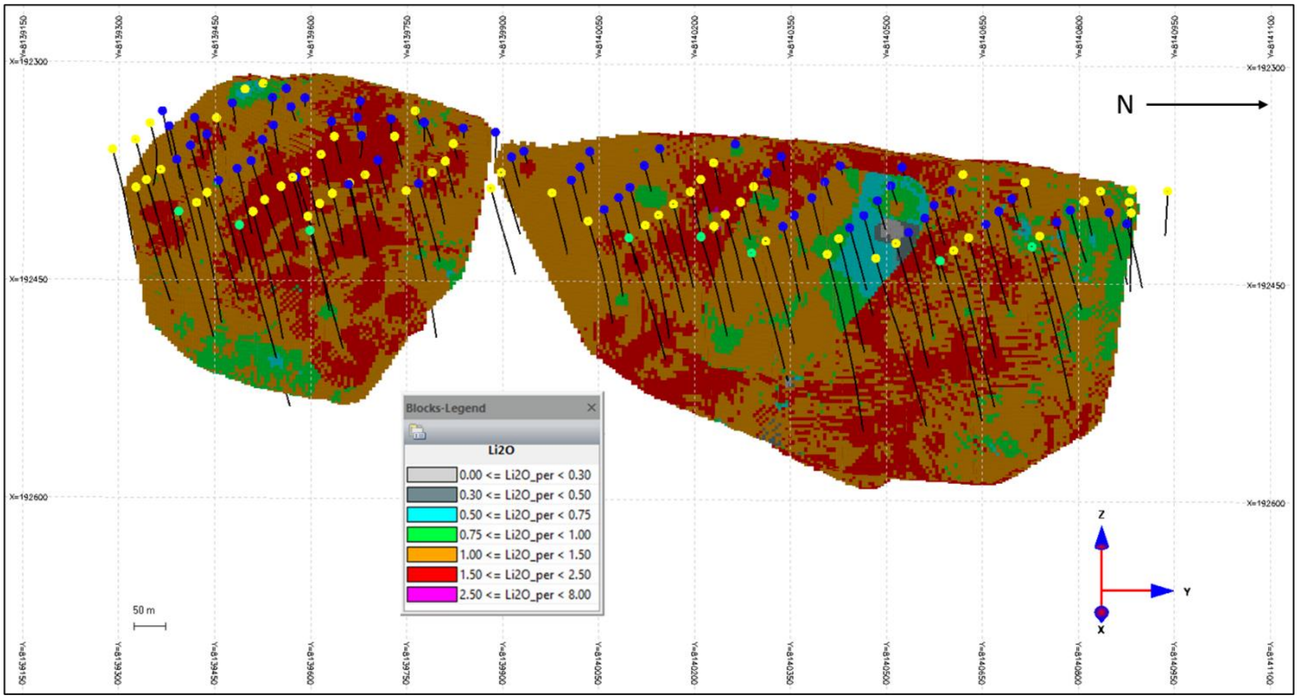
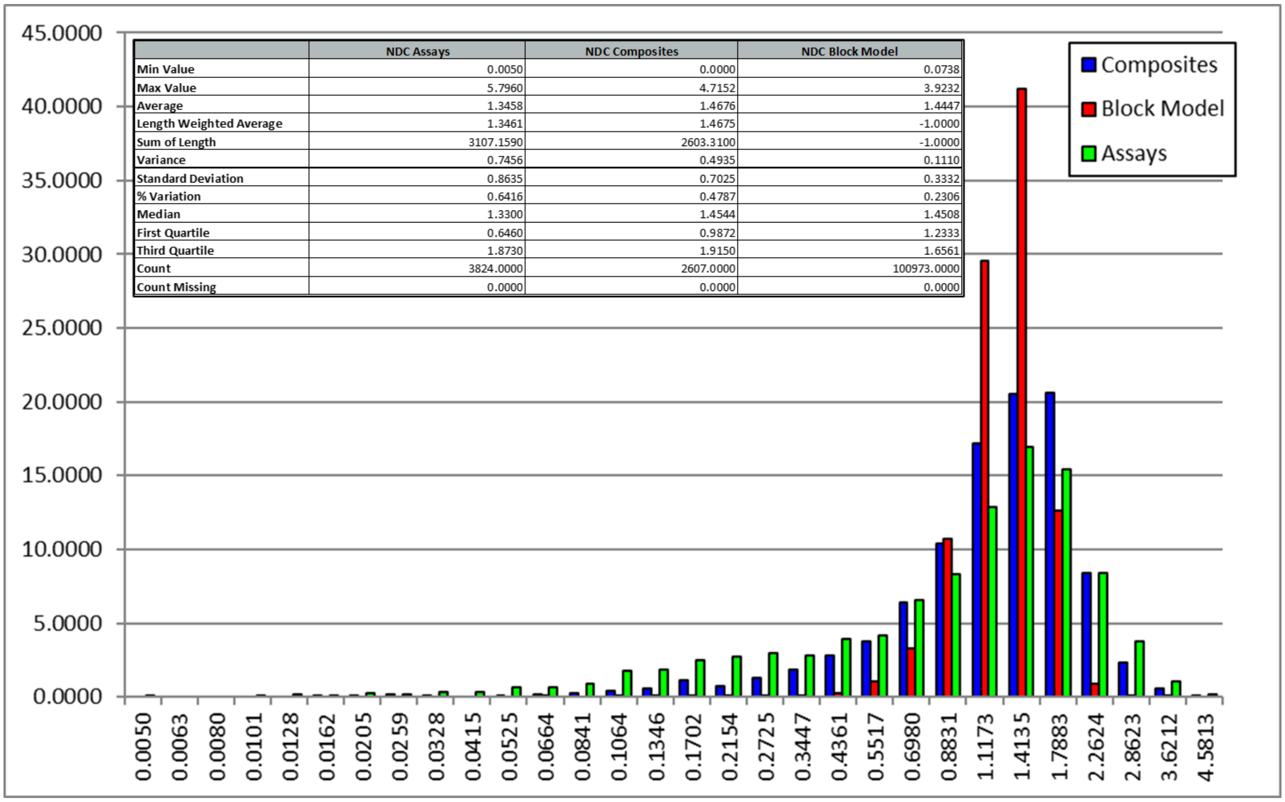


Figure 14-5: Isometric View of the NDC Interpolated Block Model

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 14-6). The assays and composites have average values of 1.35% and 1.47% Li_2O with variances of 0.75% and 0.49% Li_2O respectively. The interpolated blocks have an average value of 1.44% Li_2O with a variance of 0.11% Li_2O.



	NDC Assays	NDC Composites	NDC Block Model
Min Value	0.0050	0.0000	0.0738
Max Value	5.7960	4.7152	3.9232
Average	1.3458	1.4676	1.4447
Length Weighted Average	1.3461	1.4675	-1.0000
Sum of Length	3107.1590	2603.3100	-1.0000
Variance	0.7456	0.4935	0.1110
Standard Deviation	0.8635	0.7025	0.3332
% Variation	0.6416	0.4787	0.2306
Median	1.3300	1.4544	1.4508
First Quartile	0.6460	0.9872	1.2333
Third Quartile	1.8730	1.9150	1.6561
Count	3824.0000	2607.0000	100973.0000
Count Missing	0.0000	0.0000	0.0000

Figure 14-6: Statistical Comparison of NDC Assay, Composite and Block Data

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 0.24 (R^2) was established between the blocks and the composites (Figure 14-7). This confirms what can be seen in Figure 14-7, namely that the block model is smoothed in relation to the composites. It is the opinion of the QP that this level of smoothing is acceptable for this type of deposit.

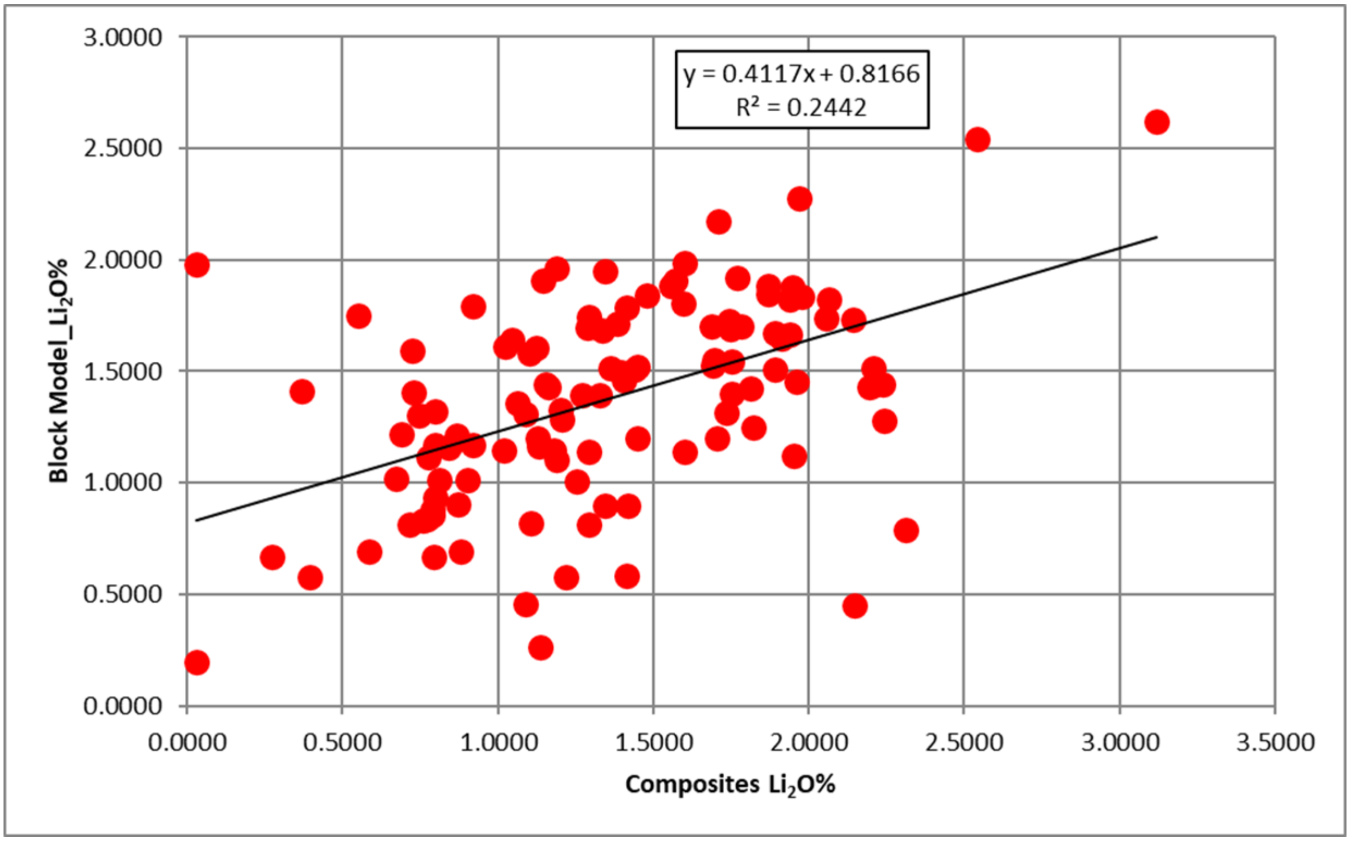


Figure 14-7: Comparison NDC Block Values Versus Composites Inside Blocks

14.1.10 Mineral Resource 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 14-8 is a plan view showing the final classifications.

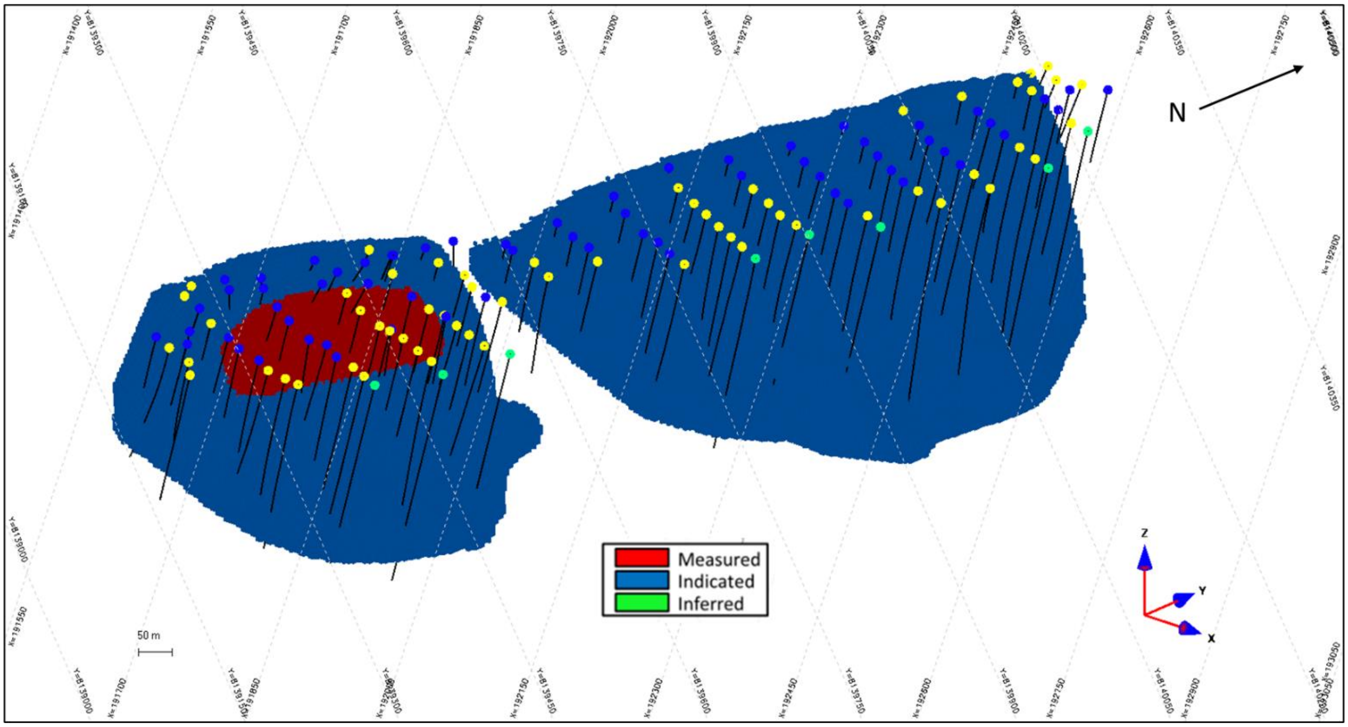


Figure 14-8: NDC Block Model Classification

14.1.11 Reasonable Prospects of Eventual Economic Extraction

The general requirement that all mineral resources have “reasonable prospects for eventual economic extraction” implies that the quantity and grade estimates meet certain economic thresholds and that the mineral resources are reported at an appropriate cut-off grade considering extraction scenarios and processing recoveries. To meet this requirement, the lithium mineralization of the NDC deposit is considered amenable to open pit extraction.

To determine the quantity of material representing “reasonable prospects for eventual economic extraction” by an open pit mining method, Whittle pit optimization software was used with reasonable mining and economic assumptions. The pit optimization for the NDC deposit was completed by SGS for the current MRE. The pit optimization parameters used are summarized in Table 14-4. A conservative and balanced approach was applied when optimizing the open pit scenario. A Whittle pit shell at a revenue factor of 1.0 ($1,300/t concentrate price) was selected as the ultimate pit shell for the purposes of the MRE for the NDC deposit.

During the modelling process, the proximity of the Maxixe, Tamboril and Lavra do Meio pegmatites to the NDC pegmatites was noted. Various open pit options for the four mineralized areas were investigated, but ultimately, it was determined that the best option for reasonable prospects for eventual economic extraction was a single pit encompassing all four zones. Figure 14-9 shows the pit with all the mineralized surfaces.

The reader is cautioned that the results from the pit optimization are used solely for the purpose of testing the “reasonable prospects for economic extraction” by an open pit and do not represent an attempt to estimate mineral reserves. The results are used as a guide to assist in the preparation of a mineral resource statement and to select an appropriate resource reporting cut-off grade.

Table 14-4: NDC Pit Optimization Parameters

Parameter	Unit	Value
Concentrate Price (6% Li_2O)	US$ per tonne	$1,300
Pit Slope	Degrees	60
Mining Cost	US$ per tonne mined	$2.20
Processing Cost & G&A	US$ per tonne milled	$16.46
Mining Recovery	Percent (%)	95
Concentration Recovery (DMS)	Percent (%)	60
Royalties	Percent (%)	2
Mining loss / Dilution	Percent (%) / Percent (%)	5 / 5
Cut-off Grade	Percent (%) Li_2O	0.3

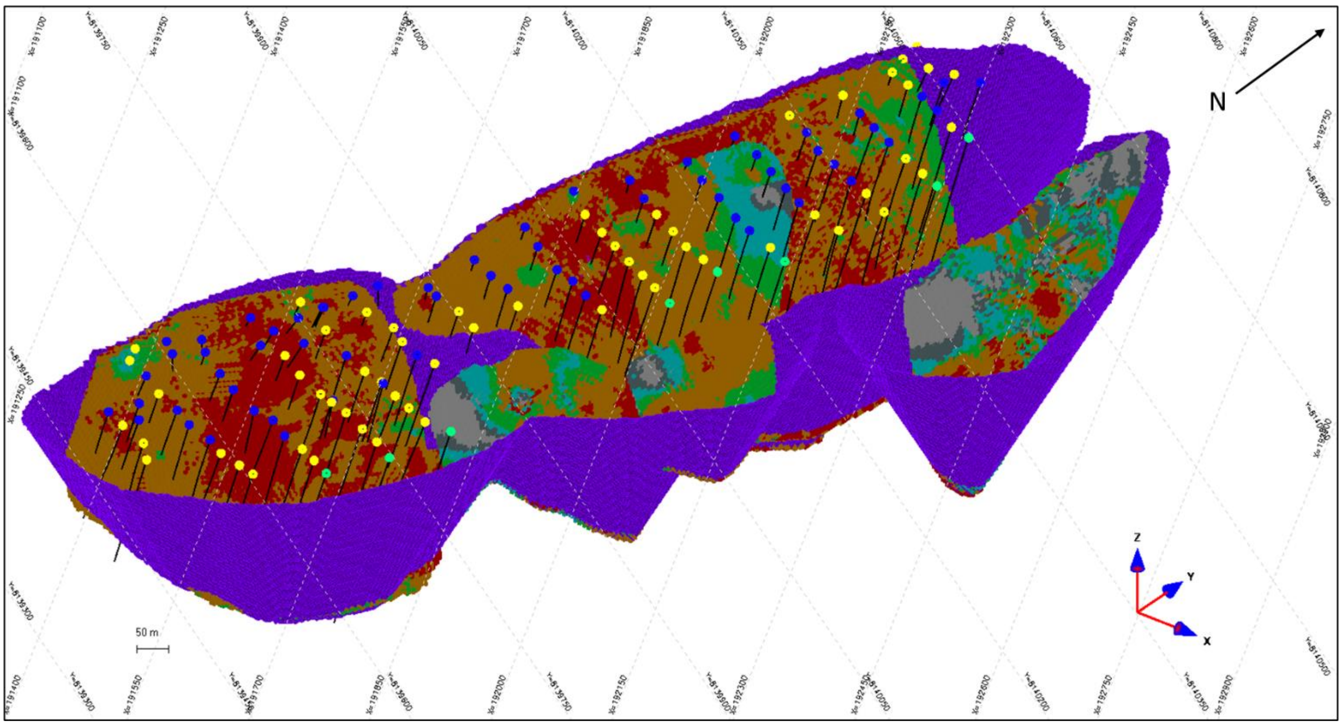


Figure 14-9: NDC Deposit Mineral Resource Block Model and Revenue Factor 1 Pit

14.1.12 Mineral Resource Statement

The Mineral Resource estimate is reported in Table 14-5 using a 0.3% Li_2O cut-off. The Mineral Resources are constrained by the topography and based on the conceptual economic parameters detailed in Table 14-5. The estimate has an effective date of the 18th January, 2024. The QP for the estimate is Mr. Marc-Antoine Laporte, P.Geo., an SGS employee.

Table 14-5: NDC Deposit Mineral Resource Estimate

Cut-off Grade Li_2O (%)	Category	Tonnes (Mt)	Average Grade Li_2O (%)	Contained LCE (Kt)
0.3	Measured	2.4	1.58	94
0.3	Indicated	31.2	1.43	1,103
0.3	**Measured + Indicated**	**33.6**	**1.45**	**1,205**

Notes to accompany Mineral Resource table:

8. Mineral Resources have an effective date of the 18th January, 2024 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.
9. All Resources are presented undiluted and in situ, constrained by continuous 3D wireframe models, and are considered to have reasonable prospects for eventual economic extraction.
10. Mineral Resources are reported assuming open pit mining methods, and the following assumptions: lithium concentrate (6% Li_2O) price of US$1,300/t, mining costs of US$2.2/t for mineralization and waste, crushing and processing costs of US$10.7/t, general and administrative (G&A) costs of US$4/t, concentrate recovery of 60%, 2% royalty payment, pit slope angles of 55º, and an overall cut-off grade of 0.3% Li_2O.
11. Tonnages and grades have been rounded in accordance with reporting guidelines. Totals may not sum due to rounding.
12. Mineral resources which are not mineral reserves do not have demonstrated economic viability. An Inferred Mineral Resource has a lower level of confidence than that applying to a Measured and Indicated Mineral Resource and must not be converted to a Mineral Reserve. It is reasonably expected that the majority of Inferred Mineral Resources could be upgraded to Indicated Mineral Resources with continued exploration.
13. The results from the pit optimization are used solely for the purpose of testing the “reasonable prospects for economic extraction” by an open pit and do not represent an attempt to estimate mineral reserves. The results are used as a guide to assist in the preparation of a Mineral Resource statement and to select an appropriate resource reporting cut-off grade.
14. The estimate of Mineral Resources may be materially affected by environmental, permitting, legal, title, taxation, socio-political, marketing, or other relevant issues.

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.

14.2 MURIAL DEPOSIT

14.2.1 Exploratory Data Analysis

The final database used for the Murial pegmatite Mineral Resource estimation was transmitted to SGS by SMSA on the 7th December 2024, in Microsoft Excel format. The database validation steps are discussed in Section 12. The database comprised 179 drill holes with entries for:

- Down hole surveys (n = 11,825)
- Assays (n = 9,810)
- Lithologies (n = 4,362).

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 14-10 is a drill collar location plan.

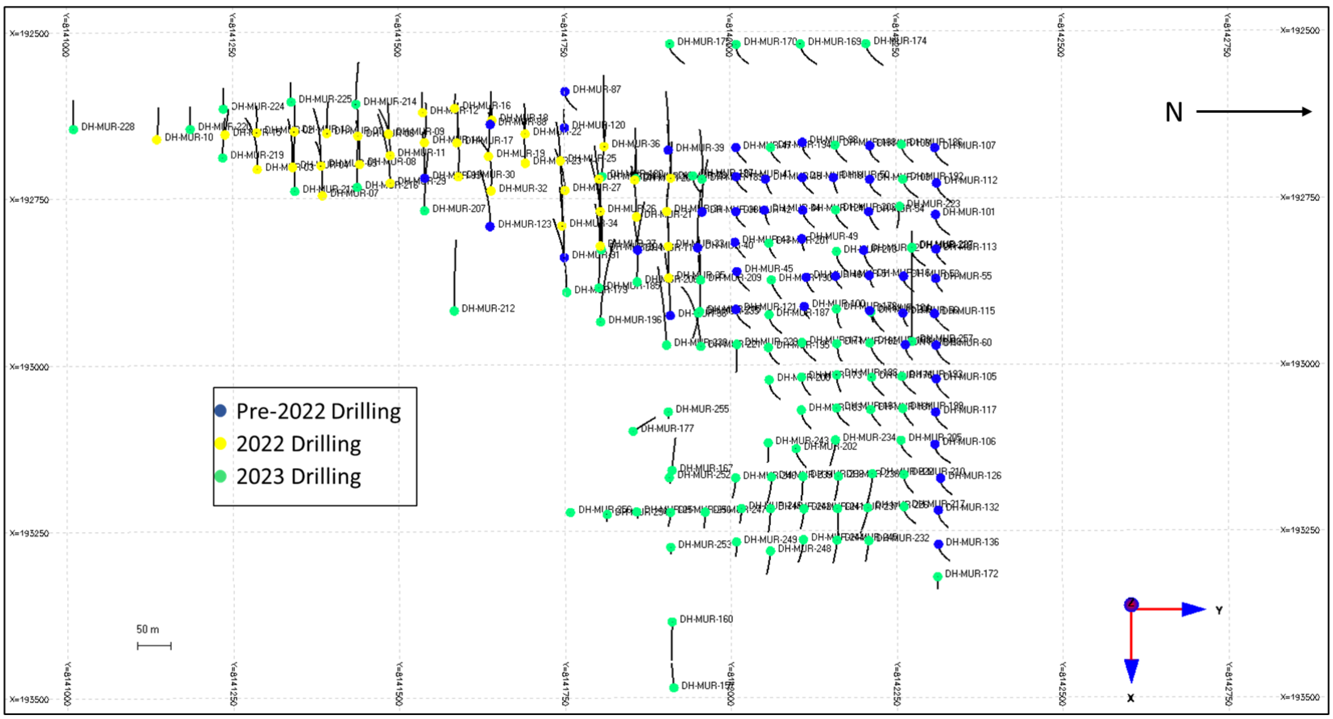


Figure 14-10: Murial Drill Hole Collar Location

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 9,810 assay intervals in the database used for mineral resource estimation; 2,550 assays are contained inside the mineralized solids. Most of the drill hole intervals defining the mineralized solids have been sampled continuously. Table 14-6 shows the range of Li_2O values from the analytical data.

Table 14-6 – Murial Assay Statistics Inside Mineralized Solids

	Li_2O (%)
Count	2,550
Mean	1.26
Std. Dev.	0.76
Min	0.007
Median	1.29
Max	4.99

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 began at the top of the mineralized wireframe and continued to the end of the mineralized wireframe. 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.

Table 14-7: Murial 1 m Composite Statistics

	Li_2O (%)
Count	2.093
Mean	1.31
Std. Dev.	0.66
Min	0.0
Median	1.36
Max	4.48

14.2.4 Density

Density determinations are outlined in Section 11.3. An average density value of 2.68 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 north and looking west 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. 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 11 pegmatite bodies in two distinct orientations: a sub-vertical orientation expressed in two pegmatites at the southern end of the mineralized horizon, with a strike of approximately 010° an a dip of 55° to the east and a series of nine sub-horizontal pegmatites at the northern end of the mineralized horizon, with a strike of approximately 010° and dips varying from 20° west to 15° east.

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 14-11 shows the final 3D wireframe solids in isometric view with the drill hole pierce points.

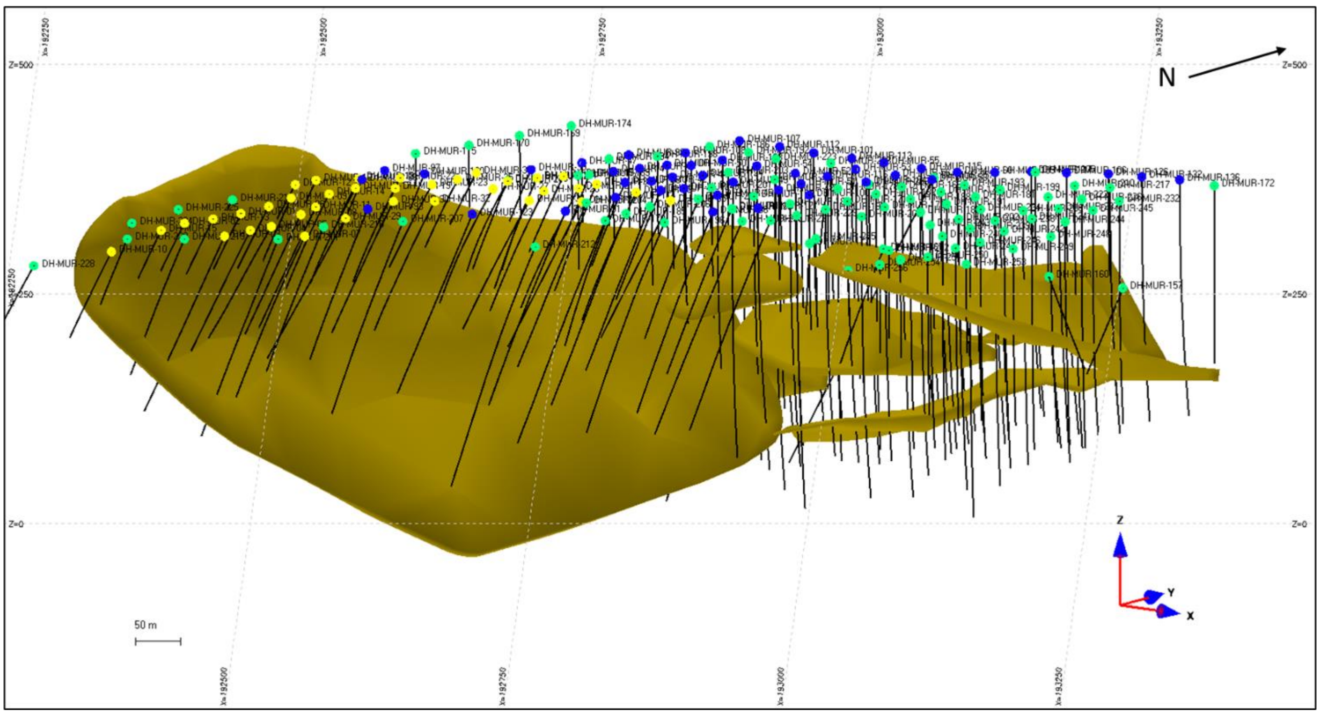


Figure 14-11: Murial Pegmatite Solid (looking west)

14.2.6 Resource Block Modeling

A block size of 5 m by 5 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 5 m northwest–southeast block dimension accounts for the average minimum width of the mineralization modelled at Murial. The resource block model contains 114,866 blocks located inside the mineralized solids, for a total volume of 8,058,979 m^3. Table 14-8 summarizes the block model limit parameters.

Table 14-8: Murial Resource Block Model Parameters

Direction	Block Size (m)	Number of Blocks	Coordinates Min (m)	Coordinates Max (m)
East–west (x)	5	236	192,310	193,485
North–south (y)	5	581	8,140,747	8,143,647
Elevation (z)	5	143	-150	143

14.2.7 Variography

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 data was plotted as a correlogram, which normalises the data to a sill value of 1.0.

An example of the Murial South correlogram is shown in Figure 14-3.

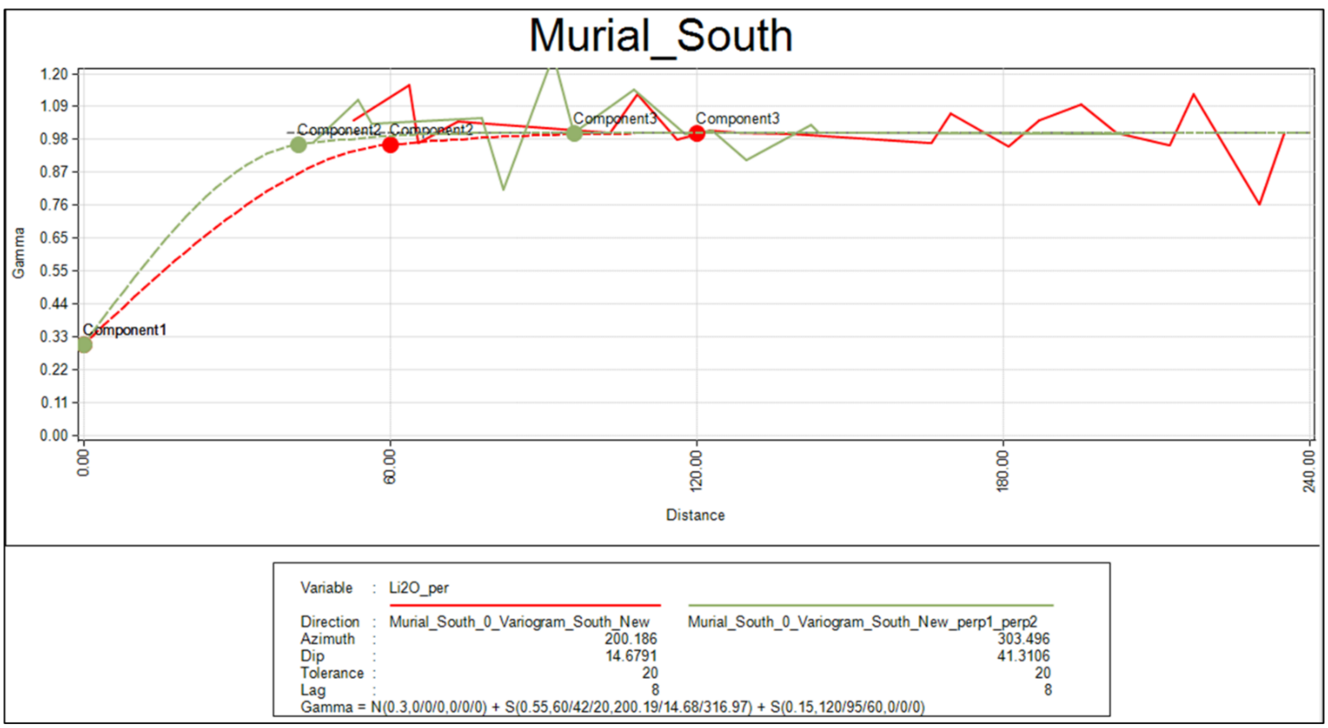


Figure 14-12: Murial South Combined Correlogram

14.2.8 Block Model Interpolation

The grade interpolation for the Murial 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.

Separate search ellipses were developed for the sub-vertical and sub-horizontal pegmatites, based on their respective orientations. However, each set of ellipses had the same set of ranges.

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 azimuth and dip aligned to the respective pegmatites. 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. Finally, the search distance of the third pass was increased to 300 m (long axis) by 300 m (intermediate axis) by 50 m (short axis). The purpose of the last interpolation pass was to interpolate the remaining un-estimated blocks mostly located at the edges of the block mode.

Figure 14-13 illustrates the three search ellipsoids used for the different interpolation passes for the Murial south pegmatite.

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

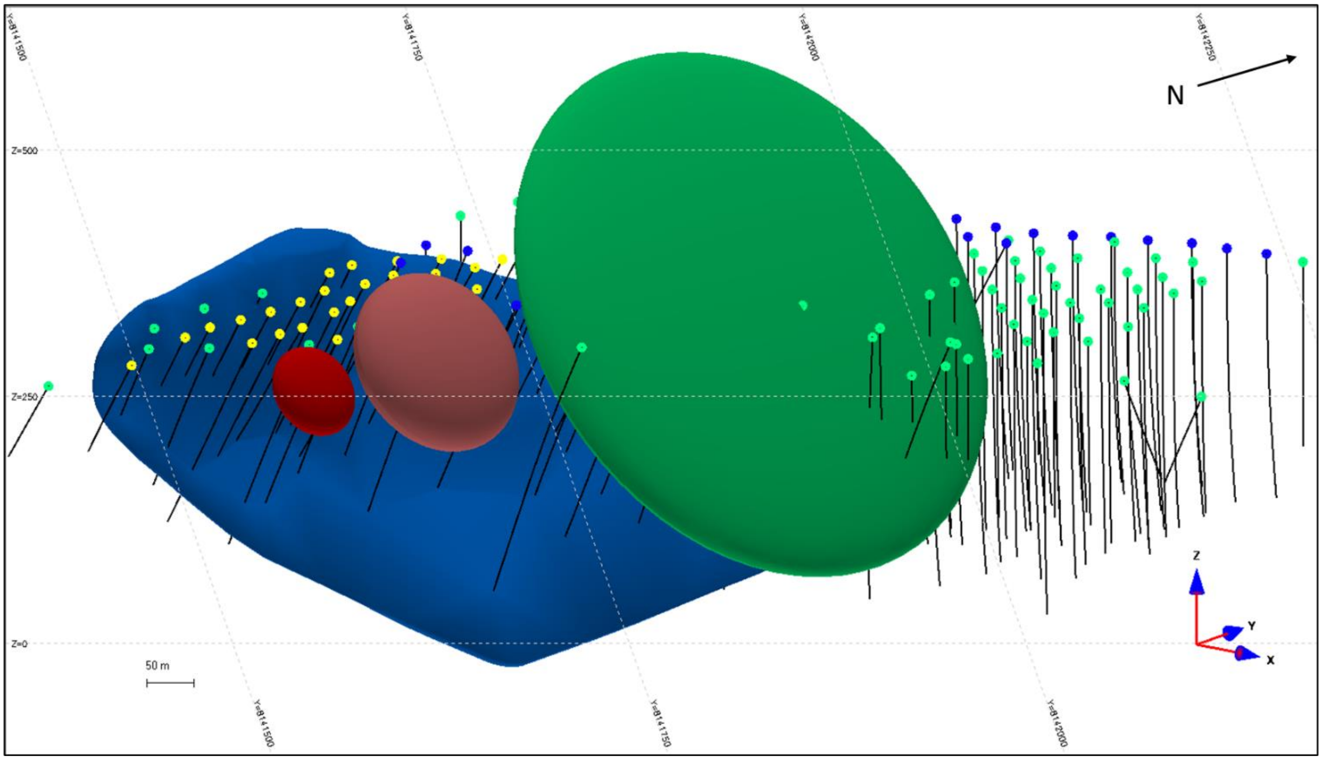


Figure 14-13: Isometric View of the Murial South Search Ellipsoids

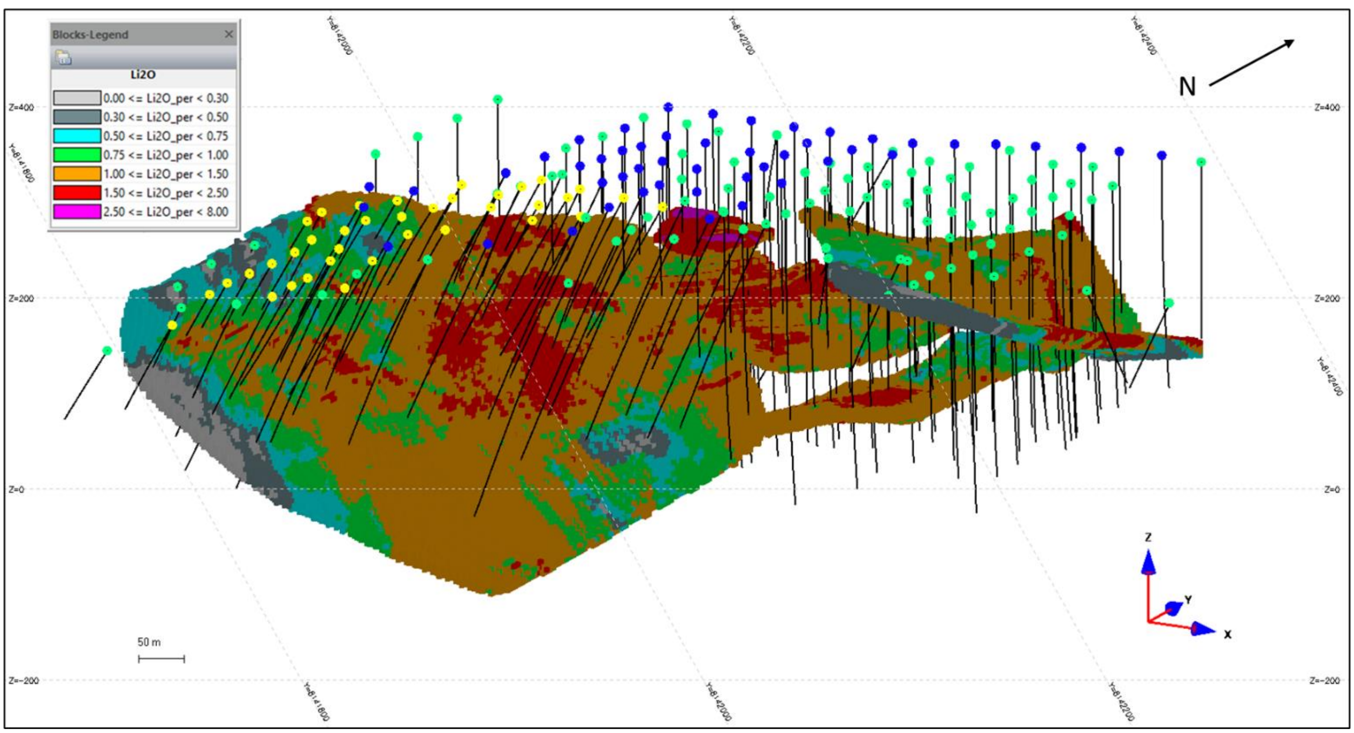
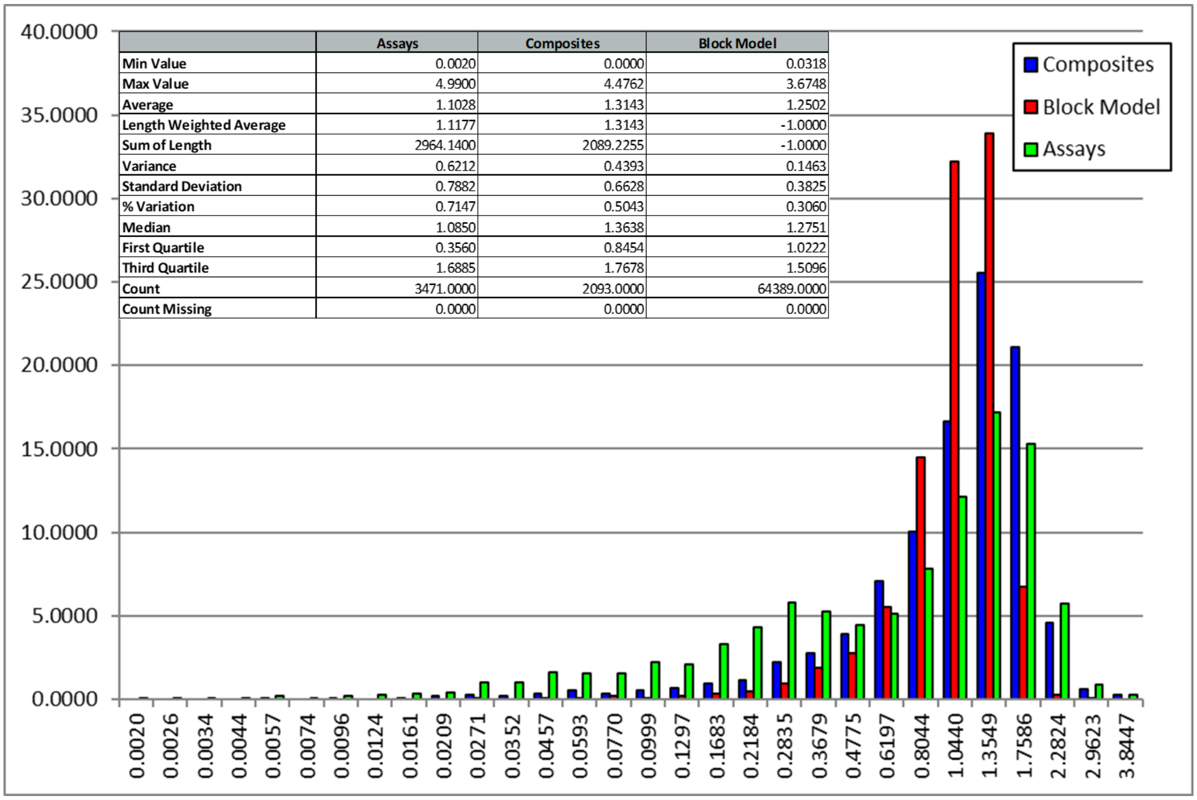


Figure 14-14: Isometric View of Murial Interpolated Block Model

14.2.9 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 14-15).



	Assays	Composites	Block Model
Min Value	0.0020	0.0000	0.0318
Max Value	4.9900	4.4762	3.6748
Average	1.1028	1.3143	1.2502
Length Weighted Average	1.1177	1.3143	-1.0000
Sum of Length	2964.1400	2089.2255	-1.0000
Variance	0.6212	0.4393	0.1463
Standard Deviation	0.7882	0.6628	0.3825
% Variation	0.7147	0.5043	0.3060
Median	1.0850	1.3638	1.2751
First Quartile	0.3560	0.8454	1.0222
Third Quartile	1.6885	1.7678	1.5096
Count	3471.0000	2093.0000	64389.0000
Count Missing	0.0000	0.0000	0.0000

Figure 14-15: Statistical Comparison of Murial Assay, Composite and Block Data

The assays and composites have average values of 1.10% and 1.31% Li_2O with variances of 0.62% and 0.44% Li_2O. The interpolated blocks have an average value of 1.25% Li_2O with a variance of 0.15% 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 0.33 (R^2) was established between the blocks and the composites (Figure 14-16). This confirms what can be seen in Figure 14-15, namely that the block model is smoothed in relation to the composites. It is the opinion of the QP that this level of smoothing is acceptable for this type of deposit.

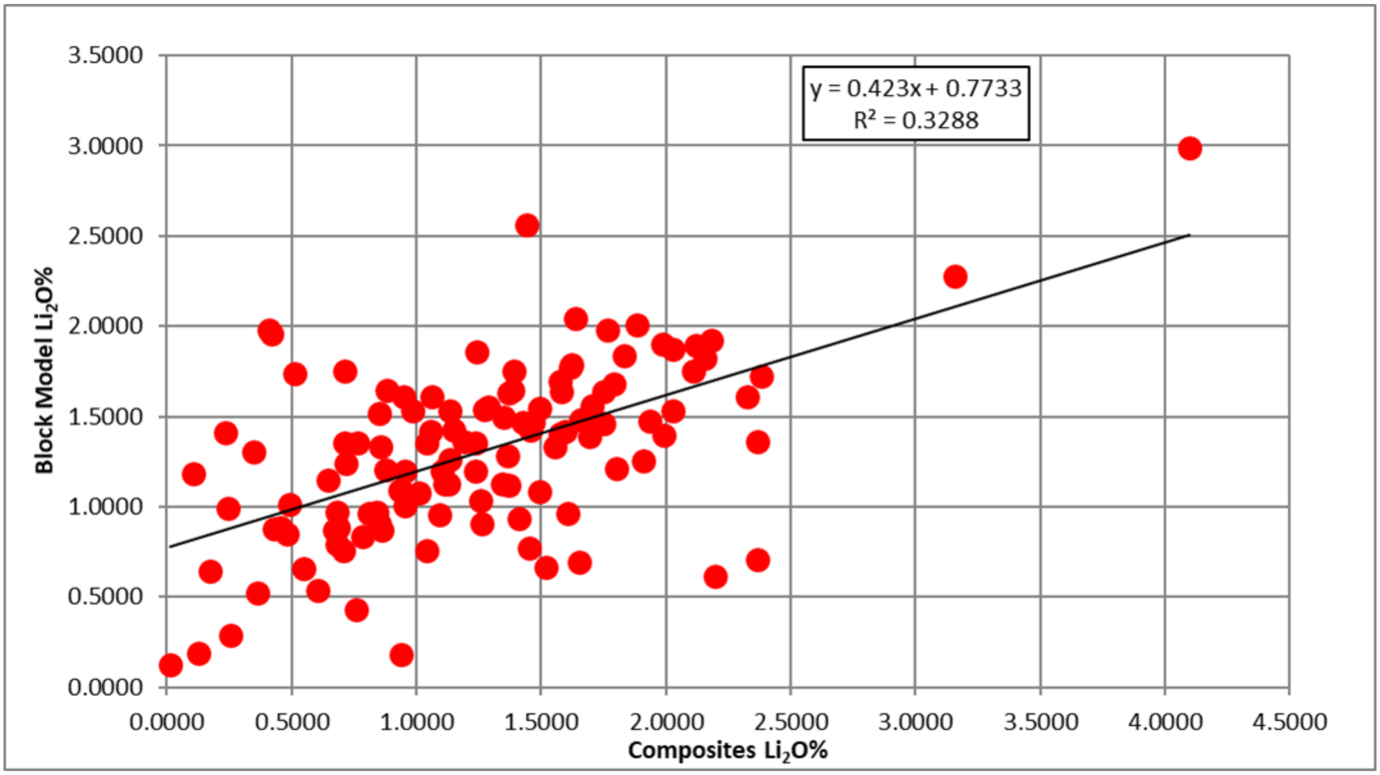


Figure 14-16: Comparison Murial Block Values Versus Composites Inside Blocks

14.2.10 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 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 50 m (strike) by 50 m (dip) by 25 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 14-17 is an isometric view showing the final classifications.

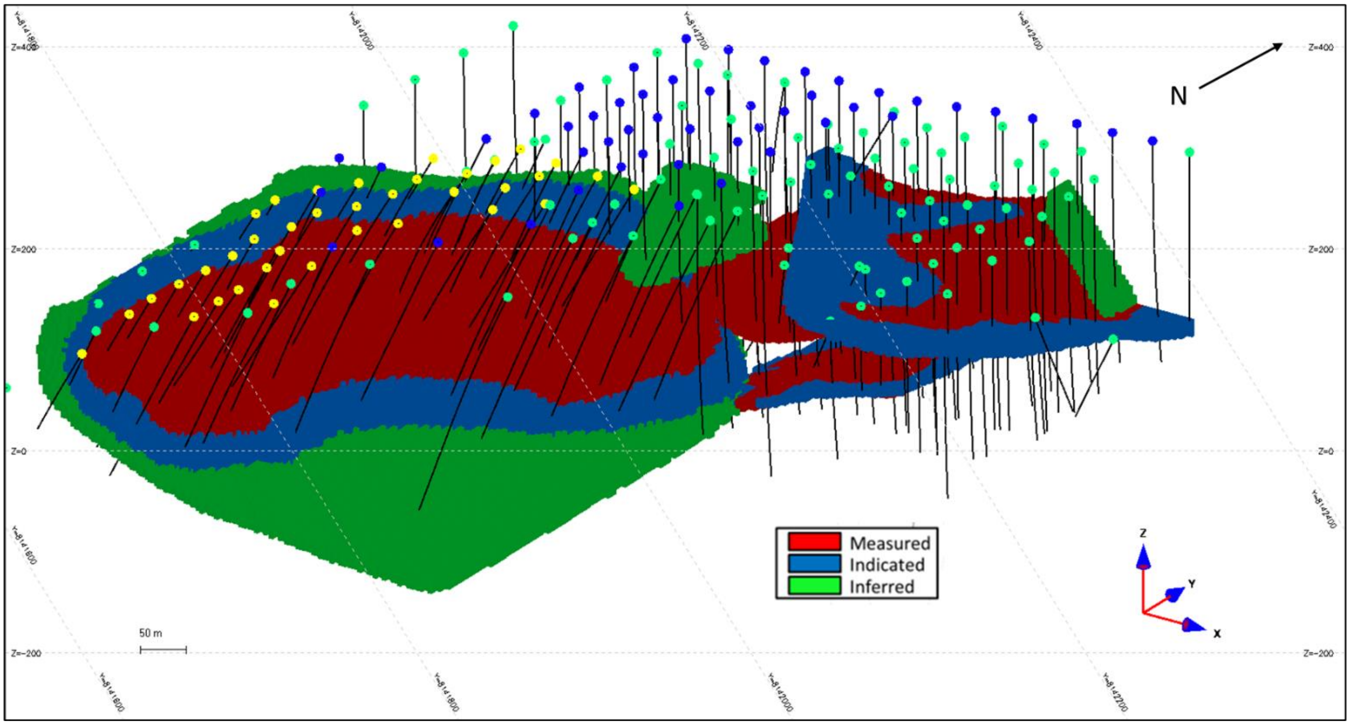


Figure 14-17: Murial Block Model Classification

14.2.11 Reasonable Prospects for Eventual Economic Extraction

The general requirement that all mineral resources have “reasonable prospects for eventual economic extraction” implies that the quantity and grade estimates meet certain economic thresholds and that the mineral resources are reported at an appropriate cut-off grade considering extraction scenarios and processing recoveries. To meet this requirement, the lithium mineralization of the Murial deposit is considered amenable to open pit extraction.

To determine the quantity of material representing “reasonable prospects for eventual economic extraction” by an open pit mining method, Whittle pit optimization software was used with reasonable mining and economic assumptions. The pit optimization for the Murial deposit was completed by SGS for the current MRE. The pit optimization parameters used are summarized in Table 14-9. A conservative and balanced approach was applied when optimizing the open pit scenario. A Whittle pit shell at a revenue factor of 1.0 ($1,300/t concentrate price) was selected as the ultimate pit shell for the purposes of the MRE for the Murial deposit.

The reader is cautioned that the results from the pit optimization are used solely for the purpose of testing the “reasonable prospects for economic extraction” by an open pit and do not represent an attempt to estimate mineral reserves. The results are used as a guide to assist in the preparation of a mineral resource statement and to select an appropriate resource reporting cut-off grade.

Table 14-9: Murial Parameters for Reasonable Prospect for Eventual Economic Extraction

Parameter	Unit	Value
Concentrate Price (6% Li_2O)	US$ per tonne	$1,300
Pit Slope	Degrees	60
Mining Cost	US$ per tonne mined	$2.20
Processing Cost & G&A	US$ per tonne milled	$16.46
Mining Recovery	Percent (%)	95
Concentration Recovery (DMS)	Percent (%)	60
Royalties	Percent (%)	2
Mining loss / Dilution	Percent (%) / Percent (%)	5 / 5
Cut-off Grade	Percent (%) Li_2O	0.3

Figure 14-18 shows the pit with all the mineralized surfaces.

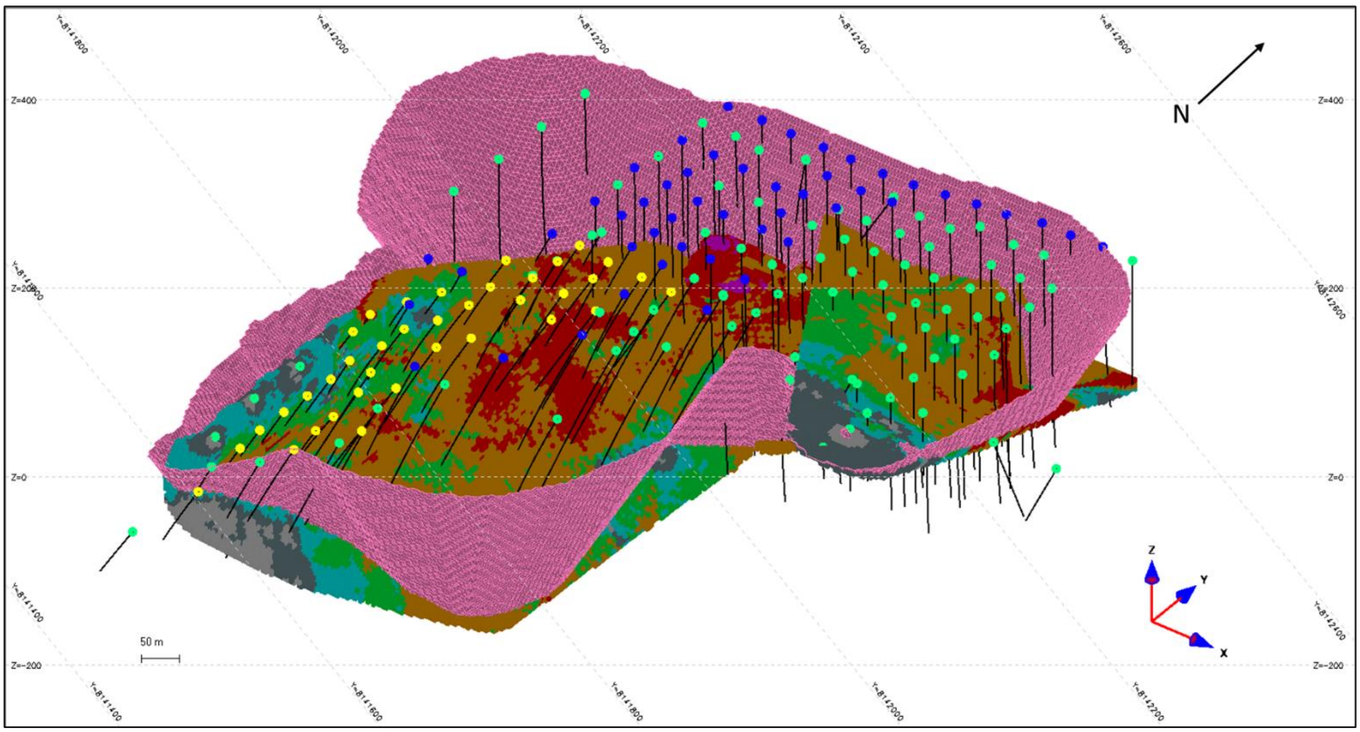


Figure 14-18: Murial Deposit Mineral Resource Block Model and Revenue Factor 1 Pit

14.2.12 Mineral Resource Statement

The Mineral Resource estimate is reported using a 0.3% Li_2O cut-off. The Mineral Resources are constrained by the topography and are based on the conceptual economic parameters detailed in Table 14-10. The estimate has an effective date of the 18th January, 2024. The QP for the estimate is Mr. Marc-Antoine Laporte, P.Geo., an SGS employee.

Table 14-10: Murial Deposit Mineral Resource Estimate

Cut-off Grade Li_2O (%)	Category	Tonnage (Mt)	Average Grade Li_2O (%)	LCE (Kt)
0.3	Measured	10.1	1.31	327
0.3	Indicated	3.4	1.07	90
0.3	**Measured + Indicated**	**13.5**	**1.25**	**417**
0.3	Inferred	2.6	1.29	83

Notes to accompany Mineral Resource table:

1. Mineral Resources have an effective date of the 18th January, 2024 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. All Resources are presented undiluted and in situ, constrained by continuous 3D wireframe models, and are considered to have reasonable prospects for eventual economic extraction.
3. Mineral Resources are reported assuming open pit mining methods, and the following assumptions: lithium concentrate (6% Li_2O) price of US$1,300/t, mining costs of US$2.2/t for mineralization and waste, crushing and processing costs of US$10.7/t, general and administrative (G&A) costs of US$4/t, concentrate recovery of 60%, 2% royalty payment, pit slope angles of 55º, and an overall cut-off grade of 0.3% Li_2O.
4. Tonnages and grades have been rounded in accordance with reporting guidelines. Totals may not sum due to rounding.
5. Mineral resources which are not mineral reserves do not have demonstrated economic viability. An Inferred Mineral Resource has a lower level of confidence than that applying to a Measured and Indicated Mineral Resource and must not be converted to a Mineral Reserve. It is reasonably expected that the majority of Inferred Mineral Resources could be upgraded to Indicated Mineral Resources with continued exploration.
6. The results from the pit optimization are used solely for the purpose of testing the “reasonable prospects for economic extraction” by an open pit and do not represent an attempt to estimate mineral reserves. The results are used as a guide to assist in the preparation of a Mineral Resource statement and to select an appropriate resource reporting cut-off grade.
7. The estimate of Mineral Resources may be materially affected by environmental, permitting, legal, title, taxation, socio-political, marketing, or other relevant issues.

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.

14.3 LAVRA DO MEIO DEPOSIT

14.3.1 Exploratory Data Analysis

The final database used for the Lavra do Meio pegmatite mineral resource estimation was transmitted to SGS by SMSA on the 9th January 2024 in Microsoft Excel format and Datamine format. The database validation steps are discussed in Section 12. The database comprised 44 drill holes with entries for:

- Down hole surveys (n = 1,382)
- Assays (n = 1,594)
- Lithologies (n = 598)

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.

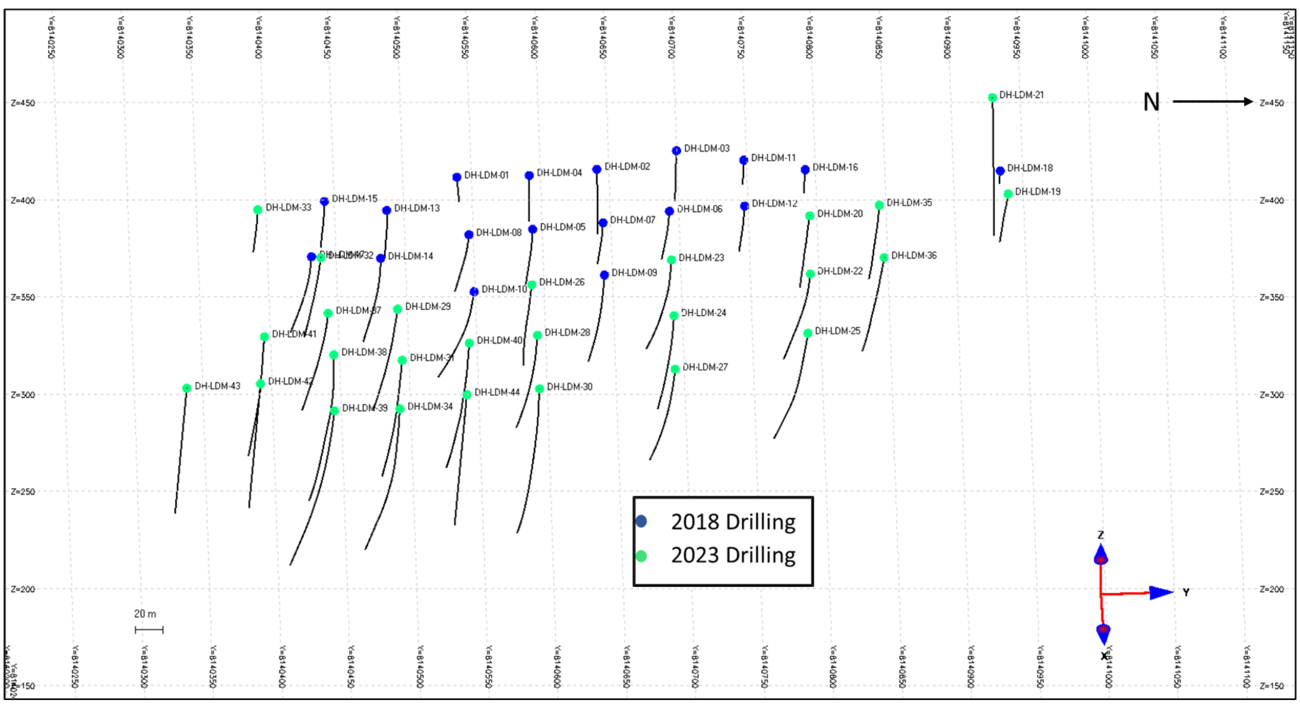


Figure 14-19: Lavra Do Meio Drill Hole Collar Locations

14.3.2 Analytical Data

There is a total of 1,594 assay intervals in the database used for the Mineral Resource estimate; 851 assays are contained inside the interpreted mineralized solids. Most of the drill holes 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: Lavra do Meio Assay Statistics Inside Mineralized Solids

	Li_2O (%)
Count	851
Mean	1.10
Std. Dev.	1.09
Min	0.005
Median	0.81
Max	6.15

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 5 m by 5 m block size defined for the resource block model. Compositing began at the top of the mineralized wireframe and continued to the end of the mineralized wireframe. No capping was applied on the analytical composite data.

Table 14-22 shows the grade statistics of the analytical composites used for the interpolation of the resource block model.

Table 14-12: Lavra do Meio 1 m Composite Statistics

	Li_2O (%)
Count	658
Mean	1.10
Std. Dev.	0.96
Min	0.006
Median	0.95
Max	5.53

14.3.4 Density

Density determinations are outlined in Section 11.3. An average density value of 2.67 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 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 330° and a dip averaging -70° to the east.

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 14-20 shows the final 3D wireframe solids in isometric view with the drill hole pierce points.

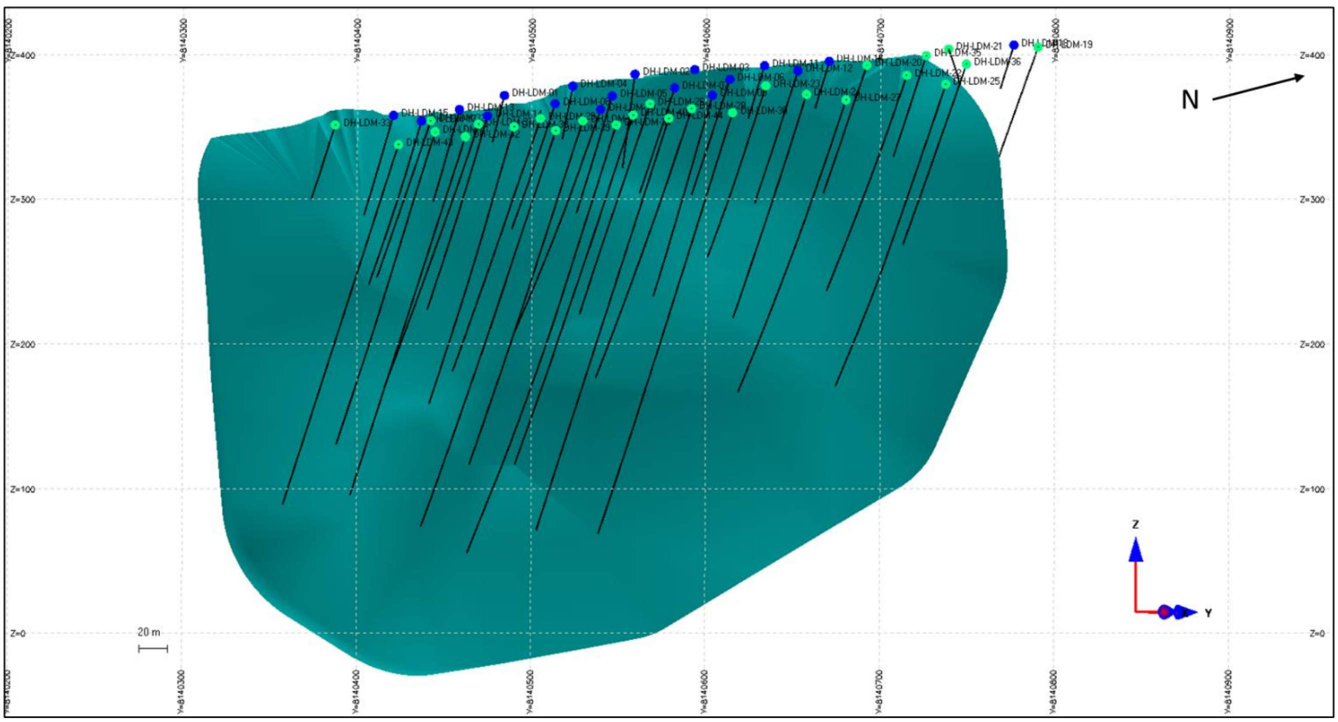


Figure 14-20: Lavra do Meio Pegmatite Solid

14.3.6 Resource Block Modeling

A block size of 5 m (northeast–southwest) by 5 m (northwest–southeast) by 5 m (vertical) was selected for the Lavra 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 Lavra do Meio. The resource block model contains 27,794 blocks located inside the mineralized solids, for a total volume of 2,012,613 m^3. Table 14-13 summarizes the block model limit parameters.

Table 14-13: Lavra do Meio 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	308	191,152	192,687
North–south (y)	5	458	8,138,971	8,141,256
Elevation (z)	5	163	-228	582

14.3.7 Block Model Interpolation

The grade interpolation for the Lavra do Meio resource block model was completed using an inverse distance weighting to the second power (ID^2) 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 ID^2 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.

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 50 m (long axis) by 50 m (intermediate axis) and 25 m (short axis) with an orientation of 180º azimuth and -72º dip. 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. 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). The purpose of the last interpolation pass was to interpolate the remaining un-estimated blocks mostly located at the edges of the block mode.

Figure 14-21 illustrates the three search ellipsoids used for the different interpolation passes. Figure 14-22 shows the results of the block model interpolation in longitudinal view.

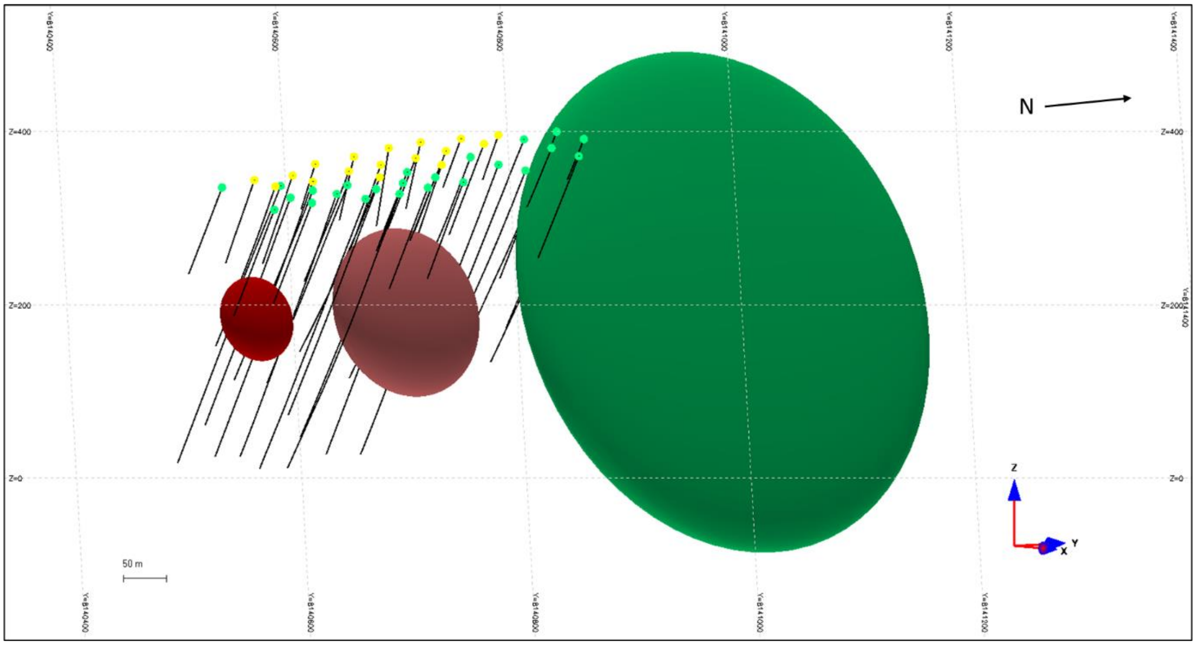


Figure 14-21: Isometric View of Lavra do Meio Search Ellipses

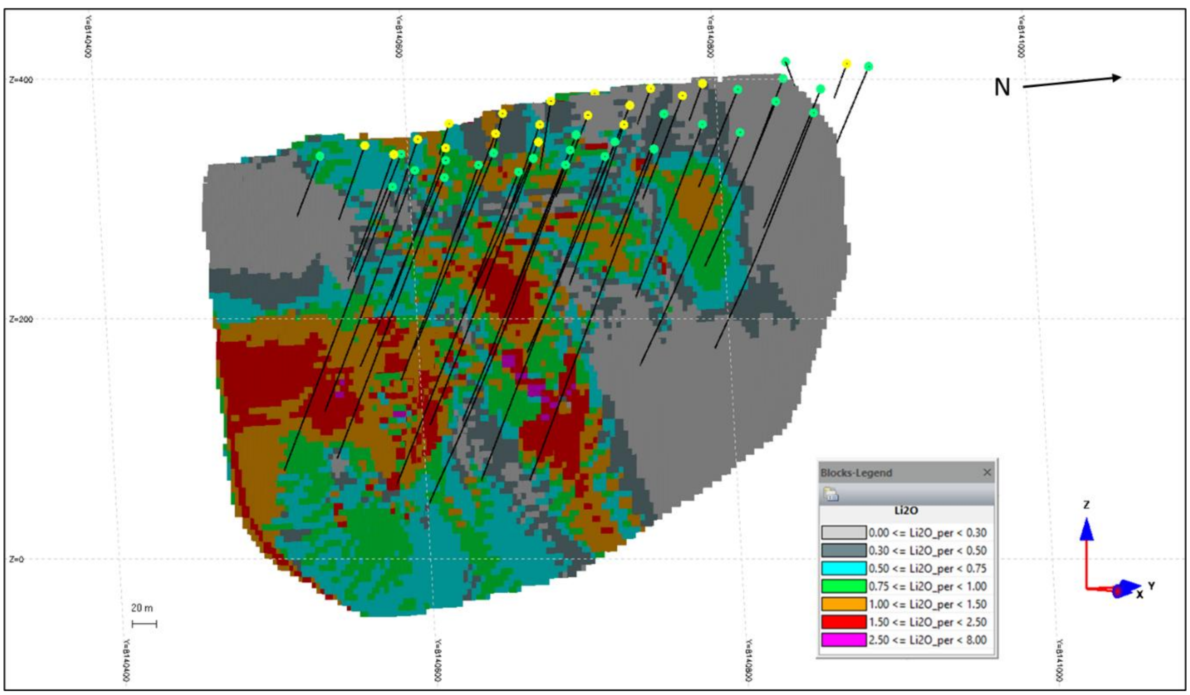
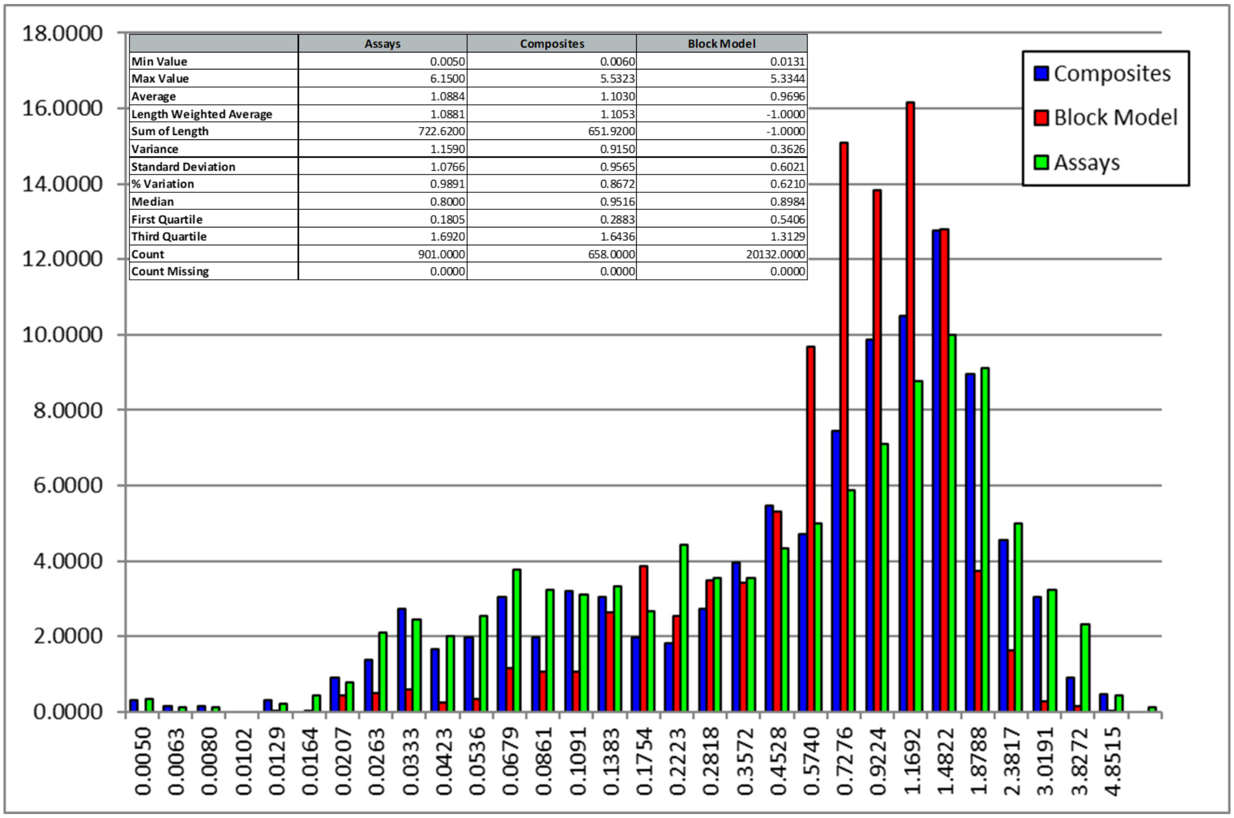


Figure 14-22: Isometric View of Lavra Do Meio Interpolated Block Model

14.3.8 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 14-23).



	Assays	Composites	Block Model
Min Value	0.0050	0.0060	0.0131
Max Value	6.1500	5.5323	5.3344
Average	1.0884	1.1030	0.9696
Length Weighted Average	1.0881	1.1053	-1.0000
Sum of Length	722.6200	651.9200	-1.0000
Variance	1.1590	0.9150	0.3626
Standard Deviation	1.0766	0.9565	0.6021
% Variation	0.9891	0.8672	0.6210
Median	0.8000	0.9516	0.8984
First Quartile	0.1805	0.2883	0.5406
Third Quartile	1.6920	1.6436	1.3129
Count	901.0000	658.0000	20132.0000
Count Missing	0.0000	0.0000	0.0000

Figure 14-23: Statistical Comparison of Lavra Do Meio Assay, Composite and Block Data

The assays and composites have respective averages of 1.09% Li_2O and 1.10% Li_2O with variances of 1.16 and 0.92. The interpolated blocks have and average value of 0.97% Li_2O with a variance of 0.36.

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 0.56 (R^2) was established between the blocks and the composites (Figure 14-24). This confirms what can be seen in Figure 14-23, namely that the block model is smoothed in relation to the composites. It is the opinion of the QP that this level of smoothing is acceptable for this type of deposit.

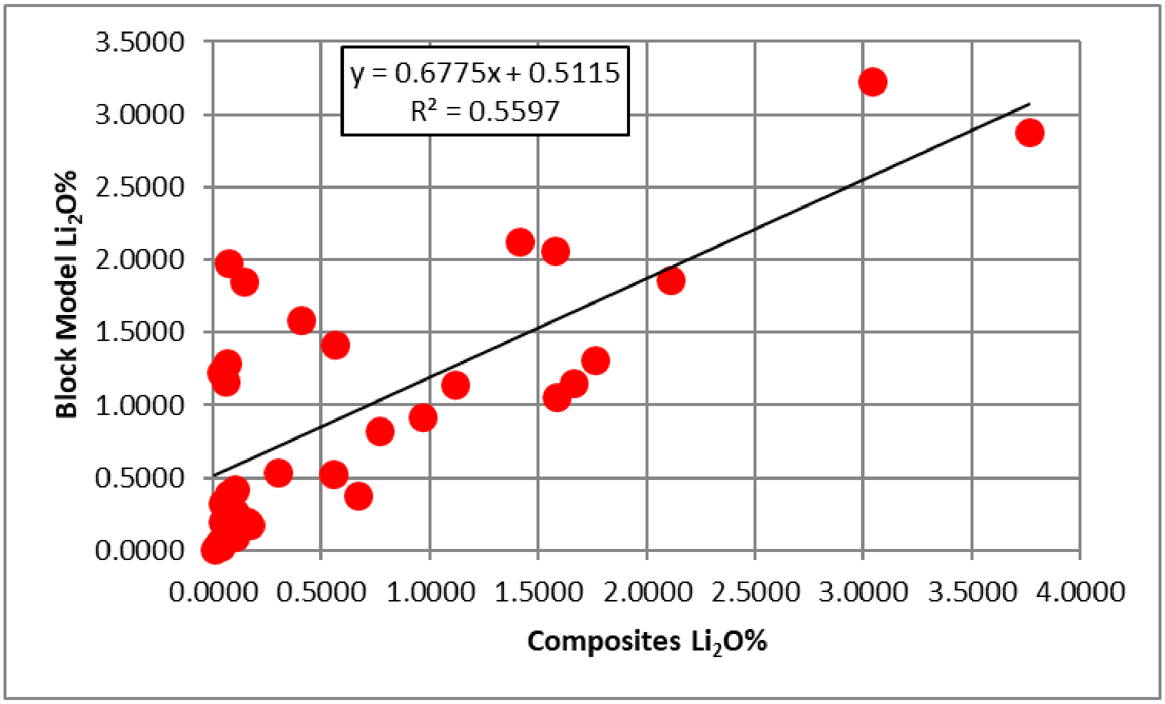


Figure 14-24: Lavra Do Meio Block Values Versus Composites Inside Those Blocks

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 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 50 m (strike) by 50 m (dip) by 25 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 14-25 is an isometric view showing the final classifications.

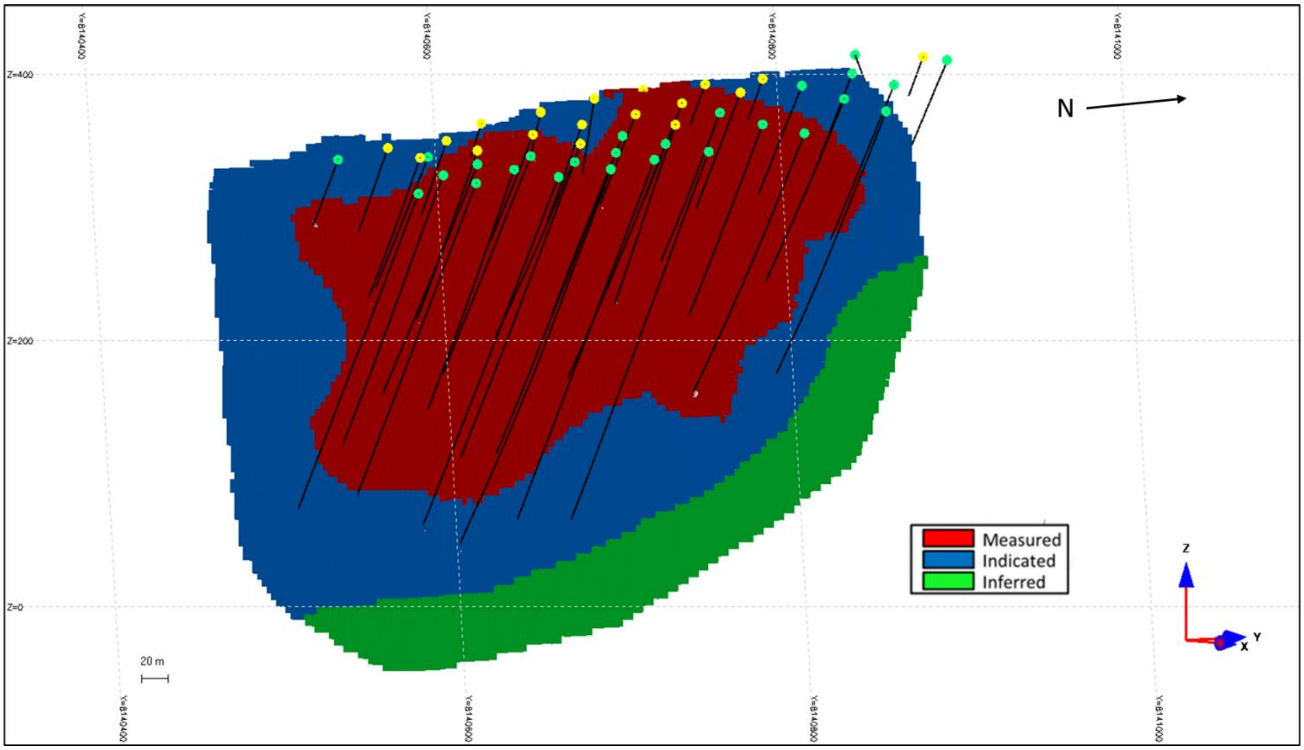


Figure 14-25: Lavra Do Meio Block Model Classification

14.3.10 Reasonable Prospects of Eventual Economic Extraction

The general requirement that all mineral resources have "reasonable prospects for eventual economic extraction" implies that the quantity and grade estimates meet certain economic thresholds and that the mineral resources are reported at an appropriate cut-off grade considering extraction scenarios and processing recoveries. To meet this requirement, the lithium mineralization of the LDM deposit is considered amenable to open pit extraction.

To determine the quantity of material representing "reasonable prospects for eventual economic extraction" by an open pit mining method, Whittle pit optimization software was used with reasonable mining and economic assumptions. The pit optimization for the LDM deposit was completed by SGS for the current MRE. The pit optimization parameters used are summarized in Table 14-14. A conservative and balanced approach was applied when optimizing the open pit scenario. A Whittle pit shell at a revenue factor of 1.0 ($1,300/t concentrate price) was selected as the ultimate pit shell for the purposes of the MRE for the LDM deposit.

During the modelling process, the proximity of the NDC, Maxixe and Tamboril pegmatites to the Lavra do Meio pegmatite was noted. Various open pit options for the four mineralized areas were investigated, but ultimately, it was determined that the best option for reasonable prospects for eventual economic extraction was a single pit encompassing all four zones. Figure 14-26 shows the pit with all the mineralized surfaces.

The reader is cautioned that the results from the pit optimization are used solely for the purpose of testing the "reasonable prospects for economic extraction" by an open pit and do not represent an attempt to estimate mineral reserves. The results are used as a guide to assist in the preparation of a mineral resource statement and to select an appropriate resource reporting cut-off grade.

Table 14-14: Lavra do Meio Parameters for Reasonable Prospect for Eventual Economic Extraction

Parameter	Unit	Value
Concentrate Price (6% Li_2O)	US$ per tonne	$1,300
Pit Slope	Degrees	60
Mining Cost	US$ per tonne mined	$2.20
Processing Cost & G&A	US$ per tonne milled	$16.46
Mining Recovery	Percent (%)	95
Concentration Recovery (DMS)	Percent (%)	60
Royalties	Percent (%)	2
Mining loss / Dilution	Percent (%) / Percent (%)	5 / 5
Cut-off Grade	Percent (%) Li_2O	0.3

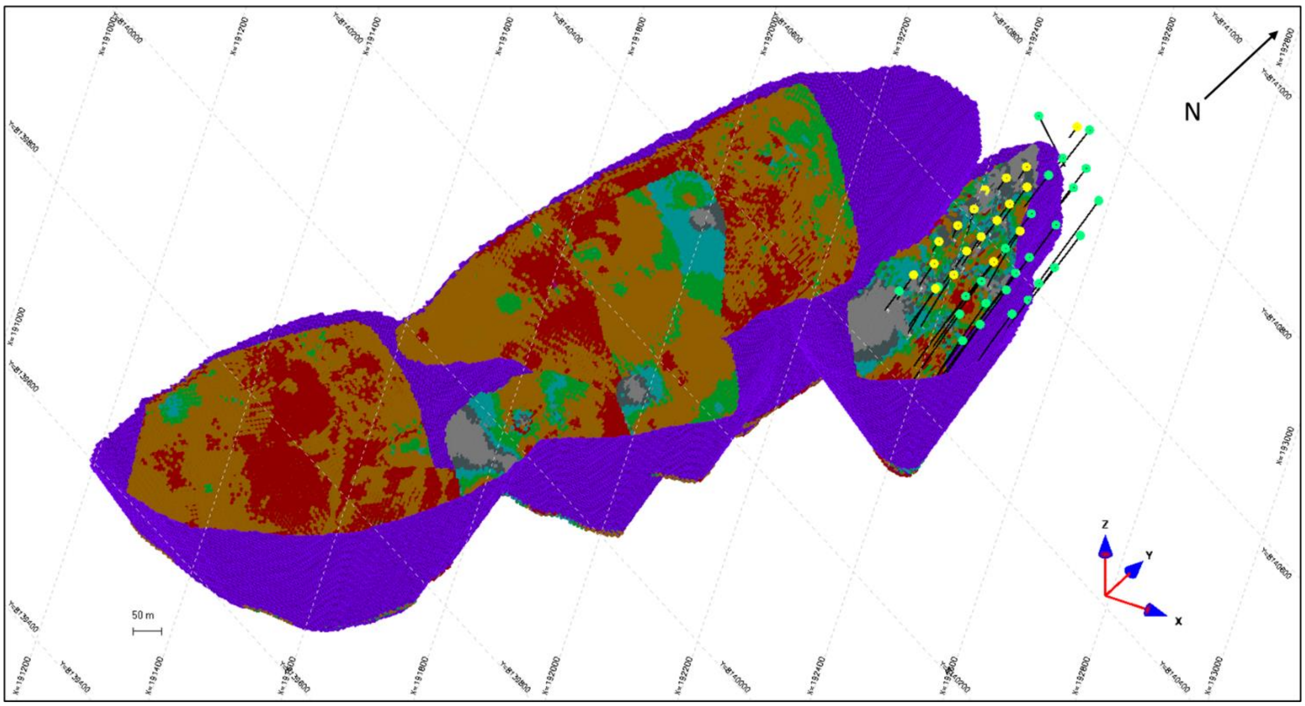


Figure 14-26: Lavra do Meio Deposit Mineral Resource Block Model and Revenue Factor 1 Pit

14.3.11 Mineral Resource Estimation

The Mineral Resource estimate is reported in Table 14-15 using a 0.3% Li_2O cut-off. The Mineral Resources are constrained by the topography and based on the conceptual economic parameters detailed in Table 14-24. 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: Lavra do Meio Deposit Mineral Resource Estimate

Cut-off Grade Li_2O (%)	Category	Tonnage (Mt)	Average Grade Li_2O (%)	LCE (Kt)
0.3	Measured	3.0	1.16	86
0.3	Indicated	1.2	1.20	36
0.3	**Measured + Indicated**	**4.2**	**1.17**	**122**
0.3	Inferred	0.02	1.34	0.7

Notes to accompany Mineral Resource table:

1. Mineral Resources have an effective date of the 18th January, 2024 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. All Resources are presented undiluted and in situ, constrained by continuous 3D wireframe models, and are considered to have reasonable prospects for eventual economic extraction.
3. Mineral Resources are reported assuming open pit mining methods, and the following assumptions: lithium concentrate (6% Li_2O) price of US$1,300/t, mining costs of US$2.2/t for mineralization and waste, crushing and processing costs of US$10.7/t, general and administrative (G&A) costs of US$4/t, concentrate recovery of 60%, 2% royalty payment, pit slope angles of 55º, and an overall cut-off grade of 0.3% Li_2O.
4. Tonnages and grades have been rounded in accordance with reporting guidelines. Totals may not sum due to rounding.
5. Mineral resources which are not mineral reserves do not have demonstrated economic viability. An Inferred Mineral Resource has a lower level of confidence than that applying to a Measured and Indicated Mineral Resource and must not be converted to a Mineral Reserve. It is reasonably expected that the majority of Inferred Mineral Resources could be upgraded to Indicated Mineral Resources with continued exploration.
6. The results from the pit optimization are used solely for the purpose of testing the "reasonable prospects for economic extraction" by an open pit and do not represent an attempt to estimate mineral reserves. The results are used as a guide to assist in the preparation of a Mineral Resource statement and to select an appropriate resource reporting cut-off grade.
7. The estimate of Mineral Resources may be materially affected by environmental, permitting, legal, title, taxation, socio-political, marketing, or other relevant issues.

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.

14.4 MAXIXE DEPOSIT

14.4.1 Exploratory Data Analysis

The final database used for the Maxixe pegmatite mineral resource estimation was transmitted to SGS by SMSA on the 13th January 2024 in Microsoft Excel format and Datamine format. The database validation steps are discussed in Section 12. The database comprised 26 drill holes with entries for:

- Down hole surveys (n = 1,866)
- Assays (n = 857)
- Lithologies (n = 485)

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.

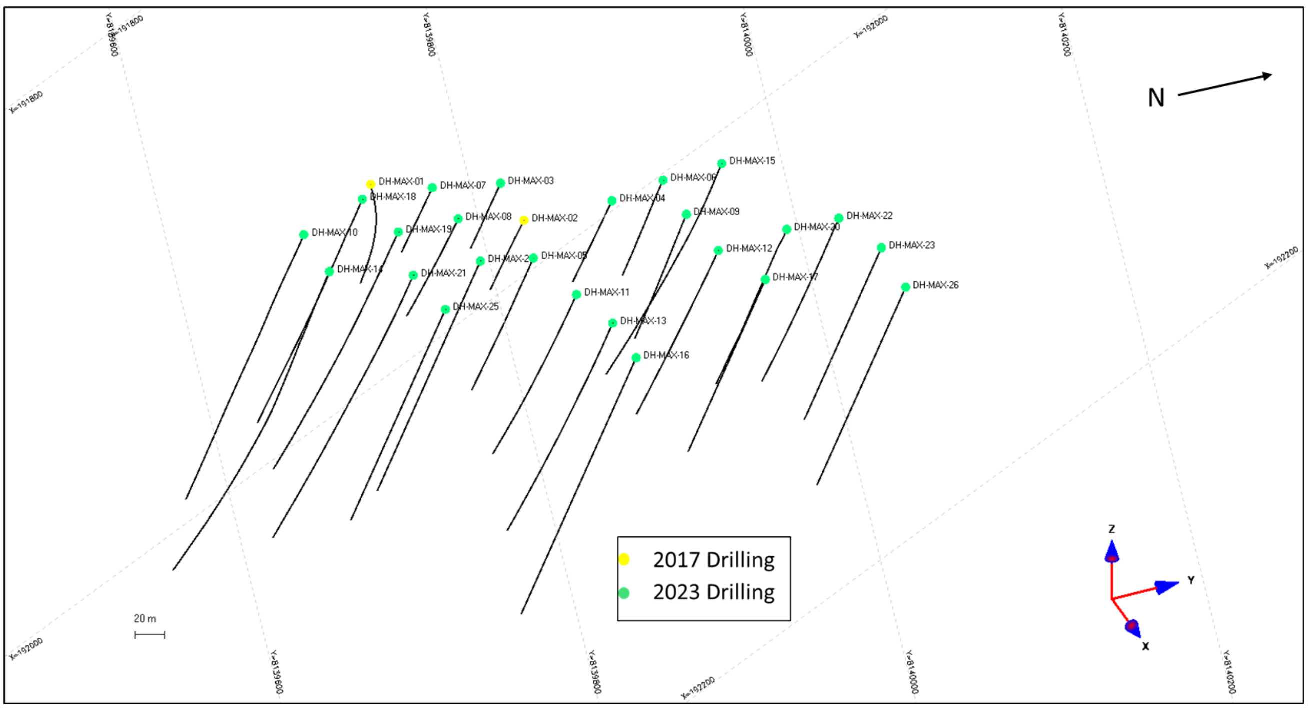


Figure 14-27: Maxixe Drill Hole Collar Locations

14.4.2 Analytical Data

There is a total of 857 assay intervals in the database used for the Mineral Resource estimate; 216 assays are contained inside the interpreted mineralized solids.

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

Table 14-16: Maxixe Assay Statistics Inside Mineralized Solids

	Li_2O (%)
Count	216
Mean	1.24
Std. Dev.	1.25
Min	0.006
Median	0.84
Max	5.30

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 5 m by 5 m block size defined for the resource block model. Compositing began at the top of the mineralized wireframe and continued to the end of the mineralized wireframe. 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.

Table 14-17: Maxixe 1 m Composite Statistics

	Li_2O (%)
Count	227
Mean	1.22
Std. Dev.	1.13
Min	0.0
Median	0.98
Max	4.89

14.4.4 Density

Density determinations are outlined in Section 11.3. An average density value of 2.62 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 010° and a dip averaging -60° to the east.

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 14-28 shows the final 3D wireframe solids in isometric view with the drill hole pierce points.

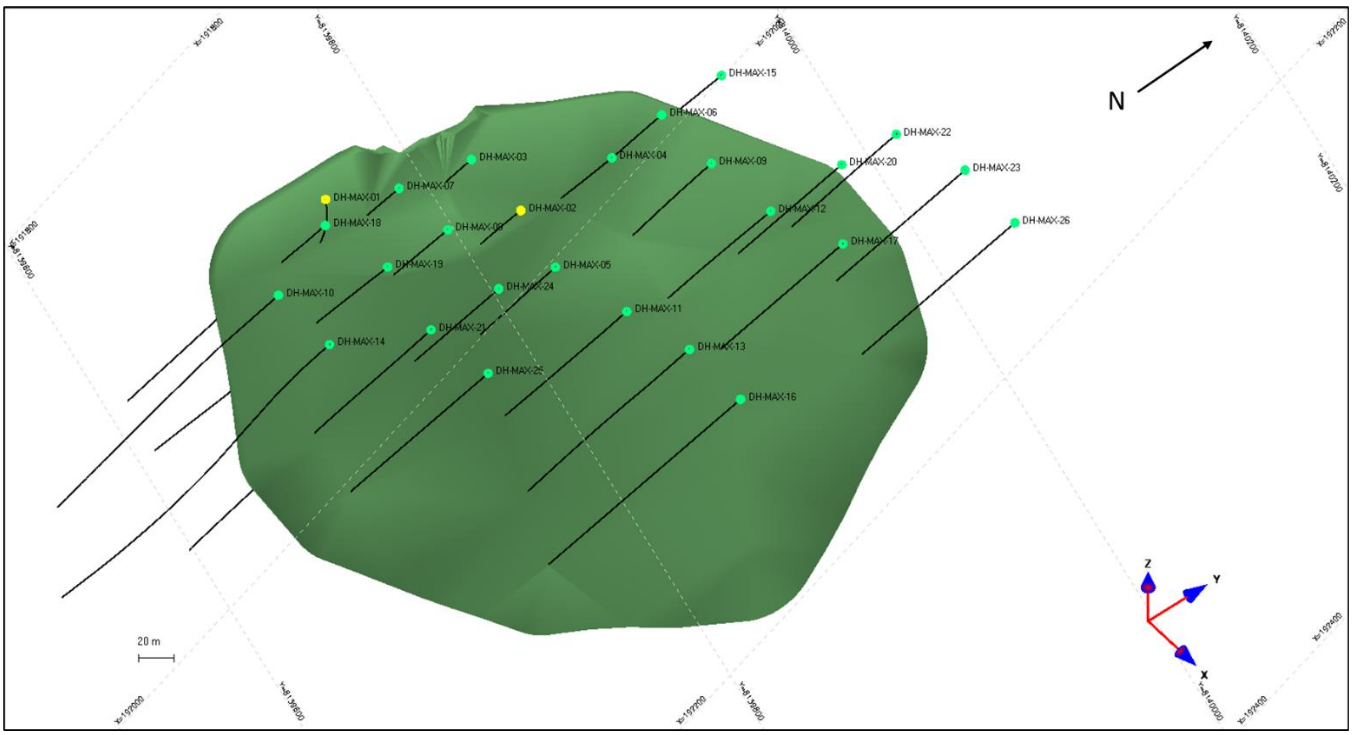


Figure 14-28: Maxixe Pegmatite Solid

14.4.6 Resource Block Modeling

A block size of 5 m (northeast–southwest) by 5 m (northwest–southeast) by 5 m (vertical) was selected for the Maxixe 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 Maxixe.

The resource block model contains 12,584 blocks located inside the mineralized solids, for a total volume of 774,933 m^3. Table 14-18 summarizes the block model limit parameters.

Table 14-18: Maxixe 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	308	191,152	192,687
North–south (y)	5	458	8,138,971	8,141,256
Elevation (z)	5	163	-228	582

14.4.7 Block Model Interpolation

The grade interpolation for the Maxixe resource block model was completed using an inverse distance weighting to the second power (ID^2) 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 ID^2 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.

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 50 m (long axis) by 50 m (intermediate axis) and 25 m (short axis) with an orientation of 180º azimuth and -55º dip. 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. 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). The purpose of the last interpolation pass was to interpolate the remaining un-estimated blocks mostly located at the edges of the block mode.

Figure 14-29 illustrates the three search ellipsoids used for the different interpolation passes. Figure 14-30 shows the results of the block model interpolation in longitudinal view.

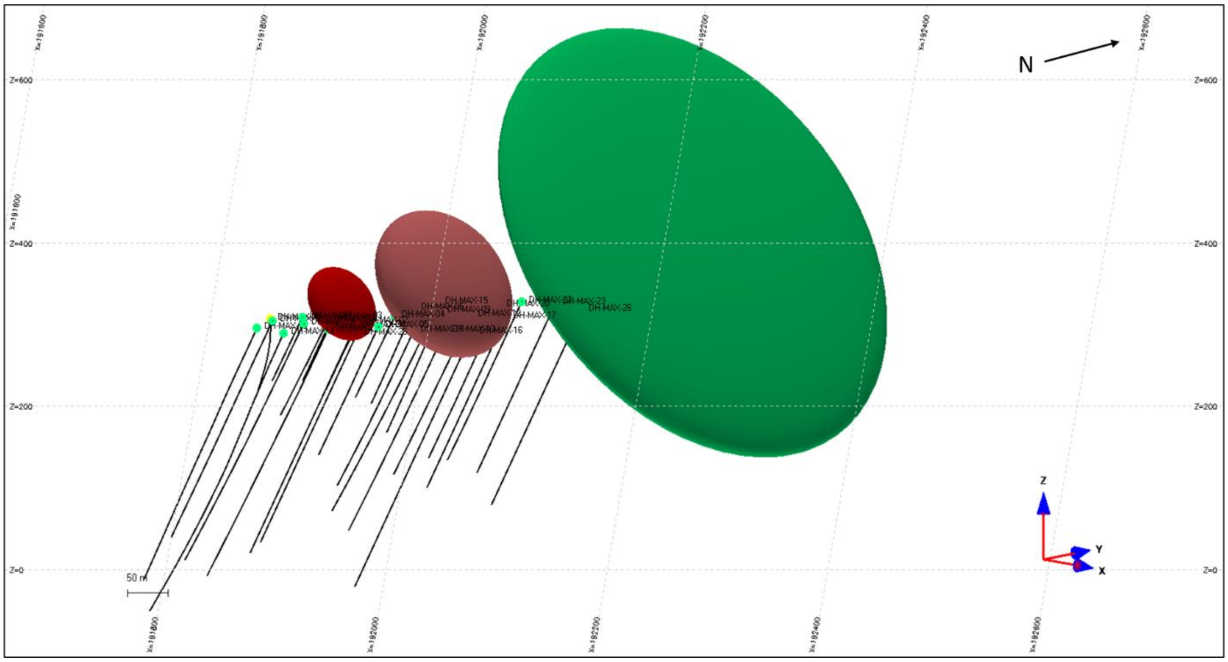


Figure 14-29: Isometric View of Maxixe Search Ellipses

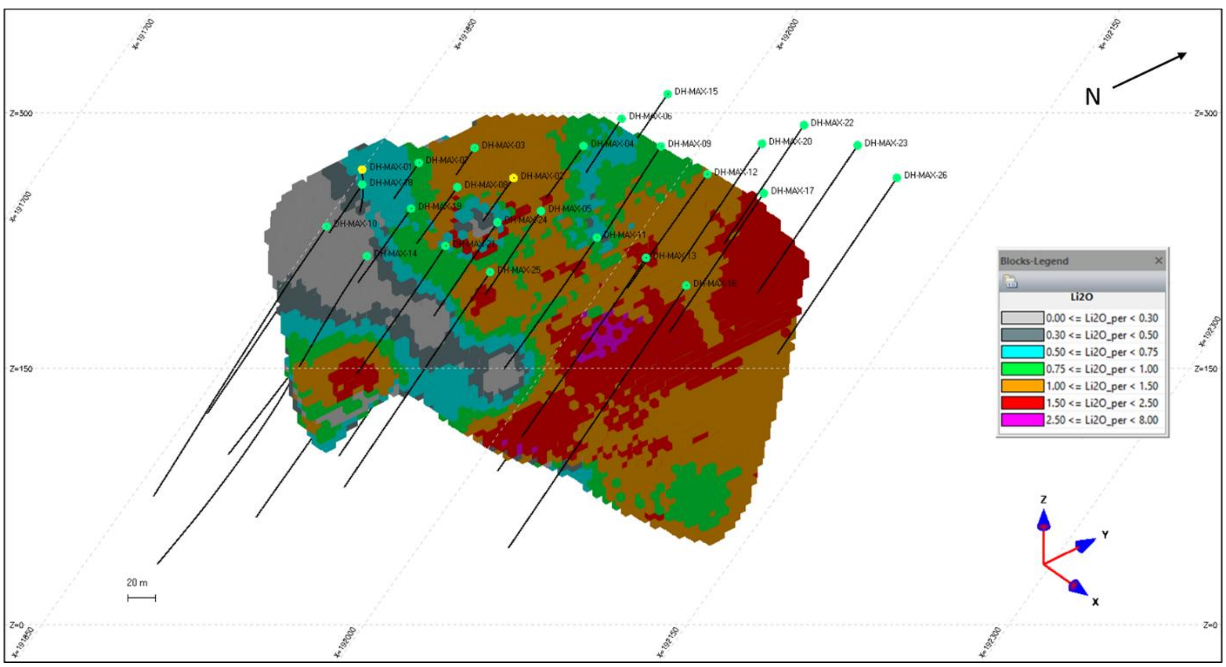
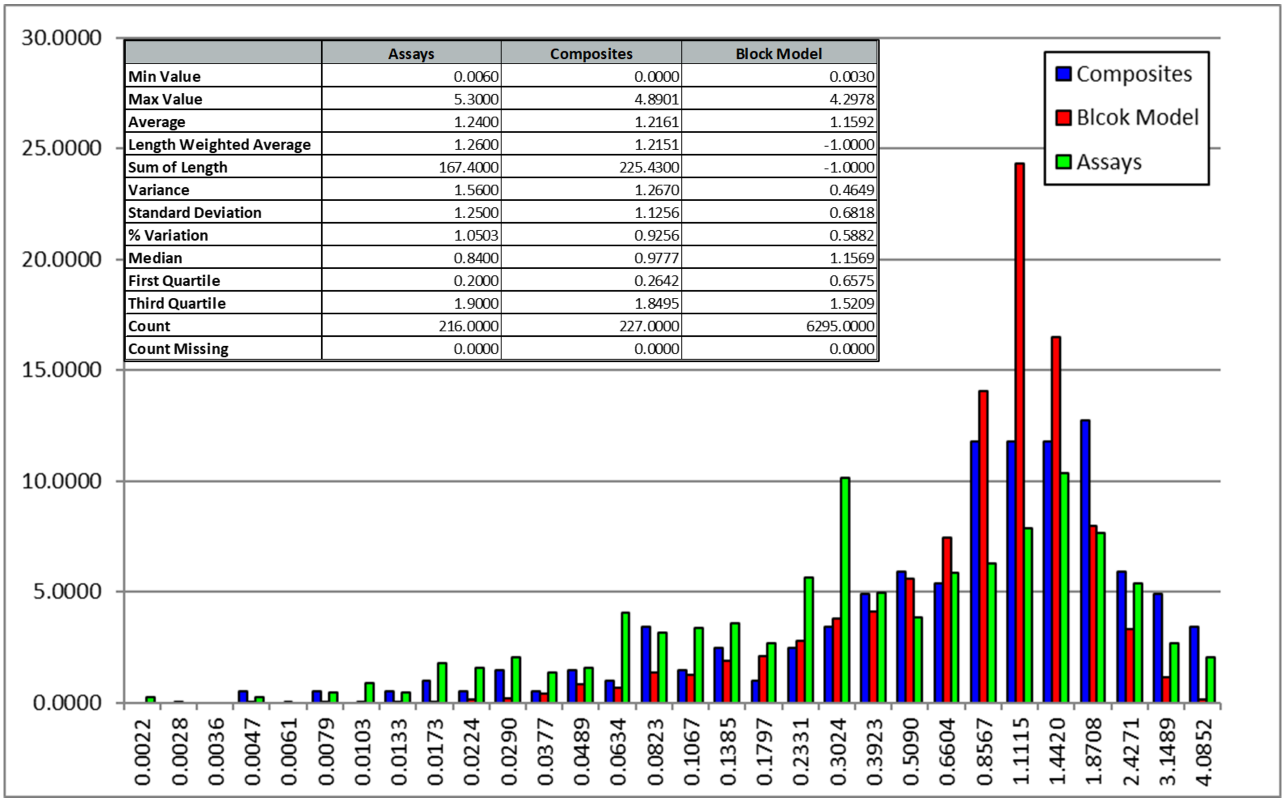


Figure 14-30: Isometric View of Maxixe Interpolated Block Model

14.4.8 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 14-31).



	Assays	Composites	Block Model
Min Value	0.0060	0.0000	0.0030
Max Value	5.3000	4.8901	4.2978
Average	1.2400	1.2161	1.1592
Length Weighted Average	1.2600	1.2151	-1.0000
Sum of Length	167.4000	225.4300	-1.0000
Variance	1.5600	1.2670	0.4649
Standard Deviation	1.2500	1.1256	0.6818
% Variation	1.0503	0.9256	0.5882
Median	0.8400	0.9777	1.1569
First Quartile	0.2000	0.2642	0.6575
Third Quartile	1.9000	1.8495	1.5209
Count	216.0000	227.0000	6295.0000
Count Missing	0.0000	0.0000	0.0000

Figure 14-31: Statistical Comparison of Maxixe Assay, Composite and Block Data

The assays and composites have respective averages of 1.24% Li_2O and 1.22% Li_2O with variances of 1.56 and 0.27. The interpolated blocks have and average value of 1.16% Li_2O with a variance of 0.46.

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 0.54 (R^2) was established between the blocks and the composites (Figure 14-32). This confirms what can be seen in Figure 14-31, namely that the block model is smoothed in relation to the composites. It is the opinion of the QP that this level of smoothing is acceptable for this type of deposit.

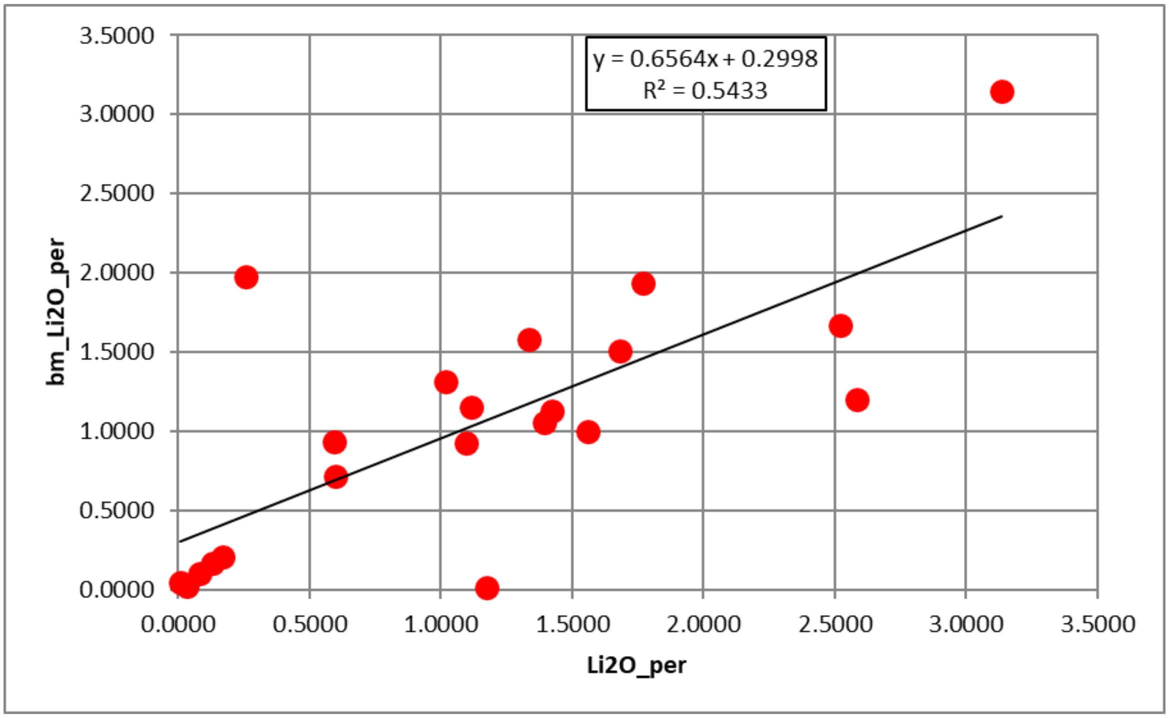


Figure 14-32: Maxixe Block Values Versus Composites Inside Those Blocks

14.4.9 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 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 50 m (strike) by 50 m (dip) by 25 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 14-33 is an isometric view showing the final classifications.

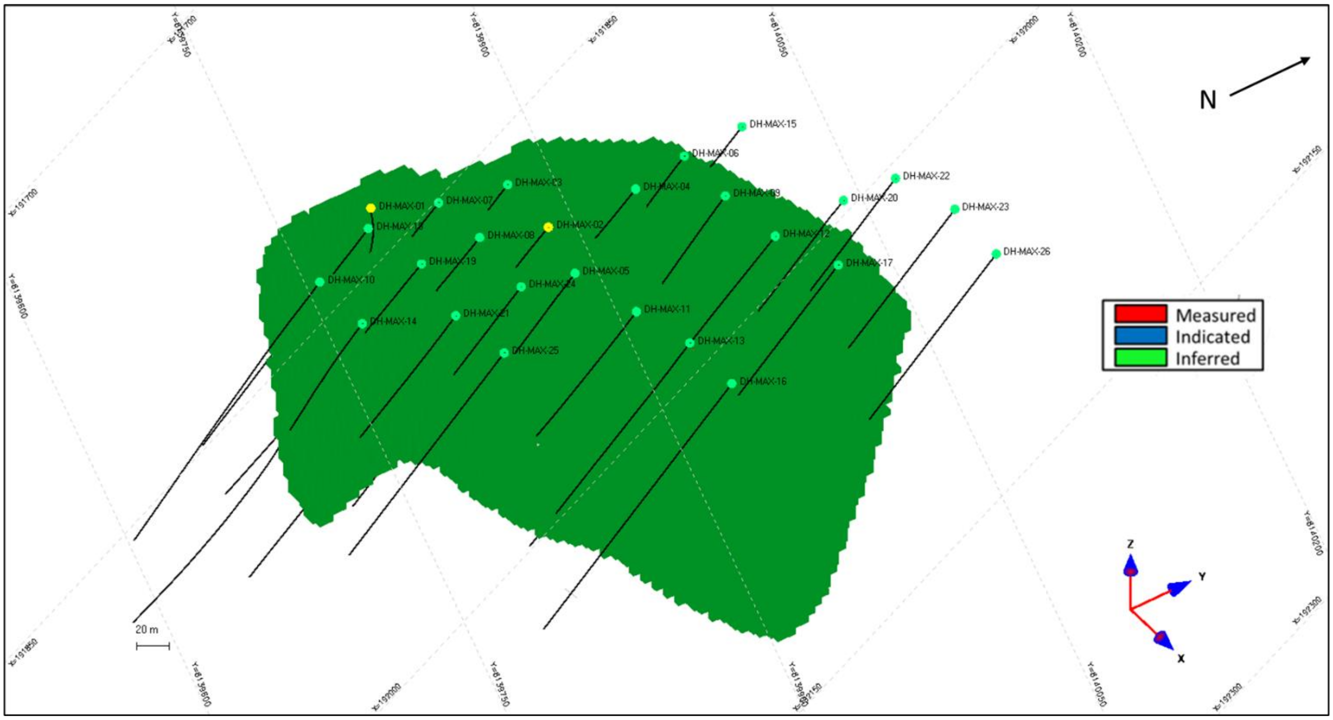


Figure 14-33: Maxixe Block Model Classification

14.4.10 Reasonable Prospects of Eventual Economic Extraction

The general requirement that all mineral resources have “reasonable prospects for eventual economic extraction” implies that the quantity and grade estimates meet certain economic thresholds and that the mineral resources are reported at an appropriate cut-off grade considering extraction scenarios and processing recoveries. To meet this requirement, the lithium mineralization of the Maxixe deposit is considered amenable to open pit extraction.

To determine the quantity of material representing “reasonable prospects for eventual economic extraction” by an open pit mining method, Whittle pit optimization software was used with reasonable mining and economic assumptions. The pit optimization for the Maxixe deposit was completed by SGS for the current MRE. The pit optimization parameters used are summarized in Table 14-19. A conservative and balanced approach was applied when optimizing the open pit scenario. A Whittle pit shell at a revenue factor of 1.0 ($1,300/t concentrate price) was selected as the ultimate pit shell for the purposes of the MRE for the LDM deposit.

During the modelling process, the proximity of the NDC, Lavra do Meoi and Tamboril pegmatites to the Maxixe pegmatite was noted. Various open pit options for the four mineralized areas were investigated, but ultimately, it was determined that the best option for reasonable prospects for eventual economic extraction was a single pit encompassing all four zones. Figure 14-34 shows the pit with all the mineralized surfaces.

The reader is cautioned that the results from the pit optimization are used solely for the purpose of testing the “reasonable prospects for economic extraction” by an open pit and do not represent an attempt to estimate mineral reserves. The results are used as a guide to assist in the preparation of a mineral resource statement and to select an appropriate resource reporting cut-off grade.

Table 14-19: Maxixe Parameters for Reasonable Prospect for Eventual Economic Extraction

Parameter	Unit	Value
Concentrate Price (6% Li_2O)	US$ per tonne	$1,300
Pit Slope	Degrees	60
Mining Cost	US$ per tonne mined	$2.20
Processing Cost & G&A	US$ per tonne milled	$16.46
Mining Recovery	Percent (%)	95
Concentration Recovery (DMS)	Percent (%)	60
Royalties	Percent (%)	2
Mining loss / Dilution	Percent (%) / Percent (%)	5 / 5
Cut-off Grade	Percent (%) Li_2O	0.3

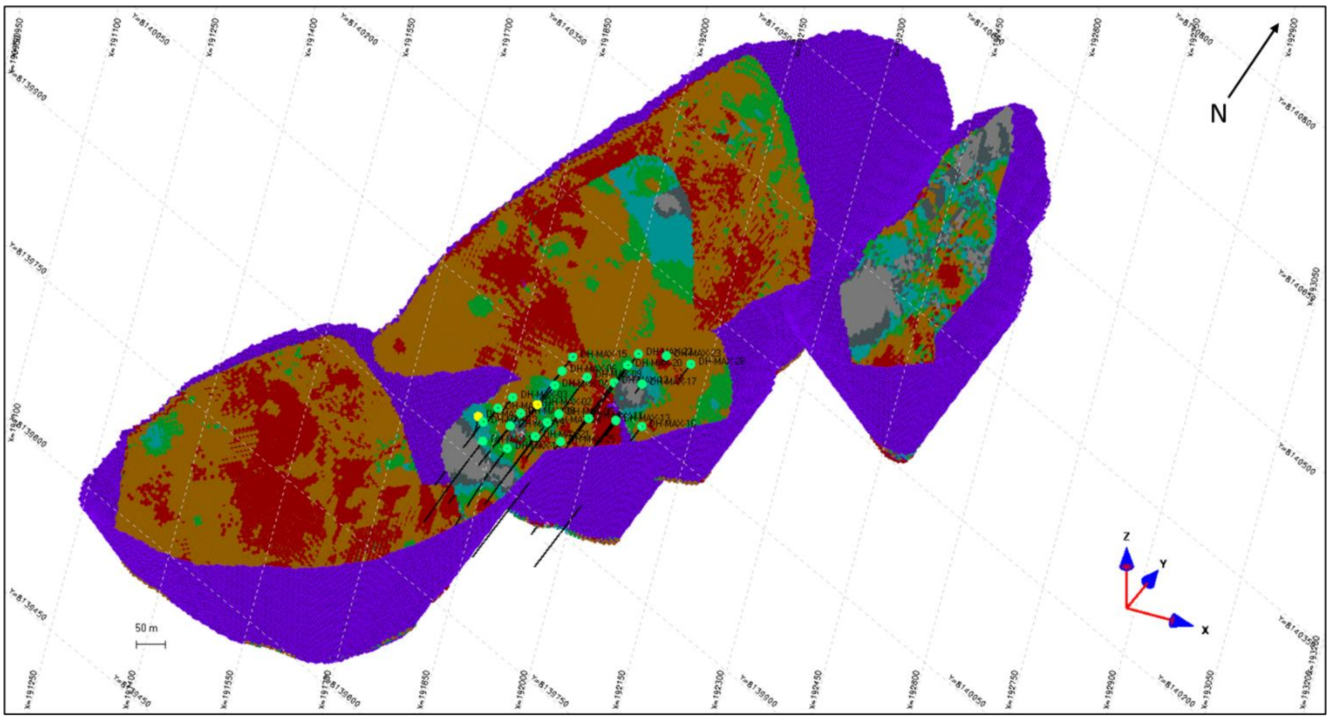


Figure 14-34: Maxixe Deposit Mineral Resource Block Model and Revenue Factor 1 Pit

14.4.11 Mineral Resource Estimation

The Mineral Resource estimate is reported in Table 14-20 using a 0.3% Li_2O cut-off. The Mineral Resources are constrained by the topography and based on the conceptual economic parameters detailed in Table 14-24. 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: Maxixe Deposit Mineral Resource Estimate

Cut-off Grade Li_2O (%)	Category	Tonnage (Mt)	Average Grade Li_2O (%)	LCE (Kt)
0.3	Measured	-	-	-
0.3	Indicated	-	-	-
0.3	**Measured + Indicated**	**-**	**-**	**-**
0.3	Inferred	1.6	1.35	53.4

Notes to accompany Mineral Resource table:

1. Mineral Resources have an effective date of the 18th January, 2024 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. All Resources are presented undiluted and in situ, constrained by continuous 3D wireframe models, and are considered to have reasonable prospects for eventual economic extraction.
3. Mineral Resources are reported assuming open pit mining methods, and the following assumptions: lithium concentrate (6% Li_2O) price of US$1,300/t, mining costs of US$2.2/t for mineralization and waste, crushing and processing costs of US$10.7/t, general and administrative (G&A) costs of US$4/t, concentrate recovery of 60%, 2% royalty payment, pit slope angles of 55º, and an overall cut-off grade of 0.3% Li_2O.
4. Tonnages and grades have been rounded in accordance with reporting guidelines. Totals may not sum due to rounding.
5. Mineral resources which are not mineral reserves do not have demonstrated economic viability. An Inferred Mineral Resource has a lower level of confidence than that applying to a Measured and Indicated Mineral Resource and must not be converted to a Mineral Reserve. It is reasonably expected that the majority of Inferred Mineral Resources could be upgraded to Indicated Mineral Resources with continued exploration.
6. The results from the pit optimization are used solely for the purpose of testing the "reasonable prospects for economic extraction" by an open pit and do not represent an attempt to estimate mineral reserves. The results are used as a guide to assist in the preparation of a Mineral Resource statement and to select an appropriate resource reporting cut-off grade.
7. The estimate of Mineral Resources may be materially affected by environmental, permitting, legal, title, taxation, socio-political, marketing, or other relevant issues.

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.

14.5 TAMBORIL DEPOSIT

14.5.1 Exploratory Data Analysis

The final database used for the Tamboril pegmatite mineral resource estimation was transmitted to SGS by SMSA on the 12th January 2024 in Microsoft Excel format and Datamine format. The database validation steps are discussed in Section 12. The database comprised 19 drill holes with entries for:

- Down hole surveys (n = 1,339)
- Assays (n = 424)
- Lithologies (n = 254)

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 14-35 is a drill collar location plan.

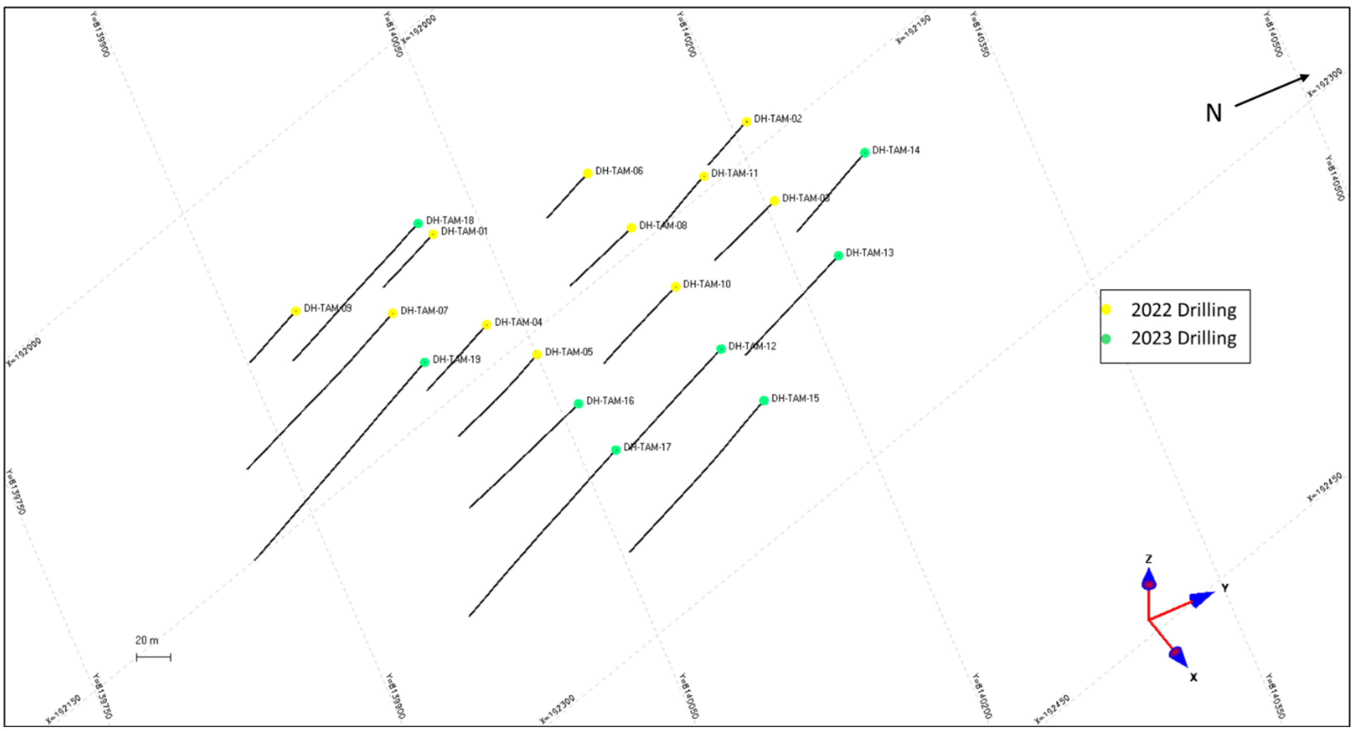


Figure 14-35: Tamboril Drill Hole Collar Locations

14.5.2 Analytical Data

There is a total of 424 assay intervals in the database used for the Mineral Resource estimate; 88 assays are contained inside the interpreted mineralized solids.

Table 14-21 shows the range of Li_2O values from the analytical data.

Table 14-21: Tamboril Assay Statistics Inside Mineralized Solids

	Li_2O (%)
Count	88
Mean	0.99
Std. Dev.	0.77
Min	0.005
Median	0.93
Max	4.38

14.5.3 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 began at the top of the mineralized wireframe and continued to the end of the mineralized wireframe. No capping was applied on the analytical composite data.

Table 14-22 shows the grade statistics of the analytical composites used for the interpolation of the resource block model.

Table 14-22: Tamboril 1 m Composite Statistics

	Li_2O (%)
Count	81
Mean	1.03
Std. Dev.	0.61
Min	0.015
Median	1.02
Max	2.85

14.5.4 Density

Density determinations are outlined in Section 11.3. An average density value of 2.68 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.

14.5.5 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 010° and a dip averaging -60° to the east.

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 14-36 shows the final 3D wireframe solids in isometric view with the drill hole pierce points.

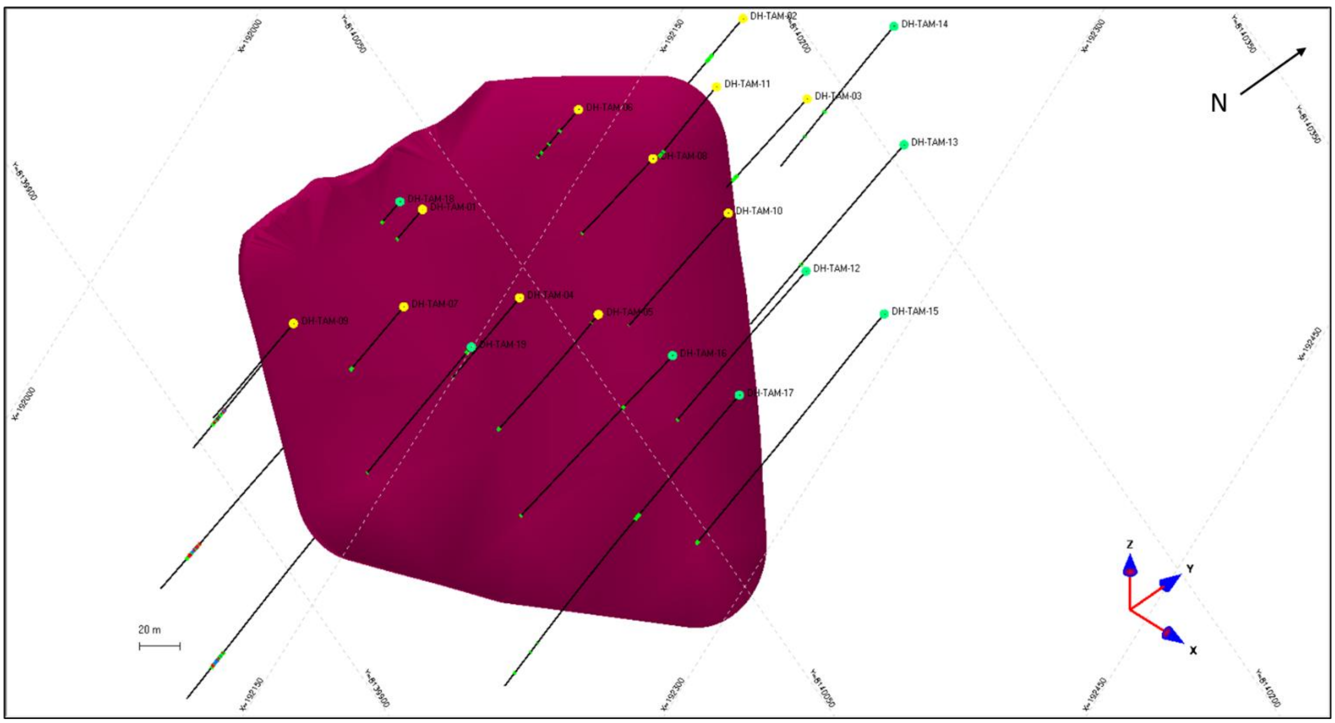


Figure 14-36: Tamboril Pegmatite Solid

14.5.6 Resource Block Modeling

A block size of 5 m (northeast–southwest) by 5 m (northwest–southeast) by 5 m (vertical) was selected for the Tamboril 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

Tamboril. The resource block model contains 5,984 blocks located inside the mineralized solids, for a total volume of 285,755 m^3. Table 14-23 summarizes the block model limit parameters.

Table 14-23: Tamboril 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	308	191,152	192,687
North–south (y)	5	458	8,138,971	8,141,256
Elevation (z)	5	163	-228	582

14.5.7 Block Model Interpolation

The grade interpolation for the Maxixe resource block model was completed using an inverse distance weighting to the second power (ID^2) 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 ID^2 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.

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 50 m (long axis) by 50 m (intermediate axis) and 25 m (short axis) with an orientation of 180º azimuth and -55º dip. 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. 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). The purpose of the last interpolation pass was to interpolate the remaining un-estimated blocks mostly located at the edges of the block mode.

Figure 14-37 illustrates the three search ellipsoids used for the different interpolation passes. Figure 14-38 shows the results of the block model interpolation in longitudinal view.

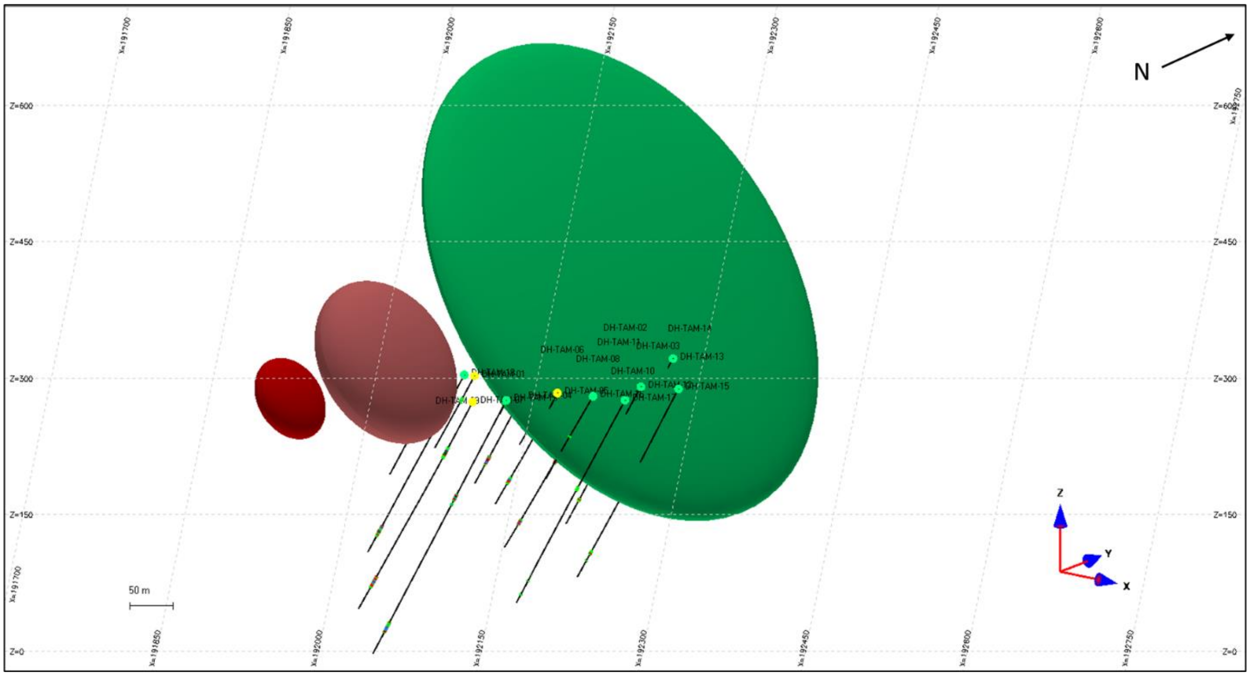


Figure 14-37: Isometric View of Tamboril Search Ellipses

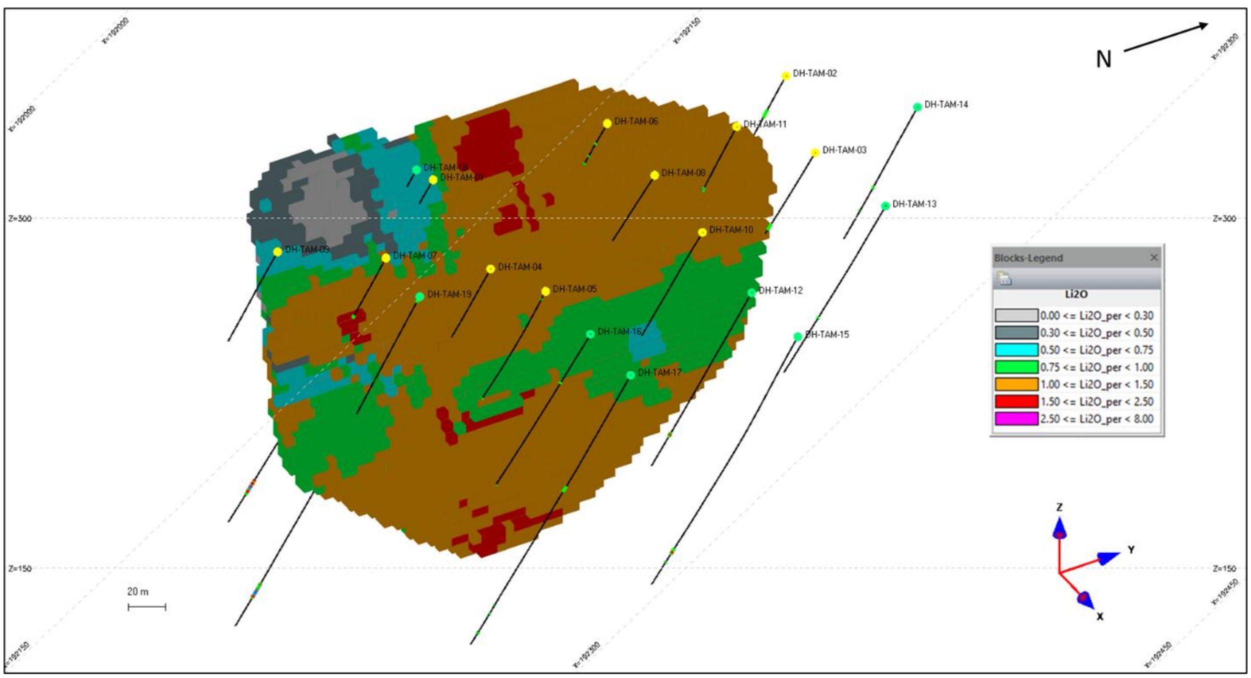
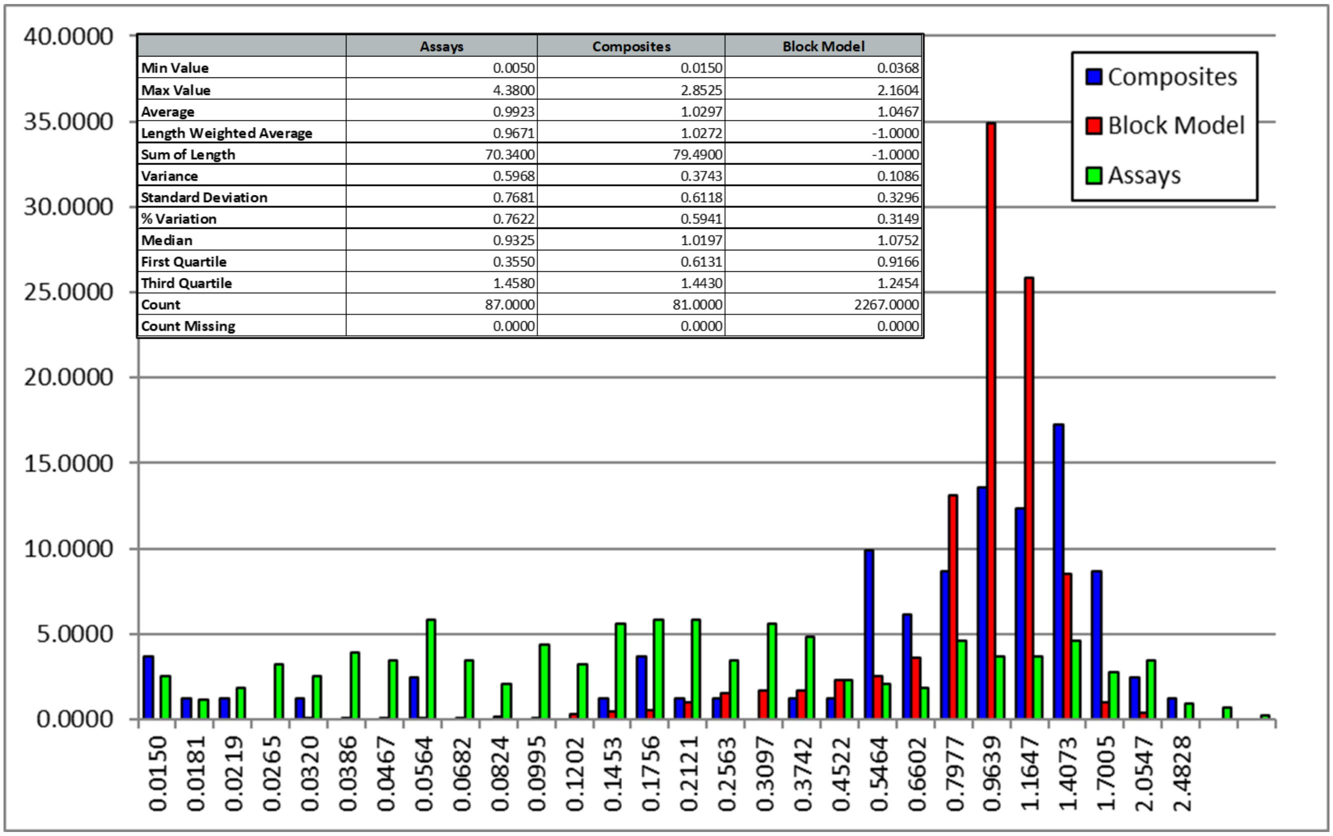


Figure 14-38: Isometric View of Tamboril Interpolated Block Model

14.5.8 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 14-39).



	Assays	Composites	Block Model
Min Value	0.0050	0.0150	0.0368
Max Value	4.3800	2.8525	2.1604
Average	0.9923	1.0297	1.0467
Length Weighted Average	0.9671	1.0272	-1.0000
Sum of Length	70.3400	79.4900	-1.0000
Variance	0.5968	0.3743	0.1086
Standard Deviation	0.7681	0.6118	0.3296
% Variation	0.7622	0.5941	0.3149
Median	0.9325	1.0197	1.0752
First Quartile	0.3550	0.6131	0.9166
Third Quartile	1.4580	1.4430	1.2454
Count	87.0000	81.0000	2267.0000
Count Missing	0.0000	0.0000	0.0000

Figure 14-39: Statistical Comparison of Tamboril Assay, Composite and Block Data

The assays and composites have respective averages of 0.99% Li_2O and 1.03% Li_2O with variances of 0.60 and 0.37. The interpolated blocks have and average value of 1.05% Li_2O with a variance of 0.11.

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 0.15 (R^2) was established between the blocks and the composites (Figure 14-40). This confirms what can be seen in Figure 14-39, namely that the block model is smoothed in relation to the composites. It is the opinion of the QP that this level of smoothing is acceptable for this type of deposit.

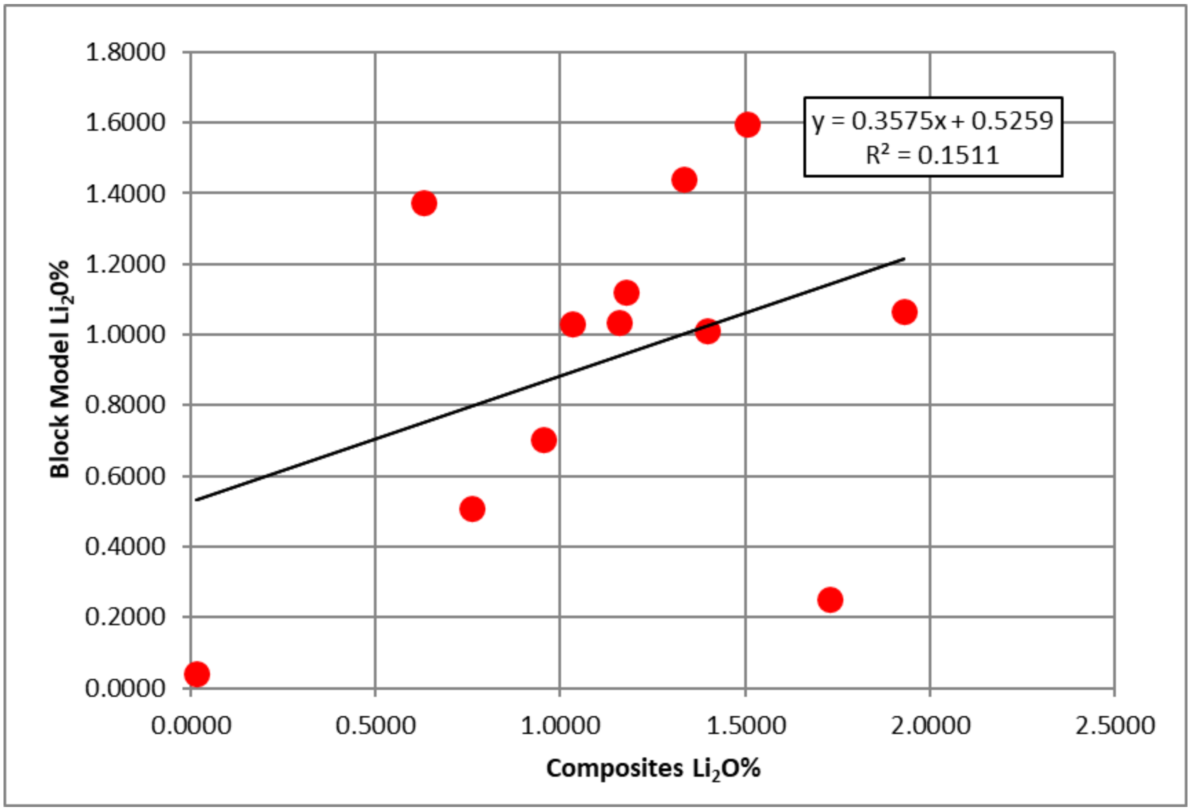


Figure 14-40: Tamboril Block Values Versus Composites Inside Those Blocks

14.5.9 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 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 50 m (strike) by 50 m (dip) by 25 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 14-41 is an isometric view showing the final classification.

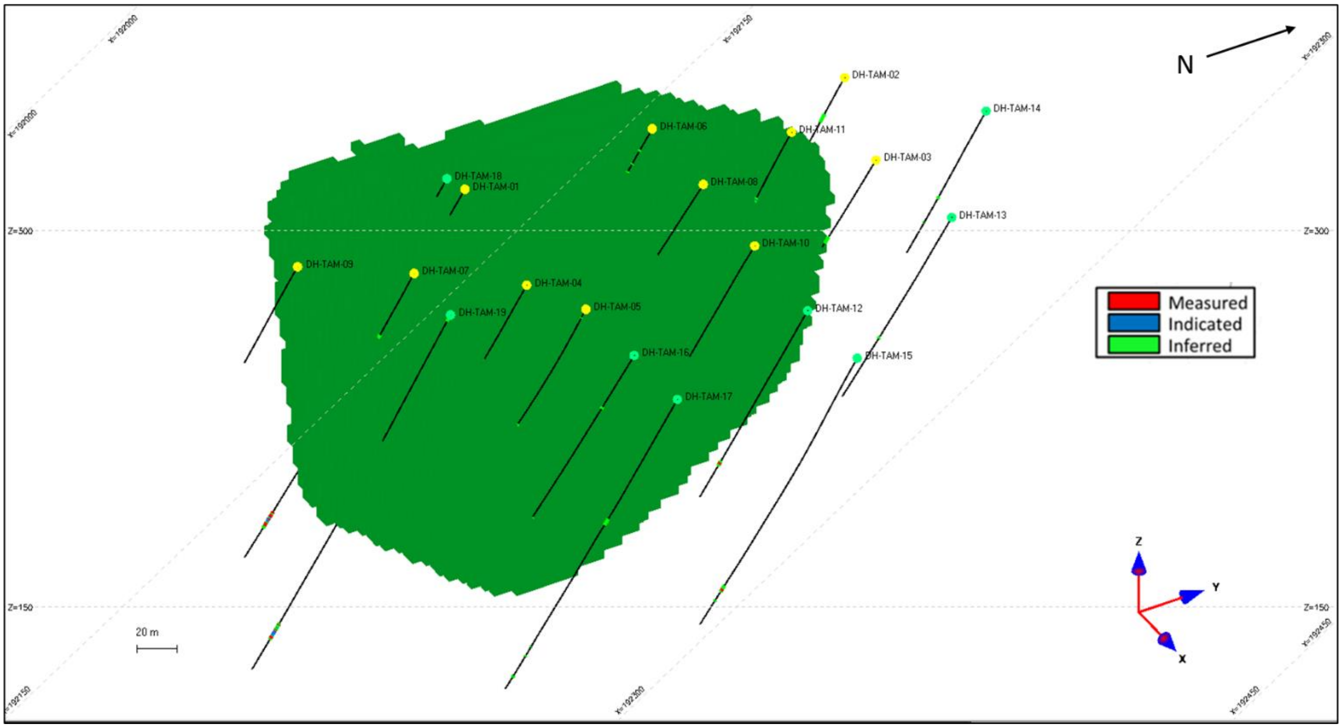


Figure 14-41: Tamboril Block Model Classification

14.5.10 Reasonable Prospects of Eventual Economic Extraction

The general requirement that all mineral resources have "reasonable prospects for eventual economic extraction" implies that the quantity and grade estimates meet certain economic thresholds and that the mineral resources are reported at an appropriate cut-off grade considering extraction scenarios and processing recoveries. To meet this requirement, the lithium mineralization of the Maxixe deposit is considered amenable to open pit extraction.

To determine the quantity of material representing "reasonable prospects for eventual economic extraction" by an open pit mining method, Whittle pit optimization software was used with reasonable mining and economic assumptions. The pit optimization for the Maxixe deposit was completed by SGS for the current MRE. The pit optimization parameters used are summarized in Table 14-24. A conservative and balanced approach was applied when optimizing the open pit scenario. A Whittle pit shell at a revenue factor of 1.0 ($1,300/t concentrate price) was selected as the ultimate pit shell for the purposes of the MRE for the LDM deposit.

During the modelling process, the proximity of the NDC, Lavra do Meoi and Maxixe pegmatites to the Tamboril pegmatite was noted. Various open pit options for the four mineralized areas were investigated, but ultimately, it was determined that the best option for reasonable prospects for eventual economic extraction was a single pit encompassing all four zones. Figure 14-42 shows the pit with all the mineralized surfaces.

The reader is cautioned that the results from the pit optimization are used solely for the purpose of testing the "reasonable prospects for economic extraction" by an open pit and do not represent an attempt to estimate mineral reserves. The results are used as a guide to assist in the preparation of a mineral resource statement and to select an appropriate resource reporting cut-off grade.

Table 14-24: Tamboril Parameters for Reasonable Prospect for Eventual Economic Extraction

Parameter	Unit	Value
Concentrate Price (6% Li_2O)	US$ per tonne	$1,300
Pit Slope	Degrees	60
Mining Cost	US$ per tonne mined	$2.20
Processing Cost & G&A	US$ per tonne milled	$16.46
Mining Recovery	Percent (%)	95
Concentration Recovery (DMS)	Percent (%)	60
Royalties	Percent (%)	2
Mining loss / Dilution	Percent (%) / Percent (%)	5 / 5
Cut-off Grade	Percent (%) Li_2O	0.3

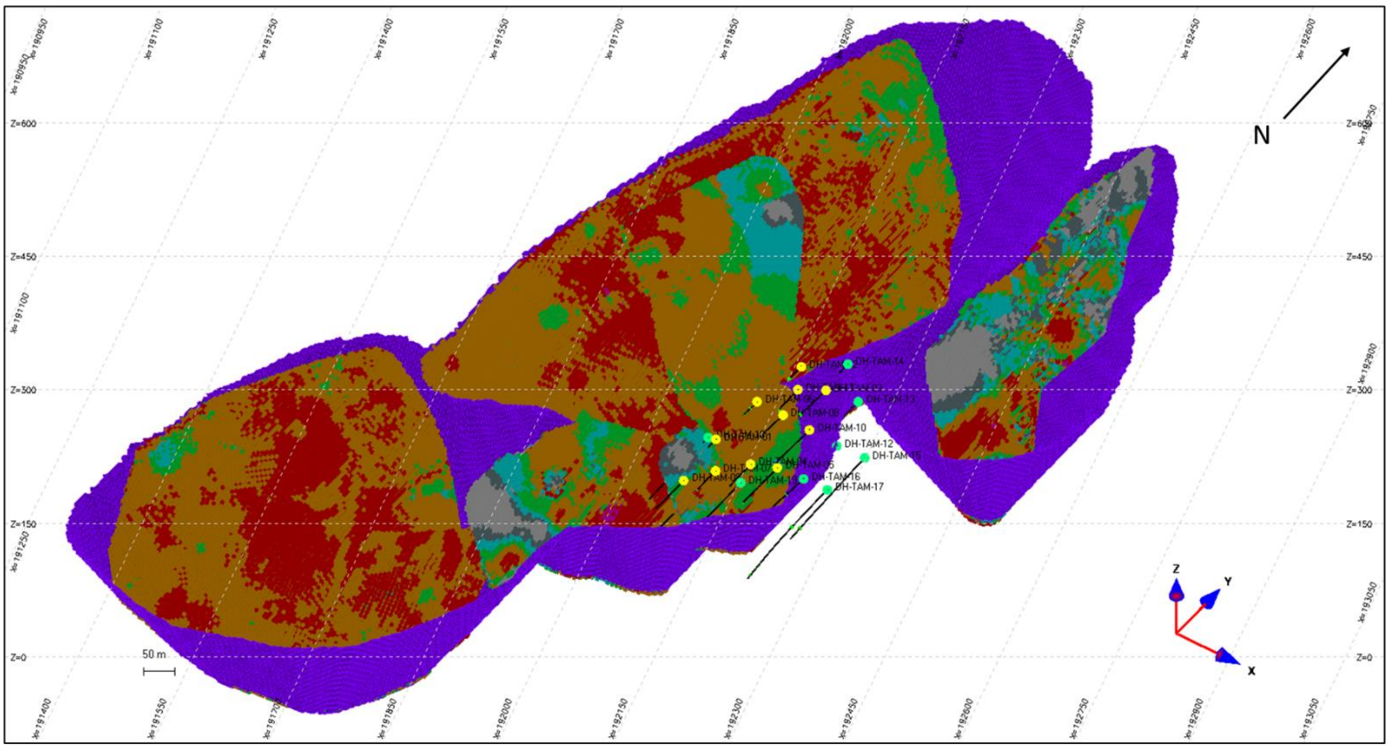


Figure 14-42: Tamboril Deposit Mineral Resource Block Model and Revenue Factor 1 Pit

14.5.11 Mineral Resource Estimation

The Mineral Resource estimate is reported in Table 14-25 using a 0.3% Li_2O cut-off. The Mineral Resources are constrained by the topography and based on the conceptual economic parameters detailed in Table 14-24. 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 14-25: Tamboril Deposit Mineral Resource Estimate

Cut-off Grade Li_2O (%)	Category	Tonnage (Mt)	Average Grade Li_2O (%)	LCE (Kt)
0.3	Measured	-	-	-
0.3	Indicated	-	-	-
0.3	**Measured + Indicated**	**-**	**-**	**-**
0.3	Inferred	0.7	1.05	18.1

Notes to accompany Mineral Resource table:

1. Mineral Resources have an effective date of the 18th January, 2024 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. All Resources are presented undiluted and in situ, constrained by continuous 3D wireframe models, and are considered to have reasonable prospects for eventual economic extraction.
3. Mineral Resources are reported assuming open pit mining methods, and the following assumptions: lithium concentrate (6% Li_2O) price of US$1,300/t, mining costs of US$2.2/t for mineralization and waste, crushing and processing costs of US$10.7/t, general and administrative (G&A) costs of US$4/t, concentrate recovery of 60%, 2% royalty payment, pit slope angles of 55º, and an overall cut-off grade of 0.3% Li_2O.
4. Tonnages and grades have been rounded in accordance with reporting guidelines. Totals may not sum due to rounding.
5. Mineral resources which are not mineral reserves do not have demonstrated economic viability. An Inferred Mineral Resource has a lower level of confidence than that applying to a Measured and Indicated Mineral Resource and must not be converted to a Mineral Reserve. It is reasonably expected that the majority of Inferred Mineral Resources could be upgraded to Indicated Mineral Resources with continued exploration.
6. The results from the pit optimization are used solely for the purpose of testing the “reasonable prospects for economic extraction” by an open pit and do not represent an attempt to estimate mineral reserves. The results are used as a guide to assist in the preparation of a Mineral Resource statement and to select an appropriate resource reporting cut-off grade.
7. The estimate of Mineral Resources may be materially affected by environmental, permitting, legal, title, taxation, socio-political, marketing, or other relevant issues.

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.

14.6 ELVIRA DEPOSIT

14.6.1 Exploratory Data Analysis

The final database used for the Elvira pegmatite mineral resource estimation was transmitted to SGS by SMSA on the 9th January 2024 in Microsoft Excel format and Datamine format. The database validation steps are discussed in Section 12. The database comprised nine drill holes with entries for:

- Down hole surveys (n = 128)
- Assays (n = 207)
- Lithologies (n = 108)

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 14-43 is a drill collar location plan.

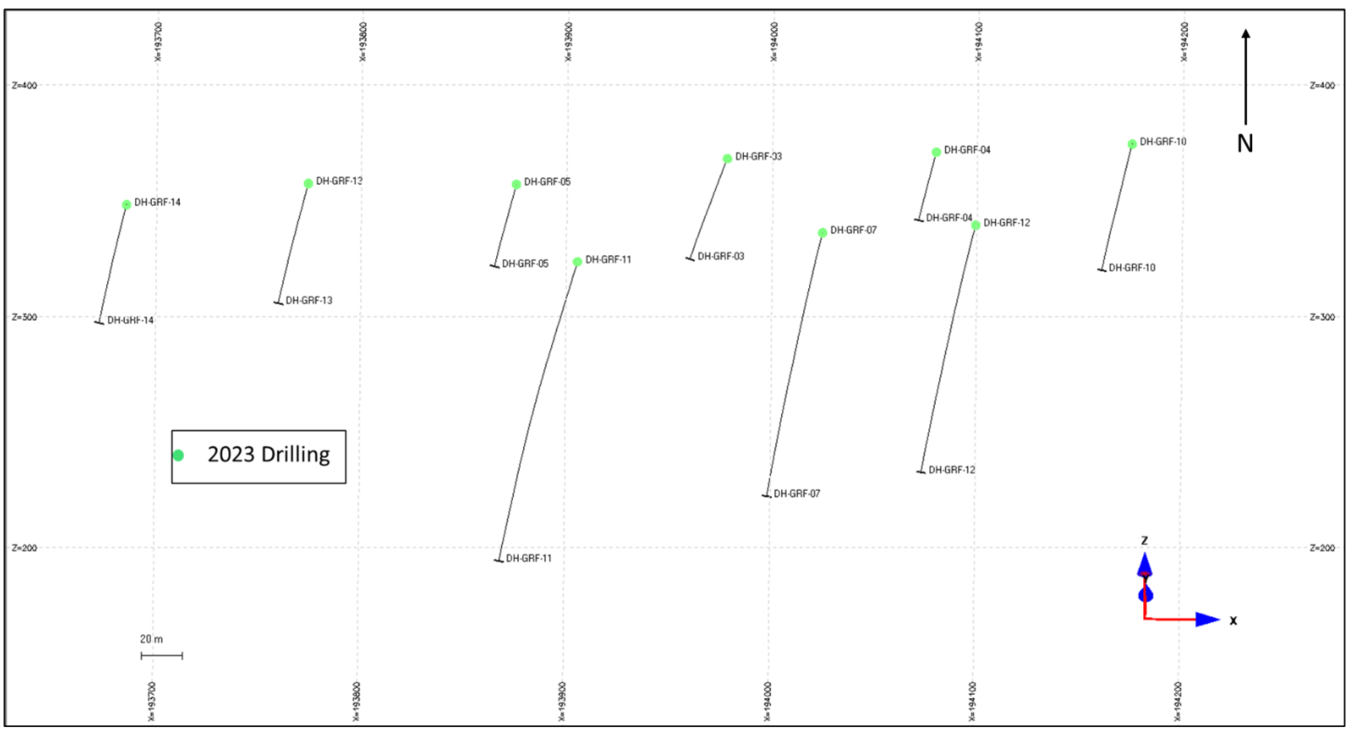


Figure 14-43: Elvira Drill Hole Collar Locations

14.6.2 Analytical Data

There is a total of 224 assay intervals in the database used for the Mineral Resource estimate; 103 assays are contained inside the interpreted mineralized solids.

Table 14-26 shows the range of Li_2O values from the analytical data.

Table 14-26: Elvira Assay Statistics Inside Mineralized Solids

	Li_2O (%)
Count	103
Mean	1.25
Std. Dev.	0.64
Min	0.053
Median	1.26
Max	2.62

14.6.3 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 began at the top of the mineralized wireframe and continued to the end of the mineralized wireframe. No capping was applied on the analytical composite data.

Table 14-27 shows the grade statistics of the analytical composites used for the interpolation of the resource block model.

Table 14-27: Elvira 1 m Composite Statistics

	Li_2O (%)
Count	70
Mean	1.38
Std. Dev.	0.57
Min	0.02
Median	1.18
Max	2.37

14.6.4 Density

Density determinations are outlined in Section 11.3. An average density value of 2.70 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.

14.6.5 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 077° and a dip averaging -75° to the south.

The mineralized solids were clipped directly on the DEM surface.

Figure 14-44 shows the final 3D wireframe solids in isometric view with the drill hole pierce points.

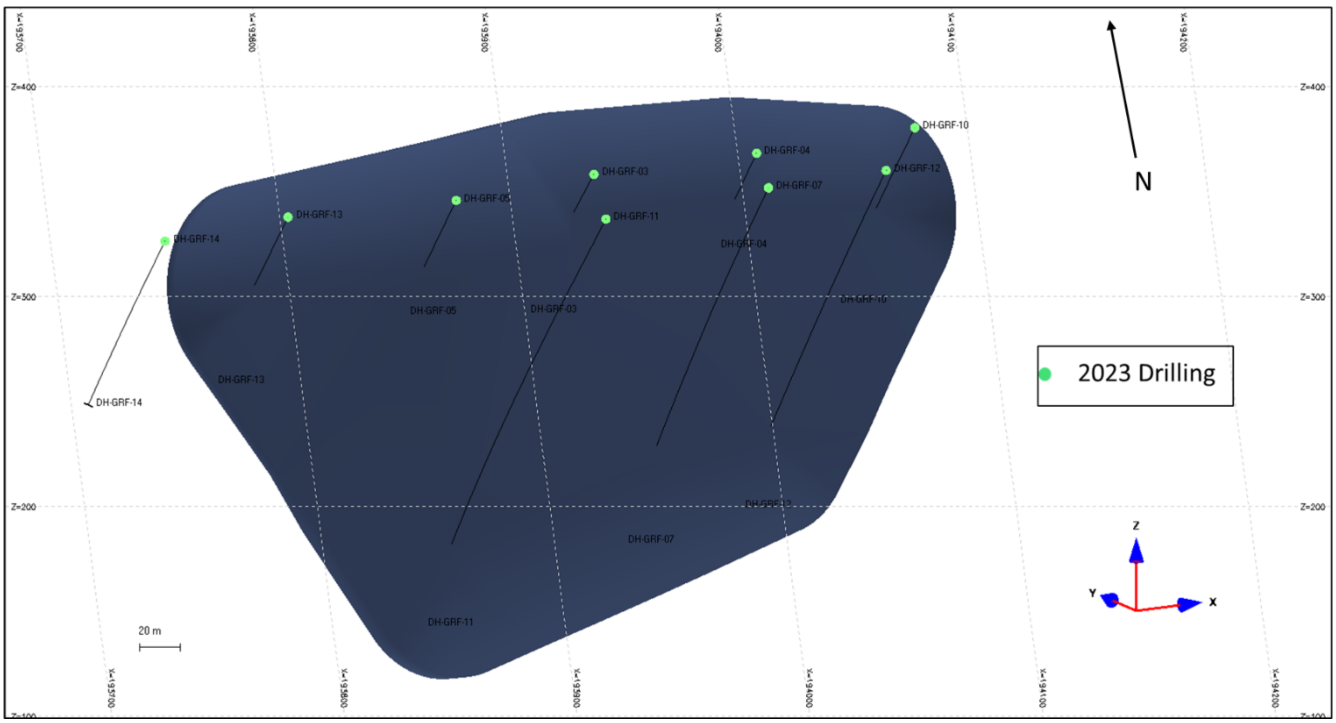


Figure 14-44: Elvira Pegmatite Solid

14.6.6 Resource Block Modeling

A block size of 5 m (northeast–southwest) by 5 m (northwest–southeast) by 5 m (vertical) was selected for the Tamboril 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 Tamboril. The resource block model contains 12,811 blocks located inside the mineralized solids, for a total volume of 943,130 m^3. Table 14-28 summarizes the block model limit parameters.

Table 14-28: Elvira 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	118	193,628	194,213
North–south (y)	5	161	8,135,928	8,136,728
Elevation (z)	5	73	76	436

14.6.7 Block Model Interpolation

The grade interpolation for the Elvira resource block model was completed using an inverse distance weighting to the second power (ID^2) 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 ID^2 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.

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 50 m (long axis) by 50 m (intermediate axis) and 25 m (short axis) with an orientation of 75º azimuth and -75º dip. 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. 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). The purpose of the last interpolation pass was to interpolate the remaining un-estimated blocks mostly located at the edges of the block mode.

Figure 14-45 illustrates the three search ellipsoids used for the different interpolation passes. Figure 14-46 shows the results of the block model interpolation in longitudinal view.

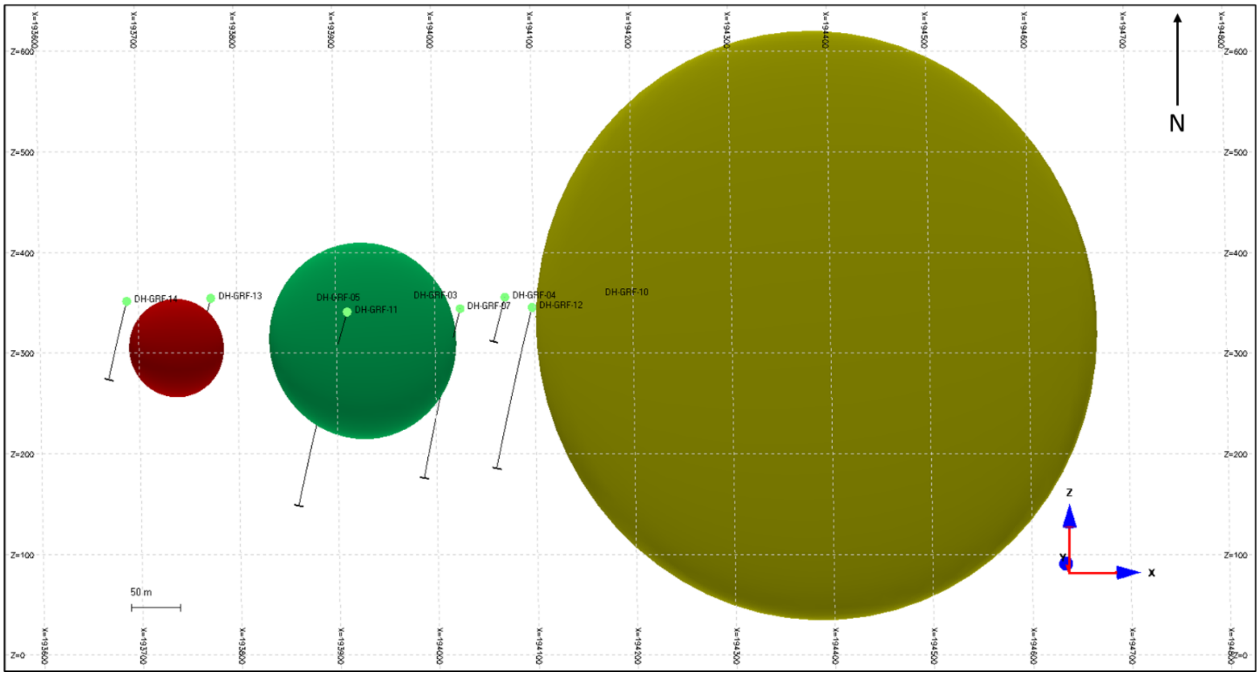


Figure 14-45: Isometric View of Elvira Search Ellipses

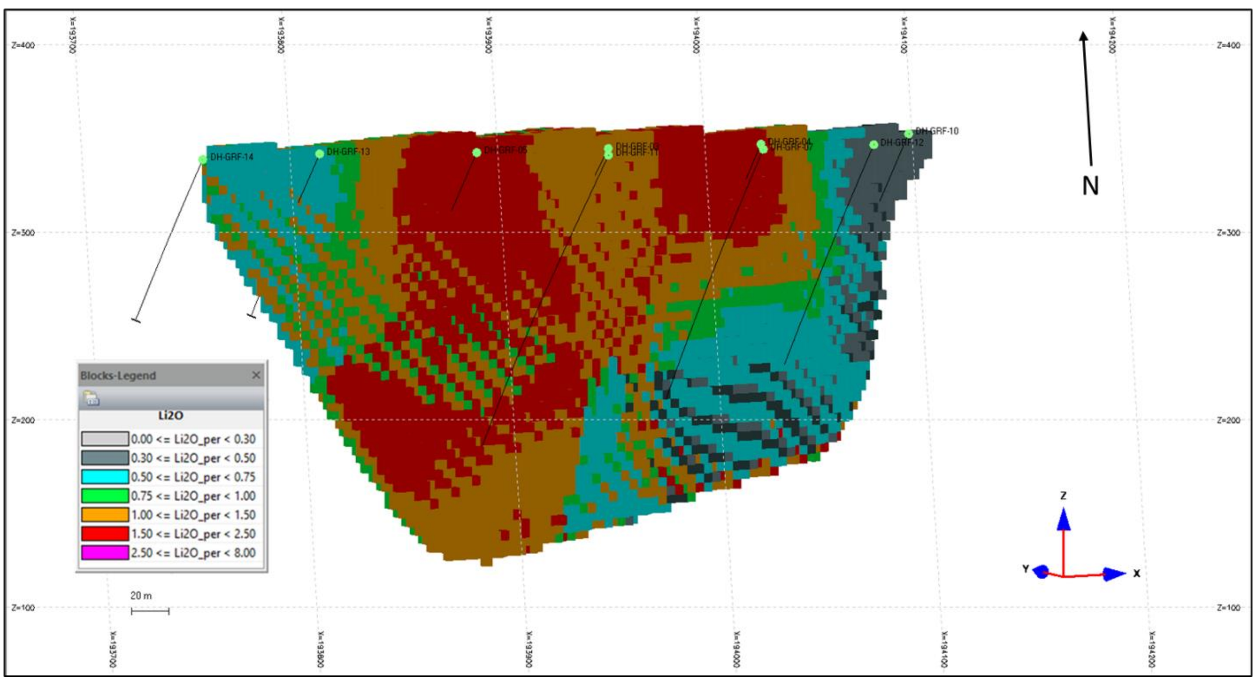
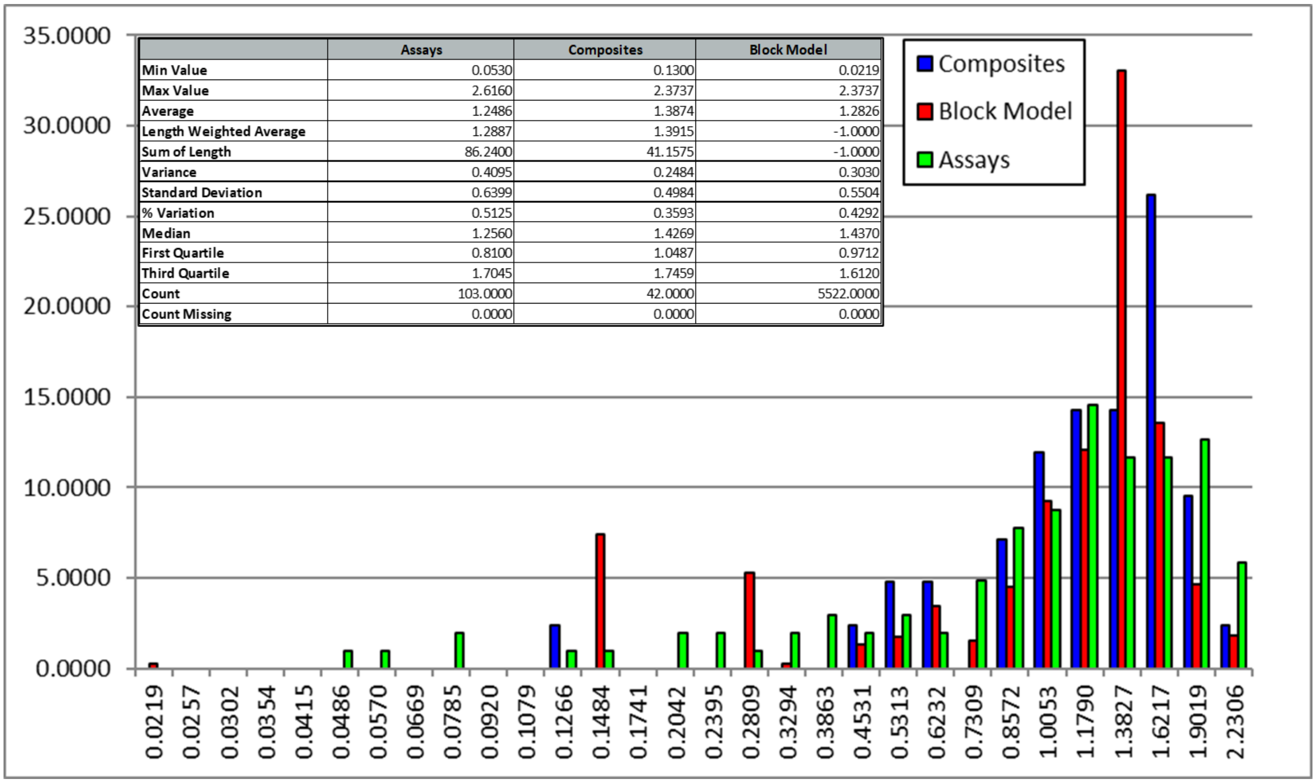


Figure 14-46: Isometric View of Elvira Interpolated Block Model

14.6.8 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 14-47).



	Assays	Composites	Block Model
Min Value	0.0530	0.1300	0.0219
Max Value	2.6160	2.3737	2.3737
Average	1.2486	1.3874	1.2826
Length Weighted Average	1.2887	1.3915	-1.0000
Sum of Length	86.2400	41.1575	-1.0000
Variance	0.4095	0.2484	0.3030
Standard Deviation	0.6399	0.4984	0.5504
% Variation	0.5125	0.3593	0.4292
Median	1.2560	1.4269	1.4370
First Quartile	0.8100	1.0487	0.9712
Third Quartile	1.7045	1.7459	1.6120
Count	103.0000	42.0000	5522.0000
Count Missing	0.0000	0.0000	0.0000

Figure 14-47: Statistical Comparison of Elvira Assay, Composite and Block Data

The assays and composites have respective averages of 1.25% Li_2O and 1.39% Li_2O with variances of 0.41 and 0.25. The interpolated blocks have and average value of 1.28% Li_2O with a variance of 0.55.

14.6.9 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 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 50 m (strike) by 50 m (dip) by 25 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 14-48 is an isometric view showing the final classification.

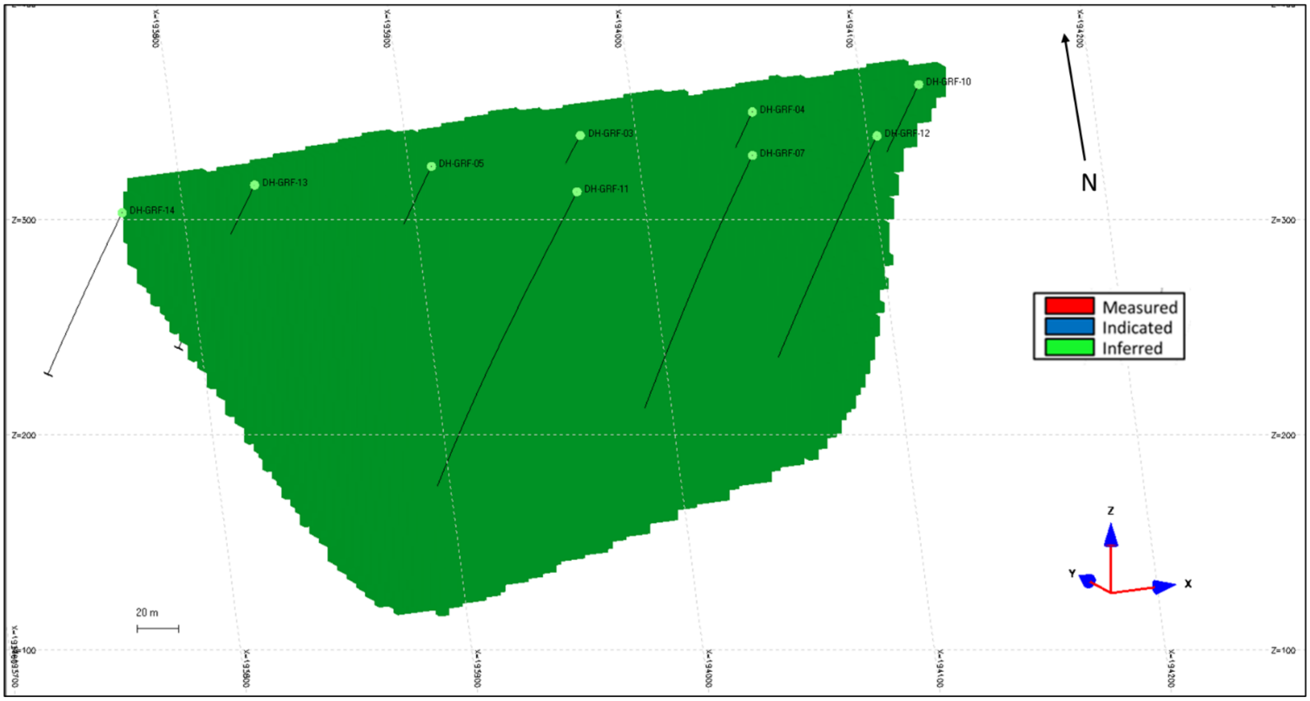


Figure 14-48: Elvira Block Model Classification

14.6.10 Reasonable Prospects of Eventual Economic Extraction

The general requirement that all mineral resources have “reasonable prospects for eventual economic extraction” implies that the quantity and grade estimates meet certain economic thresholds and that the mineral resources are reported at an appropriate cut-off grade considering extraction scenarios and processing recoveries. To meet this requirement, the lithium mineralization of the Maxixe deposit is considered amenable to open pit extraction.

To determine the quantity of material representing “reasonable prospects for eventual economic extraction” by an open pit mining method, Whittle pit optimization software was used with reasonable mining and economic assumptions. The pit optimization for the Maxixe deposit was completed by SGS for the current MRE. The pit optimization parameters used are summarized in Table 14-29. A conservative and balanced approach was applied when optimizing the open pit scenario. A Whittle pit shell at a revenue factor of 1.0 ($1,300/t concentrate price) was selected as the ultimate pit shell for the purposes of the MRE for the LDM deposit. Figure 14-42 shows the pit with all the mineralized surfaces.

The reader is cautioned that the results from the pit optimization are used solely for the purpose of testing the “reasonable prospects for economic extraction” by an open pit and do not represent an attempt to estimate mineral reserves. The results are used as a guide to assist in the preparation of a mineral resource statement and to select an appropriate resource reporting cut-off grade.

Table 14-29: Elvira Parameters for Reasonable Prospect for Eventual Economic Extraction

Parameter	Unit	Value
Concentrate Price (6% Li_2O)	US$ per tonne	$1,300
Pit Slope	Degrees	60
Mining Cost	US$ per tonne mined	$2.20
Processing Cost & G&A	US$ per tonne milled	$16.46
Mining Recovery	Percent (%)	95
Concentration Recovery (DMS)	Percent (%)	60
Royalties	Percent (%)	2
Mining loss / Dilution	Percent (%) / Percent (%)	5 / 5
Cut-off Grade	Percent (%) Li_2O	0.3

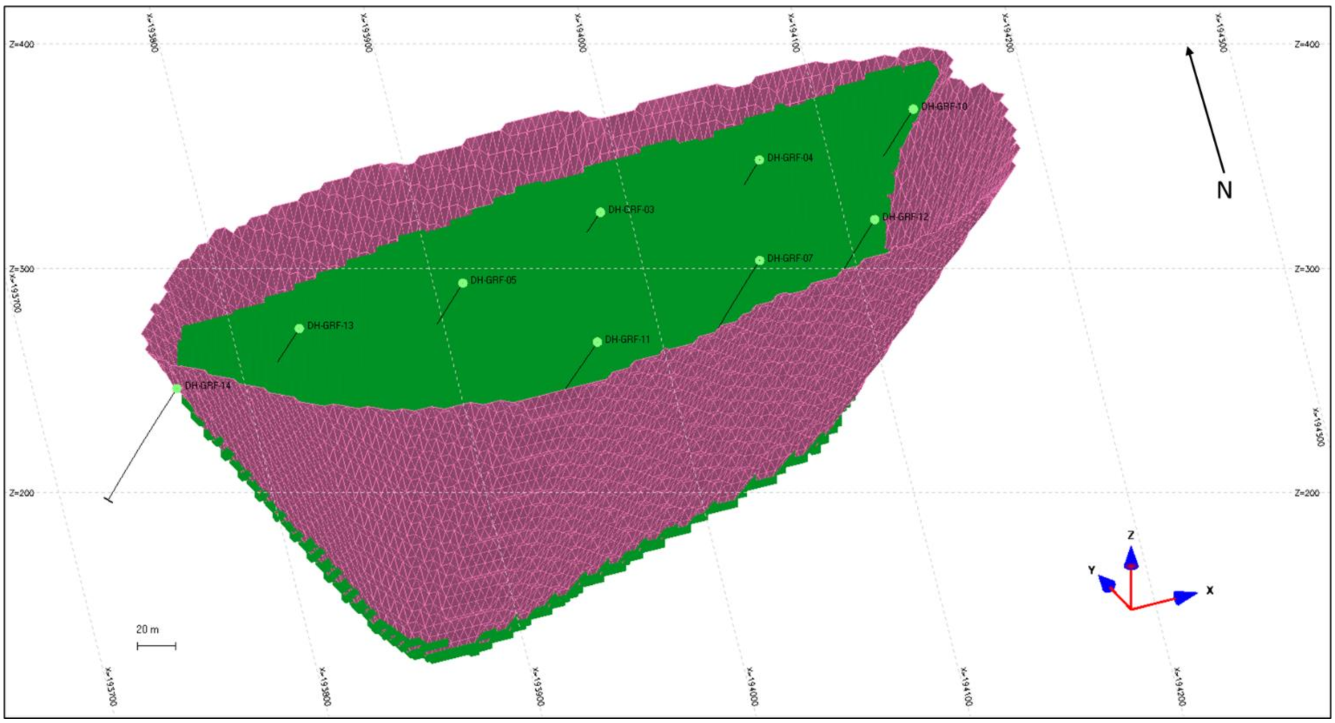


Figure 14-49: Elvira Deposit Mineral Resource Block Model and Revenue Factor 1 Pit

14.6.11 Mineral Resource Estimation

The Mineral Resource estimate is reported in Table 14-30 using a 0.3% Li_2O cut-off. The Mineral Resources are constrained by the topography and based on the conceptual economic parameters detailed in Table 14-24. 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 14-30: Elvira Deposit Mineral Resource Estimate

Cut-off Grade Li_2O (%)	Category	Tonnage (Mt)	Average Grade Li_2O (%)	LCE (Kt)
0.3	Measured	-	-	-
0.3	Indicated	-	-	-
0.3	**Measured + Indicated**	**-**	**-**	**-**
0.3	Inferred	2.1	1.16	60.2

Notes to accompany Mineral Resource table:

8. Mineral Resources have an effective date of the 18th January, 2024 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.
9. All Resources are presented undiluted and in situ, constrained by continuous 3D wireframe models, and are considered to have reasonable prospects for eventual economic extraction.
10. Mineral Resources are reported assuming open pit mining methods, and the following assumptions: lithium concentrate (6% Li_2O) price of US$1,300/t, mining costs of US$2.2/t for mineralization and waste, crushing and processing costs of US$10.7/t, general and administrative (G&A) costs of US$4/t, concentrate recovery of 60%, 2% royalty payment, pit slope angles of 55º, and an overall cut-off grade of 0.3% Li_2O.
11. Tonnages and grades have been rounded in accordance with reporting guidelines. Totals may not sum due to rounding.
12. Mineral resources which are not mineral reserves do not have demonstrated economic viability. An Inferred Mineral Resource has a lower level of confidence than that applying to a Measured and Indicated Mineral Resource and must not be converted to a Mineral Reserve. It is reasonably expected that the majority of Inferred Mineral Resources could be upgraded to Indicated Mineral Resources with continued exploration.
13. The results from the pit optimization are used solely for the purpose of testing the "reasonable prospects for economic extraction" by an open pit and do not represent an attempt to estimate mineral reserves. The results are used as a guide to assist in the preparation of a Mineral Resource statement and to select an appropriate resource reporting cut-off grade.
14. The estimate of Mineral Resources may be materially affected by environmental, permitting, legal, title, taxation, socio-political, marketing, or other relevant issues.

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

14.7 BARREIRO DEPOSIT

14.7.1 Exploratory Data Analysis

The final database used for the Barreiro pegmatite mineral resource estimation was transmitted to SGS by SMSA on January 22, 2022, in Microsoft® Excel format and Datamine format. The database validation steps are discussed in Section 12. The database comprises 128 drill holes with entries for:

- Down hole surveys (n = 8,455)
- Assays (n = 6,672)
- Lithologies (n = 2,174)

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 14-19 is a drill collar layout plan.

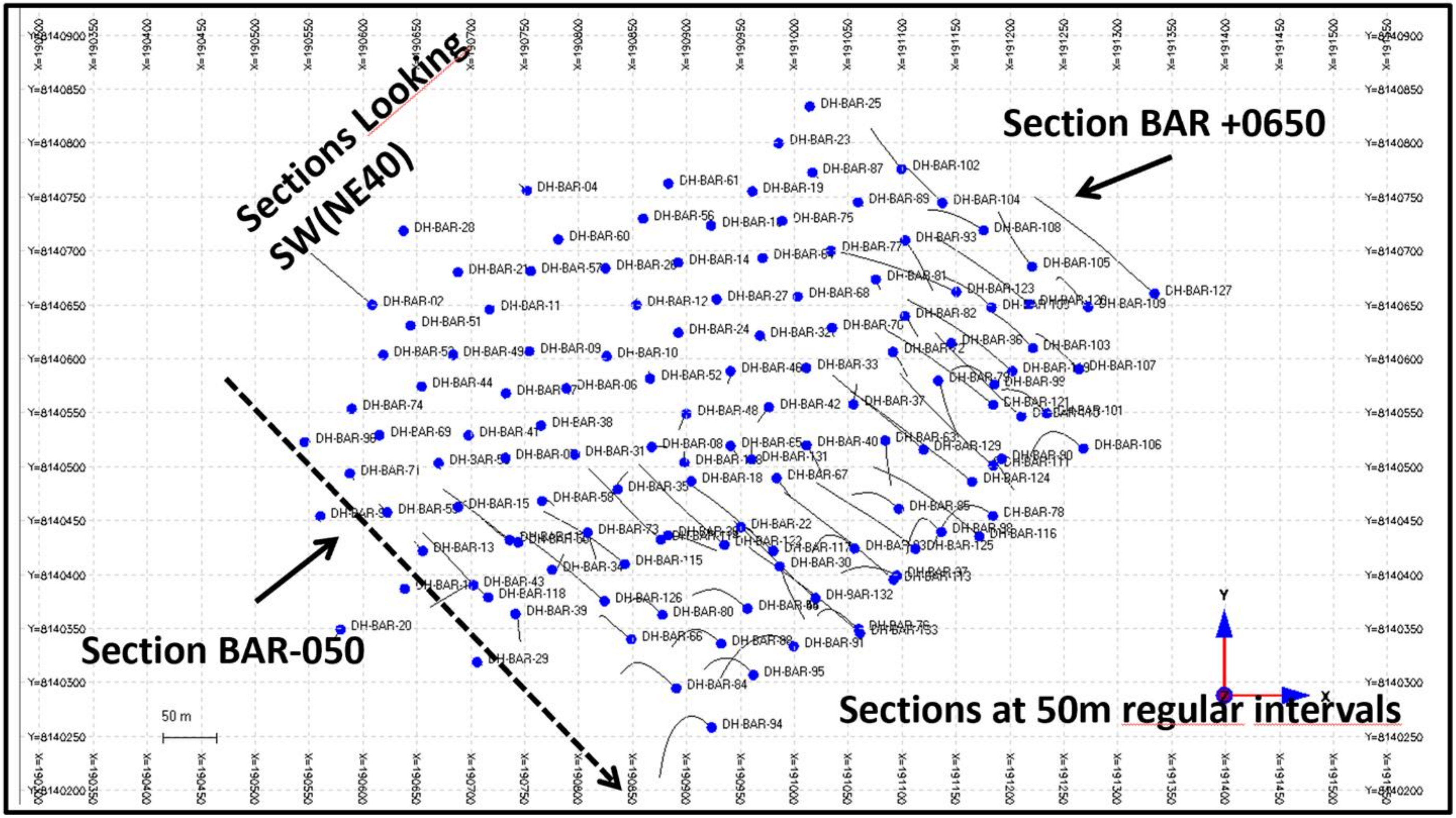


Figure 14-50: Barreiro Drillhole Collar Locations

Note: 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).

14.7.2 Analytical Data

There is a total of 6,672 assay intervals in the database that were used for the Barreiro Mineral Resource estimate; 4,493 assays are contained inside the interpreted mineralized solids. Most of the drill holes defining the mineralized solids have been sampled continuously. Table 14-11 shows the range of Li_2O values from the analytical data inside the mineralized solids.

Table 14-31: Barreiro Assay Statistics Inside Mineralized Solids

	Li_2O (%)
Count	4,493
Mean	1.40
Std. Dev.	1.04
Min	0.02
Median	1.27
Max	7.62

14.7.3 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 14-12 shows the statistics of the analytical composites used for the interpolation of the resource block model. Figure 14-20 shows an example histogram.

Table 14-32: Barreiro 1 m Composite Statistics

	Li_2O (%)
Count	3,604
Mean	1.38
Std. Dev.	0.90
Min	0.03
Median	1.31
Max	6.07

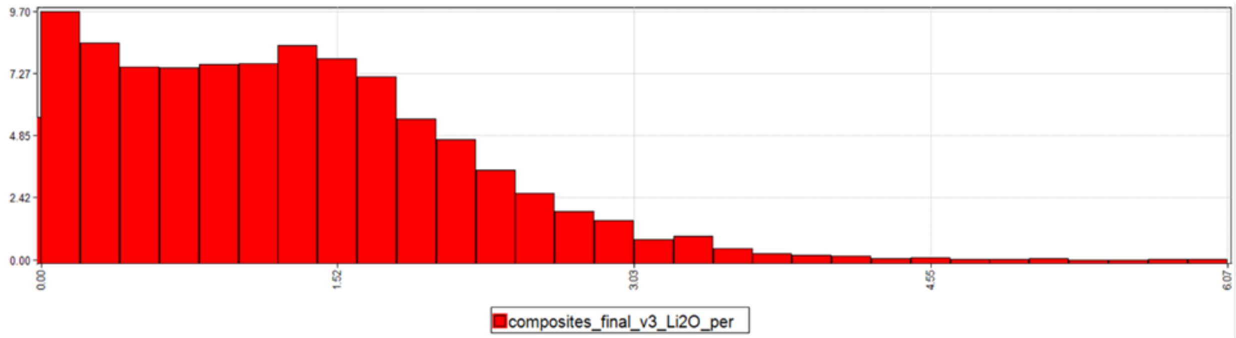


Figure 14-51: Barreiro 1 m Composite Histogram

14.7.4 Density

Density determinations are outlined in Section 11.3. An average density value of 2.72 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.

14.7.5 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. The final 3D wireframe model (solid) was constructed by linking the defined mineralized shapes based on the geological interpretation using a planar envelope model that uses an implicit modeling methodology.

The linked interpretation shows six pegmatite bodies, with a general orientation of azimuth 155° and a dip averaging -35° to the southeast. The pegmatite body was modelled with two main envelopes surrounded by four smaller pegmatite bodies above and below the main zone. The goal of the 2021 drilling program was to add more detail to the gap zone modeled in 2018 and to understand the fault system in Barreiro, if any. The results proved that the 2 main sections are linked and slightly folded on the center. No evidence of major faults was found in the drill core.

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 14-21 shows the 3D wireframe solids of the Barreiro pegmatite in isometric view with the drill hole pierce points.

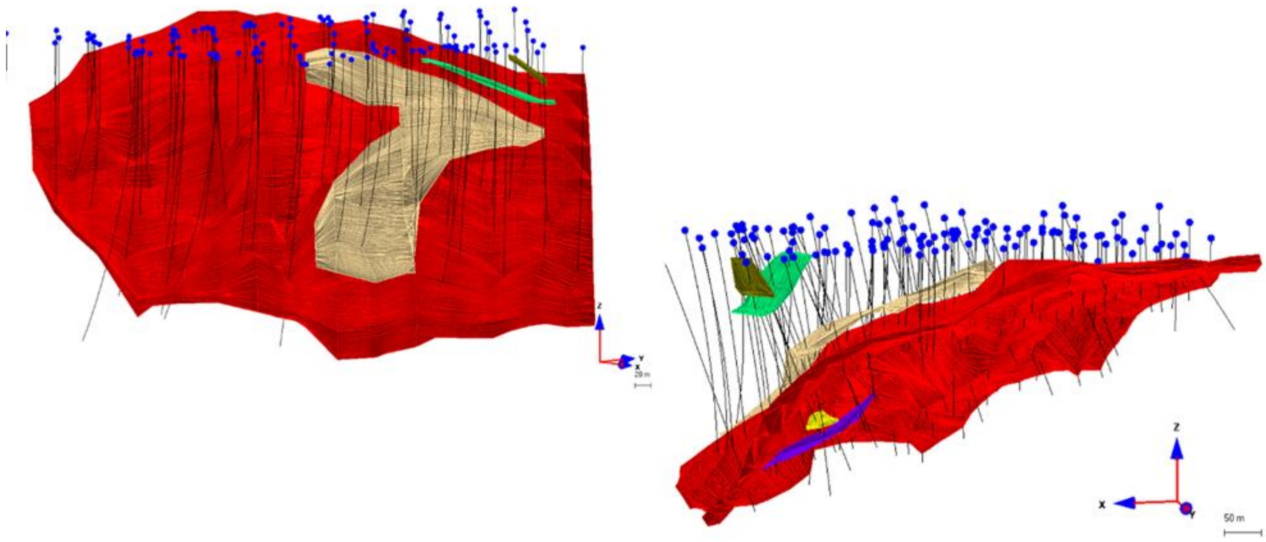


Figure 14-52: Sectional Interpretations of the Barreiro Pegmatite Unit (looking north and west)

14.7.6 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 117,371 blocks located inside the mineralized solids, for a total volume of 10,100,000 m^3. Table 14-13 summarizes the block model limit parameters.

Table 14-33: 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	219	190,356	191,446
North–south (y)	5	182	8,140,153	8,141,058
Elevation (z)	5	108	-143	392

14.7.7 Variography

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 0.90 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 14-22.

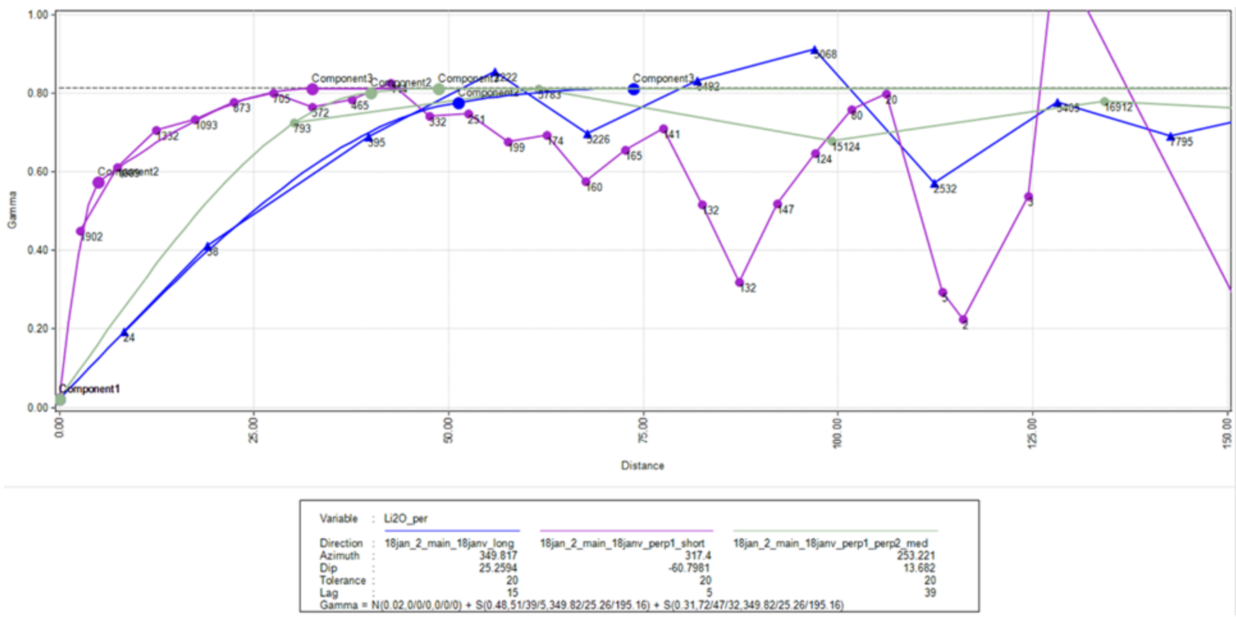


Figure 14-53: Barreiro Combined Correlogram

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 317º of azimuth and -29º dip. The long-distance model is therefore optimal in this preferred orientation.

14.7.8 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 50 m (long axis) by 50 m (intermediate axis) and 25 m (short axis) with an orientation of 317° azimuth, and -29° dip to the southeast which represents the general geometry of the pegmatites in the deposit. Using search conditions defined by a minimum of 11 composites, a maximum of 25 composites and a minimum of five 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 14-23 illustrates the three search ellipsoids used for the different interpolation passes. Figure 14-24 show the results of the block model interpolation in longitudinal view.

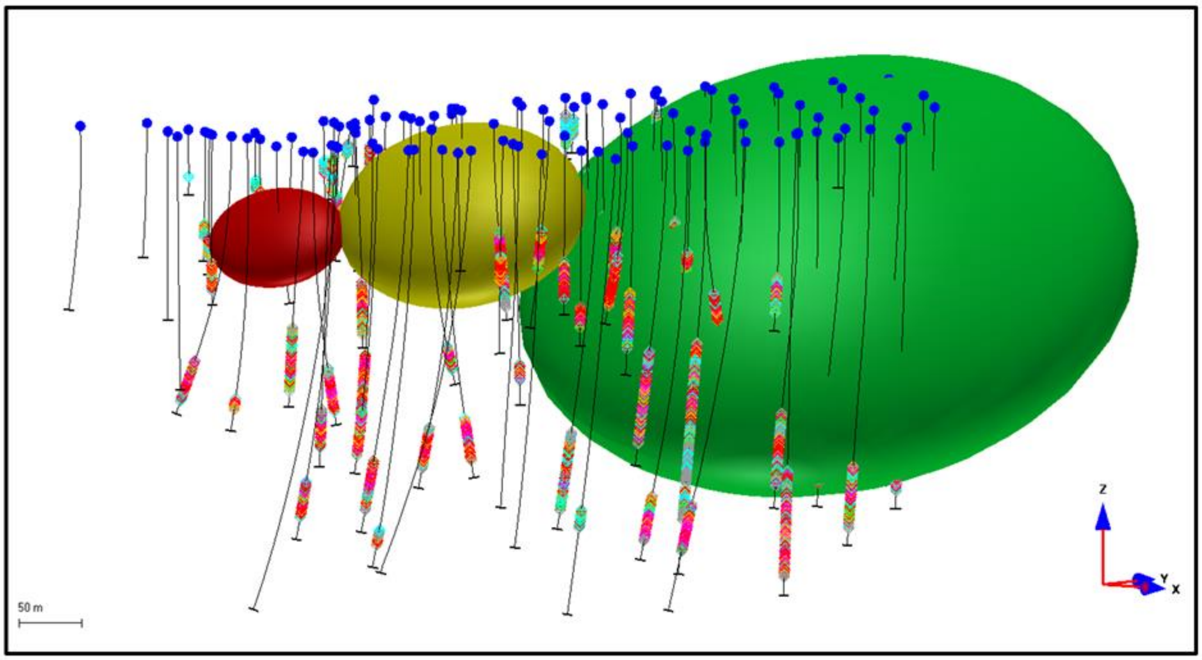


Figure 14-54: Isometric View of Barreiro Search Ellipses

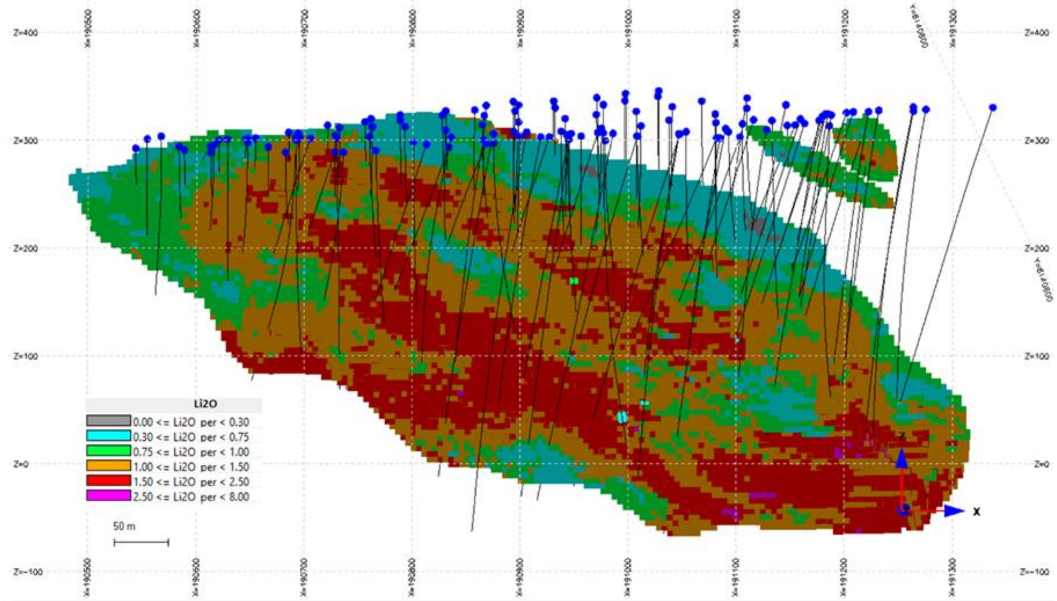
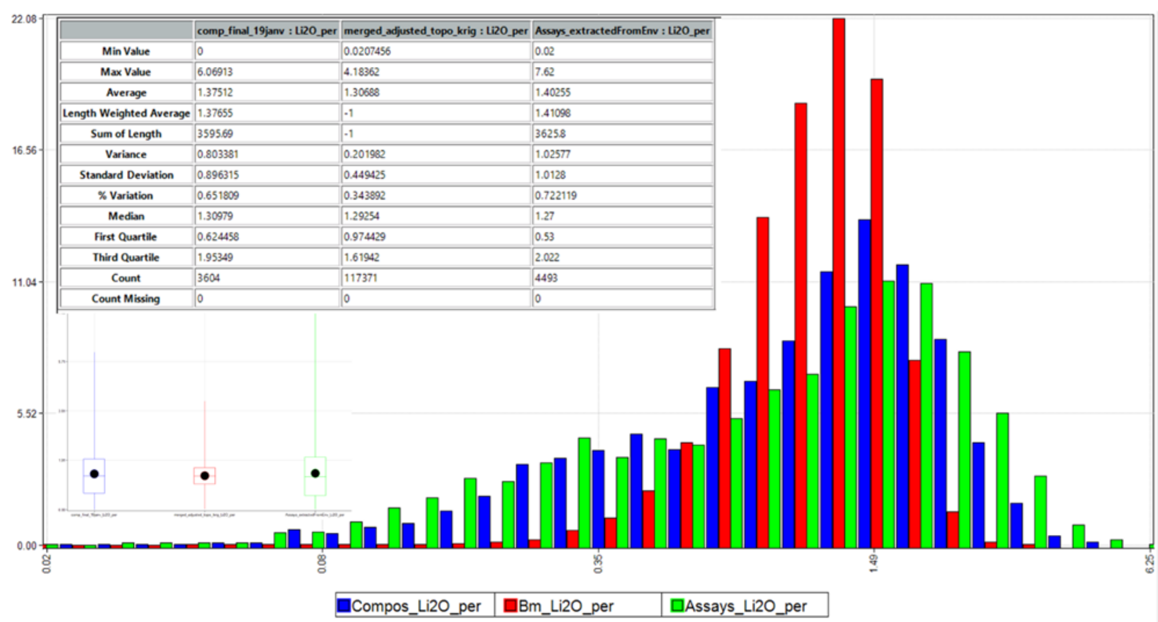


Figure 14-55: Isometric View of the Barreiro Interpolated Block Model

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

14.7.9 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 14-25).



	comp_final_19janv : Li2O_per	merged_adjusted_topo_krig : Li2O_per	Assays_extractedFromEnv : Li2O_per
Min Value	0	0.0207456	0.02
Max Value	6.06913	4.18362	7.62
Average	1.37512	1.30688	1.40255
Length Weighted Average	1.37655	-1	1.41098
Sum of Length	3595.69	-1	3625.8
Variance	0.803381	0.201982	1.02577
Standard Deviation	0.896315	0.449425	1.0128
% Variation	0.651809	0.343892	0.722119
Median	1.30979	1.29254	1.27
First Quartile	0.624458	0.974429	0.53
Third Quartile	1.95349	1.61942	2.022
Count	3604	117371	4493
Count Missing	0	0	0

Figure 14-56: Statistical Comparison of Barreiro Assay, Composite and Block Data

The assays and composites have average values of 1.38% and 1.40% Li_2O respectively with variances of 0.8 and 1.0% Li_2O. The interpolated blocks have an average value of 1.31% Li_2O with a variance of 0.20% 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 0.70 (R^2) was established between the blocks and the composites (Figure 14-26) which is typical and considered acceptable for this type of deposit.

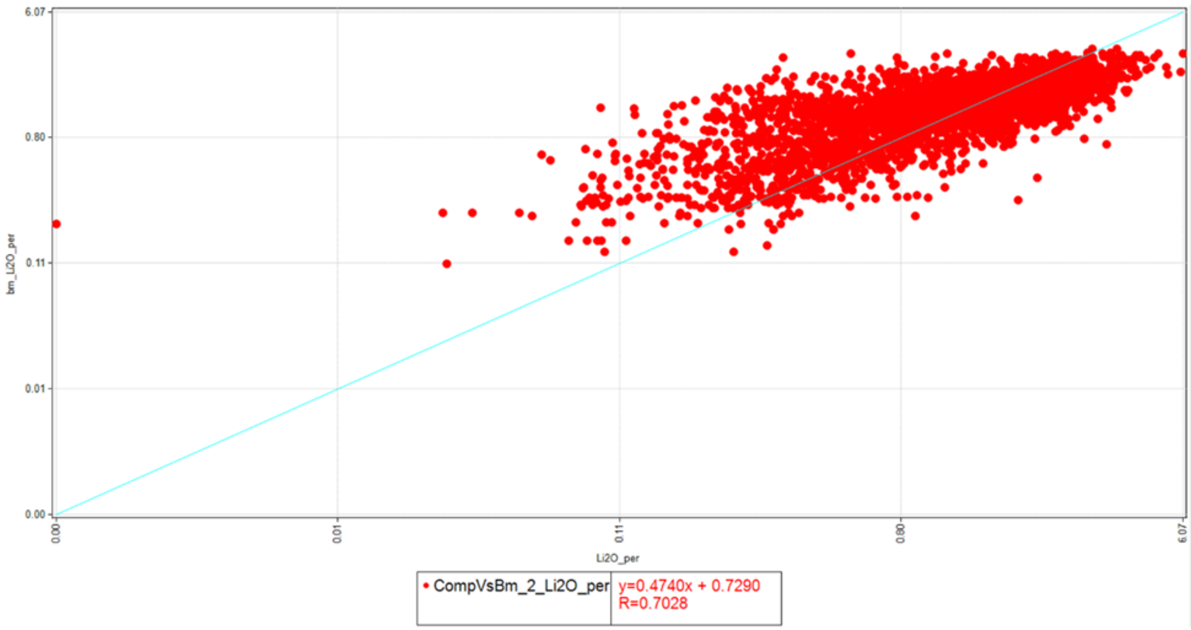


Figure 14-57: Barreiro Block Values Versus Composites Inside Those Blocks

14.7.10 Mineral Resources Classification

The MRE for the Barreiro deposit is prepared and disclosed in compliance with all current disclosure requirements for mineral resources set out in the NI 43-101 Standards of Disclosure for Mineral Projects. The classification of the current MRE into Measured, Indicated and Inferred resources is consistent with current 2014 CIM Definition Standards - For Mineral Resources and Mineral Reserves, including the critical requirement that all mineral resources “have reasonable prospects for eventual economic extraction”.

Mineral Resources are sub-divided, in order of increasing geological confidence, into Inferred, Indicated and Measured categories. An Inferred Mineral Resource has a lower level of confidence than that applied to an Indicated Mineral Resource. An Indicated Mineral Resource has a higher level of confidence than an Inferred Mineral Resource but has a lower level of confidence than a Measured Mineral Resource.

A Mineral Resource is a concentration or occurrence of solid material of economic interest in or on the Earth’s crust in such form, grade or quality and quantity that there are reasonable prospects for eventual economic extraction.

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 50 m (strike) by 50 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 14-27 is a plan view showing the final classifications.

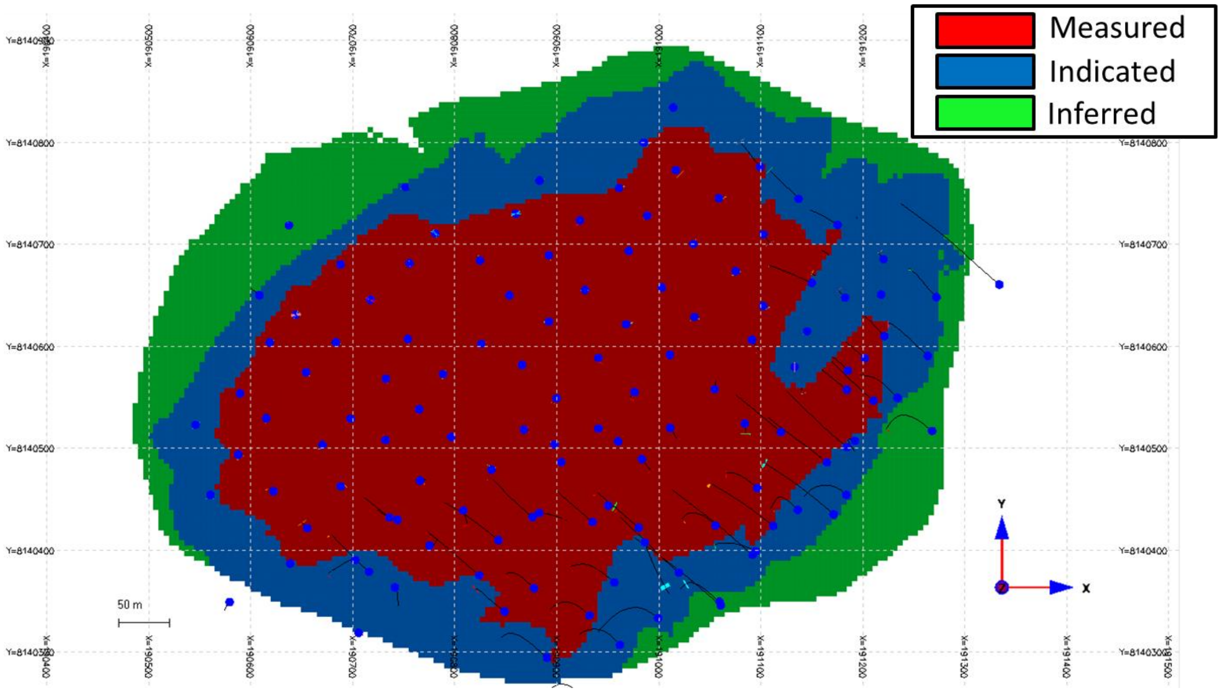


Figure 14-58: Barreiro Block Model Classification

14.7.11 Reasonable Prospects of Eventual Economic Extraction

The general requirement that all mineral resources have "reasonable prospects for eventual economic extraction" implies that the quantity and grade estimates meet certain economic thresholds and that the mineral resources are reported at an appropriate cut-off grade considering extraction scenarios and processing recoveries. To meet this requirement, the lithium mineralization of the Barreiro deposit is considered amenable to open pit extraction.

To determine the quantity of material representing "reasonable prospects for eventual economic extraction" by an open pit mining method, Whittle™ pit optimization software was used with reasonable mining and economic assumptions. The pit optimization for the Barreiro deposit was completed by SGS for the current MRE. The pit optimization parameters used are summarized in Table 14-14. A conservative and balanced approach was applied when optimizing the open pit scenario. A Whittle pit shell at a revenue factor of 1.0 ($1,500/t concentrate price) was selected as the ultimate pit shell for the purposes of the MRE for the Barreiro deposit.

The reader is cautioned that the results from the pit optimization are used solely for the purpose of testing the "reasonable prospects for economic extraction" by an open pit and do not represent an attempt to estimate mineral reserves. The results are used as a guide to assist in the preparation of a mineral resource statement and to select an appropriate resource reporting cut-off grade.

The parameters detailed in Table 14-14 came from either SGS Canada, SMSA or contractors. These parameters are believed to be sufficient to include all block models for future open pit mine planning.

Table 14-34: Barreiro Pit Optimization Parameters

Parameter	Unit	Value
Concentrate Price (6% Li_2O)	US$ per tonne	$1,500
Pit Slope	Degrees	60
Mining Cost	US$ per tonne mined	$2.20
Processing Cost (incl. crushing)	US$ per tonne milled	$10.7
General and Administrative	US$ tonne of feed	$4
Mining Recovery	Percent (%)	95
Concentration Recovery (DMS)	Percent (%)	60.7
Pit Slopes Fresh Rock	Degrees	52-55
Royalties	Percent (%)	2
Mining loss / Dilution	Percent (%) / Percent (%)	5 / 5
Cut-off Grade	Percent (%) Li_2O	0.5

Figure 14-28 shows a view of the optimized Barreiro pit together with the Barreiro block model.

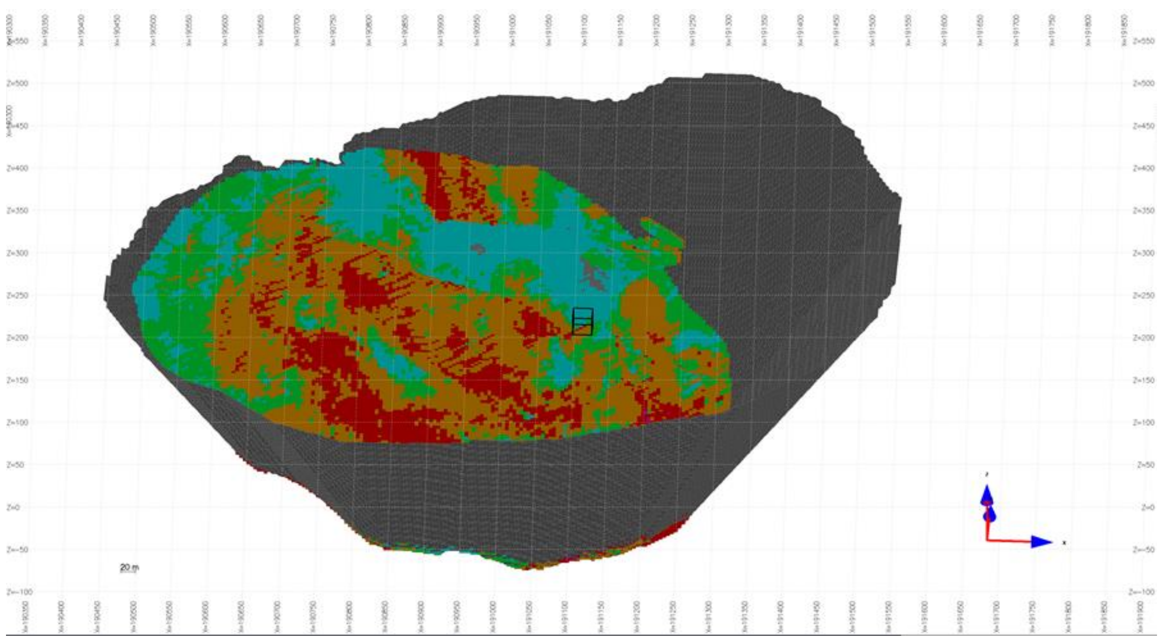


Figure 14-59: Isometric View Looking Northeast: Barreiro Deposit Mineral Resource Block Grades and Revenue Factor 1 Pit

14.7.12 Mineral Resource Statement

The Mineral Resource estimate is reported in Table 14-15 using a 0.3% 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 February 11, 2022. The QP for the estimate is Mr. Marc-Antoine Laporte, P.Geo., an SGS employee.

Table 14-35: Barreiro Deposit Mineral Resource Estimate

Cut-off Grade Li_2O (%)	Category	Tonnage (t)	Average Grade Li_2O (%)	LCE (Kt)
0.3	Measured	19.5	1.38	665
0.3	Indicated	6.1	1.29	195
0.3	**Measured + Indicated**	**25.6**	**1.36**	**861**
0.3	Inferred	3.8	1.38	132

Notes to accompany Mineral Resource table:

1. Mineral Resources have an effective date of February 24, 2022 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. All Resources are presented undiluted and in situ, constrained by continuous 3D wireframe models, and are considered to have reasonable prospects for eventual economic extraction.
3. Mineral Resources are reported assuming open pit mining methods, and the following assumptions: lithium concentrate (6% Li_2O) price of US$1,500/t, mining costs of US$2.2/t for mineralization and waste, crushing and processing costs of US$10/t, general and administrative (G&A) costs of US$4/t, concentrate recovery of 60.7%, 2% royalty payment, pit slope angles of 52-55º, and an overall cut-off grade of 0.3% Li_2O.
4. Tonnages and grades have been rounded in accordance with reporting guidelines. Totals may not sum due to rounding.
5. Mineral resources which are not mineral reserves do not have demonstrated economic viability. An Inferred Mineral Resource has a lower level of confidence than that applying to a Measured and Indicated Mineral Resource and must not be converted to a Mineral Reserve. It is reasonably expected that the majority of Inferred Mineral Resources could be upgraded to Indicated Mineral Resources with continued exploration.
6. The results from the pit optimization are used solely for the purpose of testing the "reasonable prospects for economic extraction" by an open pit and do not represent an attempt to estimate mineral reserves. The results are used as a guide to assist in the preparation of a Mineral Resource statement and to select an appropriate resource reporting cut-off grade.
7. The estimate of Mineral Resources may be materially affected by environmental, permitting, legal, title, taxation, socio-political, marketing, or other relevant issues.

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.

14.8 XUXA DEPOSIT

14.8.1 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 14-10 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).

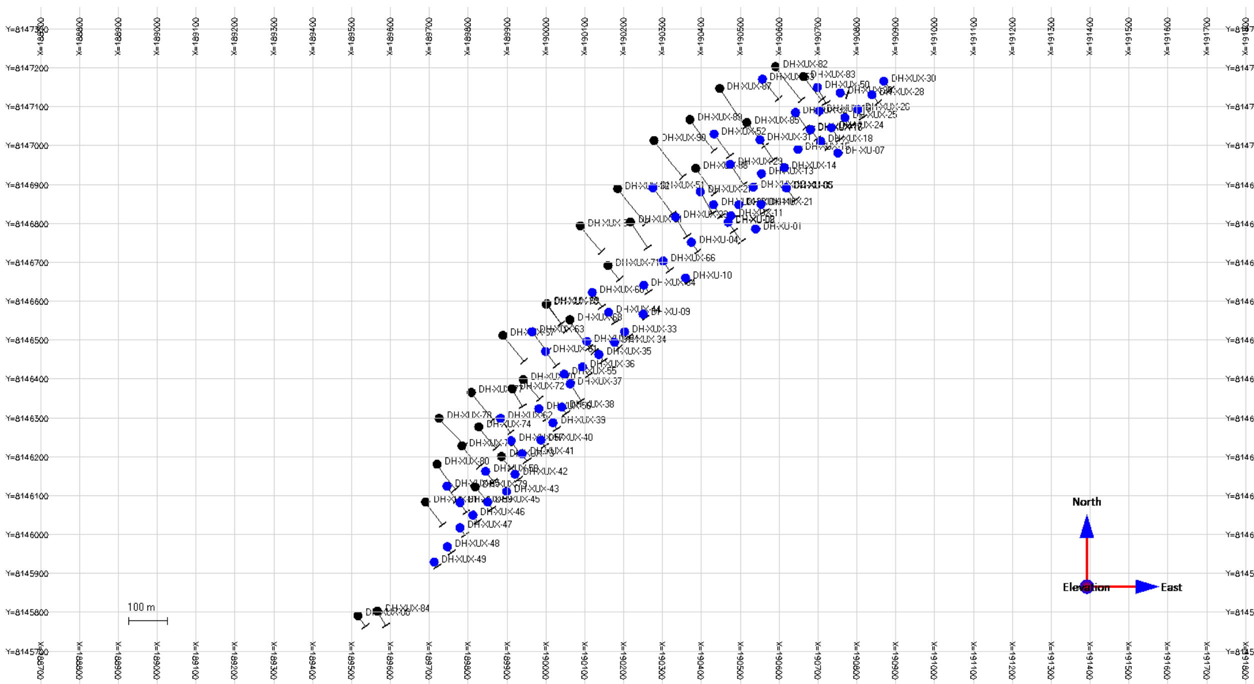


Figure 14-60: Xuxa Drill Hole Collar Locations (2017 collars shown in blue and 2018 collars shown in black)

Note: North is to top of figure.

14.8.2 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 14-6 shows the range of Li_2O values from the analytical data within the interpreted mineralized shapes.

Table 14-36: 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

14.8.3 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 14-7 shows the grade statistics of the analytical composites used for the interpolation of the resource block model and Figure 14-11 is an example histogram.

Table 14-37: 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**

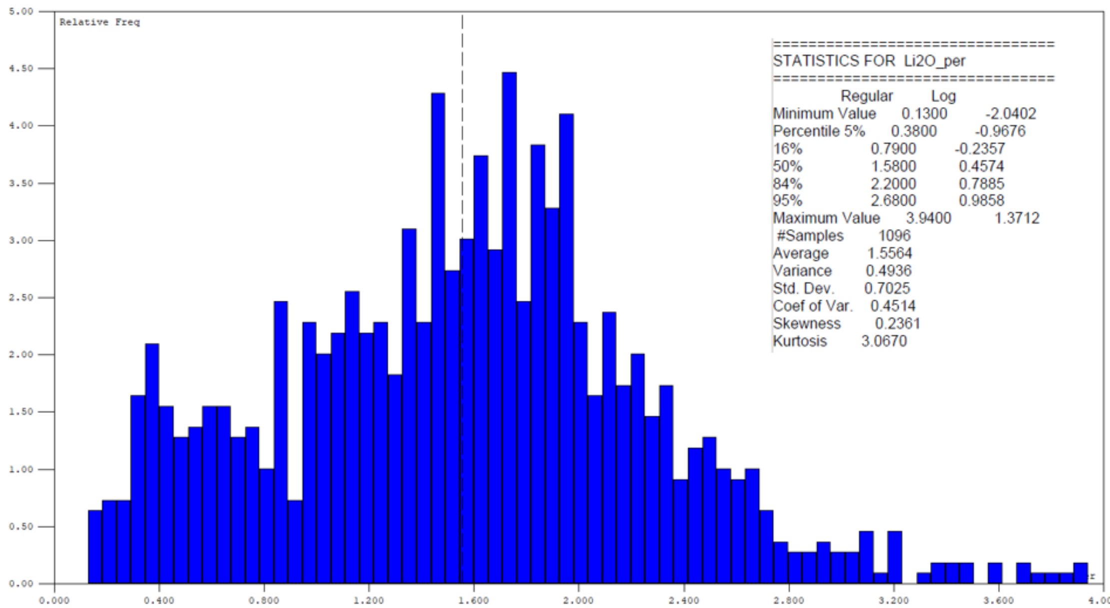


Figure 14-61: Xuxa 1 m Composite Histogram

14.8.4 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.

14.8.5 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 River 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 14-12 shows the final 3D wireframe solids in isometric view with the drill holes pierce points.

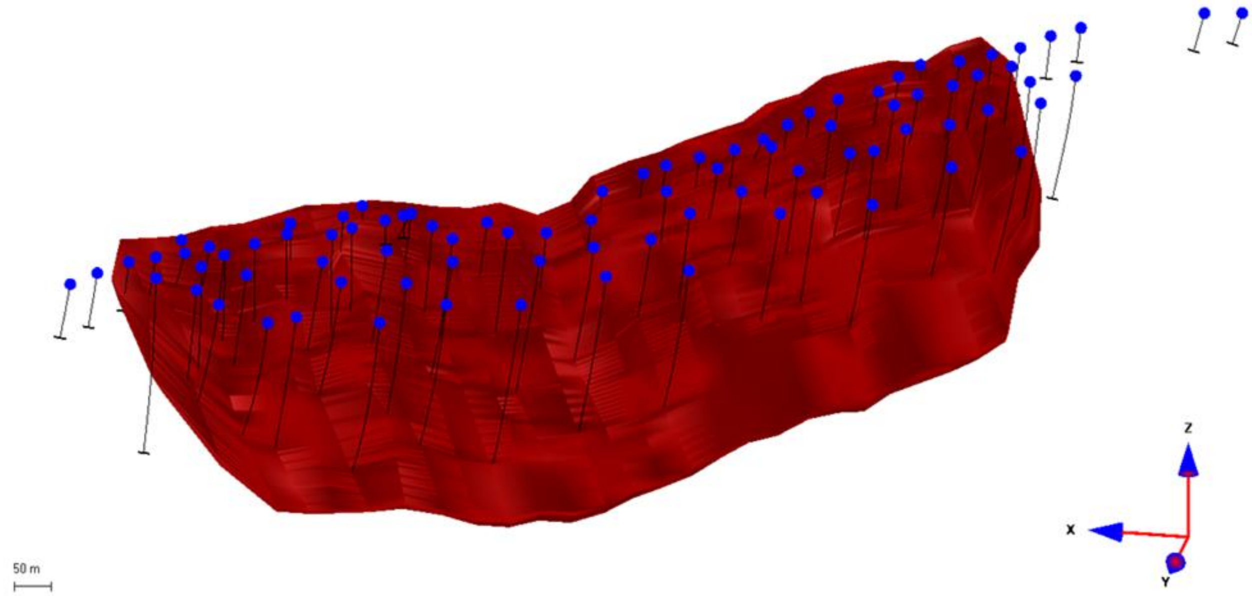


Figure 14-62: Xuxa Pegmatite Solid (looking southeast)

14.8.6 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 14-8 summarizes the block model limit parameters.

Table 14-38: 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

14.8.7 Variography

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 0.70 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 identify long distance thin structures 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 14-13.

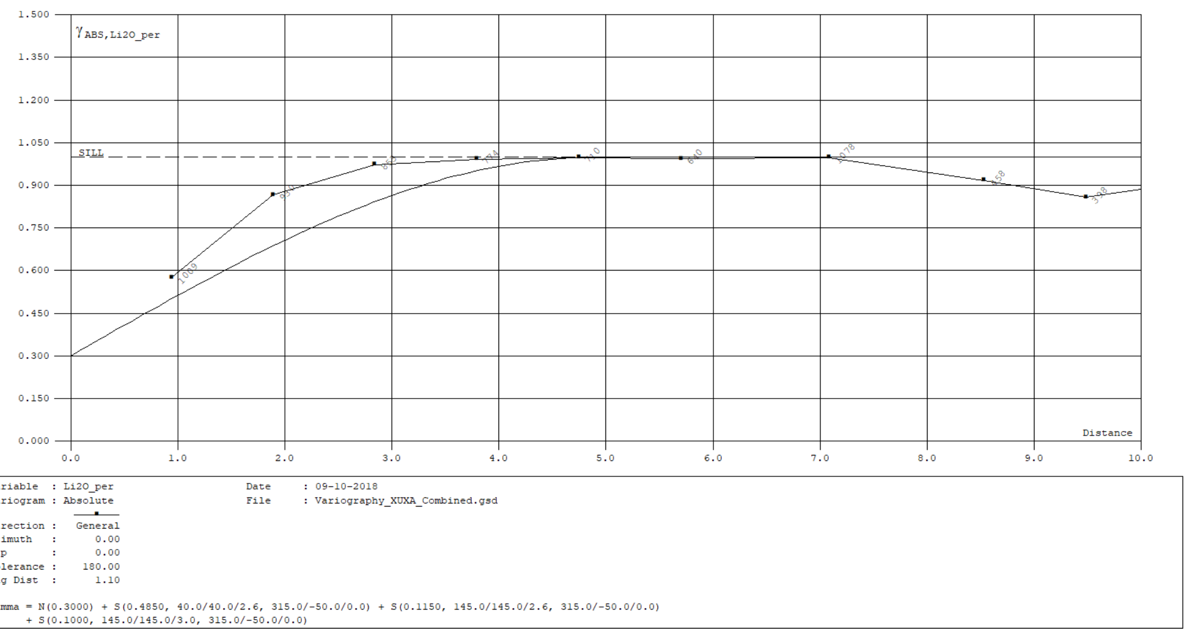


Figure 14-63: Xuxa Combined Correlogram

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.

14.8.8 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 included in the interpolation process is estimated by the QP to be at 1% of the overall volume (78,900 m^3). Internal dilution of 0.5% or 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 therefore 1% is considered reasonable by the QP.

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

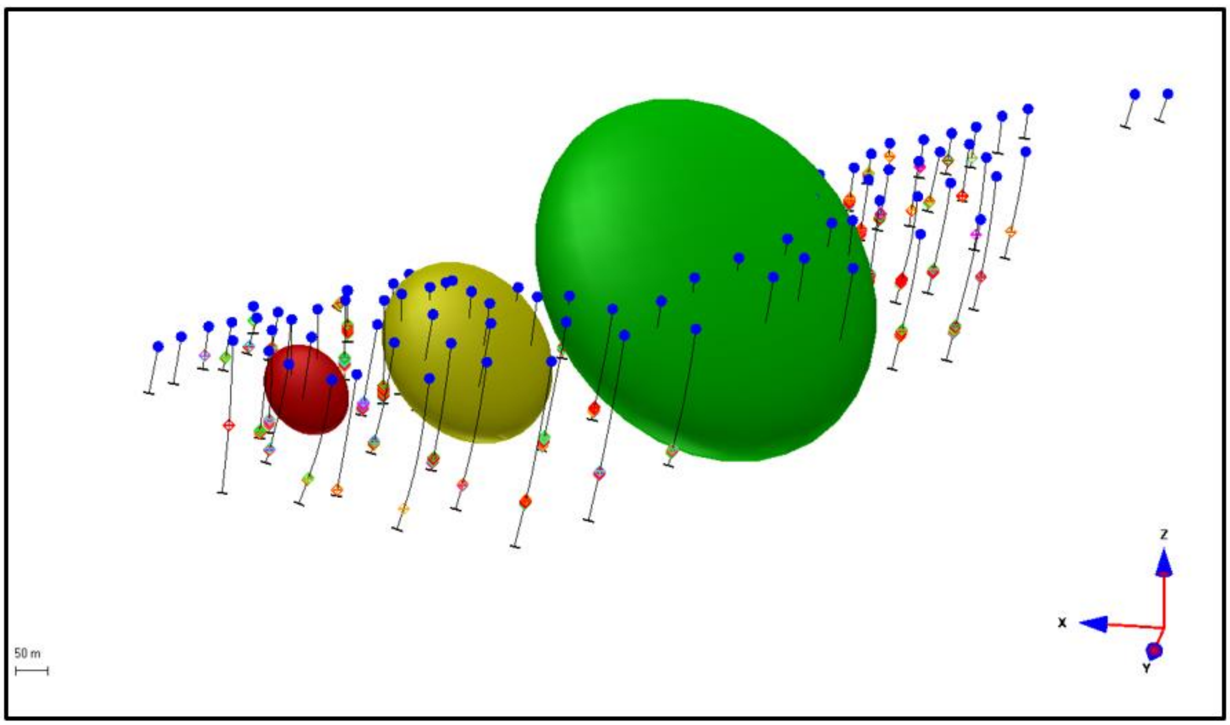


Figure 14-64: Isometric View of Xuxa Search Ellipsoids

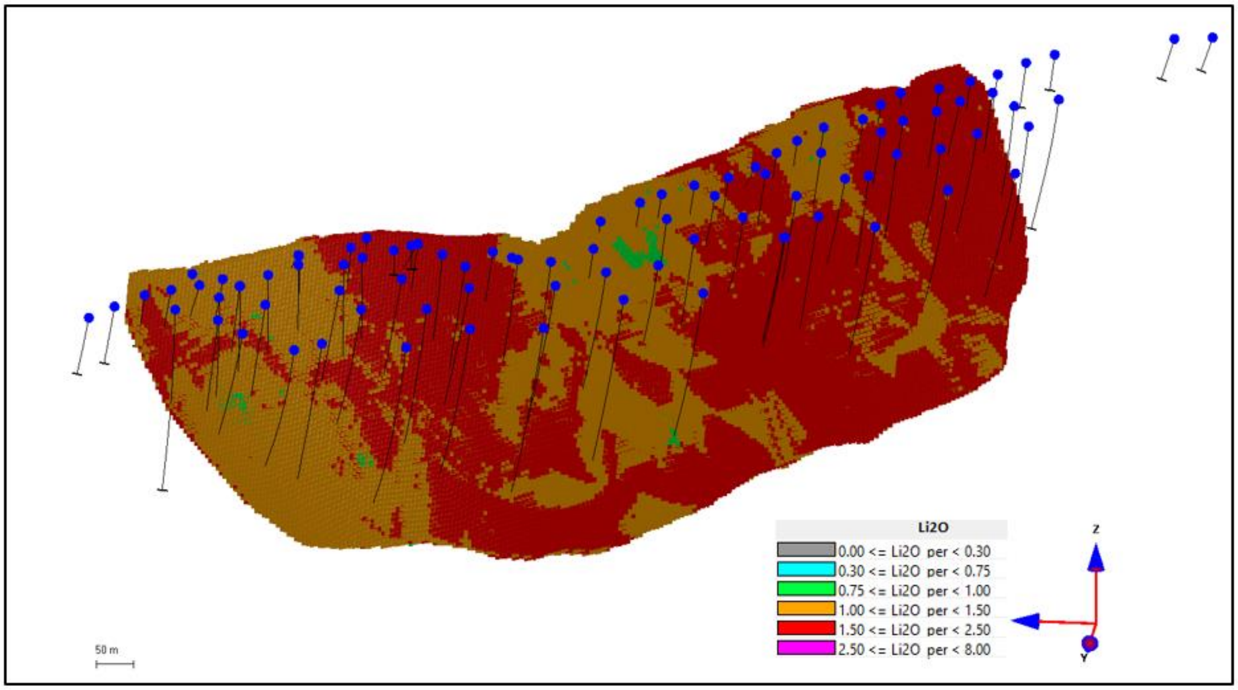


Figure 14-65: Isometric View of the Xuxa Interpolated Block Model

14.8.9 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 14-16). 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 respectively. The interpolated blocks have an average value of 1.53% Li_2O with a variance of 0.07% Li_2O.

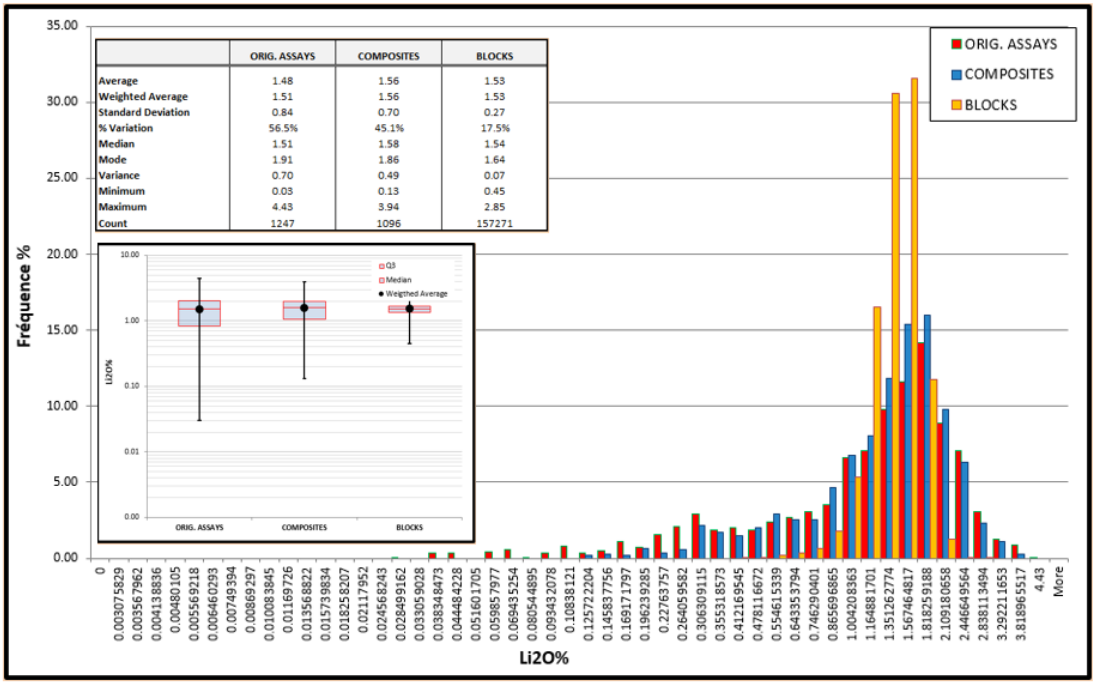


Figure 14-66: Statistical Comparison of Xuxa Assay, Composite and Block Data

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 14-17), 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.

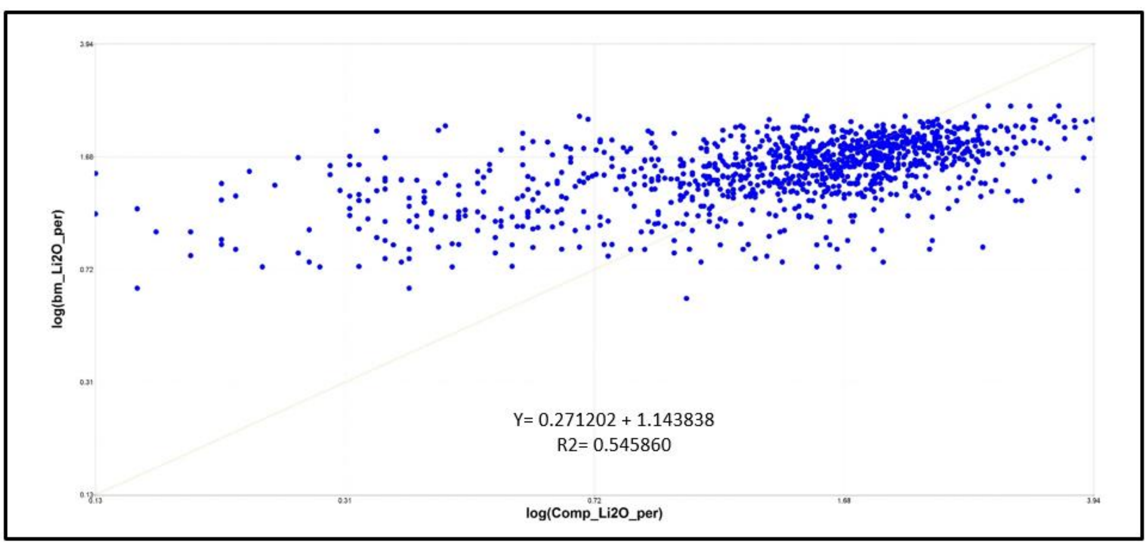


Figure 14-67: Comparison Xuxa Block Values Versus Composites Inside Blocks

14.8.10 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 14-18 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.

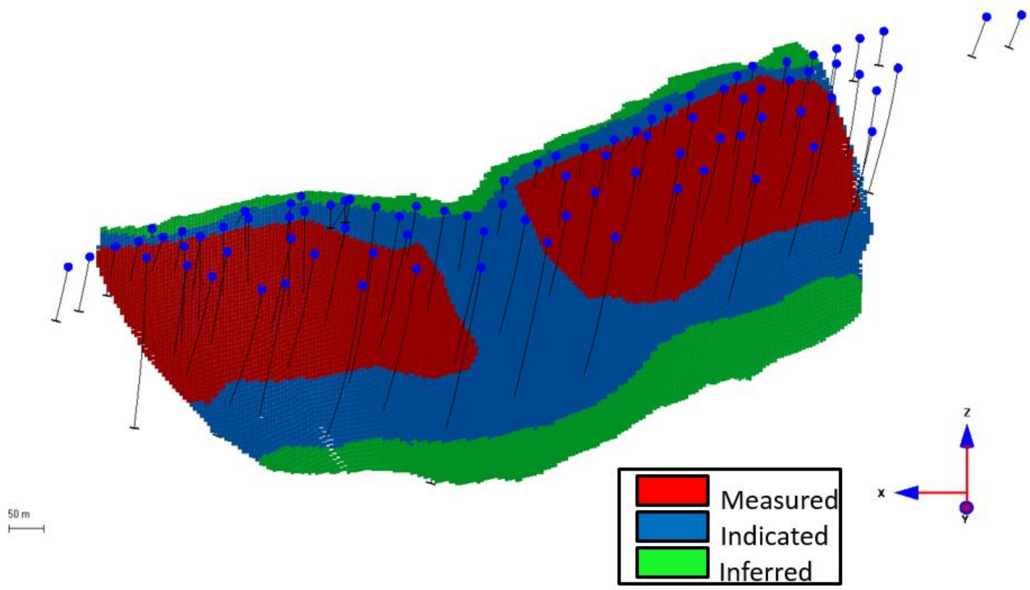


Figure 14-68: Xuxa Block Model Classification

14.8.11 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.

Table 14-39: Xuxa Parameters for Reasonable Prospects for Eventual Economic Extraction

Parameters	Value	Unit	References
Sales Revenues			
Concentrate Price (6% Li_2O)	1000.00	US$/t	Sigma
Operating Costs			
Mining Mineralized Material	2.0	US$/t	Sigma
Mining Overburden	1.2	US$/t	Sigma
Mining Waste	2.0	US$/t	Sigma
Crushing and Processing	12.0	US$/t	Sigma
General and Administration	4.0	US$/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/m^3	SGS Canada Inc
Waste Material Density	2.76	t/m^3	SGS Canada Inc
Overburden	1.61	t/m^3	SGS Canada Inc
Cut-Off Grade	0.5	%Li_2O	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)

14.8.12 Mineral Resource Statement

The Mineral Resource estimate is reported in Table 14-10 using a 0.3% 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 14-40: Xuxa Deposit Mineral Resource Estimate

Cut-off Grade Li_2O (%)	Category	Tonnage (Mt)	Average Grade Li_2O (%)	LCE (Kt)
0.3	Measured	10.2	1.59	401
0.3	Indicated	7.2	1.49	266
0.3	**Measured + Indicated**	**17.4**	**1.55**	**667**
0.3	Inferred	3.8	1.58	149

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. All Resources are presented undiluted and in situ, constrained by continuous 3D wireframe models, and are considered to have reasonable prospects for eventual economic extraction.
3. 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 0.3% Li_2O.
4. Tonnages and grades have been rounded in accordance with reporting guidelines. Totals may not sum due to rounding.
5. Mineral resources which are not mineral reserves do not have demonstrated economic viability. An Inferred Mineral Resource has a lower level of confidence than that applying to a Measured and Indicated Mineral Resource and must not be converted to a Mineral Reserve. It is reasonably expected that the majority of Inferred Mineral Resources could be upgraded to Indicated Mineral Resources with continued exploration.
6. The results from the pit optimization are used solely for the purpose of testing the “reasonable prospects for economic extraction” by an open pit and do not represent an attempt to estimate mineral reserves. The results are used as a guide to assist in the preparation of a Mineral Resource statement and to select an appropriate resource reporting cut-off grade.
7. The estimate of Mineral Resources may be materially affected by environmental, permitting, legal, title, taxation, socio-political, marketing, or other relevant issues.

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 DFS 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 50 m 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.

15 MINERAL RESERVE ESTIMATES

15.1 XUXA MINERAL RESERVES

The Xuxa deposit will be mined by conventional open pit mining methods for an eight-year mine life, at a plant feed rate of 1.5 Mtpa, with Mineral Reserves totalling 11.8 Mt grading 1.57% Li_2O (lithium oxide), based on a long-term lithium spodumene selling price of US$1,500/t concentrate FOB Mine

The effective date for the Mineral Reserve Estimate is June 29, 2021. A CIM-compliant Mineral Resource Estimate, from which this reserve was calculated, was completed by SGS in 2019 as documented in section 14 of this report.

Development of the life of mine (LOM) plan includes pit optimization, pit design, mine scheduling and the application of modifying factors, economic and metallurgical, of the Measured and Indicated Mineral Resources. The basis of which Mineral Reserves are defined is the point where mined ore is delivered to the primary crusher. The tonnages and grades reported are inclusive of geological losses, mining recovery and mining dilution.

The Mineral Reserves for the open pit aspects of the Xuxa deposit were prepared by Porfirio Cabaleiro Rodriguez, FAIG., Senior Mining Engineer with GE21, a Qualified Person (QP) as defined under National Instrument 43-101 regulations.

The Mineral Reserve for the Xuxa deposit was estimated based on a topographic surface dated June 29, 2021, and on a diluted and recoverable block model built over the Mineral Resource block model. This block model applies to two surface pits for mining the North and South pits, as defined in relation to the Piaui River. Geometric limits were determined using an environmental barrier as a protective buffer from the Piaui River separating the pits. Extensive geotechnical and hydrogeological studies also contributed to determining the mining limits. A pit design was developed based upon operational and reliable parameters, resulting in a mine life of eight years.

The Mineral Reserve Estimate has been developed using best practices in accordance with the 2019 CIM guidelines and National Instrument 43-101 reporting.

The QP is of the opinion that no known risks including legal, political, or environmental, would materially affect potential development of the Mineral Reserve, except for those risks discussed in this Report.

Table 15-7 presents the Mineral Reserves that have been estimated for the Xuxa deposit, namely 8.34 Mt of Proven Mineral Reserves at an average grade of 1.55% Li_2O and 3.46 Mt of Probable Mineral Reserves at an average grade of 1.54% Li_2O for a total of 11.80 Mt of Proven and Probable Mineral Reserves at an average grade of 1.55% Li_2O. To access these Mineral Reserves, 195.4 Mt of waste rock must be mined, resulting in a strip ratio of 16.6:1 t/t.

Mineral Reserves are an estimate of the ore grade and tonnage that can be economically mined and processed. For the Project, Mineral Reserve estimation used open-pit mining methods as this was determined to be the most economic mining method for the Xuxa deposit.

The final pit and the mine planning were based on a pit optimization using Whittle software. The mining plan developed in this report is based on Measured and Indicated Mineral Resources only. There is a low geological confidence associated with Inferred Mineral Resources, and there is no certainty that further exploration work will result in the Inferred Mineral Resources becoming Indicated Mineral Resources.

Figure 15-1 shows the final Xuxa mine configuration.

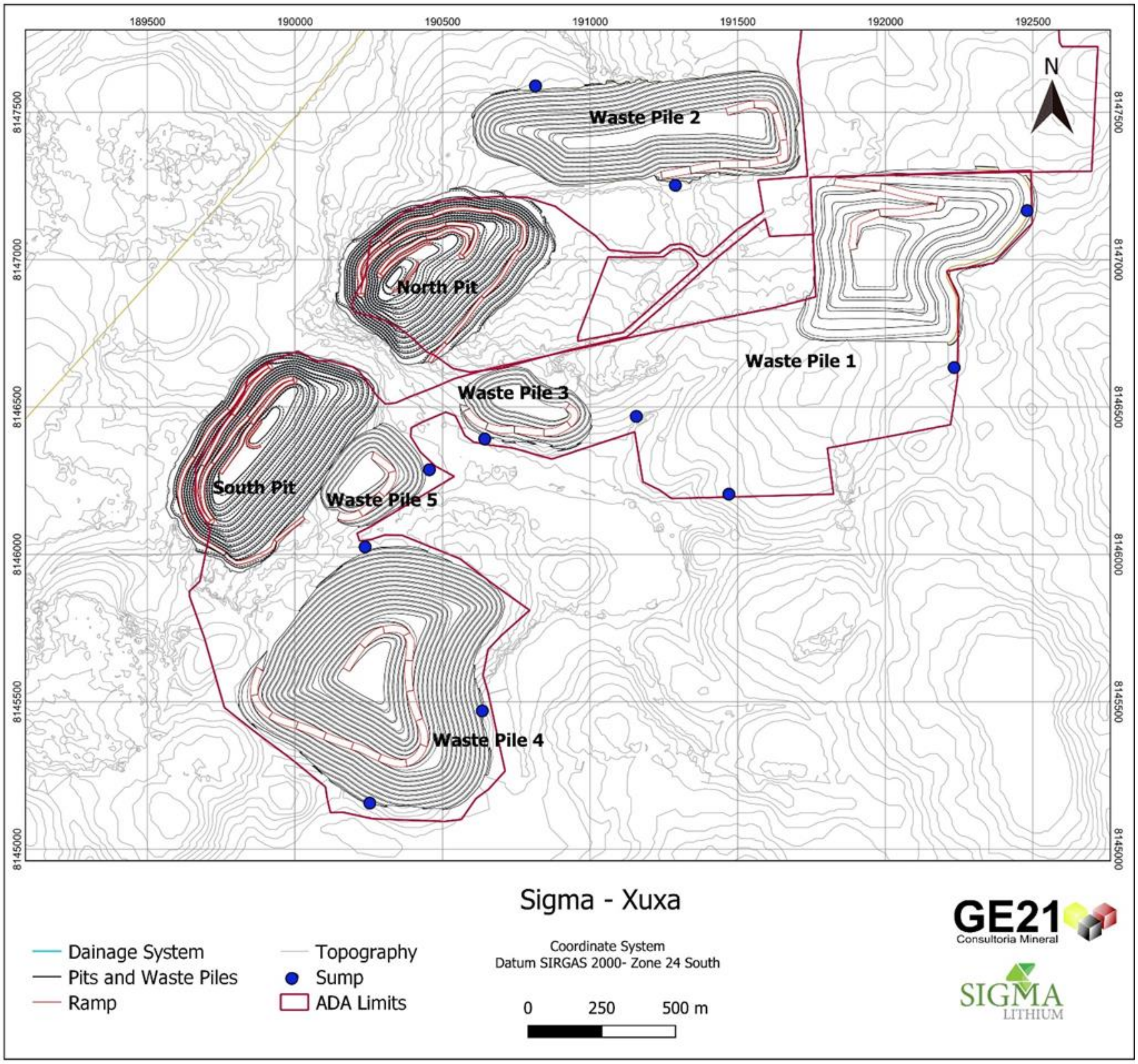


Figure 15-1: Final Xuxa Mine Configuration

15.2 XUXA PIT OPTIMIZATION PARAMETERS

The technical and economic parameters listed in Table 15-1 were used to generate the optimal pit, which consists of a pit that maximizes the project economic value, as obtained by applying the Lerchs-Grossman algorithm implemented by the Geovia Whittle software program.

The methodology for the selection of the optimal pit consists of generating a set of nested pits from the application of revenue factors. The factor is applied to the sale price of the commercial product, resulting in a mathematical pit for each factor applied. The resulting generated pits are analyzed to define the final optimal pit for the deposit.

Table 15-1: Technical and Economic Parameters Used in the Final Xuxa Pit Optimization

Item			Unit	Value
Revenue	Sales Price		US$/t conc.*	$1500.00
	Ore	Density	g/cm^3	fixed in model
		Grade	% Li_2O	fixed in model
	Mining	Mine Recovering	%	fixed in model
		Dilution		fixed in model
	Block Model Dimensions	Block Dimensions	Unit	value
		X x Y x Z	m	5 x 3 x 5
	General Angle	Soil	º	34
		Saprolite		37.5
		Fresh Rock		Sector 1 – 72º Sector 2 – 50º
	Processing	Metallurgical Recovery**	%	60.7
		Mass Recovery***	%	Calculated in block
		Concentrated Grade	% Li_2O	6.0
		Cut-off	% Li_2O	0.5
Costs		Mining	US$/t mined	$2.20
		Processing	US$/t ore	$10.70
		G&A (Adjusted for OPEX)		$4.00
		Sale (2% cost of sale)	US$/t product	$14.66
		Royalties (CFEM 2%)		$14.66

Note: * conc. = concentrate, ** based on DMS Tests, *** Including 15% fines losses - FOB Mine

15.2.1 Physical Parameters

The information relative to the physical aspects and restrictions that were used for the open pit designs and Mineral Reserve Estimate included the topographic surface, the geological block model, and the rock type properties for ore, waste and overburden.

The mine planning work carried out for the DFS was performed using Geovia MineSched 2020 software.

15.2.1.1 Topographic Surface

The mine design was based on a topographic surface based on 1 m contour intervals. The contours were supplied by SMSA and derived from a drone topographic survey that took place June 29, 2021.

15.2.1.2 Geotechnical Parameters

Figure 15-2 shows the geotechnical sectors for the North, and South pits presented in this feasibility study. The red lines represent the limits for the sectors in each pit. The pit slope angles used are listed in Table 15-2.

The geotechnical and hydrogeological parameters used in the open-pit design are defined in Section 16.1 – Geotechnical and Hydrogeological Analysis.

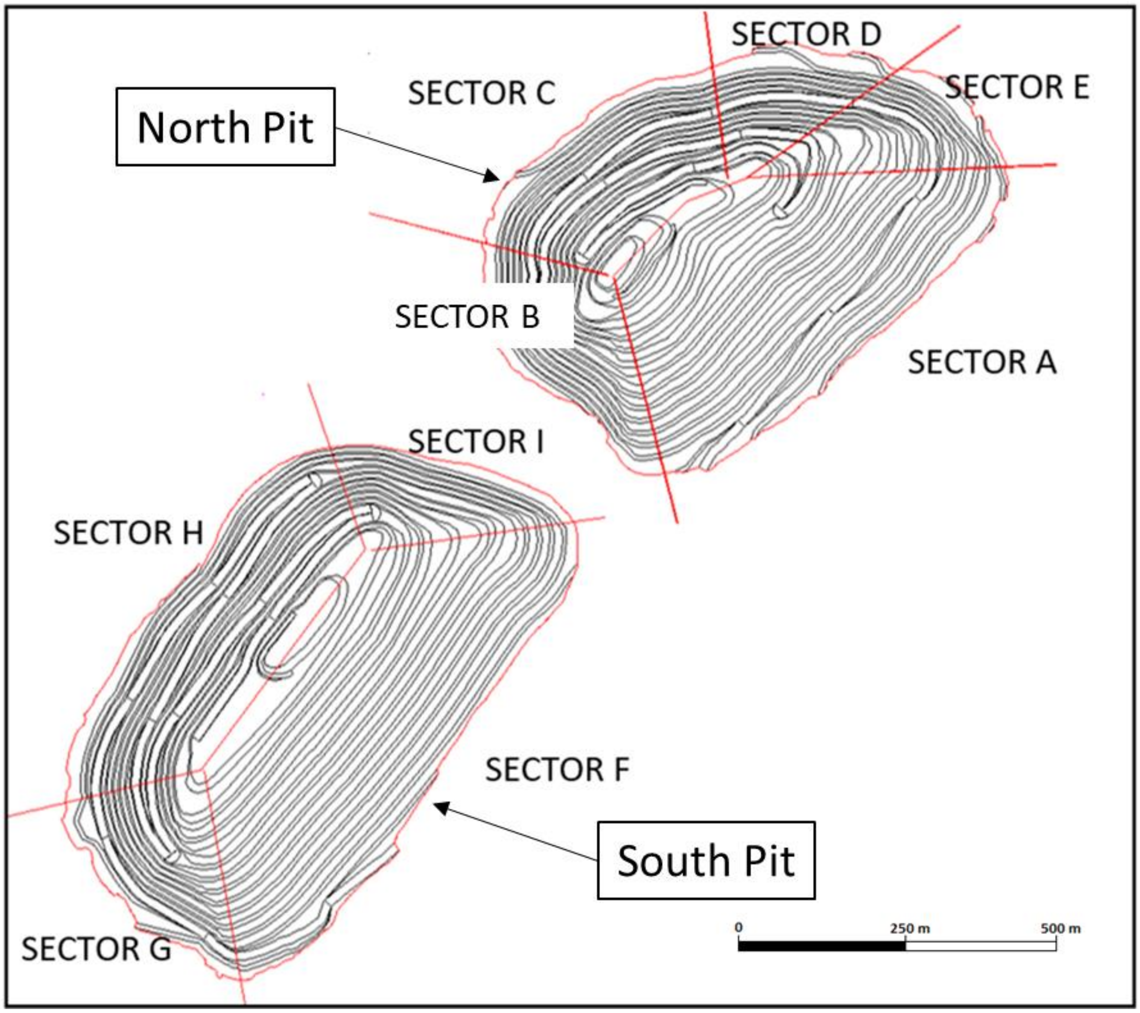


Figure 15-2: Xuxa North and South Pit Geotechnical Sectors

Table 15-2: Xuxa Geotechnical Pit Slope Design Criteria

Sectors	Face Angle (°)	Berm Width (m)	Bench Height (m)	Angle between Ramps / Overall (°)
A	60	6	20	48 / 46
B	82	6	20	66 / 61
C	82	6	20	67 / 62
D	82	6	20	66 / 61
E	82	6	20	66 / 61
F	60	6	20	48 / 48
G	82	6	20	66 / 59
H	82	6	20	66 / 61
I	82	6	20	66 / 59

15.2.1.3 Natural Limits

A buffer of 30 m from the pit crests to the Piaui River was used as the surface limit of mining, as defined by the environmental license permits.

15.2.1.4 Rock Type Properties

The rock type properties are outlined below. Rock properties are important in estimating the Mineral Reserves, the equipment fleet requirements, as well as the dump and stockpile design capacities.

15.2.1.4.1 Density

The in-situ dry density of the mineralized material was estimated to be 2.70 t/m³. A density of 2.73 t/m³ has been used for waste schist rock, a density of 2.20 t/m³ for weathered schist overburden, and a density of 2.30 t/m³ for soil overburden.

15.2.1.4.2 Swell Factor

An average swell factor of 15% was estimated for the in-situ material transported to the waste dump. This factor was used to define waste dump volumes but does not affect the Mineral Reserves estimate.

15.2.1.4.3 Moisture Content

A general moisture content factor of 6% was estimated for in-situ rock material. The final fleet sizing was provided by a contractor who will carry out mining activities during the life of the mining operation. This factor was used to define fleet sizing and does not influence the Mineral Reserve estimate.

15.2.1.5 Mineral Resource Block Model

The Mineral Resource block model provided by SGS (described in section 14) was the base used by GE21 to build the modified Mineral Reserve block model.

15.3 XUXA MODIFYING FACTORS

The modifying factors listed below were applied to convert the Mineral Resources into Mineral Reserves for the pit optimization analysis and the open pit design.

15.3.1 Economic and Metallurgical Factors

The economic and metallurgical factors used for the open pit and Mineral Reserve Estimates include the assumed long-term Li2O concentrate sale price, economic cut-off grade, metallurgical recovery, concentrate grade, mining costs, processing costs, G&A costs, sales cost, and royalties.

15.3.1.1 Long-Term Concentrate Price

A long-term sale price of US$1,500/t concentrate FOB Mine for spodumene (6% Li_2O) was used, based on market studies provided by Sigma.

15.3.1.2 Cut-Off Grade

A cut-off grade of 0.3% Li_2O as defined for the Mineral Resource Estimate.

15.3.1.3 Metallurgical Factors

An overall metallurgic recovery of 60.7% for the dense media separation (DMS) operation was used for metallurgical recovery, with a concentrate grade of 6% Li_2O, resulting in a calculated mass recovery, after allowing for fines losses of 15%, block by block of mined ore by the formula:

$$Mass\ Recovery = \frac{metallurgical\ recovery}{concentrate\ grade} \times feed\ grade\ x\ (1 - fine\ losses)$$

15.3.1.4 Mining and Processing Costs Factors

Optimization economics used a mining cost of US$2.20/t and a processing cost of US$10.7/t ore, based on the 2019 Feasibility Study developed for the Xuxa deposit.

15.3.1.5 Other Costs

The cost assumptions were compiled using a value of US$4.00/t ore for G&A cost, and royalties at 2% of the concentrate price (US$14.66/t concentrate).

15.3.2 Selective Mining Unit (SMU) Selection

The conventional definition of the selective mining unit (SMU) is the smallest volume of material on which ore/waste classification is determined.

In order to determine the optimal SMU for Xuxa, GE21 analyzed a number of block dimension alternatives, ranging in size from 20 m x 12 m x 5 m (x, y, z) to 5 m x 3 m x 2.5 m (x, y, z). Isastis software was used to perform a uniform conditioning simulation on the various SMU alternatives using Li_2O% as the estimated variable.

Figure 15-3 shows the results of the uniform conditioning estimate.

Based on the analysis, GE21 determined that an SMU of 5 m x 3 m x 5 m was suitable.

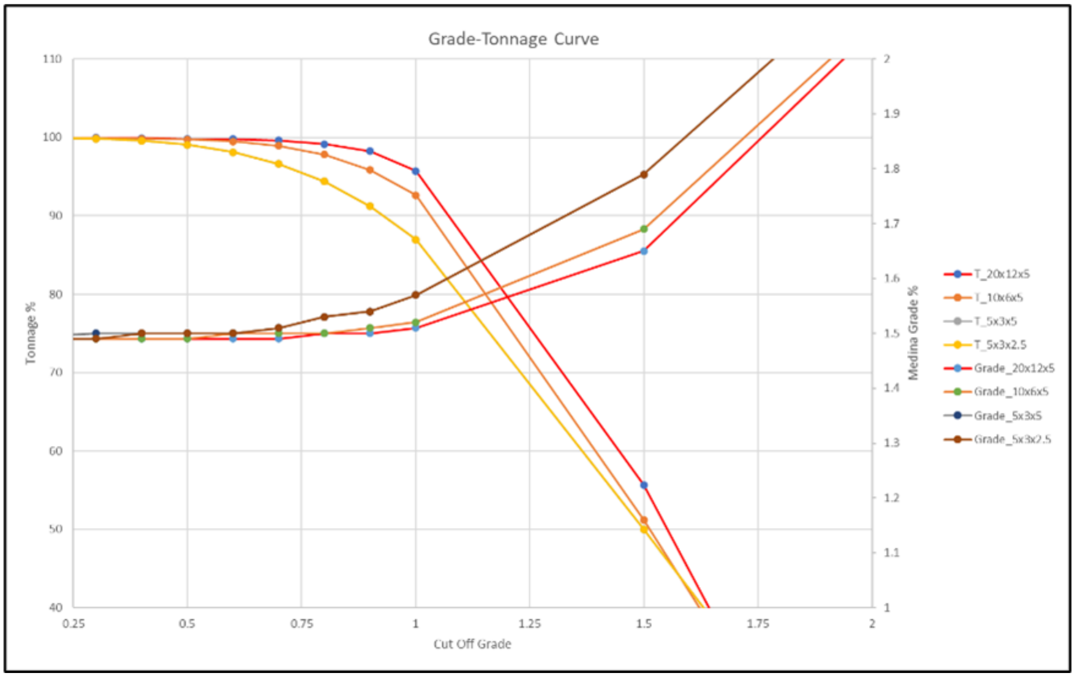


Figure 15-3: Grade x Tonnage Curve with Selectivity Results Based on Local Uniform Conditioning Estimate

15.3.3 Dilution and Loss Estimate

Once the SMU was defined and a grade control procedure established, GE21 prepared a diluted block model to be used in mine planning. The main assumptions adopted by GE21 were:

- Considering that the grade control drill hole can only be checked every metre, a pegmatite bounding envelope was created based on the one-metre-wide edge, as shown in Figure 15-4.
- The block model was sub-blocked at 5 m x 3 m x 1 m.
- The blocks within the enclosed envelope, the pegmatite bounding envelope, were classified as waste. The schematic diagram in Figure 15-5 represents the partial effect of this assumption on the blocks near the end face of the bench.
- For the blocks still within the remaining pegmatite solid, a minimum 97% ore recovery was assumed, allowing an average 3.75% schist dilution in ROM, as shown in the dilution parameterization curve in Figure 15-6.
- GE21 has considered accepting blocks at the edge of the fixed pegmatitic wireframe structure with a minimum 64% to 76% recovery rate.

An overall 3.75% mean dilution was assumed for the diluted pegmatite, with results varying for blocks with different heights (5 m and 1 m), as shown in the Table 15-3, resulting in a mining recovery equivalent to 83% when considering the relationship between the undiluted model for the resource model, or 82.5% while maintaining a 3.75% average dilution rate relative to a partial model in the original resource model. A simulation with a more conservative method was performed maintaining the 3.75% dilution rate, using a partial model in the wire structure fixed over the diluted zone and the schist zone, and using both 5-metre- and 1-metre-high blocks (Figure 15-6, Figure 15-7 and Figure 15 8).

GE21 adopted option (1), representing effective ore recovery of 82.5%, and maintaining a 3.75% dilution rate, to be used in the pit optimization phase.

Table 15-3: Mining Recovery Versus Partial Percentage on Block Height

Source	Partial Percentage Cut	Total Mass After Cut (Mt)	Minimum Mining Recovery	Average Partial Percentage	Total Resource on Source (Mt)	Mining Recovery
Resource Model	-	-	100%	-	21.2	100%
Undiluted Solid (1)	0.72	17.5	82.5%	0.97	17.7	99%
Undiluted Solid (2)	0.76	13.6	64%	0.97	17.7	83%
Undiluted Solid (3)	0.64	15.6	74%	0.97	17.7	83%

(1) 5-metre block model in general pegmatite resource Z model

(2) 5-metre block model in Z, enclosed pegmatite

(3) 1-metre block model in Z, enclosed pegmatite

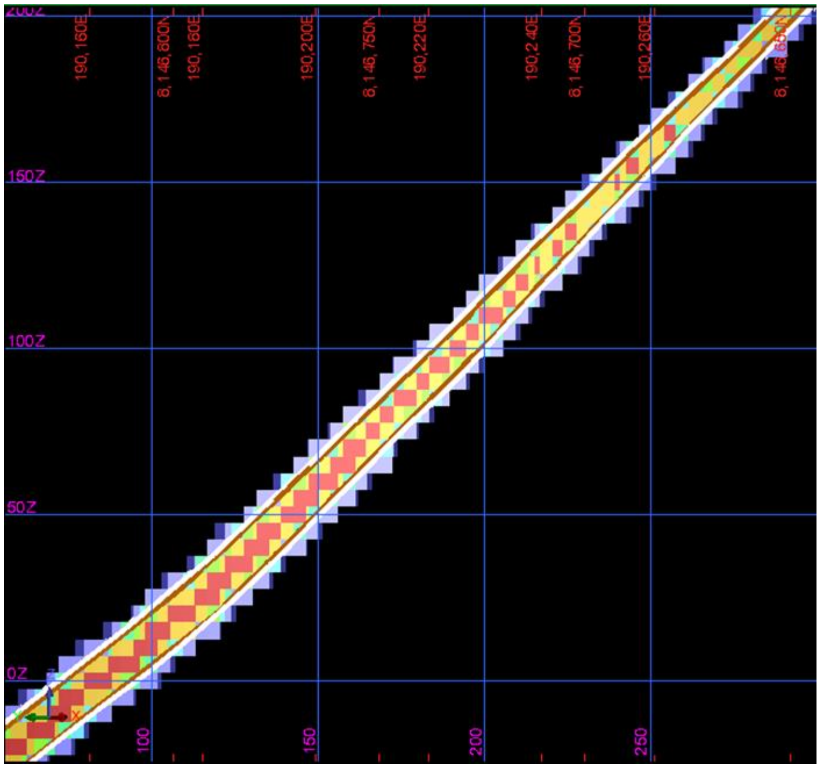
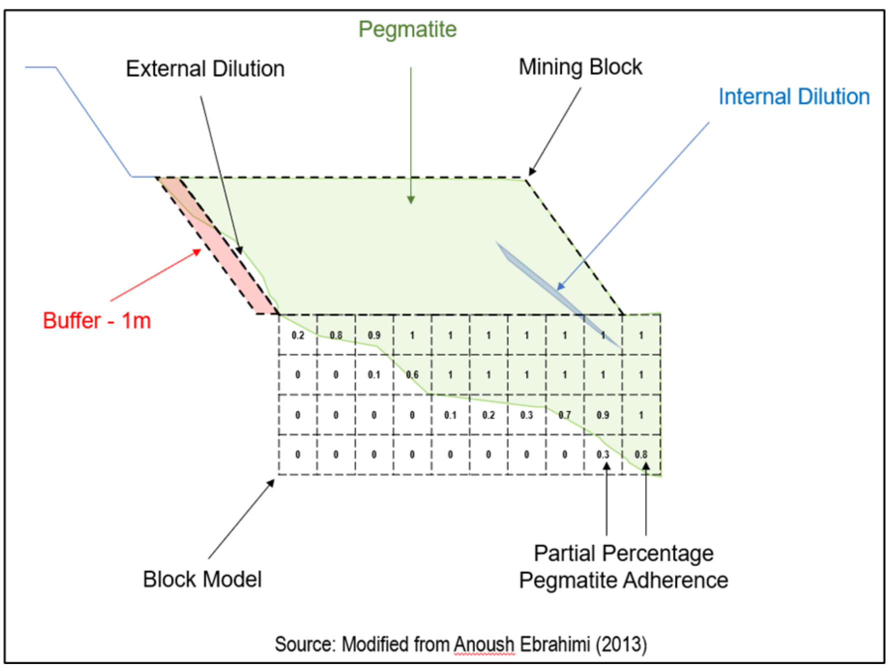


Figure 15-4: Cross-Section Showing the Original Pegmatite (white line) and the One Reduced At 1 M from the Edge (brown line). Blocks are Coloured Blue to Red in Relation to their Partial Percentage within the Reduced Solid (Blue = 0%, Red = 100%)



Source: Modified from Anoush Ebrahimi (2013)

Figure 15-5: Schematic Representation of the Dilution Analysis

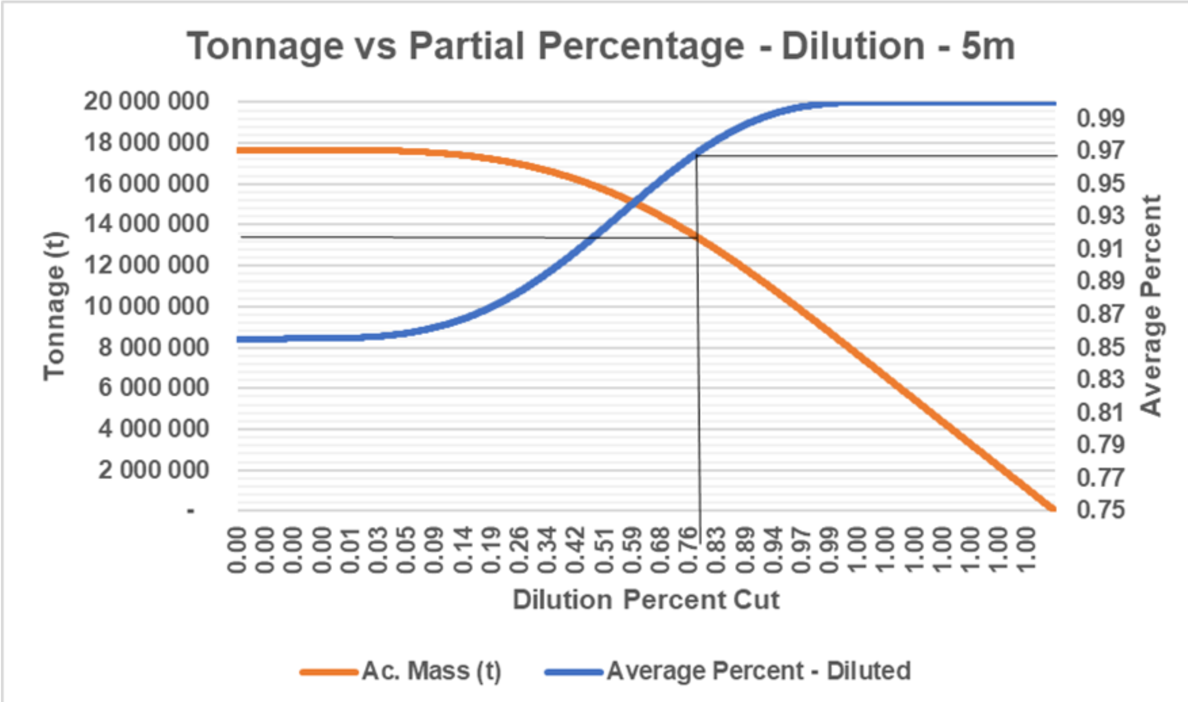


Figure 15-6: Xuxa Tonnage vs Partial Percentage – Dilution – 5 m

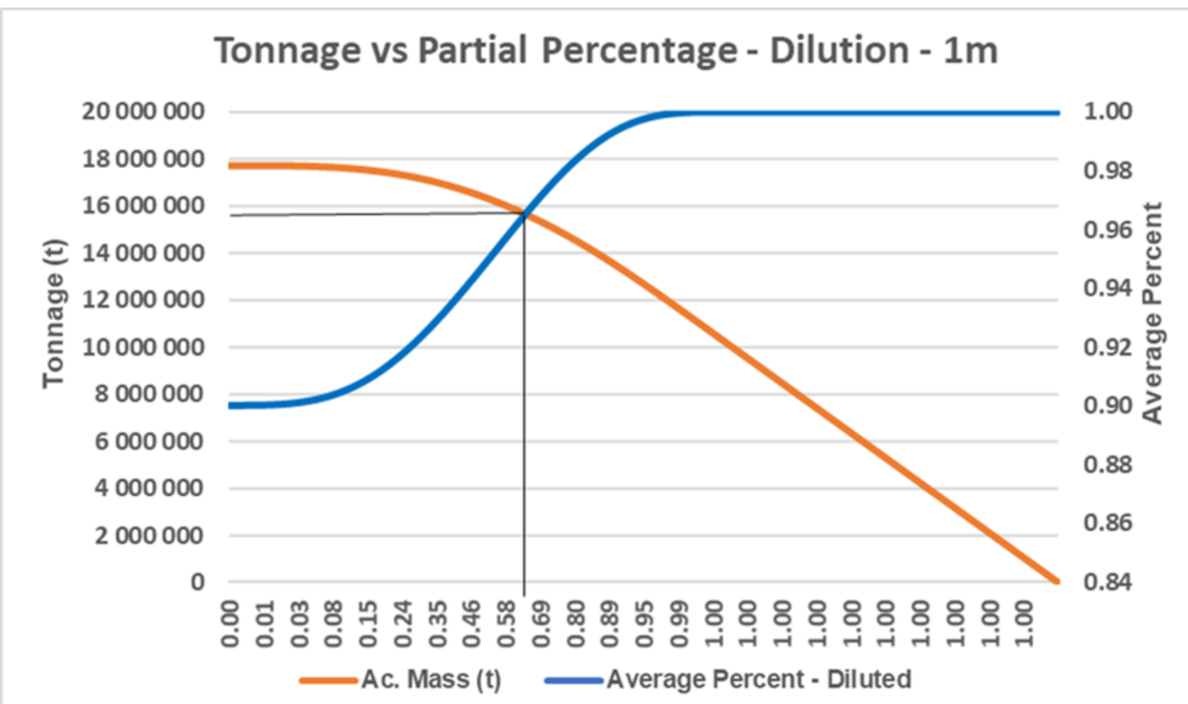


Figure 15-7: Tonnage vs Partial Percentage – Dilution – 1 m

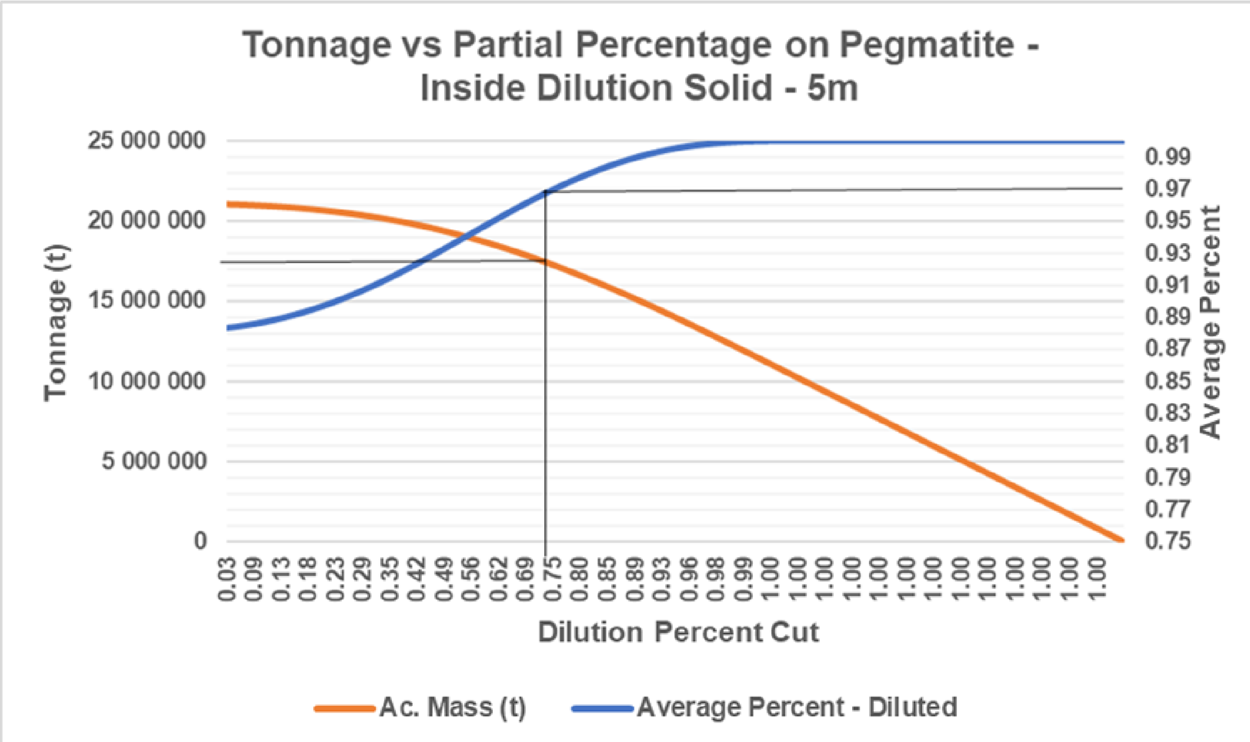


Figure 15-8: Tonnage vs Partial Percentage – Solid Internal Dilution – 5 m

15.4 XUXA PIT OPTIMIZATION STUDY

The determination of the pit optimization was based on:

- Definition of economic and geometric parameters, cut-off grade, and physical restrictions.
- Modified Mineral Resource Block Model to include the modified factors.
- Definition of an optimal pit using Geovia Whittle 4.3 software.
- The selection of the optimum pit, based on a strip ratio limit, and allowance for a mine life long enough to support a positive cash flow.

The technical and economic parameters listed in Table 15-1 were used to generate the optimal pit, which consists of a pit that maximizes the project economic value, as obtained by applying the Lerchs-Grossman algorithm implemented by the Geovia Whittle software program.

The optimal pit sequence was obtained by varying the revenue factor in a range from 30% to 200% of the base product selling price. To determine the evolution of the pits over time, an annual production rate of 1.5 Mtpa of ore feed was established at an annual discount rate of 10%. Table 15-4, and Figure 15-9 present the pit optimization parameters and shows the evolution of the resulting optimization pushbacks with the chosen optimal pit highlighted.

The selected pit was the Pit 6 related to a revenue factor of 0.7 which represents a sales price of around US$ 1,050/t conc. Li2O. The selection was based on the selling price below the reference price (US$ 1,500/t conc. Li2O) that stabilizes the parameters of the optimization results, such as:

- Relative NPV
- Ore tonnage
- Strip ratio
- Grade

It is observed that there is no meaningful economic benefit when the sales price of the concentrate for pit optimization is greater than US$ 1050/t conc. Li_2O since the pits are physically constrained by the Piauí River and a product price increase does little to increase ore tonnage.

Table 15-4: Xuxa Pit Optimization Results

Pit	Revenue Factor	Total Movement	Ore	Waste	Waste-Ore Ratio	Li_2O
		(Mt)	(Mt)	(Mt)		%
1	0.2	40.0	4.60	35.4	7.69	1.70
2	0.3	123.5	10.44	113.1	10.83	1.63
3	0.4	149.0	11.59	137.4	11.85	1.61
4	0.5	163.6	12.07	151.5	12.55	1.60
5	0.6	172.5	12.28	160.2	13.04	1.60
6	0.7	176.8	12.36	164.5	13.3	1.60
7	0.8	178.8	12.40	166.4	13.42	1.60
8	0.9	180.6	12.43	168.2	13.54	1.60
9	1	183.7	12.47	171.2	13.73	1.60
10	1.1	186.1	12.49	173.6	13.9	1.60
11	1.2	186.4	12.50	173.9	13.92	1.60
12	1.3	187.0	12.50	174.5	13.96	1.60
13	1.4	187.2	12.50	174.6	13.97	1.60
14	1.5	187.7	12.51	175.2	14.01	1.60
15	1.6	188.6	12.51	176.1	14.07	1.60
16	1.7	188.8	12.51	176.3	14.09	1.60
17	1.8	189.3	12.52	176.8	14.12	1.60
18	1.9	189.6	12.52	177.1	14.15	1.60

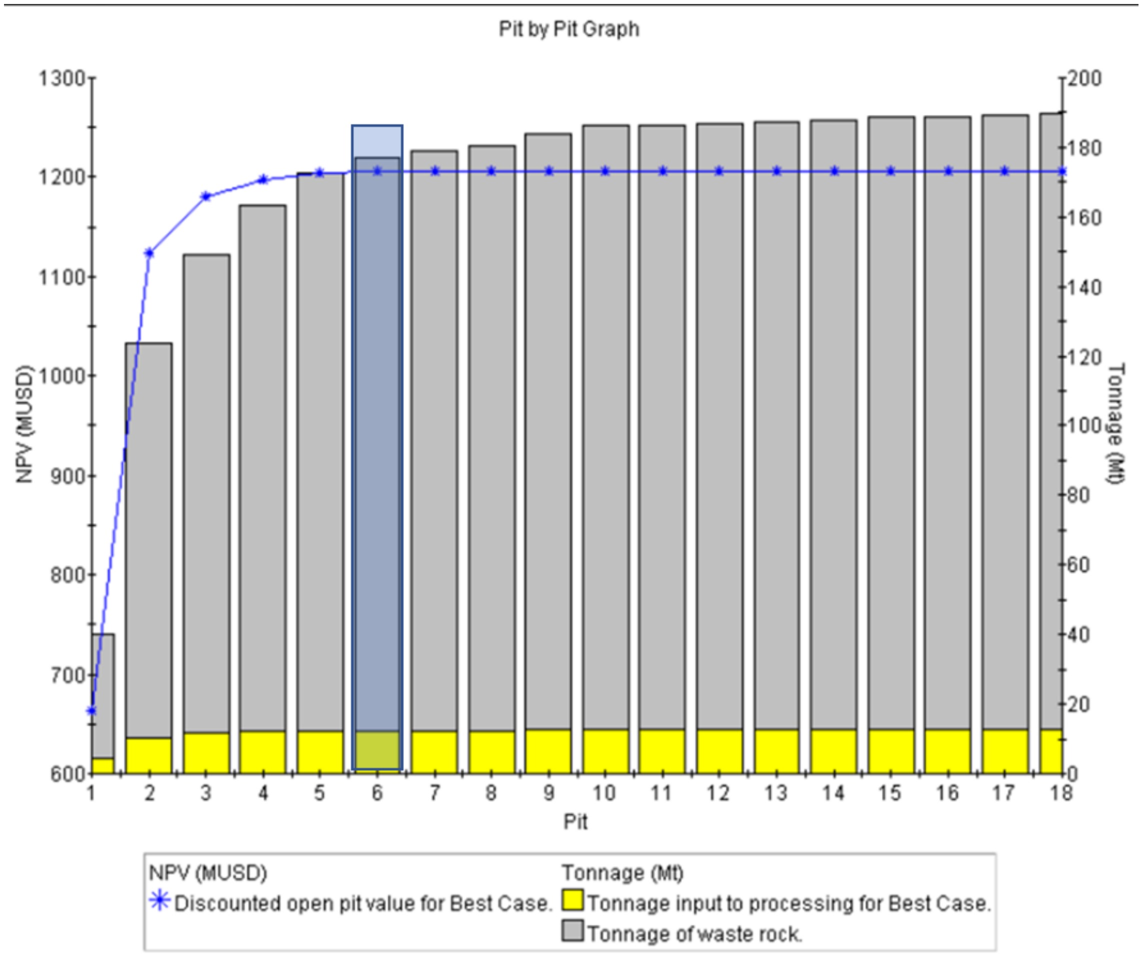


Figure 15-9: Pit by Pit Graph of Optimization Results

15.4.1 Mine Design

Mine design comprises the design of an operational pit, including the main elements, ramps, berms, and access over the selected optimal pit, for the mining of the Mineral Reserves in an operationally feasible design.

The methodology consists of tracing the benches, toe and crest outline, safety berms, construction sites, and access ramps, while respecting the geometric and geotechnical parameters defined by geotechnical and hydrogeological studies. The assumptions adopted for the operationalization of the final pit were:

- Minimize ore mass loss.
- Define access routes for shorter average transport distances.

Table 15-5 presents the geometric parameters adopted to develop the mine design and Figure 15-11 presents the pit wall configuration based on those parameters.

Table 15-5: Xuxa Open Pit Operational Design Parameters

Final Pit Operational Parameters			
Parameters		Value	Unit
Bench Height		20.0	metres
Overburden	General Angle - Soil	40.0	º
	Berm Width - Soil	6.0	metres
	General Angle - Saprolite	42.0	º
	Berm Width - Saprolite	6.0	metres
Fresh Rock	General Angle - Sector 1	82.0	º
	Berm Width - Sector 1	6.0	metres
	General Angle - Sector 1	60.0	º
	Berm Width - Sector 1	6.0	metres
Access Ramps Width		12.0	metres
Access Ramps Inclination		10.0	%

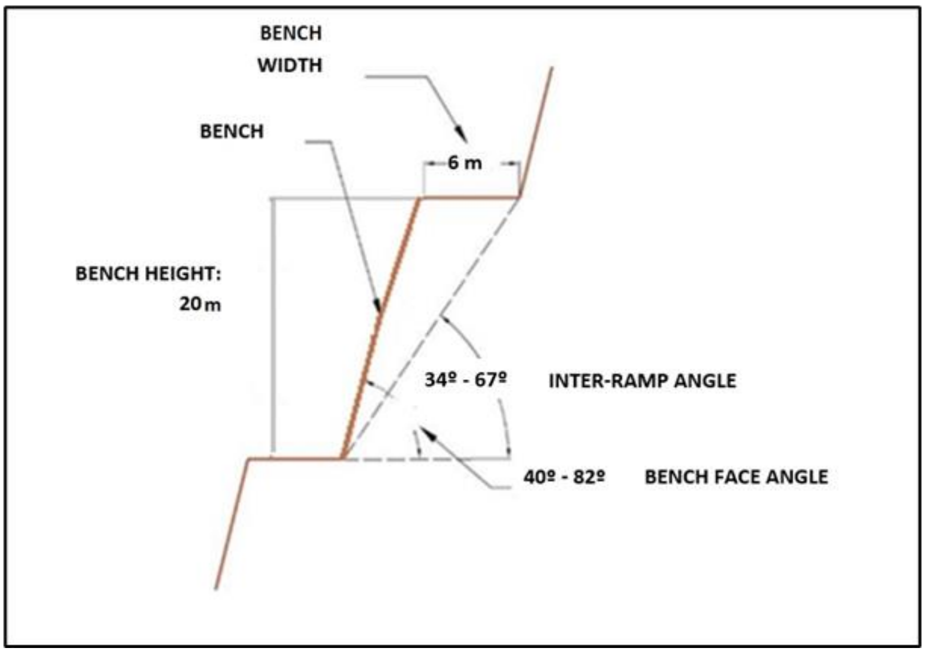


Figure 15-10: Xuxa Pit Wall Configuration

A fleet of conventional road trucks is planned to transport ore and waste. The width of the access road to the final pit was designed at 12 m. Within the pit, the road has a running surface of 10 m for trucks and a total width of 12 m (Figure 15-11). For mining the lower benches, which mainly consist of mineralized material, the width of the road was reduced to 6 m.

Figure 15-12 shows the final design of the operational pit and Table 15-6 shows the total ore and waste expected to be mined.

The final commissioned pit would contain 11.8 Mt of ore and 195.4 Mt of waste with a 16.6:1 strip-ratio, resulting in a mine life of approximately eight years.

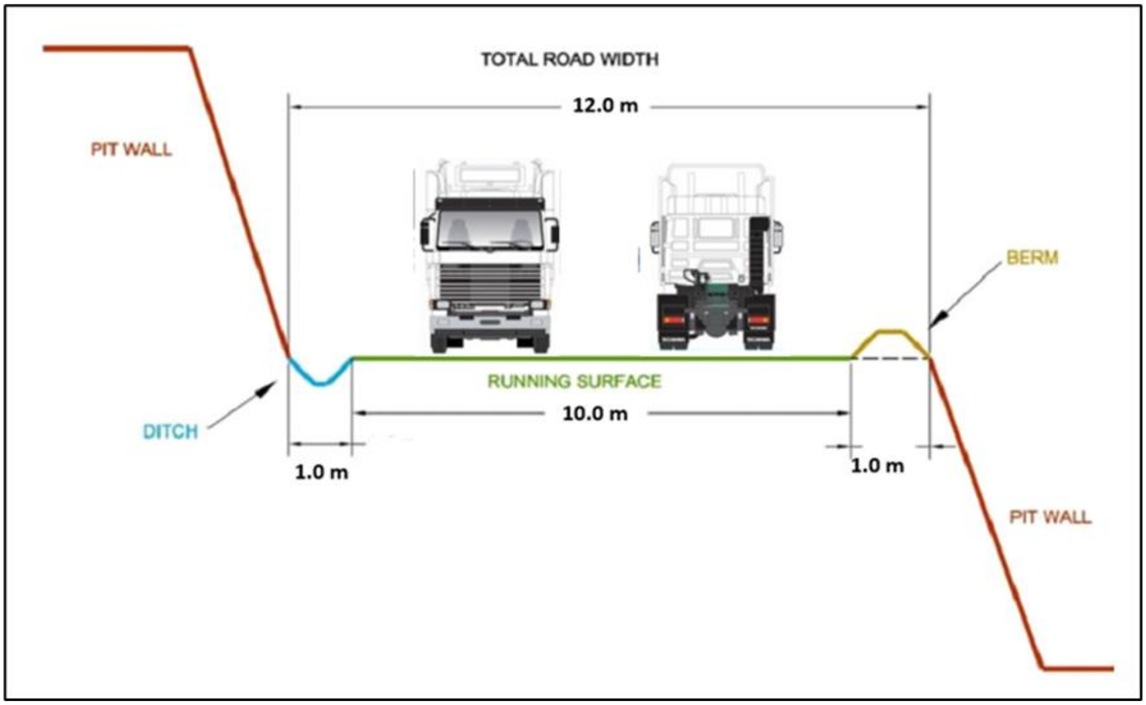


Figure 15-11: Xuxa Pit Ramp Design

Table 15-6: Xuxa Pit Final Optimization Ore and Waste

Xuxa Pit Ore, Waste and Stripping Ratio		
Classification	**Tonnage (Mt)**	**Li_2O (%)**
Ore	**11.8**	**1.55**
Waste	195.4	
Stripping Ratio	16.6:1	

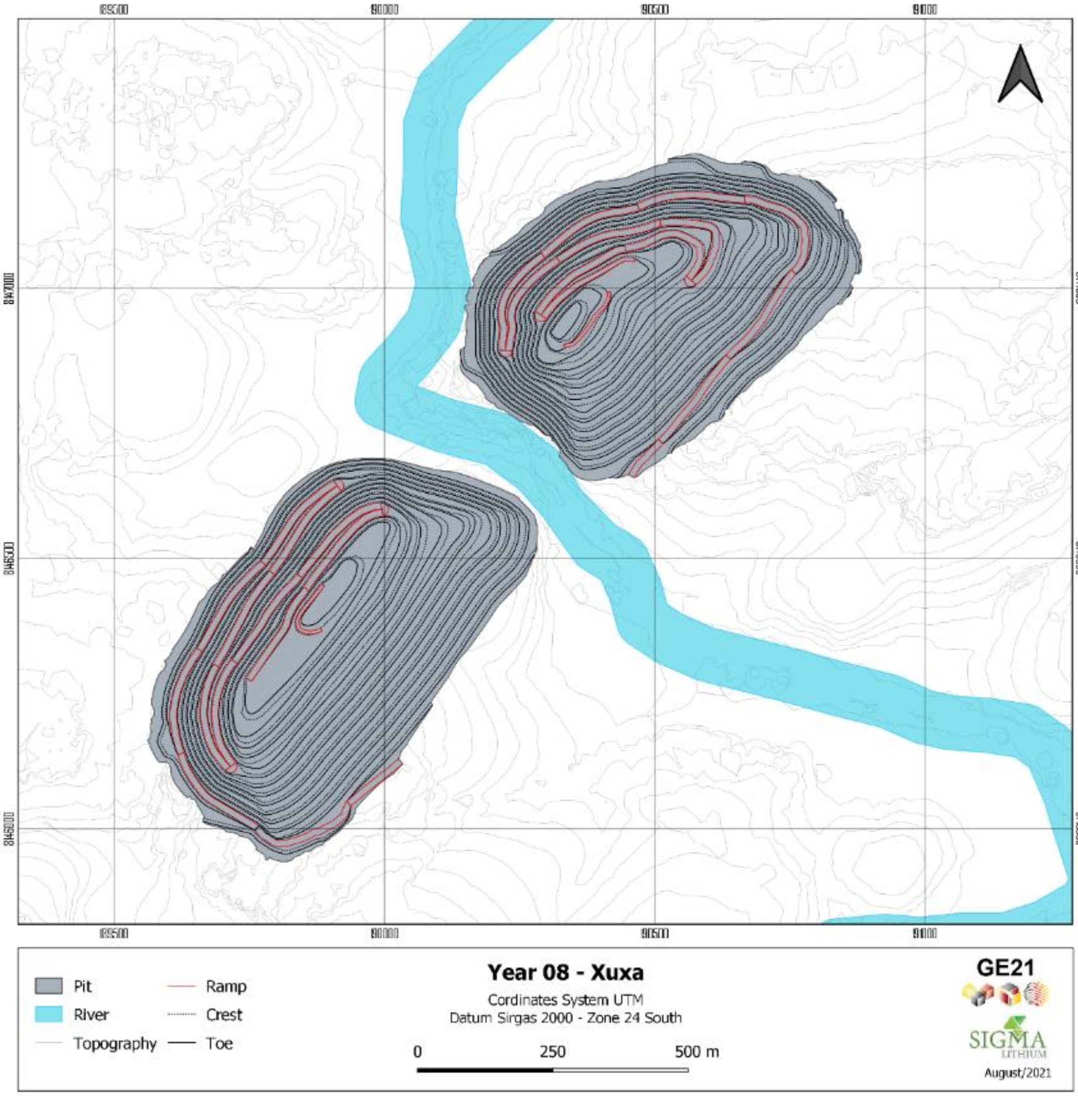


Figure 15-12: Xuxa Final Optimized Pit Design

15.5 XUXA MINERAL RESERVES STATEMENT

The Mineral Reserves are shown in Table 15-8 and were estimated by GE21's Porfirio Cabaleiro Rodriguez, a Qualified Person under NI 43-101 and a Fellow of the Australian Institute of Geoscientists.

Table 15-7: Xuxa Mineral Reserves

Sigma FS Xuxa 5 x 3 x 5 (m) Block Dimensions 97% Mine Recovery, 3.75% Dilution (Effective date: 6/26/2021)			
Classification	**Tonnage (Mt)**	**Li2O(%)**	**LCE(Kt)**
Proven	8.34	1.55	319.7
Probable	3.46	1.54	131.8
Total	11.80	1.55	451.5

Notes to accompany Mineral Resource table

1. *Mineral Reserves were estimated using Geovia Whittle 4.3 software and following the economic parameters listed below:*
2. *Sale price for Lithium concentrate at 6% Li_2O = US$1,500/t concentrate FOB mine gate.*
3. *Exchange rate US$1.00 = R$5.00.*
4. *Mining costs: US$2.20/t mined.*
5. *Processing costs: US$10.70/t ore milled.*
6. *G&A: US$4.00/t ROM (run of mine).*
7. *Mineral Reserves are the economic portion of the Measured and Indicated Mineral Resources.*
8. *82.5% Mine Recovery and 3.75% Mine Dilution*
9. *Final slope angle: 34° to 72° based on geotechnical considerations presented in Section 16.*
10. *Inferred Mineral Resources within the Final Operational Pit totals 0.68 Mt grading 1.52% Li_2O. The Inferred Mineral Resources are not included in the Mineral Reserves.*
11. *Strip Ratio = 16.6 t/t (waste+Inferred mineral resource)/mineral reserve.*
12. *The Qualified Person for the estimate is Porfírio Cabaleiro Rodriguez, BSc. (MEng), FAIG, an employee of GE21.*

15.6 BARREIRO MINERAL RESERVES

The Barreiro Deposit will be mined by conventional open pit mining methods for a twelve-year mine life, at a plant feed rate of 1.80 Mtpa, with Mineral Reserves totalling 21.8 Mt grading 1.36% Li_2O (lithium oxide), based on a long-term lithium spodumene selling price of US$1,500/t concentrate FOB Mine

The effective date for the Mineral Reserve Estimate is February 11, 2022. A CIM-compliant Mineral Resource Estimate, from which this reserve was calculated, was completed by SGS Canada in 2022 as documented in section 14 of this report.

Development of the LOM (life of mine) plan includes pit optimization, pit design, mine scheduling and the application of modifying factors, economic and metallurgical, of the Measured and Indicated Mineral Resources. The basis on which Mineral Reserves are defined is the point where mined ore is delivered to the primary crusher. The tonnages and grades reported are inclusive of geological losses, mining recovery and mining dilution.

The Mineral Reserves for the open pit aspects of the Barreiro deposit were prepared by Porfirio Cabaleiro Rodriguez, FAIG., Senior Mining Engineer with GE21, a Qualified Person (QP) as defined under National Instrument 43-101 regulations.

The Mineral Reserve for the Barreiro deposit was based on a diluted and recoverable block model built over the Mineral Resource block model. A pit design was developed based upon operational and reliable parameters, resulting in a mine life of twelve years.

The Mineral Reserve Estimate has been developed using best practices in accordance with the 2019 CIM guidelines and National Instrument 43-101 reporting.

The QP is of the opinion that no known risks including legal, political, or environmental, would materially affect potential development of the Mineral Reserve, except for those risks discussed in this Report.

Table 15-14 presents the Mineral Reserves that have been estimated for the Barreiro deposit, which include 16.93 Mt of Proven Mineral Reserves at an average grade of 1.38% Li_2O and 4.83 Mt of Probable Mineral Reserves at an average grade of 1.29% Li_2O for a total of 21.76 Mt of Proven and Probable Mineral Reserves at an average grade of 1.36% Li_2O. To access these Mineral Reserves, 271.37 Mt of waste rock must be mined, resulting in a strip ratio of 12.5:1 t/t.

The final pit and the mine planning were based on a pit optimization using Whittle software. The mining plan developed in this report is based on Measured and Indicated Mineral Resources only. There is a low geological confidence associated with Inferred Mineral Resources, and there is no certainty that further exploration work will result in the Inferred Mineral Resources becoming Indicated Mineral Resources.

Mineral Reserves are an estimate of the grade and tonnage of measured and indicated mineral resources that can be economically mined and processed. For the Project, Mineral Reserve estimation used open-pit mining methods as this was assumed to be the most economic mining method for the Barreiro Deposit.

Figure 15-13 presents a general layout of the Barreiro deposit mine site.

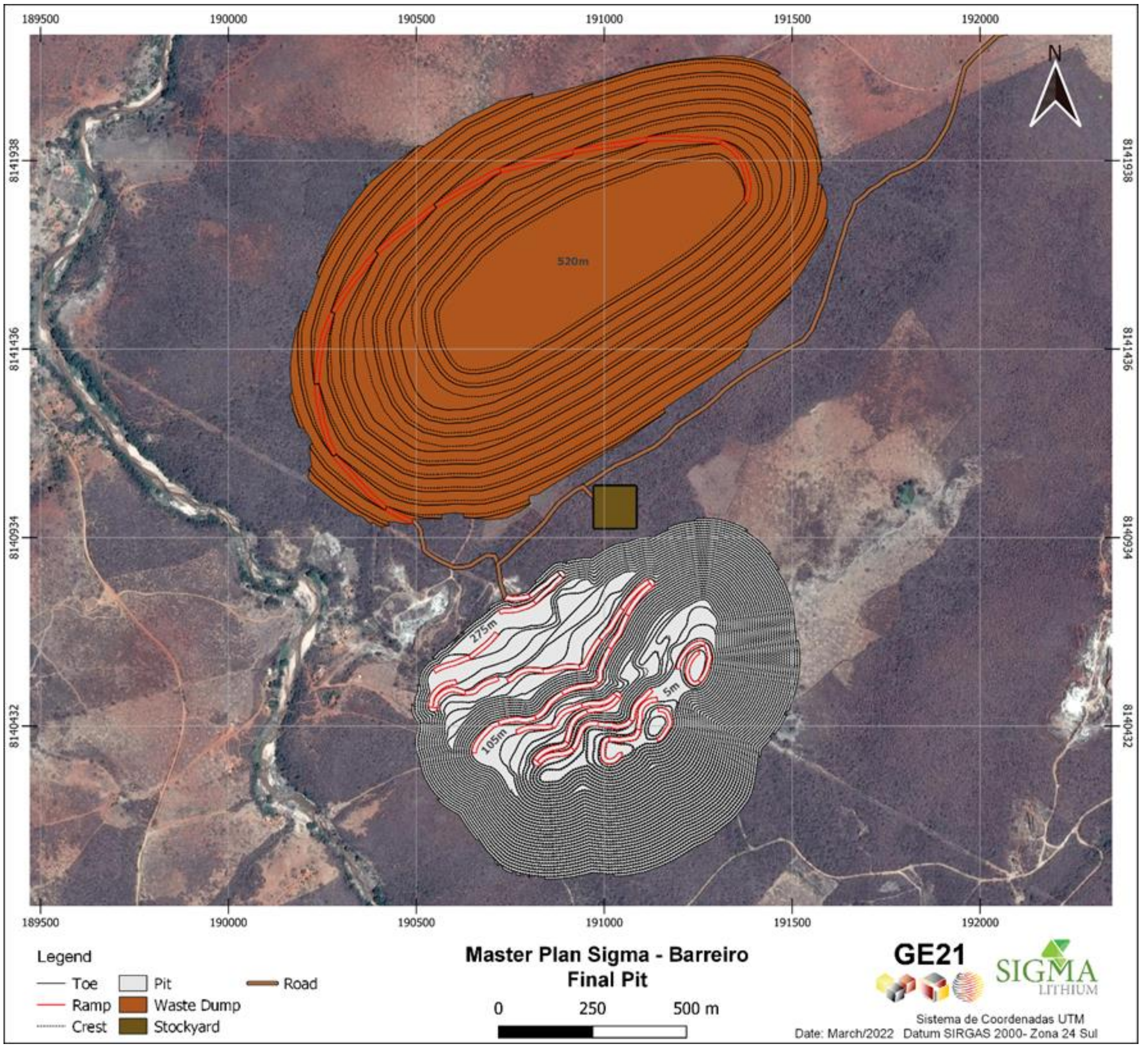


Figure 15-13: Final Barreiro Mine Configuration

15.7 BARREIRO PIT OPTIMIZATION PARAMETERS

The technical and economic parameters listed in Table 15-8 were used to generate the optimal pit, which consists of a pit that maximizes the project economic value, as obtained by applying the Lerchs-Grossman algorithm implemented by the Geovia Whittle software program.

The classic methodology for the selection of the optimal pit consists of generating a set of nested pits from the application of revenue factors. The factor is applied to the sale price of the commercial product, resulting in a mathematical pit for each factor applied. The resulting generated pits are analyzed to define the final optimal pit for the deposit.

Table 15-8: Technical and Economic Parameters Used in the Final Barreiro Pit Optimization

Item			Unit	Value
Revenue	Sales Price		US$/t conc.*	$1500
	Ore	Density	g/cm^3	Block model
		Grade	% Li_2O	Block model
	Mining	Mine Recovering	%	Block model
		Dilution		Block model
	Block Model Dimensions	Block Dimensions	Unit	value
		X x Y x Z	m	5 x 5 x 5
	General Angle	Overburden	º	Sectors 1, 2, 4 & 5 – 35º Sector 3 – 37º
		Fresh Rock		Sectors 1, 2, 4 & 5 – 55º Sector 3 – 52º
	Processing	Metallurgical Recovery**	%	60.0
		Mass Recovery***	%	Calculated in block
		Concentrated Grade	% Li_2O	6.0
		Cut-off	% Li_2O	0.5
Costs		Mining	US$/t mined	$2.20 (Ore)/$1.88 (Waste)
		Processing	US$/t ore	$10.70
		G&A (Adjusted for OPEX)		$4.00
		Sale (2% cost of sale)	US$/t product	$14.66
		Royalties (CFEM 2%)		$14.66

Note: * conc. = concentrate, ** based on DMS Tests, *** Including 15% fines losses

15.7.1 Physical Parameters

The information relative to the physical aspects and restrictions that were used for the open pit designs and Mineral Reserve Estimate included the topographic surface, the geological block model, and the rock type properties for ore, waste and overburden.

The mine planning work carried out for the Feasibility Study Update was performed using Geovia MineSched 2020 software.

15.7.1.1 Topographic Surface

The mine design was based on a topographic surface based on 1 m contour intervals. The contours were supplied by Sigma and derived from a drone topographic survey that took place on June 29, 2021.

15.7.1.2 Geotechnical Parameters

Figure 15-14 shows the five geotechnical sectors for the optimized Barreiro pit presented in this preliminary feasibility study. The red lines represent the limits for the sectors within the pit shell. The pit slope angles used are listed in Table 15-9.

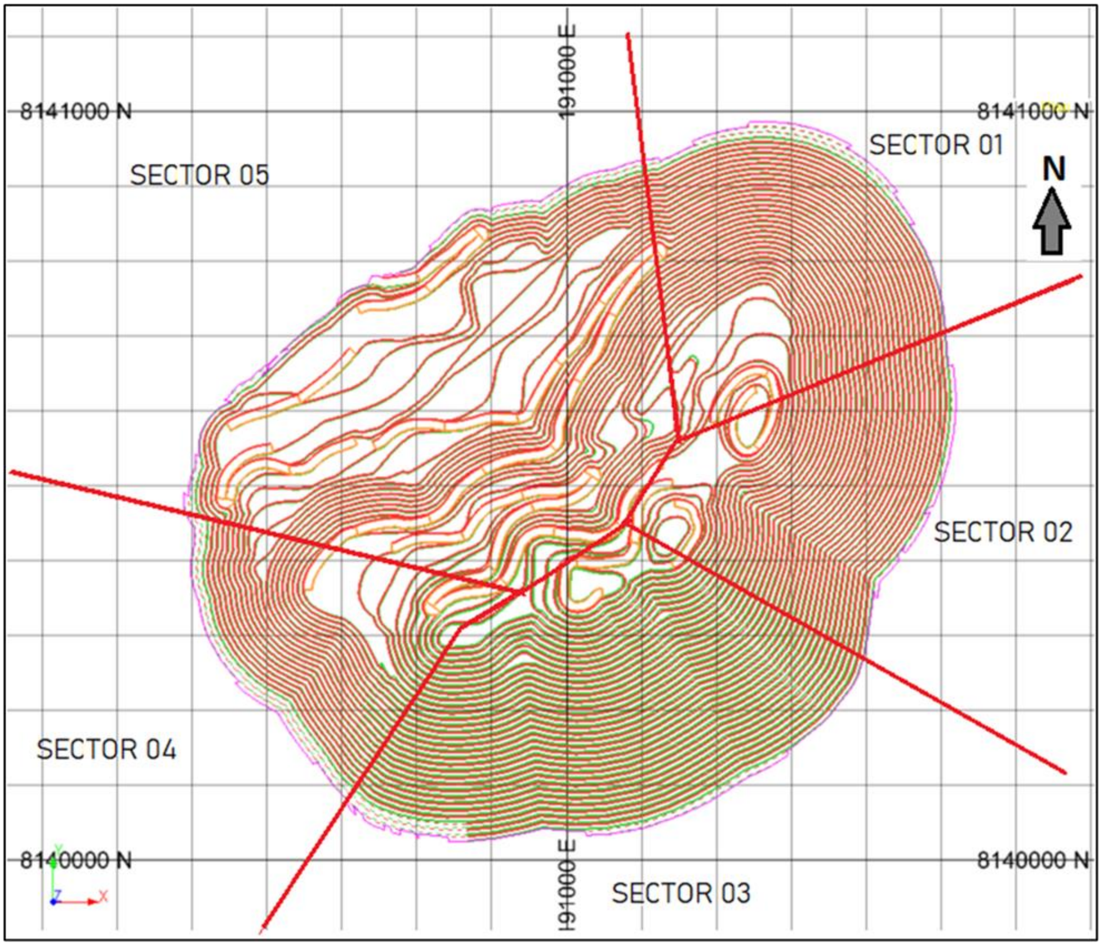


Figure 15-14: Barreiro Pit Geotechnical Sectors

Table 15-9: Barreiro Geotechnical Pit Slope Design Criteria

Sectors	Face Angle (º)	Berm Width (m)	Bench Height (m)	Inter-Ramp Slopes Angle (º)
01 - Overburden	55	6	10	37.6
01 - Fresh Rock	84	6	10	55
02 - Overburden	55	6	10	37.6
02 - Fresh Rock	84	6	10	55
03 - Overburden	47	6	10	33.7
03 - Fresh Rock	75	5	10	52
04 - Overburden	55	6	10	37.6
04 - Fresh Rock	84	6	10	55
05 - Overburden	55	6	10	37.6
05 - Fresh Rock	84	6	10	55

The geotechnical and hydrogeological parameters used in the open-pit design are defined in Section 16.1 – Geotechnical and Hydrogeological Analysis.

15.7.1.3 Rock Type Properties

The rock type properties are outlined below. Rock properties are important in estimating the Mineral Reserves, the equipment fleet requirements, as well as the waste dump and stockpile design capacities.

15.7.1.3.1 Density

The in-situ dry density of the mineralized material is estimated to be 2.72 t/m³. A density of 2.76 t/m³ has been used for schist waste rock and a density of 1.61 t/m³ for overburden.

15.7.1.3.2 Swell Factor

An average swell factor of 30% and a compaction factor of 15% were estimated for the in-situ material transported to the waste dump. These factors were used to define waste dump volumes.

15.7.1.3.3 Moisture Content

A general moisture content factor of 5% was estimated for in-situ rock material. The final fleet sizing was provided by a mining contractor who will carry out mining activities during the life of the mining operation. This factor was used to define fleet sizing.

15.7.1.4 Mineral Resource Block Model

The Mineral Resource block model provided by SGS Canada (described in section 14) was the base used by GE21 to build the Mineral Reserve block model.

15.8 BARREIRO MODIFYING FACTORS

The modifying factors listed in the Sections below were applied to convert the Mineral Resources into Mineral Reserves for the pit optimization analysis and the open pit design.

15.8.1 Economic and Metallurgical Factors

15.8.1.1 Long-Term Concentrate Price

A long-term sale price of US$1,500/t concentrate FOB Mine for spodumene (6% Li_2O) was used, based on market studies provided by Sigma.

15.8.1.2 Cut-Off Grade

A cut-off grade of 0.3% Li_2O as defined for the Mineral Resource Estimate.

15.8.1.3 Metallurgical Factors

An overall metallurgic recovery of 60.0% for a dense media separation (DMS) operation was used for metallurgical recovery, with a concentrate grade of 6% Li_2O, resulting in a calculated mass recovery, after allowing for fines losses of 15%, block by block of mined ore by the formula:

$$Mass\ Recovery = \frac{metallurgical\ recovery}{concentrate\ grade} \times feed\ grade\ x\ (1 - fine\ losses).$$

15.8.1.4 Mining and Processing Cost Factors

Optimization economics used a mining cost of US$2.20/t mined and a processing cost of US$10.7/t ore, based on a proposal from a Brazilian mining contractor.

15.8.1.5 Other Costs

The cost assumptions also included US$4.00/t ore for G&A expenses, and royalties at 2% of the concentrate price (US$14.66/t concentrate).

15.8.2 Selective Mining Unit (SMU) Selection

The conventional definition of the selective mining unit (SMU) is the smallest volume of material on which ore/waste classification is determined.

In order to determine the optimal SMU for Xuxa, GE21 analyzed a number of block dimension alternatives, ranging in size from 20 m x 20 m x 5 m (x, y, z) to 5 m x 5 m x 2.5 m (x, y, z). Isastis software was used to perform a uniform conditioning simulation on the various SMU alternatives using Li_2O% as the estimated variable.

Figure 15-15 shows the results of the uniform conditioning estimate.

Based on the analysis, GE21 determined that an SMU of 5 m x 5 m x 5 m was suitable.

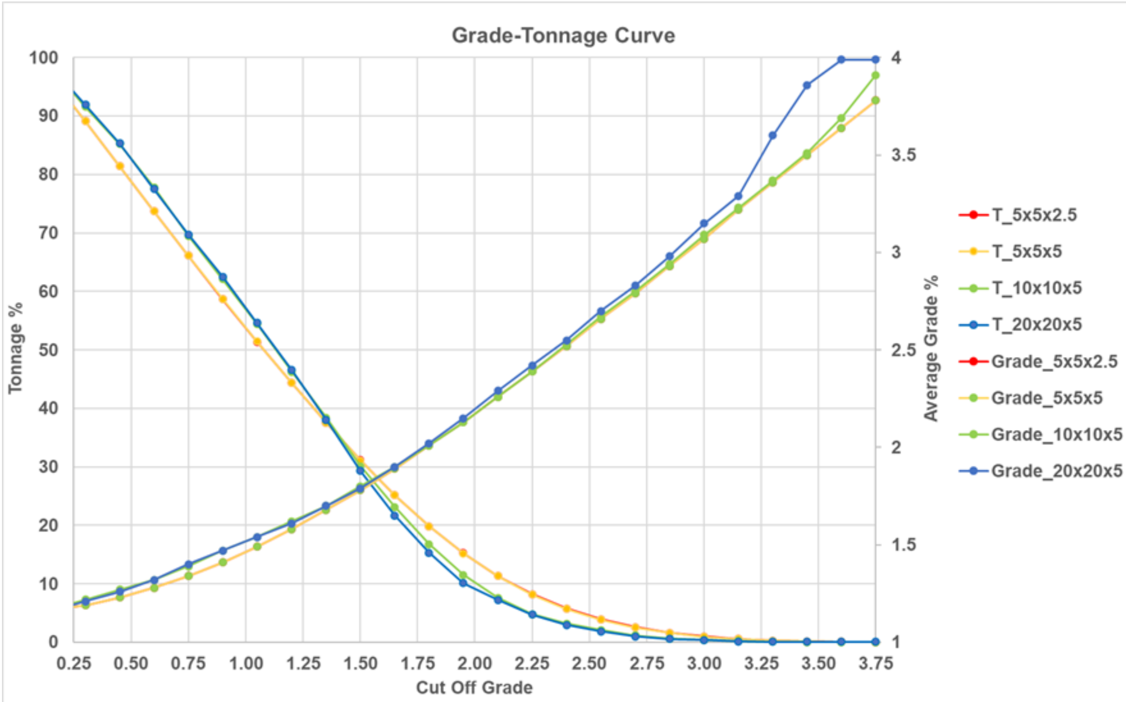


Figure 15-15: Barreiro Grade x Tonnage Curve with Selectivity Results Based on Local Uniform Conditioning Estimate

15.8.3 Dilution and Loss Estimate

Once the SMU was defined and a grade control procedure established, GE21 prepared a diluted block model to be used in mine planning. The main assumptions adopted by GE21 were:

- Considering the fact that the grade control drill hole can only be checked every metre, a pegmatite bounding envelope was created based on the one-metre-wide edge, as shown in Figure 15-16.

- The blocks within the enclosed envelope, the pegmatite bounding envelope, were classified as waste. The schematic diagram in Figure 15-17 represents the partial effect of this assumption on the blocks near the end face of the bench.

- For the blocks still within the remaining pegmatite solid, a maximum 3% of operational dilution was allowed, as shown in the dilution parameterization curve in Figure 15-18 below.

- GE21 has considered accepting blocks at the edge of the fixed pegmatitic wireframe structure with a minimum 61% of ore on the block.

An overall 3% mean dilution was assumed for the diluted pegmatite, as shown in the Table 15-10 below, resulting in a mining recovery equivalent to 95% relative to a partial model in the original resource model.

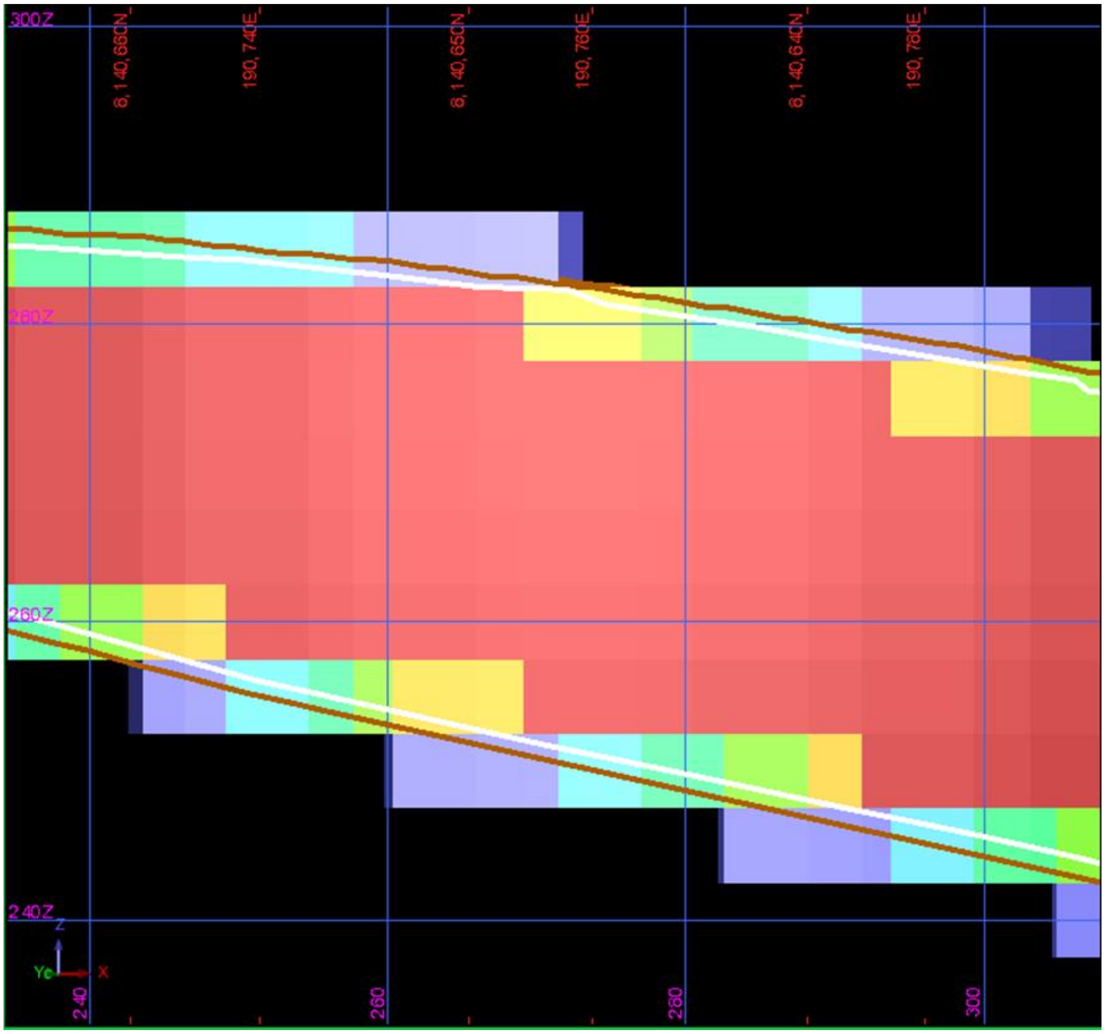


Figure 15-16: Cross-Section Showing the Original Pegmatite (brown line) and the One Reduced At 1 M from the Edge (white line). Blocks are Coloured Blue to Red in Relation to their Partial Percentage within the Reduced Solid (Blue = 0%, Red = 100%)

Table 15-10: Barreiro Dilution Analysis

Source	Partial Percent Cut	Total Mass After Cut (Mt)	Average Partial Percentage	Total Resource on Source (Mt)	Mining Recovery
Resource Model	-	-	-	29.6	100%
Undiluted Model (1)	0.61	27.9 (2)	0.97	29.4	95%

(1) Resource restricted within pegmatite model.
(2) Whole blocks including dilution model

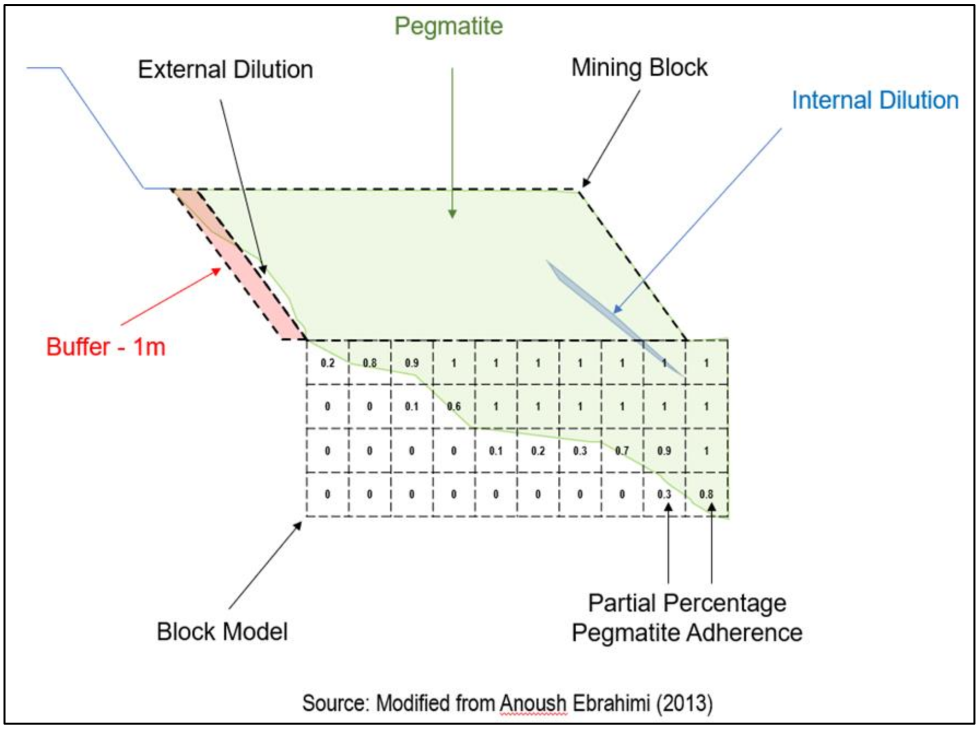


Figure 15-17: Schematic Representation of the Dilution Analysis

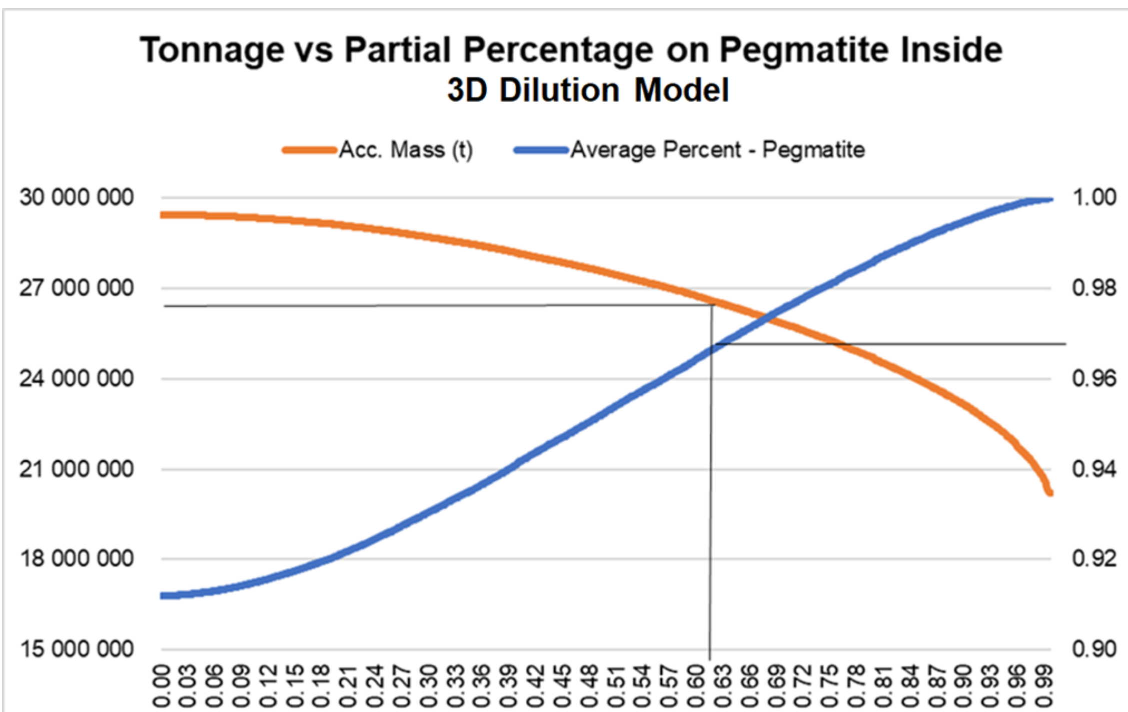


Figure 15-18: Barreiro Tonnage vs Partial Percentage Curves

GE21 intends to use the 61% cut-off on the partial percentage of pegmatite, representing an effective 95% mining recovery, keeping a 3% dilution rate, on the pit optimisation phase.

15.9 BARREIRO PIT OPTIMIZATION STUDY

The pit optimization was based on:

- Definition of economic and geometric parameters, cut-off grade, and physical restrictions.
- Modified Mineral Resource Block Model to include the modified factors.
- Definition of an optimal pit using Geovia Whittle 4.3 software.
- The selection of the optimum pit, based on a strip ratio limit, and allowance for a mine life long enough to support a positive cash flow.

The technical and economic parameters listed in Table 15-8 were used to generate the optimal pit, which consists of a pit that maximizes the project economic value, as obtained by applying the Lerchs-Grossman algorithm implemented by the Geovia Whittle software program.

The optimal pit sequence was obtained by varying the revenue factor in a range from 30% to 200% of the base product selling price. To determine the evolution of the pits over time, an annual production rate of 1.8 Mtpa of ore feed was established at an annual discount rate of 10%. Table 15-11, and Figure 15-9 present the pit optimization parameters and shows the evolution of the resulting optimization pushbacks with the chosen optimal pit highlighted.

Table 15-11: Barreiro Nested Pit Optimization Results

Pit	Revenue Factor	Ore	Waste	Total Movement	Waste-Ore Ratio	Li_2O
		(Mt)	(Mt)	(Mt)	t/t	%
1	30%	20.60	179.64	200.23	8.72	1.41

Pit	Revenue Factor	Ore	Waste	Total Movement	Waste-Ore Ratio	Li_2O
		(Mt)	(Mt)	(Mt)	t/t	%
2	40%	22.15	210.62	232.78	9.51	1.41
3	50%	22.76	227.01	249.77	9.97	1.40
4	60%	23.19	241.49	264.68	10.41	1.40
5	70%	23.42	250.10	273.52	10.68	1.39
6	80%	23.52	254.24	277.76	10.81	1.39
7	90%	23.56	256.73	280.29	10.90	1.39
8	100%	23.59	258.75	282.34	10.97	1.39
9	110%	23.63	260.63	284.25	11.03	1.39
10	120%	23.64	261.87	285.51	11.08	1.39
11	130%	23.65	263.49	287.14	11.14	1.39
12	140%	23.66	264.18	287.85	11.16	1.39
13	150%	23.67	264.60	288.27	11.18	1.39
14	160%	23.68	265.58	289.26	11.22	1.39
15	170%	23.68	266.37	290.05	11.25	1.39
16	180%	23.69	267.26	290.95	11.28	1.39
17	190%	23.69	267.87	291.57	11.30	1.39
18	200%	23.70	268.14	291.83	11.32	1.39

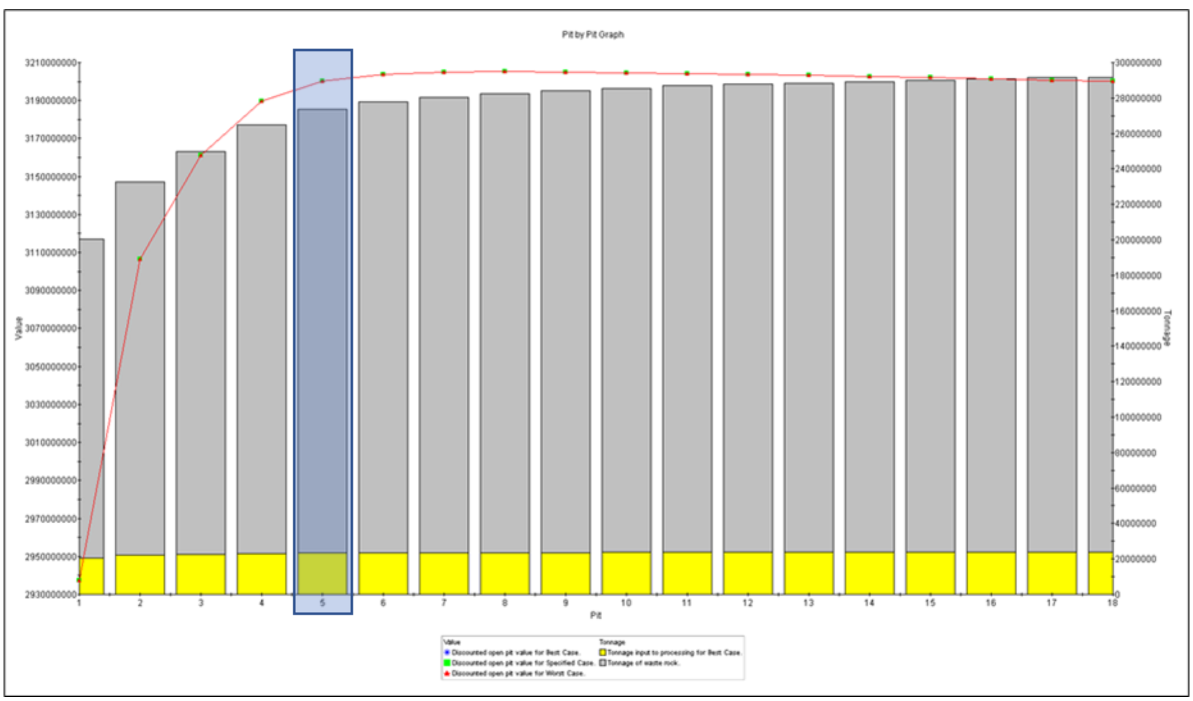


Figure 15-19: Barreiro Nested Pit Tonnage and NPV

GE21 performed a series of pit optimization scenarios considering sales prices of lithium concentrate @6% ranging from US$450 (Pit 1) to US$1,500 (Base Case – Pit 8). It was observed that the sales price above US$1,050/t conc (Pit 5), relative at a Revenue Factor of 70%, does not demonstrate any significant gain in the optimization results (ore tonnage). For this reason and representing lower risk, Pit 5 was selected to serve as the basis for the pit design.

15.9.1 Mine Design

Mine design comprises the design of an operational pit, including ramps, berms, and access over the life of the selected optimal pit shell, and recovery of the Mineral Reserves in an operationally feasible design.

The methodology consists of tracing the benches, toe and crest outline, safety berms, construction sites, and access ramps, while respecting the geometric and geotechnical parameters defined by geotechnical and hydrogeological studies. The assumptions adopted for the operationalization of the final pit were:

- Minimize ore mass loss.
- Define access routes for shorter average transport distances.

Table 15-12 presents the geometric parameters adopted to develop the mine design and Figure 15-20 presents the pit wall configuration based on those parameters.

Table 15-12: Barreiro Open Pit Operational Design Parameters

Final Pit Operational Parameters			
Parameters		Value	Unit
Bench Height		10	metres
Overburden	Face Angle – Sector 01	55	º
	Berm Width - Sector 01	6	metres
	Face Angle - Sector 02	55	º
	Berm Width – Sector 02	6	metres
	Face Angle – Sector 03	47	º
	Berm Width - Sector 03	6	metres
	Face Angle – Sector 04	55	º
	Berm Width - Sector 04	6	metres
	Face Angle – Sector 05	55	º
	Berm Width - Sector 05	6	metres
Fresh Rock	Face Angle – Sector 01	84	º
	Berm Width - Sector 01	6	metres
	Face Angle - Sector 02	84	º
	Berm Width – Sector 02	6	metres
	Face Angle – Sector 03	75	º
	Berm Width - Sector 03	6	metres
	Face Angle – Sector 04	84	º
	Berm Width - Sector 04	6	metres
	Face Angle – Sector 05	84	º
	Berm Width - Sector 05	6	metres
Access Ramps Width		12.0	metres
Access Ramps Inclination		10.0	%

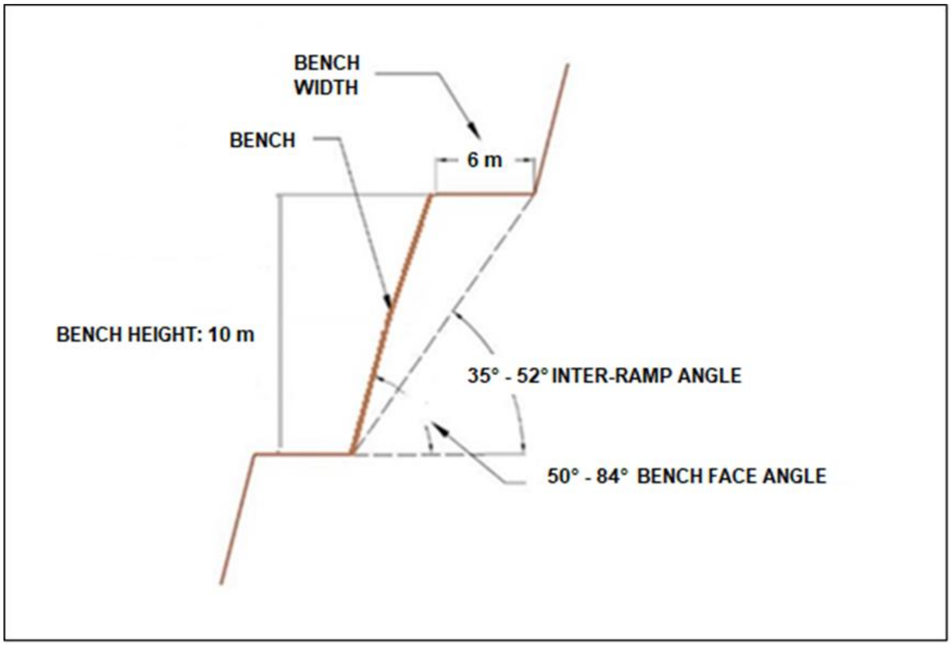


Figure 15-20: Barreiro Pit Wall Configuration

A fleet of conventional road trucks is planned to transport ore and waste rock. The width of the access road to the final pit was designed at 12 m. Within the pit, the road has a running surface of 10 m for trucks and a total width of 12 m (Figure 15-21). For mining the lower benches, which mainly consist of mineralized material, the width of the road was reduced to 6 m.

Figure 15-22 shows the final design of the operational pit and Table 15-13 shows the total ore and waste expected to be mined.

The final commissioned pit would contain 21.8 Mt of ore and 271.4 Mt of waste, including Inferred Mineral Resources, with a 12.5:1 strip-ratio, and a mine life of approximately 12 years.

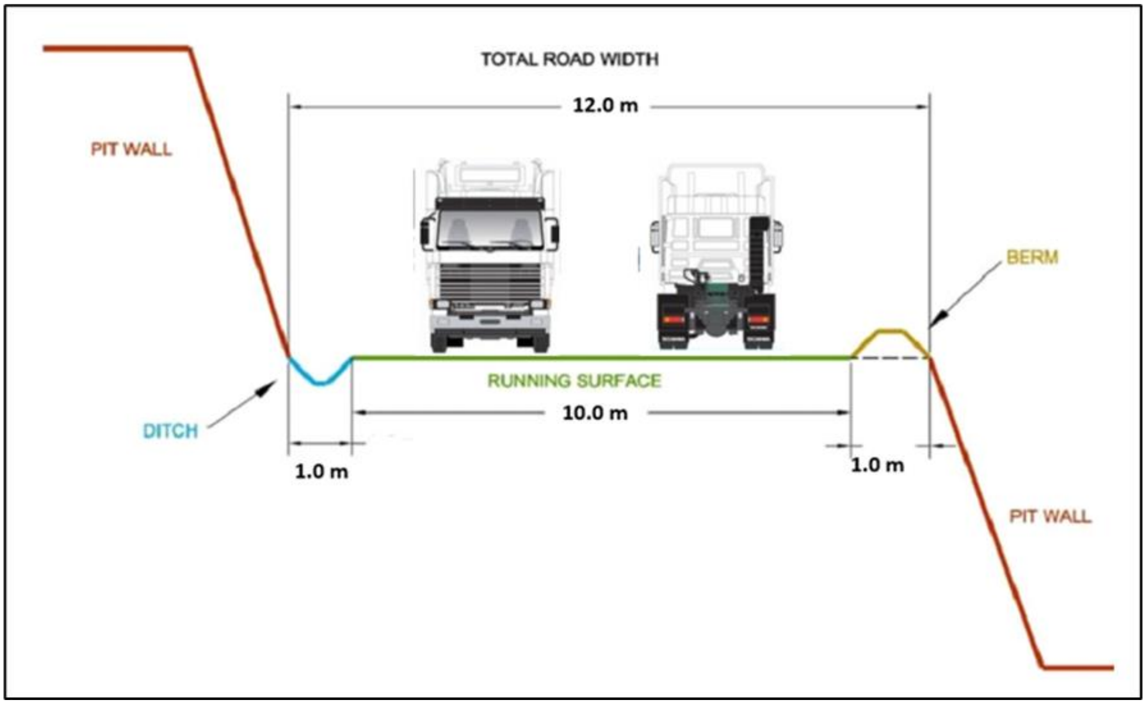


Figure 15-21: Barreiro Pit Ramp Design

Table 15-13: Barreiro Pit Final Optimization Ore and Waste

Barreiro Pit Ore, Waste and Stripping Ratio		
Classification	**Tonnage (Mt)**	**Li_2O (%)**
Ore	**21.8**	**1.36**
Waste	271.4	
Stripping Ratio	12.5:1	

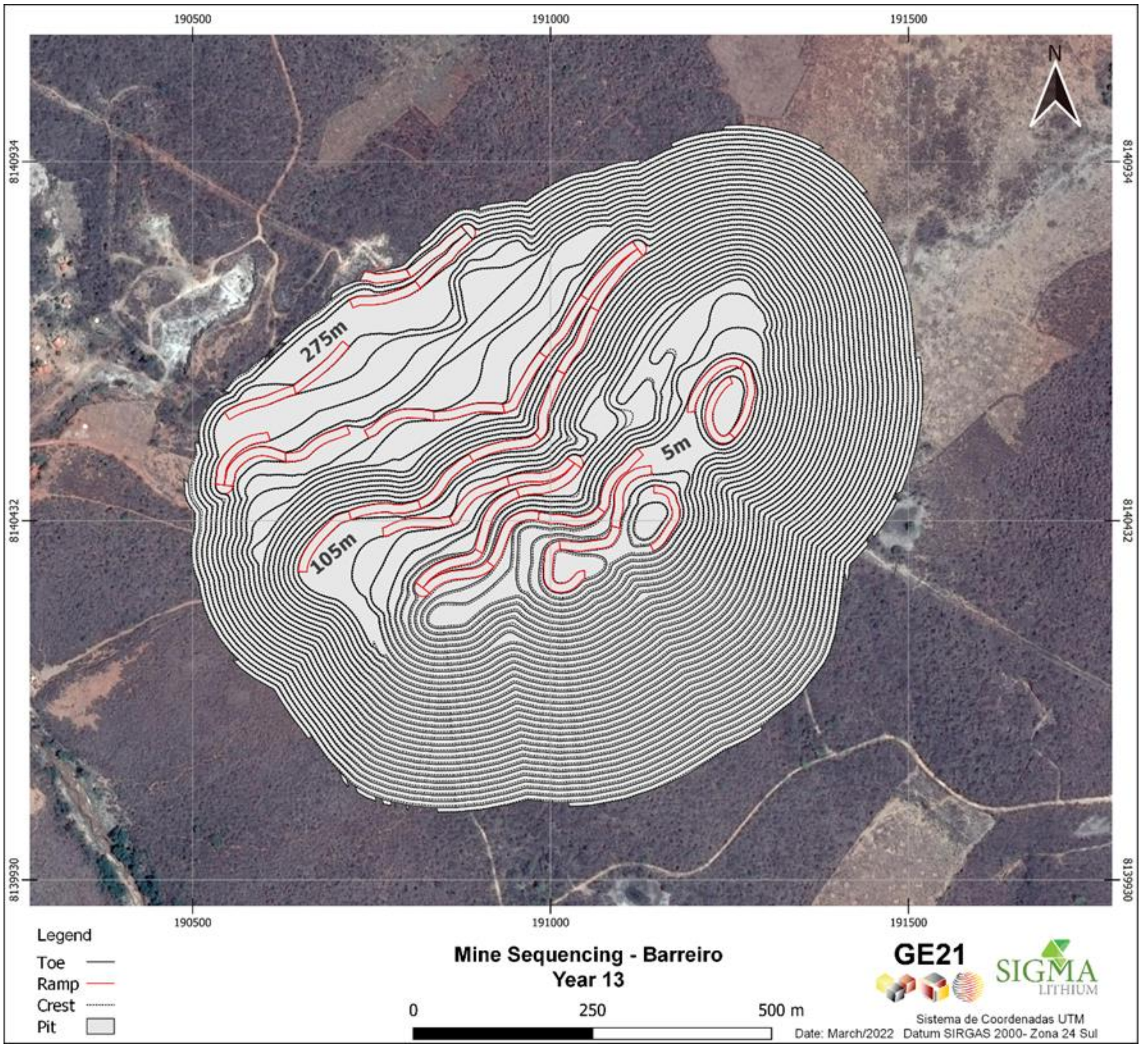


Figure 15-22: Barreiro Final Operational Pit Design

15.10 BARREIRO MINERAL RESERVES STATEMENT

The Mineral Reserves shown in Table 15-14 were estimated by GE21's Porfirio Cabaleiro Rodriguez, a Qualified Person under NI 43-101 and a Fellow of the Australian Institute of Geoscientists.

Table 15-14: Barreiro Mineral Reserves

Sigma PFS Barreiro 5 x 5 x 5 (m) Block Dimensions 97% Mine Recovery, 3.00% Dilution (Effective date: 2/24/2022)			
Classification	**Tonnage (Mt)**	**Li2O(%)**	**LCE(Kt)**
Proven	16.93	1.38	576.8
Probable	4.83	1.29	153.1
Total	**21.76**	**1.36**	**729.9**

Notes to accompany Mineral Resource table

1. *Mineral Reserves were estimated using Geovia Whittle 4.3 software and following the economic parameters listed below:*
2. *Sale price for Lithium concentrate at 6% Li_2O = US$1,500/t concentrate FOB Mine.*
3. *Exchange rate US$1.00 = R$5.00.*
4. *Mining costs: US$2.19/t mined.*
5. *Processing costs: US$10.7/t ore milled.*
6. *G&A: US$4.00/t ROM (run of mine).*
7. *Mineral Reserves are the economic portion of the Measured and Indicated Mineral Resources.*
8. *95% Mine Recovery and 3% Mine Dilution*
9. *Final slope angle: 35° to 55° based on Geotechnical Document presented in Section 16.*
10. *Inferred Mineral Resources with the Final Operational Pit is 0.59 Mt grading at 1.32% Li_2O. The Inferred Mineral Resources are not included in the Mineral Reserves.*
11. *Strip Ratio = 12.5 t/t (waste+Inferred mineral resource)/mineral reserve.*
12. *The Competent Person for the estimate is Porfírio Cabaleiro Rodriguez, BSc. (MEng), FAIG, an employee of GE21.*

15.11 NEZINHO DO CHICAO MINERAL RESERVES

The Nezinho do Chicão (NDC) Deposit will be mined by conventional open pit mining methods for a twelve-year mine life, at a plant feed rate of 1.80 Mtpa, with Mineral Reserves totaling 21.2 Mt grading 1.45% Li_2O, based on a long-term lithium spodumene selling price of US$3,500/t concentrate FOB Mine.

The effective date for the Mineral Reserve Estimate is October 31, 2022. A CIM-compliant Mineral Resource Estimate, from which this reserve was calculated, was completed by SGS in 2022 as documented in section 14 of this report.

Development of the life of mine (LOM) plan includes pit optimization, pit design, mine scheduling and the application of modifying factors, economic and metallurgical, of the Measured and Indicated Mineral Resources. The basis of which Mineral Reserves are defined is the point where mined ore is delivered to the primary crusher. The tonnages and grades reported are inclusive of geological losses, mining recovery and mining dilution.

The Mineral Reserves for the open pit aspects of the Nezinho do Chicão deposit were prepared by Porfirio Cabaleiro Rodriguez, FAIG., Senior Mining Engineer with GE21, a Qualified Person (QP) as defined under National Instrument 43-101 regulations.

The Mineral Reserve for the Nezinho do Chicão deposit was based on a diluted and recoverable block model built over the Mineral Resource block model prepared by SGS Canada. A pit design was developed based upon operational and reliable parameters, resulting in a mine life of twelve years.

The Mineral Reserve Estimate has been developed using best practices in accordance with the 2019 CIM guidelines and National Instrument 43-101 reporting.

The QP is of the opinion that no known risks including legal, political, or environmental, would materially affect potential development of the Mineral Reserve, except for those risks discussed in this Report.

Table 15-21 presents the Mineral Reserves that have been estimated for the Nezinho do Chicão deposit, which include 2.2 Mt of Proven Mineral Reserves at an average grade of 1.53% Li_2O and 19.0 Mt of Probable Mineral Reserves at an average grade of 1.44% Li_2O for a total of 21.2 Mt of Proven and Probable Mineral Reserves at an average grade of 1.45% Li_2O. In order to access these Mineral Reserves, 339.8 Mt of waste rock must be mined, resulting in a strip ratio of 16:1 t/t.

The final pit and the mine planning were based on a pit optimization using Whittle software. The mining plan developed in this report is based on Measured and Indicated Mineral Resources only. There is a low geological confidence associated with Inferred Mineral Resources, and there is no certainty that further exploration work will result in the Inferred Mineral Resources becoming Indicated Mineral Resources.

Mineral Reserves are an estimate of the grade and tonnage of measured and indicated mineral resources that can be economically mined and processed. For the Project, Mineral Reserve estimation used open-pit mining methods as this was assumed to be the most economic mining method for the Nezinho do Chicão deposit.

Figure 15-23 presents a general layout of the Nezinho do Chicão deposit mine site.

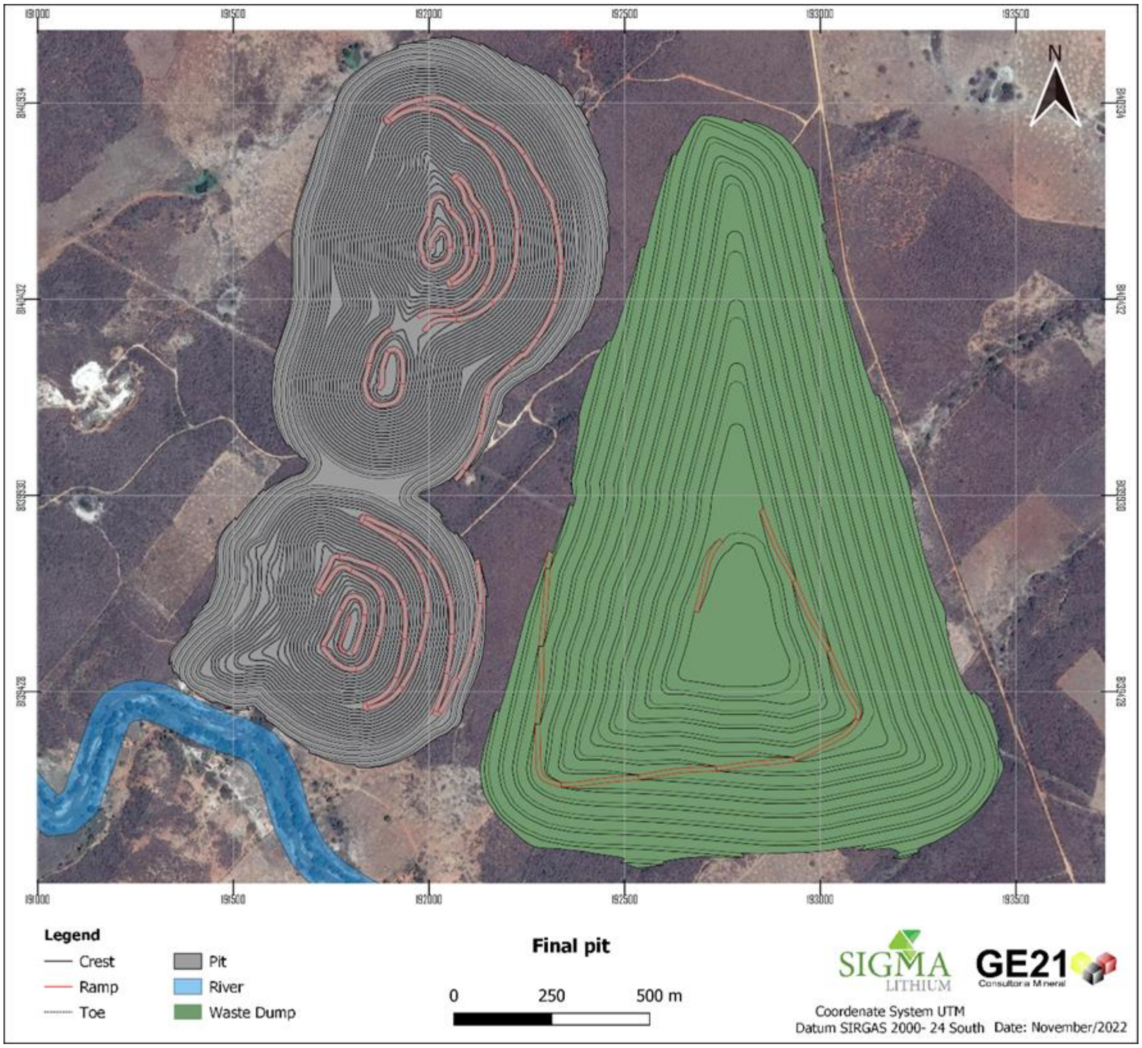


Figure 15-23: Final Nezinho do Chicão Mine Configuration

15.12 PIT OPTIMIZATION PARAMETERS

The technical and economic parameters listed in Table 15-15 were used to generate the optimal pit, which consists of a pit that maximizes the project economic value, as obtained by applying the Lerchs-Grossman algorithm implemented by the Geovia Whittle software program.

The methodology for the selection of the optimal pit consists of generating a set of nested pits from the application of multiple revenue factors. The factor is applied to the sale price of the commercial product, resulting in a mathematical pit for each factor applied. The resulting generated pits are analyzed to define the final optimal pit for the deposit.

Table 15-15: Technical and Economic Parameters Used in the Final Nezinho do Chicão Pit Optimization

Item			Unit	Value
Revenue	Financial Parameters	Sales Price	US$/t conc	3 500
		Discount rate	%	10
	ROM	Density	g/cm³	model
		Grades	% Li_2O	model
	Mining	Mining Recovery	%	model
		Dilution		model
	Block Model	Block dimensions	Unit	Value
		X	m	5
		Y		3
		Z		5
	Overall Slope Angle	Overburden	º	35
		Fresh Rock		52
	Processing	Metallurgical Recovery DMS**	%	60.7
		Mass Recovery	%	Calculated for each block
		Concentrate Grade	% Li_2O	6
		Cut-off Grade (to be fixed by Software)	% Li_2O	0.5
Costs		Mining	US$/t mined	2.43
		Processing	US$/t ROM	10.7
		G&A		4
		Sales (2% sales cost)	US$/t product	14.66
		Royalties (CFEM 2%)		14.66

Note: * conc. = concentrate, ** based on DMS Tests, *** Including 15% fines losses - FOB Mine

15.12.1 Physical Parameters

The information relative to the physical aspects and restrictions that were used for the open pit designs included the topographic surface, buffer to Piaui river, the geological block model, and the rock type properties for ROM, waste and overburden.

15.12.1.1 Topographic Surface

The mine design was based on a topographic surface. The contours were supplied by Sigma and derived from a topographic survey of June 29, 2021.

15.12.1.2 Geotechnical Parameters

The final pit slope angles and other geotechnical parameters used for the pit optimization and pit design, are listed below in Table 15-16.

Table 15-16: NDC Geotechnical Pit Slope Design Criteria

Sectors	Face Angle (°)	Berm Width (m)	Bench Height (m)	Overall Slope Angle (°)
Overburden	50	6	10	35
Fresh Rock	75	6	10	52

15.12.1.3 Piaui River Buffer

A 50 m buffer boundary from the final pit crest to the Piauí River was assumed as reasonable for the pit optimization and PEA.

15.12.1.4 Rock Type Properties

The rock type properties are outlined below. Rock properties are important in estimating the mineral reserves, the equipment fleet requirements, as well as the dump and stockpile design capacities.

15.12.1.4.1 Density

The in-situ dry density of the mineralized material was estimated to be 2.70 t/m³. A density of 2.76 t/m³ has been used for waste schist rock, and a density of 1.61 t/m³ for overburden.

15.12.1.4.2 Swell Factor

An average swell factor of 15% was estimated for the in-situ material transported to the waste dump. This factor was used to define waste dump volumes but does not affect the Mineral Reserve estimate.

15.12.1.4.3 Moisture Content

A general moisture content factor of 6% was estimated for in-situ rock material. The final fleet sizing was provided by a contractor who will carry out mining activities during the life of the mining operation. This factor was used to define fleet sizing and does not influence the mineral reserve estimate.

15.12.1.5 Mineral Resource Block Model

GE21 used a mineral resource block model provided by SGS Canada to design the mine and develop a mineral reserve block model.

15.13 MODIFYING FACTORS

Modifying factors listed in the sections below were applied to the pit optimization analysis and the open pit design.

15.13.1 Economic and Metallurgical Factors

The economic and metallurgical factors used for the open pit and mineral resource estimates include an assumed long-term Li2O concentrate sale price, economic cut-off grade, metallurgical recovery, concentrate grade, mining costs, processing costs, G&A costs, sales cost, and royalties.

15.13.1.1 Long-Term Concentrate Price

A long-term sale price of US$3,500/t concentrate FOB Mine for spodumene (6.0% Li_2O) was used based on market studies provided by Sigma.

15.13.1.2 Cut-Off Grade

A cut-off grade of 0.3% Li_2O was applied to the Mineral Resource Estimate.

15.13.1.3 Metallurgical Factors

An overall metallurgic recovery of 60.7% for a dense media separation (DMS) operation was used for metallurgical recovery, with a concentrate grade of 6.0% Li_2O, resulting in a calculated mass recovery, after allowing for fines losses of 15%, block by block of mined ore by the formula:

$$Mass\ Recovery = \frac{metallurgical\ recovery}{concentrate\ grade} \times feed\ grade\ x\ (1 - fine\ losses).$$

15.13.1.4 Mining and Process Cost Factors

Optimization economics used a mining cost of US$2.43/t based on a proposal from a Brazilian contract miner, which is also currently operating (Xuxa mine pre-stripping) at the Project site and also assuming a processing cost of US$10.7/t process feed based on the Phase 1 Feed study estimate.

15.13.1.5 Other Costs

The cost assumptions also included US$4.00/t ore for G&A expense, and cumulative royalties of 2% of the concentrate net sale price (US$14.66/t concentrate).

15.13.2 Selective Mining Unit (SMU) Selection

The conventional definition of the selective mining unit (SMU) is the smallest volume of material on which ore/waste classification is determined.

The optimal SMU for Nezinho do Chicão is the same as the Resource, which is an SMU of 5 m x 3 m x 5 m.

15.13.3 Recoverable Resources Block Model

15.13.3.1 Dilution and Losses

GE21 prepared a diluted block model to be used in mining planning. The main assumptions adopted by GE21 were:

- Mining unit considered by GE21 was 5 x 3 x 5 m, which is the same as SGS resource block model.
- Considering that the grade control drillholes can only be checked every meter, a pegmatite bounding
- envelope was created based on the one-meter-wide edge, as shown in Figure 15-24.

- The blocks within the enclosed envelope, the pegmatite bounding envelope, were classified as waste.
- The schematic diagram in Figure 15-25 represents the partial effect of this assumption on the blocks near the end face of the bench.
- GE21 has considered accepting blocks at the edge of the fixed pegmatitic wireframe structure with a minimum 64% to 76% recovery rate.

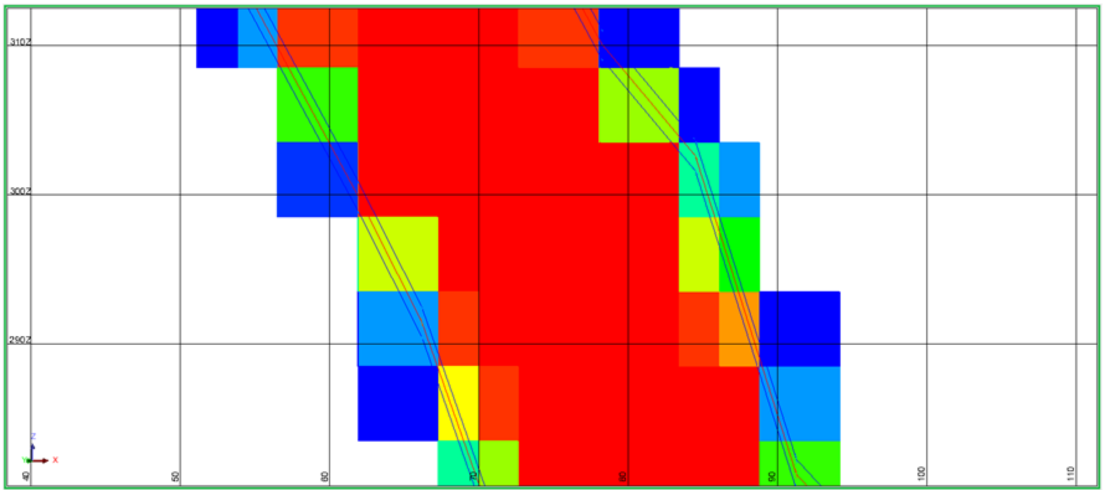


Figure 15-24: Cross-Section Showing the Original Pegmatite and the One Reduced At 1 m from the Edge. Blocks are Coloured Blue to Red in Relation to their Partial Percentage within the Reduced Solid (Blue = 0%, Red = 100%)

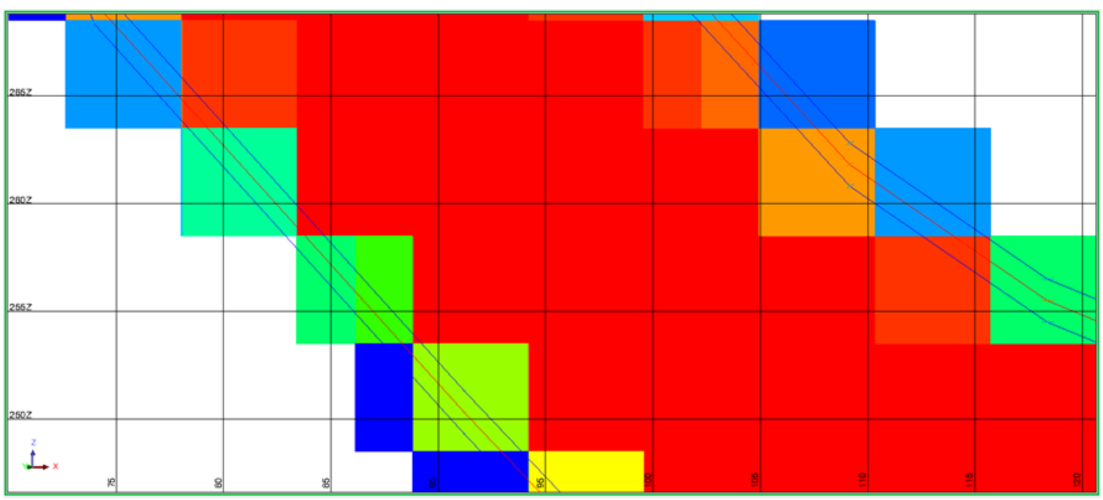


Figure 15-25: Bench Cross-Section

An overall average dilution of 3% was targeted for the final pit. Through numerous iterations, GE21 has accepted a 3.8% average dilution in the whole pegmatite, which led to 3% average dilution inside the optimum pit shell.

The average dilution and resulting recoverable portions of the pegmatite is shown in Table 15-17 which has deemed 7.8% of the ore body, mainly its borders, as unfit for processing, with 92.2% of the pegmatite fit for plant feed.

The average dilution obtained for different cut-offs of partial percentages are shown in the dilution parameterization curve in Figure 15-26.

Table 15-17: Dilution Analysis

Block Model	Partial Percent Cut (%)	Average Partial Percentage (%)	Tonnage (Mt)	Recoverable Pegmatite (%)
Mineral Resource	-	71	26.77	100
For optimization	65	96.2	24.68[1]	92.2

1. tonnage of whole blocks, including dilution.

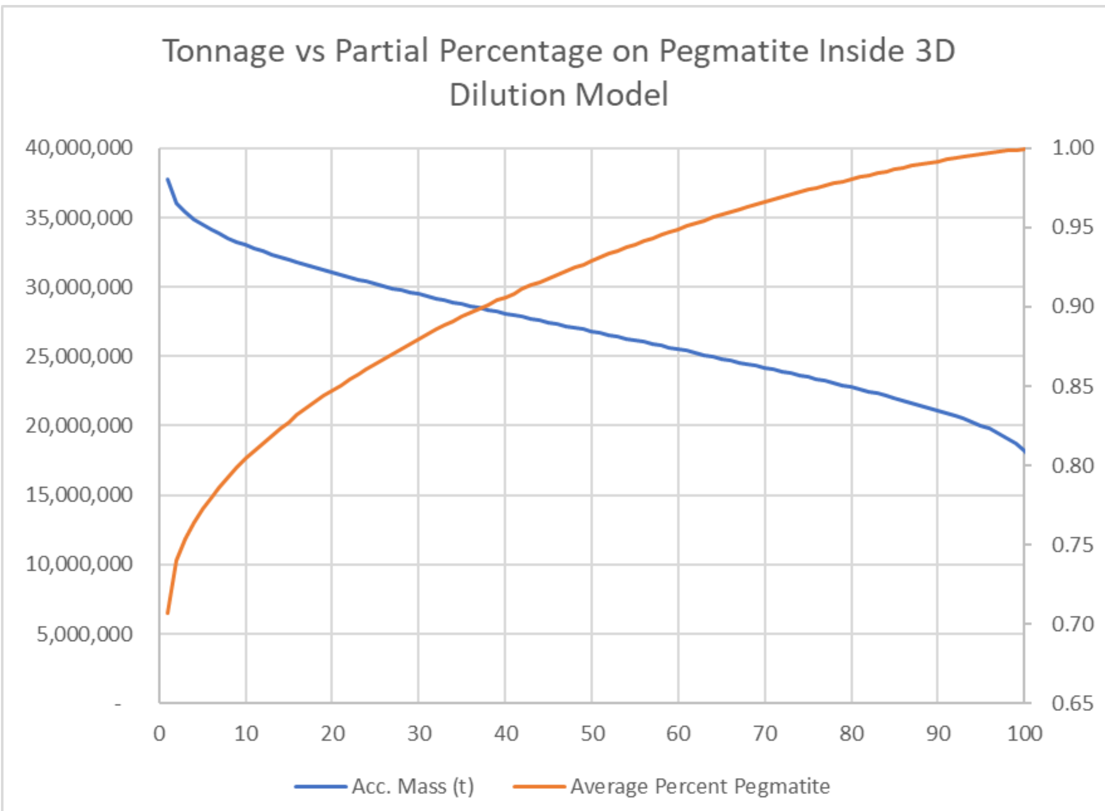


Figure 15-26: Tonnage vs Partial Percentage Curves

15.14 PIT OPTIMIZATION STUDY

The determination of the pit optimization was based on:

- Definition of economic and physical parameters, cut-off grade, and site geographic restrictions.
- Development of a Modified Mineral Resource Block Model to include the modifying factors.
- Definition of an optimal pit shell using Geovia Whittle 4.7 software.
- The selection of the optimum pit shell, based on a strip ratio limit, and allowance for a life-of-mine long enough to support a positive cash flow.

The technical and economic parameters listed in Table 15-15 were used to generate the optimal pit shell, which consists of a pit shell that maximizes the project economic value, as obtained by applying the Lerch-Grossman algorithm implemented by the Geovia Whittle software program.

The determination of the optimal pit shell geometry was chosen from the generation of an optimal sequence of pushbacks, corresponding to feasible increments of the generated pit shells, from the use of Lerchs-Grossman's three-dimensional algorithm for different blocks values, and obtained by product price variations using the revenue factor.

This sequence of expansion pit shells, or pushbacks, is the basis of open pit mine planning when using Whittle software, which projects the evolution of mine geometry over time. The evolution of mining over time can be simulated with two criteria: the maximization route or the stationary route. The first tries to maximize the operational financial return from a sequence of pushbacks that optimize the cash flow; the latter aims to keep the parameters of the processing plant feed material constant. The first approach was applied, and the optimal pit sequence was obtained by varying the revenue factor in a range from 30% to 150% of the product selling price

The optimal pit used to develop the pit design was Pit 7 with a revenue factor of 90%. Table 15-18, and Figure 15-27 present the pit optimization parameters and show the evolution of the resulting optimization pushbacks with the chosen optimal pit shell highlighted.

The selected pit shell refers to the point which the increment of ROM is minimal related to the increment in tonnages of waste, with the project's value curve reaching almost its peek value. This approach is adherent to the best practices in mining planning.

Table 15-18: Nested Pit Optimization Results

Pit	Revenue Factor	ROM (Mt)	Waste (Mt)	Total Movement (Mt)	Strip Ratio	Li_2O (t)	Li_2O (%)
1	0.3	21.48	220.10	241.58	11.2	312 349	1.454
2	0.4	21.73	231.71	253.44	11.7	315 693	1.453
3	0.5	21.78	235.28	257.06	11.8	316 263	1.452
4	0.6	21.82	238.26	260.08	11.9	316 825	1.452
5	0.7	21.86	242.33	264.20	12.1	317 473	1.452
6	0.8	21.88	243.38	265.26	12.1	317 741	1.452
7	**0.9**	**21.89**	**244.93**	**266.82**	**12.2**	**317 909**	**1.452**
8	1	21.90	245.02	266.92	12.2	317 921	1.452
9	1.1	21.90	245.10	267.00	12.2	317 711	1.451
10	1.2	21.90	245.38	267.28	12.2	317 737	1.451
11	1.3	21.90	246.04	267.94	12.2	317 785	1.451
12	1.4	21.91	247.12	269.03	12.3	317 864	1.451
13	1.5	21.91	247.30	269.21	12.3	317 888	1.451

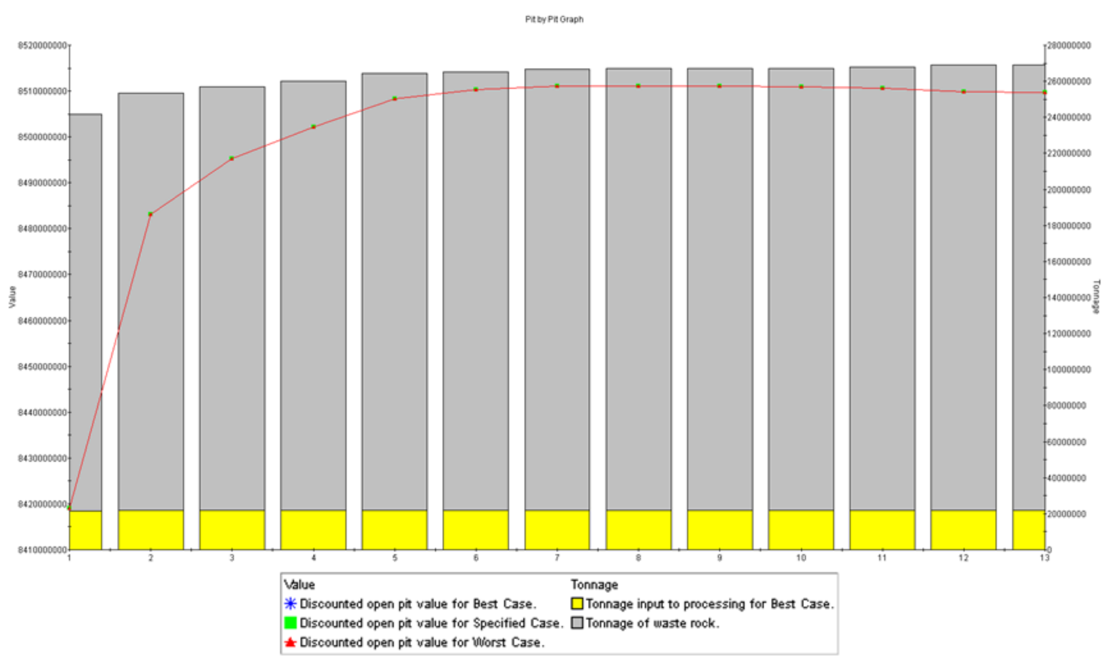


Figure 15-27: Nested Pits Tonnage and NPV Graph

15.14.1 Mine Design

Mine design comprises the design of an operational pit, including ramps, berms, and access over the life of the selected optimal pit shell, and recovery of mineral resources in an operationally feasible design.

The methodology consists of tracing the benches, toe and crest outline, safety berms, construction sites, and access ramps, while respecting the geometric and geotechnical parameters defined by geotechnical and hydrogeological studies. The assumptions adopted for the operationalization of the final pit were:

- Minimize the loss of mineralized material.
- Define access routes for shorter average transport distances.

Table 15-19 presents the geometric parameters adopted to develop the mine design and Figure 15-28 presents the final pit wall configuration.

Table 15-19: Parameters for the Pit Operational Design

Parameters		Value	Unit
Face Angle	Overburden	50	°
	Fresh Rock	75	°
Bench Height		10	m
Berm width		6	m
Ramp gradient		10	%
Ramp width		12	m
Minimum mining width		30	m
Mining Recovery		Block Model	%
Mining Dilution		Block Model	%

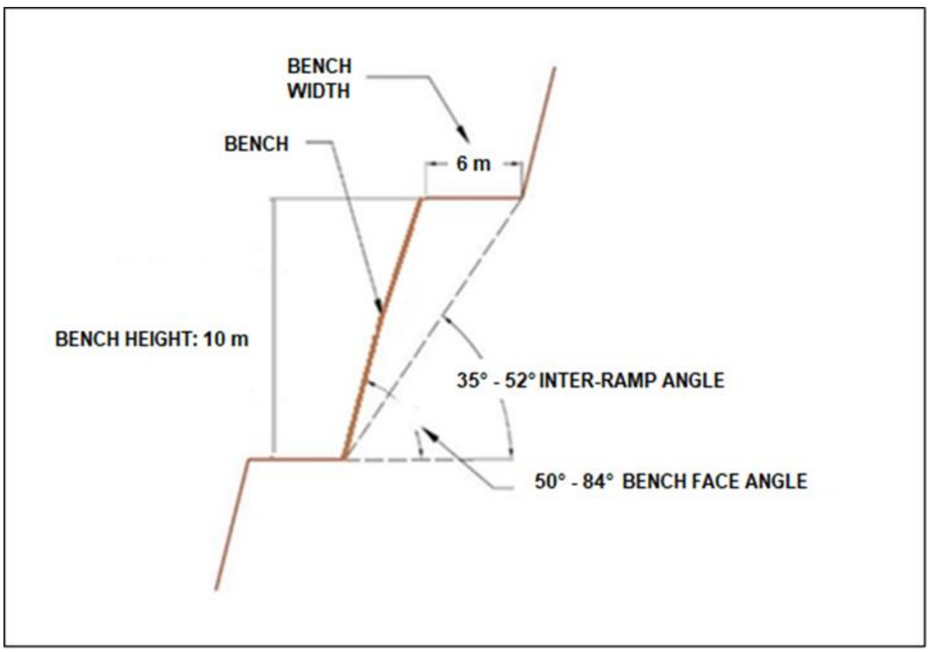


Figure 15-28: Pit Wall Configuration

A fleet of conventional road trucks is planned to transport ROM and waste rock. The width of the access road to the final pit was kept at 12m. Within the pit, the road has a running surface of 10 m for trucks and a total width of 12m (see Figure 15-29). However, the lower benches, (which mainly consist of mineralized material), have a 6m width for the access road.

Figure 15-30 shows the final design of the operational pit and Table 15-20 the total ore and waste expected to be mined.

The final commissioned pit would contain 21.2 Mt of ore and 339.8 Mt of waste with a 16:1 strip-ratio, resulting in a mine life of approximately twelve years.

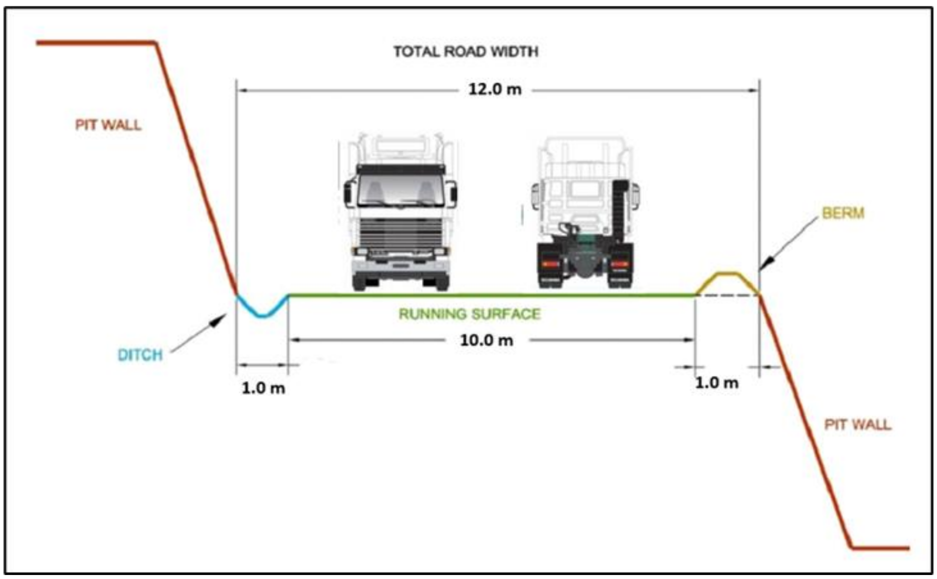


Figure 15-29: Ramp Design

Table 15-20: Final NDC Operational Pit Summary

Nezinho do Chicão Pit Ore, Waste and Stripping Ratio		
Classification	**Tonnage (Mt)**	**Li_2O (%)**
Ore	21.2	1.45
Waste	339.8	
Stripping Ratio	16:1	

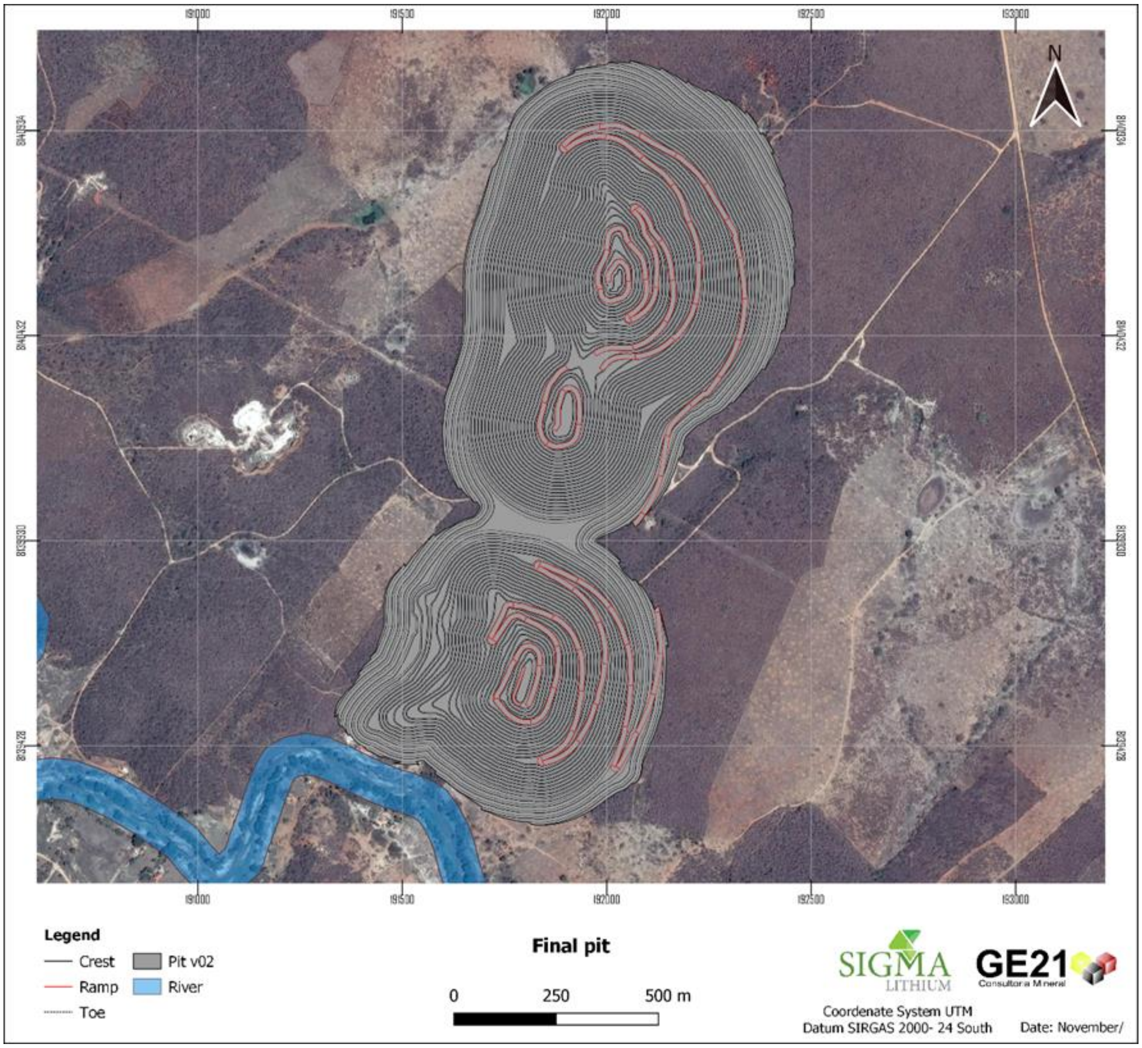


Figure 15-30: Final Operational NDC Pit

15.15 NEZINHO DO CHICÃO MINERAL RESERVES STATEMENT

The Mineral Reserves are shown in Table 15-21 and were estimated by GE21's Porfirio Cabaleiro Rodriguez, a Qualified Person under NI 43-101 and a Fellow of the Australian Institute of Geoscientists.

Table 15-21: Nezinho do Chicão Mineral Reserves

Sigma PFS Nezinho do Chicão 5 x 3 x 5 (m) Block Dimensions 94% Mine Recovery, 3.75% Dilution (Effective date: 10/31/2022)			
Classification	**Tonnage (Mt)**	**Li_2O(%)**	**LCE(Kt)***
Proven	2.2	1.53	82.1
Probable	19,0	1.44	677.3
Total	21.2	1.45	759.4

1. Mineral Reserves were estimated using Geovia Whittle 4.3 software and following the economic parameters listed below:
2. Sale price for Lithium concentrate at 6% Li2O = US$3,500/t concentrate FOB Mine.
3. Mining costs: US$2.43/t mined.
4. Processing costs: US$10.7/t ore milled.
5. G&A: US$4.00/t ROM (run of mine).
6. Exchange rate US$1.00 = R$5.30.
7. Mineral Reserves are the economic portion of the Measured and Indicated Mineral Resources.
8. 93% Mine Recovery and 3% Mine Dilution
9. Final slope angle: 35° to 52° based on Geotechnical Document presented in Section 16.
10. Strip Ratio = 16.01 t/t (waste)/mineral reserve.
11. The Competent Person for the estimate is Porfírio Cabaleiro Rodriguez, BSc. (MEng), FAIG, an employee of GE21.

16 MINING METHODS

16.1 XUXA OPEN PIT MINING

The Xuxa deposit will be mined by open pit mining methods, using a contracted mining fleet consisting of hydraulic excavators, front loaders, and 40 t transport trucks for waste and ore, coupled with appropriate auxiliary support equipment.

16.1.1 Geotechnical and Hydrogeological Analysis

16.1.1.1 Geotechnical

A geotechnical field study, analysis and design was performed to provide key pit design parameters for the Xuxa North and South pits.

Data analysis is supported by a comprehensive investigation and geotechnical assessment of the drill hole samples, and laboratory tests consisting of uniaxial compressive testing (UCS), triaxial testing, indirect tensile strength testing (Brazilian test), and direct shear strength testing. The stability analyses led to the recommendation of inclination angles for the pit walls which are considered prudent and within appropriate safety factors. The stability analyses considered information on the strength parameters of various rock and soil materials, in association with the understanding of the expected rupture mechanisms that could occur on the pit slopes.

The kinematic analysis in the most critical portion of the pit indicates a 9% probability of planar rupture due to schistosity, as shown in Figure 16-1, which is in accordance with good mining practices that allow up to a 30% probability.

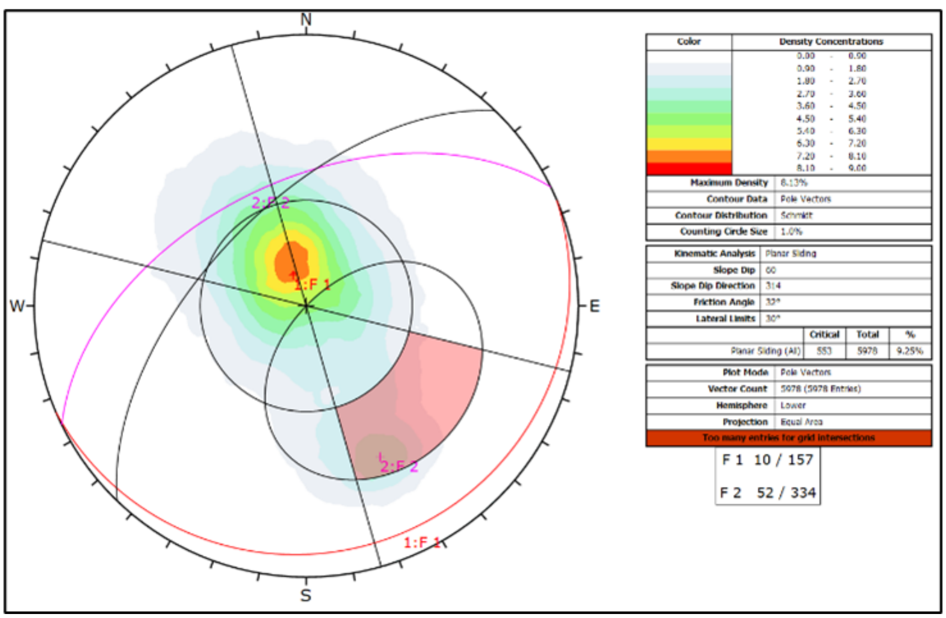
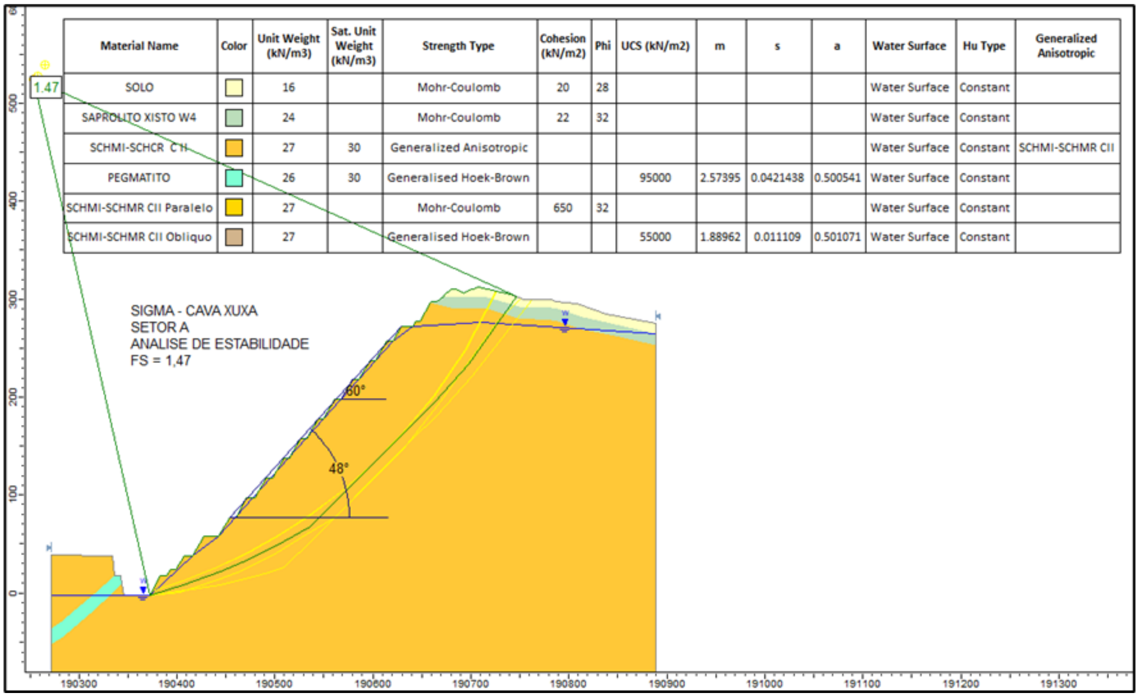


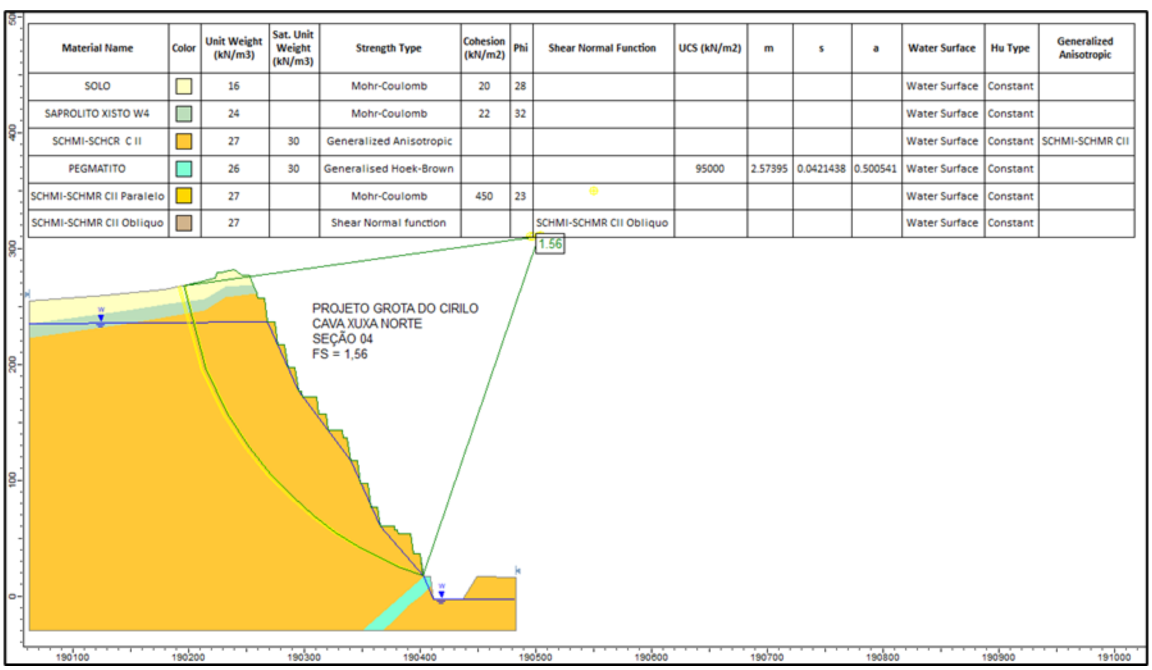
Figure 16-1: Kinematic Analysis of Sector A, Xuxa North Pit

The stability analysis of sectors A and C indicate that the pit slopes are stable, even using conservative parameters. Figure 16-2 and Figure 16-3 show the analyses with safety factors above the minimum permitted for open-pit mines, which is a factor of safety FS = 1.30.



Material Name	Color	Unit Weight (kN/m3)	Sat. Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	UCS (kN/m2)	m	s	a	Water Surface	Hu Type	Generalized Anisotropic
SOLO		16		Mohr-Coulomb	20	28					Water Surface	Constant	
SAPROLITO XISTO W4		24		Mohr-Coulomb	22	32					Water Surface	Constant	
SCHMI-SCHCR C II		27	30	Generalized Anisotropic							Water Surface	Constant	SCHMI-SCHMR CII
PEGMATITO		26	30	Generalised Hoek-Brown			95000	2.57395	0.0421438	0.500541	Water Surface	Constant	
SCHMI-SCHMR CII Paralelo		27		Mohr-Coulomb	650	32					Water Surface	Constant	
SCHMI-SCHMR CII Obliquo		27		Generalised Hoek-Brown			55000	1.88962	0.011109	0.501071	Water Surface	Constant	

Figure 16-2: Xuxa North Pit, Sector A Stability Analysis, FS=1.47



Material Name	Color	Unit Weight (kN/m3)	Sat. Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Shear Normal Function	UCS (kN/m2)	m	s	a	Water Surface	Hu Type	Generalized Anisotropic
SOLO		16		Mohr-Coulomb	20	28						Water Surface	Constant	
SAPROLITO XISTO W4		24		Mohr-Coulomb	22	32						Water Surface	Constant	
SCHMI-SCHCR C II		27	30	Generalized Anisotropic								Water Surface	Constant	SCHMI-SCHMR CII
PEGMATITO		26	30	Generalised Hoek-Brown				95000	2.57395	0.0421438	0.500541	Water Surface	Constant	
SCHMI-SCHMR CII Paralelo		27		Mohr-Coulomb	450	23						Water Surface	Constant	
SCHMI-SCHMR CII Obliquo		27		Shear Normal function			SCHMI-SCHMR CII Obliquo					Water Surface	Constant	

Figure 16-3: Xuxa North Pit, Sector C Stability Analysis, FS=1.56

Based on the stability analyses, the sectorization corresponding to the face angle, berm width, and inter-ramp angle was performed, as illustrated in Figure 16-4, and summarized in Table 16-1.

The criteria applied to the final operational pit design was discussed extensively among SMSA and GE21 engineers to determine the best approach for Mineral Reserve risk assessment. The confidence level related to a feasibility study and rules from ANM were also considered in the discussions.

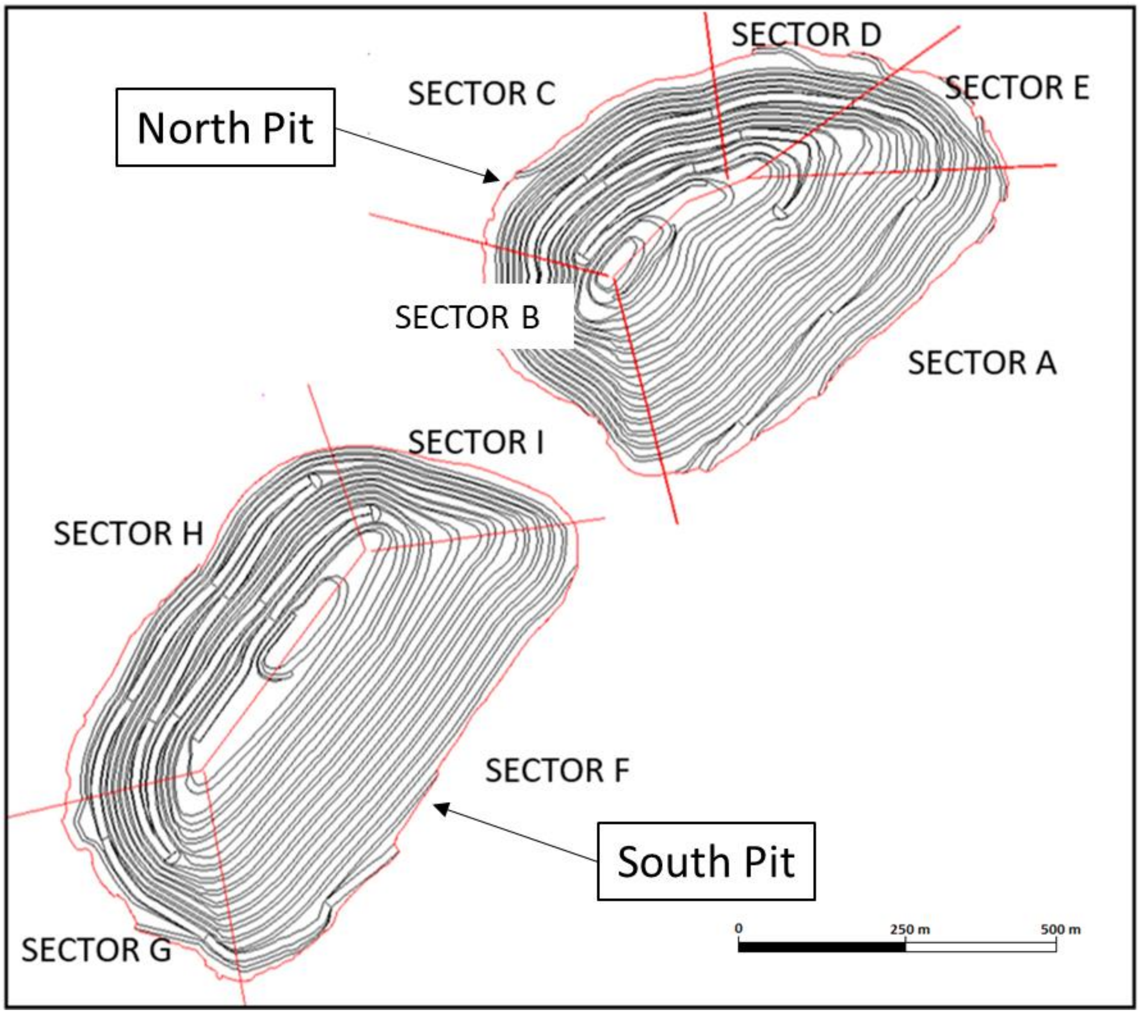


Figure 16-4: Xuxa North and South Pits with Geotechnical Sectors

Table 16-1: Xuxa Geotechnical Slope Results Designed Pit

Sectors	Face Angle (°)	Berm Width (m)	Bench Height (m)	Angle between Ramps / Overall (°)
A	60	6	20	48 / 46
B	82	6	20	66 / 61
C	82	6	20	67 / 62
D	82	6	20	66 / 61
E	82	6	20	66 / 61
F	60	6	20	48 / 48
G	82	6	20	66 / 59
H	82	6	20	66 / 61
I	82	6	20	66 / 59

16.1.1.2 Hydrogeology

A hydrogeological study, consisting of fieldwork, mathematical modeling, studies of regional water characteristics, and the potential impacts on Xuxa open pit mining, was performed.

A complementary campaign of geotechnical oriented drill holes and pressurized water loss tests (Packer Test) was carried out to measure the hydraulic conductivity of the rock mass, the hydrogeological characterization of the operation site, and to assess the likelihood of groundwater inflow from Piaui River into the North and South Xuxa pits.

Figure 16-5 presents a conceptual model of regional groundwater circulation. In this area, the primary permeability is very low, therefore, aquifers in a fractured environment predominate. The recharge takes place through the fracture system, which also controls surface drainage. Discharge from these fractured aquifers occurs predominantly at the bottom of valleys.

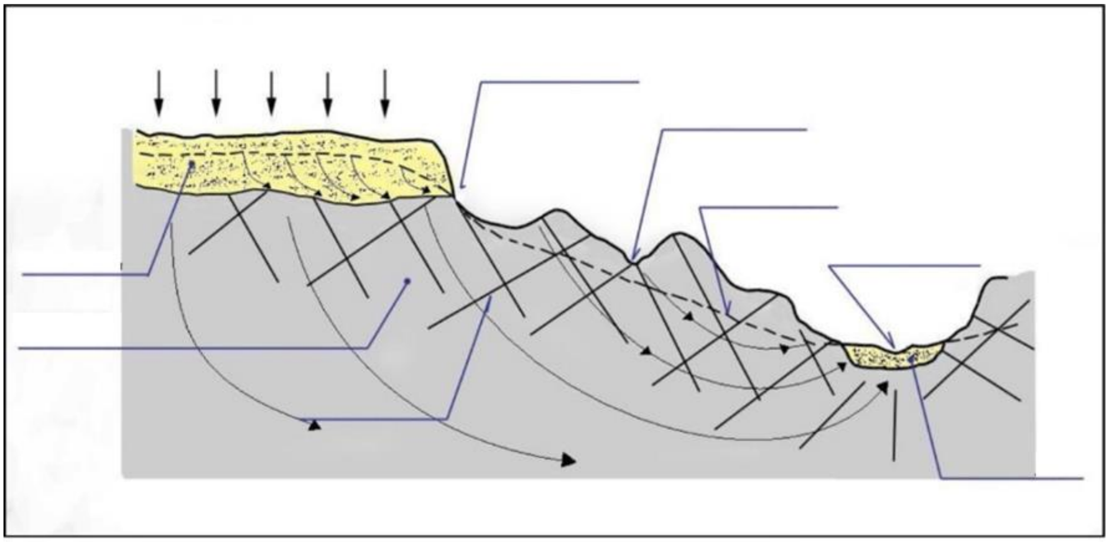


Figure 16-5: Regional Hydrogeological Conceptual Model

The Project area is in a semi-arid region with average annual rainfall between 620 and 720 mm. The annual water deficit is 800 mm which implies a low ratio of aquifer recharge throughout the year.

The Project is in the geomorphological portion of the Salinas Formation schist rocks, with an undulating topography. The hydrogeological characteristics of the Salinas Formation are exclusive fractured aquifers with a small contribution from the granular medium in its altered portion, if it is of reasonable thickness.

The Project is in the Piaui River sub-basin, which acts as intermittent drainage, being a right bank tributary to the Jequitinhonha River (Figure 16-6).

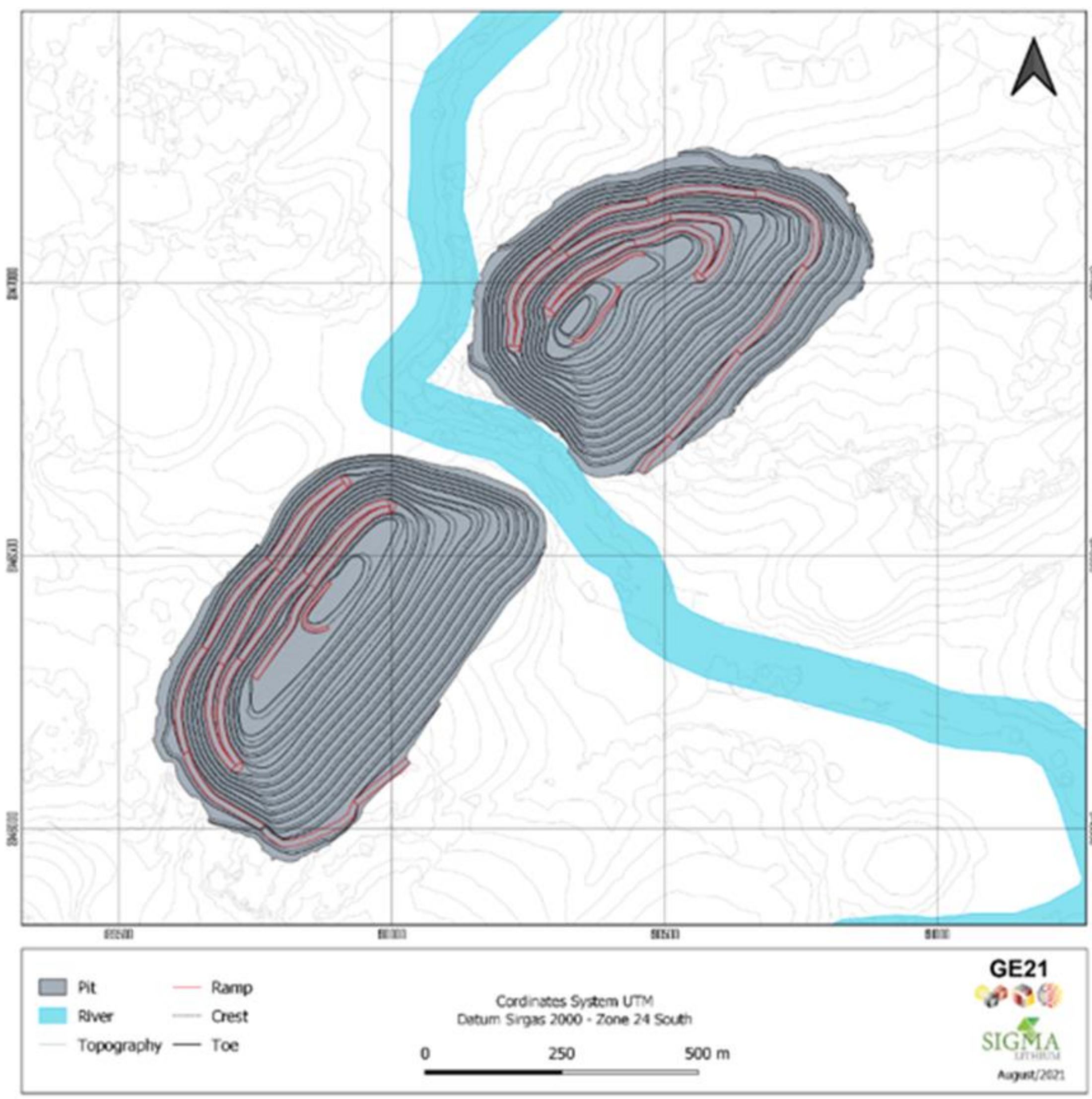


Figure 16-6: Xuxa North and South Pits Separated by Piaui River

The water test sampling in the area covered by the project area was carried out between 11 January 2021 and 13 January 2021. All drainages with connections to the Piaui River were visited, and no surface water was identified. All drainage systems were found to be dry. The conclusion is that these trenches are purely drainage for rainwater with no springs existing in the area from an underground aquifer.

Data on physical-chemical water parameters (pH, EH, conductivity, temperature) were collected from several points along the Piaui River. The average measurement shows a 7.8 pH in the Piaui River within the project area, an important parameter that clearly indicates rainwater without any acidic water characteristics. The average electrical conductivity measured at Piaui River is 54.3 µS. This extremely low value demonstrates that the water, although muddy in appearance, has very little suspended solids. The water grade of dissolved solids is extremely low, with an average of 27.4 ppm, which gives the water a low electrical conductivity, an important parameter to analyze the origin of water when related to pH. The average obtained from the measurements was 217.9 mv, and this positive value indicates fast circulating water and an oxidizing environment typical of rainwater. The average water temperature of the Piaui River in the project area was 28.9 °C.

Figure 16-7 presents the potentiometric map of the pit region. There is an extensive area in which the water surface appears as if it were tabular and regulated by the water of Piaui River.

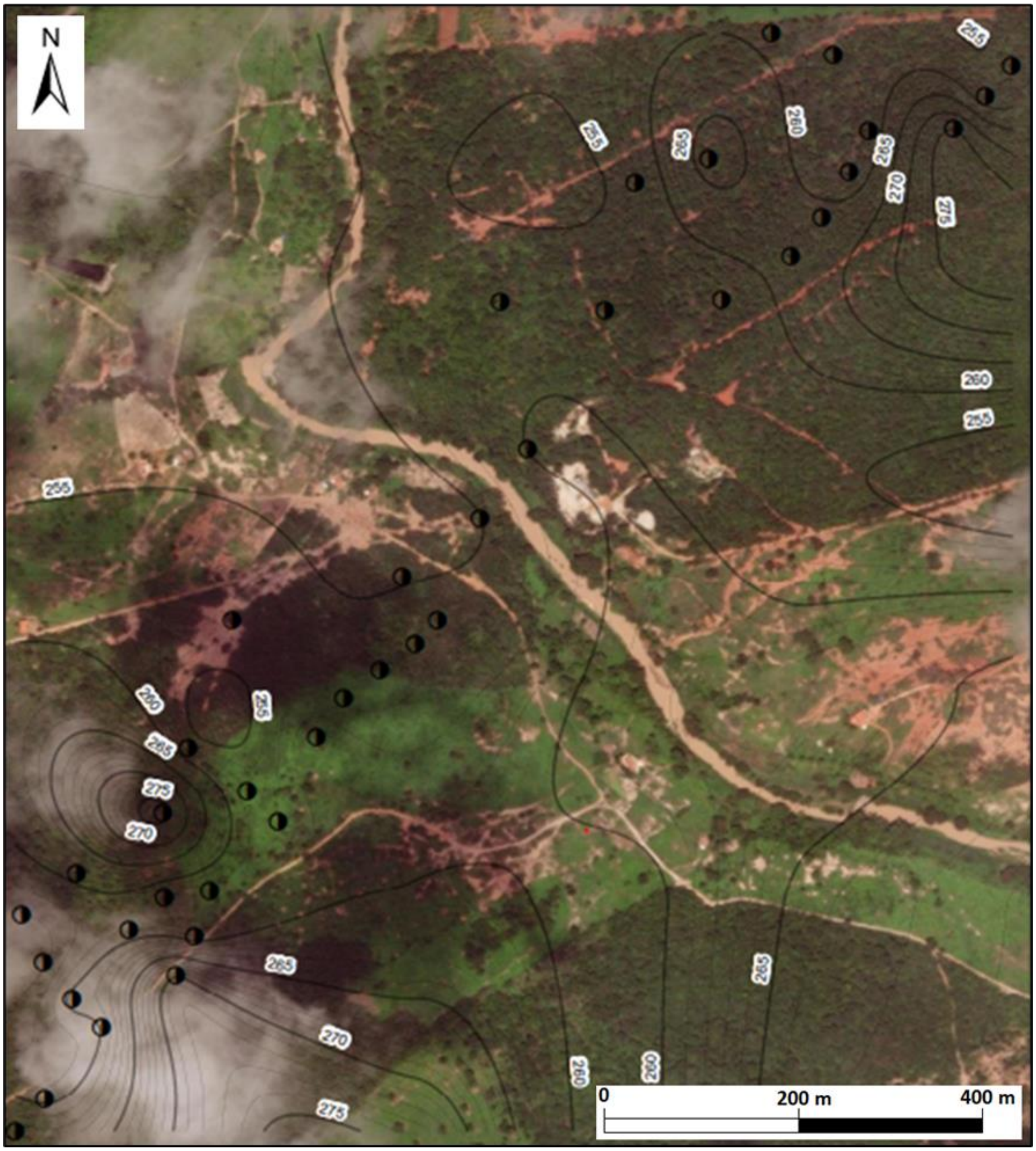


Figure 16-7: Potentiometric Map of the Xuxa Pit Region

Some unobstructed drill-holes were selected for the installation of dual-chamber piezometers (Casagrande type), the first being located in altered and compact schist, and the second above the contact of the altered schist with the unaltered schist. A total of 12 piezometers were installed on the Property. Table 16-2 shows the piezometer locations, the measured and observed water levels, the expected and calculated water levels, and the difference between them, observed minus calculated values.

Table 16-2: Xuxa Piezometer Locations and Results

Instrument	UTM Coordinates		Water Level (m)		
	E-W	N-S	Obs.	Calc.	Obs. Calc.
PZ01/A	190837	8147133	254.8	254.9	0.1
PZ02/A	190515	8147060	263.0	255.6	-7.4
PZ03/A	190273	8146894	257.1	255.8	-1.3
PZ04/A	190660	8147179	254.0	255.1	1.1
PZ05/A	190531	8146895	256.6	256.4	-0.2
PZ06/A	190537	8146788	260.5	256.6	-3.9
PZ08/A	189962	8146524	257.5	256.6	-0.9
PZ09/A	190250	8146643	257.7	255.8	-1.9
PZ10/A	189710	8145931	258.2	258.5	0.3
PZ11/A	189782	8146230	259.0	258.1	-0.9
PZ12/A	190174	8146496	255.3	256.4	1.1
PZ13/A	190061	8146389	246.1	257.1	11.0

Data on water levels and water samples were collected for hydrogeochemical characterization, emphasizing that the water found in the holes initially had muddy characteristics.

In addition to the water levels being measured monthly in the drill holes, two monthly streamflow measurements were carried out downstream and upstream of the Project area in the Piaui River, starting in February 2021, during the rainy seasons. Considering the piezometer results, which include both rainy and dry seasons, with the results which were unaffected by the losses and gains of the streamflow, it can be concluded that these are independent systems. Piezometry does not reflect the variations detected in the river, leading us to conclude that the Piaui River exerts a great influence on the maintenance of water levels in the shallow granular aquifer that flows along the Piaui River drainage, located between elevation 255 m asl and 250 m asl.

Tests were performed in the installed piezometers to determine the hydraulic conductivity (slug test). The results of the slug test tests were consistent with the expectations for an aquifer with low fracture and mean rock quality designation of RQD >91. The variations presented are directly linked to depth and are discussed in section 16.1.3. Test results measured the average conductivity for the rock mass which is around 10-4 m/day.

In addition to the tests carried out in the piezometers to determine the conductivity, water loss tests (packer test) were also carried out in 6 holes contained within the area of the proposed Xuxa pits. Overall, test results showed that rock fractures have very low to low specific losses, giving them a virtually tight rock classification.

16.1.1.3 Mathematical Model

The mathematical model, in its third version, was developed and calibrated based on the conceptual hydrogeological model, which considered three independent systems:

- A fractured system composed of schists and pegmatites with low conductivity and decreasing depth of regional water flow
- A granular system composed of soil and schist saprolite superimposed on the fractured system, with high conductivity, variable thickness, and seasonal flow depending on rainfall input, and
- An isolated granular system located in the Piaui River channel, with high conductivity, variable thickness and width, and seasonal flow depending on rainfall input.

For the numerical modelling of the groundwater flow, the MODFLOW program was adopted, which works with the finite difference method of modelling. The software used was “Visual Modflow”, version 4.6.0.166. The matrix solver WHS (Preconditioned-Conjugate Gradient Stabilized) was used. The model was calibrated in a steady state with the existing data. The groundwater level drawdown was then simulated in a transient state according to the annual mining plan.

Based on the permeability tests carried out in the region (slug test), decreased hydraulic conductivity (K) was verified according to the depth. Thus, a different K-value was adopted for each layer of the numerical model. In general, a conservative position was taken, using values slightly higher than those obtained in the tests.

Figure 16-8 shows the RQD inversely proportional to the hydraulic conductivity (K).

The lowest RQD values are found to be closer to the surface. At depths below the pit depth, the RQD approaches 100%, indicating a virtually null hydraulic conductivity.

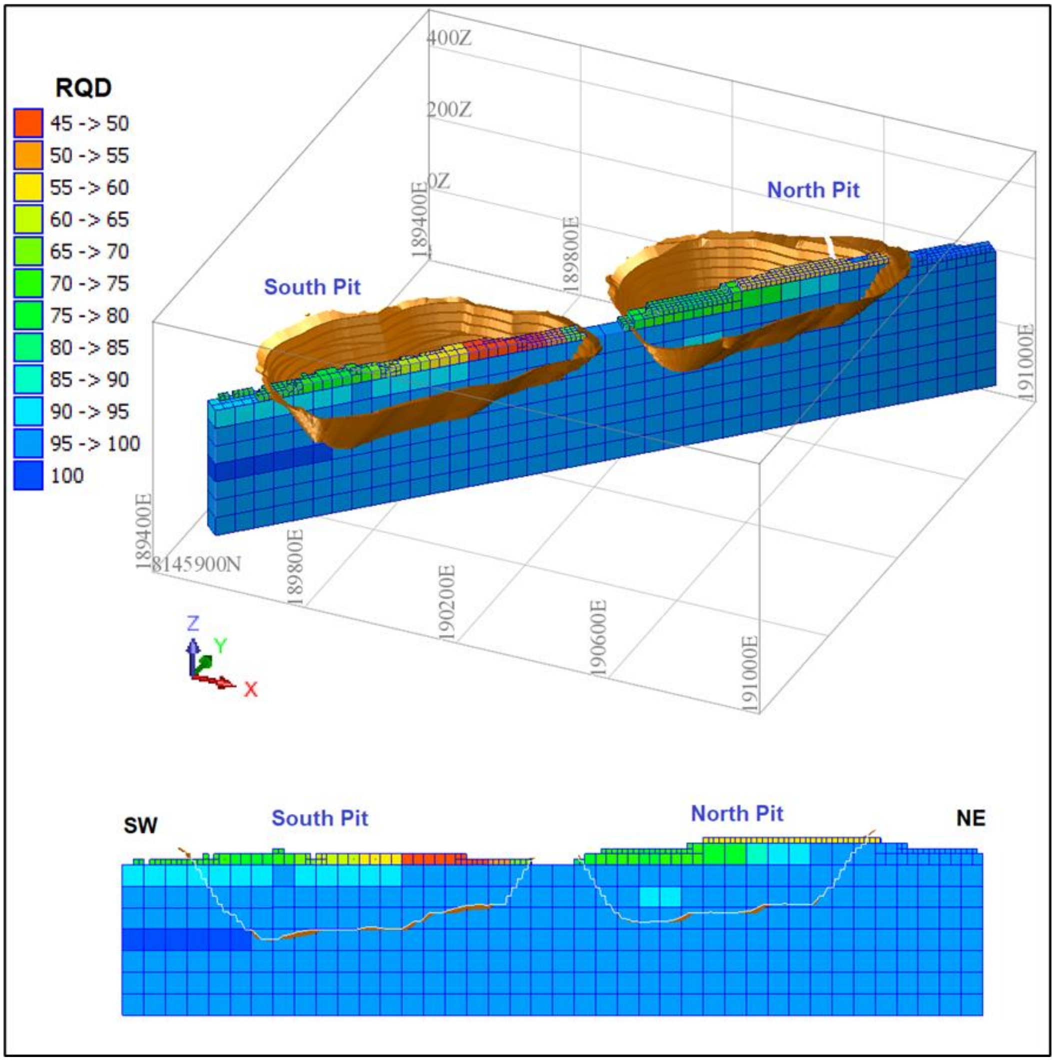


Figure 16-8: Relationship between RQD and Depth Evaluated in the Block Model for the Proposed Pits

Table 16-3 presents the numerical values of the K variation, according to the numerical model layer for the position of the piezometer PZ03.

Table 16-3: Variation of Hydraulic Conductivity and Storage According to Depth

					Average values at the PZ03 coordinate	
layer	lithology	K (m/day)	Ss	Sy	quote (m)	depth (m)
1	soil	1	1.00E-04	0.15	302	2
2	altered rock	0.05	1.00E-04	0.05	290	-290
3	altered rock	0.015	1.00E-04	0.03	271	-271
4	fresh rock	0.005	5.00E-05	0.01	245	-245
5	fresh rock	0.0015	1.00E-05	0.01	212	-212
6	fresh rock	0.0005	1.00E-05	0.01	176	-176
7	fresh rock	0.00015	1.00E-05	0.005	129	-129
8	fresh rock	0.00005	1.00E-05	0.005	63	-63
9	fresh rock	0.000015	1.00E-05	0.005	-2	2
10	fresh rock	inactive	inactive	inactive	-67	67

A comparison between the calculated values of K from permeability tests with the values adopted in the numerical model is presented in Table 16-4. The table shows actual K test data, calculated data and adopted data. The numerical model adopted a general trend of K values, seeking a conservative position.

Table 16-4: Comparison between Calculated and Adopted Values of K

Instrument	Prof. Chamber	Numerical Model Layer	Calculated K (m/day)	Adopted K
	(m)		GE21	(m/day)
PZ01	78 to 90	5	-	1.50E-03
PZ02	102 to 120	6	-	5.00E-04
PZ03	46 to 52	4	7.49E-03	5.00E-03
PZ04	76 to 94	5	-	1.50E-03
PZ05	61 to 79	5	3.80E-04	1.50E-03
PZ06	114 to 135	7	1.87E-05	1.50E-04
PZ07	30 to 36	3	0.00629	1.50E-02
PZ08	48 to 60	5	1.04E-01	5.00E-02
PZ09	53 to 65	5	6.89E-03	1.50E-03
PZ10	33 to 45	4	5.21E-05	5.00E-03
PZ11	107 to 119	6	2.80E-02	5.00E-04
PZ12	47 to 53	4	1.02E-01	5.00E-02
PZ13	65 to 75	5	4.32E-05	1.50E-03

The boundary conditions used in this numerical model were: zero-flow, recharge, river, and deep aquifer continuity (General Head Boundaries - GHB). An active flow was only considered in the Piaui River basin, with a zero-flow being adopted throughout this basin. The hydraulic load (level) was defined according to land topography, with a water depth of 1 metre and a conductance of 1,000 m/day. Drainage is between levels 255 m and 250 m asl elevation.

The recharge values were obtained through back analysis of the numerical model during the steady-state calibration step. Thus, $1x10^{-6}$ m/day was defined as the value for the entire modeled area. This is a very-low value, which is compatible with the existing hydric deficit in the region where evaporation exceeds rainfall.

Figure 16-9 shows the steady-state calibration graph of calculated versus observed values. In this graph, the instrument results are plotted with the observed values on the x-axis and the calculated values on the y-axis. The closer the results plot to the central line, the better the model's calibration. Table 16-5 shows the statistical values from the graph. The results provide confidence in the mathematical model developed.

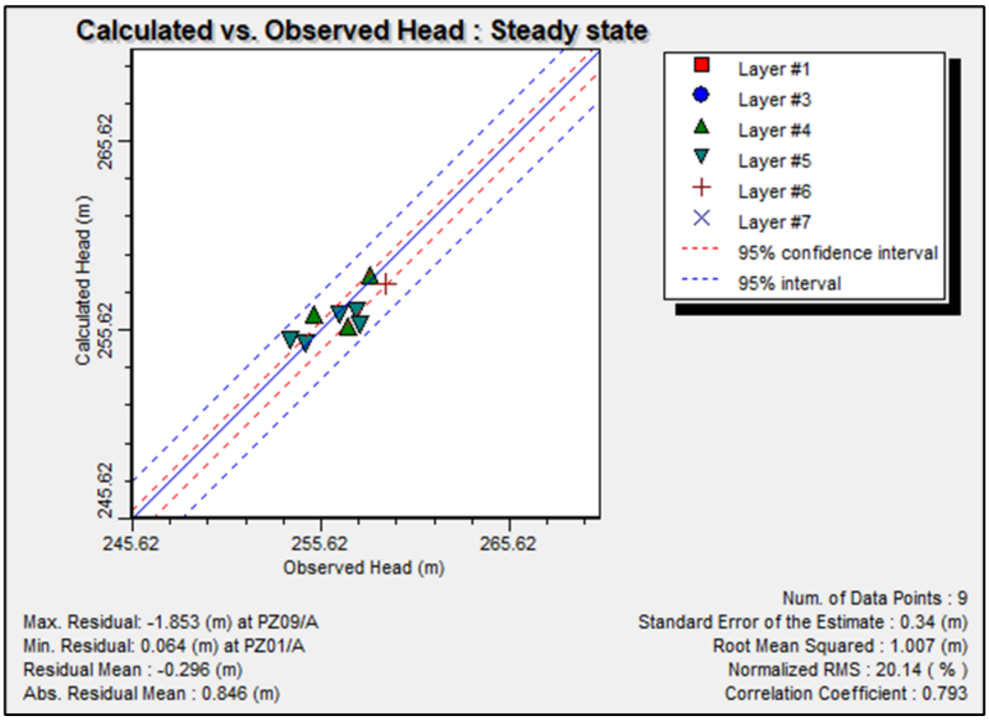


Figure 16-9: Steady-State Calibration Graph of Calculated vs Observed Head Values

Table 16-5: Calibration Parameters for Calculated vs Observed Head Values

Calibration Parameters	
Number of points	9
Residual error	-0.296 m
Absolute residual error	0.846 m
Estimate standard error	0.34 m
Mean square root of error	1.007 m
Normalized error (RMS)	20.14%
Correlation coefficient	0.793

16.1.1.4 Results

The main result obtained from the simulation refers to the pits dewatering streamflow. This streamflow is obtained through the numerical model by verifying the calculated streamflow for the drainage model used in the water level drawdown

Table 16-6 presents the levels reached by the drawdown in the simulated period in the North and South pits. Table 16-7 presents the individual pit results and the yearly streamflow.

Table 16-6: Xuxa Water Levels Reached in the Drawdown Numerical Model Simulation

Year	Drawdown Level (m)	
	North Pit	South Pit
Year 01	282	
Year 02	234	
Year 03	168	
Year 04	138	258
Year 05	96	234
Year 06	48	204
Year 07	6	168
Year 08	6	114
Year 09	6	0

Table 16-7: Simulated Dewatering Streamflow (Annual Average)

	Flow in m³/hr		
Year	North Pit	South Pit	**Total**
Year 01	0	0	**0**
Year 02	11.5	0	**11.5**
Year 03	14.6	0	**14.6**
Year 04	11.6	3.3	**14.9**
Year 05	10.5	15.5	**26.0**
Year 06	10.4	12.1	**22.5**
Year 07	10.0	9.2	**19.2**
Year 08	8.0	10.6	**18.6**
Year 09	6.4	9.2	**15.5**
Average	**9.2**	**6.6**	**15.9**

As shown by the data, the average dewatering streamflow is around 16 m^3/hr, with a maximum of 26 m^3/hr.

Figure 16-10 presents the equipotential of the layer-5 water level from the numerical model to the simulated final status. A direction of water flow is observed around and moving towards the pits, converging at them.

It is concluded that there is limited local water availability as an alternative source for water collection. The values obtained in the modelling are conservative and maximized to ensure operational safety and slope stability.

According to the result obtained in the drawdown simulation of the final pit, the pit dewatering streamflow is low, totalling about 16 m^3/hr on average. This value will be easily managed by the mine operation in the dry season, through small drainage channels located before entering the pit and through sump-type structures at the pit entrance.

According to the simulation, quantitative interference in local water availability is not expected. Even by adding rain volume to the simulation, the operational situation for dewatering is manageable and was not found to be a concern for the development of the pits, as well as the for the stability of the pit slopes.

Effects such as the inversion of water flow from the Piaui River to the interior of the pit are not expected according to the conceptual model. No increase in streamflow rate due to blasting is anticipated.

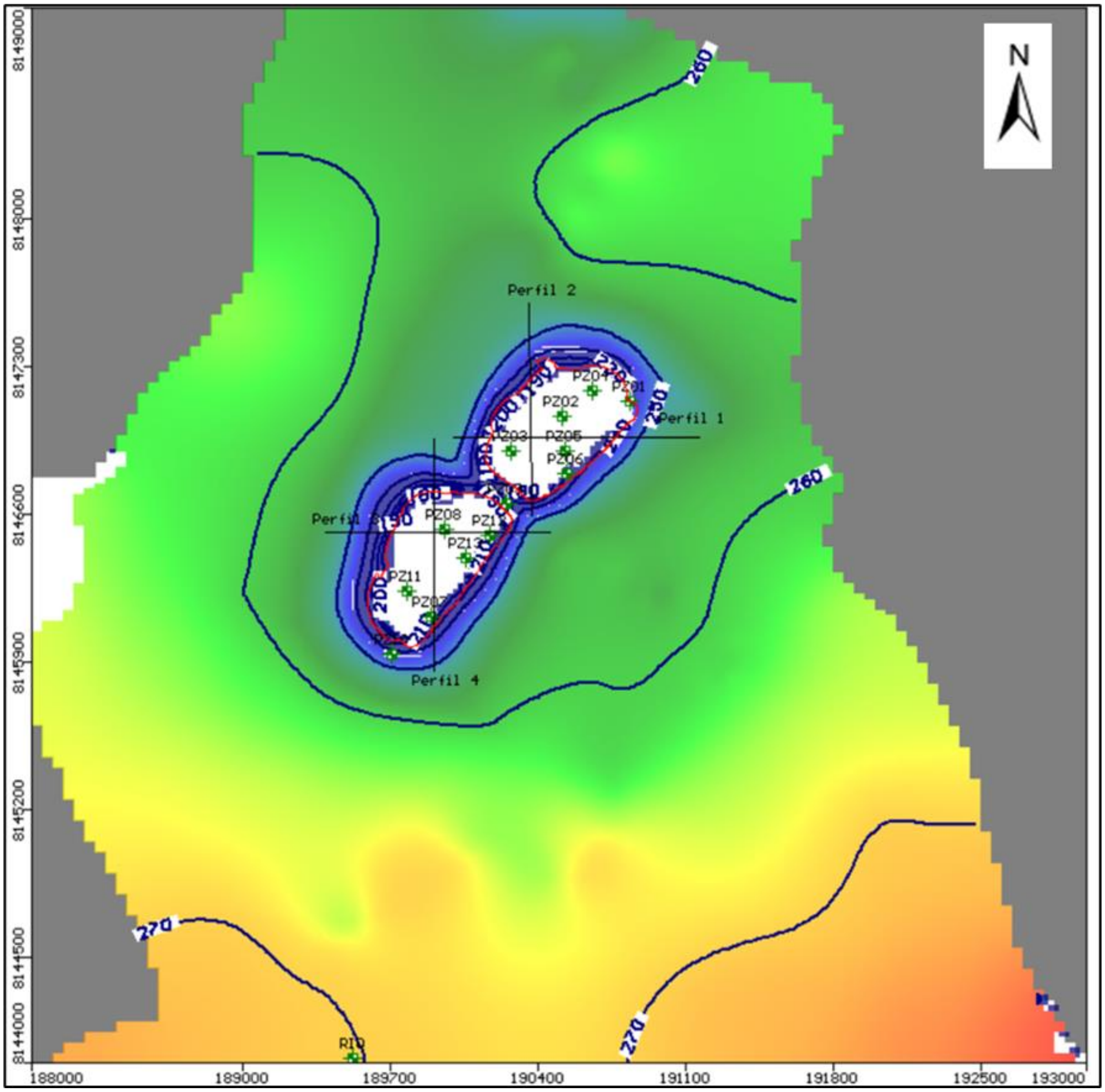


Figure 16-10: Equipotential Surface of Groundwater Level in Year-9 Simulation Plan

16.2 XUXA MINE SEQUENCING

In order to define the annual production plan, the following criteria were applied:

- Feed rate 1.50 Mtpa.
- Li_2O feed grade: 1.56%.
- 3.75% dilution rate.
- Mining recovery: 97%.
- Fines losses: 15%.

- DMS metallurgical recovery: 60.4%.
- Concentrate grade (Li_2O): 6%.
- Product mass recovery

This study consisted of sequencing production, the definition of waste and ore, and the mining sequence of the waste rock blocks, in addition to the evolution of pit(s) geometries throughout the mine life.

One pre-stripping phase was considered for the mine as mining development.

For the production development, the areas to be mined annually were established, generating operational plans for years 1 to 8.

Operational sequencing results can be found in Figure 16-11 to Figure 16-18 and Table 16-8 below. Table 16-9 presents sequencing details not operationalized for the period.

Table 16-8: Xuxa Designed Mine Sequencing

Year	Classification	ROM	ROM (Mt)	Li_2O Partial (%)	Waste (t)	Waste (Mt)	Pre-Stripping	Total Waste (Mt)	Stripping Ratio	Total Stripping Ratio
1	Proven	906,593	0.91	1.58						
	Probable	593,326	0.59	1.53						
Subtotal		1,499,919	1.50	1.56	13,417,268	11.1	2.34	13.4	7.39	8.95
2	Proven	1,338,323	1.34	1.52						
	Probable	167,873	0.17	1.36						
Subtotal		1,506,196	1.51	1.50	22,556,241	22.6		22.6	14.98	15.0
3	Proven	1,395,631	1.40	1.61						
	Probable	68,648	0.07	1.66						
Subtotal		1,464,279	1.46	1.61	27,730,862	27.7		27.7	18.94	18.9
4	Proven	1,461,038	1.46	1.63						
	Probable	24,706	0.02	1.58						
Subtotal		1,485,744	1.49	1.63	22,553,266	22.6		22.6	15.18	15.2
5	Proven	1,015,538	1.02	1.59						
	Probable	491,063	0.49	1.69						
Subtotal		1,506,601	1.51	1.63	27,428,536	27.4		27.4	18.21	18.2
6	Proven	949,725	0.95	1.46						
	Probable	503,415	0.50	1.67						
Subtotal		1,453,140	1.45	1.54	28,989,385	29.0		29.0	19.95	19.9
7	Proven	1,114,358	1.11	1.47						
	Probable	365,918	0.37	1.60						
Subtotal		1,480,276	1.48	1.50	38,241,206	14.6	23.6	38.2	9.89	25.8
8	Proven	153,293	0.15	1.38				0.0		
	Probable	1,248,413	1.25	1.42						
Subtotal		1,401,706	1.40	1.42	14,522,953	14.5		14.5	10.36	10.4
Grand Total		11,797,861	11.80	1.55				195.4		16.6

able 16-9: Xuxa Non-Designed Mine Sequencing

	Schedule - XUXA -Year 1-8					
	Period	Total ROM Mt	Pre-Stripping Mt	Waste Mt	Total Moved Mt	%Li_2O Diluted
Y0	Period 006 - 012		2.34		**2.34**	-
Y1	Period 001	0.13		0.89	1.03	1.41
	Period 002	0.13		0.90	1.03	1.52
	Period 003	0.12		0.89	1.02	1.57
	Period 004	0.13		0.90	1.03	1.46
	Period 005	0.12		0.82	0.94	1.43
	Period 006	0.12		0.84	0.96	1.54
	Period 007	0.13		0.89	1.02	1.61
	Period 008	0.13		0.87	0.99	1.66
	Period 009	0.14		0.90	1.04	1.66
	Period 010	0.13		0.89	1.02	1.70
	Period 011	0.12		0.96	1.08	1.57
	Period 012	0.10		0.99	1.09	1.64
	Total	**1.50**		**10.74**	**12.24**	**1.56**
Y2	Period 001	0.12		1.94	2.05	1.45
	Period 002	0.13		2.00	2.13	1.43
	Period 003	0.13		1.80	1.92	1.56
	Period 004	0.13		1.99	2.12	1.43
	Period 005	0.12		1.85	1.97	1.57
	Period 006	0.14		2.07	2.21	1.49
	Period 007	0.11		1.83	1.94	1.57
	Period 008	0.13		1.83	1.96	1.60
	Period 009	0.12		1.74	1.86	1.31
	Period 010	0.13		1.75	1.88	1.57
	Period 011	0.12		1.81	1.93	1.49
	Period 012	0.13		1.60	1.73	1.53
	Total	**1.51**		**22.21**	**23.72**	**1.50**
Y3	Period 001	0.31		7.78	8.09	1.66
	Period 002	0.35		6.68	7.03	1.65
	Period 003	0.41		6.76	7.17	1.56
	Period 004	0.40		6.28	6.68	1.59
	Total	**1.46**		**27.50**	**28.96**	**1.61**
Y4	Period 001	0.34		7.88	8.22	1.65
	Period 002	0.41		5.81	6.22	1.64

	Period 003	0.36		5.81	6.16	1.67
	Period 004	0.37		2.91	3.28	1.57
	Total	**1.49**		**22.40**	**23.89**	**1.63**
Y5	Period 001	0.36		10.88	11.24	1.59
	Period 002	0.37		6.94	7.31	1.65
	Period 003	0.40		4.81	5.21	1.63
	Period 004	0.37		4.68	5.05	1.66
	Total	**1.51**		**27.31**	**28.81**	**1.63**
Y6	Yearly	1.45		28.90	30.35	1.54
	Total	**1.45**		**28.90**	**30.35**	**1.54**
Y7	Yearly	1.43	23.60	15.25	40.28	1.50
	Total	**1.43**	**23.60**	**15.25**	**40.28**	**1.50**
Y8	Yearly	1.40		15.10	16.50	1.55
	Total	**1.40**		**15.10**	**16.50**	**1.55**

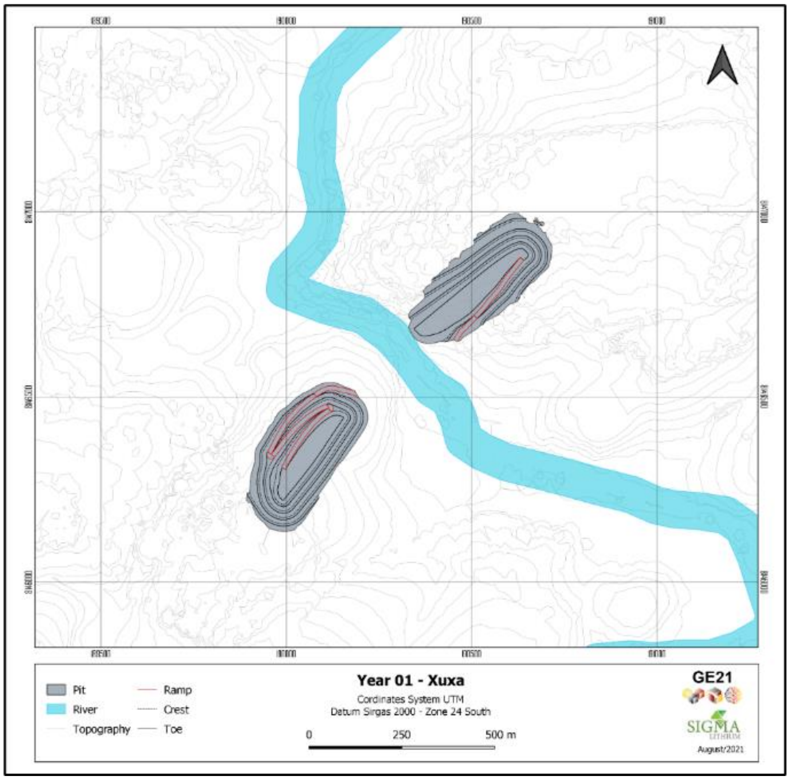


Figure 16-11: Xuxa North and South Pits Year 1

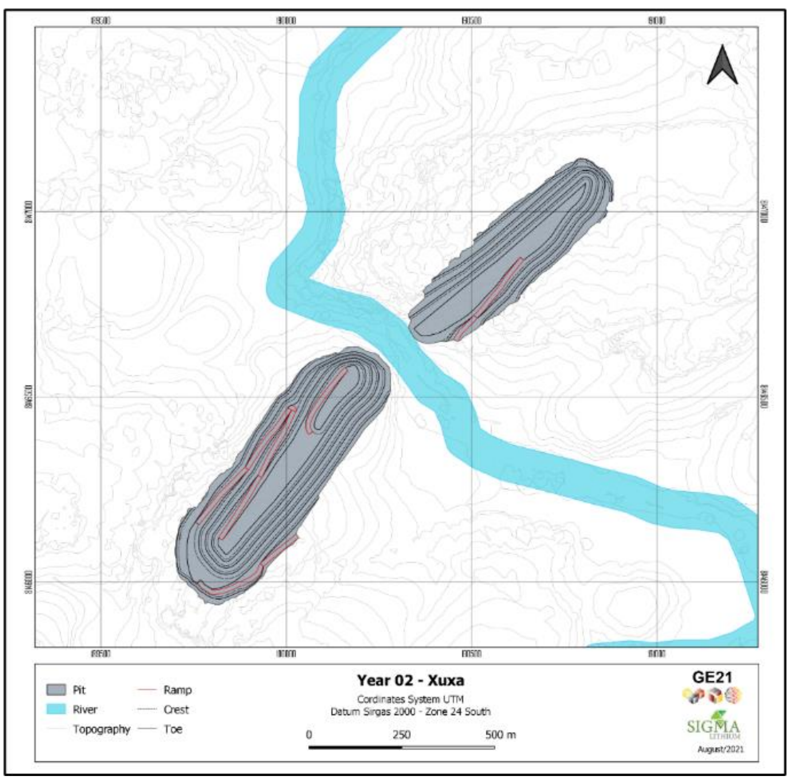


Figure 16-12: Xuxa North and South Pits Year 2

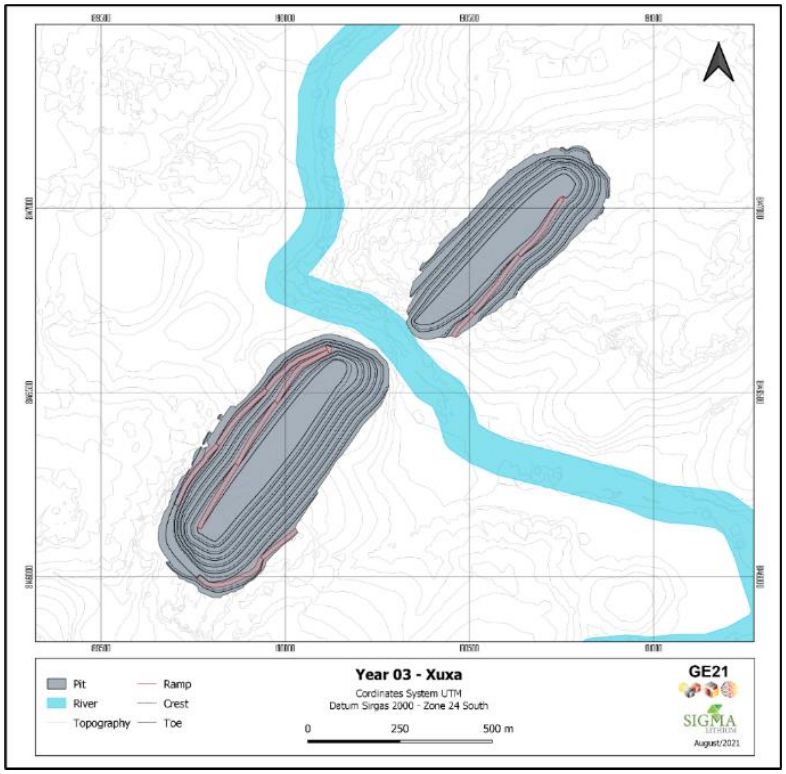


Figure 16-13: Xuxa North and South Pits Year 3

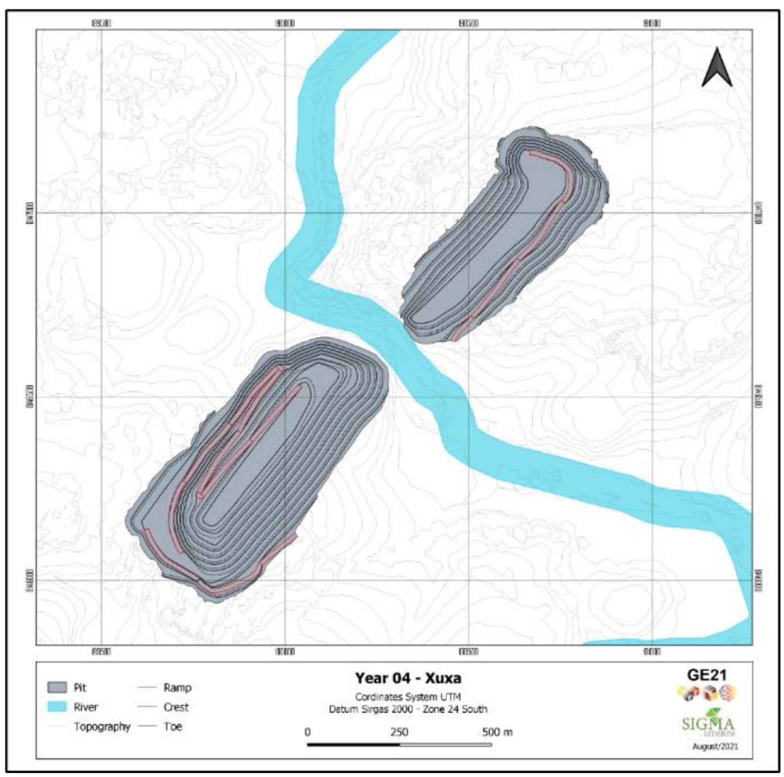


Figure 16-14: Xuxa North and South Pits Year 4

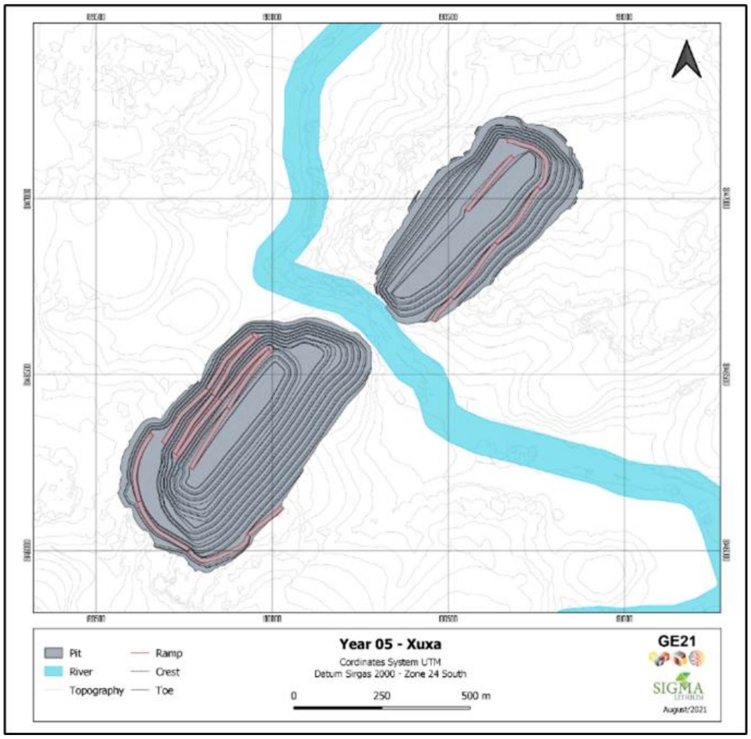


Figure 16-15: Xuxa North and South Pits Year 5

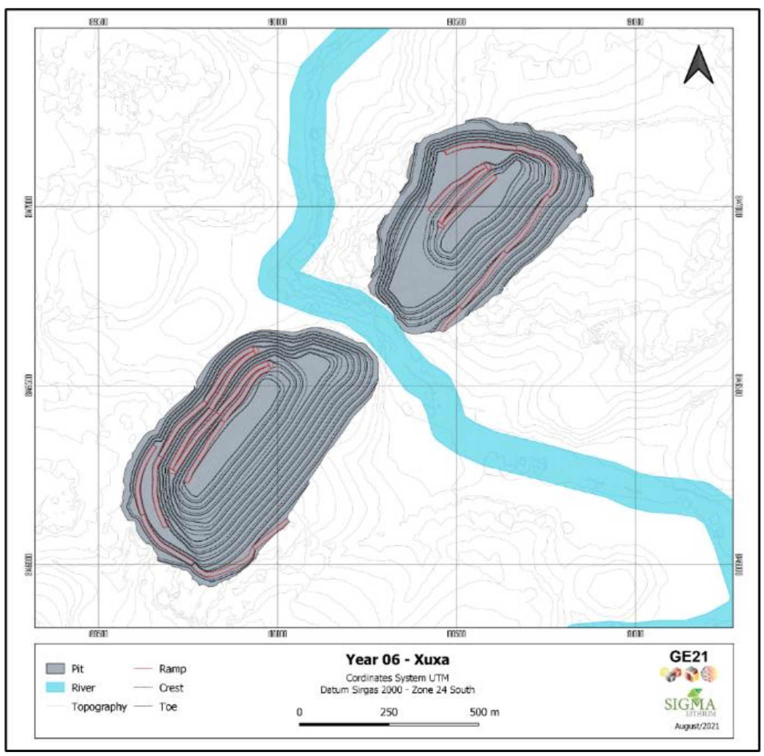


Figure 16-16: Xuxa North and South Pits Year 6

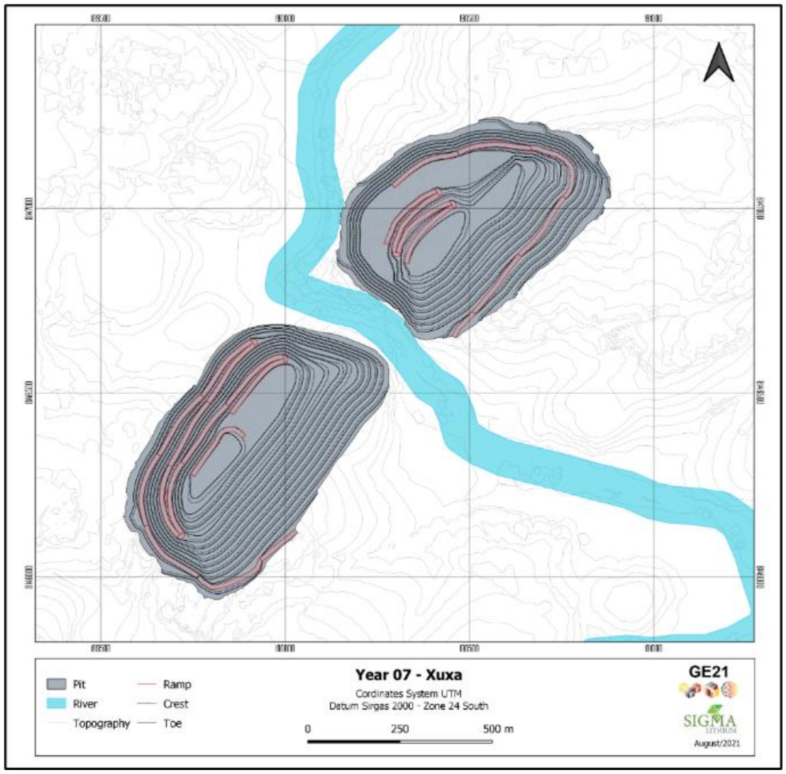


Figure 16-17: Xuxa North and South Pits Year 7

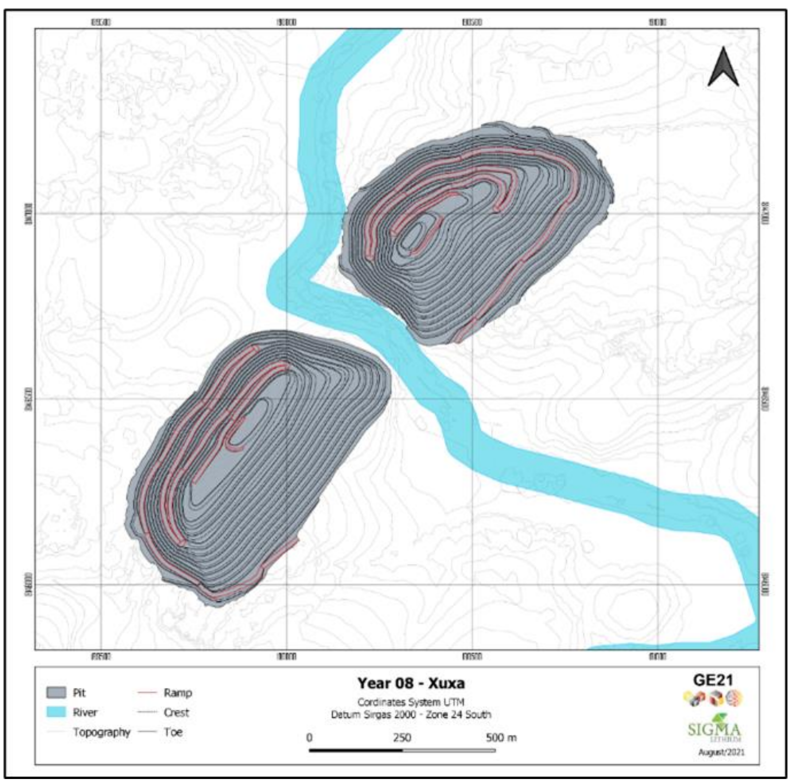


Figure 16-18: Xuxa North and South Pits Year 8

16.3 XUXA MINE FLEET

At the Xuxa deposit, the mining operations will be carried out by a third-party contractor, with proven experience with similar sized operations in Brazil. In order to select the mining operations contractor, operational work technical specifications were compiled and forwarded to the companies for technical and commercial proposals. After selecting the company and signing a contract, the work of mobilization and construction of the construction site will begin immediately.

The run of mine (ROM) ore will be drilled, blasted, loaded and transported by trucks to the ROM pad, near to the primary crusher. The ore will be loaded by a wheel loader and fed into the primary crusher. The oversize material, >1000 mm, will be fragmented by a rockbreaker installed in the crusher protection grate. A minimum ore stockpile of around 30,000 t will be kept in the ROM yard, with the aim of stabilizing the supply of feed to the plant when the mine production rate decreases or stops. This also helps to maintain the mine's ore production rate should the primary crusher have unscheduled production stops.

Ore below the cut-off grade will be blasted, loaded and transported to specifically delimited discharge points within the waste disposal piles.

The percentage of material drilled and blasted is expected to be:

- Ore: 100%
- Soil: 5%
- Weathered rock (Saprolite): 30%
- Fresh Rock: 100%.

The main mining activities will be:

- Digging or rock blasting of ore and waste
- Excavation, loading and transport of ore and waste
- Disposal of ore in the ROM yard and waste in the waste dump
- Construction and maintenance of all internal accesses to the pit(s) and the waste dumps
- Maintenance of the floor, drainage, coating and signaling of all access roads used in the operation
- Implementation and maintenance of the mine's surface drainage systems at access points to the mining operation, waste deposit, ore yard and other areas linked to mining operations
- Execution of mine infrastructure services, such as: construction and maintenance of accesses to the mining areas, crusher, waste dump, workshops and offices, mine drainage services, access signaling, mine dewatering, etc.
- Feeding the primary crusher at an average rate of 320 t/hr, per wheel loader
- Build and maintain the operation support facilities (offices, workshops, cafeteria, living quarters, warehouses, changing rooms, bathrooms, septic tanks, environmental, health and safety

emergency (HSE), explosive magazine, electrical and hydraulic installations and others, in strict accordance with the Brazilian environmental standards and labour laws.

16.3.1 Equipment

For the execution of mining activities, the equipment used must be in full working order, always observing the technical standards necessary for the services to be carried out safely. The equipment must comply with the respective Maintenance and Inspection Plans, as well as carrying out scheduled shutdowns for preventive and predictive maintenance. The proposed equipment to be used in the mine will have high operational reliability and provide comfort and safety to operators (Table 16-10).

Table 16-10: List of Main Equipment to be used in the Operation of the Xuxa Pits

Equipment	Brand	Model	Capacity	Quantity Year 1	Quantity Year 2	Quantity Year 3	Quantity Year 4	Quantity Year 5	Quantity Year 6	Quantity Year 7	Quantity Year 8
Hydraulic drill	Sandvik or Similar	DP 1500 or Similar	4" to 5.5"	4	10	12	10	12	13	15	7
Hydraulic drill	Sandvik or Similar	DX 800 or Similar	4" to 5.5"	1	1	1	2	2	2	2	1
Excavator	Liebherr or Similar	R966 SME or Similar	70 t	0	3	4	3	3	4	6	3
Excavator	Liebherr or Similar	R944 CSME or Similar	45 t	2	5	5	5	6	4	5	2
Excavator	Caterpillar or Similar	336D or Similar	35 t	2	2	2	2	2	2	2	2
Excavator	Caterpillar or Similar	320D with Rock Drill Hammer or Similar	20 t	1	1	2	2	2	2	2	1
Wheel Loader	Caterpillar or Similar	966H or Similar	18 t	2	2	2	2	2	2	2	2
Bulldozer	Caterpillar or Similar	D7T or Similar	38 t	2	2	2	2	2	2	2	2
Bulldozer	Caterpillar or Similar	D6T or Similar	18 t	3	3	3	3	3	3	3	3
Motor Grader	Caterpillar or Similar	140K or Similar	16 t	2	2	2	2	2	2	2	2
Truck	Mercedes Benz or Similar	Actros 8X4 or Similar	40 t	21	58	71	63	70	70	70	32
Water truck	Mercedes Benz or Similar	3340K or Similar	22,000 l	4	4	5	5	5	5	6	4
Operation Support Truck	Mercedes Benz or Similar	1726 or Similar	6,000 l	1	2	2	2	2	2	2	2
Crane Truck	Mercedes Benz or Similar	2426K or Similar	11 t	1	1	1	1	1	1	1	1
Lightning Tower	Light Source	NA-T4	-	7	13	14	13	13	13	16	10
Light Vehicle	Toyota or Similar	Hilux or Similar	5 people	4	5	6	6	6	6	7	5

16.3.2 Operations

Mining will commence after the removal and storage of topsoil and waste overburden material. Small excavators will be used initially for drainage work, digging trenches, minor material removal and material disposal. The 70 t and 45 t excavators will be assigned based upon the volume of material for large and medium volume handling. For transport, road trucks (8X4) with a capacity of 40 t are planned.

16.3.2.1 Loading, Transporting and Unloading of Ore

The ore and waste will be blasted, loaded by excavators, transported by trucks with a capacity of 40 t and unloaded on the ROM pad and waste dump respectively. If necessary, a hydraulic rockbreaker will be used to break rock larger than the opening of the crusher's fixed protection grid.

The process plant will be fed at an average rate of 320 t/hr, 24 hours per day, 7 days per week.

It is estimated that 100% of the ore, 5% of the soil, 30% of the saprolite and 100% of the fresh rock must be blasted using explosives.

As an initial premise, a drilling diameter of 4.0 inches was adopted for ore with 5-metre-high benches and 4.0 inches for waste in 10-metre-high benches.

A careful analysis of the characteristics of the Xuxa Mine was performed to determine the most appropriate drilling equipment, as shown in Table 16-11.

Table 16-11: Drilling Equipment for Xuxa Pits

Size	Brand	Series	Model	Hammer	Diameter		Type
					mm	inch	
23 t	Sandvik	Pantera	DP1500	Top hammer	102 to 140	4.0 to 5.5	Production
16 t	Sandvik	Ranger	DX800	Top hammer	89 to 114	3.5 to 4.5	Pre-split, secondary blasts, small-diameter holes

The drilling operation will be supported by a bulldozer and/or hydraulic excavator to carry out cleaning activities in the drilling areas, construction of access points to the drilling area, as well as the use of a hydraulic hammer coupled to the hydraulic excavator for rock handling in the operational area.

The rock blasting work comprises primary and secondary blasting and a hydraulic hammer will be used as required.

16.3.3 Explosives Supply

The provision of explosives and the execution of blasting services will be carried out by a subcontractor specializing in blasting, under the guidance of Sigma.

For the Xuxa Mine, where appropriate, pumped explosives, stemming and non-electrical accessories will be used.

During the mine operation, the daily blasting plans will be prepared by Sigma´s technical team and the results will be evaluated, and any necessary adjustments made to improve blasting effectiveness.

16.3.4 Explosives Magazine and Accessories

The explosive magazines will be supplied and built by the company contracted to perform the mining activities. This company will supply and maintain a remote security system, following the guidelines of ORDINANCE No. 147 - COLOG, of November 21, 2019, which provides the administrative procedures for the use and storage of explosives and accessories, as well as ORDINANCE No. 56 - COLOG, of June 5, 2017, which provides the administrative procedures related to registration with the army for the use and storage of army-controlled products (PCE).

Area security will be established through compliance with the minimum distances from the storage location to inhabited areas, railways, or highways, according to distances established in the regulation for the Inspection of Controlled Products (R-105). To this end, the plan for transporting, handling and storage of explosives and explosive accessories will be reviewed by SMSA management together with GE21 so that all conditions are fully complied.

The security of products controlled by the army (PCE) will be guaranteed through the adoption of measures against deviations, loss, theft, and theft against obtaining knowledge about activities with PCE, in order to avoid their use in the practice of illicit acts. These measures will be included in the Security Plan.

Access control will be carried out electronically, 24 hours a day, covering storage and access areas. For this, cameras connected to a remote base will be used and monitored online.

The facilities will undergo regular internal inspection to ensure the integrity of the active and passive protection systems. In the case of accidents of any nature, the Security Plan will determine the procedures related to the simultaneous activation of the competent public security bodies, including military and civil police, army and fire department.

Contingency measures will be adopted in the event of accidents or detection of illegal practices with explosives, including information to the inspection of army-controlled products (PCE). In these situations, quick and safe activation of the monitoring center and competent authorities listed in the Security Plan will be adopted.

For the storage of explosive and blasting accessories, a Rustic Mobile Storage container, installed in accordance with Technical-Administrative Instruction No. 18/99-DFPC, is planned as shown in Figure 16-19. This structure consists of a box truck or adapted container located in a fenced and monitored area, under the same security and monitoring conditions applied to the explosive magazine as shown in, Figure 16-20.

Figure 16-19: Explosives Magazines in Container

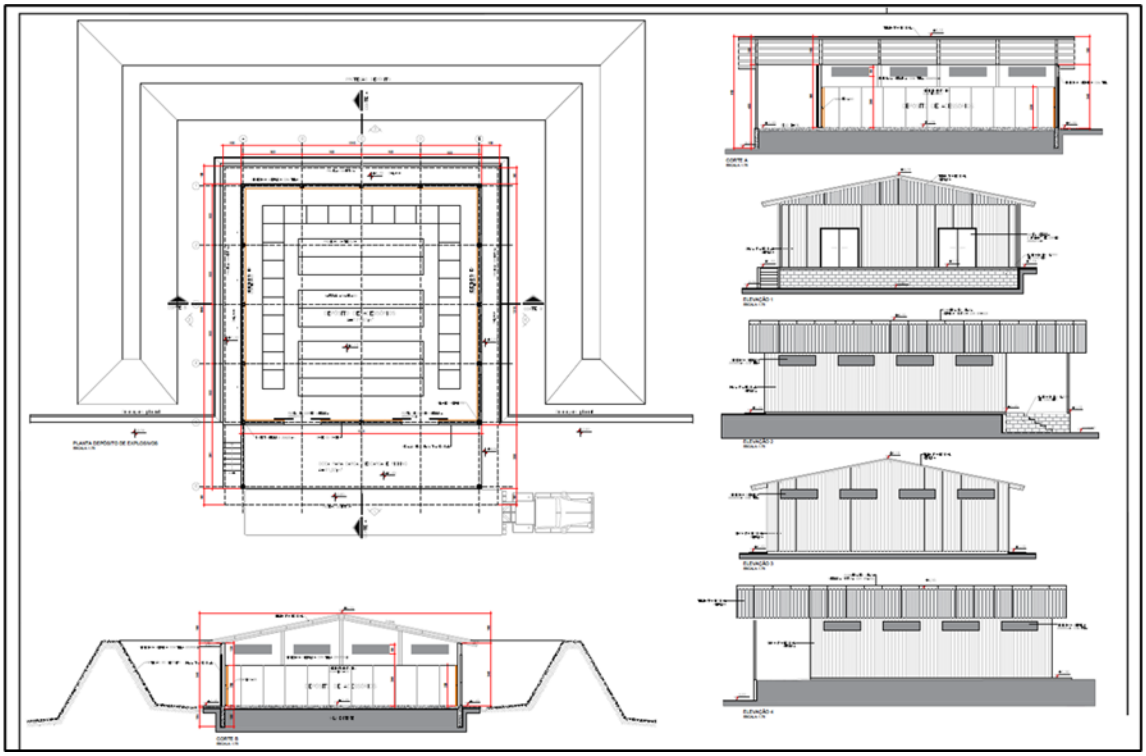


Figure 16-20: Example of Ammonium Nitrate Emulsion Storage Structure

16.3.5 Fleet Monitoring System

The fleet monitoring system (dispatch) to the Xuxa mine will be carried out through an electronic system that allows the monitoring and management of the mine's operation in real time. SMSA will work with solutions that allow for the monitoring, management, and optimization of the truck fleet. Using the most advanced hardware, the software monitors and manages each piece of equipment at all stages of the mining production cycle. The software uses algorithms that provide solutions to maximizing productivity and reduce operating costs.

A monitoring device is installed in each piece of equipment (excavator and truck) that is responsible for sending various information to control centre, including: location, status of equipment, etc. A communication network will be established between the monitoring equipment, antennas, and the control centre, this enables the monitoring of the entire mine fleet, operations and production with a high level of detail.

16.3.6 Work Shifts

The teams will work in different shifts. The administrative group will work 9 hours a day from Monday to Friday, with 1 hour off for a meal, and 4 hours on Saturday mornings. The operational team will work 7 days a week, 24 hours a day, in a 6x2 shift scheme, where the employees work 6 days consecutively, for 9 hours per shift, and then have 2 days off. This method of shift work provides uninterrupted work and is in accordance with Brazilian labour legislation. The explosives supplier will work 5 days per week, taking Saturdays and Sundays off.

16.3.7 Labour Mining

SMSA is committed to prioritizing the hiring of local labour.

Table 16 12 lists the expected annual labour requirements for the eight years of mine life; these expectations will be adjusted as required during the mining operation.

Table 16-12: Xuxa Staffing Requirement Summary

Office	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Manager	1	1	1	1	1	1	1	1
Coordinator	1	1	2	2	2	2	1	1
Production Coordinator	6	6	6	6	8	8	8	6
Operational Instructor	2	2	2	2	2	2	2	2
Machine Operators	46	66	73	69	97	92	106	65
Truck Drivers	89	215	261	234	343	343	348	215
Production Assistants	10	11	11	12	14	14	14	11
Drilling and Rock Blasting Supervisor	7	7	7	7	9	9	9	7
Machine Operator	20	44	52	48	56	60	68	44
Drilling Assistant	23	47	55	51	59	63	71	47
Maintenance Officer	4	4	4	4	5	5	5	4
Mechanic	5	14	17	15	16	16	16	14
Welder	8	10	12	16	20	20	20	10
Tire Fitter/Electrician/Tinsmith	3	3	4	5	5	5	5	3
Greaser	8	8	13	12	15	15	15	8
Maintenance Assistants	8	12	14	14	20	20	20	12
Geologist	1	1	1	1	1	1	1	1
Security Engineer	1	1	1	1	1	1	1	1
Occupational Physician	1	1	1	1	1	1	1	1
Safety Technician	6	6	7	7	9	9	9	6
Surveyor	1	1	1	1	1	1	1	1
Surveying Assistants	2	2	2	2	2	2	2	2
Administrative	3	3	4	4	5	5	5	3
Administrative - Control Room Technician	3	3	4	4	5	5	5	3
Warehouser	3	3	4	4	5	5	5	3
Total	262	472	559	523	702	705	730	471

16.3.8 Labour and Equipment

For the mobilization of technical and operational personnel, priority will be given to a local people and those living close to Araçuaí & Itinga municipalities, using the following schedule:

- Recruitment
- Selection
- Conducting admission exams
- SMSA integration
- Introductory equipment/vehicle training
- Initiation into assisted operation
- Final aptitude test

16.3.9 Site Construction

The site construction shall consist of:

- Mine Office
- Meeting room
- Control room
- Auditorium
- Cafeteria
- Changing rooms
- First aid post
- Warehouse
- Workshop
- Washing ramp
- Oil and grease storage area
- Fuel storage area
- Recreation area
- Explosive magazine

The total area of infrastructure will be approximately 1,390 m², and the total area that the buildings will occupy is approximately 1.5 hectares.

All built-up areas will have waterproof flooring, so that there is no risk of soil contamination from the operations, especially in the workshop and washing ramp. The runoff from the roofs will be drained into the gutters to supply the cistern, which will be used at the washing ramp. After using the water in the washing ramp, the water will be sent to the effluent treatment station, which starts in the decanter, followed by the oil and grease separator box with capacity of 20m³/day.

The water and oil separator system must operate at a flow rate of 20m³/day, which complies with the ABNT NBR 14605 standard and the ASTM D 6104/03 international standard. The analysis standards to verify the efficiency and quality of the water must follow the CONAMA Resolution No. 357/2005 for the parameters of oils and greases. After treatment the water will be pumped back to the process water tank.

16.3.10 Wastewater Treatment

Step 1: The effluent from the drains (channels) from the workshop, washing ramp and oil deposit, oil and grease separator stage, will be drained to the decanter where it will undergo the first sedimentation process. The process consists of separating solid particles from water by the action of gravity. The flow velocity of the liquid is reduced, favoring the sedimentation of these particles. The water enters the next step, which further separates the suspended solids. The solids from the first process are deposited at the bottom of the decanter, where they will be periodically removed.

Step 2: In the module for separation of solids (MSS) the solids coming from the water used to wash the equipment are separated by the process of gravity and sedimentation of the particles. This process removes the remaining particulate matter suspended in the fluid, allowing oil and water to flow to the next stage, avoiding the silting of the remaining procedure. Solids will be removed and stored in an appropriate place.

Step 3: The water and oil separator box (WOSB) receive all the effluent from the MSS process. This system has, among others, two basic constituents: water and oil. The process of separating water and oil occurs by density difference. The clean water will be released into the rainwater drainage network. Periodically (biannually) samples will be collected at the final outlet, the third box of the water and oil separation system, so that the efficiency of the system and the quality of the effluent is known.

Step 4: The supernatant oil goes to the oil collection reservoir (OCR) to be removed and sent for recycling. Used oils will be sent to a certified and approved company, with the relevant documentation and authorization, in accordance with the applicable legal requirements. Likewise, tailings will be monitored, in relation to quantity and classification, and recorded in the waste inventory worksheet of the Sigma integrated management system.

Step 5: Contaminated oil and grease residues (Class I) must be packed in properly identified drums and sent to an appropriate collection company. This waste output will be registered by Sigma by filling out the waste transport manifest (MTR), according to the waste management procedure.

Figure 16-21 shows a schematic of the model to be built for the water treatment of effluent from the washing ramp and the modules of the water and oil separator box.

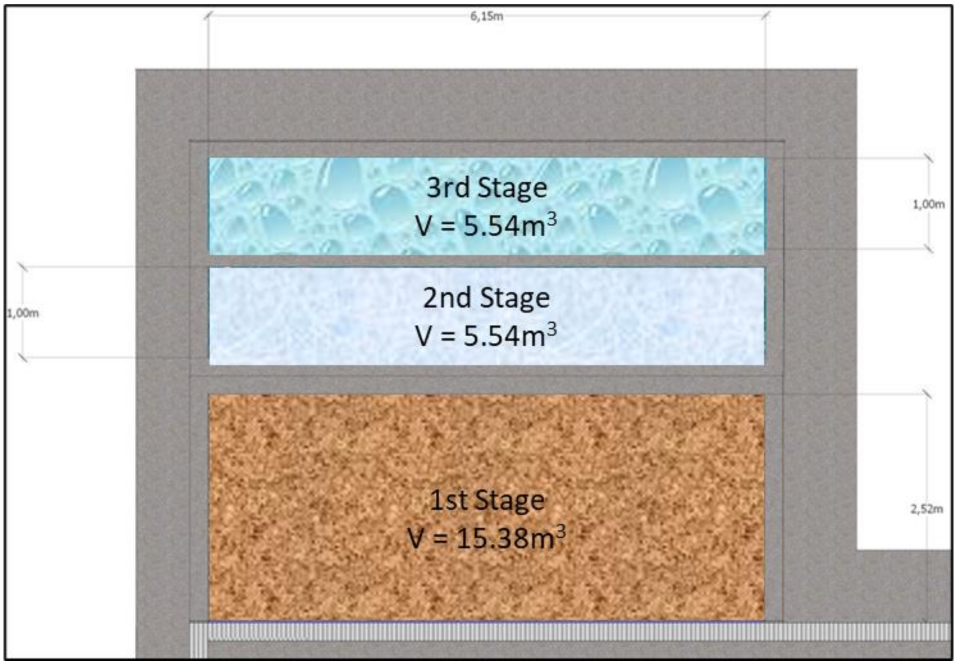


Figure 16-21: Schematic of Wash Ramp Oil-Water Separator

16.3.11 Solid Waste Management

To meet the demand for internal solid waste generation, SMSA will have a waste deposit located next to the oil storage structure, physically separated in accordance with safety standards, such as physical divisions, roof, waterproofed floor, channels, and drains. Next to this will be located waste disposal bays for items such as plastic, paper/cardboard, metals, glass, and contaminated waste (towels, filters, PPE, etc.). Tires must be stored inside the warehouse until they are sent to their final destination off site. Organic waste must be delivered to locations properly prepared to receive this type of material. Figure 16-22 shows the solid waste temporary storage layout.

According to ABNT NBR 10.004 - Waste Classification, waste must be collected, segregated/packaged, and sent to the final destination, to companies licensed by the appropriate environmental agency. Periodically, SMSA will be monitoring their waste generation, and checking the internal waste inventory worksheet, a tool that it uses within the integrated management system.

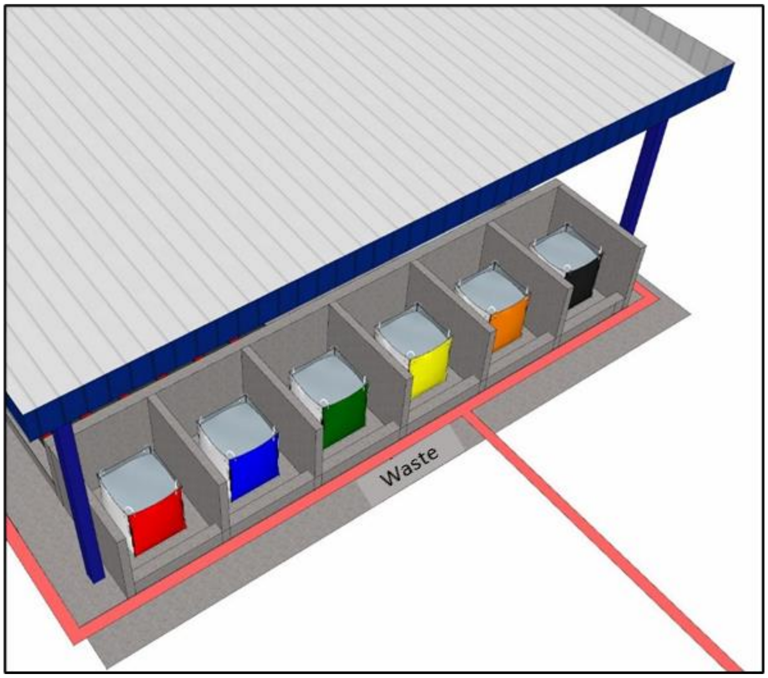


Figure 16-22: Schematic of Solid Waste Temporary Storage Facility

16.3.12 Site Access

The construction of site access necessary to start ore mining operations, waste removal, access to the waste dump and marginal ore, auxiliary accesses and others that may be required will be carried out according to the specific project's requirements.

If necessary, land clearing, including the removal of trees, undergrowth and debris will be performed using a D6T crawler tractor with ripper. The material removed will be loaded with a 35t excavator and transported with trucks with a capacity of 20m³.

The leveling of accesses, considering slope and slope for land drainage will be carried out through cutting and filling using a D6T crawler tractor, 35 t and 55 t excavator, 20m³ trucks, grader and water trucks. Low strength soils will be replaced. Surface drainage and construction of berms will be carried out with a 20 t excavator.

16.3.13 Road Construction and Maintenance

The construction and maintenance of site roads will require the following:

- Initial construction of the roads
- Water and storm drainage
- Construction of safety berms
- Reflective signage
- Dust suppression.

16.3.14 Excavation, Loading, Transport and Soil Treatment

The excavation stage will start after the removal and storage of the topsoil.

As the excavation progresses, drainage systems will be installed to avoid the accumulation of rainfall.

It is planned to mobilize a 20 t excavator for drainage services, trench excavation, material disposal and small handling. 70 t and 45 t excavators will be used according to the volume requirements for large and medium volumes. For transport, 8x4 trucks, with a capacity of 40 t, will be used, allowing for productivity and safety.

16.3.15 Drilling and Blasting

The geology and rock types at the Xuxa deposit are crucial for defining drilling and blasting parameters, which relates to mining recovery. The mineralized bodies are made up of tabular dykes with sub-horizontal foliation and shallow dip (40° to 45°), which can range in thickness from a few metres to more than 40 metres, averaging 12 to 13 metres.

It is important to know the limits of the ore body to minimize dilution and losses. SMSA will have a geologist as part of its technical staff who will work directly with the drilling, blasting, and loading teams. Employees who are directly involved in activities related to optimizing the mining recovery, such as drill operators, drilling assistants, rock blasting team, and excavator operators, will be trained to recognize minerals to avoid deviation from planned mineral boundaries.

As this is a greenfield project, it is foreseeable that SMSA's technical teams will go through a learning period based on the empirical results acquired with operation commencement. Naturally, changes to rock blast parameters and operating methods will be required. Consideration should be given not only to the complexity of the geological formation and the operational challenges resulting from this condition, but also to the context of the environment in which the mine will be located.

Previous studies (pre-blast survey) before the first blasting should be developed to establish the minimum distances between pre-existing structures that will be kept and the blasted benches. As a result, restrictions or opportunities relating to the maximum load per drill hole may be revealed, which may indicate the maximum blasthole diameter, as well as the type of accessories used. These factors, among others, may imply technical and commercial adjustments throughout the life of the mine operation, Table 16-13, Table 16-14 and Table 16-15 detail the drilling and blasting for ore, weathered waste and fresh waste respectively.

Table 16-13: Xuxa Preliminary Drill and Blast Plan - Ore

Drilling and Blasting Rock Parameters		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Ore	m³ in situ	555,937	558,264	542,727	550,683	558,414	538,599	548,657	519,535
Ore	t	1,578,861	1,585,469	1,541,345	1,563,940	1,585,895	1,529,621	1,558,185	1,475,480
Average Density	t/m³	2.84	2.84	2.84	2.84	2.84	2.84	2.84	2.84
Hole Diameter	inch	4	4	4	4	4	4	4	4
Burden	m	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Spacing	m	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Blast Pattern	m²	6.44	6.44	6.44	6.44	6.44	6.44	6.44	6.44
Spacing/Burden	-	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22
Subdrilling	m	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Bench height	m	5	5	5	5	5	5	5	5
Stiffness Ratio (Height/Burden)	-	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17
Drill Angle	degrees °	8	8	8	8	8	8	8	8
Hole Length	m	5.76	5.76	5.76	5.76	5.76	5.76	5.76	5.76
Volume per Hole	m³	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2
Mass per Hole	t	91.45	91.45	91.45	91.45	91.45	91.45	91.45	91.45
m³ Blasted/m Drilled	m³/m	5.59	5.59	5.59	5.59	5.59	5.59	5.59	5.59
Specific Drilling	m/m³	0.179	0.179	0.179	0.179	0.179	0.179	0.179	0.179
Specific Drilling	m/t	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063
Drilled Metres	m	99,378	99,794	97,017	98,439	99,821	96,279	98,077	92,871
Necessary Holes	hole	17,265	17,337	16,855	17,102	17,342	16,727	17,039	16,135
Explosive Density	g/cm³	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
Linear Load Ratio	kg/m	9.32	9.32	9.32	9.32	9.32	9.32	9.32	9.32
Top Stemming	m	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Explosive Column	m	3.96	3.96	3.96	3.96	3.96	3.96	3.96	3.96
Load per Hole	kg	36.87	36.87	36.87	36.87	36.87	36.87	36.87	36.87
Load Ratio	g/m³	1,145	1,145	1,145	1,145	1,145	1,145	1,145	1,145
Load Ratio	g/t	403	403	403	403	403	403	403	403

Table 16-14: Xuxa Preliminary Drill and Blast Plan – Waste, Soil and Saprolite - Weathered

Drilling and Blasting Rock Parameters		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Waste Soil and Weathered	m³ in situ	144,470	430,446	234,875	170,535	147,165	200,151	205,179
Waste Soil and Weathered	t	390,315	1,149,734	626,176	444,244	397,295	536,241	553,914
Weighted Average Density	t/m³	2.7	2.67	2.67	2.61	2.7	2.68	2.7
Hole Diameter	inch	4	4	4	4	4	4	4
Burden	m	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Spacing	m	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Blast Pattern	m²	8.84	8.84	8.84	8.84	8.84	8.84	8.84
Spacing/Burden	-	1.31	1.31	1.31	1.31	1.31	1.31	1.31
Subdrilling	m	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Bench height	m	10	10	10	10	10	10	10
Stiffness Ratio (Height/Burden)	-	3.85	3.85	3.85	3.85	3.85	3.85	3.85
Drill Angle	degrees °	8	8	8	8	8	8	8
Hole Length	m	10.81	10.81	10.81	10.81	10.81	10.81	10.81
Volume per Hole	m³	88.4	88.4	88.4	88.4	88.4	88.4	88.4
Mass per Hole	t	238.83	236.12	235.67	230.28	238.65	236.84	238.65
m³ Blasted/m Drilled	m³/m	8.18	8.18	8.18	8.18	8.18	8.18	8.18
Specific Drilling	m/m³	0.122	0.122	0.122	0.122	0.122	0.122	0.122
Specific Drilling	m/t	0.045	0.046	0.046	0.047	0.045	0.046	0.045
Drilled Metres	m	17,659	52,613	28,709	20,845	17,988	24,464	25,079
Necessary Holes	holes	1,634	4,869	2,657	1,929	1,665	2,264	2,321
Explosive Density	g/cm³	1.15	1.15	1.15	1.15	1.15	1.15	1.15
Linear Load Ratio	kg/m	9.32	9.32	9.32	9.32	9.32	9.32	9.32
Top Stemming	m	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Explosive Column	m	8.61	8.61	8.61	8.61	8.61	8.61	8.61
Load per Hole	kg	80.2	80.2	80.2	80.2	80.2	80.2	80.2
Load Ratio	g/m³	907	907	907	907	907	907	907
Load Ratio	g/t	336	340	340	348	336	339	336

Table 16-15: Xuxa Preliminary Drill and Blast Plan – Waste - Fresh

Drilling and Blasting Rock Parameters		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Waste Fresh Rock	m³ in situ	1,456,444	6,035,115	8,873,041	7,247,742	9,235,880	9,520,679	12,876,779	5,261,939
Waste Fresh Rock	t	4,238,252	17,562,184	25,820,548	21,090,928	26,876,412	27,705,175	37,471,428	15,312,243
Weighted Average Density	t/m³	2.91	2.91	2.91	2.91	2.91	2.91	2.91	2.91
Hole Diameter	inch	4	4	4	4	4	4	4	4
Burden	m	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Spacing	m	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15
Blast Pattern	m²	8.19	8.19	8.19	8.19	8.19	8.19	8.19	8.19
Spacing/Burden	-	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21
Subdrilling	m	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Bench height	m	10	10	10	10	10	10	10	10
Stiffness Ratio (Height/Burden)	-	3.85	3.85	3.85	3.85	3.85	3.85	3.85	3.85
Drill Angle	degrees °	8	8	8	8	8	8	8	8
Hole Length	m	10.81	10.81	10.81	10.81	10.81	10.81	10.81	10.81
Volume per Hole	m³	81.9	81.9	81.9	81.9	81.9	81.9	81.9	81.9
Mass per Hole	t	238.33	238.33	238.33	238.33	238.33	238.33	238.33	238.33
m³ Blasted/m Drilled	m³/m	7.58	7.58	7.58	7.58	7.58	7.58	7.58	7.58
Specific Drilling	m/m³	0.132	0.132	0.132	0.132	0.132	0.132	0.132	0.132
Specific Drilling	m/t	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
Drilled Metres	m	192,150	796,219	1,170,630	956,202	1,218,500	1,256,073	1,698,847	694,213
Necessary Holes	holes	17,783	73,689	108,340	88,495	112,770	116,248	157,226	64,248
Explosive Density	g/cm³	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
Linear Load Ratio	kg/m	9.32	9.32	9.32	9.32	9.32	9.32	9.32	9.32
Top Stemming	m	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Explosive Column	m	8.61	8.61	8.61	8.61	8.61	8.61	8.61	8.61
Load per Hole	kg	80.2	80.2	80.2	80.2	80.2	80.2	80.2	80.2
Load Ratio	g/m³	979	979	979	979	979	979	979	979
Load Ratio	g/t	337	337	337	337	337	337	337	337

Based upon the rock characteristics and operating parameters, the top hammer drilling method has been chosen as the optimal method. Due to experience with and availability of the equipment, tools, original replacement parts, and technical services, the authors recommend the Sandvik equipment listed in Table 16-16.

Table 16-16: Xuxa Recommended Drill and Blast Rigs

Size	Brand	Series	Model	Hammer	Diameter		Type
					mm	inch	
23 t	Sandvik	Pantera	DP1500	Top	102 to 140	4.0” a 5.5”	Production, pre-split, occasional services
16 t	Sandvik	Ranger	DX800	Top	76 to 114	3.0” a 4.5”	Production, pre-split, secondary blasts

Using the parameters established for blasting, it was possible to calculate the drill requirements needed to meet the planned production schedule for the Xuxa Mine as shown in Table 16-17.

A drop in physical availability over time due to the natural wear and tear and increased use of the equipment once the mine is operational is expected. An efficiency factor was also included for the learning period needed by the operational team and for optimization of operations over time.

If the fleet has operational variations throughout the mine life, it is understood that operations planning will be adjusted, making it possible to optimize the available resources.

If it is necessary to implement different grids than was originally planned or to add slope preservation methods, such as damping lines, pre-cut or post-cut, the amount of drilling will tend to increase. Should an increase in the amount of drilling be required, the fleet and staff will be adequate to meet this demand.

The proposed top hammer drills have an operating cabin with ROPS/FOPS certification, air conditioning, acoustic insulation system, dust collector, hole cleaning air monitoring system, rod greasing system, angle and depth gauge, and water injection for dust control.

The drilling operation will be supported by a bulldozer and/or hydraulic excavator to carry out the cleaning and preparation of the drilling benches, access construction to the drilling benches, as well as a hydraulic rock breaker coupled to the hydraulic excavator to remove blocks in the operational area.

Table 16-17: Xuxa Preliminary Calculations for Drilling Requirements

Drilling Sizing		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Drilled Metres	quantity	309,187	948 627	1 296 356	1 075 486	1 336 309	1 376 817	1 822 003	787 085
Days / Year	quantity	365	365	366	365	365	365	365	365
Shifts / Day	quantity	3	3	3	3	3	3	3	3
Hours / Shift	quantity	8	8	8	8	8	8	8	8
Calendar Hours	hours	8.76	8.76	8.784	8.76	8.76	8.76	8.76	8.76
FA - Physical Availability	%	85%	84%	82%	80.50%	80%	80%	80%	80%
Hours Available	hours	7 446	7 315	7 203	7 052	7 008	7 008	7 008	7 008
Unproductive Hours	hours	2 949	2 402	2 408	2 402	2 402	2 219	2 219	2402
GU - Global Usage	%	55%	59%	62%	62%	62%	62%	62%	62%
OI Operating Income	%	47%	49%	51%	50%	50%	50%	50%	50%
Efficiency Factor	%	90%	92%	94%	96%	98%	100%	100%	100%
Productivity Ore	m/hr	22	22	22	22	22	22	22	22
Soil And Saprolite Productivity	m/hr	35	35	35	35	35	35	35	35
Waste Productivity	m/hr	30	30	30	30	30	30	30	30
Weighted Average Productivity	m/hr	27.7	29.4	29.5	29.4	29.5	29.5	29.6	29.1
Global Specific Drilling	m/m^3	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.14
Drilling Productivity	m^3/hr	193.3	217.9	219.7	217.6	219.2	220	221.7	213.4
Effective Hours Worked	hours	3 686	3 970	4 198	4 197	4 258	4 345	4 345	4 345
Metres Per Drill	m/year	102 148	116 871	123 887	123 250	125 484	128 304	128 777	126 247
Metres Per Drill	m/month	8 512	9 739	10 324	10 271	10 457	10 692	10 731	10 521
Equipment Numbers Required	quantity	4	9	11	9	11	11	15	7

16.3.16 Explosives Consumption

The consumption of explosives and accessories was calculated based on the parameters of the blasting plans presented above in Table 16-13 to Table 16-15. The tables below, Table 16-18 to Table 16-20 show the estimated annual consumption of pumped explosives, non-electrical accessories, and remote activation through electronic fuse for ore, waste, and the combined totals respectively. In addition, small allowances for explosives and accessories were included, for secondary blasting of oversize rock.

Table 16-18: Xuxa Estimated Annual Consumption of Explosives - Ore

Rock Blasting / Pumped Emulsion Blaster + Non-Electric / Bulk Emulsion + Non-Electric										
Ore										
Item / Quantities	**Unit**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Total**
Bulk Emulsion	kg	636,566	639,231	621,441	630,551	639,402	616,714	628,230	594,885	5,007,02
Ammonium Nitrate	kg									
Packaged Explosive	kg	9,548	9,588	9,322	9,458	9,591	9,251	9,423	8,923	75,105
250 g Booster	unit	17,610	17,684	17,192	17,444	17,689	17,061	17,380	16,457	138,518
450 g Booster	unit									
NP05 Detonating cord	unit									
NP10 Detonating cord	unit									
6 m NW in hole delay	unit	17,610	17,684	17,192	17,444	17,689	17,061	17,380	16,457	138,518
12 m NW in hole delay	unit	3,453	3,467	3,371	3,420	3,468	3,345	3,408	3,227	27,160
15 m NW in hole delay	unit									
18 m NW in hole delay	unit									
4.8 m NW Surface delay	unit									
6 m NW Surface delay	unit	1,151	1,156	1,124	1,140	1,156	1,115	1,136	1,076	9.053
300 m NW Initiator	unit									
500 m NW Initiator	unit									
Electronic	unit	115	116	112	114	116	112	114	108	905
Blasting fuse	unit									
Electronic cable	m	2,302	2,312	2,247	2,280	2,312	2,230	2,272	2,151	18,107

Table 16-19: Xuxa Estimated Annual Consumption of Explosives - Waste

Rock Blasting / Pumped Emulsion Blaster + Non-Electric / Bulk Emulsion + Non-Electric										
Waste										
Item / Quantities	**Unit**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Total**
Bulk Emulsion	kg	1,557,282	6,300,365	8,901,955	7,252,020	9,177,690	9,504,648	12,795,650	5,152,720	60,642,330
Ammonium Nitrate	kg									
Packaged Explosive	kg	23,359	94,505	133,529	108,780	137,665	142,570	191,935	77,291	909,635
250 g Booster	unit	19,806	80,129	113,217	92,233	116,724	120,882	162,738	65,533	771,261
450 g Booster	unit									
NP05 Detonating cord	unit									
NP10 Detonating cord	unit									
6 m NW in hole delay	unit	19,417	78,558	110,997	90,424	114,435	118,512	159,547	64,248	756,138
12 m NW in hole delay	unit	23,689	95,841	135,416	110,317	139,611	144,584	194,647	78,383	922,489
15 m NW in hole delay	unit									
18 m NW in hole delay	unit									
4.8 m NW Surface delay	unit									
6 m NW Surface delay	unit	19,806	112,076	158,356	129,005	163,261	169,077	227,620	91,661	1,070,861
300 m NW Initiator	unit									
500 m NW Initiator	unit									
Electronic	unit	129	524	740	603	763	790	1.064	428	5.041
Blasting fuse	unit									
Electronic cable	m	2,589	10,474	14,800	12,057	15,258	15,802	21,273	8,566	100,818

Table 16-20: Xuxa Estimated Annual Consumption of Explosives – Combined Ore and Waste

Rock Blasting / Pumped Emulsion Blaster + Non-Electric / Bulk Emulsion + Non-Electric										
Total Production										
Item / Quantities	**Unit**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Total**
Bulk Emulsion	kg	2,193,849	6,939,595	9,523,496	7,882,571	9,817,093	10,121,362	13,423,880	5,747,605	65,649,351
Ammonium Nitrate	kg									
Packaged Explosive	kg	32,908	104,094	142,851	118,239	147,256	151,820	201,358	86,214	984,740
250 g Booster	unit	37,416	97,813	130,409	109,677	134,413	137,943	180,117	81,991	909,779
450 g Booster	unit									
NP05 Detonating cord	unit									
NP10 Detonating cord	unit									
6 m NW in hole delay	unit	37,028	96,242	128,189	107,868	132,124	135,573	176,926	80,706	894,656
12 m NW in hole delay	unit	27,142	99,308	138,787	113,738	143,079	147,930	198,055	81,610	949,649
15 m NW in hole delay	unit									
18 m NW in hole delay	unit									
4.8 m NW Surface delay	unit									
6 m NW Surface delay	unit	20,957	113,232	159,479	130,145	164,417	170,192	228,756	92,737	1,079,914
300 m NW Initiator	unit									
500 m NW Initiator	unit									
Electronic	unit	245	639	852	717	879	902	1,177	536	5,946
Blasting fuse	unit									
Electronic cable	m	4,891	12,786	17,047	14,337	17,570	18,032	23,545	10,718	118,925

16.3.17 Blasting Plan

During the operation, the daily blast plans will be prepared by the explosive supplier’s technical staff. These plans will be analysed and validated by the Sigma rock blasting team.

After each blast, the blast plan will be updated according with the equipment quantities actually used. Physical and digital copies of all generated documentation will be kept, which will be available for audits or inspection by regulatory bodies.

16.3.18 Execution of Blasting

Rock blasts will be carried out on scheduled dates, the frequency of which will meet the demand for blasted ore and waste.

For all rock blasting, the authorities will also be previously communicated through the Rock Blasting Notice, as per Annex of ORDINANCE No. 147 - COLOG, of November 21, 2019.

16.3.19 Fragmentation Control

The fragmentation control will be carried out through specialized software, generating granulometric distribution curves from photographic records. This monitoring allows for blast pattern adjustments, sequencing and other parameters according to the results history. Monitoring will be carried out on a monthly basis for rock blasting and/or whenever the contractor's technical team deems is necessary to optimize the operation.

Figure 16-23 shows an example of image analysis and particle size distribution calculation using granulometric distribution curves.

The blasts will be filmed with high-definition cameras that allow a detailed visual assessment of factors such as detonation sequencing, mass displacement, top stemming efficiency and ultra-launch.

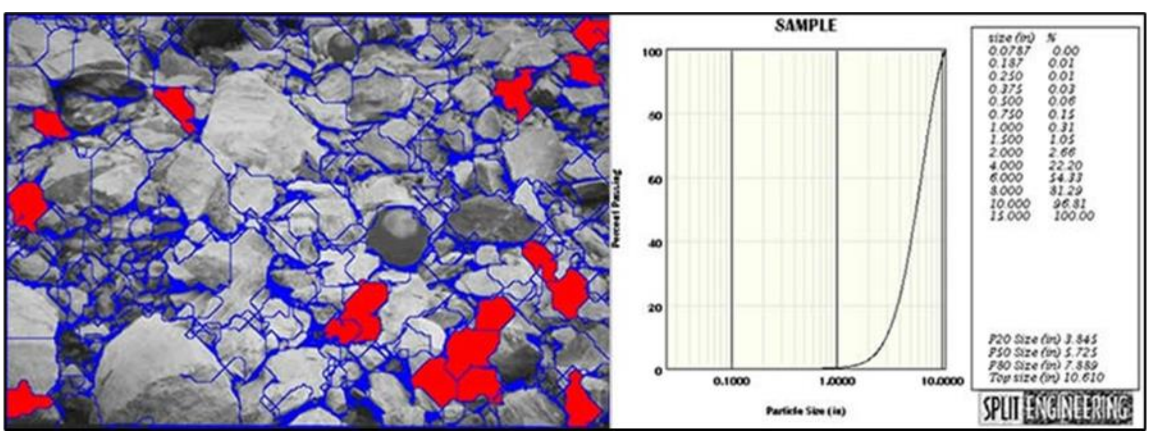


Figure 16-23: Image Analysis and Calculation of Granulometric Distribution

16.4 BARREIRO OPEN PIT MINING

The Barreiro Deposit will be mined by open pit mining methods, using a contracted mining fleet consisting of hydraulic excavators, front-end loaders, and 40 t trucks for both waste and ore, coupled with appropriate auxiliary support equipment.

16.4.1 Risk Evaluation

GE21 evaluated the potential risks of mining and geotechnical activities for the Barreiro deposit. Six risks were identified and considered as follows:

1. Mineral Resources block model, backing the LOM, may not be robust.
2. Deficient geological information (deeper horizons) may compromise the LOM model precision.
3. The Mineral Resource block model is deficient (lacking diverse parameters such as recovery, work index (WI), contaminants, or mineralogy for example), compromising the preparation of a proper plant feed blending plan.
4. Atmospheric contamination caused by mine dust.
5. Production problems and interruption, due to environmental licensing delays.
6. Model cannot predict dilution with proper precision due to deficiencies in the mine geological mapping and blasting mixing.

GE21 recommend a continuous monitoring of the identified risks, with regular reports submitted to Sigma management for consideration.

16.4.2 Geotechnical and Hydrogeological Analysis

16.4.2.1 Geotechnical

A geotechnical field study, analysis and design was performed to provide key design parameters for the Barreiro pit.

Data analysis is supported by a comprehensive investigation and geotechnical assessment of the drill hole samples, and laboratory tests consisting of uniaxial compressive testing (UCS), triaxial testing, indirect tensile strength testing (Brazilian test), and direct shear strength testing. The stability analyses led to the recommendation of inclination angles for the pit walls which are considered to be prudent and within appropriate safety factors expected of a PFS. The stability analyses considered information on the strength parameters of various rock and soil materials, in association with the understanding of the expected rupture mechanisms that could occur on the pit slopes.

The walls of the Barreiro pit will be entirely within a biotite schist unit, consisting of a low to medium intensity of schistosity. Figure 16-24 is a stereogram of two joint main structures identified at Barreiro using optical televiewing (OPTV).

The soil and overburden are up to 5 m deep, with a transition zone of saprolite with moderately altered rock up to 30 m in depth. The basement (fresh rock) is a compact biotite schist, showing little to no change in the original colour of the minerals and moderate to high mechanical strength (weathering zone ranging from W2 on the top to W1).

The rock mass has good to excellent RQD (75 – 100%), low fracturing degree (F2), and RMR class II/I, corresponding from good to very good rock mass strength.

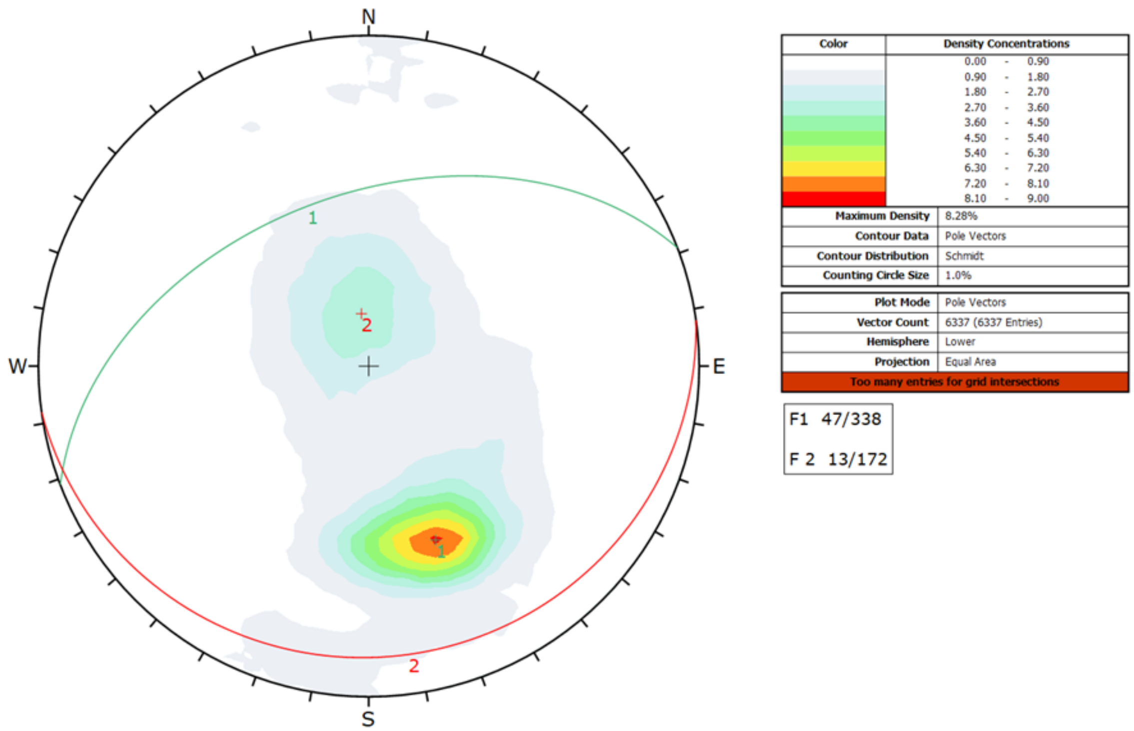


Figure 16-24: OPTV-derived stereogram showing two main joint structures at Barreiro

16.4.2.2 Geomechanical Characterization

Three oriented geotechnical holes were drilled to help determine the geomechanical characteristics of the biotite schist in the Barreiro pit walls. The holes were logged, and images and geological structures were obtained by OPTV. Uniaxial compression tests (UCS) and direct shear tests were completed on the core and the results are presented in Table 16-21 and 16-22 respectively.

Half of the mean values for the friction angle and cohesion were adopted in the stability analyses, based on a conservative approach.

Table 16-21: Uniaxial Compression Test (UCS) Results Barreiro Pit

Lithology	Code	Height (mm)	Diameter (mm)	UCS (MPa)	Young Modulus (Gpa)	Poisson's Ratio
Biotite schist	GT-0077_CP_01	170.83	62.98	52.30	38.48	0.305
	GT-0082_CP_02	170.26	61.48	45.13	29.84	0.281
	GT-0083_CP_03	165.56	62.73	55.02	24.89	0.263
	GT-0084_CP_04	162.10	62.71	66.42	23.34	0.221
	GT-0085_CP_05	169.53	62.93	54.20	21.68	0.288

S.Dev.	6.86	6.06	0.03
Mean	54.61	27.65	0.27
C.V.	0.13	0.22	0.11

Table 16-22: Direct Shear Test Results Barreiro Pit

RESIDUAL RESISTANCE

Lithological Code	Friction Angle (°)	Cohesion (MPa)
SCHMI	67	1.7
	66	1.2
	60	1.1

S.Dev.	3.0	0.32
Mean	64	1.33
C.V.	5%	24%

16.4.2.3 Pit Sectorization

The pit was divided into 5 sectors according to the orientation of the pit wall slopes and geological structures, as shown in Figure 16-25.

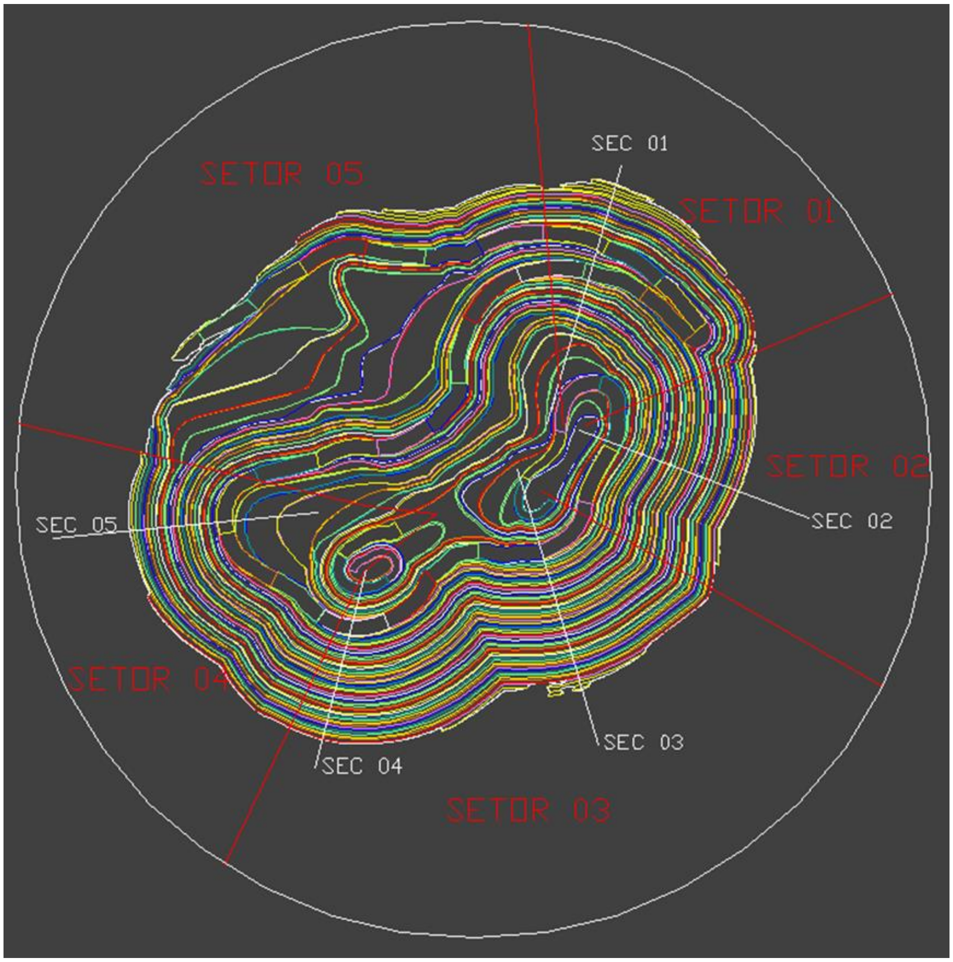


Figure 16-25: Barreiro Pit Sectorization

16.4.2.4 Kinematic Analyses

Kinematic analyses were performed for the different sectors to assess planar and toppling ruptures.

The friction angle adopted was obtained from the direct shear tests result values and was calculated using the mean minus two standard deviations.

Figure 16-26 to Figure 16-31 show the analyses for the sectors and the respective percentages of occurrences.

Based on the analysis results, the greatest risk is within sector 5, with the possibility of 30% failure due to wall collapse. However, this risk is within the acceptable limits set out under international best practices for pit projects. This risk can be mitigated and controlled by screening the pit walls in this area.

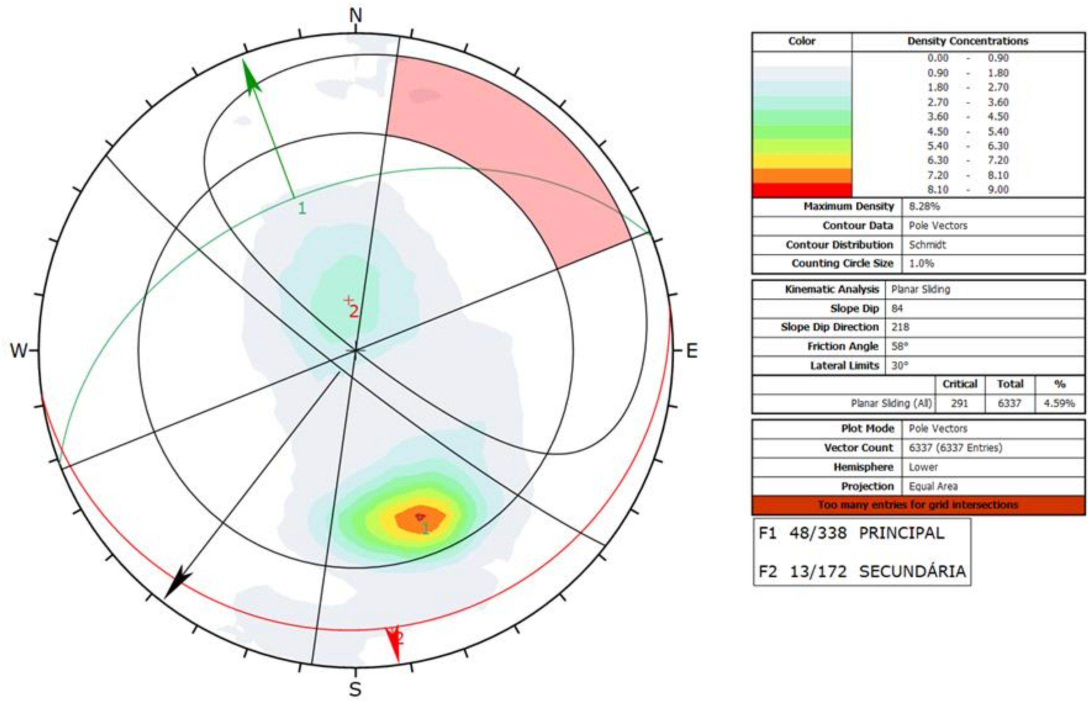


Figure 16-26: Barreiro kinematic analysis for sector 1 with 5% planar rupture occurring

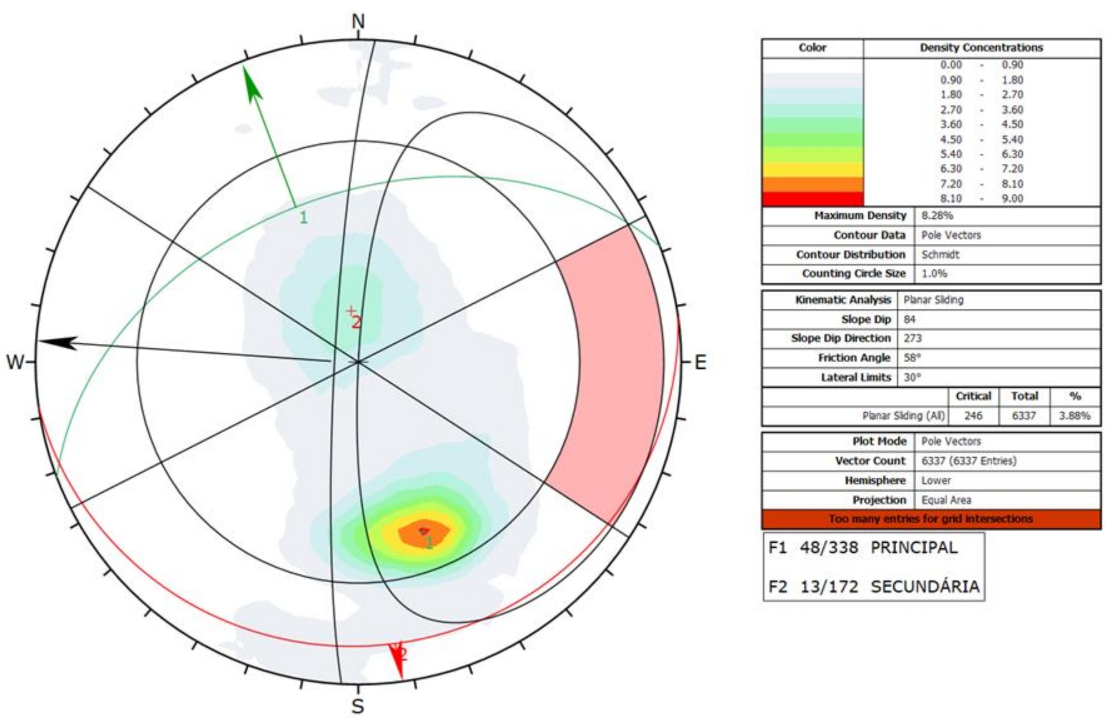


Figure 16-27: Barreiro kinematic analysis for sector 1 with 4% planar rupture occurring

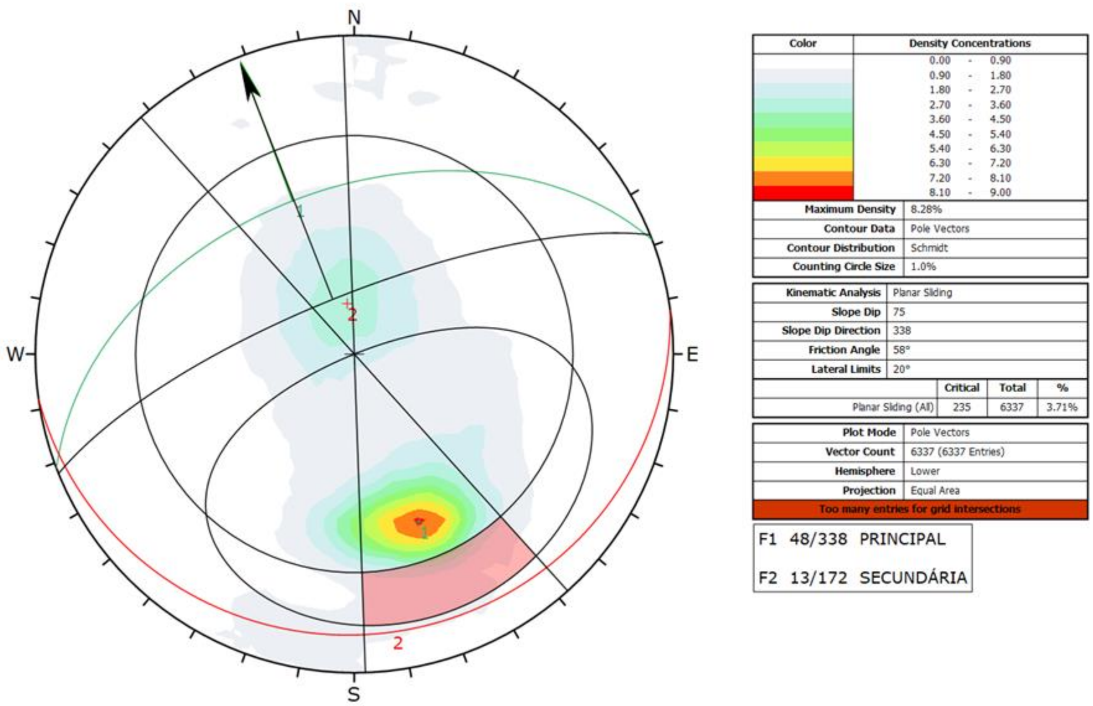


Figure 16-28: Barreiro kinematic analysis for sector 3 with 4% planar rupture occurring

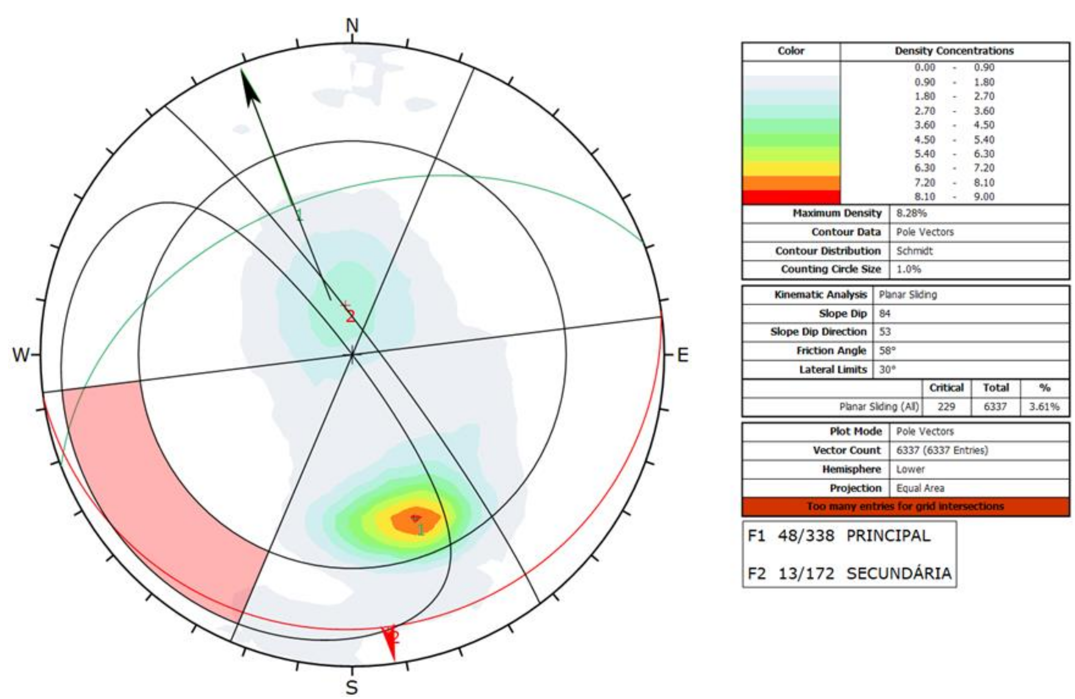


Figure 16-29: Barreiro kinematic analysis for sector 4 with 4% planar rupture occurring

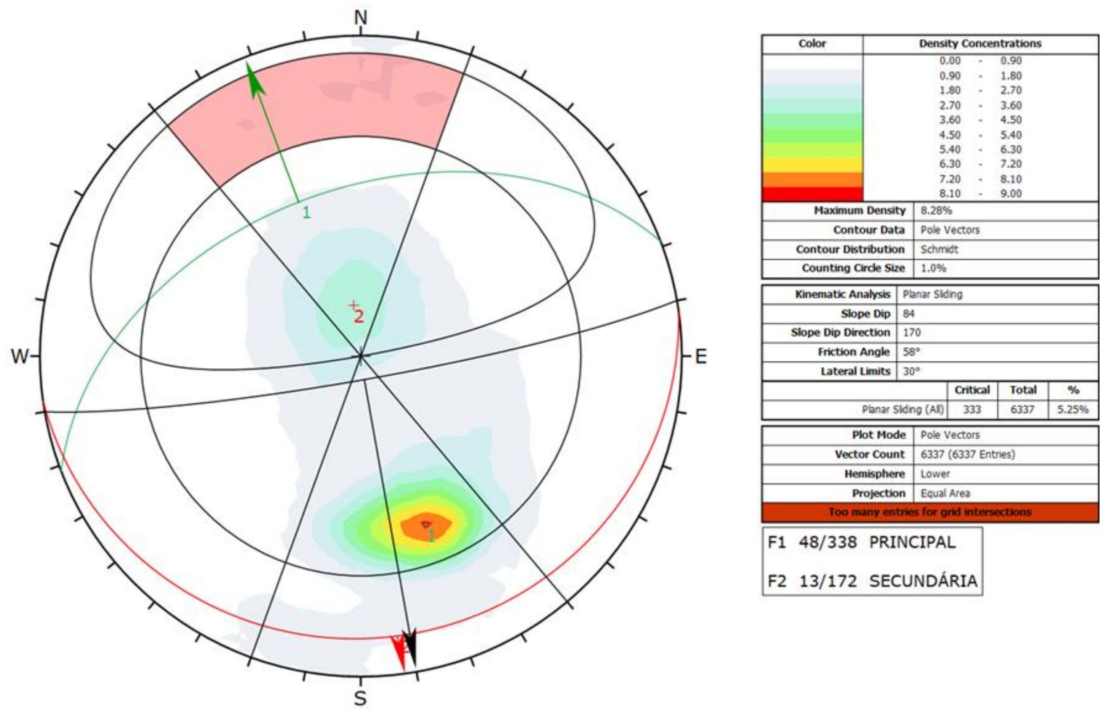


Figure 16-30: Barreiro kinematic analysis for sector 5 with 5% planar rupture occurring

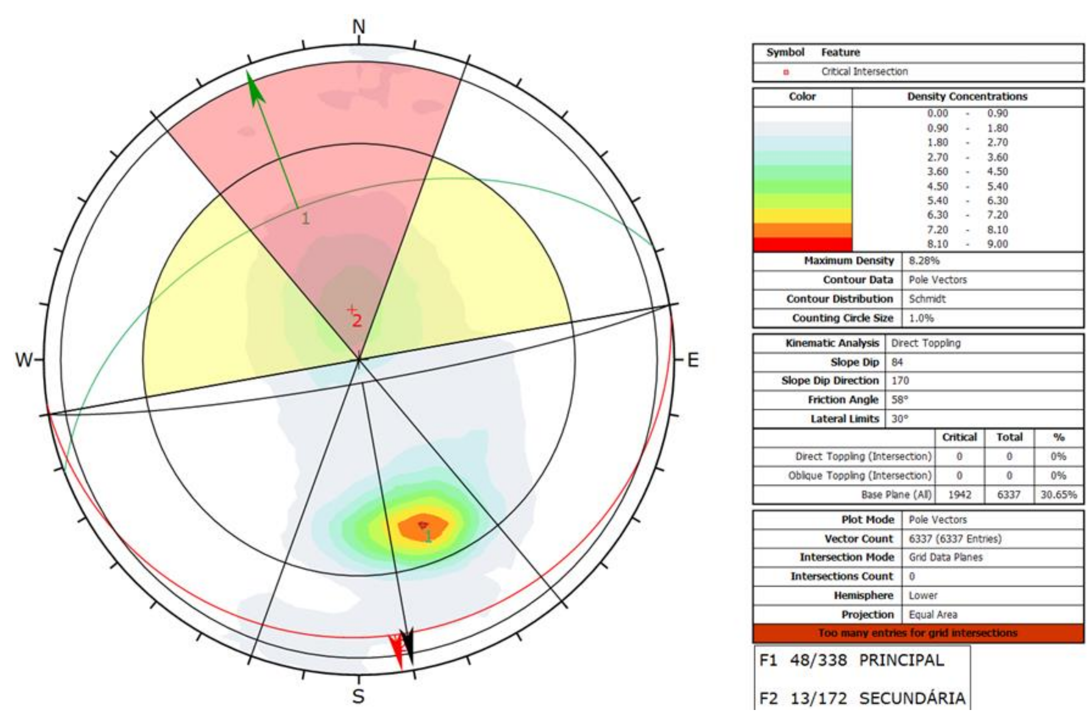


Figure 16-31: Barreiro Kinematic analysis for sector 5 with 30% planar rupture occurring

16.4.2.5 Limit Equilibrium Slope Stability Analysis

The following conditions were assumed for the stability analysis:

- The rock mass was considered an anisotropic material
- For the condition perpendicular to foliation, the residual strength of direct shear tests was considered
- Foliation was considered half the mean of the friction angle and cohesion for the parallel condition
- Slope partially saturated

The results of the analyzes are shown in Table 16-23 and in Figure 16-32 to Figure 16-36.

Table 16-23: Barreiro Slope Stability Analysis

Section	Sector	Minimum SF
SEC 01	01	1.92
SEC 02	02	1.43
SEC 03	03	1.80
SEC 04	03	1.99
SEC 05	04	2.18

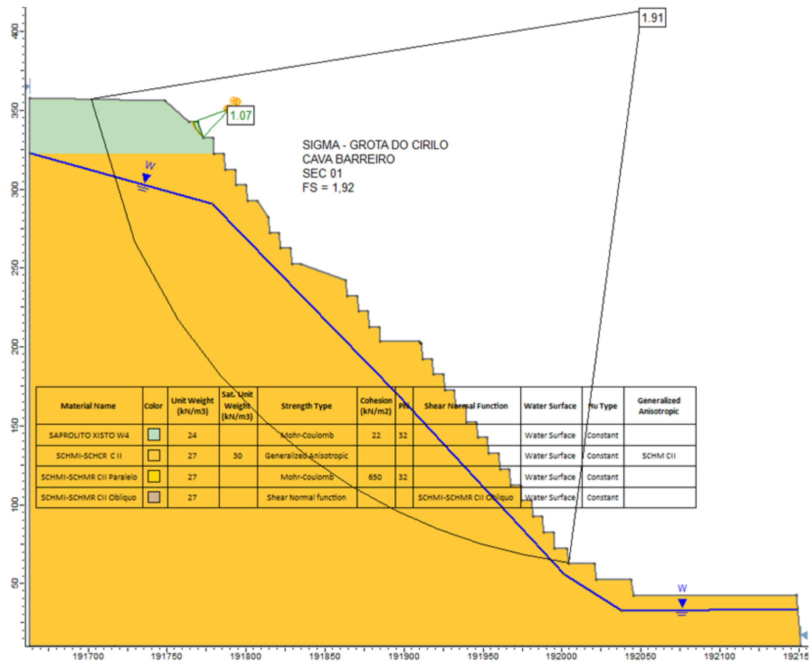


Figure 16-32: Analysis of section 01 with FS = 1.92

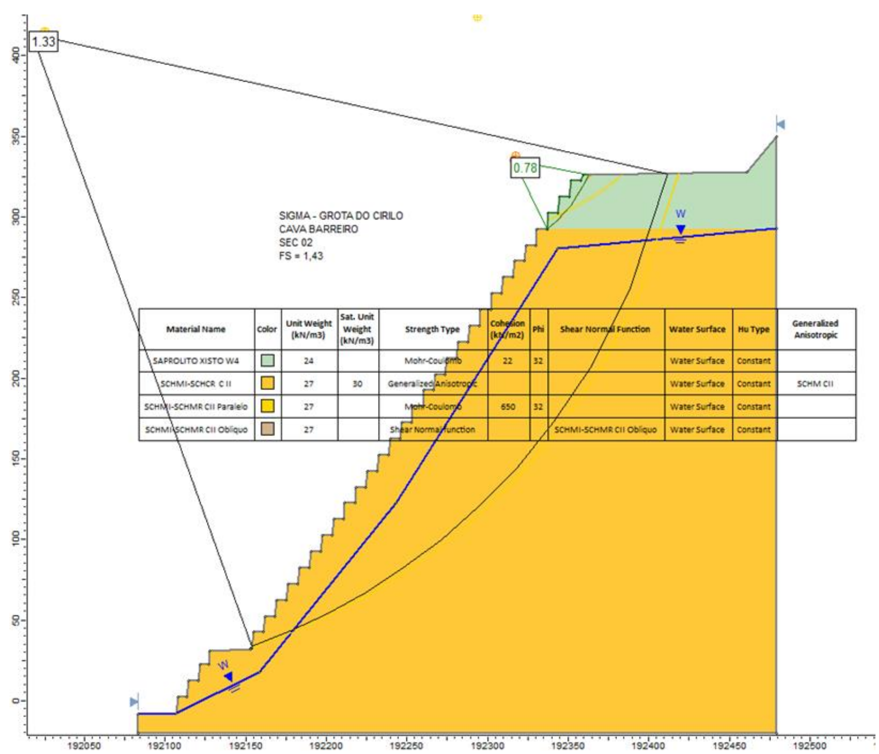


Figure 16-33: Analysis of section 02 with FS = 1.43

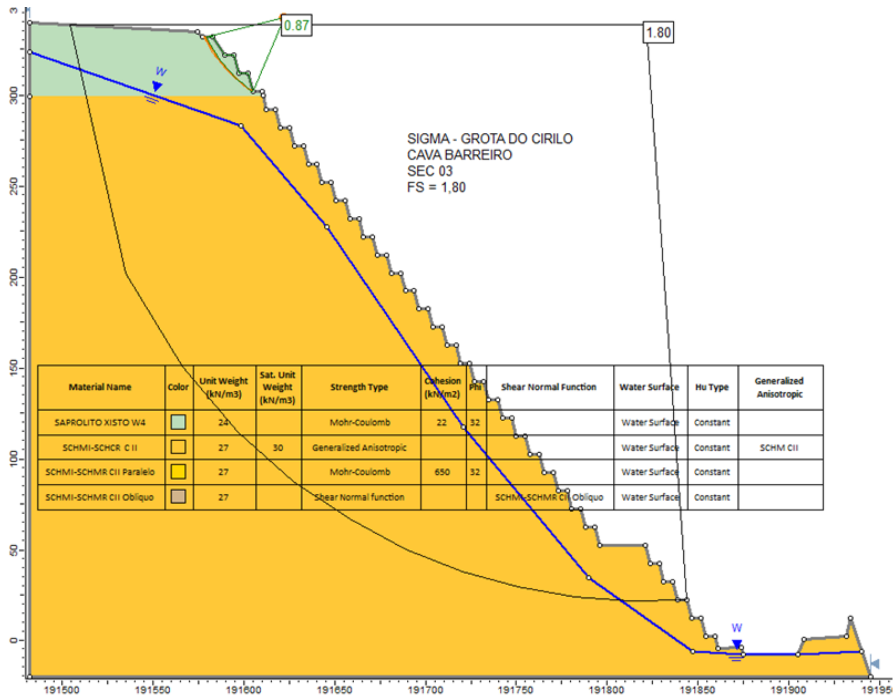


Figure 16-34: Analysis of section 03 with FS = 1.80

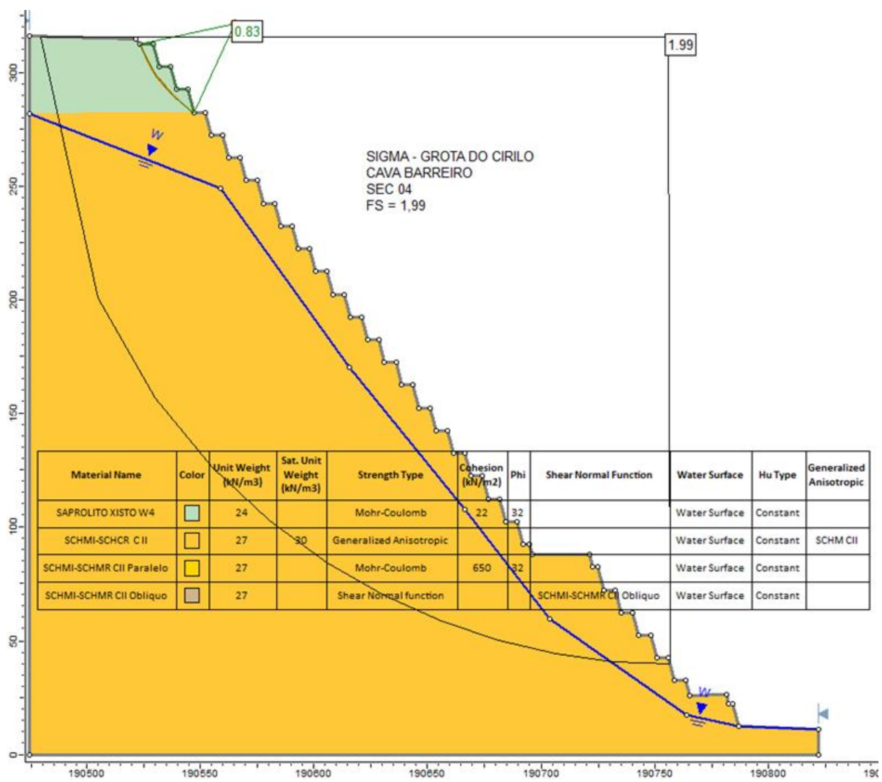


Figure 16-35: Analysis of section 04 with FS = 1.99

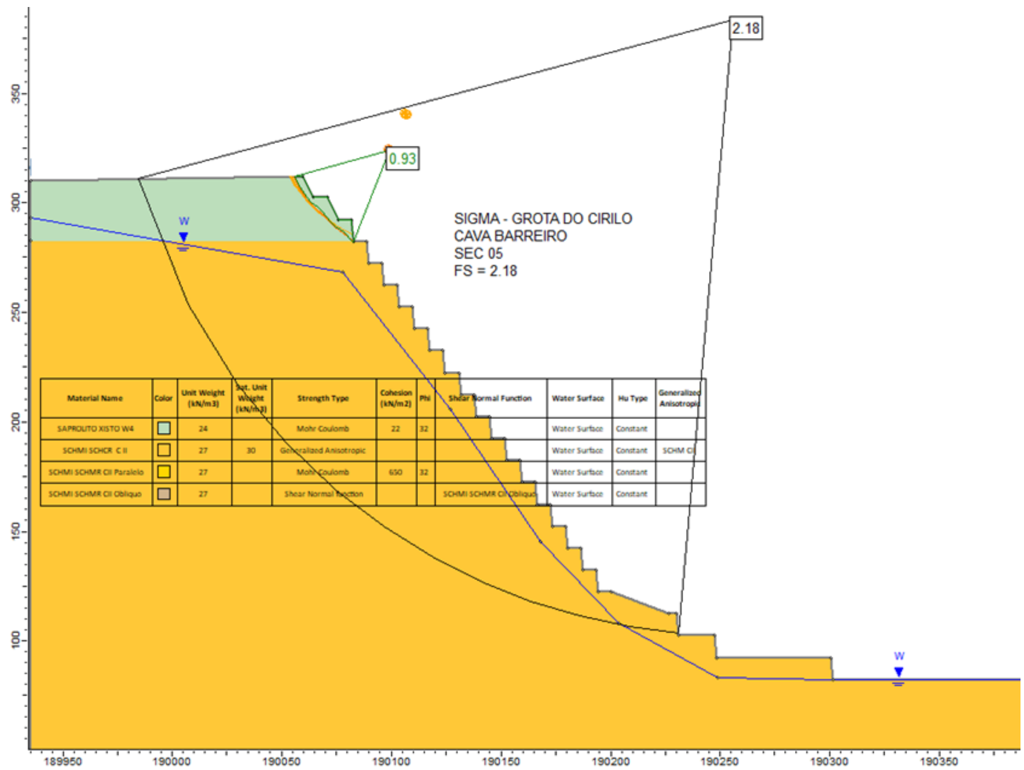


Figure 16-36: Analysis of section 05 with FS = 2.18

16.4.2.6 Recommended Geometry for Pit Slopes

Based on the results of the kinematic analyses and the limit equilibrium analyses, adjustments must be made to the pit wall slopes projected in the upper pit portions, from surface to a depth of 35 m.

In the current phase of the studies, the following geometry, shown in Table 16-24, is recommended.

Table 16-24: Barreiro Recommended Pit Slope Geometry

Sectors	Face Angle (º)	Berm Width (m)	Bench Height (m)	Inter-ramps Slopes Angle (º)
01 - Overburden	55	6	10	37.6
01 - Fresh Rock	84	6	10	55
02 - Overburden	55	6	10	37.6
02 - Fresh Rock	84	6	10	55
03 - Overburden	47	6	10	33,7
03 - Fresh Rock	75	5	10	52
04 - Overburden	55	6	10	37,6
04 - Fresh Rock	84	6	10	55
05 - Overburden	55	6	10	37,6
05 - Fresh Rock	84	6	10	55

16.4.2.7 Hydrogeology

Sigma's Grota do Cirilo Project is situated within the Jequitinhonha River Hydrographic Basin (Figure 16-37) which is located in the mesoregions of the Jequitinhonha Valley and Northern Minas Gerais, with a drainage area of 19,803 km². The climate in the basin is considered semi-arid, with a dry period varying from four to five months per year, and hydraulic availability between 2 and 10 litres per second per square kilometre.

The Barreiro deposit is situated immediately east of the Piauí River, a shallow, intermittent river that is a tributary of the Jequitinhonha River (Figure 16-38). GE21 conducted a field inspection of the site on the 5th and 6th April 2021. All the secondary drainage channels from the Barreiro site to the Piauí River were inspected. All the drainage channels were dry, and it was concluded that the secondary drainage channels only flow after a rainfall event. Figure 16-38 shows the area of the field trip and the drainage points inspected.

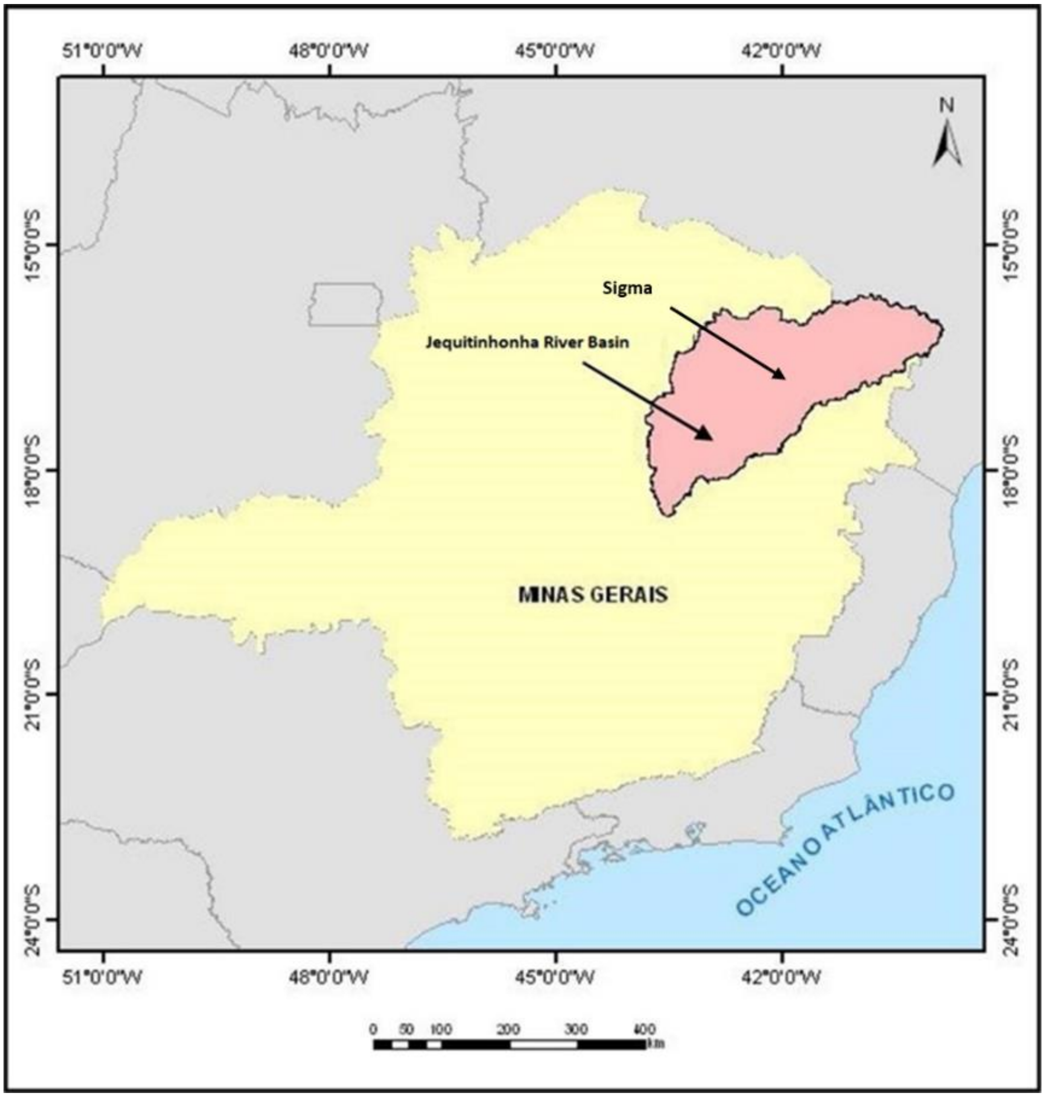


Figure 16-37: Jequitinhonha River Basin in Minas Gerais state, Brazil

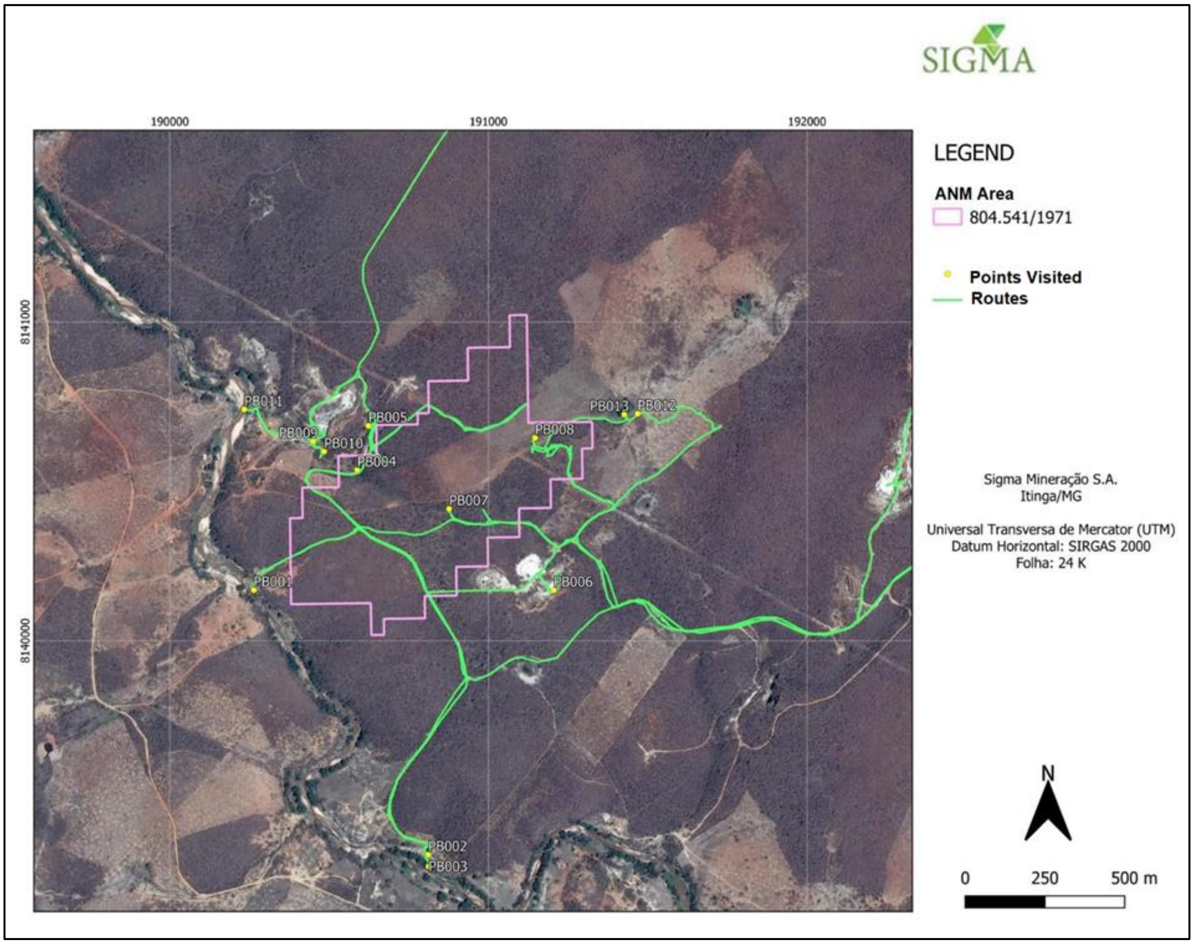


Figure 16-38: Route map and drainage points inspected in the Barreiro area

Water samples to determine the physical and chemical parameters of the water (pH, EH, conductivity and temperature) were collected at 2 points in the Piaui River. The average measurement shows a 7.8 pH in the Piaui River within the project area, an important parameter that clearly indicates rainwater without any acidic water characteristics. The average electrical conductivity measured at Piaui River is 54.3 µS. This extremely low value demonstrates that the water, although muddy in appearance, has very little suspended solids. The water grade of dissolved solids is extremely low, with an average of 27.4 ppm, which gives the water a low electrical conductivity, an important parameter to analyze the origin of water when related to pH. The average obtained from the measurements was 217.9 mv, and this positive value indicates fast circulating water and an oxidizing environment typical of rainwater. The average water temperature of the Piaui River in the project area was 28.9 °C.

16.4.2.7.1 Hydrogeological Characterization

Regarding the hydrogeological characterization of the Barreiro pit area, the following considerations can be stated:

- In general terms, the Piaui River has characteristics of both an influent and an effluent river, with the influent component being more prominent
- Effluent rivers receive water from the ground through their streambeds, while influent rivers lose water through evaporation and seepage into the ground

- The main groundwater flow occurs in the contact region between the altered saprolite/fresh rock, as observed in the drill cores of geotechnical drillholes campaign

Nine drill holes from the Barreiro drilling campaigns were assessed for groundwater levels. Table 16-25 shows the results of that assessment and Figure 16-39 shows the location of the drill holes and the estimated potentiometric map of the Barreiro area.

Table 16-25: Survey results of groundwater levels in Barreiro exploration drillholes

Hole Id	Coordinates (UTM - SIRGAS 2000)		Hole Depth (m)	Water Level (m)
	X	Y		
DH-BAR-15	190687	8140463	291.79	279.76
DH-BAR-40	191010	8140521	305.77	289.13
DH-BAR-60	190780	8140711	320.04	279.42
DH-BAR-62	190882	8140763	331.25	317.94
DH-BAR-81	191075	8140675	322.24	288.14
DH-BAR-86	191145	8140616	313.36	289.46
DH-BAR-93	191102	8140711	326.85	287.53
DH-BAR-96	190545	8140524	293.79	278.46
DH-BAR-98	191135	8140440	313.93	287.04

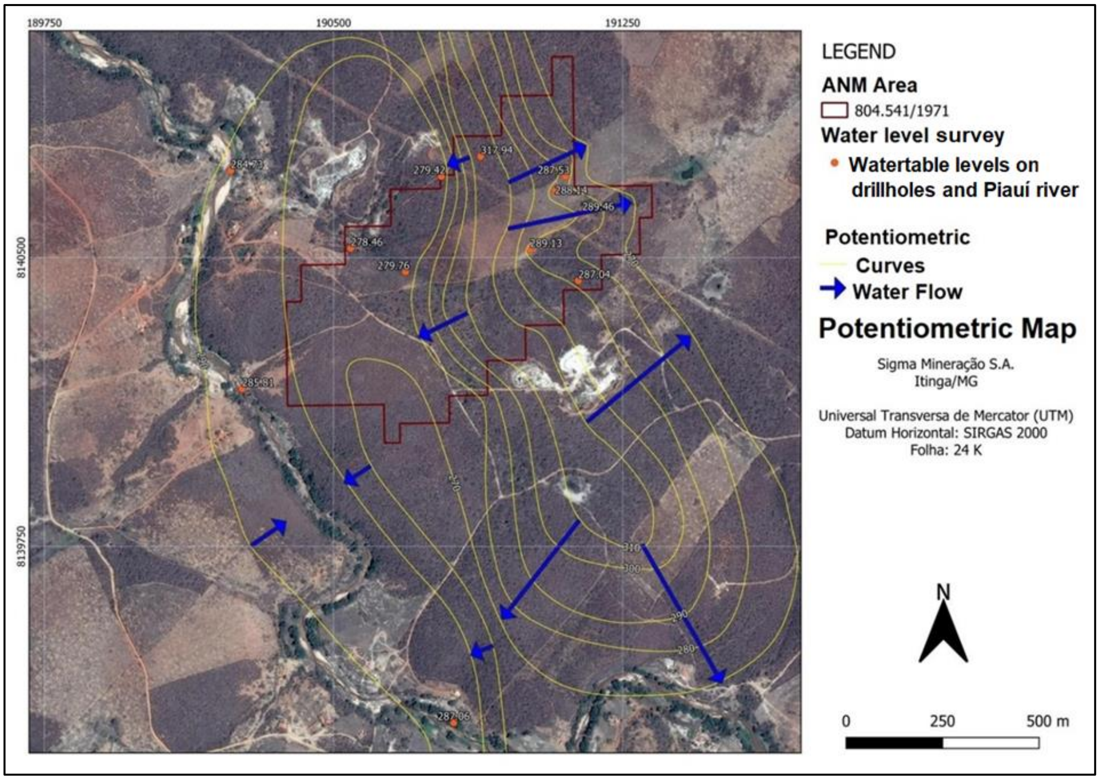


Figure 16-39: Drill hole locations and potentiometric map of the Barreiro area

The interpretation of the water level survey data in the drillholes is preliminary and shows an underground watershed divided in the central area of the rock massif, with SW flows to the Piaui River basin and NE flow to the opposite side.

16.4.2.7.2 Water Circulation Potential

Three geotechnical drill holes were drilled into the proposed Barreiro pit area (Figure 16-40). The data from these holes, together with geotechnical data logged in other exploration holes were assessed to determine the water circulation potential for the Barreiro pit.

The holes were assessed on two criteria:

- Zones with RQD below 70 and below the contact zone between the saprolite and fresh rock were selected
- Areas with RQD below 70 and above the depth of 180 metres (bottom of the pit) were selected

The contact between the saprolite and fresh rock was selected as the area with highest potential for water circulation. Table 16-26 shows the drill holes assessed with the contact depths.

Table 16-26: Depth values of saprolite-fresh rock boundary Barreiro drill holes

Hole Id	Contact Depth (m)	Litho-Code
GTB-DH-001	10.00	SAP
GTB-DH-002	20.95	SAP
GTB-DH-003	22.50	SAP
DH-BAR-09	7.15	SAP
DH-BAR-13	21.06	SAP
DH-BAR-18	5.75	SAP
DH-BAR-26	21.05	SAP
DH-BAR-30	9.75	SAP
DH-BAR-31	16.27	SAP
DH-BAR-33	7.91	SAP
DH-BAR-37	5.36	SAP
DH-BAR-40	1.98	SUN
DH-BAR-41	21.24	SAP
DH-BAR-43	16.41	SAP
DH-BAR-45	11.78	SAP
DH-BAR-47	8.07	SAP
DH-BAR-50	5.69	SAP
DH-BAR-52	21.45	SAP
DH-BAR-54	27.66	SAP
DH-BAR-75	14.92	SAP
DH-BAR-76	5.85	SAP
DH-BAR-84	7.95	SAP
DH-BAR-99	15.20	SAP

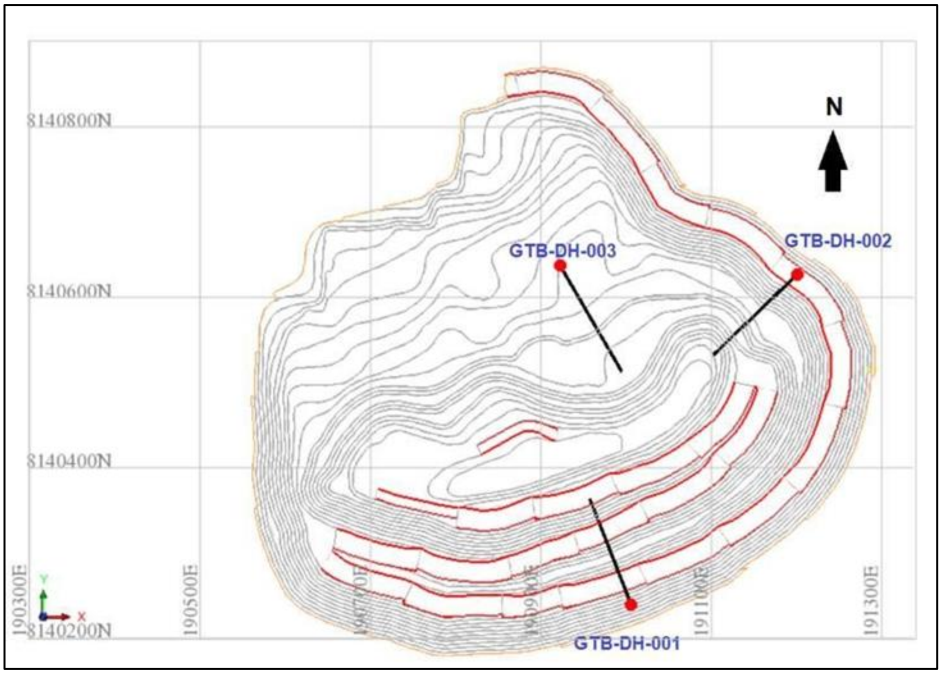


Figure 16-40: Barreiro geotechnical drill hole locations

16.4.2.7.3 Climatological and Hydrological Assessment

Broadly speaking, the area of Brazil where the Grota do Cirilo project is located is within the tropical savannah climate (Aw – drier winter) under the Köppen Climatic Classification system. Locally, however, the climate in Intinga and Aracuai is characterized as hot semi-arid (BSh) under the same classification system.

The region has an average annual rainfall of 755.8 mm, distributed irregularly throughout the year. The rains are concentrated in the period from October to March, with the November-January quarter accounting for more than 50% of the average annual total rainfall. In the Araçuaí weather station, the annual average temperature is 25.0°C, with an average annual spread of around 12.2°C. The lowest temperatures occur in June and July (lows 15.9°C) and the highest in January and February (highs of 34.4°C). Table 16-27 shows the average climatic data for Aracuai between 1981 and 2010.

Table 16-27: Average climatic data for Araçuaí (1981-2010)

Climatic Parameters	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall (mm)	109,3	78,9	110,2	30,7	15,6	3,5	4,6	6,6	13,9	58,0	154,3	170,2	755,8
Evaporation (mm)	121,9	137,3	126,1	120,7	125,8	120,4	134,4	174,8	206,6	218,1	143,1	109,5	1738,7
Evapotranspiração Potencial (mm)	201,2	184,7	185,6	151,5	132,3	101,2	103,6	136,2	173,1	230,5	202,2	182,8	165,4
Humidity (%)	66,8	62,4	66,0	64,4	64,0	62,0	58,9	55,5	53,7	55,9	65,5	70,4	62,1
Average Temperature (º C)	26,5	27,1	26,4	25,5	23,7	22,2	21,9	23,2	25,3	26,8	26,0	25,8	25,0
Average Temperature Low (º C)	21,5	21,7	21,6	20,5	18,2	16,4	15,9	16,9	19,6	21,5	21,6	21,5	19,7
Average Temperature Upper (º C)	33,4	34,4	33,3	32,2	30,8	29,5	29,4	30,5	32,3	33,5	32,0	32,1	32,0
Heat Stroke (h)	220,0	210,9	188,9	175,2	183,1	177,3	189,0	194,2	175,8	190,8	169,6	181,1	2255,9

Fonte: (INMET, 2021) 3

The estimates of monthly average precipitation will be used in future works to develop the studies of water balance of the Barreiro pit and estimation of the expected water volumes from the surface runoff for pumping system design.

The analysis of the mining plan and results of the mathematical modeling in permanent groundwater regime and the hydrological analysis above will allow the design of the drainage system of the Barreiro pit.

16.4.2.7.4 Hydrogeology Conclusions

- Further hydrogeological studies will take place in 2022
- The model of the circulation and interaction of water is not expected to be different from what was obtained in the studies of the Xuxa deposit
- The major difference between the Xuxa rock mass and the Barreiro rock mass is that the pegmatite at Xuxa is parallel to the schist foliation while the pegmatite at Barreiro crosscuts foliation. This cross-cutting feature can affect the level of fracturing, the depth of the alteration or even a separation of aquifers
- Operational problems caused by groundwater interference are not expected
- During the field study, no water springs related to any lithology were found. All secondary drainages were dry.

16.5 BARREIRO MINE SEQUENCING

In order to define the annual production plan, the following criteria were applied:

- Feed rate 1.80 Mtpa.
- Li_2O feed grade: 1.40%.

- 3.0% dilution rate.

- Mining recovery: 95%.
- Fines losses: 15%.
- DMS metallurgical recovery: 60.0%.
- Concentrate grade (Li_2O): 6%.
- Product mass recovery

This study consisted of sequencing production, the definition of waste and ore, and the mining sequence of the waste rock blocks, in addition to the evolution of pit geometries throughout the mine life.

For the production development, the areas to be mined annually were established, generating operational plans for years 1 to 12.

Operational sequencing results can be found in Figure 16-41 to Figure 16-48 and Table 16-28.

Table 16-28: Barreiro Designed Mine Sequence

YEAR	Classification	Tonnes (Mt)	Grade LI_2O Diluted 3%	WASTE (Mt)	Intermediate Stripping (Mt)	Total Waste (Mt)	Strip Ratio*	Strip Ratio Total	Total Mov. (Mt)
1	Proven	1.68	1.33	18.00	-	18.00	9.93	9.93	19.82
	Probable	0.14	0.84						
	Total	**1.81**	**1.30**						
2	Proven	1.50	1.36	18.02	-	18.02	9.83	9.83	19.86
	Probable	0.33	1.10						
	Total	**1.83**	**1.31**						
3	Proven	1.70	1.43	18.59	-	18.59	10.08	10.08	20.43
	Probable	0.14	1.46						
	Total	**1.84**	**1.43**						
4	Proven	1.70	1.41	17.91	23.81	41.72	9.88	23.02	43.53
	Probable	0.11	0.89						
	Total	**1.81**	**1.38**						
5	Proven	1.78	1.39	16.47	21.02	37.48	9.10	20.72	39.29
	Probable	0.03	0.98						
	Total	**1.81**	**1.39**						
6	Proven	1.67	1.41	17.85	21.81	39.66	9.89	21.96	41.46
	Probable	0.14	1.20						
	Total	**1.81**	**1.39**						
7 - 10	Proven	5.73	1.36	84.67	-	84.67	11.57	11.57	91.99
	Probable	1.58	1.26						
	Total	**7.32**	**1.34**						
11 - 12	Proven	1.16	1.38	13.22	-	13.22	3.75	3.75	16.75
	Probable	2.37	1.38						
	Total	**3.53**	**1.38**						
Total	Proven	16.93	1.38	204.73	66.63	271.37	9.41	12.47	293.13
	Probable	4.83	1.29						
	Total	**21.76**	**1.36**						

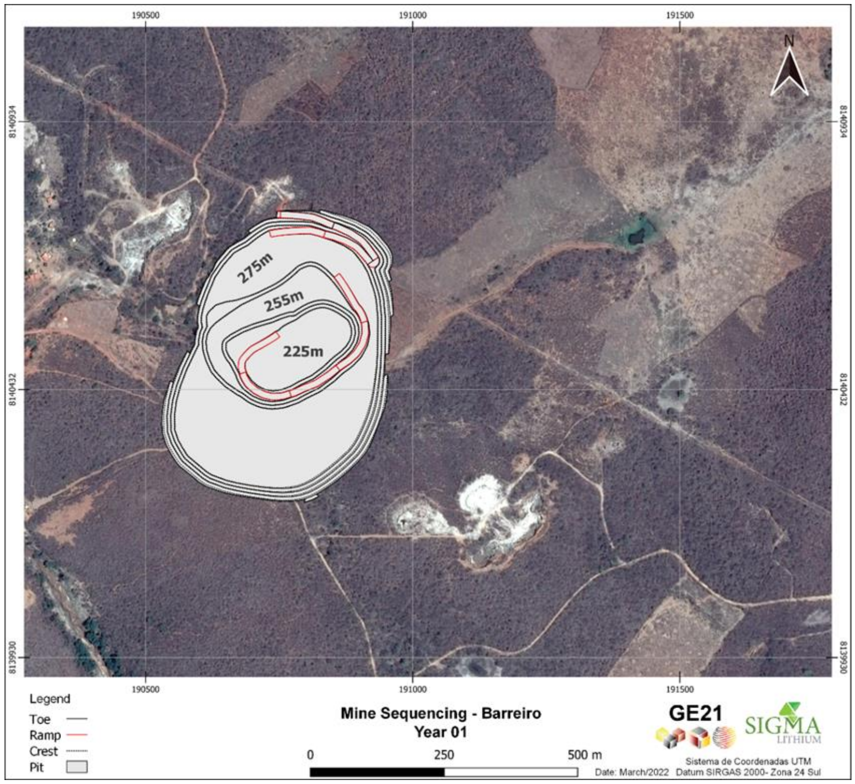


Figure 16-41: Barreiro Pit Year 1

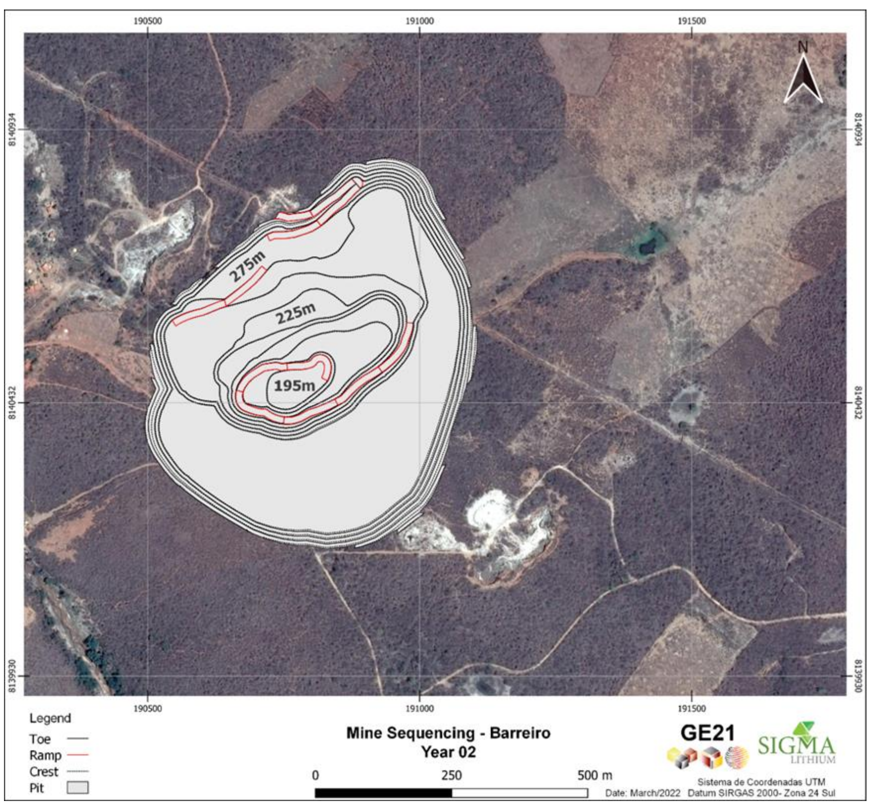


Figure 16-42: Barreiro Pit Year 2

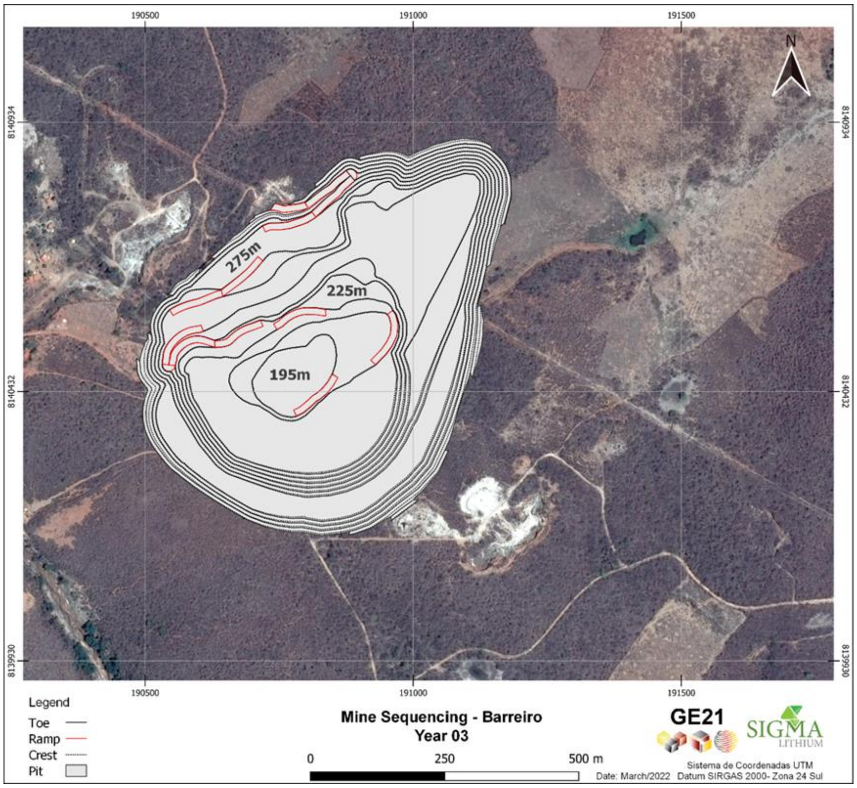


Figure 16-43: Barreiro Pit Year 3

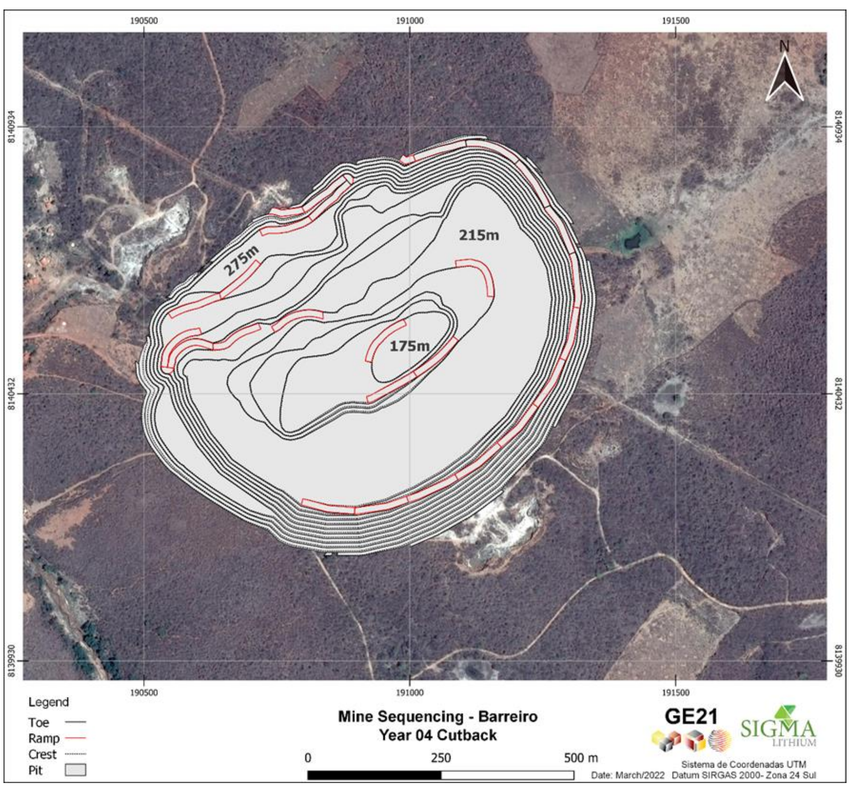


Figure 16-44: Barreiro Pit Year 4

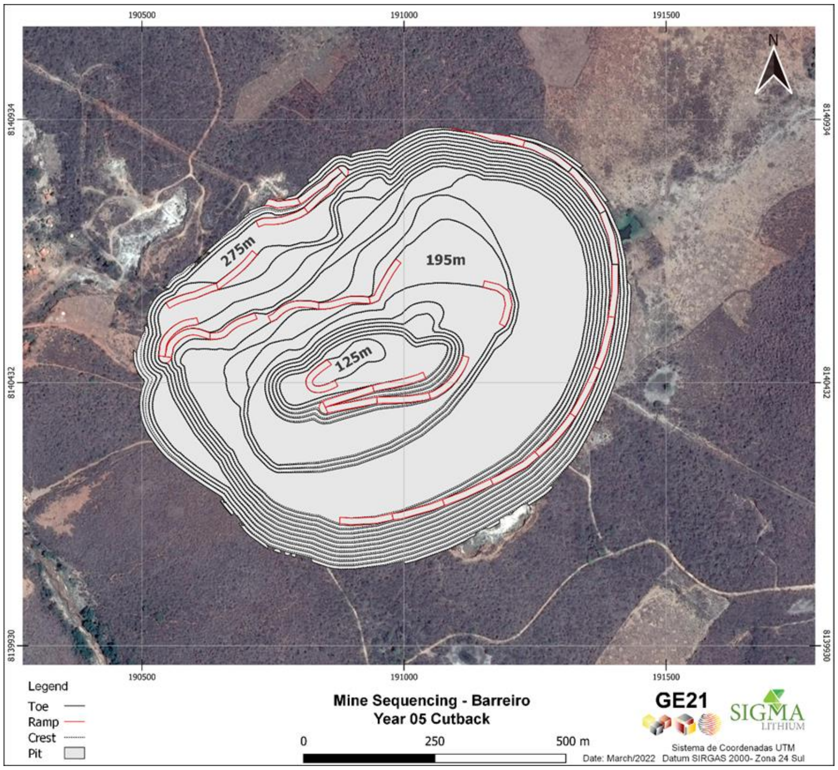


Figure 16-45: Barreiro Pit Year 5

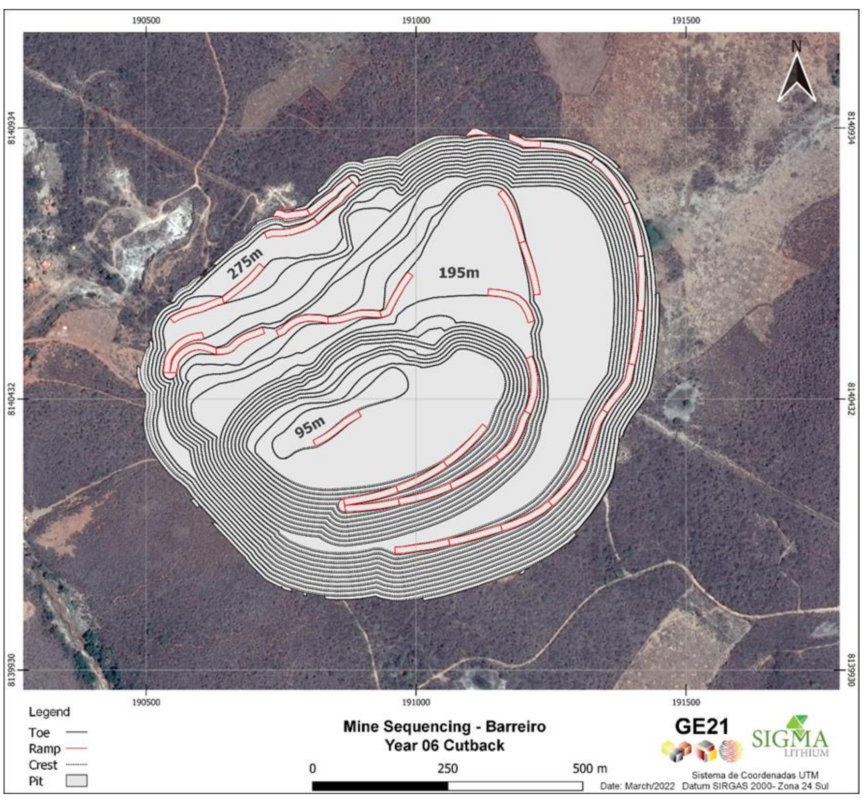


Figure 16-46: Barreiro Pit Year 6

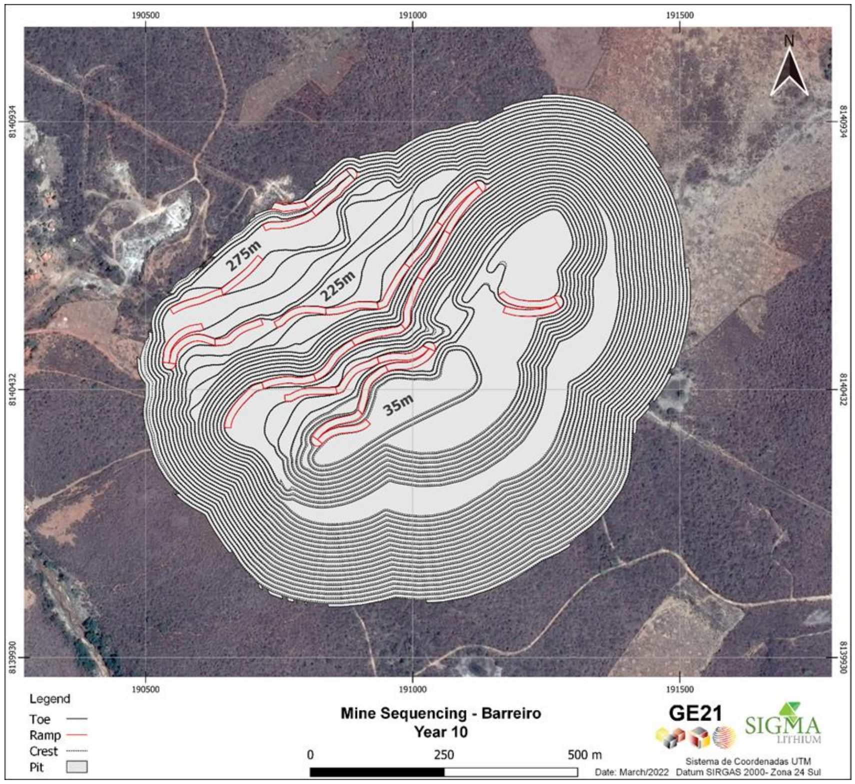


Figure 16-47: Barreiro Pit Year 10

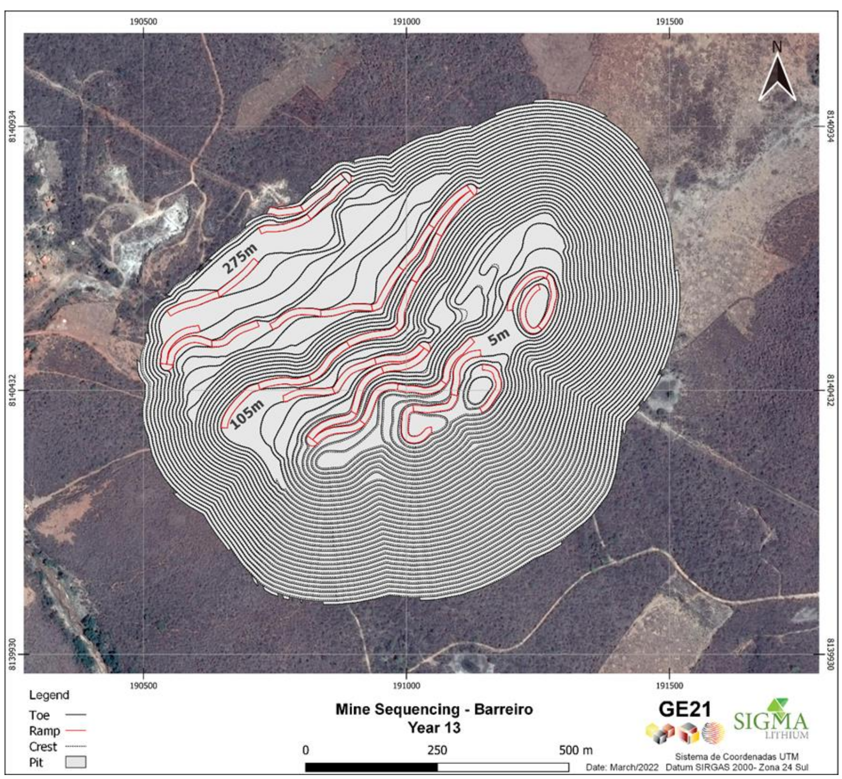


Figure 16-48: Barreiro Pit Year 12

16.6 BARREIRO MINE FLEET

At the Barreiro deposit, the mining operations will be carried out by a third-party contractor, with proven experience with similar sized operations in Brazil. In order to select the mining operations contractor, operational work technical specifications were compiled and forwarded to the companies for technical and commercial proposals. After selecting the company and signing a contract, the work of mobilization and construction of the construction site will begin immediately.

The run of mine (ROM) ore will be drilled, blasted, loaded and transported by trucks to the ROM pad. The ore will be loaded by a wheel loader and fed into the primary crusher. The oversize material, >1000 mm, will be fragmented by a rockbreaker installed in the crusher protection grate. A minimum ore stockpile of around 30,000 t will be kept in the ROM yard, with the aim of stabilizing the supply of feed to the plant when the mine production rate decreases or stops. This also helps to maintain the mine's ore production rate should the primary crusher have unscheduled production stops.

Ore below the cut-off grade will be blasted, loaded, and transported to specifically delimited discharge points within the waste disposal pile.

The main mining activities will be:

- Digging or rock blasting of ore and waste
- Excavation, loading and transport of ore and waste
- Disposal of ore in the ROM yard and waste in the waste dump
- Construction and maintenance of all internal accesses to the pit(s) and the waste dumps
- Maintenance of the floor, drainage, coating and signaling of all access roads used in the operation
- Implementation and maintenance of the mine's surface drainage systems at access points to the mining operation, waste deposit, ore yard and other areas linked to mining operations
- Execution of mine infrastructure services, such as: construction and maintenance of accesses to the mining areas, crusher, waste dump, workshops and offices, mine drainage services, access signaling, mine dewatering, etc.
- Feeding the primary crusher at an average rate of 320 t/hr, per wheel loader
- Build and maintain the operation support facilities (offices, workshops, cafeteria, living quarters, warehouses, changing rooms, bathrooms, septic tanks, environmental, health and safety emergency (HSE), explosive magazine, electrical and hydraulic installations and others, in strict accordance with the Brazilian environmental standards and labour laws.

16.6.1 Equipment

For the execution of mining activities, the equipment used must be in full working order, always observing the technical standards necessary for the services to be carried out safely. The equipment must comply with the respective Maintenance and Inspection Plans, as well as carrying out scheduled shutdowns for preventive and predictive maintenance. The proposed equipment to be used in the Mine will have high operational reliability and provide comfort and safety to operators.

Table 16-29 shows the main list of equipment to be used at Barreiro, while Table 16-30 shows the designed production of ore and waste and the percentage of material to be blasted.

Table 16-29: Barreiro Schedule of Primary Mining Equipment

Mining Fleet	Year											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Hydraulic Excavator	7	7	7	7	6	7	8	8	8	8	3	3
Haul Truck	40	40	43	45	43	52	58	58	58	58	26	25
Drilling Machine	9	9	9	9	8	9	10	10	10	10	4	4
Wheel Loader	1	1	1	1	1	1	1	1	1	1	1	1
Bulldozer CAT D8 T - Caterpillar	4	4	4	4	3	4	4	4	4	4	2	2
Bulldozer CAT D6 T - Caterpillar	4	4	4	4	3	4	4	4	4	4	2	2
Grader - Komatsu	2	2	2	2	2	2	3	3	3	3	1	1
Operation Support Truck - Scania	2	2	2	2	2	2	3	3	3	3	1	1
Water Truck (20.000 l) - Mercedes	4	4	4	4	3	4	4	4	4	4	2	2
Backhoe Excavator - JVC	2	2	2	2	2	2	2	2	2	2	2	2
Hydraulic Hammer - Komatsu	2	2	2	2	2	2	3	3	3	3	1	1
Forklift - Hyster	2	2	2	2	2	2	3	3	3	3	1	1
Blasting Support Truck - Scania	2	2	2	2	2	2	3	3	3	3	1	1
Fuel and Lube Truck - Mercedes	2	2	2	2	2	2	3	3	3	3	1	1
Maintenance Support Truck - Crane Mercedes	2	2	2	2	2	2	3	3	3	3	1	1
Crane (30 t of capacity) - SANYI	1	1	1	1	1	1	1	1	1	1	1	1
Portable Lightning Tower - Pramac	7	7	7	7	6	7	8	8	8	8	3	3
Light Vehicle - Mitsubish	7	7	7	7	6	7	8	8	8	8	3	3
Total	**100**	**100**	**103**	**105**	**96**	**112**	**129**	**129**	**129**	**129**	**56**	**55**

Table 16-30: Ore and Waste Production and percentage of material to be blasted Barreiro Pit

Production / Year	1	2	3	4	5	6	7	8	9	10	11	12	Total
Total ROM x 1.000 t - Wet Basis	**1 909**	**1 931**	**1 941**	**1 908**	**1 904**	**1 901**	**1 925**	**1 925**	**1 925**	**1 925**	**1 895**	**1 819**	**22 908**
ROM to Stock	1 909	1 931	1 941	1 908	1 904	1 901	1 925	1 925	1 925	1 925	1 895	1 819	**22 908**
ROM - Stock to Plant	1 909	1 931	1 941	1 908	1 904	1 901	1 925	1 925	1 925	1 925	1 895	1 819	**22 908**
Total Waste x 1.000 t - Wet Basis	**18 953**	**18 973**	**19 564**	**43 913**	**39 458**	**41 744**	**22 282**	**22 282**	**22 282**	**22 282**	**6 958**	**6 958**	**285 649**
Waste	18 953	18 973	19 564	18 851	17 332	18 791	22 282	22 282	22 282	22 282	6 958	6 958	**215 509**
Waste - Pushback				25 061	22 126	22 953							**70 140**
Hard Ore o be blasted x 1.000 t	1 909	1 931	1 941	1 908	1 904	1 901	1 925	1 925	1 925	1 925	1 895	1 819	**22 908**
Hard Waste to be blasted x 1.000 t	14 290	14 973	16 473	37 361	33 918	35 516	19 154	19 742	19 742	19 742	6 165	6 165	**243 241**
Total to be blasted	16 200	16 904	18 414	39 269	35 822	37 417	21 079	21 667	21 667	21 667	8 060	7 984	**266 149**
% Hard ROM	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	**100%**
% Hard Waste	75%	79%	84%	85%	86%	85%	86%	89%	89%	89%	89%	89%	**85%**
Stripping Ratio (t/t)	**9.93**	**9.83**	**10.08**	**9.88**	**9.10**	**9.89**	**11.57**	**11.57**	**11.57**	**11.57**	**3.67**	**3.83**	**9.41**
Stripping Ratio Pushback Waste (t/t)				**13.14**	**11.62**	**12.08**							**3.06**
Stripping Ratio General (t/t)	**9.93**	**9.83**	**10.08**	**23.02**	**20.72**	**21.96**	**11.57**	**11.57**	**11.57**	**11.57**	**3.67**	**3.83**	**12.47**
Total Earthmoving x 1,000 t	**20 862**	**20 904**	**21 505**	**45 820**	**41 362**	**43 645**	**24 207**	**24 207**	**24 207**	**24 207**	**8 853**	**8 777**	**308 557**

16.6.2 Operations

Mining will commence after the removal and storage of topsoil and waste overburden material. Small excavators will be used initially for drainage work, digging trenches, minor material removal and material disposal. An excavator with a bucket capacity of 4.4 m^3 has been selected for digging and loading. For transport, road trucks (8X4) with a capacity of 40 t are planned.

16.6.2.1 Loading, Transporting and Unloading

The ore and waste will be blasted, loaded by excavators, transported by trucks with a capacity of 40 t and unloaded on the ROM pad and waste dump respectively. If necessary, a hydraulic rockbreaker will be used to break rock larger than the opening of the crusher's fixed protection grid.

The process plant will be fed at an average rate of 320 t/hr, 24 hours per day, 7 days per week.

It is estimated that 100% of the ore, 85% of the waste must be blasted using explosives.

As an initial premise, a drilling diameter of 4.5 inches was adopted for ore with 5-metre-high benches and 4.5 inches for waste in 10-metre-high benches.

A careful analysis of the characteristics of the Barreiro Mine was performed to determine the most appropriate drilling equipment, as shown in Table 16-31.

Table 16-31: Drilling Equipment for Barreiro Pit

Brand	Model	Diameter		Type
		mm	inch	
Atlas Copco	F9/T45	102 to 140	4.5	Production

The drilling operation will be supported by a bulldozer and/or hydraulic excavator to carry out cleaning activities in the drilling areas, construction of access points to the drilling area, as well as the use of a hydraulic hammer coupled to the hydraulic excavator for rock handling in the operational area.

The rock blasting work comprises primary and secondary blasting and a hydraulic hammer will be used as required.

16.6.3 Explosives Supply

The provision of explosives and the execution of blasting services will be carried out by a subcontractor specializing in blasting, under the guidance of Sigma.

For the Barreiro Mine, where appropriate, pumped explosives, stemming and non-electrical accessories will be used.

During the mine operation, the daily blasting plans will be prepared by Sigma´s technical team and the results will be evaluated, and any necessary adjustments made to improve blasting effectiveness.

16.6.4 Explosives Magazine and Accessories

The explosive magazines will be supplied and built by the company contracted to perform the mining activities. This company will supply and maintain a remote security system, following the guidelines of ORDINANCE No. 147 - COLOG, of November 21, 2019, which provides the administrative procedures for the use and storage of explosives and accessories, as well as ORDINANCE No. 56 - COLOG, of June 5, 2017, which provides the administrative procedures related to registration with the army for the use and storage of army-controlled products (PCE).

Area security will be established through compliance with the minimum distances from the storage location to inhabited areas, railways, or highways, according to distances established in the regulation for the Inspection of Controlled Products (R-105). To this end, the plan for transporting, handling and storage of explosives and explosive accessories will be reviewed by Sigma management together with GE21 so that all conditions are fully complied.

The security of products controlled by the army (PCE) will be guaranteed through the adoption of measures against deviations, loss, theft, and theft against obtaining knowledge about activities with PCE, in order to avoid their use in the practice of illicit acts. These measures will be included in the Security Plan.

Access control will be carried out electronically, 24 hours a day, covering storage and access areas. For this, cameras connected to a remote base will be used and monitored online.

The facilities will undergo regular internal inspection to ensure the integrity of the active and passive protection systems. In the case of accidents of any nature, the Security Plan will determine the procedures related to the simultaneous activation of the competent public security bodies, including military and civil police, army and fire department.

Contingency measures will be adopted in the event of accidents or detection of illegal practices with explosives, including information to the inspection of army-controlled products (PCE). In these situations, quick and safe activation of the monitoring center and competent authorities listed in the Security Plan will be adopted.

For the storage of explosive and blasting accessories, a Rustic Mobile Storage container, installed in accordance with Technical-Administrative Instruction No. 18/99-DFPC, is planned as shown in Figure 16-49. This structure consists of a box truck or adapted container located in a fenced and monitored area, under the same security and monitoring conditions applied to the explosive magazine as shown in, Figure 16-50.

Figure 16-49: Explosives Magazines in Container

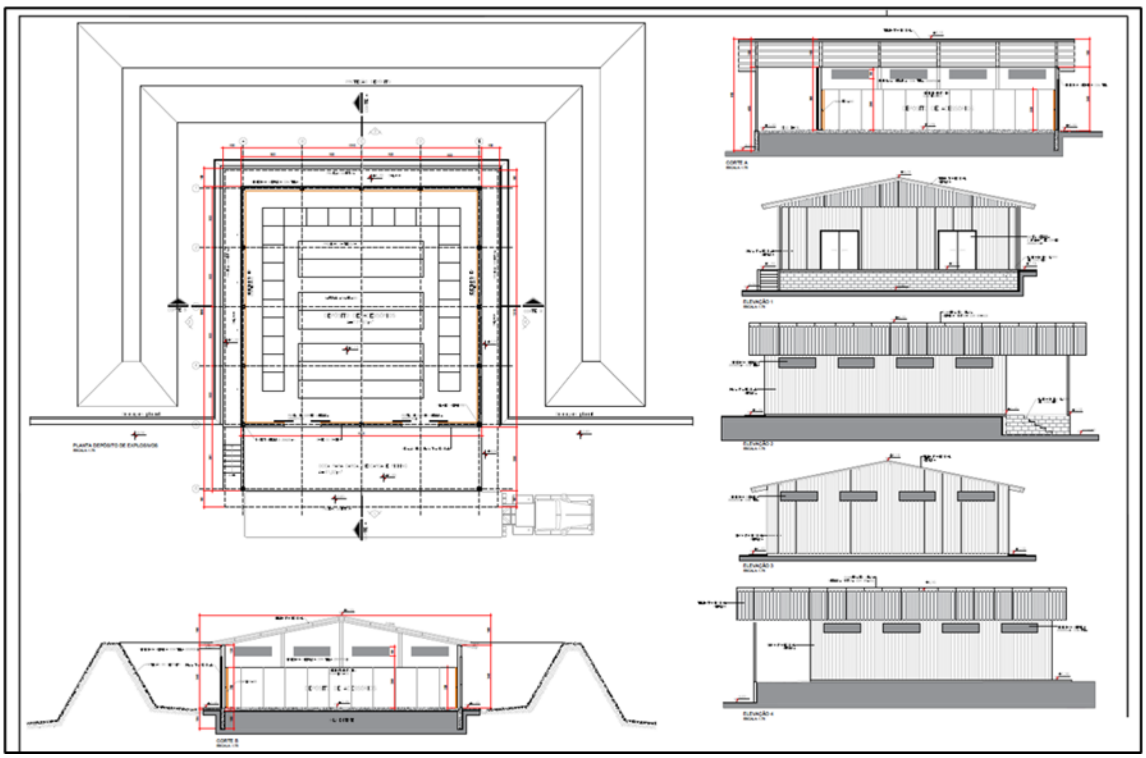


Figure 16-50: Example of Ammonium Nitrate Emulsion Storage Structure

16.6.5 Fleet Monitoring System

The fleet monitoring system (dispatch) to the Barreiro mine will be carried out through an electronic system that allows the monitoring and management of the mine's operation in real time. SMSA will work with solutions that allow for the monitoring, management, and optimization of the truck fleet. Using the most advanced hardware, the software monitors and manages each piece of equipment at all stages of the mining production cycle. The software uses algorithms that provide solutions to maximizing productivity and reduce operating costs.

A monitoring device is installed in each piece of equipment (excavator and truck) that is responsible for sending various information to control centre, including: location, status of equipment, etc. A communication network will be established between the monitoring equipment, antennas, and the control centre, this enables the monitoring of the entire mine fleet, operations and production with a high level of detail.

16.6.6 Work Shifts

The mine workforce teams will work in various shift schedules. The administrative group will work 9 hours a day from Monday to Friday, with 1 hour off for a meal, and 4 hours on Saturday mornings. The operational team will work 7 days a week, 24 hours a day, in a 6x2 shift scheme, where the employees work 6 days consecutively, for 9 hours per shift, and then have 2 days off. This method of shift work provides uninterrupted work and is in accordance with Brazilian labour legislation. The explosives supplier will work 5 days per week, taking Saturdays and Sundays off.

16.6.7 Labour Mining

SMSA is committed to prioritizing the hiring of local labour.

Table 16-32 lists the expected annual labour requirements for the 12 years of mine life; these expectations will be adjusted as required during the mining operation.

Table 16-32: Barreiro Staffing Schedule

Position	Shift	Nº Teams	Year											
Operation Team			**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
General Manager	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mine Operation Manager	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Maintenance Manager	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Environmental & Safety Manager	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Production Coordinator	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Infrastructure Coordinator	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Maintenance Coordinator	1	1	3	3	3	3	3	3	3	3	3	3	3	3
Mining Planning Coordinator	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Production Supervisor	3	4	4	4	4	4	4	4	4	4	4	4	4	4
Infrastructure Supervisor	3	4	4	4	4	4	4	4	4	4	4	4	4	4
Maintenance Supervisor	1	1	3	3	3	3	3	3	3	3	3	3	3	3
Dispatcher	3	4	4	4	4	4	4	4	4	4	4	4	4	4
Training & Development Technician	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Environment & Safety Coordinator	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Hydrology & Geotechnical Coordinator	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Junior Geotech Engineer	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Senior Mine Engineer	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Mine Planner	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Mine Field Engineer	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Drill & Blast Engineer	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Surveyor	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Assistant Surveyor	1	1	4	4	4	4	4	4	4	4	4	4	4	4
Senior Geologist	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Geologist	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Shift Coordinator Quality	3	4	4	4	4	4	4	4	4	4	4	4	4	4
Ore Sampler	3	4	8	8	8	8	8	8	8	8	8	8	8	8
Senior Maintenance Engineer	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Junior Maintenance Engineer	1	1	3	3	3	3	3	3	3	3	3	3	3	3
Maintenance Senior Technician	1	1	4	4	4	4	4	4	4	4	4	4	4	4
Field Inspector	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Part Coordinator	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Contract Coordinator	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Sub Total			**74**	**74**	**74**	**74**	**74**	**74**	**74**	**74**	**74**	**74**	**74**	**74**

Operators Team														
Hydraulic Excavator	3	4	28	28	28	28	24	28	32	32	32	32	12	12
Haul Truck	3	4	131	131	141	148	141	171	190	190	190	190	85	82
Drilling Machine	3	4	36	36	36	36	32	36	40	40	40	40	16	16
Wheel Loader	3	4	4	4	4	4	4	4	4	4	4	4	4	4
Bulldozer CAT D8 T - Caterpillar	3	4	16	16	16	16	12	16	16	16	16	16	8	8
Bulldozer CAT D6 T - Caterpillar	3	4	16	16	16	16	12	16	16	16	16	16	8	8
Grader - Komatsu	3	4	8	8	8	8	8	8	12	12	12	12	4	4
Operation Support Truck - Scania	2	2	4	4	4	4	4	4	6	6	6	6	2	2
Water Truck (20.000 l) - Mercedes	3	4	16	16	16	16	12	16	16	16	16	16	8	8
Backhoe Excavator - JVC	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Hydraulic Hammer - Komatsu	1	1	2	2	2	2	2	2	3	3	3	3	1	1
Fork Lift - Hyster	1	1	2	2	2	2	2	2	3	3	3	3	1	1
Blasting Support Truck - Scania	1	1	2	2	2	2	2	2	3	3	3	3	1	1
Fuel and Lube Truck - Mercedes	2	2	4	4	4	4	4	4	6	6	6	6	2	2
Maintenance Support Truck Crane Mercedes	2	2	4	4	4	4	4	4	6	6	6	6	2	2
Crane (30 t of capacity) - SANYI	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Detonation operator	1	2	12	12	12	12	12	12	12	12	12	12	12	12
Team in Holidays	1	1	26	26	27	28	25	30	33	33	33	33	15	15
Sub Total Operation			**314**	**314**	**325**	**332**	**303**	**357**	**402**	**402**	**402**	**402**	**185**	**181**
Maintenance team														
Mechanical Technician	3	4	29	29	30	30	28	33	38	38	38	38	17	16
Electrical Technician	3	4	6	6	6	6	6	7	8	8	8	8	3	3
Welding Technician	2	2	6	6	6	6	6	7	8	8	8	8	3	3
Fueling / Lube	3	4	14	14	14	15	13	16	18	18	18	18	8	8
Tyre Repair	2	2	4	4	4	5	4	5	6	6	6	6	3	2
Maintenance Assistant	1	1	4	4	4	5	4	5	6	6	6	6	3	2
Management and Maintenance Control	1	1	4	4	4	5	4	5	6	6	6	6	3	2
Team in Holidays			6	6	6	6	6	7	8	8	8	8	4	3
Sub total Maintenance			**73**	**73**	**75**	**77**	**71**	**83**	**96**	**96**	**96**	**96**	**42**	**42**
Total General			**461**	**461**	**475**	**483**	**448**	**514**	**571**	**571**	**571**	**571**	**301**	**297**

16.6.8 Labour and Equipment

For the mobilization of technical and operational personnel, priority will be given to local people and those living near to Araçuaí & Itinga Municipalities, and the following criteria:

- Recruitment
- Selection
- Conducting admission exams
- SMSA integration
- Introductory equipment/vehicle training
- Initiation into assisted operation
- Final aptitude test

16.6.9 Site Construction

The site construction shall consist of:

- Mine Office
- Meeting room
- Control room
- Auditorium
- Cafeteria
- Changing rooms
- First aid post
- Warehouse
- Workshop
- Washing ramp
- Oil and grease storage area
- Fuel storage area
- Recreation area
- Explosive magazine

The total area of infrastructure will be approximately 1,390 m², and the total area that the buildings will occupy is approximately 1.5 hectares.

All built-up areas will have waterproof flooring, so that there is no risk of soil contamination from the operations, especially in the workshop and washing ramp. The runoff from the roofs will be drained into the gutters to supply the cistern, which will be used at the washing ramp. After using the water in the washing ramp, the water will be sent to the effluent treatment station, which starts in the decanter, followed by the oil and grease separator box with capacity of 20 m³/day.

The water and oil separator system must operate at a flow rate of 20 m³/day, which complies with the ABNT NBR 14605 standard and the ASTM D 6104/03 international standard. The analysis standards to verify the efficiency and quality of the water must follow the CONAMA Resolution No. 357/2005 for the parameters of oils and greases. After treatment the water will be pumped back to the process water tank.

16.6.10 Wastewater Treatment

Step 1: The effluent from the drains (channels) from the workshop, washing ramp and oil deposit, oil and grease separator stage, will be drained to the decanter where it will undergo the first sedimentation process. The process consists of separating solid particles from water by the action of gravity. The flow velocity of the liquid is reduced, favoring the sedimentation of these particles. The water enters the next step, which further separates the suspended solids. The solids from the first process are deposited at the bottom of the decanter, where they will be periodically removed.

Step 2: In the module for separation of solids (MSS) the solids coming from the water used to wash the equipment are separated by the process of gravity and sedimentation of the particles. This process removes the remaining particulate matter suspended in the fluid, allowing oil and water to flow to the next stage, avoiding the silting of the remaining procedure. Solids will be removed and stored in an appropriate place.

Step 3: The water and oil separator box (WOSB) receive all the effluent from the MSS process. This system has, among others, two basic constituents: water and oil. The process of separating water and oil occurs by density difference. The clean water will be released into the rainwater drainage network. Periodically (biannually) samples will be collected at the final outlet, the third box of the water and oil separation system, so that the efficiency of the system and the quality of the effluent is known.

Step 4: The supernatant oil goes to the oil collection reservoir (OCR) to be removed and sent for recycling. Used oils will be sent to a certified and approved company, with the relevant documentation and authorization, in accordance with the applicable legal requirements. Likewise, tailings will be monitored, in relation to quantity and classification, and recorded in the waste inventory worksheet of the Sigma integrated management system.

Step 5: Contaminated oil and grease residues (Class I) must be packed in properly identified drums and sent to an appropriate collection company. This waste output will be registered by Sigma by filling out the waste transport manifest (MTR), according to the waste management procedure.

Figure 16-51 shows a schematic of the model to be built for the water treatment of effluent from the washing ramp and the modules of the water and oil separator box.

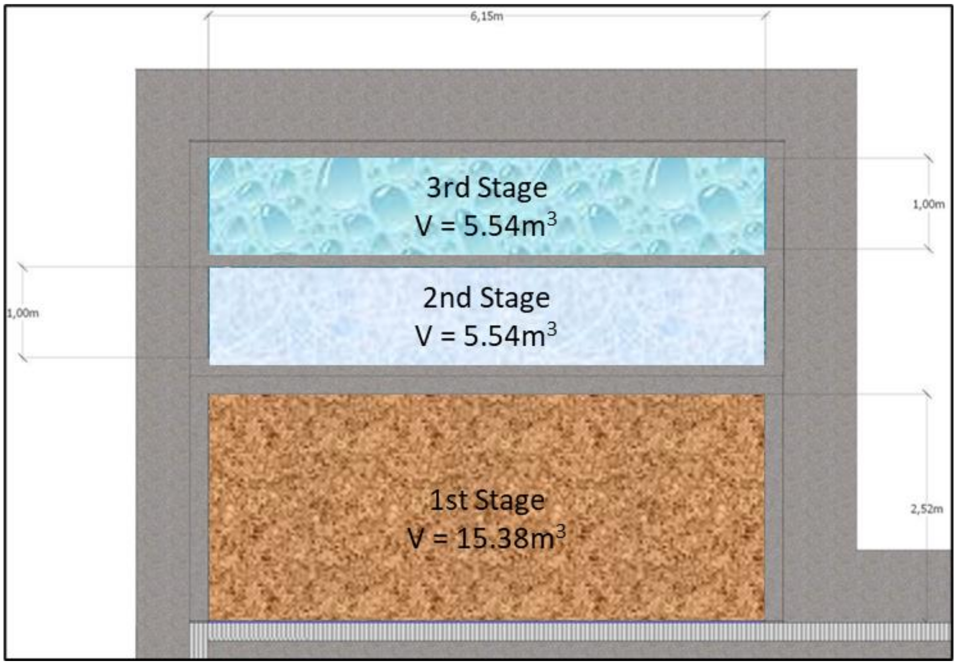


Figure 16-51: Schematic of Wash Ramp Oil-Water Separator

16.6.11 Solid Waste Management

To meet the demand for internal solid waste generation, Sigma will have a waste deposit located next to the oil storage structure, physically separated in accordance with safety standards, such as physical divisions, roof, waterproofed floor, channels, and drains. Next to this will be located waste disposal bays for items such as plastic, paper/cardboard, metals, glass, and contaminated waste (towels, filters, PPE, etc.). Tires must be stored inside the warehouse until they are sent to their final destination off site. Organic waste must be delivered to locations properly prepared to receive this type of material. Figure 16-52 shows the solid waste temporary storage layout.

According to ABNT NBR 10.004 - Waste Classification, waste must be collected, segregated/packaged, and sent to the final destination, to companies licensed by the appropriate environmental agency. Periodically, Sigma will be monitoring their waste generation, and checking the internal waste inventory worksheet, a tool that it uses within the integrated management system.

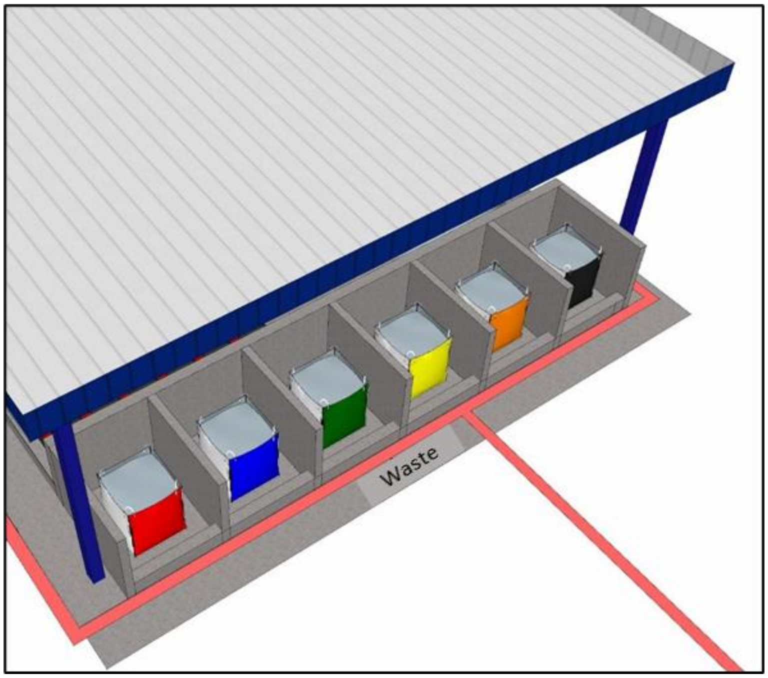


Figure 16-52: Schematic of Solid Waste Temporary Storage Facility

16.6.12 Site Access

The construction of site access necessary to start ore mining operations, waste removal, access to the waste dump and marginal ore, auxiliary accesses and others that may be required will be carried out according to the specific project's requirements.

If necessary, land clearing, including the removal of trees, undergrowth and debris will be performed using a D6T crawler tractor with ripper. The material removed will be loaded with a 35 t excavator and transported with trucks with a capacity of 20 m³.

The leveling of accesses, considering slope and slope for land drainage will be carried out through cutting and filling using a D6T crawler tractor, 35 t and 55 t excavator, 20 m³ trucks, grader and water trucks. Low strength soils will be replaced. Surface drainage and construction of berms will be carried out with a 20 t excavator.

16.6.13 Road Construction and Maintenance

The construction and maintenance of site roads will require the following:

- Initial construction of the roads
- Water and storm drainage
- Construction of safety berms
- Reflective signage
- Dust suppression

16.6.14 Excavation, Loading, Transport and Soil Treatment

The excavation stage will start after the removal and storage of the topsoil.

As the excavation progresses, drainage systems will be installed to avoid the accumulation of rainfall.

It is planned to mobilize a backhoe excavator for drainage services, trench excavation, material disposal and small handling. 70 t excavators will be used according to the volume requirements for large and medium volumes. For transport, 8x4 trucks, with a capacity of 40 t, will be used, allowing for productivity and safety.

16.6.15 Drilling and Blasting

The geology and rock types at the Barreiro deposit are crucial for defining drilling and blasting parameters, which relates to mining recovery.

It is important to know the limits of the ore body to minimize dilution and losses. SMSA will have a geologist as part of its technical staff who will work directly with the drilling, blasting, and loading teams. Employees who are directly involved in activities related to optimizing the mining recovery, such as drill operators, drilling assistants, rock blasting team, and excavator operators, will be trained to recognize minerals to avoid deviation from planned mineral boundaries.

As this is a greenfield project, it is foreseeable that SMSA's technical teams will go through a learning period based on the empirical results acquired with operation commencement. Naturally, changes to rock blast parameters and operating methods will be required. Consideration should be given not only to the complexity of the geological formation and the operational challenges resulting from this condition, but also to the context of the environment in which the mine will be located.

Previous studies (pre-blast survey) before the first blasting should be developed to establish the minimum distances between pre-existing structures that will be kept and the blasted benches. As a result, restrictions or opportunities relating to the maximum load per drill hole may be revealed, which may indicate the maximum blasthole diameter, as well as the type of accessories used. These factors, among others, may imply technical and commercial adjustments throughout the life of the mine operation. Table 16-33 and Table 16-34 detail the drilling and blasting for ore and waste respectively.

Table 16-33: Barreiro Preliminary Drill and Blast Plan - Ore

Drilling and Blasting Rock Parameters		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
Ore	m³ in situ	664 713	672 269	675 768	664 215	662 877	661 666	670 242	670 242	670 242	670 242	659 649	633 277
Ore	kt	1 909	1 931	1 941	1 908	1 904	1 901	1 925	1 925	1 925	1 925	1 895	1 819
Average Density	t/m³	2.87	2.87	2.87	2.87	2.87	2.87	2.87	2.87	2.87	2.87	2.87	2.87
Hole Diameter	inch	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Burden	m	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Spacing	m	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Blast Pattern	m²	9.10	9.10	9.10	9.10	9.10	9.10	9.10	9.10	9.10	9.10	9.10	9.10
Spacing/Burden	-	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35
Subdrilling	m	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Bench height	m	5	5	5	5	5	5	5	5	5	5	5	5
Total Hole Length	m	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40
Volume per Hole	m³	49.14	49.14	49.14	49.14	49.14	49.14	49.14	49.14	49.14	49.14	49.14	49.14
Mass per Hole	t	141.15	141.15	141.15	141.15	141.15	141.15	141.15	141.15	141.15	141.15	141.15	141.15
m³ Blasted/m Drilled	m³/m	9.10	9.10	9.10	9.10	9.10	9.10	9.10	9.10	9.10	9.10	9.10	9.10
Specific Drilling	m/m³	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Specific Drilling	m/t	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038
Drilled Metres	m	73 045	73 876	74 260	72 991	72 844	72 711	73 653	73 653	73 653	73 653	72 489	69 591
Necessary Holes	hole	13 527	13 681	13 752	13 517	13 490	13 465	13 639	13 639	13 639	13 639	13 424	12 887
Explosive Density	g/cm³	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21
Linear Load Ratio	kg/m	10.79	10,79	10.79	10,79	10.79	10,79	10.79	10,79	10.79	10,79	10.79	10,79
Top Stemming	m	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Explosive Column	m	4.70	4.70	4.70	4.70	4.70	4.70	4.70	4.70	4.70	4.70	4.70	4.70
Load per Hole	kg	58.28	58.28	58.28	58.28	58.28	58.28	58.28	58.28	58.28	58.28	58.28	58.28
Load Ratio	kg/m³	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19
Load Ratio	kg/t	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41

Table 16-34: Barreiro Preliminary Drill and Blast Plan – Waste

Drilling and Blasting Rock Parameters		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
Waste	m³ in situ	6 105 838	6 397 699	7 038 521	15 963 267	14 492 163	15 175 085	8 183 867	8 435 209	8 435 209	8 435 209	2 634 076	2 634 076
Waste	kt	14 290	14 973	16 473	37 361	33 918	35 516	19 154	19 742	19 742	19 742	6 165	6 165
Average Density	t/m³	2.34	2.34	2.34	2.34	2.34	2.34	2.34	2.34	2.34	2.34	2.34	2.34
Hole Diameter	inch	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Burden	m	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
Spacing	m	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Blast Pattern	m²	12.80	12.80	12.80	12.80	12.80	12.80	12.80	12.80	12.80	12.80	12.80	12.80
Spacing/Burden	-	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Subdrilling	m	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Bench height	m	10	10	10	10	10	10	10	10	10	10	10	10
Hole Length	m	10.80	10.80	10.80	10.80	10.80	10.80	10.80	10.80	10.80	10.80	10.80	10.80
Volume per Hole	m³	138.24	138.24	138.24	138.24	138.24	138.24	138.24	138.24	138.24	138.24	138.24	138.24
Mass per Hole	t	323.54	323.54	323.54	323.54	323.54	323.54	323.54	323.54	323.54	323.54	323.54	323.54
m³ Blasted/m Drilled	m³/m	12.80	12.80	12.80	12.80	12.80	12.80	12.80	12.80	12.80	12.80	12.80	12.80
Specific Drilling	m/m³	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Specific Drilling	m/t	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033
Drilled Metres	m	477 019	499 820	549 884	1 247 130	1 132 200	1 185 554	639 365	659 001	659 001	659 001	205 787	205 787
Necessary Holes	hole	44 168	46 280	50 915	115 475	104 833	109 773	59 200	61 019	61 019	61 019	19 054	19 054
Explosive Density	g/cm³	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21
Linear Load Ratio	kg/m	10.79	10,79	10.79	10,79	10.79	10,79	10.79	10,79	10.79	10,79	10.79	10,79
Top Stemming	m	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
Explosive Column	m	9.40	9.40	9.40	9.40	9.40	9.40	9.40	9.40	9.40	9.40	9.40	9.40
Load per Hole	kg	116.55	116.55	116.55	116.55	116.55	116.55	116.55	116.55	116.55	116.55	116.55	116.55
Load Ratio	kg/m³	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Load Ratio	kg/t	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36

Based upon the rock characteristics and operating parameters, the top hammer drilling method has been chosen as the optimal method. Due to experience with and availability of the equipment, tools, original replacement parts, and technical services, the authors recommend the Atlas Copco equipment listed in Table 16-35.

Table 16-35: Barreiro Recommended Drill Rig

Brand	Model	Diameter		Type
		mm	inch	
Atlas Copco	F9/T45	102 to 140	4.5 to 5.5	Production

Using the parameters established for blasting, it was possible to calculate the number of drills needed to meet the planned production schedule for the Barreiro mine as shown in Table 16-36.

If it is necessary to implement different grids than was originally planned or to add slope preservation methods, such as damping lines, pre-cut or post-cut, the amount of drilling will tend to increase. Should an increase in the amount of drilling be required, the fleet and staff will be adequate to meet this demand.

The proposed top hammer drills have an operating cabin with ROPS/FOPS certification, air conditioning, acoustic insulation system, dust collector, hole cleaning air monitoring system, rod greasing system, angle and depth gauge, and water injection for dust control.

The drilling operation will be supported by a bulldozer and/or hydraulic excavator to carry out the cleaning and preparation of the drilling benches, access construction to the drilling benches, as well as a hydraulic rock breaker coupled to the hydraulic excavator to remove blocks in the operational area.

Table 16-36: Barreiro Preliminary Calculations for Drilling Requirements

Drilling Sizing		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**
Blasted Material	kt	20 862	20 904	21 505	20 759	19 236	20 692	24 207	24 207	24 207	24 207	8 853	8 777
Days / Year	quantity	365	365	366	365	365	365	365	365	365	365	365	365
Shifts / Day	quantity	3	3	3	3	3	3	3	3	3	3	3	3
Hours / Shift	quantity	8	8	8	8	8	8	8	8	8	8	8	8
FA - Physical Availability	%	82%	82%	82%	82%	82%	82%	82%	82%	82%	82%	82%	82%
Hours Available	hours	7 183	7 183	7 183	7 183	7 183	7 183	7 183	7 183	7 183	7 183	7 183	7 183
Unproductive Hours	hours	4 791	4 791	4 791	4 791	4 791	4 791	4 791	4 791	4 791	4 791	4 791	4 791
Utilization	%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Efficiency Factor	%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Drillholes per hour - Ore	Drill/hr	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
Drillholes per hour - Waste	Drill//hr	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Meters drilled per hour	m/hr	20	20	20	20	20	20	20	20	20	20	20	20
Drilling Productivity - Ore	Mtpy	2.07	2.07	2.07	2.07	2.07	2.07	2.07	2.07	2.07	2.07	2.07	2.07
Drilling Productivity - Waste	Mtpy	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38
Effective Hours Worked	hours	3 969	3 969	3 969	3 969	3 969	3 969	3 969	3 969	3 969	3 969	3 969	3 969
Tonnage per drillhole - Ore	t/Drill	141	141	141	141	141	141	141	141	141	141	141	141
Tonnage per drillhole - Waste	t/Drill	324	324	324	324	324	324	324	324	324	324	324	324
Equipment Numbers Required	quantity	**9**	**9**	**9**	**9**	**8**	**9**	**10**	**10**	**10**	**10**	**4**	**4**

16.6.16 Explosives Consumption

The consumption of explosives and accessories was calculated based on the parameters of the blasting plans presented above in Table 16-33 and Table 16-34. The tables below, Table 16-37 and Table 16-38 show the estimated annual consumption of pumped explosives, non-electrical accessories, and remote activation through electronic fuse for ore, waste and the combined totals respectively. In addition, small allowances for explosives and accessories were included, for secondary blasting of oversize rock.

Table 16-37: Barreiro Estimated Annual Consumption of Explosives - Ore

Rock Blasting / Pumped Emulsion Blaster + Non-Electric / Bulk Emulsion + Non-Electric														
Ore														
Item / Quantities	**Unit**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**	**Total**
60% Emulsion/40% ANFO - 1.21 g/cm3	Kg x 1,000	788	797	801	788	786	785	795	795	795	795	782	751	9 458
Booster 250 g	unit	12 174	12 313	12 377	12 165	12 141	12 118	12 275	12 275	12 275	12 275	12 081	11 598	146 070
Detonating cord	m	47 344	47 882	48 132	47 309	47 213	47 127	47 738	47 738	47 738	47 738	46 984	45 105	568 049
Non-Electric	unit	332	336	338	332	331	331	335	335	335	335	330	317	3 988
Burning fuse	unit	260	260	260	260	260	260	260	260	260	260	260	260	3 120
Powder Factor	Kg/t	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41

Table 16-38: Barreiro Estimated Annual Consumption of Explosives - Waste

Rock Blasting / Pumped Emulsion Blaster + Non-Electric / Bulk Emulsion + Non-Electric														
Waste														
Item / Quantities	**Unit**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**	**Total**
60% Emulsion/40% ANFO - 1.21 g/cm3	Kg x 1,000	5 148	5 394	5 934	13 459	12 218	12 794	6 900	7 112	7 112	7 112	2 221	2 221	87 624
Booster 250 g	unit	39 752	41 652	45 824	103 928	94 350	98 796	53 280	54 917	54 917	54 917	17 149	17 149	676 629
Detonating cord	m	176 674	185 119	203 661	461 900	419 333	439 094	236 802	244 074	244	244 074	76 217	76 217	3 007 240
Non-Electric	unit	3 053	3 199	3 519	7 982	7 246	7 588	4 092	4 218	4 218	4 218	1 317	1 317	51 965
Burning fuse	unit	260	260	260	260	260	260	260	260	260	260	260	260	3 120
Powder Factor	Kg/t	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36

16.6.17 Blasting Plan

During the operation, the daily blast plans will be prepared by the explosive supplier’s technical staff. These plans will be analysed and validated by the Sigma rock blasting team.

After each blast, the blast plan will be updated according with the equipment quantities actually used. Physical and digital copies of all generated documentation will be kept, which will be available for audits or inspection by regulatory bodies.

16.6.18 Execution of Blasting

Rock blasts will be carried out on scheduled dates, the frequency of which will meet the demand for blasted ore and waste.

For all rock blasting, the authorities will also be previously communicated through the Rock Blasting Notice, as per Annex of ORDINANCE No. 147 - COLOG, of November 21, 2019.

16.6.19 Fragmentation Control

The fragmentation control will be carried out through specialized software, generating granulometric distribution curves from photographic records. This monitoring allows for blast pattern adjustments, sequencing and other parameters according to the results history. Monitoring will be carried out on a monthly basis for rock blasting and/or whenever the contractor's technical team deems is necessary to optimize the operation.

Figure 16-53 shows an example of image analysis and particle size distribution calculation using granulometric distribution curves.

The blasts will be filmed with high-definition cameras that allow a detailed visual assessment of factors such as detonation sequencing, mass displacement, top stemming efficiency and ultra-launch.

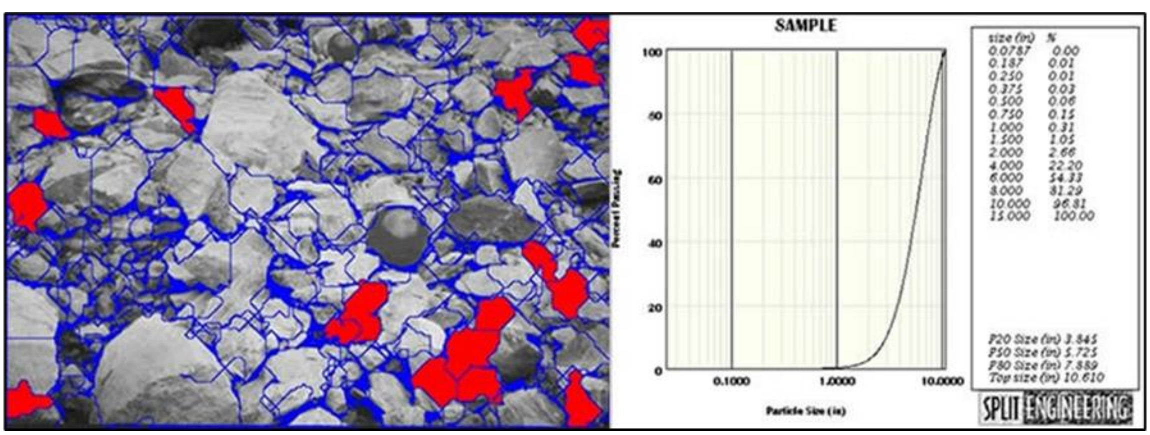


Figure 16-53: Image Analysis and Calculation of Granulometric Distribution

16.7 NEZINHO DO CHICÃO OPEN PIT MINING

The Nezinho do Chicão deposit will be mined by open pit mining methods, using a contracted mining fleet consisting of hydraulic excavators, front loaders, and 40 t transport trucks for waste and ore, coupled with appropriate auxiliary support equipment.

16.7.1 Geotechnical and Hydrogeological Analysis

16.7.1.1 Geotechnical

A geotechnical field study, analysis and design was performed to provide key pit design parameters for the Nezinho do Chicão pit.

Data analysis is supported by a comprehensive investigation and geotechnical assessment of the drill hole samples, and laboratory tests consisting of uniaxial compressive testing (UCS), triaxial testing, indirect tensile strength testing (Brazilian test), and direct shear strength testing. The stability analysis was done for the recommendation of slope angles for the pit walls within appropriate safety factors. The stability analyses considered information on the strength parameters of various rock and soil materials, in association with the understanding of the expected rupture mechanisms that could occur on the pit slopes.

Nezinho do Chicão pit walls material will be entirely within a biotite schist unit, consisting of a low to medium intensity of schistosity. Figure 16-54 is a stereogram of two main joint structures identified at Nezinho do Chicão using optical televiewing (OPTV).

The soil and overburden are up to 5 m deep, with a transition zone of saprolite with moderately altered rock up to 30 m in depth. The basement (fresh rock) is a compact biotite schist, showing little to no change in the original color of the minerals and moderate to high mechanical strength (weathering zone ranging from W2 on the top to W1).

The rock mass has good to excellent RQD (75 – 100%), low fracturing degree (F2), and RMR class II/I, corresponding from good to very good rock mass strength.

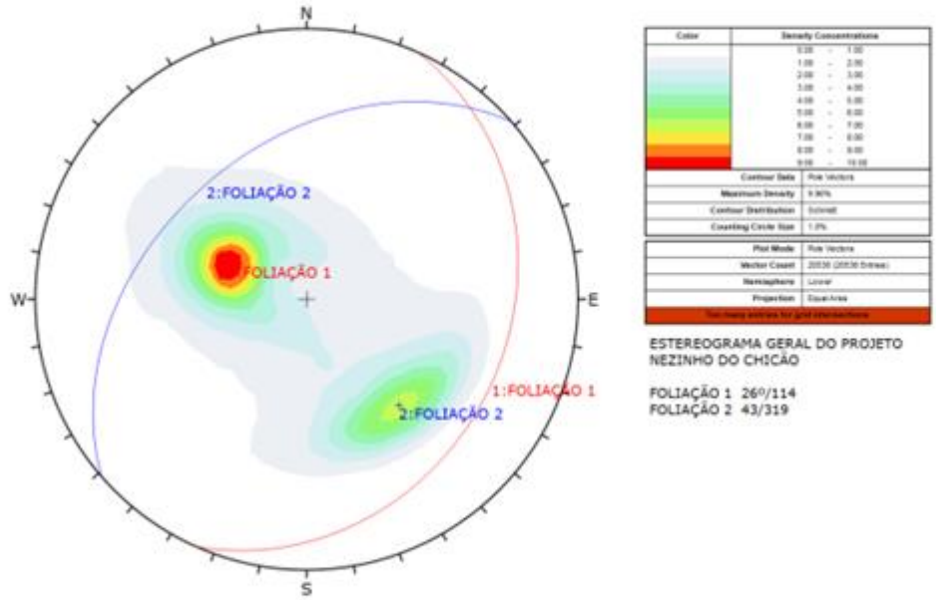


Figure 16-54: OPTV-derived stereogram showing two main joint structures at Nezinho do Chicão

16.7.1.2 Geomechanical Characterization

The Uniaxial Compression Tests (UCS) had the specification of the International Society for Rock Mechanics - ISRM (1978) as a technical reference. Suggested methods for determining the strength of rock materials in triaxial compression. Int. J. Rock Mech. Min. Sci. & Geomech. Abstracts., vol. 15, pp 49-51. The results can be found in Table 16-39 and Table 16-40.

Table 16-39: Results of laboratory tests in rock (UCS), 2022 campaign

Biotita Xistos							
Lithology	Code Sigma	Code Lab.	Height (mm)	Diameter (mm)	UCS (MPa)	Young Modulus (Gpa)	Poisson's Ratio
SCHBT	GT 0126	16620-I	131,6	62,7	93,7	14,2	0,26
	GT 0127	16621-I	130,8	62,95	66,7	19,2	0,24
	GT 0128	16622-I	130,8	62,9	57,9	11,7	0,25
	GT 0129	16623-I	131,5	63,2	123,9	18,6	0,32
	GT 0130	16624-I	130,6	63,1	68,7	14,2	0,39
	GT 0131	16625-I	133,6	63,3	52,6	13,5	0,27
	GT 0132	16626-I	130,1	63,2	56,4	17,3	0,17
	GT 0133	16627-I	130,9	63,4	56,5	18,2	0,27
	GT 0134	16628-I	130,8	63	32,6	10	0,31
	GT 0135	16629-I	130	62,8	32,9	10,2	0,32
	GT 0136	16630-I	130	63,1	30,8	12,1	0,24
	GT 0137	16631-I	132,6	63,3	42,4	11,4	0,32
				S.Dev.	25,93	3,20	0,05
				Mean	59,59	14,22	0,28
				C.V.	0,44	0,22	0,19

The coefficient of variation (CV) was much greater than 0.30, samples that presented values considered as anomalous (lower and higher values) were excluded (samples GT 0129, GT 0134, GT 0135, GT 0136), resulting in an acceptable CV of 0.23, as presented at Table 16-40.

Table 16-40: Results of tests after outlier treatment and adopted as test parameters UCS

Biotita Xistos								
Lithology	**Code Sigma**	**Code Lab.**	**ɣ kPa**	**Height (mm)**	**Diameter (mm)**	**UCS (MPa)**	**Young Modulus (Gpa)**	**Poisson's Ratio**
	GT 0126	16620-I	27	131,6	62,7	93,7	14,2	0,26
	GT 0127	16621-I	27,9	130,8	62,95	66,7	19,2	0,24
	GT 0128	16622-I	27,5	130,8	62,9	57,9	11,7	0,25
	GT 0129	16623-I	27	131,5	63,2			
	GT 0130	16624-I	27,9	130,6	63,1	68,7	14,2	0,39
SCHBT	GT 0131	16625-I	27,9	133,6	63,3	52,6	13,5	0,27
	GT 0132	16626-I	27,5	130,1	63,2	56,4	17,3	0,17
	GT 0133	16627-I	27,8	130,9	63,4	56,5	18,2	0,27
	GT 0134	16628-I	27,6	130,8	63			
	GT 0135	16629-I	27,2	130	62,8			
	GT 0136	16630-I	27,5	130	63,1			
	GT 0137	16631-I	27,6	132,6	63,3	42,4	11,4	0,32
		S.Dev.	0,31		**S.Dev.**	14,24	2,75	0,06
		Mean	27,53		**Mean**	61,86	14,96	0,27
		C.V.	0,01		**C.V.**	0,23	0,18	0,22

The results indicate a medium quality rock.

16.7.1.3 Pit Sectorization

Figure 16-55 shows the 8 sectors into which the pit was divided, and Table 16-41 shows the direction of the sectors.

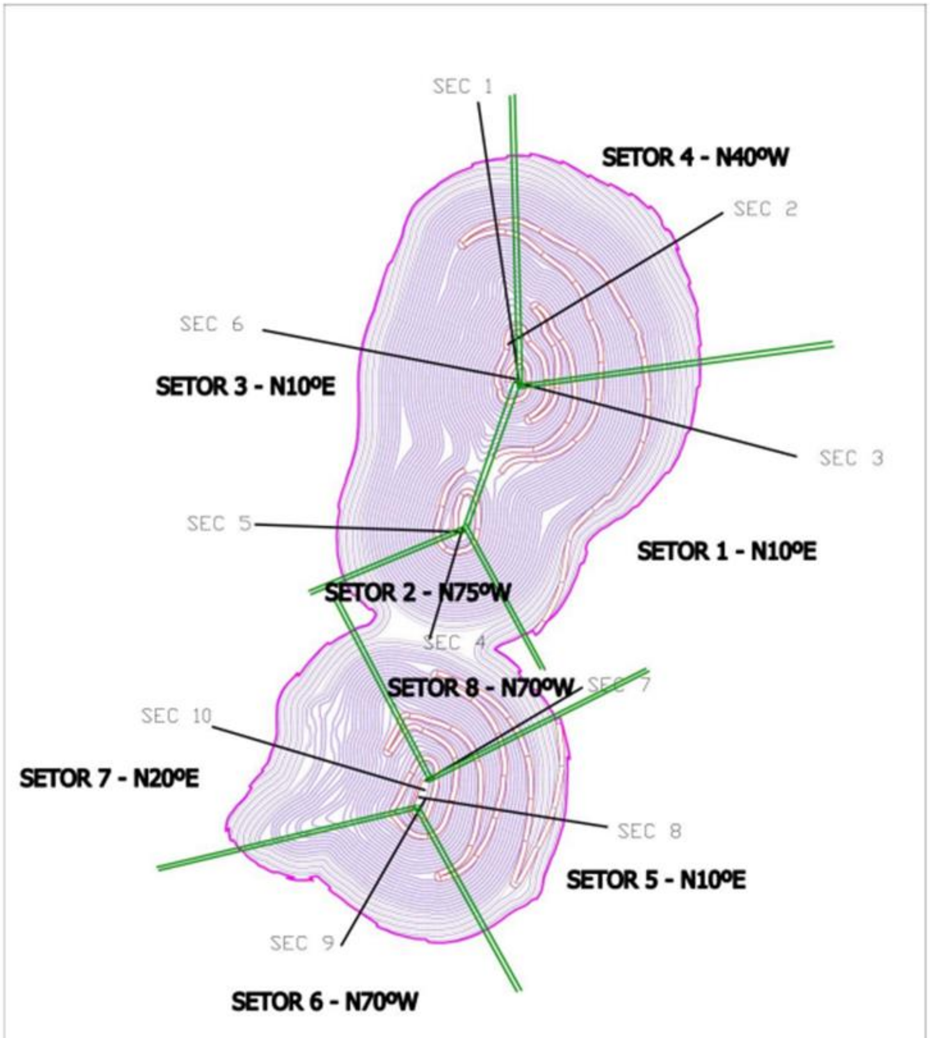


Figure 16-55: Nezinho do Chicão Pit Sectors (Green) and Stability Analysis Sections (Black)

Table 16-41: Average direction of slopes in sectors and general slope geometry

Sectors	Characteristic of the sector	Slope Direction - Dip Dip Direction (º) Overall Angle
1	Planar failure	N10E – 45/280
2	Failure blocked	N75W – 48/015
3	Toppling failure	N10E – 48/100
4	Failure blocked	N40W – 45/230
5	Planar failure	N10E – 45/280
6	Failure blocked	N70W – 48/020
7	Failure blocked	N20E – 46/110
8	Toppling failure	N70W – 45/200

16.7.1.4 Kinematic Analyses

Kinematic analyzes were performed for all sectors, even for those in which eventual failures are blocked by the geometry of the structures and the pit. Analyses were made for planar failure and failure due to toppling by face angle. Figure 16-56 to Figure 16-71 show the result of the kinematic analysis.

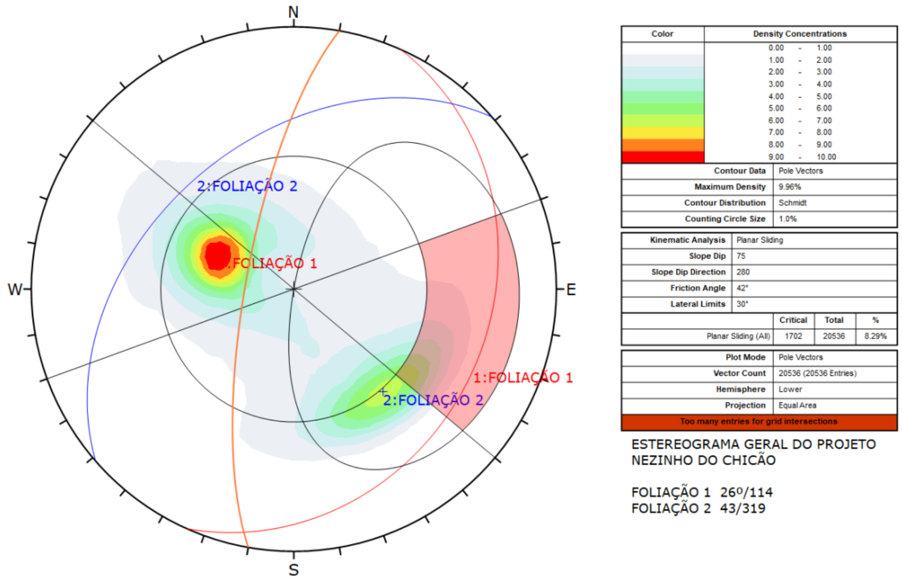


Figure 16-56: Kinematic analysis for sector 1, planar rupture, face angle

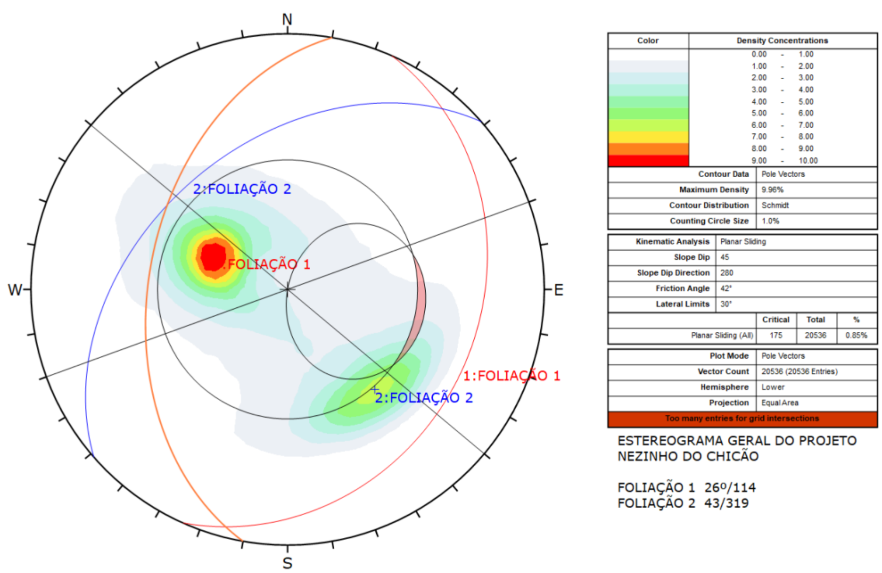


Figure 16-57: Kinematic analysis for sector 1, planar rupture, general angle

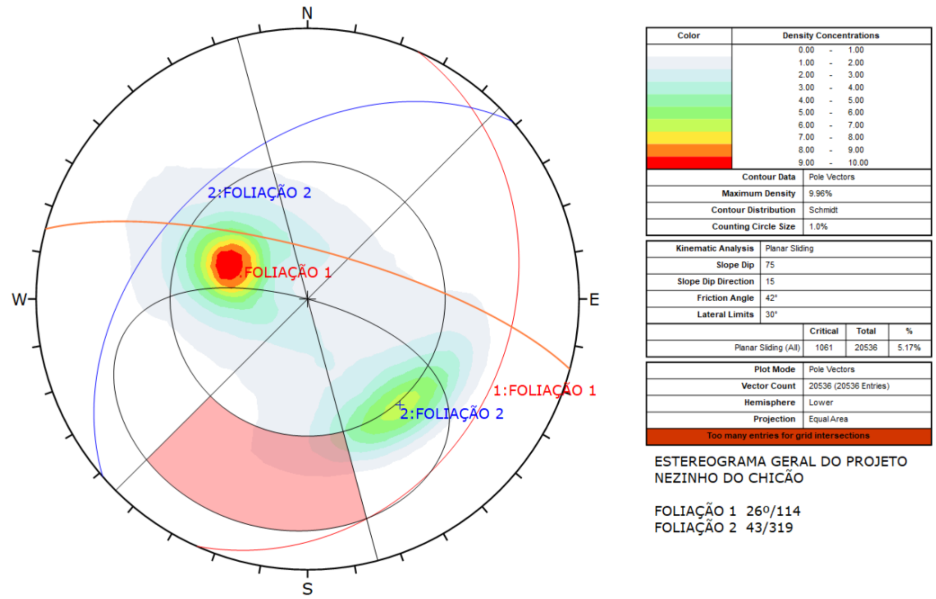


Figure 16-58: Kinematic analysis for sector 2, planar rupture, face angle

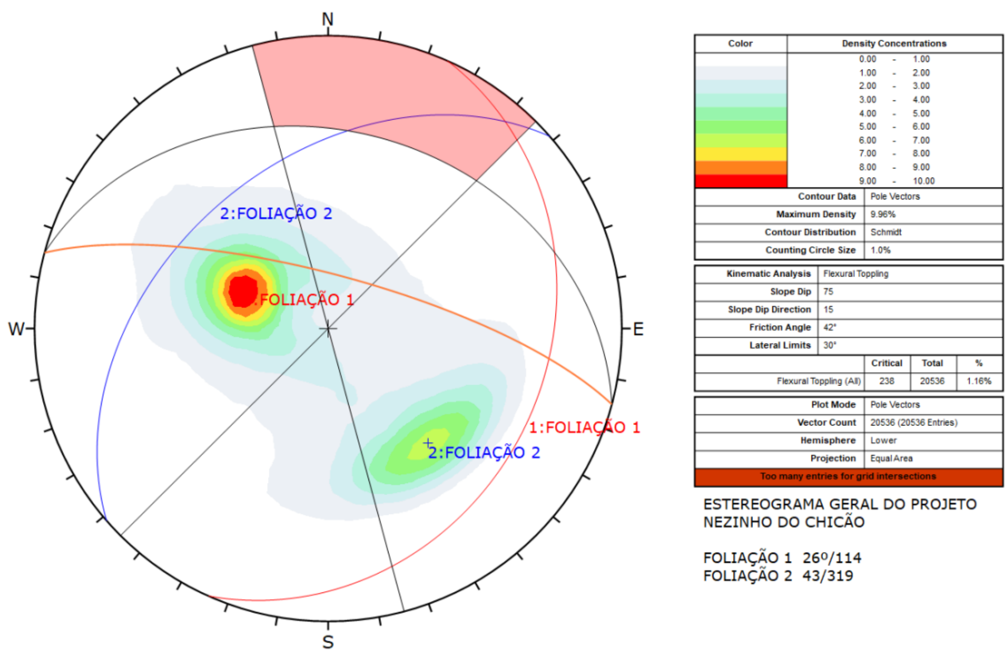


Figure 16-59: Kinematic analysis for sector 2, toppling failure

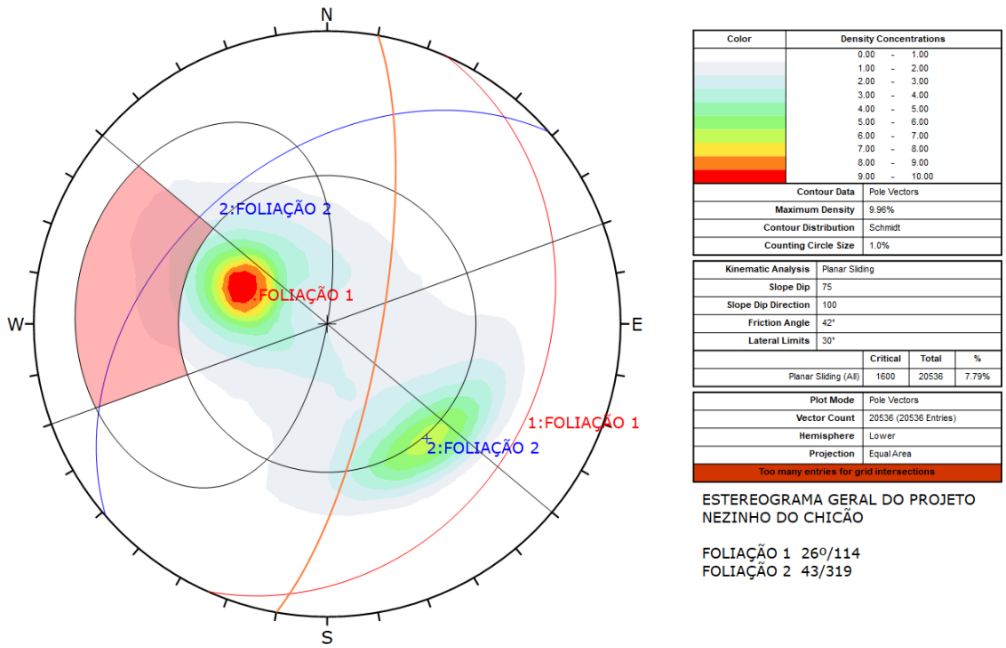


Figure 16-60: Kinematic analysis for sector 3, planar rupture, face angle

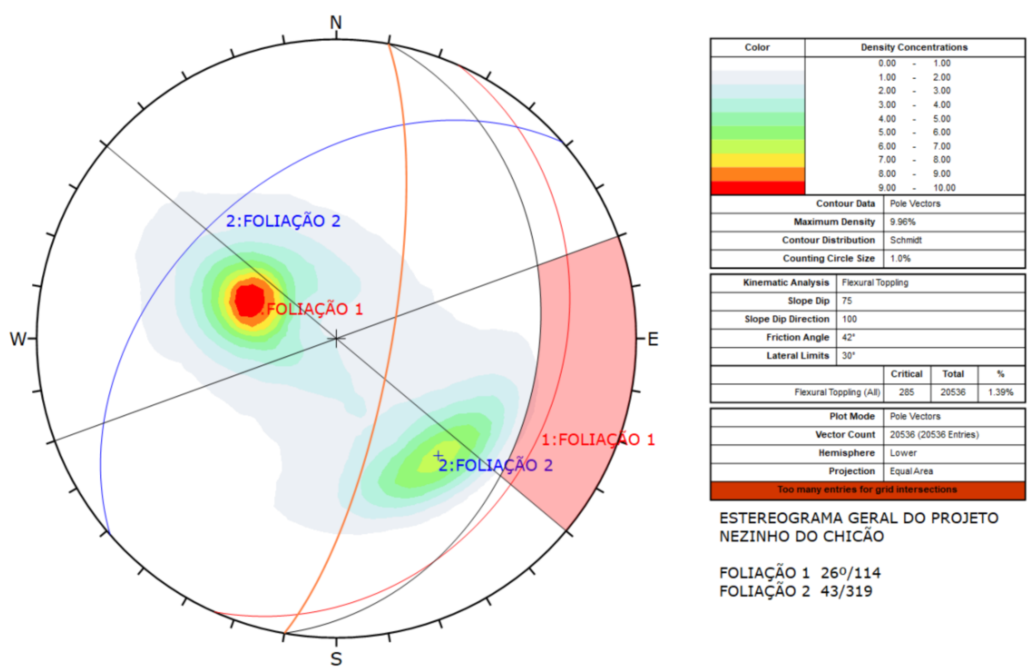


Figure 16-61: Kinematic analysis for sector 3, toppling failure

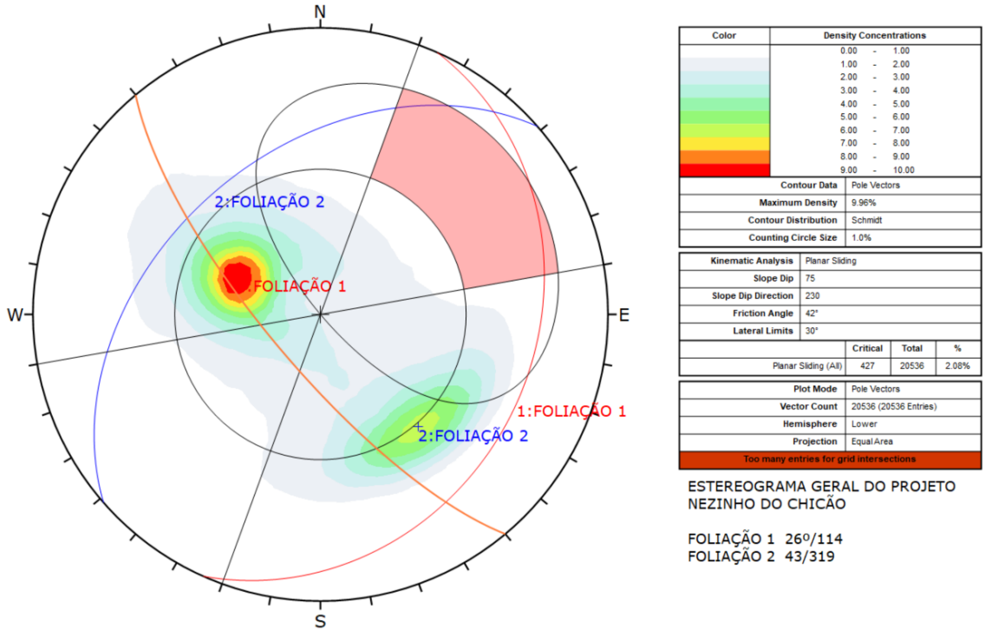


Figure 16-62: Kinematic analysis for sector 4, planar rupture, face angle

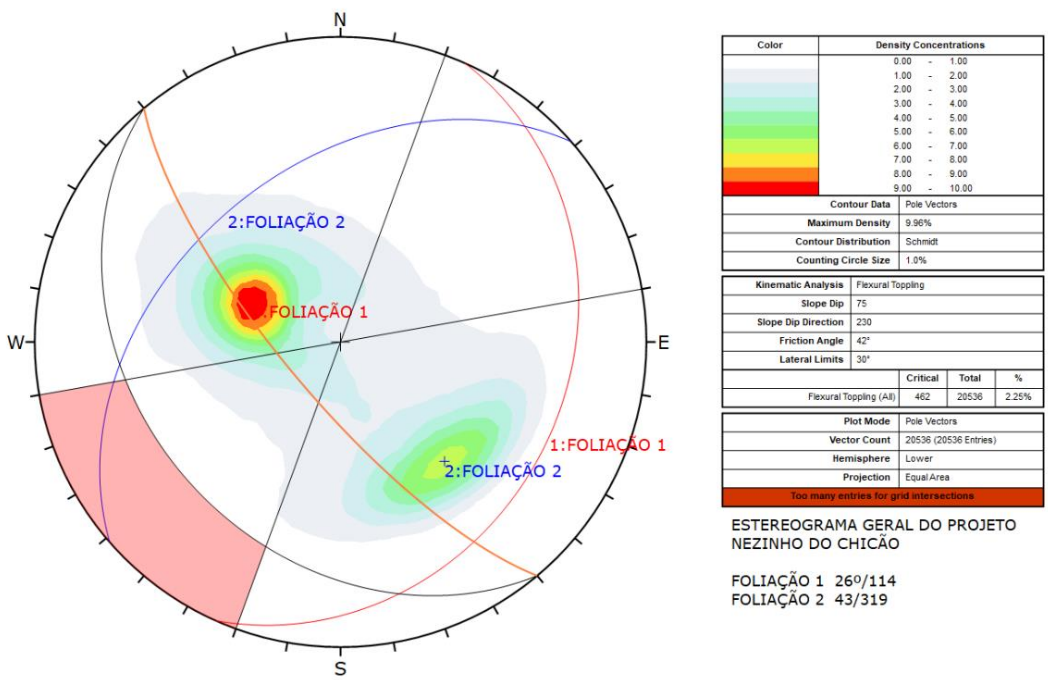


Figure 16-63: Kinematic analysis for sector 4, toppling failure

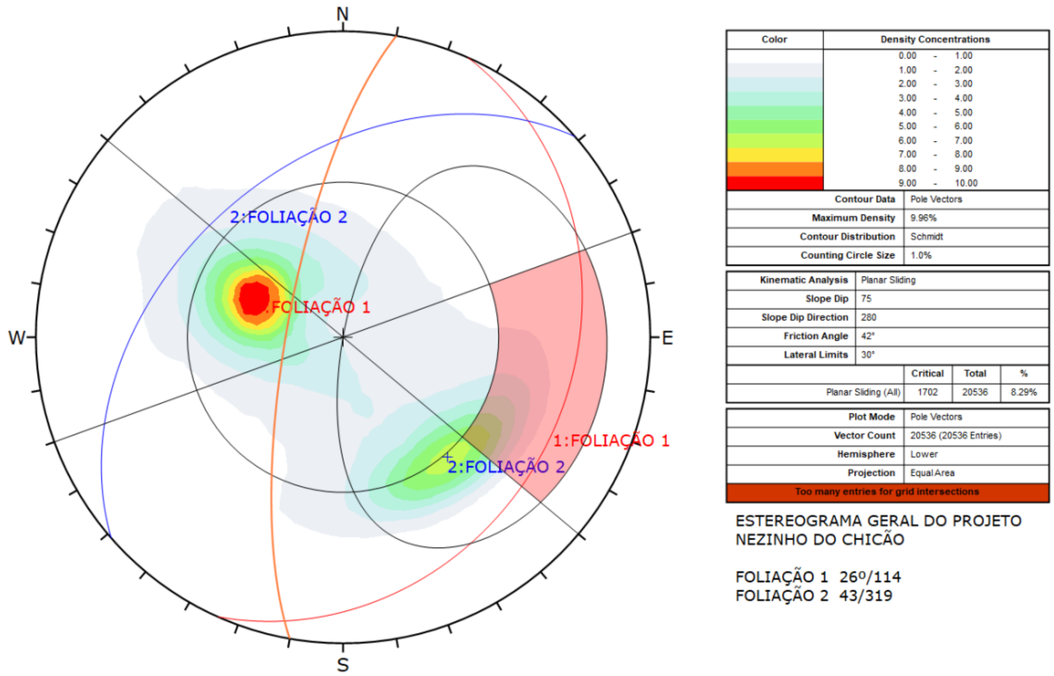


Figure 16-64: Kinematic analysis for sector 5, planar rupture, face angle

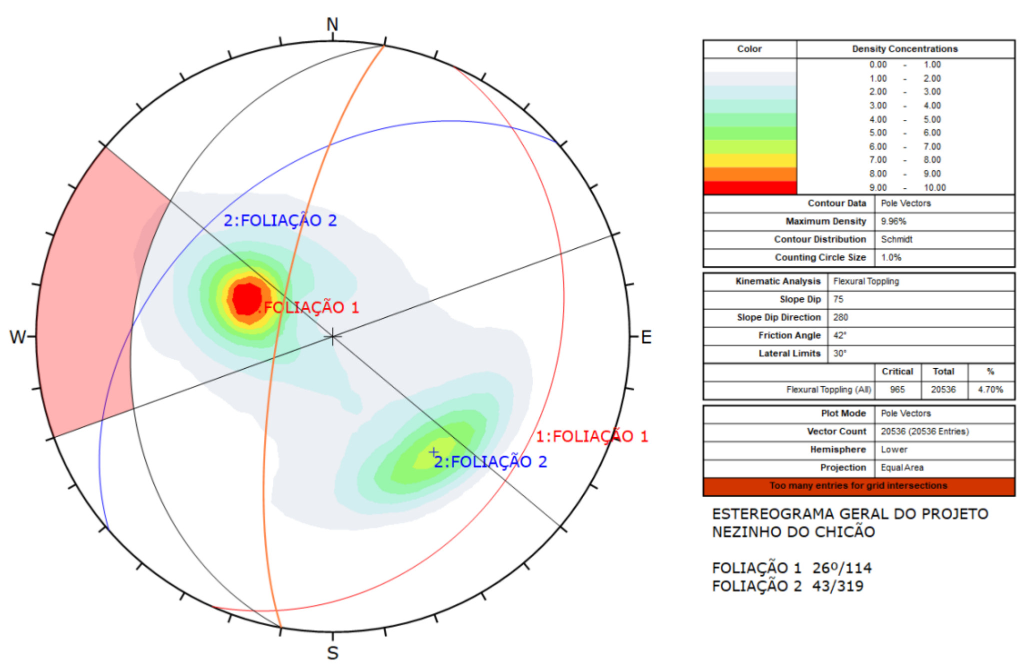


Figure 16-65: Kinematic analysis for sector 5, toppling failure

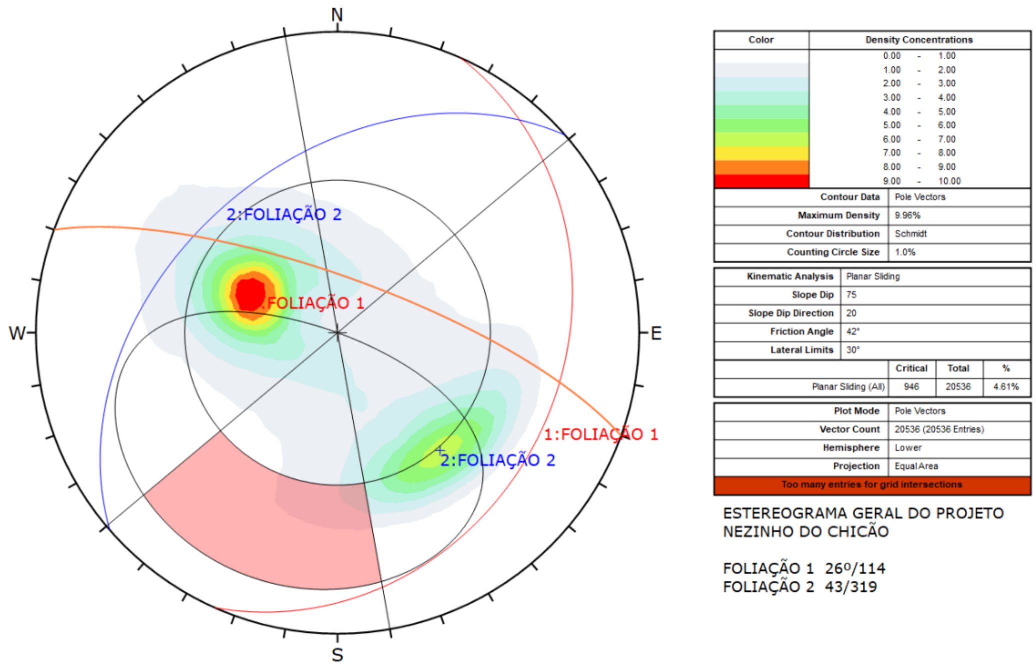


Figure 16-66: Kinematic analysis for sector 6, planar rupture, face angle

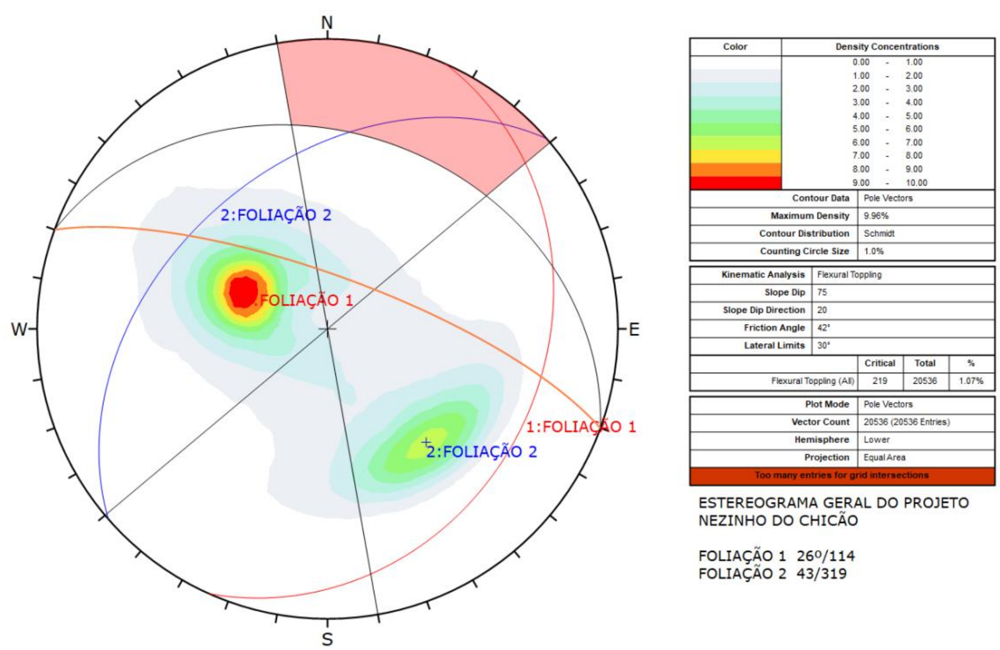


Figure 16-67: Kinematic analysis for sector 6, toppling failure

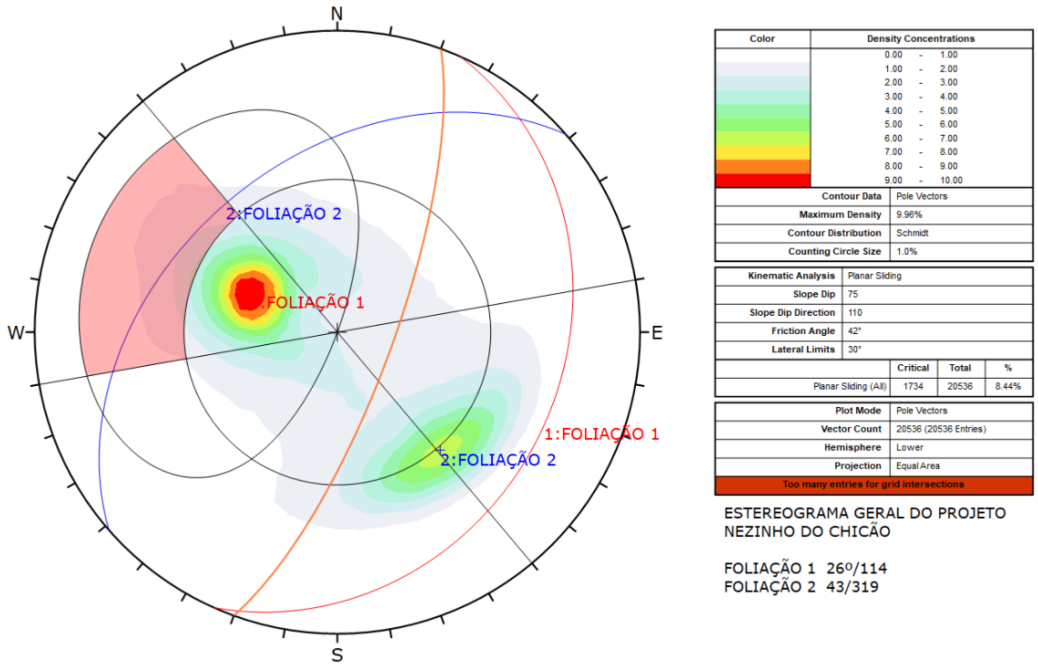


Figure 16-68: Kinematic analysis for sector 7, planar rupture, face angle

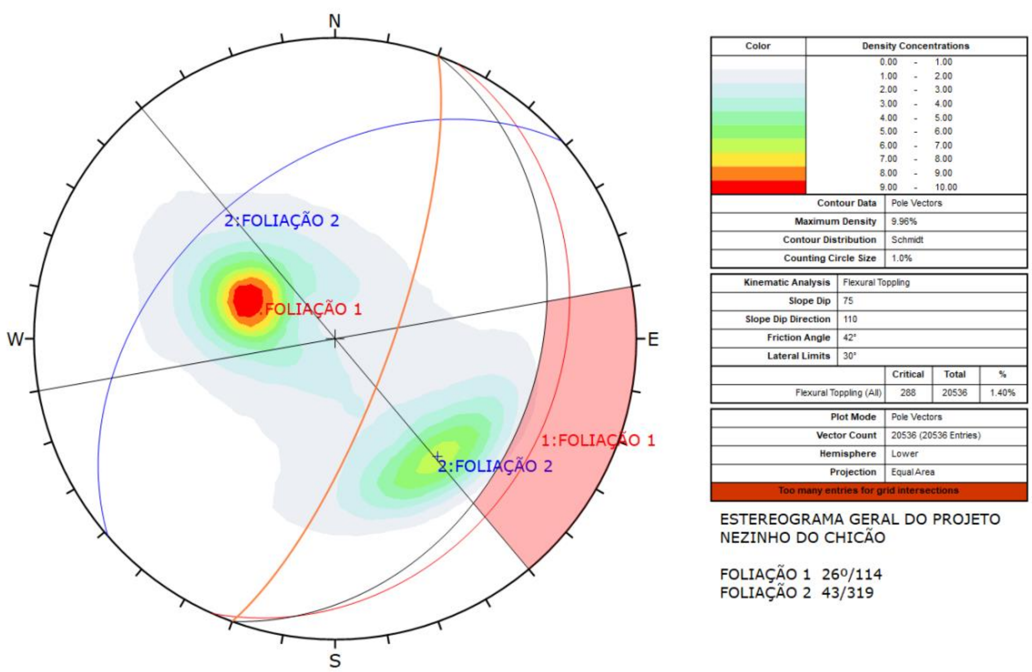


Figure 16-69: Kinematic analysis for sector 7, toppling failure

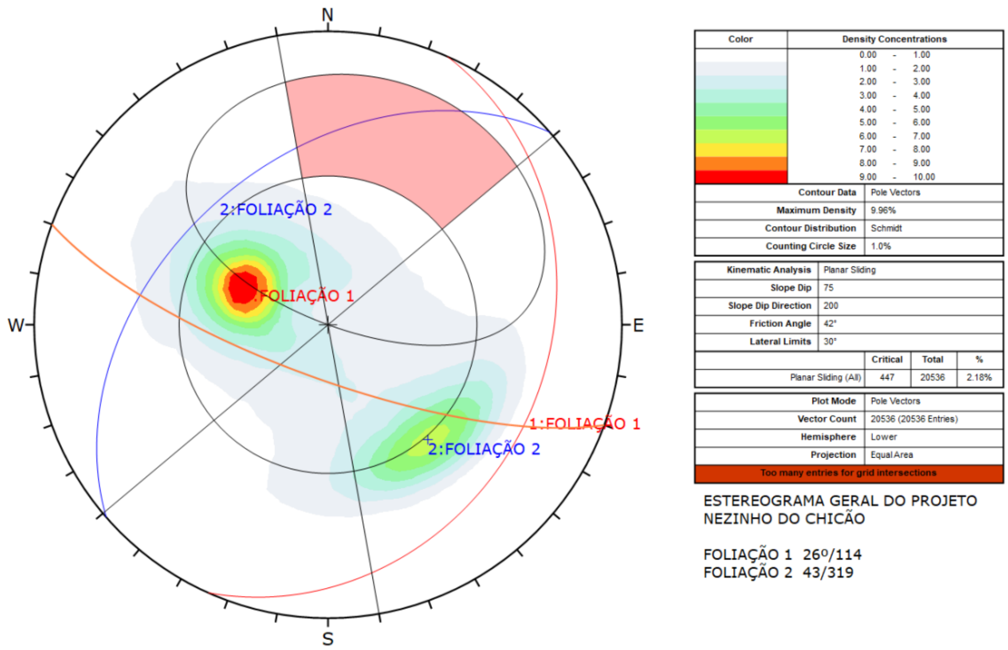


Figure 16-70: Kinematic analysis for sector 8, planar rupture, face angle

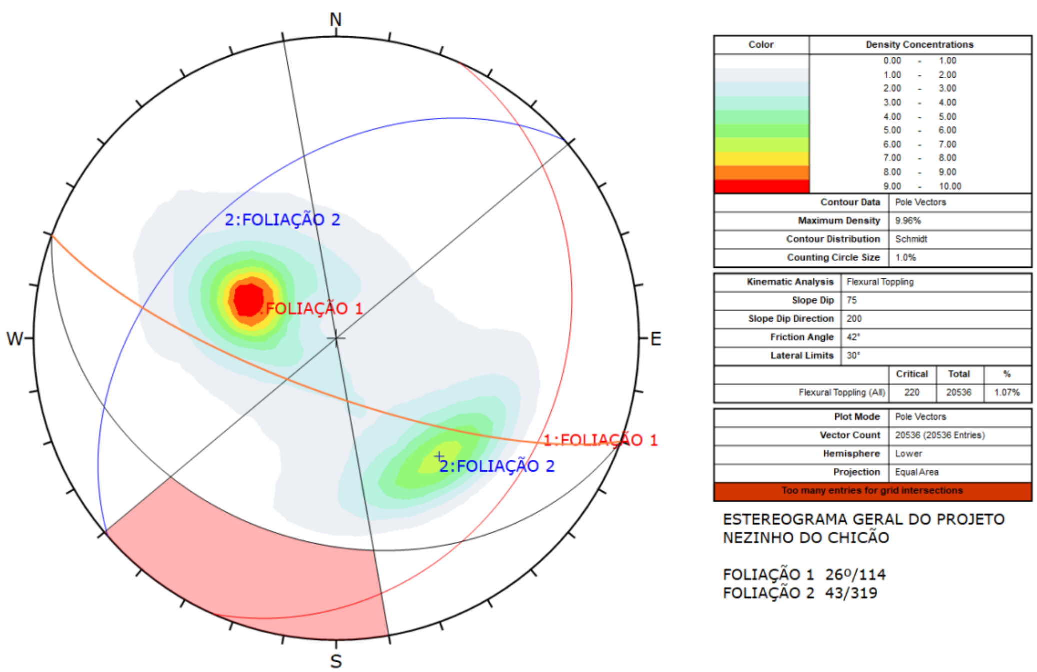


Figure 16-71: Kinematic analysis for sector 8 toppling failure

The analyzes showed that the probabilities of rupture occurrences are within the acceptable range according to the best international practices for pit design, which should be less than 30%.

16.7.1.5 Limit Equilibrium Slope Stability Analysis

The following conditions were assumed for the stability analysis:

- The minimum safety factor to be SF ≥ 1.30
- The rock mass, despite showing an incipient schistosity, was considered anisotropic
- Strength parameters based on laboratory tests, but with a conservative bias
- Parallel strength parameter in the anisotropic function was half of the residual strength of the direct shear test, 650kPa of cohesion and 35º friction angle
- Rocky mass considered as saturated, without lowering

The results of the analyzes are shown in Table 16-42 and in Figure 16-72 to Figure 16-81.

Table 16-42: Result of limit equilibrium analysis

Sector / Section	General Angle	SoF	SoF Seismic load
3 / 01	47º	1.59	>1.1
4 / 02	46º	1.33	>1.1
1 / 03	68º	1.37	1.29
2 / 04	60º	1.68	>1.1
3 / 05	48º	1.37	1.28
3 / 06	49º	1.31	1.20
8 / 07	61º	1.37/1.63	>1.1
5 / 08	61º	1.38	>1.1
6 / 09	46º	1.54	>1.1
7 / 10	41º	1.33	1.22

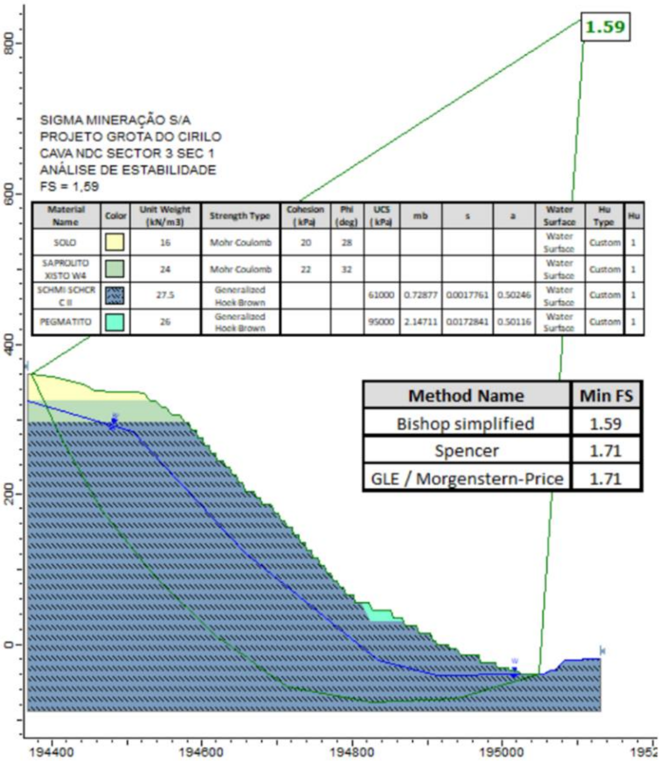


Figure 16-72: Sector 3 section 1 SF = 1.59

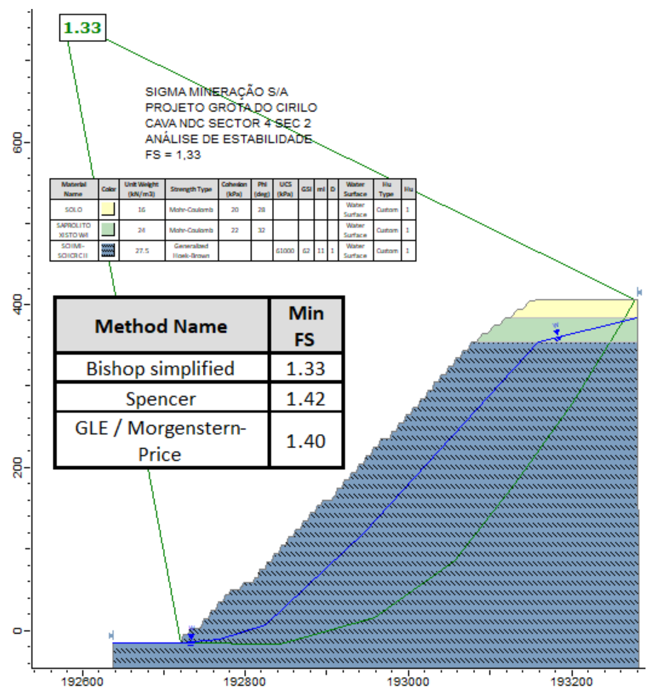


Figure 16-73: Sector 3 section 2 SF = 1.33

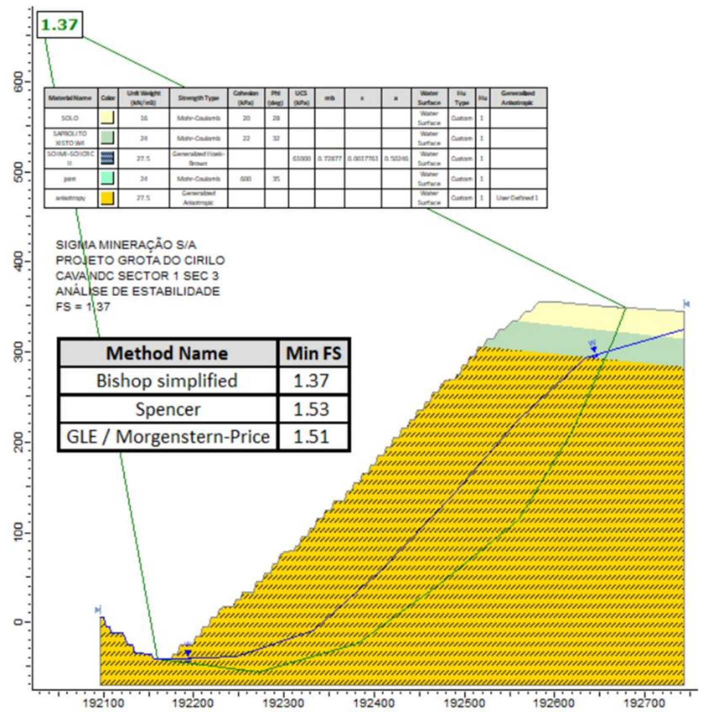


Figure 16-74: Sector 3 section 1 SF = 1.37

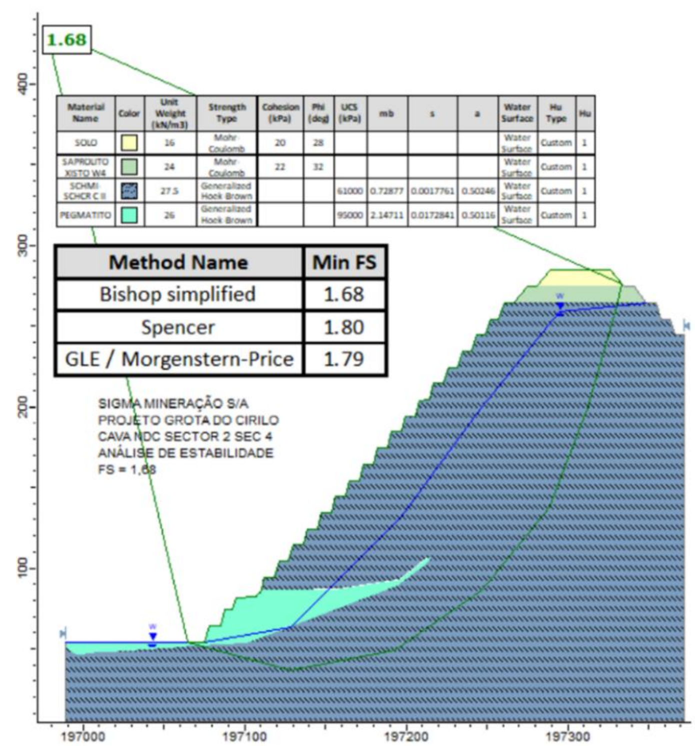


Figure 16-75: Sector 2 section 4 SF = 1.68

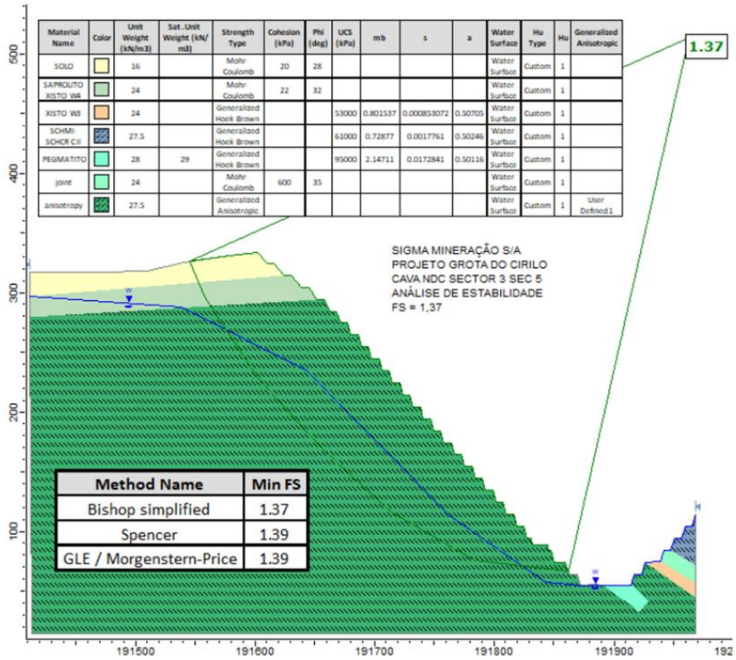


Figure 16-76: Sector 3 section 5 SF= 1.37

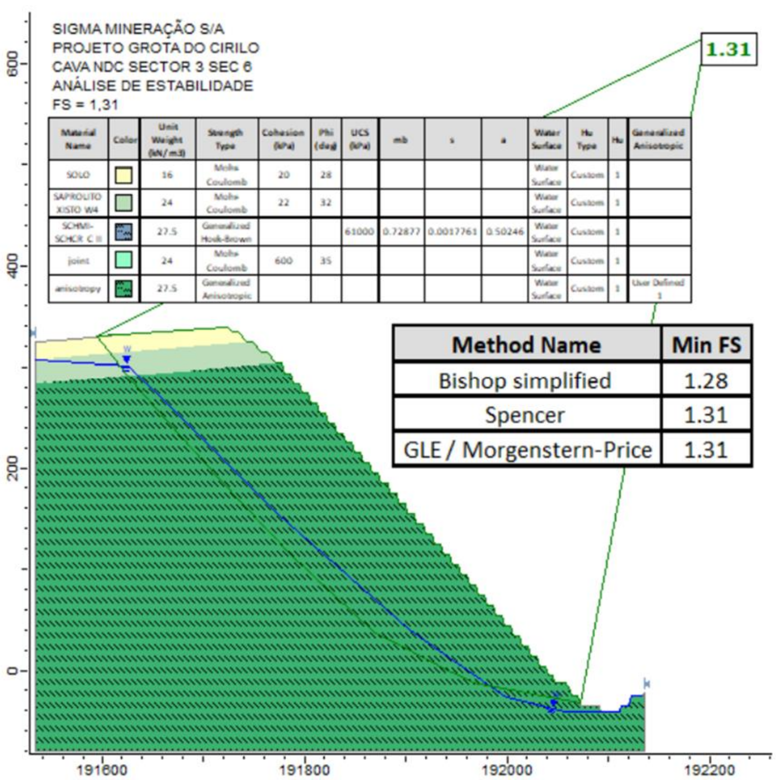


Figure 16-77: Sector 3 section 6 SF = 1.31

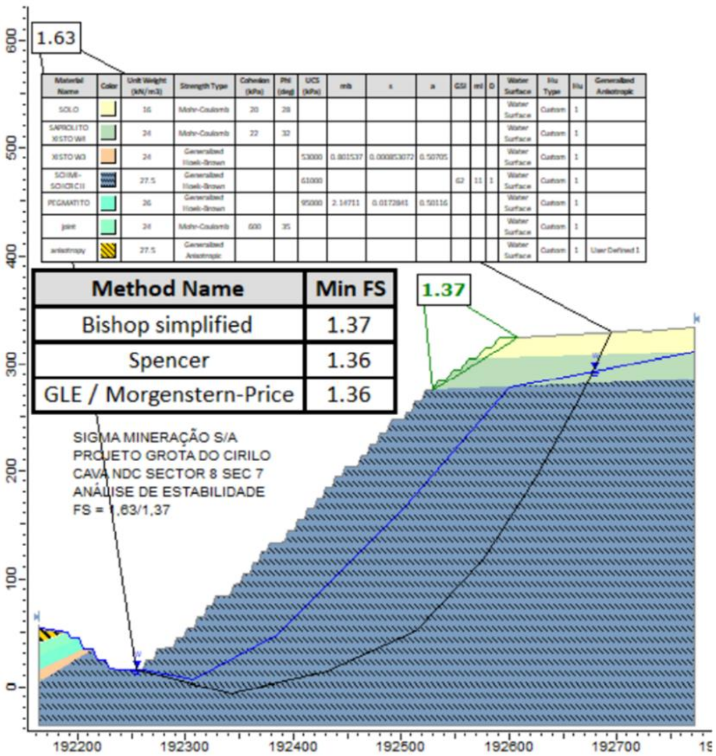


Figure 16-78: Sector 8 section 7 SF= 1.63/1.37

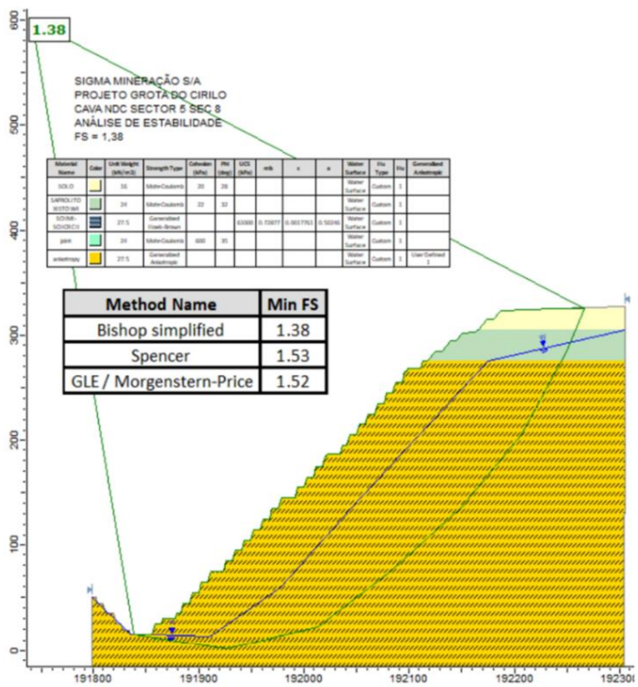


Figure 16-79: Sector 5 section 8 SF = 1.38

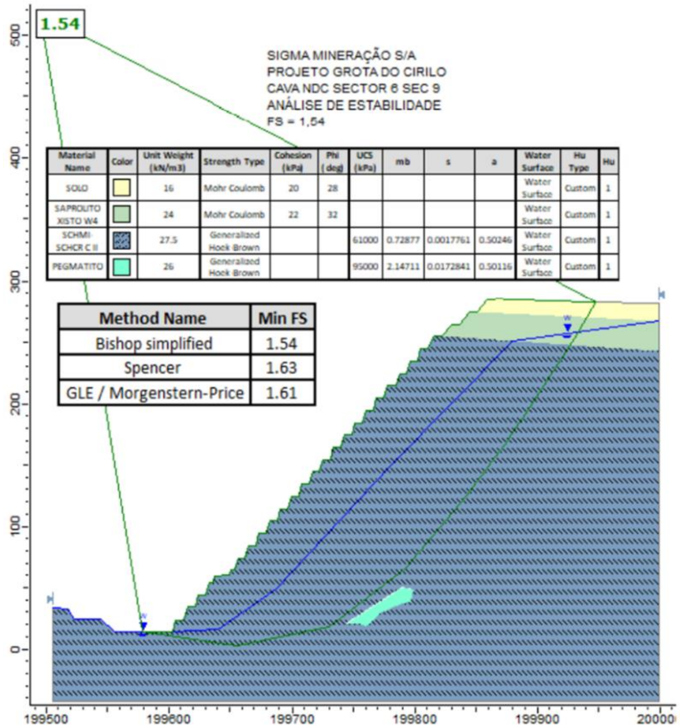


Figure 16-80: Sector 6 section 9 SF = 1.54

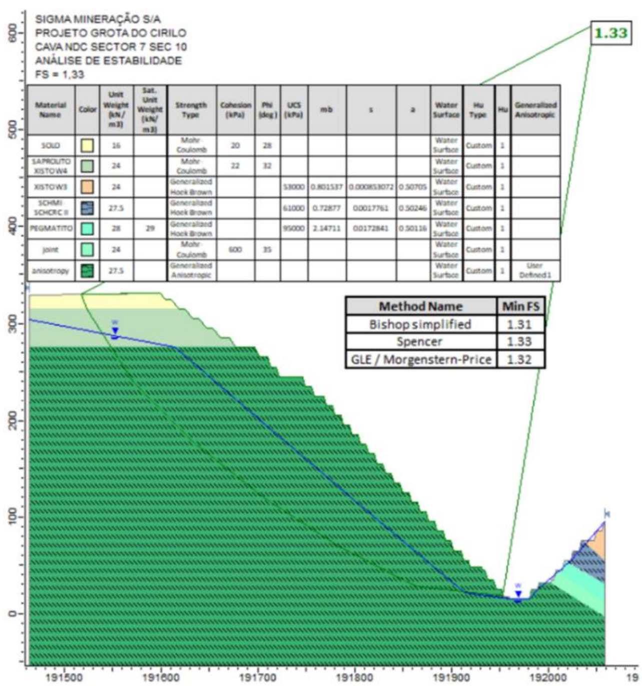


Figure 16-81: Sector 7 section 10 SF = 1.33

16.7.1.6 Hydrogeology

Sigma's Grota do Cirilo Project is situated within the Jequitinhonha River Hydrographic Basin (Figure 16-82) which is in the mesoregions of the Jequitinhonha Valley and Northern Minas Gerais, covering a drainage area of 19,803 km². The climate in the basin is considered semi-arid, with a dry period varying from four to five months per year, and hydraulic availability between 2 and 10 litres per second per square kilometre.

The Nezinho do Chicão deposit is situated immediately northwest of the Piauí River, a shallow, intermittent river that is a tributary of the Jequitinhonha River (Figure 16-83).

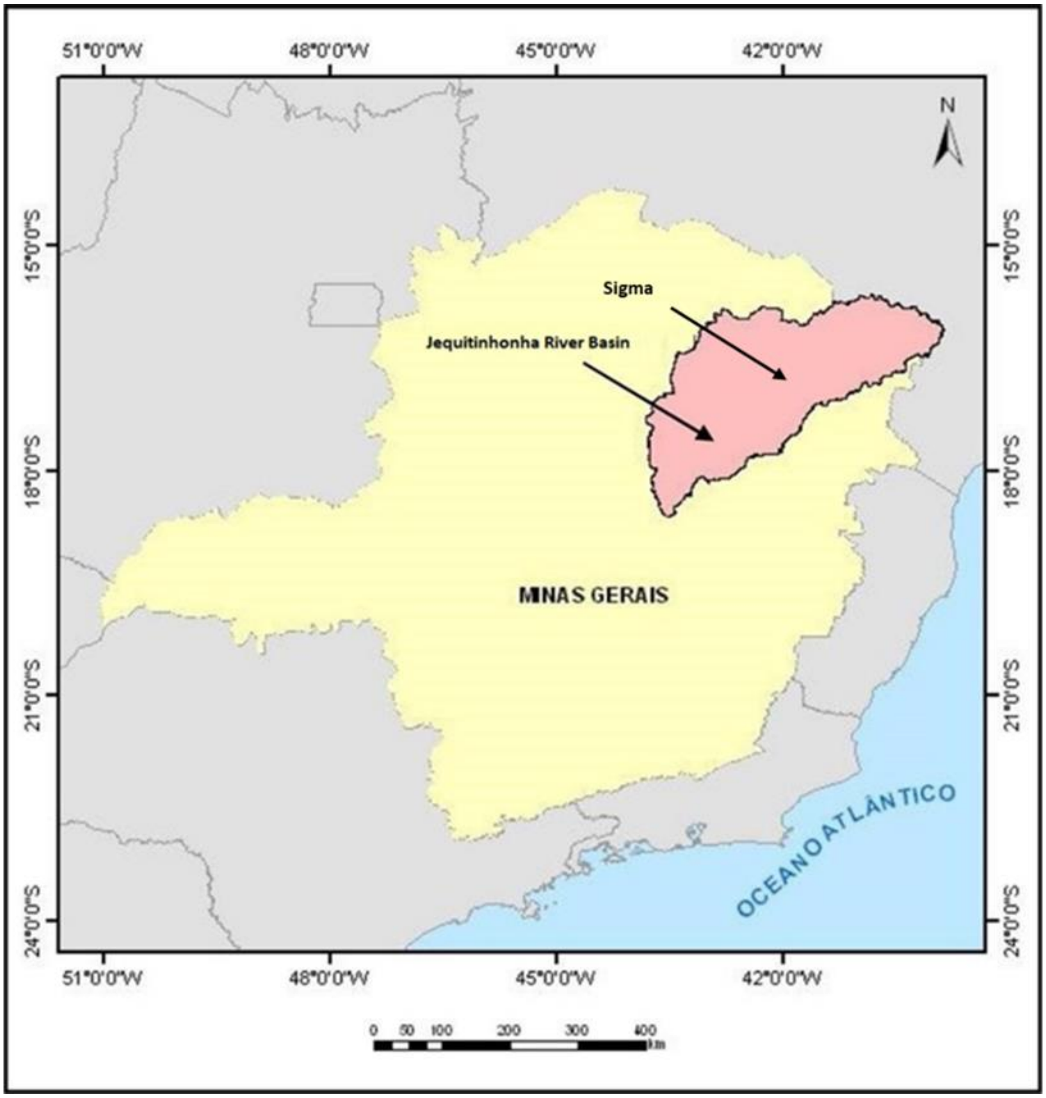


Figure 16-82: Jequitinhonha River Basin in Minas Gerais state, Brazil

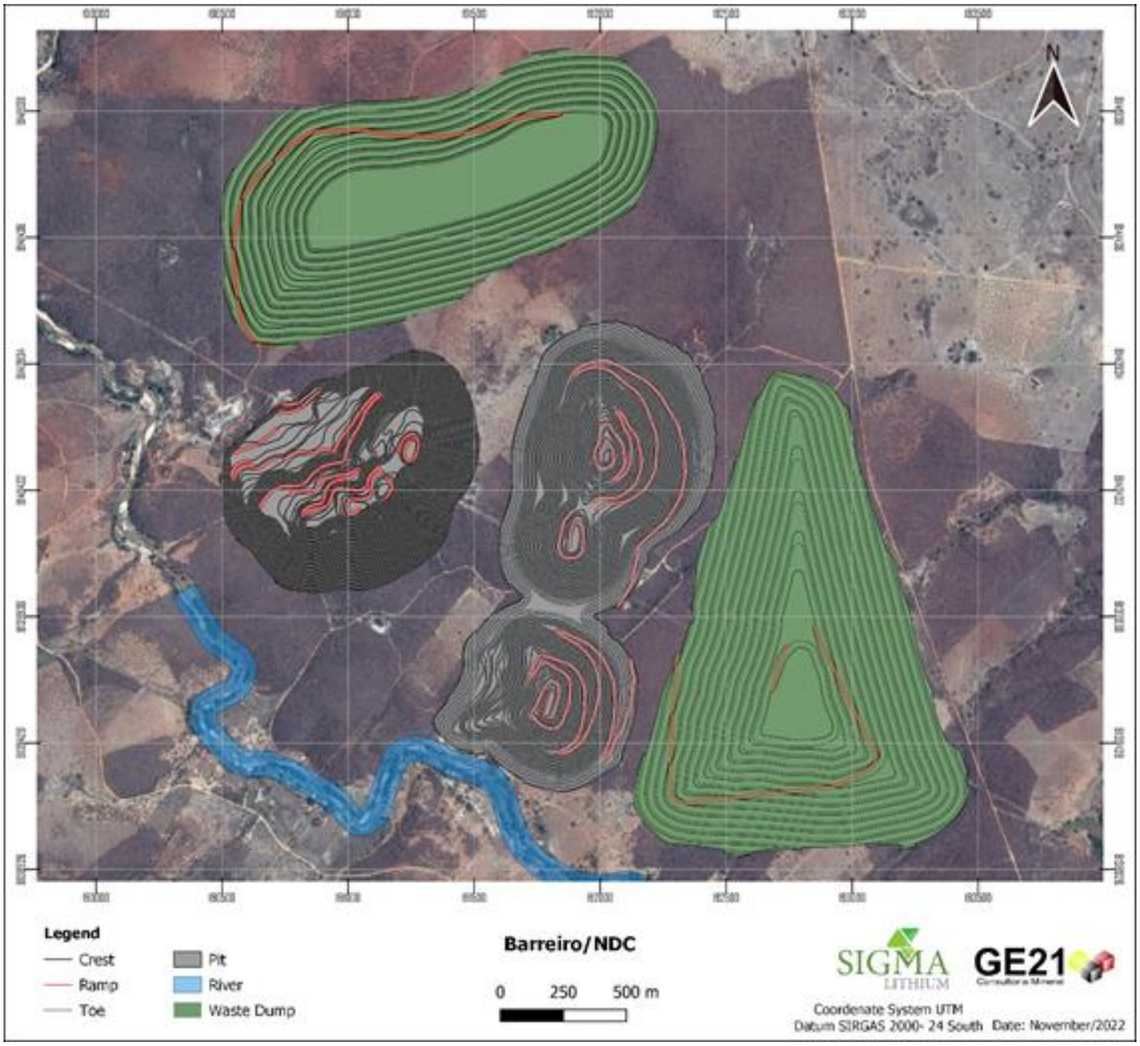


Figure 16-83: Barreiro and NDC pit and waste dump arrangement in relation to Piauí River

16.7.1.7 Regional Hydrogeological Context

The lithologies present in the regional aquifers can be classified as such:

Unit 1: Comprise the rare alluvial coverings, which occur in some portions of the Jequitinhonha and Araçuaí rivers, they are of very reduced dimensions. They may become very important locally, although the rural properties located on the banks of these rivers do not suffer the problems caused by the lack of water, as these rivers are perennial.

Unit 2: The aquifers in this unit are of a granular nature and comprise the thick packages of coarsely stratified sediments of the São Domingos Formation, which can exceed 100 m in thickness in the Virgem da Lapa region, and other coverings of an eluvial-coluvial nature that cover the tertiary planing surfaces.

Infiltration conditions for this formation are not significantly affected by the presence of fine material or limonite crust in its upper portion, although both factors commonly act to reduce permeability, decreasing and delaying infiltration. On the other hand, the fact that this formation is located in the highest portions of the area, with elevations between 650-800 m and presents a very flat relief, factors that help in infiltration.

Unit 3: This unit, the largest in the area, comprises the lithologies of the Macaúbas Group, especially the Salinas Formation. The hydrogeological characteristics of the Salinas Formation are practically only fractured aquifers with a small contribution, in its altered portion, when of considerable thickness, of granular medium. The Salinas Formation has a very wide occurrence, sustains relief dominated by smooth to moderately undulating and polyconvex hills, when predominantly schist in composition, representing dissected areas, with altitudes in general of up to 500 m, with an alteration layer of variable thickness, but in average length of 10.0 m, with a dense net of drainage with patterns clearly dictated by the regional structural pattern (shale, fracturing, faulting directions), which facilitates surface runoff, to the detriment of infiltration. When of quartzite composition, the Salinas Formation, occupied higher altimetric positions, supporting plateaus and hills.

Portions of the Salinas Formation, with a predominantly schist composition, potentially have the possibility of constituting quantitatively reasonable aquifers, for regional standards, when the following conditions coexist:

- Metamorphic-structural discontinuity patterns
- Thick levels of alteration
- Smooth relief
- Overlap of the São Domingos Formation

Unit 4: This unit encompasses intrusive granitic rocks. The altered granitoids are extensive aquifers in the region. The granitic terrains are typical elevated topographical portions. They have drainage networks in radial and dendritic patterns, especially in larger bodies. Fractures represent the most important means where local granitic rocks can conduct and store water.

Figure 16-84 presents a conceptual model of regional groundwater circulation. In this area, the primary permeability is very low, therefore, aquifers predominate in fractured medium. Recharge is carried out by the fracture system, which also controls surface drainage. This structural control of the drainage is less accentuated, if compared to what occurs in the areas of occurrence of schist and quartzite rocks of the Macaúbas Group and Espinhaço Supergroup, respectively. Discharge from these fractured aquifers occurs predominantly at the bottom of valleys.

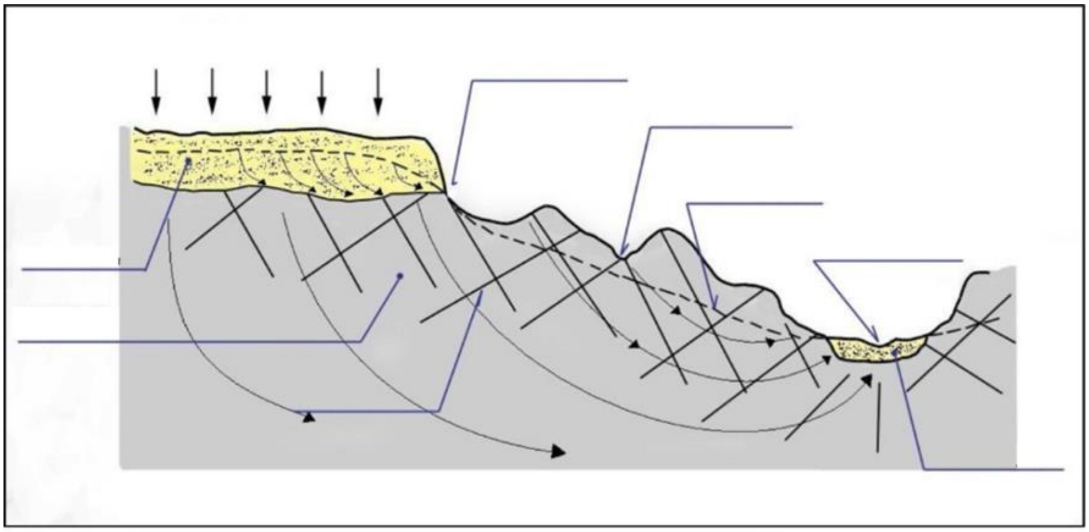


Figure 16-84: Regional Hydrogeological Conceptual Model

16.7.1.8 Local Hydrogeology

Figure 16-85 shows the location of Grota do Cirilo Project and the operational structures (pits and waste dumps) of the Xuxa, Barreiro and Nezinho do Chicão deposits.

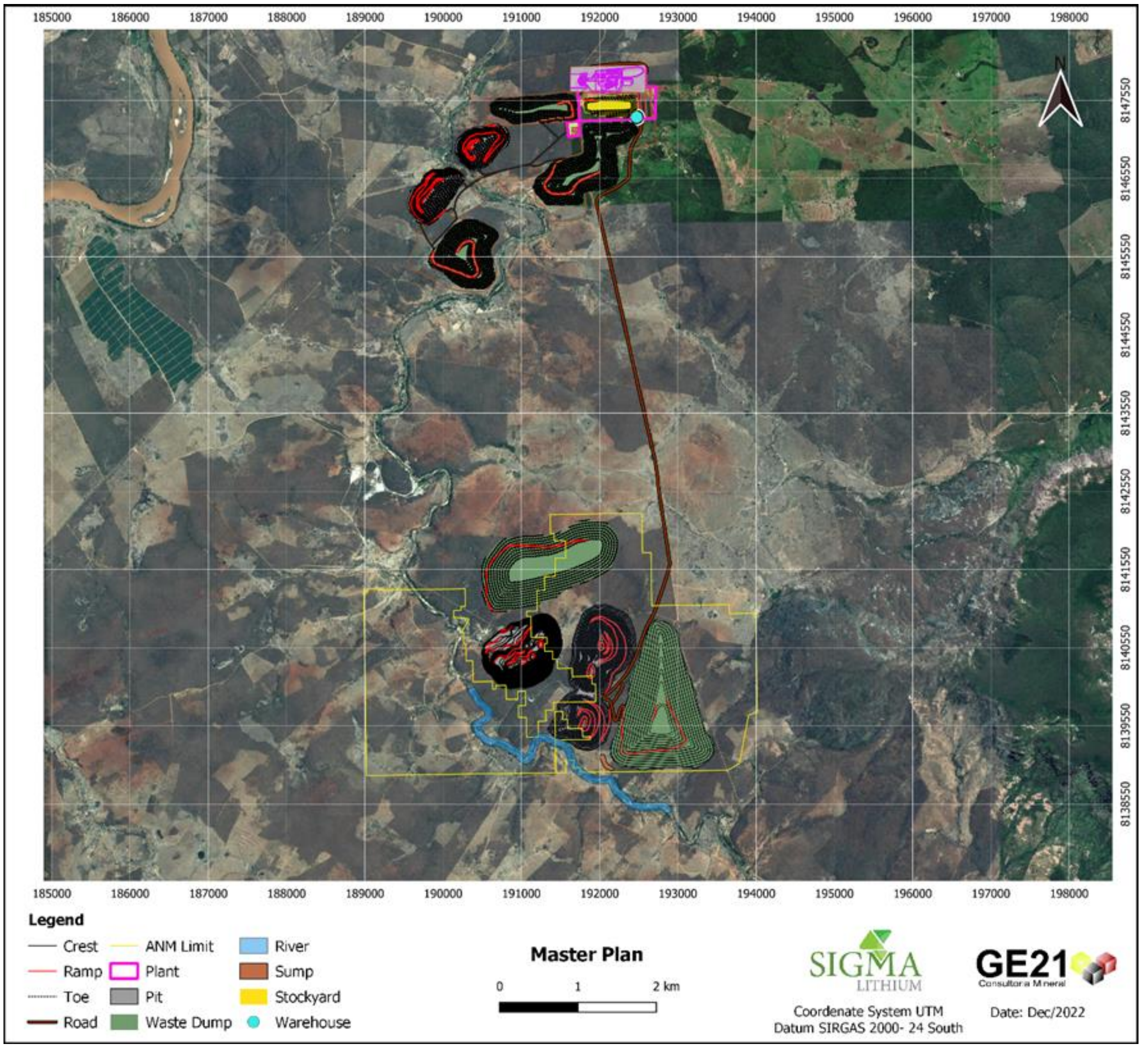


Figure 16-85: Master Plan- Grota do Cirilo Project

Initial considerations for the hydrogeological assessment are:

1) The project area is located where the average annual rainfall varies between 620 and 720 mm.
2) The climate in the project region is semi-arid.
3) The annual water deficit of 800.00 mm.
4) The Project is in the geomorphological portion of the schist rocks of the Salinas Formation, slightly undulating topography.
5) The hydrogeological characteristics of the Salinas Formation are fractured aquifers with a small contribution, in its altered portion, when of considerable thickness as a granular medium.
6) The Salinas Formation may behave as an aquifer with regional patterns when the following conditions coexist:
   - Metamorphic-structural discontinuity patterns.

- Thick levels of alteration.
- Smooth relief.
- Overlap of the São Domingos Formation.

7) The Project is in the Piauí River sub-basin, which behaves as an intermittent drainage being a tributary of the right bank of the Jequitinhonha River.

8) The pegmatites are intruded in the schists of the Salinas Formation of the Macaúbas Group. The intrusions appear, in general, in structural agreement with the foliation of the host rock, however in the case of the Nezinho do Chicão Body these are discordant.

The possibility of hard rocks constituting aquifers, with volumes correlated with regions with water deficit, such as the project region, increases with the occurrence of families of joints, penetrative of orientations: NW, WNW and NE.

16.7.1.9 Registration of Water Points

Work was carried out to register water points in the area covered by the project's polygon between July 25 2022 to July 29 2022.

All the drainage channels that run into the Piauí River were visited, and no water surges were observed. All of them were dry. The conclusion is that water only occurs in these channels on surface runoff from rain.

At four points in the Piauí River, data were collected on the physical-chemical parameters of the water (pH, EH, Conductivity, Temperature).

No evidence of water surges were found in the higher and lower elevations at the points where these drainages meet the Piauí River.

A total of 32 locations were inspected as part of the drainage channel inspection. Figure 16-86 and Table 16 5 list all the visited points.

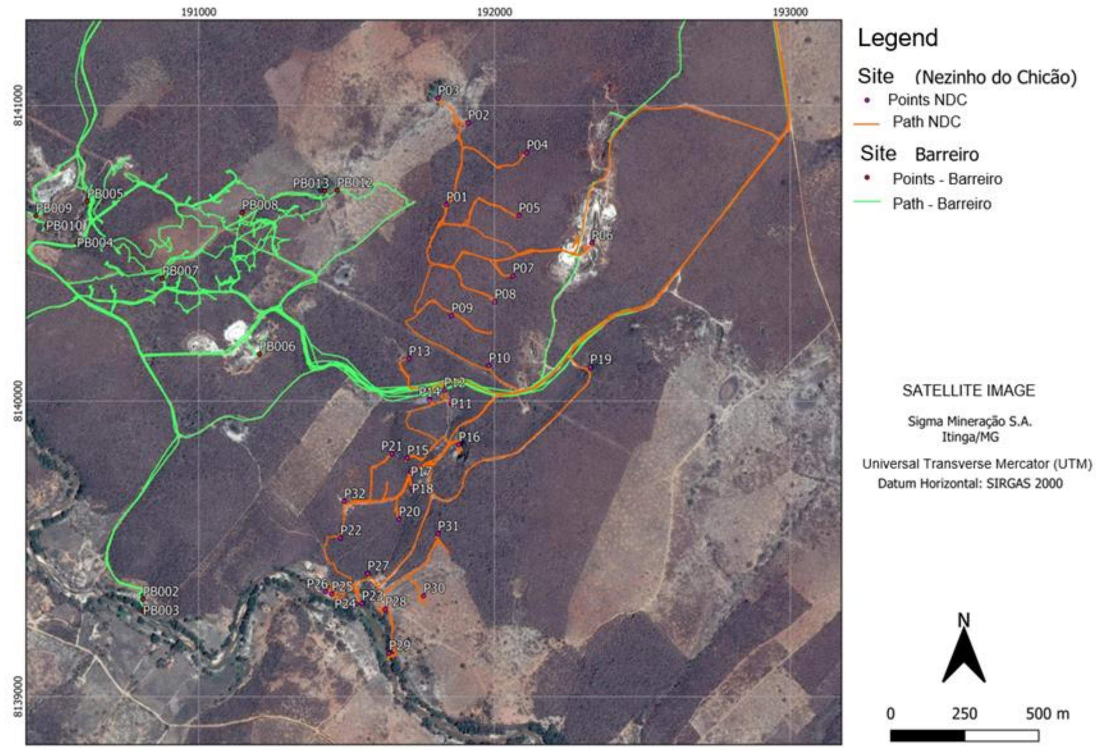


Figure 16-86: Route Map and Drainage Points Inspected

Table 16-43: Drainage Point Inspection List and Details

Point	Description	X	Y	Z	pH	Conductivity	Temperature	Solid
		m				µs	°C	ppm
P01	Area bordering Barreiro. Facing west	191838	8140664	375.88				
P02	Drain concentration point	191911	8140941	345.96				
P03	Artificial pond for watering animals	191809	8141024	344.19	7.9	95	24.8	45
P04	Checkpoint	192109	8140840	384.88				
P05	Checkpoint. Facing east	192082	8140627	372.58				
P06	Lavra do Meio Pit: Old prospector mine, adjacent to the NCD area. It does not show emergence, but it has muddy water accumulated at its bottom due to a large ephemeral drainage ending in it. In this pit it is possible to observe pegmatitic bodies concordant and discordant to the schist. The weathering profile is shown with a depth greater than 30 m. Foliation 270/50, 300/30, 305/35.	192329	8140535	373.43	7.9	203	21.2	105
P07	Checkpoint	192062	8140423	365.45				
P08	Checkpoint	192001	8140335	355.11				
P09	Checkpoint	191855	8140289	353.57				
P10	Checkpoint	191981	8140119	346.15				
P11	Bottom of a dry cave, ephemeral drainage	191853	8139992	322.24				
P12	Schist outcrop	191830	8140036	325.72				
P13	Checkpoint	191711	8140143	347.42				
P14	Dry basin of rain accumulation	191781	8140004	329.84				
P15	Checkpoint at the dry drainage margin	191705	8139807	327.06				
P16	Maxixe Pit: Prospector pit with transparent water accumulated at the bottom. There is great drainage directed towards it and also fish.	191879	8139852	320.93	7.2	442	25	231
P17	Dry Drainage	191717	8139761	318.28				
P18	Dry Drainage	191721	8139703	317.12				
P19	Drainage and dry pond	192324	8140115	338.46				
P20	Dry Drainage	191676	8139600	306.27				
P21	Dry Drainage	191654	8139821	313.52				
P22	Dry Drainage	191479	8139537	316.17				
P23	Arrival of drainage in Piauí	191552	8139315	289.95	8	94	21.5	49
P24	Schist outcrop on the Piauí River	191532	8139314	289.37				
P25	Piauí Riverbank	191450	8139347	290.18	8.3	93	21.5	48
P26	Piauí Riverbank	191429	8139355	290.69	7.8	93	19.6	49
P27	Dry Drainage	191571	8139416	294.59				
P28	Point with river erosion	191630	8139295	296.32				
P29	Arrival of drainage on the Piauí River	191644	8139147	293.81	6.9	93	20.3	48
P30	Checkpoint	191760	8139341	315.85				
P31	Checkpoint	191809	8139551	328.02				
P32	NDC pegmatite outcrop in trench	191492	8139660	337.44				

16.7.1.10 Hydrogeochemical Characterization

Water samples to determine the physical and chemical parameters of the water (pH, EH, conductivity and temperature) were collected at 4 points in the Piaui River. The speed at which this drainage fills/increases flow and empties/decreases flow is characterized in drainages strongly controlled by surface runoff and supply by shallow aquifers of small magnitude. The average measurement shows a 7.8 pH in the Piaui River within the project area, an important parameter that clearly indicates rainwater without any acidic water characteristics. The average electrical conductivity measured at Piaui River is 93.3 µS. This extremely low value demonstrates that the water, although muddy in appearance, has very little suspended solids. The water grade of dissolved solids is extremely low, with an average of 40.5 ppm, which gives the water a low electrical conductivity. The average water temperature of the Piaui River in the project area was 20.7 °C.

16.7.1.11 Initial Conclusions

From these considerations present in this evaluation and observing the geological and hydrogeological similarities of the area with the bodies of Xuxa and Barreiro, where the evaluation is more advanced, it can be expected that in the case of the Body Nezinho do Chicão that:

- In general, the Piauí River should present a dual character of influent and effluent, with the influent character being more prominent
- The main groundwater flow occurs in the contact region between soil/weathered rock and bedrock

Table 16-44 presents the measured groundwater level elevations in the research holes in Nezinho do Chicão (MWL = measured water level in the field and CWL = calculated water level).

Table 16-44: Groundwater Levels in NDC Drillholes

Name	X	Y	Z	Depth	MWL	CWL
DH-NDC-05	191582	8139629	315,00	75,63	29,18	285,82
DH-NDC-10	191616	8139885	313,02	49,49	20,88	292,14
DH-NDC-13	191480	8139537	306,41	93,19	24,44	281,97
DH-NDC-14	191498	8139587	314,89	65,60	31,41	283,48
DH-NDC-15	191522	8139565	311,34	94,35	29,72	281,62
DH-NDC-17	191611	8139521	297,25	136,10	23,54	273,71
DH-NDC-19	191719	8139482	300,00	205,30	22,95	277,05
DH-NDC-27	191568	8139434	285,61	150,85	9,90	275,71
DH-NDC-30	191765	8139574	308,22	165,80	29,44	278,78
DH-NDC-32	191886	8140504	352,54	148,26	67,75	284,79
DH-NDC-33	191858	8140401	345,32	150,28	58,26	287,06
DH-NDC-35	191944	8140693	358,43	139,31	71,53	286,90
DH-NDC-37	192043	8140873	363,67	151,27	68,90	294,77
DH-NDC-38	191954	8140572	352,21	180,06	64,40	287,81
DH-NDC-39	191813	8140310	339,21	151,23	51,94	287,27
DH-NDC-40	191996	8140557	350,37	224,52	63,96	286,41
DH-NDC-41	191992	8140845	358,69	171,76	53,38	305,31
DH-NDC-42	192050	8140532	351,77	303,64	64,96	286,81
DH-NDC-43	191987	8140673	357,45	176,06	70,58	286,87
DH-NDC-47	192041	8140763	365,29	250,37	78,23	287,06
DH-NDC-49	191708	8140142	329,84	80,44	40,74	289,10
DH-NDC-50	191752	8140118	321,68	110,22	32,07	289,61
DH-NDC-52	191811	8140425	350,44	100,61	64,20	286,24
DH-NDC-54	191906	8140380	341,21	177,02	52,69	288,52
DH-NDC-55	191893	8140056	314,48	241,46	24,57	289,91
DH-NDC-57	192018	8140440	344,06	300,69	56,41	287,65
DH-NDC-58	191692	8140033	316,99	70,27	26,87	290,12
DH-NDC-59	191736	8140018	311,27	92,43	19,53	291,74
DH-NDC-62	191681	8139930	311,59	67,22	21,53	290,06
DH-NDC-63	191711	8139911	316,43	97,47	26,33	290,10
DH-NDC-64	191768	8140333	345,67	100,27	57,44	288,23
DH-NDC-66	191895	8140714	363,15	110,33	74,19	288,96
DH-NDC-68	191854	8140289	335,19	171,06	47,12	288,07
DH-NDC-69	191761	8140227	331,45	117,91	42,28	289,17
DH-NDC-70	191634	8139728	314,57	121,59	26,68	287,89
DH-NDC-71	191951	8140807	358,03	120,02	75,19	282,84
DH-NDC-73	191746	8139682	302,33	180,80	12,51	289,82
DH-NDC-75	191901	8140269	331,57	196,50	43,70	287,87

DH-NDC-77	191644	8139820	306,90	88,53	17,42	289,48
DH-NDC-78	191885	8140881	345,25	79,96	54,90	290,35
DH-NDC-79	191797	8139658	313,25	257,16	29,48	283,77
DH-NDC-80	191895	8140164	324,77	230,34	34,97	289,80
DH-NDC-81	191706	8139807	307,05	138,25	16,95	290,10
DH-NDC-82	191869	8140937	335,50	110,40	43,86	291,64
DH-NDC-86	191833	8139746	317,47	353,35	25,77	291,70
DH-NDC-88	191992	8140228	333,73	321,56	43,07	290,66
DH-NDC-89	191939	8140141	327,54	280,73	38,59	288,95
DH-NDC-91	191943	8140031	319,01	302,03	29,67	289,34
DH-NDC-92	191626	8139634	310,53	120,66	21,20	289,33
DH-NDC-94	192089	8140737	364,85	345,63	75,23	289,62
DH-NDC-95	191671	8139613	301,21	141,90	14,40	286,81
DH-NDC-97	191730	8139588	300,00	196,84	20,31	279,69
DH-NDC-98	191520	8139449	290,92	136,57	17,54	273,38
DH-NDC-99	192084	8140626	359,64	351,33	72,09	287,55
DH-NDC-100	192094	8140512.	354,15	381,62	62,05	292,10
DH-NDC-101	192061	8140423	346,85	351,45	56,02	290,83
DH-NDC-102	191767	8139569	308,20	230,47	28,49	279,71
DH-NDC-105	191885	8139611	320,66	315,09	43,46	277,20
DH-NDC-106	191811	8139435	303,52	317,86	22,68	280,84
DH-NDC-107	191708	8139363	292,82	279,75	12,67	280,15
DH-NDC-108	191586	8139323	285,75	200,01	7,19	278,56
DH-NDC-109	191860	8139525	314,94	310,73	40,17	274,77
DH-NDC-110	191760	8139340	301,14	297,21	22,14	279,00
DH-NDC-111	191622	8139295	285,00	256,30	3,12	281,88

Figure 16-87 shows the location of the drillholes tested, while Figure 16-88 shows the potentiometric map of the area.

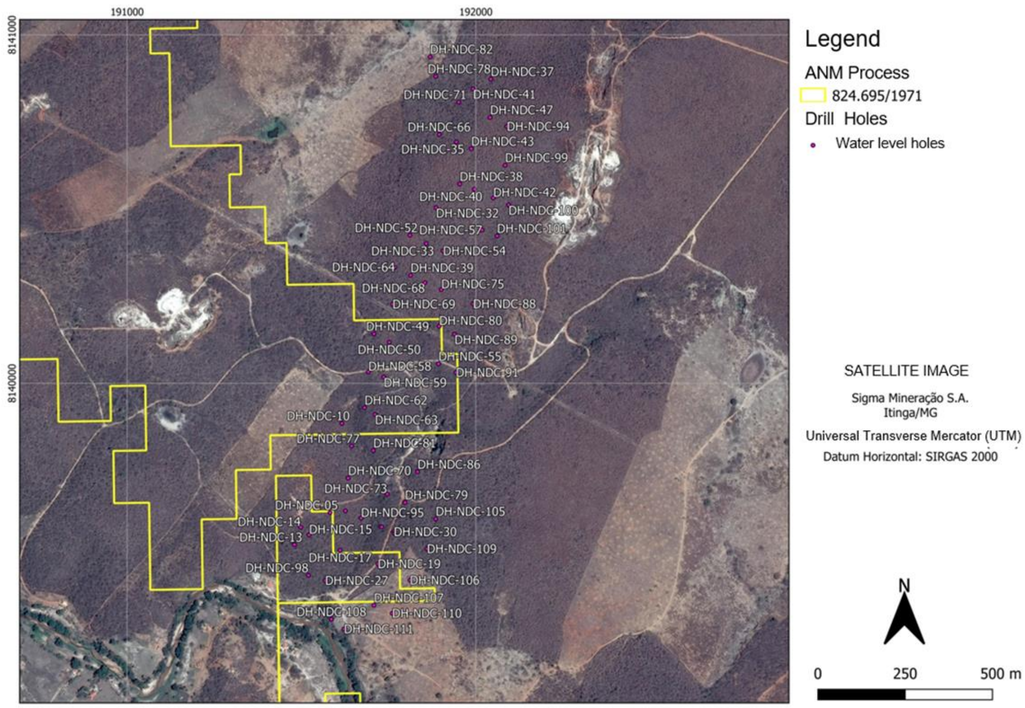


Figure 16-87: NDC Drillhole Location Map

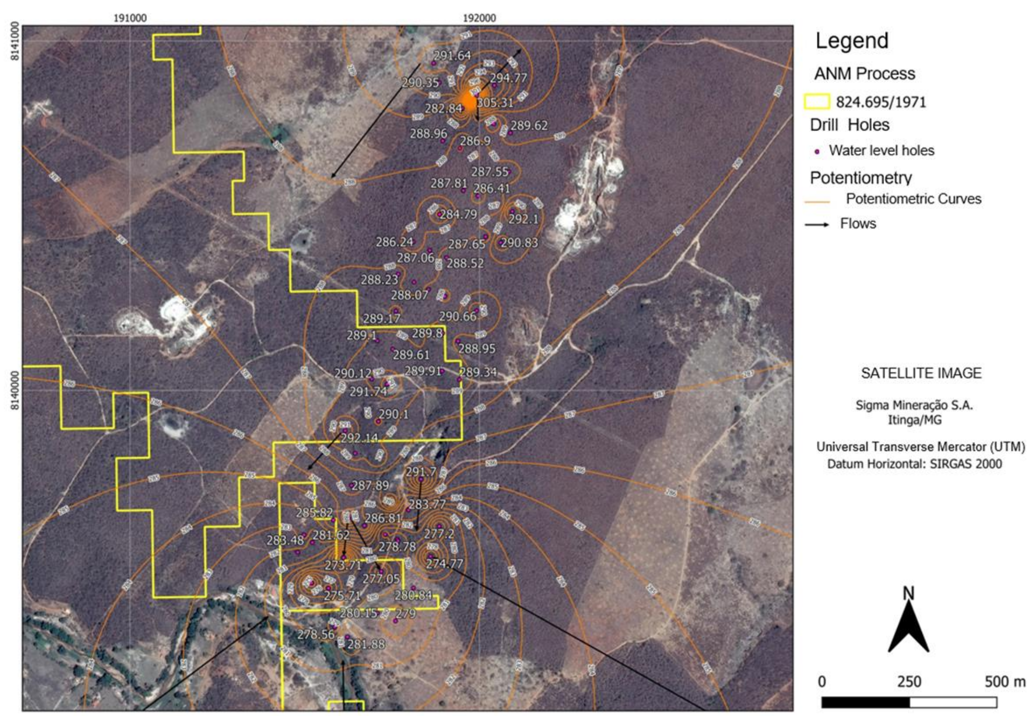


Figure 16-88: NDC Potentiometric Map

16.7.1.12 Water Circulation Potential

Assumptions

- Considering that the flow of water has its circulation in the contact zone between the bedrock and the cover (soil and saprolite) and in zones of fracture in the rock mass, the thickness of the cover material was determined.
- Considering the direct relationship between groundwater circulation and degree of fracturing, in the holes, zones with RQD lower than 70% (greater fracturing) were selected, below the contact zone between saprolite/soil and sound rock.

Methodology

An analysis on drillhole database was made in order to obtain the necessary information about the contact between the soil/saprolite and the bedrock. Figure 16-89 presents in graphic form the great variation of this contact (non-specialized) whose average depth was evaluated and defined at 13.8 metres, with a minimum thickness of 1.3 metres and a maximum of 44 metres. The variability of the coverage thickness is very large.

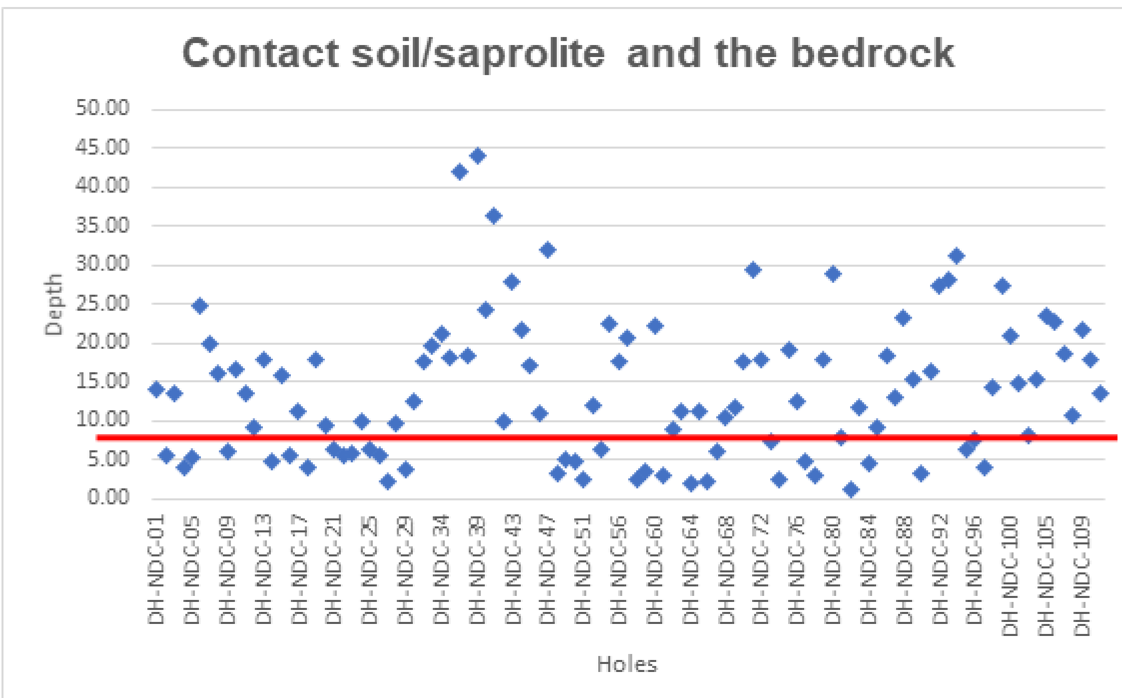


Figure 16-89: Depth variation between weathered material (soil/saprolite) and bedrock. (Mean in red).

Figure 16-90 highlights the zone (shaded) where the drillhole intervals with RQD below 70% were selected.

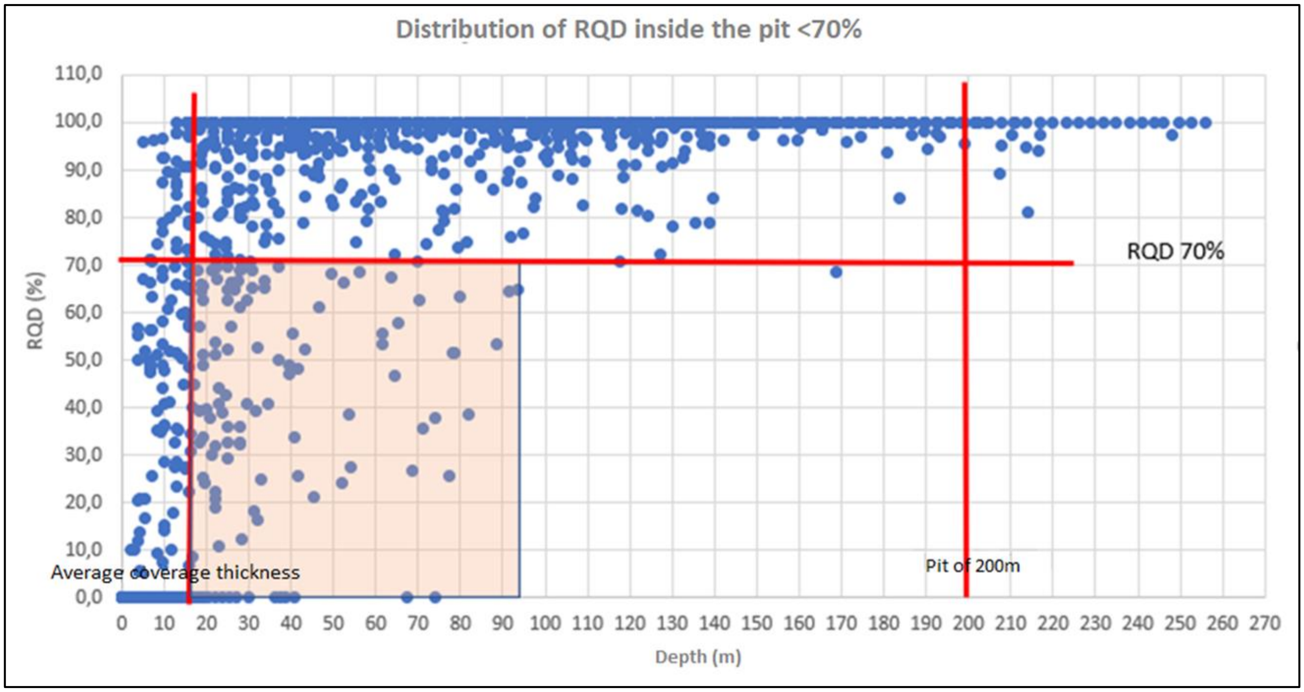


Figure 16-90: Zone selected for verification of drillholes (RQD less than 70%).

16.7.1.13 Analysis and Verification of Defined Surveys

Drillhole fractured zones and RQD below 70 were visually evaluated in the core shed for the characterization of possible water passages.

The observation of these holes suggests fractured sections with water circulation at depths of up to 100 meters. The main water-conducting structure is a system of fractures parallel to the foliation. The most fractured zones and with signs of water are close to the thickest portions of the pegmatite.

16.7.1.14 Piezometer Installation Campaign

After verifying in the field, the preservation conditions of the 111 holes made in the research campaigns, 10 holes were defined for the installation of instruments (piezometers), which will be of the Casagrande type with a single chamber. Five instruments will be installed in the rock mass/pegmatite (PZ - Deep) and another six in the saprolite/rock contact (PZ - Shallow). Table 16-45 and Table 16-46 show their information.

The work sequence for the hydrogeological assessment as the project matures will consist of the following steps:

- Analysis of the drillings carried out (lithological and geotechnical descriptions) to identify possible features of water circulation in the rest of the holes (NDC-38 to NDC-111): The lithology and geotechnical drillhole database tables and the photographic archives will be examined in order to find some structure or system that characterizes groundwater circulation. An evaluation of the drillholes in which the imagery survey has been carried out (Televiewer).

- Measurement of 1 more flow point in the Piauí River: Piauí river will have 3 control points, the Barreiro project control points (one is upstream from the NDC and the other close to the project), while the downstream one from Nezinho do Chicão will be defined in the field.

- Implementation of Casa Grande type piezometers in selected holes: The piezometers will be used to monitor the water levels in the altered layer and in the bedrock and water samples will also be collected using the “low flow” methodology for the analysis of the physical-chemical parameters of the water according to CONAMA 396/2008.

- Performing a “slug test” on the Piezometers to determine the hydraulic conductivity: The Piezometers will also be used for hydraulic tests to obtain the hydraulic conductivity of the rocks.

Table 16-45: Holes selected for installation of piezometers in the rock mass

Name	x	y	z	Slope	Depth	Status	Water	MWL	CWL	Type	Installation (m)
DH -NDC-111	191622	8139295	285.00	-65	256.30	L	S	3.12	281.88	P	240
DH -NDC-41	191992	8140845	358.69	-65	171.76	L	S	53.38	305.31	P	100
DH -NDC-40	191996	8140557	350.37	-65	224.52	L	S	63.96	286.41	P	150
DH -NDC-55	191893	8140056	314.48	-65	241.46	L	S	24.57	289.91	P	200
DH -NDC-79	191797	8139658	313.25	-65	257.16	L	S	29.48	283.77	P	180

Table 16-46: Holes selected for installation of piezometers in roofing material and saprolite

Name	x	y	z	Slope	Depth	Status	Water	MWL	CWL	Type	Installation (m)
DH -NDC-108	191586	8139323	285.75	-65	200.01	L	S	7.19	278.56	R	10
DH -NDC-82	191869	8140937	335.50	-65	110.40	L	S	43.86	291.64	R	10
DH -NDC-38	191954	8140572	352.21	-65	180.06	L	S	64.4	287.81	R	20
DH -NDC-50	191752	8140118	31.68	-65	110.22	L	S	32.07	289.61	R	15
DH -NDC-73	191746	8139682	302.33	-65	180.80	L	S	12.51	289.82	R	20

Figure 16-91 shows the proposed locations of the piezometers.

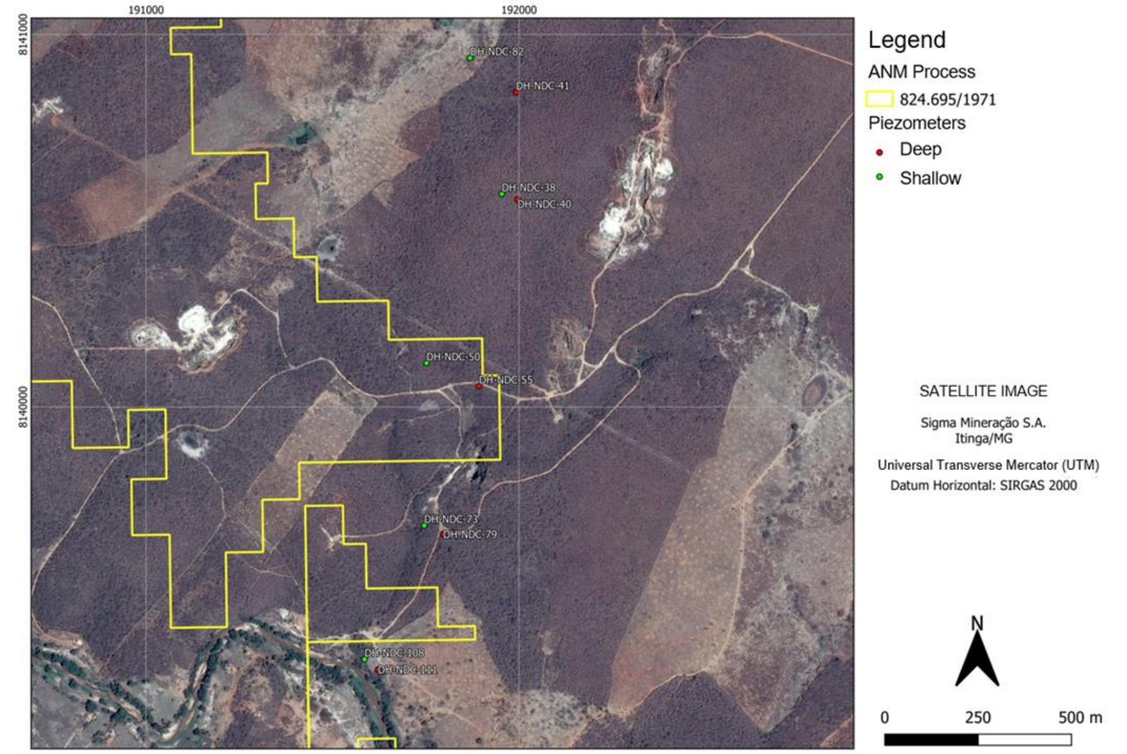


Figure 16-91: Proposed locations of piezometers

Mathematical modeling will be important for defining the relationship between groundwater and the Piauí River and pluviometry. This will define the flow required for draining the pits and depressurizing the slopes.

The Final Hydrogeological Characterization Report will present information from the previous steps and conclude on the groundwater relationship with the region to be mined.

16.7.1.15 Conclusions

Conclusions based on the hydrogeological analysis are:

- The main flow of groundwater occurs in the contact region between the soil/weathered rock and the bedrock.
- Quantitative interference in local water availability is not expected. Qualitative interference will depend on operational care.
- Operational problems caused by groundwater interference are not expected.
- The first information presents the Piauí River as an effluent of shallow regional aquifers.

16.8 MINE SEQUENCING

To define the annual production plan, the following criteria were applied:

- Feed rate: 1.80 Mtpa
- Li_2O feed grade: 1.45%
- Mining dilution 3%
- Mining recovery: 93%
- Fines losses: 15%
- DMS metallurgical recovery: 60.7 %
- Concentrate grade (Li_2O): 6%
- Product mass recovery is calculated as:

$ass\ Recovery = \frac{metallurgical\ recovery}{concentrate\ grade} \times feed\ grade\ x\ (1 - fine\ losses)$.This study consisted of sequencing production, and waste rock blocks, in addition to defining the evolution of pit(s) geometries throughout the life of mine.

For the production development, the areas to be mined annually were established and designed pushbacks plans for years 1 to 5, 10 and 12.

Operational sequencing results can be found in Figure 16-92 to Figure 16-98 and Table 16-47 below.

Table 16-47: Nezinho do Chicão Mine Schedule (Dry Basis)

Year	Classification	ROM	Li_2O	Li2O Cont.	Waste	Stripping Ratio	Total Mov.
		Mt	%	kt	Mt	t/t	Mt
1	Proven	-	-	-			
	Probable	1.52	1.34	20.33			
Subtotal		**1.52**	**1.34**	**20.33**	**7.73**	**5.08**	**9.25**
2	Proven	0.30	1.50	4.44			
	Probable	1.50	1.39	20.97			
Subtotal		**1.80**	**1.41**	**25.40**	**10.99**	**6.11**	**12.79**
3	Proven	0.48	1.51	7.29			
	Probable	1.33	1.42	18.87			
Subtotal		**1.81**	**1.44**	**26.16**	**16.28**	**8.98**	**18.10**
4	Proven	0.63	1.52	9.51			
	Probable	1.19	1.57	18.59			
Subtotal		**1.81**	**1.55**	**28.10**	**18.66**	**10.29**	**20.47**
5	Proven	0.26	1.56	4.03			
	Probable	1.56	1.50	23.37			
Subtotal		**1.82**	**1.51**	**27.39**	**26.37**	**14.51**	**28.19**
6 - 10	Proven	0.50	1.56	7.86			
	Probable	8.50	1.48	125.86			
Subtotal		**9.00**	**1.49**	**133.72**	**231.11**	**25.68**	**240.11**
11 - 12	Proven	-	-	-			
	Probable	3.42	1.36	46.50			
Subtotal		**3.42**	**1.36**	**46.50**	**28.03**	**8.19**	**31.45**
Total		**21.19**	**1.45**	**307.62**	**339.17**	**16.01**	**360.36**

Note: 93% Mine Recovery, 3% Dilution

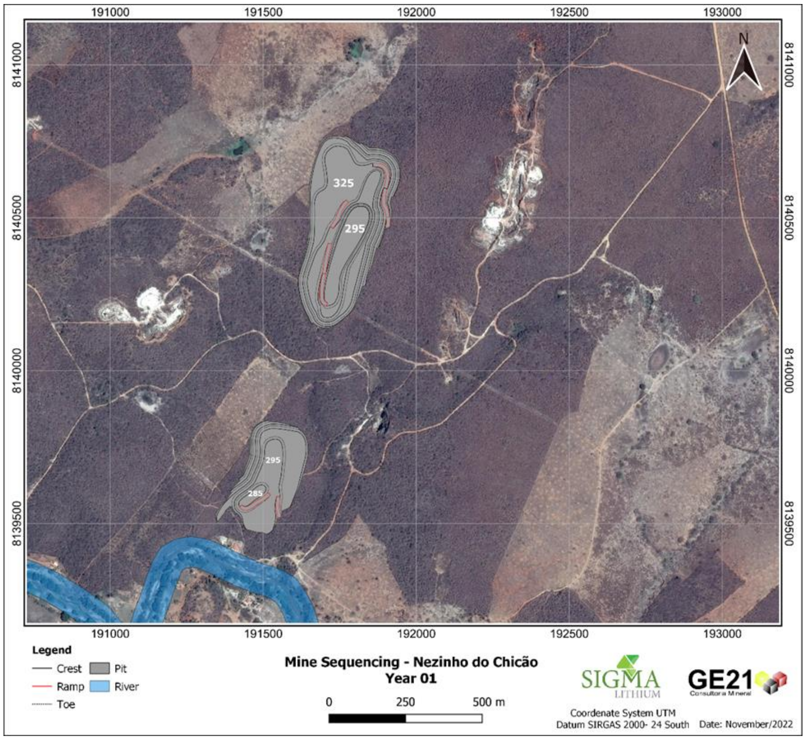


Figure 16-92: Pit Nezinho do Chicão - Year 01

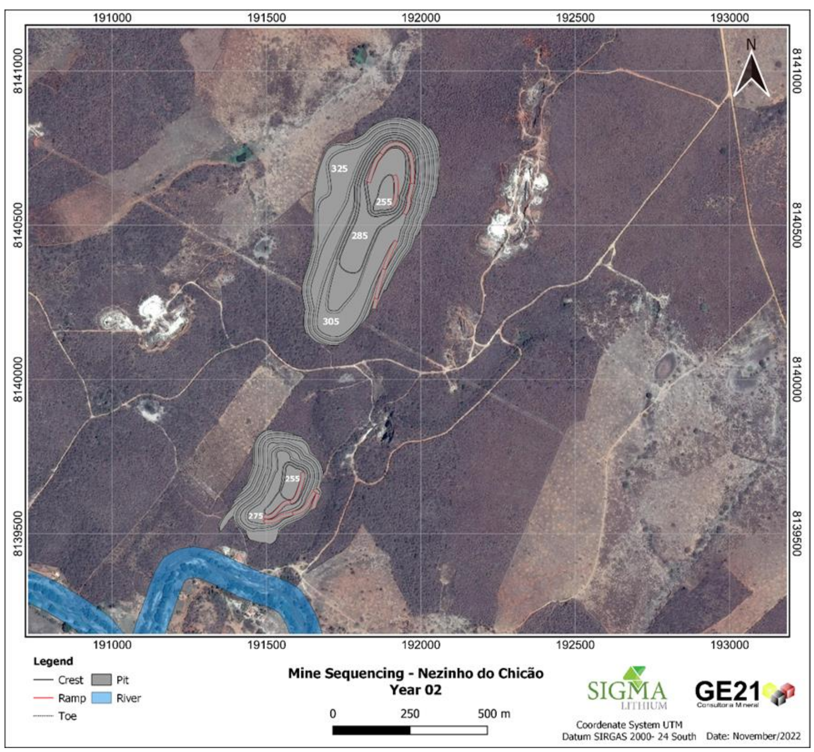


Figure 16-93: Pit Nezinho do Chicão - Year 02

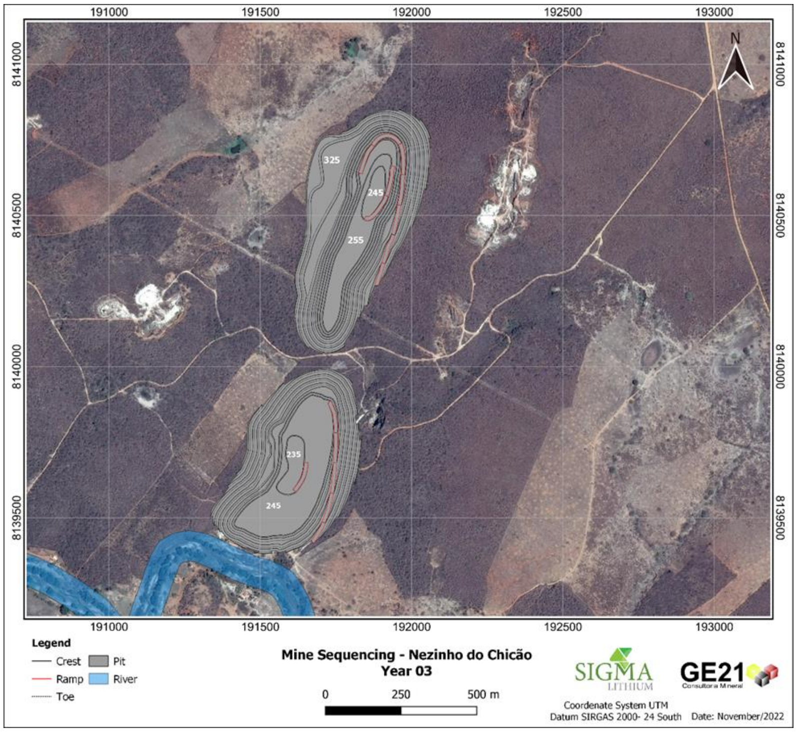


Figure 16-94: Pit Nezinho do Chicão - Year 03

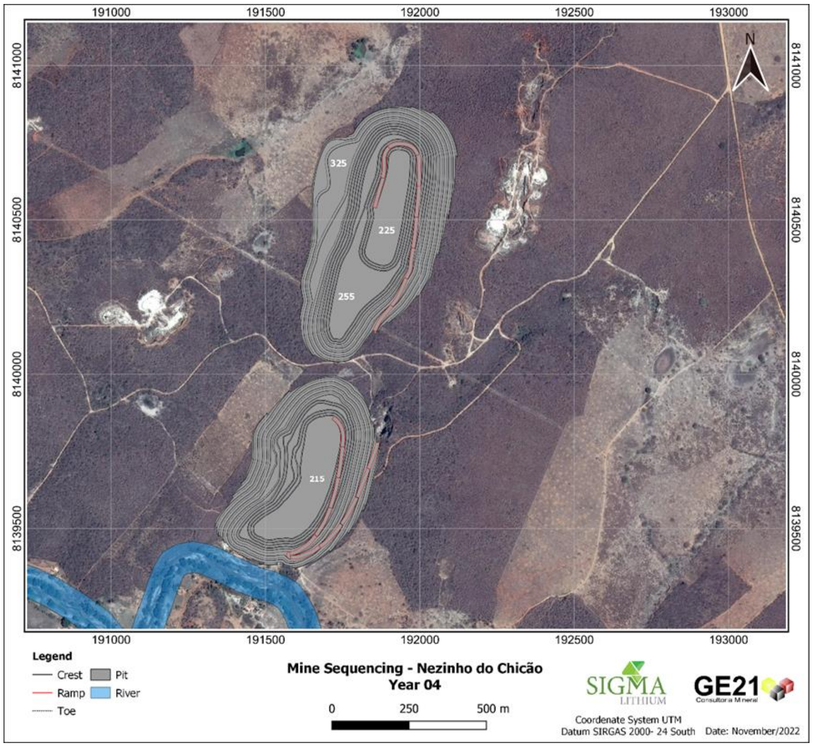


Figure 16-95: Pit Nezinho do Chicão - Year 04

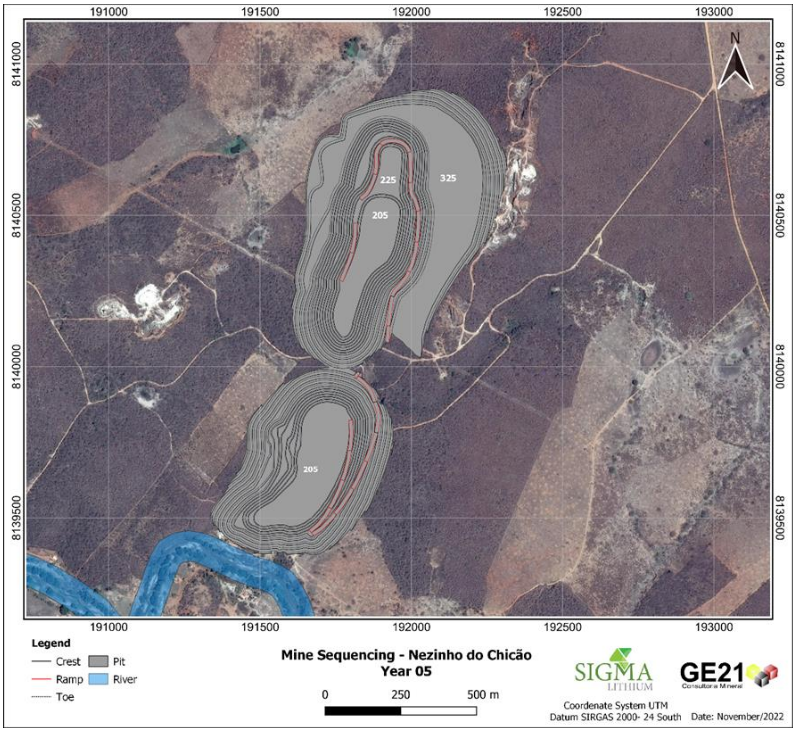


Figure 16-96: Pit Nezinho do Chicão - Year 05

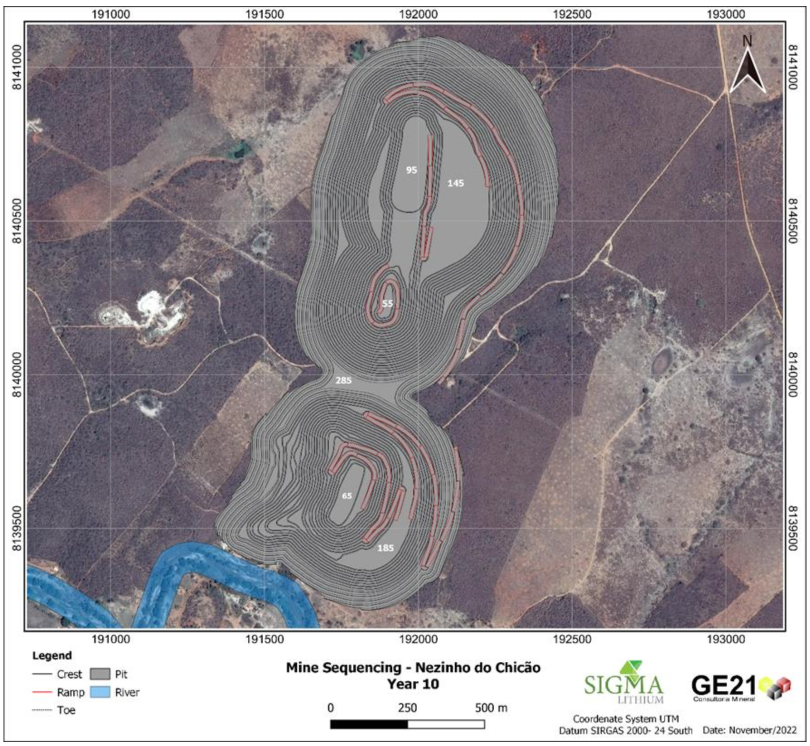


Figure 16-97: Pit Nezinho do Chicão - Year 10

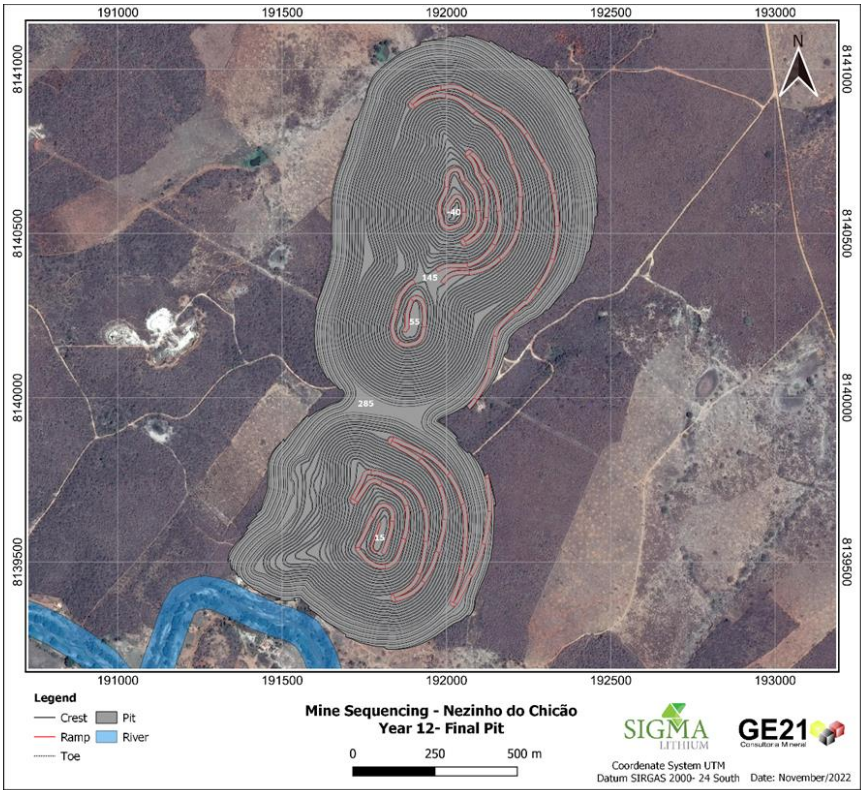


Figure 16-98: Pit Nezinho do Chicão - Year 12- Final Pit

16.9 MINE FLEET SIZING

At the Nezinho do Chicão deposit, the mining operations will be by a third-party contractor, with proven experience with similar sized operations in Brazil. In order to select the mining operations contractor, operational work technical specifications were compiled and forwarded to the companies for technical and commercial proposals. After selecting the company and signing a contract, the work of mobilization and construction of the construction site would begin.

The run of mine (ROM) will be drilled, blasted, loaded, and transported by trucks to the ROM pad, near to the primary crusher. The ROM will be loaded by a wheel loader and fed into the primary crusher. The ore will be loaded by a wheel loader and fed into the primary crusher. The oversize material, >800 mm, will be fragmented by a rockbreaker installed adjacent to the crusher grizzly grate. A minimum ore stockpile of around 30,000 t will be kept in the ROM yard, with the aim of stabilizing the supply of feed to the plant when the mine production rate decreases or stops. This also helps to maintain the mine's ore production rate should the primary crusher have unscheduled production stops.

Ore below the cut-off grade will be blasted, loaded, and transported to specifically delimited discharge points within the waste disposal pile.

The percentage of material drilled and blasted is expected to be:

- Ore: 100%
- Soil: 5%

- Weathered rock (Saprolite) and Fresh Rock: 85% - 100%

The main mining activities will be:

- Digging or rock blasting of ore and waste
- Excavation, loading and transport of ore and waste
- Disposal of ore in the ROM yard and waste in the waste dump
- Construction and maintenance of all internal accesses to the pit(s) and the waste dumps
- Maintenance of the floor, drainage, coating and signaling of all access roads used in the operation
- Implementation and maintenance of the mine's surface drainage systems at access points to the mining operation, waste deposit, ore yard and other areas linked to mining operations
- Execution of mine infrastructure services, such as: construction and maintenance of accesses to the mining areas, crusher, waste dump, workshops and offices, mine drainage services, access signaling, mine dewatering, etc.
- Feeding the primary crusher at an average rate of 320 tph, performed by wheel loader
- Build and maintain the operation support facilities (offices, workshops, cafeteria, living quarters, warehouses, changing rooms, bathrooms, septic tanks, environmental, health and safety emergency (HSE), explosive magazine, electrical and hydraulic installations, and others, in strict accordance with the Brazilian environmental standards and labour laws

16.9.1 Equipment

For the execution of mining activities, the equipment used must be in full working order, always observing the technical standards necessary for the services to be carried out safely. The equipment must comply with the respective Maintenance and Inspection Plans, as well as carrying out scheduled shutdowns for preventive and predictive maintenance. The proposed equipment to be used in the mine will have high operational reliability and provide comfort and safety to operators.

Table 16-48 shows the schedule of the main equipment to be used at Nezinho do Chicão, while Table 16-49 shows the designed production of ore and waste tonnages and the percentage of material to be blasted.

Table 16-48: Schedule of Primary Mining Equipment

Mining Fleet	Reference Model	Year											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Hydraulic Excavator	CAT 374	3	4	6	7	9	15	15	15	15	14	5	5
Haul Truck	Heavy Tipper G500	19	24	33	35	46	85	86	86	86	85	41	40
Drilling Machine	Sandvik DP 1500	3	4	5	5	7	11	12	12	12	12	5	4
Wheel Loader	CAT 966	2	2	2	2	2	2	2	2	2	2	2	2
Bulldozer CAT D8 T - Caterpillar	D8T	1	1	2	2	3	4	4	4	4	4	2	2
Bulldozer CAT D6 T - Caterpillar	D6T	1	1	2	2	3	5	5	5	5	5	2	2
Grader - Komatsu	GD 655	1	1	2	2	3	4	4	4	4	4	2	2
Operation Support Truck - Scania	P360	1	1	2	2	3	4	4	4	4	4	2	2
Water Truck (20.000 l) - Mercedes	Axor 3131	1	2	2	3	3	5	5	5	5	5	2	2
Backhoe Excavator - JVC	3C	1	1	1	2	2	3	3	3	3	3	1	1
Hydraulic Hammer - Komatsu	PC 350	1	1	2	2	2	3	3	3	3	3	1	1
Forklift - Hyster	H135-155FT	1	1	1	2	2	3	3	3	3	3	1	1
Blasting Support Truck - Scania	P360	1	1	2	2	2	3	3	3	3	3	1	1
Fuel and Lube Truck - Mercedes	Axor 3131 / Mastercom	1	1	2	2	2	3	3	3	3	3	1	1
Crane Truck	Axor 3131 / Argos 12,5	1	1	2	2	2	3	3	3	3	3	1	1
Crane (30 t of capacity) - SANYI	STC 300S	1	1	1	1	1	1	1	1	1	1	1	1
Portable Lightning Tower - Pramac	LM	2	2	3	4	5	8	8	8	8	7	3	3
Light Vehicle - Mitsubish	L 200	6	6	6	6	6	6	6	6	6	6	6	6
Total		**47**	**55**	**76**	**83**	**103**	**168**	**170**	**170**	**170**	**167**	**78**	**76**

Table 16-49: Ore and Waste Wet Basis Production and percentage of material to be blasted

Production / Year	**Year**												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
Total ROM x 1,000 t - Wet Basis	1.600	1.899	1.906	1.905	1.917	1.895	1.895	1.895	1.895	1.895	1.900	1.702	**22.304**
DMT ROM - Km	10,6	10,8	11,1	11,0	11,1	12,0	11,9	11,9	11,9	12,0	12,8	12,8	11,7
Total Waste x1,000 t - Wet Basis	8.105	11.579	17.158	19.684	27.789	48.632	48.632	48.632	48.632	48.632	14.737	14.737	**356.947**
DMT Estéril - Km	2,1	1,9	2,0	1,9	1,9	2,5	2,5	2,5	2,5	2,5	3,8	3,9	2,5
Hard Ore o be blasted x 1,000 t	1.600	1.899	1.906	1.905	1.917	1.895	1.895	1.895	1.895	1.895	1.900	1.702	22.304
Hard Waste to be blasted x1,000 t	6.241	9.333	14.756	17.106	24.399	42.261	42.699	44.012	44.012	44.012	13.337	13.337	315.502
Total to be blasted	7.841	11.232	16.662	19.010	26.316	44.156	44.593	45.907	45.907	45.907	15.237	15.039	337.806
% Hard ROM to be blasted	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
% Hard Waste to be blasted	77%	81%	86%	87%	88%	87%	88%	91%	91%	91%	91%	91%	88%
Stripping Ratio (t/t)	5,07	6,10	9,00	10,33	14,50	25,67	25,67	25,66	25,66	25,66	7,76	8,66	16,00
Total Earthmoving - 1,000 t	**9.705**	**13.478**	**19.064**	**21.589**	**29.707**	**50.526**	**50.526**	**50.527**	**50.527**	**50.527**	**16.637**	**16.439**	**379.251**

16.9.2 Operations

Mining will commence after the removal and storage of topsoil and waste overburden material. Small excavators will be used initially for drainage work, digging trenches, minor material removal and material disposal. A hydraulic excavator equipped with a 4.4 m³ bucket was selected. For transport, road trucks (8X4) with a capacity of 40 t are planned.

16.9.2.1 Loading, Transporting and Unloading

The ore and waste will be blasted, loaded by excavators, transported by trucks with a capacity of 40 t and unloaded on the ROM pad and waste dump respectively. If necessary, a hydraulic rockbreaker will be used to break oversize rock larger than the opening of the crusher's fixed grizzly grid.

The process plant will be fed at an average rate of 320tph, 24 hours per day, 7 days per week.

It is estimated that 100% of the ore, and 87% of the waste tonnage must be blasted using explosives.

As an initial assumption, a drilling diameter of 4 inches was adopted for ore with 5-metre-high benches and 5.5 inches for waste at 10 m high benches.

A careful analysis of the characteristics of the Nezinho do Chicão deposit was performed to determine the most appropriate drilling equipment, as shown in Table 16-50.

Table 16-50: Drilling Equipment for Nezinho do Chicão Pit

Brand	Model	Diameter		Type
		mm	inch	
Sandvik	DP 1500	102 to 140	4.0 – 5.5	Production

The drilling operation will be supported by a bulldozer and/or hydraulic excavator to carry out cleaning activities in the drilling areas, construction of access points to the drilling area, as well as the use of a hydraulic hammer coupled to the hydraulic excavator for rock handling in the operational area.

The rock blasting work comprises primary and secondary blasting and a hydraulic hammer will be used as required.

16.9.3 Explosives Supply

The provision of explosives and the execution of blasting services will be carried out by a subcontractor specializing in blasting, under the guidance of Sigma mine management.

For the Nezinho do Chicão mine, where appropriate, pumped slurry explosives, stemming and non-electrical detonation accessories and electronic accessories will be used.

During the mine operation, the daily blasting plans will be prepared by SMSA´s technical team and the results will be evaluated, and any necessary adjustments made to improve blasting effectiveness.

16.9.4 Explosive Magazine and Accessories

The explosive magazines will be supplied and built by the company contracted to perform the mining activities. This company will supply and maintain a remote security system, following the guidelines of ORDINANCE No. 147 - COLOG, of November 21, 2019, which provides the administrative procedures for the use and storage of explosives and accessories, as well as ORDINANCE No. 56 - COLOG, of June 5, 2017, which provides the administrative procedures related to registration with the army for the use and storage of army-controlled products (PCE).

Area security will be established through compliance with the minimum distances from the storage location to inhabited areas, railways, or highways, according to distances established in the regulation for the Inspection of Controlled Products (R-105). To this end, the plan for transporting, handling and storage of explosives and explosive accessories will be reviewed by SMSA management together with GE21 so that all conditions are fully complied.

The security of products controlled by the army (PCE) will be guaranteed through the adoption of measures against deviations, loss, theft, and theft against obtaining knowledge about activities with PCE, in order to avoid their use in the practice of illicit acts. These measures will be included in the Security Plan.

Access control will be carried out electronically, 24 hours a day, covering storage and access areas. For this, cameras connected to a remote base will be used and monitored online.

The facilities will undergo regular internal inspection to ensure the integrity of the active and passive protection systems. In the case of accidents of any nature, the Security Plan will determine the procedures related to the simultaneous activation of the competent public security bodies, including military and civil police, army and fire department.

Contingency measures will be adopted in the event of accidents or detection of illegal practices with explosives, including information to the inspection of army-controlled products (PCE). In these situations, quick and safe activation of the monitoring center and competent authorities listed in the Security Plan will be adopted.

For the storage of explosive and blasting accessories, a Rustic Mobile Storage container, installed in accordance with Technical-Administrative Instruction No. 18/99-DFPC, is planned as shown in Figure 16-49. This structure consists of a box truck or adapted container located in a fenced and monitored area, under the same security and monitoring conditions applied to the explosive magazine as shown in Figure 16-50.

16.9.5 Fleet Monitoring System

The fleet monitoring system (dispatch) to the Nezinho do Chicão mine will be carried out through an electronic system that allows the monitoring and management of the mine's operation in real time. Sigma will work with solutions that allow for the monitoring, management, and optimization of the truck fleet. Using the most advanced hardware, the software monitors and manages each piece of equipment at all stages of the mining production cycle. The software uses algorithms that provide solutions to maximizing productivity and reduce operating costs.

A monitoring device is installed in each piece of equipment (excavator and truck) that is responsible for sending various information to the control centre, including: location, status of equipment, etc. A communication network will be established between the monitoring equipment, antennas, and the control centre, this enables the monitoring of the entire mine fleet, operations, and production with a high level of detail.

16.9.6 Work Shifts

The mine workforce teams will work in various shift schedules. The administrative group will work 9 hours a day from Monday to Friday, with 1 hour off for a meal, and 4 hours on Saturday mornings. The operational team will work 7 days a week, 24 hours a day, in a 6x2 shift scheme, where the employees work 6 days consecutively, for 9 hours per shift, and then have 2 days off. This method of shift work provides uninterrupted work and is in accordance with Brazilian labour legislation. The explosives supplier will work 5 days per week.

16.9.7 Labour Mining

SMSA is committed to prioritizing the hiring of local labour.

Table 16-51 lists the expected annual labour requirements for the 12 years of mine life; these expectations will be adjusted as required during the mining operation.

Table 16-51: Nezinho do Chicão Staffing

Position	Shift	Nº Teams	Year											
Operation Team			**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
General Manager	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mining Manager	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mine Planning Manager	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Environmental & Safety Manager	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mine Planning Supervisor	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Geology Supervisor	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Safety Supervisor	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Environmental Supervisor	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Contract Coordinator	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Senior Mine Engineer	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Mine Planner	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Geotechnical	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Senior Geologist	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Junior Mine Engineer	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Junior Mine Planner	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Junior Geologist	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Maintenance Engineer	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Dispatch Technician	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Dispatcher	3	4	4	4	4	4	4	4	4	4	4	4	4	4
Team Leader Mine Training & Development	1	2	1	1	1	1	1	1	1	1	1	1	1	1
Camp Support Officer & Data Technician	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Surveyor	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Assistant Surveyor	1	1	8	8	8	8	8	8	8	8	8	8	8	8
Ore Sampler	3	4	4	4	4	4	4	4	4	4	4	4	4	4
Field Inspector														
Sub Total			**55**	**55**	**55**	**55**	**55**	**55**	**55**	**55**	**55**	**55**	**55**	**55**
Operators	**Shift**	**Nº Teams**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Hydraulic Excavator	3	4	12	16	24	28	36	60	60	60	60	56	20	20
Haul Truck	3	4	76	96	132	140	184	340	344	344	344	340	164	160
Drilling Machine	3	4	12	16	20	20	28	44	48	48	48	48	20	16
Wheel Loader	3	4	8	8	8	8	8	8	8	8	8	8	8	8

Bulldozer CAT D8 T - Caterpillar	3	4	4	4	8	8	12	16	16	16	16	16	8	8
Bulldozer CAT D6 T - Caterpillar	3	4	4	5	8	9	12	20	20	20	20	19	7	7
Grader - Komatsu	3	4	4	4	8	8	12	16	16	16	16	16	8	8
Operation Support Truck - Scania	3	4	4	4	8	8	12	16	16	16	16	16	8	8
Water Truck (20.000 l) - Mercedes	3	4	4	8	8	12	12	20	20	20	20	20	8	8
Backhoe Excavator - JVC	3	4	4	4	4	8	8	12	12	12	12	12	4	4
Hydraulic Hammer - Komatsu	3	4	4	4	8	8	8	12	12	12	12	12	4	4
Forklift - Hyster	2	2	2	2	2	4	4	6	6	6	6	6	2	2
Blasting Support Truck - Scania	3	4	4	4	8	8	8	12	12	12	12	12	4	4
Fuel and Lube Truck - Mercedes	3	4	4	4	8	8	8	12	12	12	12	12	4	4
Crane Truck	3	4	4	4	8	8	8	12	12	12	12	12	4	4
Crane (30 t of capacity) - SANYI	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Portable Lightning Tower - Pramac	1	1	2	2	3	4	5	8	8	8	8	7	3	3
Light Vehicle - Mitsubish	1	1	6	6	6	6	6	6	6	6	6	6	6	6
Detonation operator	1	2	12	12	12	12	18	18	18	18	18	18	18	12
Subtotal Operation			**171**	**204**	**284**	**308**	**390**	**639**	**647**	**647**	**647**	**637**	**300**	**286**
Maintenance team														
Mechanical Technician	3	4	9	11	15	17	21	34	34	34	34	33	16	15
Electrical Technician	2	2	2	3	4	4	5	8	8	8	8	8	4	4
Auxiliary Mechanical	3	4	9	11	15	17	21	34	34	34	34	33	16	15
Auxiliary Electrician	2	2	2	3	4	4	5	8	8	8	8	8	4	4
Welding Technician	2	2	2	2	3	3	4	7	7	7	7	7	3	3
Tyre Repairman	1	1	2	3	4	4	5	8	8	8	8	8	4	4
Maintenance Assistant	1	2	5	6	8	8	10	17	17	17	17	17	8	8
Maintenance Management & Control	1	1	2	3	4	4	5	8	8	8	8	8	4	4
Subtotal Maintenance			**34**	**41**	**56**	**61**	**76**	**124**	**125**	**125**	**125**	**123**	**58**	**56**
Absenteeism (4%)			**8**	**10**	**14**	**15**	**19**	**30**	**31**	**31**	**31**	**30**	**14**	**14**
Vacation Team			**19**	**23**	**32**	**35**	**44**	**72**	**73**	**73**	**73**	**72**	**34**	**32**
Total General			**287**	**333**	**441**	**474**	**583**	**920**	**931**	**931**	**931**	**917**	**461**	**444**

16.9.8 Labour and Equipment

For the mobilization of technical and operation's manpower, priority will be given to local people and those living near Araçuaí & Itinga municipalities, and the following criteria:

- Recruitment
- Selection
- Conducting admission exams
- SMSA integration
- Introductory equipment/vehicle training
- Initiation into assisted operation
- Final aptitude test

16.9.9 Site Construction

The construction site will consist of:

- Mine Office
- Meeting room
- Control room
- Auditorium
- Cafeteria
- Changing rooms
- First aid post
- Warehouse
- Workshop
- Washing ramp
- Oil and grease storage area
- Fuel storage area
- Recreation area
- Explosive magazine

The total area of mine infrastructure for NDC will be approximately 1,390 m^2, and the total area that the buildings will occupy is approximately 1.5 hectares.

All built-up areas will have waterproof flooring, so that there is no risk of soil contamination from the operations, especially in the workshop and washing ramp. The runoff from the roofs will be drained into the gutters to supply the cistern, which will be used at the washing ramp. After using the water in the washing ramp, the water will be sent to the effluent treatment station, which starts in the decanter, followed by the oil and grease separator box with capacity of $20m^3$/day.

The water and oil separator system must operate at a flow rate of $20m^3$/day, which complies with the ABNT NBR 14605 standard and the ASTM D 6104/03 international standard. The analysis standards to verify the efficiency and quality of the water must follow the CONAMA Resolution No. 357/2005 for the parameters of oils and greases. After treatment the water will be pumped back to the process water tank.

16.9.10 Wastewater Treatment

Step 1: The effluent from the drains (channels) from the workshop, washing ramp and oil deposit, oil and grease separator stage, will be drained to the decanter where it will undergo the first sedimentation process. The process consists of separating solid particles from water by the action of gravity. The flow velocity of the liquid is reduced, favoring the sedimentation of these particles. The water enters the next step, which further separates the suspended solids. The solids from the first process are deposited at the bottom of the decanter, where they will be periodically removed.

Step 2: In the module for separation of solids (MSS) the solids coming from the water used to wash the equipment are separated by the process of gravity and sedimentation of the particles. This process removes the remaining particulate matter suspended in the fluid, allowing oil and water to flow to the next stage, avoiding the silting of the remaining procedure. Solids will be removed and stored in an appropriate place.

Step 3: The water and oil separator box (WOSB) receive all the effluent from the MSS process. This system has, among others, two basic constituents: water and oil. The process of separating water and oil occurs by density difference. The clean water will be released into the rainwater drainage network. Periodically (biannually) samples will be collected at the final outlet, the third box of the water and oil separation system, so that the efficiency of the system and the quality of the effluent is known.

Step 4: The supernatant oil goes to the oil collection reservoir (OCR) to be removed and sent for recycling. Used oils will be sent to a certified and approved company, with the relevant documentation and authorization, in accordance with the applicable legal requirements. Likewise, tailings will be monitored, in relation to quantity and classification, and recorded in the waste inventory worksheet of the Sigma integrated management system.

Step 5: Contaminated oil and grease residues (Class I) must be packed in properly identified drums and sent to an appropriate collection company. This waste output will be registered by Sigma by filling out the waste transport manifest (MTR), according to the waste management procedure.

Figure 16-51 shows a schematic of the model to be built for the water treatment of effluent from the washing ramp and the modules of the water and oil separator box.

16.9.11 Solid Waste Management

To meet the demand for internal solid waste generation, SMSA will have a waste deposit located next to the oil storage structure, physically separated in accordance with safety standards, such as physical divisions, roof, waterproofed floor, channels, and drains. Next to this will be located waste disposal bays for items such as plastic, paper/cardboard, metals, glass, and contaminated waste (towels, filters, PPE, etc.). Tires must be stored inside the warehouse until they are sent to their final destination off site. Organic waste must be delivered to locations properly prepared to receive this type of material. Figure 16-52 shows the solid waste temporary storage layout.

According to ABNT NBR 10.004 - Waste Classification, waste must be collected, segregated/packaged, and sent to the final destination, to companies licensed by the appropriate environmental agency. Periodically, SMSA will be monitoring their waste generation, and checking the internal waste inventory worksheet, a tool that it uses within the integrated management system.

The effluent treatment stations will have a certificate of Technical Function Annotation (AFT) of the person responsible and duly qualified.

16.9.12 Site Access

The construction of site access necessary to start ore mining operations, waste removal, access to the waste dump and marginal ore, auxiliary accesses and others that may be required will be carried out according to the specific project’s requirements.

If necessary, land clearing, including the removal of trees, undergrowth and debris will be performed using a D6T crawler tractor with ripper. The material removed will be loaded with a 35t excavator and transported with trucks with a capacity of 20m³.

The leveling of accesses, considering slope and slope for land drainage will be carried out through cutting and filling using a D6T crawler tractor, 35 t and 55 t excavator, 20m³ trucks, grader, and water trucks. Low strength soils will be replaced. Surface drainage and construction of berms will be carried out with a 20 t excavator.

16.9.13 Road Construction and Maintenance

The construction and maintenance of site roads will require the following:

- Initial construction of the roads
- Water and storm drainage
- Construction of safety berms
- Reflective signage
- Dust suppression

16.9.14 Excavation, Loading, Transport and Soil Treatment

The excavation stage will start after the removal and storage of the topsoil.

As the excavation progresses, drainage systems will be installed to avoid the accumulation of rainfall.

It is planned to mobilize a 20 t excavator for drainage services, trench excavation, material disposal and small handling. 70 t and 45 t excavators will be used according to the volume requirements for large and medium volumes. For transport, 8x4 trucks, with a capacity of 40 t, will be used, allowing for productivity and safety.

16.9.15 Drilling and Blasting

The geology and rock types at the Nezinho do Chicão deposit are crucial for defining drilling and blasting parameters, which relates to mining recovery.

It is important to know the limits of the ore body to minimize dilution and losses. SMSA will have a geologist as part of its technical staff who will work directly with the drilling, blasting and loading teams. Employees who are directly involved in activities related to optimizing the mining recovery, such as drill operators, drilling assistants, rock blasting team, and excavator operators, will be trained to recognize minerals to avoid deviation from planned mineral boundaries.

As this is a greenfield project, it is foreseeable that SMSA's technical teams will go through a learning period based on the empirical results acquired with operation commencement. Naturally, changes to rock blast parameters and operating methods will be required. Consideration should be given not only to the complexity of the geological formation and the operational challenges resulting from this condition, but also to the context of the environment in which the mine will be located.

Previous studies (pre-blast survey) before the first blasting should be developed to establish the minimum distances between pre-existing structures that will be kept and the blasted benches. As a result, restrictions or opportunities relating to the maximum load per drill hole may be revealed, which may indicate the maximum blasthole diameter, as well as the type of accessories used. These factors, among others, may imply technical and commercial adjustments throughout the life of the mine operation, Table 16-52 and Table 16-53 detail the drilling and blasting for ore and waste respectively.

Table 16-52: Preliminary Blasting Plan: Ore

Ore Blast design	Unit	Value											
Bench height	m	5,00											
Blast hole diameter	(')	4											
Blast hole diameter	m	0,102											
Burden	m	2,50											
Spacing	m	3,00											
Subdrill	m	0,50											
Total hole depth	m	5,50											
Stemming	m	1,30											
Bottom charge	m												
Column charge	m	4,20											
Explosive density	g/cm³	1,21											
Specific charge	kg/ml	9,80											
Hole charge	kg/hole	41,15											
Volume per hole	m3	41,25											
Tonnes per hole	t	116,94											
Powder factor	kg/m³	1,00											
Powder factor	Kg/t	0,35											
Ore Detonation data	**Unit**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Blasted Material – wet basis	1.000 t	1.600	1.899	1.906	1.905	1.917	1.895	1.895	1.895	1.895	1.895	1.900	1.702
Volume	1.000 m³	564	670	672	672	676	668	668	668	668	669	670	600
Number of hole/year	unit	13.683	16.238	16.300	16.289	16.393	16.202	16.203	16.205	16.204	16.207	16.247	14.552
Number of hole/week	unit	263	312	313	313	315	312	312	312	312	312	312	280
Number of hole / day	unit	37	44	45	45	45	44	44	44	44	44	45	40
Days per week available to detonation	5												
Blast design													
Number of hole / day	unit	37	44	45	45	45	44	44	44	44	44	45	40
Number Detonation per day	unit	2	3	3	3	2	2	2	2	2	2	2	2
holes per detonation	unit	19	15	15	15	22	22	22	22	22	22	22	20
Tones per day	t	6.154	7.304	7.331	7.327	7.373	7.288	7.288	7.289	7.288	7.290	7.308	6.545

		Year											
Ore Consumption		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
60% Emulsion/40% ANFO - 1.21 g/cm3	Kg x 1,000	563	668	671	670	675	667	667	667	667	667	669	599
Booster 250 g	unit	12.315	14.615	14.670	14.660	14.754	14.582	14.582	14.584	14.584	14.586	14.622	13.097
Detonating cord	m	41.049	48.715	48.899	48.867	49.180	48.607	48.608	48.614	48.612	48.620	48.741	43.655
Non Electric detonator	unit	282	335	336	336	338	334	334	334	334	334	335	300
Burning fuse	unit	520	780	780	780	520	520	520	520	520	520	520	520
Kg Explosive / t detonated	Kg/t	0,35	0,35	0,35	0,35	0,35	0,35	0,35	0,35	0,35	0,35	0,35	0,35

Table 16-53: Preliminary Blasting Plan: Waste

Waste Blast design	Unit	Value
Bench height	m	10,00
Blast hole diameter	(')	5,5
Blast hole diameter	m	0,140
Burden	m	3,50
Spacing	m	4,20
Subdrill	m	1,00
Total hole depth	m	11,00
Stemming	m	1,50
Bottom charge	m	
Column charge	m	9,50
Explosive density	g/cm³	1,21
Specific charge	kg/ml	18,52
Hole charge	kg/hole	175,96
Volume per hole	m3	161,70
Tonnes per hole	t	458,42
Powder factor	kg/m³	1,09
Powder factor	Kg/t	0,38

Waste Blast data	Unit	1	2	3	4	5	6	7	8	9	10	11	12
Blasted Material	1.000 t	6.241	9.333	14.756	17.106	24.399	42.261	42.699	44.012	44.012	44.012	13.337	13.337
Volume	1.000 m³	2.340	3.499	5.533	6.414	9.149	15.846	16.010	16.502	16.502	16.502	5.001	5.001
Number of hole/year	unit	14.472	21.641	34.216	39.665	56.577	97.995	99.010	102.055	102.055	102.055	30.926	30.926
Number of hole/week	unit	278	416	658	763	1.088	1.885	1.904	1.963	1.963	1.963	595	595
Number of hole / day	unit	40	59	94	109	155	268	271	280	280	280	85	85
Days per week available to detonation	5												
Blast design													
Number of hole / day	unit	40	59	94	109	155	268	271	280	280	280	85	85
Number Detonation per day	unit	1	2	2	2	2	2	2	2	2	2	2	2
holes per detonation	unit	40	30	47	54	78	134	136	140	140	140	42	42
Tones per day	t	24.004	35.895	56.753	65.791	93.843	162.542	164.225	169.275	169.275	169.275	51.296	51.296

		Year											
Waste Consumption		1	2	3	4	5	6	7	8	9	10	11	12
60% Emulsion/40% ANFO - 1.21 g/cm3	Kg x 1,000	2.396	3.582	5.664	6.566	9.365	16.221	16.389	16.893	16.893	16.893	5.119	5.119
Booster 250 g	unit	13.025	19.477	30.794	35.698	50.920	88.196	89.109	91.849	91.849	91.849	27.833	27.833
Detonating cord	m	60.782	90.891	143.707	166.592	237.624	411.580	415.843	428.631	428.631	428.631	129.888	129.888
Non Electric detonator	unit	1.170	1.750	2.766	3.207	4.574	7.923	8.005	8.251	8.251	8.251	2.500	2.500
Burning fuse	unit	260	520	520	520	520	520	520	520	520	520	520	520
Kg Explosive / t detonated	Kg/t	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38	0,38

Based upon the rock characteristics and operating parameters, the top hammer drilling method has been chosen. Due to experience with and availability of the equipment, tools, original replacement parts, and technical services, the authors recommend the Sandvik equipment listed in Table 16-54.

Table 16-54: List of Selected Equipment

Size	Brand	Series	Model	Hammer	Diameter		Type
					mm	inch	
23 t	Sandvik	Pantera	DP1500	Top	102 to 140	4.0” a 5.5”	Production, pre-split, occasional services
16 t	Sandvik	Ranger	DX800	Top	76 to 114	3.0” a 4.5”	Production, pre-split, secondary blasts

Using the parameters established for blasting, it was possible to calculate the drills requirements needed to meet the planned production schedule for the Nezinho do Chicão mine.

A drop in physical availability over time due to the natural wear and tear and increased use of the equipment once the mine is operational is expected. An efficiency factor was also included for the learning period needed by the operational team and for optimization of operations over time.

If the fleet has operational variations throughout the mine life, it is understood that operations planning will be adjusted, making it possible to optimize the available resources.

If it is necessary to implement different grids than was originally planned or to add slope preservation methods, such as damping lines, pre-cut or post-cut, the amount of drilling will tend to increase. Should an increase in the amount of drilling be required, the fleet and staff will be adequate to meet this demand.

The proposed top hammer drills have an operating cabin with ROPS/FOPS certification, air conditioning, acoustic insulation system, dust collector, hole cleaning air monitoring system, rod greasing system, angle and depth gauge, and water injection for dust control.

The drilling operation will be supported by a bulldozer and/or hydraulic excavator to carry out the cleaning and preparation of the drilling benches, access construction to the drilling benches, as well as a hydraulic rock breaker coupled to the hydraulic excavator to remove blocks in the operational area.

16.9.16 Blasting Plan

During the operation, the daily blast plans will be prepared by the explosive supplier’s technical staff. These plans will be analysed and validated by the SMSA rock blasting team.

After each blast, the blast plan will be updated according with the equipment quantities actually used. Physical and digital copies of all generated documentation will be kept, which will be available for audits or inspection by regulatory bodies.

16.9.17 Execution of Blasting

Rock blasts will be carried out on scheduled dates, the frequency of which will meet the demand for blasted ore and waste.

For all rock blasting, the authorities will also be previously communicated through the Rock Blasting Notice, as per Annex of ORDINANCE No. 147 - COLOG, of November 21, 2019.

16.9.18 Fragmentation Control

The fragmentation control will be carried out through specialized software, generating granulometric distribution curves from photographic records. This monitoring allows for blast pattern adjustments, sequencing and other parameters according to the results history. Monitoring will be carried out on a monthly basis for rock blasting and/or whenever the contractor's technical team deems is necessary to optimize the operation.

Figure 16-53 shows an example of image analysis and particle size distribution calculation using granulometric distribution curves.

The blasts will be filmed with high-definition cameras that allow a detailed visual assessment of factors such as detonation sequencing, mass displacement, top stemming efficiency and ultra-launch.

17 RECOVERY METHODS

17.1 PROCESSING OVERVIEW

The Xuxa concentrator will be located approximately 1.5 km northeast of the Xuxa open pits. The spodumene concentrate will be produced by DMS. The DMS plant is designed based on Xuxa design parameters and will produce a spodumene concentrate with a target grade of 6.0% Li_2O. The Xuxa plant throughput capacity is based on 1.7 Mtpa (dry) of ore fed to the crushing circuit.

A second DMS concentrator would be constructed to process the Barreiro ore (Phase 2). This plant would produce a spodumene concentrate with a target grade of 6.0% Li_2O from an ore grade of 1.39% Li_2O (diluted). The Barreiro plant throughput capacity is based on 1.85 Mtpa (dry) of ore fed to the crushing circuit.

Phase 3 involves either a third DMS concentrator to be constructed, or a combined Barreiro and NDC plant. The stand alone NDC plant would be a duplicate of the PEA Barreiro design, with a plant capacity based on 1.85 Mtpa (dry) of ore fed to the crushing circuit and an ore grade of 1.45% Li_2O (diluted). The combined plant throughput capacity is 3.9 Mtpa (dry) of ore fed to a dedicated crushing circuit from both the Barreiro and NDC ore bodies. The plant is designed to produce a combined spodumene and petalite concentrate of 5.5% Li_2O.

17.2 NEZINHO DO CHICAO TRADE-OFF UPDATE

As part of the Nezinho do Chicao design, a number of studies were completed to define and plan the scope of work for Phase 2 and Phase 3 of the project. The study builds on the previous work done for Xuxa FEED estimates and the Barreiro PFS.

Three scenarios were analyzed in the study through an economic assessment of the three phases of the project. The three plant scenarios are:

- Scenario 1: Phase 1 (Existing Xuxa Plant) and Phase 2 (Barreiro Plant - as per PFS) - the addition of a scavenger (Petalite) DMS circuit in year 8
- Scenario 2: Phase 1 (Existing Xuxa Plant) + Phase 2 (New Barreiro Plant - with petalite DMS circuit) + Phase 3 (Duplicate Barreiro Plant with a petalite DMS circuit for the NDC ore body)
- Scenario 3: Phase 1 (Existing Xuxa Plant) + Phase 2 (Combined Barreiro & NDC, 3.9Mtpa)

A high-level mass balance of the various scenarios is presented in Table 17-1.

Table 17-1: High-Level Mass Balance for Scenario 1, 2 and 3

Scenario	Parameter	Unit	Phase 1 Xuxa	Phase 2 Barreiro	Phase 3 NDC
1	Crushing Throughput - Nom	Mtpa	1.7	1.85	N/A
	Crushing Throughput - Des	dtph	285	390	N/A
	Wet Plant Throughput - Nom	Mtpa	1.7	1.85	N/A
	Wet Plant Throughput - Des	dtph	250	250	N/A
	Process Water Demand	m³/hr	2500	2500	N/A
	Raw Water Demand	m³/hr	38.6	41.5	N/A
	Recrush Feed	dtph	23.8	15.2	N/A
	Coarse Scav DMS Feed	dtph	N/A	N/A	N/A
	Fine Scav DMS Feed	dtph	N/A	N/A	N/A
	UF Scav DMS Feed	dtph	N/A	N/A	N/A
	Wet Tails (Th. Fresh Feed)	dtph	37.9	39.6	N/A
	BFD		Figure 17 2	Figure 17 2	N/A
	Study/data Status	-	DFS	PFS	N/A
2	Crushing Throughput	Mtpa	1.7	1.85	1.85
	Crushing Throughput - Design	dtph	285	390	390
	Wet Plant Throughput	Mtpa	1.7	1.85	1.85
	Wet Plant Throughput - Design	dtph	250	250	250
	Process Water Demand	m³/hr	2500	2500	2500
	Raw Water Demand	m³/hr	38.6	41.5	41.5
	Recrush Feed	dtph	23.8	15.2	15.2
	Coarse Scav DMS Feed	dtph	N/A	58.7	58.7
	Fine Scav DMS Feed	dtph	N/A	30.2	30.2
	UF Scav DMS Feed	dtph	N/A	N/A	N/A
	Wet Tails (Th. Fresh Feed)	dtph	37.9	39.6	39.6
	BFD		Figure 17 2	Figure 17 2	Figure 17 2
	Study/data Status	-	DFS	PEA	PEA
3	Crushing Throughput	Mtpa	1.7	3.9	
	Crushing Throughput - Design	dtph	285	780	
	Wet Plant Throughput	Mtpa	1.7	3.9	
	Wet Plant Throughput - Design	dtph	250	530	
	Process Water Demand	m³/hr	2500	5300	
	Raw Water Demand	m³/hr	38.6	88.0	
	Recrush Feed	dtph	23.8	32.2	
	Coarse Scav DMS Feed	dtph	N/A	124.4	
	Fine Scav DMS Feed	dtph	N/A	64.0	
	UF Scav DMS Feed	dtph	N/A	N/A	
	Wet Tails (Th. Fresh Feed)	dtph	37.9	83.9	
	BFD		Figure 17 2	Figure 17 2	
	Study/data Status	-	DFS	PEA	

17.3 XUXA PROCESS PLANT (PHASE 1)

17.3.1 Description

The Xuxa 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 the coarse fraction
- Two-stage DMS circuit for the fines fraction with a magnetic separation step
- Two-stage DMS circuit for the ultrafines fraction with a magnetic separation step
- Re-crush circuit to recover lithium in middlings
- Thickening, filtration (belt filter) and dry stacking of hypofines fraction with the waste
- Tailings from the DMS plant trucked for co-disposal with the waste rock.

Figure 17 1 shows the planned layout for the crushing circuit and DMS plant.

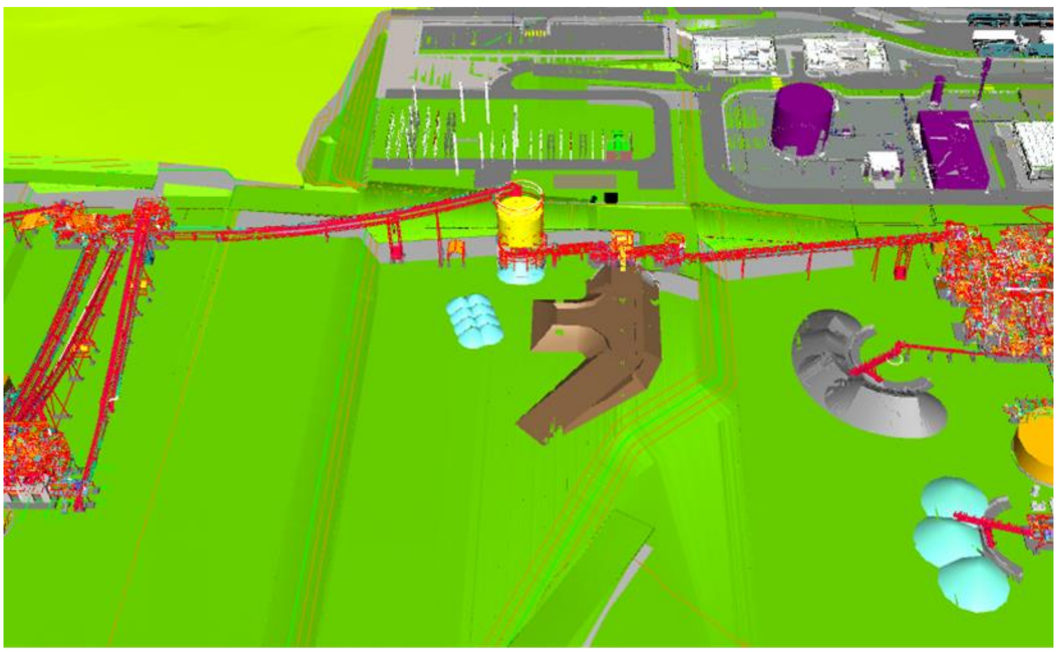


Figure 17-1: Xuxa Process Plant

Ore trucked from the mine will be stacked on ROM piles. A Front-End Loader (FEL) will feed material into the crusher feed bin, and an apron feeder will draw the material into the primary crusher. A magnet will remove any tramp metal as the material passes to the scalping screen. The scalping screen undersize material (<9.5 mm) is taken to the DMS feed bin. The oversize material passes to the secondary cone crusher for size reduction. The secondary cone crusher product is joined by the tertiary cone crusher product and directed to a classification screen. The undersize material (-9.5 mm) joins the scalping screen undersize on the DMS feed bin conveyor. The oversize material is conveyed to the tertiary cone crusher feed bin, which splits the material between the two tertiary cone crushers, for size reduction, before it returns to the classification screen.

The crushed ore bin provides an 8-hour live capacity buffer between the crusher and the wet plant for stable operation. An emergency feeder allows for wet plant feed in the case where the bin is not able to supply feed

The wet plant will consist principally of a two-stage DMS circuit for coarse fractions, two-stage DMS circuit for fines fraction and a two-stage DMS circuit for the ultrafines 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 ultrafines cyclone will report to a tailings stockpile.

The sinks from the secondary ultrafines DMS will report to the ultrafines 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 hypofines with the waste pile.

During FEED, the process mass balance and all technical documentation were updated to reflect the changes in design.

Figure 17-2 is a block flow diagram for the crushing circuit and the DMS plant.

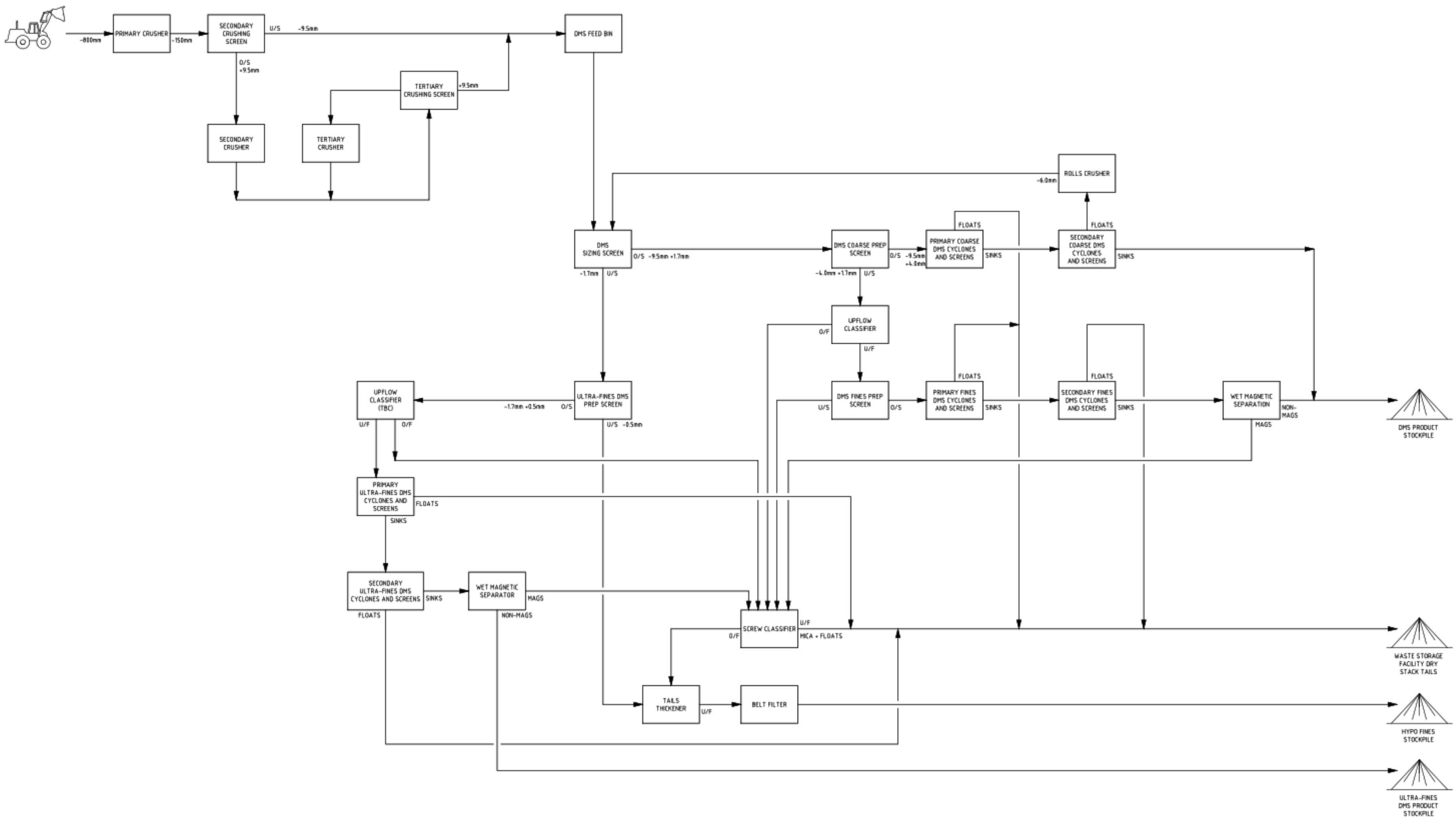


Figure 17-2: Block Flow Diagram for Xuxa Crushing Circuit and DMS Plant

17.3.2 Crushing Facilities

The Xuxa crushing circuit is a fixed plant operation and is designed to process a nominal throughput of 1.7 Mtpa. The crushing circuit will include a jaw crusher, scalping screen, secondary cone crusher, classification screen and two tertiary cone crushers. Crushed ore will be stored in a bin with reclaim feeder upstream of the wet-plant feed. The bin is sized for nominal eight hours storage with additional capacity via underflow stockpile and front-end loader reclaim to a hopper and feeder.

The primary crusher is designed to be fed via front end loader and can accommodate a nominal feed size up to 960 mm. Primary crushed ore feeds a double deck scalping screen where -9.5 mm material is removed to final crushed ore and +9.5 mm material is conveyed to a secondary crusher. Secondary crushed ore feeds a double deck classification screen where -9.5 mm material is combined with scalping screen undersize and conveyed to the crushed ore feed bin and +9.5 mm material feeds two tertiary crushers. Tertiary crushed material combines with secondary crushed material feeding the classification screen. When the crushing plant is not operating, the DMS plant may be fed via front end loader from stockpiles from an emergency feed bin and feeder.

Figure 17-3 and Figure 17-4 show the crushing circuit and DMS plant layouts.

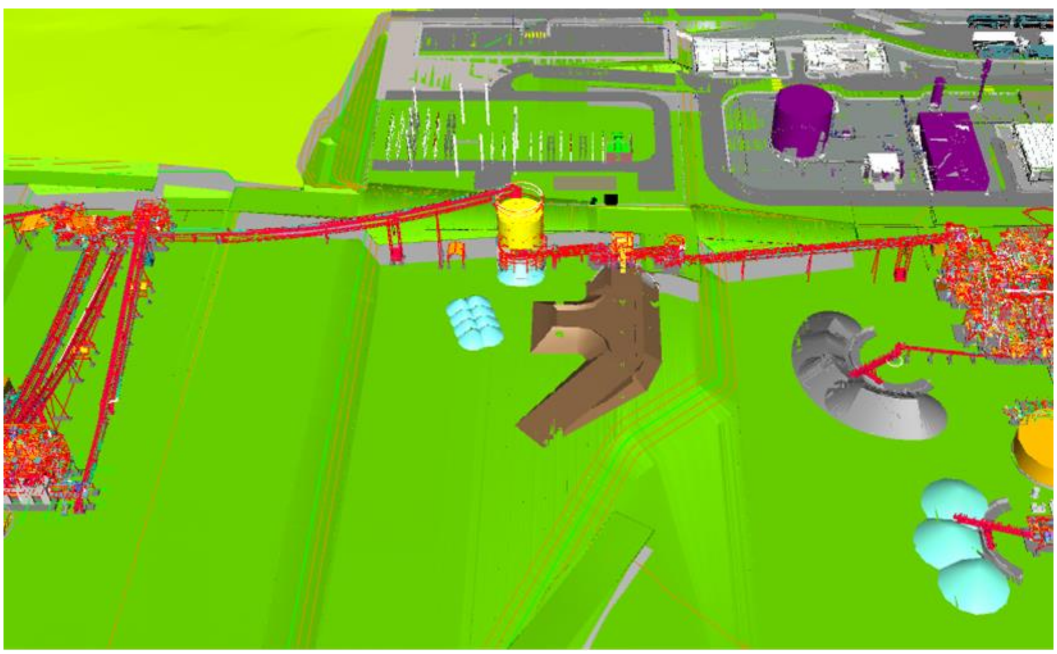


Figure 17-3: Sigma Crushing and DMS Plant Overview

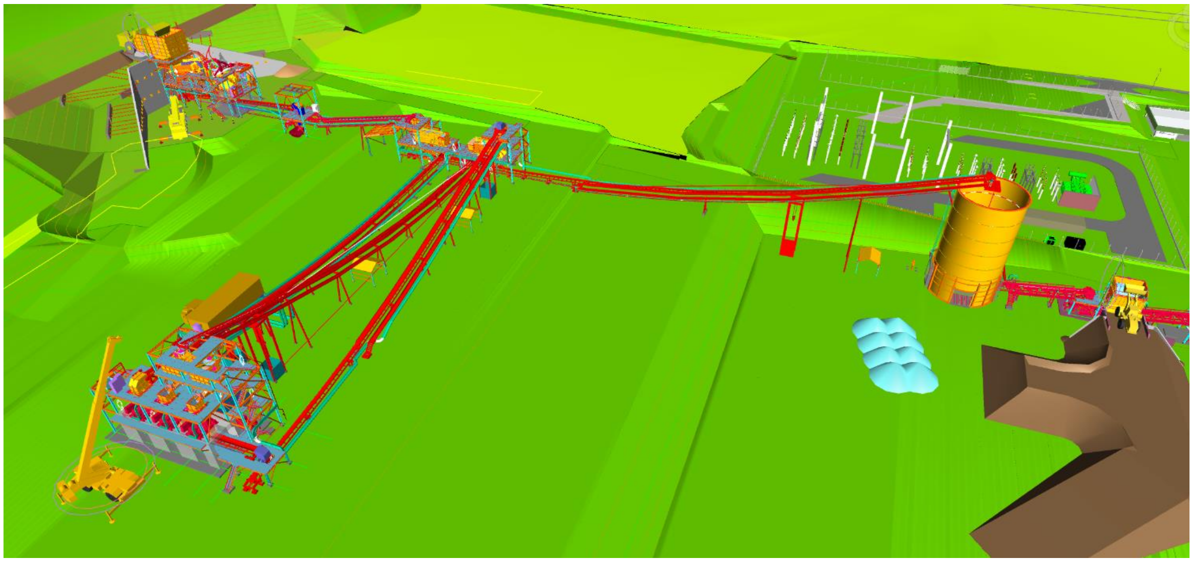


Figure 17-4: Sigma Primary Crushing Facility and Crushed Ore Bin

17.3.3 DMS Plant

Crushed ore from the crushed ore feed bin will be conveyed to a sizing screen to remove the -1.7 mm material which will be sent to the ultrafines DMS circuit. The -9.5 mm / +1.7 mm material will report to the DMS coarse sizing screen where it will be screened at 4.0 mm to produce:

- -9.5 mm / +4.0 mm coarse product which reports to the primary coarse DMS
- -4.0 mm / +1.7 mm fines product which reports to the primary fines DMS via a REFLUX™ classifier

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 target 6.0% Li2O 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).

Figure 17-5 shows the plant layout in relation to the planned stockpile areas.

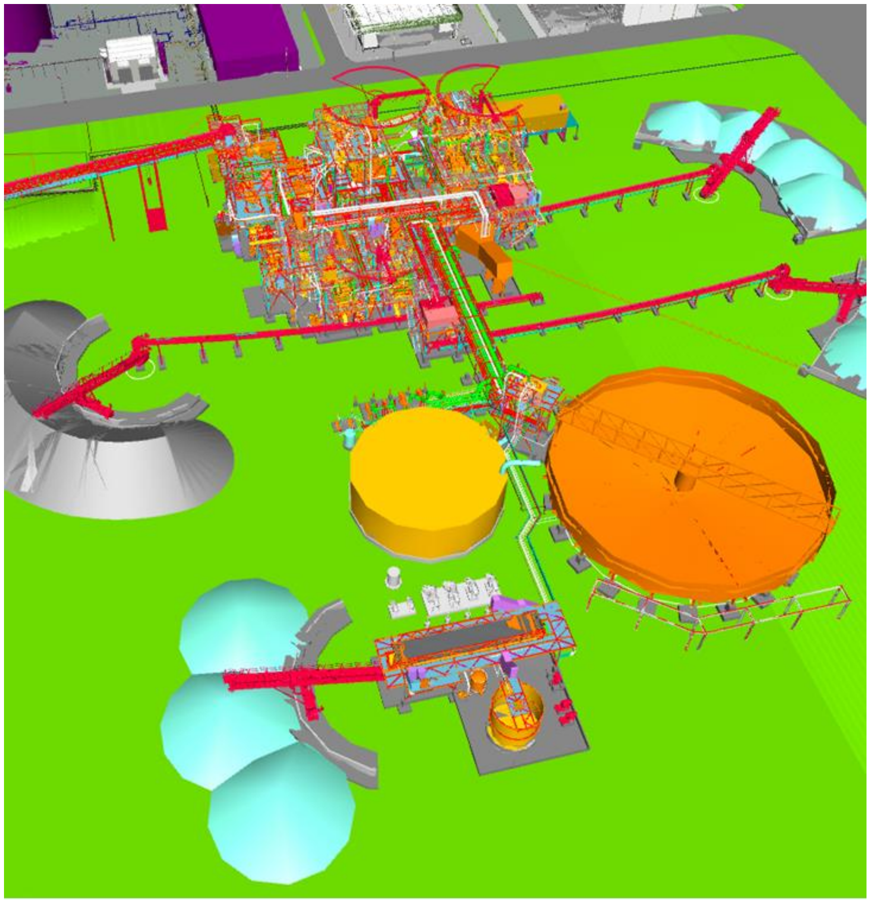


Figure 17-5: Sigma Xuxa DMS Plant and Product Stockpiles

17.3.3.1 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 target SG cut point (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.

17.3.3.2 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 target SG cut point (2.90) ferrosilicon medium.

The floats from the secondary coarse DMS stage will be re-crushed through a rolls crusher and transferred to the re-crush cyclones. 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 a target grade of 6% Li_2O.

17.3.3.3 Ultrafines DMS Circuit

The undersize (-1.7mm) material from the DMS sizing screen will be screened further by a subsequent ultrafines DMS preparation screen. The +0.5 mm material will report to the ultrafines DMS circuit and the -0.5 mm material will be pumped to the tails thickener.

The ultrafines DMS circuit will consist of primary and secondary DMS cyclones to efficiently separate spodumene from the gangue material. The primary ultrafines cyclones will have a target SG cut point (2.60) ferrosilicon medium. The secondary ultrafines cyclones will have a target SG cut point (2.85) ferrosilicon medium.

The ultrafines DMS circuit feed will be processed through a REFLUX™ classifier, which aims to remove a portion of the mica. This mica stream overflows to the screw classifier, while the REFLUX™ classifier underflow will report to the primary fines DMS cyclones. The floats from the primary ultrafines DMS cyclones will be sent to tailings, while the underflow stream (sinks) will report to the secondary ultrafines DMS cyclone.

The sinks from the secondary ultrafines DMS cyclones will be sent to the ultrafines DMS product stockpile via a magnetic separator for iron removal to meet the product iron content criteria. This will be the final spodumene concentrate product at a target grade of 6% Li_2O.

17.3.4 Thickening, Filtration and Hypofines Stacking

The ultrafines preparation screen undersize (-0.5 mm), screw classifier overflow and ultrafines tails will report to the 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 stockpile.

17.3.5 Tailings Disposal System

The floats from the primary coarse and fines DMS cyclones, the secondary fines cyclone as well as the underflow from the screw classifier (mica and floats) will be stockpiled to be co-disposed with mine waste.

17.3.6 Basis of Design and Mass Balance

Data for the 2019 Feasibility Study was based on the 2019 metallurgical test work data. Recovery data are based on the data from Var 3 and Var 4. Further testing was undertaken in 2021 which increased the confidence levels of the average global recovery of 60.4%. 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 design was further refined during the FEED phase in 2021 and detailed design in 2022.

The operating parameters used as a basis for design are summarized in Table 17-2.

Table 17-2 – Xuxa 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 17-3.

Table 17-3: Xuxa Design Basis and Mass Balance Summary

Parameter	Units	Value	Source	Comment
Nominal ore processing rate	dry tonnes per year	1,500,000	1	Client
	wet tonnes per year	1,530,612	4	Calculation
Spodumene ore grade (incl. dilution)	% Li_2O	1.46	1	2019 DFS
Ore moisture	% w/w	2	1	Client
Crushing Plant				
Dilute ore stockpile	days	2	1	Client
Ore fed to crusher	dry tonnes per year	1,500,000	1	Client
	wet tonnes per year	1,530,612	4	Calculation
Design ore fed to crusher	dry tonnes per year	1,700,000	1	Client
Crusher overall availability	%	68.0	1	Client
Crusher operating hours	hours per year	5,957	1	Client
Design ore crushing rate	dry tonnes per day	6,849	4	Calculation
Design ore crushing rate	dry tonnes per hour	285	4	Calculation
	wet tonnes per hour	291	4	Calculation
Wet Plant				
DMS plant feed bin	hours	8	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
Design feed rate to wet plant	Dry tonnes per year	1,700,000	1	Client

Parameter	Units	Value	Source	Comment
Wet plant overall availability	%	85	6	Industry Standard
Wet plant operating hours	hour per year	7,446	6	Industry Standard
Wet plant feed rate	dry tonnes per day	5,479	4	Calculation
Wet plant feed rate	dry tonnes per hour	228	4	Calculation
	wet tonnes per hour	233	4	Calculation
Reflux Classifier mica rejection rate	%w/w	2.5	3	SGS 2019 Test work
DMS coarse prep screen oversize (-9.5 mm / +4.0 mm)	%w/w Mass	38.4	3	Benchmarking
DMS coarse prep screen undersize (-4.0 mm / +1.7 mm)	%w/w Mass	27.9	3	Benchmarking
Ultrafines DMS sizing screen oversize (-1.7 mm / +0.5 mm)	%w/w Mass	19.1	3	Benchmarking
Ultrafines DMS sizing screen undersize (-0.5 mm) (hypofines)	%w/w Mass	14.6	3	Benchmarking
Wet plant spodumene concentrate grade	%w/w Li_2O	6.0	7	Industry Standard
Li_2O Recovery				
Li_2O recovery (DMS - global)	%	60.4	4	Calculated from 6.0% Li_2O grade at mass balance throughput
Stockpiles				
Coarse & Fines spodumene	dry tonnes per year	190,853	4	Calculation
	wet tonnes per year	216,878	4	Calculation
Ultrafines spodumene	dry tonnes per year	31,479	4	Calculation
	wet tonnes per year	35,771	4	Calculation
Total spodumene concentrate production	dry tonnes per year	222,332	4	Calculation
	wet tonnes per year	252,650	4	Calculation
Hypofines stockpile	dry tonnes per year	309,783	4	Calculation
	wet tonnes per year	352,036	4	Calculation
Process tails – tonnage	dry tonnes per year	1,330,649	4	Calculation
	wet tonnes per year	1,170,058	4	Calculation

Operating hours assumptions for the main facilities are provided in Table 17-4.

Table 17-4: Xuxa Operating Hours for Main Facilities

Facilities	Calendar Hours (h/a)	Operating Hours (h/a)	Overall utilization (%)
Crushing and conveying	8,760	5,957	68
Dense medium separation circuit	8,760	7,446	85
Tails filter plant and conveyor	8,760	7,446	85

17.3.7 Utilities Requirements

The power consumption requirements are approximately 6.3 MW for the processing plant.

The raw water consumption is a nominal 38 m^3/hr (with an additional make-up raw water requirement to process water when necessary).

The process water will be recycled within the plant with 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 as needed.

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

Reagents will include ferrosilicon a consumption rate of 530 g/t DMS feed and 960 g/t ultrafines DMS feed. and flocculant (Magnafloc 10 or equivalent) at a consumption rate of 10-40 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.

17.4 BARREIRO PROCESS PLANT (SCENARIO 1: PHASE 2)

17.4.1 Overview

The Barreiro concentrator will be located approximately 7 km from the Barreiro open pit and in proximity to the Xuxa plant. Spodumene concentrate will be produced using dense media separation (DMS). The plant is designed to produce a minimum 6.0% Li_2O spodumene concentrate. The run-of-mine ore has a feed grade of 1.39% Li_2O (mine plan is based on 3% dilution).

The Barreiro plant throughput capacity is 1.85 Mtpa (dry) of ore fed to a dedicated crushing circuit. The Barreiro plant is designed to produce 220,000 tpa of 6% Li_2O spodumene concentrate.

Figure 17-6 shows the planned layout for the Xuxa and Barreiro crushing and process plants.

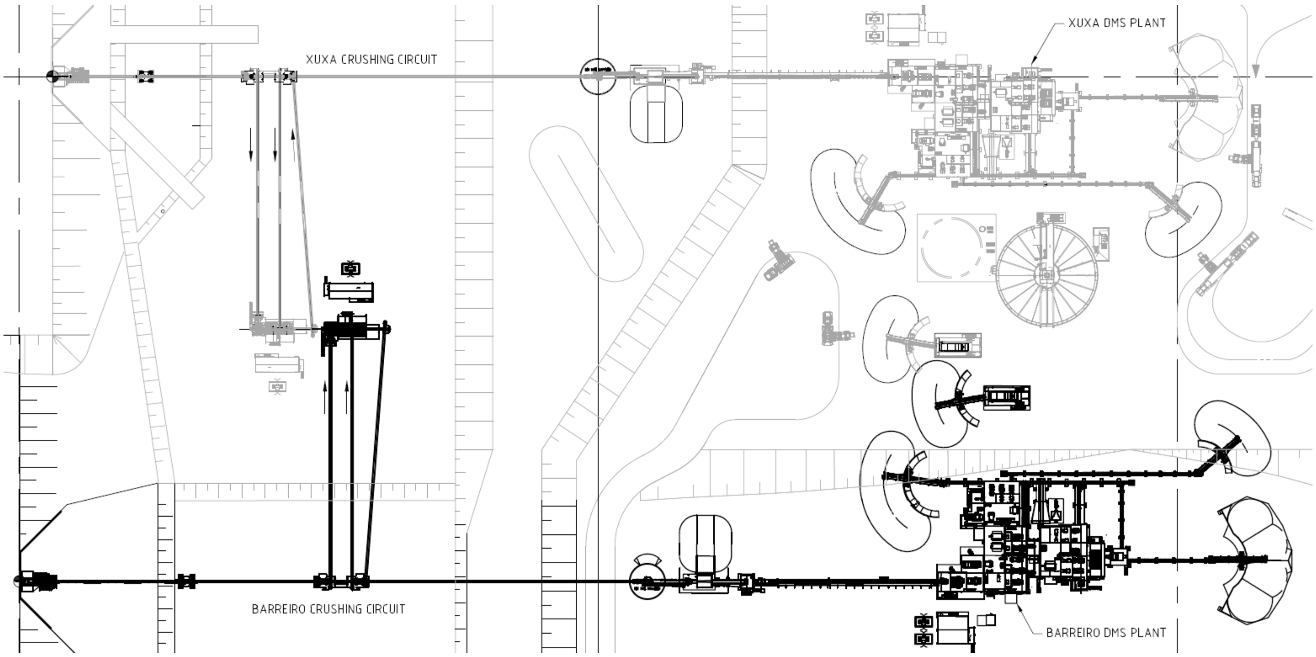


Figure 17-6: Xuxa and Barreiro Process Plant Layout (2021 Design)

17.4.2 Description

The spodumene concentrator process plants are designed based on a proven DMS circuit and includes the following:

- Three-stage conventional crushing and screening
- DMS screening and mica removal via up-flow classification
- Two-stage DMS circuit for the coarse fraction, with recrush of middlings stream
- Two-stage DMS circuit for the fines fraction
- Two-stage DMS circuit for the ultrafines fraction
- Thickening, belt filtration and dry stacking of the hypofines fraction with waste rock
- Magnetic separation of the concentrate streams
- DMS plant tailings will be trucked for co-disposal
- DMS product will be stockpiled ready for dispatch.

Ore trucked from the mine will be stacked on ROM piles. A Front-End Loader (FEL) will feed material into the crusher feed bin, and an apron feeder will draw the material into the primary crusher. A magnet will remove any tramp metal as the material passes to the scalping screen. The scalping screen undersize material (<9.5 mm) is taken to the DMS feed bin. The oversize material passes to the secondary cone crusher for size reduction. The secondary cone crusher product is joined by the tertiary cone crusher product and directed to a classification screen. The undersize material (-9.5 mm) joins the scalping screen undersize on the DMS feed bin conveyor. The oversize material is conveyed to the tertiary cone crusher feed bin, which splits the material between the two tertiary cone crushers, for size reduction, before it returns to the classification screen.

The crushed ore bin provides an 8-hour live capacity buffer between the crusher and the wet plant for stable operation. An emergency feeder allows for wet plant feed in the case where the bin is not able to supply feed.

The wet plant will consist of a two-stage DMS circuit for coarse fraction (-9.5 mm / +4.0 mm), a two-stage DMS circuit for the fines fraction (-4.0 mm / +1.7 mm) and a two-stage DMS circuit for the ultrafines fraction (-1.7 mm / +0.5 mm). The sinks from the secondary stage coarse and fines DMS circuits (which includes wet magnetic separation) will report to the DMS product stockpile. The sinks from the ultrafines DMS will report to the ultrafines product stockpile, after magnetic separation, for blending with coarse/fine spodumene product for sale.

The floats from the secondary stage coarse DMS cyclone will be crushed to improve liberation and returned to the feed preparation screen. The floats from the primary stage coarse DMS cyclone, primary and secondary stage fines cyclones and those from the ultrafines cyclones will report to a tailings pile. The DMS tailings (-0.5 mm hypofines fraction) will be thickened and filtered prior to stockpiling with the waste pile.

Figure 17-7 is a block flow diagram for the crushing circuit and DMS plant.

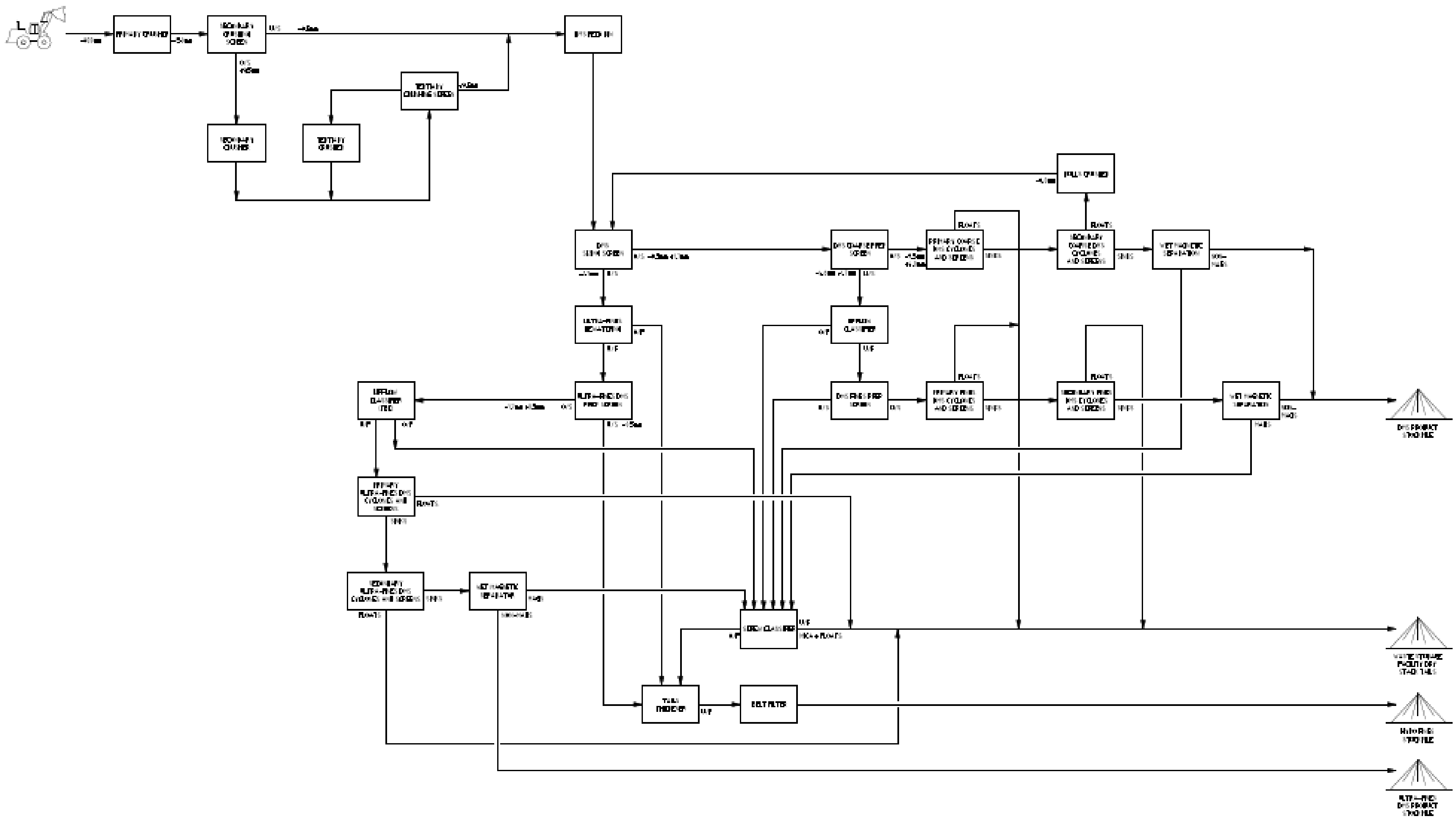


Figure 17-7: Block Flow Diagram for the Barreiro Crushing Circuit and DMS Plant

17.4.3 DMS Plant

Crushed ore from the feed bin will be transported to the DMS feed inlet where it will be conveyed to a sizing screen to remove the -1.7 mm material which will be sent to the ultrafines DMS circuit. The -9.5 mm / +1.7 mm material will report to the DMS coarse sizing screen where it will be screened at 4.0 mm to produce:

- A coarse fraction (-9.5 mm / +4.0 mm) which reports to the primary coarse DMS
- A fines fraction (-4.0 mm / +1.7 mm) which reports to the primary fines DMS via a REFLUX™ classifier

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 gangue minerals and consequently the spodumene will report to the DMS cyclone underflow (sinks), with the gangue material reporting to the cyclone overflow (floats).

17.4.3.1 Primary DMS Circuit (Coarse and Fines)

The primary DMS circuit will have two sets of DMS cyclones (coarse and fines). They will both 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.

17.4.3.2 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. This will be the final spodumene concentrate product at 6% Li2O.

17.4.3.3 Ultrafines DMS Circuit

The ultrafines (-1.7 mm / +0.5 mm) from the sizing screen will be dewatered using a hydrocyclone and screened. The -1.7 mm / +0.5 mm material will report to the ultrafines two stage DMS circuit. The floats will report to a waste pile.

17.4.4 Thickening, Filtration and Hypofines Stacking

The ultrafines dewatering cyclone overflow, the ultrafines screens undersize (-0.5 mm), the screw classifier overflow and other screen underflows will report to the DMS tailings thickener for dewatering. The underflow will be discharged to a belt filter and the filter cake will report to the hypofines stockpile which will then report to a waste pile.

17.4.5 Tailings Disposal System

The floats from the primary coarse and fines DMS cyclones, the secondary fines DMS cyclone, and the ultrafines 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.

17.4.6 Basis of Design and Mass Balance

For the current pre-feasibility study, Barreiro design is based on the metallurgical test-work data on four variability samples and a composite sample. Engineering and design were developed to a pre-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 17-5.

Table 17-5: Barreiro Operating Parameters

Parameter	Value
Operating days/annum	365
Operating hours/day	24
Shifts/day (Crushing & Wet Plant)	3 x 8 h
Overall Availability (Crushing)	68%
Overall Availability (Wet Plant)	85%

The design basis and mass balance based on the test work results are summarized in Table 17-6.

Table 17-6: Barreiro Design Basis and Mass Balance Summary

Parameter	Units	Barreiro Value
Total ore processing rate	dry tonnes per year	1,850,000
	wet tonnes per year	1,888,000
Spodumene ore grade (incl. dilution)	% Li_2O	1.39
Ore moisture	% w/w	2
Dilution factor	% w/w	3
Crushing Plant		
Crusher overall availability (nominal/design)	%	68/54
Crusher operating hours (nominal/design)	hours per year	5,962/4,744
Ore crushing rate (design)	dry tonnes per hour	390
Nominal ore crushing rate	dry tonnes per hour	3292
	wet tonnes per hour	298
Wet Plant		
DMS plant feed bin	hours	8
Feed rate to wet plant	dry tonnes per year	1,850,000
	wet tonnes per year	1,888,000
Wet plant overall availability	%	85
Wet plant operating hours	hour per year	7,446
Nominal wet plant feed rate	dry tonnes per day (24 h/d)	5069
Nominal wet plant feed rate	dry tonnes per hour	248
	wet tonnes per hour	254
Reflux Classifier mica rejection rate	%w/w Reflux feed	5
DMS coarse prep screen oversize (-9.5 mm / +4.0 mm)	%w/w	31.5
DMS coarse prep screen undersize (-4.0 mm / +1.7 mm)	%w/w	31.5
DMS sizing screen undersize (-1.7 mm / +0.5 mm)	%w/w	21.0
Ultrafines dewatering cyclone undersize (-0.5 mm hypofines)	%w/w	16.0
Wet plant spodumene concentrate grade	%w/w Li_2O	6.0
Li_2O DMS Stage Recovery		59.1
Li_2O global recovery (Combined)	%	50.9

Parameter	Units	Barreiro Value
Li_2O global recovery – Coarse DMS	%	18.8
Li_2O global recovery – Fines DMS	%	19.6
Li_2O global recovery – Ultrafines DMS	%	12.6
Stockpiles		
Coarse & Fines spodumene	dry tonnes per year	165,600
	wet tonnes per year	170,000
Ultrafines spodumene	dry tonnes per year	54,400
	wet tonnes per year	57,100
Total spodumene concentrate production	dry tonnes per year	220,000
	wet tonnes per year	226,900
Hypofines Production	dry tonnes per year	296,000
	wet tonnes per year	340,400
Process Tailings Production	dry tonnes per year	1,630,000
	wet tonnes per year	1,880,040

17.4.7 Utilities Requirements

The power consumption requirements for the Barreiro plant is approximately 6.3 MW.

The raw water consumption for process water is a nominal 41.5 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 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 or 312 tpa
- Flocculant: has a maximum consumption rate of 60 g/t or 23 tpa

In the crushing circuit, consumables will include liners for all the crushers and the screen panels. The primary jaw crusher liner change outs are estimated to be an average of 9.2 sets per year and 18.5 sets per year for the secondary and tertiary cone crushers liners. The change out frequency of the crushing circuit and DMS screen panels is based on 3 sets per year per screen. Other consumable items for the DMS plant include wear parts for cyclones, pumps, and belt filters.

17.5 BARREIRO PROCESS PLANT (SCENARIO 2: PHASE 2)

As part of the PEA for the expansion of the Xuxa project, the Barreiro flowsheet was revised to include a coarse and fine scavenger DMS circuit to recover Petalite. The design basis and mass balance for the revised flowsheet based on the NDC test work results.

The design, block flow diagram, and description of the major processes of the Barreiro PEA plant with the coarse and fine scavenger DMS circuits is described in Section 17.6 Nezinho do Chicao Plant (Scenario 2: Phase 3).

17.6 NEZINHO DO CHICAO PLANT (SCENARIO 2: PHASE 3)

17.6.1 Overview

The Nezinho do Chicao concentrator is a duplicate of the revised Scenario 2 Barreiro PEA plant. Due to the spodumene deportment, to maximise lithia recovery, an additional DMS stage for recovering Petalite from the main DMS plant tailings has been incorporated. The plant will be located to the south of the proposed Barreiro plant (Phase 2). Spodumene concentrate and petalite concentrate will be produced using dense media separation (DMS).

The NDC plant throughput capacity is 1.85 Mtpa (dry) of ore fed to a dedicated crushing circuit. The NDC plant is designed to produce a combined spodumene and petalite concentrate of 5.5% Li_2O. The run-of-mine ore has a feed grade of 1.45% Li_2O (mine plan is based on 3% dilution).

Figure 17-8 shows the planned layout for the Xuxa, Barreiro, and NDC crushing and process plants.

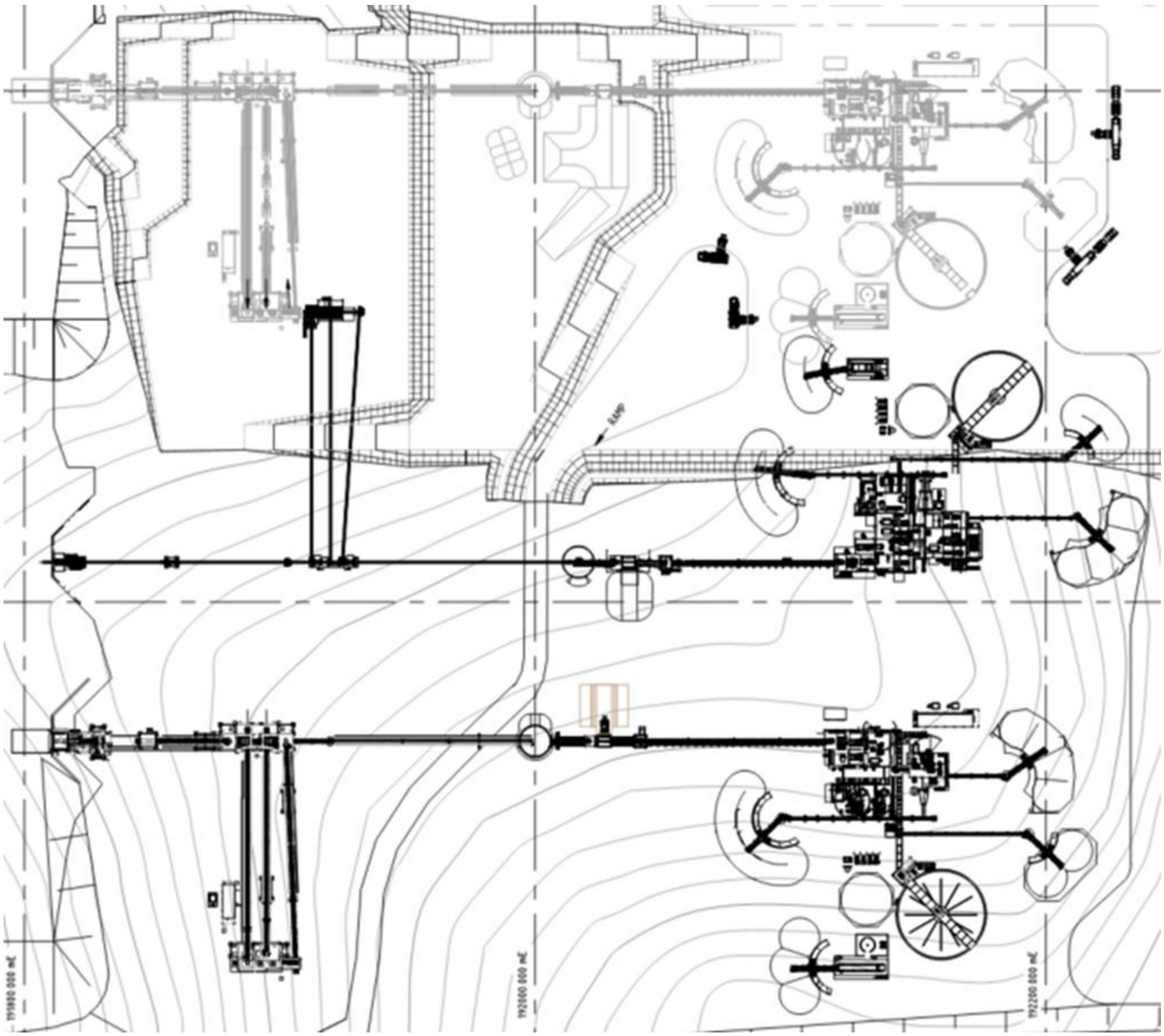


Figure 17-8: Xuxa (Top), Barreiro (Middle), and Nezinho do Chicao (Bottom) Process Plant Layout (2022)

17.6.2 Description

The concentrator process plants are designed based on a proven DMS circuit and includes the following:

- Three-stage conventional crushing and screening
- DMS screening and mica removal via up-flow classification
- Two-stage DMS circuit for the coarse fraction, with a coarse scavenger DMS for petalite and recrush of middlings stream
- Two-stage DMS circuit for the fines fraction with a fine scavenger DMS for petalite
- Two-stage DMS circuit for the ultrafines fraction
- Thickening, belt filtration and dry stacking of the hypofines fraction with waste rock

- Magnetic separation of the fine and ultrafine concentrate streams
- DMS plant tailings will be trucked for co-disposal
- DMS product will be stockpiled ready for dispatch

The high-level material flow consists of the following, with the next sections providing the specific details.

Ore trucked from the mine will be stacked on ROM piles. A Front-End Loader (FEL) will feed material into the crusher feed bin, and an apron feeder will draw the material into the primary crusher. A magnet will remove any tramp metal as the material passes to the scalping screen. The scalping screen undersize material (<9.5 mm) is conveyed to the DMS feed bin. The oversize material passes to the secondary cone crusher for size reduction. The secondary cone crusher product is combined with the tertiary cone crusher product and conveyed to a classification screen. The undersize material (-9.5 mm) joins the scalping screen undersize on the DMS feed bin conveyor. The oversize material is conveyed to the tertiary cone crusher feed bin, which splits the material between the two tertiary cone crushers, for size reduction, before it returns to the classification screen.

The crushed ore bin provides an 8-hour live capacity buffer between the crusher and the wet plant for stable operation. An emergency feeder allows for wet plant feed in the case where the bin is not able to supply feed.

The wet plant will consist of a two-stage DMS circuit for coarse fraction (-9.5 mm / +4.0 mm), a two-stage DMS circuit for the fines fraction (-4.0 mm / +1.7 mm), a two-stage DMS circuit for the ultrafines fraction (-1.7 mm / +0.5 mm), and a fine and ultrafine scavenger DMS for petalite. The sinks from the secondary stage coarse and fines DMS circuits (which includes wet magnetic separation) will report to the DMS product stockpile. The sinks from the ultrafines DMS will report to the ultrafines product stockpile, after magnetic separation, for blending with coarse/fine spodumene product for sale. The floats from the primary fines and primary ultrafines DMS cyclones will be pumped to scavenger DMS. The floats from the scavenger DMS will report to the petalite product stockpile, and the sinks will report to the tailings.

The floats from the secondary stage coarse DMS cyclone will be stockpiled and sent to the Xuxa re-crush circuit to improve liberation and be further processed. The floats from the primary stage coarse DMS cyclone, secondary stage fines cyclones and the secondary ultrafines cyclones will report to a tailings pile. The DMS tailings (-0.5 mm hypofines fraction) will be thickened and filtered prior to stockpiling with the waste pile.

Figure 17-9 is a block flow diagram for the crushing circuit and DMS plant.

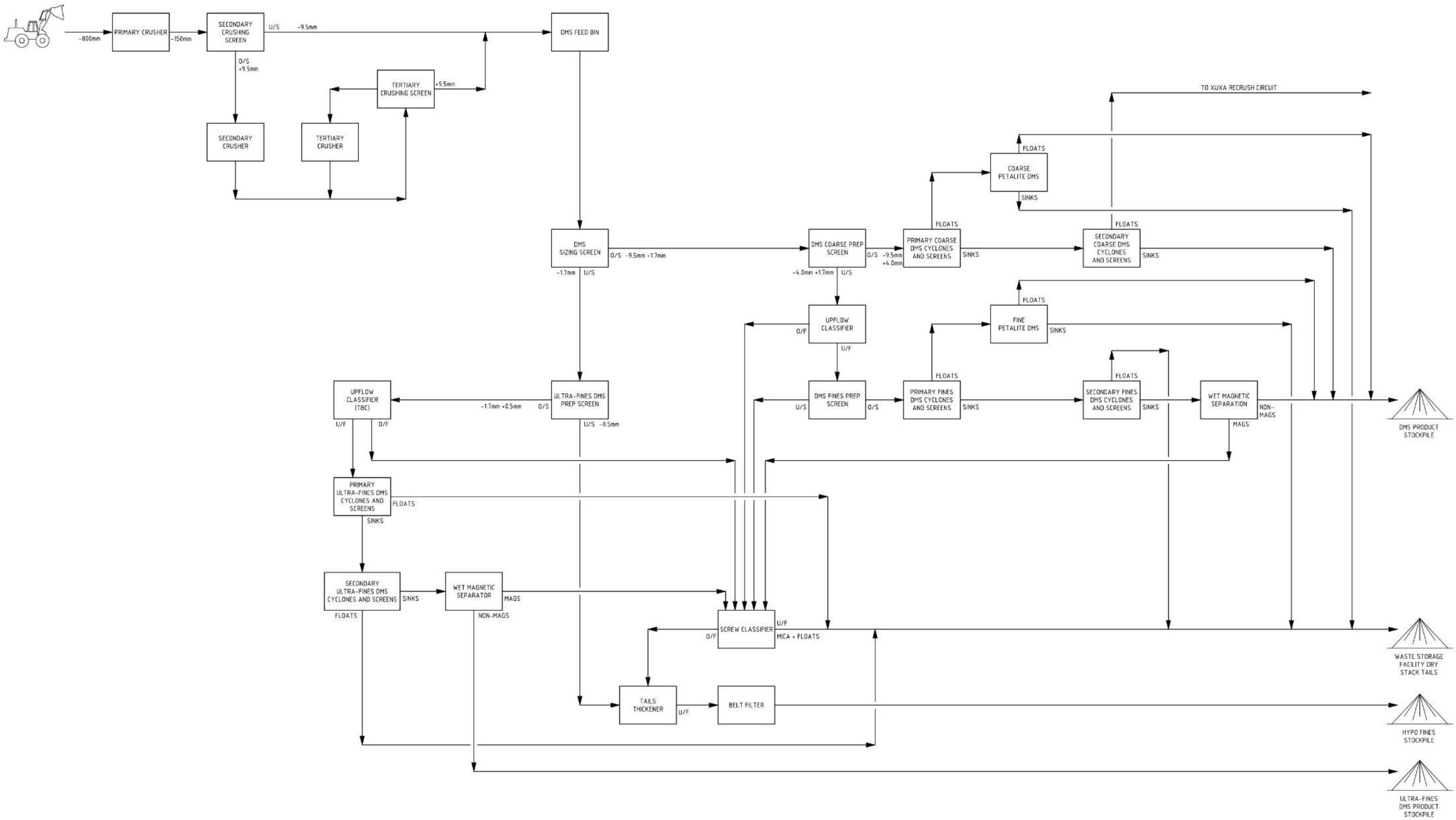


Figure 17-9: Block Flow Diagram for the NDC Crushing Circuit and DMS Plant

17.6.3 DMS Plant

The detailed DMS flowsheet consists of the following:

Crushed ore from the feed bin will be transported to the DMS feed inlet where it will be conveyed to a sizing screen to remove the -1.7 mm material which will be pumped to the ultrafines DMS circuit. The -9.5 mm / +1.7 mm material will report to the DMS coarse sizing screen where it will be screened at 4.0 mm to produce:

- A coarse fraction (-9.5 mm / +4.0 mm) which reports to the primary coarse DMS
- A fines fraction (-4.0 mm / +1.7 mm) which reports to the primary fines DMS via a REFLUX™ classifier

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 spodumene concentrate grade. The coarse and fine scavenger DMS circuits will consist of DMS cyclones to produce >3.8% Li_2O petalite concentrate. The combined spodumene and petalite DMS concentrate produced will have a 5.5% Li_2O average 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 gangue minerals and consequently the spodumene will report to the DMS cyclone underflow (sinks), with the gangue material reporting to the cyclone overflow (floats).

17.6.3.1 Primary DMS Circuit (Coarse and Fines)

The primary DMS circuit will have two sets of DMS cyclones (coarse and fines). They will both share the same sg (2.65) ferrosilicon medium.

The floats from the primary coarse DMS cyclones will be pumped to the coarse scavenger DMS, 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 the fine scavenger DMS, while the underflow streams (sinks) will report to the secondary fines DMS cyclones.

17.6.3.2 Petalite DMS Circuit (Coarse and Fines)

The coarse and fine scavenger DMS cyclone will operate at an SG 2.4 using ferrosilicon medium. The floats from the coarse and fine scavenger DMS cyclone will be sent to DMS product stockpile, while the underflow streams (sinks) will be sent to tailings.

17.6.3.3 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 stockpiled and sent to the Xuxa re-crush circuit for processing. 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. This will be the final spodumene concentrate product at 6% Li_2O, which combined with the petalite floats from the scavenger DMS, will produce an on average 5.5% Li_2O concentrate final product.

17.6.3.4 Ultrafines DMS Circuit

The ultrafines (-1.7 mm / +0.5 mm) from the sizing screen will be dewatered using a hydrocyclone and screened. The -1.7 mm / +0.5 mm material will report to the ultrafines two stage DMS circuit. The floats will report to a waste pile.

17.6.4 Thickening, Filtration and Hypofines Stacking

The ultrafines dewatering cyclone overflow, the ultrafines screens undersize (-0.5 mm), the screw classifier overflow and other screen underflows will report to the DMS tailings thickener for dewatering. The underflow will be discharged to a belt filter and the filter cake will report to the hypofines stockpile which will then report to a waste pile.

17.6.5 Tailings Disposal System

The floats from the primary coarse and fines DMS cyclones, the secondary fines DMS cyclone, and the ultrafines 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.

17.6.6 Basis of Design and Mass Balance

For the current pre-feasibility study, the NDC design is based on the metallurgical test-work data on three variability samples and a composite sample. Engineering and design were developed to a pre-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 17-7.

Table 17-7: NDC Operating Parameters

Parameter	Value
Operating days/annum	365
Operating hours/day	24
Shifts/day (Crushing & Wet Plant)	3 x 8 h
Overall Availability (Crushing)	68%
Overall Availability (Wet Plant)	85%

The design basis and mass balance based on the test work results are summarized in Table 17-8.

Table 17-8: NDC Design Basis and Mass Balance Summary

Parameter	Units	Value
Total ore processing rate	dry tonnes per year	1,850,000
	wet tonnes per year	1,888,000
Spodumene ore grade (incl. dilution)	% Li2O	1.45
Ore moisture	% w/w	2
Dilution factor	% w/w	3
Crushing Plant		
Crusher overall availability (nominal/design)	%	68 / 54
Crusher operating hours (nominal/design)	hours per year	5,957 / 4,730
Ore crushing rate (design)	dry tonnes per hour	391
Nominal ore crushing rate	dry tonnes per hour	311
	wet tonnes per hour	317
Wet Plant		
DMS plant feed bin	hours	8
Feed rate to wet plant	dry tonnes per year	1,850,000
	wet tonnes per year	1,887,755
Wet plant overall availability	%	85
Wet plant operating hours	hour per year	7,446
Nominal wet plant feed rate	dry tonnes per day (24 h/d)	5,963
Nominal wet plant feed rate	dry tonnes per hour	248
	wet tonnes per hour	254
Reflux Classifier mica rejection rate	%w/w Reflux feed	5
DMS coarse prep screen oversize (-9.5 mm / +4.0 mm)	%w/w	32
DMS coarse prep screen undersize (-4.0 mm / +1.7 mm)	%w/w	32
DMS sizing screen undersize (-1.7 mm / +0.5 mm)	%w/w	21
Ultrafines dewatering cyclone undersize (-0.5 mm hypofines)	%w/w	16
Wet plant spodumene concentrate grade	%w/w Li2O	5.9
Wet plant petalite concentrate grade	%w/w Li2O	3.8
Wet plant blended concentrate grade	%w/w Li2O	5.5
Recovery - Spodumene		
Li_2O DMS stage recovery - spodumene	%	52.8
Li_2O global recovery (Combined) - spodumene	%	45.5
Li_2O global recovery – Coarse DMS - spodumene	%	31.6
Li_2O global recovery – Fines DMS - spodumene	%	9.7
Li_2O global recovery – Ultrafines DMS - spodumene	%	4.2
Recovery - Petalite		
Li_2O DMS stage recovery - petalite	%	5.9
Li_2O global recovery (Combined) - petalite	%	5.1
Li_2O global recovery – Coarse DMS - petalite	%	2.7
Li_2O global recovery – Fines DMS - petalite	%	1.3

Parameter	Units	Value
Li_2O global recovery – Ultrafines DMS - petalite	%	1.1
Recovery - Overall		
Li_2O DMS stage recovery - overall	%	58.7
Li_2O global recovery (Combined) - overall	%	50.6
Li_2O global recovery – Coarse DMS - overall	%	34.3
Li_2O global recovery – Fines DMS - overall	%	11.0
Li_2O global recovery – Ultrafines DMS - overall	%	5.3
Stockpiles		
Total spodumene concentrate production	dry tonnes per year	220,042
	wet tonnes per year	225,889
Total petalite concentrate production	dry tonnes per year	38,020
	wet tonnes per year	39,030
Total concentrate production	dry tonnes per year	258,062
	wet tonnes per year	264,919
Petalite stockpile	dry tonnes per year	25,009
	wet tonnes per year	25,674
Hypofines Production	dry tonnes per year	338,830
	wet tonnes per year	389,654
Process Tailings Production	dry tonnes per year	1,591,938
	wet tonnes per year	1,836,139

17.6.7 Utilities Requirements

The power consumption requirements for the NDC plant is approximately 7.6 MW.

The raw water consumption for process water is a nominal 41.5 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 as needed.

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

Reagents will include ferrosilicon a consumption rate of 530 g/t DMS feed and 960 g/t ultrafines DMS feed and flocculant (Magnafloc 10 or equivalent) at a consumption rate of 10-40 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.

17.7 COMBINED BARREIRO & NEZINHO DO CHICAO PLANT (SCENARIO 3: PHASE 2 AND 3)

17.7.1 Overview

The combined Barreiro and Nezinho do Chicao concentrator will be in proximity to the Xuxa plant. Spodumene concentrate and petalite concentrate will be produced using dense media separation (DMS).

The plant throughput capacity is 3.9 Mtpa (dry) of ore fed to a dedicated crushing circuit from both the Barreiro and NDC ore bodies. The plant is designed to produce a combined spodumene and petalite concentrate of 5.5% Li_2O.

Figure 17-10 shows the planned layout for the Xuxa and combined crushing and process plants.

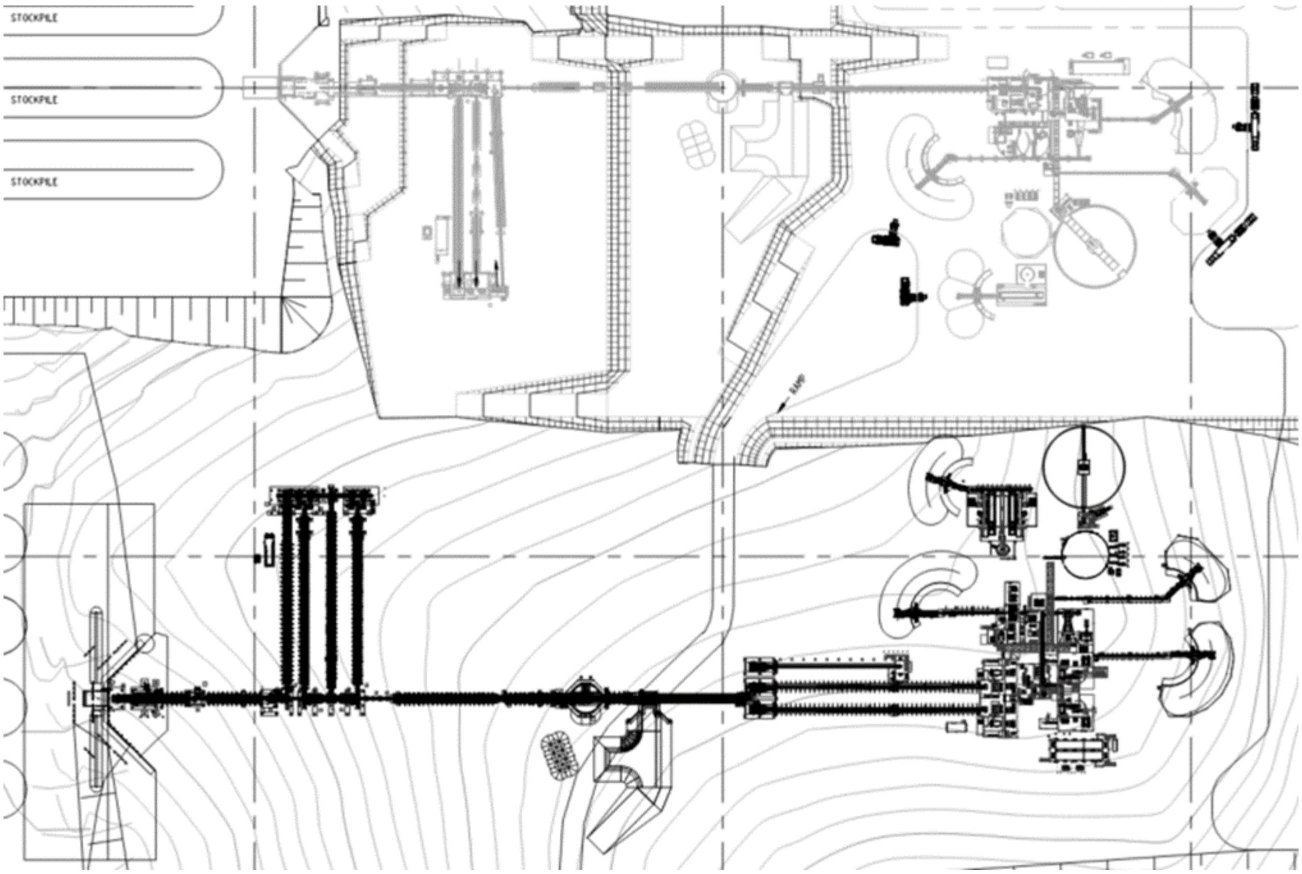


Figure 17-10: Xuxa (Top Phase 1) and Combined Barreiro/NDC (Bottom Phase 2) Process Plant Layout (2022)

17.7.2 Description

The concentrator process plants are designed based on a proven DMS circuit and includes the following:

- Three-stage conventional crushing and screening
- DMS screening and mica removal via up-flow classification
- Two-stage DMS circuit for the coarse fraction, with a coarse scavenger DMS and recrush of middlings stream
- Two-stage DMS circuit for the fines fraction with a fine scavenger DMS for petalite
- Two-stage DMS circuit for the ultrafines fraction
- Thickening, belt filtration and dry stacking of the hypofines fraction with waste rock
- Magnetic separation of the fine and ultrafine concentrate streams
- DMS plant tailings will be trucked for co-disposal

- DMS product will be stockpiled ready for dispatch

Ore trucked from the mine will be stacked on ROM piles. Two Front-End Loaders (FELS) will feed material into the crusher feed bin, and an apron feeder will draw the material into the primary crusher. A magnet will remove any tramp metal as the material passes to the scalping screen. The scalping screen undersize material (<9.5 mm) is taken to the DMS feed bin. The oversize material passes to the secondary cone crusher for size reduction. The secondary cone crusher product is joined by the tertiary cone crusher product, where it is split, and directed to two classification screens. The undersize material (-9.5 mm) joins the scalping screen undersize on the DMS feed bin conveyor. The oversize material from each screen is conveyed to one of two dedicated tertiary crushing circuits, each consisting of tertiary cone crusher feed bin, which splits the material between two (of four) tertiary cone crushers, for size reduction, before it returns to the classification screens.

The crushed ore bin provides a 3 to 4-hour live capacity buffer between the crusher and the wet plant for stable operation. An emergency feeder allows for wet plant feed in the case where the bin is not able to supply feed.

The wet plant will consist of a two-stage DMS circuit for coarse fraction (-9.5 mm / +4.0 mm), a two-stage DMS circuit for the fines fraction (-4.0 mm / +1.7 mm), a two-stage DMS circuit for the ultrafines fraction (-1.7 mm / +0.5 mm), and a fine and ultrafine scavenger DMS for petalite. The sinks from the secondary stage coarse and fines DMS circuits (which includes wet magnetic separation) will report to the DMS product stockpile. The sinks from the ultrafines DMS will report to the ultrafines product stockpile, after magnetic separation, for blending with coarse/fine spodumene product for sale. The floats from the primary fines and primary ultrafines DMS cyclones will be sent to scavenger DMS. The floats from the scavenger DMS will report to the product stockpile, and the sinks will report to the tailings.

The floats from the secondary stage coarse DMS cyclone will be sent to the Xuxa re-crush circuit to improve liberation. The floats from the primary stage coarse DMS cyclone, secondary stage fines cyclones and the secondary ultrafines cyclones will report to a tailings pile. The DMS tailings (-0.5 mm hypofines fraction) will be thickened and filtered prior to stockpiling with the waste pile.

Figure 17-11 is a block flow diagram for the crushing circuit and DMS plant.

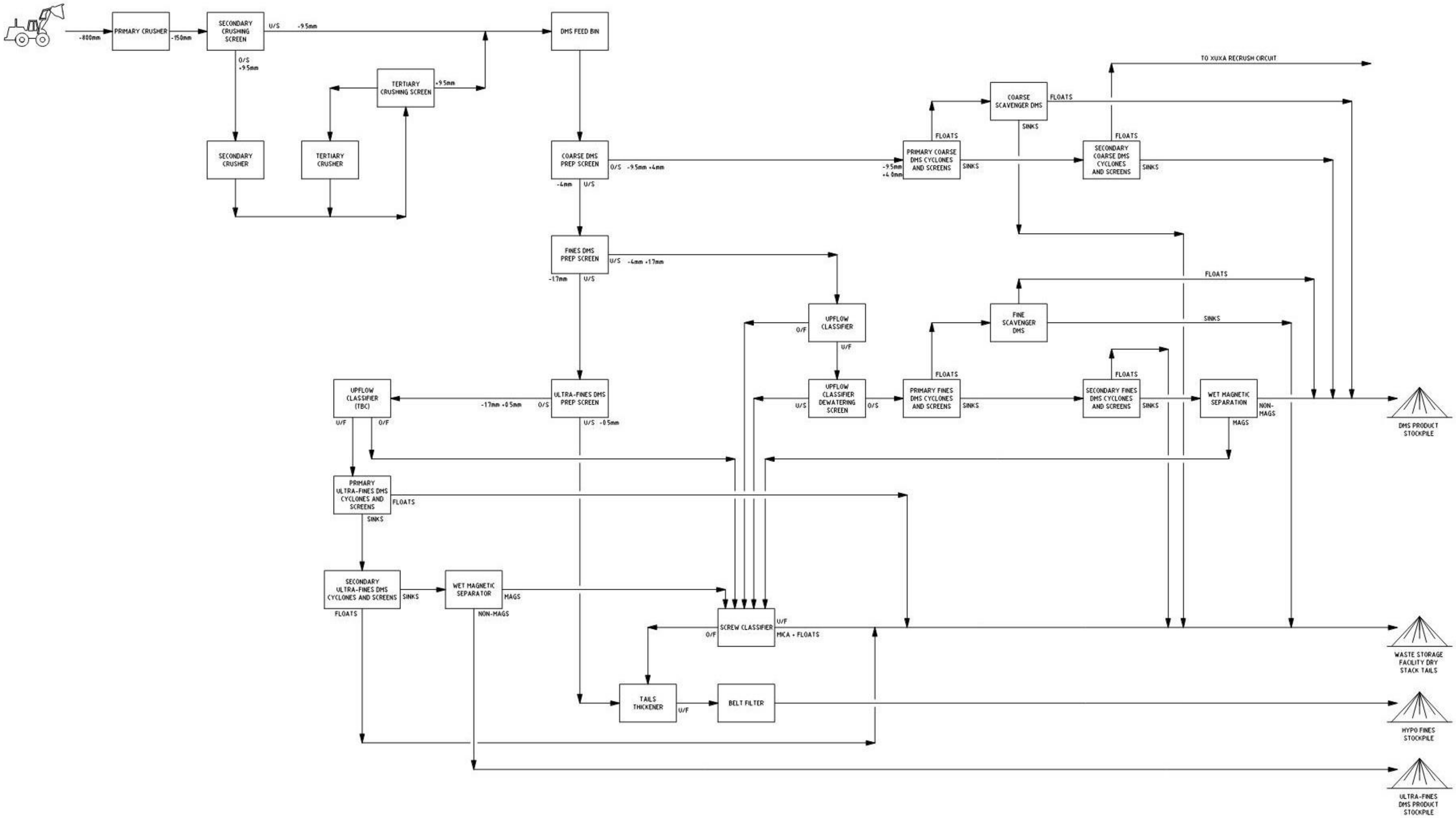


Figure 17-11: Block Flow Diagram for the Combined Barreiro/NDC Crushing Circuit and DMS Plant

17.7.3 Crushing

The Combined Barreiro/NDC crushing circuit is a fixed plant operation and is designed to process a nominal throughput of 3.9 Mtpa. The crushing circuit will include a jaw crusher, scalping screen, secondary cone crusher, classification screen and four tertiary cone crushers. Crushed ore will be stored in a bin with reclaim feeder upstream of the wet-plant feed. The bin is sized for nominal three to four hours storage with additional capacity via underflow stockpile and front-end loader reclaim to a hopper and feeder.

The primary crusher is designed to be fed via front end loader and can accommodate a nominal feed size up to 960 mm. Primary crushed ore feeds a double deck scalping screen where -9.5 mm material is removed to final crushed ore and +9.5 mm material is conveyed to a secondary crusher. Secondary crushed ore feeds one of two double deck classification screens where -9.5 mm material is combined with scalping screen undersize and conveyed to the crushed ore feed bin and +9.5 mm material feeds four tertiary crushers. Tertiary crushed material combines with secondary crushed material feeding the classification screen. When the crushing plant is not operating, the DMS plant may be fed via front end loader from stockpiles from an emergency feed bin and feeder.

17.7.4 DMS Plant (Main)

Crushed ore from the feed bin will be transported to the DMS feed inlet where it will be conveyed to a series of DMS prep screens. The coarse DMS prep screen removes the -4 mm material, the undersize going to the fine DMS prep screen where it will be screened at 1.7 mm. The final screen is the ultrafines DMS prep screen which removes the hypo fines (-0.5mm). The series of DMS prep screens produce:

- A coarse fraction (-9.5 mm / +4.0 mm) which reports to the primary coarse DMS
- A fines fraction (-4.0 mm / +1.7 mm) which reports to the primary fines DMS via a REFLUX™ classifier
- An ultrafine fraction (-1.7 mm / +0.5 mm) which reports to the primary ultrafines DMS
- A hypo fines fraction (-0.5 mm) which reports to the tailings thickener

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 spodumene concentrate. A coarse and fine scavenger DMS circuits will consist of DMS cyclones to produce a >3.8% Li_2O petalite concentrate. The combined spodumene and petalite DMS concentrate produced will have a 5.5 Li_2O grade average. 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 gangue minerals and consequently the spodumene will report to the DMS cyclone underflow (sinks), with the gangue material reporting to the cyclone overflow (floats).

17.7.4.1 Primary DMS Circuit (Coarse and Fines)

The primary DMS circuit will have two sets of DMS cyclones (coarse and fines). They will both share the same sg (2.65) ferrosilicon medium.

The floats from the primary coarse DMS cyclones will be sent to the coarse scavenger DMS, 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 the fine scavenger DMS, while the underflow streams (sinks) will report to the secondary fines DMS cyclones.

17.7.4.2 Petalite DMS Circuit (Coarse and Fines)

The coarse and fine scavenger DMS cyclone will operate at an SG 2.4 using ferrosilicon medium. The floats from the coarse and fine scavenger DMS cyclone will be sent to DMS product stockpile, while the underflow streams (sinks) will be sent to tailings.

17.7.4.3 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 sent to the Xuxa re-crush circuit. 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. This will be the final spodumene concentrate product at 6% Li_2O, which combined with the petalite floats from the scavenger DMS, to produce an average 5.5% Li_2O concentrate final product.

17.7.4.4 Ultrafines DMS Circuit

The ultrafines (-1.7 mm / +0.5 mm) from the sizing screen will be dewatered using a hydrocyclone and screened. The -1.7 mm / +0.5 mm material will report to the ultrafines two stage DMS circuit. The floats will report to a waste pile.

17.7.5 Thickening, Filtration and Hypofines Stacking

The ultrafines dewatering cyclone overflow, the ultrafines screens undersize (-0.5 mm), the screw classifier overflow and other screen underflows will report to the DMS tailings thickener for dewatering. The underflow will be discharged to a belt filter and the filter cake will report to the hypofines stockpile which will then report to a waste pile.

17.7.6 Tailings Disposal System

The floats from the primary coarse and fines DMS cyclones, the secondary fines DMS cyclone, and the ultrafines 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.

17.7.7 Basis of Design and Mass Balance

For the current pre-feasibility study, combined Barreiro/NDC design is based on the metallurgical test-work data on three variability samples and a composite sample. Engineering and design were developed to a pre-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 17-9

Table 17-9: Combined Barreiro/NDC Operating Parameters

Parameter	Value
Operating days/annum	365
Operating hours/day	24
Shifts/day (Crushing & Wet Plant)	3 x 8 h
Overall Availability (Crushing)	68%
Overall Availability (Wet Plant)	85%

The design basis and mass balance based on the test work results are summarized in Table 17-10

Table 17-10: Combined Barreiro/NDC Design Basis and Mass Balance Summary

Parameter	Units	Value
Total ore processing rate	dry tonnes per year	3,900,000
	wet tonnes per year	4,087,200
Spodumene ore grade (incl. dilution)	% Li2O	1.42*
Ore moisture	% w/w	2
Dilution factor	% w/w	3
Crushing Plant		
Crusher overall availability (nominal/design)	%	68 / 54
Crusher operating hours (nominal/design)	hours per year	5,957 / 4,730
Nominal ore crushing rate	dry tonnes per hour	655
	wet tonnes per hour	668
Wet Plant		
DMS plant feed bin	hours	8
Feed rate to wet plant	dry tonnes per year	3,900,000
	wet tonnes per year	3,979,592
Wet plant overall availability	%	85
Wet plant operating hours	hour per year	7,446
Nominal wet plant feed rate	dry tonnes per day (24 h/d)	12,571
Nominal wet plant feed rate	dry tonnes per hour	524
	wet tonnes per hour	534
Reflux Classifier mica rejection rate	%w/w Reflux feed	5
DMS coarse prep screen oversize (-9.5 mm / +4.0 mm)	%w/w	32
DMS coarse prep screen undersize (-4.0 mm / +1.7 mm)	%w/w	32
DMS sizing screen undersize (-1.7 mm / +0.5 mm)	%w/w	21
Ultrafines dewatering cyclone undersize (-0.5 mm hypofines)	%w/w	16
Wet plant spodumene concentrate grade	%w/w Li2O	5.9
Wet plant petalite concentrate grade	%w/w Li2O	3.8
Wet plant blended concentrate grade	%w/w Li2O	5.5
Recovery - Spodumene		
Li_2O DMS stage recovery - spodumene	%	52.8

Parameter	Units	Value
Li_2O global recovery (Combined) - spodumene	%	45.5
Li_2O global recovery – Coarse DMS - spodumene	%	31.6
Li_2O global recovery – Fines DMS - spodumene	%	9.7
Li_2O global recovery – Ultrafines DMS - spodumene	%	4.2
Recovery - Petalite		
Li_2O DMS stage recovery - petalite	%	5.9
Li_2O global recovery (Combined) - petalite	%	5.1
Li_2O global recovery – Coarse DMS - petalite	%	2.7
Li_2O global recovery – Fines DMS - petalite	%	1.3
Li_2O global recovery – Ultrafines DMS - petalite	%	1.1
Recovery - Overall		
Li_2O DMS stage recovery - overall	%	58.7
Li_2O global recovery (Combined) - overall	%	50.6
Li_2O global recovery – Coarse DMS - overall	%	34.3
Li_2O global recovery – Fines DMS - overall	%	11.0
Li_2O global recovery – Ultrafines DMS - overall	%	5.3
Stockpiles		
Total spodumene concentrate production	dry tonnes per year	463,873
	wet tonnes per year	476,198
Total petalite concentrate production	dry tonnes per year	80,150
	wet tonnes per year	82,280
Total concentrate production	dry tonnes per year	544,023
	wet tonnes per year	558,477
Petalite stockpile	dry tonnes per year	52,722
	wet tonnes per year	54,123
Hypofines Production	dry tonnes per year	714,289
	wet tonnes per year	821,433
Process Tailings Production	dry tonnes per year	3,355,977
	wet tonnes per year	3,870,780

*Ore Grade assumes a 50/50 split between Barreiro and NDC

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:

- Five open pits in three separate deposits and five waste stockpiles
- Raw water supply (underground pipeline) from Jequitinhonha River to the site (utility plant)
- Electrical supply infrastructure to provide power to the site and related substations
- Federal access road BR367
- Deviation from BR367, by a municipal road, to the process plant
- Bridge over the Piauí River spanning Xuxa 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

18.1 XUXA GENERAL SITE PLAN

The overall site plan shows the Xuxa 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 highway BR367. The Phase 1 plant site and Xuxa mine pits, which is approximately 4 km from the main highway, is accessible via an existing municipal road from highway BR367. This road will be widened to a width of 8 m. The existing municipal road located between the process plant and the Xuxa mine workings, will be closed to public traffic. A new road will be built by the municipal authorities 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.

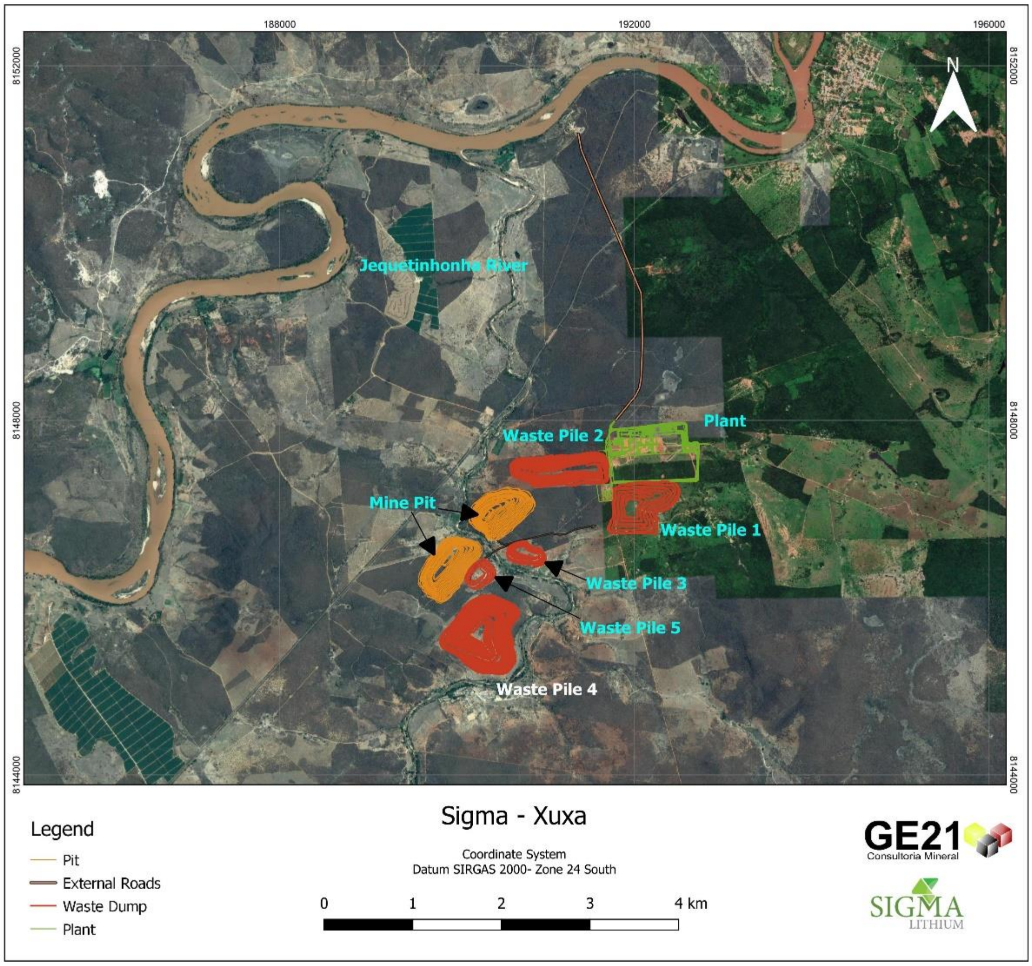


Figure 18-1– Sigma Lithium Project General Layout Plan for Xuxa

The planned locations for the processing plant and related infrastructure including the ROM pad are shown on Figure 18-2.

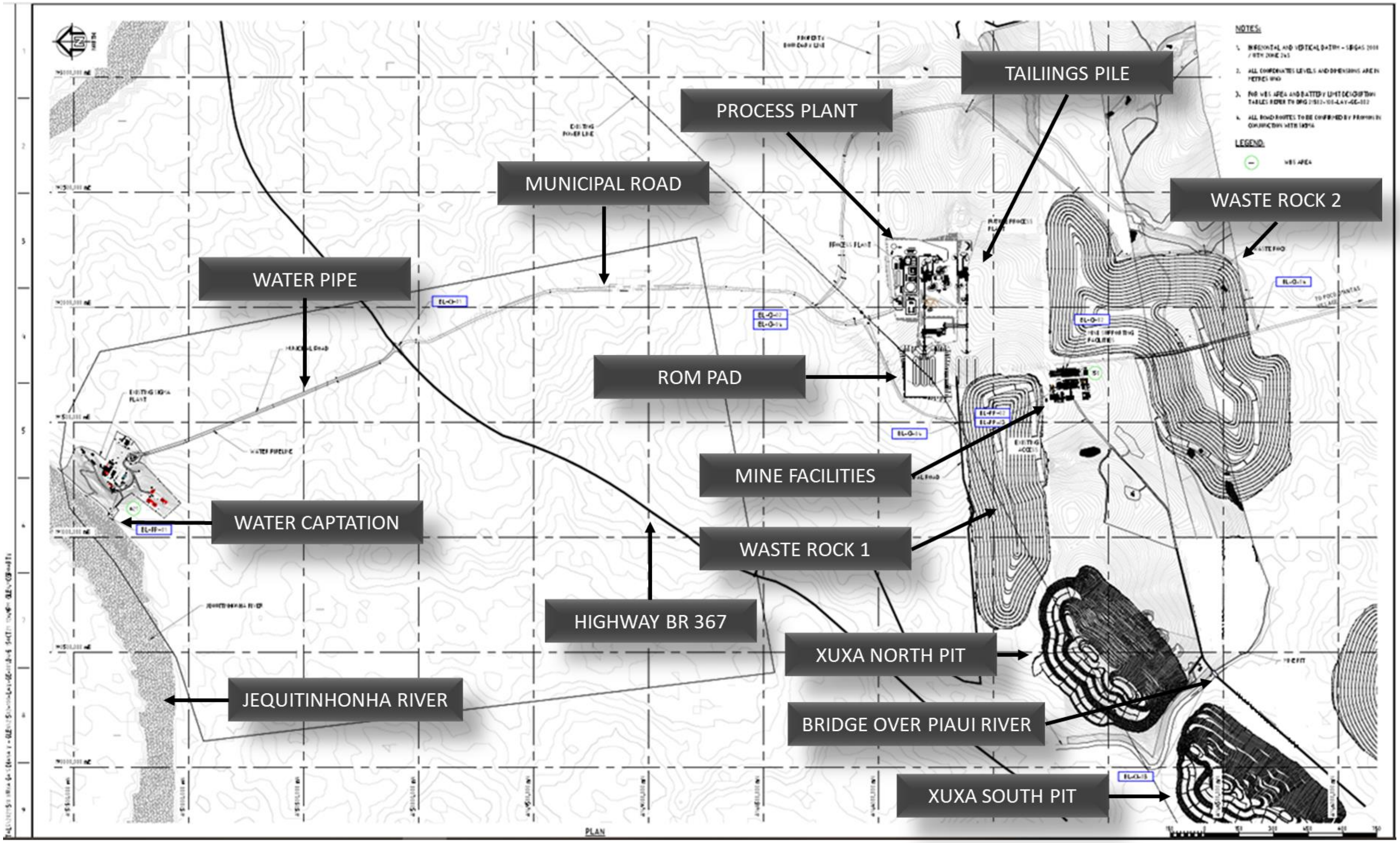


Figure 18-2– Overall Site Plan

Note: Grid squares are 500 m x 500 m.

18.2 ROADS

The existing municipal road needs to be upgraded to be suitable for the trucks traveling to the port for product export. The road will be 11 m in width, with an active road surface of 8 m (Figure 18-3).

A 2.6 km long municipal road will be built 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 be 8.0 m in width, with an active road surface of 7.0 m.

Figure 18-4 shows the layout of the municipal road from the highway exit to the site entrance (Access 1) and the new bypass for community access (Access 2).

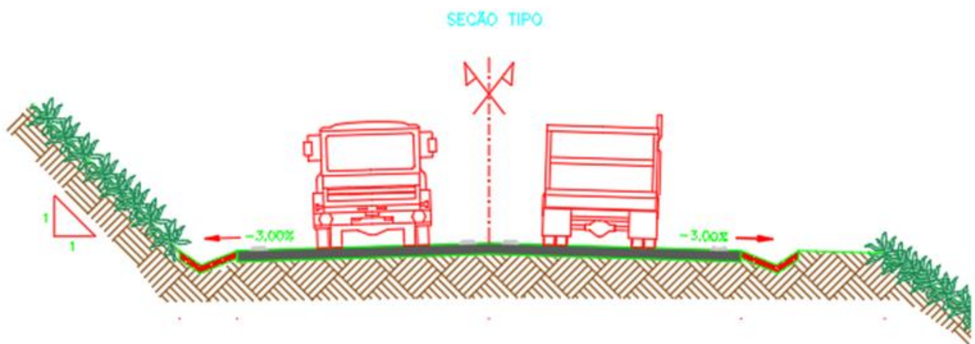


Figure 18-3: Schematic of the proposed municipal road upgrades

Figure 18-4: Proposed municipal access road and community bypass road

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 the North Pit and the South Pit. The concrete bridge will have a span of 30.0 m and 8.0 m of free lane being designed for Scania G440 trucks or similar.

The planned bridge location is shown in Figure 18-5.

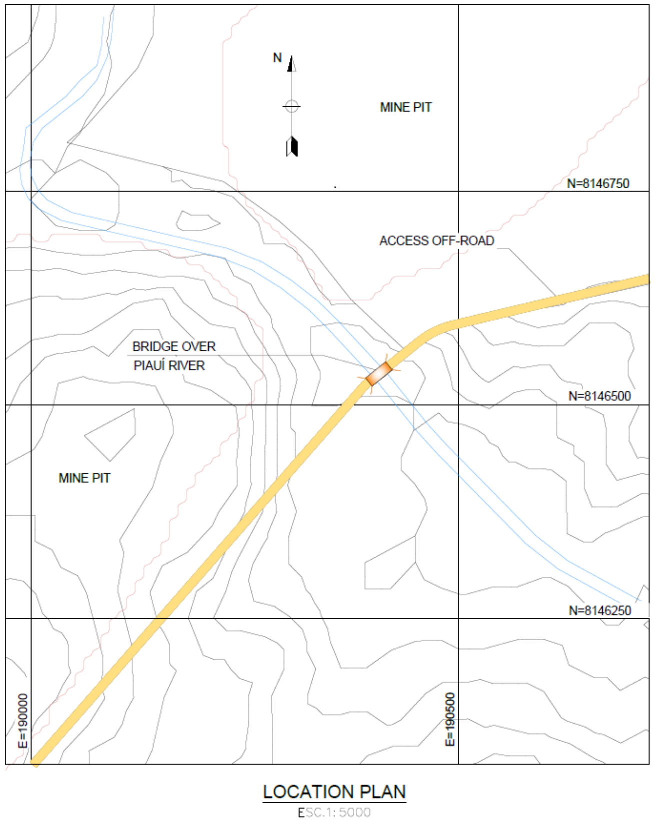


Figure 18-5 – Proposed Bridge Location Xuxa Mine

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

The process plant construction includes earthworks on different elevations, necessitating both cut and fill operations. The Project is divided into three major areas: Process Plant; Mine Support Area and Access to the Process Plant.

In addition to the studies of geometry and elevation of the levels, geotechnical analyzes were carried out to verify the angles of slope stability. As a result, slopes equal to 1:1 (H:V) for cuts and 1.5:1 (H:V) for embankments were determined. The total earth movement is around 600,000 m³, of which 400,000 m³ consists of cutting and 200,000 m³ of landfill.

Appropriate water drainage was designed into the system to minimize slope erosion and the slopes will be hydroseeded to provide additional erosion control.

18.4 WATER BALANCE (STORM WATER, WATER TREATMENT) XUXA

18.4.1 Hydrology and Hydrogeology

18.4.1.1 Hydrology

For the process plant and mine 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 was conducted over a 12-month period. The investigation determined the baseline study of the pre-mining conditions, including the following:

- Review of historical data, which included the 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
- Identification of potential contaminant sources
- Determination of 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 pumping tests 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
- Collected groundwater samples for select parameters to set up baseline groundwater chemistry from monitoring wells
- Developed a hydrogeological model for the site.

The metasedimentary schist host rock has low primary permeability/porosity.

A hydrogeological monitoring program will be employed during the mining operation and will likely include:

- Installation of a 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, 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 piles 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 2 ,3, 4 and 5 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/hr (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 18-6 is a balance projection for operations. Some of the recycled water will also be used for dust suppression.

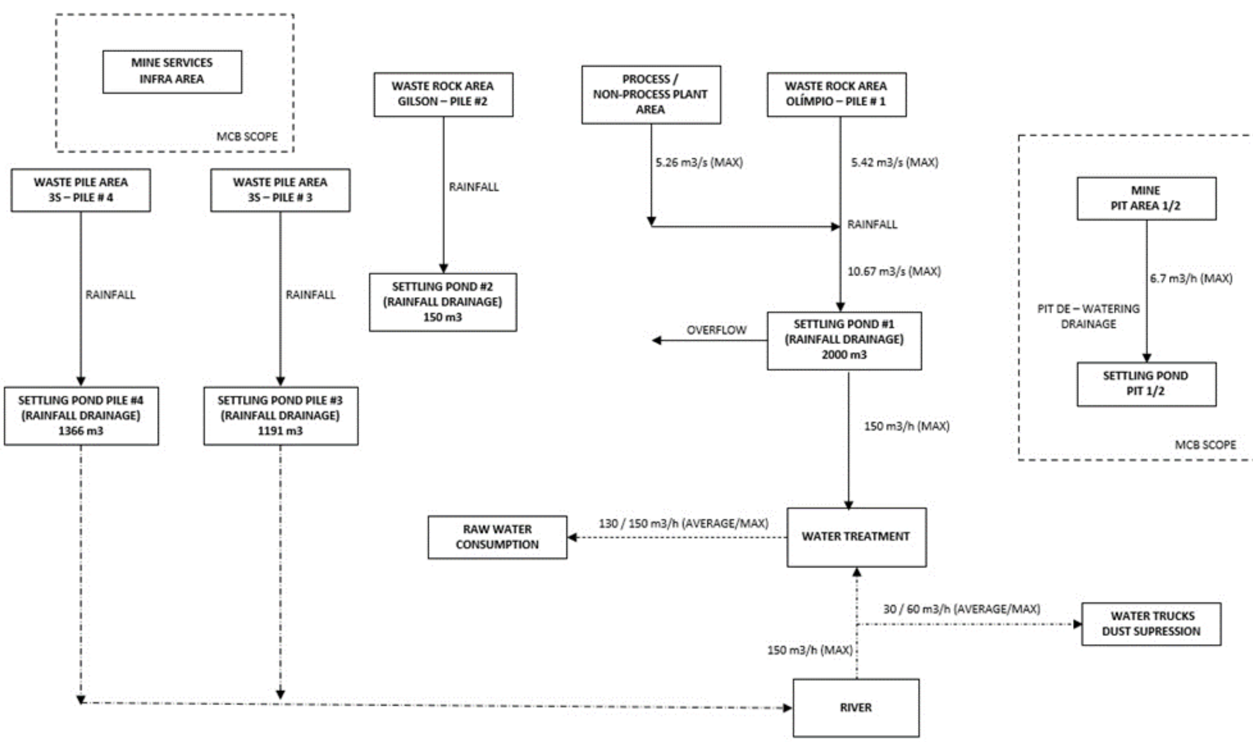


Figure 18-6 – Xuxa Mine Water Balance

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 Tailings and Waste Piles

18.4.4.1 Tailings Pile and Waste Piles 1

Runoff will be directed from higher ground around the tailings and 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 peripheral 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 2, 3, 4 and 5

The graded surfaces will be sloped to allow for rainwater to be discharged by gravity out of the pile, where it will be picked up by drainage channels and/or other drainage devices to settling ponds 3 and 4.

18.4.5 Water Treatment Plant

The Water Treatment Plant for the Jequitinhonha's River water treatment has treatment capacity of 150 m^3/hr, providing 20 m^3/hr of drinkable water as determined by Decree 2914/2011 of the Health Ministry. The water treatment plant is modular and allows the expansion of treatment capacity according to customer demand. The plant includes a physical-chemical water treatment, chemical dosing system and disinfection for drinkable water. The water treatment plant will remove sand, suspended solids, and sludge.

Treated water will be sent for storage in a primary 3,500 m^3 capacity storage tank. The water intakes and proposed treatments are summarized in Figure 18-7.

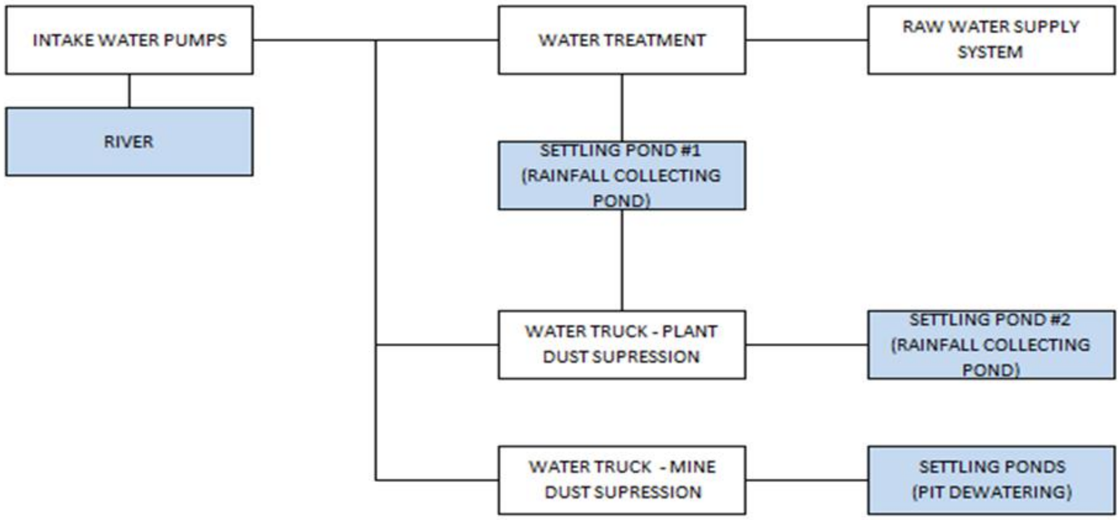


Figure 18-7 – Intake Water / Water Treatment

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 and utilities areas (12 m^3/day, equivalent to 100 persons) and the mine services area (42 m^3/day equivalent to 350 persons).

The sewage treatment plants are modular and consist of a preliminary treatment, a secondary treatment, in addition to a tertiary treatment for disinfection. The treated wastewater from the sewage treatment will need to be disinfected to be able to be sent to a drainage system (compliance to CONSEMA 128 and CONAMA 430). The sludge coming from sewage treatment plant will be trucked off site for disposal by specialized contractors.

18.6 BUILT INFRASTRUCTURE

The main processing facilities will consist of unclad steel structures for access, maintenance and equipment support. Floor layouts for access and maintenance around the equipment will generally be open grating; where required, checker-plate or elevated concrete slabs will be 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.

The steel structures will be built on foundations supported directly under the soil, through floors, and reinforced concrete footings according to the needs of each structure.

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 substations (switch-rooms).

Operational support facilities, such as the compressor room and others, will be of conventional construction consisting of metal structure sheds and masonry offices, except workshops and warehouses, which will consist of metal structure sheds with vinyl canvas coverings.

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 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 and change room	380 m²; separate areas for male/female; prefabricated modular construction
Gate house	110 m²; prefabricated modular construction
Kitchen and canteen	350 m²; canteen and Kitchen; prefabricated modular construction
Plant workshop and warehouse	The workshop building will be 630 m². The warehouse will have 320 m² of covered area and 300 m² of open area. metal structure building with vinyl canvas closure.
Laboratories	445 m²; metal shed. Will have containers for the physical laboratory (13.4 m), chemical laboratory (13.4 m) and an office (6.7 m).
First aid clinic, fire station.	110 m²; first aid clinic; prefabricated modular construction Covered parking for the ambulance and fire truck.
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 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 B-Double-sized trucks
Truck scale control room and truck driver rest area	35 m²; prefabricated modular construction and located near the truck scale.

Item	Comment
Compressor Room	55 m² Single conventional metal structure building
Waste management	110 m^2; 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 18-2 summarizes the planned built non-process infrastructure requirements and Figure 18-8 shows a conceptual representation of the workshop areas.

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 and 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 North Pit. Distances from the magazines and the emulsion plant will be in accordance with the Brazilian regulation for the storage of explosives (R105 Brazilian Army code). The emulsion will be stored in a vertical silo.

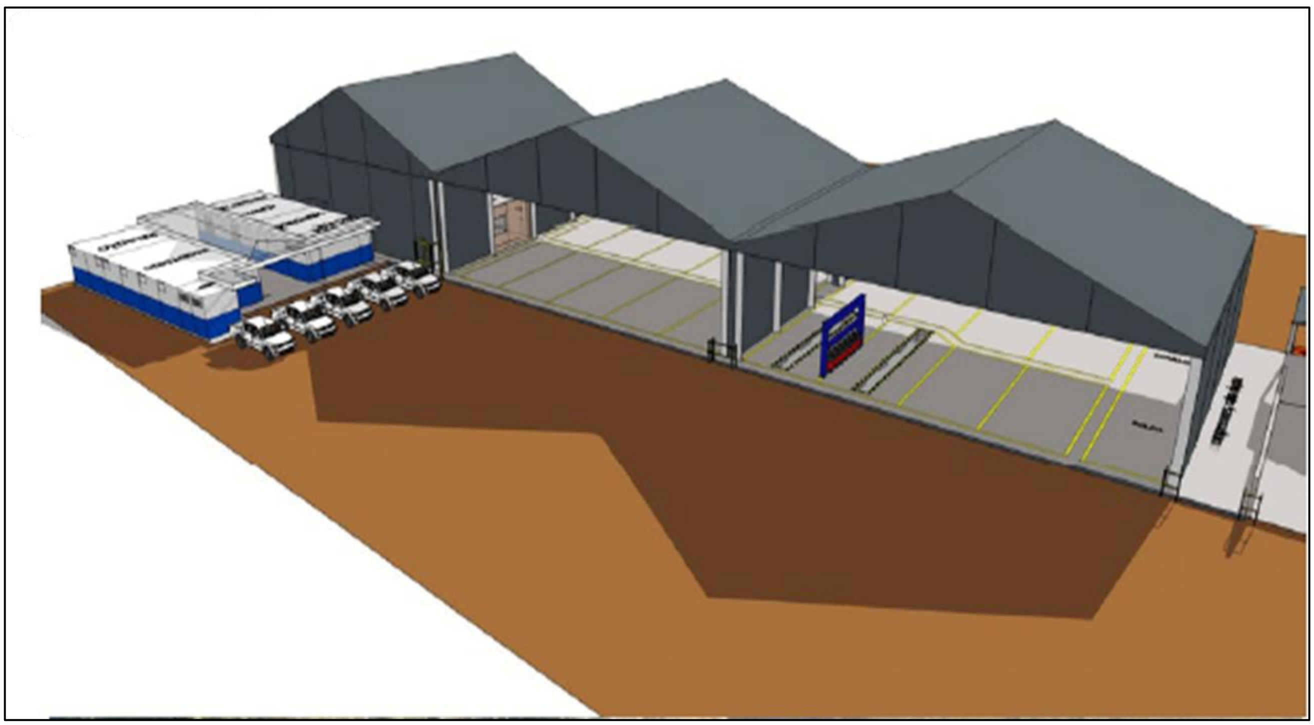


Figure 18-8: Conceptual Representation of Workshop Areas

18.7 STOCKPILES

18.7.1 ROM Stockpiles

There will be two ROM pads located at the feed of the primary crushing circuit which 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. Each ROM stockpile will occupy an area of about 20,000 m^2 of the ROM pad and have an approximate base of 200 m x 100 m and a maximum height of 10 m for a capacity of 5,000 t or 1 day's plant feed. Approximately 15,000 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 which connect to the overall plant rainwater drainage collection system.

18.7.2 Crushed Ore Feed Bins

Crushed ore will be sent to the DMS feed bin which will have a capacity of 8 hours and includes an emergency overflow chute. The crushed ore will be automatically fed from the feed bin to the DMS circuit. The DMS circuit will also have a secondary feed chute which can be fed by a front-end loader during extended maintenance periods of the crushing plant.

18.7.3 Spodumene Concentrate Stockpile

The concentrate stockpile will be fed by a radial stacker and sized for one day for a storage of 720 t. The stockpile will have a concrete pad and 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.

18.8 WASTE DISPOSAL

18.8.1 Xuxa Waste Disposal

The waste rock disposal areas are located close to the Xuxa pits. The sites will be properly prepared to include drainage of each waste pile base, and the construction of channels to direct the groundwater flow, aiding the geotechnical stability and mitigating erosion of the stored material. Figure 18-9 shows the proposed location of waste piles and sumps, although operational requirements may warrant changing the exact location of the piles.

The geotechnical investigation of the waste pile locations was carried out based on sampling campaigns, laboratory tests and field visits. Altered and unaltered samples were collected to carry out laboratory tests for each of the waste piles. Other available information has been updated, such as laboratory tests, probes with SPT tests and rotary diamond drill hole logs. Figure 18-10 shows the location of the field investigations and test pits.

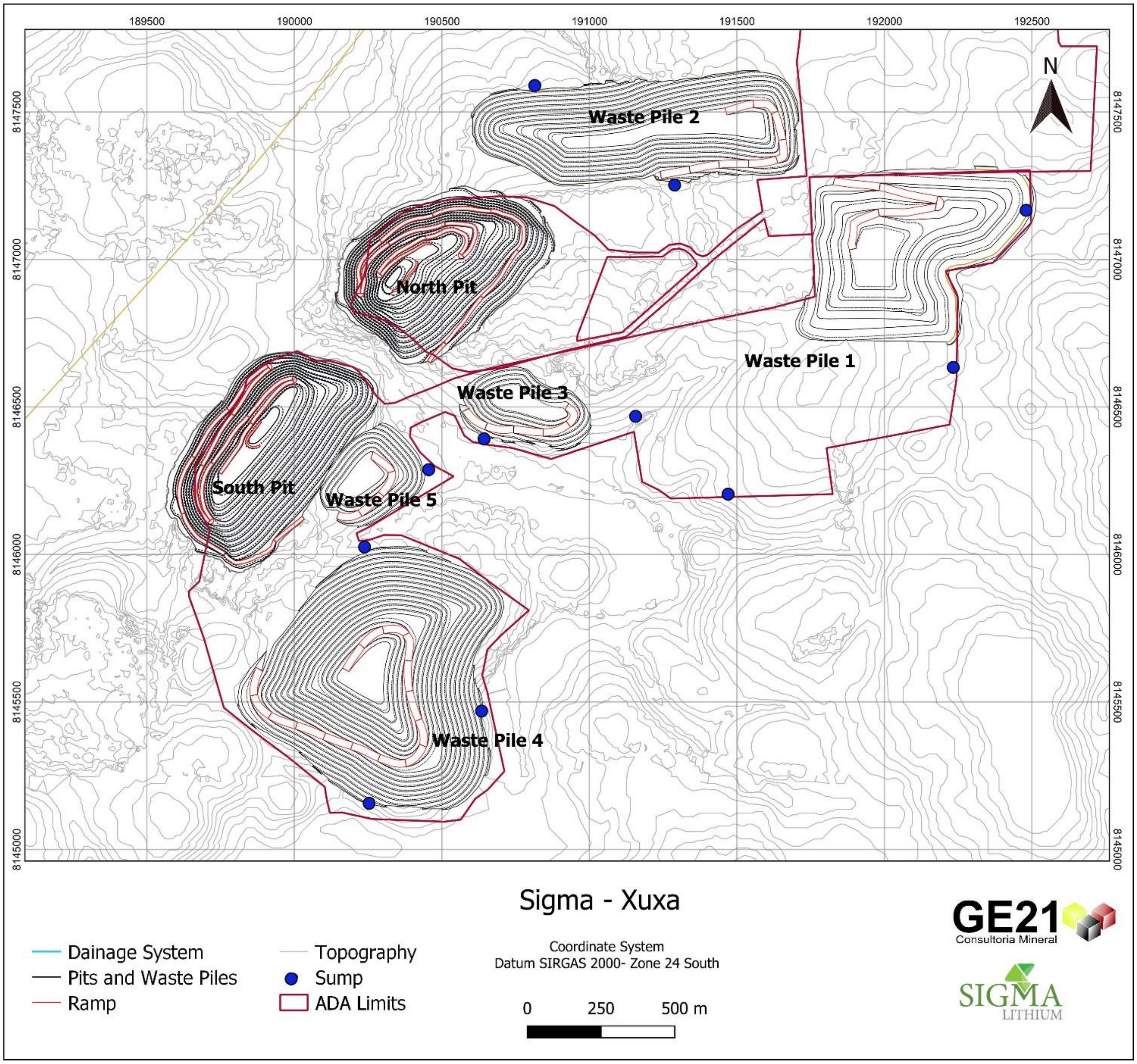


Figure 18-9: Xuxa Waste Piles Location Map

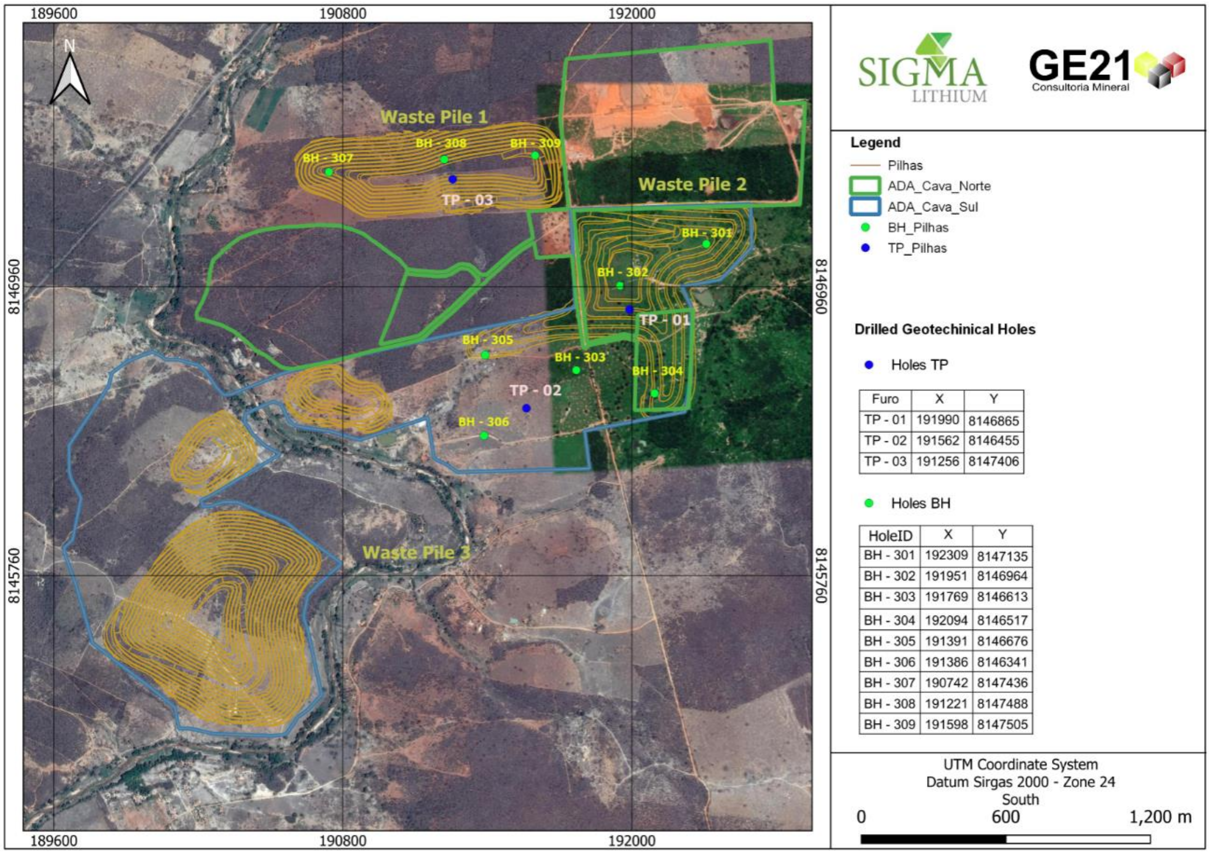


Figure 18-10: Xuxa Waste Piles Geotechnical Sampling Locations

The waste piles will be built using the ascending method, which allows a construction sequence of multiple lifts, beginning with the construction of the base of the pile. Waste will be dumped by trucks and be uniformly distributed and leveled using a bulldozer. The procedure is then repeated, stacking another bench above the original, while maintaining a ramp so that trucks can access the area.

Upon completion of a bench, it will be ready to be revegetated by hydroseeding or another method.

Figure 18-11 shows an example of the construction sequence for a berm.

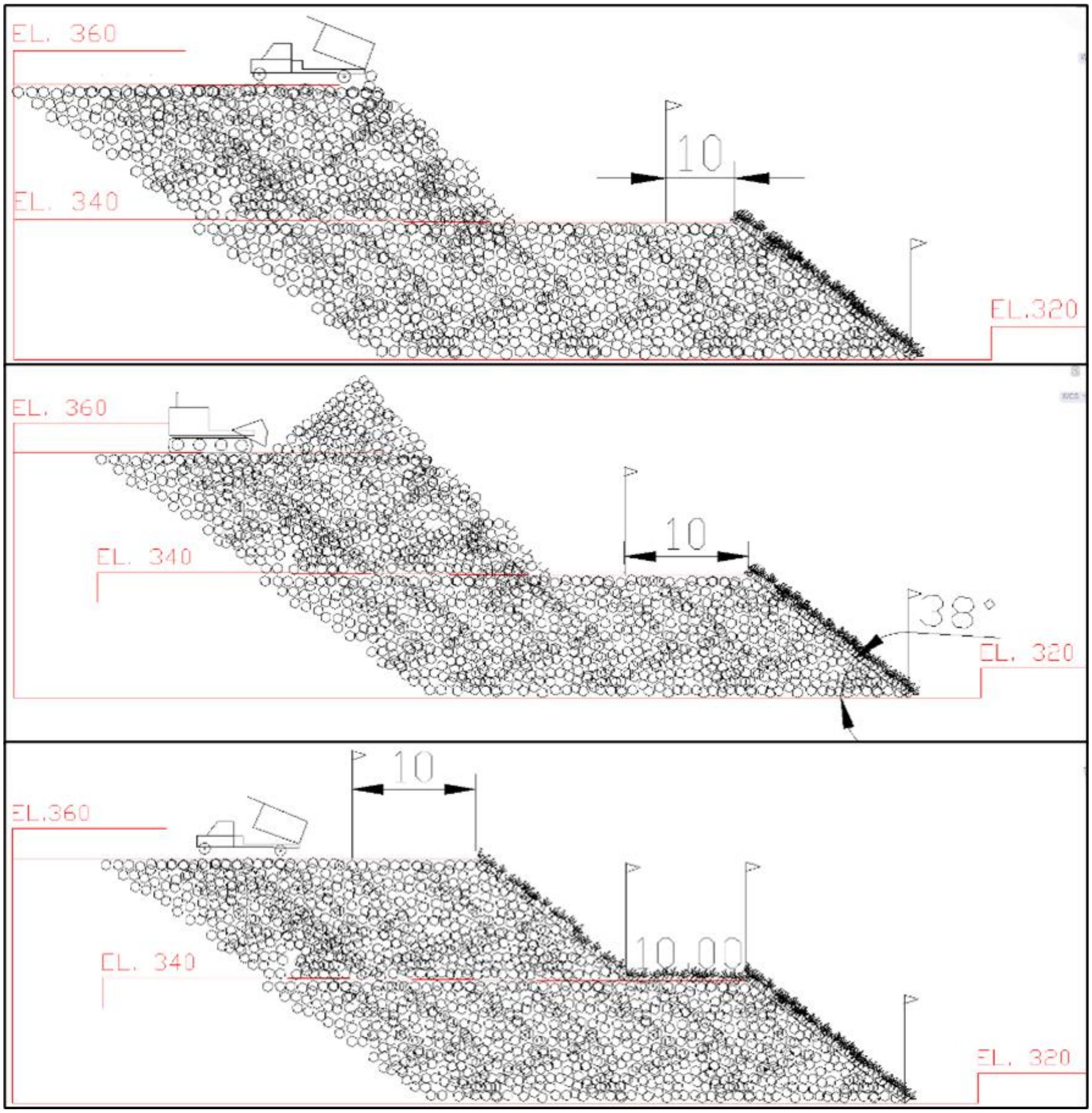


Figure 18-11: Constructive Sequencing of the 340 M Level of the Waste Pile Berm

Stability analysis cross-sections were selected passing through the highest points of the waste piles assuming the hypothesis of circular rupture for granular material. The Slide program was used with the Simplified Bishop method, adopting as resistance parameters those usually used in rockfill piles. For the foundation, the average strength parameters of the CIU triaxial tests were adopted, as shown in Table 18-3.

Table 18-3: Xuxa Waste Pile Parameters for Stability Analysis

Waste Pile Number	Materials	γ (kN/m³)	Cohesion C' (kPa)	Friction Angle Φ (°)
Waste Pile 1	Embankment (waste)	19	1	40
	Foundation 1 (schist/saprolite)	16.9	9.6	26.9
	Foundation 2 (biotite schist)	21	50	34
Waste Pile 2	Embankment (waste)	19	1	40
	Foundation 1 (schist/saprolite)	16.4	7.1	28.5
	Foundation 2 (biotite schist)	21	50	34
Waste Pile 3	Embankment (waste)	19	1	40
	Foundation 1 (schist/saprolite)	17.2	8	27.4
Waste Pile 4	Embankment (waste)	19	1	40
	Foundation 1 (schist/saprolite)	17.7	3.4	32
	Foundation 2 (schist)	21	50	34
Waste Pile 5	Embankment (waste)	19	1	40
	Foundation 1 (schist/saprolite)	17.7	3.4	32

Results of the stability analysis are presented in Table 18-4 and shown in Figure 18-12.

The results indicate that the safety factor is greater than 1.5 without a low water table level and 1.3 with a high-water table level. These safety factors are in accordance with those usually adopted for similar structures.

Table 18-4: Safety Factor from Xuxa Waste Pile Stability Analysis

Waste Pile Number	Section	Safaty Factor (minimum)
Waste Pile 1	AA	1.58
	BB	1.56
Waste Pile 2	AA	1.58
	BB	1.56
Waste Pile 3	AA	1.54
	BB	1.51
Waste Pile 4	AA	1.64
	BB	1.63
	CC	1.64
Waste Pile 5	1	1.64

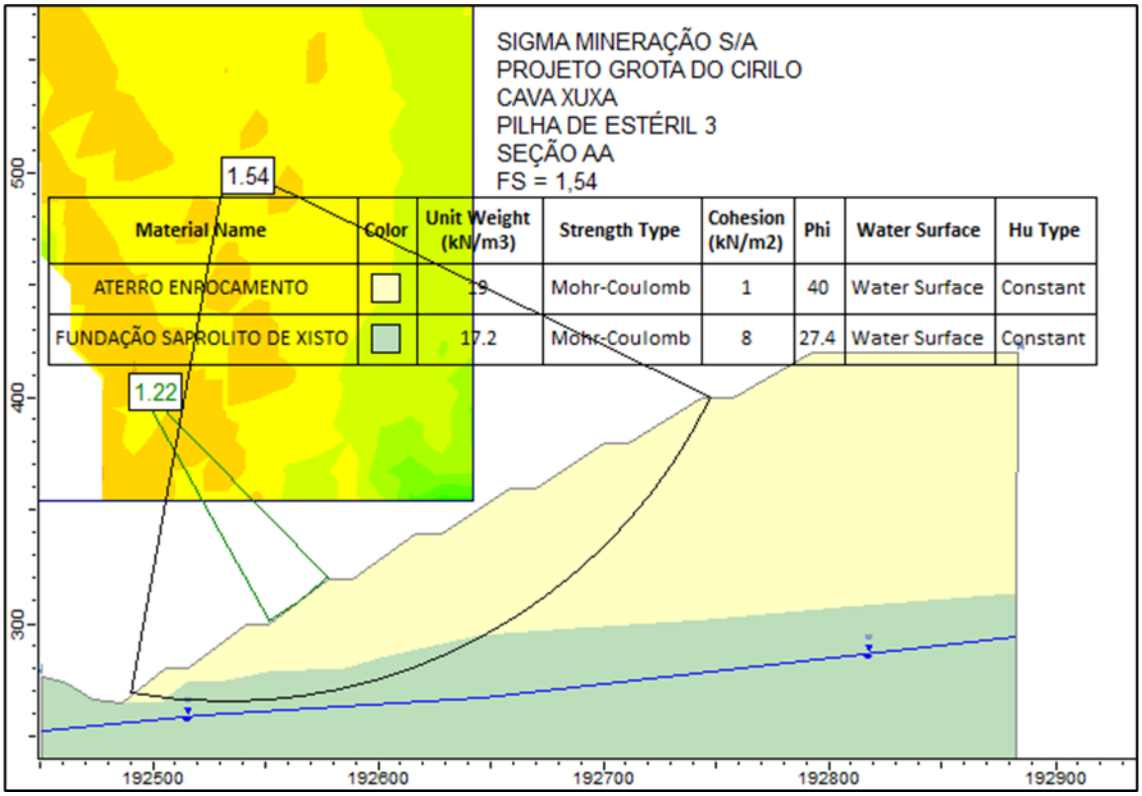


Figure 18-12: Stability Analysis Section AA for Xuxa Waste Pile 03

Instrumentation sections designed with water level indicators must be installed after the construction of the landfill in order to monitor any rock deformations and verify the efficiency of the internal drainage system.

GE21 recommends bi-weekly visual inspections in the dry months, and an increase in the frequency of inspections during the rainy season, especially for drainage channels and water level indicators.

Table 18-5 presents the design parameters of the waste dumps. Table 18-6 shows the capacities of surface areas for the waste dumps designed for the project. The total capacity of the waste dumps was estimated using 25% expansion and 10% compaction factors.

Table 18-5: Xuxa Waste Pile Design Parameters

Parameter	Value
Bench Height	20 m
Minimal Berm Width	10 m
Face Angle	38º
Access Ramp Width	12 m
Ramp Inclination Angle	10%

Table 18-6: Xuxa Waste Pile Capacities and Surfaces Areas

Designed Pile	Volume (Mm^3)	Area (ha)
Pile 1	16.2	35.9
Pile 2	15.1	34.1
Pile 3	1.8	8.7
Pile 4	35.9	55.8
Pile 5	2.4	8.3
TOTAL	***71.4***	**142.8**

18.8.2 Barreiro Waste Disposal

The Barreiro waste rock disposal area is planned to be located close to the Barreiro pit, although the final location will depend on the results of environmental analysis and licensing. The site will be properly prepared to include drainage of the waste pile base, and construction of channels to direct the groundwater flow, aiding the geotechnical stability and mitigating erosion of the stored material. Figure 18-13 shows the proposed location of waste pile location.

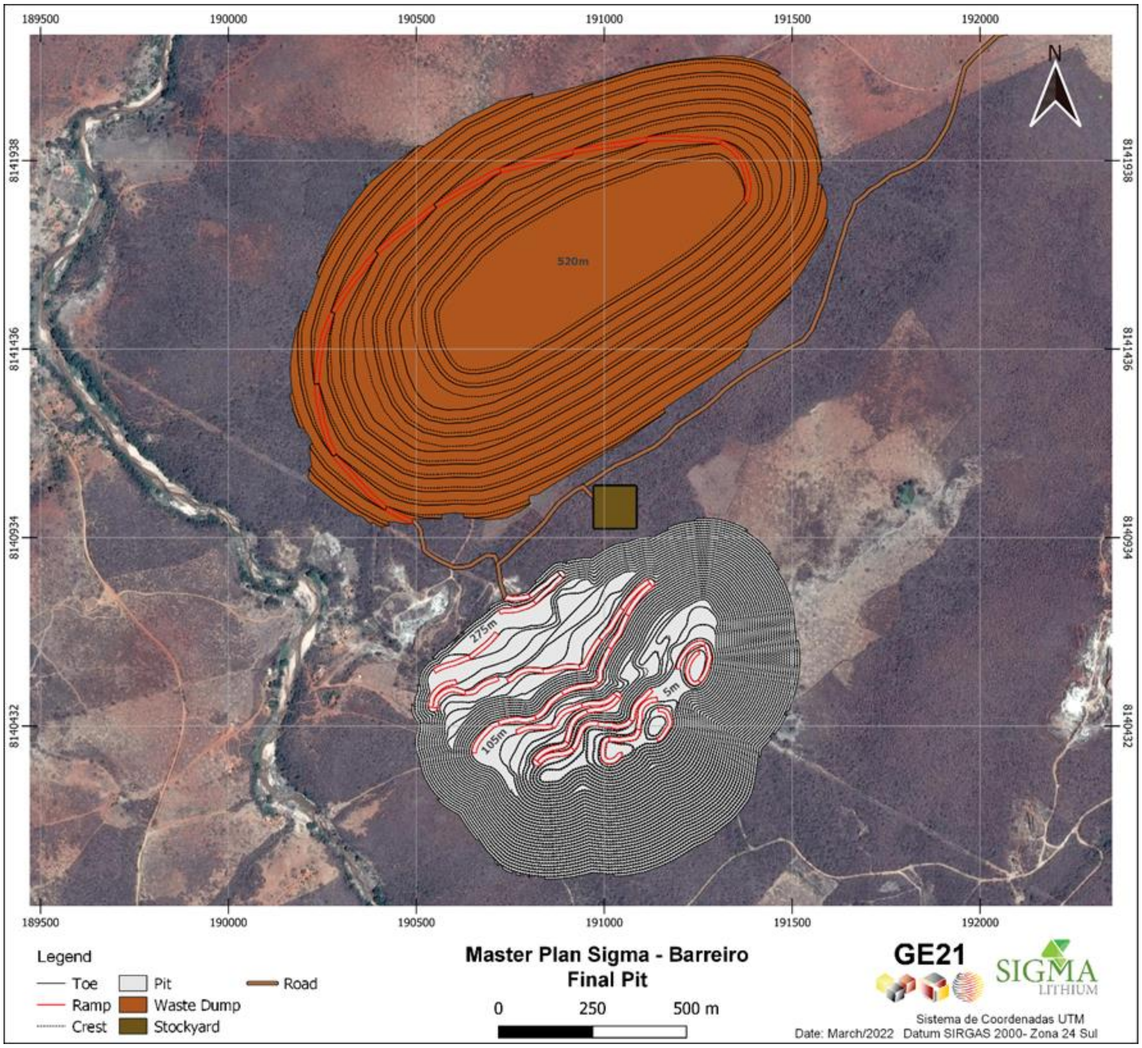


Figure 18-13: Proposed Location of Barreiro Waste Dump

The waste rock dump will be built using the ascending method, which allows a construction sequence of multiple lifts, beginning with the construction of the base of the pile. Waste will be dumped by trucks and be uniformly distributed and leveled using a bulldozer. The procedure is then repeated, stacking another bench above the original, while maintaining a ramp so that trucks can access the area.

Upon completion of a bench, it will be ready to be revegetated by hydroseeding or another method.

Figure 18-10 shows an example of the construction sequence for a berm.

Instrumentation sections designed with water level indicators will be installed after the construction of the landfill to monitor any rock deformations and verify the efficiency of the internal drainage system.

GE21 recommends bi-weekly visual inspections in the dry months, and an increase in the frequency of inspections during the rainy season, especially for drainage channels and water level indicators.

Table 18-7 presents the design parameters of the Barreiro waste dump. Table 18-8 shows the capacity of surface area for the waste dump designed for the project. The total capacity of the waste dump was estimated using 30%

expansion and 15% compaction factors. This final waste dump layout is designed to allow for the expansion of the waste pile. Figure 18-14 shows the mine layout with pits, process plant and waste piles locations.

Table 18-7: Barreiro Waste Pile Design Parameters

Parameter	Value
Bench Height	20 m
Minimal Berm Width	10 m
Face Angle	38º
Access Ramp Width	12 m
Ramp Inclination Angle	10%

Table 18-8: Barreiro Waste Pile Capacity and Surface Area

Waste Pile	Value
Volume (Mm^3)	110.9
Area (ha)	122.7
Maximum height (m)	220

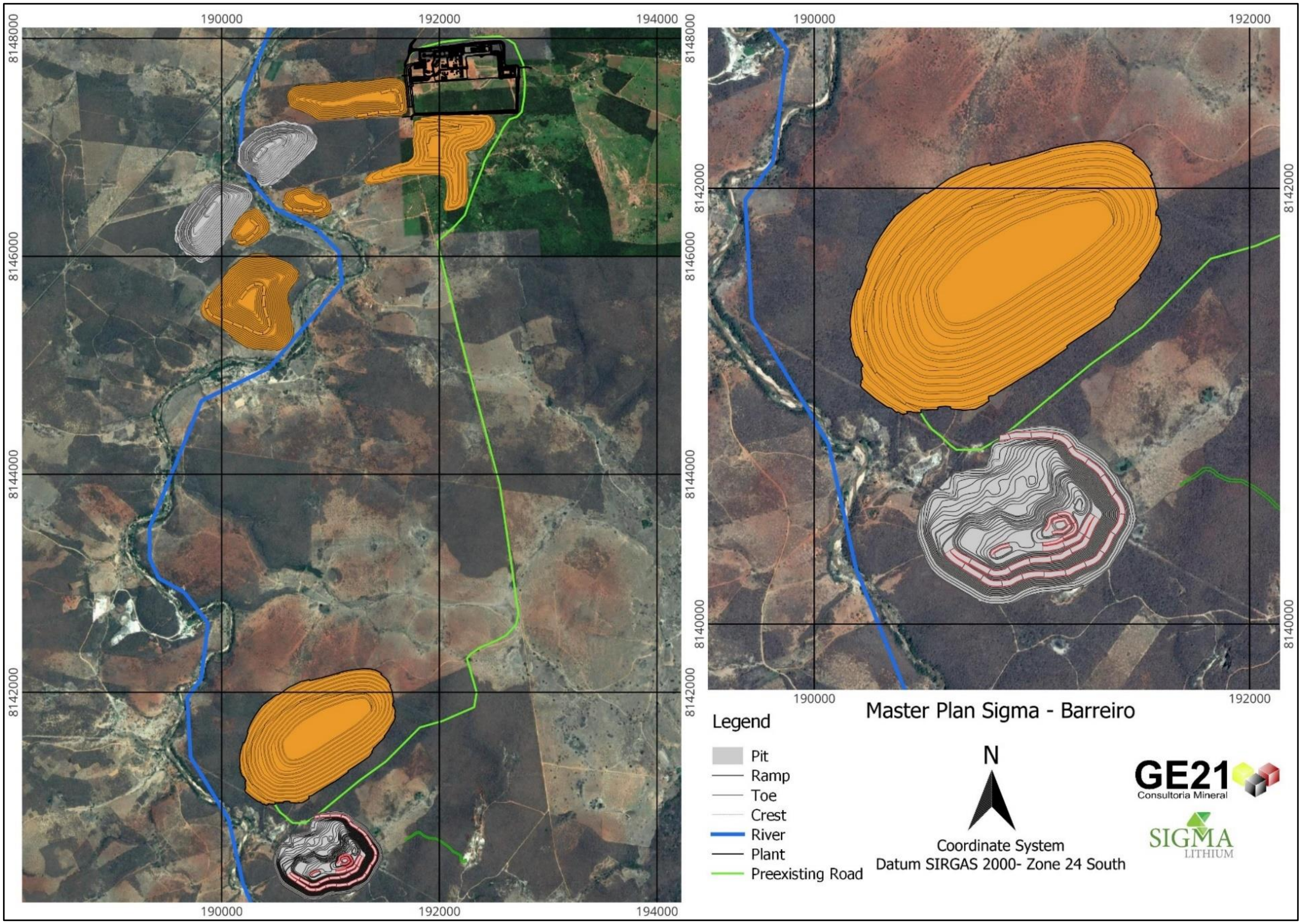


Figure 18-14: Mine Configuration Showing Xuxa and Barreiro Pits and Sigma Processing Plant

18.8.3 Nezinho do Chicão Waste Disposal

The waste rock disposal area was planned to be located close to the Nezinho do Chicão pit. Waste rock materials will be transported from the mine by haul truck. The final location will depend on results of environmental analysis and licensing. The site must be properly prepared to include drainage of the waste pile base, and channels to direct the groundwater flow, thus aiding geotechnical stability and mitigate erosion of the stored material. Figure 18-15 shows the location of waste dump.

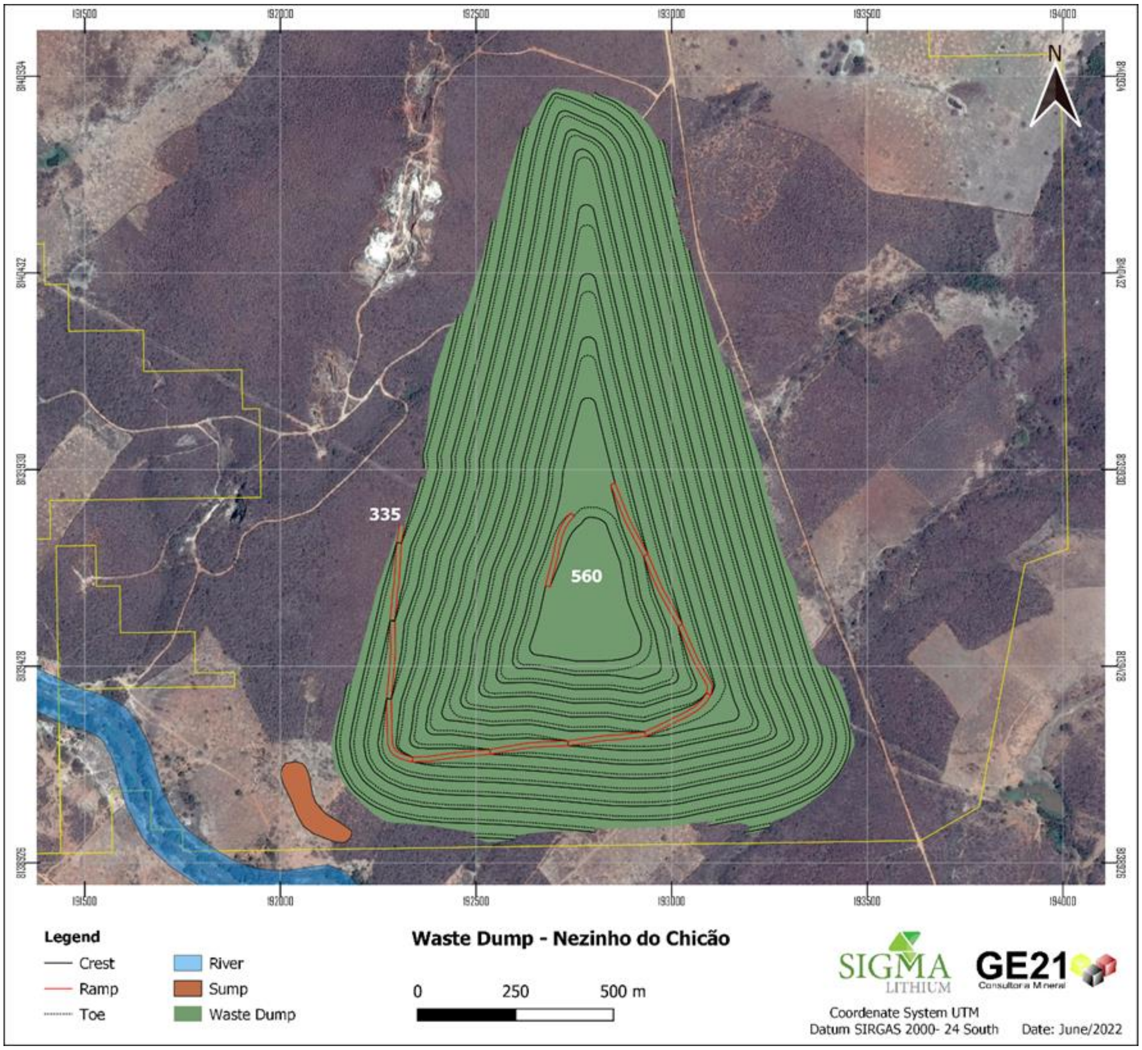


Figure 18-15: Nezinho do Chicão Waste Dump Location

The waste rock dump will be built using the ascending method, which allows a construction sequence of multiple lifts, beginning with the construction of the base of the pile. Waste will be dumped by trucks and be uniformly distributed and leveled using a bulldozer. The procedure is then repeated, stacking another bench above the original, while maintaining a ramp so that trucks can access the area.

Upon completion of a bench, it will be ready to be revegetated by hydroseeding or another method.

Figure 18-10 shows an example of the construction sequence for a berm.

Instrumentation sections designed with water level indicators will be installed after the construction of the landfill in order to monitor any rock deformations and verify the efficiency of the internal drainage system.

GE21 recommends bi-weekly visual inspections in the dry months, and an increase in the frequency of inspections during the rainy season, especially for drainage channels and water level indicators.

Table 18-9 presents the design parameters of the Barreiro waste dump. Table 18-10 shows the capacity of surface area for the waste dump designed for the project. The total capacity of the waste dump was estimated using 30% expansion and 15% compaction factors. This final waste dump layout is designed to allow for the expansion of the waste pile. Figure 18-16 shows the mine layout with pits, process plant and waste piles locations.

Table 18-9: Nezinho do Chicão Waste Pile Design Parameters

Parameter	Value
Bench Height	20m
Minimal Berm Width	10m
Face Angle	38º
Access Ramp Width	12m
Ramp Inclination Angle	10%

Table 18-10: Nezinho do Chicão Waste Pile Capacity and Surface Area

Waste Pile	Value
Volume (Mm^3)	162.5
Area (ha)	158.8
Maximum height (m)	225

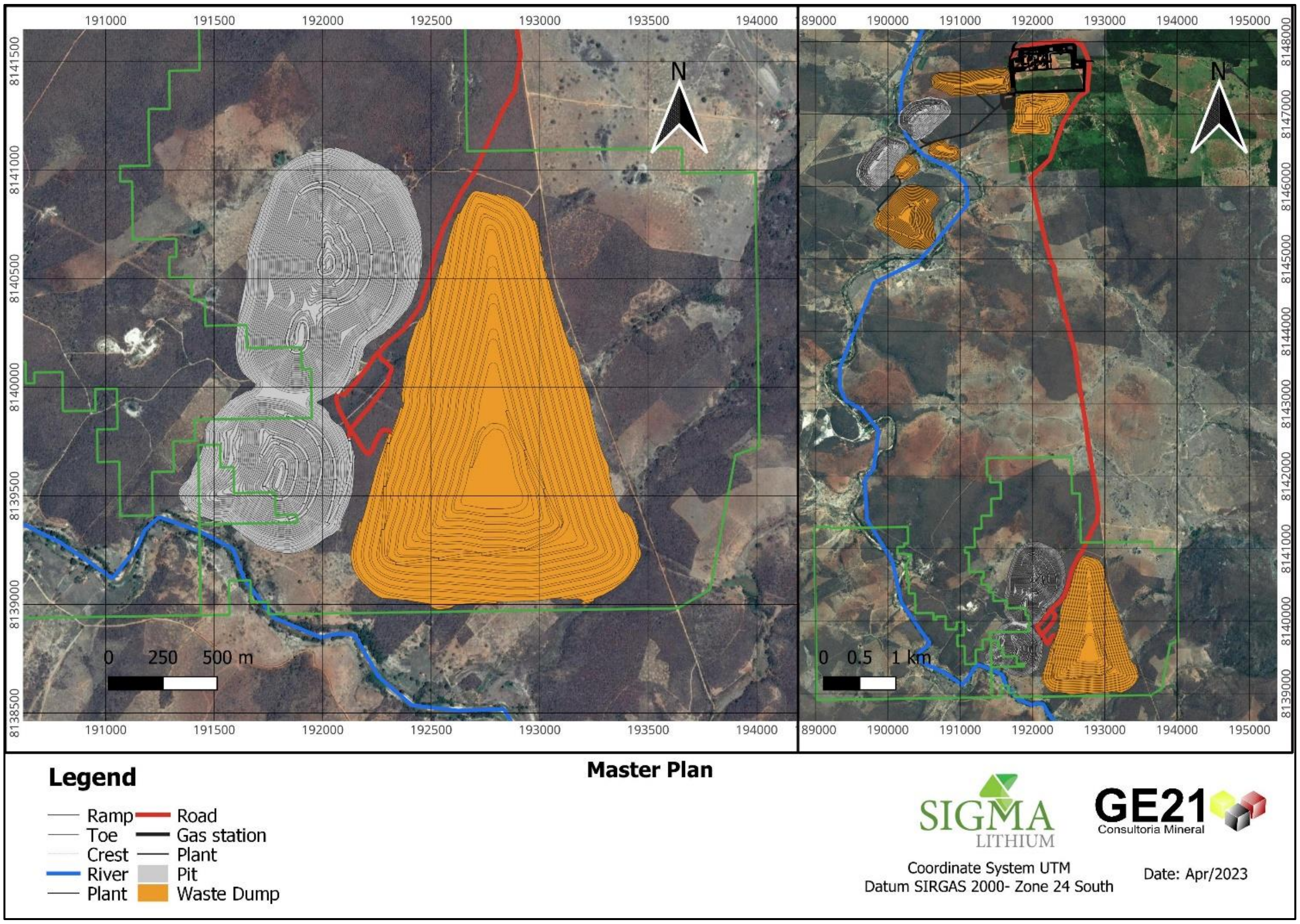


Figure 18-16: Mine Configuration Showing Xuxa, Barreiro and Nezinho do Chicão Pits and Sigma Processing Plant

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 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 reduced to 13.8 kV by two 138-13.8 kV transformers that connects to the medium voltage switchgear for primary distribution. Both Phase 1 and Phase 2 & 3 will each connect to stepdown 13.8-0.44 kV transformers, as below:

- Two transformers for DMS
- One transformer for crushing
- Two transformers for utilities
- One transformer for mine

The secondary distribution voltage is 440 Vac from above transformers for all loads. For small loads and lighting power, the voltages are:

- 220V AC 3 phase, 60 Hz for road lighting and small loads
- 127V AC 1 phase, 60 Hz for offices and working stations

- 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 Plants

The crushing equipment is fed by a cable from the plant substation switchgear to a 13.8/0.44 kV transformer. The transformer is connected to a switch room (440 V) MCC for distribution to the crushing equipment. The contract crushing load is estimated at 1.1 MW, including auxiliary electrical loads.

The DMS equipment is fed by two circuits from the plant substation switchgear to two 13.8/0.44 kV transformers. The transformers are connected to a switch room (440 V) MCCs for distribution to the DMS equipment. Table 18-11 shows the process power plant demand for Phase 1, while Table 18-12 shows the demand for Phase 2 & 3.

Table 18-11 – Total Process Plant Power Demand for Phase 1

Areas	Equipment Number	VSD Heat Load (kW)	Connected Load	Peak Demand			Average Running Demand		
			Name Plate (kW)	kW	kVAr	kVA	kW	kVAr	kVA
Crushing 440V MCC	**210-MCC-001**	**1.5**	**1850**	**1386**	**1034**	**1729**	**1157**	**861**	**1442**
DMS 440V MCC 1	**310-MCC-001**	**26.3**	**1747**	**1389**	**501**	**1476**	**1145**	**395**	**1211**
DMS 440V MCC 2	**310-MCC-002**	**25.9**	**2266**	**1499**	**581**	**1608**	**1243**	**465**	**1327**
Main Bus	310-MCC-002	14.8	1576	975	428	1065	797	335	865
Emergency Bus	310-MCC-002-EMB	11.1	690	524	153	546	445	130	464
Totals		53.7	5863	4274	2116	4769	3545	1721	3941
		Power Factors			0.90			0.90	

Table 18-12: Total Process Plant Power Demand for Phase 2 & 3

Areas	Connected Load	Peak Demand	Average Running Demand
	Name Plate (kW)	kW	kW
Crushing	**2632**	**2105**	**1432**
DMS	**4056**	**3245**	**2758**
Plant Services, Tails, Water	**2167**	**1733**	**1473**
Total	**8855**	**7083**	**5663**

18.11 WATER SUPPLY

The primary water source will be from the Jequitinhonha River.

Sigma has been granted a flow of 150 m^3/hr for all months of the year by the Agencia Nacional das Águas (ANA) for a period of 10 years. The water will be taken from the Jequitinhonha River by two floating pumps, one operating and one on standby, to the water treatment plant and for the filling station of the trucks that wet the floor of the mine when necessary.

Two pumps, one operating and one on standby, will supply treated raw water from the water treatment plant to a day storage tank of 3,500 m^3 for Phase 1. For Phase 2&3, a second supply line will be built to feed the day storage tank as well as a separate line to supply the mine infrastructure. The distribution of treated raw water from the process water tank to consumption points will be performed by three raw water distribution pumps (two operating and one on standby). The consumers are listed below:

- Two Process Plants (Areas 200 and 300)
- Mine services (Area 700)
- Service stations (Area 600)
- Technical fire reserve

Potable water will be supplied directly from the water treatment plant. The potabilization unit will supply 20 m^3/hr of potable water to a potable water storage tank of 75 m^3. Two pumps, one operating and one on standby, will supply potable water to the following consumers:

- Process Plant (Area 300)
- Shower and eye washes (Area 600)

For the auxiliary buildings (bathroom, canteen, etc.) the distribution of potable water will be by gravity flow from the potable water tanks.

18.12 COMPRESSED AIR

The compressed air system is responsible for supplying service air and instrument air to process plants (Areas 300, Areas 200) and to utilities area (Area 600). Compressed air is supplied by two compressors, one operating and one on standby. The air compressed system has a nominal capacity of 700 Nm^3 /hr, and it is composed by air dryers and lung vessels. The lung vessels have the function of storing dry air and absorbing variations in air consumption and acting as an accumulator, serving to guarantee a maximum operating time in the event of a system or plant stop.

The compressed air distribution network is split into two branches, one for the delivery of instrument air and the other for service air. However, the instrument air will go to a drying step before being sent for consumption.

For the mine and at the mine workshop, compressors will be provided as required by the mining contractor.

18.13 CONTROL SYSTEMS

The Programmable Logic Controller (PLC) is an industrial automation device that makes use of programmable memory to store instructions previously defined by the user.

For Sigma's industrial plant, a Process Control System (PCS) is being considered. It contains three main PLCs, where they will monitor all equipment and instruments in the plant and control all equipment not associated with a supplier's programmable logic controller (PLC). There will be two control rooms within the process plant: the crushing control room and the main control room. The crushing control room will be located next to the crushing switch room, while the main control room will be located next to the DMS switch room.

Within the main control room will be a SCADA server. The SCADA is the main plant's supervisory control and data acquisition system hardware. It will consist of a pair of redundant master-follower servers of rack-mounted computers. All computers will remotely control equipment, panel, mains power supply from a source of failure, remote control equipment, panel, remote control equipment, panel, and power supply system in case of failure.

The control room will house the operating and engineering stations (where the operators are located) and the entire closed-circuit television (CCTV) monitoring system. From the Control Room there is a fibre optic ring connection with the two control rooms of the plant: Crushing Switch Room and DMS Switch Room. The fibre optic network will connect to locations outside the switch room/control room buildings.

The remote panels are located in the field and are responsible for transmitting information from the instruments and sending it to the PLC of each area.

18.14 COMMUNICATION SYSTEMS

The communications system will consist of:

- Telecommunications network and internet services
- Access control
- CCTV
- All IT infrastructure will be the same for these systems, fibre optics will connect the areas and there will be a central rack that will accommodate equipment like NVR, telecom server, DIO, switches and patch panel. Each area will have network outlet and/or access point.
- Security cameras will be installed at the main gate, warehouse and parking lot.

18.15 CAMPS AND ACCOMMODATION

There will be no construction or operations camp for the Project considering the proximity of nearby towns.

18.16 PORT FACILITIES

SMSA will use the port facilities located at Port of Vitória for solid bulk storage port operations. The Port of Vitória 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 Vitória will manage reporting of reception and loading, command of the ship and/or its agents, co-ordinate cargo loading and include port operation insurance.

19 MARKET STUDIES AND CONTRACTS

Information in this section regarding lithium demand, supply and price forecasts are summarized from Benchmark Mineral Intelligence (2022).

19.1 LITHIUM DEMAND FORECAST

Lithium's demand growth profile increased dramatically in 2022, driven by structural changes in the automotive industry with manufactures increasingly transitioning towards electric vehicles ("EVs"). Benchmark Mineral Intelligence estimates that 2022 will end in a deficit position with total base-case battery demand expected to end the year at 591 GWh, translating to 475 kt of lithium carbonate equivalent ("LCE") demand, up from 348kt LCE in 2021. Total lithium demand in 2022 expected to be 613 kt of LCE vs 482 kt in 2021.

Benchmark Mineral Intelligence estimates that the deficit will continue going forward, with 2023 forecasted to have a base case demand from battery end-use of 630 kt LCE, a 33% increase from 2022. Total lithium demand is expected in 2023 to be 774 kt LCE. The deficit position is expected to continue to increase, reaching a net deficit position of 159 kt LCE by 2030 and 2,580 kt LCE by 2040.

Refer to Figure 19-1 below for a summary of Benchmark Mineral Intelligence's lithium supply-demand forecast.

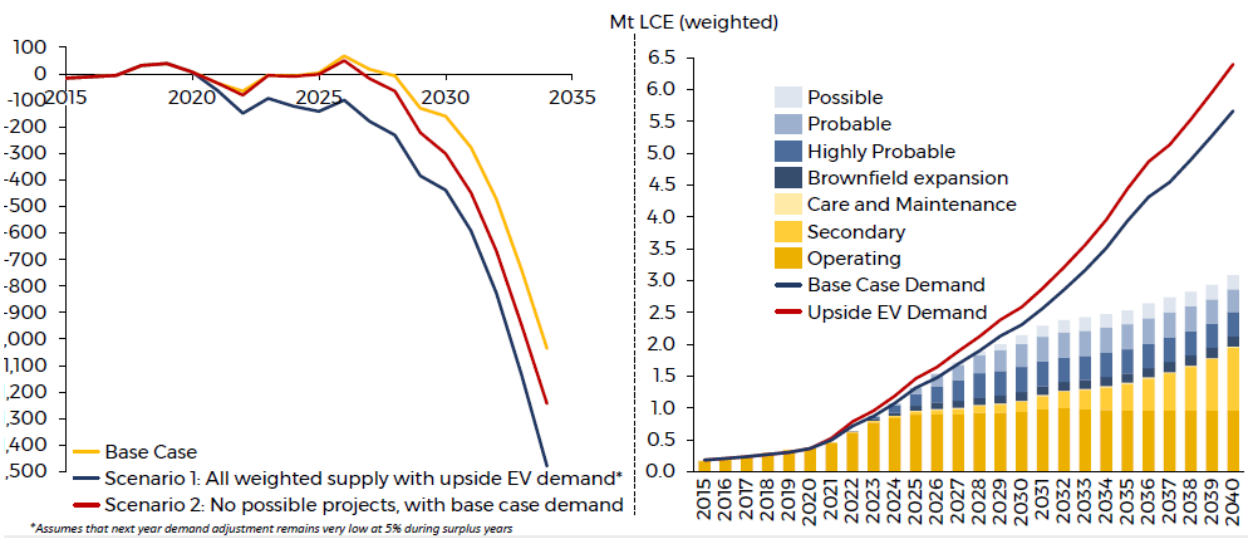


Figure 19-1: Lithium Supply-Demand Forecast (Benchmark Market Intelligence 2022)

The importance of end-use demand from EVs is further highlighted in Figure 19-2 and Figure 19-3 below, with Benchmark Mineral Intelligence estimating that approximately 77% of the total demand estimated in 2022 was from battery related end-uses.

Benchmark Mineral Intelligence estimates global EV penetration will reach 12.4% in 2022, up from 8.0% in 2021, as global EV sales continue to accelerate, particularly from Europe and China. This figure is expected to climb to 21% by 2025 and reach 74% by 2040.

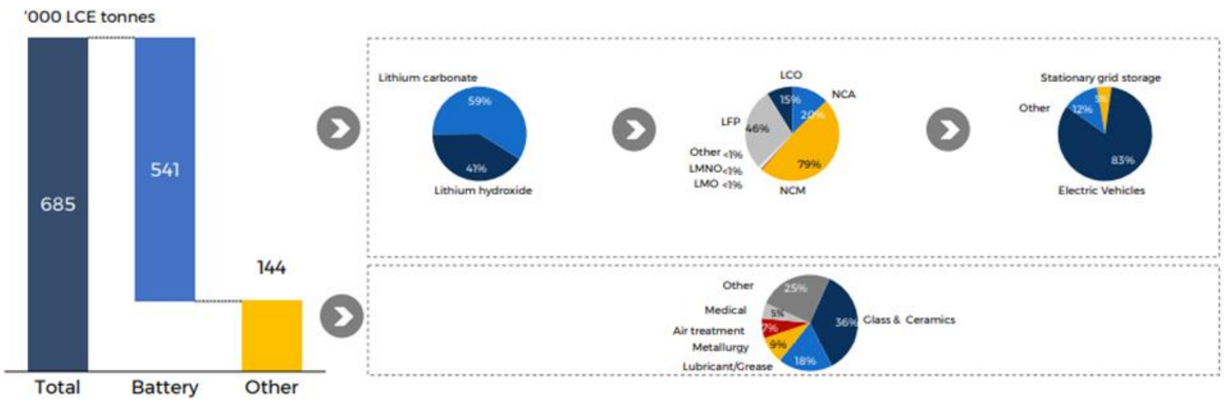


Figure 19-2: Lithium Demand Breakdown by End-Use 2022 (Benchmark Market Intelligence 2022)

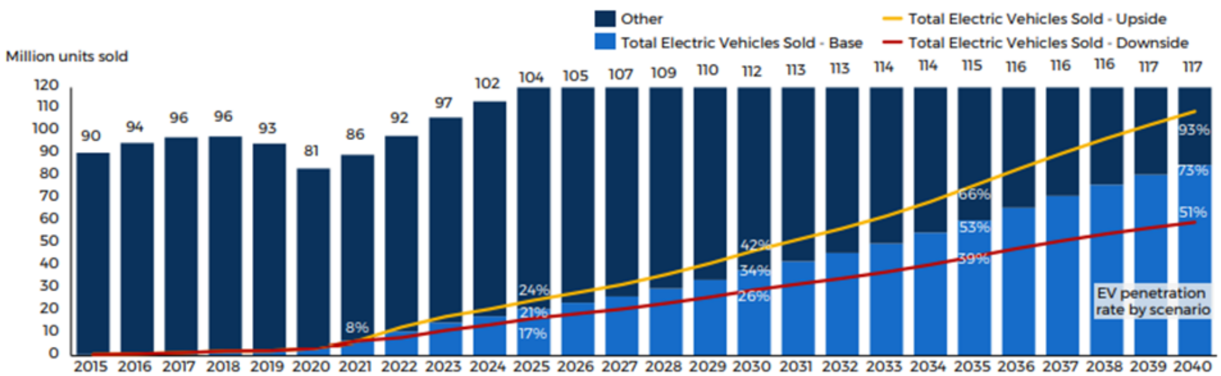


Figure 19-3: Electric Vehicle Sales as a Share of Total Cars (Benchmark Market Intelligence 2022)

19.2 LITHIUM SUPPLY FORECAST

Benchmark Mineral Intelligence expects lithium supply to increase over the 634 kt LCE of total supply estimated in 2022, given the robust commodity price outlook for lithium. The majority of 2022 lithium supply is expected to come from Australian hardrock producers, amounting to 45% of Benchmark Mineral Intelligence's total estimated supply. Commensurate with the supply increase expected, including the entry of new producing mines discussed below, Benchmark Mineral Intelligence expects the lithium supply to be more diversified by 2031. However, the supply market will still be relatively geographically concentrated with Australia, Chile, China and Argentina contributing 66% of the total supply estimated by Benchmark Mineral Intelligence in 2031.

In the longer term, Benchmark Mineral Intelligence forecasts that the total lithium supply will reach 2.1 Mt LCE by 2030 and 3.0Mt LCE by 2040. Benchmark Mineral Intelligence's supply forecast includes expansions from existing mines as well as new entrants developing pre-production projects. In 2021, Benchmark Mineral Intelligence increased the likelihood of "possible" and "probable" lithium development projects to 60% and 75%, respectively (previous estimates were at a 25% and 55% likelihood). These probabilities have been maintained in Benchmark Mineral Intelligence's Q3-2022 forecast. Additionally, Benchmark Mineral Intelligence's supply model includes several early-stage projects, that are expected to define a resource or reserve and undergo feasibility studies and announce production forecasts within the next 6-12 months, in order to show a more complete pipeline of possible projects.

Refer to Figure 19-4 below for a summary of Benchmark Mineral Intelligence's lithium supply forecast.

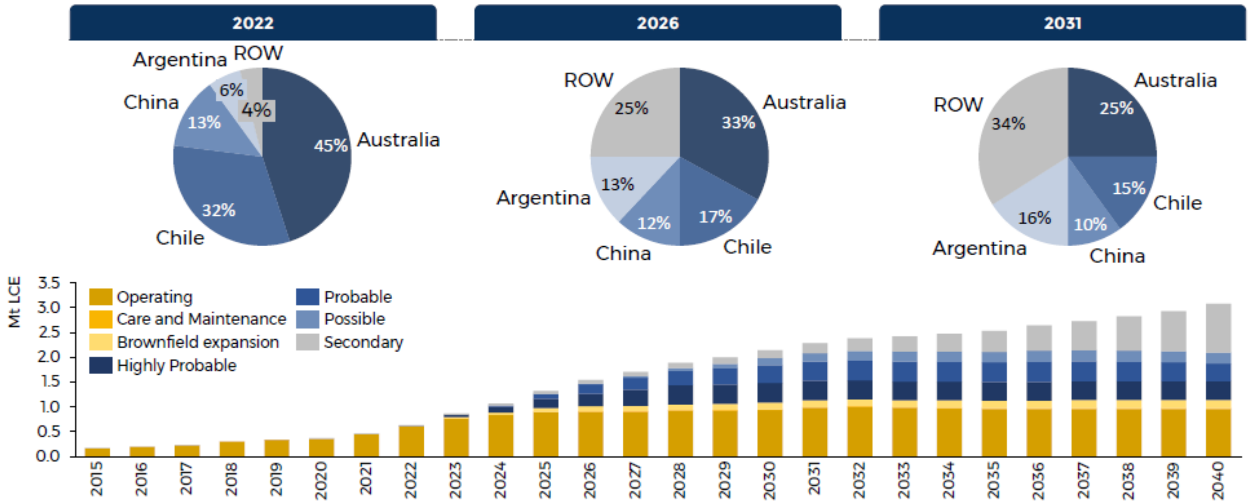


Figure 19-4: Lithium Feedstock Supply Forecast (Benchmark Market Intelligence 2022)

Historically, lithium carbonate has been the primary lithium chemical supplied to end-uses, with Benchmark Mineral Intelligence estimating that it will contribute 64% of total lithium chemical supply in 2022. This lithium chemical supply mix is expected to transition over the coming decades, with the lithium hydroxide and carbonate supply breakdown changing to 57% and 43%, respectively by 2040.

Refer to Figure 19-5 below for a summary of Benchmark Mineral Intelligence's lithium chemical supply forecast.

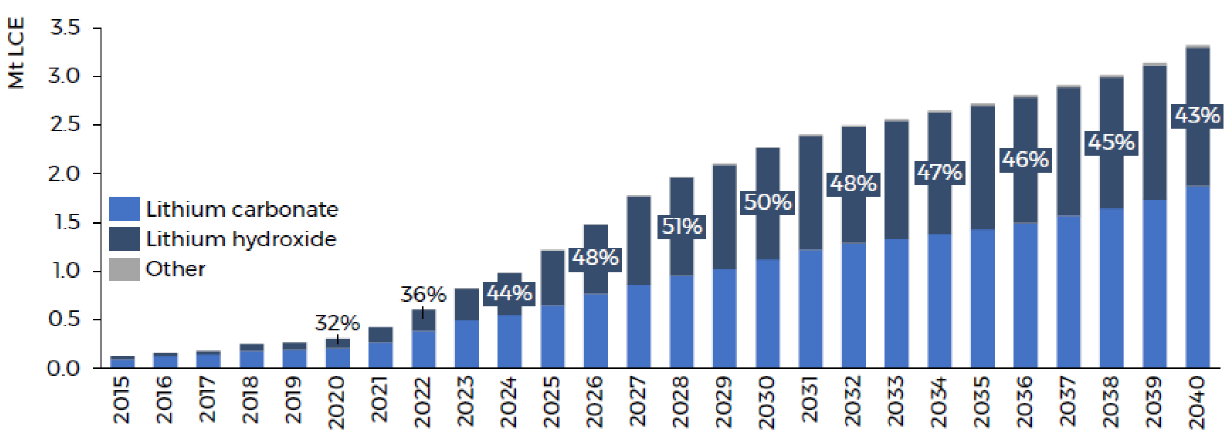


Figure 19-5 Lithium Chemical Supply Breakdown (Benchmark Market Intelligence 2022)

Refer to Figure 19-6 below for a summary of the long-term C1 lithium carbonate cost curve considered by Benchmark Mineral Intelligence when making its long-term lithium supply forecast. As highlighted in Figure 19-6, all of the potential lithium supply modelled is economic at a LCE price above US$9,000/t, with the majority of projects and mines having C1 costs at or below US$6,000/t LCE.

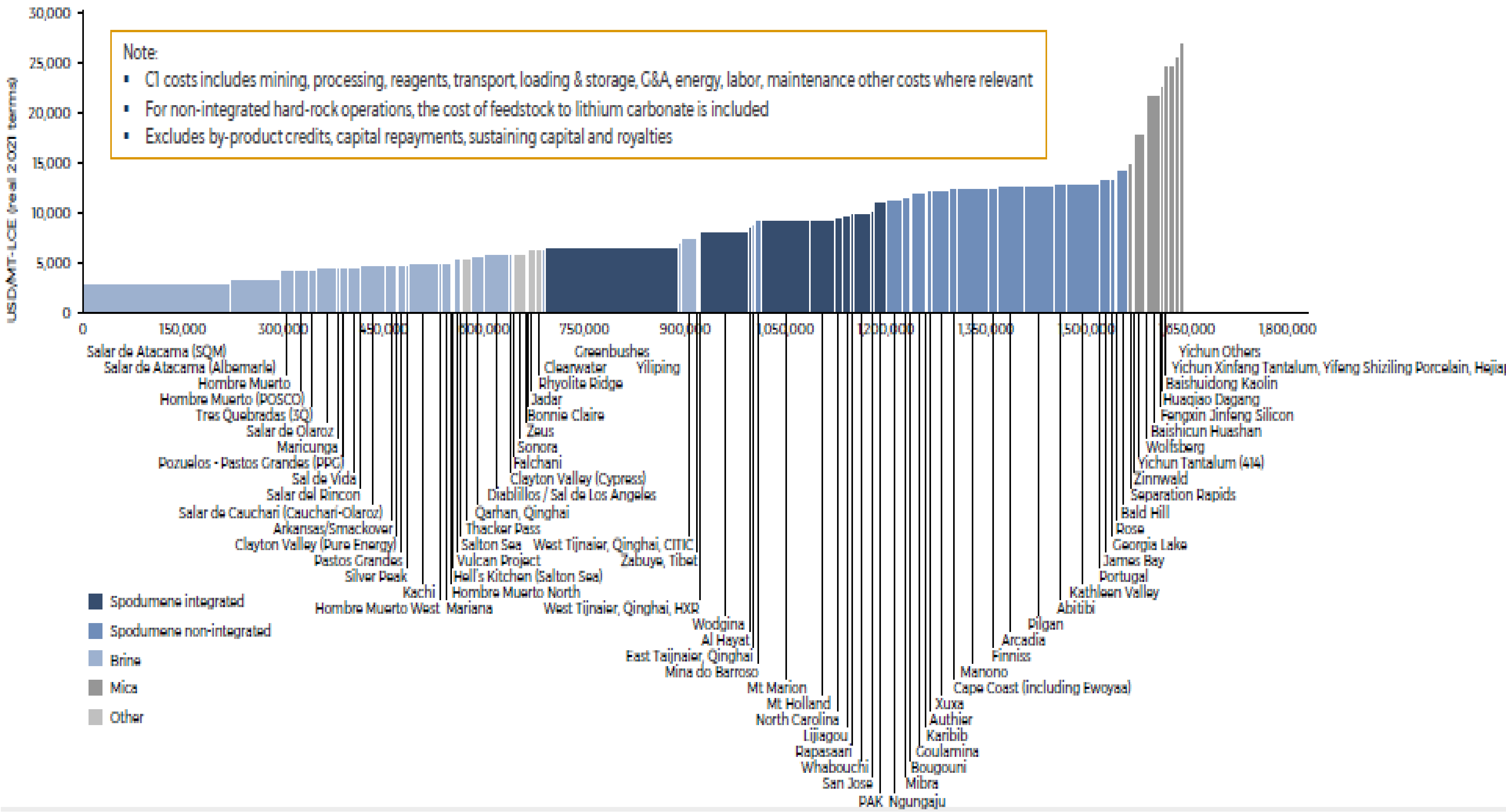


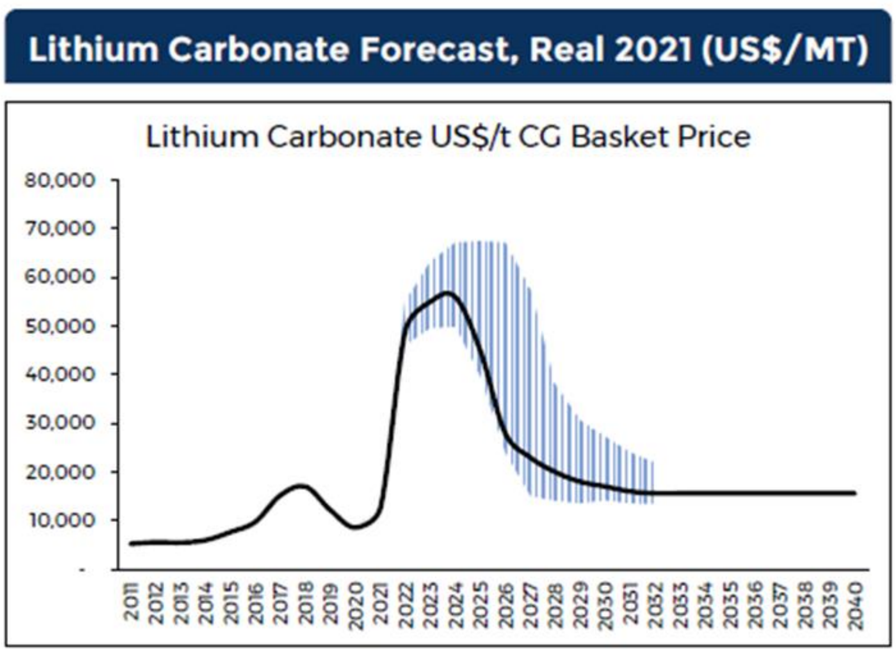
Figure 19-6: Long-Term Supply C1 Lithium Carbonate Cost Curve 2030 (Benchmark Market Intelligence 2022)

19.3 LITHIUM PRICE FORECAST

Lithium prices have increased materially as supply continues to fall short of robust demand. Additionally, contract prices have begun to be revised higher and producers are now seeking to introduce more regular pricing breaks in contract structures given the potential upside in lithium prices.

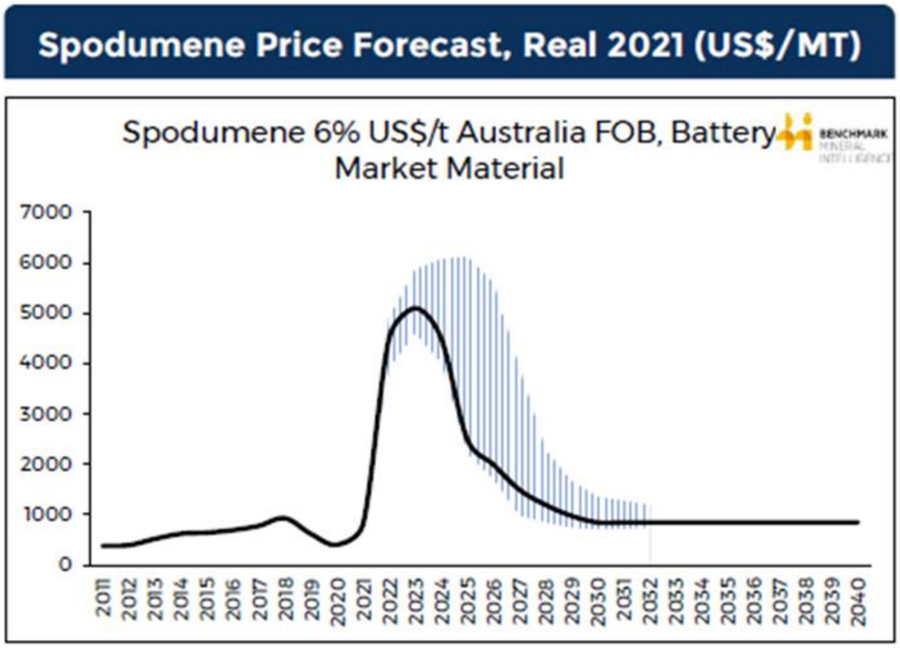
Tight market supply combined with rapidly improving demand for lithium chemicals is expected to put continued strong upward pressure on prices. Benchmark Mineral Intelligence's base case forecast expects prices to continue to rise through 2023 as demand outstrips supply with real lithium hydroxide and spodumene 6% prices hitting US$55,900/t and US$5,100/t in 2023, respectively. Benchmark then expects prices to stabilize at higher levels in 2024 and begin to decline to more stable levels in a balanced supply-demand market in 2025. This balanced market forecast assumes substantial new supply, including new projects coming onstream (which are subject to delays and in some cases do not yet have production targets).

Figure 19-7 shows the forecast for battery-grade lithium carbonate, while Figure 19-8 shows the forecast for 6% spodumene concentrate.



Note: Shading indicates the area between bullish and conservative cases.

Figure 19-7: Battery-Grade Lithium Chemical Price Forecast (Benchmark Market Intelligence 2022)



Note: Shading indicates the area between bullish and conservative cases.

Figure 19-8: Spodumene Price Forecast (Benchmark Market Intelligence 2022)

19.4 CONTRACTS AND OFF-TAKE AGREEMENTS

19.4.1 Operational Contracts

Sigma has received proposal from different parties to establish the Project's operations, but sill has no contracts signed 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:

19.4.1.1 Outsourcing of Mining Contract

Mining contractors provided 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 an 8-year period. Outsourcing of mining is very common in the lithium industry.

19.4.1.2 Road Transport Contract

Sigma received proposals for the transport by truck of 20,000-40,000 t of concentrate per month to the Port of Vitória.

19.4.1.3 Port Handling Contract

Sigma received proposals for storing and loading of 20,000-40,000 t of concentrate at the Port of Vitória. The proposals include the following services: (i) receiving; (ii) stacks formation; (iii) loading in articulated buckets; (iv) port internal transport; (v) stowage of the ship; and (vi) SHINC Operation (nights, Sundays and holidays included).

19.4.1.4 Power Contract with CEMIG

Sigma has signed an agreement ("Contrato de Uso do Sistema de Distribuição") to establish the conditions, procedures, rights and obligations that will regulate the connection of the facilities of the Sigma's consumption unit to the distribution system operated by Companhia Energética de Minas Gerais ("CEMIG") and the use of this distribution system by the Company at the contracted voltage of 138kV.

19.4.2 Construction Contracts

19.4.2.1 Engineering, Procurement, Construction Management ("EPCM") Contract

Sigma is currently in construction building a 230 000 t per year Production Plant and associated infrastructure with engineering firm Promon. Primero is the plant designer, and the construction is 70% complete.

19.4.2.2 Detailed Engineering

Sigma completed detailed engineering in October 2021. The scope of work encompassed design consultation, coordination, process design, and detailed engineering.

19.4.2.3 Civil Construction

Civil construction of the Production Plant and infrastructure is being completed by Tucumann Engenharia e Empreendimentos Ltda ("Tucumann"). The scope of work includes all civil construction works and services for the implementation of the Project, including the supply of materials, commissioning, provision of documentation, topographic survey services, excavations, shallow foundations, concrete structures, buildings, paving, streets, urbanization and landscaping and rainwater drainage and spare parts.

19.4.2.4 Substation and Transmission Line

Sigma has signed an agreement for the construction of a substation and the displacement of an existing transmission line with Tecnova Engenharia Ltda ("Tecnova"). The scope of work includes all civil construction, electromechanical and electrical assembly works and services for the implementation of the including, the civil project, the electrical project, the electromechanical project, the supply and installation of materials, structures and equipment, as well as commissioning, supply of documentation as built of the civil, electromechanical and electrical works, considering all the technical information informed by CEMIG.

19.4.2.5 Laboratory

Sigma has signed an agreement for the construction of a laboratory with SGS Geosol Laboratórios Ltda ("SGS Geosol"). The scope of work includes all work for the management of the assembly of the Sigma's internal laboratory and implementation, including the electrical project, the electromechanical project (including, but not limited to, the drawings, layouts, technical specifications, bills of materials, calculation memorials and documents), hydraulic design, supply and installation of materials, structures and equipment, as well as commissioning, start-up, supply of "as built" documentation of the projects, electromechanical, hydraulic and electrical, and all other services necessary for the execution of the scope of work.

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) in relation to the Xuxa Phase 1 project development.

For the Barreiro Phase 2 project, the information is based on the EIA – RIMA prepared by Vetor Ambiental e Urbanística dated May 20, 2021.

For NDC Phase 3, the information is based on the EIA – RIMA prepared by CERN - Consultoria e Empreendimentos De Recursos Naturais dated August 2024.

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 impact. 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 of 150 m^3 per hour for the project.

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 Xuxa North pit, processing plant and waste piles 1 and 2 was obtained on June 3, 2019. Approval of the Xuxa South pit and waste piles 3, 4 and 5 was received in July 2022. The Operation License was obtained in March 2023 for the Xuxa North Pit and in April 2023 for the Xuxa South Pit.

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 was approved.

On August 17, 2022, SMSA applied for the environmental licences for the Phase 2 mine and waste piles.

On January 31st, 2024, COPAM granted a LP LI + LO (concurring environmental licensing) to SMSA for the processing plant production increase.

Table 20-1 summarizes the granted Operations Licences, Environmental Operating Authorizations, and water leases within the Grota do Cirilo property. Some licenses were optimized for the licensing process and unified, as indicated in Table 20-1.

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	Included in 281/2019
08190/2017	Faz. Barreiro Barreiro	Environmental Operating Authorization	Feasibility (pilot stage production)		Nov. 14.2017	Nov. 14.2021	Included in SLA 4078/2022
07137/2016	Faz. Maxixe Lavra do Meio	Environmental Operating Authorization	Feasibility (pilot stage production)		Nov. 29.2016	Nov. 29.2020	Expired, and voluntarily not renewed
08190/2017	Faz. Monte Belo	Environmental Operating Authorization	Feasibility (pilot stage production)		Nov.11.2017	Nov.11.2021	Included in 281/2019
36073/2016	Faz. Monte Belo	Water Usage License for Small Volumes	Feasibility (pilot stage production)		Oct. 05.2016	0ct. 05.2019	Included in 43/2019
43150/2016	Faz. Maxixe	Water Usage License for Small Volumes	Feasibility (pilot stage production)		Nov. 29.2016	Nov. 29.2019	Included in 43/2019
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 and Installation License	Production		June 3 2019	June 3 2027	Valid

NUMBER	AREA	LICENSE SCOPE	PROJECT PHASE	LICENSE PHASE	PERMIT PERIOD		STATUS
					Begin	End	
4497/2021	Grota Cirilo	Environmental Preliminary and Installation License	Production		June 24 2022	June 24 2028	Valid
4078/2022	Grota do Cirilo	Environmental Operation License	Production		March 31 2023	March 31 2033	Valid
144/2023	Grota do Cirilo	Environmental Operation License	Production		April 29 2023	April 29 2033	Valid
1267/2023	Grota do Cirilo	Environmental Preliminary, Installation and Operation License	Production		January 26 2024	March 26 2033	Valid

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 macrofauna (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

Area	Comment
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 and ground water. Water from the Jequitinhonha and Piaui rivers are monitored monthly. Dust, noise, and vibration baselines have been determined and ongoing monthly monitoring continues.

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

An 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 $CaCO_3$/t for NP and 2.5 kg $CaCO_3$/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

On November 16, 2022, SMSA filed its request for the permitting of the operational license (LO) for Xuxa's Pit #1 and areas and processing plant, which was obtained in March 2023. On January 23, 2023, SMSA filed its request for the permitting of Xuxa's Pit #2 areas, which was obtained in April 2023.

On August 17, 2022, Sigma applied for the permitting of the environmental license for the Barreiro Mine and piles.

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 PAE 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.

With the granted LP + LI, the SMSA commenced the installation of the project, complied, and continues to comply with the environmental conditions established in the LP + LI certificate and finally, applied and obtained the Operation License for Xuxa Pit #1 and Pit #2. SMSA currently awaits the approval of the Preliminary, Installation and Operation License for the Barreiro Mine and Piles.

The formalization of the environmental licensing process also included the filing of an EIA and a RIMA.

The purpose of this authorization is to allow for environmental intervention in an area of about 63.9 ha of native vegetation. 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, 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; DN COPAM N° 217 dated 06 December 2017.
Suppression of Vegetation	Mining ventures that depend on the removal of vegetation in the advanced and medium stages of regeneration.	CONAMA N° 392, dated 25 July 2007, 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; Law N° 47.479 dated 11 November 2019.

20.2.1.3 Water Usage Permit

Sigma has been granted a permit for 150 m^3/hr 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, which is expected to be sufficient for the life-of mine (LOM) requirements for mining and product processing from Xuxa. 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 were issued by both the Itinga and Araçuai town councils.

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.

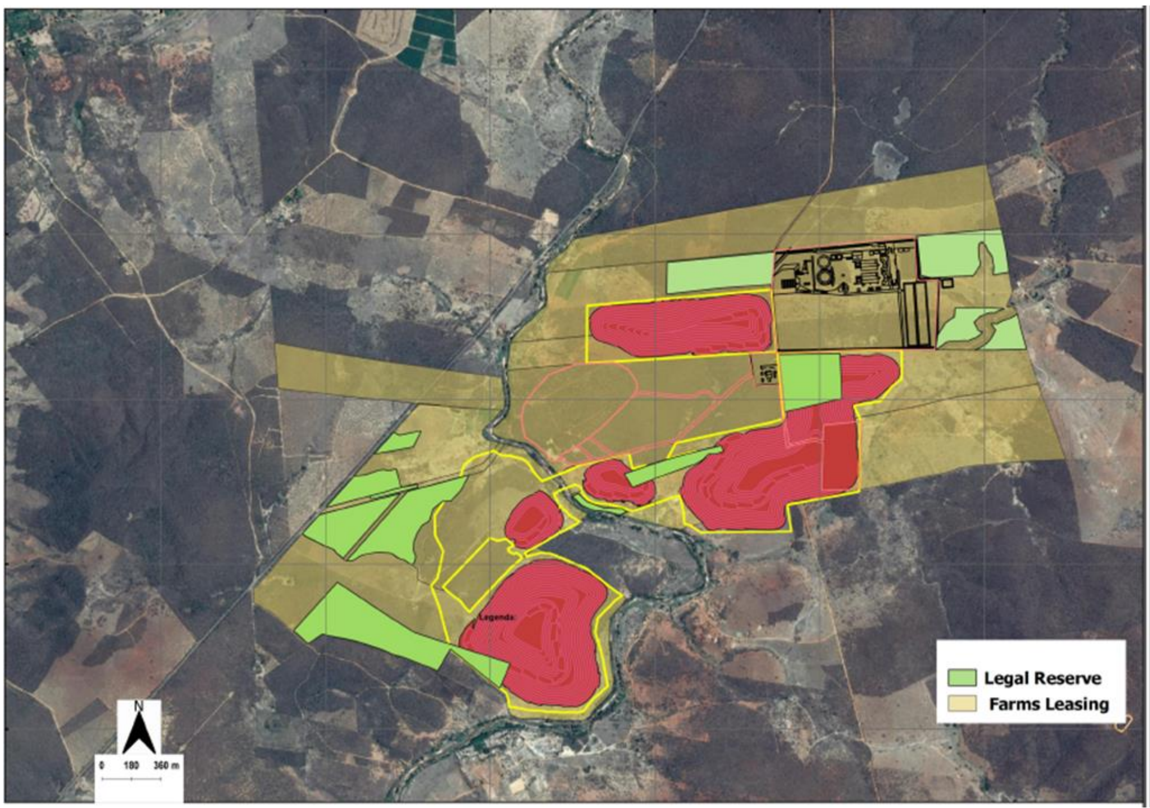


Figure 20-1 – Location of Areas of Interest and Properties. (Note: The position of the Xuxa pits and waste piles (shown in red) are conceptual only and subject to change based on operational requirements)

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 "neighbouring" 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 subsistence 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 Taquaral Seco
- October 13 and October 25, 2018: community of Piaui-Poco Dantas
- October 14 and October 26, 2018: community of Ponte Piaui

A further 29 community meetings were held in 2020, 37 community meetings in 2021 and 18 community meetings year-to-date in 2022. A summary of these meetings is:

- Meetings in 2020: 6 - Date of the last meeting: 25 November: community of Taquaral Seco
- Meetings in 2020: 8 - Date of the last meeting: 26 November: community of Piaui-Poco Dantas
- Meetings in 2020: 6 - Date of the last meeting: 26 November: community of Ponte Piaui
- Meetings in 2020: 9 - Date of the last meeting: 26 November: community of Taquaral de Minas
- Meetings in 2021: 10 - Date of the last meeting: 22 November: community of Taquaral de Minas
- Meetings in 2021: 9 - Date of the last meeting: 23 November: community of Taquaral Seco
- Meetings in 2021: 10 - Date of the last meeting: 23 November: community of Piaui-Poco Dantas
- Meetings in 2021: 8 - Date of the last meeting: 26 November: community of Ponte Piaui
- Meetings in 2022: 4 - Date of the last meeting: 22 April: community of Taquaral de Minas
- Meetings in 2022: 6 - Date of the last meeting: 23 April: community of Taquaral Seco

- Meetings in 2022: 4 - Date of the last meeting: 23 April: community of Piaui-Poco Dantas
- Meetings in 2022: 4 - Date of the last meeting: 26 April: community of Ponte Piaui

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 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 was 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. (Figure 20-2)

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 are housed in a seedling nursery for future reintroduction in the areas to be recovered.
Management and environmental supervision plan	The Plan is to 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. (Figure 20-2)
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.

Wildlife Rehabilitation Centre

Bird Rehabilitation Aviary

Mammal Rehabilitation Enclosure

Reptile Rehabilitation Enclosure

Seedling Nursery

Seedling Nursery

Figure 20-2: Sigma Wildlife Rehabilitation Centre and Seedling Nursery

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.

The waste rock and tailings piles are 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 considered one of the poorest region in Minas Gerais which is plighted by poverty and is in the lowest quartile of the Human Development Index (HDI). Sigma will be one of the largest investments and operations in the area and the project will be transformational to the local communities. The largest direct economic benefit is that Sigma is subject to a 2% CFEM 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. Studies identified that 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 are 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 Projetos) 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. Sigma has provided 7,000 monthly food parcels during the period of the pandemic and has agreed to supply a further 7,000 by the end of 2022. Sigma has donated 24 tons of disinfectant and 24 tons of hand sanitizer to the local hospitals and clinics over the period of the pandemic. The company has donated materials for the building and repairing of roads in Itinga and Araçuai, jointly sponsored the upgrade of the Headquarters of the Police, provided a 4x4 vehicle to the Environmental Police and continues to be supportive of community needs. Sigma also established and sponsored a Local Development Agency to attract further investment to the area. 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 consist 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.

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 the local environment
- Preparation of the Closure Plan on a deposit-by-deposit basis.

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 will be mining Phase 2 and 3 and other deposits in the Grota do Cirilo area, the process plant will remain operational after the Mineral Reserves at the Phase 1 (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
Restoration	Restoration shall be executed according to the specific characteristics of the land where mining 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. 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, 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.

20.8 PHASE 2 BARREIRO PEGMATITE ENVIRONMENTAL WORK

The information provided in this section is based on the Environmental Impact Study and Environmental Impact Report (EIA – RIMA) prepared by Vetor Ambiental e Urbanística on August, 2022.

20.8.1 Environmental Considerations

The Environmental Impact Study - EIA and its respective Environmental Impact Report - RIMA was submitted to the regulatory agency in August, 2022, Bureau of Priority Projects - SUPPRI, as a supporting document to obtain a Preliminary License – LP, Installation License – LI and Operation License for Grota do Cirilo Project - Barreiro Pegmatite.

Considering the parameters defined by the current laws and regulations, CONAMA Resolution 09/90, the environmental licensing of mining projects is conditioned to EIA/RIMA submission, and these studies are the main technical resources to assess project feasibility.

This document has been drafted by a multidisciplinary technical team in strict compliance with the relevant laws and regulations, as well as with the General Reference Term for Mining made available by the State Secretariat for the Environment and Sustainable Development - SEMAD on its website, outlining criteria and guidelines for EIA/RIMA execution and drafting.

20.8.2 Environmental Licensing

The project falls under the Concurrent Environmental Licensing modality - LAC1, according to Environmental Policy Council - COPAM Normative Deliberation - DN No. 217/2017. In this modality, the stages of environmental feasibility, installation, and operation of the project will be in a single phase, and a Preliminary License - LP, an Installation License, and an Operation License will be granted if all stages are approved.

The environmental licensing process started in October 2020 and was formalized in August 2022, with the submission of the technical studies requested through the Environmental Licensing System - SLA, request No.: 2020.10.01.003.0003780 for the production of: 1,800,000 t/year for open pit mining and 251.89 ha for waste heaps. According to the application to be filed, the project is predominantly classified as Class 4, location criterion 1, defined by the following activities, which have been analyzed individually:

- A-02-01-1 - Gross production of 1,800,000 t/year from open pit mining
- A-05-04-6 - Tailing/waste heap of ornamental and coating rocks, pegmatites, gemstones, and non-metallic minerals.

Sigma Mineração S.A. has a certificate of Concurrent Environmental License (LO) No. 4078, granted on March 31, 2023, valid for 10 years. This license refers to Grota do Cirilo Project - Xuxa Pegmatite - North Pit, where the following structures were licensed:

- The mine pit (open pit mining)
- Tailings
- Dry Ore Treatment Unit and Wet Ore Treatment Unit
- Supply stations

The mineralized material proposed to be mined in the Barreiro Project will be processed in the Ore Treatment Unit part of the aforementioned license. Table 20-1 summarizes the Environmental Licenses granted, Environmental Authorizations and Water Grants required for project operation. As indicated in the table, some of the licenses are being renewed or updated.

The studies carried out describe and analyze the physical, biotic, and socioeconomic environments to describe and interpret the resources and processes that may be affected by the activities planned for the project. Elements vulnerable to direct or indirect impacts to be caused by the project have been identified and analyzed, considering project planning, installation, operation, and decommissioning, focusing on the most significant aspects.

This is intended to provide an overview of the situation of the environment susceptible to the impacts generated by the project, whether such impacts are positive or negative, for a comparison between the current condition of the area and the scenario foreseen after project approval and implementation.

On August 17, 2022, the Company filed at SUPPRI (the Priority Projects Superintendence of Minas Gerais) the environmental studies, including, among others, the EIS and EIR (Barreiro EIS/EIR) for the permitting of the LP+LI+LO for the Barreiro deposit and its piles. Once the EIS/EIR is approved by the environmental authorities, SMSA will be authorized to commence the construction and installation of the Barreiro deposit. Operation permits from environmental authorities will also be required.

20.8.3 Baseline Studies

A summary of the studies performed can be found in the Table 20-6 below.

Table 20-6 – Environmental Studies

Area	Comment
Land use	The current land uses include agriculture and subsistence farming.
Flora	Flora zones include 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 are 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 mammalian fauna (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 harbouring 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 are underway and would include greenhouse gas assessment, additional tests on Piauí River and water responses to water treatment plans, noise and vibration baselines, and particulate matter baseline studies.

Figure 20-3 to Figure 20-5 show examples of the avifauna, herpetofauna and terrestrial mammalian fauna respectively that were recorded on the Barreiro project property.

Figure 20-3: Avifauna: A) Nest of Red Ovenbird; individual of B) Red-Cowled Cardinal, C) Grassland Sparrow; D) Smooth-billed Ani; E) Rufous-collared Sparrow; F) Tropical Kingbird; G) Burrowing Owl and H) Yellow-chevroned Parakeet.

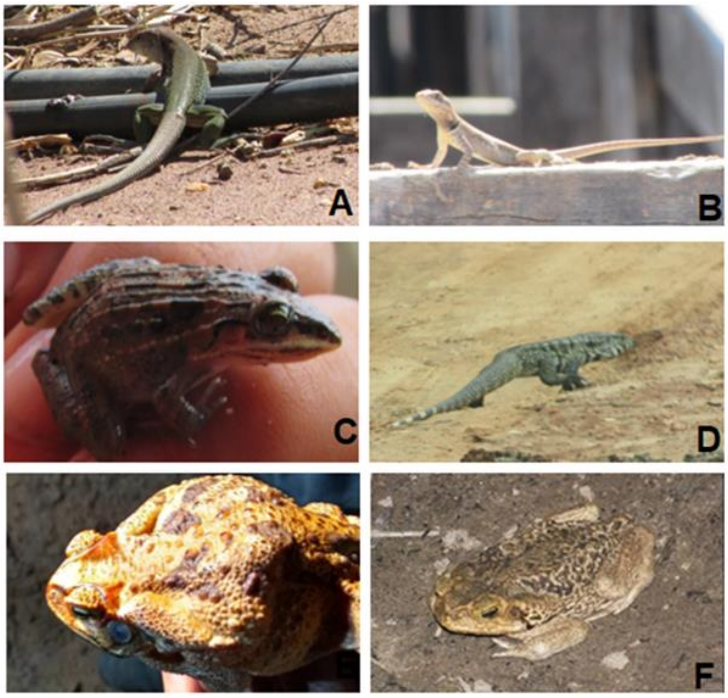


Figure 20-4: Herpetofauna: A) Neotropical Ameiva, B) Tropidurus oreadicus, C) Leptodactilus fuscus; D) Tegu; E) Rhinella granulosa and F) Rhinellaschneideri.

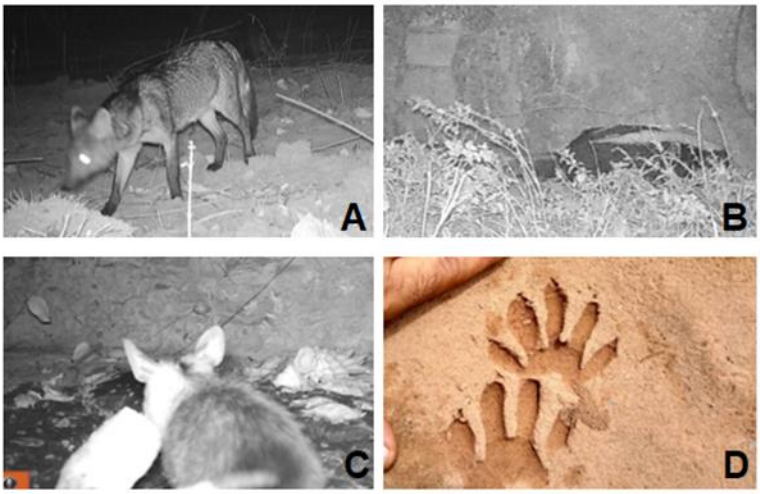


Figure 20-5: Terrestrial mammalian fauna: A) wild dog; B) skunk; C) big-eared opossums; and D) footprint of Procyon cancrivorus.

20.8.4 Water Considerations

Rainwater will be drained and collected in decantation ponds, which will then be treated and will follow to water trucks used to spray roads during the dry season. This will reduce the volume of water taken from Jequitinhonha River. During the rainy season, excess water from the ponds will be discharged into an overflow channel. The quality of reused water will follow the Brazilian Regulation, under CONAMA 357/2005; CONAMA 396/2008, and CONAMA 420/2009.

It should be noted that Barreiro Project will not require new water consumption since Sigma already has a Water Use Grant, license No. 02500.001337 / 2019-47

20.8.5 Considerations about the Permit

Once the Barreiro EIS/EIR is approved by the environmental authorities, SMSA will be authorized to commence the construction, installation and operation of the Barreiro deposit.

20.8.5.1 Authorizations

20.8.5.1.1 Federal

Concerning Mineral Rights, SMSA holds right No. 931.021/1983, which comprises a group of mining concessions, as listed below:

- 824.695/1978
- 810.345/1968
- 005.804/1953
- 831.116/2016
- 9135/1967.

The Mineral Right No. 804.541/1971 is in the Mining Application phase. The operation of the project will start after the granting of the mining concession and the environmental license. Sigma will apply to the ANM for the mining easement areas necessary for project implementation, in a total of 388.49 ha, to house waste piles, pits, and accesses. So far, the company has carried out research works only in the area. Mining activities will begin according to the company's strategic planning, and social and environmental reorganization. The Figure 20-6 below shows the Status Plan, with location of ANM mining applications.

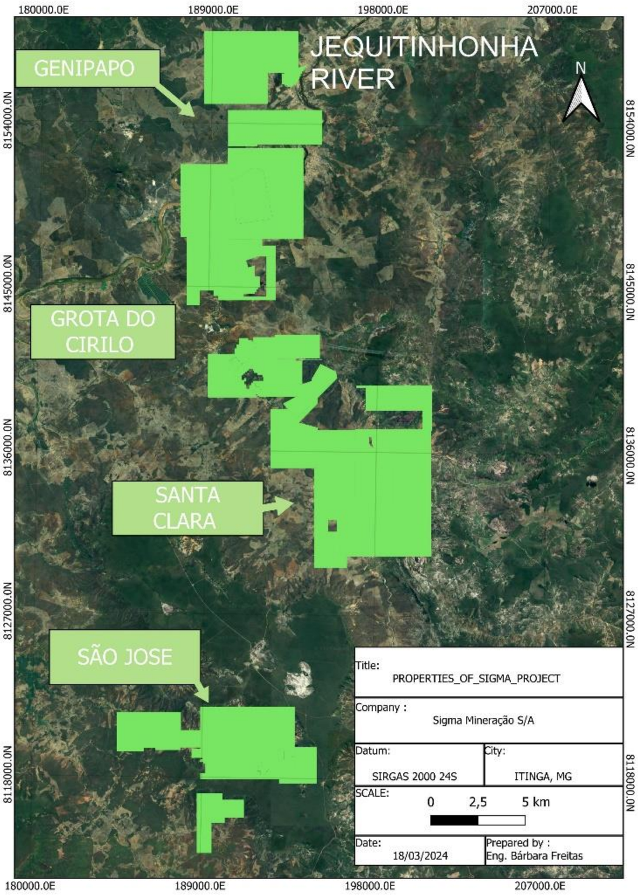


Figure 20-6 – Project Status Plan with Mining Applications

20.8.5.1.2 State

The project's environmental licensing process was formalized through the Environmental Licensing System (SLA) on an online platform as per DN 217/20171. To formalize the LAC1 Concurrent Environmental Licensing process (LP + LI + LO), the EIA / RIMA, the Environmental Control Plan - PCA, and the Degraded Area Recovery Plan - PRAD were submitted, as required.

The approval process includes a technical and legal analysis carried out by the environmental regulatory agency. Upon obtaining the LP + LI + LO, the company must implement the project complying with the environmental conditions established in the LP + LI + LO certificate to be obtained after appreciation by the regulatory agency. Environmental licensing process formalization also includes applying for and granting of the authorization for environmental intervention.

20.8.5.1.3 Environmental Intervention Authorization - AIA

The purpose of this authorization is to allow environmental intervention in an area of approximately 229,78 ha of native vegetation. The current legislation (Federal Law 11.428 / 2006) provides for mining projects as a public service and, therefore, allows intervention in the form of clearance of the vegetation that is in an intermediate stage of regeneration and removal of protected species, provided they are properly entered in an inventory list and the proposed reforestation plan is legally enforced. The compensations listed in Table 20- will therefore apply to the project.

Table 20-7 – Environmental Compensations

Situation	Legislation	
Environmental	Ventures of significant environmental impact.	SNUC Law Nº 9.985/2000, dated 18 July 2000; DN COPAM N° 217 dated 06 December 2017.
Suppression of Vegetation	Mining ventures that depend on the removal of vegetation in the advanced and medium stages of regeneration.	CONAMA N° 392, dated 25 July 2007, 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; Law N° 47.479 dated 11 November 2019.

20.8.5.1.4 Water Use Authorization

Sigma was granted 150 m^3/hr of water from Jequitinhonha River every month of the year by the National Water Agency (ANA) for a period of 10 years. The process was formalized in February 2019 under registration number 02501.004570 / 2018-91.

20.8.5.2 Municipal

The project must comply with municipal legislation and declarations of the City Council of Itinga.

20.8.5.3 Surface Rights

Sigma is under commercial negotiation with landowners located in the area of Barreiro Pegmatite Project. Negotiations for the lease or purchase of properties are carried out in accordance with the current legislation and are not considered to be obstacles to project implementation in the region. It is worth mentioning that this region is characterized by a low-income population, and any money generated, whether by sale or lease, creates expectations for the players involved. The area covered by the project occupies 5 rural properties. Table 20-8 shows the surface areas, the properties, and their respective legal reserve areas.

Table 20-8 – Environmental Compensations

Owner	Property	Municipality	Property area (ha)	Used area (ha)	Legal reserve (ha)
-	Property 01	Itinga	89.94 ha	6.4	19.26 Proposed
Sigma	Property 02	Itinga	127.92 ha	71.38	55.81 Registered
Sigma	Property 03	Itinga	30.40 ha	11.4	No data
-	Property 04 - Fazenda Brejo	Itinga	1,377.73 ha	37.098	307.72 Registered
-	Property 05	Itinga	No data	No data	No data

20.8.6 Social Considerations

20.8.6.1 Social Setting of the Project

The project is located 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.

Barreiro Community is located approximately 22 km from the urban area of the municipality of Araçuaí, located near BR 367 highway, with part of its territory on the left bank and part on the right bank of Piauí River, being characterized by a low-income population with little access to healthcare and education.

The surrounding areas of the project are sparsely populated, with few vehicles traveling by. The communities are mainly concentrated along BR 367 highway and in the municipality of Araçuaí that has approximately 40,000 inhabitants. The main economic activities in the region are agriculture and livestock.

20.8.6.2 Sigma Consultations

A quantitative and qualitative analysis was carried out in the entire project area to collect information about the social and environmental perception of Barreiro community regarding project implementation.

GPS Garmin 64s and Etrex 10 socioeconomic forms were used to map out households in the field, during the interviews, and a camera was used for photography recording.

The form used during the interviews aimed to collect information about the socio-environmental status of the population, such as the economic activities carried out on the properties and basic infrastructure (water, energy, and sewage), as well as any expectations regarding the project. The meetings took place between the 20th and the 23rd March 2021 and the community strongly supported Sigma project. When interviewees were questioned about the potential benefits of the project for local families and the region, they mentioned employment, increased income, contributing to local development, and improved road infrastructure.

20.8.7 Assessing Environmental Impacts and Mitigation Actions

Table 20-9 summarizes the measures that have been planned to minimize environmental impact.

Table 20-9 – Measures to Minimize Environmental Impacts

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.

20.8.8 Relationship with Interested Parties

Sigma maintains a harmonious relationship with the communities and town halls within the project area. The company, therefore, structures its community relations activities to consider the concerns of the local population and strives to communicate and demonstrate its commitment in a way that it can be better appreciated and understood to maintain the social license for operation.

Sigma has identified and continues to consult/commit to various stakeholders in support of project development, which include the following:

- Communities
- Intinga and Araçuaí Town Halls
- Religious leaders in Itinga and Araçuaí
- UNIP University and youth leaders from Araçuaí
- Regional City Council meeting with the general public and merchants
- Consultations with local communities in Barreiro
- Araçuaí and Itinga Town Halls
- Regulatory and government institutions
- National Mining Agency (ANM) in Brasília and Belo Horizonte
- State Environmental Agency (Suppri and Supram) in Belo Horizonte
- INDI - Minas Gerais Investment and Foreign Trade Promotion Agency

20.8.9 Rehabilitation and Closure Planning

The mine closure term provides for the definitive cessation of mining operations when project decommissioning takes place, i.e., when project areas are released followed by their recovery and adaptation for other purposes or uses.

Therefore, ANM will be notified in advance before closure, and closure will only take place after authorization from the respective agency. After prior notice, a justification application will be submitted to the Minister of Mines and Energy, duly accompanied by the following supporting documents:

i. Report of the work carried out
ii. Characterization of remaining reserves
iii. Demobilization plan for the facilities and equipment that make up the infrastructure of the mining project, indicating the destination of each item
iv. Update of all topographic surveys of the mine
v. Mine plan with mined areas recovered, impacted areas recovered and to be recovered, areas for disposal of organic soil, waste heaps, ore, and tailings, disposal systems, access roads, and other construction works
vi. Follow-up and monitoring program related to:
    - Disposal and containment systems
    - Slopes in general
    - Water table behavior and
    - Water drainage
vii. Control plan for soil, air, and water pollution, with a description of controlling parameters
viii. Effluent release control plan with a description of controlling parameters

ix. Measures to prevent outsiders from accessing the mine and preventing access to dangerous areas
x. Definition of environmental impacts in the project's areas of influence, taking into account the physical, biotic, and anthropic environments
xi. Fit for purpose and intention of use of the area in the future
xii. Topographic and landscape conformation taking into account aspects of stability, erosion control, and drainage
xiii. Report on the occupational health conditions of workers during the useful life of the mining project; and
xiv. Schedule of the proposed activities, including financially.

Decommissioning or closure is understood as project activities or part of project activities coming to an end, with the application of appropriate and recognized techniques and approval by competent agencies, in such a way that the company does not have any liabilities.

Thus, the closure or decommissioning program of the intended project will be designed so that the following general and specific objectives are achieved.

It is important to emphasize that this study concerns a Preliminary License and an Installation License for the project in question. Therefore, the Mine Closure Plan will be submitted and detailed during project operation licensing.

20.9 PHASE 3 NEZINHO DO CHICÃO ENVIRONMENTAL WORKS

The Environmental Impact Study – EIA/EIS and its respective Environmental Impact Report – RIMA EIR for the NDC deposit, jointly with other mandatory documents, was submitted at August, 2023, to the regulatory agency, Superintendence of Priority Projects -– SUPPRI for the permitting of a LP+LI+LO, as a supporting document for obtaining a Preliminary License – LP, Installation License - LI and Operation License for the Grota do Cirilo Project - Pegmatite from Nezinho do Chicão.

Considering the parameters defined by the laws and regulations in force, CONAMA Resolution 09/90, the environmental licensing of mining projects is conditioned to the submission of the EIA/RIMA, these studies being the main technical resources to assess the viability of the projects.

The environmental licensing process began in December 2022 and was formalized with the presentation of the such technical studies requested through the Environmental Licensing System - SLA, for the production of 1,8200,000 t/year for open pit mining and 182. 2 ha for waste piles.

21 CAPITAL AND OPERATING COSTS – PHASE 1 AND PHASE 2 & 3

21.1 BASIS OF ESTIMATE

The capital cost estimate (CAPEX) and operating cost estimate (OPEX) were developed to provide substantiated costs for the FEED study of Phase 1 and the PFS study of Phase 2 & 3 processing plant and to provide Sigma with an overall risk and opportunity profile to enable a Phase 1 production decision and to advance off-take agreements and project financing.

The Phase 1 plant estimate parameters used for this estimation is from the FEED study completed in 4Q21.

The Phase 2 & 3 plant estimate parameters used for this estimation are as follows:

- Estimate accuracy plant capital costs: +25% / -25%
- Estimate accuracy infrastructure capital costs: +25% / -25%
- Estimate accuracy operating costs: +25% / -25%
- Estimate period: 4Q21
- Estimate currency: US$

21.2 WORK BREAKDOWN STRUCTURE

The following first level work breakdown structure was used for the Phase 1 and Phase 2 & 3 concentrators. It is based on the recent Xuxa FEED study following WBS structure:

- 001 – Mine
- 002 – Plant
- 003 – Environment
- 004 – EPCM & Engineering Services
- 005 – Substation & Utility Power Supply
- 006 – Owners Project Costs
- 007 – Working Capital and Spares
- 008 – Sustaining and Deferred Capital

21.3 ESTIMATE PLAN

21.3.1 Xuxa Plant (Phase 1)

For the Xuxa plant, the CAPEX estimates were performed by the following firms:

- GE21: Mining
- Primero: Crushing Circuit and DMS wet plant (with the related material take-offs for concrete, steel, platework, piping, and electrical bulks)
- Promon: Infrastructure (e.g., Infrastructure, Power Supply, Water Supply, Buildings, etc. and all Bulk Earthworks for the entire site, roads and site water run-off catchment)

21.3.2 Barreiro/NDC Plant (Phase 2 & 3)

For the CAPEX and OPEX estimation of the Phase 2 & 3 plant, Primero used as a strong basis, the FEED study results for the Xuxa plant (Phase 1). Process design criteria was developed to take into consideration the various test work results associated to the Barreiro ore characteristics. The mineral recovery methods evaluated and proposed for the Xuxa plant was determined to be suitable for the Barreiro plant. With the main production target criteria consisting of yielding 220k tonnes of spodumene concentrate per annum, the Xuxa FEED CAPEX was updated as outlined below to account for the updated Xuxa FEED design that was progressed at the time.

Scope (upgrades from the Xuxa FEED)

- Contract Crushing replaced with 3 stage fixed crushing facility to handle 1000 mm ROM top size
- Throughput increased from 1,5 Mtpa to 1.80 Mtpa
- Ore sorting removed
- Thickener pricing reduced allowing for a 25 m thickener for Phase 2 & 3
- Dedicated Phase 2 & 3 Belt Filter increased from 7 m^2 to 22 m^2
- All common facilities (Site infrastructure, HV Power supply, water supply/storage, compressed air supply, fire water system etc.) excluded. Assumed that this will be included in Xuxa CAPEX and be suitably sized for Phase 2 & 3.
- Secondary Ultrafines DMS circuit included

In-Directs

- FX rates updated – average for the six-month period (Q3 and Q4 2021)
- Contractor in-directs removed and included within installation labour rates
- Costs associated with contract crushing removed
- EPCM Cost for Process Plant: Priced based on 18% of process plant direct costs. Includes fixed plant crushing
- Temporary construction facilities removed
- Additional spares allowance included for fixed plant crushing/screening plant, assessed as 100% of Xuxa FEED CAPEX allowance
- Commissioning included for Fixed plant crushing and screening circuit. Commissioning durations reduced compared to Xuxa assuming synergies

Directs – Bulks

- The Xuxa FEED CAPEX was used as the basis and as such, all bulk quantities relevant to the Phase 2 & 3 scope are as per the quantities included in the Xuxa FEED estimate with the following adjustments to account for the differences in scope between Phase 1 and Phase 2 & 3.
    - Non-Process Infrastructure and common infrastructure: Quantities removed (0% of Xuxa)
    - Process Plant: Quantities retained (100% of Xuxa)
    - Sitewide Drainage: Assessed as 50% of Xuxa quantities

Directs – Equipment

- The Xuxa FEED CAPEX was used as the basis and as such, all direct costs relevant to the Barreiro scope are as per the costs included in the Xuxa FEED estimate with the following adjustments to account for the difference s in scope between Xuxa and Phase 2 & 3.
    - All common facilities such as truck weigh station, buildings, NPI, roads: Quantities removed (0% of Xuxa)
    - Plant & Pre-production: 50% of Xuxa allowance
    - Compressed air: 25% of Xuxa allowance
    - Fencing: 50% of Xuxa allowance
    - Process water: Retained process pumps, reduced water storage (assessed as 30% of Xuxa allowance)
    - Water treatment: 50% of Xuxa allowance
    - Sewerage treatment: Quantities removed (0% of Xuxa)
    - Tails handling: Retained infrastructure quantities however assessed Tails Thickener as 70% of Xuxa allowance (to allow an additional, however smaller, thickener), 60% of feed box allowance
    - Sewerage and Water treatment: Quantities removed
    - HV Switchyard and transmission line: Quantities removed
    - All other process equipment quantities and allowances have been retained at 100% of Xuxa

Directs – Piping

- The Xuxa FEED CAPEX was used as the basis and as such, all direct costs relevant to the Phase 2 & 3 scope are as per the costs included in the Xuxa FEED estimate with the following adjustments to account for the difference s in scope between Xuxa and Phase 2 & 3.
    - Pipe racks: Quantities doubled (200% of Xuxa)
    - Process piping: Retained as per Xuxa quantities
    - Compressed air: Assessed as 25% of Xuxa
    - Process Water: Quantities removed
    - Fire Water: Quantities removed
    - Water intake: Quantities removed

21.3.3 Currency Conversion

The CAPEX is presented in United States Dollars (USD). All costs have been expressed in their native currency and converted to USD currency as per the following yearly average exchange rates:

Table 21-1 – Quoted Currency Exchange Rates

Code	Description	Rate
US$	US Dollars	1.000
EUR	Euro	0.832
AUD	Australian Dollars	1.302
BRL	Brazilian Real	5.30
CAD	Canadian Dollars	1.25

21.4 CAPITAL COST

21.4.1 Capital Cost Estimate

A summary of the capital cost estimate for the Phase 1 concentrator and the site infrastructure are shown in Table 21-2. The summary of the capital cost estimate for the Phase 2 & 3 concentrator is presented in Table 21-3.

Table 21-2 – Phase 1 Concentrator Capital Cost Estimate Summary

AREA	TOTALS (USD)		
	DIRECTS + INDIRECTS (USD)	CONTINGENCY (USD)	TOTAL (USD)
001 MINE	**7,856,938**	**605,014**	**8,461,952**
001.001 Mine general	**6,168,390**	**474,996**	**6,643,386**
001.001.700 Mine pre-stripping	–	–	–
001.001.730 Mining Pre-Production	6,168,390	474,996	6,643,386
001.001.770 Mine Mobile Equipment - LME	–	–	–
001.001.780 FUELS & LUBRICANTS	–	–	–
001.002 Mine infrastructure general	**1,688,548**	**130,018**	**1,818,566**
001.002.635 Bridge	458,228	35,284	493,512
001.002.720 Mine Establishment	–	–	–
001.002.750 Mining Infrastructure & Services	1,230,320	94,735	1,325,054
002 PLANT	**64,841,255**	**4,992,777**	**69,834,032**
002.001 Crushing system - Primary/Secondary/ Scalping	**21,799,701**	**1,678,577**	**23,478,278**
002.001.210 General Crushing	6,488,886	499,644	6,988,530
002.001.211 Primary Crushing	4,596,466	353,928	4,950,393
002.001.212 Secondary Crushing	1,241,152	95,569	1,336,721
002.001.215 Scalping Screening	1,400,181	107,814	1,507,995
002.001.223 Classification Screening	1,040,080	80,086	1,120,167
002.001.224 Ore Sorting	–	–	–
002.001.225 Tertiary Crushing	3,346,887	257,710	3,604,597
002.001.227 Crushed Ore Storage & Reclaim	3,686,048	283,826	3,969,873

002.001.229 Waste	–	–	–
002.002 DMS System	**21,654,142**	**1,667,369**	23,321,511
002.002.030 Vendor Representatives	118,000	9,086	127,086
002.002.310 General DMS	2,432,499	187,302	2,619,801
002.002.311 DMS Sizing Screen	3,283,690	252,844	3,536,534
002.002.312 Primary DMS	2,917,697	224,663	3,142,359
002.002.313 Secondary DMS	3,684,882	283,736	3,968,618
002.002.314 Primary Ultrafines DMS	2,269,313	174,737	2,444,050
002.002.315 Secondary Ultrafines DMS	1,483,006	114,191	1,597,198
002.002.325 Ultrafines DMS Product Stockpile	161,775	12,457	174,231
002.002.331 FeSi	61,985	4,773	66,758
002.002.332 FeSi - Secondary	–	–	–
002.002.333 FeSi - Ultrafine	–	–	–
002.002.335 Flocculant	465,334	35,831	501,165
002.002.340 Coarse & Fines DMS Product Stockpile	920,012	70,841	990,853
002.002.345 Truck Weigh Station	167,306	12,883	180,189
002.002.350 Tails Handling	–	–	–
002.002.351 Screw Classifier	649,760	50,032	699,792
002.002.352 Thickening	–	–	–
002.002.353 Filtration	–	–	–
002.002.354 Tails Deposition (Dry Stack)	–	–	–
002.002.820 Plant & Pre-Production	3,038,883	233,994	3,272,877
002.002.841 Commissioning	–	–	–
002.003 AUTOMATION/DIGITALIZATION	**3,852,981**	**296,680**	**4,149,661**
002.003.100 Plant Control Systems	1,177,532	90,670	1,268,202
002.003.210 Automation in General Crushing	9,741	750	10,491
002.003.211 Automation in Primary Crushing	9,154	705	9,859
002.003.310 Automation in DMS area	25,443	1,959	27,402
002.003.311 Automation in DMS Sizing Screen	15,647	1,205	16,852
002.003.312 Automation in Primary DMS	–	–	–
002.003.313 Automation in Secondary DMS	12,932	996	13,928
002.003.314 Automation in Primary Ultrafines DMS	791,659	60,958	852,616
002.003.315 Automation in Secondary Ultrafines DMS	101,992	7,853	109,845
002.003.350 DMS automation	101,992	7,853	109,845
002.003.630 General automation	1,606,891	123,731	1,730,621
002.004 INFRASTRUCTURE	**17,534,431**	**1,350,151**	**18,884,582**
002.004.111 Pipe Racks	104,619	8,056	112,674
002.004.115 Bulk Site Earthworks	4,096,943	315,465	4,412,407
002.004.370 Process Plant Services	–	–	–
002.004.371 Compressed Air	396,335	30,518	426,853
002.004.372 Maintenance/Workshops	619,353	47,690	667,043
002.004.373 Warehouse Stores	453,123	34,890	488,014
002.004.380 Process Water	–	–	–
002.004.381 Gland Water	63,287	4,873	68,161
002.004.600 Infrastructure	–	–	–
002.004.625 Stormwater Drainage System	1,503,732	115,787	1,619,520

002.004.627 Fire Water System	102,999	7,931	110,930
002.004.628 Water intake	771,557	59,410	830,967
002.004.630 Infrastructure – General	5,556,353	427,839	5,984,193
002.004.631 Public Roads	732,881	56,432	789,313
002.004.632 Carparks/Hardstand, Roads	493,096	37,968	531,064
002.004.634 Fencing	511,199	39,362	550,561
002.004.639 Central Waste	137,619	10,597	148,215
002.004.660 Buildings - Admin	313,309	24,125	337,434
002.004.661 Canteen	335,363	25,823	361,186
002.004.662 Clinic	210,770	16,229	226,999
002.004.663 Laboratory	911,910	70,217	982,127
002.004.665 Gatehouse	189,635	14,602	204,237
002.004.670 Non-process Electrical Services	–	–	–
002.004.673 Plant Security System	–	–	–
002.004.675 Fire Detection and Protection	–	–	–
002.004.676 Communications & Network	30,347	2,337	32,683
002.004.680 Fuel Storage & Distribution	–	–	–
002.004.811 Owners Temporary Infrastructure	–	–	–
003 ENVIRONMENTAL	**14,418,492**	**1,121,428**	**15,539,921**
003.001 WATER RECYCLING	**2,357,698**	**192,747**	**2,550,445**
003.001.641 Environmental Process Water	1,200,286	166,998	1,367,283
003.001.623 Water Treatment	968,513	11,204	979,717
003.001.624 Sewage Collection & Treatment	188,899	14,545	203,445
003.002 TAILINGS DRY STACKING	**9,792,436**	**754,018**	**10,546,454**
003.002.352 Environmental Thickener	667,396	51,390	718,786
003.002.353 Environmental filtration	372,730	28,700	401,431
003.002.354 Environmental Deposition	523,536	40,312	563,848
003.002.350 Environmental Tails handling	8,228,774	633,616	8,862,389
003.003 SEWAGE & WATER TREATMENT	**2,268,358**	**174,664**	**2,443,022**
003.003.620 Water & Sewage	779,134	59,993	839,127
003.003.621 Raw Water Supply	1,259,928	97,014	1,356,942
003.003.622 Potable Water Supply	229,297	17,656	246,953
004 EPCM & ENGINEERING SERVICES	**17,867,543**	**1,375,801**	**19,243,344**
004.001 Management	**17,867,543**	**1,375,801**	**19,243,344**
004.001.010 EPCM	13,467,417	1,036,991	14,504,408
004.001.030 Subconsultants	84,480	6,505	90,985
004.001.050 Construction Indirects – Contractors	2,613,730	201,257	2,814,988
004.001.060 Site Construction Facilities	426,710	32,857	459,566
004.001.080 Construction Operations	–	–	–
002.001.841 Commissioning	1,275,206	98,191	1,373,397
005 SUBSTATION & UTILITY POWER SUPPLY	**6,888,863**	**530,442**	**7,419,305**
005.001 SUBSTATION SYSTEM	**6,888,863**	**530,442**	**7,419,305**
005.001.652 HV Switchyard/Substation	5,781,316	445,161	6,226,477
005.001.650 Utility Power Supply	–	–	–
005.001.651 Transmission Line	1,107,547	85,281	1,192,828
Total Construction Capital Cost	**111,873,091**	**8,625,462**	**120,498,553**

006 OWNERS PROJECT COSTS	**8,901,677**	**890,168**	**9,791,844**
006.001 GENERAL	**8,901,677**	**890,168**	**9,791,844**
006.001.810 Owners Project Costs	8,901,677	890,168	9,791,844
007.001.811 Owners Temporary Infrastructure	–	–	–
006.001.815 Training	–	–	–
006.001.818 Policies & Procedures	–	–	–
006.001.824 First Fill Reagents & Consumable	–	–	–
006.001.825 Fuels & Lubricants	–	–	–
006.001.827 Small Tools & Maintenance Equipment	–	–	–
006.001.842 Operating Spares	–	–	–
006.001.843 Insurance Spares	–	–	–
006.001.850 Fees / Taxes / Duties	–	–	–
006.001.860 Community	–	–	–
006.001.870 Plant Mobile Equipment	–	–	–
006.001.880 Safety	–	–	–
007.001 Working Capital and Spares	**6,137,293**	**–**	**6,137,293**
007.001 Working Capital	5,200,000	–	5,200,000
007.002 Spare Parts	937,293	–	937,293
Total Construction Capital Cost (ex VAT Tax Incentive)	**126,912,061**	**9,515,630**	**136,427,691**
009.001 Estimated VAT Tax Incentive	**(5,859,000)**	**–**	**(5,859,000)**
Total Construction Capital Cost	**121,053,061**	**9,515,630**	**130,568,691**

008 Sustaining and Deferred Capital	**3,200,000**	**246,400**	**3,446,400**
008.001 GENERAL	**3,200,000**	**246,400**	**3,446,400**
008.001.910 Mine / Plant / Other	–	–	**–**
008.001.920 Mine / Plant / Tailings Dam/ Other	3,000,000	231,000	3,231,000
008.001.930 Mine/Plant/Waste rock & Tailings disposal	200,000	15,400	215,400

The total Capex for Phase 1 is US$136.4 M (this is including the Owner's cost, working capital, contingency and excluding the Sustaining Capital and the Estimated Vat Tax Incentive). The Vat Tax Incentive estimated amount is US$5.9 M.

The total Capex for Phase 1 including the Estimated Vat Tax Incentive is US$130.6 M.

Sustaining capital is estimated at US$3.2 M (including contingency) for replacement of key plant components over the 8-year Phase 1 Mine life, considering the modelled operating life and useful life of major equipment items. The sustaining capex is mainly for the crushing area and allows for crusher rebuilds (replacements).

Table 21-3: Phase 2 & 3 Concentrator Capital Cost Estimate Summary

AREA	TOTALS		
	(USD)		
MEGA PLANT	DIRECTS + INDIRECTS (USD)	CONTINGENCY (USD)	TOTAL (Excluding recoverables) (USD)
000 MEGA (Excluding Sustaining Capital)	**144,429,471**	**10,473,002**	**154,902,473**
000 MEGA (Including Sustaining Capital)	**157,499,471**	**11,479,392**	**168,978,863**
001 MINE	**2,096,208**	**161,408**	**2,257,616**
001.001 Mine general	**0**	**0**	**0**
001.001.700 Mine pre-stripping		0	0
001.001.730 Mining Pre-Production	0	0	0
001.001.770 Mine Mobile Equipment - LME	0	0	0
001.001.780 FUELS & LUBRICANTS	0	0	0
001.002 Mine infrastructure general	**2,096,208**	**161,408**	**2,257,616**
001.002.635 Bridge	0	0	0
001.002.720 Mine Establishment	0	0	0
001.002.750 Mining Infrastructure & Services	2,096,208	161,408	2,257,616
002 PLANT	**89,536,397**	**6,718,807**	**96,255,204**
002.001 Crushing system - Primary/Secondary/ Scalping	**30,624,198**	**2,358,063**	**32,982,261**
002.001.210 General Crushing	7,804,774	600,968	8,405,742
002.001.211 Primary Crushing	4,638,700	357,180	4,995,880
002.001.212 Secondary Crushing	1,453,110	111,889	1,564,999
002.001.215 Scalping Screening	1,834,840	141,283	1,976,122
002.001.223 Classification Screening	2,080,161	160,172	2,240,333
002.001.224 Ore Sorting	0	0	0
002.001.225 Tertiary Crushing	6,693,774	515,421	7,209,195
002.001.227 Crushed Ore Storage & Reclaim	6,118,839	471,151	6,589,990
002.001.229 Waste	0	0	0
002.002 DMS System	**41,331,541**	**3,007,033**	**44,338,574**
002.002.030 Vendor Representatives	145,300	11,188	156,488
002.002.310 General DMS	4,740,775	365,040	5,105,815
002.002.311 DMS Sizing Screen	6,122,539	471,436	6,593,975
002.002.312 Primary DMS	5,496,066	423,197	5,919,263
002.002.313 Secondary DMS	6,259,376	481,972	6,741,348
002.002.314 Primary Ultrafines DMS	4,004,014	308,309	4,312,323
002.002.315 Secondary Ultrafines DMS	1,782,270	137,235	1,919,505
002.002.316 Recrush DMS	1,803,546	138,873	1,942,419
002.002.317 Scavenger DMS Circuit	5,130,763	395,069	5,525,831
002.002.325 Ultrafines DMS Product Stockpile	161,775	12,457	174,231
002.002.331 FeSi	61,985	4,773	66,758
002.002.332 FeSi - Secondary	0	0	0
002.002.333 FeSi - Ultrafine	0	0	0
002.002.335 Flocculant	763,998	58,828	822,826
002.002.340 Coarse & Fines DMS Product Stockpile	1,762,904	135,744	1,898,648
002.002.345 Truck Weigh Station	167,306	12,883	180,189
002.002.350 Tails Handling	0	0	0
002.002.351 Screw Classifier	649,760	50,032	699,792
002.002.352 Thickening	0	0	0
002.002.353 Filtration	0	0	0
002.002.354 Tails Deposition (Dry Stack)	0	0	0

002.002.820 Plant & Pre-Production	2,279,163	0	2,279,163
002.002.841 Commissioning	0	0	0
002.003 AUTOMATION/DIGITALIZATION	**6,213,037**	**478,404**	**6,691,441**
002.003.100 Plant Control Systems	1,560,211	120,136	1,680,347
002.003.210 Automation in General Crushing	9,741	750	10,491
002.003.211 Automation in Primary Crushing	18,307	1,410	19,717
002.003.310 Automation in DMS area	50,886	3,918	54,804
002.003.311 Automation in DMS Sizing Screen	25,974	2,000	27,974
002.003.312 Automation in Primary DMS	0	0	0
002.003.313 Automation in Secondary DMS	25,864	1,992	27,855
002.003.314 Automation in Primary Ultrafines DMS	1,583,317	121,915	1,705,233
002.003.315 Automation in Secondary Ultrafines DMS	101,992	7,853	109,845
002.003.350 DMS automation	169,306	13,037	182,343
002.003.630 General automation	2,667,438	205,393	2,872,831
002.004 INFRASTRUCTURE	**11,367,621**	**875,307**	**12,242,928**
002.004.111 Pipe Racks	209,238	16,111	225,349
002.004.115 Bulk Site Earthworks	3,879,662	298,734	4,178,396
002.004.370 Process Plant Services	0	0	0
002.004.371 Compressed Air	528,269	40,677	568,946
002.004.372 Maintenance/Workshops	450,458	34,685	485,144
002.004.373 Warehouse Stores	299,061	23,028	322,089
002.004.380 Process Water	0	0	0
002.004.381 Gland Water	107,441	8,273	115,714
002.004.600 Infrastructure	0	0	0
002.004.625 Stormwater Drainage System	632,093	48,671	680,764
002.004.627 Fire Water System	123,599	9,517	133,116
002.004.628 Water intake	771,557	59,410	830,967
002.004.630 Infrastructure – General	3,424,491	263,686	3,688,177
002.004.631 Public Roads	207,625	15,987	223,612
002.004.632 Carparks/Hardstand, Roads	0	0	0
002.004.634 Fencing	0	0	0
002.004.639 Central Waste	137,619	10,597	148,215
002.004.660 Buildings - Admin	0	0	0
002.004.661 Canteen	335,363	25,823	361,186
002.004.662 Clinic	210,770	16,229	226,999
002.004.663 Laboratory	0	0	0
002.004.665 Gatehouse	0	0	0
002.004.670 Non-process Electrical Services	0	0	0
002.004.673 Plant Security System	0	0	0
002.004.675 Fire Detection and Protection	0	0	0
002.004.676 Communications & Network	50,375	3,879	54,254
002.004.680 Fuel Storage & Distribution	0	0	0
002.004.811 Owners Temporary Infrastructure	0	0	0
003 ENVIRONMENTAL	**15,252,504**	**1,174,443**	**16,426,946**
003.001 WATER RECYCLING	**2,561,995**	**197,274**	**2,759,269**
003.001.641 Environmental Process Water	1,593,482	122,698	1,716,180
003.001.623 Water Treatment	968,513	74,576	1,043,089
003.001.624 Sewage Collection & Treatment	0	0	0
003.002 TAILINGS DRY STACKING	**12,137,663**	**934,600**	**13,072,263**
003.002.352 Environmental Thickener	1,001,094	77,084	1,078,178
003.002.353 Environmental filtration	745,461	57,400	802,861
003.002.354 Environmental Deposition	785,303	60,468	845,772
003.002.350 Environmental Tails handling	9,605,805	739,647	10,345,452
003.003 SEWAGE & WATER TREATMENT	**552,845**	**42,569**	**595,414**

003.003.620 Water & Sewage	183,396	14,122	197,518
003.003.621 Raw Water Supply	140,152	10,792	150,944
003.003.622 Potable Water Supply	229,297	17,656	246,953
004 EPCM & ENGINEERING SERVICES	**21,672,011**	**1,668,745**	**23,340,755**
004.001 Management	**21,672,011**	**1,668,745**	**23,340,755**
004.001.010 EPCM	16,430,248	1,265,129	17,695,377
004.001.030 Subconsultants	84,480	6,505	90,985
004.001.050 Construction Indirects – Contractors	2,613,730	201,257	2,814,988
004.001.060 Site Construction Facilities	426,710	32,857	459,566
004.001.080 Construction Operations	0	0	0
004.001.841 Commissioning	2,116,842	162,997	2,279,839
005 SUBSTATION & UTILITY POWER SUPPLY	**663,829**	**51,115**	**714,943**
005.001 SUBSTATION SYSTEM	**663,829**	**51,115**	**714,943**
005.001.652 HV Switchyard/Substation	663,829	51,115	714,943
005.001.650 Utility Power Supply	0	0	0
005.001.651 Transmission Line	0	0	0
006 OWNERS PROJECT COSTS	**9,071,230**	**698,485**	**9,769,715**
006.001 GENERAL	**9,071,230**	**698,485**	**9,769,715**
006.001.810 Owners Project Costs	9,071,230	698,485	9,769,715
007.001.811 Owners Temporary Infrastructure	0	0	0
006.001.815 Training	0	0	0
006.001.818 Policies & Procedures	0	0	0
006.001.824 First Fill Reagents & Consumable	0	0	0
006.001.825 Fuels & Lubricants	0	0	0
006.001.827 Small Tools & Maintenance Equipment	0	0	0
006.001.830 Admin Pre-Production Other	0	0	0
006.001.840 Spare Parts	0	0	0
006.001.842 Operating Spares	0	0	0
006.001.843 Insurance Spares	0	0	0
006.001.850 Fees / Taxes / Duties	0	0	0
006.001.860 Community	0	0	0
006.001.870 Plant Mobile Equipment	0	0	0
006.001.880 Safety	0	0	0
007 WORKING CAPITAL & SPARES	**6,137,293**	**0**	**6,137,293**
007.001 GENERAL	**6,137,293**	**0**	**6,137,293**
007.001.830 Working Capital	5,200,000	0	5,200,000
007.001.840 Spare Parts	937,293	0	937,293
007.001.920 Deferred Capital	0	0	0
008 SUSTAINING & DEFERRED CAPITAL	**13,070,000**	**1,006,390**	**14,076,390**
008.001 GENERAL	**13,070,000**	**1,006,390**	**14,076,390**
008.001.910 Sustaining Capital	12,000,000	924,000	12,924,000
008.001.930 Closure Cost	1,070,000	82,390	1,152,390

The total Capex for Phase 2 & 3 is US$154.9 M (this is including the Owner's cost, working capital, contingency and excluding the Sustaining Capital).

It is worth noting that the cost amount of the common concentrators Infrastructure (002.004), tailings dry stacking (003.002), EPCM & Engineering Services (004), substation & utility Power Supply (005), Owner's project costs (006), has been accounted for in the Xuxa concentrator Capex estimate, and thus explaining most of the cost differences between the two plants.

Sustaining Capital includes a provision of US$6.5 M every 5 years (for a total of US$13.4 M over the duration of the mine life) to account for key plant components to be replaced to sustain existing production. Additional US$1.2M of mine closure costs were included at the end of the mine life.

21.4.2 Summary of Key Quantities

A summary of the key construction material quantities for the process plants are presented in Table 21-4.

Table 21-4: Process Plant Material Quantity Summary

TYPE	UNIT	XUXA CONCENTRATOR TOTAL	BARREIRO CONCENTRATOR TOTAL
Steelwork	t	782	872
Platework	t	514	432
Concrete	m³	4,176	3,554
Cable	m	52,630	47,540
Equipment	num	204	207

21.4.3 Basis of Process Plant Estimate

21.4.3.1 Summary Table

The process plant capital cost for Phase 1 and Phase 2 & 3 estimate were assembled in accordance with Table 21-5.

Table 21-5: 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	Promon / Primero	Quoted (equipment, platework and structural steel) *Unit rates from Promon budgetary pricing or in-house data RFQs based on Primero MTOs and equipment list.*

Description	Responsible	Data Requirement
Bulks supply and installation	Promon / Primero	Quoted (for concrete and electrical supply & installation) *Unit rates obtained from budgetary pricing RFQs based on Primero MTOs.* *Piping supply and installation factored form similar projects for process plant.*
Civil	Promon / Promon Primero	Quoted *Unit rates obtained from budgetary pricing RFQs.*
Process Infrastructure	Primero	Provided from Primero
Freight	Primero	Calculated *Pricing obtained from major procurement locations to site.*
Commissioning	Primero	Calculated *Built up from historic data*
Indirect Costs		
Indirect labour rates	Promon / Primero	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	Promon / Primero	Calculated/Quoted *Duration build up from detailed project schedule for EPCM and Client facilities. Contractor's facilities quoted*
Construction plant	Promon / Primero	Quoted *Contractor plant included in quotes*
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	Primero	(1.25% for the piping)
Owner's costs	Sigma	*Information provided by Sigma*
Training	Primero	Estimated
First fills and consumables	Primero	Calculated
Spares	Primero	Calculated
Sustaining Capital	Sigma	*Information provided by Sigma*
Taxes	Sigma	Estimated *Refer to section 21.4.4.1 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 FEED level for the Phase 1 plant and a pre-feasibility level for the Phase 2 & 3 plant with approval of key deliverables obtained from Sigma. These included the design basis, process design criteria, block flow diagram, process flow diagram, a high-level mass balance basis of design along with a similar project execution plan, schedule and site conditions as Phase 1 FEED.

21.4.3.2 Estimate Area Facility and Commodity Coding

The estimate was developed based on the Xuxa project WBS structure and Promon's coding structure.

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 21-6.

Table 21-6 – 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 in the cost estimation. 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 at the time of this report was 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 21-7.

Table 21-7 – 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 was based on the Xuxa Phase 1 DFS Project Execution and Contracting Plan as defined in Section 24 and deemed suitable to be used for the similar Barreiro plant. Table 21-5 states the assumptions and exclusions made to complete the estimate.

No allowance was made in the estimate for withholding tax. Import duties have been excluded.

21.4.4 Basis of Estimate – NPI and Earthworks

The estimate for the non-process infrastructure (NPI) and earthworks portion for Xuxa Phase 1 and Barreiro Phase 2 was developed by GE21, Promon and Sigma. The following items were included in the cost estimate:

- The bulk earthworks for the plant site preparation
- The mine establishment including the access and service roads, electrical substation and water reservoir with pump.
- Buildings including workshops, offices , laboratory, canteen, changing rooms, perimeter fencing, security entrance, first aid and fire fighting station
- Plant and waste pile water drainage system
- Lighting and communications systems

21.4.4.1 Taxes

The following taxes were used when applicable 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:

- Switch room buildings (HV and 3 NPI switch rooms): considered in the OPEX.
- CCTV: there will be no CCTV

21.4.5 Basis of Estimate – Mining

The mining fleet and all mining infrastructure including workshops and administrative buildings are the mining contractor's responsibility. The capital cost for Xuxa mining is limited to the pre-stripping phase, ROM pad construction and the mine site road construction, while for Barreiro and NDC, it is limited to pre-stripping, road construction, ROM pad construction and waste stripping in years 4, 5 and 6.

Table 21-8 shows the summary of the estimated capital mining cost for Phase 1 and Table 21-9 summarizes the estimated capital mining cost Phase 2 & 3.

Table 21-8 – Phase 1 Estimated Capital Mining Cost

Mining Item	Cost ($US)
Bridge	493,512
Pre-stripping (with Mobilization)	6,643,386
Infrastructure & Services	1,325,054
Total	8,461,952

Table 21-9: Phase 2 & 3 Estimated Capital Mining Cost

Operating Year	Mining Item	Cost ($US)
Year 0	Mobilization	692,206
	Site Construction	792,510
	Roads	772,899
	Sub Total	2,257,616
Year 4	Waste	56,729,223
Year 5	Waste	52,927,849
Year 6	Waste	50,830,672
	Total	**162,745,359**

21.4.6 Basis of Estimate – Owner's cost

The project Owner's cost for Phase 1 and Phase 2 & 3 as estimated and provided by Sigma are US$9.8 M.

21.5 OPERATING COSTS

21.5.1 Operating Cost Summary

The processing plant operating cost estimate includes the operation of a three-stage crushing and screening circuit and DMS circuits (two stages for coarse, fine and ultra fines material classes).

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 variable OPEX for the Phase 1 concentrator will be $5.30/t of ore feed and US$7.5M of fixed OPEX.. The estimated variable OPEX for the Phase 2 & 3 concentrator is $4.80/t of ore feed and US$6.7M of fixed OPEX.

Table 21-10 shows the Phase 1 OPEX summary, while Table 21-11 shows the Phase 2 & 3 OPEX summary.

Table 21-10: Phase 1 OPEX Processing Cost Summary

DESCRIPTION	OPEX (US$)
Mining (US$/t material mined)	$2.1
Process (US$/t ore feed)	$10.4
G&A (US$/t ore feed)	$5.3
Shipping (US$/t SC)	$120

Table 21-11: Phase 2 & 3 OPEX Processing Cost Summary

DESCRIPTION	OPEX (US$)
Barreiro Mining (US$/t material mined)	$2.68
NDC Mining (US$/t material mined)	$1.98
Phase 2 & 3 Process (US$/t ore feed)	$7.1
Phase 2 & 3 G&A (US$/t ore feed)	$2.7
Shipping (US$/t SC)	$120

21.5.2 Operating Cost Details

The OPEX cost summary breakdown for Phase 1 and Phase 2 & 3 are presented in Table 21-12 and Table 21-13 respectively.

Table 21-12: Phase 1 Processing Plant OPEX Cost Summary Breakdown

Unit Cash Cost Analysis	US$ 000 per / year	US$/t ROM
Plant		
Labour	3,278	1.93
Operating consumables	3,657	2.15
Power	3,471	2.04
Maintenance supplies	3,768	2.22
Lease mobile equipment	2,321	1.37
Total	**16,494**	**9.70**
Plant		
Variable	8,984	5.28
Fixed	7,510	
Total	**16,494**	

Table 21-13: Phase 2 & 3 Processing Plant OPEX Cost Summary Breakdown

Unit Cash Cost Analysis	US$ 000 per / year	US$/t ROM
Plant		
Labour	3,560	0.91
Operating consumables	9,067	2.32
Power	5,225	1.34
Maintenance supplies	5,139	1.32
Lease mobile equipment	3,731	0.96
Total	26,7236	6.85
Plant		
Variable	17,521	4.79
Fixed	9,202	
Total	26,723	

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 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
- The DMS plant is based upon three shifts of eight hours per day operation

Personnel requirements are provided in Table 21-14. The staffing levels reflect previous experiences of similar hardrock lithium operations and the Brazilian labour law.

Table 21-14: Labour Summary

Labour	Phase 1 Plant Total Number Employed	Phase 2 & 3 Plant Total Number Employed
Administration Department		
Operations Manager	1	0
Plant Operations		
Chief Metallurgist	1	0
Shift Supervisor	4	4
Control room operator	4	4
Store man	4	0
Head of Security	1	0
Crushing Operator	12	12
DMS Operator	12	12
Utility Operator/Crusher feed/DMS feed	8	8
Journeyman (mechanic and electrician)	8	8
Mobile Equipment Operator	4	4
Mining and Geology		
Mining Engineer	2	0
Geology	2	3
Surveyor	2	2
Laboratory		
Metallurgist	3	2
Met tech	3	2
Laboratory Supervisor	4	4
Laboratory Technician	8	8

Labour	Phase 1 Plant Total Number Employed	Phase 2 & 3 Plant Total Number Employed
HSE and Environment		
HSE and Sustainability coordinator	1	0
HSE Assistant	2	2
Environment Controller	1	1
Maintenance		
Maintenance chief	1	1
Mechanical maintenance supervisor	1	1
Production / maintenance coordination planner	1	1
Mechanics	4	6
Assistant Mechanics	4	6
Electricians	4	3
Assistant Electrician	4	3
Technicians / instrumentation	4	3
Production / Maintenance Coordinator Planner	1	1
TOTAL LABOUR EMPLOYED	**110**	**101**

Operating labor cost is estimated to be US$3.3 M per annum for the Phase 1 processing cost and US$9.1 M per annum for the Phase 2 & 3 processing cost.

21.5.2.1.2 Operating Consumables

The consumables are split into three areas: Crushing and screening circuit, DMS plant and reagents. In the crushing circuit, costs for crusher liners and screen panels are provisioned. In the DMS plant, costs for cyclones, pumps, screens and belt filter replacement are included in maintenance supply cost estimates.

21.5.2.1.3 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/t 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 with a similar processing facility and quotes from the in-country sources.

21.5.2.1.4 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 6.3 MW; an allowance of 241 kW has also been made for lighting, heating and ancillary buildings. This includes the power consumed in the crushing circuit.

21.5.2.1.5 Maintenance Materials

Laboratory supply costs have been allocated a lump sum of US$250,000.

21.5.2.1.6 Lease of Mobile Equipment

The mobile equipment will be leased. The lease costs rates for light vehicles for supervisors, heavy equipment for feeding ore, service trucks for maintenance and minibuses for personnel transport have been used for the estimates.

21.5.2.1.7 Concentrate Transport

Concentrate transport cost has been estimated at an average LOM of US$120/t of concentrate produced for all phases per Sigma input based on preliminary estimates. This includes the cost from the site to the Port of Vitória in Brazil and to the final port of Shanghai, China.

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, 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 Vitória, 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
- 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 – Mining

Table 21-15 shows the summary of the estimated operating mining cost for Phase 1 and Table 21-16 summarizes the estimated operating mining cost for Phase 2 & 3.

Table 21-15: Phase 1 Mining OPEX Costs

Year	Drilling	Blasting	Load	Transport	Scattering	Diesel	Site Maint.	Mob+Site	Demob	Total US$x1,000
1	2,463	3,891	3,189	9,743	1,161	4,382	498			25,327
2	4,838	7,700	5,909	18,426	2,307	8,394	498			48,072
3	6,276	10,007	7,057	22,429	2,797	10,174	498			59,238
4	5,443	8,671	5,760	18,397	2,247	8,437	498			49,452
5	6,527	10,409	6,867	22,012	2,711	10,079	498			59,103
6	6,848	10,926	7,171	23,081	2,846	10,603	498			61,972
7	9,045	14,448	9,266	31,534	3,726	13,825	498			82,342
8	3,819	6,069	3,751	14,716	1,410	5,525	498		643	36,430
Total	45,259	72,120	48,970	160,338	19,203	71,420	3,985	-	643	421,938

Table 21-16: Phase 2 & 3 Mining OPEX Costs

Year	Drilling	Blasting	Load	Transport	Scattering	Diesel	Site Maint	Mob+Site	Demob	Total
Pre Stripping	-	-	-	-	-	-				-
1	4,099	6,502	4,752	23,001	1,781	6,910	498	1,378		48,923
2	4,271	6,777	4,763	21,990	1,783	6,924	498			47,006
3	4,636	7,361	4,898	23,907	1,839	7,124	498			50,262
4	4,522	7,180	4,732	25,447	1,772	6,879	498			51,029
5	4,240	6,728	4,388	24,252	1,629	6,369	498			48,104
6	4,504	7,151	4,713	28,332	1,766	6,853	498			53,818
7	5,278	8,392	5,499	32,390	2,094	8,019	498			62,170
8	5,419	8,619	5,499	32,390	2,094	8,019	498		-	62,539
9	5,419	8,619	5,499	32,390	2,094	8,019	498		-	62,539
10	5,419	8,619	5,499	32,390	2,094	8,019	498		-	62,539
11	2,127	3,340	2,076	17,344	654	2,932	498		-	28,972
12	2,102	3,302	2,055	16,943	654	2,907	498		643	29,104
Total	52,035	82,593	54,372	310,776	20,255	78,974	5,977	1,378	643	607,004

22 ECONOMIC ANALYSIS

22.1 ECONOMIC ASSUMPTIONS

Three levels of economic analyses were undertaken for the Project, contemplating the mining of the Mineral Reserves of:

- the Xuxa deposit (Phase 1)
- the Barreiro and NDC deposits (Phase 2 & 3) and
- both Phase 1 and Phase 2 & 3 (Phase 1, 2 & 3)

The economic analyses contemplate the production of spodumene concentrate (SC) at grades of 5.5% Li_2O, in line with the current lithium market conditions.

The economic analyses were undertaken on a 100% equity basis and were developed using the discounted cash flow method based on the data and assumptions detailed in this report for revenue, capital expenditure (Capex) and operating cost (OPEX) estimates. An exchange rate of 5.30 BRL per US$ was used to convert particular components of the cost estimates into US$. No provisions were made for the effects of inflation and the base currency was considered on a constant 2022 US$ basis. Exploration costs are deemed outside of the Project and any additional Project study costs have not been included in the analyses.

The base case scenario after-tax net present value (NPV) results are detailed in Table 22-1 below. The discount rate assumed for the after-tax NPVs is 8%.

Table 22-1 – Base Case After-Tax NPVs

MODELLED CASE	UNIT	@ 5.5% LI_2O SC
Phase 1	US$ M	$5,699
Phase 2 & 3	US$ M	$9,587
Phase 1, 2 & 3	**US$ M**	**$15,289**

A sensitivity analysis reveals that the Project's viability will not be significantly vulnerable to variations in capital expenditures, within the margins of error associated with the DFS and study estimates for Phase 1 and Phase 2 & 3, respectively. In contrast, the Project's economic returns remain most sensitive to changes in spodumene prices, feedstock grades and recovery rates.

22.1.1 Spodumene Concentrate Price Forecast

The commodity price forecast used in the base case scenarios is detailed in Figure 22-1 below. The price forecast for spodumene concentrate was based on a 9.0% factor applied to Benchmark Mineral Intelligence's Q3-2022 lithium hydroxide price projections. The sensitivity analyses consider a range of ±20% versus the base case forecasts.

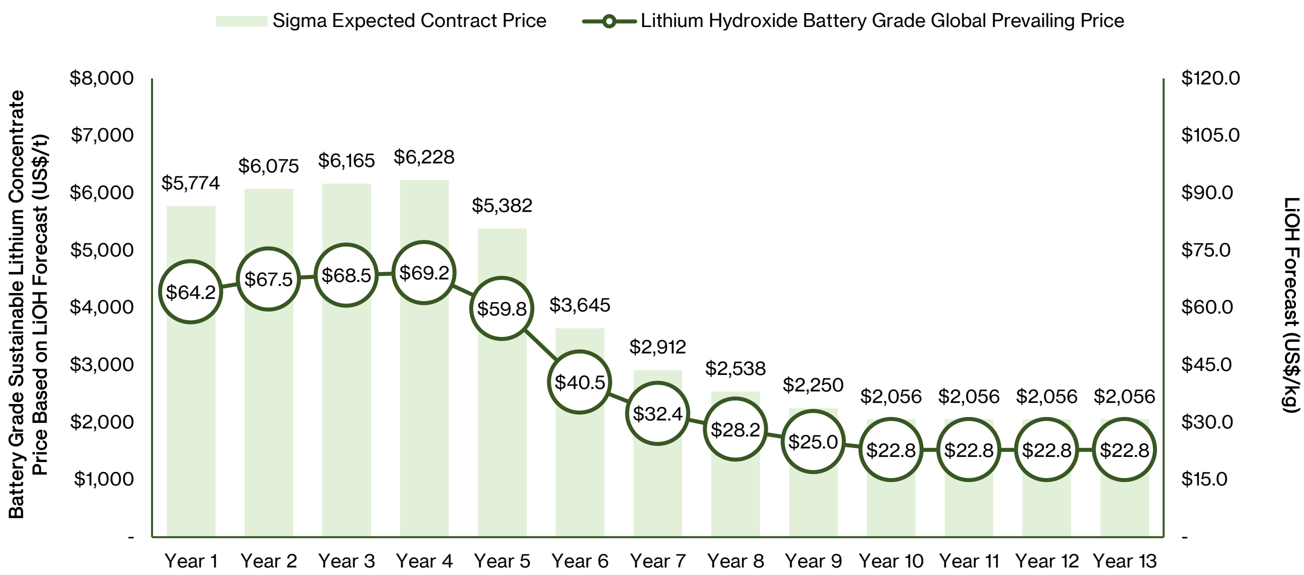


Figure 22-1: Spodumene Concentrate Price Forecast

22.1.2 Taxation

Phase 1, Phase 2 & 3 and Phase 1, 2 & 3 were 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 analyses 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 stimulating 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). For Phase 2 & 3, the Sudene tax incentive is expected to be renewed after the 10th anniversary of achieving at least 20% of their production capacities.

The Project is expected to be exempt from all importation taxes for products where 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.

22.1.3 Royalties

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%).
- A 1.0% NSR royalty with permissible deductions from gross spodumene revenue including the CFEM royalty, any commercial discounts, transportation costs and taxes paid.

22.2 PHASE 1 DFS ECONOMIC ANALYSIS

The Phase 1 economic analysis is based on an eight-year operation sourcing feedstock ore from the Xuxa deposit's Mineral Reserve of 11.8 Mt grading at 1.55% Li2O. Phase 1 is expected to generate run-rate production of 270 ktpa of lithium concentrate, delivering US$990 million of annual free cash flow, at a 5.5% Li_2O SC grade.

The base case scenario results are detailed in Table 22-2 below.

Table 22-2: Phase 1 Base Case Scenario Results

ITEM	UNIT	@ 5.5% LI_2O SC
After-Tax NPV @ 8%	US$ M	$5,699
After-Tax IRR	%	1,282%
After-Tax Payback Period	Years	0.1

22.2.1 Phase 1 DFS Technical Assumptions

The key technical assumptions used in the base case are highlighted below in Table 22-3.

Table 22-3: Key Phase 1 Technical Assumptions

ITEM	UNIT	@ 5.5% LI_2O SC
Total Ore Processed (ROM)	Mt	11.8
Annual ROM Ore Processed	Mt	1.5
Run-Rate SC Production	Ktpa	270

ITEM	UNIT	@ 5.5% Li_2O SC
Run-Rate LCE Production (Note 1)	Ktpa	37
Strip Ratio	Ratio	16.4: 1
Average Li_2O Grade	%	1.55%
Spodumene Recovery Rate	%	65.0%
Spodumene Concentrate Grade	% Li_2O	5.5%
Operating Life	Years	8
Total Cash Cost ex. Royalties (@ Mine Gate)	US$/t SC	$288
Total Cash Cost incl. Royalties (@ Mine Gate)	US$/t SC	$419
Transportation Costs (CIF China)	US$/t SC	$120
Total Cash Cost (CIF China)	US$/t SC	$539
AISC (CIF China)	US$/t SC	$541
Mining Costs	US$/t Material Mined	$2.06
Processing Costs	US$/t ROM	$10.38
G&A Costs	US$/t ROM	$5.29

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

22.2.2 Phase 1 DFS Financial Results

Table 22-4 and Figure 22-2 illustrate the after-tax cash flow and cumulative cash flow profiles of Phase 1 under the base case scenario. The intersection of the after-tax cumulative cash flow with the horizontal zero line represents the payback period of the Capex to production.

As highlighted in Table 22-4, the total gross revenue derived from the sale of spodumene concentrate is estimated at US$10.6 billion, an average revenue of US$4,909/t 5.5% SC with total operating costs (including royalty payments and commercial discounts) of US$1.3 billion at an average cost of US$581/t 5.5% SC. The resulting after-tax earnings margin (gross revenue less realization, operating costs and taxes) was estimated at US$7.9 billion.

This robust cash flow profile compares to an estimated remaining pre-production Capex of US$88.0 million (as of October 2022) which includes the DMS plant, non-process infrastructure, and owner's cost. The estimated sustaining and mine closure costs are approximately US$3.4 million and are considered in the base case of the economic study.

Additionally, a summary of the Phase 1 Financial Model under the base case scenario 5.5% is provided in Figure 22-3 below. The discount rate assumed for the pre- and after-tax NPV is 8%.

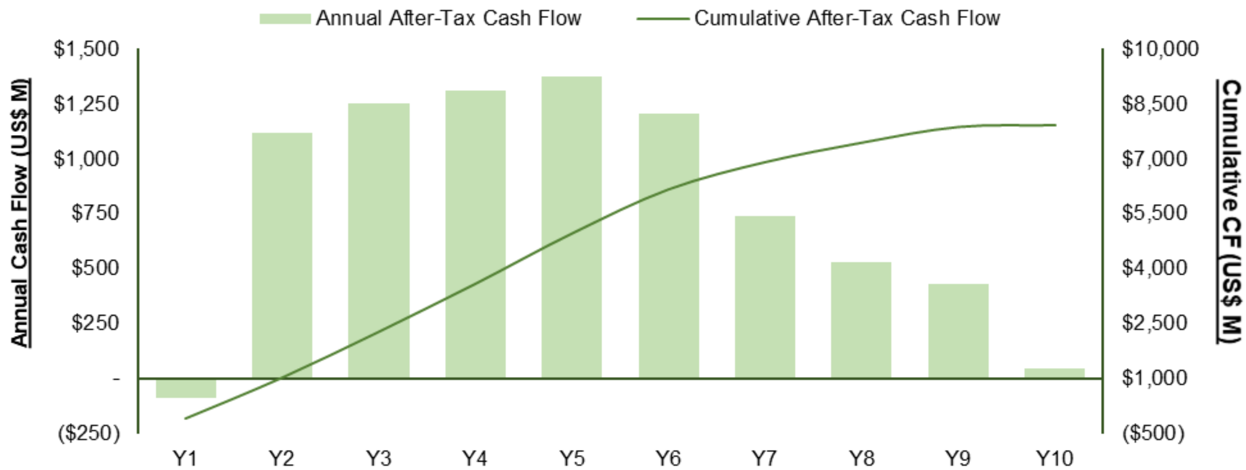


Figure 22-2: : Phase 1 After-Tax Cash Flow and Cumulative Cash Flow Profile @ 5.5% SC

Table 22-4: Phase 1 Estimated Revenue and Operating Costs

	5.5% Li_2O **SC**	
	Total US$ M	**Avg. US$/t**
Gross Revenue	$10,605	$4,909
Less: Realization Costs		
Royalties	$299	$138
Commercial Discounts	-	-
Total Realization Costs	$299	$138
Net Revenue	$10,306	$4,771
Less: Site Operating Costs		
Mining	$422	$195
Processing	$122	$57
Selling, General & Administration	$62	$29
Transportation	$259	$120
Total Operating Costs	$866	$401
Less: Depreciation	$90	$42
Pre-Tax Earnings	$9,350	$4,328
% Pre-Tax Earnings Margin of Net Sales	*91%*	*91%*
Less: Taxes	$1,426	$660
After-Tax Earnings	$7,924	$3,668
% After-Tax Earnings Margin of Net Sales	*77%*	*77%*

Grota do Cirilo Financial Model (Phase 1 Only)		*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*	*Year 6*	*Year 7*	*Year 8*	*Year 9*	*Year 10*
Consolidated	**Phase 1 Only**										
Production											
Ore Mined	*(kt)*	-	1,500	1,506	1,464	1,486	1,507	1,453	1,480	1,402	-
Waste Mined	*(kt)*	-	11,077	22,556	27,731	22,553	27,429	28,989	38,241	14,523	-
Total Mined Volume	*(kt)*	-	12,577	24,062	29,195	24,039	28,935	30,443	39,721	15,925	-
Strip Ratio	*(w : o)*	-	7.4	15.0	18.9	15.2	18.2	19.9	25.8	10.4	-
Ore Processed	*(kt)*	-	1,500	1,506	1,464	1,486	1,507	1,453	1,480	1,402	-
Process Plant Feed Grade	*(% Li_2O)*	-	1.56%	1.50%	1.61%	1.63%	1.63%	1.54%	1.50%	1.42%	-
Contained Spodumene	*(kt)*	-	23	23	24	24	25	22	22	20	-
Process Plant Recovery	*(%)*	-	65.0%	65.0%	65.0%	65.0%	65.0%	65.0%	65.0%	65.0%	-
Recovered Spodumene	*(t)*	-	15	15	15	16	16	15	14	13	-
Concentrate Percentage	*(%)*	-	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%	-
Lithium Concentrate Production	*(kt)*	-	277	268	278	286	290	264	263	235	-
Revenue											
Sale Price	*(US$/t)*	-	$5,774	$6,075	$6,165	$6,228	$5,382	$3,645	$2,912	$2,538	-
Gross Revenue	*(US$ 000s)*	-	$1,599,305	$1,625,944	$1,715,504	$1,783,430	$1,558,850	$961,777	$764,453	$596,144	-
CFEM Royalty	*(US$ 000s)*	-	$31,986	$32,519	$34,310	$35,669	$31,177	$19,236	$15,289	$11,923	-
NSR Royalty #1	*(US$ 000s)*	-	$13,122	$13,388	$14,139	14681.00817	$12,824	$7,862	$6,254	$4,811	-
Net Revenue	*(US$ 000s)*	-	$1,554,196	$1,580,037	$1,667,055	$1,733,080	$1,514,848	$934,680	$742,910	$579,410	-
Operating Costs											
Mining	*(US$ 000s)*	-	$25,327	$48,072	$59,238	$49,452	$59,103	$61,972	$82,342	$36,430	-
Processing	*(US$ 000s)*	-	$15,437	$15,470	$15,249	$15,362	$15,472	$15,190	$15,333	$14,918	-
G&A	*(US$ 000s)*	-	$7,802	$7,802	$7,802	$7,802	$7,802	$7,802	$7,802	$7,802	-
Transportation	*(US$ 000s)*	-	$33,241	$32,117	$33,392	$34,363	$34,757	$31,663	$31,508	$28,186	-
Total Operating Costs	*(US$ 000s)*	-	$81,807	$103,462	$115,681	$106,979	$117,134	$116,627	$136,985	$87,336	-
Capital Expenditures											
Pre-Production / Growth	*(US$ 000s)*	$87,969	-	-	-	-	-	-	-	-	-
Sustaining	*(US$ 000s)*	-	-	-	-	-	$3,231	-	-	-	-
Closure Costs	*(US$ 000s)*	-	-	-	-	-	-	-	-	$215	-
Total Capital Expenditures	*(US$ 000s)*	$87,969	-	-	-	-	$3,231	-	-	$215	-
Cash Flow											
Pre-Tax Operating Cash Flow	*(US$ 000s)*	-	$1,472,390	$1,476,576	$1,551,375	$1,626,101	$1,397,715	$818,052	$605,925	$492,074	-
Capital Expenditures	*(US$ 000s)*	$87,969	-	-	-	-	$3,231	-	-	$215	-
NSR Royalty #2 Buyback	*(US$ 000s)*	-	$3,800	-	-	-	-	-	-	-	-
Changes in Working Capital	*(US$ 000s)*	-	$129,422	$1,596	$7,026	$5,821	($18,737)	($49,061)	($16,776)	($12,473)	($46,819)
Pre-Tax Free Cash Flow	*(US$ 000s)*	($87,969)	$1,339,167	$1,474,980	$1,544,348	$1,620,280	$1,413,220	$867,113	$622,702	$504,332	$46,819
Cumulative Pre-Tax Cash Flow	*(US$ 000s)*	*($87,969)*	*$1,251,199*	*$2,726,178*	*$4,270,527*	*$5,890,806*	*$7,304,027*	*$8,171,140*	*$8,793,841*	*$9,298,173*	*$9,344,992*
Taxes	*(US$ 000s)*	-	$221,856	$222,495	$233,902	$245,297	$210,468	$124,654	$92,305	$74,943	-
After-Tax Cash Flow	*(US$ 000s)*	($87,969)	$1,117,311	$1,252,485	$1,310,447	$1,374,982	$1,202,752	$742,458	$530,397	$429,389	$46,819
Cumulative After-Tax Cash Flow	*(US$ 000s)*	*($87,969)*	*$1,029,342*	*$2,281,827*	*$3,592,274*	*$4,967,256*	*$6,170,008*	*$6,912,467*	*$7,442,863*	*$7,872,252*	*$7,919,072*

Economics		**Pre-Tax**	**After-Tax**
NPV @ 8.0% WACC	***(US$ 000s)***	**$6,736,662**	**$5,699,069**
IRR	***(%)***	**1,532%**	**1,282%**
Payback	***(years)***	**0.1**	**0.1**

Figure 22-3 : Phase 1 Financial Model Summary @ 5.5% Li_2O SC

22.2.3 Phase 1 DFS Sensitivity Analysis

A sensitivity analysis for Phase 1 was carried out with the base case 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 of changes in spodumene price, spodumene recovery rates, lithium grade, BRL to US$ exchange rate, CAPEX, OPEX, and discount rate on Phase 1 after-tax NPV and IRR.

As seen in Figure 22-4, the Phase 1 after-tax NPV is not significantly vulnerable to changes in BRL to US$ exchange rate, CAPEX, OPEX, or discount rate considered. In contrast, the Phase 1 after-tax NPV is more sensitive to variation in spodumene price, lithium grade, and spodumene recovery rates.

As seen in Figure 22-5, the Phase 1 after-tax IRR is not significantly vulnerable to changes in OPEX. In contrast, the Phase 1 after-tax IRR is more sensitive to variation in spodumene price, lithium grade, spodumene recovery rates, BRL to US$ exchange rate and Capex. Note that the Phase 1 after-tax IRR is independent of the discount rate considered.

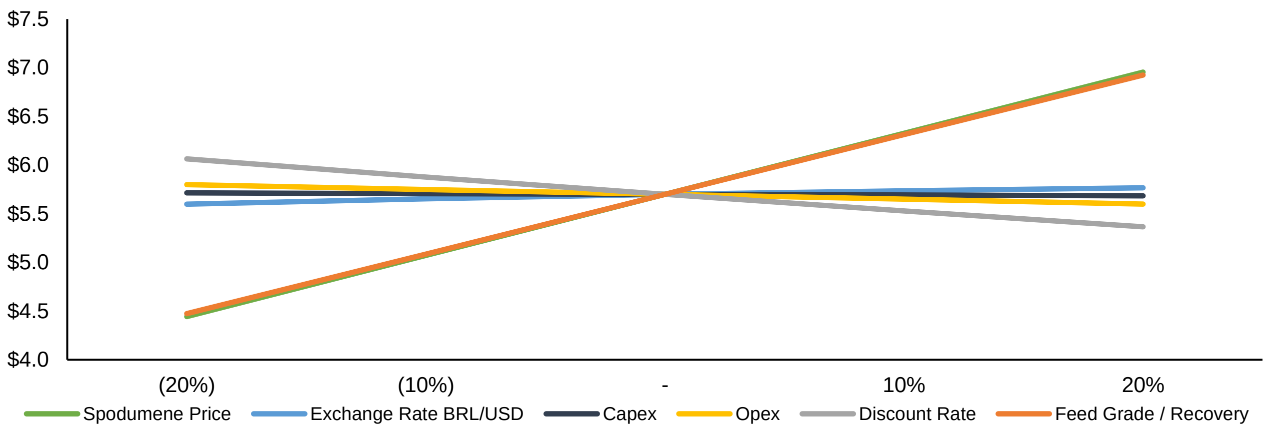


Figure 22-4: Phase 1 After-Tax NPV Sensitivity Analysis @ 5.5% Li_2O SC (US$ B)

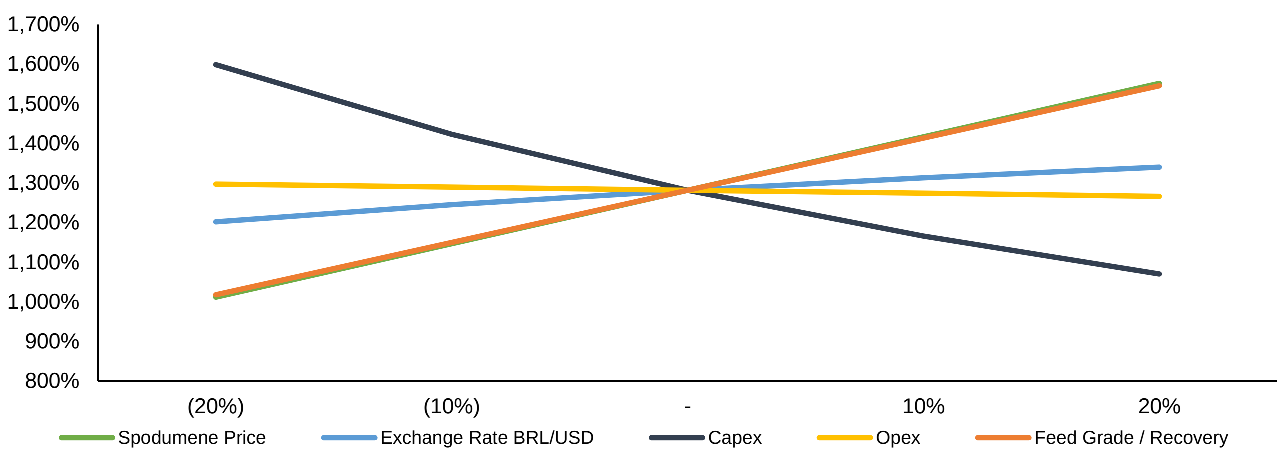


Figure 22-5: Phase 1 After-Tax IRR Sensitivity Analysis @ 5.5% Li_2O SC (%)

22.3 PHASE 2 & 3 PFS ECONOMIC ANALYSIS

The Phase 2 & 3 economic analysis is based on a twelve-year operation sourcing feedstock ore from the Barreiro deposit's Mineral Reserve of 21.8 Mt grading at 1.37% Li_2O and the NDC deposit's Mineral Reserve of 21.2 Mt grading at 1.45% Li_2O. Phase 2 & 3 is expected to generate run-rate production of 496 ktpa of lithium concentrate, delivering US$1,179 million of annual free cash flow, at a 5.5% SC grade.

The base case scenario results are detailed in Table 22-5 below.

Table 22-5: Phase 2 & 3 Base Case Scenario Results

ITEM	UNIT	@ 5.5% LI_2O SC
After-Tax NPV @ 8%	US$ M	$9,587
After-Tax IRR	%	1,207%
After-Tax Payback Period	Years	0.1

22.3.1 Phase 2 & 3 PFS Technical Assumptions

The key technical assumptions used in the base case are highlighted below in Table 22-6.

Table 22-6: Key Phase 2 & 3 Technical Assumptions

ITEM	UNIT	@ 5.5% LI_2O SC
Total Ore Processed (ROM)	Mt	42.9
Annual ROM Ore Processed	Mt	3.3
Run-Rate SC Production	Ktpa	496
Run-Rate LCE Production (Note 1)	Ktpa	67
Phase 2 Strip Ratio	Ratio	12.5: 1
Phase 3 Strip Ratio	Ratio	16.0: 1
Phase 2 Average Li_2O Grade	%	1.36%
Phase 3 Average Li_2O Grade	%	1.45%
Phase 2 Spodumene Recovery Rate	%	57.9%
Phase 3 Spodumene Recovery Rate	%	50.6%
Spodumene Concentrate Grade	% Li_2O	5.5%
Operating Life	Years	12
Total Cash Cost ex. Royalties (@ Mine Gate)	US$/t SC	$292
Total Cash Cost incl. Royalties (@ Mine Gate)	US$/t SC	$394
Transportation Costs (CIF China)	US$/t SC	$120
Total Cash Cost (CIF China)	US$/t SC	$514
AISC (CIF China)	US$/t SC	$516
Mining Costs	US$/t Material Mined	$2.25
Processing Costs	US$/t ROM	$7.06
G&A Costs	US$/t ROM	$2.68

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

22.3.2 Phase 2 & 3 PFS Financial Results

Table 22-7 and Figure 22-6 below illustrate the after-tax cash flow and cumulative cash flow profile of Phase 2 & 3 under the base case scenario. The intersection of the after-tax cumulative cash flow with the horizontal zero line represents the payback period of the Capex to production.

As highlighted in Table 22-7, the total gross revenue derived from the sale of spodumene concentrate is estimated at US$21.5 billion, an average revenue of US$3,610/t 5.5% SC with total operating costs (including royalty payments and commercial discounts) of US$3.4 billion at an average cost of US$569/t 5.5% SC. The resulting after-tax earnings margin (gross revenue less realization, operating costs and taxes) was estimated at US$15.3 billion.

This robust cash flow profile compares to an estimated pre-production Capex of US$154.9 million which includes the DMS plant, non-process infrastructure, and owner's cost. The estimated sustaining and mine closure costs are approximately US$15.2 million and are considered in the base case of the economic study. Phase 2 & 3 also assumes capitalized stripping for Phase 2 mining of US$56.7 million, US$52.9 million and US$50.8 million in years 6, 7 and 8 of the operating life, respectively.

Additionally, a summary of the Phase 2 & 3 Financial Model under the base case scenario at 5.5% SC is provided in Figure 22-7 below. The discount rate assumed for the pre- and after-tax NPV is 8%.

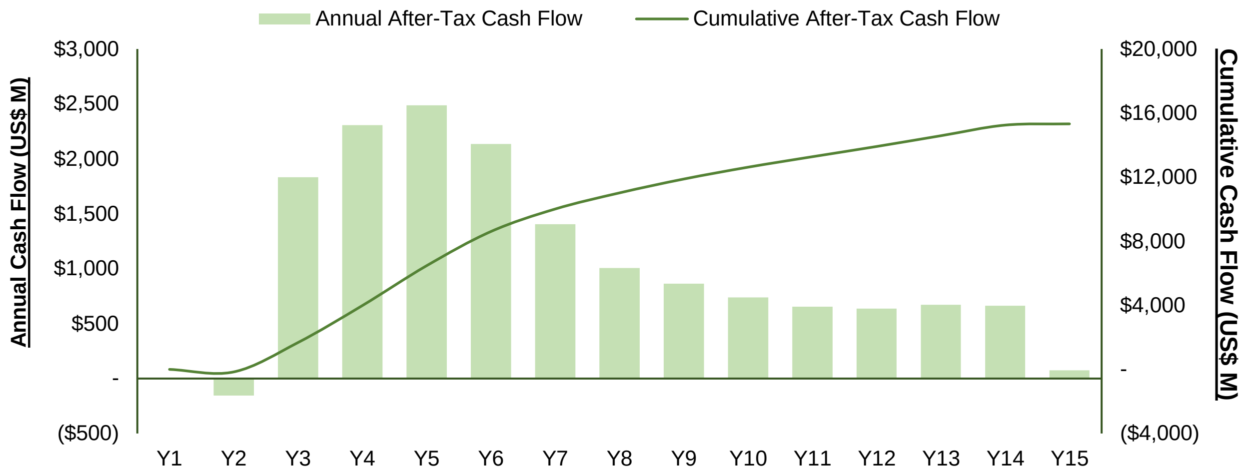


Figure 22-6: Phase 2 & 3 After-Tax Cash Flow and Cumulative Cash Flow Profile @ 5.5% Li_2O SC

Table 22-7: Phase 2 & 3 Estimated Revenue and Operating Costs

	5.5% Li_2O SC	
	Total US$ M	**Avg. US$/t**
Gross Revenue	$21,477	$3,610
Less: Realization Costs		
Royalties	$605	$102
Commercial Discounts	-	-
Total Realization Costs	$605	$102
Net Revenue	$20,872	$3,508
Less: Site Operating Costs		
Mining	$1,320	$222
Processing	$303	$51
Selling, General & Administration	$115	$19
Transportation	$714	$120
Total Operating Costs	$2,453	$412
Less: Depreciation	$324	$55
Pre-Tax Earnings	$18,094	$3,042
% Pre-Tax Earnings Margin of Net Sales	*87%*	*87%*
Less: Taxes	$2,759	$464
After-Tax Earnings	$15,335	$2,578
% After-Tax Earnings Margin of Net Sales	*73%*	*73%*

Grota do Cirilo Financial Model (Phase 2 & 3 Only)		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Consolidated	**Phase 2 & 3 Only**							
Production								
Ore Mined	(kt)	-	-	3,334	3,634	3,654	3,622	3,629
Waste Mined	(kt)	-	-	25,735	29,014	34,866	36,569	42,835
Total Mined Volume	(kt)	-	-	29,069	32,649	38,520	40,191	46,464
Strip Ratio	(W:O)	-	-	7.7	8.0	9.5	10.1	11.8
Ore Processed	(kt)	-	-	3,334	3,634	3,654	3,622	3,629
Process Plant Feed Grade	(% Li_2O)	-	-	1.32%	1.36%	1.44%	1.47%	1.45%
Contained Spodumene	(kt)	-	-	44	49	52	53	53
Process Plant Recovery	(%)	-	-	54.5%	54.2%	54.3%	54.0%	54.1%
Recovered Spodumene	(t)	-	-	24	27	28	29	28
Concentrate Percentage	(%)	-	-	5.5%	5.5%	5.5%	5.5%	5.5%
Lithium Concentrate Production	(kt)	-	-	435	487	518	522	517
Revenue								
Sale Price	(US$/t)	-	-	$6,075	$6,165	$6,228	$5,382	$3,645
Gross Revenue	(US$ 000s)	-	-	$2,643,209	$3,004,147	$3,225,403	$2,807,803	$1,884,271
CFEM Royalty	(US$ 000s)	-	-	$52,864	$60,083	$64,508	$56,156	$37,685
NSR Royalty #1	(US$ 000s)	-	-	$21,749	$24,706	26535.47179	$23,066	$15,423
Net Revenue	(US$ 000s)	-	-	$2,568,596	$2,919,358	$3,134,360	$2,728,581	$1,831,163
Operating Costs								
Mining	(US$ 000s)	-	-	$69,797	$73,839	$86,660	$92,185	$103,014
Processing	(US$ 000s)	-	-	$24,180	$25,530	$25,618	$25,476	$25,505
G&A	(US$ 000s)	-	-	$9,602	$9,602	$9,602	$9,602	$9,602
Transportation	(US$ 000s)	-	-	$52,212	$58,475	$62,146	$62,604	$62,034
Total Operating Costs	(US$ 000s)	-	-	$155,790	$167,445	$184,026	$189,867	$200,154
Capital Expenditures								
Pre-Production / Growth	(US$ 000s)	-	$154,902	-	-	-	$56,729	$52,928
Sustaining	(US$ 000s)	-	-	-	-	-	-	$6,462
Closure Costs	(US$ 000s)	-	-	-	-	-	-	-
Total Capital Expenditures	(US$ 000s)	-	$154,902	-	-	-	$56,729	$59,390
Cash Flow								
Pre-Tax Operating Cash Flow	(US$ 000s)	-	-	$2,412,806	$2,751,912	$2,950,333	$2,538,714	$1,631,009
Capital Expenditures	(US$ 000s)	-	$154,902	-	-	-	$56,729	$59,390
NSR Royalty #2 Buyback	(US$ 000s)	-	-	$3,800	-	-	-	-
Changes in Working Capital	(US$ 000s)	-	-	$213,245	$29,347	$17,731	($34,483)	($76,189)
Pre-Tax Free Cash Flow	(US$ 000s)	-	($154,902)	$2,195,761	$2,722,566	$2,932,602	$2,516,468	$1,647,808
Cumulative Pre-Tax Cash Flow	(US$ 000s)	-	*($154,902)*	*$2,040,859*	*$4,763,424*	*$7,696,027*	*$10,212,495*	*$11,860,302*
Taxes	(US$ 000s)	-	-	$363,228	$414,942	$445,201	$382,429	$242,274
After-Tax Cash Flow	(US$ 000s)	-	($154,902)	$1,832,533	$2,307,623	$2,487,401	$2,134,039	$1,405,534
Cumulative After-Tax Cash Flow	(US$ 000s)	-	*($154,902)*	*$1,677,630*	*$3,985,254*	*$6,472,655*	*$8,606,693*	*$10,012,227*

Grota do Cirilo Financial Model (Phase 2 & 3 Only)		Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Consolidated	**Phase 2 & 3 Only**								
Production									
Ore Mined	(kt)	3,606	3,629	3,629	3,628,904	3,628,904	3,474,019	3,474,019	-
Waste Mined	(kt)	64,074	67,390	67,390	67,390,036	67,390,036	20,625,175	20,625,175	-
Total Mined Volume	(kt)	67,679	71,019	71,019	71,018,940	71,018,940	24,099,194	24,099,194	-
Strip Ratio	(W:O)	17.8	18.6	18.6	18.6	18.6	5.9	5.9	-
Ore Processed	(kt)	3,606	3,629	3,629	3,628,904	3,628,904	3,474,019	3,474,019	-
Process Plant Feed Grade	(% Li_2O)	1.44%	1.41%	1.41%	1.41%	1.41%	1.37%	1.37%	-
Contained Spodumene	(kt)	52	51	51	51,293	51,293	47,660	47,660	-
Process Plant Recovery	(%)	54.1%	54.1%	54.1%	54.1%	54.1%	54.3%	54.3%	-
Recovered Spodumene	(t)	28	28	28	27,741	27,741	25,897	25,897	-
Concentrate Percentage	(%)	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%	-
Lithium Concentrate Production	(kt)	511	504	504	504,378	504,378	470,858	470,858	-
Revenue									
Sale Price	(US$/t)	$2,912	$2,538	$2,250	$2,056	$2,056	$2,056	$2,056	-
Gross Revenue	(US$ 000s)	$1,487,787	$1,280,112	$1,134,851	$1,036,799,566	$1,036,799,566	$967,895,132	$967,895,132	-
CFEM Royalty	(US$ 000s)	$29,756	$25,602	$22,697	$20,735,991	$20,735,991	$19,357,903	$19,357,903	-
NSR Royalty #1	(US$ 000s)	$12,168	$10,476	$9,269	$8,401,985	$8,401,968	$7,722,327	$7,723,246	-
Net Revenue	(US$ 000s)	$1,445,863	$1,244,034	$1,102,885	$1,007,661,590	$1,007,661,607	$940,814,903	$940,813,983	-
Operating Costs									
Mining	(US$ 000s)	$146,408	$154,854	$155,670	$155,670,241	$155,670,241	$63,013,969	$63,626,330	-
Processing	(US$ 000s)	$25,400	$25,505	$25,505	$25,505,255	$25,505,255	$24,809,421	$24,809,421	-
G&A	(US$ 000s)	$9,602	$9,602	$9,602	$9,601,511	$9,601,511	$9,601,511	$9,601,511	-
Transportation	(US$ 000s)	$61,320	$60,525	$60,525	$60,525,369	$60,525,369	$56,502,927	$56,502,927	-
Total Operating Costs	(US$ 000s)	$242,730	$250,486	$251,302	$251,302,376	$251,302,376	$153,927,828	$154,540,189	-
Capital Expenditures									
Pre-Production / Growth	(US$ 000s)	$50,831	-	-	-	-	-	-	-
Sustaining	(US$ 000s)	-	-	-	-	$6,462,000	-	-	-
Closure Costs	(US$ 000s)	-	-	-	-	-	-	$2,304,780	-
Total Capital Expenditures	(US$ 000s)	$50,831	-	-	-	$6,462,000	-	$2,304,780	-
Cash Flow									
Pre-Tax Operating Cash Flow	(US$ 000s)	$1,203,133	$993,548	$851,583	$756,359,214	$756,359,231	$786,887,075	$786,273,794	-
Capital Expenditures	(US$ 000s)	$50,831	-	-	-	$6,462,000	-	$2,304,780	-
NSR Royalty #2 Buyback	(US$ 000s)	-	-	-	-	-	-	-	-
Changes in Working Capital	(US$ 000s)	($33,754)	($17,282)	($11,962)	$78,507,808	-	($2,995,582)	($16,777)	($75,582,102)
Pre-Tax Free Cash Flow	(US$ 000s)	$1,186,057	$1,010,829	$863,544	$677,851,406	$749,897,231	$789,882,657	$783,985,791	$75,582,102
Cumulative Pre-Tax Cash Flow	(US$ 000s)	*$13,046,359*	*$14,057,189*	*$14,920,733*	*$692,772,139*	*$1,442,669,370*	*$2,232,552,028*	*$3,016,537,819*	*$3,092,119,921*
Taxes	(US$ 000s)	$179,936	$146,424	$124,774	$115,339,688	$115,341,421	$119,801,638	$119,709,663	-
After-Tax Cash Flow	(US$ 000s)	$1,006,121	$864,405	$738,770	$562,511,718	$634,555,810	$670,081,020	$664,276,129	$75,582,102
Cumulative After-Tax Cash Flow	(US$ 000s)	*$11,018,348*	*$11,882,753*	*$12,621,523*	*$575,133,241*	*$1,209,689,051*	*$1,879,770,071*	*$2,544,046,200*	*$2,619,628,301*

Economics		Pre-Tax	After-Tax
NPV @ 8.0% WACC	(US$ 000s)	$11,335,735	$9,586,774
IRR	(%)	1,440%	1,207%
Payback	(years)	0.1	0.1

Figure 22-7: Phase 2 & 3 Financial Model Summary @ 5.5% Li_2O SC

22.3.3 Phase 2 & 3 PFS Sensitivity Analysis

A sensitivity analysis for Phase 2 & 3 was carried out with the base case 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 of changes in spodumene price, spodumene recovery rates, lithium grade, BRL to US$ exchange rate, CAPEX, OPEX, and discount rate on Phase 2 & 3 after-tax NPV and IRR.

As seen in Figure 22-8, the Phase 2 & 3 after-tax NPV is not significantly vulnerable to changes in BRL to US$ exchange rate, CAPEX, OPEX, or discount rate considered. In contrast, the Phase 2 & 3 after-tax NPV is more sensitive to variation in spodumene price, lithium grade, and spodumene recovery rates.

As seen in Figure 22-9, the Phase 2 & 3 after-tax IRR is not significantly vulnerable to changes in OPEX. In contrast, the Phase 2 & 3 after-tax IRR is more sensitive to variation in spodumene price, lithium grade, spodumene recovery rates, BRL to US$ exchange rate and Capex. Note that the Phase 2 & 3 after-tax IRR is independent of the discount rate considered.

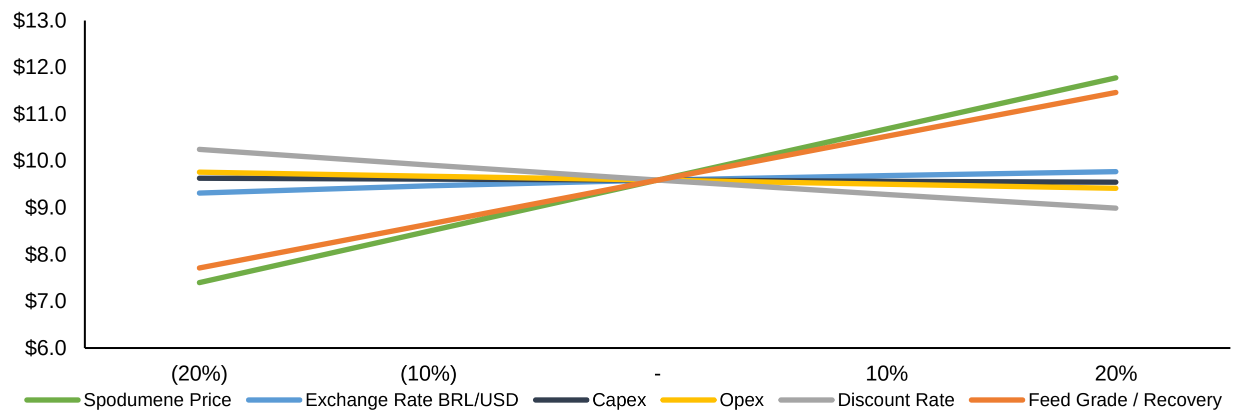


Figure 22-8: Phase 2 & 3 After-Tax NPV Sensitivity Analysis @ 5.5% Li_2O SC (US$ B)

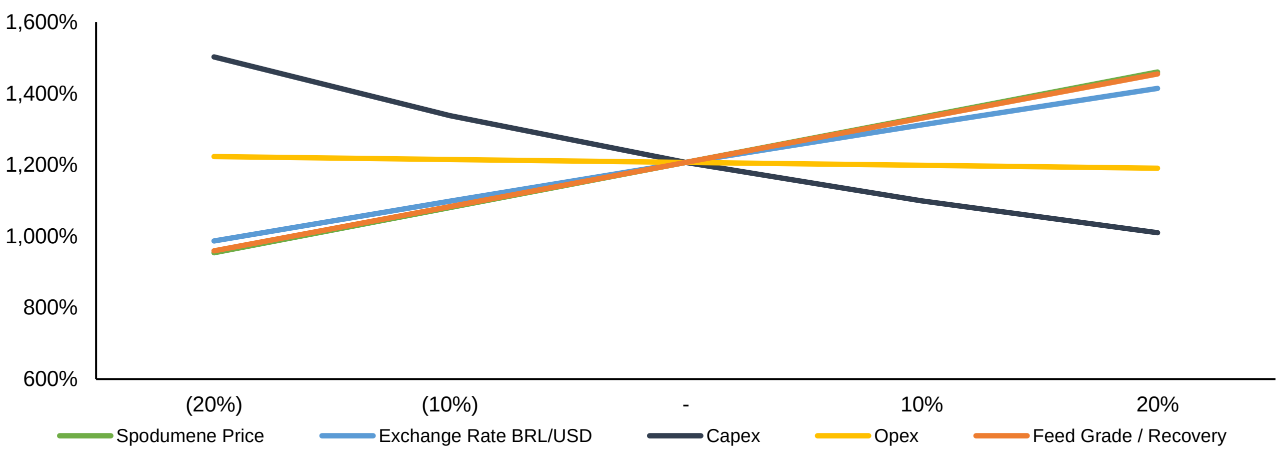


Figure 22-9: Phase 2 & 3 After-Tax IRR Sensitivity Analysis @ 5.5% Li_2O SC (%)

22.4 PHASE 1, 2 & 3 ECONOMIC ANALYSIS

The Phase 1, 2 & 3 economic analysis is based on a thirteen-year operation sourcing feedstock ore from the Xuxa deposit's Mineral Reserve of 11.8 Mt grading at 1.55% Li_2O, Barreiro deposit's Mineral Reserve of 21.8 Mt grading at 1.37% Li_2O and the NDC deposit's Mineral Reserve of 21.2 Mt grading at 1.45% Li_2O. Phase 1, 2 & 3 is expected to generate run-rate production of up to 766 ktpa of lithium concentrate, delivering US$1,788 million of annual free cash flow, at a 5.5% SC grade.

The base case scenario results are detailed in Table 22-8 below.

Table 22-8: Phase 1, 2 & 3 Base Case Scenario Results

ITEM	UNIT	@ 5.5% LI_2O SC
After-Tax NPV @ 8%	US$ M	$15,289
After-Tax IRR	%	1,273%
After-Tax Payback Period	Years	0.1

22.4.1 Phase 1, 2 & 3 Technical Assumptions

The key technical assumptions used in the base case are highlighted below in Table 22-9.

Table 22-9: Key Phase 1, 2 & 3 Technical Assumptions

ITEM	UNIT	@ 5.5% Li_2O SC
Total Ore Processed (ROM)	Mt	54.7
Annual ROM Ore Processed	Mt	4.2
Run-Rate SC Production	ktpa	766
Run-Rate LCE Production (Note 1)	ktpa	104
Phase 1 Strip Ratio	ratio	16.4: 1
Phase 2 Strip Ratio	ratio	12.5: 1
Phase 3 Strip Ratio	ratio	16.0: 1
Phase 1 Average Li_2O Grade	%	1.55%
Phase 2 Average Li_2O Grade	%	1.36%
Phase 3 Average Li_2O Grade	%	1.45%
Phase 1 Spodumene Recovery Rate	%	65.0%
Phase 2 Spodumene Recovery Rate	%	57.9%
Phase 3 Spodumene Recovery Rate	%	50.6%
Spodumene Concentrate Grade	% Li_2O	5.5%
Operating Life	years	13
Total Cash Cost ex. Royalties (@ Mine Gate)	US$/t SC	$289
Total Cash Cost incl. Royalties (@ Mine Gate)	US$/t SC	$401
Transportation Costs (CIF China)	US$/t SC	$120
Total Cash Cost (CIF China)	US$/t SC	$521
AISC (CIF China)	US$/t SC	$523
Mining Costs	US$/t Material Mined	$2.20
Processing Costs	US$/t ROM	$7.78
G&A Costs	US$/t ROM	$3.24

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

22.4.2 Phase 1, 2 & 3 Financial Results

Table 22-10 and Figure 22-10 below illustrate the after-tax cash flow and cumulative cash flow profile of Phase 1, 2 & 3 under the base case scenario. The intersection of the after-tax cumulative cash flow with the horizontal zero line represents the payback period of the Capex to production.

As highlighted in Table 22-10, the total gross revenue derived from the sale of spodumene concentrate is estimated at US$32.1 billion, an average revenue of US$3,956/t 5.5% SC with total operating costs (including royalty payments and commercial discounts) of US$4.6 billion at an average cost of US$572/t 5.5% SC. The resulting after-tax earnings margin (gross revenue less realization, operating costs and taxes) was estimated at US$23.3 billion.

This robust cash flow profile compares to estimated Phase 1 pre-production Capex of US$88.0 million (as of October 2022) and Phase 2 & 3 expansionary Capex estimate of US$154.9 million in the second year of operations. The estimated project and mine closure costs are approximately US$18.7 million and are considered in the base case of the economic study. Phase 1, 2 & 3 also assumes the Phase 2 capitalized stripping of US$56.7 million, US$52.9 million and US$50.8 million in years 6, 7 and 8 of the operating life respectively.

Additionally, a summary of the Phase 1, 2 & 3 Financial Model under the base case scenario 5.5% is provided in Figure 22-11. The discount rate assumed for the pre- and after-tax NPV is 8%.

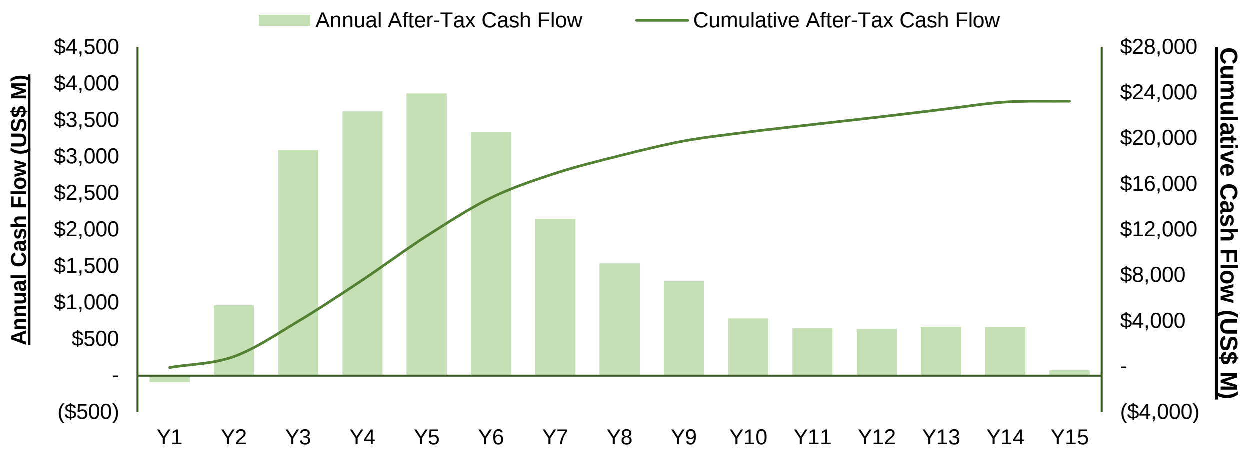


Figure 22-10: Phase 1, 2 & 3 After-Tax Cash Flow and Cumulative Cash Flow Profile @ 5.5% Li_2O SC

Table 22-10: Phase 1, 2 & 3 Estimated Revenue and Operating Costs

	5.5% Li_2O SC	
	Total US$ M	**Avg. US$/t**
Gross Revenue	$32,082	$3,956
Less: Realization Costs		
Royalties	$904	$112
Commercial Discounts	-	-
Total Realization Costs	$904	$112
Net Revenue	$31,178	$3,845
Less: Site Operating Costs		
Mining	$1,742	$215
Processing	$426	$53
Selling, General & Administration	$178	$22
Transportation	$973	$120
Total Operating Costs	$3,319	$409
Less: Depreciation	$416	$51
Pre-Tax Earnings	$27,443	$3,384
% Pre-Tax Earnings Margin of Net Sales	*88%*	*88%*
Less: Taxes	$4,185	$516
After-Tax Earnings	$23,258	$2,868
% After-Tax Earnings Margin of Net Sales	*75%*	*75%*

Grota do Cirilo Financial Model (Total Operation)		*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*	*Year 6*	*Year 7*	*Year 8*	*Year 9*	*Year 10*
Consolidated	**Total Operation**										
Production											
Ore Mined	*(kt)*	-	1,500	4,840	5,099	5,140	5,129	5,082	5,086	5,031	3,629
Waste Mined	*(kt)*	-	11,077	48,291	56,745	57,419	63,997	71,825	102,315	81,913	67,390
Total Mined Volume	*(kt)*	-	12,577	53,131	61,844	62,559	69,126	76,907	107,401	86,944	71,019
Strip Ratio	*(w : o)*	-	7.4	10.0	11.1	11.2	12.5	14.1	20.1	16.3	18.6
Ore Processed	*(kt)*	-	1,500	4,840	5,099	5,140	5,129	5,082	5,086	5,031	3,629
Process Plant Feed Grade	*(% Li_2O)*	-	1.56%	1.37%	1.43%	1.49%	1.51%	1.47%	1.46%	1.41%	1.41%
Contained Spodumene	*(kt)*	-	23	67	73	77	78	75	74	71	51
Process Plant Recovery	*(%)*	-	65.0%	58.1%	57.7%	57.7%	57.5%	57.3%	57.4%	57.1%	54.1%
Recovered Spodumene	*(t)*	-	15	39	42	44	45	43	43	41	28
Concentrate Percentage	*(%)*	-	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%
Lithium Concentrate Production	*(kt)*	-	277	703	766	804	811	781	774	739	504
Revenue											
Sale Price	*(US$/t)*	-	$5,774	$6,075	$6,165	$6,228	$5,382	$3,645	$2,912	$2,538	$2,250
Gross Revenue	*(US$ 000s)*	-	$1,599,305	$4,269,154	$4,719,651	$5,008,833	$4,366,653	$2,846,048	$2,252,239	$1,876,255	$1,134,851
CFEM Royalty	*(US$ 000s)*	-	$31,986	$85,383	$94,393	$100,177	$87,333	$56,921	$45,045	$37,525	$22,697
NSR Royalty #1	*(US$ 000s)*	-	$13,122	$35,137	$38,845	41216.47996	$35,891	$23,285	$18,421	$15,287	$9,270
Net Revenue	*(US$ 000s)*	-	$1,554,196	$4,148,634	$4,586,413	$4,867,439	$4,243,429	$2,765,842	$2,188,773	$1,823,444	$1,102,884
Operating Costs											
Mining	*(US$ 000s)*	-	$25,327	$117,870	$133,077	$136,113	$151,287	$164,986	$228,750	$191,284	$155,670
Processing	*(US$ 000s)*	-	$15,437	$39,650	$40,779	$40,980	$40,949	$40,695	$40,733	$40,423	$25,505
G&A	*(US$ 000s)*	-	$7,802	$17,403	$17,403	$17,403	$17,403	$17,403	$17,403	$17,403	$9,602
Transportation	*(US$ 000s)*	-	$33,241	$84,329	$91,867	$96,509	$97,361	$93,697	$92,828	$88,712	$60,525
Total Operating Costs	*(US$ 000s)*	-	$81,807	$259,252	$283,126	$291,005	$307,000	$316,781	$379,715	$337,822	$251,302
Capital Expenditures											
Pre-Production / Growth	*(US$ 000s)*	$87,969	$154,902	-	-	-	$56,729	$52,928	$50,831	-	-
Sustaining	*(US$ 000s)*	-	-	-	-	-	$3,231	$6,462	-	-	-
Closure Costs	*(US$ 000s)*	-	-	-	-	-	-	-	-	$215	-
Total Capital Expenditures	*(US$ 000s)*	$87,969	$154,902	-	-	-	$59,960	$59,390	$50,831	$215	-
Cash Flow											
Pre-Tax Operating Cash Flow	*(US$ 000s)*	-	$1,472,390	$3,889,382	$4,303,287	$4,576,434	$3,936,429	$2,449,061	$1,809,059	$1,485,622	$851,582
Capital Expenditures	*(US$ 000s)*	$87,969	$154,902	-	-	-	$59,960	$59,390	$50,831	$215	-
NSR Royalty #2 Buyback	*(US$ 000s)*	-	$3,800	-	-	-	-	-	-	-	-
Changes in Working Capital	*(US$ 000s)*	-	$129,422	$214,841	$36,373	$23,552	($53,220)	($125,249)	($50,530)	($29,755)	($58,781)
Pre-Tax Free Cash Flow	*(US$ 000s)*	($87,969)	$1,184,265	$3,674,541	$4,266,914	$4,552,882	$3,929,688	$2,514,921	$1,808,759	$1,515,161	$910,362
Cumulative Pre-Tax Cash Flow	*(US$ 000s)*	*($87,969)*	*$1,096,296*	*$4,770,837*	*$9,037,751*	*$13,590,633*	*$17,520,322*	*$20,035,242*	*$21,844,001*	*$23,359,162*	*$24,269,524*
Taxes	*(US$ 000s)*	-	$221,856	$585,723	$648,844	$690,499	$592,898	$366,929	$272,241	$221,367	$124,669
After-Tax Cash Flow	*(US$ 000s)*	($87,969)	$962,409	$3,088,817	$3,618,070	$3,862,383	$3,336,791	$2,147,992	$1,536,517	$1,293,795	$785,693
Cumulative After-Tax Cash Flow	*(US$ 000s)*	*($87,969)*	*$874,440*	*$3,963,257*	*$7,581,328*	*$11,443,711*	*$14,780,502*	*$16,928,494*	*$18,465,011*	*$19,758,806*	*$20,544,499*

Economics		Pre-Tax	After-Tax
NPV @ 8.0% WACC	*(US$ 000s)*	$18,075,531	$15,289,082
IRR	*(%)*	1,523%	1,273%
Payback	*(years)*	0.1	0.1

Figure 22-11: Phase 1, 2 & 3 Financial Model Summary @ 5.5% Li_2O SC

22.4.3 Phase 1, 2 & 3 Sensitivity Analysis

A sensitivity analysis for Phase 1, 2 & 3 was carried out with the base case 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 of changes in spodumene price, spodumene recovery rates, lithium grade, BRL to US$ exchange rate, capital expenditures, operating expenses, and discount rate on Phase 1, 2 & 3 after-tax NPV and IRR.

As seen in Figure 22-12, the Phase 1, 2 & 3 after-tax NPV is not significantly vulnerable to changes in BRL to US$ exchange rate, CAPEX, OPEX, or discount rate considered. In contrast, the Phase 1, 2 & 3 after-tax NPV is more sensitive to variation in spodumene price, lithium grade, and spodumene recovery rates.

As seen in Figure 22-13, the Phase 1, 2 & 3 after-tax IRR is not significantly vulnerable to changes in OPEX. In contrast, the Phase 1, 2 & 3 after-tax IRR is more sensitive to variation in spodumene price, lithium grade, spodumene recovery rates, BRL to US$ exchange rate and Capex. Note that the Phase 1, 2 & 3 after-tax IRR is independent of the discount rate considered.

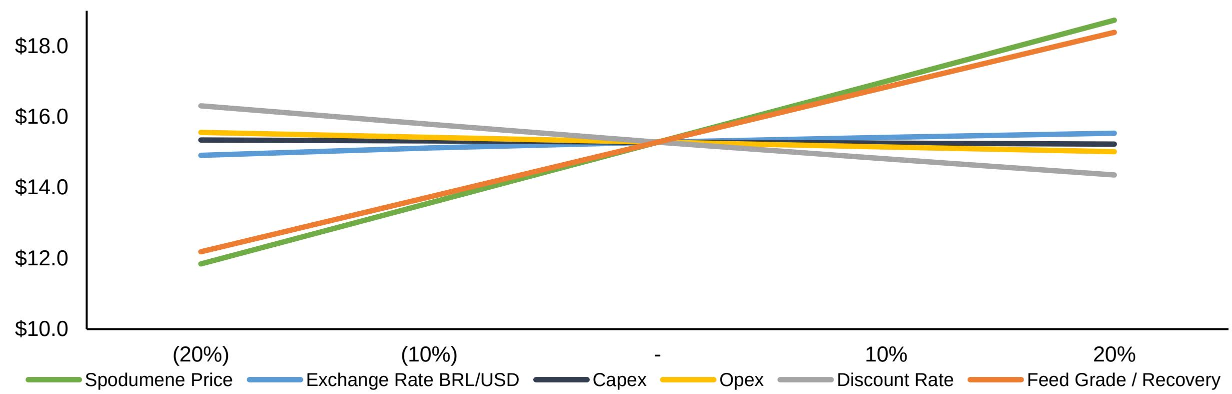


Figure 22-12: Phase 1, 2 & 3 After-Tax NPV Sensitivity Analysis @ 5.5% Li_2O SC (US$ B)

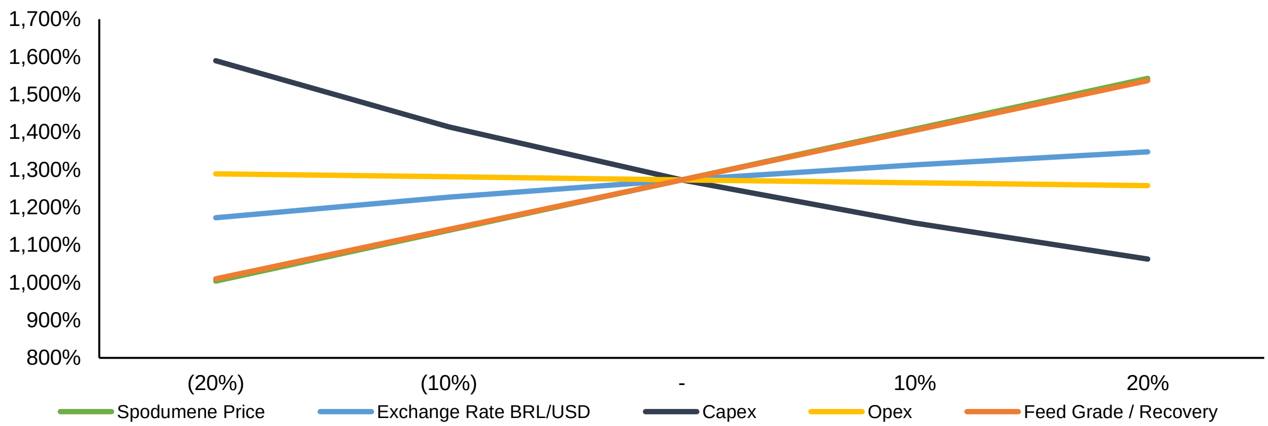


Figure 22-13: Phase 1, 2 & 3 After-Tax IRR Sensitivity Analysis @ 5.5% Li_2O SC (%)

23 ADJACENT PROPERTIES

This section is not relevant to this Report.

24 OTHER RELEVANT DATA AND INFORMATION

24.1 SCHEDULE FOR XUXA PHASE 1

The project implementation schedule was developed in conjunction with GE21, 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 was awarded for the front-end engineering and design (FEED) for the process plant. This approach allowed process design to progress sufficiently to confirm selection of major long-lead equipment and associated pricing. Both milestones were met in December 2021, long-lead item orders can be placed, and detailed engineering continued after the FEED was completed at the end of November 2021.

The schedule for the engineering and design itself is based on a detailed deliverables list with estimated hours and rationalised using Primero's and Promon's experience with 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.

Site mobilisation for the bulk earthwork's construction commenced in November 2021 with grubbing, preparation of laydowns and topsoil removal. Full site establishment for all other site installation works has commenced as bulk earthworks have been completed. 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 schedule is shown in Figure 25-1.

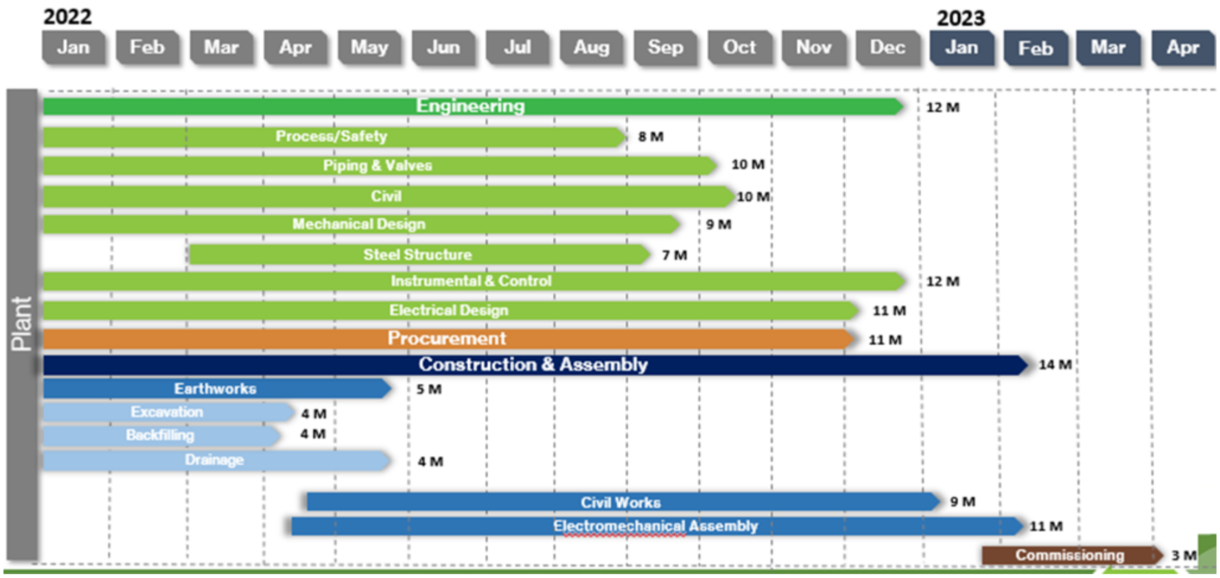


Figure 24-1: Xuxa Schedule

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 SCHEDULE FOR BARREIRO PHASE 2

GE21, Primero and SGS prepared a Pre-Feasibility Study (PFS) for the Barreiro deposit.

It is noted that the Company has not yet made a production decision in respect of the Barreiro deposit. The Company has made a decision to proceed with a definitive feasibility study before making a production decision in respect of the Barreiro deposit. All statements regarding mine development or production in respect of the Barreiro deposit in this report are expressly qualified by this statement.

It is anticipated that the implementation schedule timeline presented in Table 24-1 are applicable for the Phase 2 works. The Phase 2 works will not be concurrent with Phase 1.

24.3 SCHEDULE FOR NDC PHASE 3

GE21, Primero and SGS prepared a Pre-Feasibility Study (PFS) for Nezinho do Chicao deposit.

It is noted that the Company has not yet made a production decision in respect of the Nezinho do Chicao deposit. The Company has made a decision to proceed with a definitive feasibility study before making a production decision in respect of the NDC deposit.

25 INTERPRETATION AND CONCLUSIONS

25.1 CONCLUSIONS

The DFS for Xuxa outlines the requirements and parameters for the development of two open pits, namely North pit and the South pit. Phase 1 will mine 1.8 Mt ROM per annum for 8 years. The Dense Media concentration plant is designed to produce 220 ktpa of 6% Li_2O spodumene concentrate. The DFS describes all the related plant and mine direct and indirect infrastructure required for the project. The PFS for Barreiro details the requirements and parameters for the development of an open pit mine consisting of one pit on the Barreiro deposit (Phase 2), together with the concentration plant and related infrastructure to process 1.80 Mtpa of mineralized material per year for a LOM of 12.7 years. The PFS for Nezinho do Chicao details the requirements and parameters for the development of an open pit mine consisting of pits on the Nezinho do Chicao deposit (Phase 3), together with the concentration plant and related infrastructure to process 1.80 Mtpa of mineralized material per year for a LOM of 12 years.

The Company has made a construction decision for Phase 1 and has finalized the PFS for Phase 2 and Phase 3 of the Grota do Cirilo project. All statements regarding mine development or production in respect of both Phase 1 and 2 in this report are expressly qualified by this statement.

25.1.1 Mineral Resource

Mineral Resource estimates are reported for the Xuxa, Barreiro, Lavra do Meio, Murial, Nezinho do Chicao, Maxixe, Tamboril and Elvira 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 to have been obtained, in addition, these surface rights will support project evaluation such as DMS pilot plant test work 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 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 409 core holes (71,538 m) were completed in 2014, and 2017, 2018, 2021 and 2022 for the different MREs. 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 (2022) 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.
- Mineral Resources were estimated using ordinary kriging, 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 0.3% 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 Lavra do Meio, Murial, Nezinho do Chicao, Maxixe, Tamboril and Elvira estimates have an effective date of the 18th January 2024. The QP for the estimates is Mr. Marc-Antoine Laporte, P.Geo., an employee of SGS Canada Inc.

25.1.2 Process Plant

Spodumene concentrate with a minimum grade of 6.0% and 5.5% Li_2O was achieved during metallurgical testing programs on both Phase 1 (Xuxa) ,Phase 2 (Barreiro) and Phase 3 (Nezinho do Chicao) samples 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. Based on test work results, plant design was based on stage lithium recoveries of 70% for Phase 1, 60% for Phase 2 and 58% for Phase 3 to produce 5.5% Li_2O spodumene concentrate.

The spodumene concentration plants are designed to process 1.8 Mtpa for Phase 1 , 1.80 Mtpa for Phase 2 and 1.8 Mtpa for Phase 3 to produce jointly a total >570 000 dry tonnes of 5.5% -6.0% Li_2O spodumene concentrate.

The flowsheets include conventional three-stage crushing/screening, upflow classification, DMS, magnetic separation, thickening, filtration, and storage and shipping areas for spodumene concentrate. The QP concluded that the project is technically feasible to proceed to detailed engineering and construction for phase 1 and further studies for Phase 2.

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-fighting 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

The Xuxa Deposit will be mined by conventional open-pit mining methods for an eight-year mine life, at a plant feed rate of 1.5 Mtpa, with Mineral Reserves totaling 11.8 Mt grading at 1.55% Li_2O. The Barreiro Deposit will also be mined by conventional open-pit methods for a twelve-year mine life, at a plant feed rate of 1.80 Mtpa, with Mineral Reserves totalling 21.8 Mt grading 1.36% Li_2O. The Nezinho do Chicao Deposit will also be mined by conventional open-pit methods for a twelve-year mine life, at a plant feed rate of 1.80 Mtpa, with Mineral Reserves totalling 21.2 Mt grading 1.45 % Li_2O

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) techniques will be used for the mineralized domain to reduce back-break and to better control dilution.

25.1.5.1 Waste and tailings

Five waste dumps are proposed for the Xuxa mine, one waste dump for the Barreiro mine and one waste dump for the Nezinho do Chicao mine . All dumps are near the respective open pits. The dumps are considered suitable for the volume of waste that will be generated from each of the respective mines.

Tailings from the DMS plants will be thickened, dewatered and dry-stacked in a tailings waste pile.

25.1.6 Geotechnical and Hydrogeology

Geotechnical field studies, analyses and design were performed to provide key pit design parameters for the Xuxa North and South pits , and the Barreiro pit. and both Nezinho do Chicao pits.

Stability analyses for both the Xuxa ,and Barreiro and Nezinho do Chicao pits indicate the pit slope designs are stable and fall within acceptable safety limits for open-pit designs.

A hydrogeological study, consisting of fieldwork, mathematical modeling, studies of regional water characteristics, and the potential impacts was completed for Xuxa , Barreiro and Nezinho do Chicao.

A complementary campaign of geotechnical oriented drill holes and pressurized water loss tests (Packer Test) was carried out to measure the hydraulic conductivity of the rock mass, the hydrogeological characterization of the operation site, and to assess the likelihood of groundwater inflow from Piaui River into the North and South Xuxa pits.

Overall, test results showed that rock fractures have very low to low specific losses, giving them a virtually tight rock classification.

25.1.7 Environment

The Environmental Impact Study - EIA and its respective Environmental Impact Report - RIMA will be submitted to the regulatory agency, Bureau of Priority Projects - SUPPRI, as a supporting document to obtain a Preliminary License - LP and an Installation License - LI for Grota do Cirilo Project - Barreiro Pegmatite.

Sigma holds approved PAEs over the Xuxa, Barreiro, Lavra do Meio, Murial, Maxixe and Nezinho do Chicão deposits within the Grota do Cirilo property. Licenses are renewed in a timely manner when due.

25.1.8 Capital Cost Estimate

The capital cost estimate (CAPEX) was developed to provide substantiated costs for the FEED study of Phase 1 and the PFS-level study of Phase 2 & 3 processing plant and to provide Sigma with an overall risk and opportunity profile to enable a Phase 1 production decision and to advance off-take agreements and project financing.

The total CAPEX for Phase 1 including the Estimated Vat Tax Incentive is US$130.6 M.

The total Capex for Phase 2 & 3 is US$154.9 M (this is including the Owner's cost, working capital, contingency and excluding the Sustaining Capital).

The CAPEX estimate has an accuracy of ±25% and is summarized in Table 25-1 (Phase 1) and Table 25-2 (Phase 2 & 3).

Table 25-1 – Capital Cost Estimate Summary Phase 1

AREA	TOTALS (USD)		
	DIRECTS + INDIRECTS (USD)	CONTINGENCY (USD)	TOTAL (USD)
001 MINE	7,856,938	605,014	8,461,952
002 PLANT	64,841,255	4,992,777	69,834,032
002.003 AUTOMATION/DIGITALIZATION	3,852,981	296,680	4,149,661
003 ENVIRONMENTAL	14,418,492	1,121,428	15,539,921
004 EPCM & ENGINEERING SERVICES	17,867,543	1,375,801	19,243,344
005 SUBSTATION & UTILITY POWER SUPPLY	6,888,863	530,442	7,419,305
Total Construction Capital Cost	111,873,091	8,625,462	120,498,553
006 OWNERS PROJECT COSTS	8,901,677	890,168	9,791,844
007.001 Working Capital and Spares	6,137,293	–	6,137,293
Total Construction Capital Cost (ex VAT Tax Incentive)	126,912,061	9,515,630	136,427,691
009 Estimated VAT Tax Incentive	(5,859,000)	–	(5,859,000)
Total Construction Capital Cost	121,053,061	9,515,630	130,568,691

008 Sustaining and Deferred Capital	3,200,000	246,400	3,446,400

Table 25-2: Capital Cost Estimate Summary Phase 2 & 3

AREA	TOTALS		
	(USD)		
MEGA PLANT	DIRECTS + INDIRECTS	CONTINGENCY	TOTAL
	(USD)	(USD)	(Excluding recoverables)
			(USD)
000 MEGA (Excluding Sustaining Capital)	**144,429,471**	**10,473,002**	**154,902,473**
000 MEGA (Including Sustaining Capital)	**157,499,471**	**11,479,392**	**168,978,863**
001 MINE	**2,096,208**	**161,408**	**2,257,616**
002 PLANT	**89,536,397**	**6,718,807**	**96,255,204**
003 ENVIRONMENTAL	**15,252,504**	**1,174,443**	**16,426,946**
004 EPCM & ENGINEERING SERVICES	**21,672,011**	**1,668,745**	**23,340,755**
005 SUBSTATION & UTILITY POWER SUPPLY	**663,829**	**51,115**	**714,943**
006 OWNERS PROJECT COSTS	**9,071,230**	**698,485**	**9,769,715**
007 WORKING CAPITAL & SPARES	**6,137,293**	**0**	**6,137,293**
008 SUSTAINING & DEFERRED CAPITAL	**13,070,000**	**1,006,390**	**14,076,390**

Note: The Phase 2 & 3 substation costs are included in the Xuxa CAPEX estimate

25.1.9 Operating Cost Summary

The processing plant operating cost estimate includes the operation of a three-stage crushing and screening circuit and DMS circuits (two stages for coarse, fine and ultra fines material classes).

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 variable OPEX for the Phase 1 concentrator will be $5.3/t of ore feed and US$7.5M of fixed OPEX. The estimated variable OPEX for the Phase 2 & 3 concentrator is $4.8/t of ore feed and US$6.7M of fixed OPEX.

Operating cost estimates are summarized in Table 25-3 (Phase 1) and Table 25-4 (Phase 2 & 3)

Table 25-3 – Phase 1 Operating Cost Estimate Summary

DESCRIPTION	OPEX (US$)
Mining (US$/t material mined)	$2.1
Process (US$/t ore feed)	$10.4
G&A (US$/t ore feed)	$5.3
Shipping (US$/t SC)	$120

Table 25-4: Phase 2 & 3 Operating Cost Estimate Summary

DESCRIPTION	OPEX (US$)
Barreiro Mining (US$/t material mined)	$2.68
NDC Mining (US$/t material mined)	$1.98
Phase 2 & 3 Process (US$/t ore feed)	$7.1
Phase 2 & 3 G&A (US$/t ore feed)	$2.7
Shipping (US$/t SC)	$120

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 receiving the Environmental Operation License
- Delay in obtaining the power permit and CEMIG substation energization: impact on plant start-up date
- Delay in obtaining the license for Barreiro and NDC Pits
- 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
- The production rate and size of the pit may impose challenges for operations
- 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

25.3 OPPORTUNITIES

The following opportunities are identified for the Grota do Cirilo project:

- Recovery of Li_2O from hypofines with a flotation circuit
- Sales of hypofines as DSO
- Recovery of Li_2O from petalite
- Sale of plant rejects to the ceramics industry
- 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 at both Phase 1 and Phase 2 projects.

- Exchange rate may work in the Project's favour.

26 RECOMMENDATIONS

The following summarizes the recommendations from the 2024 MRE update.

26.1 GEOLOGY AND RESOURCES

The overall cost for the drill program is estimated at US$3M and consists of a 10,000 m drill program to test the area northwest of Barreiro and east of Maxixe/Tamboril. 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 10,000 m drill program as follows:

- Barreiro: step-out drilling to the northwest, 5,000 m
- Maxixe/Tamboril step-out drilling to the east, 5,000 m

Drilling will be completed with HQ size core tools with total depths between 150–500 m. Core sampling will be conducted on 1 m intervals. The all-in program costs, including drilling, logging, and assays, is estimated at US$250 to $US300/m.

27 REFERENCES

Behre Dolbear, (2018): Competent Person's Report, Greenbushes Lithium Mine, Western Australia: 15 August, 2018, 148 p.

Bilal, E., Horn, AH., and Machado de Melo, M (2012): P-Li-Be Bearing Pegmatite of the South-East Brazil, International Journal of Geosciences, Vol. 3, pp.281-288.

Bonàs, T. B. (2017): Mineral Resource Diligence Xuxa Sector, Sigma Internal Documentation, 11 p.

Bradley D., and McCauley A., (2013): A Preliminary Deposit Model for Lithium-Cesium-Tantalum (LCT) Pegmatites: U.S. Geological Survey, Open-File Report 2013–1008 Version 1.1, December 2016.

FMC, (2018): BMO Global Metals and Mining Conference: February 27, 2018, 15 p.

Harpia Consultoria Ambiental, (2019), Environmental Regularization Summary – Xuxa Project'' (DNPM 824 692 71, 2019).

Gibson, C., Aghamirian, M., and Grammatikopoulos, T., (2017): A Review: The Beneficiation of Lithium Minerals from Hard Rock Deposits: SME Annual Meeting, Feb. 19- 2, 2017, Denver, CO, Preprint 17-003

Grammatikopoulos, T., (2018): The Mineralogical Characteristic of a Composite Sample from a Lithium Project, Brazil, SGS internal report, 89 p.

Johnston, G., and Baker. M., (2002): Araçuaí Tantalum Prospect Exploration Review, SRK private report, UK, 41 p.

Lefosse Advogados (2019), Sigma Legal Opinion – SUDENE and RECAP Tax Incentives: 25 March 2019.

London, D., (1984): Experimental Phase Equilibria in the System LiAlSiO4- SiO2-H2O; a Petrogenetic Grid for Lithium-rich Pegmatites, American Mineralogist, 69(11-12), pp. 995-1004

José de Castro Paes, V., (2017): Assessment of the Lithium Potential in Brazil: Geological Survey of Brazil PowerPoint presentation, 23 p.

Pedrosa-Soares, A., De Campos, C., Noce, C., and Alkmim, F. (2011): Late Neoproterozoic- Cambrian Granitic Magmatism in the Araçuaí Orogen (Brazil), The Eastern Brazilian Pegmatite Province and Related Mineral Resources, Geological Society London Special Publications, Vol. 350, pp.25-51.

Pedrosa-Soares, A., Chavez, M., Scholz, R (2009): Field Trip Guide Eastern Brazilian Pegmatite Provinces, 4th International Symposium on Granitic Pegmatite, 28 p.

Quemeneur, J., and Lagache, M., (1999): Comparative Study of Two Pegmatitic Field from Minas Gerais, Brazil, using the Rb and Cs Contents of Mica and Feldspars, Revista Brasileira de Geociencias, No. 29, Vol. 1. pp.27-32.

Rose, S and Fahey, G, 2014. Effective grade control systems, in Mineral Resource and Ore Reserve Estimation – The AusIMM Guide to Good Practice, second edition, pp 679-684. The Australasian Institute of Mining and Metallurgy: Melbourne.

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

Sigma Lithium Resources Inc. (2019): Sigma Lithium Triples Measured and Indicated Mineral Resources at Grota do Cirilo, news release 10 January 2019, 7 p.

Sigma Mineração SA, (2017): Developing World-Class Potential. Hard Rock Lithium in Brazil, corporate presentation, 31 p.

Slade, C., Neuhoff, L., Zan, I., and Pogorelev, M. (2014): Arqueana Mineração – Exploration Report, Sigma Internal documentation, 48 p.

Tan. T.S. (2003): Characterisation and Engineering Properties of Natural Soils. Volume 2, CRC Press, 1531p.

Tassos, G. (2018): The Mineralogical Characteristic of a Composite Sample from a Lithium Project, Brazil, SGS internal report, 89p.

Viana, R.R., Manttari, I., Kunst, H., and Jordt-Evangelista, H., (2003): Age of Pegmatites from Eastern Brazil and Implication of Mica Intergrowths on Cooling Rates and Age Calculation, Journal of South American Earth Sciences, Vol. 16, pp.493-501.

Aghamirian, Massoud, (2018), Scoping Study and Preliminary Lithium Flowsheet Development for The Sigma Lithium Deposit (Report number: 16193-001, June 5, 2018).