Report for Companhia Siderúrgica Nacional (CSN)

Technical Report Summary– S-K 1300 Casa de Pedra Mining Complex Mineral Resources and Mineral Reserves

Project number 24687

October 2022

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1 EXECUTIVE SUMMARY

1.1 Property description and ownership

Snowden Optiro was retained by CSN Mineração S.A. (CSN Mineração) to prepare a technical report summary for the Casa de Pedra mining complex, located in Minas Gerais, Brazil.

CSN Mineração is controlled by CSN (Companhia Siderúrgica Nacional), a Brazilian business group with 80 years of history.

The purpose of this technical report summary is to disclose mineral resource and mineral reserve estimates for the Casa de Pedra mining complex as of 31 December 2021.

This technical report summary conforms to the United States Securities and Exchange Commission's (SEC) Modernized Property Disclosure Requirements for Mining Registrants as described in Subpart 229.1300 of Regulation S-K, Disclosure by Registrants Engaged in Mining Operations (S-K 1300) and Item 601 (b)(96) Technical Report Summary.

CSN Mineração owns the Casa de Pedra mining complex, the Pires beneficiation complex, as well as a stake in the MRS Logística railroad and a captive iron ore export terminal at the Port of Itaguaí, Rio de Janeiro. The Casa de Pedra mining complex is in the southwest portion of the Quadrilátero Ferrífero (Iron Quadrangle), in the state of Minas Gerais.

To carry out research, or to exploit minerals, in Brazil, it is necessary to follow the rules and procedures defined by the National Mining Agency (ANM), according to the mineral regime to which the substance of interest fits. In the case of the Casa de Pedra mining complex titles, the substance of interest is iron oxide and the regime is the mining concession. Therefore, as summarized in Table 1.1, CSN Mineração holds five mining concessions, two mining requests, three exploration authorizations and one exploration request. The mining concessions are for the mining, processing, and commercialization of the iron mineralization.

Table 1.1 Casa de Pedra mining complex mineral rights

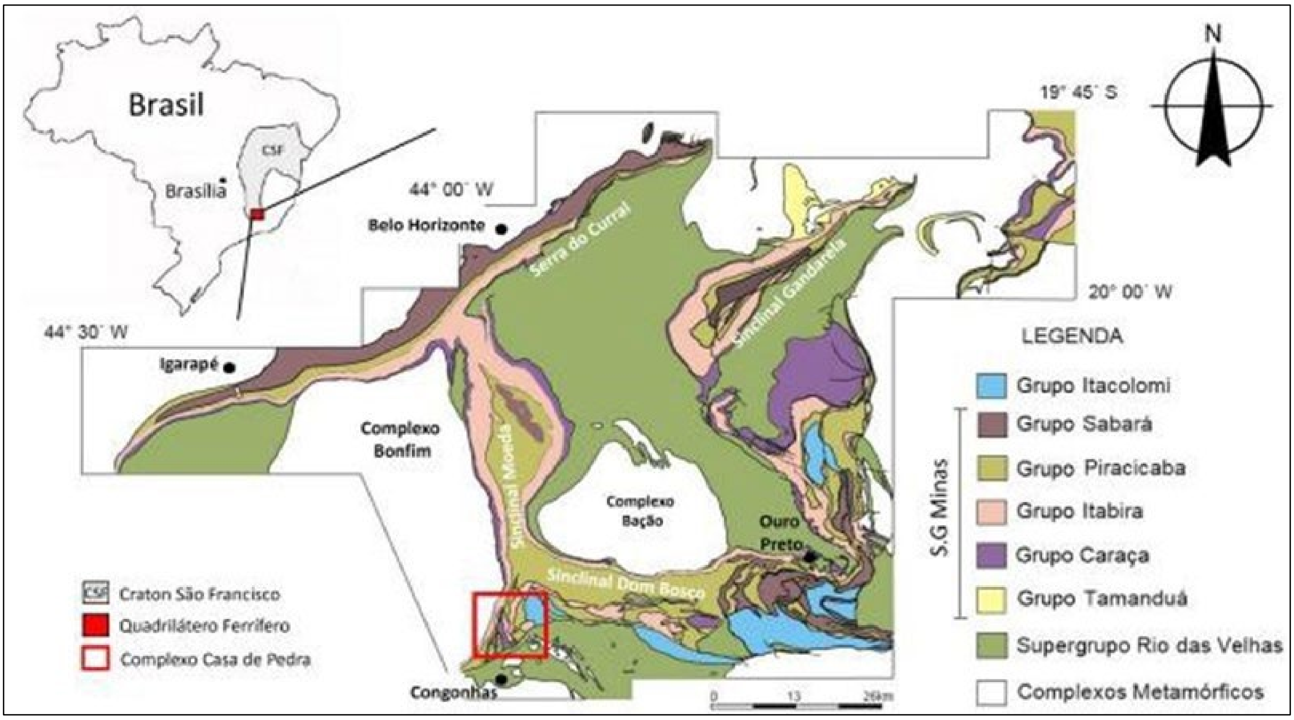
Mineral rights – CSN – Casa de Pedra mining complex					
Process	**Area (ha)**	**Titleholder**	**Mine**	**Current phase**	**Note**
004.384/1945	143.54	CSN Mineração S.A.	Engenho	Mining Concession	Mining Group 931.230/2013
006.763/1953	20.22	CSN Mineração S.A.	Casa de Pedra	Mining Concession	Mining Group 931.230/2013
830.512/1982	126.52	CSN Mineração S.A.	Engenho	Mining Concession	Mining Group 931.230/2013
003.664/1942	74.28	CSN Mineração S.A.	Engenho	Mining Concession	-
043.306/1956	2516.30	CSN Mineração S.A.	Casa de Pedra	Mining Concession	-
832.997/2002	10.83	CSN Mineração S.A.	Casa de Pedra	Mining Request	-
833.057/2002	1.39	CSN Mineração S.A.	Casa de Pedra	Mining Request	-
832.143/2017	30.43	CSN Mineração S.A.	Casa de Pedra	Exploration Authorization	Exploration Authorization Expire Date: 09/24/2022
831.109/2015	1.28	Companhia Siderurgica Nacional	Engenho	Exploration Authorization	Exploration Authorization Expire Date: 10/01/2023
832.777/2014	102.1	Companhia Siderurgica Nacional	Casa de Pedra	Exploration Request	-
832.782/2014	1.12	Companhia Siderurgica Nacional	Casa de Pedra	Exploration Authorization	Exploration Authorization Expire Date: 09/04/2023

Source: Snowden Optiro, 2022

1.2 Geology and mineralization

The Casa de Pedra iron oxide deposit is located within the Quadrilátero Ferrífero, an area of approximately 7,000 km^2 within the San Francisco Craton in the central part of Minas Gerais, Brazil. The general geology of the Quadrilátero Ferrífero is presented in Figure 1.1.

Figure 1.1 Geological map of the Quadrilátero Ferrífero (modified from Dorr II 1969), highlighting the area of the Casa de Pedra mining complex in red



Source: CSN - Relatório_2017_Reserve_Resource.pdf

English translation of terms in the figure: Complexo – Complex, Grupo – Group, Metamórficos – Metamorphic, Serra – Ridge, Sinclinal – Syncline, Supergrupo -Supergroup.

The Minas Supergroup includes four groups: Caraça, Itabira, Piracicaba and Sabará. The thickest sequence of banded iron formation (BIF) with economically exploitable high-grade iron oxides belong to the Itabira Group, which consists of itabirites, dolomites and subordinately, metapelites. The itabirites are metamorphosed and strongly oxidized iron formations with discontinuously high iron contents, a more or less lenticular morphology and dimensions ranging from a few decimeters to hundreds of metres (Rosiére and Chemale, 2000).

The economic formations of interest in the Casa de Pedra mine are hosted within the Cauê Formation (Itabira Group). The Cauê Formation is divided into six distinct units for mining purposes: hematites (>64% Fe), rich itabirites (58% to 64% Fe), siliceous itabirites, goethitic itabirites, carbonate itabirites and manganese itabirites. These units form the basis for the mineral resources and estimation domains.

The rocks termed hematites are characterized by high levels of iron oxide (>64% Fe) and by having small quartz interstratifications. In most of the deposit they have a friable behaviour.

The itabirites have alternating millimetre to centimetre bands of iron oxide, in general comprising magnetite and hematite with quartz bands. Rich itabirites are characterized by contents ranging from 58% to 64% Fe and have the same characteristics as the hematites in general.

The iron deposits of the Casa de Pedra mining complex are typically of weathered origin, however, there is a strong contribution from tectonic and lithological conditions.

According to Rosiére and Chemale (2000), the evolution of the Quadrilátero Ferrífero and adjacent areas occurred during the Archean and Proterozoic ages. At the end of the Archean, rift-related faulting commenced followed by further opening of the basin into a continental shelf environment. Widening of the basin was succeeded by the generation of a dome and basin structure.

The ca. 3,700 m thick continental shelf sediments of the Minas Supergroup were deposited between 2.6 Ga and 2.12 Ga. Widening of the basin allowed the deposition of the BIF-bearing sequence of the Itabira Group, with thick (ca. 250–300 m) iron formations (itabirites and hematite bodies), hematite phyllites, dolomitic phyllites, marbles and dolomites.

1.3 Exploration, development and operations

All exploration at the Casa de Pedra mining complex has been performed by diamond drilling methods. CSN Mineração's drill hole database for the Casa de Pedra mining complex area includes:

- 900 unique drillhole collars
- 145,996 m of total drilling, all by diamond drill core
- Drillholes completed between 1962 and 2014
- A mean depth of drilling of 162 m
- An average spacing between holes of between 120 m and 200 m, which varies across the deposit.

The drilling carried out at the Casa de Pedra mining complex is divided into two categories:

- Historical data – drilling carried out between 1962 and 2011 and corresponds to drilling information that is not sufficiently reliable to be considered in the estimation of mineral resources. Most of the drill core from that period has not been preserved and there is insufficient documentation for the traceability.
- Recent – drilling carried out from 2012 to 2014 where it is possible to trace a large part of the data collection procedures and processes. The drilling from 2012 to 2014 represents 33% of the total holes drilled at Casa de Pedra mining complex.

There has been a variety of sampling and analytical testing at Casa de Pedra mining complex going back multiple decades. Both internal and external laboratories have been utilized with the most recent work (2012 to present) using also the independent laboratories SGS, ACME for preparation and analytical work.

For the drilling campaigns prior to 2012, there were no quality assurance and quality control (QAQC) practices applied. During the 2012–2014 campaigns, CSN Mineração introduced a QAQC program. There was no "in time" quality control and sample failures were not investigated to identify the reason for the failure. However, QAQC results were considered in the resource classifications adopted by CSN Mineração, with QAQC failure batches considered of less confidence in the resource classification methodology.

1.4 Mineral resource estimate

Geological modeling, grade estimation and mineral resource classification were performed considering the amount and spacing of available data, interpreted mineralization controls, mineralization styles and data quality. The estimate was made in portions limited by geological interpretation and the limit of the mining rights.

CSN Mineração classified the drilling data into a series of lithology codes based on a combination of grain size (lump and fines) and chemical thresholds:

- Hematite with ≥ 64% Fe, termed hematite.
- Itabirite between 64% and 58% Fe, termed rich itabirite.
- Itabirite with <58% Fe was deemed silica itabirite or other itabirites. Rocks below about 20% Fe were defined as waste.

Modeling was performed based on surface mapping data, drill core logging data and lithogeochemical classification of drill core samples. Vertical and horizontal sections were drawn, from which the block model was built. Geostatistical methodologies were applied to estimate grades, limited by specific domains related to the type of mineralization and geostructural control of the deposit.

CSN Mineração utilizes a classification ranking system which accounts for a variety of geological, quality and estimation inputs. This scoring system combined with a smoothing of broad volumes into categories results in a classification system that meets international reporting guidelines and definitions for measured, indicated and inferred mineral resources. The increased confidence in classification aligns well with geological continuity and drilling density.

CSN Mineração used an optimized pit shell as a constraint to demonstrate reasonable prospects of economic extraction. All the reasonable prospects of eventual economic extraction are CSN Mineração's accountability. CSN Mineração ensures that all the eventual extraction requirements can be made.

The average product price applied by CSN Mineração is US$95.00/t. Material outside the optimal pit shell is excluded and is not reported as mineral resource. The mineral resource is also constrained by the limit of the Casa de Pedra mining complex mining rights, property area limit, cultural protected sites and legal protection reserves.

There are several in-pit stockpiles that are reported as mineral resource. Stockpile mass, grades and classification were provided by CSN Mineração in its block model.

Snowden Optiro considers the most critical issue is the inclusion of 136 Mt of mineralized material below the processing plant. Although this forms part of the mineral resource reporting, CSN Mineração has not allocated capital cost for its removal or relocation.

The Casa de Pedra mining complex mineral resources exclusive of mineral reserves as of 31 December 2021 are summarized in Table 1.2 The mineral resources are 100% attributable to CSN Mineração. All grades and tonnages reported are in-situ and are undiluted.

Table 1.2 Casa de Pedra mining complex – summary of iron exclusive mineral resources as of 31 December 2021 based on an iron price of US$95.00/t

Rock type group	Measured		Indicated		Measured + Indicated		Inferred	
	Amount (Mt)	Fe %	Amount (Mt)	Fe %	Amount (Mt)	Fe %	Amount (Mt)	Fe %
Canga	0.0	41.2	1.5	55.2	1.6	54.9	37.1	52.9
Hematite	27.4	65.7	36.3	65.5	63.6	65.6	4.3	65.1
Itabirite	422.6	38.0	1,451.5	36.7	1,874.1	37.0	1,670.8	36.6
Stockpiles	11.8	45.6	27.9	47.8	39.6	47.1	11.4	51.2
Total	**461.8**	**39.8**	**1,517.20**	**37.6**	**1,979.0**	**38.1**	**1,723.6**	**37.1**

Notes:

- *Mineral resources are reported exclusive of mineral reserves as in "in situ" tonnes and have been rounded to the nearest 100,000.*
- *Mineral resources include inferred resources within the mineral reserve pit shell.*
- *Stockpiles are reported as mineral resources. Stockpile masses, grades and classification were provided by CSN Mineração in its block model.*
- *Mineral resources are reported on a wet basis. The average moisture considered for all mineralized lithologies is 6%. The Fe% grade is reported on a dry basis.*
- *The classification of mineral resources is in accordance with the S-K 1300 classification system.*
- *Mineral resources that are not mineral reserves do not have demonstrated economic viability.*
- *Snowden Optiro certifies that a pit optimization was carried out to demonstrate reasonable prospects of economic extraction.*
- *Snowden Optiro agrees with the current mineral resource estimation practices.*
- *The effective date is 5 January 2022.*

Source: Snowden Optiro, 2022

1.5 Mineral reserve estimate

To convert the mineral resources to mineral reserves, consideration was given to forecasts and estimates of product price, metallurgical recovery, mining dilution and ore loss factors, royalties and costs associated with mining, processing, overheads and logistics. These parameters were used to derive economic cut-off grades, create a feasible pit design based on the geotechnical assumptions, a production schedule and a financial model.

The estimates described herein are consistent with the quality of information available at the time of preparation, data supplied by outside sources and the assumptions used.

The basis of the mine planning work was the mineral resource model.

The detailed breakdown of the mineral reserve is presented in Table 1.3. The Reserve classification reflects the level of accuracy of the modifying factors of the Reserve.

The Casa de Pedra mining complex mineral reserves as of 31 December 2021 are summarized in Table 1.3. The point of reference for the mineral reserves is ore delivered to the processing facility.

Table 1.3 Casa de Pedra mining complex – summary of mineral reserves as of 31 December 2021 based on an iron price of US$95.00/t

Category	Tonnage (Mt)	Fe (%)
Proven	152.9	42.49
Probable	1,925.5	41.07
Total	**2,078.4**	**41.17**

Notes:
- *Tonnages are reported on a wet basis.*
- *Mineral reserves are based on measured and indicated mineral resources only.*

The mineral reserve is based on measured and indicated resources only. The estimate includes dilution and ore loss factors. Stockpiles within the current pit limits were considered waste as they are not classified as mineral resources.

The mineral reserve classification reflects the level of accuracy of the associated studies (PFS). In this respect, compact itabirites were only converted to the probable reserve category as additional metallurgical and processing studies are required to increase the level of confidence.

1.6 Mining methods

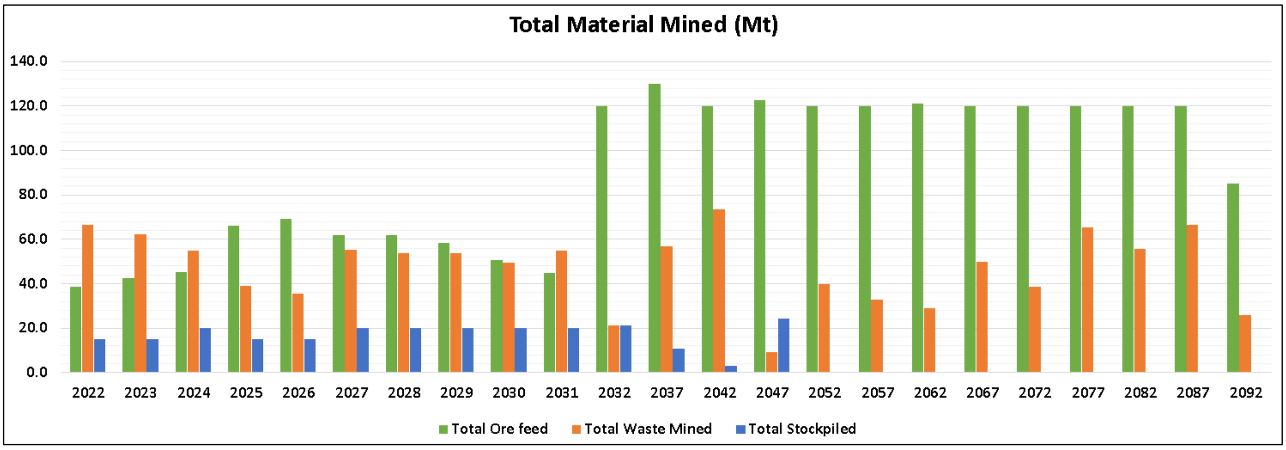
The Casa de Pedra mine uses conventional drill, blast, load-and-haul techniques for all mining areas and rock types. All rock is blasted and loaded with excavators and loaders into off-road trucks and hauled to the final destination (primary crusher, stockpiles or waste dumps). Primary mining is undertaken by large hydraulic excavators (26 m^3 bucket capacity) coupled with 240 t off-road trucks. Front-end loaders with a 25 m^3 bucket capacity also operate at the pit and stockpiles. The pits are mined in 13 m high benches, which is considered an appropriate balance between productivity and selectivity.

Grade control is performed via drilling, sampling and assaying over potential ore material within the pit boundaries.

It is Snowden Optiro's opinion that the mining method is appropriate to the orebody geometry, mineralization style and production rate.

The mine scheduling achieved the production rates and head grade targets for each processing plant.

Figure 1.2 Casa de Pedra mining complex mine scheduling



1.7 Processing and recovery methods

The Casa de Pedra mining complex wet processing plant (Central plant) currently has an installed capacity to produce around 22 Mtpa of marketable ore products. As graphically represented in Figure 1.3, the main processing steps include crushing, screening, homogenizing, sorting and concentration, thickening, product filtration and tailings filtration. The products generated are granulated, sinter feed and pellet feed. The process flow sheet in place uses well proven technologies in the iron ore processing industry.

With decreasing iron head grades, the concentration of the fine fraction of the sinter feed will be necessary. In this context, a concentration circuit for the fine sinter feed using concentrator spirals is envisaged. It will consist of four parallel modules, each consisting of three stages: rougher, cleaner and scavenger.

For the reuse of the coarse tailings of the spirals, it is proposed the implementation of a new magnetic separation plant of medium and high intensity.

The Dry System is composed of the ITM unit – pires and mobile screening units (UPMs). ITM – Iron Ore Processing Facility of the pires unit receives ores from the Casa de Pedra mining complex. Operating with a predominantly dry system, ITM is now responsible for producing more than 5 Mt of iron ore per year. ITM has a primary crushing circuit, a secondary crushing circuit and screening and handling circuits of the products. Mobile screening units (UPMs) are dry processing plants with a capacity of 6.5 Mtpa and are powered by loaders and excavators. The material from the mine, through the truck fleet, is classified according to granulometry in: sinter feed, granulated and over. After processing by the UPMs, the product is transported again by the fleet of trucks for cargo formation for railway compositions, at the Itacolomy Railway Terminal (TFI), at a distance of 1 km.

The P15 project consists of an ore processing plant which will process friable itabirites (42% Fe and 37.1% SiO_2 content) until 2031 for the production of 15 Mtpa (dry basis) of Direct Reduction Pellet Feed content of 67.7% of Fe and 1.5% (SiO_2 + Al_2O_3). Thereafter, the plant will be fed with compact itabirites operating at an average mass yield of 45.9% and 62.3% Fe Pellet Feed. The plant will operate until 2031 at 31 Mtpa friable itabirite feed rate followed by a 24 Mtpa of compact itabirite. The mineral processing method adopted in the project is well known in the iron ore industry (Figure 1.4). It has been validated by the Gorceix Foundation, which conducted several tests in the Department of Mining and Metallurgy Technology. The CSN Mineração geology team selected and collected representative samples. The samples were shipped to the Goiceix Foundation laboratory that performed mineralogical characterization, bench tests, pilot plant tests and mass balance using BILCO software.

The presence of material classified as “compact” (ICS - Itabirito Compacto Silicoso) in the mineral reserves of Casa de Pedra mining complex is quite significant, justifying the concept of feeding this ore in the P15 plant. The CSN Mineração geology team has been developing the characterization of this rock type aiming to determine some technological characteristics. For this, a technical work was developed at the Federal University of Rio de Janeiro with core drill samples. The studies indicate that the P15 circuit can be fed by compact ores and produce commercial pellet feed. The grinding/sorting circuit, composed of primary and secondary grinding, will require further adjustments with another power distribution and, eventually, additional ball load. It is thus expected a reduction in the feed rate and, accordingly, in production.

All tailings generated are filtered and stacked at the tailings storage facility (TSF) with 15% moisture. The average iron content of the tailings is 17% and the silica content is 72%.

Figure 1.3 Central processing plant flowsheet

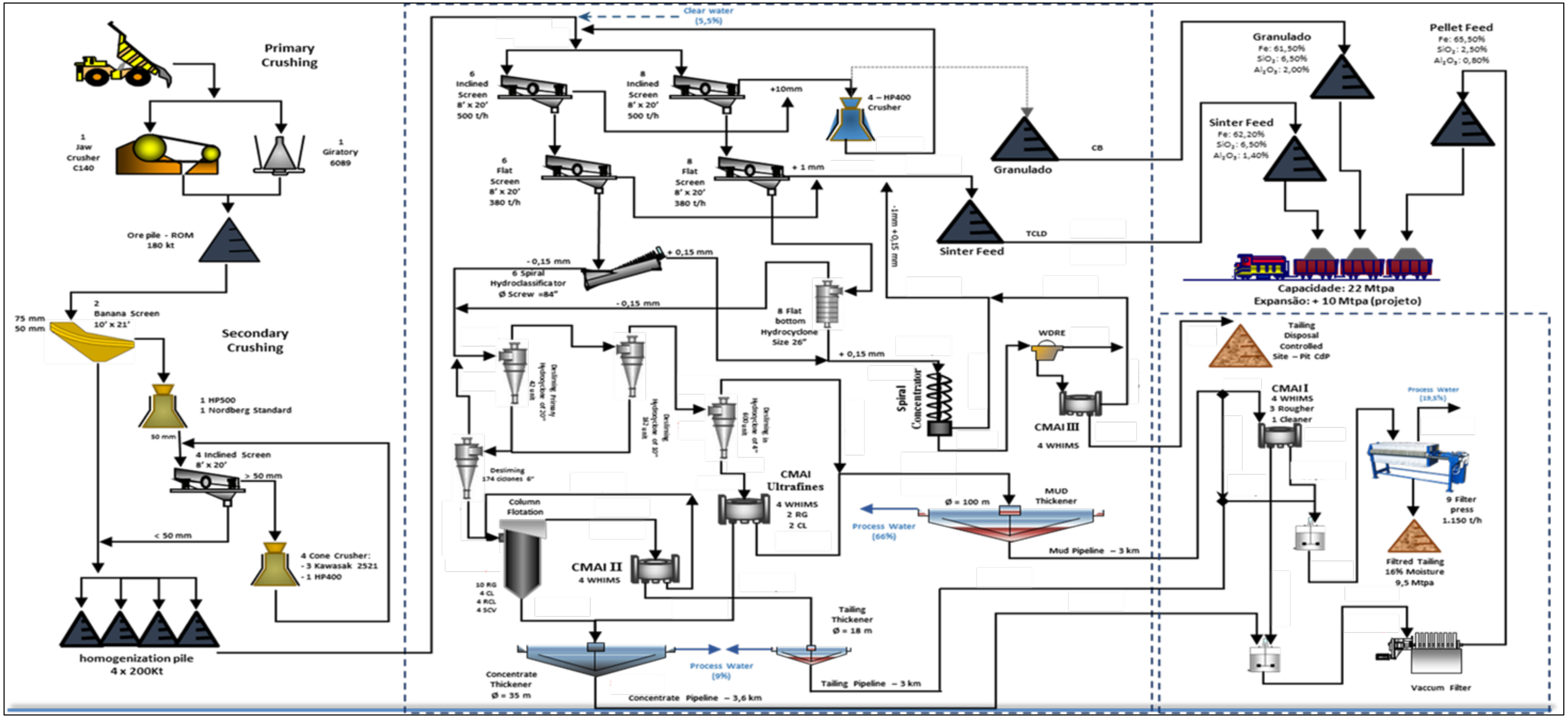
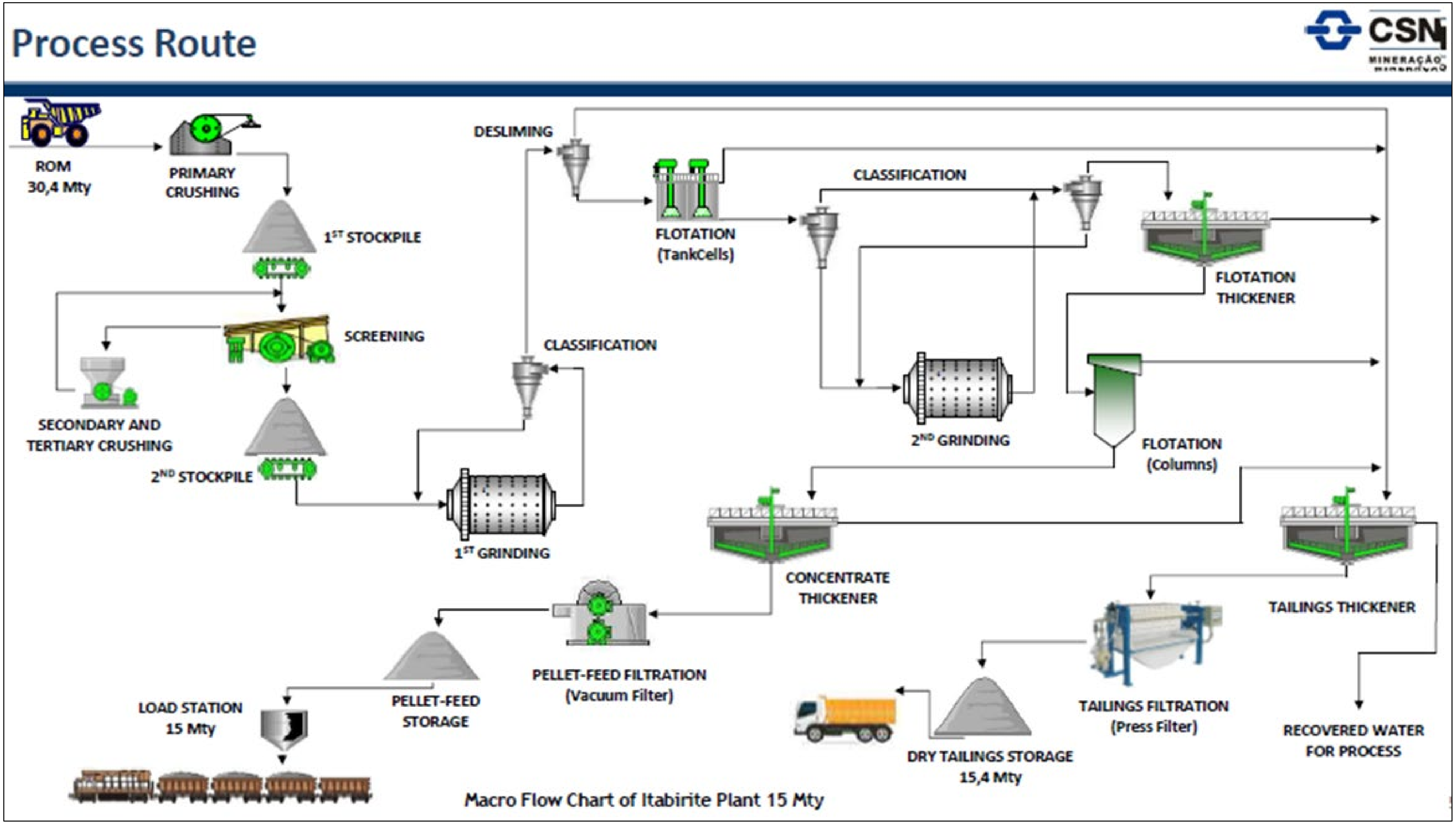


Figure 1.4 P15 processing plant flowsheet



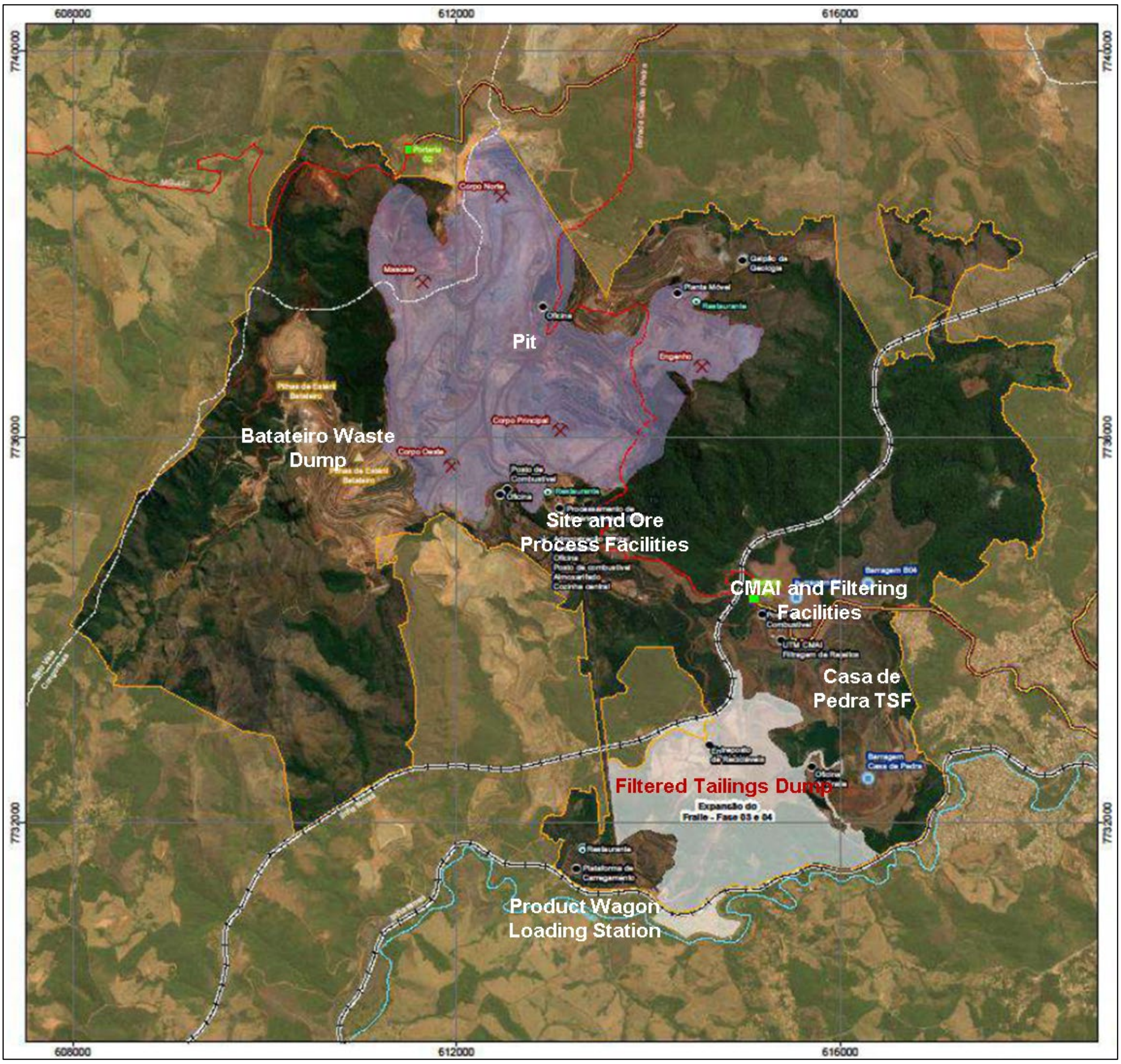
1.8 Project infrastructure

The key infrastructure components are:

- Site facilities
- Waste dumps
- Filtered tailings dumps
- Water infrastructure
- Power line
- Product handling and transportation railway
- Port facilities.

All infrastructure components required for the current operation are in place. Executive and conceptual engineering projects were developed by CSN Mineração to support the base case for the mineral reserves, including the waste and filtered tailings dumps expansions. The mine site infrastructure layout is shown in Figure 1.5.

Figure 1.5 Casa de Pedra infrastructure layout



1.9 Environmental studies and permitting

A number of environmental impact assessments (EIAs) have been completed by CSN Mineração including expansion of the open pit, processing plant, waste dumps, filtered tailings dumps, etc.

All Casa de Pedra mining complex mining rights and land are owned by CSN Mineração. The key tenement is no. 043.306/1956 which occupies an area of 2,516 ha where the Casa de Pedra mine is mainly located.

All required environmental licenses required to operate the mine and associate facilities are in place. Ongoing licensing programs to meet the requirements for future mine developments are in progress.

1.10 Capital and operating cost estimates

Capital costs were estimated by CSN Mineração based on the physical requirements of the life of mine plan. Given the Casa de Pedra mining complex is an operating mine, all future capital expenditures are related to new facilities, the expansion of existing infrastructure, sustaining activities and mine closure.

The estimates have an overall accuracy range of -10% to +15%.

The summary of capital costs for the life of mine plan are summarized in Table 1.4.

Table 1.4 Life of mine capital expenditure summary

Item	Value (US$ M)
Mining sustaining	2,185
Processing sustaining	1,287
Processing and mining equipment acquisitions	1,481
Port sustaining	475
Central plant improvements	16
Itabirite P10+5 plant construction	1,037
Waste/filtered tailings dump expansions	191
Other operational sustaining	87
Other capital expenditures	100
Mine closure	299
Total	**7,158**

The operating cost estimate is broken down by area including mining, processing, general and administration (G&A) and tailings management.

The mining, processing, tailings filtering and disposal, and G&A operating costs were estimated by CSN Mineração based on a combination of historical costs and projections.

Key operating cost input assumptions are:

- Diesel price: US$1.30/L
- Power cost: US$0.14/kWh.

Table 1.5 summarizes the operating costs, which equates to US$22.64/t processed over the life of mine.

Table 1.5 Operating cost estimate summary

Item	Units	Value
Mining	US$/t processed	4.23
Processing	US$/t processed	5.22
Rail	US$/t processed	2.60
Port	US$/t processed	2.07
Royalties (CFEM+TFRM)	US$/t processed	1.32
Other cost	US$/t processed	0.96
G&A and sales expenses	US$/t processed	2.18
Depreciation	US$/t processed	4.06
Total	**US$/t processed**	**22.64**

1.11 Economic analysis

The economic analysis of the life of mine plan was evaluated by CSN Mineração using conventional discounted cash flow methods based the production schedules, capital expenditures and operating costs disclosed in this technical report summary.

The economic analysis is based on the mineral reserve estimate only.

The life of mine financial outputs from the cash flow model are summarized in Table 1.6.

Table 1.6 Life of mine financial outputs

Item	Units	Value
Production	**Mt**	**1,062**
Net revenue	**US$ M**	**70,556**
Operating costs	**US$ M**	**-42,529**
Mining	US$ M	8,797
Processing	US$ M	10,844
Rail transport	US$ M	5,402
Port operations	US$ M	4,307
Royaltiess (CFEM+TFRM)	US$ M	2,744
Other costs	US$ M	1,991
Depreciation	US$ M	8,444
Gross profit	**US$ M**	**28,026**
Sales expenses and G&A	**US$ M**	**-4,537**
EBITDA	**US$ M**	**31,934**
Cash flow		
EBITDA	**US$ M**	**31,934**
Depreciation	US$ M	8,444
Taxes	US$ M	-7,986
NOPLAT	**US$ M**	**32,392**
Depreciation	US$ M	0
Capex	US$ M	-7,158
Free cash flow	**US$ M**	**25,234**
Discounted cash flow	**US$ M**	**7,097**

The after-tax net present value (NPV) using a 9% annual discount rate is US$7,097 million and confirms the economic viability of the mineral reserve estimate.

1.12 Recommendations

1.12.1 Mineral resource estimates

- The geology is understood to a satisfactory level at regional and local scales and is appropriate for the determination of mineral resources and mine geology.
- Drilling methods are considered satisfactory. Additional drilling should be completed with an emphasis on deeper holes, angled drilling, structural modeling, and infill drilling in areas of wide spacing.
- For the pre-2012 drilling campaigns, there were no QAQC practices applied. Result batches with QAQC failures from the 2012 to 2014 drilling campaigns were considered of less confidence in the resources classification methodology.
- For future drilling campaigns, the QAQC procedures should be described, the results more clearly presented, and the results consistently monitored as part of an ongoing process, so that analytical flaws can be quickly identified, investigated, and remedied.
- The overall database for global values from the 2012 to 2014 drilling campaigns is considered satisfactory for use in mineral resource estimation. For drilling campaigns executed before 2012, analytical certificates are unavailable, therefore data validation was not possible.
- The granulometric fractions database and estimation were not validated by SRK or Snowden Optiro. This validation must be done and documented as soon as possible by CSN Mineração and independently audited.
- The lithological classification appears acceptable for estimation as they represent discrete and mineable volumes.
- Based on the average drill spacing across the main mineralized zones, the block size is appropriate to represent volumes and grade values.
- The nugget values, anisotropy, and general variography parameters are as expected based on studies of other global iron deposits and aligns with the deposit type.
- Currently, the variography method is over-reliant on expecting Total Fe (global) spatial continuity to be the same for all variables (Total Fe, SiO_2, Al_2O_3, P, MnO, CaO, TiO_2, MgO, and LOI). The validation based on mean grades between composited values and blocks, in the case of secondary/deleterious elements, illustrates material differences.
- The use of ordinary kriging (OK) for variables using a unique modeled semi-variogram per hard domain is recommended. The results should provide improved validation with original composited data. There are multiple locations where the estimation should be modified to provide an improved local estimate.
- CSN Mineração utilizes a classification ranking system which accounts for a variety of geological, quality and estimation inputs. The increased confidence in classification aligns well with geological continuity and drilling density.
- CSN Mineração must implement reconciliation between the resource model, mining and the processing plant including a comparison with depletion by mining on a regular basis (at least every three months). Problems should be identified, investigated and remedied.
- The granulometric fraction estimation of quality variables are reliant on historical data that has been modified to account for the changing particle size bins over time. The quality of the various size fractions is required for the mineral reserve, therefore the fundamental assumptions associated with size fraction quality require review as part of mineral reserve estimation.
- Snowden Optiro's qualified person recommends CSN Mineração run a new economic pit shell, applying updated parameters and economic assumptions. The economic pit shell run must include capital allocated to move infrastructure, capital costs, sustaining costs and CFEM.

- In Snowden Optiro's opinion, the issues related to all relevant technical and economic factors likely to influence the prospect of economic extraction at CSN Mineração can be resolved with further technical work and analysis.

1.12.2 Mineral reserve estimates

- The block height of the mineral resource model is 13 m. This dimension reflects historical mining operating techniques by which 13 m benches were drilled and blasted. Further recommendations by the mine operation's team led to the reduction to a 10 m bench to avoid the excessive use of track dozers to lower the blasted bench crest and create safe loading conditions. Snowden Optiro recommends a cell height adjustment from 13 m to 10 m to reflect the current selective mining unit (SMU).
- It is noted that constant unit mining costs were applied to the pit optimization. No mining adjustment cost factors were considered to reflect specific operating mining conditions such variable haul distances, drilling patterns, dewatering requirements, etc. While the use of mining adjustment cost factors has material impact on the Casa de Pedra mining complex pit design, it is mainly constrained by physical boundaries rather than by economic aspects. Snowden Optiro recommends future iterations to include variable mining costs that reflect local operating conditions.
- Detailed mining costs calculated out of mining physicals estimates (fleet sizing, mining consumables, workforce, etc.) are higher than those used in the pit optimization reflecting the current volatile economic conditions (diesel price, foreign exchange rates, etc.). While this may not have a material impact on the Casa de Pedra mining complex pit boundaries as the pit optimization bottoms out at Price Factor 0.80, Snowden Optiro recommends that future mine planning work is adjusted accordingly.
- It is recommended that a pit sensitivity analysis on key optimization parameters is performed to assess the impact on the mining inventories and economics of the project.
- It is noted that after 2032 the average annual total rock movement decreases from 120 Mtpa to 30 Mtpa. Snowden Optiro recommends further investigations are undertaken on the benefit of reducing the mining equipment size to match the annual mining rate.
- In Snowden Optiro's opinion, the level of detail of the infrastructure design is adequate for mineral reserve reporting. However, it was noted that the studies concerning the design of the filtered tailings facilities after 2029 are conceptual. Snowden Optiro recommends that detailed engineering work be completed for the life of mine tailings production strategy.
- For the planned P15 processing plant, several friable/compact scenarios were evaluated by CSN Mineração that demonstrated its technical viability. Further studies may unlock additional value by improving metallurgical recoveries and, thus, production rates. In this respect, compact itabirites were only converted to the probable reserve category as additional metallurgical and processing studies are required to increase the level of confidence.
- While all relevant data and documents required for the mineral reserve are adequate and well detailed, the absence of a consolidated Terms of Reference (ToR) document for mine planning purposes is note. Snowden Optiro recommends that a ToR document be compiled including all relevant aspects of the project that can guide the mineral reserves team. The document should be updated every year reflecting any variation such as commodity prices, costs, depletion, etc. The results and findings of annual mine planning cycles should be consolidated along with the ToR in a stand-alone report.

2 INTRODUCTION

2.1 Registrant for whom the technical report summary was prepared

Snowden Optiro was retained by CSN Mineração S.A. to assist in the preparation of a technical report summary for the Casa de Pedra mining complex, located in Minas Gerais, Brazil. CSN Mineração S.A. is the registrant of this technical report summary.

CSN Mineração S.A. is the second largest exporter of iron ore in Brazil (www.csn.com.br).

The purpose of this technical report summary is to disclose mineral resource and mineral reserve estimates for the Casa de Pedra mining complex as of 31 December 2021.

This technical report summary conforms to the United States SEC Modernized Property Disclosure Requirements for Mining Registrants as described in Subpart 229.1300 of Regulation S-K, Disclosure by Registrants Engaged in Mining Operations (S-K 1300) and Item 601 (b)(96) Technical Report Summary.

Metric units are used throughout this report, except where otherwise stated.

2.2 Sources of information

The technical information upon which the mineral resources in this technical report summary are based represents a compilation of work performed by CSN Mineração (Relatório_2017_Reserve_Resource.pdf) and its contracted independent consulting firm – SRK (SRK Consulting – Mineral Resource Audit Review, Casa de Pedra Mine – 2021).

SRK is an independent international consulting firm with 44 offices worldwide. For mining projects, SRK provides services from mineral exploration to mine closure. It was founded in 1974 in Johannesburg, South Africa.

All input data and relevant documentation for the mineral reserve estimate were provided by CSN Mineração. Snowden Optiro verified the information and made comments when necessary. Based on this information, Snowden Optiro consolidated the mine planning sections of the report (Section 12 and Section 13).

The studies and additional references for this technical report summary are listed in Section 24. Snowden Optiro incorporated appropriate comments and adjustments as needed.

2.3 Qualified persons and details of inspection

Snowden Optiro is responsible for the listed sections in this technical report summary in accordance with the table below.

Table 2.1 List of responsibility sections on this technical report summary.

2	INTRODUCTION	
2.1	Registrant for whom the technical report summary was prepared	Snowden Optiro
2.2	Terms of reference and purpose of the technical report summary	Snowden Optiro
2.3	Sources of Information	Snowden Optiro
2.4	Qualified Persons and details of inspection	Snowden Optiro
2.5	Report version update	Snowden Optiro
3	PROPERTY DESCRIPTION	
3.1	Property location	Snowden Optiro
3.2	Property area	Snowden Optiro
3.3	Property mineral titles, claims, mineral rights, leases and options	CSN Mineração
3.4	Mineral rights description	CSN Mineração
3.5	Encumbrances	CSN Mineração

3.6	Other significant factors and risks	CSN Mineração
3.7	Royalties or similar interest	CSN Mineração
4	ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE AND PHYSIOGRAPHY	
4.1	Topography, elevation, and vegetation	Snowden Optiro
4.2	Access	Snowden Optiro
4.3	Climate	Snowden Optiro
4.4	Infrastructure	Snowden Optiro
5	HISTORY	
5.1	Previous operations	CSN Mineração
5.2	Results of exploration and development work	CSN Mineração
6	GEOLOGICAL SETTINGS, MINERALIZATION, AND DEPOSIT	
6.1	Geological setting	Snowden Optiro
6.1.1	Regional geology	Snowden Optiro
6.1.2	Local geology	Snowden Optiro
6.1.3	Mineralised zones	Snowden Optiro
6.2	Deposit type	Snowden Optiro
7	EXPLORATION	
7.1	Exploration	Snowden Optiro
7.2	Drilling	Snowden Optiro
7.2.1	Type and extent	Snowden Optiro
7.2.2	Procedures	Snowden Optiro
7.2.3	Results	Snowden Optiro
7.3	Hydrogeological data and testing	CSN Mineração
7.4	Geotechnical data and testing	CSN Mineração
8	SAMPLE PREPARATION, ANALYSES, AND SECURITY	
8.1	Sample preparation	Snowden Optiro
8.2	Sample analysis	Snowden Optiro
8.3	Quality control and quality assurance (QA/QC)	Snowden Optiro
8.4	Qualified Person's opinion	Snowden Optiro
9	DATA VERIFICATION	
9.1	Data verification procedures	Snowden Optiro
9.2	Limitations on data verification	Snowden Optiro
9.3	Qualified Person's opinion	Snowden Optiro
10	MINERAL PROCESSING AND METALLURGICAL TESTING	
10.1	Testing and procedures	CSN Mineração
10.2	Sample representativity	CSN Mineração
10.3	Testing laboratories	CSN Mineração
10.4	Metallurgical recovery	CSN Mineração
10.5	Deleterious elements	CSN Mineração
10.6	Qualified Person's opinion	Snowden Optiro
11	MINERAL RESOURCE	
11.1	Mineral resource estimation criteria	Snowden Optiro
11.1.1	Geological model and interpretation	Snowden Optiro
11.1.2	Block modelling	Snowden Optiro
11.1.3	Bulk density	Snowden Optiro
11.1.4	Compositing and domaining	Snowden Optiro
11.1.5	Top cuts	Snowden Optiro

11.1.6	Variography	Snowden Optiro
11.1.7	Grade estimation	Snowden Optiro
11.1.9	Model validation	Snowden Optiro
11.1.10	Cut-off grades	Snowden Optiro
11.1.11	Classification criteria	Snowden Optiro
11.2	Mineral resource reporting	CSN Mineração
11.3	Comparison with previous estimate	Snowden Optiro
11.4	Audits and reviews	Snowden Optiro
11.5	Qualified Person’s opinion	Snowden Optiro
12	MINERAL RESERVE ESTIMATES	
12.1	Mineral reserve estimation criteria	Snowden Optiro
12.1.1	Estimation methodology	Snowden Optiro
12.1.2	Input assumptions	CSN Mineração
12.1.3	Effective date	CSN Mineração
12.2	Mineral reserve reporting	Snowden Optiro
12.3	Economic assessment factors	CSN Mineração
12.4	Cut-off grades	CSN Mineração
12.4.1	Open pit	CSN Mineração
12.4.2	Underground	Not Applicable
12.5	Classification criteria	Snowden Optiro
12.6	Audits and reviews	CSN Mineração
12.7	Comparison with previous estimate	Snowden Optiro
13	MINING METHODS	
13.1	Geotechnical models	CSN Mineração
13.2	Hydrological models	CSN Mineração
13.3	Mining methods	Snowden Optiro
13.4	Mine schedule	Snowden Optiro
13.5	Mine layout	Snowden Optiro
13.6	Mining equipment	Snowden Optiro
14	PROCESSING AND RECOVERY METHODS	
14.1	Flow sheet	CSN Mineração
14.2	Plant throughput	CSN Mineração
14.3	Plant design	CSN Mineração
14.4	Plant requirements	CSN Mineração
14.4.1	Energy	CSN Mineração
14.4.2	Water	CSN Mineração
14.4.3	Process materials	CSN Mineração
14.4.4	Personnel	CSN Mineração
15	INFRASTRUCTURE	
15.1	Overview	CSN Mineração
15.2	Tailings storage facilities (TSF)	CSN Mineração
15.3	Waste rock dumps	CSN Mineração
15.4	Water	CSN Mineração
15.5	Power	CSN Mineração
15.6	Accommodation	CSN Mineração
15.7	Site access	CSN Mineração
16	MARKET STUDIES	
16.1	Product market	CSN Mineração

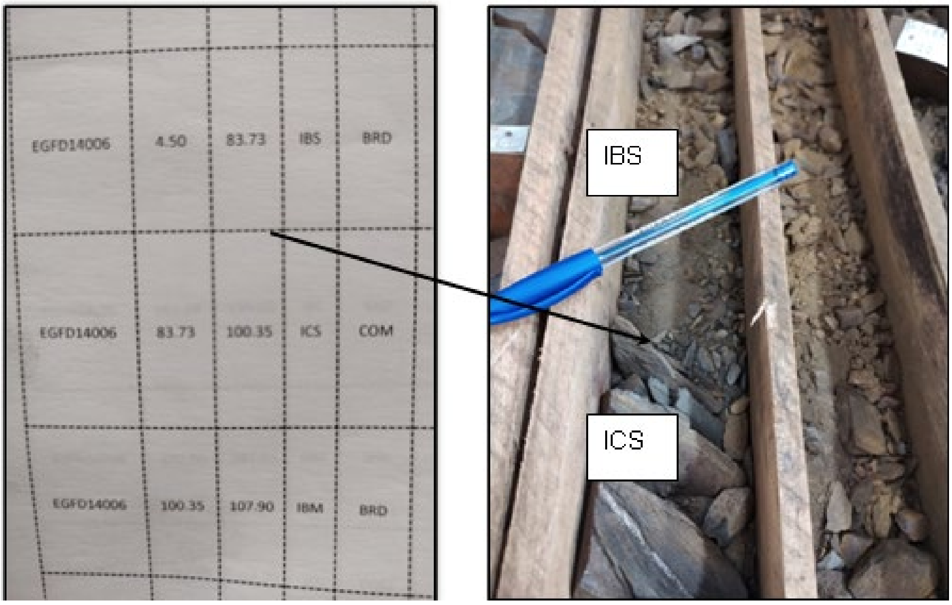
16.2	Commodity price projections	CSN Mineração
16.3	Material contracts	CSN Mineração
17	ENVIRONMENTAL STUDIES, PERMITTING, AND PLANS, NEGOTIATIONS, OR AGREEMENTS WITH LOCAL INDIVIDUALS OR GROUPS	
17.1	Environmental studies	CSN Mineração
17.2	Waste disposal, monitoring and water management	CSN Mineração
17.2.1	Tailings storage facilities (TSF)	CSN Mineração
17.2.2	Waste rock dumps	CSN Mineração
17.2.3	Water management	CSN Mineração
17.3	Permitting	CSN Mineração
17.4	Social and community	CSN Mineração
17.5	Mine closure	CSN Mineração
17.6	Qualified Person's opinion	Snowden Optiro
18	CAPITAL AND OPERATING COSTS	
18.1	Capital costs	SnowdenOptiro (mining)/CSN Mineração (all other costs)
18.2	Operating costs	SnowdenOptiro (mining)/CSN Mineração (all other costs)
19	ECONOMIC ANALYSIS	
19.1	Key assumptions and methods	CSN Mineração
19.2	Results of the economic analysis	CSN Mineração
19.3	Sensitivity analysis	CSN Mineração
20	ADJACENT PROPERTIES	CSN Mineração
21	OTHER RELEVANT DATA AND INFORMATION	CSN Mineração
22	INTERPRETATION AND CONCLUSIONS	Snowden Optiro
23	RECOMMENDATIONS	Snowden Optiro
24	REFERENCES	Snowden Optiro
25	RELIANCE ON INFORMATION PROVIDED BY THE REGISTRANT	Snowden Optiro

Snowden Optiro's qualified person for the mineral resources visited the property on 27 July 2022. Mr Rodrigo da Conceição Lordão, Geology Manager at Casa de Pedra mining complex, guided Snowden Optiro during the visit.

The site visit consisted of reviewing the drill core and logging procedures, an inspection of the open pit mining operations and main rock types, and a tour of the property including the beneficiation plant and tailings facility.

Snowden Optiro compared the logging of two drill cores with the original core logging documentation and found that they are consistent and within industry best practices. Figure 2.1 is an example of the drill core and corresponding core logging interval, showing compact/hard (ICS) and soft itabirite contact (IBS).

Figure 2.1 Drill EGF 14006 core and corresponding core logging interval, showing compact (ICS) and soft itabirite contact (IBS)



Source: Snowden Optiro, 2022

Snowden Optiro's visit to the Casa de Pedra mining complex open pits confirmed that the mineralized zones are quite evident. Figure 2.2 and Figure 2.3 present some of the visited areas.

Figure 2.2 Mining operation and soft hematite at Casa de Pedra mining complex – Mascate area

Source: Snowden Optiro, 2022

Figure 2.3 Casa de Pedra open pit and beneficiation plant

Source: Snowden Optiro, 2022

Snowden Optiro’s mineral reserve team visited the Casa de Pedra mining complex site on 20 September 2022. During the site visit, the team inspected the mining operations, waste dump, processing plant, site facilities and accesses.

2.4 Report version update

There is a previous technical report summary submitted by CSN Mineração S.A. on May 17, 2022. The link for this report is:

https://www.sec.gov/Archives/edgar/data/1049659/000129281422002374/ex96-3.html

The effective date of this technical report summary on the Casa de Pedra mineral resources and mineral reserves is 20 October 2022.

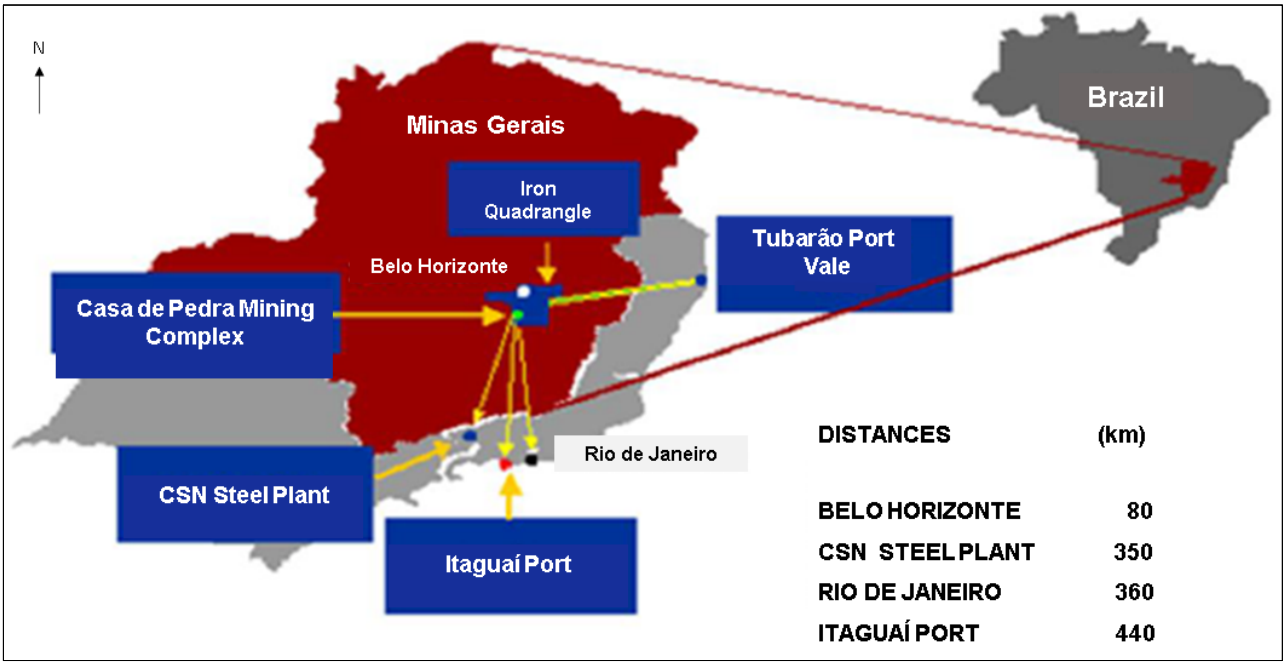
The topography was current as of 5 January 2022 for depletion purposes and the the effective date of the resources and reserves report is 5 January 2022.

3 PROPERTY DESCRIPTION

3.1 Property location

The Casa de Pedra mining complex (which includes Mina Casa de Pedra and Mina do Engenho) is located in the southwest portion of the Quadrilátero Ferrífero (Iron Quadrangle), in the municipalities of Congonhas and Belo Vale, in the state of Minas Gerais (MG). The Casa de Pedra mining complex is approximately 80 km from Belo Horizonte, the state´s capital, and 7 km from the urban perimeter of Congonhas (Figure 3.1).

Figure 3.1 CSN Mineração operations schematic location map



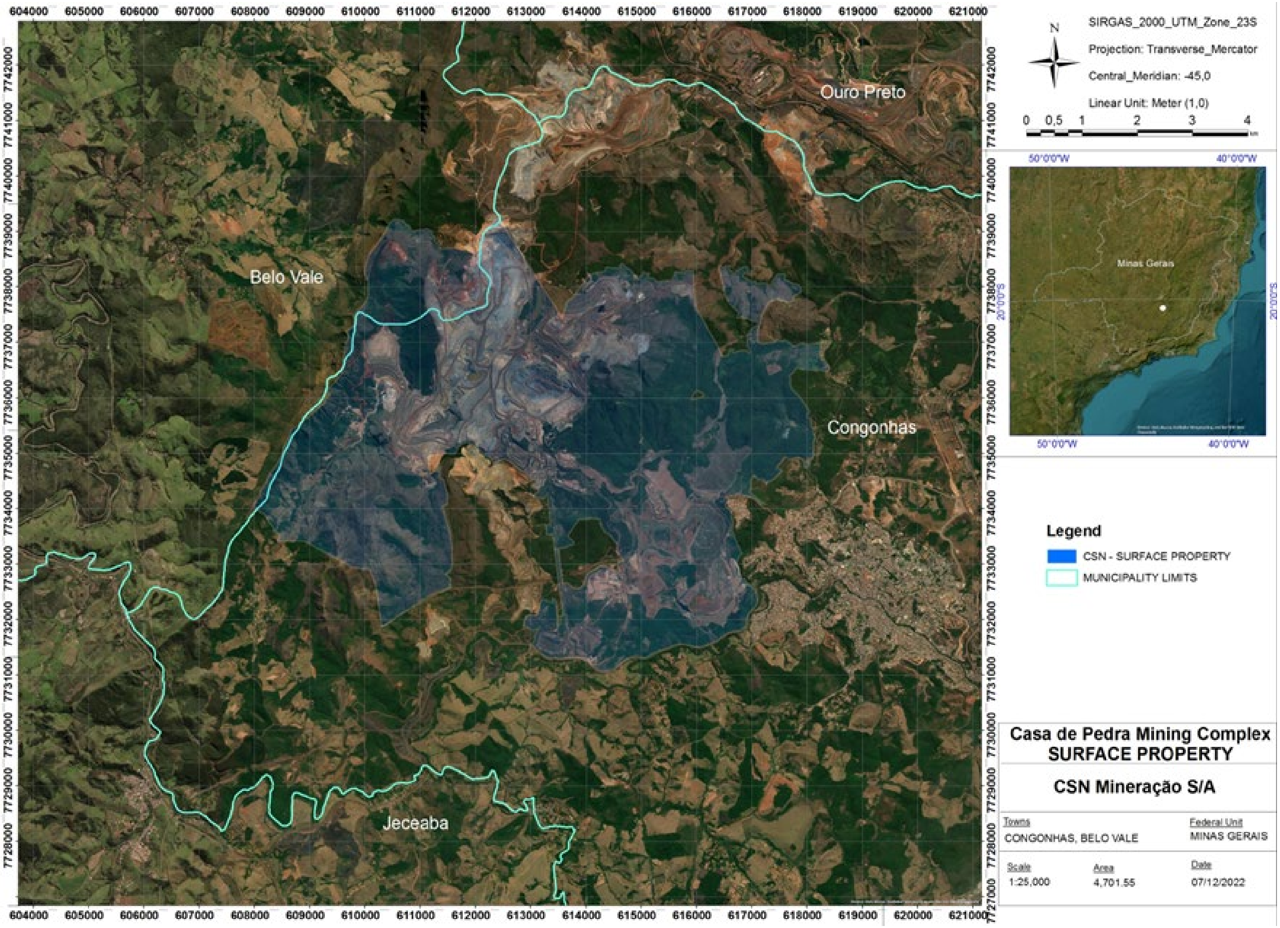
Source: CSN 20-F 2021.pdf

The centre of the Casa de Pedra mining complex is at coordinates of 612,000E and 7,773,600 N, based on the Brazilian SIRGAS 2000 Datum.

3.2 Property area and ownership

The Casa de Pedra mining complex (Mina Casa de Pedra and Mina do Engenho) property covers an area of 4,701.55 ha and is owned by CSN Mineração (Figure 3.2).

Figure 3.2 Casa de Pedra Complex surface property area



Source: Snowden Optiro. 2022

CSN Mineração S.A. is controlled by CSN (Companhia Siderúrgica Nacional), a Brazilian business group with 80 years of history. The iron ore produced in Minas Gerais state guarantees the self-sufficiency of Usina Presidente Vargas (CSN UPV), CSN Mineração's main steel plant located in Volta Redonda (Rio de Janeiro state) and first integrated steel producer in the country.

CSN Mineração owns the Casa de Pedra mining complex, the Pires beneficiation complex, as well as a stake in the MRS Logística (MRS) railroad and a captive iron ore export terminal at the Port of Itaguaí (TECAR).

MRS Logística is a concessionaire that operates more than 170 million tons of cargo per year, with rail operations in the regions of Minas Gerais, Rio de Janeiro, and São Paulo. CSN Mineração holds an 18.63% interest in the controlling group. Iron ore destined for export is transported by MRS Logística from the mines in the state of Minas Gerais to the Port of Itaguaí, in the state of Rio de Janeiro (Figure 3.1).

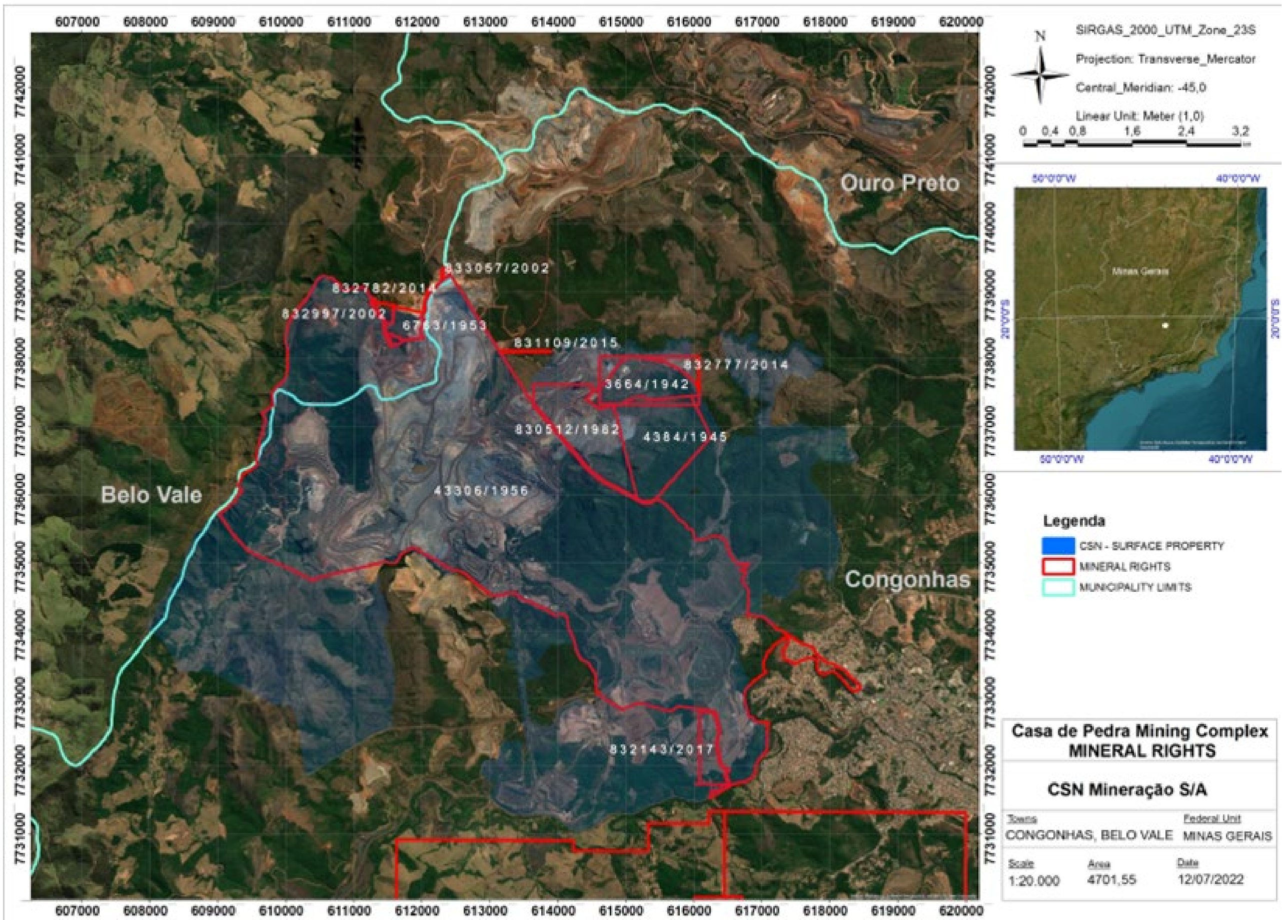
TECAR, located in the Port of Itaguaí, is the port terminal managed by CSN Mineração and connected to MRS, with an export capacity of over 42 Mt of iron ore per annum.

CSN Mineração was consolidated in 2015 from the merger of the mining assets of CSN (Companhia Siderúrgica Nacional) and Namisa (Nacional Minérios S.A.). In February 2021, the company made its initial public offering (IPO) on the B3 (Brazilian Stock Exchange).

3.3 Property mineral titles, claims, mineral rights, leases and options

CSN Mineração's mineral rights cover an area of 4701 ha (Figure 3.3) and are owned by CSN Mineração S.A. Mineração's surface rights cover an area of which allows the company to mine and produce iron ore and are registered in the company names in accordance with the table 3.1 below.

Figure 3.3 Casa de Pedra Complex mineral rights



Source: Snowden Optiro, 2022

Qualified Person Opinion: Snowden Optiro has not verified CSN Mineração's surface rights and mineral titles and is relying on information provided by the registrant. Snowden Optiro also attests that CSN Mineração has the operational licenses currently approved and the company is operating Casa de Pedra mine in accordance to the current Brazilian mining regulations and is not aware of significant issues.

3.4 Mineral rights description

In Brazil, the National Mining Agency (ANM), created under Law no. 13.575/2017 as a substitute of the National Department of Mining Production (DNPM), has the purpose of promoting mineral exploration and the use of mineral resources, supervising geological and mineral research, as well as to ensure, control and supervise mining activities throughout the national territory, as provided for in the Mining Code, the Mineral Water Code, the respective regulations and the legislation that complements them.

To carry out research or to exploit minerals in Brazil, it is necessary to follow the rules and procedures defined by the ANM, according to the mineral regime to which the substance of interest fits. In the case of the Casa de Pedra mining complex titles, the substance of interest is iron oxide, and the regime is the mining concession. Therefore, as shown in Table 3.1, CSN Mineração holds five mining concessions, two mining requests, three exploration authorizations and one exploration request. The mining concession aims at the mining, processing, and commercialization of the mineralization.

Table 3.1 Casa de Pedra mining complex mineral rights

Mineral Rights - CSN Mineração - Casa de Pedra mining complex					
Process	**Area (ha)**	**Titleholder**	**Mine**	**Current phase**	**Note**
004.384/1945	143.54	CSN Mineração S.A.	Engenho	Mining Concession	Mining Group 931.230/2013
006.763/1953	20.22	CSN Mineração S.A.	Casa de Pedra	Mining Concession	Mining Group 931.230/2013
830.512/1982	126.52	CSN Mineração S.A.	Engenho	Mining Concession	Mining Group 931.230/2013
003.664/1942	74.28	CSN Mineração S.A.	Engenho	Mining Concession	-
043.306/1956	2516.30	CSN Mineração S.A.	Casa de Pedra	Mining Concession	-
832.997/2002	10.83	CSN Mineração S.A.	Casa de Pedra	Mining Request	-
833.057/2002	1.39	CSN Mineração S.A.	Casa de Pedra	Mining Request	-
832.143/2017	30.43	CSN Mineração S.A.	Casa de Pedra	Exploration Authorization	Exploration Authorization Expire Date: 09/24/2022
831.109/2015	1.28	Companhia Siderurgica Nacional	Engenho	Exploration Authorization	Exploration Authorization Expire Date: 10/01/2023
832.777/2014	102.1	Companhia Siderurgica Nacional	Casa de Pedra	Exploration Request	-
832.782/2014	1.12	Companhia Siderurgica Nacional	Casa de Pedra	Exploration Authorization	Exploration Authorization Expire Date: 09/04/2023

Source: Snowden Optiro, 2022

It should be noted that the possession of surface rights does not include the right to use the corresponding underground minerals. In other words, the Brazilian federal government has dominion and control over mineral resources and consents their exploitation to private entrepreneurs. In this way, the underground resources constitute a distinct unit from the surface for the purpose of mineral exploitation.

Qualified Person Opinion: Snowden Optiro has not verified CSN Mineração's surface rights and mineral titles and is relying on information provided by the registrant, however, Snowden Optiro may attest that CSN Mineração S.A. is operating Casa de Pedra Mine with all the operational licenses in accordance with the Brazilian mining regulations.

3.5 Encumbrances

In Brazil, mining companies need consent from various regulatory agencies for a mining operation to proceed. The granting of the Mining Concession is linked to obtaining an Environmental Installation License (LI). The Environmental Operating License (LO) is necessary for the actual mining operation.

Snowden Optiro is not aware of any significant encumbrances related to CSN Mineração's mineral rights, including current and future permitting requirements and associated timelines, permit conditions, and violations and fines.

Section 17 provides further details on the environmental licensing status of the Casa de Pedra mining complex.

3.6 Other significant factors and risks

Mining companies in Brazil must comply with all requests from regulatory and inspection agencies. The penalty of license suspension and the application of fines are among the penalties and sanctions provided for in federal and state legislation.

Snowden Optiro is not aware of any significant factors or risks that could affect the current operations within the Casa de Pedra mining complex.

3.7 Royalties or similar interest

Snowden Optiro is not aware of any royalty or similar interests held by CSN Mineração at the Casa de Pedra mining complex.

4 ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE AND PHYSIOGRAPHY

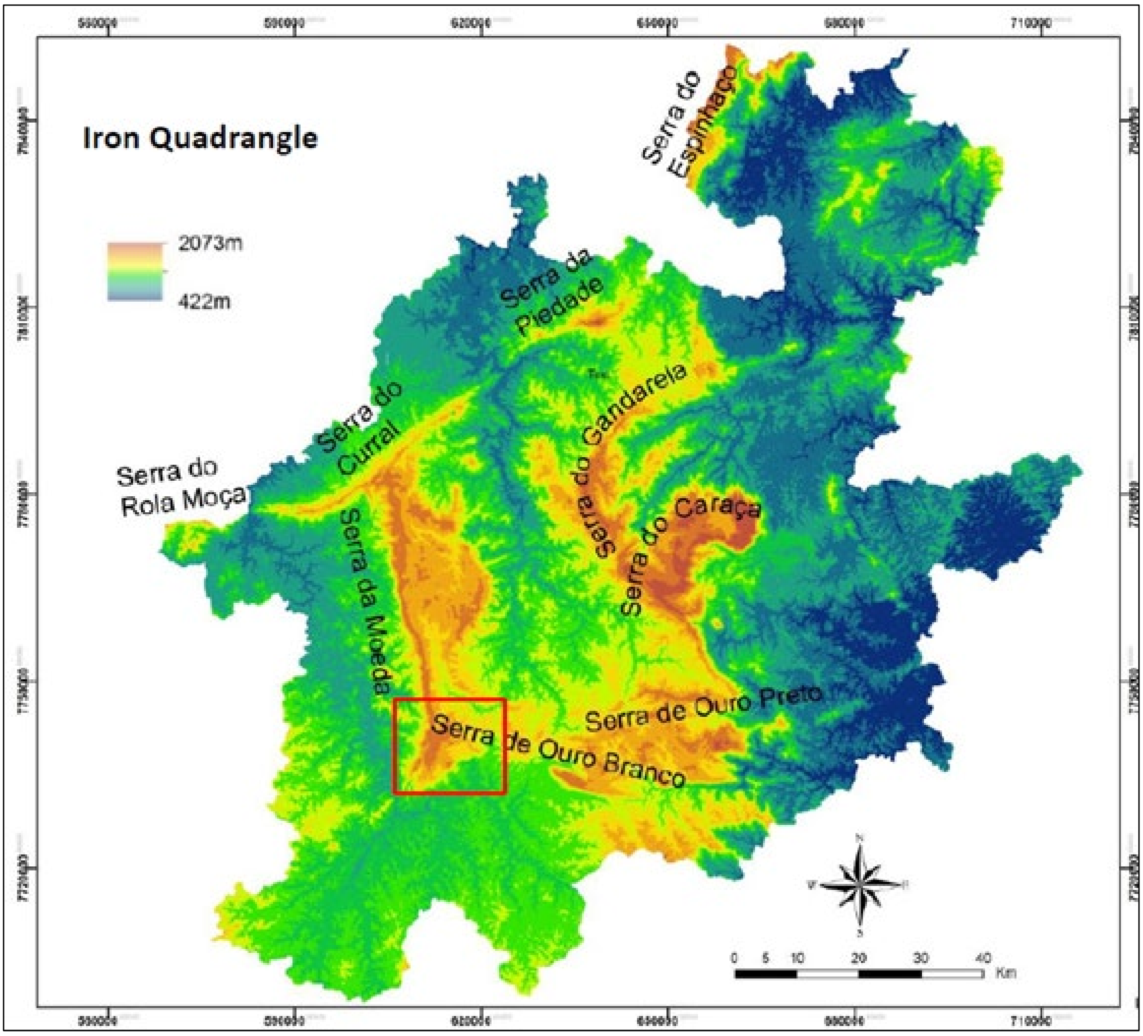
4.1 Topography, elevation and vegetation

According to environmental studies on the area of influence of the property (Estudo de Impacto Ambiental – EIA, Projeto de Expansão da Lavra do Mascate e Corpo Principal, 2021), the Casa de Pedra mining complex is in a regional landscape corresponding to the dissected plateaus of the center south and east of Minas state.

The contact of the dissected plateaus within the Quadrilátero Ferrífero constitutes a clear topographic contrast since the structural escarpments of the latter are opposed to the dissected hills with less pronounced altitudes of the former. These hills have altitudes that vary from 800 to 1,100 m.

In the Casa de Pedra mining complex area, the Quadriláreto Ferrífero (Iron Quadrangle) (Figure 4.1) makes up the mountain elevations of Serra da Moeda and Pico do Engenho. In these areas, slopes above 45% predominate, where the exposure of rocky outcrops is common, especially on the tops of these features. In addition to young and shallow soils, these scarps are locally covered by detritic-lateritic covers (canga) that flatten their peaks.

Figure 4.1 Quadrilátero Ferrífero (Iron Quadrangle) elevation map with property area in red box



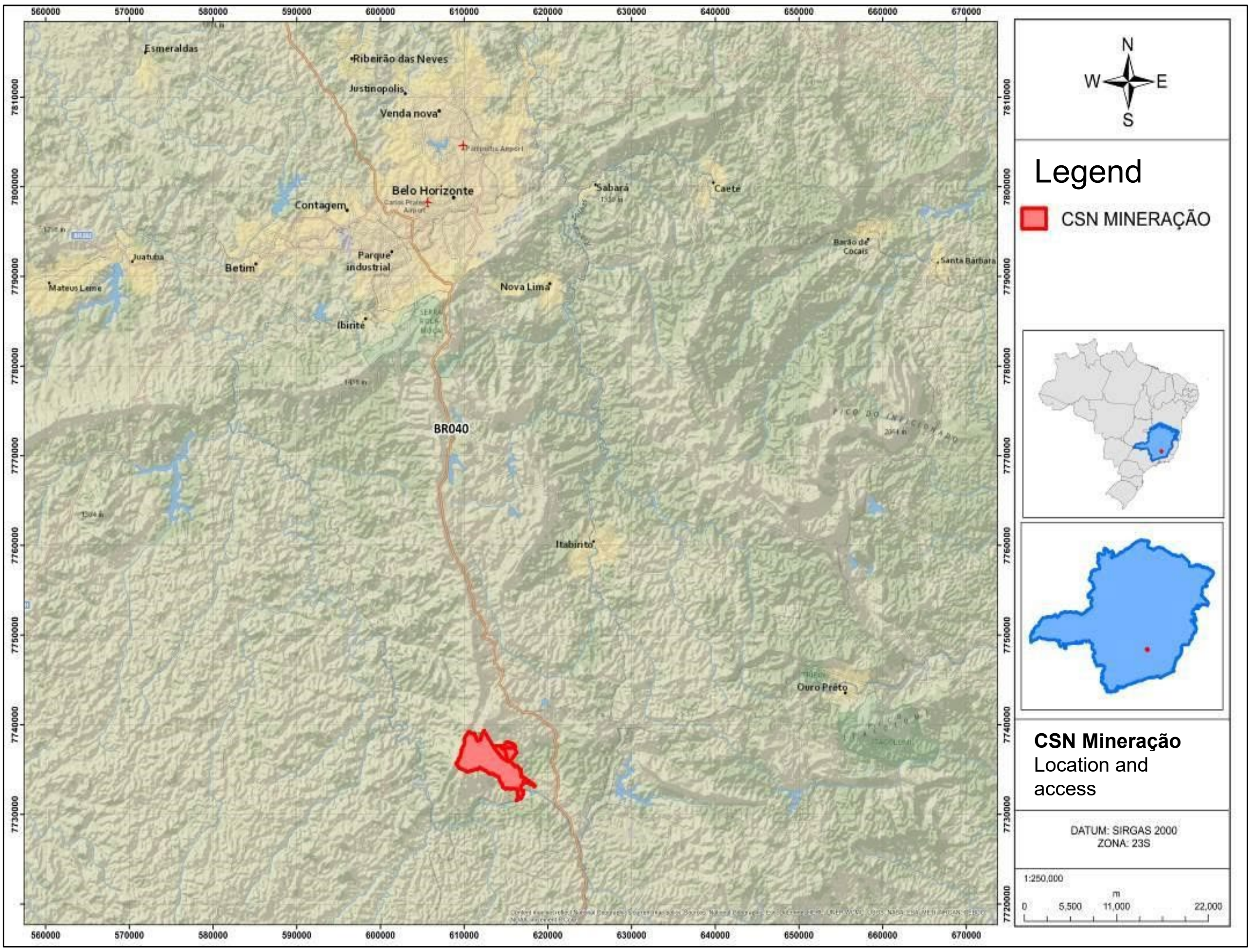
Source: DER, SISEMANET, IBGE, ANM, 2017/2018

The natural vegetation cover is related to the area between the Cerrado and Atlantic Forest biomes. The mosaic of natural vegetation cover is impacted by the different classes of land use and occupation.

4.2 Access

Access from Minas Gerais state capital Belo Horizonte to the Casa de Pedra mining complex is via the BR-040 highway (Figure 4.2). The nearest airport is Belo Horizonte Confins (CNF), which is 97.6 km away.

Figure 4.2 CSN Mineração mineral rights location and access



Source: Relatório_2017_Reserve_Resource.pdf

The transport of iron ore destined for export is via the MRS Logistica railroad from the Casa de Pedra mining complex in the state of Minas Gerais to the Port of Itaguaí, in the state of Rio de Janeiro (Figure 3.1).

The railroad is also used to supply the domestic steel mills throughout the southeast region of Brazil. MRS Logistica, with rail operations in the Minas Gerais (MG), Rio de Janeiro (RJ) and São Paulo (SP) regions, is a concessionaire that operates more than 170 Mt of cargo per annum. CSN Mineração holds an 18.63% interest in the controlling group.

4.3 Climate

The summers months are hot and humid (December to February), with mild and dry winters (June to September). The highest rainfall rates are recorded from November to February.

4.4 Infrastructure and local resources

Mining at the Casa de Pedra mining complex is by open pit methods using drilling, loading, transport and auxiliary service equipment. The main equipment consists of hydraulic excavators, wheel loaders, off-road trucks, bulldozers, tire tractors, motor graders and diesel drills.

The mine operates 24 hours a day and 7 days a week, totaling 8,760 hours per annum. The shift duration is 6 hours a day in a four-shift rotation regime.

The mined material is transported in off-road trucks to the site crushing and processing plants and waste dumps.

The processing infrastructure is equipped with a crushing and screening unit, a spiral classification and concentration plant and a high-intensity magnetic concentration plant. CSN Mineração currently produces lump, sinter feed and concentrate.

The products are transported by conveyor belts to the stockyards. The product piles are later moved by reclaimers, which transport it for loading onto trains. The products are shipped via the rail terminal located in the complex itself.

According to its 2021 Integrated Report, CSN Mineração has been promoting the recovery of water from tailings generated at the processing plant (Central plant) since 2018, allowing its reuse in the ore beneficiation process. In 2021, the water recirculation rate at the Central plant was 87%. In addition, the initiative allows the dry residue to be stacked, instead of the disposal in a tailings dam.

Based on Resolution No. 13/2019 of the National Mining Agency (ANM), it was determined that all tailings storage dams with an upstream construction method must be de-characterized. Since 2020, CSN Mineração has been conducting a program to de-characterize its dams.

The increase in water efficiency in mining is complemented by the monitoring of the mine’s wells and spillways, which ensures control of the water table level and the water supply for industrial processes, in addition to the maintenance of water courses that supply the surrounding communities.

Detailed information regarding the site infrastructure is presented in Section 15.

5 HISTORY

5.1 Previous operations

Mining is one of the main industrial activities in Minas Gerais state, and Quadrilátero Ferrífero is the region that stands out due to its rich deposits of iron.

In 1911, the Danish Arn Thun purchased land from the then Baron of Paraopeba in the city of Congonhas and two years later, started mining activities at Casa de Pedra. Since then, iron ore production at Casa de Pedra has been ongoing. In 1946, the Casa de Pedra mine was nationalized and incorporated into CSN.

In 1993, CSN was privatized. Namisa, a subsidiary of CSN, was founded in 2006 to sell iron ore to foreign markets. CSN incorporated the operations of Namisa in 2008 and sold 40% of the shares to an Asian consortium.

In 2009, CSN acquired Mina do Engenho, which then became part of Casa de Pedra mining complex. CSN approved the establishment of a strategic alliance with an Asian consortium, composed of Japanese, Korean and Thai companies in 2014. CSN Mineração S.A. was consolidated in 2015 from the merger of the mining assets of CSN and Namisa and was divided between CSN (87.52%) and a consortium composed of large Asian steelmakers (12.48%).

CSN Mineração concluded its initial public offering on B3 (Brazilian Stock Exchange) in February 2021, ranking among the 10 largest initial public offerings in the history of the Brazilian Stock Exchange by volume.

In 2021, CSN Mineração sold 33.2 Mt of iron ore, an increase of 7% over the previous year.

5.2 Results of exploration and development work

The Casa de Pedra mine has been operated by CSN since 1946, and there are no records of work undertaken by the previous owners or operators.

Between 1962 and 2014, CSN completed 145,966 m of drilling, all by diamond core.

The most recent mining operation acquired by CSN was Mina do Engenho in 2009, which became part of Casa de Pedra mining complex.

6 GEOLOGICAL SETTING, MINERALIZATION AND DEPOSIT TYPE

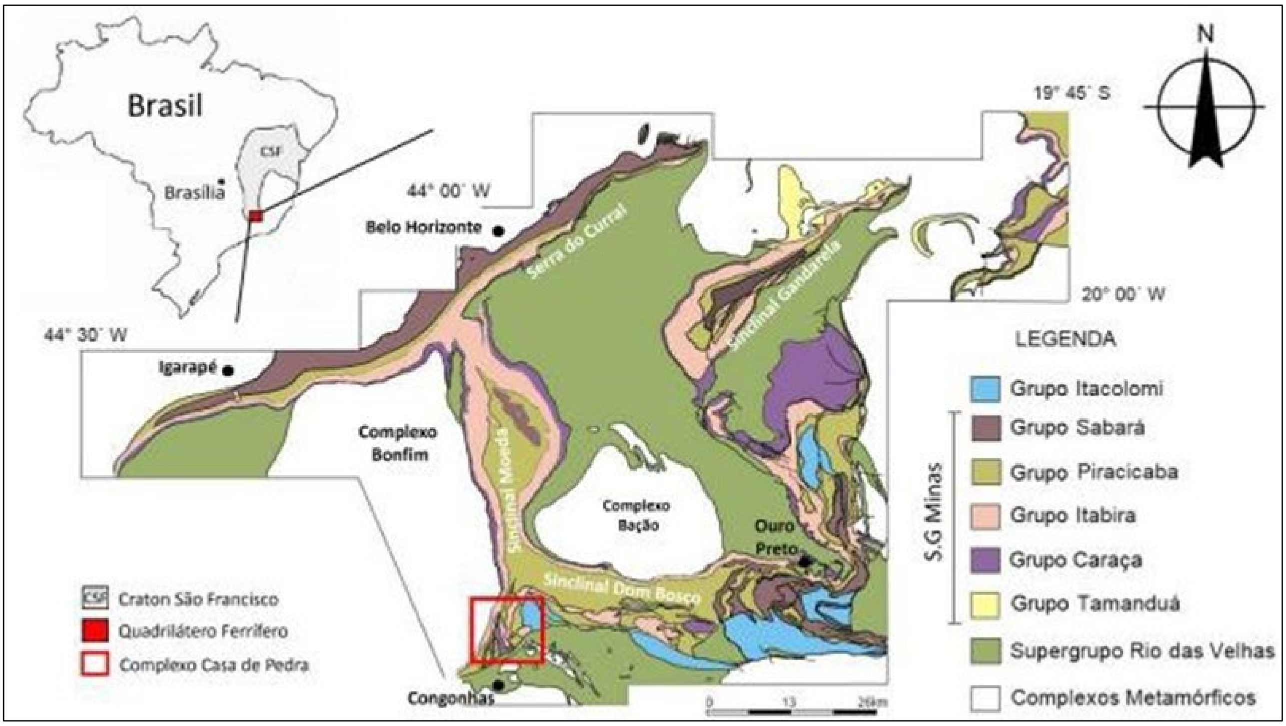
6.1 Geological setting

6.1.1 Regional geology

The iron oxide deposits of the Casa de Pedra mining complex are located within the Quadrilátero Ferrífero, an area of approximately 7,000 km^2 within the San Francisco Craton in the central part of Minas Gerais, Brazil. The Quadrilátero Ferrífero is one of the most important metallogenic provinces in the world and its geology has been studied since the 18th century. The Quadrilátero Ferrífero name derives from the arrangement of the regional mountains and being composed primarily of iron-bearing formations that form a quadrilateral.

The regional geology was originally mapped by a collaboration of American and Brazilian geologists during the mid-20th century in an agreement between the Brazilian government and the United States Geological Survey (USGS). The general geology of the Quadrilátero Ferrífero is presented in Figure 6.1.

Figure 6.1 Geological map of the Quadrilátero Ferrífero (modified from Dorr II 1969), highlighting the area of Casa de Pedra Mine in red



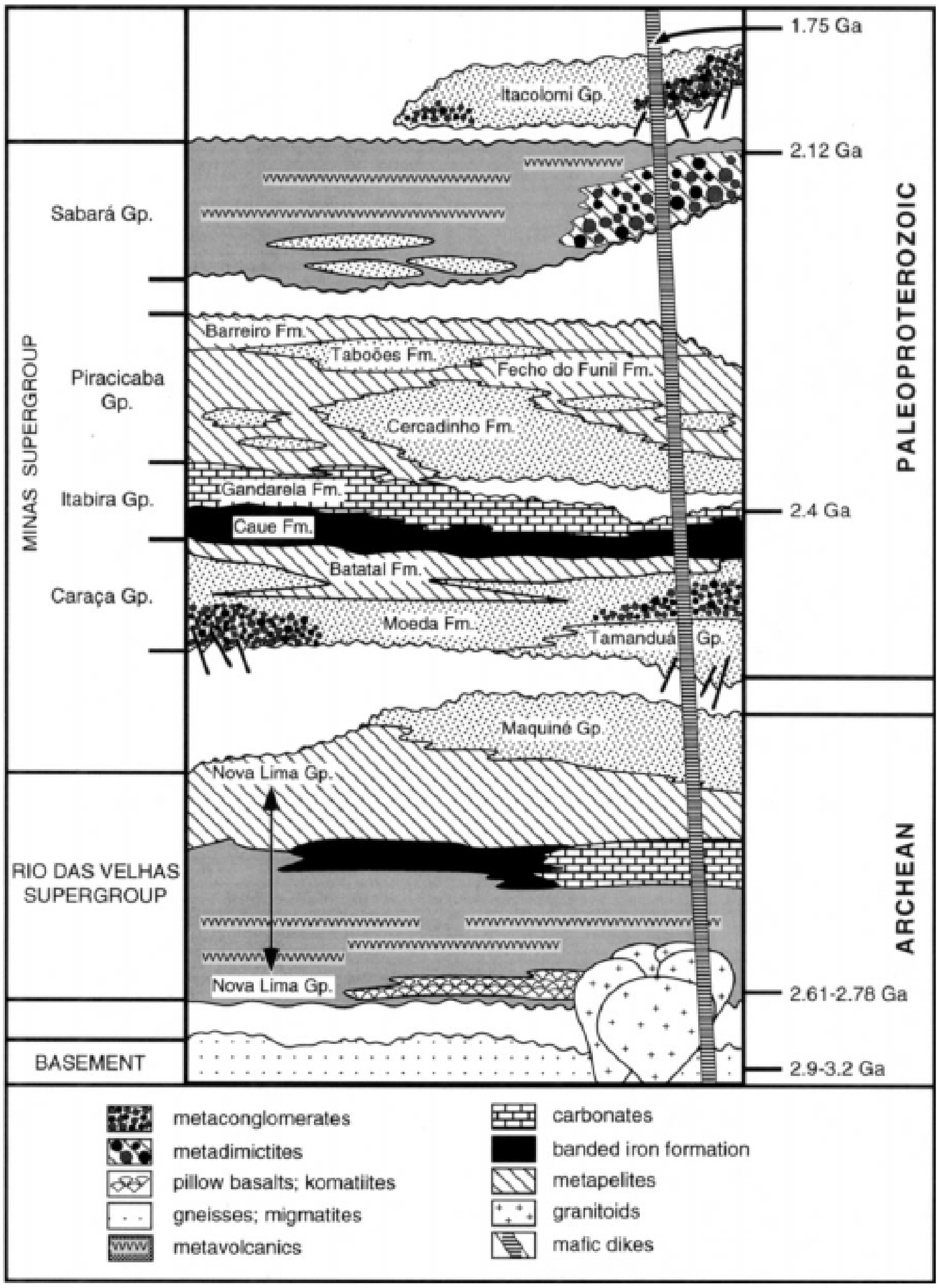
Source: CSN - Relatório_2017_Reserve_Resource.pdf

English translation of terms in the figure: Complexo – Complex, Grupo – Group, Metamórficos – Metamorphic, Serra – Ridge, Sinclinal – Syncline, Supergrupo -Supergroup.

The Quadrilatero Ferrífero is subdivided into four Archean to Paleoproterozoic lithostratigraphic units (Figure 6.2):

- Archean metamorphic complexes composed of gneisses, migmatites and granitoids
- The Archean Rio das Velhas Supergroup, comprising low- to medium-grade metavolcanic and metasedimentary rocks
- The Neoarchean Paleoproterozoic Minas Supergroup, consisting of low- to medium-grade metasedimentary rocks
- The Paleoproterozoic Itacolomi Group composed of metasandstones and conglomerates.

Figure 6.2 Stratigraphic column of the Quadrilátero Ferrífero



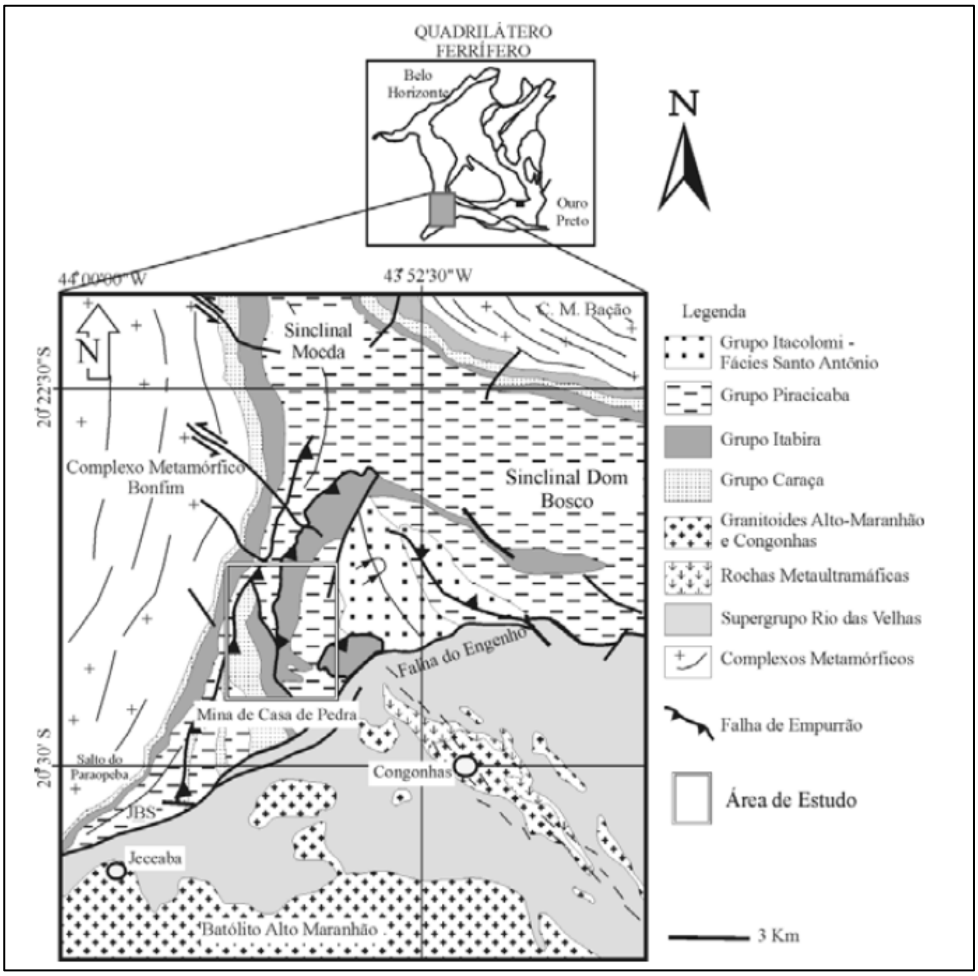
Source: Alkmim & Marshak (1998)

The Minas Supergroup includes four groups: Caraça, Itabira, Piracicaba and Sabará. The thickest sequence of BIF with high-grade iron oxides belong to the Itabira Group, consisting of itabirites, dolomites and subordinately, metapelites. The itabirites are metamorphosed and strongly oxidized iron formations with a more or less lenticular morphology and dimensions ranging from a few decimetres to hundreds of meters (Rosiére and Chemale, 2000).

6.1.2 Local geology

The iron formations of economic interest in the property are hosted within the Minas Supergroup, Itabira Group and Cauê Formation (Figure 6.1 and Figure 6.2). The area of the Casa de Pedra mining complex is characterized by several occurrences of iron oxide, where the main hematitic bodies occur as lenses in the northwest-southeast direction. These lenses are present along a 50 km synformal structure, with a normal flank in a north-south direction to the west and an inverted flank to the east, surrounding the Bação Metamorphic Complex in the south. The Casa de Pedra mining complex is located on the western hinge of the Sinclinal Moeda (Figure 6.3).

Figure 6.3 Geological map of the Casa de Pedra area



Source: Trzaskos and Alkmin, 2011

English translation of terms in the figure: Batólito – Batolith, Complexo – Complex, Falha – Fault, Falha de Empurrão – Thrust Fault, Mina – Mine; Grupo – Group, Metamórficos – Metamorphics, Rochas Metaultramáficas – Metaultramaphic Rocks, Sinclinal – Syncline.

The Casa de Pedra mining complex area has undergone three deformational events which control the attributes between the Main and Western deposits. These two deposits exhibit distinct differences in mineralogy and texture because of the individual structural domains. The Main deposit is composed of granular hematite and magnetite (itabirite) with porosity averaging 20%, compared to the West body which is richer in specularite (specular hematite) and goethite with lower porosities averaging 17%.

Within the Casa de Pedra mining complex, lithologies are defined from oldest to youngest as:

- Chlorite schists (Nova Lima Group – Rio das Velhas Supergroup)
- Quartzites (Caraça Group – Moeda Formation)
- Carbonous phyllites (Grupo Caraça – Batatal Formation)
- Iron formations and manganese rocks (Grupo Itabira – Cauê Formation)
- Dolomites and dolomitic phyllites (Grupo Itabira – Gandarela Formation)
- Sericite schists - (Grupo Piracicaba – Cercadinho Formation)
- Mafic (basic) intrusives, primarily metagabbro
- Tertiary deposits (stratified clays)
- Quaternary cover.

The Cauê Formation is broken into seven distinct units for mining purposes: hematites (>64% Fe) (Figure 6.4), rich itabirites (58–64% Fe), siliceous itabirites (Figure 6.5), goethitic itabirites, carbonate itabirites and manganese itabirites. These units form the basis for the mineral exploration program and mineral resource estimation domains.

Figure 6.4 Compact (hard) hematite

Source: CSN – Relatório_2017_Reserve_Resource.pdf

Figure 6.5 Siliceous compact Itabirite

Source: CSN – Relatório_2017_Reserve_Resource.pdf

6.1.3 Mineralized zones

At the Casa de Pedra mining complex, enriched iron oxide is present as compact (hard) or soft/friable hematite, semi-compact to compact itabirites, composed of millimetre to centimetre bands of hematite and/or magnetite with interlayered quartz.

The hematites are characterized by elevated levels of iron oxide (>64% Fe) and by having small quartz interstratifications. In most of the deposit they have a friable behaviour.

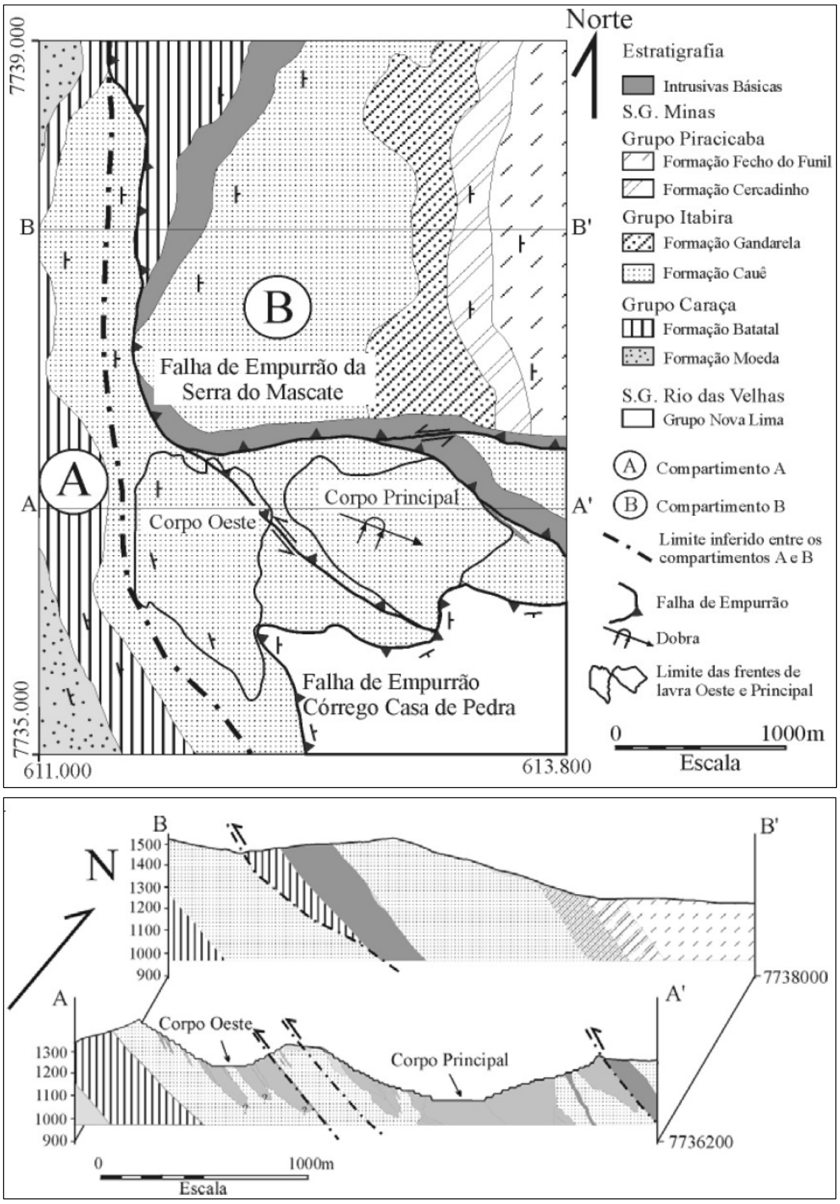
The itabirites have alternating millimetre to centimetre bands of iron oxide, in general magnetite and hematite with quartz bands. Rich itabirites are characterized by contents ranging from 58% to 64% Fe and have the same characteristics as hematites in general.

The Casa de Pedra mining complex deposits typically formed from weathering processes, however, there is a strong contribution from tectonic and lithological conditions. Commonly, the iron oxide bodies present complex geometries influenced by the diversity of structural and lithological controls. Weathering generated material more enriched in iron and/or with appropriate granulometric characteristics for mineral processing.

Iron oxide enrichment through supergene processes is controlled along northwest-southeast thrust faults that bound the Main and West bodies. Hypogene alteration is evident through the presence of martite (hematite pseudomorphs after magnetite). The Cauê Formation consists of BIF, amphibolitic BIF and dolomitic BIF with subordinate manganese and phyllite-rich zones. Stratigraphically above the Cauê Formation lies the Gandarela Formation consisting of carbonates and phyllitic itabirite.

Figure 6.6 illustrates the local geology with a representative cross section through the Casa de Pedra mining complex deposit. The importance of in-pit thrust faults and their relationship to the mineralization are clearly shown.

Figure 6.6 Geologic map and cross sections through the Casa de Pedra mining complex deposit

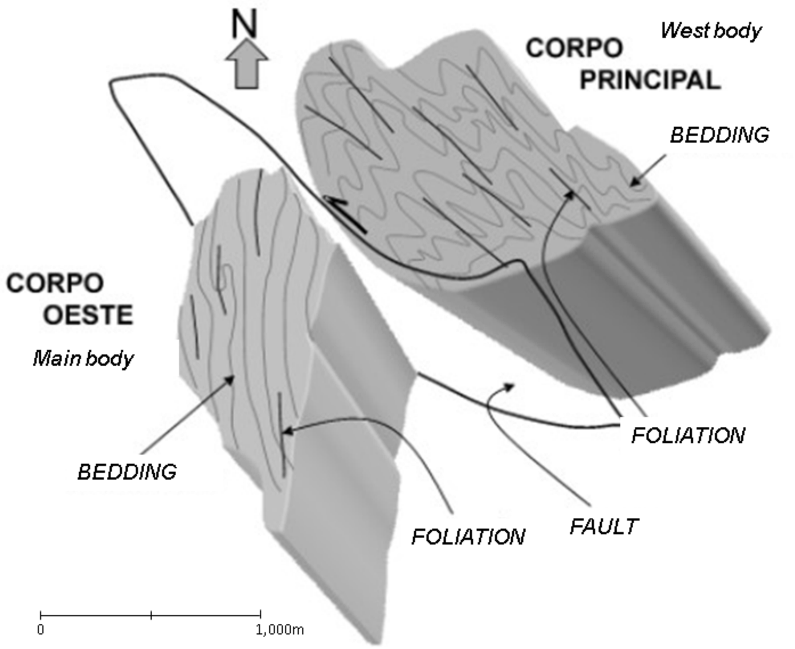


Source: CSN – Relatório_2017_Reserve_Resource.pdf

English translation of terms in the figure: Corpo Oeste – West Body, Corpo Principal – Main Body, Compartimento – Compartment, Dobra – Fold, Estratigrafia – Stratigraphy, Falha de Empurrão – Thrust Fault, Formação – Formation, Frentes de lavra – Mining Faces, Grupo – Group, Intrusivas Básicas – Basic Intrusive Rocks, Limite Inferido – Inferred Limit.

The geometry of the deformation within the two host deposits varies slightly due to the influence of regional structures. The West body exhibits foliation and bedding in a north-south direction until truncated by the main thrust fault separating the deposits. The more deformed Main body exhibits a northwest-southeast foliation roughly perpendicular to the highly deformed bedding (Figure 6.7).

Figure 6.7 Block diagram illustrating the geometry of the West body (Corpo Oeste) and the Main body (Corpo Principal)



Source: Trzaskos and Alkmim, 2011

6.2 Deposit type

According to Rosiére and Chemale (2000), the evolution of the Quadrilátero Ferrífero and adjacent areas occurred during the Archean and Proterozoic ages. At the end of Archean, rift-related faulting commenced followed by further opening of the basin into a continental shelf environment. Widening of the basin was succeeded by the generation of a dome and basin structure.

The ca. 3,700 m thick continental shelf sediments of the Minas Supergroup were deposited between 2.6 Ga and 2.12 Ga. Widening of the basin allowed the deposition of the BIF-bearing sequence of the Itabira Group, with thick (ca. 250–300 m) iron formations (itabirites and hematite bodies), hematite phyllites, dolomitic phyllites marbles and dolomites.

Chemical and mineralogical variation during deposition resulted in compositional BIF types. They are related to changes of facies in the basin, originating as cherty jaspilites, clay-rich and carbonatic iron formations and lenses of hard banded iron rich bodies (high-grade mineralization). Metamorphic overprint generated normal itabirites or quartz-itabirites (iron-oxide rich and silica-rich layers), carbonatic (dolomitic) itabirites, amphibolitic itabirites, hematite phyllites, iron-sulfide phyllites and hematite-rich bodies (primary iron oxide bodies).

The action of deep-reaching tropical weathering on the diverse types of iron formation produced soft and friable itabirites and hematite bodies (supergene iron oxide).

Snowden Optiro qualified person's opinion

The regional geology is well understood based on the extensive documentation in the region with both public and internal company documents. This includes general geology of the area, major controls on iron oxide mineralization, and the regional/site structural setting. All the geological modelling is based on mapping and drilling information which is available in the mine site and the information is material and free of any fatal flaw to be used. More detailed information is provided in the mineral resource estimation of this technical report summary (item 10).

The local or deposit-scale geology is understood to a satisfactory degree and is appropriate for the estimation of mineral resources.

7 EXPLORATION

7.1 Exploration

7.1.1 Topographical surveys

All topographical surveys prior to 2012 used a Universal Transverse Mercator (UTM) coordinate system adapted from the Córrego Alegre datum. The conversion of the drillhole collars to SIRGAS 2000 datum was made by using an equation that considered the original datum.

The 2006 topographic surface used in the geological modeling included the toes and crests of benches within the open pit surveyed using total station and real time kinematics global positioning system (GPS).

From 2012 onwards, drillhole surveying was by CSN Mineração´s survey team using a static GPS tracking method and total station to obtain the drillhole inclination and direction. All surveys carried out at the Casa de Pedra mine use the UTM coordinate system and have a SIRGAS 2000 planimetric datum and Imbituba altimetric datum linked to the Brazilian Geodetic System (SGB-IBGE). Topography is acquired by using light detecting and ranging (LiDAR) survey and is updated by in-pit survey to generate a final pit surface.

Snowden Optiro qualified person's opinion

The topographic surface is regularly updated using LiDAR surveys resulting in accurate and precise topographic control for the property. The qualified person recommends CSN Mineração perform regular (monthly) updates to the site topography for tonnage tracking and reconciliation purposes with continued annual LiDAR flyovers and monthly input survey updates.

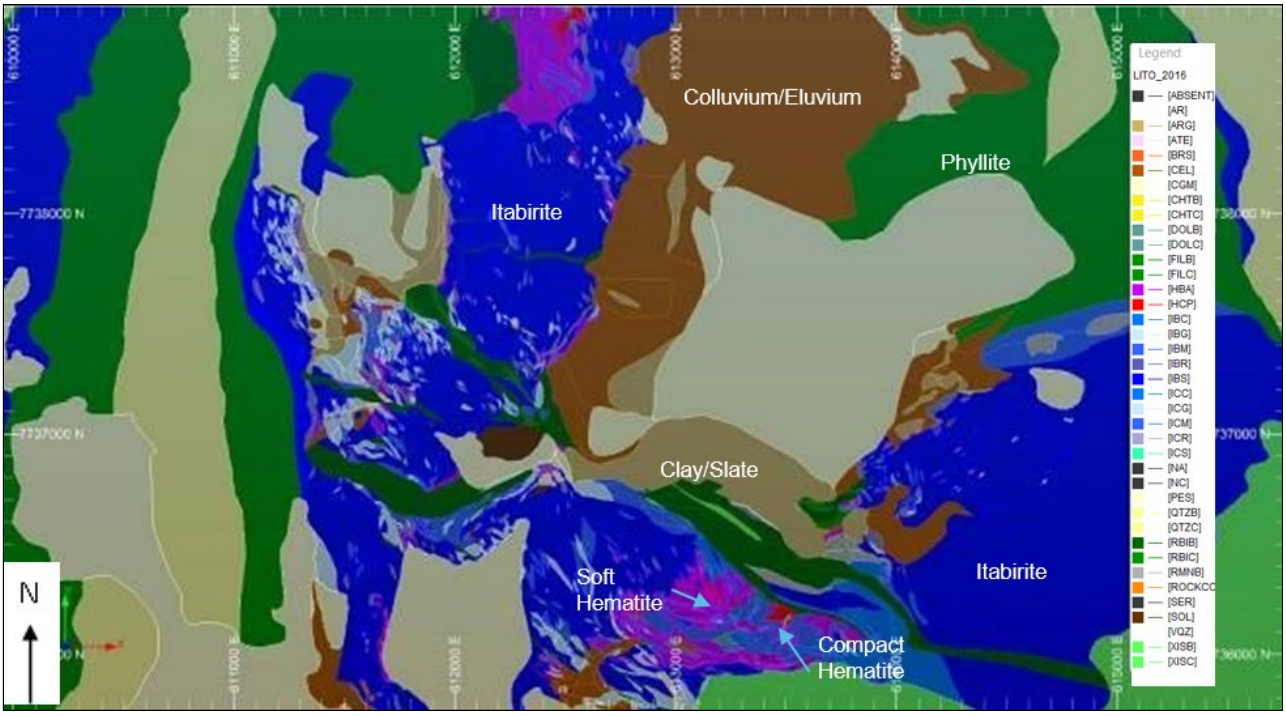
Snowden Optiro's opinion is that the resultant topography is satisfactory for use in estimating mineral resources.

The drillhole collar survey methodology is considered satisfactory, but documentation requires updating. Details are missing for collar survey, equipment used and accuracy, thus the qualified person is unable to comment on the appropriateness of these methods.

7.1.2 Mapping

Geological mapping has been carried out in the property since the mid-1950s including some initial mapping performed by the USGS under an agreement with the Brazilian federal government. CSN Mineração performs regular pit mapping for lithology and structure and uses the geological surface map dated 18 July 2017 as base for the geological modeling (Figure 7.1).

Figure 7.1 Geological surface map used as base for geological modeling



Source: CSN – Relatório_2017_Reserve_Resource.pdf

Snowden Optiro qualified person's opinion

The qualified person recommends regular (quarterly) pit mapping to capture lithologic contacts, major structures and ensure all data is recorded digitally for incorporation into the geological model.

7.2 Drilling

The drilling carried out at the Casa de Pedra mining complex is divided into two categories – historical data and recent data.

Historical data is drilling carried out between 1962 and 2011 that is not sufficiently reliable to be considered in mineral resource estimation. Most of the drill core from that period has not been preserved and there is inadequate documentation on the traceability.

The main problems in relation to the reliability of information are:

- There is no confidence in the spatial position of the drill holes
- There is no record of the companies that carried out the drilling
- No drilling bulletins are available
- There is no record of the drill core recovery
- There is no record of geological logging
- There is no record of the sample preparation procedures
- There is no record of the analytical methodology
- There are no chemical analysis certificates available
- There is no record of the downhole surveying procedure (when performed, it was done with Tropari equipment which is susceptible to magnetic effects).

Recent data is drilling carried out from 2012 onwards where it is possible to trace large parts of the data collection procedures and processes. The drilling completed from 2012 to 2014 represents 33% of the total holes drilled at the Casa de Pedra mining complex.

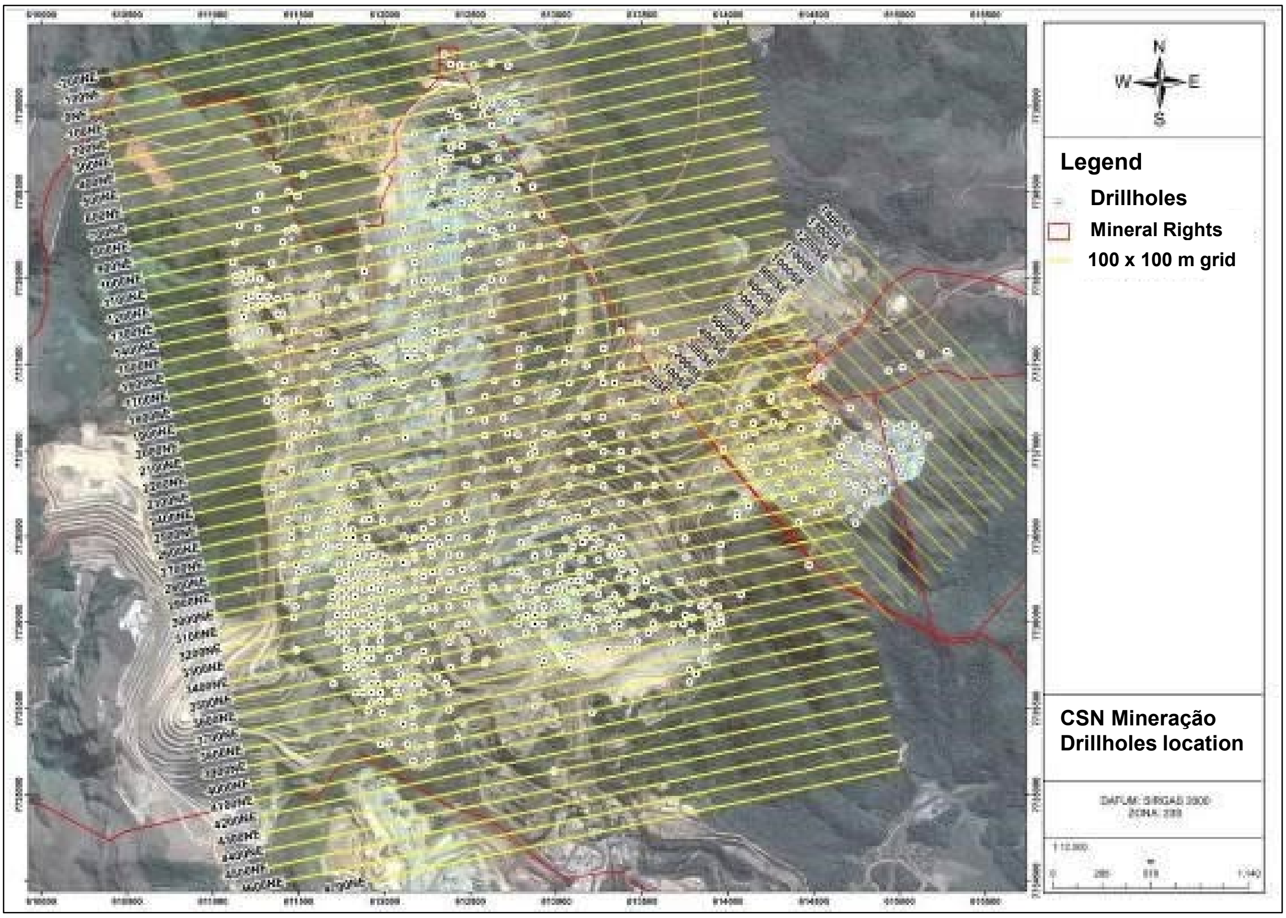
7.2.1 Type and extent

All drilling at Casa de Pedra mining complex has been performed using diamond core drilling methods. The Casa de Pedra mining complex drillhole database includes:

- 900 unique drillhole collars
- 145,996 m of drilling in total, all by diamond core
- Drillholes completed between 1962 and 2014
- A mean depth of drilling of 162 m
- Average spacing between holes of between 120 m and 200 m which varies across the deposits
- A dominant core barrel diameter of HQ2, NQ and NQ2.

The drillhole database also contains collar, survey and assay files with most holes angled towards the west to provide a near-perpendicular intercept with the regional stratigraphy and mineralization. Figure 7.2 shows the drillhole distribution.

Figure 7.2 Casa de Pedra mining complex drilling distribution



Source: CSN – Relatório_2017_Reserve_Resource.pdf

The number of drillholes completed by year is presented in Table 7.1.

Table 7.1 Drillhole summary by year

Data category	Year	No. of drillholes	No. of samples
Historical data	1962	5	441
	1963	17	636
	1964	24	833
	1965	5	46
	1969	3	23
	1972	32	303
	1973	3	31
	1974	16	77
	1980	49	NA
	1983	10	19
	1984	7	20
	1985	14	39
	1986	14	67
	1987	8	79
	1988	10	19
	1989	7	32
	1990	4	26
	1991	6	19
	1993	38	607
	1996	14	412
	1997	15	158
	1998	77	1,205
	1999	17	325
	2000	17	254
	2001	14	NA
	2002	13	190
	2003	75	1,301
	2004	9	129
	2005	29	255
	2007	10	134
	2008	45	508
	2009	35	265
	2010	68	391
	Total	**710**	**8,844**
Recent data	2012	8	212
	2013	81	1,793
	2014	101	1,957
	Total	**190**	**3,962**
TOTAL (Historical + Recent)		**900**	**12,806**

NA – Not available.

Source: CSN – Relatório_2017_Reserve_Resource.pdf

Drilling executed between 2012 and 2014 was carried out by Geosol, a Brazilian company with extensive drilling experience.

The inspection of the drilling between 2012 and 2014 was carried out by teams composed of a geologist and a technician through daily visits to the drilling operation sites.

7.2.2 Procedures

The following procedures were carried out by CSN Mineração:

- Drill core sampling
- Laboratory spare samples storage
- Core case identification photography
- Drill core storage
- Water immersion bulk density testwork
- Drill core logging
- QAQC sample dispatch
- Drillhole surveying inspection
- Drilling inspection
- Geological modeling.

Downhole surveys

In the 2012 to 2014 campaigns, all holes were drilled to an azimuth of approximately 258° with inclinations ranging from 60° to 90° according to the dip of the stratigraphy.

The downhole surveys in these campaigns were performed with DeviFlex and Maxibor II equipment. The procedure implemented in 2012 required that only holes over 150 m are surveyed.

Readings were made every 3 m while descending with another when ascending. The descending measurement was used as the final value.

Core recovery

For the drilling campaigns carried out before 2012, there is no record of the core recovery rates.

From 2012 onwards, drill core with a recovery of less than 85% was considered low quality. Low quality samples represented 28% of the samples from the 2012 to 2014 drilling campaigns.

Core logging

In the 2012 to 2014 drilling campaigns, the following steps were taken for core logging:

- Define and log contacts of weathering zones
- Define and log lithological contacts
- Describe the lithological interval
- Measure and log structures
- Set and log compactness
- Define and log granulometry
- Define and log mineralogy
- Define and record the degree of free silica
- Define and record the degree of magnetism.

The geological descriptions were based on procedures and the holes were logged onsite by geologists. All drill core from the 2012 to 2014 campaign was photographed.

The descriptions are archived in physical and digital media using acQuire database software. The drillhole database contains 39 unique logging codes based on the dominant lithology in the logged interval.

Drill core from the historical and recent campaigns are stored in a core shed at the Casa de Pedra mining complex facilities.

Drill core sampling

There is no record of the core sampling procedures prior to 2012.

In the 2012 to 2014 campaigns, half of the core was sampled with the other half preserved. The compact (hard) material was organized, marked and sawed. A steel plate was used to divide the core of softer materials.

The following steps are described in CSN Mineração's sampling procedure:

- Define sampling intervals within each lithological unit. Samples must be defined from the beginning to the end of the hole (even if it will not be sampled), marked in the geological description log according to the following designation criteria:
  - AP – For the mineralized lithotypes, the standard sample support of 13 m is used, and minimum sizes of 6.5 m and maximum of 13 m can be used, depending on the lithological contact position
  - For mineralized lithotypes where there are samples smaller than 6.5 m, but larger than 2.0 m, a sample is taken, for global (or total) analysis only
  - For intervals with less than 80% recovery, global samples are defined
  - NA – For non-sampled intervals of waste material and in maneuvers with advance greater than 2 m and without recovery.
  - Drill core sampling is performed by CSN Mineração geologists. Diamond drill core is cut at the site logging facility, bagged and then transported to the laboratory for preparation and analyses. All sampling is supervised or directly performed by CSN Mineração geologists. No further information or details are provided on sampling or sample security.

7.2.3 Results

Snowden Optiro qualified person's opinion

In line with what is stated by SRK in its audit review report, the qualified person is of the opinion that the diamond core drilling method is satisfactory and appropriate for geological logging, structural measurements, and metallurgical testing.

The available documentation needs to include greater detail on collar and downhole survey methods and accuracies, geological logging, drill core sampling, security, transport and storage. The qualified person also recommends that details of the annual drilling campaigns including summary information of meters drilled, contractors, core diameter, purpose of drilling and additional supporting information is documented.

Variable azimuths for the drilling are also recommended for structural measurements as nearly all deeper diamond holes are drilled from east to west to intercept bedding at oblique angles. Alternative azimuths will provide additional structural information across perpendicular discontinuities and bedding.

Due to geological complexities in rock type and structure, the qualified person recommends additional drilling should be completed with an emphasis on deeper holes, angled drilling, structural modeling and infill drilling in areas of wide spacing. As the deposit is structurally complex, maintaining a three-dimensional (3D) structural model is recommended to best model the interaction between the various geological and resources domains.

In the 2012 to 2014 drilling campaigns there are no drilling, sampling, or recovery factors that could materially affect the accuracy and reliability of the results.

7.3 Hydrogeological data and testing

In September 2016, a hydrogeological inventory was produced for the Casa de Pedra mine and surroundings. This inventory consisted of the registration of springs, surges and areas of surface water capture.

At the points visited, in situ physical-chemical parameters (temperature, pH, electrical conductivity, ox-reduction potential and total dissolved solids) and flow were measured. A total of 238 points were registered comprising:

- 149 springs
- 47 surges
- 29 dry thalwegs
- 13 surface water capture points.

The following observations were made on the physical-chemical parameters:

- The electrical conductivity values were higher in the springs of intrusive rocks, schists and phyllites, and the lowest values were from the springs in quartzites
- The springs in the iron formation, in turn, showed greater variation in relation to this parameter
- The observed pH values were neutral in the entire area apart from the micro basins of the Bichento and Engenho streams, whose sources are slightly acidic.

7.3.1 Piezometers

A piezometer is a device installed at a certain depth in the ground to monitor the groundwater. It consists of a smooth tube installed in a drillhole with a filter at the tip at the depth to be investigated.

The piezometers are divided according to the lithologies associated with the filters to investigate the local depth of the water table:

- Iron formation – when all filters are installed on lithotypes of the Cauê Formation
- Mixed – when there are filters installed in the iron formation, but there are also filters installed in other lithotypes
- Others – when all filters are installed outside the iron formation.

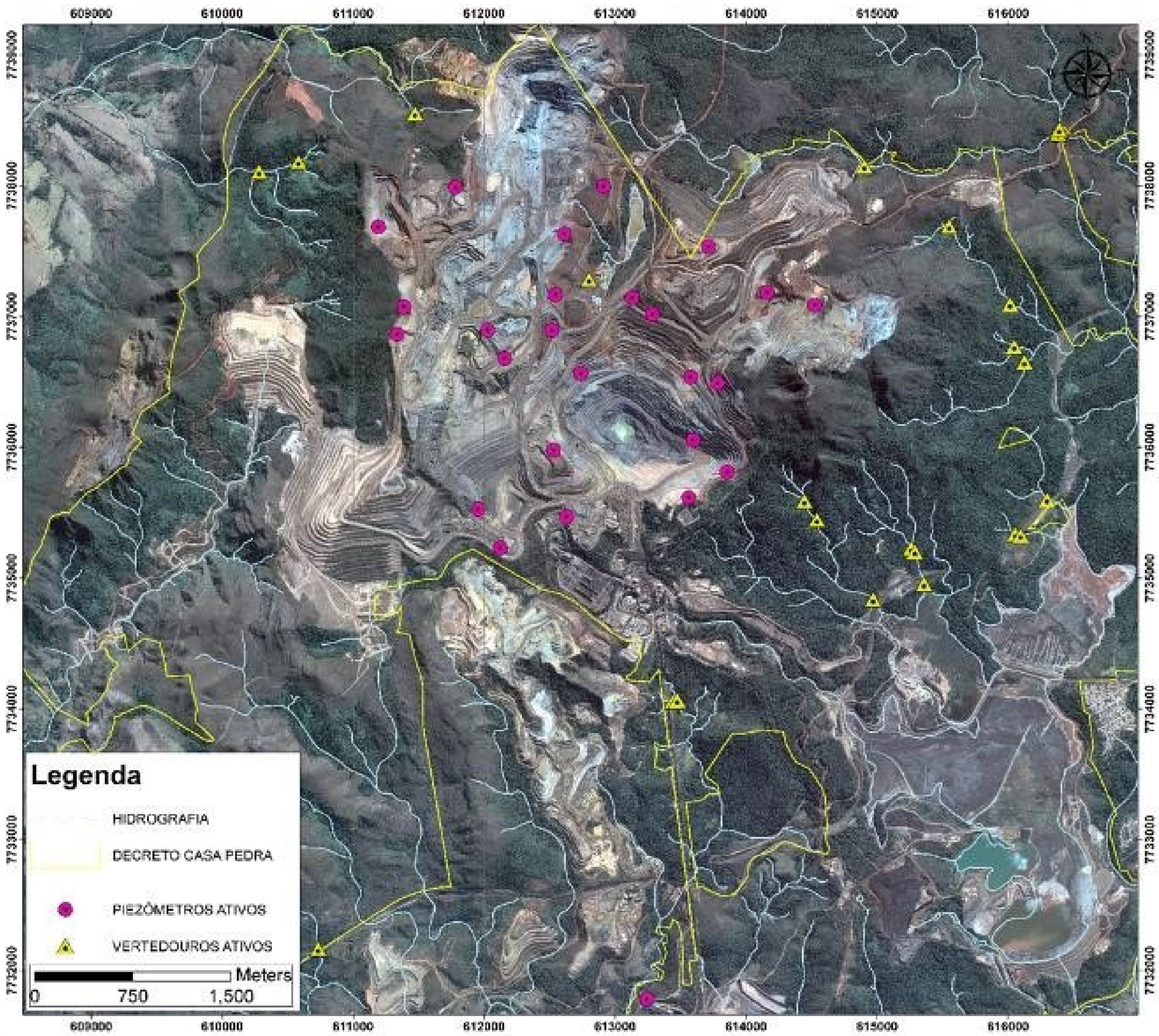
7.3.2 Spillways

In the Casa de Pedra mine area, 31 monitoring points in the surface water discharges are installed, of which 25 are spillways, and the others are for fluviometric measurements.

The monitoring of surface discharges through spillways is important. In addition to environmental monitoring, it establishes whether there is an influence of the water table lowering system in the runoff associated with the different geological units.

The most important data are from the spillways installed in water courses, whose flow is associated with the aquifer unit within the Cauê Formation where the mining activities are located. Figure 7.3 shows the monitoring sites for the current Casa de Pedra mining complex water table lowering system.

Figure 7.3 Casa de Pedra mining complex hydrogeological monitoring sites



Source: CSN – Relatório_2017_Reserve_Resource.pdf

English translation of terms in the figure: Ativos – Actives, Decreto – Mining Concession, Hidrografia- Hydrography, Piezômetro – Piezometer, Vertedouro – Spillway.

7.3.3 Recharge rating

An important application of monitoring surface flow data is obtaining base flow data and calculating groundwater recharge rates. The base flow represents the recharge of the aquifer, which is the portion of precipitation that reaches the aquifer unit and flows freely, maintaining the balance of the system. Through the water balance, the base flow, surface flow and aquifer recharge values are obtained.

Based on precipitation, temperature and global solar radiation data for the city of Congonhas (Minas Gerais state), the water balance was calculated, which generated information on potential evapotranspiration, actual evapotranspiration, surplus and soil water deficit.

After processing these data, a value of 30% was obtained for evaporation in the region of the Casa de Pedra mine. As the surface runoff is not considered in the pit (only infiltration and evaporation), the value of 70% is obtained for recharge within the pit limits.

Details are missing for the hydrogeological data and testing; therefore Snowden Optiro is unable to comment on the appropriateness of these methods.

More information is presented in Section 15 (Water management).

7.4 Geotechnical data and testing

In the 2012 to 2014 drilling campaigns, geotechnical descriptions considered the lithological contacts and geotechnical parameters of the rock (Alteration-W, Resistance-R, rock quality designation (RQD), "broken core" zones, etc.). The minimum description interval was equal to or greater than 2 m. Below this value, the descriptions were included in the predominant interval.

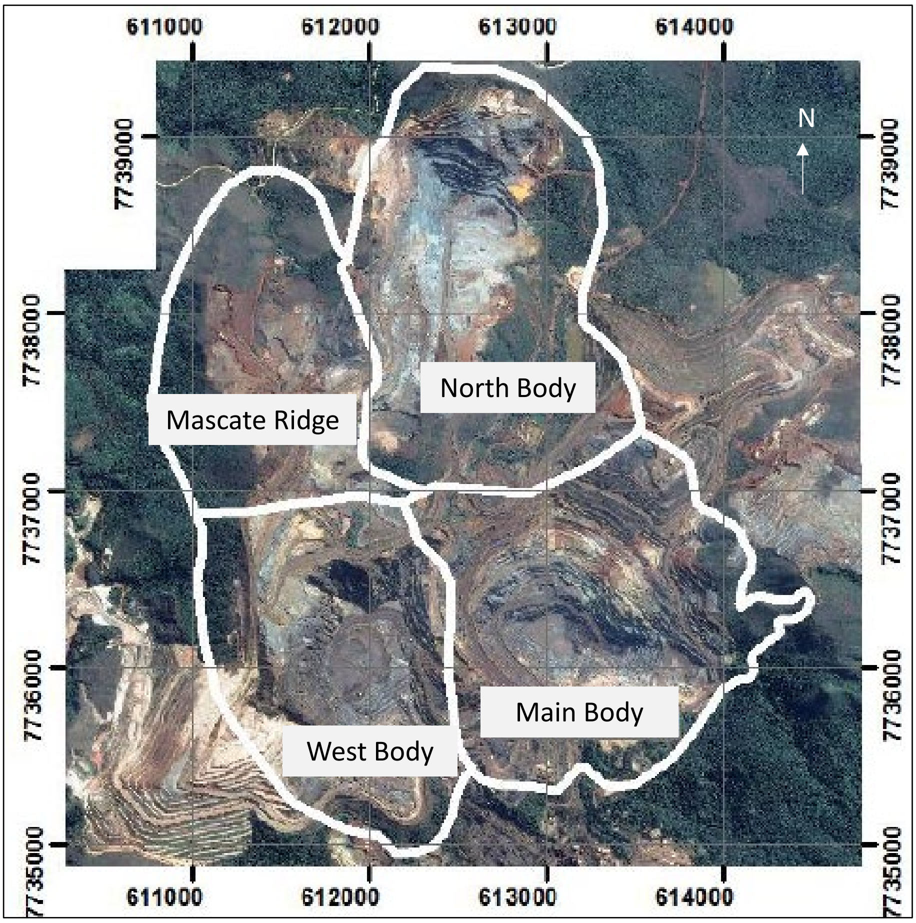
The geotechnical descriptions were based on CSN Mineração's procedures and were made by geotechnical professionals.

All descriptions were archived in physical and on digital media in the acQuire database system.

In 2015, Vogbr Recursos Hídricos & Geotecnia Ltda (Vogbr) carried out geotechnical studies for the open pit slopes. The following description was extracted from this report.

The Casa de Pedra mine is composed of four pits, identified as North Body, West Body, Main Body and Mascate Ridge (Figure 7.4).

Figure 7.4 Casa de Pedra mining complex areas

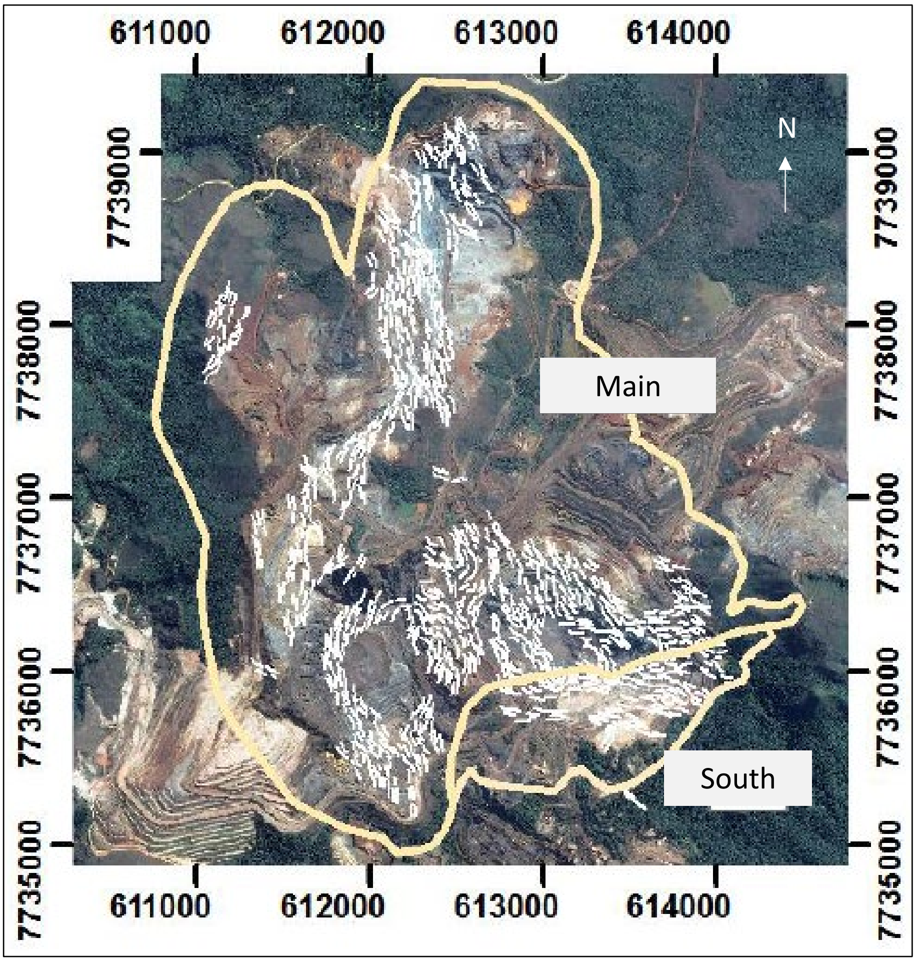


Source: Vogbr – Estudos Geotécnicos para os taludes das cavas da CSN - 2015

The estimation of rock discontinuity strength parameters was based on data from geomechanical mapping and geomechanical drill core logging.

The Casa de Pedra mining complex is divided into two structural domains (Figure 7.5). Based on these domains, the rupture models in the pit were defined.

Figure 7.5 Casa de Pedra mining complex structural domains



Source: Vogbr – Estudos Geotécnicos para os taludes das cavas da CSN - 2015

According to the geomechanical studies and stability analyses carried out, Vogbr recommended the sectorization of the pit and the adoption of maximum values for its geometry. More information is presented in Section 12.1.1 (Geotechnical considerations).

With regard to data collection, Vogbr recommended that as mining progresses and exposes new regions of the pit slope, further systematic and detailed geomechanical mapping is carried out, as well as updating the 3D geomechanical model. Vogbr also recommended that new drilling should be considered in the surrounding areas in the next drilling campaigns.

Details are missing for the geotechnical data and testing thus Snowden Optiro is unable to comment on the appropriateness of these methods.

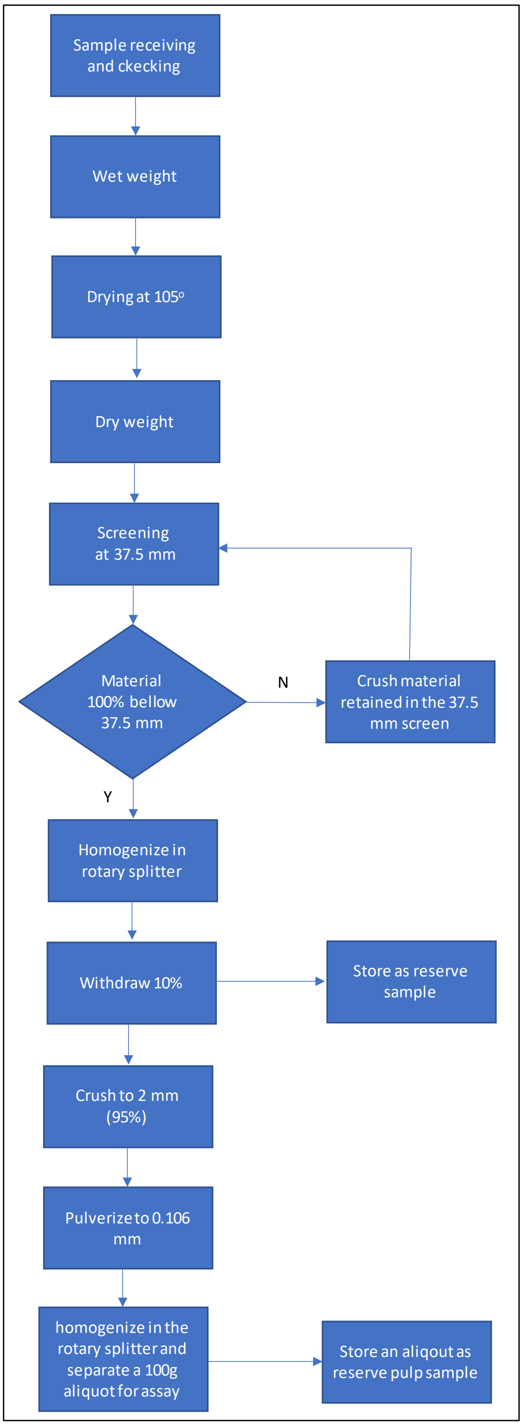
8 SAMPLE PREPARATION, ANALYSES AND SECURITY

8.1 Sample preparation

Sample preparation prior to 2012 was performed in commercial and in-house laboratories, but there are no records of flowcharts and preparation procedures.

From 2012, drill core samples were sent to two independent commercial laboratories for sample preparation: the Intertek commercial laboratory, located in Nova Lima, Minas Gerais, and the ACME commercial laboratory, located in the city of Vespasiano, Minas Gerais. Intertek's standard sample preparation flowchart is presented in Figure 8.1.

Figure 8.1 Intertek's global sample preparation flowchart



Source: CSN – Relatório_2017_Reserve_Resource.pdf

Intertek is accredited by the Inmetro (National Institute of Metrology, Quality and Technology) General Accreditation Coordination for NBR (Brazilian standard) ISO/IEC 17025 tests. ACME accreditation information is not available.

Samples are stored in the core shed located in the Casa de Pedra mining complex. No further information or details are provided on sample security.

8.2 Sample analysis

There are no references made to the analytical methods used prior to 2012.

Chemical analysis was performed at SGS GEOSOL Laboratories (SGS), a reputable independent laboratory located in Minas Gerais, Brazil for the 2012 to 2014 drilling campaign. Historical analyses were performed at the CSN Mineração in-house laboratory.

SGS Geosol Laboratory is certified by ISO 9001.

The current analyses include:

- FeO by titration (CLA80C). A solution, called titrant, is added to a sample to be analyzed. The titrant contains a known concentration of a chemical which reacts with the substance to be determined.
- Multi-element major oxide analysis is by x-ray fusion (XRF) (XRF79C), which measures the fluorescent (or secondary) x-rays emitted from a sample when excited by a primary x-ray source. Each of the elements present in a sample produces a set of characteristic fluorescent x-rays.
- Carbon and sulfur analysis is by LECO, which uses infrared absorption and thermal conductivity to measure combustion gases within a metallic sample.
- Loss-on-ignition (LOI) is determined by calcination at 405°C and 1,000°C (PHY01E). The practice consists of "igniting" (vigorous heating) a sample at a designated temperature which enables volatile substances within the sample material to escape, until the mass of the sample ceases to change.

Analyses were performed on raw sample intervals and on grain size distributions to provide quality parameters for various crushed grain size fractions.

Table 8.1 presents the theoretical precision of the analytical methods.

Table 8.1 Theoretical precision of the analytical methods

Variable	Assay method	Unit	Detection limit	Quantification limit
Al_2O_3	XRF79C	%	0.1	0.5
CaO	XRF79C	%	0.01	0.1
Fe_2O_3	XRF79C	%	0.01	0.1
K_2O	XRF79C	%	0.01	0.1
MgO	XRF79C	%	0.1	1
MnO	XRF79C	%	0.01	0.1
Na_2O	XRF79C	%	0.1	1
P_2O_5	XRF79C	%	0.01	0.1
SiO_2	XRF79C	%	0.1	1
TiO_2	XRF79C	%	0.01	0.1
LOI	PHY01E	%	0.01	0.1
FeO	CLA80C	%	0.14	1.4

Source: CSN – Relatório_2017_Reserve_Resource.pdf

Detection limit is the lowest concentration of a substance that can be detected, but not necessarily quantified, by the method used.

Quantification limit is the lowest concentration of a substance that can be quantitatively determined with precision and accuracy by the method used.

8.3 Quality control and quality assurance (QAQC)

QAQC procedures were implemented in 2012 and there are no records of any prior procedures and controls.

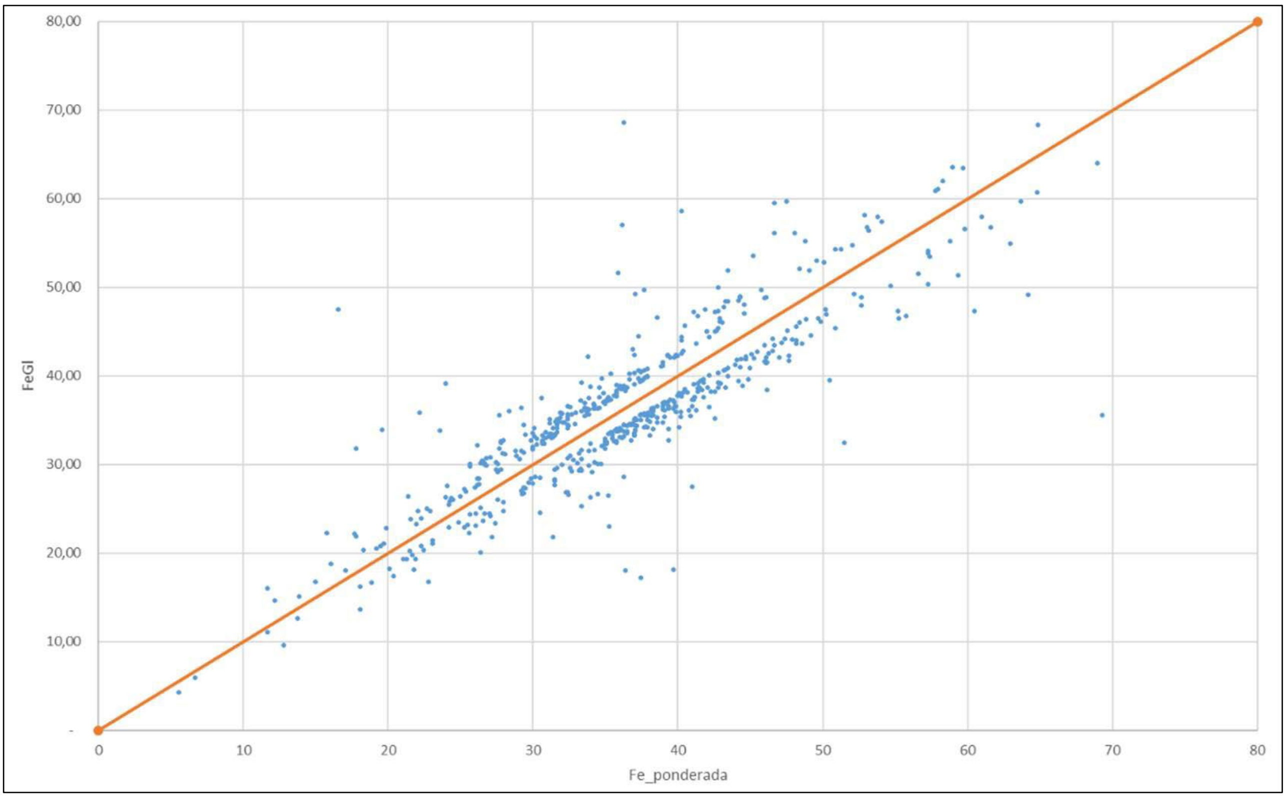
8.3.1 QAQC for sample preparation

For the 2012 to 2014 drilling campaigns, QAQC tools were not used to assess the physical preparation process (grinding and mass reduction), and screening tests were not performed.

The general practice for iron ore mining is to analyze the raw drill core sample (global/original sample) and perform the standard test (also known as granulometric test, size fraction test or processing test). The standard test consists of a series of crushing and screening steps aimed to simulate the products by granulometric fraction (or range) that will be generated in the processing plant.

A total of 2,657 granulochemical samples were prepared, of which 575 returned more than 5% difference between the global and weighted analysis of the granulometric size fractions. Figure 8.2 shows the correlation graph between the Fe% from the global analysis and the Fe% from the weighting of the size fractions. The plotted points show a relative difference of more than 5%, that indicates problems in the global or size fraction sample preparation or both, which should be investigated and corrected by CSN Mineração.

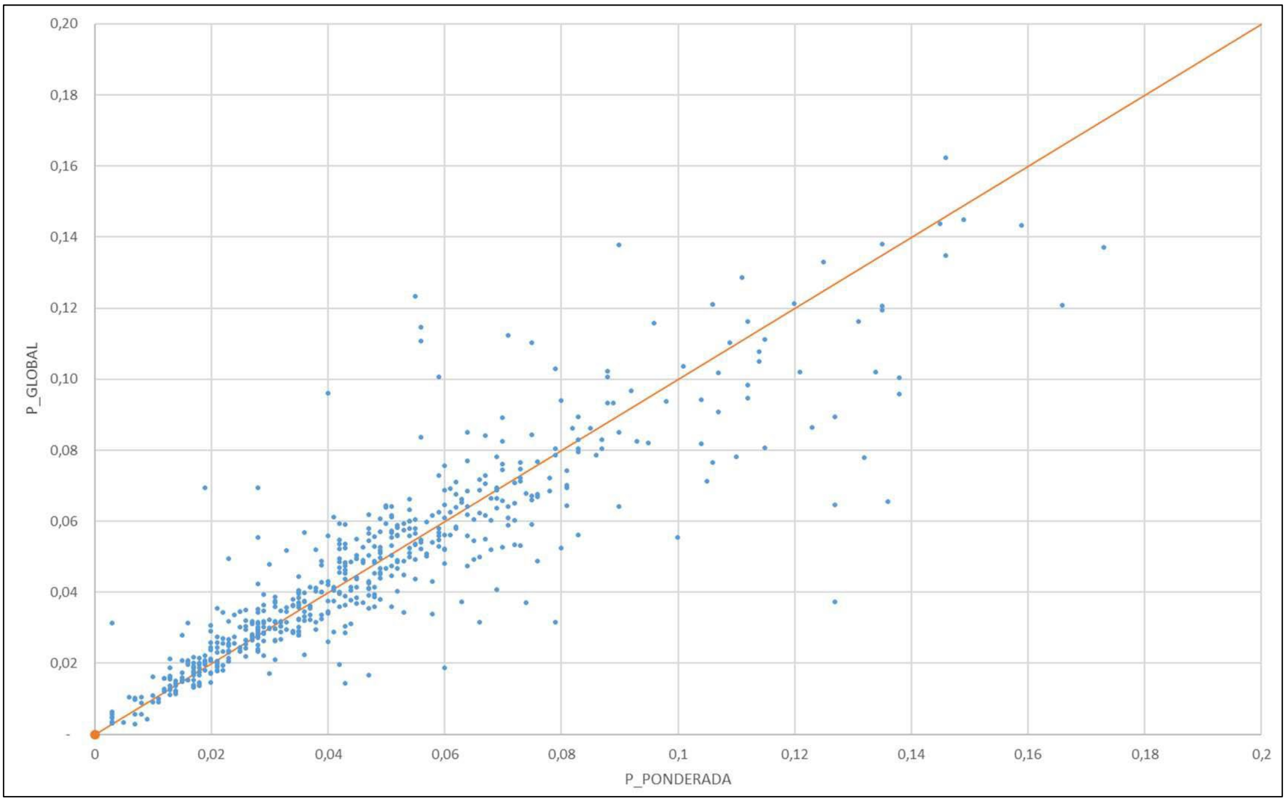
Figure 8.2 Correlation graph between global Fe% and Fe% weighted by granulometric ranges



Source: CSN - Relatório_2017_Reserve_Resource.pdf

To evaluate the impact of sample preparation by size fraction on the weighted analysis of contaminants, the correlation of global P% with weighted P% was used. The graph in Figure 8.3 indicates problems of homogenization for smaller elements, since there is low precision between the global analysis of the contaminant and the weighted size fraction values.

Figure 8.3 Correlation graph between global P% and P% weighted by granulometric ranges



Source: CSN – Relatório_2017_Reserve_Resource.pdf

Comparing the sample mass (core shed weight) with the mass at the beginning of the sample preparation process, sample swaps were identified, considering an absolute difference of more than 2 kg.

Comparing the initial mass of the granulometric size fractions with the initial mass of the global sample, swaps were identified, considering an absolute difference of more than 5 kg.

The results indicate that the process of physical preparation of the campaigns from 2012 to 2014 returned 28% errors, much higher than the accepted 5% difference.

8.3.2 QAQC for sample analysis

During the 2012 to 2014 drilling campaigns, CSN Mineração introduced QAQC practices that included use of blank samples, certified reference materials (CRMs) (standards), laboratory pulp duplicates and check assays. There was no “in time” quality control, therefore sample failures were not investigated to identify the reason for the failure. However, QAQC results were considered in the resource classification procedure adopted by CSN Mineração, as batches with failures in QAQC results were considered of less confidence in the resources classification methodology.

Table 8.2 shows the rate of QAQC sample insertion. Frequency of inserted samples was calculated based on the number of samples from the 2012, 2013 and 2014 campaigns (2,424 samples were analyzed for global elements and 10,854 samples for elements per size fraction).

Table 8.2 Rate of QAQC sample insertion

Tool	Rate of insertion
Blank	11%
Standards	6%
Pulp Duplicate	6%
Check Assay	4%

Source: CSN – Relatório_2017_Reserve_Resource.pdf

The practices concerning blank sample production was not clearly documented, therefore the results were considered unreliable and were disregarded for the purpose of this technical report summary.

Accuracy monitoring requires the use of standards, also known as CRMs. The standards chosen should have a concentration of the element for property of interest, similar to that expected in the samples. It is preferable to use several standards that bracket the range of values expected on the samples. Commercially prepared standards are supplied with the accepted value, confidence limits and an acceptable failure rate.

CSN Mineração generated two matrix-matched CRM standards. The CRMs were labeled 1CNIB (pale itabirite goethite bands) representing a very low-grade (15.90% Fe) standard and 1CNHB (powdery grey hematite) representing a high-grade (65.64% Fe) standard. The CRMs were generated by SGS Geosol in 2013 using standard industry practices for certification. The low-grade CRM (1CNIB) provided a minimal value for quality control purposes due to its much lower grade than expected in mineralized lithotypes. The evaluation of the accuracy of the assays using the high-grade 1CNHB standard was done for Fe, SiO_2, Al_2O_3, P and LOI. Other variables for this standard were below the detection limit for the analytical method. Table 8.3 summarizes the results of the 1CNBH analysis. Ninety-five percent of the results are expected to be within the stipulated minimum and maximum limits.

Table 8.3 Results of the 1CNBH standard analysis

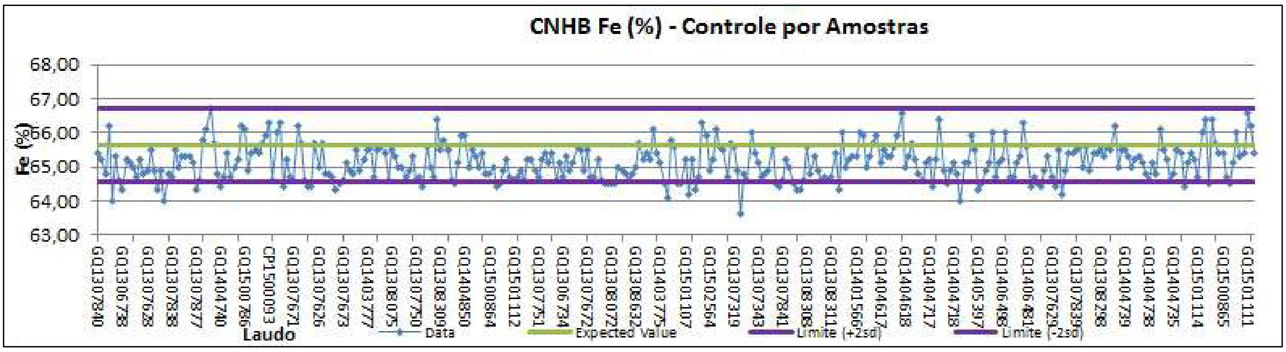
Variable	Expected value (%)	Minimum (%)	Maximum (%)	No. of standard samples	Minimum (%)	Maximum (%)	Average (%)	% Within limits
Fe	65.64	64.54	66.74	332	66.70	63.60	65.13	86.45%
SiO_2	3.22	3.01	3.44	332	4.25	3.08	3.25	97.59%
Al_2O_3	1.99	1.9	2.08	332	2.15	1.89	2.00	93.37%
P	0.0278	0.01	0.02	332	0.028	0.02	0.03	87.86%
LOI	0.82	0.58	1.06	332	1.73	0.62	0.88	94.59%

Source: CSN – Relatório 2017_Reserve_Resource.pdf

The Fe results for 86.45% of the 1CNHB standard in sample batches from the 2012 to 2014 drilling campaigns were within limits.

Figure 8.4 shows standard control graph results for 1CNHB in sample batches from the 2012 to 2014 campaigns.

Figure 8.4 Control graph for Fe in standard 1CNHB



Source: CSN - Relatório_2017_Reserve_Resource.pdf

Precision monitoring requires the use of duplicates. Duplicates are used to make sure that the assay is repeatable. The re-assay needs to be sufficiently similar to the original result to give confidence in the repeatability of the sample.

Pulp duplicates were obtained by splitting the original pulverized sample. The duplicate was then renumbered and inserted blindly in the same analytical batch with the original sample.

To evaluate the precision of laboratory analysis, the concept of HARD (Half Absolute Relative Difference) was used. It is generated by calculating |x1-x2|/(x1+x2) expressed as a percentage and sorted from smallest to largest. Pairs that are identical will give a value of 0% and values completely different (i.e. 0 and 1) will give a value of 100%. As a rule of thumb, pulp duplicates should have 90% less than 10% difference.

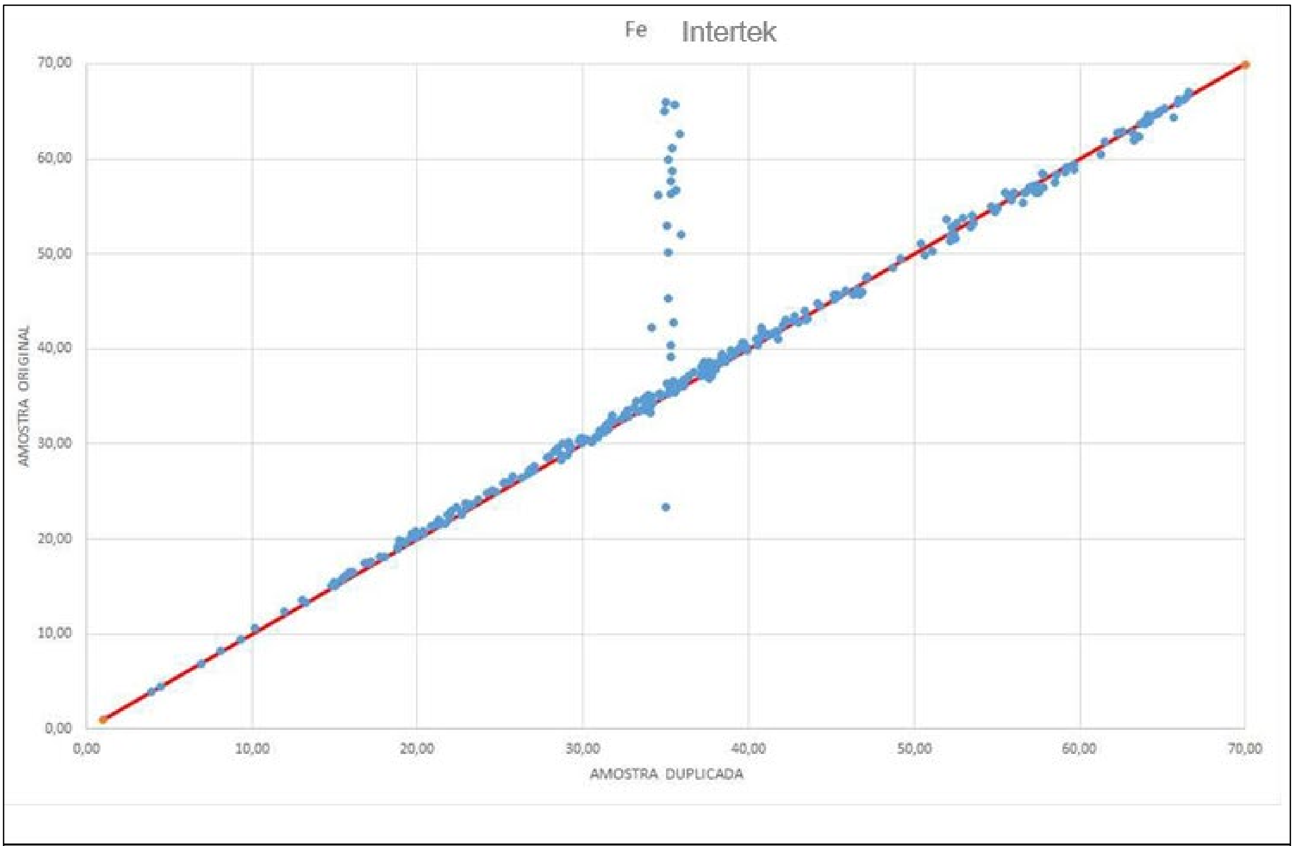
Duplicate assay average results for Fe and SiO_2 are 90% less than the 10% difference. Al_2O_3, Mn, P and LOI returned average results lower than 90%. Poor repeatability can point to small samples being taken, insufficient crushing before splitting, insufficient pulverizing before splitting, contamination or inaccurate assay equipment.

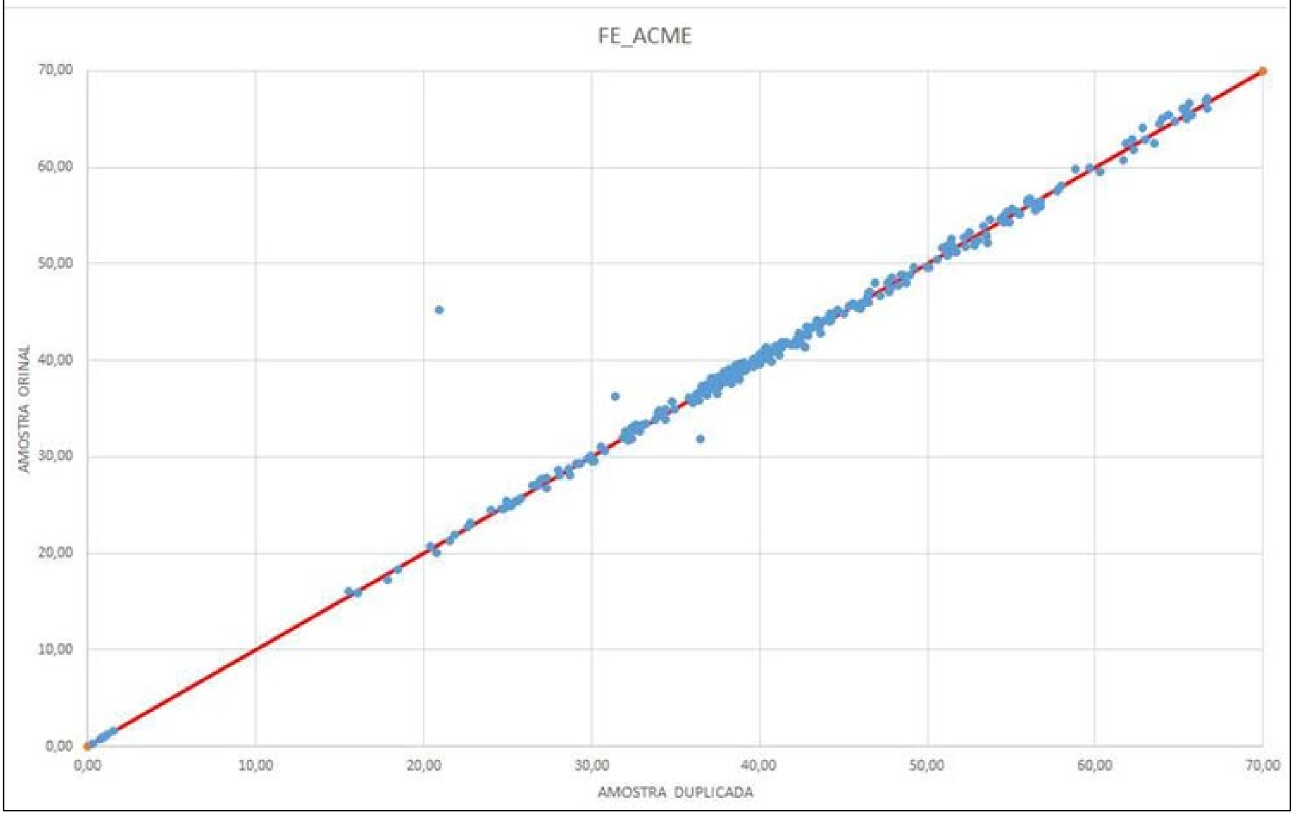
To assess the reproducibility of the analytical results, rejects from the original sample were sent to a secondary laboratory. The check assaying was performed at ACME laboratories in Vespasiano, Minas Gerais and Intertek in Cotia, Minas Gerais. The batches consisted of varying numbers of samples, with a total of 567 duplicate samples sent for analysis.

Correlation graphs were produced to analyse the differences. Samples swaps were identified in the batches sent to Intertek and ACME laboratories, although it was not possible to conclude whether the swap was made during the physical preparation (which would compromise the batch of original samples) or when sent to the secondary laboratory. At Intertek, 99% of the swapped samples belonged to a single preparation batch (CDP-13Q/0048). At ACME, samples exchanges were identified in three batches (EGFD13002-010-B, EGFD13002-012-A and FEFD13009-007-E) (Figure 8). Except for these problems, reproducibility for Fe, SiO_2 and Al_2O_3 were at a satisfactory level and confirmed the SGS assays.

In the analytical batch BHZ13000214, a significant bias was identified for the Mn and P in ACME assays. CSN Mineração should complete the analysis of Intertek and ACME check assay results for Mn, P and LOI for all batches available.

Figure 8.5 Correlation graph between original sample (amostra original) and check assay duplicate (amostra duplicata) for Fe (Intertek and ACME)





Source: CSN – rel_qaqc_revDD.pdf - 2017

8.4 Qualified person's opinion

Snowden Optiro qualified person's conclusions and recommendations on the sample preparation, analytical and QAQC practices of CSN Mineração are:

- There has been a variety of sampling and analytical testing at Casa de Pedra mining complex going back multiple decades. Both internal and external laboratories have been utilized with the most recent work (2012 to present) focused on use of Intertek and ACME laboratories for all sample preparation and the SGS laboratory for analytical work. Intertek, ACME and SGS Geosol are widely recognized laboratories in the Brazilian mining industry and the results for CSN Mineração's sample preparation and chemical analyses are recognized by Snowden Optiro.

- For the drilling campaigns prior to 2012, there were no QAQC practices applied. CSN Mineração attempted to validate these campaigns by drilling holes close to old ones (twin holes), but with insufficient and inconclusive results.
- During the 2012–2014 campaigns, CSN Mineração introduced a QAQC program. There was no "in time" quality control and sample failures were not investigated to identify the reason for the failure. However, the QAQC results were considered in the resource classification procedure adopted by CSN Mineração, as batches of results with failures were considered of less confidence in the resource classification methodology, which the qualified person considers mandatory and good practice.
- Practices concerning blank samples production were not clearly documented, therefore the results are considered unreliable and should be disregarded.
- The CRMs are satisfactory for use, although the low-grade CRM provides minimal value for quality control purposes and should be replaced with a mid-grade or near cut-off grade standard (i.e. ~ 30% Total Fe). A mid-grade or near cut-off grade standard will aid in providing confidence in the analytical data near the economic cut-off grade and should include an appropriate mix of deleterious elements aligned with standard values observed at the Casa de Pedra mining complex.
- Check assays at the Intertek and ACME laboratories indicate reproducibility for Fe, SiO_2 and Al_2O_3 are satisfactory and confirm the SGS assays. In the analytical batch BHZ13000214, a significant bias was identified for Mn and P in the ACME assays. CSN Mineração should complete the analysis of Intertek and ACME check assay results for Mn, P and LOI for all batches available.
- Certain information in the QAQC report should be more detailed, such as number of samples per batch, information on whether standard samples were sent blindly to the laboratories or not, and clearly state that QAQC insertion rates are based on global or size fraction sample batches.

CSN Mineração did not present proper quality assurance and quality control documentation, procedures, data, interpretation, and reanalyzes. For future drilling, the qualified person recommends that QAQC procedures should be described (including clear definition of tolerances and unconformities), the results more clearly presented, and QAQC results consistently monitored as part of an ongoing process. The monitoring should be done during exploration programs so that analytical flaws can be quickly identified, investigated, and remedied.

9 DATA VERIFICATION

9.1 Data verification procedures

The drillhole database used for resource modelling was prepared using acQuire software. The data contained in this database was frozen on 18 August 2016.

From this, a database was imported in GEMS software, which consisted of collar, survey, lithology, assay, rotary drilling manoeuvres (drilling bulletin), granulometric and granulochemical analysis and bulk density tables.

As part of its 2021 audit, SRK reviewed all geological data provided including:

- The drillhole database dated 18 August 2016
- Thirteen geological wireframes
- Resource block model coded by lithology
- Supporting geological publications and internal CSN Mineração documents summarizing the Casa de Pedra geology.

SRK conducted an extensive data validation exercise based on a comparison of the CSN Mineração provided database (18 August 2016) with the original analytical certificates from 2012 through to 2014, provided by SGS Geosol Laboratories.

The database included 900 drillholes completed on the property between 1962 and 2014. Each sample interval may contain up to 14 subsamples based on various grain size distributions from grinding. SRK focused on the global values as the primary attributes used for mineral resource estimation. The global values represent the total sample and not a subset from grinding or processing. Granulometric fractions were not validated.

A total of 52,033 unique values were reviewed based on the sample intervals, various granulometric fraction and multiple analytical variables. In summary, 98.5% of the data was validated between the 2012–2014 campaigns including the laboratory certificates. Of these, 676 entries did not match the values between the CSN Mineração assay database and original assay certificates.

9.2 Limitations on data verification

For drilling campaigns executed before 2012, analytical certificates are unavailable with the historical samples analyzed in-house with no certificates produced. Therefore, a data validation was not possible.

The granulometric fraction database was not validated by SRK or Snowden Optiro.

9.3 Qualified person’s opinion

In accordance with SRK’s review, for which Snowden Optiro’s qualified person agrees, the overall database for drilling campaigns between 2012 and 2014 is considered satisfactory for use in mineral resource estimation. The qualified person recommends CSN Mineração corrects the discrepancies identified.

For the drilling campaigns executed before 2012, the samples were analyzed in-house with no analytical certificates produced. Therefore, a data validation was not possible.

SRK focused on the global (GL) values as the primary attributes used for mineral resources definition. The GL values represent the total sample and not a sub-set from grinding or processing. Granulometric fractions were not validated.

Details are missing for the collar and downhole survey methods and accuracies therefore Snowden Optiro was unable to comment on the appropriateness of these data and methods.

10 MINERAL PROCESSING AND METALLURGICAL TESTING

10.1 Testing and procedures

Conventional industry practice is to analyze the global or original drill core sample and also to perform standard tests consisting of a series of crushing and screening steps aimed at simulation of the products by granulometric/size fraction (or range) that will be generated in the processing plant. It is also important to consider if the test is on a wet, dry basis or both.

CSN Mineração's core sample preparation prior to 2012 was performed in commercial and in-house laboratories, but there are no records of flowcharts and preparation procedures related to the global or processing tests.

From 2012, drill core samples were sent to the Intertek commercial laboratory, located in Nova Lima, Minas Gerais, and the ACME commercial laboratory, located in the city of Vespasiano, Minas Gerais, for physical preparation. Table 10.1 shows number of size fraction samples through the years.

Table 10.1 Drilling information and samples size fraction per campaign

Data category	Year	No. of drillholes	No. of samples	No. of size fraction samples
Historical data	1962	5	441	NA
	1963	17	636	NA
	1964	24	833	NA
	1965	5	46	NA
	1969	3	23	NA
	1972	32	303	NA
	1973	3	31	NA
	1974	16	77	NA
	1980	49	NA	NA
	1983	10	19	NA
	1984	7	20	NA
	1985	14	39	NA
	1986	14	67	NA
	1987	8	79	NA
	1988	10	19	NA
	1989	7	32	NA
	1990	4	26	NA
	1991	6	19	12
	1993	38	607	229
	1996	14	412	414
	1997	15	158	164
	1998	77	1,205	1,263
	1999	17	325	325
	2000	17	254	254
	2001	14	NA	NA
	2002	13	190	190
	2003	75	1,301	1,301
	2004	9	129	129
	2005	29	255	255
	2007	10	134	134
	2008	45	508	508
	2009	35	265	263
	2010	68	391	390
	Total	**710**	**8,844**	**5,831**

Data category	Year	No. of drillholes	No. of samples	No. of size fraction samples
Recent data	2012	8	212	98
	2013	81	1,793	867
	2014	101	1,957	926
	Total	**190**	**3,962**	**1,891**
TOTAL (Historical + Recent)		**900**	**12,806**	**7,722**

NA – Not available.

Source: CSN – Relatório_2017_Reserve_Resource.pdf

10.2 Sample representativeness

During the years of operation of the Casa de Pedra mining complex there were significant changes in the sampling strategies, mainly in relation to the granulometric intervals analyzed in the drill core samples. This diversity is explained, in part, by the evolution of the specifications of the mineral products sold and by the technological changes in the beneficiation process over the decades. This resulted in a heterotopic (incomplete) database, due to the presence of samples without all the chemical variables analyzed, as well as a variation between the granulometric ranges obtained over the years.

For this reason, CSN Mineração defined three main granulometric ranges (or fractions) representative of the main products: lump (+6.3 mm), sinter feed (-6.3 mm +0.15 mm) and pellet feed (-0.15 mm). The range -6.3 mm +0.15 mm was obtained by compositing the -6.3 mm +1.0 mm and -1.0 mm +0.15 mm range, and part of the fraction data was obtained by regression from one range to the other. It is unclear if the sum of the size fractions were validated to add up 100% in the database and also in the estimated variables in the block model.

CSN Mineração also calculated correlations between chemical variables in size fractions to obtain an isotopic database (with all variables in the same position in space). This was carried out through regression of the missing elements by the existing elements of greater correlation. This methodology was also applied for global TiO_2%, CaO% and MgO%.

10.3 Qualified person’s opinion

The granulometric fraction database and estimation were not validated by SRK or Snowden Optiro. This validation must be done and documented as soon as possible by CSN Mineração and independently audited.

CSN Mineração should check, and report, whether the sum of the size fractions was validated to add up 100% in the database, considering the test results and the ones calculated by regression, and also the estimated variables in the block model.

Assumptions and validations of stoichiometric closure should also be clearly reported.

It should be clearly stated from which drilling campaigns partial size fraction where calculated due to lack of the size fraction information (mass recovery and chemical variables), especially for 2012 to 2014 campaigns which are the most significant in terms of measured resource classification.

CSN should perform screening tests with all screens of interest and use this result as a basis for calculating missing gaps in size fraction information rather than relying on regression calculations.

Snowden Optiro recommends that the recovery and assay results by size fraction for the mineral resource model be supported by a reconciliation study, including masses and chemical grades.

The granulometric fraction estimation of quality variables are complex with some areas of the mineral resource reliant on historical data that has been modified to account for the changing particle size bins over time. As the quality of the various size fractions are required for mineral reserve calculations and cash flow determination, the fundamental assumptions associated with determining size fraction quality require detailed review.

11 MINERAL RESOURCES

11.1 Mineral resource estimation criteria

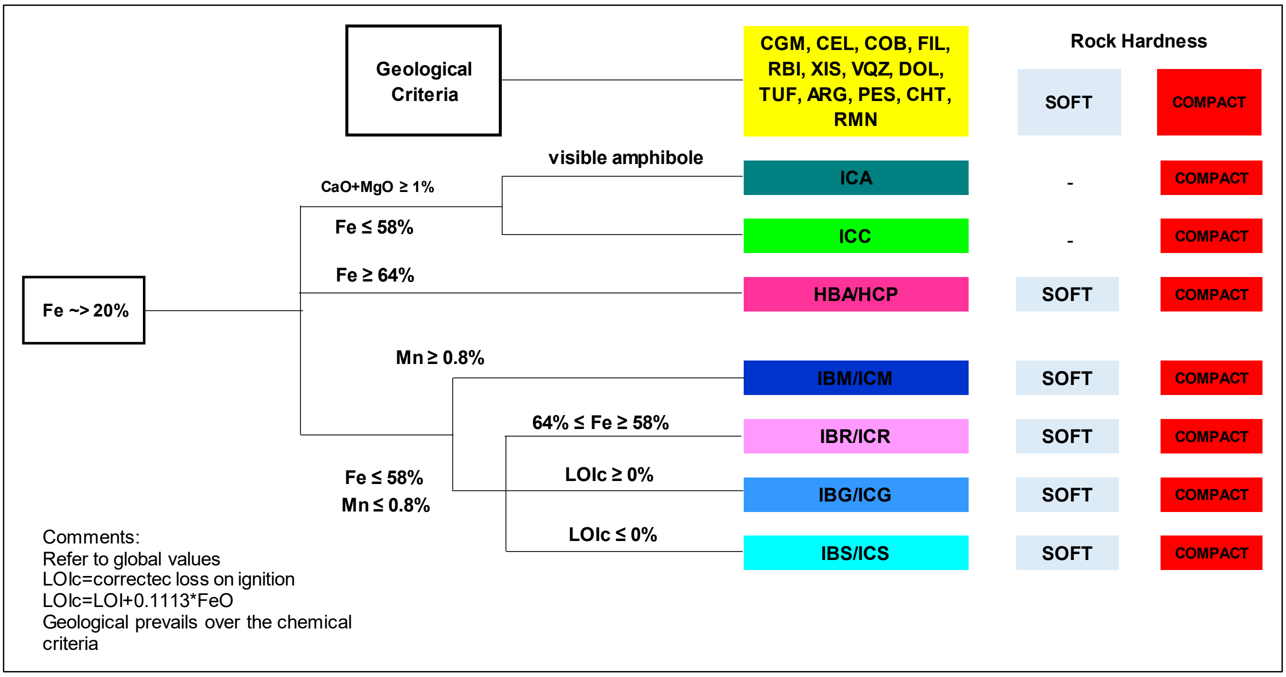
Geological modeling, grade estimation and mineral resource classification were performed considering a set of factors, including the amount and spacing of available data, the interpreted mineralization controls, mineralization style and the quality of the data used. The estimate was made in portions limited by the geological interpretations and the extent of the mining rights.

11.1.1 Geological model and interpretation

Lithological types definition

Based on field knowledge and chemical analysis, a decision diagram was developed to define the lithologies to be modeled (Figure 11.1).

Figure 11.1 Decision diagram for lithological definition



Source: CSN – Relatório_2017_Reserve_Resource.pdf

CSN Mineração classifies the drilling data into a series of lithology codes based on a combination of grain size (lump and fines) and chemical thresholds. These codes are based on the following criteria:

- HBA/HCP: Hematite with ≥ 64% Fe is hematite.
- IBR/ICR: Itabirite between 64% and 58% Fe is rich itabirite.
- IBS/IBC: Itabirite with <58% Fe is deemed silica itabirite or other itabirites. Rocks below about 20% are deemed as waste.
- IBM/ICM: Itabirite with <64% Fe and MnO >0.8%.
- ICC: Itabirite with >20% Fe and CaO and MgO contents above 1%.
- Hard or Soft material: Based on the sum of the granulometric size fractions F1 (>12.5 mm) and F2 (6.3 mm) with values >70% considered hard (compact). Values less than 70% are coded as soft (brando).

The classifications used by CSN Mineração represent a combination of several attributes that are applicable to the products sold and are considered satisfactory for the domaining of iron oxide deposits.

Snowden Optiro qualified person's opinion

Based on SRK's review, the lithological classification appears acceptable for resource estimation as they represent discrete and mineable volumes. Snowden Optiro agrees with SRK opinion.

There is minor risk involved with the breakdown of domains using Total Fe. Zones that are not constrained by surrounding lower grade data will likely display extrapolated volumes away from data and have the potential to unrealistically increase tonnage above the cut-off grade due to unsupported volumetric blow-outs in the geological model.

A combination of grade shell/indicator shell techniques coupled with broader 3D wireframe geology to improve the key ore-bearing zones of HBA/HCP and IBR/ICR is recommended.

Geological model

Modeling was performed based on surface mapping data, drill core logging data and lithogeochemical classification of the drill core samples (Table 11.1).

Table 11.1 Casa de Pedra mining complex rock types and rock codes

Mineralized lithologies			Waste		
Rock type	Rock code	Description	Rock type	Rock code	Description
HBA	1	HEMATITA BRANDA (Soft Hematite)	SOL	17	SOLO/LATERITA ARGILOSA (Soil/Clayey Laterite)
HCP	2	HEMATITA COMPACTA (Compact Hematite)	ATE	18	ATERRO/PILHA DE MINÉRIO (Landfill/Mineralized Material Pile)
ICR	3	ITABIRITO COMPACTO RICO (Rich Compact Itabirite)	TUR	19	TURFA (PEAT)
IBR	4	ITABIRITO BRANDO RICO (Rich Soft Itabirite)	ARG	20	ARGILA/ARGILITO (Clay/Slate)
IBS	5	ITABIRITO BRANDO SILICOSO (Soft Siliceous Itabirite)	PES	21	PILHA DE ESTÉRIL (Waste Pile)
ICS	6	ITABIRITO COMPACTO SILICOSO (Compact Siliceous Itabirite)	FILC	22	FILITO COMPACTO (Compact Phyllite)
IBC	7	ITABIRITO BRANDO CARBONÁTICO	FILB	23	FILITO BRANDO (Soft Phyllite)
ICC	8	ITABIRITO COMPACTO CARBONÁTICO (Compact Carbonate Itabirite)	XISC	24	XISTO COMPACTO (Compact Schist)
IBM	9	ITABIRITO BRANDO MANGANESÍFERO (Soft Manganese Itabirite)	XISB	25	XISTO BRANDO (Soft Schist)
ICM	10	ITABIRITO COMPACTO MANGANESÍFERO (Compact Manganese Itabirite)	DOLC	26	ROCHA CARBONÁTICA COMPACTA (Compact Carbonatic Rock)
IBG	11	ITABIRITO BRANDO GOETHÍTICO (Soft Goethitic Itabirite)	DOLB	27	ROCHA CARBONÁTICA BRANDA (Soft Carbonatic Rock)
ICG	12	ITABIRITO COMPACTO GOETHÍTICO (Compact Goethitic Itabirite)	QTZC	28	QUARTZITO COMPACTO (Compact Quatzite)
ICA	13	ITABIRITO COMPACTO ANFIBOLÍTICO (Compact Amphibolitic Itabirite)	QTZB	29	QUARTZITO BRANDO (Soft Quatzite)
IBA	14	ITABIRITO BRANDO ANFIBOLÍTICO (Soft Amphibolitic Itabirite)	RBIB	31	ROCHA BÁSICA INTRUSIVA BRANDA (Soft Basic Intrusive Rock)
CEL	15	COLÚVIO/ELÚVIO (Colluvium/Eluvium)	RBIC	32	ROCHA BÁSICA INTRUSIVA COMPACTA (Compact Basic Intrusive Rock)
CGM	16	CANGA DE MINÉRIO (Ferriferous Canga)	GRGC	33	GRANITO GNAISSE COMPACTO (Compact Granite Gneiss)
BRS	30	BRECHA SEDIMENTAR MINERALIZADA (Mineralized Sedimentary Breccia)	GRGB	34	GRANITO GNAISSE BRANDO (Soft Granite Gneiss)
			VQZ	35	VEIO DE QUARTZO (Quartz Vein)
			CHTB	37	CHERT BRANDO (Soft Chert)
			CHTC	38	CHERT COMPACTO (Compact Chert)
			RMNC	41	ROCHA MANGANESÍFERA COMPACTA (Compact Manganese Rock)
			RMNB	42	ROCHA MANGANESÍFERA BRANDA (soft Manganese Rock)

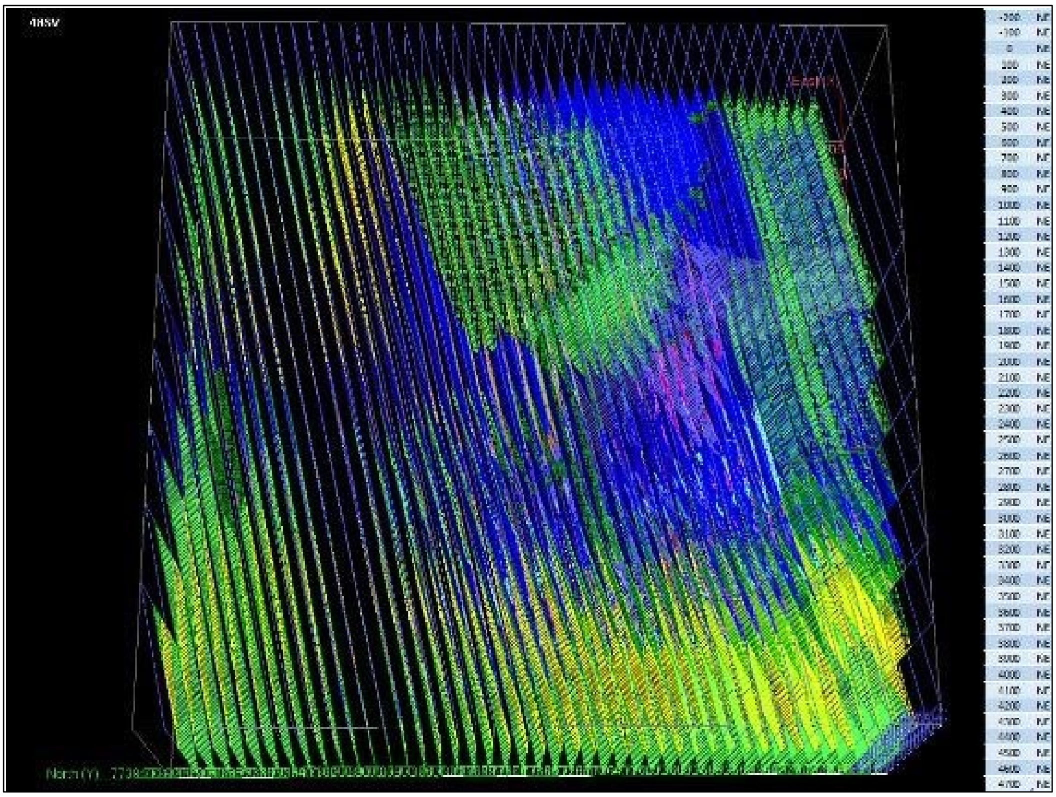
Source: CSN 2022 – ROCKCODE.xls

The geological model was created in GEMS software (Geovia GEMS 6.8) which is based on explicit modeling using vertical and horizontal sections. The contacts determined in the drill cores logging were interpolated to generate top and bottom surfaces of the layers.

Fifty vertical cross sections were created and interpreted along a northeast-southwest direction, with a spacing of 100 m between them (section -200 NE to 4700 NE) and a clipping of 50 m.

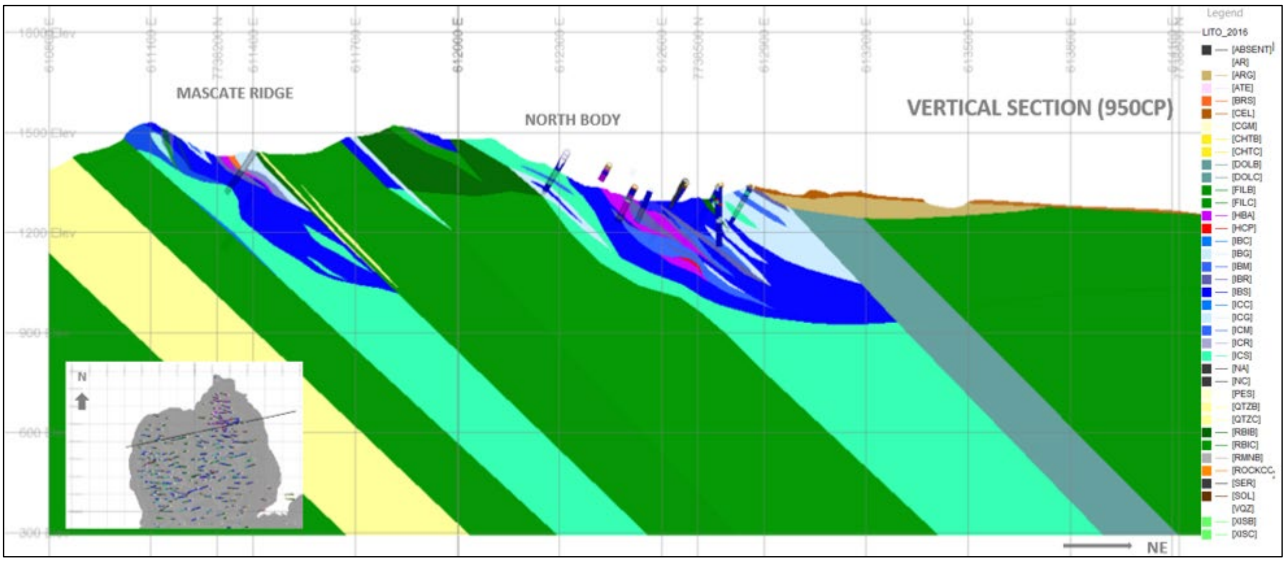
The location of the vertical sections is shown in Figure 11.2 to Figure 11.5 show representative cross sections through the Casa de Pedra mining complex.

Figure 11.2 Casa de Pedra mining complex vertical geological sections



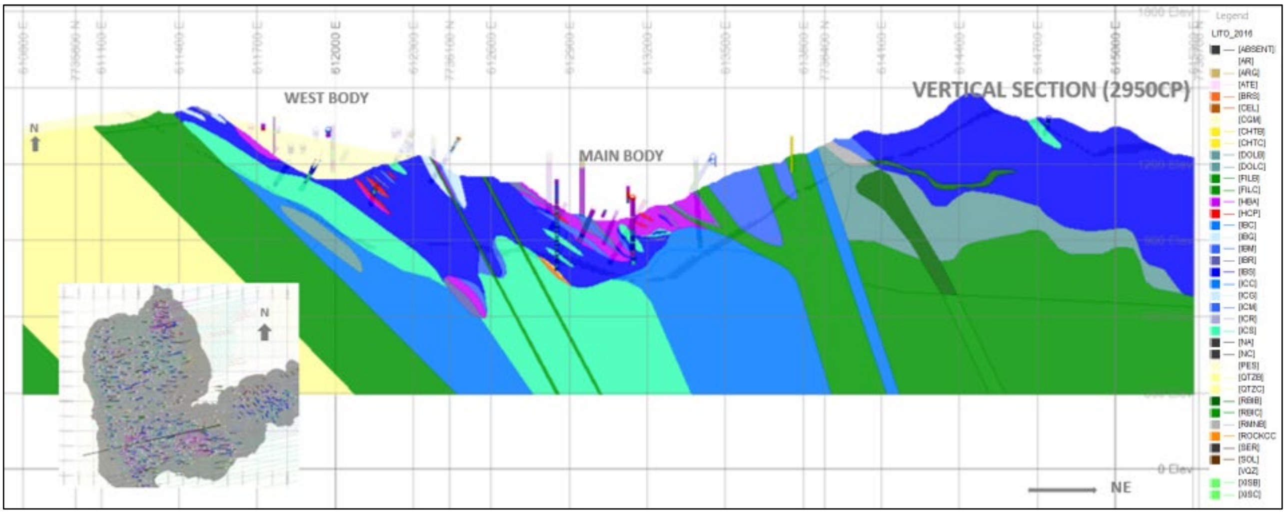
Source: CSN – Relatório_2017_Reserve_Resource.pdf

Figure 11.3 Vertical section 950CP – Casa de Pedra mine (legend in Table 11.1)



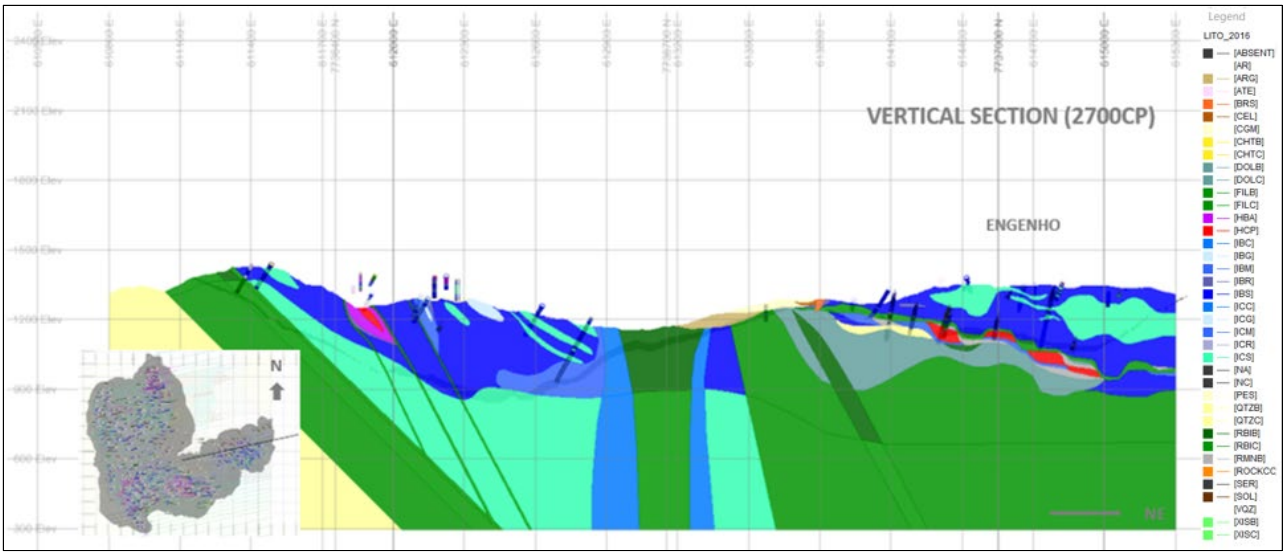
Source: CSN, 2022

Figure 11.4 Vertical section 2950CP – Casa de Pedra mine (legend in Table 11.1)



Source: CSN, 2022

Figure 11.5 Vertical section 2700CP – Engenho mine (legend in Table 11.1)



Source: CSN, 2022

One hundred and five horizontal sections were created and interpreted, ranging from level 300.5,652.5 and spaced every 13 m.

11.1.2 Block modeling

The horizontal sections were extruded midway between them (6.5 m for the top and 6.5 m for the bottom) to generate the geological solids. These solids were used to define the lithologies in the block model. The block dimensions are:

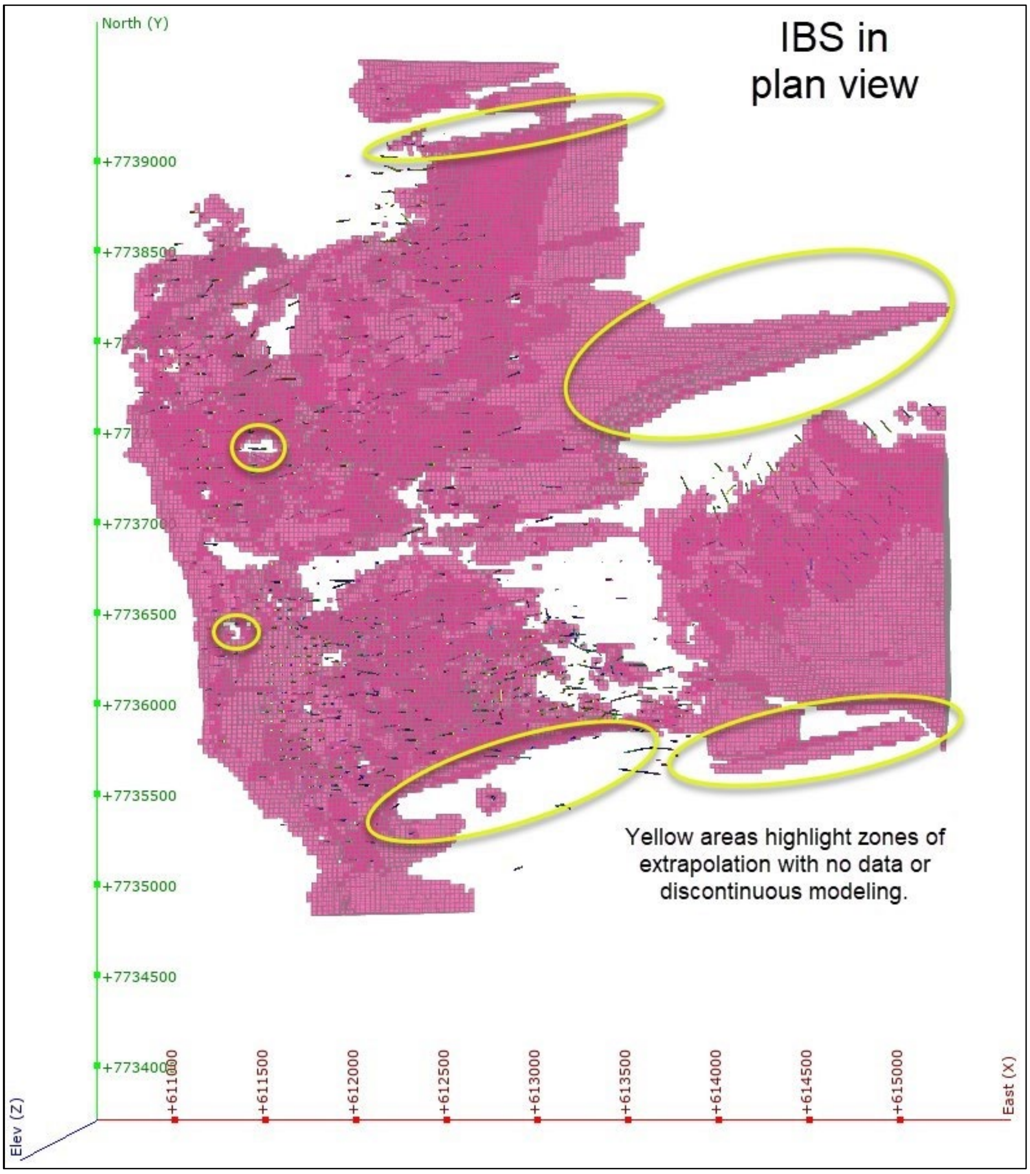
- Column size – 25 m
- Row size – 25 m
- Level size – 13 m.

Snowden Optiro qualified person's opinion

The qualified person agrees with SRK's audit review, which states that due to software restrictions, CSN Mineração does not produce 3D wireframe volumes. By not producing 3D wireframes, CSN Mineração cannot perform an accurate volumetric check and ensure continuity in 3D prior to coding the resource block model. This represents a low to medium risk to the mineral resource tonnage. SRK performed visual checks of the block model containing rock codes along various sections for conformity and continuity with the drill logs.

In general, the modeled lithology provided a satisfactory representation of the drill logs. Although the block model rock codes and drill logs align in section, there are multiple 3D issues with continuity that are commonly observed in the sectional interpretation. These issues include isolated pods of discontinuous mineralized zones, volume extrapolation or abrupt stoppage of a lithology that may or may not be supported by faulting or other geological evidence. Figure 11.6 illustrates some of the identified issues in plan view.

Figure 11.6 Plan view of IBS (soft siliceous itabirite) geological model



Source: SRK Consulting – Mineral Resource Audit Review, Casa de Pedra Mine - 2021

Based on these observed issues, future geological models should use 3D wireframing methods including a combination of implicit and explicit modeling techniques to generate an improved geological model. Additionally, structural data should be incorporated into the 3D wireframe model to provide evidence of discontinuous lithologies, potential offsets and the interaction of rock types.

Overall, the current geological model is satisfactory for the reporting of mineral resources, however, improvements should be implemented in future model updates with the move to a 3D modeling approach and incorporation of structures to improve the volumetric modeling of the various domains/lithologies.

SRK reviewed the long-term block model provided (modelo_lp_20170828) using Seequent's Leapfrog Geo software. The model contains regularized blocks sized 25 m (X) by 25 m (Y) by 13 m (Z) and is not rotated. The model extents cover the main mineralized areas of the Casa de Pedra mining complex deposits and includes 5,486,250 blocks. The Z size was selected to correspond with bench height in the pit which is considered standard industry practice in bulk mining operations.

Based on the average drill spacing across the main mineralized zones, the block size is appropriate to represent volumes and grade values. In areas of wider spaced drilling or drilling with variable depths, the block size is relatively small presenting a potential risk for estimation biases in these zones. Overall, the block model construction is satisfactory for the estimation of quality and quantity for mineral resource reporting within the optimized pit shell area.

11.1.3 Bulk density

Bulk density or specific gravity is measured using two methods at the Casa de Pedra mining complex :

- Water immersion method. This method is based on submerging a portion of drill core sample into a cylinder of water after its weight has been determined. The difference in water level before and after the drill core sample is submerged is measured as its volume.
- Pycnometer or "sand bottle" method. A pycnometer is a device used to determine the density of a liquid or solid. It is a flask with a close-fitting ground glass stopper with a capillary tube through it that enables volume measurement. The sand bottle method uses sand for filling a hole on the ground to define the volume of the rock type to be tested. The mass removed from the hole is weighed to obtain the density.
- Bulk density testing was primarily conducted from 2012 to 2014 on various lithologies. The different methods performed were based on the hardness of the rock type, with the immersion method conducted on competent material while the pycnometer method was used for soft and friable material. Based on the data provided by CSN Mineração, 1,284 pycnometer and 644 immersion bulk density measurements were completed across all rock types.

The bulk density samples represent a spatially diverse population across the Casa de Pedra mining complex. The mean values are presented in Table 11.2.

Table 11.2 Mean bulk density values for Casa de Pedra mining complex rock types

Mineralized Lithologies			Waste		
Rock type	Bulk density	Description	Rock type	Bulk density	Description
HBA	3,416	HEMATITA BRANDA (Soft Hematite)	SOL	2,159	SOLO/LATERITA ARGILOSA (Soil/Clayey Laterite)
HCP	4.77	HEMATITA COMPACTA (Compact Hematite)	ATE	2,529	ATERRO/PILHA DE MINÉRIO (Landfill/Mineralized Material Pile)
ICR	4,236	ITABIRITO COMPACTO RICO (Rich Compact Itabirite)	TUR	1.2	TURFA (Peat)
IBR	2,968	ITABIRITO BRANDO RICO (Rich Soft Itabirite)	ARG	1,974	ARGILA/ARGILITO (Clay/Slate)
IBS	2,569	ITABIRITO BRANDO SILICOSO (Soft Siliceous Itabirite)	PES	2.05	PILHA DE ESTÉRIL (Waste Pile)
ICS	3,047	ITABIRITO COMPACTO SILICOSO (Compact Siliceous Itabirite)	FILC	2,548	FILITO COMPACTO (Compact Phyllite)
IBC	1,799	ITABIRITO BRANDO CARBONÁTICO (Soft Carbonate Itabirite)	FILB	2,182	FILITO BRANDO (Soft Phyllite)
ICC	3,134	ITABIRITO COMPACTO CARBONÁTICO (Compact Carbonate Itabirite)	XISC	2.62	XISTO COMPACTO (Compact Schist)
IBM	2,522	ITABIRITO BRANDO MANGANESÍFERO (Soft Manganese Itabirite)	XISB	2,027	XISTO BRANDO (Soft Schist)
ICM	2,839	ITABIRITO COMPACTO MANGANESÍFERO (Compact Manganese Itabirite)	DOLC	2,686	ROCHA CARBONÁTICA COMPACTA (Compact Carbonatic Rock)
IBG	2,339	ITABIRITO BRANDO GOETHÍTICO (Soft Goethitic Itabirite)	DOLB	1,635	ROCHA CARBONÁTICA BRANDA (Soft Carbonatic Rock)
ICG	2.97	ITABIRITO COMPACTO GOETHÍTICO (Compact Goethitic Itabirite)	QTZC	2.3	QUARTZITO COMPACTO (Compact Quatzite)
ICA	2.8	ITABIRITO COMPACTO ANFIBOLÍTICO (Compact Anphibolitic Itabirite)	QTZB	1.67	QUARTZITO BRANDO (Soft Quatzite)

Mineralized Lithologies		
Rock type	Bulk density	Description
IBA	2.8	ITABIRITO BRANDO ANFIBOLÍTICO (Soft Anphibolitic Itabirite)
CEL	2,879	COLÚVIO/ELÚVIO (Colluvium/Eluvium)
CGM	2,282	CANGA DE MINÉRIO (Ferriferous Canga)
BRS	2.92	BRECHA SEDIMENTAR MINERALIZADA (Mineralized Sedimentary Breccia)

Waste		
Rock type	Bulk density	Description
RBIB	2,066	ROCHA BÁSICA INTRUSIVA BRANDA (Soft Basic Intrusive Rock)
RBIC	2,694	ROCHA BÁSICA INTRUSIVA COMPACTA (Compact Basic Intrusive Rock)
VQZ	1.67	VEIO DE QUARTZO (Quartz Vein)
CHTB	2,381	CHERT BRANDO (Soft Chert)
CHTC	2,783	CHERT COMPACTO (Compact Chert)
RMNC	2.5	ROCHA MANGANESÍFERA COMPACTA (Compact Manganese Rock)
RMNB	1,705	ROCHA MANGANESÍFERA BRANDA (soft Manganese Rock)

Source: SRK Consulting – Mineral Resource Audit Review, Casa de Pedra Mine - 2021

Snowden Optiro qualified person's opinion

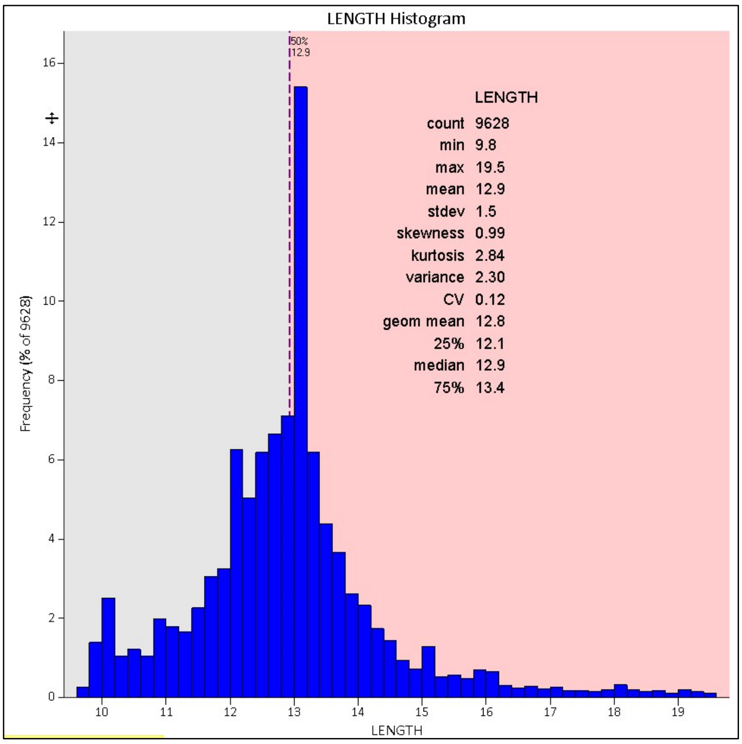
The qualified person agrees with SRK's recommendation to continue bulk density testing as the open pit progresses to ensure adequate data per domain/rock type and to produce a statistically significant population (>30) for determination of bulk density by estimation domain. Based on the domain and rock type descriptions, the mean bulk density values appear reasonable.

CSN Mineração should make it clear whether densities were estimated or averaged from test results by lithology.

11.1.4 Compositing

Drill data is composited on a 13 m length derived from bench heights and broken by changes in rock code/lithology. The resulting composited database has a mean length of 12.9 m, with 9.8 m and 19.5 m representing the minimum and maximum lengths, respectively. The compositing method results in approximately one sample per bench and a block height with reasonable consistency in support size as evidence from Figure 11.

Figure 11.7 Histogram of composite lengths



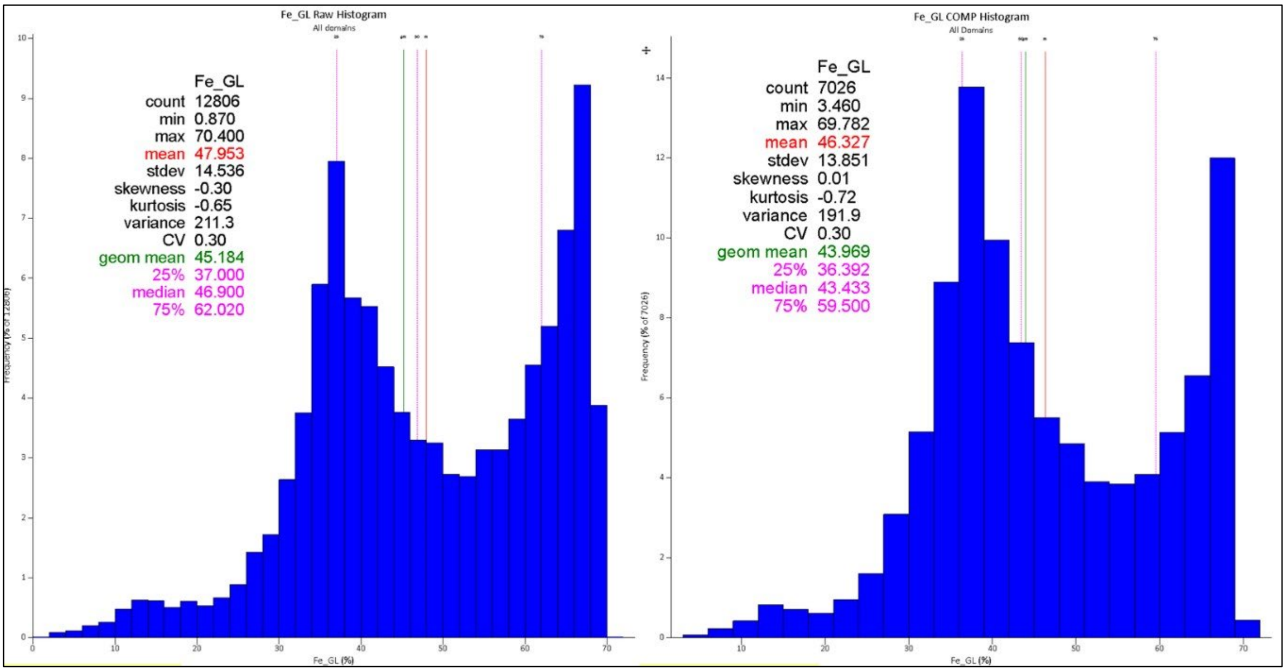
Source: SRK Consulting – Mineral Resource Audit Review, Casa de Pedra Mine - 2021

Snowden Optiro qualified person's opinion

SRK reviewed the compositing practices and output composited data. Comparisons of Total Fe values between the raw samples and composited data show only minor differences in means and population distributions as shown in Figure 11.

The qualified person agrees that current compositing methods are satisfactory for the estimation of mineral resources.

Figure 11.8 Histogram total Fe in (left) raw samples and (right) composited samples



Source: SRK Consulting – Mineral Resource Audit Review, Casa de Pedra Mine - 2021

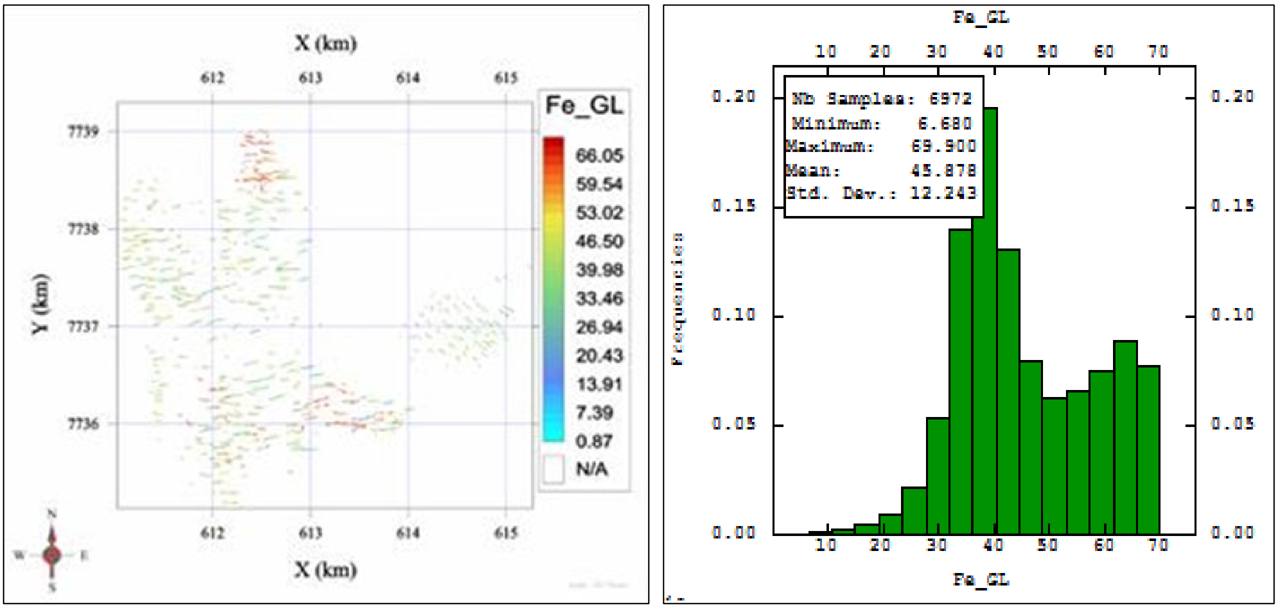
11.1.5 Exploratory data analysis

Statistical analysis of the composited data was performed for the variables Fe %, SiO_2 %, Al_2O_3 %, Mn %, P %, CaO % and LOI % for all mineralized domains.

There is a bimodal behavior arising from the mixture of populations of rich (contents greater than 58% Fe) and poor material. The rich samples are grouped in well-defined sectors in each of the four major areas of the Casa de Pedra mining complex deposits (Main Body, West Body, Mascate Body and North Body). The poor material is widespread throughout the deposit area.

Figure 11 illustrates the iron grade spatial distribution along the deposit and its respective histogram.

Figure 11.9 Global Fe grades spatial distribution and histogram



Source: CSN – Relatório_2017_Reserve_Resource.pdf

The poor lithotypes are, in general, the most siliceous. Among the mineralized lithotypes, ICS has the highest silica (SiO_2) content.

The Al_2O_3 distribution presents a highly asymmetrical behavior, with a predominance of lithotypes with a low mean. The highest levels are associated with the CGM, CEL, IBG and ICG lithotypes.

Manganese, as well as Al_2O_3, present a very asymmetric behavior. Its spatial distribution presents some high content clusters, mainly associated with manganese lithotypes.

The distribution of phosphorous also presents high asymmetry, with a few clusters of extreme values (e.g. southeast of the Main Body). The phosphorous content has an approximately regular distribution between the lithotypes, with a slightly higher average content in the CGM and IBM (Table 11.1 defines the lithocodes).

11.1.6 Variography

Domaining

CSN Mineração grouped similar modelled domains for variography and estimation purposes. The grouping represents geological and grade features along with zones of specific anisotropy that would lend well to estimation. A summary of grouped estimation domains is presented in Table 11.3.

Table 11.3 Estimation domains

Groups	Estimation domains		
	North sector	Main body	ENGENHO
HBA + IBR	HBA_IBR_SN	HBA_IBR_CP	ENG_RICOS
CGM + CEL	CGM_CEL_SN	CGM_CEL_CP	ENG_POBRES
ICS_ICC	ICS_ICC_SN	ICS_ICC_CP	ENG_POBRES
HCP + ICR	HCP_ICR_SN	HCP_ICR_CP	ENG_RICOS
IBS_IBG	IBS_IBG_SN	IBS_IBG_CP	ENG_POBRES
IBM	IBM_SN	IBM_CP	ENG_POBRES
ICM_ICG	ICM_ICG_SN	ICM_ICG_CP	ENG_POBRES

Source: SRK Consulting – Mineral Resource Audit Review, Casa de Pedra Mine - 2021

CSN Mineração’s focus on domaining and variography was based on Total Fe analytical values. Although Total Fe is the primary economic variable for the Casa de Pedra mining complex, a few domains account for secondary or deleterious materials that may not be correlated with Total Fe domains. Variables such as silica, manganese oxide and percent magnetic iron are also key contributors to rock types and the final determination of domains.

Snowden Optiro qualified person´s opinion: The qualified person agrees with SRK that the grouping for domaining is considered satisfactory for estimation purposes based on the documented procedures and a review of the exploratory data analysis. Silica, with its high indirect correlation to Total Fe will be appropriate for common domaining but manganese oxide may display materially different properties in domaining such as structural control, internal zones of high/low manganese oxide, or other geological controls separate from Total Fe at the Casa de Pedra mining complex.

It is recommended that manganese oxide (and other potentially deleterious materials) be reviewed to understand spatial continuity of these individual variables separate from Total Fe. Based on differences in spatial continuity and exploratory data analysis for individual elements, it may be beneficial to have unique domains for certain variables if the mineralization is unrelated to iron enrichment.

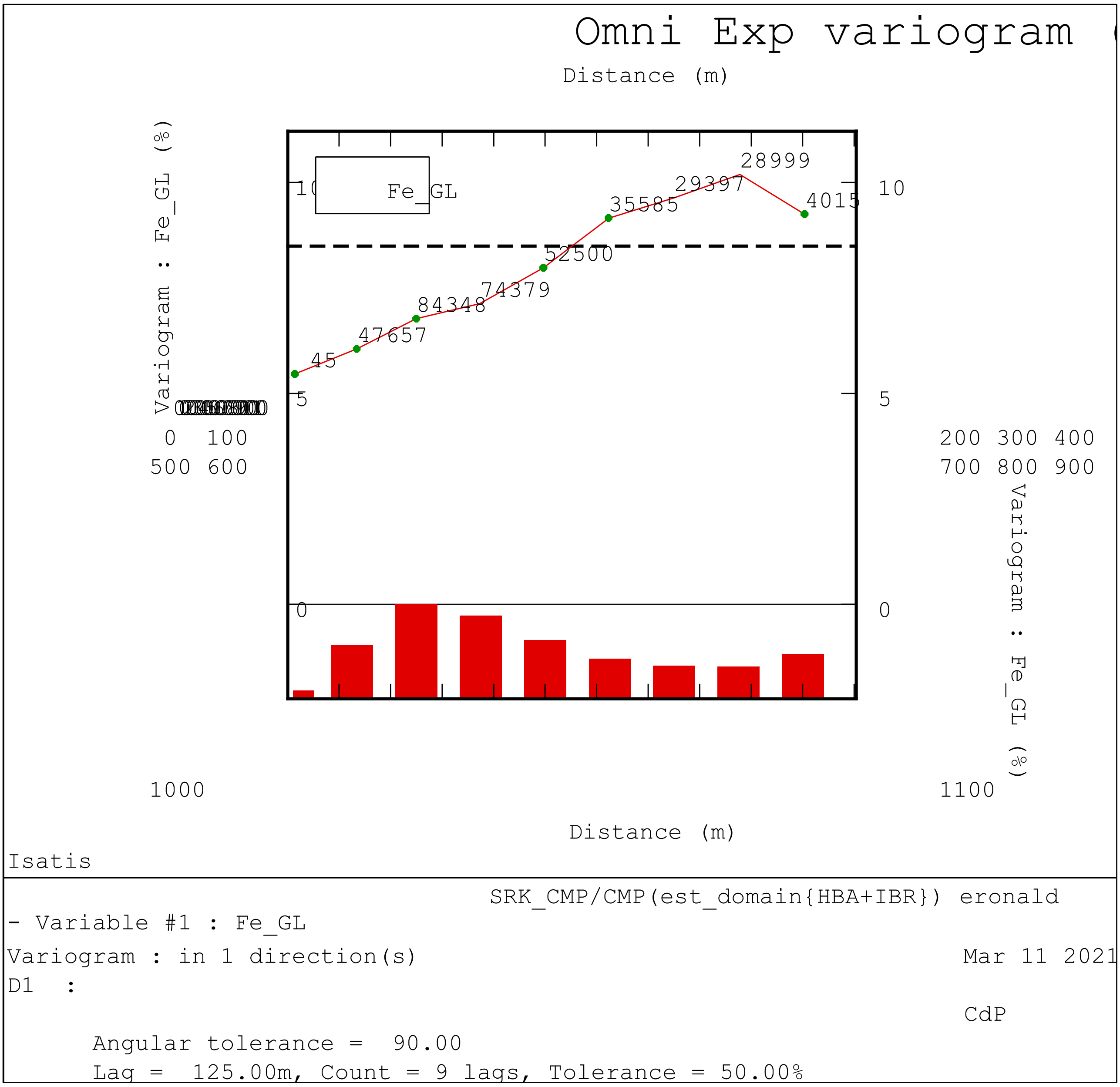
Variography

The variography strategy used by CSN Mineração for spatial continuity analysis is based on the linear model of co-regionalization (LMC) which is necessary for the cokriging strategy. The LMC was based on the analysis of continuity of the Fe percentage and considered all six variables (Fe %, SiO_2 %, Al_2O_3 %, Mn %, P % and LOI %) globally and by granulometric size fraction ranges.

Most domains exhibit a low to moderate nugget effect and are modeled using one or two structures. CSN Mineração noted that bedding exhibits the primary or major direction of anisotropy.

As part of the mineral resource audit, SRK calculated the experimental variogram in the primary high-grade domain of HBA+IBR to compare spatial continuity assumptions. Directional along major trends, omni-directional and cross-variograms were calculated which show material differences between quality variables. In general, the experimental directional variograms show ranges approaching 300 m in major and semi-major directions and ranges downhole of up to 20 m. In general, the experimental omni-directional variogram showed the best variogram structure with a range near 850 m (Figure 11.). Cross-variograms showed relatively poor continuity between variables except Fe_GL and SiO_2_GL and Al_2O_3_GL and P_GL. Individual omni-directional variograms showed acceptable structure and ranges thus demonstrating evidence for unique controls on mineralization for most variables related to the complex genesis of the deposit.

Figure 11.10 Experimental omni-directional variogram for Fe_GL in HBA+IBR domain



Source: SRK Consulting – Mineral Resource Audit Review, Casa de Pedra Mine - 2021

Snowden Optiro qualified person's opinion

The qualified person agrees with SRK's opinion that the nugget values, anisotropy and general variography parameters are as expected based on studies of other global iron deposits and aligns with the type of deposit.

A review of variography for each primary element per domain is recommended. This will result in calculating multiple variograms, but each estimation will be unique based on the properties of the individual variable and the domain. Currently, the method is over reliant on expecting Total Fe (or global) spatial continuity to be the same for all variables (global Fe, SiO_2, Al_2O_3, P, MnO, CaO, TiO_2, MgO, and LOI). Typically, global Fe, SiO_2, Al_2O_3, and occasionally P will display similar spatial continuity while the other variable concentrations are not necessarily associated with global Fe, thus generating a poor correlation coefficient and should be evaluated independently. Table 11.4 shows the correlation coefficients of raw quality variables (global). Fe, SiO_2, Mn, and TiO_2 display high correlations that may be appropriate for cross variography, LMC for variography or co-kriging estimation while other variables are not well correlated, thus their spatial distribution are based on a variety of geological processes different from the primary iron oxide enrichment.

Table 11.4 Correlation coefficients of raw quality variables (global)

Column	Fe_GL	SiO2_GL	Al2O3_GL	P_GL	Mn_GL	PPC_GL	TiO2_GL	CaO_GL	MgO_GL
Fe_GL	1	-0.9	-0.2	0	-0.07	-0.22	-0.32	-0.28	-0.32
SiO2_GL	-0.9	1	-0.07	-0.07	-0.09	-0.23	0.03	-0.18	-0.14
Al2O3_GL	-0.2	-0.07	1	0.13	0.1	0.37	0.81	-0.01	0.07
P_GL	0	-0.07	0.13	1	0.1	0.11	0.64	0.03	0.09
Mn_GL	-0.07	-0.09	0.1	0.1	1	0.21	0.02	0	0.01
PPC_GL	-0.22	-0.23	0.37	0.11	0.21	1	0.28	0.84	0.8
TiO2_GL	-0.32	0.03	0.81	0.64	0.02	0.28	1	0.03	0.13
CaO_GL	-0.28	-0.18	-0.01	0.03	0	0.84	0.03	1	0.89
MgO_GL	-0.32	-0.14	0.07	0.09	0.01	0.8	0.13	0.89	1

Source: SRK Consulting – Mineral Resource Audit Review, Casa de Pedra Mine – 2021 (PPC=LOI)

11.1.7 Grade estimation

Estimation methodology

Global variables (Fe %, SiO_2 %, Al_2O_3 %, Mn %, P % and LOI %) and chemical analyses in three granulometric fractions were estimated. These fractions were chosen due to their compatibility with the mineral products sold by CSN Mineração and are distributed according to Table 11.5.

Table 11.5 Estimated size fraction intervals

Size fraction	Product	Screen size (mm)	
		Superior limit	Inferior limit
1	Granulado (Lump)	50.0	6.3
2	Sinter Feed	6.3	0.15
3	Pellet Feed	0.15	-

Source: CSN - Relatório_2017_Reserve_Resource.pdf

Ordinary co-kriging (COK) was used to interpolate quality variables in the various granulometric fractions. COK is commonly utilized when data contains various counts across different variables, thus it relies on high correlation coefficients of two or more variables to inform locations where one variable is absent. In theory, COK appears to be an acceptable method for interpolation given the challenges of the granulometric fractions, however, the documentation is insufficient to review the details and performance of this estimation method.

In discussions with CSN Mineração staff, they indicated that OK is used for interpolation with LMC used to determine appropriate cross-variograms for estimation purposes.

Snowden Optiro qualified person's opinion

In general, it was the opinion of SRK and the qualified person, that the documentation is not satisfactory to describe the estimation methodology and it is unclear how OK/COK was utilized across domains for both grain size values and multiple quality elements. LMC can be an appropriate means of obtaining a robust semi-variogram in highly correlated variables, but it often results in incorrect spatial continuity of poorly correlated variables and results in poor estimation.

The basic statement of the linear model is that all regionalized variables being studied are generated by a same set of physical processes acting additively at different spatial scales (Goulard, 1992)

The application of OK for variables using a unique modeled semi-variogram per hard domain is recommended. This represents a more time intensive process for modeling and estimation, however, the results should provide improved validation with the original composited data, resulting in improved prediction of quality and reconciliation.

Search neighborhood

CSN Mineração utilized a multi-pass search neighborhood by hard domain with each pass applying an increasing search ellipsoid and changing number of minimum and maximum samples. Additional constraints on the neighborhoods include the use of sectors.

CSN Mineração defined a maximum search radius in the first three steps of the estimate of 105 m, 230 m and 550 m. A fourth step (5,000 m) was used to estimate all blocks not covered by the previous steps.

A kriging neighborhood analysis (KNA) was performed on the IBS domain (largest resource domain) with the resultant neighborhood search applied to all domains and all variables. CSN Mineração documentation states that the slope of regression and kriging efficiency were the primary drivers of the KNA.

Snowden Optiro qualified person's opinion

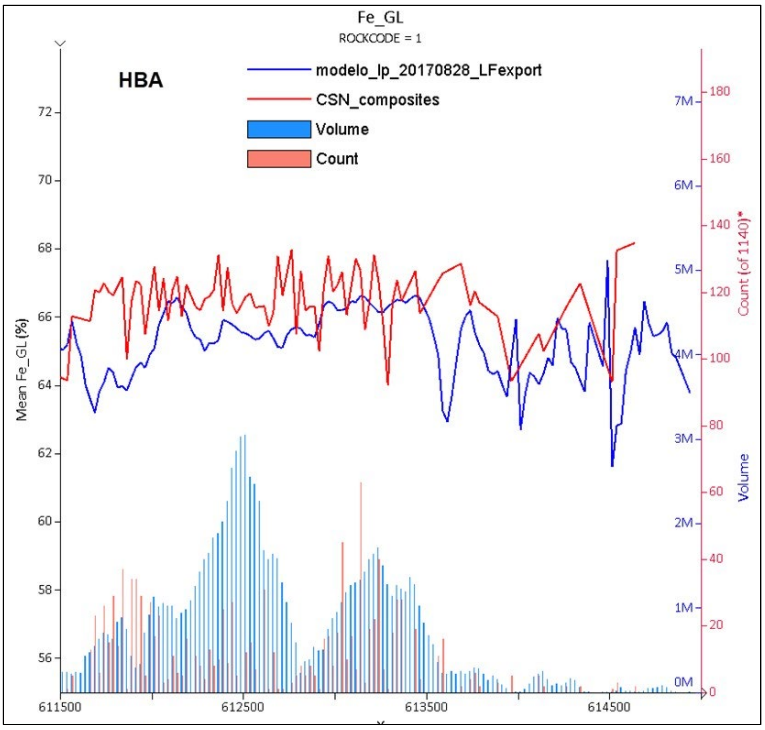
The qualified person agrees with SRK's opinion that the initial use of KNA is recommended but it should be performed on each domain for at least the key economic variable (i.e. Total Fe). If COK is utilized for estimation and LMC is the preferred method for spatial continuity, then these should be accounted for in search neighborhood selection. Currently, the documentation is insufficient to determine how effective the KNA is to the estimate and only optimizing the search for a single domain is not recommended.

11.1.8 Model validation

SRK performed a high-level validation exercise including visual checks in cross section between the raw drilling and block grades, swath plots comparing mean composited values with mean block values and summary statistical comparisons between composites and blocks. SRK noted that globally, the Total Fe mean values are within 1% to 3% but locally there are material differences and biases between composited grades and block grades in the main ore-bearing zones. Additionally, with secondary or deleterious elements, the comparison of composites and blocks shows a variety of quality with many local areas displaying poor validation.

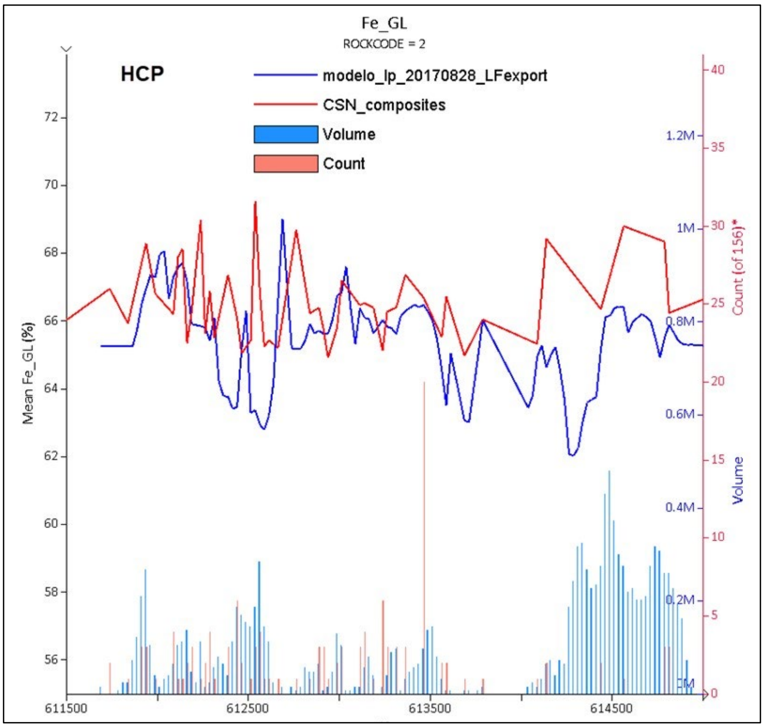
As illustrated in Figure 11.11 to Figure 11.13 for Fe_GL and Figure 11.14 for SiO2_GL, these swath plots demonstrate a material bias between composites and block grades across portions of the deposit. In some areas, the values that show acceptable validation are typically associated with increased data concentrations, but SRK noted multiple locations where the estimation should be modified to provide an improved local estimate so that the composite and block grades are more aligned.

Figure 11.11 Swath plot for Fe_GL in RockCode 1 (HBA)



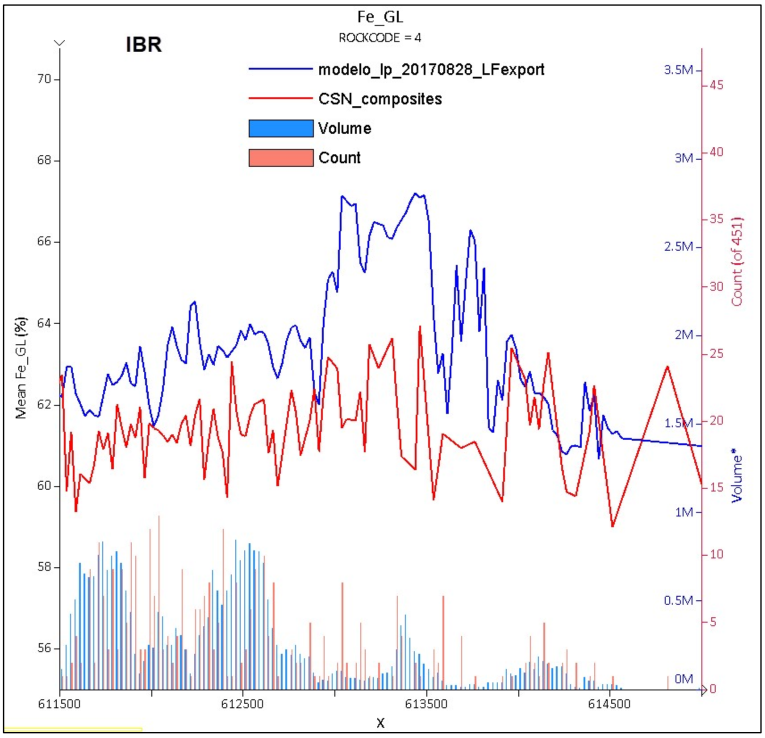
Source: SRK Consulting – Mineral Resource Audit Review, Casa de Pedra Mine – 2021

Figure 11.12 Swath plot of Fe_GL in RockCode 2 (HCP)



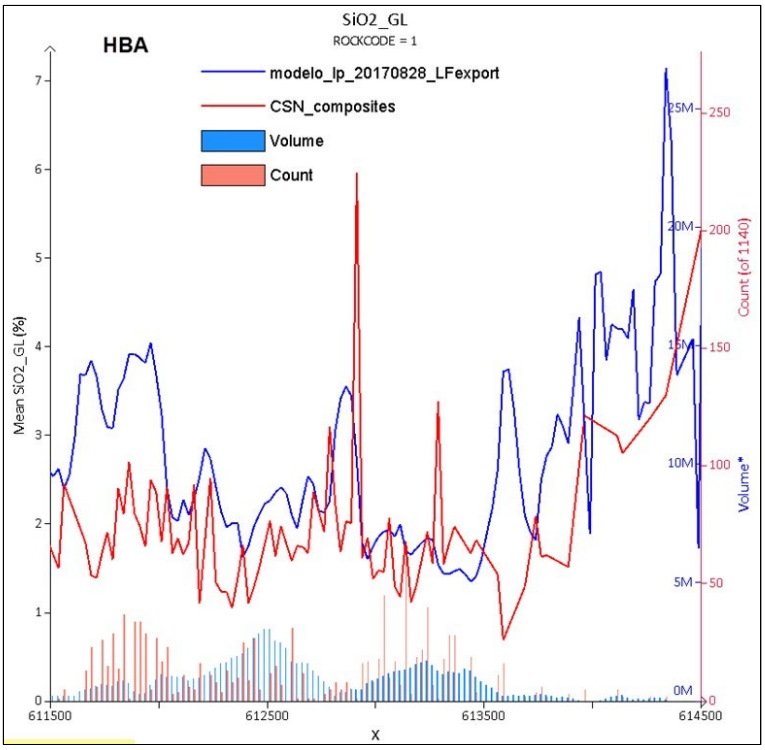
Source: SRK Consulting – Mineral Resource Audit Review, Casa de Pedra Mine - 2021

Figure 11.13 Swath plot for Fe_GL in RockCode 4 (IBR)



Source: SRK Consulting – Mineral Resource Audit Review, Casa de Pedra Mine – 2021

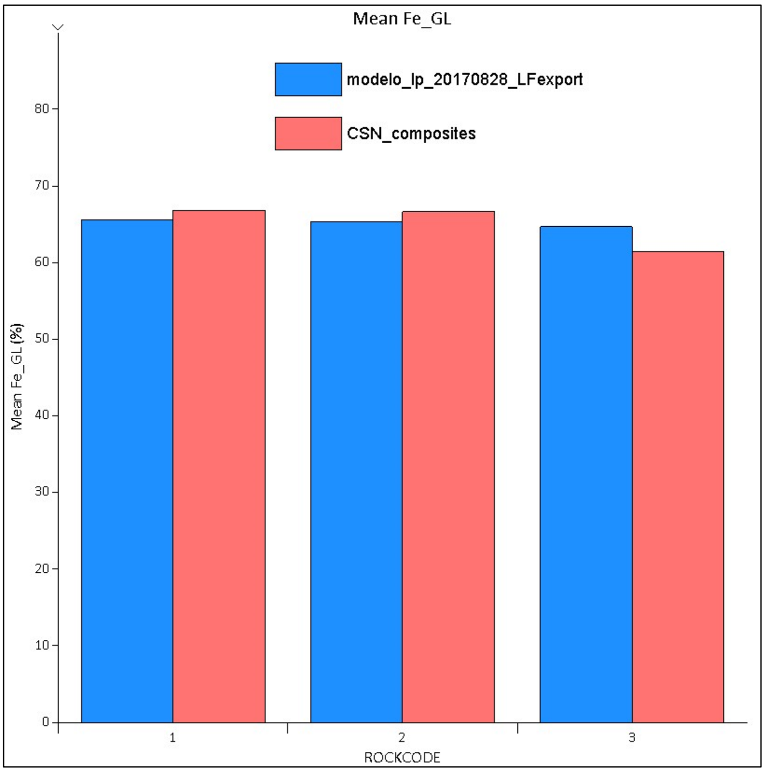
Figure 11.14 Swath plot for SiO2_GL in RockCode 1 (HBA)



Source: SRK Consulting – Mineral Resource Audit Review, Casa de Pedra Mine - 2021

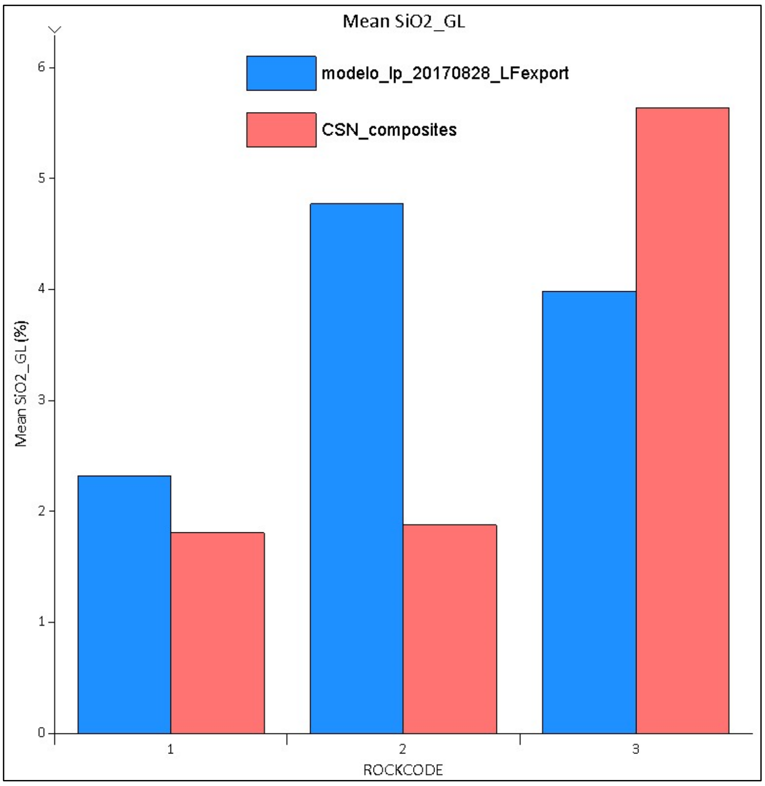
Reviewing the validation based on mean grades between composited values and blocks, SRK noted similar high variability between the various elements. In the case of Fe_GL, the differences are considered immaterial (Figure 11.15) but in the case of secondary/deleterious elements, the comparison illustrates material differences (Figure 11.16 and Figure 11.17). Since domaining and ore type quality relies on both Total Fe and deleterious materials, validation of the estimate shows poor performance resulting in inaccurate prediction of material quality at the local scale.

Figure 11.15 Mean grade comparison between composites and blocks for Fe_GL in RockCodes 1 (HBA), 2 (HCP) and 3 (ICR)



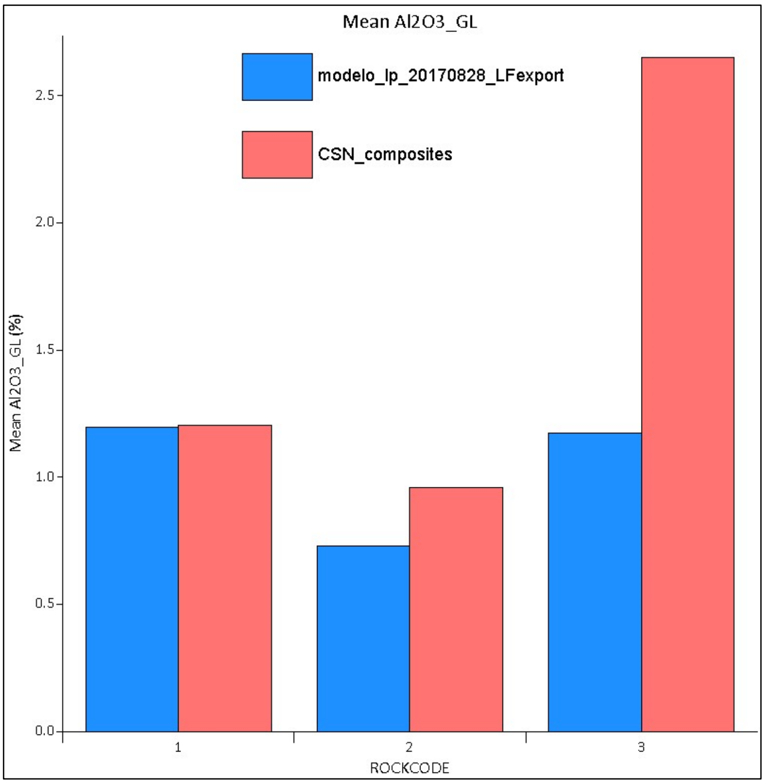
Source: SRK Consulting – Mineral Resource Audit Review, Casa de Pedra Mine - 2021

Figure 11.16 Mean grade comparison between composites and blocks for SiO2_GL in RockCodes 1 (HBA), 2 (HCP) and 3 (ICR)



Source: SRK Consulting – Mineral Resource Audit Review, Casa de Pedra Mine – 2021

Figure 11.17 Mean grade comparison between composites and blocks for Al2O3_GL in in RockCodes 1 (HBA), 2 (HCP) and 3 (ICR)



Source: SRK Consulting – Mineral Resource Audit Review, Casa de Pedra Mine - 2021

11.1.9 Cut-off grades

CSN Mineração did not apply a cut-off grade as a parameter for establishing reasonable prospects of economic extraction.

11.1.10 Classification criteria

CSN Mineração utilizes a classification ranking system which accounts for a variety of geological, quality and estimation inputs (Table 11.6).

Table 11.6 CSN Mineração´s resource classification ranking system

Input	Base	Weight
Geological complexity Number of holes per section	Vertical Section	30
Mineralized material indicator	Block	25
No QAQC	Block/Region	0
Stoichiometric closing Stoichiometric closing + accuracy Stoichiometric closing + accuracy + precision Stoichiometric closing + accuracy + precision + sample recovery		20
Variogram quality	Domain/Lithology	15
Fe Global krigging uncertainty	Block	10
Total		**100**

Source: CSN - Relatório_2017_Reserve_Resource.pdf

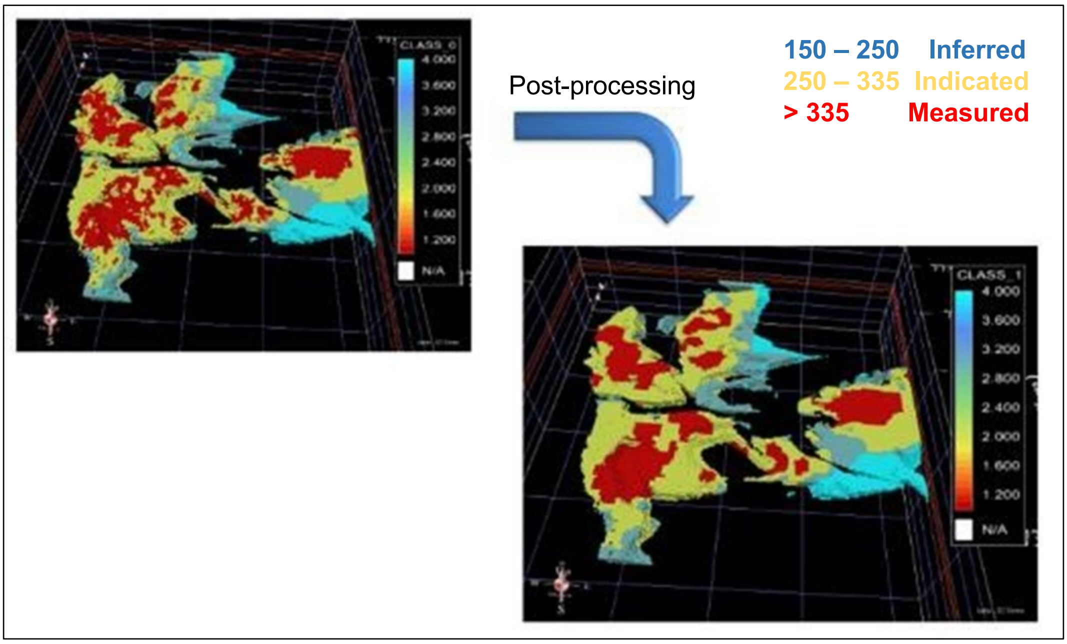
The score system ranges from zero to five for each input, with zero being the worst result and five for a result in which the inputs are fully met.

Samples without QAQC received zero weight in the resource classification ranking system, meaning that the entire historical drilling database (prior to 2012) was not considered for resource classification.

After attribution of weights to the blocks, they were added and divided into classes. Therefore, blocks with weighted criteria adding up to more than 335 were classified as measured. Blocks that obtained a sum of weighted criteria between 250 and 335 were classified as indicated. Blocks with a sum of weights between 150 and 250 were classified as inferred. The remaining blocks were not considered as resources.

A post-processing step, carried out using Isatis® software, was necessary to correct continuity problems in the classification. To do so, it considered the median of the blocks around the analyzed block. Therefore, a block classified as indicated surrounded by mainly measured blocks was reclassified to measured (Figure 11.18).

Figure 11.18 CSN Mineração's resource classification before and after post-processing

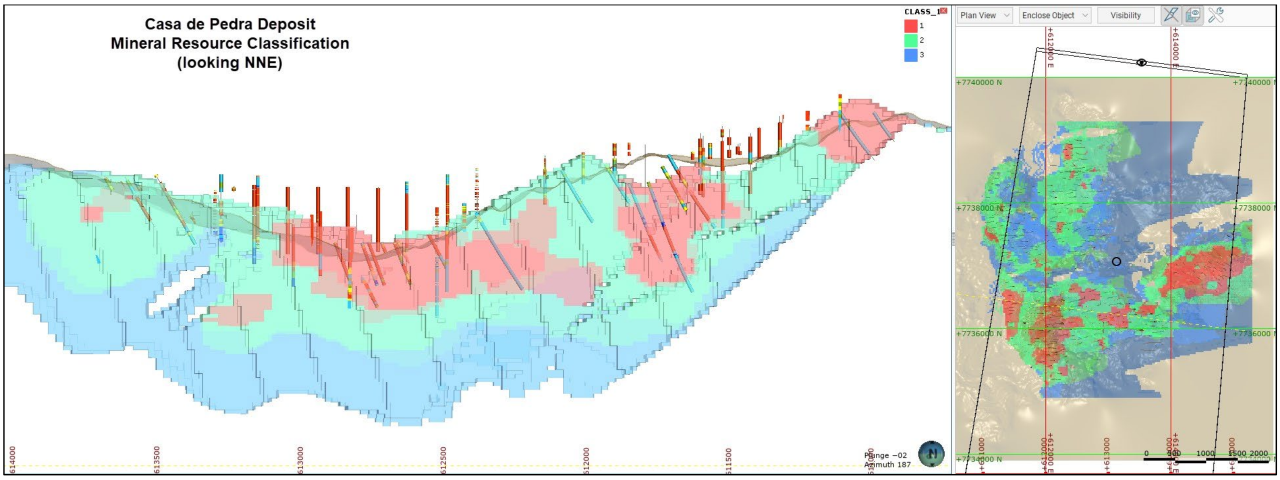


Source: CSN – Relatório_2017_Reserve_Resource.pdf

This scoring system combined with a smoothing of broad volumes into categories resulted in a satisfactory classification that meets international reporting guidelines and definitions for measured, indicated and inferred mineral resources. The increased confidence in classification aligns well with geological continuity and drilling density.

Figure 11.19 illustrate the spatial distribution of mineral resource classification and the alignment of higher classification with areas of increased drilling.

Figure 11.19 Cross section showing resource classification (red = measured, green = indicated, blue = inferred)



Source: SRK Consulting – Mineral Resource Audit Review, Casa de Pedra Mine - 2021

11.2 Mineral resources as of 31 December 2021

The Casa de Pedra mining complex mineral resources exclusive of mineral reserves as of 31 December 2021 are summarized in Table 11.7. The mineral resources are 100% attributable to CSN Mineração. All grades and tonnages reported are in-situ and are undiluted.

Table 11.7 Casa de Pedra mining complex – summary of iron exclusive mineral resources as of 31 December 2021 based on an iron price of US$95.00/t

Rock type group	Measured		Indicated		Measured + Indicated		Inferred	
	Amount (Mt)	Fe %	Amount (Mt)	Fe %	Amount (Mt)	Fe %	Amount (Mt)	Fe %
Canga	0.0	41.2	1.5	55.2	1.6	54.9	37.1	52.9
Hematite	27.4	65.7	36.3	65.5	63.6	65.6	4.3	65.1
Itabirite	422.6	38.0	1,451.5	36.7	1,874.1	37.0	1,670.8	36.6
Stockpiles	11.8	45.6	27.9	47.8	39.6	47.1	11.4	51.2
Total	**461.8**	**39.8**	**1,517.2**	**37.6**	**1,979.0**	**38.1**	**1,723.6**	**37.1**

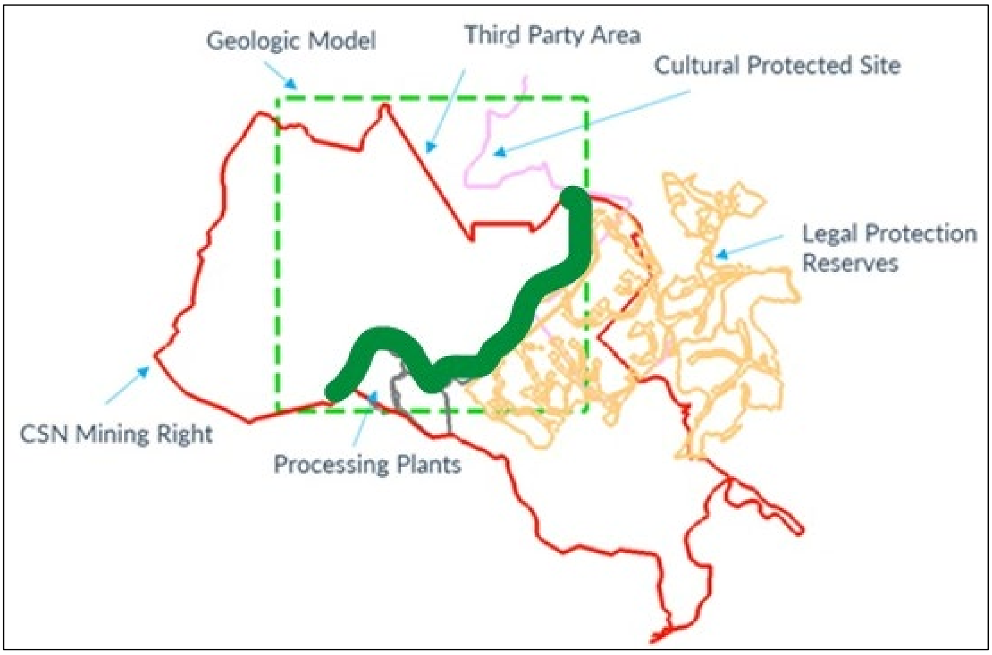
Notes:

- *Mineral resources are reported exclusive of mineral reserves as "in situ" tonnes and rounded to the nearest 100,000.*
- *Mineral resources include inferred mineral resources within the mineral reserve pit shell.*
- *Stockpiles are reported as mineral resources. Stockpile masses, grades and classification were provided by CSN Mineração in its block model.*
- *Mineral resources are reported on a wet basis. The average moisture considered for all mineralized lithologies is 6%. The Fe% grade is on a dry basis.*
- *Classification of mineral resources is in accordance with the S-K 1300 classification system.*
- *Mineral resources that are not mineral reserves do not have demonstrated economic viability.*
- *Snowden Optiro certifies that a pit optimization was completed to demonstrate reasonable prospects of economic extraction.*
- *Snowden Optiro agrees with current mineral resource estimation practices.*
- *The effective date is 5 January 2022.*

Source: Snowden Optiro, 2022

CSN Mineração used an optimized pit shell as a constraint to demonstrate reasonable prospects of economic extraction. The average product price applied by CSN Mineração for the pit shell is US$95.00/t. Material outside the pit shell is excluded and is not reported as mineral resources. The mineral resource is also constrained by CSN Mineração's mining rights, surface rights, a cultural protected site and legal protection reserves (Figure 11.20).

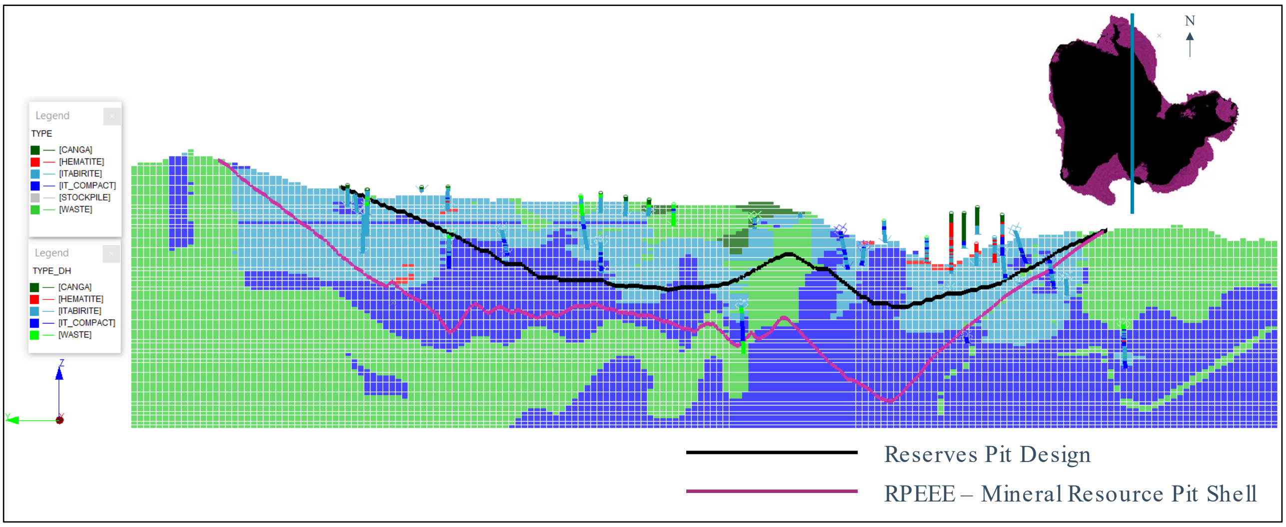
Figure 11.20 Casa de Pedra mining complex mineral resource surface constraints



Source: Snowden Optiro, 2022

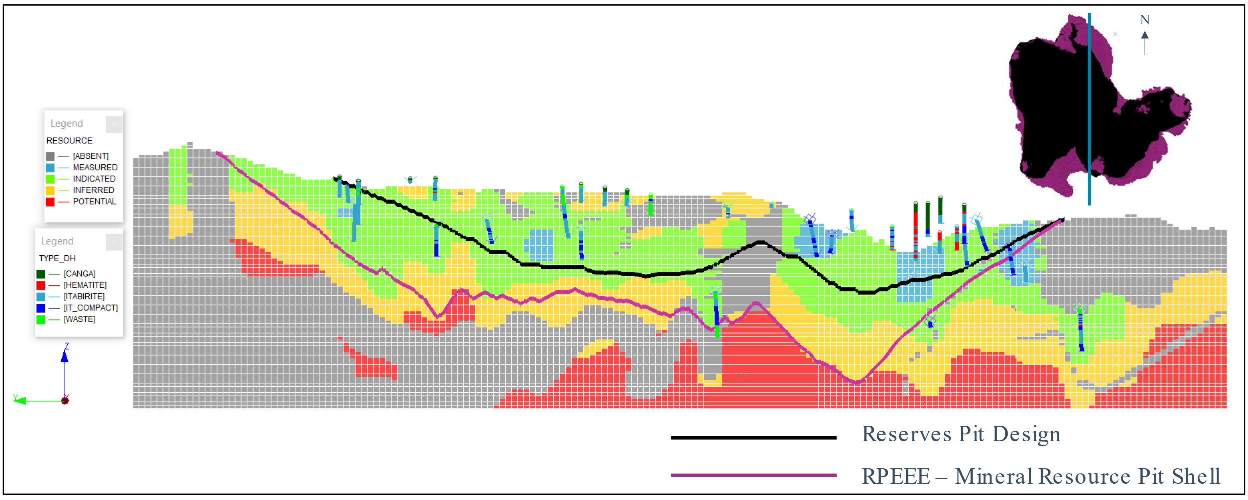
Figure 11.21 to Figure 11.24 show the pit shell projections in vertical sections with the rock types and resource classification.

Figure 11.21 Pit shell at Casa de Pedra mining complex – north-south cross section showing main rock types groups and drillholes



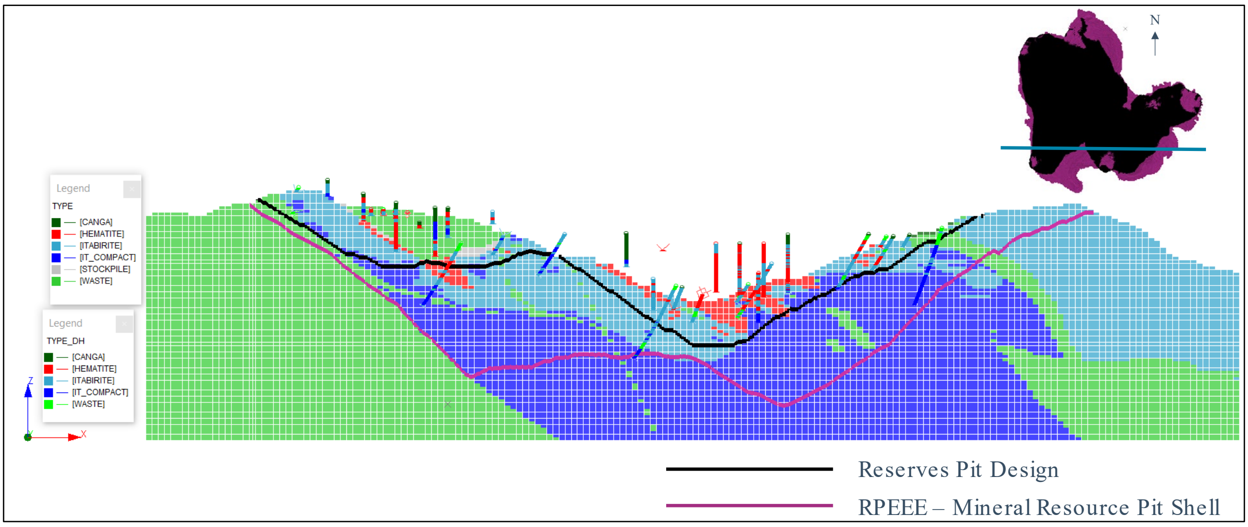
Source: Snowden Optiro, 2022

Figure 11.22 Pit shell at Casa de Pedra mining complex – north-south cross section showing resource classification and drillholes



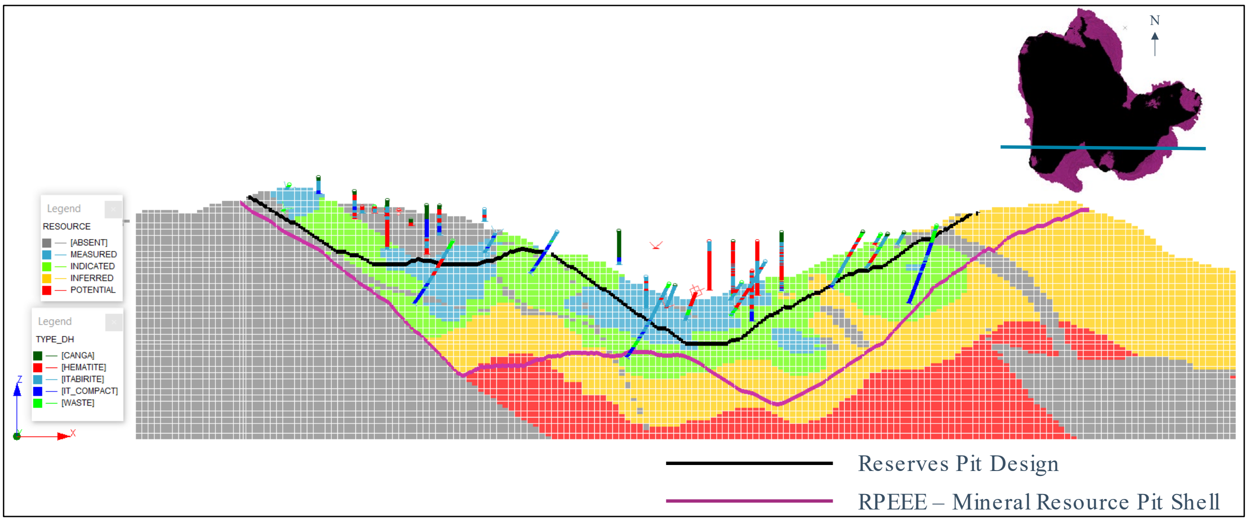
Source: Snowden Optiro, 2022

Figure 11.23 Pit shell at Casa de Pedra mining complex – east-west cross section showing main rock types groups and drillholes



Source: Snowden Optiro, 2022

Figure 11.24 Pit shell at Casa de Pedra mining complex – east-west cross section showing resource classification and drillholes



Source: Snowden Optiro, 2022

There are several in-pit stockpiles that are included in the mineral resource estimate. Stockpiles mass, grades and classification were provided by CSN Mineração in its block model.

Snowden Optiro notes that the mineral resource includes 136 Mt of mineralized material below the processing plant. Although it is part of the mineral resource reporting, CSN Mineração has not allocated a capital cost for its removal or relocation.

Snowden Optiro qualified person's opinion

The qualified person recommends that CSN Mineração runs a new pit optimization applying updated parameters and economic assumptions. The pit optimization must include the capital allocated to move infrastructure inclusive of sustaining costs and CFEM.

Offsets from major infrastructure areas need further evaluation.

CSN Mineração should also conduct a cut-off grade analysis to justify grades below the cut-off grade in some blocks within the mineral resource.

CSN Mineração should also update its mineral resource documentation to include the updated parameters and economic assumptions, report grade-tonnage sensitivities to cut-off grade and provide qualified person's opinions to meet international reporting standards.

In the qualified person's opinion, the issues related to all relevant technical and economic factors likely to influence the prospects of economic extraction can be resolved with further technical work and analysis.

11.3 Comparison with previous estimate

CSN Mineração has not previously reported exclusive mineral resources for the Casa de Pedra mining complex on the SEC. 8

11.4 Audits and reviews

Snowden Mining Industry Consultants (SMIC) completed a high-level process audit of the Casa de Pedra mining complex mineral resources for CSN Mineração in February 2015.

It was SMIC's opinion that the majority of the processes involved with the collection, analysis, estimation, classification and reporting of mineral resources at Casa de Pedra mining complex were of good standard and in particular, in accordance with the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (the JORC Code, 2012 Edition). SMIC identified no fatal flaws with the mineral resource estimation procedures.

SMIC noted several aspects of the estimation of the mineral resources that required improvement to bring them into line with current industry best practice.

SRK's audit review, on which this technical report summary is based, was completed in August 2021.The focus of the mineral resource audit included the "global" estimates for quality variables and did not include the granulometric fractional quality estimates.

SRK was provided with the drillhole database, geological model, resource block model and supporting documentation on the geology and mineral resources for the property.

In general, SRK's opinion was that the geology and supporting data were appropriate for the estimation and tabulation of mineral resources using the "global" quality estimates. SRK noted multiple unsatisfactory findings that represent potential project and mineral resource risks along with a general lack of detailed documentation for international reporting standards.

The following items were noted as key findings in SRK's mineral resource audit review.

Satisfactory findings:

- SRK re-calculated the measured, indicated and inferred mineral resources to within 5% of the stated tonnes and grade, thus validating the current mineral resource statement.
- The geological understanding, drilling methodology, recent analytical testing and regular pit mapping is considered satisfactory and aligns with recognized industry standards.
- SRK was able to validate 98.5% of assay data from 2012 through 2014. Although this was considered an acceptable validation, SRK recommended CSN Mineração review the unvalidated information to determine if data should be updated in the final drill hole database for future model updates.
- The classification of mineral resources utilizes a point-ranking system to account for a variety of geological and estimation inputs followed by a smoothing of broad volumes into risk categories. This procedure results in a satisfactory classification scheme aligned with recognized international reporting standards.
- The topography is regularly updated using LiDAR survey resulting in an accurate and precise topographic control for the property.
- Drillhole collar and downhole survey methodology was considered satisfactory, but documentation requires updating as it contradicts personal communications with CSN Mineração staff.
- The domaining of similar geological and grade units is considered satisfactory for estimation purposes.
- Communications with CSN Mineração staff showed a sound knowledge of the site geology, data, and information related to mineral resources.

Improvement items:

- The geological model was not constructed using industry-standard 3D wireframe volumes, which may result in minor volumetric discrepancies and sectional interpretation artifacts. Overall, the geological model reconciles well with drillhole logging data. SRK recommended the use of 3D modeling techniques to improve representation of geological volumes for estimation.
- Compositing methodology was considered satisfactory although the CSN Mineração provided data included rock codes with decimal values indicating some lithologies may have been accidentally composited. SRK recommended that CSN Mineração review and remedy potential issues with coding of composites by rock code.
- SRK recommended additional drilling in areas of:
  - wide-spaced data currently in the indicated and inferred resource categories
  - areas heavily dependent on historical analytical data
  - areas for future pit expansion.

Unsatisfactory findings:

- The mineral resource documentation was considered unsatisfactory for reporting and international disclosure guidelines. Many sections do not include specific details required for public reporting or the required statements by the qualified person(s). SRK recommended that the documentation be updated to align with the SEC S-K 1300 regulations and international Committee for Reserves International Reporting Standards (CRIRSCO).
- Estimation methodology was not well documented and was not satisfactory for some elements and domains based on the model validation performed by SRK. Use of COK was considered satisfactory for the interpolation of granulometric fractions, although the documentation relating to parameters, cross-variograms and other information was considered insufficient for public reporting purposes.
- For global quality values, SRK recommended use of OK per key economic variable by domain with a unique variogram and search neighborhood. Use of a linear model of co-regionalization (LMC) for spatial continuity results in unacceptable parameters for poorly correlated variables such as alumina, phosphorus, and others. SRK recommended CSN Mineração review the use of LMC for highly correlated variables only with the remaining variables to be estimated independently.

- Variography should be calculated for key economic variables per ore-bearing domain and applied during the estimation. The current simplification of using iron spatial continuity parameters for all elements was not considered appropriate, especially for elements that display low correlations with iron. SRK recommended a variography study for all key economic variables for the main domains that contain mineral resources.
- Block model validation should be documented with a focus on key domains and economic variables with sufficient evidence of acceptable global and local block estimates. This should include swath plots, general statistics, comparison with nearest neighbor estimates and visual estimates by CSN Mineração.
- The documentation required to demonstrate reasonable prospects of economic extraction under S-K 1300 is insufficient. Additional details, economic assumptions and parameters used to determine the cut-off grade and pit shell constraints should be documented and discussed by the qualified person.

11.5 Qualified person’s opinion

Snowden Optiro’s qualified person conclusions and recommendations on CSN Mineração´s geological modeling and resources estimation practices including the following:

- The lithological classification appears acceptable for estimation as it represents discrete and mineable volumes. Minor risks involving the breakdown of domains using Total Fe and zones that are not constrained by surrounding lower grade data that will likely display extrapolated volumes away from data have the potential to unrealistically increase mineralized material tonnage due to unsupported volumetric blow-outs in the geological model.
- A combination of grade shell/indicator shell techniques coupled with broader 3D wireframe geology is recommended to improve the key ore-bearing zones of HBA/HCP and IBR/ICR.
- Due to the software restrictions, CSN Mineração does not produce 3D wireframe volumes. By not producing 3D wireframes, CSN Mineração cannot perform an accurate volumetric check and ensure continuity in 3D prior to coding a resource block model. This represents a low to medium risk to the mineral resource tonnage at the Casa de Pedra mining complex.
- In general, the modeled lithology provides a satisfactory representation of logged codes. Although the block model rock codes and drillhole logging align in section, there are multiple 3D issues with continuity that are commonly observed with the sectional interpretation. These issues include isolated pods of discontinuous mineralization and volume extrapolation or abrupt stoppage of a lithology that may or may not be supported by faulting or other geological evidence.
- The current geological model is satisfactory for reporting of mineral resources, however, improvements should be implemented in future model updates with the move to a 3D modeling approach and incorporation of structure to improve the volumetric modeling of the various domains/lithologies.
- Based on average drill spacing across the main mineralized zones, the block size is appropriate to represent volumes and grades. In areas of wider spaced drilling or drilling with variable depths, the block size is relatively small presenting a potential risk for estimation biases in these zones. Overall, the block model construction is satisfactory for the estimation of quality and quantity for mineral resource reporting within the pit shell area.
- It is recommended that CSN Mineração continues the collection and testing of bulk density samples as the mine progresses to ensure adequate data per domain/rock type to produce a statistically significant population (>30) for determination of bulk density by estimation domain. Based on the domain and rock type descriptions, the mean bulk density values appear reasonable.
- CSN Mineração should make it clear whether densities were estimated or averaged from test results by lithology.
- Current compositing methods are satisfactory for the calculation of mineral resources. When CSN Mineração performed the compositing, there were artifacts of the ROCKCODE that appeared to be combined values resulting in categorical values with decimals in addition to integers. The number of

composites with decimal values is minor but should be addressed by CSN Mineração during the next model update.

- The grouping for estimation domaining is considered satisfactory for estimation purposes. Silica, with its high indirect correlation to Total Fe, will be appropriate for common domaining but manganese oxide may display materially different properties in domaining such as structural control, internal zones of high/low manganese oxide or other geological controls separate from Total Fe. It is recommended that CSN Mineração evaluates the possibility of grouping some domains with a scarce number of samples.
- No statistical parameters have been tabulated per domain. CSN Mineração should include this study in its report.
- It is recommended that manganese oxide (and other potentially deleterious materials) be reviewed to understand spatial continuity of these individual variables separate from Total Fe. Based on differences in spatial continuity and exploratory data analysis for individual elements, it may be beneficial for unique domains of certain variables if the mineralization is unrelated to iron enrichment.
- The nugget values, anisotropy and general variography parameters are as expected based on studies of other global iron deposits and aligns with the type of deposit.
- Currently, the variography method is over-reliant on expecting Total Fe (global) spatial continuity to be the same for all variables (Total Fe, SiO_2, Al_2O_3, P, MnO, CaO, TiO_2, MgO, and LOI). Typically, Total Fe, SiO_2, Al_2O_3 and occasionally P will display similar spatial continuity while other variable concentrations are not necessarily associated with Total Fe, thus generate a poor correlation coefficient, and should be evaluated independently. The correlation coefficients of raw quality variables (i.e. Fe, SiO_2, Mn and TiO_2) display high correlations that may be appropriate for cross variography, linear model of co-regionalization (LMC) for variography or co-kriging estimation while other variables are not well correlated, thus their spatial distribution are based on a variety of geological processes different from the primary iron oxide enrichment.
- A review of variography for each primary element per domain is recommended. This will result in calculating multiple variograms, but each estimate will be unique based on the properties of the individual variable and the domain. LMC can be an appropriate means of obtaining a robust semi-variogram in highly correlated variables, but it often results in incorrect spatial continuity of poorly correlated variables and poor estimation.
- The application of OK for variables using a unique modeled semi-variogram per hard domain is recommended. Although this represents a more time intensive process of modeling and estimation, the results should provide improved validation with original composited data, thus improved prediction of quality and reconciliation.
- The initial use of KNA is advised but it should be performed on each domain for at least the key economic variable (i.e. Total Fe). If COK is utilized for estimation and LMC is the preferred method for spatial continuity, then these should be accounted for in search neighborhood selection. Currently, the documentation is insufficient to determine how effective the KNA is to the estimate and only optimizing the search for a single domain is not recommended.
- The Casa de Pedra mining complex block model should be validated and documented by a variety of means including, but not limited to, visual validation, swath plots for key elements by domain, comparison with nearest neighbor estimation and general statistical validation by element per domain.
- The validation based on mean grades between composited values and blocks show similar high variability between the various elements. In the case of Fe_GL, the differences are considered immaterial but in the case of secondary/deleterious elements, the comparison illustrates material differences. Since domaining and ore type quality relies on both Total Fe and deleterious materials, the validation of estimation shows poor performance resulting in inaccurate prediction of material quality at the local scale.
- Swath plots demonstrate a material bias between composites and block grades across portions of the deposit. In some areas, the values that show acceptable validation are typically associated with increased data concentrations but there are multiple locations where the estimation should be modified to provide an improved local estimate so that composite and block grades are more aligned.

- CSN Mineração utilizes a classification ranking system which accounts for a variety of geological, quality and estimation inputs. This scoring system combined with a smoothing of broad volumes into categories results in a satisfactory classification that meets international reporting guidelines and definitions for measured, indicated, and inferred mineral resources. The increased confidence in classification aligns well with geological continuity and drilling density. Samples without QAQC received zero weight in the resource classification ranking system, meaning that the entire historical drilling database (prior to 2012), was not considered for resource classification.
- It is recommended that CSN Mineração runs a new pit optimization applying updated parameters and economic assumptions. The pit optimization must include capital allocated to move infrastructure, inclusive of sustaining costs and CFEM.
- Offsets, or the distances from the pit shell limits to major infrastructure areas need further evaluation.
- CSN Mineração should conduct a cut-off grade analysis and justify grades below the cut-off grade in some blocks within the mineral resource.
- CSN Mineração should update its mineral resource documentation with the updated parameters, economic assumptions, and grade-tonne sensitivities to cut-off grade with the qualified person's opinions to meet international reporting standards.
- The issues related to all relevant technical and economic factors likely to influence the prospects of economic extraction can be resolved with further technical work and analysis.

12 MINERAL RESERVES

12.1 Mineral reserve estimation criteria

To convert mineral resources to mineral reserves, consideration was given to forecasts and estimates of product price, metallurgical recovery, mining dilution and ore loss factors, royalties and costs associated with mining, processing, overheads and logistics. These parameters were used to derive economic cut-off grades and create a feasible pit design based on the geotechnical assumptions, a production schedule and financial model.

All studies were developed to a minimum level of accuracy of a prefeasibility study.

CSN Mineração's base case for the mineral reserve considered the treatment of ore at the current Casa de Pedra processing plant along with the greenfield P15 itabirite project which is currently being developed and licensed.

12.1.1 Geotechnical considerations

CSN Mineração completed several geotechnical studies based on geotechnical mapping, logging, sampling and testing which led to a rock mass characterization by sector and recommendations for pit slope design.

The geotechnical parameters by rock type, class and sector are summarized in Table 12.1.

Table 12.1 Geotechnical parameters for pit design

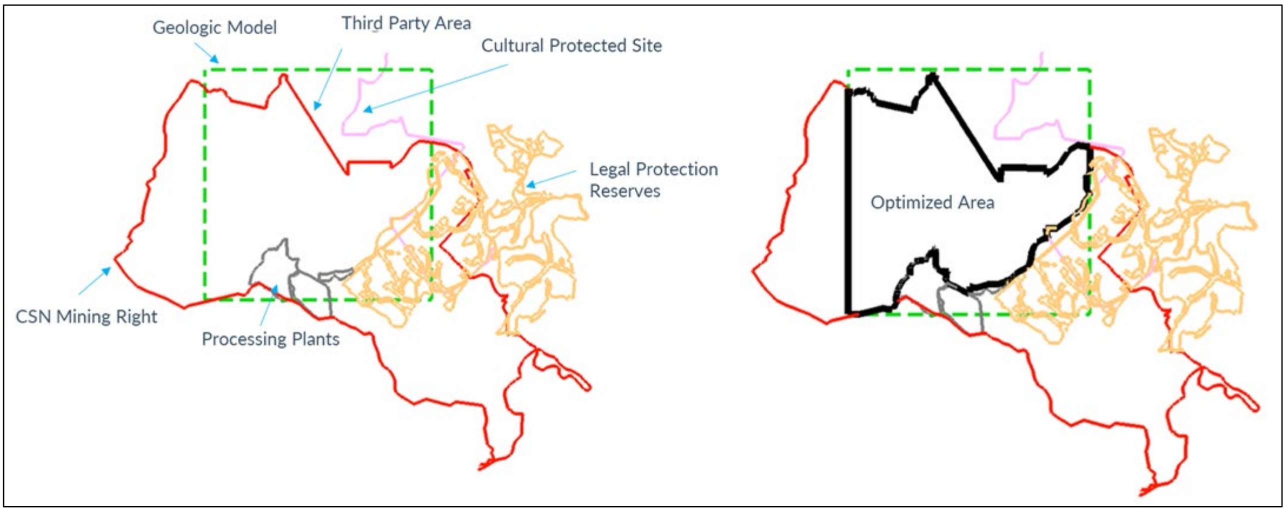
Lithology	Geotechnical Classification	Sectors	Max. Height (m)	Safety Berm (m)
Colluvium/Soil	V	All	78	20
Canga	V	All	78	20
Clay	V	All	104	20
Itabirite	V	2, 3 and 6	104	20
		7	78	
		1, 4 and 5	78	25
	IV	1, 4	78	
		5	104	
		2, 3 and 6	104	20
		7	78	
	III	1, 2, 3, 4, 5 and 7	143	
		6	143	
	I-II	1, 2, 3, 4 and 5	143	
		7	143	
		6	143	
Hematite	V	1, 4 and 6	78	25
		7	104	20
	IV	6	104	
Basic	V	2, 3, 6 and 7	78	20
		1, 4 and 5	78	25
	IV	1, 4 and 6	104	
		2, 3 and 6	104	20
		7	104	
	III	1, 2, 3, 4, 5 and 7	143	
		6	143	
	I-II	1, 2, 3, 4 and 5	143	
		7	143	
		6	143	
Schist	V	1	52	30
		3, 6	91	20
		7	78	
	IV	3, 6 and 7	104	
		1	78	25
	III	3, 6 and 7	143	20
	I-II	1 and 3	143	
		7	143	
Fillite	V	2	91	20
		4	78	25
		5	78	30
	IV	4 and 5	78	25
	III	4 and 5	104	20
Dolomite	V	2 and 6	91	20
	IV	2 and 6	104	
	III	2	143	
		6	143	
	I-II	2	143	
		6	143	

Source: CSN Mineração

12.1.2 Physical constraints

The pit boundaries were limited by several physical constraints such as mining rights, environmental licenses, land properties and infrastructure as illustrated in Figure 12.1.

Figure 12.1 Physical constraints applied to the pit design



12.1.3 Dilution and ore loss

Planned dilution and ore loss factors were incorporated to the block model through a regularization procedure. The model contains regularized blocks sized 25 m (X) by 25 m (Y) by 13 m (Z) which reflects the selective mining unit (SMU) dimensions.

Additionally, uniform 5% unplanned dilution and 95% mining recovery factors were applied to the pit optimization.

12.1.4 Metallurgical recovery

Various testwork programs have been performed in a pilot facility to derive the following mass yield function:

- Mass recovery = 1.1786 * Fe%.

Hematite, friable itabirites, compact itabirites and canga were considered amenable for processing.

12.2 Economic assessment factors

12.2.1 Financial parameters

A foreign exchange rate of R$5.40:US$ was assumed based on long range forecasts completed by CSN Mineração. A discount rate of 9% was considered.

12.2.2 Revenues assumptions

The long-range iron prices assumed by CSN Mineração for mine planning purpose correspond to year 2025. The product pricing forecast is shown in Table 12.2.

Table 12.2 Product price forecast

Platts Iron Ore Index	Unit	Forecast by Year				Long Term Forecast
		2021	2022	2023	2024	2025
Platts 62	US$/dmt	102.2	87.7	81.1	78.0	74.0
Platts 65	US$/dmt	122.6	105.2	97.3	93.6	88.8
Platts 58	US$/dmt	71.5	61.4	56.8	54.6	51.8

Source: CSN

The applicable taxes are shown in Table 12.3.

Table 12.3 Taxes

Item	Unit	US$/t
CFEM	t product	3.00
TFRM	t ROM ore	0.88

12.2.3 Cost assumptions

The input costs used for the pit optimization are based on a combination of historical data and CSN Mineração forecasts.

The mining costs assumed for the pit optimization are presented in Table 12.4.

Table 12.4 Mining costs

Item	Unit	US$/t
Drill and blast	t mined	0.10
Load	t mined	0.14
Haul	t mined	0.33
Ancillary	t mined	0.42
Total	**t mined**	**0.99**

The cost of mineral processing, product handling and transportation, and others are shown in Table 12.5.

Table 12.5 Ore processing, product handling, transportation and other costs

Item	Unit	US$/t
Processing		
Central plant	t ROM	3.86
P15 plant	t ROM	4.42
Dry process plants	t ROM	8.83
Product handling		
Stockpiling	t product	0.18
Rehandling	t product	0.32
Others		
Sustaining	t product	6.43
G&A	t product	1.36
Others	t product	2.10
Product transportation		
Rail	t product	4.86
Port	t product	5.60
Ocean freight	t product	25.64

12.3 Cut-off grades

The economic cut-off grade to decide whether a block should be mined or left in-situ was calculated by the NPVS software of Datamine.

12.4 Open pit optimization

A number of nested pit shells were generated using NPVS software for a range of revenue factors on the product price. Preliminary discounted cash flows were estimated by the optimizer based on a 9% discount rate.

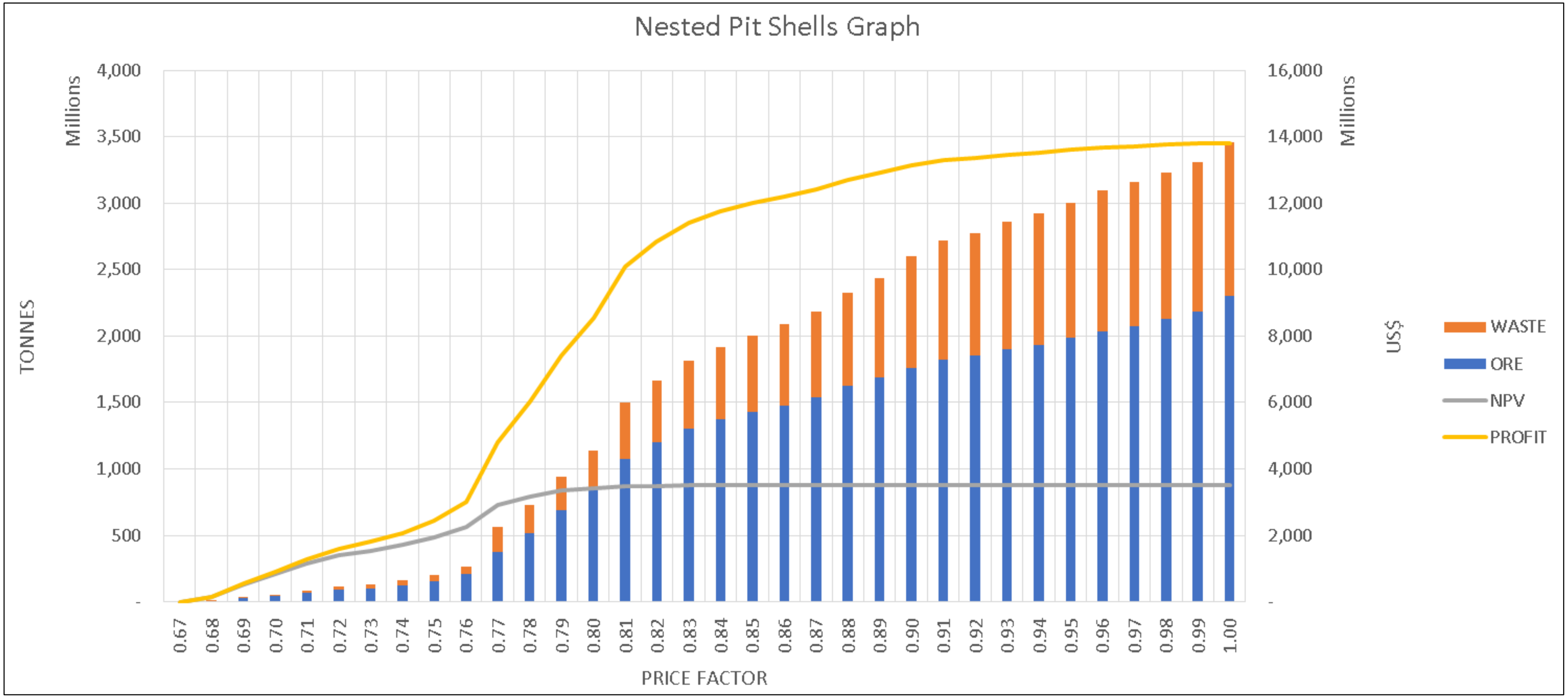
The pit optimization results are presented in Table 12.6 and Figure 12.2. At this stage, no provision for the stockpile was made. The discounted cash flow figures presented do not include capital costs.

The optimal pit shell was selected through marginal analysis. Usually, larger pit shells that have modest increases in NPV for large increases in rock tonnage are avoided. Given the fact that the mine is highly constrained by physical limits such as mining rights, environmental licenses, land tenure and infrastructure limits rather than economic aspects, the 1.0 Revenue Factor (RF) pit shell was selected for detailed design of the ultimate pit and intermediate phases.

Table 12.6 Optimized nested pit shells

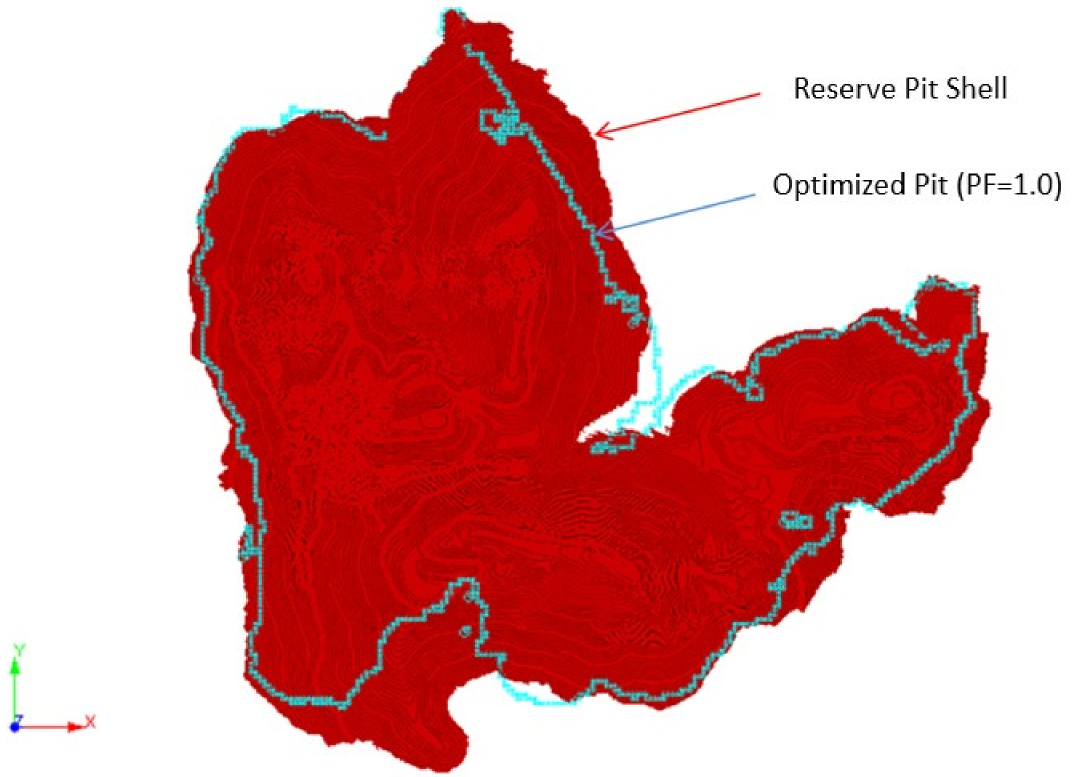
Phase	Factor	NPV MUS$	Total Ore Mt	Total Ore %	Total Waste Mt	Total Waste %	Strip t/t	Strip inc t/t
Pit 1	67%	0.63	0.0	0.0%	-	0%	-	-
Pit 2	68%	139.79	6.3	0.3%	0.1	0%	0.01	0.01
Pit 3	69%	526.50	25.6	1.1%	1.8	0%	0.07	0.09
Pit 4	70%	842.39	44.4	1.9%	6.7	1%	0.15	0.26
Pit 5	71%	1,143.41	66.3	2.9%	13.9	1%	0.21	0.33
Pit 6	72%	1,397.22	87.7	3.8%	23.2	2%	0.26	0.43
Pit 7	73%	1,538.24	101.5	4.4%	27.2	2%	0.27	0.30
Pit 8	74%	1,718.30	122.2	5.3%	39.8	3%	0.33	0.61
Pit 9	75%	1,948.67	153.5	6.7%	46.9	4%	0.31	0.23
Pit 10	76%	2,256.94	205.6	8.9%	59.2	5%	0.29	0.24
Pit 11	77%	2,902.38	377.1	16.4%	188.3	16%	0.50	0.75
Pit 12	78%	3,167.99	514.3	22.3%	213.1	18%	0.41	0.18
Pit 13	79%	3,341.59	686.9	29.8%	256.4	22%	0.37	0.25
Pit 14	80%	3,420.44	843.1	36.6%	297.4	26%	0.35	0.26
Pit 15	81%	3,476.86	1,075.0	46.7%	422.3	37%	0.39	0.54
Pit 16	82%	3,491.29	1,200.4	52.1%	460.8	40%	0.38	0.31
Pit 17	83%	3,498.56	1,300.0	56.4%	517.0	45%	0.40	0.56
Pit 18	84%	3,501.93	1,371.5	59.5%	545.8	47%	0.40	0.40
Pit 19	85%	3,503.86	1,426.3	61.9%	580.4	50%	0.41	0.63
Pit 20	86%	3,505.18	1,474.8	64.0%	616.8	54%	0.42	0.75
Pit 21	87%	3,506.39	1,538.3	66.8%	649.3	56%	0.42	0.51
Pit 22	88%	3,507.52	1,621.7	70.4%	701.7	61%	0.43	0.63
Pit 23	89%	3,508.16	1,688.5	73.3%	748.5	65%	0.44	0.70
Pit 24	90%	3,508.68	1,759.8	76.4%	841.5	73%	0.48	1.30
Pit 25	91%	3,508.99	1,823.4	79.2%	897.2	78%	0.49	0.88
Pit 26	92%	3,509.12	1,855.7	80.6%	918.2	80%	0.49	0.65
Pit 27	93%	3,509.25	1,898.0	82.4%	961.6	83%	0.51	1.03
Pit 28	94%	3,509.33	1,929.7	83.8%	990.5	86%	0.51	0.91
Pit 29	95%	3,509.43	1,985.6	86.2%	1,017.6	88%	0.51	0.48
Pit 30	96%	3,509.49	2,035.1	88.3%	1,060.6	92%	0.52	0.87
Pit 31	97%	3,509.53	2,075.1	90.1%	1,083.3	94%	0.52	0.57
Pit 32	98%	3,509.56	2,126.7	92.3%	1,100.5	95%	0.52	0.33
Pit 33	99%	3,509.57	2,185.4	94.9%	1,120.8	97%	0.51	0.35
Pit 34	**100%**	**3,509.57**	**2,303.6**	**100.0%**	**1,152.9**	**100%**	**0.50**	**0.27**

Figure 12.2 Nested pit shells graph



A comparison between the reserve pit shell and the optimized pit (PF=1.0) is shown in Figure 12.3.

Figure 12.3 Resource pit vs optimized pit (RF=1.0)



12.5 Open pit design

A detailed design was completed on the selected pit shell including accesses and ramps.

The geometrical assumptions included:

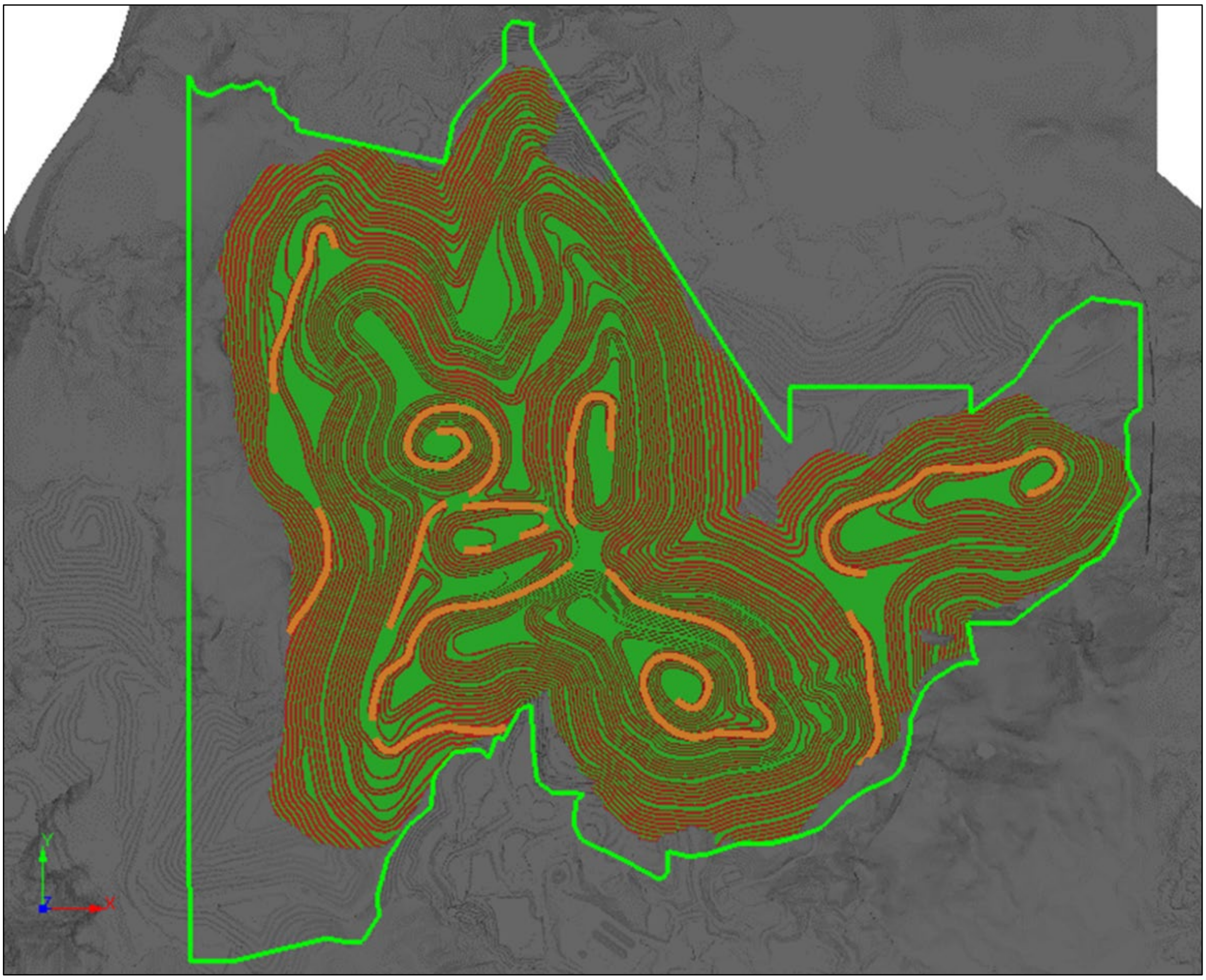
- Slope and bench geometric parameters derived from the geotechnical recommendations.
- Road and ramp width of 35 m.
- Maximum ramp gradient of 10%.

Table 12.7 summarizes the evaluation of the ultimate design shown in Figure 12.4.

Table 12.7 Pit design evaluation

Item	Unit	Value
Ore	Mt	2,078
Waste	Mt	1,091
Total rock	**Mt**	**3,170**
Strip ratio	t/t	0.52

Figure 12.4 Plan view of the pit design



A comparison of tonnage and grades of the optimized pit shell and the pit design is presented in Table 12.8. The differences in tonnage and grade are considered acceptable.

Table 12.8 Comparison of the optimized and designed pits

Item	Optimized	Designed	Difference (Mt)	Difference (%)
Ore (Mt)	2,304	2,078	-225	-9.8%
Waste (Mt)	1,153	1,091	- 62	-5.4%
Total (Mt)	**3,456**	**3,170**	**-287**	**-8.3%**
Strip ratio (t/t)	0.50	0.52	0.02	4.9%

12.6 Mineral reserve as of 31 December 2021

The Casa de Pedra mining complex mineral reserves as of 31 December 2021 are summarized in Table 12.9. The point of reference for the mineral reserves is ore delivered to the processing facility.

Table 12.9 Casa de Pedra mining complex – summary of mineral reserves as of 31 December 2021 based on an iron price of US$95.00/t

Category	Tonnage (Mt)	Fe (%)
Proven	152.9	42.49
Probable	1,925.5	41.07
Total	**2,078.4**	**41.17**

Notes: Tonnages are reported on a wet basis. Mineral reserves are based on measured and indicated mineral resources only.

The December 2021 mineral reserve estimate for the Casa de Pedra mining complex was developed in accordance with SEC standards. This section provides a summary of the procedures and methods applied to derive the mineral reserves. The work has been undertaken under the supervision of a qualified person as defined in the SEC guidelines.

To convert mineral resources to mineral reserves, consideration was given to forecasts and estimates of product price, metallurgical recovery, mining dilution and ore loss factors, royalties and costs associated with mining, processing, overheads and logistics. These parameters were used to derive economic cut-off grades and create a feasible pit design based on geotechnical assumptions, a production schedule and a financial model.

The mineral reserve estimate described herein is consistent with the quality of information available at the time of preparation, the data supplied by outside sources and the assumptions used.

The basis of the mine planning work was the mineral resource model as described in Section 11. The mineral resources were internally developed by CSN Mineração in 2017 and audited by SRK in 2021. No critical issues were reported.

The mineral reserve classification reflects the level of accuracy of the modifying factors.

The mineral reserves are based on measured and indicated mineral resources only. The estimate includes dilution and ore loss factors. Stockpiles within the current pit limits were considered as waste.

The reserve classification reflects the level of accuracy of the associated studies. In this respect, compact itabirites were only converted to the probable reserve category as additional metallurgical and processing studies are required to increase the level of confidence.

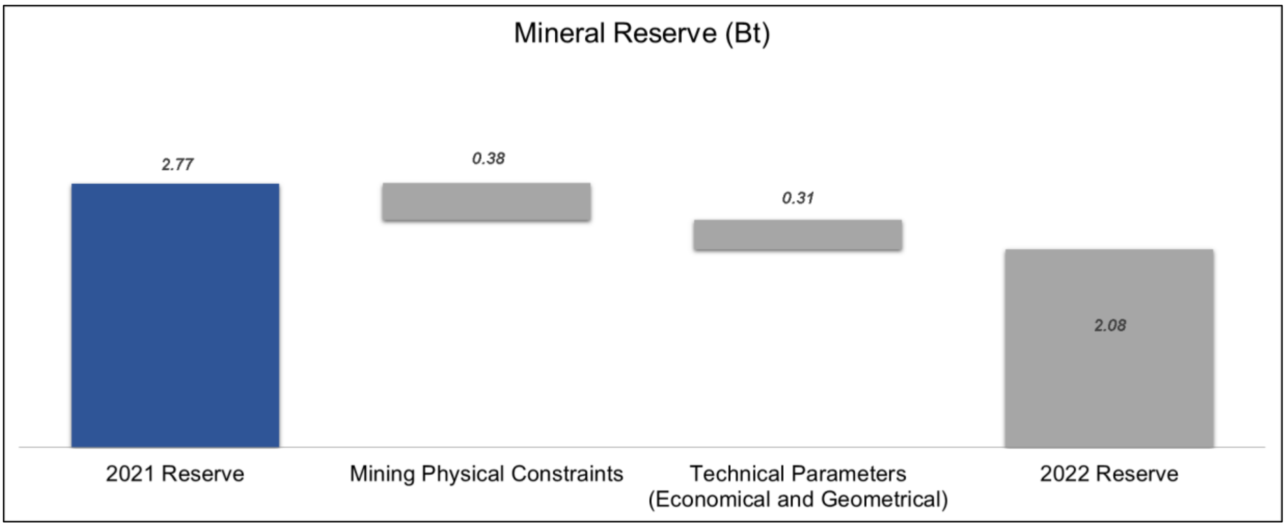
The basis for establishing economic viability is discussed in Section 19.

12.7 Comparison with previous estimate

The Casa de Pedra mining complex mineral reserve was reported as 2.80 Bt in 2020. After adjustment for the material mined in 2021 (depletion) the mineral reserve amounted to 2.77 Bt. The December 2021 mineral reserve was reported at 2.08 Bt with the variation due to the following factors as illustrated in Figure 12.7:

- The pit boundaries in the December 2021 estimate were more constrained. Specifically, CSN Mineração excluded ore within adjacent areas to the northeast of the mine because of the proximity to mineral rights owned by third parties.
- A review of the pit design according to updated technical and economic parameters.

Figure 12.5 Waterfall graph illustrating the mineral reserve changes from 2021 to 2022



12.8 Audits and reviews

This information was not provided to Snowden Optiro during the course of this work. Only information about an external audit done by SRK on the mineral resource. Snowden Optiro used the SRK work as a reference and commented accordingly in the Section 10 of this technical report summary report.

12.9 Qualified person's opinion

Snowden Optiro reviewed all the procedures and methods concerning the mineral reserve estimate completed on the Casa de Pedra mining complex. It is the qualified person's opinion that the estimation and reporting of the mineral reserves is in accordance with S-K 1300 guidelines. This opinion is based on the premise that the mineral reserves estimate and technical inputs provided by the registrant has no fatal flaws. However, there are a number of aspects in the estimate that requires attention to bring it in line with current industry best practice:

- The block height of the resource model is 13 m. This dimension reflects past mining techniques where 13 m benches were drilled and blasted. Recommendations by the mine operation's team led to the reduction to a 10 m bench to avoid the excessive use of track dozers to lower the blasted bench crest and create safe loading conditions. The qualified person recommends a cell height adjustment from 13 m to 10 m to reflect the current SMU.
- It is noted that constant unit mining costs were applied to the pit optimization. No mining adjustment cost factors were considered to reflect specific operating conditions such variable haul distances, drill patterns, dewatering requirements, etc. While the use of mining adjustment cost factors has a material impact on the Casa de Pedra pit design as it is mainly constrained by physical boundaries rather than by economic aspects, the qualified person recommends that future iterations include variable mining costs that reflect local operating conditions.
- Detailed mining costs calculated out of mining physicals estimates (fleet sizing, mining consumables, workforce, etc.) are higher than those used in the pit optimization to reflect the current highly volatile economic conditions (diesel price, foreign exchange rates, etc.). While this may not have a material impact on the Casa de Pedra pit boundaries as the pit optimization bottoms out at Revenue Factor of 0.80, the qualified person recommends that future mine planning work is accordingly adjusted to the detailed calculated mining costs.
- It is recommended that a pit sensitivity analysis on key optimization parameters is performed to assess their impact on the mining inventories and economics of the operation.
- While all relevant data and documents required for the mineral reserve estimate are in general adequate and well detailed, the absence of a consolidated Terms of Reference (ToR) document for mine planning purposes was noted. The qualified person recommends that a ToR document is compiled including all relevant aspects of the operation that can guide the mineral reserve estimation team. The document should be updated every year reflecting any variation such as commodity prices, costs, depletion, etc. The results and findings of the annual mine planning cycles should be consolidated along with the ToR in a stand-alone report.

13 MINING METHODS

13.1 Mining methods

The Casa de Pedra mine is based on conventional drill, blast, load-and-haul techniques for all mining areas and rock types. The mining fleet is fully owned by CSN Mineração. All rock is blasted and loaded with excavators and loaders into off-road trucks and hauled to the primary crusher, stockpiles or waste dumps. Primary mining is undertaken by large hydraulic excavators (26 m^3 bucket capacity) coupled with 240 t off-road trucks. Front-end loaders of 25 m^3 bucket capacity also operate at the pit and stockpiles.

All material is mined in 10 m high benches which are considered an appropriate balance between productivity and selectivity.

The mining method generates variable grades and quantities of ore that require the use of run of mine (ROM) stockpiles to meet the blending requirements. Front-end loaders are used for the ROM feed and stockpile rehandling.

The mined waste is dumped in the Batateiro waste dump.

The loss of trafficability on haulage routes occurs on a seasonal basis during the rainy season. Management plans and risk reduction strategies are in place to mitigate this.

Double-lane haul roads were designed at a 35 m width. The maximum gradient used for the haul roads is 10%.

Ore delivered to the ROM is either stockpiled or directly feed to the plant by trucks. The ore stockpiled is rehandled by front-end loaders (and/or excavator during the rainy season) or a combination of a front-end loaders and trucks, depending on the distance between the plant and stockpiles.

Grade control is performed by drilling using production drills. The holes are drilled on a 25 m x 25 m grid, with the collection of one sample per planned ore bench (usually 5 m high).

The mine operates year-round with three shifts every 24 hours. The life of mine base case is an owner's operation.

13.2 Mine schedule

The objective of the production schedule is to meet the production requirements of the processing plant and to maximize NPV while maintaining adequate operational practices including safety. Production scheduling involves the definition of practical mining phases and the development of an achievable mining schedule.

The production schedule is updated on an annual basis using NPVS software.

The following assumptions were made for the production scheduling:

- Only blocks classified as measured and indicated were scheduled and considered as ore.
- The production rates and timeline of the ore treatment facilities are:
  - Central processing plant: Maximum 32.0 Mtpa operating until 2031.
  - "Seco 61" and "Secto Add" processing facilities operating until 2026 with a combined capacity of 11.1 Mtpa.
  - P15 processing plant: Start-up in 2024, operating at 31.0 Mt until 2031 and 121.1 Mtpa thereafter.

The metallurgical specifications of each processing facility are:

- "Seco 61" plant: Average mass yield recovery of 100% and 60.5% Fe.
- "Seco Add" plant: Average mass yield recovery of 100% and 54.9% Fe.

- Central plant:
  - Sinter feed (SF): Average mass yield recoveries of 47.8% and 59.3% Fe.
  - Pellet feed (PFF): Average mass yield recoveries of 24.5% and 65.8% Fe.
- P15 plant: Average mass yield recovery of 49.2% and 67.0% Fe until 2031; thereafter an average mass yield of 45.9% and 62.3% Fe.

The guidelines observed for the mine schedule selection were:

- Maintaining realistic mining rates that are appropriate for the mining fleet
- Achieve a practical open pit mining sequence
- Manage production rates to ensure the processing facilities are consistently supplied at constant iron head grades
- Rehandling levels set to 17% of the total rock movement.

Several scheduling iterations were run with different mining rates and iron head grade targets. After the maximum product production was determined, practical mining and stockpiling strategies were applied, while maintaining the highest possible production.

Figure 13.1 to Figure 13.7 show the results of the mine schedule including ore and waste movements, strip ratio, stockpiling levels and generation of products. Figure 13.8 to Figure 13.14 show plan views of the mining sequence where ore and waste blocks are represented in red and green respectively.

Figure 13.1 Total rock mined

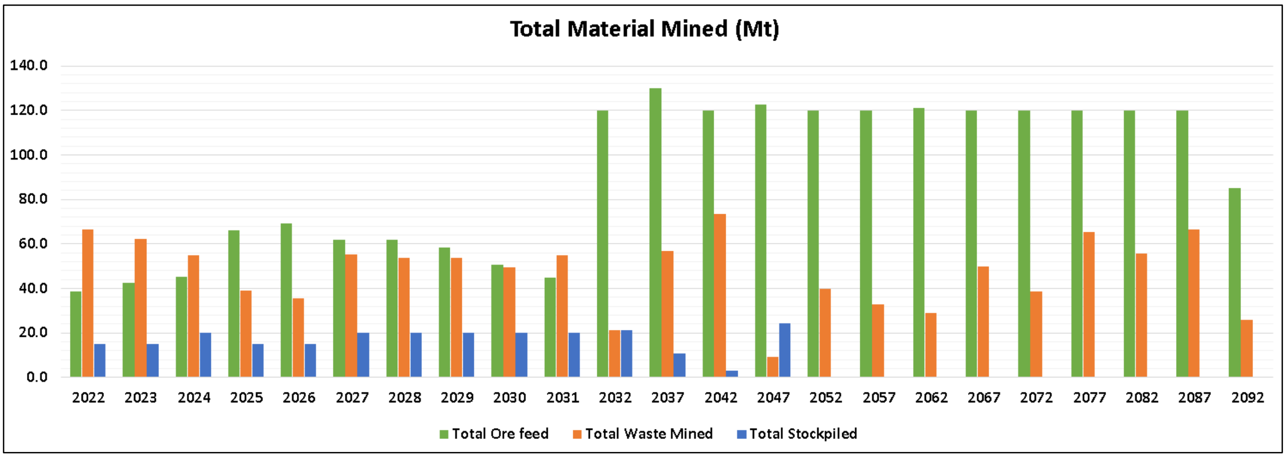


Figure 13.2 Strip ratio

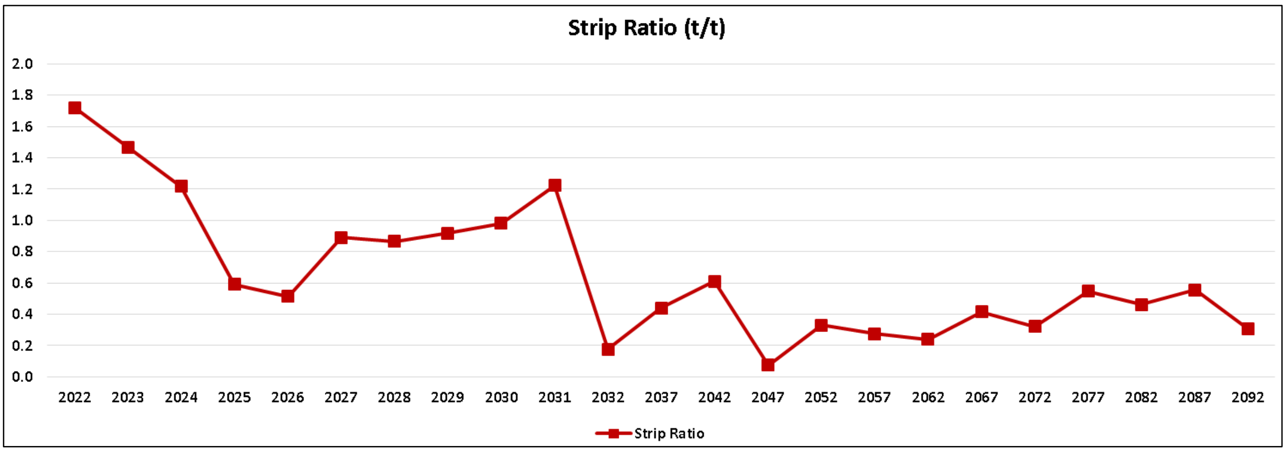


Figure 13.3 Stockpiling schedule

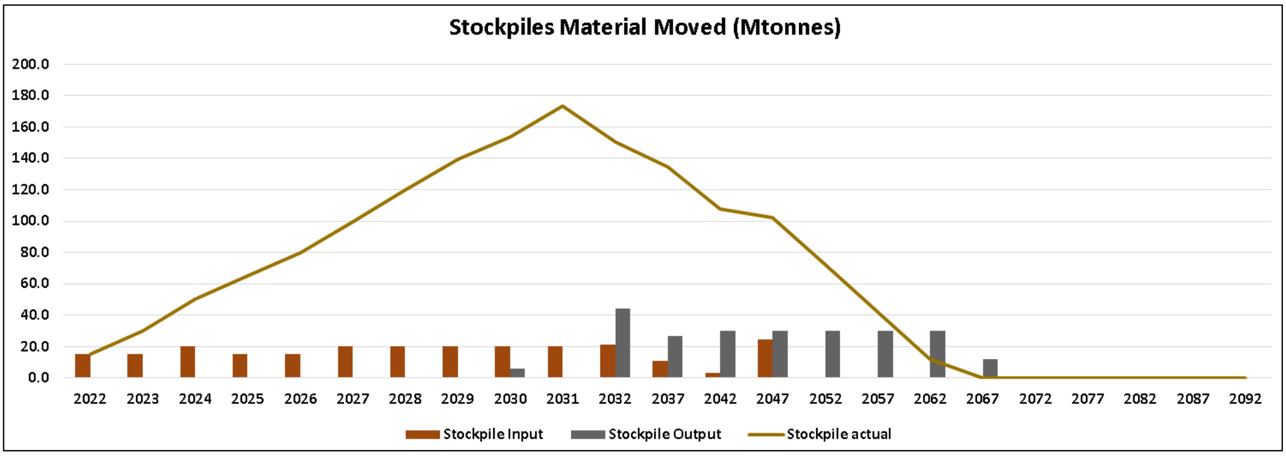


Figure 13.4 Products of the "Seco 61" processing plant

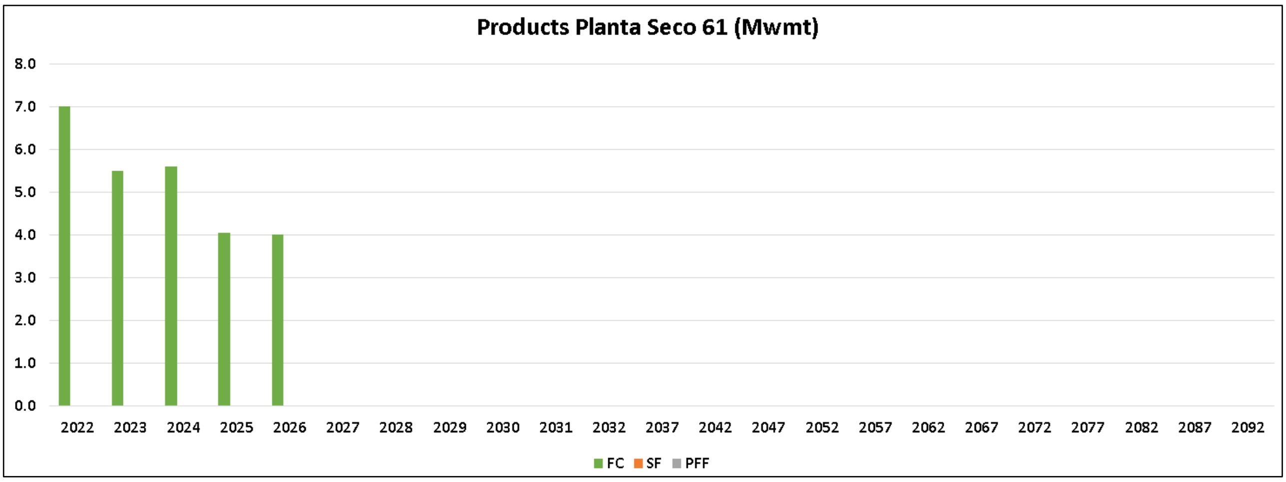


Figure 13.5 Products of the "Seco Add" processing plant

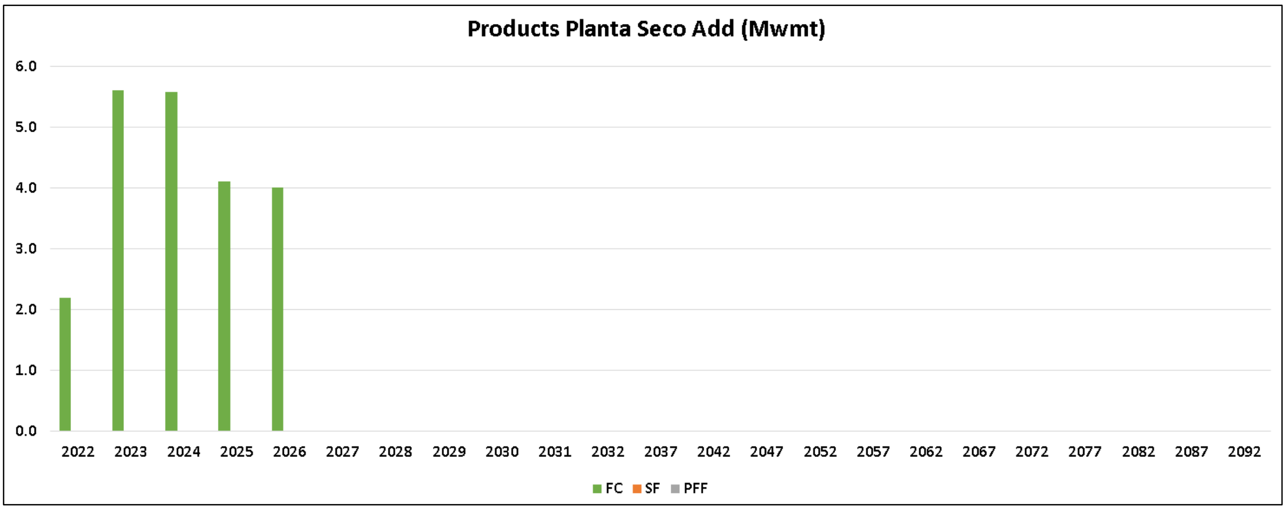


Figure 13.6 Products of the “Central” processing plant

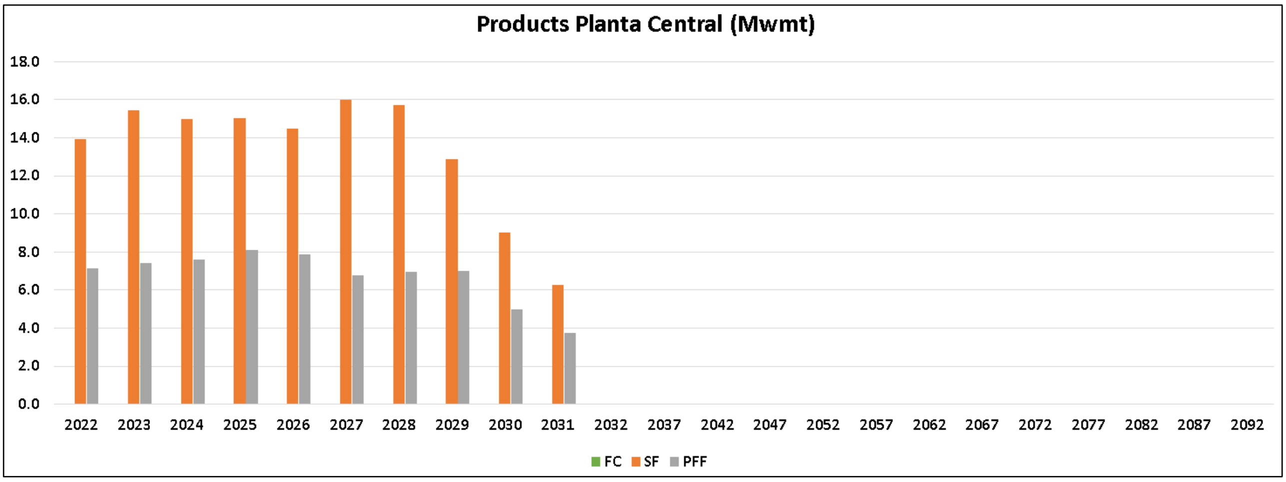


Figure 13.7 Products of the “P15” processing plant

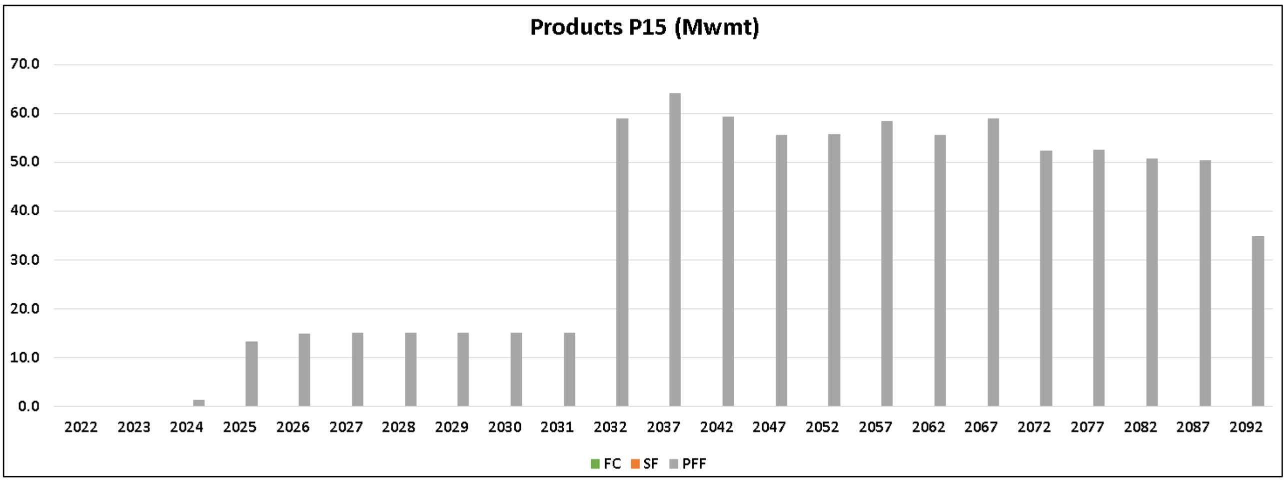


Figure 13.8 Mine schedule – year 2026

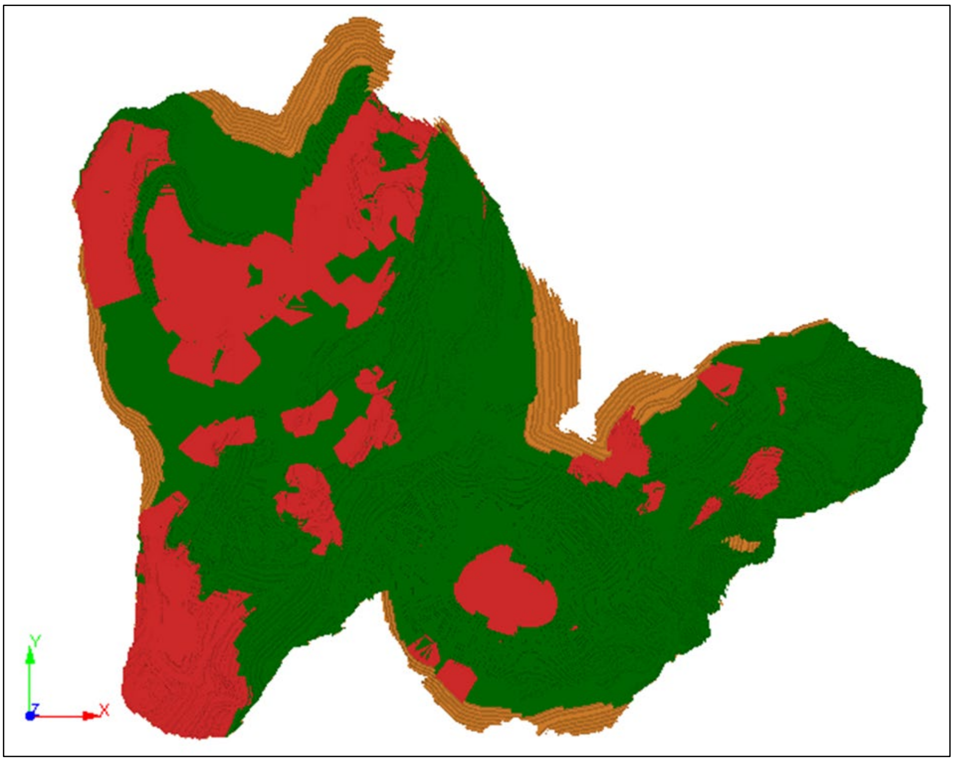


Figure 13.9 Mine schedule – year 2031

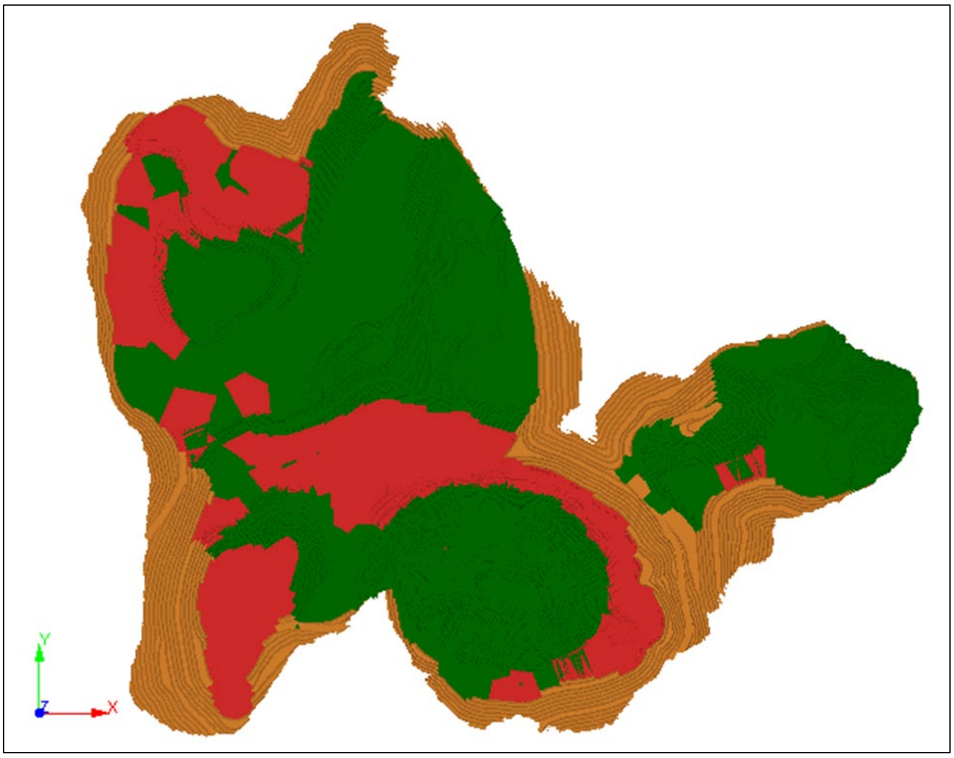


Figure 13.10 Mine schedule – year 2037

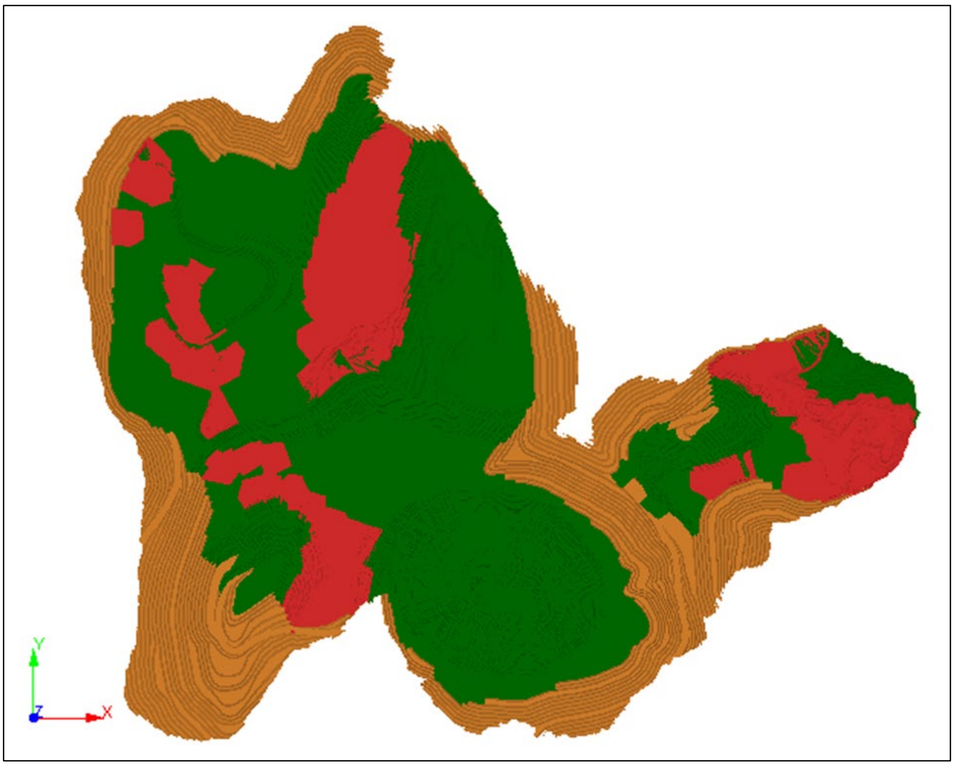


Figure 13.11 Mine schedule – year 2042

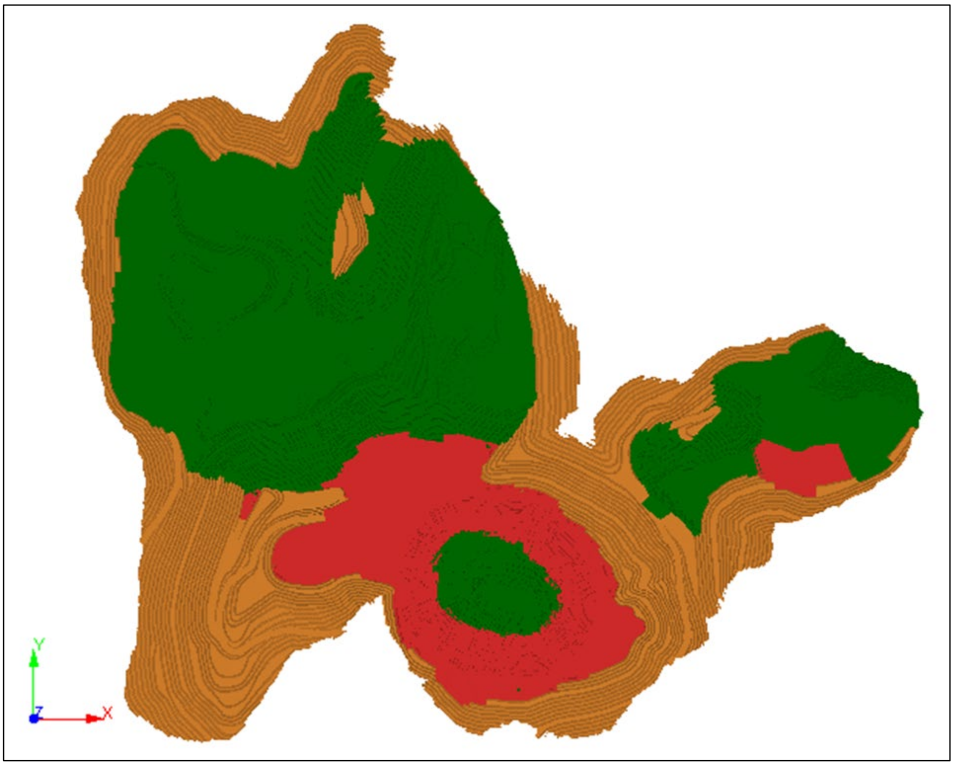


Figure 13.12 Mine schedule – year 2052

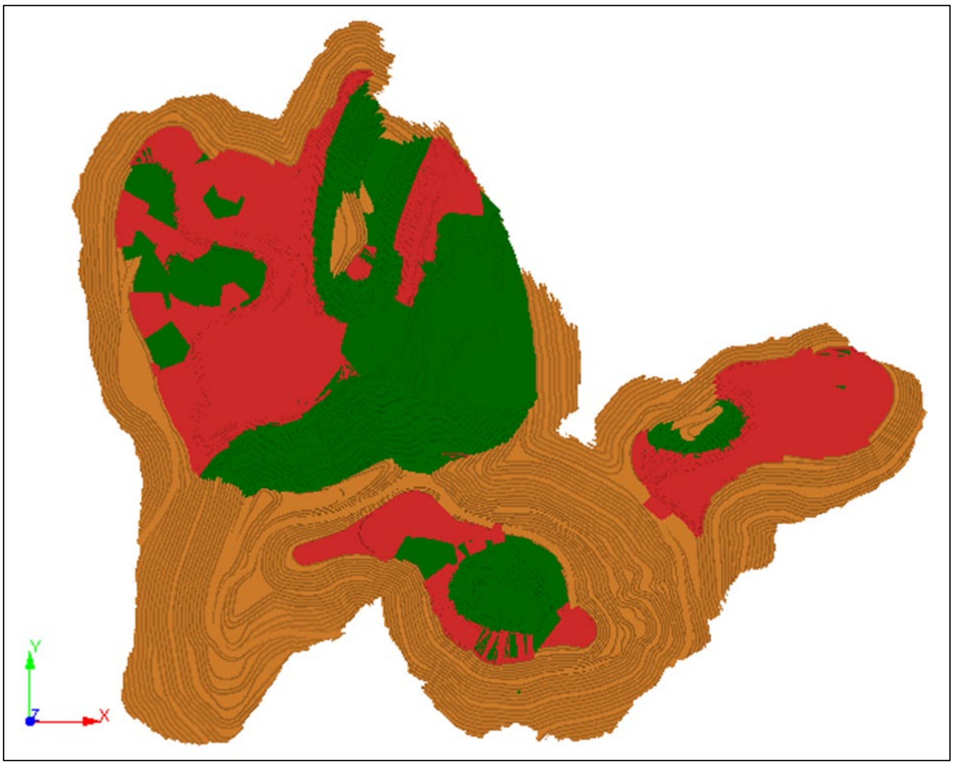


Figure 13.13 Mine schedule – year 2072

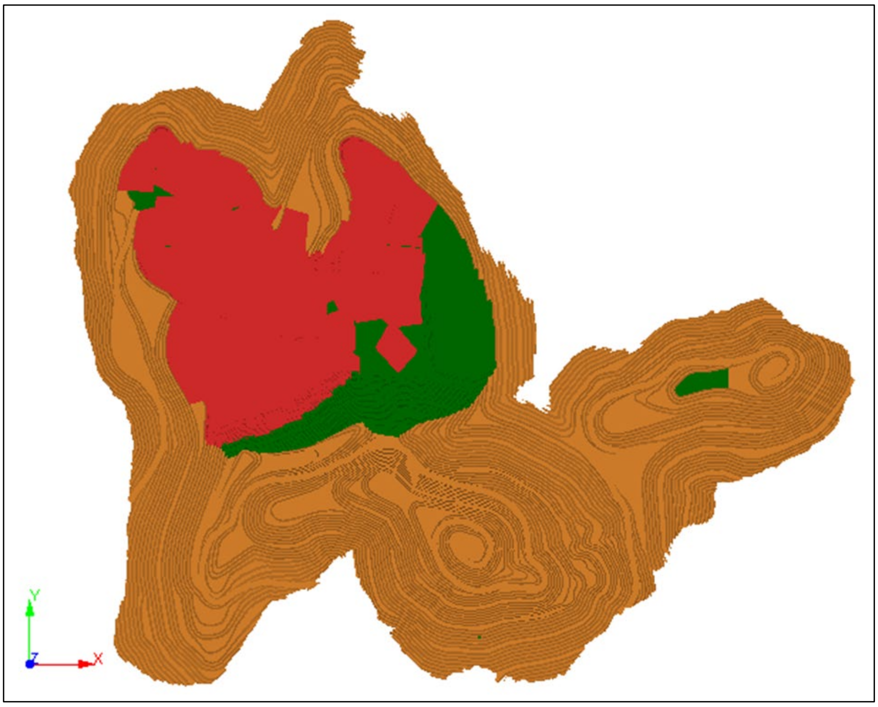
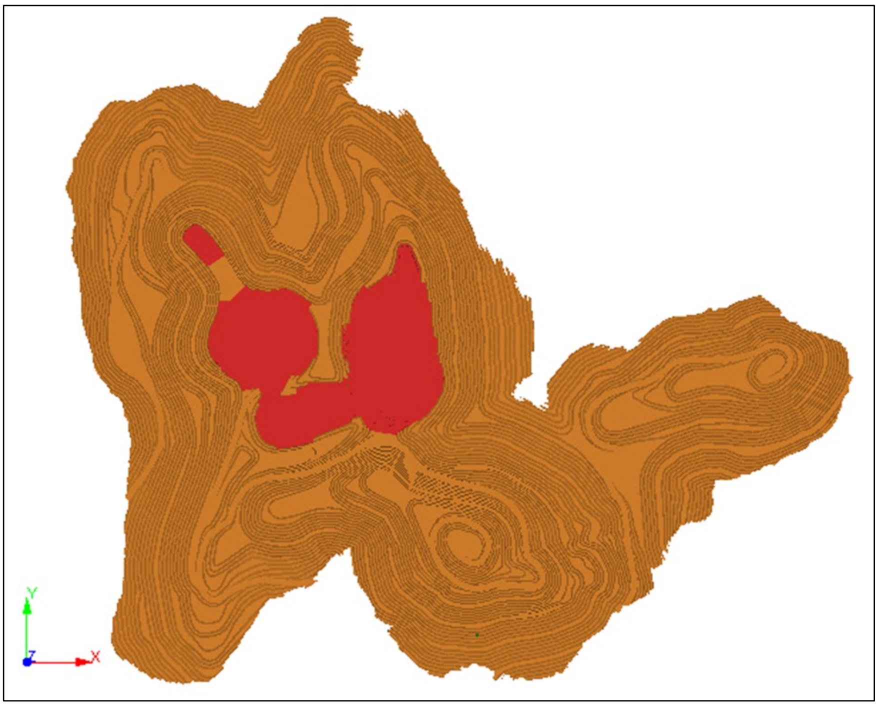


Figure 13.14 Mine schedule – year 2092



13.3 Mine operations

The Casa de Pedra mining operation is based on a mining concept which sees the use of conventional drill, blast, load-and-haul techniques for all mining areas and rock types. All material is blasted and loaded with shovels into off-highway mining dump trucks, and hauled to waste dumps, ROM ore stockpiles or to the ROM crusher hoppers.

Specifically, the mining is carried out primarily by large hydraulic shovels coupled with dump trucks.

Due to the physical characteristics of the materials, it has been assumed that 100% of ore and waste will be drilled and blasted. All materials are mined in benches of 10 m high.

The mining method will generate variable grades and quantities of ore that will require the use of ROM stockpiles to meet the blending requirements. Front-end loaders will provide ROM feed and stockpile rehandling.

The mined waste is dumped in the Batateiro waste dump (see Section 15.4).

The loss of trafficability on haulage routes occurs on a seasonal basis during the rainy season. Management plans and risk reduction strategies are in place to mitigate this.

Double-lane haul roads are designed with a 35 m width. The maximum gradient used for the haul roads is 10%.

Ore delivered to the ROM is either stockpiled or directly feed to the plant by trucks. The ore stockpiled is rehandled by front-end loaders (and/or excavator during the rainy season) or a combination of a front-end loaders and trucks, depending on the distance between the plant feed and the stockpile.

Grade control is performed by drilling, sampling and assaying potential ore material within the pit limits using production drills. Holes for grade control are drilled on a 25 m x 25 m grid, with the collection of one sample per planned ore bench (usually 5 m high).

13.4 Mine equipment

The mine equipment consists of hydraulic shovels, large off-highway trucks and a combination of rotary and down-the-hole drill rigs. The mining fleet is totally owned by CSN Mineração.

CSN Mineração selected off-highway trucks of a 250-tonne (216 Mt) payload class. These trucks are used for ore haulage from the pit to the crusher and for waste haulage from the pit to the waste dumps. These trucks are also used for haulage from the ROM stockpiles to the crusher.

Hydraulic excavators in a shovel configuration with an operating weight ranging from 660-tonne (Cat 6060) to 550-tonne (PC 5500) were selected based on the consideration of the required production rates and truck matching. Trucks are loaded in four passes on average.

The trucks direct tip into the crusher during normal work days. A front-end loader with 240-tonne operating weight is used for rehandling the ore from the ROM stockpiles. When necessary, the front-end loader can complement or replace excavators for loading in-pit ore and waste.

All material is drilled and blasted. Three sizes of drilling equipment were selected:

- Production drillholes for 10 m benches are carried out by a rotary drill rig (9 7/8” blast hole).
- Drilling on areas with a difficult access and complicate topography is by a down-the-hole (DTH) crawler drill rig (5”-6” blast hole). This equipment may also be used for pre-splitting holes.

Medium-term and short-term geology and mine planning activities are supported by the use of a reverse circulation (RC) drill rig.

The track dozer selected for the various applications in the mine is in the 110–70 tonne operating weight class. Track dozers are used mainly for waste dumping, stripping activities, and road and access construction.

A 65-tonne operating weight and 4.9 m blade length grader is used for maintaining the roads and accesses within the property.

Water trucks are required to wet temporary accesses and mining faces, keeping dust within acceptable levels and to supply water to the drill rigs.

The following auxiliary equipment is also used:

- Explosive truck for preparing, transporting and loading explosives into the blast holes
- Backhoe loader for ditch excavation and other general services

- Low bed transporter truck for drill rig and dozer transportation
- Fuel and lube truck designed to fit a 216-tonne truck
- Field mechanics truck equipped with a crane
- Skid-steer loader for filling drillholes with stemming material and other general services
- Portable lightning tower
- Light vehicles: 4x4 double cabin pickups for services and personnel transportation within the mine area (management, operation, maintenance, mine planning, geology, grade control, shift supervision, etc.)
- Tire handler to handle large tires
- Dewatering pumps.

Table 13.1 summarizes the specifications of the main mine equipment.

Table 13.1 Main mine equipment list

Equipment	Specification	Reference model
Hydraulic shovel excavator	660 t operating weight, 340 m^3 bucket	Cat 6060
Hydraulic shovel excavator	550 t operating weight, 29.0 m^3 bucket	PC 5500
Front-end loader	240 t operating weight, 19.0 m^3 bucket	Cat 994
Off-highway truck	216 t payload	Cat 793
Rotary blast hole drill rig	9 7/8” diameter blast hole – rotary	MD6290
DTH blast hole drill rig	5” diameter blast hole – DTH	FlexiRoc T40
Track dozer	110 t operating weight	Cat D11
Track dozer	70 t operating weight	Cat D10
Grader	65 t operating weight	Cat 24M

13.4.1 Operation schedule

Table 13.2 shows the mine equipment operation schedule.

An overall availability of 80% and 85% is assumed for the hydraulic shovels and trucks respectively. A maximum utilization of 80% has been applied for haul trucks and 70–74% for loading and drilling equipment. An average 2% moisture factor was applied for fleet calculation purposes.

Table 13.2 Mine operation schedule

1 Shift	2 Shift	3 Shift
Explosive truck	Grader	Hydraulic shovel excavator
Skid-steer loader	Backhoe loader	Front-end loader
	Portable lightning tower	Off-highway truck
	Track RC drill rig	Blast hole drill rigs (rotary and DTH)
		Crawler drill
		Bulldozer
		Water truck
		Low bed transportation truck (trailer)
		Fuel and lube truck
		Field mechanical truck
		Hydraulic crane
		Tire handler
		Light vehicle

13.4.2 Drill and blast parameters

An average drill penetration rate of 19 m/h and 25 m/h is assumed for ore and waste respectively. The Casa de Pedra mining operation applies bulk explosives such as ANFO and emulsion when required. The drill and blast parameters are shown in Table 13.3.

Required accessories comprise:

- Boosters 900 g and 250 g
- Detonating cord, 12 g nitropenta
- Non-electric detonators
- Blasting cap + burning fuse
- Connectors.

Table 13.3 Drill and blast parameters

Parameter	Unit	Drill rig 9 7/8"		Drill rig 5"
		Ore	Waste	Pre-split
Diameter	inches	9 7/8	9 7/8	5
Diameter	m	0.251	0.251	0.127
Bench height	m	15	15	10
Drillhole dip	°	0	0	15
Burden	m	5.0	4.5	0.0
Spacing	m	6.0	7.0	1.2
Subdrill	m	0.5	0.5	0.0
Hole length	m	15.5	15.5	10.4
Stemming	m	4.0	4.0	2.5
Column charge	m	11.5	11.5	7.4
Explosive density	g/cm^3	1.15	1.15	1.11
Diameter of decoupled charge for pre-split	m			0.03
Specific charge	kg/m	57	57	0.88
Hole charge	kg/hole	653	653	6
Volume	m^3	450	473	
Explosive specific consumption	kg/m^3	1.45	1.38	
Decoupled pre-split specific consumption	kg/m^2			0.73
Decoupled pre-split specific consumption	m/m^2			0.59
Detonating cord	m/m^3	0.01222	0.01217	
Booster	unit/m^3	0.00222	0.00212	
Delay	unit/m^3	0.00222	0.00212	
Nonel	unit/m^3	0.00222	0.00212	
Electronic Fuse	unit/m^3	0.00020	0.00019	

The average number of required rotary drill rigs until 2031 is 14 units and four thereafter. Two DTH drills are required throughout the life of mine.

The average amount of bulk explosives per annum estimated until 2031 is 68 kt.

13.4.3 Loading equipment parameters

Loading equipment requirements are calculated for the dry and wet seasons. Details of the calculation of the shovel production capacity is shown in Table 13.4.

Table 13.4 Excavator productivity with respect to truck capacity

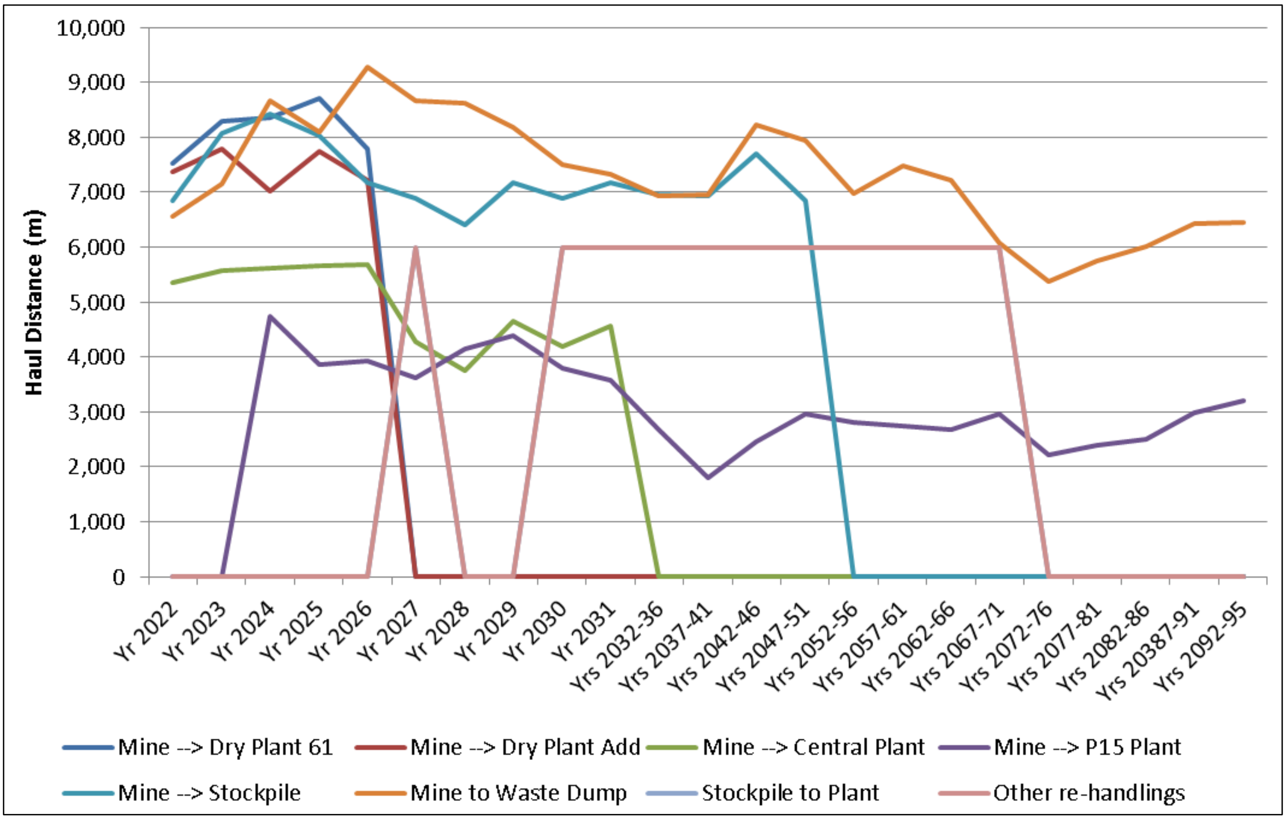
Bucket capacity	m^3	Hydraulic excavator Cat 6060 / Cat 793 34		Hydraulic excavator PC5500 / Cat 793 29		Front-end loader Cat 994 / Cat 793 19	
Rock type		Ore	Waste	Ore	Waste	Ore	Waste
Loading unit rated capacity	t	75	56	64	48	42	32
Nominal no. of passes	no.	3	4	4	5	6	7
Truck rated capacity	t	216	216	216	216	216	216
Nominal bucket factor	%	96%	96%	85%	90%	86%	98%
Effective minutes per hour	min	50	50	50	50	50	50
Shovel manoeuvre	min	0.25	0.25	0.25	0.25	0.25	0.25
Maximum truck loaded per hour	no.	22.2	17.1	17.1	14.0	9.5	8.2
Optimal trucks in cycle	no.	16.0	16.0	12.0	13.0	7.0	9.0
Extra trucks in cycle	no.	0	0	0	0	0	0
Nominal shovel wait	min	0.0	0.1	0.1	0.1	0.2	0.0
Nominal truck wait	min	1.0	0.0	0.0	0.0	0.0	1.9
Cycle time							
Pass time	seg	40	40	40	40	50	50
Queuing time	min	1.0	0.0	0.0	0.0	0.0	1.9
Spot time	min	1.3	1.3	1.3	1.3	1.3	3.3
Load time	min	2.0	2.7	2.7	3.3	5.0	5.8
Loaded travel time	min	15.0	21.0	15.0	21.0	15.0	21.0
Dump time	min	0.8	0.8	0.8	0.8	0.8	0.8
Other delays	min	0.9	0.9	0.9	0.9	0.9	0.9
Unloaded travel time	min	15.0	21.0	15.0	21.0	15.0	21.0
Cycle time	min	36.0	47.7	35.7	48.3	38.0	54.8
Truck productivity per hour	t/h	300.0	226.6	302.8	223.4	284.2	197.3
Loading unit trucks per hour	no.	25.0	18.3	18.4	14.4	9.7	8.6
Loading unit productivity	**t/h**	**5,400**	**3,957**	**3,967**	**3,114**	**2,086**	**1,851**

Until 2031, the mine will operate with three 34 m^3 bucket shovels, five 29 m^3 hydraulic shovels and six 19 m^3 front-end loaders. Thereafter, loading operations will be undertaken by two 29 m^3 hydraulic shovels and four 19 m^3 front-end loaders.

13.4.4 Haulage equipment requirements

The distances from the mine to the plant, stockpiles and waste dumps are calculated by road segments for loaded and empty conditions taking into account the actual ramp gradient and an average rolling resistance. The average haul distances are presented in Figure 13.15.

Figure 13.15 Average haul distances



Average speeds were estimated by ramp gradient as shown in Table 13.5.

Table 13.5 Average speeds by haul profile

	Unit	Loaded speed	Empty speed
Up	km/h	15	27
Flat	km/h	35	37
Down	km/h	19	25

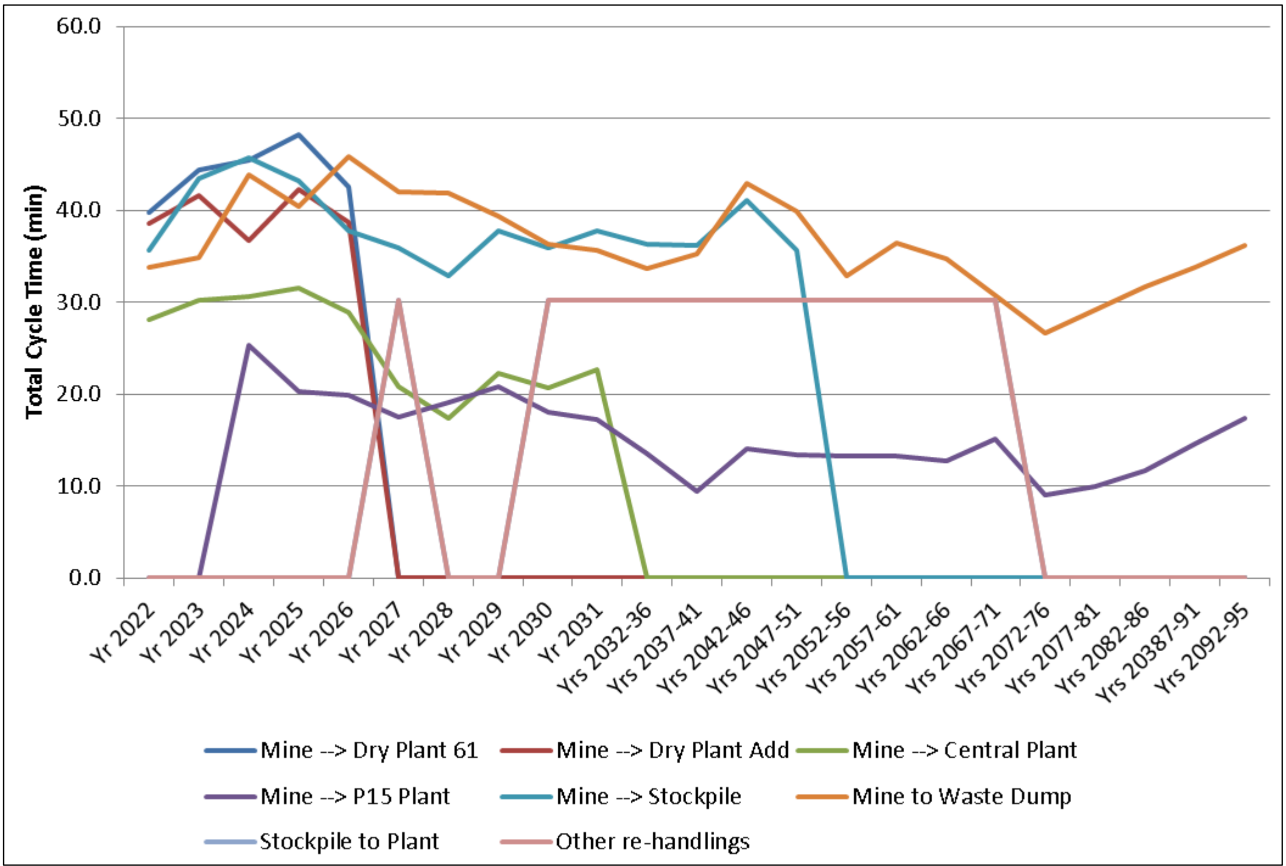
In addition to travel time, an average fixed cycle time has been added to account for loading and unloading, manoeuvring and waiting as shown in Table 13.6.

Table 13.6 Fixed cycle times

Match	Ore	Waste
Cat 6060 / Cat 793	6.0	5.7
PC 5500 / Cat 793	5.7	6.3
Cat 994 / Cat 793	8.0	12.8

The total haulage cycle time estimated throughout the life of mine is displayed in Figure 13.16.

Figure 13.16 Total haul cycle times



The average number of truck units required until 2031 is 70. Thereafter, 15 units are required on average.

13.4.5 Ancillary equipment

The maximum number of units of each type of ancillary and support equipment is shown in Table 13.7 and Table 13.8.

Table 13.7 Ancillary equipment

Ancillary	Availability	Utilization	Maximum no. of units
Track dozer D11	63%	69%	18
Track dozer D10	79%	78%	6
Wheel dozer	79%	78%	5
Large grader	76%	76%	1
Water truck	88%	67%	3
Front-end loader – small size	76%	78%	2
Front-end loader – large size	76%	78%	1

Table 13.8 Support equipment

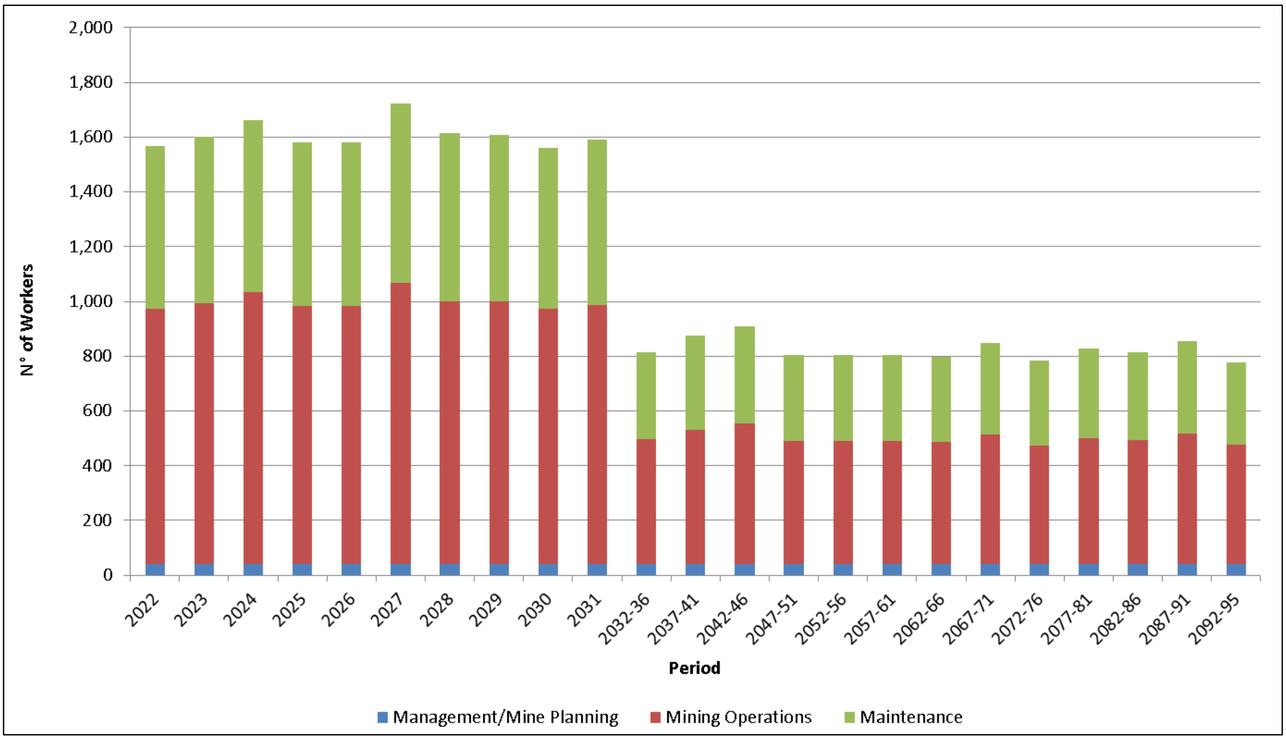
Support	Availability	Utilization	Maximum no. of units
Lube truck	75%	75%	1
Lube truck – small size	75%	75%	1
Refuelling truck	75%	75%	1
Refuelling truck – small size	75%	75%	1
Water truck – small size	88%	67%	1
Maintenance truck	75%	75%	1
Munck truck 12 t	75%	20%	2

Support	Availability	Utilization	Maximum no. of units
Munck truck 20 t	75%	20%	3
Platform truck	80%	10%	1
Low bed truck	80%	10%	1
Tow truck	80%	10%	1
Tire handler	75%	30%	1
Hydraulic excavator – long boom	75%	30%	1
Hydraulic excavator – breaker	80%	30%	1
Lighting tower	85%	30%	12
Pick-ups	70%	80%	14

13.5 Workforce

Managers, administrative workers and some technicians will work on a single shift basis (dayshift). Equipment operators will work on three, two or single shifts, depending on the type of equipment, as shown in Table 13.2. Four crews will be required to operate the equipment types scheduled to operate on three shifts. The required workforce to operate the mine averages 610 until 2031 and 323 thereafter, including allowance for vacation, sickness and training. Details of the labour requirements are shown in Figure 13.17.

Figure 13.17 Workforce



The requirement for production equipment operators (shovels, off-highway trucks and drill rigs) is dependent on the number of equipment units. Maintenance staff was estimated based on the following assumptions:

- One mechanical technician per shift and per 12 equipment units
- One electrical technician per shift and per 20 equipment units.

For the workforce estimate, an allowance for employee absenteeism, vacation and sickness has been counterbalanced by the average mine equipment availability.

13.6 Qualified person's opinion

The mining equipment selection and technical parameters are well explained and presented by CSN Mineração. The mining method selected is appropriate to the orebody geometry, mineralization style, production target and historical performance.

It is noted that after 2032, the average annual total rock movement decreases from 120 Mtpa to 30 Mtpa. The qualified person recommends that further investigation is undertaken to verify the value of reducing the mining equipment size to match the annual mining rate.

14 PROCESSING AND RECOVERY METHODS

This section describes the current processing operation at the Casa de Pedra Central plant and the modifications that will be implemented to improve the performance of the current ROM processing with a lower iron content feed and the filtration of the tailings generated.

14.1 Central processing plant

The wet processing plant, named Central plant, currently has installed capacity to produce around 22 Mtpa of marketable ore products. As shown in Figure 14.1, the process includes all the steps necessary to produce the different types of iron ore products.

The main processing steps include crushing, screening, homogenizing, sorting and concentration, thickening, and product and tailings filtration. The products generated are granulated, sinter feed and pellet feed.

14.1.1 Crushing and homogenization

The process begins with the comminution or crushing stages, composed of three stages of crushing to reduce the particle size to less than 50 mm. The ore feed is tipped into two primary crushing facilities, referred to as Crushing 01 and 02:

- Crushing 01 is a rotary crusher with -1,220 mm size ore discharged directly into the crusher. The crushed -286 mm product is directed by conveyor belts to an intermediate stockpile.
- Crushing 02 consists of a feed silo, a vibrating grille and a jaw crusher. At this facility, off-road trucks unload ore into the silo, from which the material is extracted by a feeder and unloaded on the vibrating grille. Ore retained on this grille (-1,100 mm and +200 mm) goes to the jaw crusher. The -250 mm crushed product is combined with the undersize of the vibratory grille and is discharged into an intermediate stockpile (lung stack).

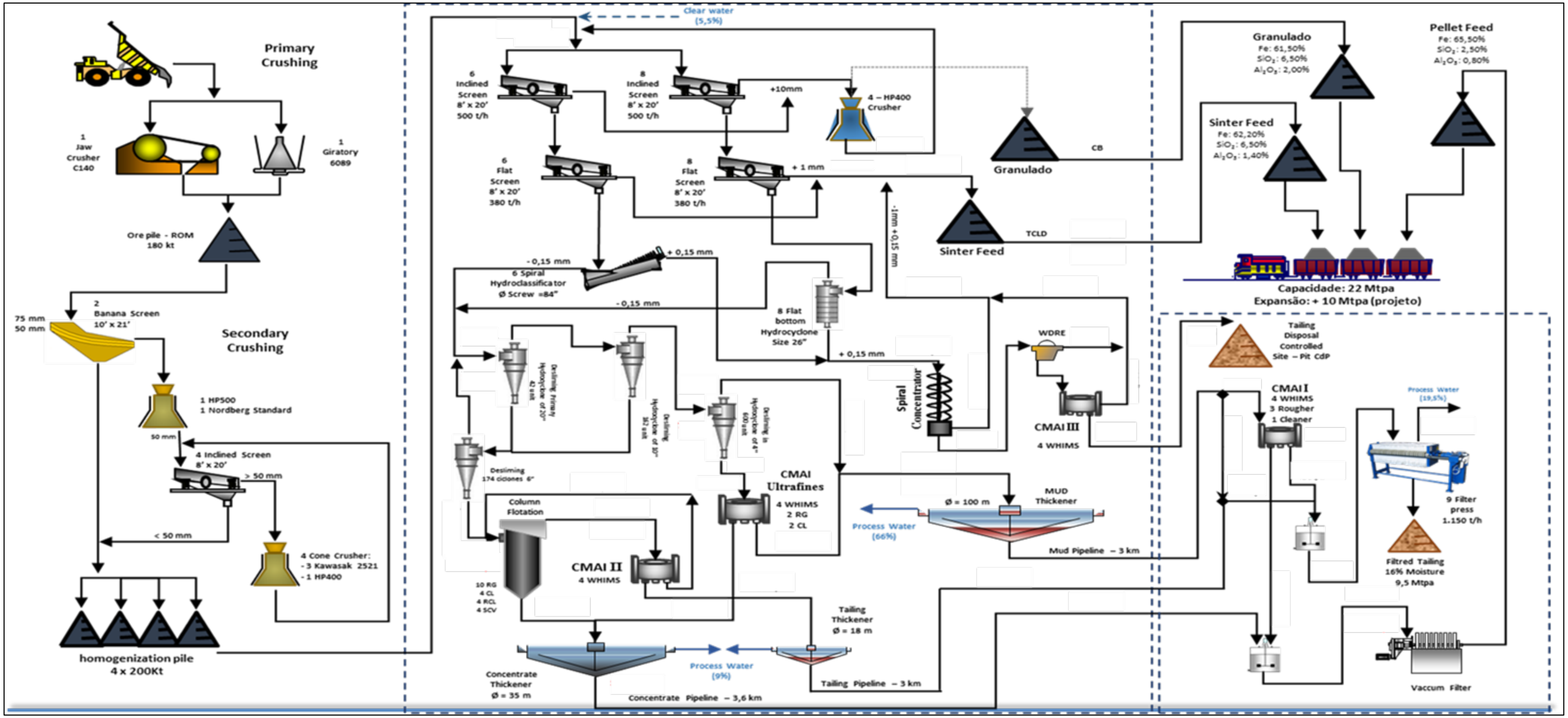
ROM ore stored in the lung stack is recovered by means of three shoe feeders and directed to the feeding system of the secondary crushing stage, which in turn consists of two parallel production lines:

- Line 01 consists of a two-deck banana screen and a Nordberg 7’ tapered crusher. The undersize of the screen (-50 mm) discharges directly into the conveyor and is directed to the homogenizing stack. Ore retained on the two decks (+50 mm) feeds the secondary crusher. The product from the secondary crusher is conveyed to the tertiary crushing stage.
- Line 02 consists of a two-deck banana screen and an HP-500 tapered crusher. The undersize of the screen (-50 mm) discharges directly into the conveyor and is directed to the homogenizing stack. The ore retained in the two decks (+50 mm) feeds the secondary crusher. The product from the secondary crusher follows is conveyed to the tertiary crushing stage.

The tertiary crushing stage consists of four parallel production lines, each consisting of a sloped screen and a tapered crusher. The crushed product of the secondary crushing stage is discharged, by means of a mobile rail feeder into the respective feed silos of these lines. In the tertiary screening, two products are obtained: undersize and oversize. The first product consists of particles less than 50 mm and together with the pass of the secondary screens, is routed to the homogenization cells. The second product (+50 mm) consists of the feeding flow from the tertiary crushers, which operate in closed circuit, with the crushed product returning to the tertiary screens.

After the comminution step, the ROM ore is conveyed to the homogenization stockyard. The stockpiles are subsequently reclaimed by two bridge bucket wheels. The recovered ROM ore is transported by conveyor belts to the classification stage.

Figure 14.1 Central processing plant flowsheet



14.1.2 Screening and concentration

The classification stage consists of equipment that is intended to separate the ROM ore into four distinct granulometric classes: granulated (+12 mm), thick sinter feed (-12 mm and +1 mm), thin sinter feed (-1 mm and +0.15 mm), and these two fractions combine, generating only one product (sinter feed), and fines (-0.15 mm). Currently, the first two consist of products, while the fines go to the desliming and flotation circuits. The desliming process is carried out in four stages. The primary stage consists of six parallel lines, three consisting of three batteries of six cyclones and the other half of batteries of eight cyclones, both with a diameter of 508 mm. The feed comes from the overflow of the spiral classifiers and boring bottom cyclones. The underflow and overflow of these cyclones are routed, respectively to the secondary and tertiary stages.

The tertiary stage consists of six lines, three of which are composed of batteries of 24 cyclones and the other three by batteries of 30 cyclones of 254 mm. The underflow from this stage together with the underflow from the primary stage constitutes the feed of the secondary stage, while the overflow of these cyclones is routed to micro-desliming. Like the two stages described above, the secondary stage consists of six lines, three of which are 28 cyclone batteries and the other three by 30 cyclone batteries of 154 mm. The underflow from this stage is directed to fines flotation while the overflow constitutes the feed for micro-desliming.

Micro-desliming and magnetic concentration of ultra-fines constitute a parallel circuit of concentration and recovery of fine iron from the slimes. As previously mentioned, the micro-desliming feed consists of the overflow of the secondary and tertiary stages of fine desliming. This stage consists of 24 batteries of 25 cyclones of 102 mm. The underflow from this stage is directed to the magnetic separation of ultra-fines and the overflow to the sledge thickener.

The magnetic concentration circuit for the ultra-fines consists of a screening stage and two stages of magnetic separation. The feed from the micro-sliming circuit is directed to a protection screen. The undersize proceeds to a pulp box where the dilution is adjusted. From this box, the pulp is pumped to the magnetic separation equipment that makes up the rougher stage. The concentrate from the magnetic separation is considered a product and is therefore send to the feed box of the concentrate thickener. The tailings from the rougher stage are directed to a pulp box that feeds the scavenger stage. The concentrate from this stage feeds a cleaner step where the concentrate is considered a product. The tailings are directed as circulating load to the scavenger stage. The tailings of the scavenger stage are pumped into the sland thickener feed box (EP-51).

The flotation of fines is carried out in four stages: rougher, cleaner, recleaner and scavenger. The underflow from the cyclones of the secondary stage is directed to the rougher stage, which consists of 10 columns. The overflow and underflow from these columns consist, respectively, of flotation tailings and feeding of the cleaner stage. The final two stages of flotation (cleaner and recleaner) are each composed of four columns. The underflow from the cleaner columns feed the recleaner stage and the concentrate from this stage consisting of flotation product is routed to the solid-liquid separation stage (thickening and filtering). The tailings from the two stages (cleaner and recleaner) are routed to the scavenger stage, comprising four columns. The concentrate and tailings from these columns consist, respectively, of circulating load (returning to the feeding of the rougher stage) and flotation rejects.

Flotation tailings are intended for IMC II (high intensity magnetic concentration). The tailings from each flotation line are pumped individually to the feed pulp dispenser of the magnetic concentration equipment (Jones or Carousel type) and are arranged in a single rougher step to recover flotation tailings. At this stage, there are three flows which are called: tailings, medium and concentrate. The first two constitute the final tailings of the flotation plant and magnetic concentrator and are discharged in two pulp boxes and sent to the tailings thickener.

The dense product obtained in 41-EP-73, called underflow, is sent by gravity to the tailings filtration feeding system. The overflow of the 41-EP-73 thickener is pumped into the slofa thickener feed box.

Concentrates from the magnetic concentration are collected by two boxes of pulp and pumped into a thickening cone, which has the function of thickening the pulp and returning the concentrate to the homogenization tank in the flotation feed. The concentrate at this stage is a circulating load of the flotation circuit + CMAI II.

The overflow from the cone, consisting of water with turbidity index less than 100 NTU, is discharged into a box from where it is preferentially pumped to the recovered water tank of 41-ES-201 (concentrate thickener) and optionally to the feeding trough of thickener.

The concentrate obtained from the fine flotation plants (flotation + CMAI II) are sent to the densification and dewatering process, consisting, respectively, of a concentrate thickener (ES-201) and a vacuum filtration plant. The thickener has the function of reducing the dilution of the concentrate for the filtration process. In this equipment, two flows are obtained: overflow consisting of reclaimed water which will be reused in the process, and the underflow containing about 40% water which flows by gravity to the lung tank feeding the filtration.

The existing filtration plant consists of nine vertical vacuum filters. The flow, coming from the lung tank, is pumped to the flow distributor, which distributes the pulp between this equipment. The pie (pellet-feed), containing about 10.5% moisture in each filter, is directed to the storage yards, where it will be forwarded to the wagon loader.

14.1.3 CMAI I and tailings filtering

The CMAI I consist of high-intensity Jones magnetic concentrators and is composed of a protection screening step, two stages of concentration and one stage of concentrating.

The thickened mud is directed in pulp form to the protection screen where two products are removed, namely oversize and undersize. The first constitutes the material retained in the screen and is discharged on the floor of the installation from where it is transported to the tailings piles. The second undersize proceeds to a pulp box from where it is pumped to the machines that makes up the rougher stage. In the rougher stage, two products are obtained called concentrate and rougher tailings. The concentrate consists of the magnetic product and is forwarded to the cleaner stage, while the second is composed of the medium and tailings flows and is discharged into a box from where it is transferred to the densification and filtration stages.

Similarly, in the cleaner stage two products are removed: tailings and concentrate. The first consists of medium and tailings flows and is routed to the rougher stage feed. The second, containing the magnetic product, goes to the concentrate densification stage.

The final concentrate coming from the cleaner stage goes to a pulp box from where it is pumped into the thickening cone. In the cone, two flows are obtained: the first called underflow consists of the dense product with a solid fraction by weight equal to 60% and is directed to box, where it is pumped via pipeline for concentrate filtration. The second overflow contains water free of suspended solids and is directed to a box where, along with makeup water, is distributed in the tailings filtration plant.

The tailings dewatering process begins with the mixture of the sandy tailings from the CMAI-II with the CMAI-I tailings in a lung tank and distributed to the regularization tanks of the two filtration plants, Filtration I and Filtration 2, composed of four and five press filters respectively. From the regularization tanks, the pulp is pumped to the densing cones, which have the function of adjusting the percentage of solids of the feed pulp of the filters from 30% to 60%. In addition, this equipment is responsible for recovering the water contained in the tailings pulp and adjusting its turbidity index, enabling the reuse of this in the process.

The dense material in the cones is pumped into the press filters and the filtered pie in the filters is discharged into a conveyor belt system and directed to a stacking system, which can stack two bean-shaped batteries alternately. The piles are re-handled by a front-end loader and hauled by 12 m^3 trucks to its final destination (stocks or drying areas). The water from the filtering of the pies in the filters is directed to the feeding tanks of their respective cones and is therefore recovered along with the water from the densification of tailings.

14.2 Sinter feed fines concentration

14.2.1 Concentrating spirals

With decreasing grades of the ROM ore and the consequent reduction of iron content, it will be necessary to concentrate the fine fraction of the sinter feed. In this context, the concentration circuit of the thin sinter feed, consisting of concentrator spirals, will be put into operation. The circuit consists of four parallel modules, each consisting of three stages: rougher, cleaner and scavenger. The rougher spiral circuit consists of 10 banks of eight triple spirals (model HG10 with five turns from Mineral Technologies®). The feeding of this stage consists of the underflow of spiral classifiers and flat-bottomed cyclones, while the concentrate and tailings will proceed to the cleaner and scavenger stages, respectively.

The cleaner stage consists of 10 banks of six triple spirals (VHG model with four turns from Mineral Technologies®). The feeding of this stage, as mentioned in the previous paragraph, will consist of the concentrate from the rougher stage, while the concentrate and tailings flows will consist, respectively, of circulating load product, returning, in this case, to the feed of the concentration circuit.

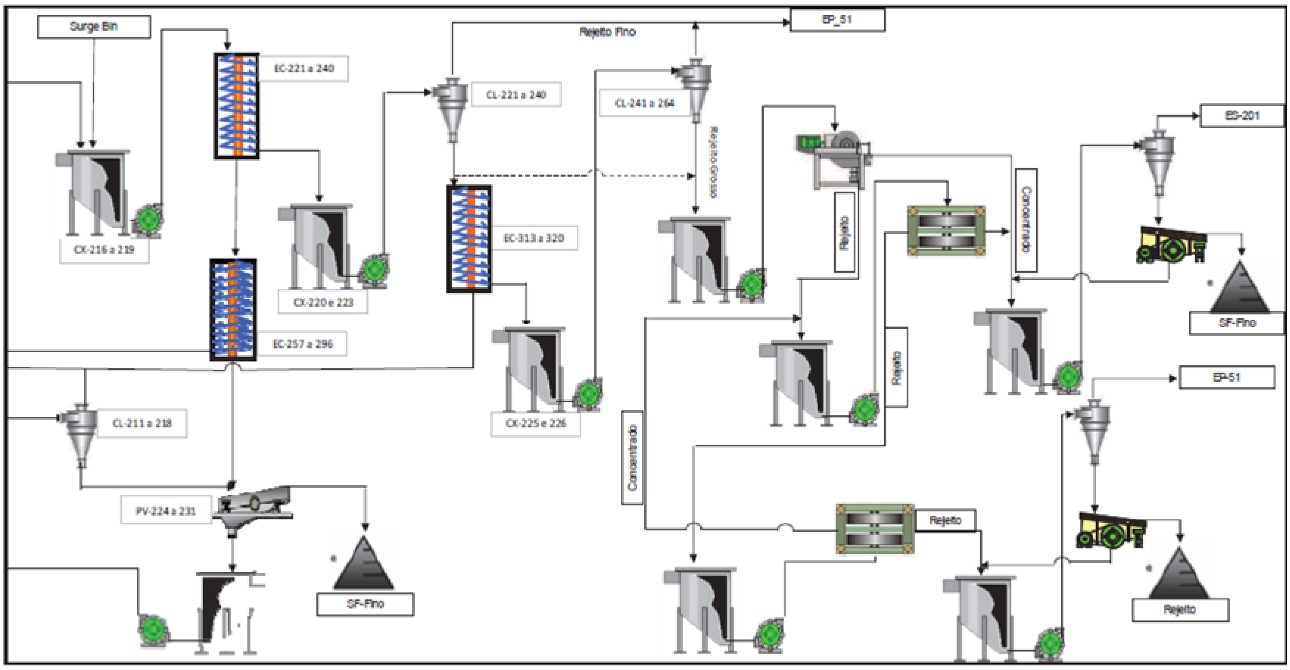
The scavenger stage consists of two banks with 12 triple spirals (model HG10 with five turns from Mineral Technologies®). In this stage, two products will be obtained: concentrate and tailings. The first will consist of a circulating load returning to the rougher feed, while the second will constitute final tailings and will be routed to the tailings densification system.

The tailings densification system consists of 10 15” cyclones and will have the task of separating the tailings into two fractions: thin and thick. The first will be routed to the sand thickener for water densification and recovery, while the properly thickened underflow will proceed to the CMAI III circuit.

14.2.2 Tailings recovery from concentrating spirals

For the reuse of coarse tailings from the spirals, the implementation of a new magnetic separation plant of medium and high intensity is proposed according to the flowchart presented in Figure 14.2.

Figure 14.2 Magnetic separation of coarse tailings by concentrating spirals



The first stage of magnetic separation will consist of medium intensity drums (WDRE or wet drum rare earth) which will have the primary function of removing the particles of high magnetic susceptibility from the pulp, preventing it from competing for obstruction of the matrices of the high intensity machines. The feed will consist of pulp containing tailings from the concentrating spirals, as previously mentioned. This flow is diluted in advance in a pulp box, from which it is pumped to the feed pulp distributor. Two products will be removed from the drums: the first, constituting the magnetic concentrate, will be directed to the feed box of the concentrate dewatering system; the second, composed of tailings, will proceed to the rougher stage of high intensity magnetic separation.

The high intensity magnetic separation will consist of two stages of concentration. The first rougher stage will have the tailings of the drums as feed flow. From this stage, two materials will be removed: the first called concentrate and will consist of a product and will be sent to the concentrate dewatering system; the second will be composed of the medium and tailings flows and will be directed to the second stage of magnetic concentration, called scavenger. The scavenger stage will have the purpose of concentrating the tailings.

At this stage, two products will be removed: the first called concentrate, composed of the magnetic product, and will constitute circulating load returning to the feed of the rougher separator(s), or optionally, can be routed to the dewatering system for the final concentrate of the magnetic separation plant. The second, composed of the tailings and medium flows, will consist of final tailings and will be forwarded to the densification and dewatering systems.

The concentrates from the WDRE and the rougher stage of the CMAI (high intensity magnetic concentration) and eventually the scavenger will consist of a product and will be forwarded to the dewatering system consisting of hydrocyclones and screen(s) installed in the concentrator spirals building. The underflow from these hydrocyclones will be directed to the dewatering screens. The overflow will be directed to the concentrate thickener. The oversize will be conveyed to the stacker, whereas the undersize will be recycled to the battery supply box of the concentrate hydrocyclones.

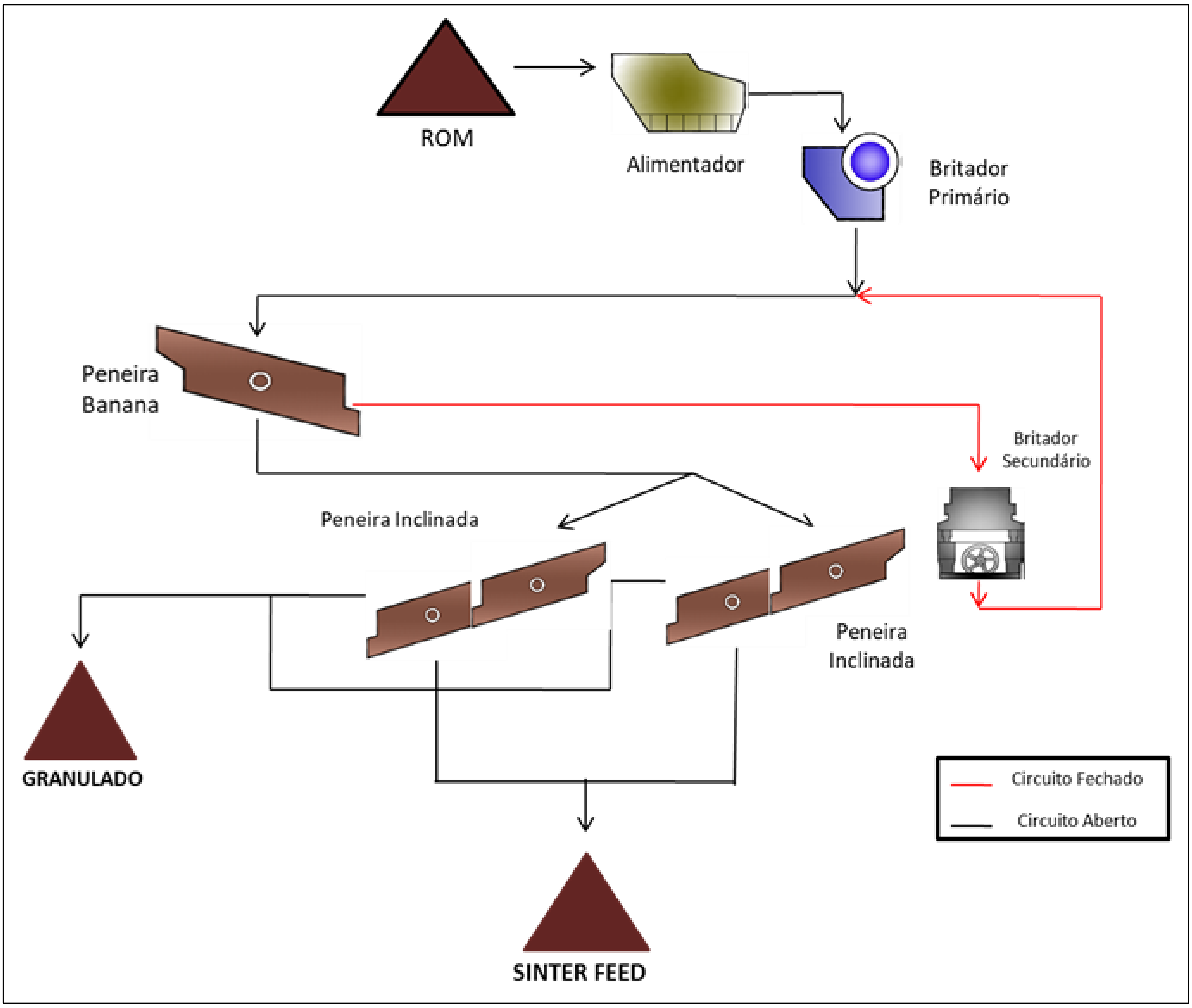
The densification and dewatering system for the final tailings will consist of hydrocyclones and dewatering screens and will be located in the old drive unit. The flow coming from the magnetic separation plant will be pumped into the 10’ hydrocyclone battery where it will be separated into two products: the first, which will consist of the underflow, will continue to the dewatering screen(s); the second, consisting of overflow, will be directed to the mud thickener (EP-51). The oversize of the dewatering screen will be directed to a stacking system consisting of conveyor belts. This system should allow the alternating stacking of two cone-shaped batteries. These batteries will be reclaimed alternately with loaders and trucks. The undersize of the screens will consist of circulating charge and should return to the hydrocyclone battery supply box.

14.3 Dry processing plant

The dry system is composed of the ITM unit – pires and mobile screening units (UPMs).

ITM – operating with a predominantly dry system, is now responsible for producing more than 5 Mt of iron ore per year. ITM has a primary crushing circuit, a secondary crushing circuit and screening and handling circuits for the products. The process is shown in Figure 14.3.

Figure 14.3 ITM-pires processing flowsheet

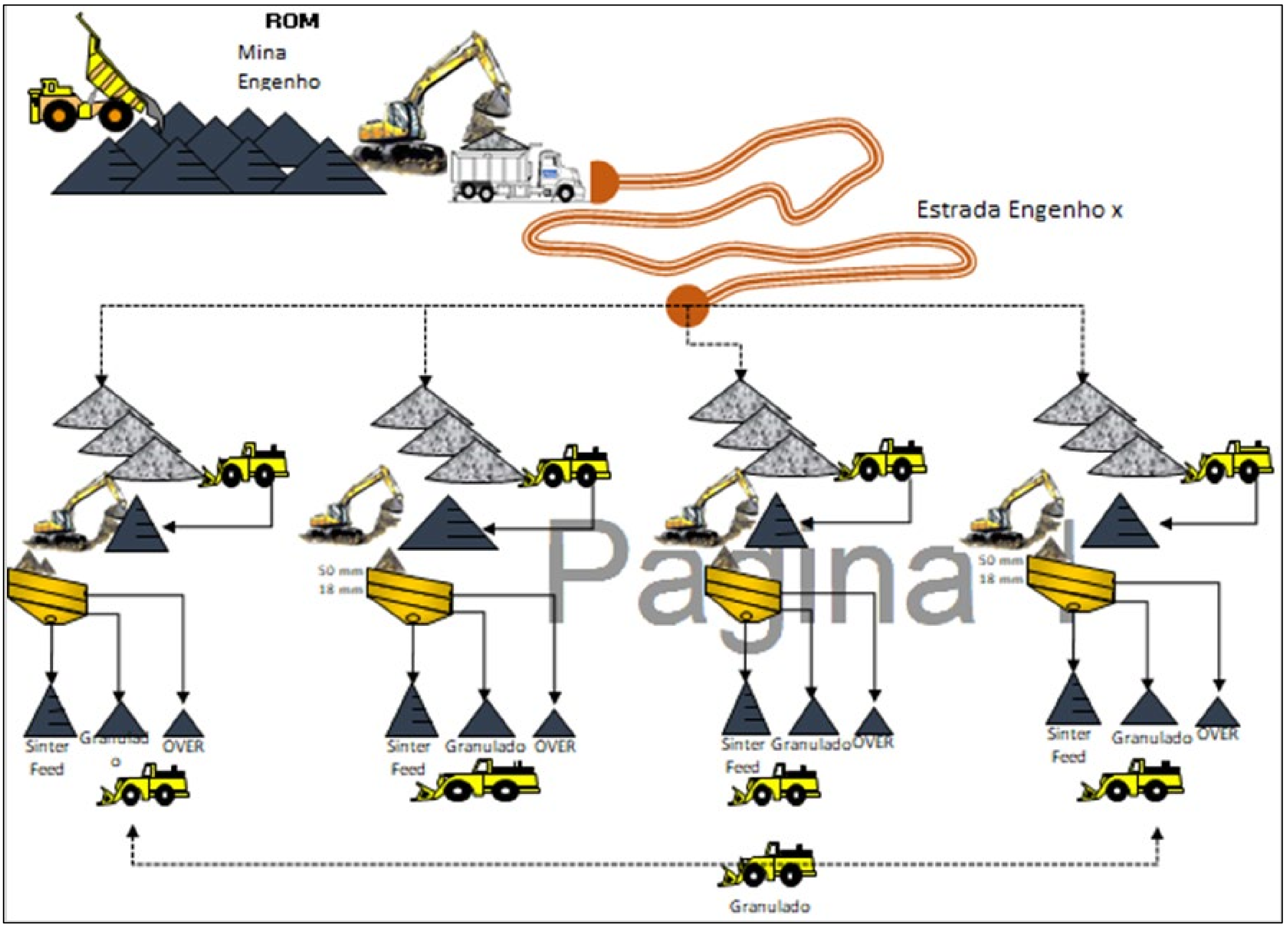


The plant is fed by loaders with hematitic ROM with an average iron content of 61% and operates with natural moisture with a mass recovery of 100%. The circuit is fed through a vibratory feeder, consisting of a table and a scalp grille with an opening of 4”. The material retained on the grille feeds the primary jaw crusher. The material passing the grille and crush (<4”) join and feed the primary classification that operates with a 40 mm x 80 mm bi-long mesh deck. The oversize (material with granulometry greater than 50 mm) is directed to secondary crushing. The secondary crusher is a tapered type and operates a with 27 mm APF. The crushed material feeds the banana screen again, closing the circuit.

The material passing the primary classification feeds the secondary classification, composed of two identical lines of vibrating inclined screens. The undersize of this circuit (material below 18 mm) constitutes the product called “Sinter Feed”, while the retained material (50 mm and 18 mm) constitutes the product called “Granulated”. Both products are stacked and subsequently processed, either for intermediate stocks or for the rail loading yard.

Mobile screening units (UPMs) are dry processing plants with a capacity of 6.5 Mtpa and are powered by loaders and excavators. The material from the mine is classified according to granulometry: sinter feed, granulated and over. After processing by the UPMs, the product is transported by the fleet of trucks to the Itacolomy Railway Terminal (TFI) – a distance of 1 km.

Figure 14.4 UPMs flowsheet



14.4 P15 project – itabirite plant

14.4.1 Background

The P15 project consists of an ore processing plant which will process friable itabirite (42% Fe and 37.1% SiO_2) until 2031 to produce 15 Mtpa (dry basis) of direct reduction pellet feed grading 67.7% Fe and 1.5% (SiO_2 + Al_2O_3). Thereafter, the plant will be fed with compact itabirite operating at an average mass yield of 45.9% and 62.3% Fe pellet feed.

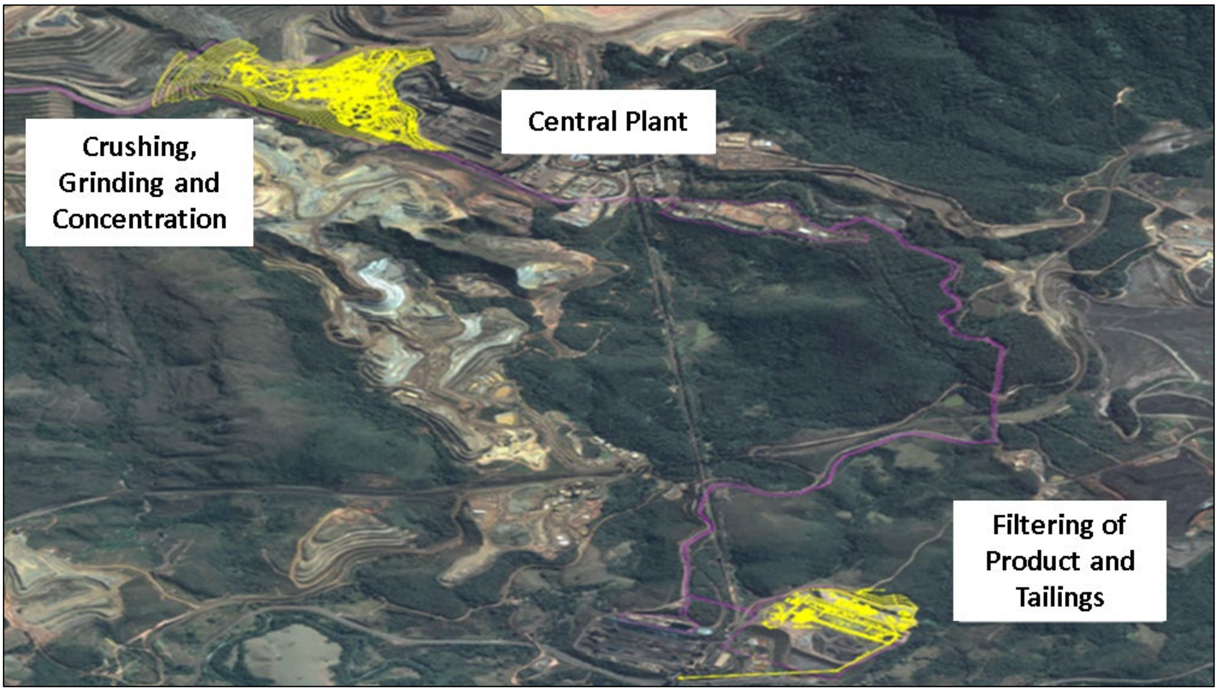
The plant will operate until 2031 at 31 Mtpa friable itabirite feed rate followed by a 24 Mtpa of compact itabirite.

All tailings generated will be filtered and stacked with 15% moisture. The tailings average iron content will be 17% with a silica content of 72%.

The project aims to apply well-established technologies in the industry with a maximum recovery of water used in the process.

The plant will be built within the CSN Mineração property in two areas as shown in Figure 14.5.

Figure 14.5 P15 project location



14.4.2 Process method

The mineral processing method adopted for the project is well-known in the iron ore industry. It has been validated by the Gorceix Foundation, which conducted several tests in the Department of Mining and Metallurgy Technology. The CSN Mineração geology team selected and collected representative samples. The samples were shipped to the Gorceix Foundation laboratory for mineralogical characterization, bench tests, pilot plant tests and mass balance using BILCO software.

The processing circuit designed comprises:

- Comminution to reduce the size of the particles to the range of interest and adapting them to the later stages of the process. The equipment used in the comminution stage are crushers and mills.
- Screening to classify particles according to size. The equipment used is banana screening that will have an optimized shape allowing capacity gain and screening efficiency.
- Classification based on the speed at which particles pass through a fluid medium. The equipment used in this stage are hydrocyclones that use the difference in density and granulometry between particles to promote separation.
- Concentration of the minerals of interest and elimination of undesirable minerals. The concentration will be by reverse cationic flotation, a process that uses the difference in surface characteristics of the minerals promoting their separation. Flotation cells and columns will be applied.
- Filtration to separate the solids contained in pulp (ore + water). It enables the recovery of the largest amount of solids with the lowest possible moisture and reclaims the filtered liquid as process water. The equipment to be used will be vacuum and pressure filters.

Compact Itibirite

Nowadays there is a strong interest in the Quadrilátero Ferrífero district for the characterization of compact itabirites, either to unlock mining faces in mining areas of friable ore and/or produce high quality products (pellet feed) through grinding and concentration processes. Such lithologies present, in general, slightly lower iron contents, thinner release mesh, higher energy demand for grinding and simpler mineralogical matrix, when compared to friable itabirites. The presence of material classified as “compact” (ICS - Itabirito Compacto Silicoso) in the mineral reserves of Casa de Pedra is quite significant, justifying the concept of feeding this ore in the Plant of Itabirites P15.

CSN Mineração's geology team has been developing the characterization of this rock type aiming to determine some technological characteristics. For this, a technical work was developed at COPPE – UFRJ (Federal University of Rio de Janeiro) with samples of probing hole testimonies.

Key relevant outcomes of this study showed:

- The modal mineralogical analysis of samples from the ICS probing holes. The result of the internal variability study of CSN Mineração showed that the minerals present are iron oxides (hematite, martite and magnetite and goethite) and quartz (more than 99%). No other silicates were identified, such as amphibole or other minerals less or not susceptible to cathional flotation with amine, a process adopted for concentration in P15. That is, the process of desliming/mechanical flotation/column flotation would be enabled to treat compact ore.
- The overall iron content should be between 36% and 38% Fe, lower than the expected friable itabirites (average of 42% Fe). This fact itself does not mean that it would be more difficult to get the pellet feed within the expected specification. Due to mineralogy, the same product quality is expected, but mass recovery (consequently production) would be reduced accordingly.
- The overall iron content should be between 36% and 38% Fe, lower than the expected friable itabiritos of feed p15 (average of 42% Fe). This fact per si does not mean that it would be more difficult to get the pellet feed within the expected specification. Due to mineralogy, the same product quality is expected, but mass recovery (consequently production) would be reduced accordingly.
- The granulometric distribution of the crushed material at minus 50 mm indicated that about 47% in weight would be above 12.5 mm (cutting mesh for grinding feed) and about 27% passing in 0.15 mm. Apparently, the ICS would be easily crushable. The predicted friable itabirite has a higher proportion of natural fines smaller than 0.15 mm (≈45%). The crushing and screening circuit of the P15 is suitable for treating the compact itabirite, but one would expect an increase in circulating load in secondary and tertiary crushing and a small capacity restriction, or any need for repowering of conveyors.
- The ICS sample was ground to P90 of 0.106 mm and a release study was carried out indicating that with this degree of grinding, the release of iron minerals would be obtained.
- The most well-known index for measuring the energy requirement of grinding is WI. As compact itabirite has few natural fines, the conventional Bond procedure would be applicable. The WI values obtained for the ICS sample in the duplicate tests were 5.7 kWh/t and 5.8 kWh/t, reaching 7.5 kWh/t. Other compact iron quad ores presented slightly higher values than predicted for ICS. For a P80 of 0.150 mm, the estimated specific energy was 4.9 kWh/t.
- Bench flotation tests were also performed and concentrates with iron content from 64% to 68% were obtained. The ICS is amenable for concentration through flotation. The recoveries obtained would not be directly related to what was expected in the industrial circuit. In the P15 circuit, where there are two flotation stages (in mechanical cells and columns) and where it operates in closed circuit, obtaining contents between 66% and 67% Fe would be fully feasible, expecting a metallic recovery of the order of 75%, industrially. For the P15 project, the expected metallic recovery is 79%.

In view of the above, it is understood that the P15 circuit may receive the compact ore and produce commercial product (certainly, pellet feed). The grinding/sorting circuit, composed of primary and secondary grinding, should have its operating points adjusted for the new hardness of the ore, with another power distribution and, eventually, new ball load. It is to be expected a reduction in the feed rate and, accordingly, in production. Due to the restriction in primary grinding, it would be expected a production of 8.0–8.5 Mtpa of pellet feed, produced with 100% ICS feed.

The other concentration and dewatering and filtering operations will be not constrained in capacity. Dilution with friable itabiritic ore (thinner and softer) should provide an increase in production and could also become a strategy. Some possible scenarios were evaluated, considering some assumptions of recovery/grindability and also considering different participations of compact ore in friable ore, with maximum use of energy installed in the grinding.

Only the increase of energy for primary grinding was evaluated, which limited the feed rate of the plant and estimated the availability of energy in the secondary milling. Due to the reduction of the rate and the recovery (lower Fe content of the ROM), the feed rate of the secondary grinding falls further and as a consequence there would be more unit energy in the secondary grinding.

There would be also operational flexibility to combine the distribution of energy in the two grinding stages (transfer more work to the secondary grinding, with a coarser grinding in the primary) and also in the two stages of flotation, seeking to maximize recovery and ensure the specification of the products.

Table 14.1 summarizes the results.

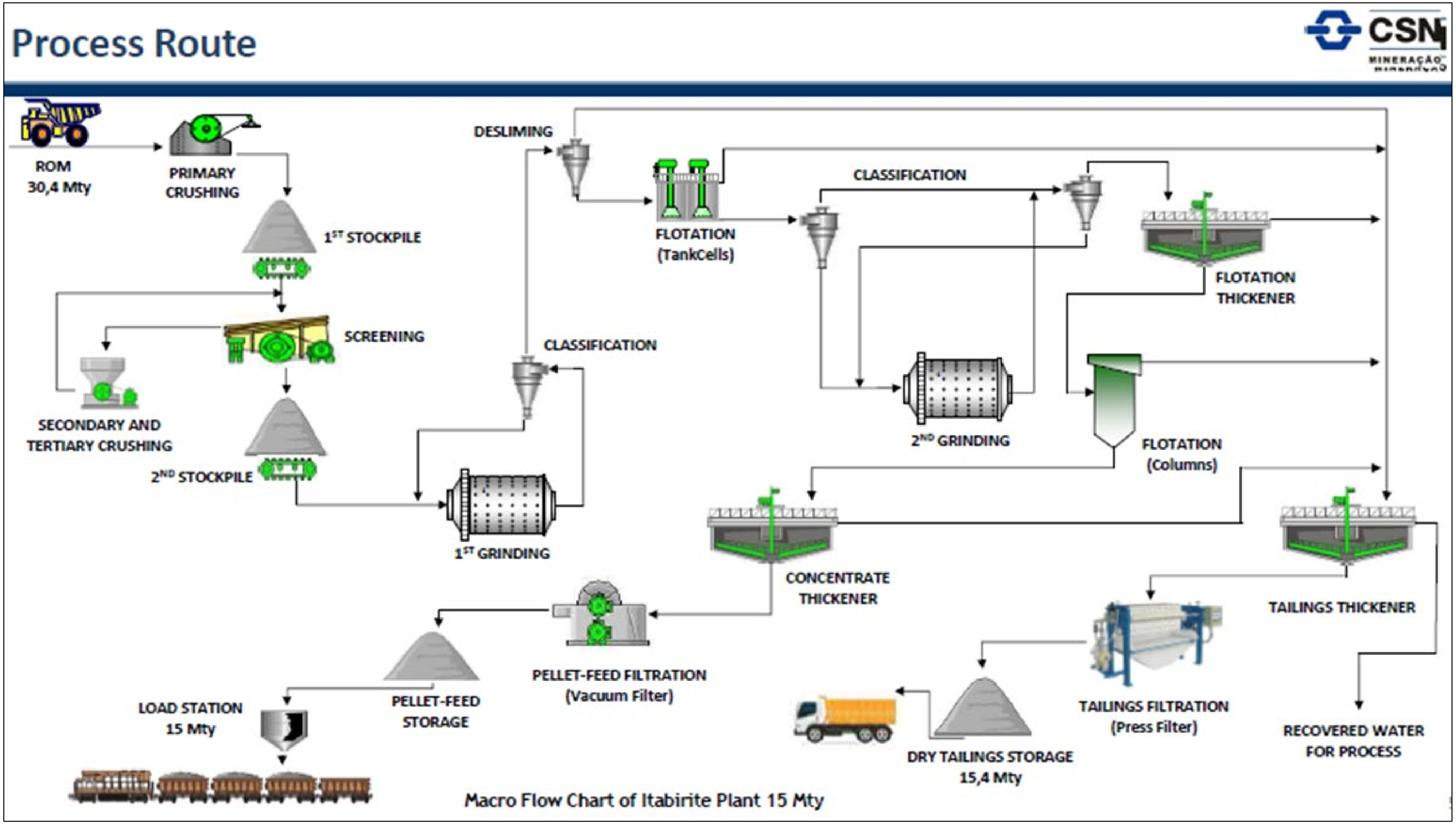
Table 14.1 Pellet Feed production estimate including siliceous compact itabirite

	P15 – Friable	Compact	Compact	Compact	Compact
Compact/friable blending	0%	25%	50%	75%	100%
t/h feed	3,938	3,437	3,076	2,784	2,542
% Fe feed	42%	37%	37%	37%	37%
% Mass yield recovery	49%	43%	43%	42%	42%
Disliming	89%	89%	90%	91%	92%
Cell flotation	59%	53%	52%	51%	50%
Column flotation	93%	92%	91%	91%	90%
% Metallurgical recovery	79%	77%	76%	75%	75%
t/h product	1,946	1,491	1,310	1,176	1,068
Working hours (88%)	7,709	7,709	7,709	7,709	7,709
Annual production (t)	15,000,000	11,496,434	10,098,333	9,063,113	8,231,343
Available net power (kW) primary grinding	12,457	12,457	12,457	12,457	12,457
Primary grinding energy (kWh/t)	3.2	3.6	4.1	4.5	4.9
Secondary Grinding feed	2,081	1,621	1,440	1,292	1,169
Available net power (kW) secondary grinding	18,791	18,791	18,791	18,791	18,791
Available secondary grinding energy (kWh/t)	9.0	11.6	13.1	14.5	16.1

14.4.3 Process circuit

The designed process flowchart is presented in Figure 14.6.

Figure 14.6 Flowsheet of the P15 project



The ROM from the mine will be transported by off-road trucks with a capacity of up to 240 tonnes to a primary crushing facility. This circuit consists of a plate feeder, vibrating grid and jaw crusher generating a pre-product with a granulometric distribution of less than 150 mm. This material will feed lung cell #1.

Plate feeders and belt conveyors will extract the ore from lung cell #1 and feed the screening circuit that has double deck banana screens. The ore retained on the first deck will feed the secondary crushing circuit and the rejects on the second deck will feed the tertiary crushing circuit. The undersize passing the screens will be directed to lung cell #2.

The ore will be removed from lung pile #2 using feeders and belt conveyors and will feed the primary grinding circuit that consists of ball mills and rating cyclones that adjust the grain size of the ore for the desliming stage.

The desliming circuit is divided into primary, secondary, and tertiary classification. This circuit is designed to remove contaminants that are harmful to the concentration process by flotation.

The flotation process will be carried out in 160 m³ cells distributed in rougher, cleaner and scavenger steps. The concentrate from this circuit will be directed to secondary grinding.

The secondary grinding stage has ball mills and classification cyclones that adapt the grain size of the ore to the concentration step by flotation in columns.

For the best performance of this circuit, the pulp is thickened. The thickener will feed the flotation columns distributed in the recleaner and scavenger steps. The concentrate will be directed to the 58 m thickener to adjust the percentage of pulp solids and subsequent feed of product filtration.

The product filtration process is carried out by vacuum disc filters generating a pellet feed with maximum humidity of 10% that is stacked in a patio. The shipment will be carried out by rail loading.

The tailings flow generated by the desliming circuit, cell flotation and columns will be directed to the 74 m tailings thickener. This thickener will feed the tailings filtration facilities (press type filters) resulting in tailings with a maximum moisture content of 15%. This material will be deposited in bean-type piles.

The water recycled in the circuit will be reused in the processing plant.

14.4.4 Processing equipment

The main processing equipment consists of:

- Primary crushing:
  - (01) 102-inch plate feeder
  - (01) Perforated plate vibratory grate – model SLR261744, supplier Schenck
  - (01) Primary crusher – model C150, supplier METSO.
- Screening and re-crushing:
  - (03) 94-inch plate feeders
  - (06) Banana sieves (12 x 28’) – supplier Schenck
  - (07) Crushers – Hp500 model, supplier METSO
  - (06) 102-inch belt feeders
  - (07) 42-inch belt feeders.
- Primary grinding:
  - (02) Mills (20 x 36’) – supplier FLSmidth
  - (02) Hydrocyclone batteries – model GMAX33, supplier FLSmidth.
- Disliming:
  - (03) Hydrocyclone batteries – model GMAX15, supplier FLSmidth.

  - (03) Hydrocyclone batteries – model GMAX10, supplier FLSmidth.
  - (06) Hydrocyclone batteries – model GMAX4U, supplier FLSmidth.
- Flotation cells:
  - (27) Cells of 160 m³ – model DO160RT, supplier FLSmidth.
- Secondary grinding:
  - (03) Mills (20 x 36') – supplier FLSmidth.
  - (06) Hydrocyclone batteries – model GMAX15, supplier FLSmidth.
- Flotation columns:
  - (09) Flotation columns (14 x 5) m – supplier ERIEZ.
  - (03) Flotation columns (12 x 5) m – supplier ERIEZ.
- Product filtering:
  - (12) Disc filters – model: (Ø8'10" x 12 discs).
- Tailings filtering:
  - (11) Press filters – plate dimension (2.5 x 2.5) m.
- Thickeners:
  - (01) 74 m thickener – Central column – supplier FLSmidth.
  - (01) 58 m thickener – Central column – supplier FLSmidth.
  - (01) 48 m thickener – Central column – supplier FLSmidth.
  - (01) 23 m thickener – Bridge model – supplier FLSmidth.
  - (02) 12 m thickeners – E-CAT type – supplier FLSmidth.

14.4.5 Power, water, consumables and workforce

The P15 project estimates that 96% of the water used in the process will be recycled. Only 650 m³/h of new fresh water is required.

The expected energy consumption for the plant's operation is 555,804 MWh per annum.

The main consumables required for the operation are summarized in Table 14.2. The grinding elements are used in the primary and secondary grinding stage. Corn starch, caustic soda, amine, flocculant and carbon dioxide are used in the flotation circuit.

Table 14.2 P15 reagents

Item	Stage	Consumption	
		g/t	t/year
Balls	Primary grinding	500	15,179
	Secondary grinding	350	4,378
	Total		**19,557**
Starch	Flotation cell	1,000	27,110
	Flotation columns	500	8,015
	EP. densify	15	240
	Total		**35,365**
Soda	Gelatinization	175	7,073
	Flotation cell	50	1,355
	Flotation columns	50	801
	Total		**9,229**

Item	Stage	Consumption	
		g/t	t/year
Amine	Floation cell	120	3,253
	Flotation columns	75	1,202
	Total		**4,455**
CO_2	EP. tailings	63	960
	EP. concentrate	63	938
	Total		**1,898**
Flocculant	EP. tailings	15	230
	EP. concentrate	8	120
	Total		**350**

In the implementation phase of the project about 4,000 people will be hired (peak of work). In the operations phase, a total of 962 personnel is planned (engineers, technicians, operators and maintenance professionals).

Local labor will be preferentially used both in the implementation and operations phases and will be recruited and trained to perform the required activities. It is a strategy of CSN Mineração to value the local workforce, contributing to the socioeconomic development of the region.

14.5 Phase 3 tailings filtration plant

Phase 3 tailings filtration plant is a project to increase the capacity of the current tailings filtration plant with the inclusion of a new tailings thickener and two more filter presses.

The tailings filtration plant will be fed by the sandy tailings and mud flows from the Central plant. Sporadically the system will also receive pulp from the containment bay with the overflows and discharges from the plant. The flow of total tailings will feed the lung filtration tank (84-TQ-22), which will feature agitation to promote the homogenization of the material. The lung tank will feed tanks 84-TQ-07, 84-TQ-15 and 84-TQ-23. In these tanks will be promoted the adjustment of the pulp density, which will feed the circuits of filtrations I, II and III respectively.

The 84-TQ-07 will feed the dewatering cones 02, 03 and 04. The overflow of these cones will discharge on the 84-TQ-12, constituting process water. The underflow will be pumped into the filter i bifangs (84-TQ-08 and 84-TQ-09), which will feed the filter presses number 1 to 4. The 84-TQ-15 will feed the dewatering cones 05, 06 and 07. The overflow of these cones will discharge on the 84-TQ-12, constituting process water. The underflow will be pumped into filtration II bifangs (84-TQ-16, 84-TQ-17 and 84-TQ-18), which will feed the filter presses number 5 to 9.

The 84-TQ-23 will be a new tank, which will receive the feed flow of the 84-ES-08 for density adjustment. After this adjustment, the pulp will feed a Hi-Rate reject thickener. Thickener overflow will discharge at 84-TQ-19, while underflow will feed a thickened pulp lung tank (84-TQ-24). It is worth mentioning that this thickener, because of its high hourly sedimentation rate equipment, will include a higher flocculant dosage (about 50 g/t) and a feeding self-dilution system, which will occur with the addition of water recovered in the Thickener, from the TQ-12.

From the thickened pulp lung tank, 84-TQ-24, 3 flows will break, which should feed, respectively, the Bifangs of Filtrations I, II and III. To ensure the equitable distribution between the tanks, the use of pressurized flow dividers of type "Y" should be contemplated. One derailleur should be included for tanks 84-TQ-08 and 09, another for tanks 84-TQ-16 and 17 and another between tanks 84-TQ-25 and 84-TQ-26. In addition, the interconnection between tanks 84-TQ-25/26 and 84-TQ-18 per communicating vessel should be contemplated.

Filter iii bifangs (84-TQ-25/26) will feed the filter presses X and XI. Filtered liquor should be directed to 84-TQ-12 and then distributed among the bifangs. The filtered pie will discharge into the 84-TC-03 and then 84-TC-06, which will stack that material. Filtered filtrations II and III pies will discharge into 84-TC-13 and 84-TC-14. It is also essential to consider the use of pumps and reserve lines at the critical points of the plant, such as the underflow of the thickener and the feeding of the filtrations.

14.6 Qualified person’s opinion

The current processing circuits are supported by the best existing mineral processing technologies and are suitable for the iron ore mined at the Casa de Pedra mining complex.

For the planned P15 processing plant, several compact/friable blending scenarios were evaluated by CSN Mineração that demonstrated the technical viability for all cases. Further studies may unlock value by introducing adjustments to the circuit to increase metallurgical recoveries and production rates.

15 INFRASTRUCTURE

15.1 Overview

The key non-process infrastructure includes:

- Site facilities
- Waste storage facilities (rock and tailings)
- Water infrastructure
- Powerline
- Product handling facilities and railway
- Port facilities.

The Casa de Pedra mining complex site layout is shown Figure 15.1. All infrastructure components required for the current operation are in place. Engineering projects have been developed by CSN Mineração to support the base case for the mineral reserves including the waste and filtered tailings dump expansions.

Figure 15.1 Casa de Pedra mining complex infrastructure layout

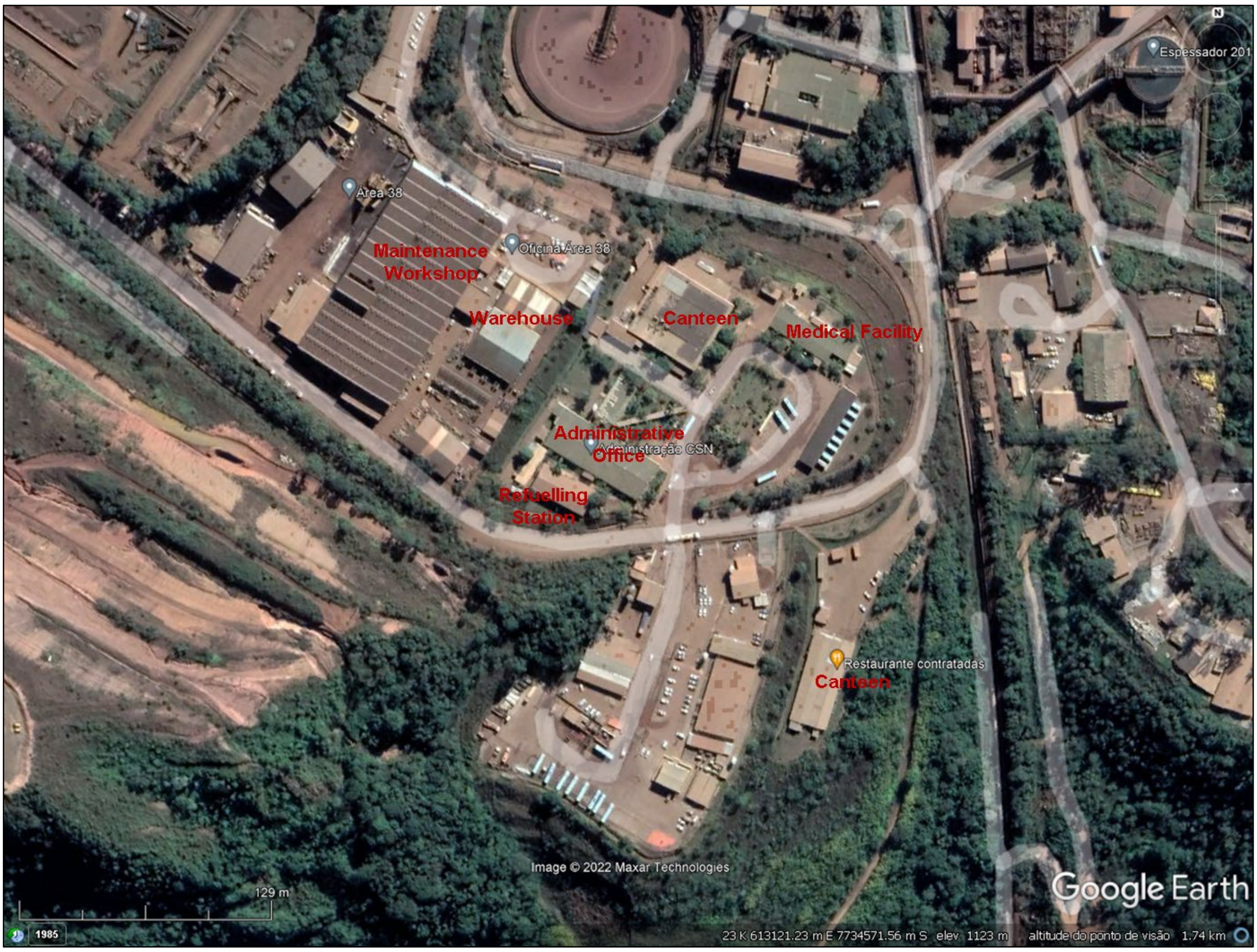
15.2 Site facilities

The site facilities include:

- Administrative and technical offices
- Maintenance workshops
- Warehouses
- Core shed
- Equipment washing bays
- Canteens
- Refuelling stations
- Site gates
- Medical facilities
- Training centre
- Explosive magazine
- Laboratories.

Some of the key support facilities at Casa de Pedra are shown in Figure 15.2.

Figure 15.2 Support site facilities



15.3 Tailings storage facilities

Historically, CSN operated three tailings storage facilities (TSFs), namely “Casa de Pedra”, B4 and B5, where conventional unfiltered tailings were disposed. These TSFs are no longer in operation and are being decommissioned. CSN Mineração currently operates two filtered tailings dumps which accommodate the currently generated tailings, namely Fraile Phase 1 and Fraile Phase 2. Future expansions are being considered and are referred to as Fraile Phase 3 and Fraile Phase 4.

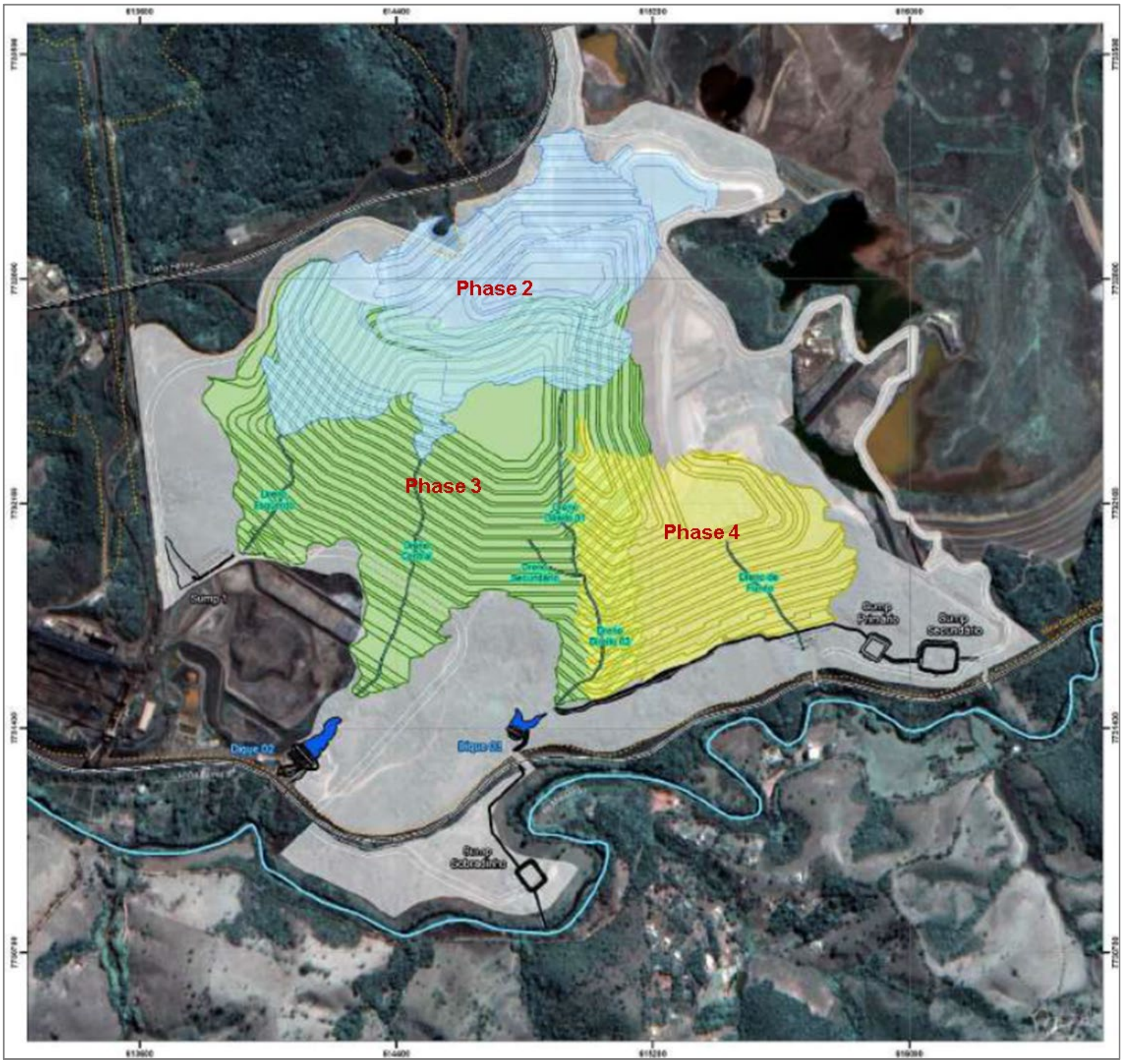
The tailings pulp is currently pumped to the Casa de Pedra TSF where a series of high intensity magnetic concentrates (CMAI) and filter presses are installed. From there, the filtered tailings with a 16% moisture content are transported by truck to the final destination at the tailings dump. Figure 15.3 and Figure 15.4 show the tailings filtering configuration at Fraile Phase 2.

Figure 15.3 Fraile Phase 2 filtered tailings dump

Figure 15.4 Tailing filtering configuration

The planned Fraile Phase 3 and Phase 4 filtered tailings facilities are shown in Figure 15.5. Phase 3 is an expansion of Phase 2, whilst Phase 4 is an expansion of Phase 3.

Figure 15.5 Planned Fraile Phase 3 and Phase 4 filtered tailings facilities



The design parameters for the Phase 3 and Phase 4 filtered tailings dumps are summarized in Table 15.1.

Table 15.1 Filtered TSF design parameters (Phase 3 and 4)

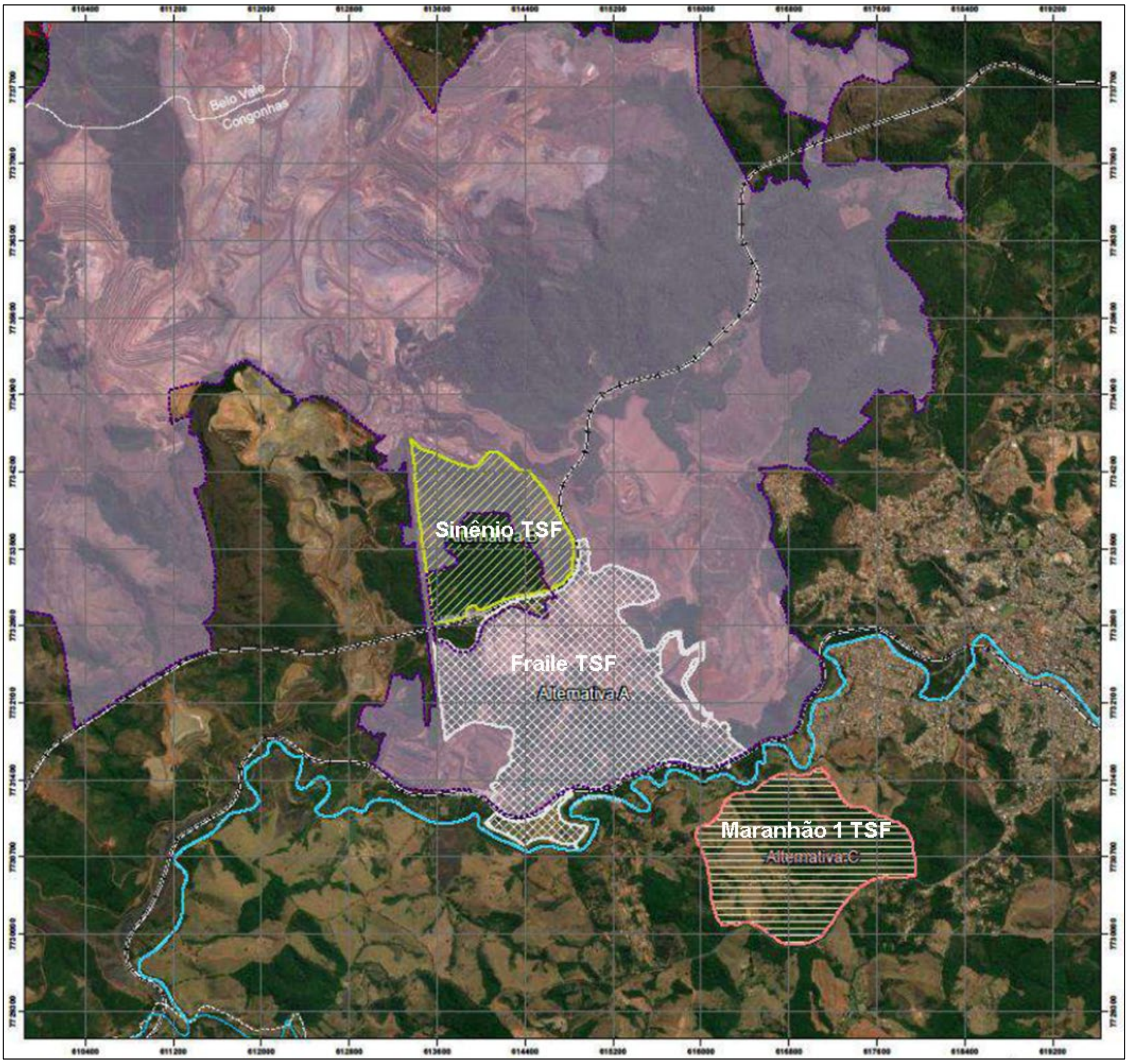
Item	Units	Phase 3	Phase 4
Crest elevation	m	1,080	1,052
Maximum height	m	217	189
Total volume	Mm^3	63.5	13.9
Footprint	ha	124	49
Overall slope angle	V:H	1V:3.5H	1V:3.5H
Inter-ramp slope angle	V:H	1V:2.5H	1V:2.5H
Bench height	m	10	10
Berm width	m	10	10
Acess width	m	10	10

Geotechnical stability analyses were performed along several sections of the TSFs which returned safety factors above the required levels. Fraile Phase 3 and Phase 4 will have capacity to accommodate tailings until 2029. Thereafter, other TSFs are being considered by CSN Mineração including the Sirênio, Maranhão, Mascate and Esmeril dumps as illustrated in Figure 15.6.

Table 15.2 Life of mine filtered tailings storage facilities

TSF	Volume (Mm³)
TQ-204	0.4
Fraile 1	0.4
Fraile 2	9.9
CDRI	2.8
Integrada	6.4
Fraile 3	41.3
Fraile 4	13.9
Sul Maranhão 1	115.0
Pilha de B4	56.3
Pilha Mascate/Esmeril Principal	1,208.3
Total	**1,454.8**

Figure 15.6 Expansion options for the filtered TSFs



15.4 Waste rock facilities

Waste rock is currently disposed at the Batateiro waste dump, which shall be successively expanded to accommodate 100% of the life of mine waste rock requirement.

The waste dump is located to the west of the pit (Figure 15.1).

The design parameters for the waste dump are summarized in Table 15.3. The design follows Brazilian regulations ABNT NBR 13.029 (ABNT, 2006). The accesses are designed with a 35 m width and 10% gradient.

Table 15.3 Waste dump geometrical design parameters

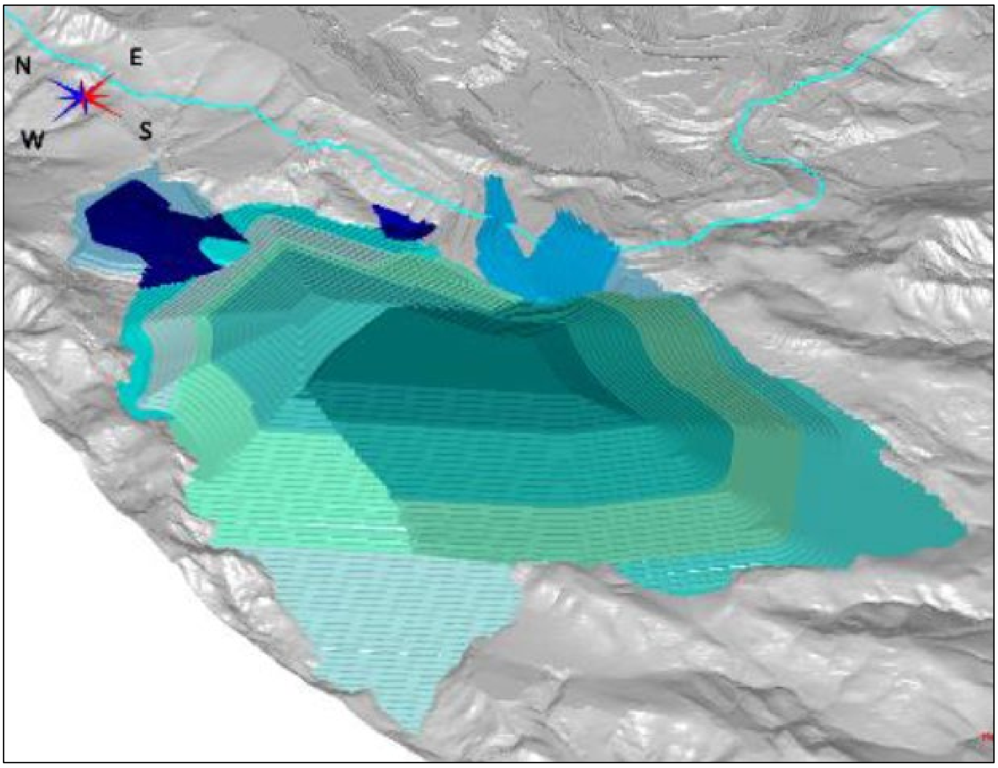
Item	Units	Value
Maximum elevation	m	1,580
Bench height	m	10
Berm width	m	10
Face slope	V:H	1V:2H
Overall slope angle	V:H	1V:2.7H

The waste dump will be developed in stages:

- Current: Phase 3A
- 2029: Start of Phase 4
- 2034: Start of Phase 1 Stage 2
- 2044: Start of Phase 2 of Stage 2.

The Batateiro waste dump design can accommodate approximately 1,500 Mt, sufficient to meet the life of mine waste volume of 1,090 Mt. A 3D view of the Batateiro waste dump is shown in Figure 15.7.

Figure 15.7 3D view of Batareiro waste dump



15.5 Water management

The surface drainage system designed for the open pit aims to ensure the control of rainwater flow through channels, sumps and pumping. These have the function of collection, temporary storage, transmission and final disposal of water flows, aiming to prevent instabilities, disaggregation and transport of rocks and sediments, and provide suitable conditions for mining during rainy periods.

The surface drainage system was developed based on the general arrangement of the current mine and considering the future sequencing of mining.

The geometry of the final pit combined with the local topography allows the transfer of a part of the water flow from the pit to the adjacent natural drainage after treatment at the sediment ponds, avoiding the addition of precipitated waters to the bottom of the pit and subsequent removal through pumping.

Water at the bottom of the pit is collected in sumps and is transferred to the natural drainage via pumps and pipes. The sumps are sized according to the flows/volumes and assist in decanting a portion of the solids carried by the water flow.

The main mechanisms to manage the water flow direction are:

- Safety channels
- Peripheral channels
- Inclined berm channels
- Berm channels
- Road platform channels
- Sump systems.

15.6 Water supply

Water used at the Casa de Pedra mining complex is pumped from the Poço Fundo River (140 m^3/h) and from groundwater (708 m^3/h).

The fresh water consumption per tonne of product in recent times has ranged from 0.182 m^3/t product in 2020 to 0.166 m^3/t of product in 2021.

The recycling of water used in the processing facilities achieved 87%. The tailings re-processing will reduce fresh water consumption by 56,900 m^3.

15.7 Power

The Casa de Pedra mining complex is energized through a 138 kV powerline which is reduced to 13.8 kV to meet the specific needs of the site. The electric energy consumption in 2021 from renewable sources was approximately 350,000 kWh.

15.8 Product handling and transportation

Iron ore for international export is transported from the Casa de Pedra site by MRS to the Port of Itaguaí in the state of Rio de Janeiro.

Domestically, this railroad is responsible for the distribution of iron ore to the Presidente Vargas plant, where it feeds CSN's steel production as well as other plants located throughout the southeast region of Brazil.

15.9 Port

CSN Mineração's facilities in the Port of Itaguaí have an export capacity of more than 42 Mt of iron ore annually.

15.10 Qualified person's opinion

CSN Mineração provided descriptions and drawings of all relevant existing and future mine infrastructure. Casa de Pedra is an operating mine and therefore all key infrastructure components are in place.

The existing and planned future infrastructure are in general adequate for the life of mine requirements and mineral reserve reporting. However, it was noted that the studies concerning the design of the filtered tailings facilities after 2029 are still at the conceptual stage. The qualified person recommends that the detailed engineering work is completed to accord with the life of mine production strategy.

All costs associated with the infrastructure have been estimated and are reflected in the life of mine cash flow model.

16 MARKET STUDIES

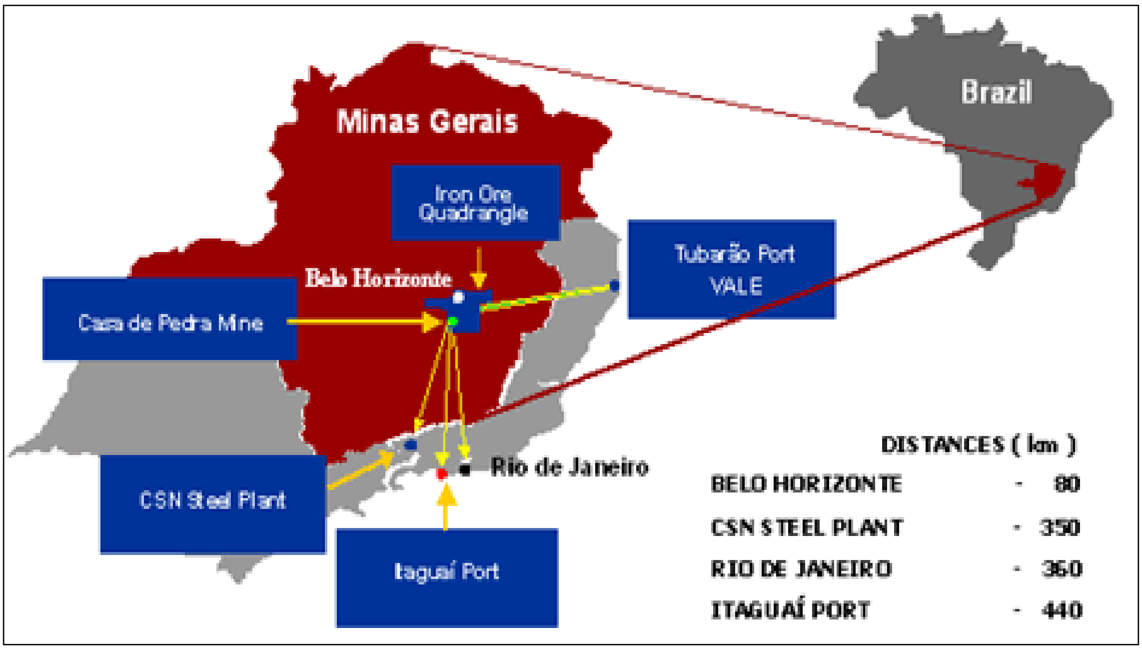
16.1 Products

CSN Mineração currently produces three types of products at Casa de Pedra:

- Lump from crushing and screening with a size distribution between 50 mm and 6.3 mm. This product can be directly used in a blast furnace.
- Sinter feed which needs to be agglomerated prior to use in a blast furnace. The size distribution is between 6.3 mm and 0.15 mm.
- Pellet feed which needs to be pelletized prior to its use in a furnace. The size is below 0.15 mm.

These products are either internally consumed by CSN Mineração or exported to the international market. The location of the Casa de Pedra mining complex with respect to the logistics in place is shown in Figure 16.1.

Figure 16.1 Casa de Pedra mining complex mine with respect to existing logistics



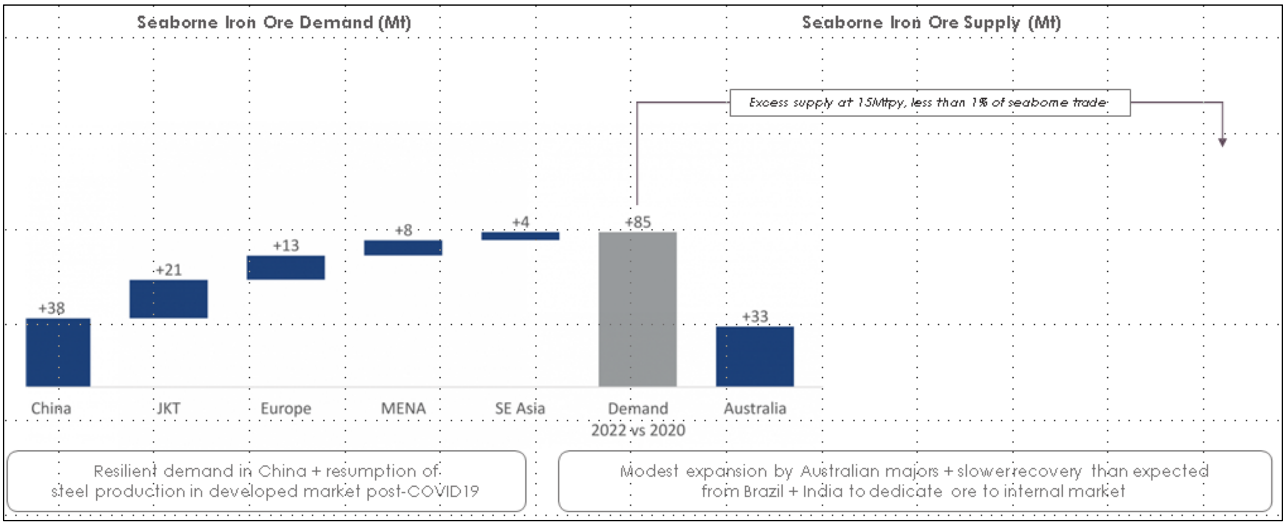
16.2 Market trends

The market trends are provided by CSN Mineração S.A. and this is the basis for their business plan. The seaborne iron ore market is expected to remain balanced in 2022 for several reasons:

- Resilient demand in China
- Resumption of steel production in developed markets post COVID-19
- Modest expansion by Australian producers
- Slower than expected recovery in Brazil
- India’s plans to dedicate iron ore production to internal markets.

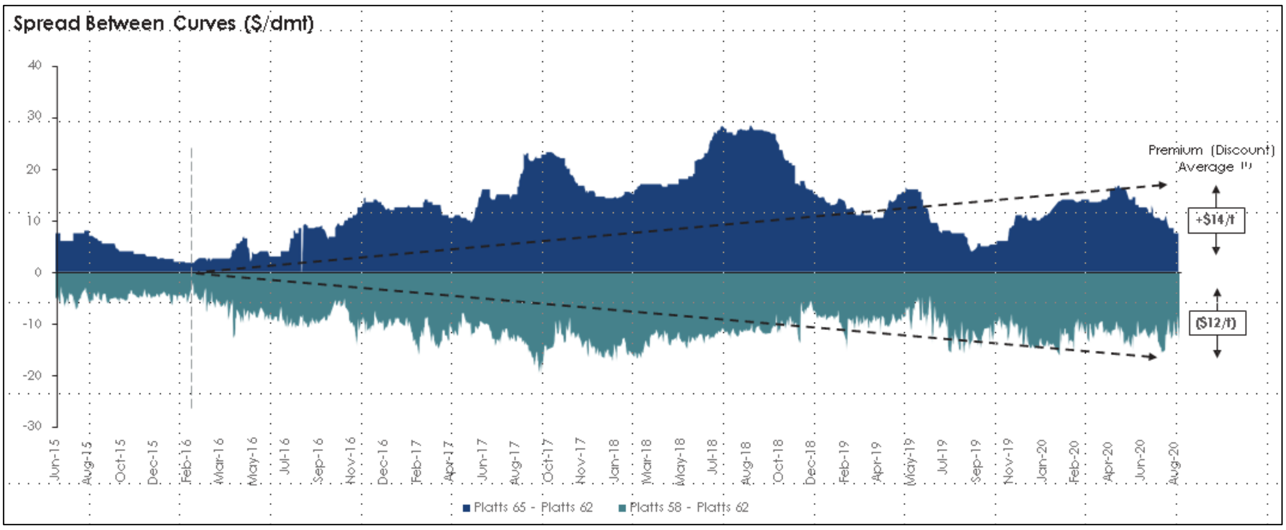
Iron ore demand and supply projected for 2022 is shown in Figure 16.2.

Figure 16.2 Iron ore demand and supply in 2022



Stricter Chinese environmental policies and new supply arrangements suggest wider spreads for 65% Fe and low alumina products as suggested in Figure 16.3.

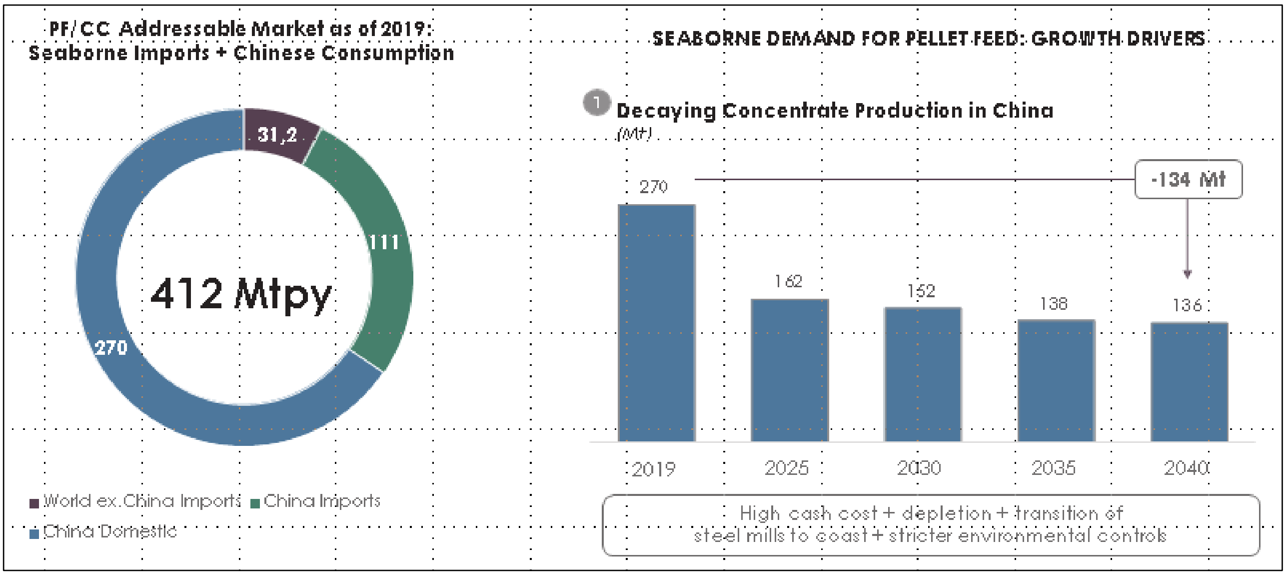
Figure 16.3 Iron ore price spread



Source: CSN Mineração

With respect to pellet feed, the Chinese market size is 412 Mtpa. An increasing demand for seaborne pellet feed backed by substitution of Chinese concentrates is expected as illustrated in Figure 16.4.

Figure 16.4 Chinese pellet feed market

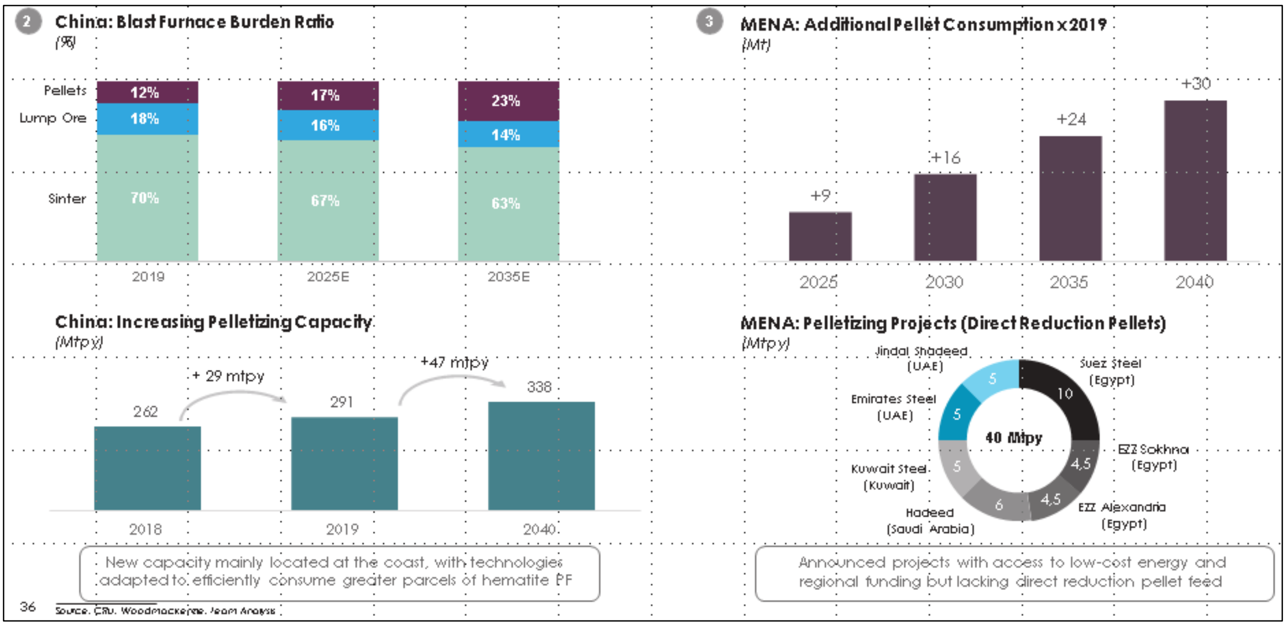


Source: CSN Mineração

Recently announced projects with access to low-cost energy and regional funding lack direct reduction pellet feed supply along with the increasing Chinese pelletizing capacity (Figure 16.5).

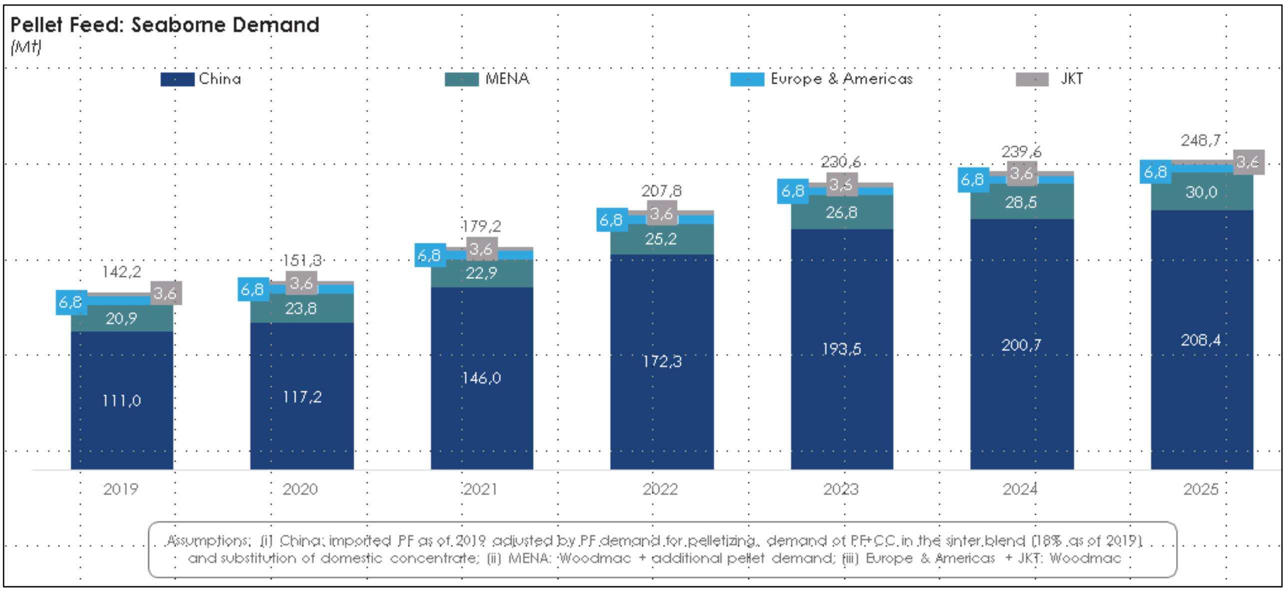
Therefore, a solid forecast for pellet feed seaborne demand is expected as shown in Figure 16.6.

Figure 16.5 Pellet feed seaborne demand



Source: CSN Mineração

Figure 16.6 Pellet feed seaborn demand



16.3 Commodity price projections

The long-range prices assumed for mine planning purpose are based on market study forecasts provided by CSN Mineração as summarized in Table 16.1.

Table 16.1 Product price forecast

Platts Iron Ore Index	Unit	Forecast by year				Long-term forecast
		2021	2022	2023	2024	2025
Platts 62	US$/dmt	102.2	87.7	81.1	78.0	74.0
Platts 65	US$/dmt	122.6	105.2	97.3	93.6	88.8
Platts 58	US$/dmt	71.5	61.4	56.8	54.6	51.8

16.4 Qualified person's opinion

Several contracts for the supply of lump, sinter feed and pellet feed are in place. The long-range prices are based on forecasts derived from market studies and are reasonable.

17 ENVIRONMENTAL STUDIES, PERMITTING AND PLANS, NEGOTIATIONS, OR AGREEMENTS WITH LOCAL INDIVIDUALS OR GROUPS

17.1 Environmental studies

Several environmental impact assessments (EIAs) have been completed by CSN Mineração concerning different aspects of the operation including expansion of the pit, processing plant, waste dumps, tailings filtering dumps, etc. Specifically, EIAs have been prepared for the following projects:

- Mining expansion project for Mascate and Corpo Principal
- Waste dumps and filtered tailings deposits for TQ-204, Fraile I and II, CDRI, Integrada and Batateiro Phase 3
- P15 processing plant expansion.

The EIAs for the Sul Maranhão I and Batateiro 4 waste dumps are currently being developed. EIAs for the Mascate, Esmeril and Batateiro Phase 5 dumps will commence when the details become available.

The EIAs covered all relevant aspects of the physical, biotic and socioeconomic environment that are impacted or influenced by the aforementioned projects.

17.2 Permitting

17.2.1 Regulatory framework

Mining projects are granted based on the Mining Code (Decree-Law 227/67, subsequently reformed by Law 9.314/96 and Provisional Measure #790, dated 25 July 2017). The Mining Code establishes that the subsoil and the mineral goods contained therein are property of the Union and not of the land (surface) owner. Upon request, any natural person or corporate body can be granted the right by the public authorities to research and later, as a corporate body, extract mineral goods, provided that the requirements are met. The requirements include obtaining full knowledge of the deposit (by mineral research), as well as the Exploitation Plan and environmental license for the activity. The system is controlled by the National Mining Agency, formerly known as the National Mining Agency, which is linked to the Ministry of Mines and Energy (MME). The mineral concession is granted by the MME through a Mining Lease, after analysing the Final Report on Mineral Research and the Economic Exploitation Plan.

An environmental license is legally required to install any activity that may potentially pollute or degrade the environment. The obligation to obtain the license is a requirement of both the State Environmental Agencies and of the Brazilian Environmental Institute (IBAMA) as they are members of the National Environmental System (SISNAMA). The main rules for environmental licensing are expressed in the National Environmental Policy (Law 6.938/81) and in the National Environmental Council (CONAMA) Resolutions 001/86 and 237/97. In the case of mining projects, there are other important resolutions such as the National Environmental Council's (CONAMA) Resolution 009/90 which establishes the procedure for obtaining the environmental license for mineral extraction activities. State Executive Order 97.632/89 establishes that mineral exploration activities must submit a recovery plan for degraded areas (Law # 6567, dated 09/24/1978 and amended by Law #13,975 dated 01/07/2020). This Law provides for a specific regime of exploration regarding the use of mineral substances, as pointed out in Art. 2: *"Licensed mineral exploitation is granted exclusively to the soil owner or to whomever has explicit authorization, unless the mineral deposit is located on properties belonging to a legal entity under Public Rights Law as in the hypothesis provided in paragraph 1 of Art.10".*

17.2.2 Permitting status

Mining rights

CSN Mineração's active mining rights are summarized in Table 17.1. The key tenement is 043.306/1956 which occupies an area of 2,516 ha where the Casa de Pedra mine is mainly located.

Table 17.1 Mining rights owned by CSN Mineração

Process	Area (ha)	Company	Mine
004.384/1945	143.56	Nacional Minérios S.A.	Engenho
832.997/2002	10.25	CSN Mineração S.A.	Casa de Pedra
006.763/1953	20.19	Nacional Minérios S.A.	Casa de Pedra
830512/1982	125.63	Nacional Minérios S.A.	Engenho
043.306/1956	2,516.29	CSN Mineração S.A.	Casa de Pedra
833.057/2002	1.39	CSN Mineração S.A.	Casa de Pedra
003.664/1942	74.28	CSN Mineração S.A.	Engenho

Environmental licenses

The status of Casa de Pedra's environmental licenses are summarized in the following tables. Specifically, the licenses being validated are presented in Table 17.2 and Table 17.3. Other licenses not being validated are presented in Table 17.4.

Table 17.2 Environmental licenses under COPAM 103/1981/074/2011 process

Process	License type	Description
COPAM 103/1981/019/2002	LO 282/2003	Casa de Pedra mine license validation
COPAM 103/1981/028/2003	LO 693/2004	Batateiro waste dump
COPAM 103/1981/036/2006	LO 476/2006	Batateiro waste dump expansion
COPAM 103/1981/037/2006	LO 010/2007	Vila waste dump
COPAM 103/1981/042/2007	LO 010/2008	Mine expansion to 30 Mtpa
COPAM 103/1981/043/2007	LO 010/2009	Corpor Norte road
COPAM 103/1981/047/2007	LO 010/2010	Sinter feed portaria stockpile
COPAM 103/1981/056/2008	LO 010/2011	Refuelling station II expansion
COPAM 103/1981/059/2008	LO 010/2012	Processing plant for 30 Mtpa

Table 17.3 Environmental licenses under COPAM 103/1981/071/2015 process

Process	License type	Description
COPAM 103/1981/019/2002	LO 282/2003	Cava Oeste waste dump and Batateiro height expansion
COPAM 103/1981/028/2003	LO 693/2004	Vila waste dump dyke
COPAM 103/1981/036/2006	LO 476/2006	Batateiro Phase 1 and Bichento III dyke

Table 17.4 Other environmental licenses not in validation

Process	License type	Description
COPAM 103/1981/084/2014	LO 001/2017	Casa de Pedra TSF expansion to 933 m elev. (valid until 24/02/2027)
COPAM 7079/1981/005/2017	LP+LI+LO 021/2017	Tailings removal from B5 and Casa de Pedra TFSs (valid until 26/07/2027)
COPAM 7079/2009/004/2017	LOC 036/2017	Tailings removal from B4 TFS and access to Fraile 1 TFS (valid until 11/08/2027)

The processing plant expansion has an LI 061/2014 (COPAM 103/1981/079/2013).

Land property

All land and surface rights within the Casa de Pedra's mine area is owned by CSN Mineração.

17.1 Waste disposal, monitoring and water management

17.1.1 Tailings storage facilities

CSN Mineração has invested in tailings filtering technologies. Currently, 100% of all tailings generated are filtered prior to their disposal at the TSF. The filtering process allows the recovery of 92% of the water content. The pulp (70% water and 30% solids) is initially treated in the thickener with 50% of the remaining water recovered in a filter press, which reduces the moisture content to 16%. The water is then recycled and reused in the processing facility.

All TFS's in place are monitored by robotic geotechnical stations to verify their stability.

More detail on the design criteria for these facilities is provided in Section 15.3.

17.1.2 Waste rock facilities

Waste generated throughout the life of mine is accommodated in waste dump structures. The main waste dump is Batateiro, which is equipped with under and peripheral drainage systems, sediment pond structures and instrumentation.

More details of the design criteria for the waste dumps are provided in Section 15.4.

17.1.3 Water management

The Casa de Pedra's mine is located within the Maranhão River drainage, a tributary of the Paraopeba River.

Water used at Casa de Pedra is pumped from the Poço Fundo River (140 m^3/h) and from groundwater (708 m^3/h). All required licenses for water collection are granted and in place.

The specific fresh water consumption per tonne of product in recent times has ranged from 0,182 m^3/t to 0.166 m^3/t of product in 2021.

The recycling of water used by the processing facilities has achieved 87%. The tailings re-processing will reduce fresh water consumption to 56,900 m^3.

In 2021, CSN Mineração completed the first water footprint study under the NBR ISO 14.046:2017 standards. The study measured all water inflows, consumption and outflows from all active processes and support areas. An action plan was implemented from the study's conclusions which led to an increase in water recycling.

The water monitoring program includes sampling points of all liquid effluents after treatment, sewage treatment stations, water/liquid separation systems, effluent from the laboratory, effluent from the thickener, sediment ponds and surface water.

17.1.4 Environmental programs

CSN Mineração has the following environmental programs in place:

- Environmental management program
- Soil and water conservation plan
- Program for monitoring water runoffs
- Rehabilitation program of the areas (PRAD)
- Fauna and flora conservation program
- Environmental education program (PEA).

17.2 Social and community

In this section Snowden Optiro did not made any work.

17.3 Mine closure

Specialist consultant ERM on behalf of CSN Mineração conducted a mine closure study in 2006 which was further updated by CSN Mineração.

The study describes a plan for decommissioning of the industrial, administrative and operational support facilities, restoring degraded areas and natural vegetation, maintaining the remaining structures and post-closure monitoring. Due to its conceptual nature, the plan makes a number of assumptions.

The mine closure study includes:

- General strategy for closure and proposals for future uses
- Environmental impact assessment of the mine closure plan
- Mine closure program
- Cost estimates of the mine closure plan.

17.4 Qualified person's opinion

Snowden Optiro reviewed the status of CSN Mineração's permitting strategy. All relevant permits and environmental and social license approvals are in place. The strategy is routinely adapted to the priorities of the evolving life of mine plan.

18 CAPITAL AND OPERATING COSTS

18.1 Capital costs

Capital costs were estimated by CSN Mineração based on the physical requirements of the life of mine plan. Given that Casa de Pedra is an operating mine, all future capital expenditure is related to new facilities, expansion of existing infrastructure, sustaining activities and mine closure. Specifically:

- Expansions and new facility investments:
  - P15 plant construction
  - Central plant investments with tailings concentration (CMAI 3), spirals and re-crushing of granulated ore
  - Waste/filtered tailings dump expansions
  - Other including tires workshop expansion, drainage improvement (A32), expansion of the water treatment station, expansion of the mining equipment workshop.
- Sustaining:
  - Mining equipment replacement
  - Additional wells for the water table depressing system
  - Central plant sustaining capital
  - Dry plants sustaining capital
  - Port sustaining capital.
- Mine closure:
  - Pre-closure activities (studies and licensing)
  - Closure activities (rehabilitation and revegetation)
  - Post-closure activities (monitoring).

The following sections describe the assumptions and estimates.

18.1.1 Capital cost assumptions

All costs are presented in US dollars (US$) at the BRL:US$ exchange rates shown in Table 18.1 unless otherwise indicated.

Table 18.1 Foreign exchange projection

FOREX	2022	2023	2024	2025	2026	2027, thereafter
BRL:US$	5.20	5.20	5.10	5.17	5.17	5.01

Source: CSN Mineração

The base date of all estimates is the last quarter of calendar year 2022.

The estimates have an overall accuracy range of -10% to +15% for their scope.

Indirect costs have been factored from the direct cost, using percentages established from actuals, historical records and projections.

Mining is an owner operation with the acquisition of mining equipment based on the life of mine fleet sizing.

The following taxes are included in the cost estimate:

- ISS (municipal service tax)
- ICMS (tax on the circulation of goods and transportation and communication services)

- DIFAL (ICMS tax difference, applied to interstate operations)
- PIS (employees' profit participation program)
- COFINS (social contribution for social security financing)
- IPI (tax on industrialized goods)
- II (importation tax)
- AFRMM (merchant marine renewal tax)
- IOF (financial operations tax).

No fiscal incentives were considered.

The contingency covers unknown or unexpected costs incurred that cannot be defined or identified at this stage of the project. The contingency allowance specifically excludes costs arising from scope changes, project risk factors and other items that are excluded from the capital cost estimate.

The contingency was estimated in accordance with a prefeasibility study level of assessment.

18.1.2 Capital cost summary

The capital costs for the life of mine plan are summarized in Table 18.2.

Table 18.2 Life of mine capital expenditure summary

Item	Value (US$ M)
Mining sustaining	2,185
Processing sustaining	1,287
Processing and mining equipment acquisitions	1,481
Port sustaining	475
Central plant improvements	16
Itabirite P15 plant construction	1,037
Waste/filtered tailings dump expansions	191
Other operational sustaining	87
Other capital expenditures	100
Mine closure	299
Total	**7,158**

18.2 Operating costs

The operating cost estimate is broken down by area including mining, processing, G&A and tailings management.

The mining, processing, tailings filtering and disposal, and G&A operating costs were estimated by CSN Mineração based on a combination of historical records and projections.

Key operating cost inputs are:

- Diesel price: US$1.30/L
- Power cost: US$0.14/kWh.

18.2.1 Operating cost summary

Table 18.3 shows the operating cost summary, which equates to US$22.64/t processed over the life of mine.

Table 18.3 Average operating cost estimate summary

Item	Units	Value
Mining	US$/t processed	4.23
Processing	US$/t processed	5.22
Rail	US$/t processed	2.60
Port	US$/t processed	2.07
Royalties (CFEM+TFRM)	US$/t processed	1.32
Other cost	US$/t processed	0.96
G&A and sales expenses	US$/t processed	2.18
Depreciation	US$/t processed	4.06
Total	**US$/t processed**	**22.64**

18.2.2 Mining operating costs

Mining costs include:

- Equipment consumables: diesel, power, tires, lube, bits, etc.
- Explosives and accessories
- Workforce: operators, maintenance staff, supervisors, management, technical positions, etc.

The mining operating costs per mined tonne (ore or waste) are summarized in Table 18.4.

Table 18.4 Summary of mining operating costs

Item	US$/t mined
Drilling	0.20
Blasting	0.12
Loading	0.33
Haulage	0.00
Ancillary	0.45
Support	0.10
Workforce	0.62
G&A	0.08
Total	**1.91**

18.2.3 Process plant operating costs

The operating costs for the Central and P15 processing plants are summarized in Table 18.5 and Table 18.6 respectively.

Table 18.5 Central plant operating costs

Item	Units	Value
Crushing and grinding	US$/t processed	0.41
Concentration	US$/t processed	1.04
Transport/Load/Product filtering	US$/t processed	0.56
Tailings filtering	US$/t processed	0.26
Tailings handling and disposal	US$/t processed	0.61
Power consumption	US$/t processed	0.96
Total	**US$/t processed**	**3.83**

Table 18.6 P15 plant operating costs

Item	Units	Value
Crushing and grinding	US$/t processed	0.78
Concentration	US$/t processed	1.27
Transport/Load/Product filtering	US$/t processed	0.42
Tailings filtering	US$/t processed	0.44
Tailings handling and disposal	US$/t processed	0.76
Power consumption	US$/t processed	0.75
Total	**US$/t processed**	**4.42**

The operating costs for the dry plants are presented in Table 18.7.

Table 18.7 Dry processing operating costs

Item	Units	Value
Beneficiation	US$/t processed	1.39
Transport/Internal movement	US$/t processed	2.45
Wagon loading	US$/t processed	0.70
Power consumption	US$/t processed	0.07
Total	**US$/t processed**	**8.83**

18.2.4 Other costs

Other items included in the operating costs are presented in Table 18.8.

Table 18.8 Other operating costs

Item	Units	Value
Rail	US$/t processed	2.60
Port	US$/t processed	2.07
Royalties (CFEM+TFRM)	US$/t processed	1.32
Other cost	US$/t processed	0.96
G&A and sales expenses	US$/t processed	2.18
Depreciation	US$/t processed	4.06
Total	**US$/t processed**	**13.19**

18.3 Qualified person's opinion

A comprehensive description of all input cost items was provided by CSN Mineração. In general, the calculated costs generated by the financial team match to the input costs used by the long-term planning team. Snowden Optiro noted that the calculated mining costs are higher than those used in the pit optimization which reflects the highly volatile current economic conditions, especially with respect to the diesel price and foreign exchange rates. While this may not have a material impact on the mineral reserves, Snowden Optiro recommends that future mine planning iterations are adjusted accordingly.

19 ECONOMIC ANALYSIS

19.1 Introduction

The economic analysis of the life of mine plan was evaluated by CSN Mineração using conventional discounted cash flow methods based the production schedules, capital expenditures and operating costs disclosed in this technical report summary.

The following key parameters were integral to the construction of the cash flow model:

- Long term product prices based on the forecasts presented in Table 16.1
- The exchange rates presented in Table 18.1
- 100% equity financing with no debt component
- All revenues and costs reported in "'real" constant US dollar terms without escalation.

The economic analysis presented in this section contains forward-looking information with regards to product prices, exchange rates, proposed mine production, projected recovery rates and costs. The results of the economic analysis are subject to a number of known and unknown risks, uncertainties and other factors that may cause actual results to differ materially from those presented here.

The economic analysis presented in this section is based on the mineral reserve estimate only.

19.2 Economic analysis

The life of mine financial outputs from the cash flow model are summarized in Table 19.1.

The post-tax NPV using a 9% annual discount rate is US$7,097 million.

Table 19.1 Life of mine financial outputs

Item	Unit	Value
Production	**Mt**	**1,062**
Net revenue	**US$ M**	**70,556**
Operating costs	**US$ M**	**-42,529**
Mining	US$ M	8,797
Processing	US$ M	10,844
Rail transport	US$ M	5,402
Port operations	US$ M	4,307
Royalties (CFEM+TFRM)	US$ M	2,744
Other costs	US$ M	1,991
Depreciation	US$ M	8,444
Gross profit	**US$ M**	**28,026**
Sales expenses and G&A	**US$ M**	**-4,537**
EBITDA	**US$ M**	**31,934**
Cash flow		
EBITDA	**US$ M**	**31,934**
Depreciation	US$ M	8,444
Taxes	US$ M	-7,986
(=) NOPLAT	**US$ M**	**32,392**
Depreciation	US$ M	0
Capex	US$ M	-7,158
Free cash flow	**US$ M**	**25,234**
Discounted cash flow	**US$ M**	**7,097**

19.3 Sensitivity analysis

A sensitivity analysis was completed on the discounted cash flow model to assess the impact on the NPV to changes in operating costs, capital costs (including sustaining) and gross revenue (iron ore price). The results are presented in Table 19.2 and Table 19.3.

Table 19.2 NPV sensitivity analysis with respect to product prices and operating costs

		Product price										
Operating costs		-25%	-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%	25%
	-25%	5,468	6,064	6,650	7,236	7,822	8,408	8,993	9,579	10,165	10,751	11,337
	-20%	5,204	5,809	6,393	6,977	7,561	8,145	8,729	9,313	9,898	10,482	11,066
	-15%	4,940	5,543	6,137	6,719	7,301	7,883	8,466	9,048	9,630	10,212	10,794
	-10%	4,676	5,277	5,878	6,461	7,041	7,621	8,202	8,782	9,362	9,943	10,523
	-5%	4,412	5,011	5,611	6,202	6,781	7,359	7,938	8,516	9,095	9,674	10,252
	0%	4,148	4,745	5,343	5,940	6,521	7,097	7,674	8,251	8,827	9,404	9,981
	5%	3,880	4,479	5,075	5,671	6,260	6,835	7,410	7,985	8,560	9,135	9,710
	10%	3,604	4,213	4,807	5,401	5,994	6,573	7,146	7,719	8,292	8,866	9,439
	15%	3,317	3,942	4,539	5,131	5,723	6,311	6,882	7,454	8,025	8,596	9,167
	20%	3,028	3,664	4,271	4,861	5,451	6,041	6,619	7,188	7,757	8,327	8,896
	25%	2,732	3,374	3,997	4,592	5,180	5,768	6,355	6,922	7,490	8,058	8,625

Table 19.3 NPV sensitivity analysis with respect to product prices and capital costs

		Product price										
Capex		-25%	-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%	25%
	-25%	4,370	4,968	5,565	6,146	6,722	7,299	7,876	8,453	9,029	9,606	10,183
	-20%	4,326	4,923	5,521	6,105	6,682	7,259	7,836	8,412	8,989	9,566	10,142
	-15%	4,281	4,879	5,476	6,065	6,642	7,218	7,795	8,372	8,949	9,525	10,102
	-10%	4,237	4,834	5,432	6,025	6,601	7,178	7,755	8,331	8,908	9,485	10,062
	-5%	4,192	4,790	5,387	5,984	6,561	7,138	7,714	8,291	8,868	9,445	10,021
	0%	4,148	4,745	5,343	5,940	6,521	7,097	7,674	8,251	8,827	9,404	9,981
	5%	4,103	4,701	5,298	5,896	6,480	7,057	7,634	8,210	8,787	9,364	9,941
	10%	4,058	4,656	5,254	5,851	6,440	7,016	7,593	8,170	8,747	9,323	9,900
	15%	4,013	4,612	5,209	5,807	6,399	6,976	7,553	8,130	8,706	9,283	9,860
	20%	3,966	4,567	5,165	5,762	6,359	6,936	7,512	8,089	8,666	9,243	9,819
	25%	3,917	4,522	5,120	5,718	6,315	6,895	7,472	8,049	8,626	9,202	9,779

19.4 Qualified person's opinion

The cash flow model demonstrates that under the current set of economic assumptions, the Casa de Pedra project provides a robust post-tax NPV of US$7,097 million at a 9% annual discount rate and confirms the economic viability of the mineral reserve estimate.

The financial sensitivity analysis shows that the project is most sensitive to changes in product prices, and least sensitive to capital expenditure.

20 ADJACENT PROPERTIES

There is no information from the adjacent properties relevant to the Casa de Pedra mining complex for disclosure in this technical report summary.

21 OTHER RELEVANT DATA AND INFORMATION

There is no other relevant data and information to disclose to provide a complete and balanced disclosure of the property.

22 INTERPRETATION AND CONCLUSIONS

22.1 Geology and mineral resource estimation

The regional geology is well understood based on the extensive documentation in public and internal company reports. The local or deposit-scale geology is understood to a satisfactory level and is appropriate for the determination of mineral resources.

The topographical survey of the property is satisfactory for use in estimating mineral resources. The drill hole collar survey methodology is considered satisfactory; however the documentation requires updating. Details are missing for collar surveys, equipment used and accuracy, thus the qualified person is unable to comment on the appropriateness of these methods.

The diamond core drilling methods are considered satisfactory and appropriate for geological and metallurgical purposes. The documentation provided covered high-level information by campaign but no details on core diameters, drilling contractors, metres drilled by year etc.

There has been a variety of sampling and analytical testing going back several decades. Both internal and external laboratories have been utilized with the most recent drilling (2012 to present) focused on use of Intertek and ACME laboratories for all sample preparation and SGS laboratory for all analytical work. Historical drilling information (pre-2012) was used for geological modeling and mineral resource estimation but was disregarded in mineral resource classification.

Database validation was focused on the global/total assay values as the primary attributes used for mineral resource definition. The global values represent the total sample and not a sub-set from grinding or processing. Granulometric fractions were not validated by SRK or Snowden Optiro.

For the drilling campaigns prior to 2012 there was no QAQC practices applied. CSN Mineração has tried to validate these campaigns by drilling holes close to old ones (twin holes), but with inconclusive results.

During the 2012-2014 drilling campaigns, CSN Mineração introduced a QAQC program. There was no "in time" QC and sample failures were not investigated to identify the reason for the failure. However, the QAQC results were considered in the resource classification procedure adopted by CSN Mineração. Batches with failures were considered of less confidence in the resource classification methodology, which the qualified person considers mandatory and good practice.

Practices concerning blank sample production were not clearly documented. Therefore, the results are not reliable and should be disregarded.

The CRMs are considered satisfactory for use, although the low-grade CRM provides minimal value for QC purposes and should be replaced with a mid-grade or near cut-off grade standard (i.e. ~ 30% Total Fe). A mid-grade or near cut-off grade standard will aid in providing confidence in the analytical data near the economic cut-off grade and should include an appropriate mix of deleterious elements aligned with the values observed at the Casa de Pedra mining complex.

Check assays at Intertek and ACME laboratory indicate reproducibility for Fe, SiO_2 and Al_2O_3 at a satisfactory level and confirm the SGS assays. In one ACME analytical batch, a significant bias was identified for Mn and P. Intertek and ACME check assay results for Mn, P and LOI for all batches were not available.

The overall database for the drilling campaigns between 2012 and 2014 is considered satisfactory for use in mineral resource estimation. For drilling campaigns executed before 2012, analytical certificates are unavailable with the historic samples analysed in-house with no certificates produced. Therefore, data validation was not possible. Samples without QAQC received zero weight in the resource classification ranking system, meaning that the entire historical drilling (pre-2012) was not considered for resource classification, which the qualified person concurs with.

The lithological classification appears acceptable for estimation as it represents discrete and mineable volumes. Minor risks involved with the breakdown of domains using Total Fe and volumes away from data have the potential to unrealistically increase tonnage due to unsupported volumetric blow-outs in the geological model.

CSN Mineração does not produce 3D wireframe volumes and therefore cannot perform an accurate volumetric check and ensure continuity in 3D prior to coding the resource block model. This represents a low to medium risk to the mineral resource tonnage at the Casa de Pedra mining complex.

In general, the modeled lithology provides a satisfactory representation of logged codes. Although the block model rock codes and drill hole logging align in section, there are multiple 3D issues with continuity that are commonly observed with the sectional interpretation. These issues include isolated pods of discontinuous mineralized zones, volume extrapolation or abrupt stoppages of a lithology that may or may not be supported by faulting or other geological evidence.

Based on the average drill spacing across the main mineralized zones, the block size is appropriate to represent volumes and grade values. In areas of wider spaced drilling or drilling with variable depths, the block size is relatively small presenting a potential risk for estimation biases within these zones.

Based on the domain and rock type descriptions, the mean bulk density values appear reasonable.

Current compositing methods are satisfactory for the calculation of mineral resources although there are artifacts of the ROCKCODE in the composites that appear to be combined values, resulting in categorical values with decimals in addition to integers.

The grouping for domaining is considered satisfactory for estimation purposes. Silica, with its high indirect correlation to Total Fe, will be appropriate for common domaining but MnO may display materially different properties in domaining such as structural control, internal zones of high/low MnO, or other geological controls separate from Total Fe.

The nugget values, anisotropy and general variography parameters are as expected based on studies of other global iron deposits and aligns with the deposit type.

Currently, the variography method is over-reliant on expecting Total Fe (global) spatial continuity to be the same for all variables (Total Fe, SiO_2, Al_2O_3, P, MnO, CaO, TiO_2, MgO, and LOI). The correlation coefficients of raw quality variables Fe, SiO_2, Mn, and TiO_2 display high correlations that may be appropriate for cross variography, linear model of co-regionalization (LMC) for variography or co-kriging estimation while other variables are not well correlated, thus their spatial distribution are based on a variety of geological processes different from the primary iron oxide enrichment. LMC can be an appropriate means of obtaining a robust semi-variogram in highly correlated variables, but it often results in incorrect spatial continuity of poorly correlated variables resulting in poor estimation.

Reviewing the validation based on mean grades between composited values and blocks, there is similar high variability between the various elements. In the case of Fe_GL, the differences are considered immaterial but in the case of secondary/deleterious elements, the comparison illustrates material differences. Since domaining and ore type quality relies on both Total Fe and deleterious materials, the validation of estimation shows poor performance resulting in inaccurate prediction of material quality at the local scale.

CSN Mineração utilizes a resource classification ranking system which accounts for a variety of geological, quality and estimation inputs. This scoring system combined with a smoothing of broad volumes into categories results in a satisfactory classification that meets international reporting guidelines and definitions for measured, indicated and inferred mineral resources. The increased confidence in classification aligns well with geological continuity and drilling density.

In Snowden Optiro´s opinion, the issues related to all relevant technical and economic factors likely to influence the reasonable prospects of economic extraction at the Casa de Pedra mining complex and can be resolved with further technical work and analysis.

In order to summarize Snowden Optiro‘s conclusions of the geology and mineral resource estimation, a risk matrix was produced (Figure 22.1 and Table 22.1).

Figure 22.1 Risk Matrix Legend

Risk Matrix	Impacts				
Likelihood	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain	H	H	E	E	E
Likely	M	H	H	E	E
Possible	L	M	H	E	E
Unlikely	L	L	M	H	E
Rare	L	L	M	H	H

(red)	E = Extreme Risk	Immediate action required
(orange)	H = High Risk	Senior Management attention needed
(yellow)	M = Medium Risk	Management responsibility must be specified
(green)	L = Low Risk	Manage by routine procedures

Source: Snowden Optiro, 2022

Table 22.1 Casa de Pedra mining complex geology and mineral resource estimation risk matrix

Item/area identified	Key risks identified	Impact Insignificant, Minor, Moderate, Major, Catastrophic	Likelihood Almost Certain, Likely, Possible, Unlikely, Rare	Final Risk E = Extreme Risk, H = High Risk, M = Medium Risk, L = Low Risk	Potential mitigants	Residual Risk after mitigation
Local Geology	Problems in mining planning and production due to lack of short term geological mapping	**Moderate**	**Unlikely**	**M**	CSN should carry on with systematic in pit mapping and geological model updating	**L**
Drilling	Low confidence in drilling results due to insufficient records	**Moderate**	**Unlikely**	**M**	CSN must complete its documentation on survey campaigns from 2012 to 2014	**L**
Drilling	Incomplete information on Mineral Resources may affect the Reserves and life of mine estimates	**Moderate**	**Likely**	**H**	Additional drilling should be completed with an emphasis on deeper holes, angled drilling, structural modeling, and infill drilling in areas currently exhibiting wide-spacing. CSN should do additional drilling in areas where volumes are classified as Indicated or Inferred.	**M**
QAQC	Low confidence in assay and fraction recoveries due to insufficient QAQC practices	**Moderate**	**Likely**	**H**	QAQC procedures should be described, the results more clearly presented, and QA/QC consistently monitored as part of an ongoing process during all exploration drilling programs.	**L**
Data Verification	Low confidence in Reserve Estimation due to lack of validation of size fraction information (sample assays and recoveries)	**Moderate**	**Likely**	**H**	Granulometric fractions database and estimation were not validated by SRK or Snowden. This validation must be done and documented as soon as possible by CSN and independently audited.	**L**
Geological Model	Lack of accurate volume check	**Minor**	**Possible**	**M**	CSN should adopt a 3D wireframe modelind technique	**L**
Variography	Poor grades estimation due to incorrect spatial continuity of poorly correlated variables	**Major**	**Almost Certain**	**E**	CSN should review variography for each primary element per domain .Variables with poor correlation coefficient should be evaluated independently.	**L**
Grade Estimation	Material bias between composites and block grades. Estimation shows poor performance resulting in inaccurate prediction of material quality at the local scale	**Major**	**Almost Certain**	**E**	There are multiple locations where the estimation should be modified to provide an improved local estimate so that composite and block grades are more aligned.	**L**
Mineral Resource Estimate	Poor estimate of mineral resources reasonable prospects of eventual economic extraction	**Moderate**	**Possible**	**H**	CSN should to run a new economic pit shell, applying updated parameters and economic assumptions. Economic assumptions, slope angles, and parameters used to determine the cut-off grade (CoG) and economic pit shell constraints should be documented and discussed by the QP.	**L**
Reconciliation	Lack and predictability in production due to the absence of reconciliation practices	**Moderate**	**Likely**	**H**	CSN must Implement reconciliation between resource model, mining and plant and comparison with depletion by mining. This should be done in a regular basis (at least every three months). Problems should be identified, investigated, and remedied.	**M**

Source: Snowden Optiro, 2022

22.2 Mining and mineral reserves

It is Snowden Optiro's opinion that the estimation and reporting of mineral reserves is in accordance with S-K 1300 guidelines. This opinion is based on the premise that the mineral resource estimate revealed no fatal flaws.

A mineral reserve of 2,078 Mt (wet) at an average grade of 41.17% Fe was reported as of 31 December 2021. This mineral reserve is based on currently available information using measured and indicated resources only. The mineral reserve classification reflects the level of accuracy of the associated studies. In this respect, compact itabirites were only converted to the probable reserve category as additional metallurgical and processing studies are required to increase the level of confidence.

The Casa de Pedra mineral reserve was 2.80 Bt in 2020. Factoring in mining depletion for 2021, the mineral reserve was reduced to 2.77 Bt. The mineral reserve reported as at 31 December 2021 was 2.08 Bt with the main differences attributed to depletion of some produced tonnage between 2017 and 2021, and some updated pit optimization and design parameters.

The Casa de Pedra mine is based on a mining concept that uses conventional drill, blast, load and haul techniques for all mining areas and rock types. All rock is blasted and loaded with excavators and loaders into off-road trucks and hauled to the final destinations (primary crusher, stockpiles or waste dumps). Specifically, primary mining is undertaken by large hydraulic excavators (26 m^3 bucket capacity) coupled with 240 st off-road trucks. Front-end loaders of 25 m^3 bucket capacity also operate at the pit and stockpiles.

The mine scheduling was carried out to meet the production needs of the processing plants and to maximize NPV while maintaining adequate operational and safety practices. Production scheduling involved the definition of practical mining phases and the development of an achievable mining schedule. An average ore feed rate of 54 Mtpa is forecast until 2031 followed by a 24 Mtpa rate. At that rate, the life of the project is 72 years.

The average number of required rotary drill rigs until 2031 is 14 units and four thereafter. Two DTH drill rigs are required throughout the life of mine. Until 2031, the mine will operate with three 34 m^3 bucket shovels, five 29 m^3 hydraulic shovels and six 19 m^3 front-end loaders. Thereafter, loading operations will be undertaken by two 29 m^3 hydraulic shovels and four 19 m^3 front-end loaders. The average number of truck units required until 2031 is 70. Thereafter, 15 units are required on average.

22.3 Recovery methods

The Casa de Pedra wet processing plant (Central plant) currently has an installed capacity to produce around 22 Mtpa of marketable ore products. Processing steps include crushing, screening, homogenizing, sorting and concentration, thickening, product filtration and tailings filtration. The products generated are granulated, sinter feed and pellet feed. The process flow sheet in place involves well proven technologies in the iron ore processing industry and thus, no significant risks are involved.

The dry system is composed of the ITM unit - Pires and mobile screening units (UPM's). ITM - Iron Ore Processing Facility of the Pires unit receives ores from the Casa de Pedra and Engenho mines. Operating with a predominantly dry system, ITM is now responsible for producing more than 5 Mt of iron ore per year. ITM has a primary crushing circuit, a secondary crushing circuit and screening and handling circuits of the products. Mobile Screening Units (UPM's) are dry processing plants with a capacity of 6.5 Mtpa and are powered by loaders and excavators. The material from the mine, through the truck fleet, is classified according to granulometry in sinter feed, granulated and over. After processing by the UPM's, the product is transported again by the fleet of trucks for cargo formation for railway compositions, at the Itacolomy Railway Terminal (TFI), at a distance of 1km.

The proposed P15 project consists of an ore processing plant to process friable itabirite (42% Fe and 37.1% SiO_2) from the mine and the PCOL stockpile for the production of 15 Mtpa (dry basis) of direct reduction pellet feed with a content of 67.7 % Fe and 1.5 % (SiO_2 + Al_2O_3).

Thereafter, the plant will be fed with compact itabirite operating at an average mass yield of 45.9% and 62.3% Fe pellet feed. The plant will operate until 2031 at a 31 Mtpa friable itabirite feed rate followed by a 24 Mtpa of compact itabirite. The project encompasses the application of well-established technologies in the industry with a maximum recovery of water used in the process.

The production rates and timelines of the ore treatment facilities are:

- Central plant: Up to 32.0 Mtpa until 2031
- ‘Seco 61’ and ‘Secto Add’ processing facilities operating until 2026 with a combined capacity of 11.1 Mtpa
- P15 processing plant. Start-up in 2024, operating at 31.0 Mtpa ore feed until 2031 and 24.0 Mtpa thereafter.

The metallurgical specifications of each processing facilities are:

- ‘Seco 61’ plant: Average mass yield recovery of 100% and 60.5% Fe
- ‘Seco Add’ plant: Average mass yield recovery of 100% and 54.9% Fe
- Central plant:
- Sinter feed (SF): Average mass yield recoveries of 47.8% and 59.3% Fe
- Pellet feed (PFF): Average mass yield recoveries of 24.5% and 65.8% Fe.
- P15 plant: Average mass yield recovery of 49.2% and 67.0% Fe until 2031; thereafter, an average mass yield of 45.9% and 62.3% Fe thereafter.

All tailings generated are filtered and stacked with 15% moisture. The average Fe content of the tailings is 17% with a silica content of 72%.

22.4 Project infrastructure

All infrastructure components required for the current operation are in place. Executive and conceptual engineering projects were developed by CSN Mineração to support the base case for the mineral reserves, including the waste and filtered tailings dump expansions.

The key project infrastructure consists of the process plants, site facilities, power line, water dam, filtered tailings piles, waste dump, ROM stockpiles, product handling systems, railways and port facilities.

Historically, three TSFs (Casa de Pedra, B4 and B5) were used, where conventional unfiltered tailings were disposed. These TSFs are no longer in operation and are being decommissioned. CSN Mineração currently operates two filtered tailings dumps (Fraile Phase 01 and Fraile Phase 02) which accommodate the tailings currently being generated. Future expansions considered are Fraile Phase 03 and Fraile Phase 4. Thereafter, other TSFs are being considered by CSN Mineração, including the Sirênio, Maranhão, Mascate and Esmeril dumps, that can accommodate the total amount of filtered tailings generated over the life of mine.

Waste is currently disposed at the Batateiro waste dump to the immediate west of the open pit, which shall be successively expanded. The final Batateiro waste dump design will accommodate approximately 1,500 Mt, sufficient to meet the total amount of waste generated throughout the life of mine (1,090 Mt).

22.5 Environmental studies and permitting

A number of Environmental Impact Assessments (EIA) have been completed by CSN Mineração including the expansion of the open pit, processing plant, waste dumps, tailings filtering dumps, etc.

All mining rights and land is owned by CSN Mineração. The key tenement is the n° 043.306/1956 which occupies an area of 2,516 ha where the Casa de Pedra mine is mainly located.

All required environmental licenses required to operate the mine and associate facilities are in place. Ongoing licensing programs are being undertaken to meet the requirements of the mine development.

22.6 Capital and operating costs

Capital and operating costs have been estimated at a level appropriate for a mineral reserve reporting. The overall accuracy is estimated at ±10% - 15% for both capital and operating costs.

All key capital and operating cost estimates are supported by a combination of historical data, projections and vendor quotes.

22.7 Economic Analysis

The life of mine cash flow model of the mineral reserves demonstrates that under the economic assumptions disclosed in Section 19, the Casa de Pedra project has a robust post-tax NPV of US$7,097 M using a 9% annual discount rate an confirms the economic viability of the mineral reserve estimate.

A sensitivity analysis shows that the operation is most sensitive to changes in product prices and least sensitive to capital expenditure.

23 RECOMMENDATIONS

23.1 Geology and mineral resource estimation

CSN Mineração should regularly perform (monthly) updates of the site topography for tonnage tracking and reconciliation purposes with continued annual LiDAR flyovers and monthly input survey updates.

The drill hole collar survey methodology documentation requires updating. Details are missing for collar surveys, the equipment used and accuracy, thus it is not possible to comment on the appropriateness of these methods.

CSN Mineração should complete regular (quarterly) pit mapping to capture lithological contacts and major structures, and ensure all data is recorded digitally for annual incorporation into the geological model.

The drilling documentation needs to include greater detail on collar and downhole survey methods and accuracies, geological logging, drill core sampling, security, transport, cutting and storage.

Variable azimuths for drilling are required for structural measurements as nearly all deep diamond holes are drilled from east to west to intercept the bedding at oblique angles. Alternative azimuths will provide additional structural information across perpendicular discontinuities and bedding.

Additional drilling should be completed with an emphasis on structural modeling and infill drilling in areas of wide spacing. As the deposit is structurally complex, maintaining a 3D structural model is recommended to best model the interaction between the various geological and resource domains.

The implementation of a new CRM for QAQC that is near the Total Fe cut-off grade of 30% Fe is recommended. This will provide additional confidence in analytical values near the cut-off grade.

CSN Mineração should complete further analysis of the Intertek and ACME check assay results for Mn, P and LOI for all batches available.

Some information in the QAQC report should be more detailed, such as the number of samples per batch, information on whether standard samples were sent blindly to the laboratories or not, and whether QAQC insertion rates were based on global or size fraction assays.

The qualified person recommends that QAQC procedures should be better described (including clear definition of tolerances and unconformities), the results more clearly presented, and the QAQC results consistently monitored as part of an ongoing process during all future exploration drilling programs. Monitoring should be carried during the exploration programs so that analytical flaws can be quickly identified, investigated, and fixed as required.

Database discrepancies for the 2012 to 2014 drilling campaigns should be identified and corrected.

The granulometric fractions database and estimation were not validated by SRK or Snowden Optiro. This validation must be done and documented as soon as possible by CSN Mineração and independently audited.

CSN Mineração should check, and include in its report, whether the sum of the size fractions were validated to add up 100% in the database, considering both tested results and the values calculated by regression, including the estimated variables in the block model.

Assumptions and validations of stoichiometric closure should also be clearly reported.

It should be clearly stated which drilling campaigns the size fractions where calculated due to lack of the size fraction information (mass recovery and chemical variables), especially for 2012 to 2014 campaigns which are the most significant ones in terms of measured resource classification.

CSN Mineração should perform screening tests and use this result as a basis for calculating missing gaps in size fraction information rather than relying on regression calculations.

Snowden Optiro recommends that the recovery and assay results by size fraction in the mineral resource model be supported by a reconciliation study, including masses and chemical grades.

With regard to geotechnical data collection, Vogbr recommended that as mining progresses into new regions systematic detail geomechanical mapping is carried out as well as updating the 3D geomechanical model. Vogbr also recommended that new drilling should be considered in the surrounding areas in future campaigns.

A combination of grade shell/indicator shell techniques coupled with broader 3D wireframe geology to improve the key ore-bearing zones of HBA/HCP and IBR/ICR is recommended.

Improvements should be implemented in future geological model updates with the move to a 3D modeling approach and incorporation of structure to improve the volumetric modeling of the various domains / lithologies.

CSN Mineração should continue the collection and testing of bulk density samples as the mine progresses to ensure adequate data per domain/rock type to produce a statistically significant populations (>30) for bulk density determination by estimation domain.

The number of composites with decimal values is minor but should be addressed by CSN Mineração during the next model update.

CSN Mineração should evaluate the possibility of grouping some variography domains with a scarce number of samples.

No statistical parameters have been tabulated per domain. Snowden Optiro advises CSN Mineração to include this study in the mineral resource report.

It is recommended that MnO (and other potentially deleterious materials) be reviewed to understand spatial continuity of these individual variables separate from Total Fe. Based on the differences in spatial continuity and EDA for individual elements, it may be beneficial for unique domains for certain variables if the mineralization is unrelated to iron enrichment.

A review of variography for each primary element per domain is recommended. Estimation of global quality variables should include unique variography and search neighborhoods for all key economic variables by domain. A focus on the primary ore-bearing domains is recommended. This will result in calculating multiple variograms, but each estimate will be unique based on the properties of the individual variable and the domain.

The use of OK for variables using a unique modeled semi-variogram per hard domain is recommended. Although this is a more time intensive process of modeling and estimation, the results should provide improved validation with the original composited data, thus improving prediction of quality and reconciliation.

The initial use of KNA is advised but it should be performed on each domain for at least the key economic variable (i.e. Total Fe). If co-kriging is utilized for estimation and LMC is the preferred method for spatial continuity, then these should be accounted for in search neighborhood selection. Currently, the documentation is insufficient to determine how effective the KNA is to the estimate and only optimizing the search for a single domain is not recommended.

Improved documentation relating to the co-kriging of elements by grain size distribution is required.

Swath plots demonstrate a material bias between composites and block grades across portions of the deposit. In some areas, the values that show acceptable validation are typically associated with increased data concentrations but there are multiple locations where the estimation should be modified to provide an improved local estimate so that composite and block grades are more aligned.

The Casa de Pedra mining complex block model should be validated and documented by a variety of means including, but not limited to, visual validation, swath plots for key elements by domain, comparison with nearest neighbor estimation and general statistical validation by element per domain.

CSN Mineração should complete additional drilling in areas where the drill spacing is considered wide, such as volumes classified as indicated or inferred.

CSN Mineração must implement reconciliations between the resource model, mining and processing plant. This should be done on a regular basis (at least every three months). Problems should be identified, investigated, and fixed as required.

The granulometric fraction estimation of quality variables is complex with some areas of the mineral resource reliant on historic data that has been modified to account for the changing particle size bins over time. As the quality of the various size fractions are required for mineral reserve calculations and determination of cash flow, the fundamental assumptions associated with determining size fraction quality need detailed review as part of mineral reserve estimation.

Snowden Optiro recommends CSN Mineração run a new optimized pit shell, applying updated parameters and economic assumptions. The optimized pit shell run must include capital allocated to move existing infrastructure (including capital and sustaining costs, and CFEM).

Offsets from mineral resource open pit limits to major infrastructure areas need further evaluation.

CSN Mineração should conduct a cut-off grade analysis to justify grades below the cut-off grade in some blocks within mineral resource.

CSN Mineração should update the mineral resource documentation to provide the updated parameters, economic assumptions, grade-tonne sensitivities to cut-off grade and provide qualified person opinions to meet international reporting standards.

23.2 Mineral reserve estimation

The block height in the mineral resource model is 13 m. This dimension reflects historical mining practices where 13 m benches were drilled and blasted. Further recommendations by the mine operation's team led to a reduction to a 10 m bench to avoid the excessive use of track dozers to lower the blasted bench crest and create safe loading conditions. Snowden Optiro recommends a cell height adjustment from 13 m to 10 m to reflect the current selective mining unit (SMU).

It is noted that constant unit mining costs were applied in the pit optimization. No mining adjustment cost factors were considered to reflect specific operating mining conditions such variable haul distances, drilling patterns, dewatering requirements, etc. While the use of mining adjustment cost factors has a material impact on the open pit design, it is mainly constrained by physical boundaries rather than by economic aspects. Snowden Optiro therefore recommends that future iterations include variable mining costs that reflect local operating conditions.

Detailed mining costs calculated from mining physicals estimates (fleet sizing, mining consumables, workforce, etc) are higher than those used in the pit optimization and reflect the current highly volatile economic conditions (diesel price, foreign exchange rates, etc). While this may not have a material impact on the open pit boundaries as the pit optimization pit bottoms out at Revenue Factor 0.80, Snowden Optiro recommends that future mine planning work is adjusted to the calculated mining costs.

A pit sensitivity analysis on key optimization parameters is recommended to assess their impact on the mining inventories and economics of the project.

It is noted that after 2032, the average annual total rock movement decreases from 120 Mtpa to 30 Mtpa. Snowden Optiro recommends further investigation is undertaken to verify the value of reducing the mining equipment size to match the annual mining rate.

In Snowden Optiro's opinion, the level of detail for the infrastructure design is in general adequate for mineral reserve reporting. However, it was noted that the studies concerning the design of the filtered tailings facilities after 2029 are conceptual. Snowden Optiro recommends that the detailed engineering work is completed for the life of mine tailings production strategy.

For the planned P15 processing plant project, several friable/compact scenarios were evaluated by CSN Mineração that demonstrated its technical viability. Further studies may unlock value by increasing metallurgical recoveries and thus production rates. In this respect, compact itabirites were only converted to the probable reserve category at this stage as additional metallurgical and processing studies are required to increase the level of confidence.

While all relevant data and documents required for the mineral reserve are adequate and well detailed, an absence of a consolidated Terms of Reference (ToR) document for mine planning purposes is noted. Snowden Optiro recommends that a ToR document is compiled including all relevant aspects of the project that can guide the mineral reserve team. The document should be updated every year reflecting any variation such as commodity prices, costs, depletion, etc. The results and findings of the annual mine planning cycles should be consolidated along with the ToR in a standalone report.

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25 ABBREVIATIONS

Abbreviation	Description
CSN	Companhia Siderúrgica Nacional
Vogbr	Vogbr Recursos Hídricos & Geotecnia Ltda

26 RELIANCE ON INFORMATION PROVIDED BY THE REGISTRANT

This report has been prepared by Snowden Optiro for CSN Mineração. The information, conclusions, opinions, and estimates contained herein are based on:

- Information available to Snowden Optiro at the time of preparation of this report
- Assumptions, conditions, and qualifications set forth in this report
- Data, reports, and information supplied by CSN Mineração and other third party sources.

Snowden Optiro has not researched the Casa de Pedra mining complex property titles or mineral rights and consider it reasonable to rely on the information provided by CSN Mineração´s legal counsel, who is responsible for maintaining this information.

Snowden Optiro has relied on CSN Mineração for guidance on applicable taxes, royalties and other government levies or interests applicable to revenue or income used in the life of mine cash flow model. As the Casa de Pedra mining complex has been in operation for over 76 years, CSN Mineração has vast experience in this area.

Snowden Optiro has relied on information provided by CSN Mineração pertaining to mineral processing, infrastructure, environmental studies, management plans, permits, compliance documentation and monitoring reports that were verified prior to their inclusion in this technical report summary.

The qualified persons have taken all reasonable steps, in their professional opinion, to ensure that the above information provided by CSN Mineração is accurate and complete, unless otherwise disclosed in this technical report summary.

Except for the purposes legislated under provincial securities laws, any use of this report by any third party is at that party's sole risk.

27 DATE AND SIGNATURE PAGE

This report titled "Technical Report Summary– S-K 1300 Casa de Pedra mining complex mineral resources and mineral reserves", Located at Congonhas do Campo, MG, Brazil, with an effective date of 31 December 2021 was prepared and signed by:

(Signed) Snowden Optiro

Dated at Belo Horizonte, MG, Brazil

25 November 2022, Snowden Optiro