Morro Agudo Project
Minas Gerais State, Brazil
NI 43-101 Technical Report on Preliminary Economic Assessment

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Prepared for:
V.M. Holding S.A.

Report Effective Date:
25 July, 2017

Project Number:
Lima P00072

CERTIFICATE OF QUALIFIED PERSON

I, William (Bill) Bagnell, P.Eng., am employed as Manager Mining with Amec Foster Wheeler Americas Limited (Amec Foster Wheeler).

This certificate applies to the technical report titled “Morro Agudo Project, Minas Gerais State, Brazil, NI 43-101 Technical Report on Preliminary Economic Assessment” that has an effective date of 25 July, 2017 (the “technical report”).

I am a Professional Engineer in the Provinces of Manitoba and Saskatchewan (#35339, and #12147 respectively). I graduated from the Technical University of Nova Scotia in 1996 with a Bachelor of Engineering, Mining Discipline.

I have practiced continuously in my profession for 21 years. I have been directly involved in pre-feasibility and feasibility level studies for underground projects in uranium, gold, potash and diamonds. I have been involved with mine operations in coal, potash, gold, and base metals.

As a result of my experience and qualifications, I am a Qualified Person as defined in National Instrument 43–101 *Standards of Disclosure for Mineral Projects* (NI 43–101).

I visited the Morro Agudo Project from 14 to 15 December, 2016.

I am responsible for Sections 1.1, 1.3, 1.13, 1.15, 1.18, 1.19, 1.23 to 1.25; Sections 2.3 to 2.6; Section 3; Section 15; Sections 16.1, 16.2.1, 16.2.3 to 16.8; Sections 18.1 to 18.4, 18.7 to 18.12; Section 19.2, Sections 21.1, 21.2.1, 21.2.2, 21.2.4, 21.2.5, 21.2.6, 21.3.1, 21.3.2, 21.3.4, 21.3.5; Section 21.4, Section 24.2.3, 24.2.5; Sections 25.7, 25.9, 25.13 to 25.15; Sections 26.1, 26.2.2, 26.3.2; and Section 27 of the technical report.

I am independent of V.M. Holdings S.A. as independence is described by Section 1.5 of NI 43–101.

I have had no previous involvement with the Morro Agudo Project.

I have read NI 43–101 and the sections of the technical report for which I am responsible have been prepared in compliance with that Instrument.

As of the effective date of the technical report, to the best of my knowledge, information and belief, the sections of the technical report for which I am responsible contain all scientific and technical information that is required to be disclosed to make those sections of the technical report not misleading.

Dated: 19 September, 2017

“Signed and sealed”

Bill Bagnell, P.Eng.

CERTIFICATE OF QUALIFIED PERSON

I, Dr. Ted Eggleston, RM SME, am employed as a Principal Geologist with AMEC E&C Services Inc. (Amec Foster Wheeler).

This certificate applies to the technical report titled "Morro Agudo Project, Minas Gerais State, Brazil, NI 43-101 Technical Report on Preliminary Economic Assessment" that has an effective date of 25 July, 2017 (the "technical report").

I am a Registered Member of the Society for Mining, Metallurgy and Exploration (#4115851RM) and licensed as a Professional Geologist in the States of Wyoming (PG-1830) and Georgia (PG002016). I graduated from Western State University of Colorado with a BA degree in 1976 and from the New Mexico Institute of Mining and Technology with MSc and PhD degrees in Geology in 1982 and 1987 respectively.

I have practiced my profession for 40 years during which time I have been involved in the exploration for, and estimation of, mineral resources and mineral reserves, for various mineral exploration projects and operating mines. I have explored for, provided technical assistance for, or audited lead, zinc, silver and copper deposits including Arctic Camp (Alaska), Red Dog (Alaska), Touro (Spain), and Kidd Creek (Canada). I conducted regional exploration in Alaska, Arizona, Utah, Colorado, Wyoming, and Canada.

As a result of my experience and qualifications, I am a Qualified Person as defined in National Instrument 43–101 *Standards of Disclosure for Mineral Projects* (NI 43–101).

I visited the Morro Agudo Project from 20 to 24 May, 2017.

I am responsible for Sections 1.1, 1.3 to 1.9, 1.23 to 1.25; Section 2; Section 3; Section 4; Section 5; Section 6; Section 7; Section 8; Section 9; Section 10; Section 11; Section 12; Section 23; Section 24.2.1; Sections 25.1 to 25.4, 25.15; Sections 26.1, 26.2.1; and Section 27 of the technical report.

I am independent of V.M. Holdings S.A. as independence is described by Section 1.5 of NI 43–101.

I have had no previous involvement with the Morro Agudo Project.

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Dated: 19 September 2017

“Signed and stamped”

Ted Eggleston, RM SME

CERTIFICATE OF QUALIFIED PERSON

I, Douglas Reid, P.Eng., am employed as a Principal Geologist with Amec Foster Wheeler E&C Services Inc. (Amec Foster Wheeler).

This certificate applies to the technical report titled "Morro Agudo Project, Minas Gerais State, Brazil, NI 43-101 Technical Report on Preliminary Economic Assessment" that has an effective date of 25 July, 2017 (the "technical report").

I am a P.Eng. registered with the Association of Professional Engineers and Geoscientists of British Columbia (#23347). I graduated with a Bachelor of Science in Geological (Geophysics) Engineering from the University of Saskatchewan in 1986.

I have practiced my profession for 30 years. I have been directly involved in the development and reviewing resource models and mineral resource estimation for mineral projects in North America and Africa since 1994.

As a result of my experience and qualifications, I am a Qualified Person as defined in National Instrument 43–101 *Standards of Disclosure for Mineral Projects* (NI 43–101).

I visited the Morro Agudo Project from 20 to 24 May, 2017.

I am responsible for Sections 1.11, 1.12, 1.22 to 1.25; Sections 2.3 to 2.6; Section 3; Section 14; Sections 24.1, 24.2.2; Sections 25.6, 25.15; Section 26.3.1 and Section 27 of the technical report.

I am independent of V.M. Holdings S.A. as independence is described by Section 1.5 of NI 43–101.

I have had no previous involvement with the Morro Agudo Project.

I have read NI 43–101 and the sections of the technical report for which I am responsible have been prepared in compliance with that Instrument.

As of the effective date of the technical report, to the best of my knowledge, information and belief, the sections of the technical report for which I am responsible contain all scientific and technical information that is required to be disclosed to make those sections of the technical report not misleading.

Dated: 19 September, 2017

"Signed and sealed"

Douglas Reid, P.Eng.

CERTIFICATE OF QUALIFIED PERSON

I, Hendrik Cornelis Laurens (Laurie) Reemeyer, P.Eng., am employed as a Process Consultant with Amec Foster Wheeler Americas Limited (Amec Foster Wheeler).

This certificate applies to the technical report titled "Morro Agudo Project, Minas Gerais State, Brazil, NI 43-101 Technical Report on Preliminary Economic Assessment" that has an effective date of 25 July, 2017 (the "technical report").

I am a Member of the Association of Professional Engineers and Geoscientists of British Columbia, (#43997), and a Fellow of the Australasian Institute of Mining and Metallurgy, (#110005). I graduated from the University of Queensland in 1993 with a Bachelor of Engineering (Minerals Process) degree, and from the University of California at Berkeley in 2010 with a Masters of Business Administration degree.

I have practiced my profession for 23 years. I have been directly involved in managing a major lead-zinc-silver concentrator at Century, Queensland, Australia, and metallurgical and financial assessment of several polymetallic mines and projects including Greens Creek, in Alaska, USA, Izok in Nunavut, Canada, and, in Australia, Rosebery in Tasmania and Dugald River in Queensland.

As a result of my experience and qualifications, I am a Qualified Person as defined in National Instrument 43–101 *Standards of Disclosure for Mineral Projects* (NI 43–101).

I have not visited the Morro Agudo Project.

I am responsible for Sections 1.2, 1.3, 1.10, 1.14, 1.15, 1.17 to 1.25; Sections 2.3, 2.6; Section 3, Section 13; Section 17; Section 18.7; Section 19, Sections 21.1, 21.2.3, 21.2.5, 21.2.6, 21.3.3, 21.3.5, 21.4; Section 22; Sections 24.1.2, 24.2.4, 24.2.5, 24.2.8; Sections 25.5, 25.8, 25.9, 25.11 to 25.15, Sections 26.3.3, 26.3.5; and Section 27 of the technical report.

I am independent of V.M. Holdings S.A. as independence is described by Section 1.5 of NI 43–101.

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As of the effective date of the technical report, to the best of my knowledge, information and belief, the sections of the technical report for which I am responsible contain all scientific and technical information that is required to be disclosed to make those sections of the technical report not misleading.

Dated: 19 September, 2017

"Signed and sealed"

Laurie Reemeyer, P.Eng.

CERTIFICATE OF QUALIFIED PERSON

I, Peter Cepuritis MAusIMM (CP), am employed as a Technical Director Geomechanics with Amec Foster Wheeler Perú S.A. (Amec Foster Wheeler).

This certificate applies to the technical report titled "Morro Agudo Project, Minas Gerais State, Brazil, NI 43-101 Technical Report on Preliminary Economic Assessment" that has an effective date of 25 July, 2017 (the "technical report").

I am a Chartered Professional (CP) and Member of The Australasian Institute of Mining and Metallurgy (MAusIMM) (#109802). I graduated from Royal Melbourne Institute of Technology with a Bachelor of Applied Science in Applied Geology (1990), a Master of Engineering Science in Mining Geomechanics (1997) and a Doctor of Philosophy in Rock Mechanics (2010) from Curtin University.

I have practiced my profession for *27* years of practical and consulting experience in geological and mining engineering since graduation and I have been directly involved in mine geotechnical engineering components of NI 43-101 and JORC reviews, due diligence, feasibility and mine design studies and reporting since 1992.

As a result of my experience and qualifications, I am a Qualified Person as defined in National Instrument 43–101 *Standards of Disclosure for Mineral Projects* (NI 43–101).

I have not visited the Morro Agudo Project.

I am responsible for Sections 2.2, 2.3, 2.6; Section 3; Section 16.2.2; Section 25.15; and Section 27 of the technical report.

I am independent of V.M. Holdings S.A. as independence is described by Section 1.5 of NI 43–101.

I have had no previous involvement with the Morro Agudo Project.

I have read NI 43–101 and the sections of the technical report for which I am responsible have been prepared in compliance with that Instrument.

As of the effective date of the technical report, to the best of my knowledge, information and belief, the sections of the technical report for which I am responsible contain all scientific and technical information that is required to be disclosed to make those sections of the technical report not misleading.

Dated: 19 September, 2017

“Signed”

Peter Cepuritis, MAusIMM (CP)

CERTIFICATE OF QUALIFIED PERSON

I, Juleen Brown, MAusIMM, (CP), am employed as a Manager, Environment with Amec Foster Wheeler Australia Pty Ltd (Amec Foster Wheeler).

This certificate applies to the technical report titled "Morro Agudo Project, Minas Gerais State, Brazil, NI 43-101 Technical Report on Preliminary Economic Assessment" dated 25 July, 2017 (the "technical report").

I am a Chartered Professional (CP) and Member of the Australasian Institute of Mining and Metallurgy (MAusIMM) (#201809). I graduated from the University of Queensland in 1999 with a Bachelor of Engineering (Mining) degree, and from the University of Queensland in 2006 with a Masters of Environmental Management degree.

I have practiced my profession for 17 years. I have been directly involved in environmental management of mining operations, environmental input and planning into feasibility studies for mining projects, environmental and social due diligence of mining operations and projects, mine closure input and reviews, and managing large multidisciplinary Environmental and Social Impact Assessments to IFC standards. My experience includes coal and metalliferous mines in Australia, Asia-Pacific, and Ecuador.

As a result of my experience and qualifications, I am a Qualified Person as defined in National Instrument 43–101 *Standards of Disclosure for Mineral Projects* (NI 43–101).

I have not visited the Morro Agudo Project.

I am responsible for Sections 1.16.1, 1.16.4 to 1.16.6, 1.23 to 1.25; Sections 2.2, 2.3, 2.6; Section 3; Sections 20.1 to 20.3, 20.8 to 20.11; Section 24.2.7; Sections 25.10.1, 25.10.3, 25.10.5, 25.10.6, 25.15; Section 26.3.4; and Section 27 of the technical report.

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As of the effective date of the technical report, to the best of my knowledge, information and belief, the sections of the technical report for which I am responsible contain all scientific and technical information that is required to be disclosed to make those sections of the technical report not misleading.

Dated: 19 September, 2017

"Signed"

Juleen Brown, MAusIMM (CP)

CERTIFICATE OF QUALIFIED PERSON

I, Bing Wang, Ph.D., P.Eng., am employed as a Senior Associate, Technical Advisor with Amec Foster Wheeler Environment & Infrastructure, a division of Amec Foster Wheeler Americas Limited (Amec Foster Wheeler).

This certificate applies to the technical report titled "Morro Agudo Project, Minas Gerais State, Brazil, NI 43-101 Technical Report on Preliminary Economic Assessment" that has an effective date of 25 July, 2017 (the "technical report").

I am a member of Professional Engineers Ontario (Licence No.: 90293754). I graduated from McGill University, Montreal, Canada, with Master of Engineering and Doctor of Philosophy degrees in 1984 and 1990, respectively.

I have practiced my profession for 30 years since graduation. I have been directly involved in field of geo-environmental engineering with site investigations, scoping, prefeasibility and feasibility studies, detailed design and construction for tailings and water management facilities, including geotechnical assessments and implementations for mining projects in Canada and worldwide.

As a result of my experience and qualifications, I am a Qualified Person as defined in National Instrument 43–101 *Standards of Disclosure for Mineral Projects* (NI 43–101).

I have not visited the Morro Agudo Project.

I am responsible for Sections 1.15, 1.16.2, 1.16.3; Sections 2.3, 2.6; Section 3; Sections 18.5, 18.6; Sections 20.6, 20.7, 20.11; Section 24.2.6; Sections 25.10.2, 25.10.4, 25.15; and Section 27 of the technical report.

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As of the effective date of the technical report, to the best of my knowledge, information and belief, the sections of the technical report for which I am responsible contain all scientific and technical information that is required to be disclosed to make those sections of the technical report not misleading.

Dated: 19 September, 2017

"Signed and sealed"

Dr Bing Wang, P.Eng.

IMPORTANT NOTICE

This report was prepared as National Instrument 43-101 Technical Report for V.M. Holding S.A. (Votorantim) by Amec Foster Wheeler Perú S.A. (Amec Foster Wheeler). The quality of information, conclusions, and estimates contained herein is consistent with the level of effort involved in Amec Foster Wheeler's services, based on i) information available at the time of preparation, ii) data supplied by outside sources, and iii) the assumptions, conditions, and qualifications set forth in this report. This report is intended for use by Votorantim subject to terms and conditions of its contract with Amec Foster Wheeler. Except for the purposed legislated under Canadian provincial and territorial securities law, any other uses of this report by any third party is at that party's sole risk.

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1.0 SUMMARY

1.1 Introduction

V.M. Holding S.A. (Votorantim) requested that Amec Foster Wheeler Perú S.A. (Amec Foster Wheeler) prepare an independent technical report (the Report) on a Preliminary Economic Assessment (PEA) in compliance with the requirements of National Instrument 43-101 Standards of Disclosure for Mineral Projects (NI 43-101) and Form 43–101F1 Technical Report for Votorantim on the Morro Agudo Project (Morro Agudo Project or the Project), located in Minas Gerais State in Brazil.

The Morro Agudo Project comprises the Morro Agudo Mine, and three deposits along what is known as the Ambrosia Trend (Ambrosia Sul, Ambrosia Norte, and Bonsucesso). The Morro Agudo Mine commenced operations in 1988, and is nearing the end of its mine life. The Ambrosia Sul deposit is being developed as an open pit operation, with first production occurring in June, 2017.

The corporate entity that conducts the mining operations is Votorantim Metais Zinco SA, an indirectly wholly-owned subsidiary of Votorantim. For the purposes of this Report, unless otherwise noted, Votorantim and Votorantim Metais Zinco SA will be referred to interchangeably as Votorantim.

1.2 Principal Outcomes

The principal outcomes from the PEA economic analysis are provided in Table 1-1.

Table 1-1: Principal Outcomes

Mine life (date from–to)	2018–2028	
Net revenue (US$ million over life-of-mine)	Zinc concentrate	528
	Lead concentrate	29
	Limestone	31
Capital cost (US$ million over life-of-mine)	82	
Operating cost (average US$/t over life-of-mine)	Mining	19.52
	Process	16.54
	General and administrative	2.64
	Total	38.70
NPV@9% (US$ million)	63	

Note: The mine plan is partly based on Inferred Mineral Resources that are considered too speculative geologically to have the economic considerations applied to them that would enable them to be categorized as Mineral Reserves, and there is no certainty that the PEA based on these Mineral Resources will be realized. Calendar years used are for illustrative purposes.

1.3 Terms of Reference

The Report was prepared to support scientific and technical disclosure on the Morro Agudo Project in the initial public offering by V.M. Holding S.A.

There are limitations on the supporting information in applying modifying factors to the Mineral Resources to convert to Mineral Reserves, and thus, the mine plan does not meet pre-feasibility study requirements in all aspects. In addition, a significant proportion of the planned mill feed is classified as Inferred. As a result, the Report is presented as a PEA.

1.4 Project Setting

The Morro Agudo Mine site is situated on Traíras Farm, about 45 km south of the municipality of Paracatu. The mine access from Paracatu is via the sealed BR-040 highway, to highway marker km 68, a distance of about 29 km, then 16 km via unsealed roads to the mine itself. The Ambrosia Trend deposits are situated about 15–20 km northeast of Paracatu. Access is via MG-188 to the village of Santo Antônio, and thence via unsealed road to Rancho Alegre or Ambrosia Farm.

1.5 Mineral Tenure, Surface Rights, Water Rights, Royalties, and Agreements

Amec Foster Wheeler was provided with legal opinion that supports that Project ownership is in the name of Votorantim Metais Zinco S.A.

The total Project area is about 80 km long, and 10 km wide at the widest extent, and covers a significant strike extent of the lithologies that host mineralization at the Morro Agudo Mine and along the Ambrosia Trend.

For the purposes of this Report, the mineral concessions have been divided into the core tenements, where the known mineral deposits are located and mining operations are occurring, and the surrounding exploration concessions.

Votorantim holds two granted mining concessions in the Morro Agudo Mine area, totalling about 828 ha and has a mining concession application for an additional approximately 619 ha. In the Ambrosia Trend area, Votorantim has one granted mining concession (about 999 ha), and two exploration permits (around 1,583 ha). The total area held under granted mining concessions, mining concession applications and exploration permits in the core tenures is about 4,028 ha.

Votorantim also holds four exploration applications (about 2,201 ha), 15 exploration authorizations (13,340 ha), three mining concession applications (2,167 ha) and a granted mining concession (1,000 ha) that surround the core tenements. These total approximately 18,708 ha in addition to the core tenements.

Votorantim holds, or has acquired through negotiation, surface rights sufficient to support the current operations. Some surface rights agreements require payments to the owners. Three easements have been granted in support of mining activities. There are no indigenous group stakeholders that may be affected by the Morro Agudo Project. Where access is required for regional exploration or drilling programs, negotiations are typically conducted on an individual basis with the affected landowner. If required, judicial action can be invoked to allow surface access.

Votorantim holds two water licences for water usage. Votorantim confirmed that renewal applications have been lodged for these.

1.6 History

Exploration activities conducted to date have included geological mapping, rock chip, pan concentrate, stream sediment, and soil sampling, airborne and ground geophysical surveys, and drilling.

Modern underground mining commenced in 1988 from the Morro Agudo Mine. The Ambrosia Norte deposit was discovered in 1973, Ambrosia Sul in 2011, and Bonsucesso in 2014. Mining of the Ambrosia Sul deposit commenced in 2017.

1.7 Geology and Mineralization

The Morro Agudo and Ambrosia Trend deposits are classified as examples of Irish-style sedimentary hosted deposits.

Mineralization is hosted within a sequence of pelitic carbonate rocks belonging to the Morro do Calcário Formation that is part of the regional Vazante Group.

The combined length of the known mineralized bodies at the Morro Agudo Mine is approximately 1,700 m, the width is about 1,200 m, and the bodies have a variable thickness with a maximum of about 10 m. Mineralization is bounded to the northwest by the Main Fault. The western limit has not yet been defined, but drilling has shown continuity of mineralization at depth. The mineralized bodies are separated from each other by waste intervals of stratified dolarenites at upper and intermediate levels, and by waste breccias at lower levels. Sulphide levels occur as concordant stratabound lenses in dolarenite, and subordinately in dolomitic and dolarenitic breccias, in addition to occurring as late tectonic structure fill (faults/fractures). These sulphide lenses are, at most, 4 m thick, separated by intervals that range from a few centimeters to several metres, depending on the lithology where they are deposited.

Stratigraphic mineralization continuity, despite the faults dividing the deposit in blocks, has allowed mine geologists to identify eight mineralized strata, denominated from G to N, from the base to the top, respectively. Sulphide mineralization can be present in the form of irregular veins of coarse sphalerite and galena, discontinuous and/or sparsely disseminated pockets of galena and coarse sphalerite, and as fine-grained sphalerite, galena, and pyrite forming clast cement and void fill.

The Ambrosia Trend deposits (Ambrosia Sul, Ambrosia Norte and Bonsucesso deposits) occur in the pelite–carbonate rocks of the Vazante Group in a similar stratigraphic position to the Morro Agudo Mine. Mineralization is predominantly vein-like, and is associated with brecciated dolomites that were tectonically interleaved in metasedimentary rocks along the Ambrosia Fault zone. In most cases, there is a single mineralized structure, but occasionally, two or more mineralized structures are present. At Ambrosia Sul, mineralization is controlled by hydrothermal breccias in a flower morphology.

Both oxide and sulphide mineralization have developed. Oxide mineralization is primarily in the form of smithsonite and cerussite. Sulphide mineralization is primarily sphalerite and galena.

The geological setting and understanding of the mineralization setting are adequately known to support Mineral Resource estimation and mine planning.

Exploration potential remains in a number of areas, including strike extensions along the Ambrosia Trend, the Fagundes deposit, and the Poções, Sucuri, Bento Carmelo, and Lapa Azul targets.

1.8 Drilling and Sampling

Core drilling using diamond tipped tools has been the primary exploration tool.

In total, there are 11,091 holes (276,228.77 m) completed outside the Morro Agudo Mine, including the drilling along the Ambrosia Trend. Drilling is primarily located within lithologies of the Morro do Calcário Formation, the most prospective mineralization host.

A total of 3,670 holes (493,757.31 m) have been drilled at the Morro Agudo Mine from 1974 to the end of 2016. In total, 584 core holes (96,296 m) have been completed at Ambrosia Sul, Ambrosia Norte and Bonsucesso between 1973 and 8 March, 2017.

Exploration and production drilling operations have been performed by company personnel over the Project history, using a variety of drilling machines. Core sizes have included NQ (75 mm), HQ (65 mm) and BQ (36 mm) core diameters.

Geological logs have been completed on all core holes. Geotechnical and descriptions are also completed and stored in the geological database. All core is currently photographed. Core recoveries are generally good.

Collar locations in the database were determined using total station instruments, with a very few drill holes picked up using a global positioning system (GPS) instrument. Where known, instruments used to collect downhole survey data have included

Tropari™, REFLEX Gyro™, Maxibor™, and Devitool Peewee™. Drill holes completed in the 1970s and 1980s typically do not have downhole surveys.

In some cases, drill intercepts, and thus sample lengths, are perpendicular to the mineralized bodies and the sample length will be equal to the true thickness. In most cases, however, the true thickness is less than the sample thickness because the drill holes intersect the mineralized bodies at oblique angles.

Samples typically respect lithological intervals with a minimum length of 0.50 m and maximum length of 1.50 m. Typically, 3 m of not-obviously mineralized hanging wall and footwall (6 m total) are sampled on either side of a mineralized interval to confirm the non-mineralized intervals, which was qualitatively defined by the logging.

Sample collection and core handling are in accordance with industry standard practices. Procedures to limit potential sample losses and sampling biases are in place. Sample intervals are consistent with the type of mineralization.

Sample preparation and analysis for mine and exploration samples from Morro Agudo were performed at the Morro Agudo mine laboratory from as early as 1987. That laboratory is not independent, and has not been accredited. Beginning in late 2015, ALS Global was chosen as the primary laboratory. The ALS Global laboratory is independent and is ISO 9001 and 17025 accredited.

Sample preparation procedures at the mine laboratory consisted of drying, crushing to 100% passing <6 mm, and pulverising to <100 mesh. The analytical methods used by the Morro Agudo mine laboratory were X-ray fluorescence (XRF) and atomic absorption (AA). Sample preparation at ALS Global is drying, crushing to 70% passing a 2-mm screen, secondary crushing and pulverizing to 85% passing a 75 µm screen. The analytical technique is AA following a four-acid digestion (AA62). Sample analysis at the mine laboratory and ALS Global is performed using standard procedures that are widely used in the industry. In both cases, analytical procedures are adequate to support Mineral Resource estimation and mine planning.

The QA/QC methodology uses standards, field duplicates, pulp duplicates, coarse rejects, blanks, and external check assays. QA/QC procedures were implemented in 2011 at the Morro Agudo Mine, and have improved over time. Evaluation of QA/QC data at the Morro Agudo Mine indicates that the analytical data, since 2011, are sufficiently precise and accurate to support Mineral Resource estimation and mine planning. A re-assay program designed to verify the quality of pre-2011 data was initiated in early 2017. Preliminary results suggest that those data are indeed adequate to support Mineral Resource estimation. QA/QC measures for the deposits on the Ambrosia Trend began in about 2008. Evaluation of the Ambrosia Trend QA/QC data indicate that the analytical data are adequately precise and accurate to support Mineral Resource estimation and mine planning.

Density determinations were completed using water displacement and immersion procedures. Both procedures are widely used in the mining industry. The data are reasonable and adequate to support Mineral Resource estimation and mine planning.

At this time, GeoEXPLO™ is the system used to manage the database but Datamine's Fusion™ system is being implemented across the company as an enterprise data management system.

Sample security consists largely of storing core and samples in locked facilities and use of chain of custody forms to track core and sample movement. This is acceptable for high-grade zinc deposits.

1.9 Data Verification

Management of the Morro Agudo Mine and Ambrosia Trend databases follows a standard procedure used for all Votorantim Metais databases. Prior to extracting data for Mineral Resource estimation, internal checks are made to assure that the right information is used in the Mineral Resource estimate. These data are also checked when data are entered into the database. When inconsistencies are discovered, corrective action is required and includes participation by the mine team and the database manager.

Three audits have been performed by independent third-parties on the Mineral Resource estimates, including Snowden Mining Industry Consultants (Snowden) on Ambrosia Norte (2012) and Ambrosia Sul (2014), and a gap analysis study performed by Amec Foster Wheeler in 2016 on the Morro Agudo Mine.

As part of the 2017 QP site visit, high-level reviews of the database and procedures were performed. These included reviews of sampling procedures, geological logging procedures, core drilling and core handling procedures, and QA/QC procedures.

Data from the Morro Agudo Mine and the Ambrosia Trend deposits have undergone significant scrutiny since 2012. The QP considers the type and amount of data validation to be consistent with modern programs and is of the opinion that the data accurately reflect the original geological logging, data locations, and assay values and that the data will support Mineral Resource estimation and mine planning.

1.10 Metallurgical Testwork

All mineralized material will be processed in the existing Morro Agudo concentrator, which has a conventional flowsheet incorporating crushing, grinding and sequential lead and zinc flotation. Metallurgical parameters are derived from a combination of plant operating history, mineralogy, laboratory, and pilot scale flotation testwork and assumptions.

Metallurgical testwork completed to date has included: mineralogy, grinding calibration tests; laboratory flotation tests; pilot plant testwork.

The Morro Agudo Mine and Ambrosia Sul mineralization contain a simple mineralogical assemblage and responded well to a simple and conventional flowsheet and reagent suite. No metallurgical testwork results are currently available for Ambrosia Norte and Bonsucesso. While it is plausible to believe that metallurgical performance will be similar to that from the Morro Agudo Mine and Ambrosia Sul, this can only be confirmed once testwork is completed. The first round of Bonsucesso testwork should be completed by about October 2017.

Separate zinc and lead recoveries were assigned to Morro Agudo, Ambrosia Sul and Ambrosia Norte/Bonsucesso mineralization. These are based on a combination of historical plant recoveries, metallurgical testwork and assumptions

Zinc recoveries of approximately 90% are achievable from Morro Agudo Mine and Ambrosia Sul mineralized material containing around 3% Zn. However, insufficient reagent additions or coarse grinds could cause significant deteriorations in zinc recovery. There is potential to significantly increase zinc concentrate grade from the 38% zinc grade target adopted in 2016, if customer requirements favour this. Lead recoveries are more sensitive to head grade and are more variable. Lead recovery is expected to fall at Ambrosia Sul, Ambrosia Norte and Bonsucesso due to lower lead grades.

The Morro Agudo plant produces clean, low-iron, zinc concentrates. The main impurity in zinc concentrate is dolomite, which contains CaO and MgO. There are no other known deleterious elements in zinc concentrate. There are no known deleterious elements in the lead concentrate, and no penalties are applied by customers.

1.11 Mineral Resource Estimation

Mineral Resources have been estimated by Votorantim staff for the Morro Agudo Mine, and, along the Ambrosia Trend, for the Ambrosia Sul, Ambrosia Norte, and Bonsucesso deposits.

Deposits were modelled and estimated using Datamine Studio 3 and Leapfrog Geo software. Databases supporting the estimate comprise:

- Morro Agudo Mine database: 114,591 samples from 3,277 drill holes representing a total of 359,777 m of drilling; close-out date 1 November, 2016
- Ambrosia Sul database: 14,539 samples in 197 drill holes, with approximately 22,000 m of drilling; close-out date of 22 June, 2015

- Ambrosia Norte database: 5,550 samples from 223 drill holes representing 31,841 m of drilling; close-out date of April 14, 2016
- Bonsucesso database: 8,496 samples in 124 drill holes, representing approximately 36,867 m of drilling; close-out date of 25 April, 2017.

Lithological models were initially constructed using a simplified geological sequence. Where required, by deposit, the following were also developed:

- Morro Agudo Mine: the modelled units were offset by the main faults. Three mineralized models or grade shells were constructed, of which only the Mid (0.02% to 2.3% Zn+Pb) and High (>2.3% Zn+Pb) models were considered during resource estimation. The Mid and High mineralized domains were combined with the lithological domains to create the overall geological model
- Ambrosia Sul: mineralized envelopes were created based on a Zn+Pb cut-off grade of 1%, in addition to the lithology model, and were grouped into three structural domains
- Ambrosia Norte: the mineralized domain was modeled inside the breccia based on a cut-off grade of 2.5% Zn+Pb. A total of eight veins were constructed
- Bonsucesso: grade envelopes were developed based on a cut-off grade of 1% Zn+Pb, and included a waste zone, and a 3 m buffer zone around the mineralization.

Composites were typically generated on 1 m intervals. Exploratory data analysis was performed. No grade capping was used for the Morro Agudo Mine, Ambrosia Sul, or Ambrosia Norte deposits, but was used for Bonsucesso. Density values were assigned to block models based on mineralization type and lithology.

Variograms were generated for zinc, lead, and density, after separating the Morro Agudo deposit into three structural blocks. Separate correlograms were created for zinc and lead based on the structural domains at Ambrosia Sul. Due to the wide drill spacing of the sulphide composites, it was not possible to generate reliable variograms for Ambrosia Norte. Variography was conducted for zinc, lead, and density separately within mineralized and buffer domains at Bonsucesso.

Estimation parameters included:

- Morro Agudo Mine: Ordinary kriging (OK) estimations were performed for zinc, lead, and density. The dimensions of the search ellipsoid were based on the zinc variogram ranges. The estimation was completed using three expanding searches. Separate estimations were completed for the Mid and High domains within each of the three structural blocks.

- Ambrosia Sul: OK was used to estimate zinc, lead, and density into the block model. A local neighborhood study (QKNA) was used to determine parameters used to select samples for grade estimation, such as number of samples used in the estimate; use of octant division and minimum samples from the same drill hole
- Ambrosia Norte: Estimation for zinc, lead, and density was performed using inverse distance weighting to the second power (ID2) with expanding search ellipses
- Bonsucesso: OK was used to estimate zinc, lead, and density into the block model.

Nearest-neighbour (NN) models were constructed as check models. Data verification included global bias checks, change of support checks, local bias checks and visual inspection. The estimated models generally compared well to the composite data.

Mineral Resource classification considerations included:

- Morro Agudo Mine: Only the blocks within the High domain are included in the Mineral Resources; "Balanced Scorecard" approach using four inputs (distance from block centroid to nearest sample; number of samples used to estimate a block; search volume or search pass; kriging variance); areas estimated with less than three drill holes intercepting the wireframes were downgraded to Inferred
- Ambrosia Sul: The quality of the supporting data, estimation variance and continuity of mineralization were considered to arrive at the confidence classifications
- Ambrosia Norte: the drill hole spacing is 100 m and the boundaries of the deposit were not extrapolated more than 50 m beyond the last drill hole; all sulphide material was classified as Inferred
- Bonsucesso: based on the drill spacing and on the overall range indicated by the variogram model, which was 60 m

Reasonable prospects of eventual economic extraction for the mineral deposits were determined using the following key assumptions:

- Morro Agudo Mine: NSR cut-off of US$44.96/t (underground mining); zinc price of US$2,767.00/t (US$1.26/lb), lead price is US$2,235/t (US$1.01/lb); zinc metallurgical recovery of 91%, lead metallurgical recovery of 83%; mining cost of US$11.31/t, plant cost of US$11.88/t, maintenance and other costs of US$21.77/t
- Ambrosia Sul: NSR cut-off of US$32.13/t (open pit mining), US$46.73/t (underground mining); zinc price of US$2,767/t (US$1.26/lb), lead price of US$2,235/t (US$1.01/lb); zinc metallurgical recovery of 91%, lead metallurgical recovery of 40%; assumed open pit mining cost of US$5.95/t, underground mining

cost of US$15.87/t, plant cost of US$11.88/t, open pit maintenance and other costs of US$14.30/t, underground maintenance and other costs of US$18.98/t

- Ambrosia Norte: NSR cut-off of US$46.73/t (underground mining); zinc price of US$2,767.00/t (US$1.26/lb), lead price is US$2,235/t (US$1.01/lb); zinc metallurgical recovery of 91%, lead metallurgical recovery of 70%; mining cost of US$15.87/t, plant cost of US$11.88/t, maintenance and other costs of US$18.98/t
- Bonsucesso: NSR cut-off of US$46.73/t (underground mining); zinc price of US$2,767.00/t (US$1.26/lb), lead price is US$2,235/t (US$1.01/lb); zinc metallurgical recovery of 91%, lead metallurgical recovery of 70%; mining cost of US$15.87/t, plant cost of US$11.88/t, maintenance and other costs of US$18.98/t.

The NSR calculations include an allocation in US$/t for the zinc premium that is paid by the Tres Marias smelter, which is the average of the 2017–2026 assumed payable premiums. The average value is US$234.72/t.

In the Morro Agudo Mine, there are remnant pillar materials in areas of former mining. A portion of these pillars retain mineralization that may be able to be recovered where geotechnical conditions permit. The Morro Agudo Mine undertook a pillar-recovery test mining program in February–July, 2016, again from October 2016–March 2017 on pillars on the 216 Level. During these programs a total of 39,600 t of pillar material, with an average grade of 2.47% Zn, and 0.90% Pb was recovered. Votorantim provided Amec Foster Wheeler with supporting data that included a list of all mineralized pillars, which were listed by level. Each pillar had been assigned a specific height, area, volume, and mass, using an approximated average SG of 2.73, and zinc and lead grade estimates. Mineralization was assumed to have similar recoveries to those used for the Morro Agudo Mine estimate.

Amec Foster Wheeler reviewed the available information, and concurred that there were reasonable prospects for eventual economic extraction for the list of mineralized pillars considered amenable to mining because all development is in place, the test mining shows that a portion of material can be safely extracted, and that the average pillar grades from the test mining to date are marginally higher, indicating a degree of conservatism in the pillar estimates.

The mineralized pillars considered potentially amenable to recovery mining were classified as Inferred Mineral Resources.

1.12 Mineral Resource Statement

The Mineral Resources were initially classified using the 2012 Joint Ore Reserves Committee (JORC) Code, and reconciled to the 2014 Canadian Institute of Mining, Metallurgy and Petroleum (CIM) Definition Standards for Mineral Resources and Mineral Reserves (the 2014 CIM Definition Standards). Mineral Resource statements have variable effective dates. The Qualified Person for the estimates is Mr Douglas Reid, RM SME, an Amec Foster Wheeler employee.

A combined Mineral Resource statement is presented on a Project basis in Table 1-2.

Factors that may affect the Mineral Resource estimates for the mineral deposits include: additional infill and step out drilling; changes in local interpretations of mineralization geometry and continuity of mineralization zones; density and domain assignments; changes to design parameter assumptions that pertain to stope design; dilution from internal and contact sources; changes to geotechnical, hydrogeological, and metallurgical recovery assumptions; and changes to the assumptions used to generate the NSR value including long-term commodity prices and exchange rates.

Factors that may affect the Mineral Resource estimates for the potentially recoverable pillar materials include: ability to safely enter the mined-out portions of the Remaining Area; geotechnical assumptions; assumptions as to the pillar dimensions that can be extracted; assumptions as mineralization grade; and assumptions as to metallurgical recovery.

1.13 Mining Methods

A mine plan at PEA level has been developed for the Morro Agudo Project that uses a subset of the Mineral Resource estimate. The mine plan is partly based on Inferred Mineral Resources that are considered too speculative geologically to have the economic considerations applied to them that would enable them to be categorized as Mineral Reserves, and there is no certainty that the PEA based on these Mineral Resources will be realized.

The PEA is based on mill feed material to be sourced from the operating underground Morro Agudo Mine, the newly-developed open pit Ambrosia Sul Mine, and the Ambrosia Norte and Bonsucesso deposits that are assumed to be mined using underground mining methods.

1.13.1 Morro Agudo Mine

The primary extraction method at the Morro Agudo Mine is inclined room-and-pillar. The mineralized zones are accessed via a ramp system that is developed in the hanging wall of the deposit. Cross-cuts are then developed into the deposit to access the mineralized material. The ore drives are developed along the strike of the deposit, and stubs are developed to establish pillars and extract the mill feed material. Backfill is in limited use at the Morro Agudo Mine and is specified on an operational basis depending upon the deposit geometry.

Table 1-2: Combined Mineral Resource Statement, Morro Agudo Project

	Deposit	Tonnage (Mt)	Zn Grade (%)	Pb Grade (%)
Measured	Ambrosia Sul	0.56	6.83	0.23
Indicated	Morro Agudo	3.92	4.01	1.45
	Ambrosia Sul	0.27	6.65	0.32
	Bonsucesso	2.02	4.15	0.59
	Ambrosia Norte	0.00	0.00	0.00
Total Measured + Indicated		6.77	4.39	1.05
Inferred	Morro Agudo	1.30	4.01	1.13
	Ambrosia Sul	1.32	4.08	0.10
	Bonsucesso	6.47	3.66	0.51
	Ambrosia Norte	2.16	3.85	0.50
	Recoverable Pillars	0.84	2.0	0.5
Total Inferred		12.09	3.66	0.53

Notes to accompany Mineral Resource table for the Morro Agudo Project:

1. Mineral Resources have varying effective dates: Morro Agudo Mine, 31 December, 2016; recoverable pillars, 23 November, 2016; Ambrosia Sul, 24 October, 2016; Bonsucesso, 5 May, 2017; Ambrosia Norte, 14 April, 2016.
2. Douglas Reid, P.Eng., an Amec Foster Wheeler employee, is the Qualified Person responsible for the Mineral Resource estimates.
3. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.
4. Mineral Resources other than the pillar material are reported using the following assumptions: Morro Agudo Mine within a 2.3% Zn+Pb envelope using a net smelter return (NSR) cut-off of $44.96/t; Ambrosia Sul within a 1% Zn+Pb envelope using a NSR cut-off of $32.13/t within a pit shell for mineralization amenable to open pit mining methods, and within a 1% Zn+Pb envelope using a NSR cut-off of $46.73/t for mineralization outside the pit shell and amenable to underground mining methods; Bonsucesso, within a 1% Zn+Pb envelope using a NSR cut-off of $46.73/t; Ambrosia Norte, within a 2.5% Zn+Pb envelope using a NSR cut-off of $46.73/t.
5. Mineral Resources within remnant mining pillars are tabulated by level, and have been had been assigned a specific height, area, volume, and mass, using an approximated average SG of 2.73. Grades were assigned based on the results on a trial mining program that ran from February–July 2016, and October 2016 to March 2017 on material from the 216 Level of the mine. Development is in place in all areas of planned pillar recovery. Certain assumptions are based on the Morro Agudo Mine Mineral Resource estimate. Zinc price used is US$2,767/t (US$1.26/lb), lead price is US$2,235/t (US$1.01/lb). Zinc metallurgical recovery is 91%, lead metallurgical recovery is 83%. Development is in place in all areas of planned pillar recovery; plant cost of US$11.88/t, maintenance and other costs of US$21.77/t.
6. For all estimates, zinc price used is US$2,767/t (US$1.26/lb), lead price is US$2,235/t (US$1.01/lb). Zinc metallurgical recovery is 91%; lead metallurgical recovery for the Morro Agudo Mine and recoverable pillars is 83%, lead recovery for Ambrosia Sul is 40%, and lead recovery for Bonsucesso is 70%. The NSR calculations include an allocation of US$234.72/t for the zinc premium paid by the Tres Marias smelter.
7. Reported Mineral Resources contain allowances for internal dilution. Mineral Resources are reported on a 100% basis.
8. Zinc and lead grade measurements are reported as percent, tonnage measurements are in metric units.
9. Rounding as required by reporting guidelines may result in apparent summation differences.

The Morro Agudo Mine is a mature operation, and staff have a well-developed understanding of the hydrogeology, geology, and mining methods required to safely extract the mineralization. Development and access profiles take advantage of the known hanging wall structural characteristics to minimise ground support requirements. Water inflows into the Morro Agudo Mine are not a major source of water volume to the mine.

The Morro Agudo Mine ventilation infrastructure is essentially at the full extent of development and is not currently planned to have significant expansion going forward.

The primary mine access for material and personnel is a ramp via the portal. A shaft is used primarily for hoisting mill feed and waste material and can be used as an emergency egress if necessary. Electrical power supply is in place underground.

Grade control is accomplished using the block model, stope grades developed by the short-range planners, face calls, and production sampling.

The forecast production rate is 1,100 t/d on average.

1.13.2 Ambrosia Norte and Bonsucesso

Assumptions presented the Ambrosia Sul and Bonsucesso deposits are based on direct analogues with, and factoring from, the Morro Agudo Mine, or Votorantim's Vazante Operations.

The proposed mine plan envisages a bulk mining operation with two mining methods: vertical retreat mining (VRM), and sub-level open stoping (SLOS). Uncemented waste rock backfill will be employed to fill the VRM stopes to provide hanging wall support to reduce mining dilution. The backfill will also provide a mucking floor for the SLOS stopes during mining. By analogy with the Morro Agudo Mine, there is assumed to be negligible water inflows.

The proposed Ambrosia Norte/Bonsucesso underground mines will be accessed through a portal and ramp developed from surface. Mine levels will be developed at nominal 30 m intervals to support the stoping extraction.

Underground distribution of the fresh air will be through a series of raises from surface and exhaust air will be returned to surface through the haulage ramp system.

It is assumed that the current 13.8 kV power supply to the Ambrosia Sul operations will be extended to support development at Ambrosia Norte and Bonsucesso. Bonsucesso will require an extension of the distribution network and an electrical substation.

The forecast production rate from Ambrosia Norte is 350 t/d on average, and from Bonsucesso is 1,750 t/d pm average.

1.13.3 Ambrosia Sul

The Ambrosia Sul open pit is approximately 35 km north of the Morro Agudo plant site. Production and waste rock from the Ambrosia Sul open pit is mined using contract mining equipment operated by Votorantim employees. Truck haulage to the Morro Agudo Mine is undertaken using contract haulage.

The pit is planned to be developed in two phases. Phase 1 is the main longitudinal development and at completion, will be 673 m long, approx. 100 m wide and 75 m deep. Phase 2 will be a smaller sub-pit that is developed on the east side of the Phase 1 pit and will be 166 m long, 65 m wide and 90 m deep.

Electrical power is provided to the Ambrosia Sul Mine by CEMIG, a regional energy provider in Minas Gerais. CEMIG has a contract to supply the mine through an existing 13.8kV distribution network.

Grade control is accomplished through an integration of the block model, the bench grades developed by the short-range planners, in field calls on the muck pile grade, and production sampling.

The forecast production will be a nominal 870 t/d on average.

1.13.4 Equipment

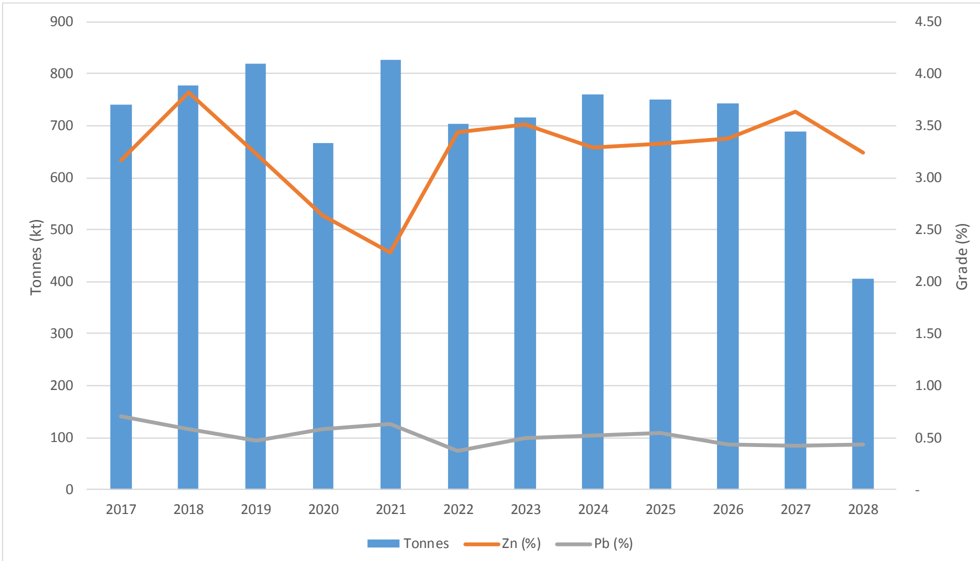
The mine plan assumes 46 pieces of production and support equipment will be required at the Morro Agudo mine, and 14 pieces at Ambrosia Norte/Bonsucesso. Ambrosia Sul will require 26 pieces, comprised of the primary production fleet, contractor supplied stand-by equipment, and the support equipment fleet.

1.13.5 Proposed Production Plan

Mining will be continuous until 2028, until the subset of the Mineral Resources for the four deposits in the PEA mine plan are depleted. The life-of-mine (LOM) also contains 475,000 t of Inferred Mineral Resources associated with pillar recovery in previously mined-areas of the Morro Agudo Mine.

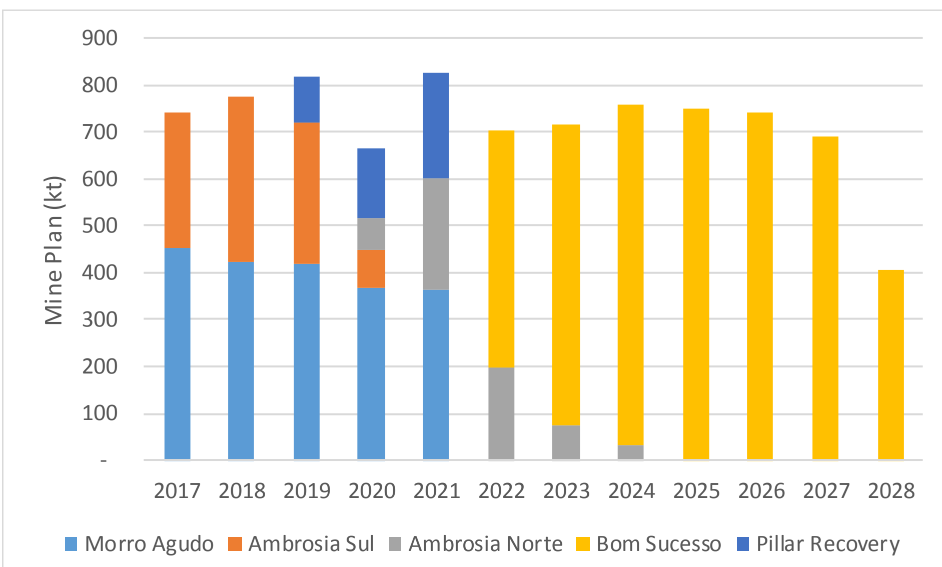
The primary focus of the mining sequence is to maintain a steady flow of material to the Morro Agudo process plant at an average rate of 1,900 t/d. The pillar recovery material is from the Morro Agudo Mine and is sequenced on a retreat basis from the previously-mined areas. The proposed mining sequence is shown in Figure 1-1 and Figure 1-2. Note that the PEA mine plan shown includes a full year of production in 2017; however, the PEA financial analysis commences 1 January, 2018.

Figure 1-1: Proposed Life of Mine Tonnage and Metal Grades



Note: Figure prepared by Amec Foster Wheeler, 2017. Calendar years used are for illustrative purposes. Note that the PEA mine plan shown includes a full year of production in 2017; however, the PEA financial analysis commences 1 January, 2018.

Figure 1-2: Planned Life of Mine Tonnage Distribution by Deposit



Note: Figure prepared by Amec Foster Wheeler, 2017. Calendar years used are for illustrative purposes. Note that the PEA mine plan shown includes a full year of production in 2017; however, the PEA financial analysis commences 1 January, 2018.

1.14 Recovery Methods

The Morro Agudo mill uses a conventional crushing, grinding and flotation circuit to produce separate lead and zinc sulphide concentrates.

The Morro Agudo plant design has developed since 2003 with a number of debottlenecking and improvement projects. In 2003, mill 2 was installed, increasing the capacity of the plant from approximately 750,000 t/a capacity to 1,150,000 t/a. Flotation columns were installed in the lead and zinc circuit that year. Additional flotation cells were installed to increase lead recovery. In 2016, an Eriez stack cell was installed as the lead second cleaner. In early 2017, a new flotation column was installed to operate as the lead second cleaner, to support the production of target final lead concentrate grades for low-grade lead ores. The stack cell is being tested in alternate duties.

The plant capacity is significantly in excess of the tonnages to be treated in the LOM plan (LOMP).

Zinc concentrate is transported to Votorantim's Tres Marias zinc smelter. The smelter process concentrates from silicate concentrates from Votorantim's Vazante Operations, sulphide concentrates from the Morro Agudo Mine and sulphide concentrates from external parties in a ratio of approximately 70%:13%:17%. The concentrates from the Morro Agudo and Ambrosia Sul Mines, and the proposed Morro Agudo Project concentrates, are important for the viability of Tres Marias, as they provide a local and accessible source of sulphide concentrates with low iron, which can be fed in ratio with the Vazante silicate concentrates. This helps produce sufficient sulphuric acid and leach solutions in appropriate ratios to optimize smelter production and economics.

1.15 Project Infrastructure

All infrastructure required for the current Morro Agudo Mine mining and processing operations has been constructed and is operational. This includes the underground mine, access roads, powerlines, water pipelines, offices and warehouses, process plant/concentrator, conveyor systems, waste rock facilities, temporary mill feed stockpiles, paste-fill plants, and tailings storage facilities.

The Ambrosia Sul open pit is a short-life operation with supporting functions and infrastructure being provided by the Morro Agudo Mine site. The PEA design for Ambrosia Norte/Bonsucesso infrastructure assumes integration with the overall Morro Agudo site for support functions such as engineering, geology, environmental, permitting etc. Infrastructure requirements for Ambrosia Norte/Bonsucesso have been evaluated to a PEA level to support underground mining activities.

1.16 Environmental, Permitting and Social Considerations

1.16.1 Environmental Considerations

Compilation of the results from monitoring programs, research studies, and public data was completed in 2017 for climate, air quality, noise, hydrology, groundwater, water quality, seismicity, biology, and social setting.

Environmental licensure requires a number of on-going monitoring programs. Votorantim provided documentation that supported that the required 2016 monitoring and reporting was completed, and the reports sent to the relevant regulatory authorities.

1.16.2 Tailings Storage Facilities

Tailings management at the Morro Agudo Mine consists of three tailings storage facilities (TSFs), denoted as Deposit 1, 2, and 3.

Tailings produced in the lead circuit feed the zinc circuit, and tailings produced in the zinc circuit are pumped in the form of a slurry to the tailings deposits where they settle. After sedimentation of the solids and depletion of the supernatant water, the tailings are extracted, marketed, and sold as corrective soil/limestone powder to the agricultural sector. Water is recovered in the deposits and returned to the process plant. Embankment raises are not planned for the deposits as increases in the total volume of the reservoirs are limited by the extraction and sale of the contained tailings.

Embankment designs considered local geological and geotechnical conditions, materials available for construction and project economics. As part of site characterization studies, drilling and test pitting campaigns were undertaken at the embankment foundations and reservoir as part of design studies for all deposits.

Monitoring of instrumentation installed in the embankments of the three deposits are carried out by Votorantim personnel and external consultants. Dam safety inspections are carried out by Votorantim professionals on a monthly basis and by third-party consultant, Geoconsultoria, annually.

1.16.3 Water Management

The approved water monitoring plan requires minimum flow, surface, effluents, groundwater and hydrobiological quality monitoring as stated in the three Operating Licenses.

Tailings dams have a diversion channel to secure the areas upstream and downstream of the dams.

The main sources of water for operations are from recycled water from the mine, and from the TSFs.

1.16.4 Closure and Reclamation Planning

The closure plan and its update (Golder, 2014; 2016) assumed that mine closure would occur in 2024. The 2016 scenario assumes that seven years will be required for progressive closure (2017–2023) and four years for final closure (2024–2027). Post-closure monitoring would require six years (conceptually from 2028–2033).

The total closure costs at the time were estimated to be approximately US$ 18.3 million. The margin of error in the accuracy estimate was stated to be ±50%.

1.16.5 Permitting Considerations

Operations must adhere to specific federal, state, and local regulations and requirements. The mine holds a number of current permits in support of the current operations. Compliance with permitting is monitored via semi-annual evaluations carried out by consulting companies, and annual audits.

1.16.6 Social Considerations

In partnership with the appropriate internal and external resources, Votorantim staff develop and implement Community Engagement Relations Plans by determining the potentially-impacted communities and probable partner stakeholders that could be potentially impacted; defining issues that are important to stakeholders; and establishing objectives consistent with what Votorantim and the affected communities wish to accomplish initially by 2025 and subsequently by 2030.

1.17 Markets and Contracts

Zinc concentrates from the Morro Agudo and Ambrosia Sul Mines are sold to Votorantim's Tres Marias smelter facility under contract. For the purposes of the PEA, it was assumed that all zinc concentrates would continue to be sold under existing arrangements. Tres Marias realizes a zinc premium on its zinc metal production due to the quality of its product. This premium is currently attributed to the Morro Agudo and Ambrosia Sul Mines, for the portion of zinc production realized from those concentrates. It is assumed for PEA purposes that the zinc premium will continue to be paid over the LOM.

Lead concentrates from the Morro Agudo and Ambrosia Sul Mines are sold to a Chinese smelter under contract. For the purposes of the PEA, it was assumed that all lead concentrates would continue to be sold under existing arrangements.

Agricultural lime recovered from mill tailings is sold under contracts with local famers. For the purposes of the PEA, it was assumed that all tailings would continue to be sold under terms and specifications similar to the existing contracts.

1.18 Capital Cost Estimates

The capital plan for 2018 to 2028 includes: remaining capital to complete Ambrosia Sul; mine development for Ambrosia Norte and Bonsucesso; and sustaining capital and other miscellaneous capital projects. Capital plans have been developed at a PEA level. Nominal allowances are included for sustaining capital of approximately US$5 M/a until 2021, then dropping to approximately US$3 M/a as Morro Agudo and Ambrosia Sul Mines are closed. These allocations continue till the last year of mine life.

The overall capital schedule for the LOMP is shown in Table 1-3.

The LOMP includes US$81.7 million of capital, including for mine development for Ambrosia Norte and Bonsucesso and sustaining capital. There is minimal capital allocated in the process area, as it is no longer fully utilized in this plan. Neither is there significant capital allocated to the Morro Agudo Mine, as it is ramping down to end of its life.

Table 1-3: Capital Cost Schedule

Item	2018	2019	2020	2021	2022	2023 to 2028	Total
Ambrosia Sul	0.5	0.0	0.0	0.0	0.0	0.0	0.5
Ambrosia Norte/Bonsucesso	4.4	1.3	6.9	0.9	6.1	3.0	22.6
Road scales modernization	0.1						0.1
Safety, health, and environment	1.2	1.2	1.2	1.2	1.2	7.0	12.9
IT	3.7	0.9					4.6
Sustaining capital	4.7	4.8	5.1	5.1	3.0	18.4	41.1
Total capital	***14.6***	***8.2***	***13.1***	***7.2***	***10.3***	***28.4***	***81.7***

Note: Calendar years used are for illustrative purposes. Totals may not sum due to rounding.

1.19 Operating Cost Estimates

Operating costs forecasts for the Morro Agudo Project were based on a combination of historical costs and scoping level assumptions and estimates. The schedule of operating costs for the LOMP is shown in Table 1-4.

Historically, unit operating costs have totally approximately US$33/t, with mine accounting for approximately US$13/t and process about US$11/t. The basis of costs is changing due to ramp-down of the Morro Agudo Mine, mill feed supply from satellite deposits mined by open pit and alternative underground mining methods, and a reduction in overall tonnage milled at the Morro Agudo process plant.

Historical variable and fixed costs have been used as the basis for cost projections for the Morro Agudo Mine, process plant and general and administration. These have been adjusted, where appropriate, to reflect changing input prices, particularly electricity. Mining operating costs for Ambrosia Sul, Ambrosia Norte and Bonsucesso have been developed at scoping level, based on internal benchmarks. The combination of historical and benchmark costs is considered a reasonable basis for future costs.

1.20 Economic Analysis

A mine plan at PEA level has been developed for the Morro Agudo Project. The mine plan is partly based on Inferred Mineral Resources that are considered too speculative geologically to have the economic considerations applied to them that would enable them to be categorized as Mineral Reserves, and there is no certainty that the PEA based on these Mineral Resources will be realized.

Table 1-4: LOM Operating Cost Forecast

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
Mining variable costs	7.8	7.7	10.8	6.3	9.5	10.3	9.5	6.6	6.4	5.5	3.2	83.6
Mining fixed costs	9.6	9.7	11.1	9.4	4.5	4.5	4.5	4.5	4.5	4.5	3.0	69.8
Process variable costs	8.3	8.45	6.95	8.57	7.38	7.50	7.95	7.78	7.69	7.14	4.19	81.9
Process fixed costs	4.4	4.44	4.40	4.38	4.38	4.38	4.38	4.38	4.38	4.38	4.38	48.3
General variable costs	0	0	0	0	0	0	0	0	0	0	0	0.0
General fixed costs	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	20.7
Total variable costs	16.1	16.1	17.7	14.9	16.9	17.8	17.4	14.4	14.0	12.7	7.4	165.5
Total fixed costs	15.9	16.0	17.4	15.7	10.8	10.8	10.8	10.8	10.8	10.8	9.3	138.9
Total costs	***32.0***	***32.1***	***35.1***	***30.6***	***27.6***	***28.6***	***28.2***	***25.2***	***24.8***	***23.5***	***16.6***	***304.3***

Note: Calendar years used are for illustrative purposes. Totals may not sum due to rounding.

Votorantim produced a stand-alone PEA financial model on a 100% basis for the Morro Agudo Project that was checked and validated by Amec Foster Wheeler. The model included the mine and mill production plans, and all on-site and off-site costs, smelter and refinery payment terms and costs, and estimated taxes. Costs and prices are in real 2018 US dollars and Brazilian Reals.

Over the proposed LOM, the Morro Agudo Project will realize US$719 million in gross revenue, and $588 million in net revenue. Zinc concentrate will make up 90% of the net revenue, lead concentrate 5% and sale of agricultural lime 5%.

Over the proposed LOM, the Morro Agudo Project is forecast to earn undiscounted cash flows of $88 million, which results in an NPV of $63 million at a discount rate of 9%. The operation will generate modest free cash flows over most years of the LOM, but will have a negative cash flow in 2020 due to capital investment in the planned Bonsucesso mine. The net income tax paid over life of mine is forecast at US$69 million.

Considerations of internal rate of return (IRR) are not applicable for the Morro Agudo Project. This is because there is a combination of an existing mining operation with development projects, and the existing mining operation contribution is such that there is a positive cashflow in the first year of the PEA mine plan, i.e. the free cashflow after capital expenditure is positive.

Payback under the assumptions in the PEA is approximately six months. This assumes that all capital expenditure in 2018 will occur at the start of that year.

1.21 Sensitivity Analysis

NPV is most sensitive to changes in metal prices, then head grade. A 20% reduction in metal prices would lead to an NPV of close to zero. NPV is relatively insensitive to capital costs, as remaining capital requirements are comparatively low.

In the event that the Morro Agudo Project would be unable to continue selling agricultural lime co-product, and assuming no change from other base case assumptions, the NPV would drop to US$49 million.

1.22 Other Relevant Data

For several years, the Morro Agudo Mine has sold some or all of its flotation tailings to local farmers as a soil modifier. Since 2016, all flotation tailings have been decanted, dried, and reclaimed for sale. Contracts are in place for this material with specification limits set out in the contract terms.

Table 1-5 summarizes the Inferred Mineral Resources for the agricultural lime material. The QP for the estimate is Mr Douglas Reid, P.Eng., an Amec Foster Wheeler employee.

Factors that may affect the agricultural lime Mineral Resource estimate include: assumptions as to the amount of mill feed tonnes and concentrate produced; assumptions that the material to be mined in the future will have similar CaO and MgO contents as those currently produced from the Morro Agudo Mine; assumption that the average batch grades are representative of the material that will be produced, and that all contract specifications can be met or exceeded; and assumption that an agricultural lime market will continue to be available over the planned LOM.

1.23 Risks and Opportunities

A summary of the key opportunities and risks identified by the QPs is provided in Table 1-6.

1.24 Interpretation and Conclusions

Under the assumptions in this Report, the Morro Agudo Project shows a positive cash flow over the life-of-mine. The PEA mine plan is achievable under the set of assumptions and parameters presented. The mine plan is partly based on Inferred Mineral Resources that are considered too speculative geologically to have the economic considerations applied to them that would enable them to be categorized as Mineral Reserves, and there is no certainty that the PEA based on these Mineral Resources will be realized.

Table 1-5: Agricultural Lime Mineral Resource Statement

	Tonnage (Mt)	CaO (%)	MgO (%)
Inferred	7.2	28.0	17.8

Notes to accompany Mineral Resource table for the agricultural lime estimate:

1. Mineral Resources have an effective date of 31 December 2016; Douglas Reid, P.Eng., an Amec Foster Wheeler employee, is the Qualified Person responsible for the Mineral Resource estimate. Mineral Resources are reported on a 100% basis.
2. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.
3. Tonnage estimate is based on Mill feed tonnes - Pb concentrate tonnes - Zn concentrate tonnes, where: Pb concentrate tonnes = Mill feed tonnes * Pb head grade * Pb recovery / Pb concentrate grade and Zn concentrate tonnes = Mill feed tonnes * Zn head grade * Zn recovery / Zn concentrate grade
4. Grade estimate is based on the average grades reported from laboratory analyses performed on five agricultural lime sales batches during June–July 2017
5. Sales contracts are in force for the agricultural lime material. Sales batches during June–July 2017 were above contract specifications.
6. Tonnages are reported as metric tonnes; all grades are rounded to one decimal places.
7. Rounding as required by reporting guidelines may result in apparent summation differences.

Table 1-6: Risk and Opportunity Summary

Discipline	Opportunity	Risks
Geology and exploration	There may be continuity of mineralization between Ambrosia Norte and Bonsucesso. Additional mineralization, including higher-grade material, may be identified during infill drilling at Ambrosia Norte and Bonsucesso, and south of the Ambrosia Sul Mine. Infill drilling may support increases in confidence categories for some of the resource blocks at Ambrosia Norte and Bonsucesso, such that this material can potentially be converted to Mineral Reserves. There are a number of regional exploration targets, that with further work, represent an excellent upside opportunity to potentially add to the resource base.	
Mineral resources	The Mineral Resource estimate is based only on sulphide mineralization. Oxide mineralization at Ambrosia Norte is not included because it cannot be treated through the Morro Agudo process plant. If a viable treatment route can be identified, this material represents Project upside. Not all available sill pillars and pillar materials have been tabulated as Mineral Resources. There is upside potential for the Project if some or all of this material can support Mineral Resource estimation.	The drill spacing study completed as part of the Ambrosia Sul resource classification review indicates a much closer drill spacing may be required to support Measured Mineral Resources than is currently assumed by Votorantim. There is a risk that some of the Measured Mineral Resources will not have the appropriate drill support until grade control drilling is completed. A number of the Mineral Resource assumptions for reasonable prospects of eventual economic extraction at Ambrosia Norte and Bonsucesso are based on analogues to Morro Agudo, including mining costs and metallurgical recoveries. Actual

Discipline	Opportunity	Risks
		data collected from the deposits may vary from these assumptions. The tonnages and grade for the potentially recoverable sill pillars are based on assumptions derived from the Morro Agudo Mine run-of-mine material. Actual data collected from the pillars may vary from these assumptions. The Mineral Resource estimate for agricultural lime may be affected by concentrate production, ability to produce tailings that are at or above specifications, and the continued existence of an agricultural lime market.
Mine plan	The PEA mine plan is based on a subset of the Mineral Resource estimate. The excluded material remains as upside potential.	The mine plan assumes that the hydrological and geotechnical setting for the Ambrosia Norte and Bonsucesso deposits is an analogue of that found at Morro Agudo. Actual data collected from the deposits may vary from these assumptions. The mine plan dilution factor is based upon typical factors for similar types of underground mining operations. If the dilution factor is higher than estimated, there is a risk of higher haulage costs to Morro Agudo process plant from the Ambrosia Trend deposits. The current Morro Agudo Mine plan has included Inferred Mineral Resources in potentially recoverable pillars within historically-mined areas where the survey information has been lost. The assumptions on these areas in the mine plan may vary from actuals once a 3D survey is completed. Mine capital and operating costs in years 2020–2021 of the PEA may underestimate the actual requirements during the ramp-up period for the planned Ambrosia Norte and Bonsucesso operations.
Tailings	If historical material in the tailings deposits can support Mineral Resource estimation such that it can be retreated through the plant, or be shown to meet specifications for sale as agricultural lime, there is potential to reduce closure and rehabilitation costs.	Tailings deposits 1, 2, and 3 have been classified by Geoconsultoria under the Brazilian Legislation Art. 3 of COPAM Normative Resolution No. 87, dated 06/17/2005. as “Class III – high Potential for Environmental Damage”. In addition, using results of the dam break study demonstrating the potential for transported tailings to impact the environment up to a distance of 5 km, the deposits are classified as “Very High Risk”.
Process	The lead second cleaner column, which was installed and commissioned in early 2017, may allow a consistent increase in lead concentrate grade to up to 55% Pb. It may also allow Morro Agudo Operations to exceed the lead recovery levels currently assumed in the production plan for lower lead head grade mill feed material, while achieving target lead concentrate specifications. The zinc regrind mill may allow Morro Agudo	Metallurgical accounting, due to uncertainties from (tailings) barrage treatment through the mill over the last 2 years. No metallurgical testwork has as yet been completed on mineralization from Ambrosia Norte and Bonsucesso. Actual testwork results could result in recoveries that are different to the projected recoveries. The PEA assumes that there will be no significant mineralogical differences in mill feed sourced

Discipline	Opportunity	Risks
	to target higher zinc concentrate grades, above the 40% assumed in the LOMP. There are historical stocks of Morro Agudo tailings that may, in the future, be analyzed and reclaimed for limestone recovery, provided that the material meets specifications and is economically viable to transport to customers. Amec Foster Wheeler notes that agricultural lime recovery from Deposit 2 may only be possible in conjunction with retreatment in the mill as the lead content likely exceeds agricultural lime specifications. Retreatment of the historic tailings deposit may provide a source of additional mill feed, if this material can support Mineral Resource and Mineral Reserve estimation. Excess plant capacity may support higher lead and zinc recoveries and improved concentrate grades.	from Ambrosia Norte and Bonsucesso and that current blending practices will continue. If the mineralogy varies from expectations, there may be additional ROM handling and blending requirements that may potentially result in a minor increase in process operating costs. There is limited extended assay information on Ambrosia Sul, Ambrosia Norte and Bonsucesso. It may be possible that gangue mineralogy deviates sufficiently from the Morro Agudo Mine assumptions that some or all of the tailings material proposed to be sold will fail to meet limestone specifications (e.g. excess pyrite content, insufficient CaO and MgO). This would affect co-product recovery and may reduce the economic attractiveness of this material. Production in the LOMP is not sufficient to keep the mill full, and therefore it may be difficult to contain operating costs to economic levels. The mine plan assumes fixed costs, based on treatment of 1 Mt/a of mill feed. However, the plan has variable annual mill feed rates, which results in throughput ranges from 0.67–0.83 Mt/a. Assumptions from the steady-state production for the ratio between fixed and variable costs may not be applicable to the lower throughput rates. This could result in higher overall costs than currently predicted. In the event that Votorantim's Tres Marias smelter was unable to process concentrates from the Morro Agudo Project, mine economics would be affected due to the significantly higher transport and treatment charges, no zinc premium, and lower payable content that would apply to an alternative customer. This could result in a reduction in the assumed profitability of the Project, or potentially rendering the Project sub-economic. If the Tres Marias smelter is unable to keep the current balance of different feed supplies to control chemistry and costs, then there is a risk that the zinc premium that is assumed to be paid could be reduced, thereby reducing the assumed profitability of the Project.
Infrastructure		Decreases in rainfall may cause lower reservoir and river levels, potentially impacting the ability of the hydroelectric stations to provide sufficient power to meet operational needs.
Environmental, closure, permitting and social		Closure costs estimated in the 2016 closure plan may be insufficient to accommodate all decommissioning and rehabilitation costs, as they do not appear to include all of the proposed development along the Ambrosia Trend.

Discipline	Opportunity	Risks
		Sending general waste to an unlicensed facility carries a potential liability risk if pollution and seepage occur from the waste facility. Authorization from the competent environmental authorities is required prior to work being conducted that may affect Permanent Preservation Areas (APPs). There is a risk that future approvals to impact APPs may not be granted for mineral concessions where the approval process has not been completed, and this may affect planned work programs such as exploration and drilling activities. Creation of new taxes, fees, and/or royalties or significant changes to the assumptions as to these in the Report will affect the cashflow estimates.
Financial analysis		Hedging is not considered in the financial evaluation, which is performed at the mine level. Votorantim has corporate hedging arrangements in place. Should a future decision be made to implement hedging at the mine level, the cashflow estimates could be affected.

1.25 Recommendations

Recommendations have been broken into two phases. Phase 2 is not contingent on the results of Phase 1 work.

The Phase 1 recommendations made in relation to exploration activities and data gathering activities in support of future mining studies are to identify mineralization that can support Mineral Resource estimation, and potential conversion to Mineral Reserves. Expenditures of about US$10 M/a are reasonable considering the numbers of mines, known deposits, and known targets and the quality of the targets.

Recommendations proposed in Phase 2 are suggestions for improvements in current operating procedures. Work proposed includes: recommendations for modifications to resource estimation methodologies; implement check scaling during mining operations; survey remnant pillar material; future plant utilisation studies; re-evaluate the potential to treat material from Deposit 2; review and address findings outlined in the Legal Audit document; review closure planning; and review the operating structure assumptions in the financial model.

The total cost for the Phase 1 work is about US$32.25 to US$32.34 million. Phase 2 is estimated at about US$0.5–0.6 million.

2.0 INTRODUCTION

2.1 Introduction

V.M. Holding S.A. (Votorantim) requested that Amec Foster Wheeler Perú S.A. (Amec Foster Wheeler) prepare an independent technical report (the Report) on a Preliminary Economic Assessment (PEA) in compliance with the requirements of National Instrument 43-101 Standards of Disclosure for Mineral Projects (NI 43-101) and Form 43–101F1 Technical Report for Votorantim on the Morro Agudo Project (Morro Agudo Project or the Project), located in Minas Gerais State in Brazil.

The Morro Agudo Project comprises the Morro Agudo Mine, and three deposits along what is known as the Ambrosia Trend (Ambrosia Sul, Ambrosia Norte, and Bonsucesso). The Morro Agudo Mine commenced operations in 1988, and is nearing the end of its mine life. The Ambrosia Sul deposit is being developed as an open pit operation, with first production occurring in June, 2017.

The corporate entity that conducts the mining operations is Votorantim Metais Zinco SA, an indirectly wholly-owned subsidiary of Votorantim. For the purposes of this Report, unless otherwise noted, Votorantim and Votorantim Metais Zinco SA will be referred to interchangeably as Votorantim.

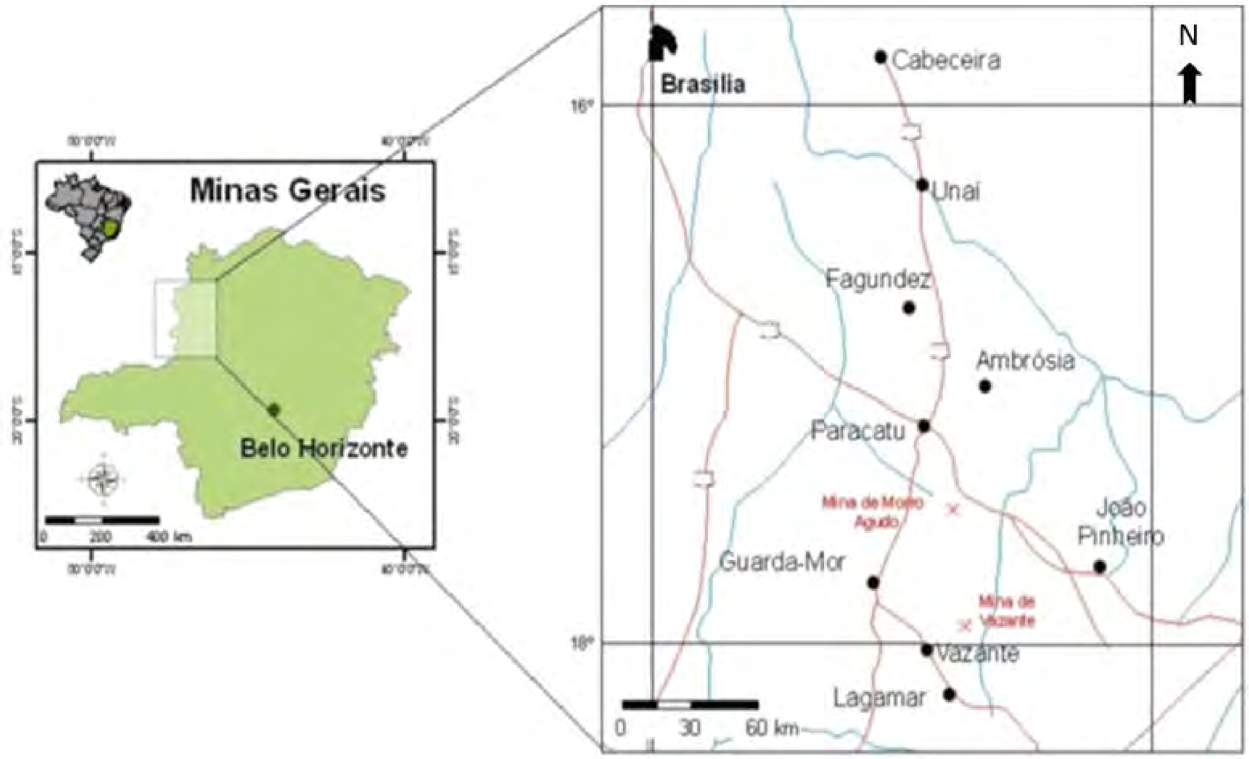
2.2 Terms of Reference

The Report was prepared to support scientific and technical disclosure on the Morro Agudo Project in the initial public offering by V.M. Holding S.A.

There are limitations on the supporting information in applying modifying factors to the Mineral Resources to convert to Mineral Reserves, and thus, the mine plan does not meet pre-feasibility study requirements in all aspects. In addition, a significant proportion of the planned mill feed is classified as Inferred. As a result, the Report is presented as a PEA.

Mineral Resources and Mineral Reserves are reported with reference to the Canadian Institute of Mining, Metallurgy and Petroleum (CIM) Definition Standards for Mineral Resources and Mineral Reserves (May 2014; the 2014 CIM Definition Standards) and the CIM Estimation of Mineral Resources and Mineral Reserves Best Practice Guidelines (November 2003; 2003 CIM Best Practice Guidelines). Mineral Resources were initially classified using the 2012 edition of the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (the 2012 JORC Code).

Figure 2-1: Location Plan



Note: Figure courtesy Votorantim, 2017.

All measurement units used in this Report are metric units and currency is expressed in US dollars (US$), unless stated otherwise. The Brazilian currency is the Real (BR$). The Report uses Canadian English. The Bonsucesso deposit referred to in this Report can also be described using an alternate spelling as Bom Sucesso in some figures.

2.3 Qualified Persons

The following Amec Foster Wheeler staff serve as Qualified Persons (QPs) as defined in NI 43-101:

- Mr William (Bill) Bagnell, P.Eng., Manager Mining
- Dr Ted Eggleston, RM SME, Principal Geologist
- Mr Douglas Reid, P.Eng., Principal Geologist
- Mr Laurie Reemeyer, P.Eng., Process Consultant
- Dr Peter Cepuritis, MAusIMM, CP, Technical Director Geomechanics

- Ms Juleen Brown, MAusIMM, CP., Manager, Environment
- Dr Bing Wang, P.Eng., Senior Associate Engineer, Geotechnical.

2.4 Site Visits and Scope of Personal Inspection

The following Amec Foster Wheeler staff performed a site visit from 20 to 24 May, 2017:

- Dr Ted Eggleston reviewed data collection, database integrity, and geological model construction. Discussions on geology and mineralization were held with Morro Agudo Mine personnel, and field site inspections were performed. Dr. Eggleston visited active mining operations to review the geology of the deposits and visit operating drill machines, inspected the main mine laboratory and reviewed procedures. He worked with site geological personnel reviewing aspects of data storage (database) and analytical quality control
- Mr Douglas Reid physically reviewed examples of underground channel samples and infill drill stations. Discussions were held on geology, controls on mineralization, and modeling methodology that incorporate geology into digital format with Morro Agudo Mine geology staff. Mr. Reid conducted visual reviews of the block model in cross sections and plans, covering geology, mineralization, and high-grade zinc domain, block grades for zinc, lead, and silver, and Mineral Resource classification
- Dr Eggleston and Mr Reid also visited the Ambrosio Sul and Ambrosia Norte sites on 20 May, 2017.

Mr Bill Bagnell visited the Morro Agudo Mine from 14 to 15 December, 2016. During the visit, he toured underground workings, including production stopes, backfill placement, the crushing and conveying system, and development areas. He also met with mine technical staff and management personnel to collect mining data, answer questions, and clarify issues.

2.5 Effective Dates

There are a number of effective dates, as follows:

- Date of the Mineral Resource estimates:
  - Morro Agudo Mine: 31 December, 2016
  - Ambrosia Sul Mine: 24 October, 2016
  - Ambrosia Norte: 14 April, 2016
  - Bonsucesso: 5 May, 2017
  - Potentially recoverable pillars: 23 November, 2016

- Date of supply of the last information on mineral tenure and permitting: 14 June, 2017
- Date of letter regarding taxation considerations that supports the financial analysis: 14 July, 2017
- Date of supply of information on process flowsheet, metallurgical accounting, and process equipment description: 29 May, 2017.
- Date of financial analysis: 25 July, 2017.

The overall effective date of the Report is taken to be the date of the financial analysis and is 25 July, 2017.

2.6 Information Sources and References

Mr Felipe Riquelme, an Amec Foster Wheeler employee, visited the Votorantim corporate offices in Sao Paulo on Friday, 26 May 2017, to discuss aspects of the environmental, permitting and social operations with Votorantim staff. Mr Riquelme provided specialist input on aspects of water management and environmental, permitting, and social considerations to Ms Juleen Brown.

Mr Ken Brisebois, P.Eng., an Amec Foster Wheeler employee, visited the site from December 14–15, 2016. Mr Brisebois reviewed data collection and database integrity and discussed geology and mineralization with Votorantim personnel, reviewed geological and block model construction, and reviewed Mineral Resource estimation procedures and some of the corporate protocols supporting the estimates. Mr Brisebois provided specialist information on aspects of Mineral Resource estimation to Mr Reid.

Mr William Colquhoun, FSAIMM, an Amec Foster Wheeler employee, visited site from December 14–15, 2016. During that visit he inspected the process plant, and held discussions on plant operating practices with Votorantim staff. Mr Colquhoun provided specialist information on aspects of the metallurgical testwork programs, plant design, and plant operation to Mr Reemeyer.

Mr Scott Marisett, P.Eng., an Amec Foster Wheeler employee, visited the site from 22 to 25 May, 2017. During that visit, Mr Marisett visited the core handling facilities, the Morro Agudo Mine underground operations, and the Ambrosia Sul open pit operation, including the waste rock facility (WRF). Discussions related to geotechnical undertakings conducted at the mine were held with key Votorantim personnel. Mr Marisett provided specialist information on geotechnical aspects to Dr Cepuritis.

The key information sources for the Report include the reports and documents listed in Section 3.0 (Reliance on Other Experts) and Section 27.0 (References) of this Report were used to support the preparation of the Report. Additional information was sought from Votorantim and Amec Foster Wheeler personnel where required.

2.7 Previous Technical Reports

No previous technical report under NI 43-101 has been filed on the Project.

3.0 RELIANCE ON OTHER EXPERTS

3.1 Introduction

The QPs have relied upon the following other expert reports, which provided information regarding mineral rights, surface rights, property agreements, royalties, taxation, and marketing sections of this Report.

3.2 Mineral Tenure, Surface Rights, and Royalties

The QPs have not independently reviewed ownership of the Project area and any underlying property agreements, mineral tenure, surface rights, or royalties. The QPs have fully relied upon, and disclaim responsibility for, information derived from Votorantim and legal experts retained by Votorantim for this information through the following documents:

- Azevedo Sette Advogados, 2017: Projects Ambrosia, Morro Agudo and Vazante: legal opinion, 14 June, 2017.
- Silva, V.H., 2017: Section 4 Content, Morro Agudo Technical Report: document prepared by Votorantim for Amec Foster Wheeler, 31 July, 2017.

This information is used in Section 4 of the Report. The information is also used in support of the Mineral Resource estimate in Section 14 and the financial analysis in Section 22.

3.3 Environmental, Permitting and Social and Community Impacts

The QPs have fully relied upon, and disclaim responsibility for, information supplied by Votorantim staff and experts retained by Votorantim for information related to environmental (including tailings, waste rock storage, water management) permitting and social and community impacts as follows

- Silva, V.H., 2017: Section 20 Content, Morro Agudo Technical Report: document prepared by Votorantim for Amec Foster Wheeler, 31 July, 2017.

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

3.4 Taxation

The QPs have fully relied upon, and disclaim responsibility for, information supplied by Votorantim staff and experts retained by Votorantim for information related to taxation as applied to the financial model as follows:

- Bertoncini, M.A., 2017: Taxation Assumptions for the Financial Model of Morro Agudo: letter prepared by Votorantim for Amec Foster Wheeler, 14 July, 2017, 3 p.

This information is used in support of the financial analysis in Section 22.

3.5 Markets

The QPs have not independently reviewed the marketing, smelter terms, or metal price forecast information. The QPs have fully relied upon, and disclaim responsibility for, information derived from Votorantim experts for this information through the following documents:

- Marinho, F.J.T., 2017: Market Assumptions for Morro Agudo Technical Report: document prepared by Votorantim for Amec Foster Wheeler, 31 July, 2017
- Da Silva, R.C.R., 2017: Smelter Terms for Morro Agudo Technical Report: document prepared by Votorantim for Amec Foster Wheeler, 31 July, 2017.
- Dario, B.F., 2017: Metal Price Assumptions for the Vazante and Morro Agudo Technical Reports: document prepared by Votorantim for Amec Foster Wheeler, 28 July, 2017.

This information is used in Section 19, and in support of the financial analysis in Section 22.

Metals marketing, global concentrate market terms and conditions, and metals forecasting are specialized businesses requiring knowledge of supply and demand, economic activity and other factors that are highly specialized and requires an extensive database that is outside of the purview of a QP. The QPs consider it reasonable to rely upon Votorantim for such information as the company is a well-known supplier of zinc and lead concentrates to the market, and maintains a specialist marketing and contracts department that tracks these concentrate markets.

4.0 PROPERTY DESCRIPTION AND LOCATION

4.1 Introduction

The deposits and mines within the Morro Agudo Project are located as follows, using the WGS 84 datum, zone 23K:

- Bonsucesso: 310500 east, 8107000 north, 550 m elevation
- Ambrosia Norte: 311200 east, 8104750 north, 570 m elevation
- Ambrosia Sul Mine: 312200 east, 8102320 north, 620 m elevation
- Morro Agudo Mine: 306800 east, 8064100 north, 578 m elevation.

4.2 Property and Title in Brazil

This section provides a general overview of mineral-related law and title in Minas Gerais State, Brazil, sourced from public domain documentation, including Castro et al., (2012), Lagodourado.com (2015), and PwC, (2013) and has not been independently verified by the QPs.

4.2.1 Introduction

Under Brazilian laws, the Federal Government owns all mineral resources.

Mining is regulated by Decree-Law 227, 1967 (the Mining Code), and Decree No. 62,934, 1968, together with rulings made by the National Department of Mineral Production (DNPM). The DNPM is part of the Ministry of Mines and Energy of Brazil (MME), and is responsible for: the administration of all mineral rights; planning and development of mineral exploitation; management of mineral resources; and control of mining activities throughout Brazil.

Under Article 176 of the Brazilian Constitution, all mineral fields (*jazida*s) belong to the Federal Government, whether or not the jazidas are in active production. Mineral rights are distinct from surface rights.

Brazil also has legislation and legal guarantees related to the exploitation and use of water rights.

4.2.2 Mineral Tenure

There are two levels of mineral tenure:

- Exploration authorizations (*autorização de pesquisa*)
- Mining concessions (*concessão de lavra*).

Exploration Authorizations

Exploration authorization applications must be accompanied by information on which minerals are to be explored for, the area and location of the area applied for, a "Exploration Work Plan" documenting the work that is intended to be performed, and an accompanying budget and work schedule.

Exploration authorizations can be granted for a minimum one year period, and a maximum three-year period, depending on the Exploration Work Plan proposed and DNPM approval. The authorization can be renewed once. Work must commence within 60 days of grant of the authorization.

A final report on the work completed must be provided to the DNPM, and be formally approved. On completion of a final report on the work conducted (termed a Final Exploration Report), the exploration authorization holder can apply for a mining concession.

Exploration authorization fees are set on a per hectare basis, and are payable annually.

Mining Concessions

The holder of an exploration authorization with an approved final report has a 12-month exclusion period in which to apply for a mining concession. After that date, any other party may apply for the ground. Depending on the minerals applied for, and the location, exploration authorizations can range in size from 50–10,000 ha.

Applications for a mining concession require documentary support, including the minerals are to be explored for, a description and location of the area applied for, a map showing the area, any easements, an "Economic Development Plan", and evidence of sufficient funds to complete the plan. Mining concessions are considered granted when an ordinance (*portaria*) is published in the Official Gazette.

Within 90 days of the publication of the portaria, the holder must apply for possession (*imissão na posse*) of the surface area that is required to enact the Economic Development Plan. The DNPM will then draft an "Access Term" that must be signed by all stakeholders. The owner of the surface area is entitled to royalties that are equivalent to 50% of the amount paid as CFEM.

Work must commence within six months of the mining concession grant. Annual production reports must be filed. Assuming all other conditions are met, mining concessions remain valid until the deposit is depleted.

The holder can conduct mining activities only in the area covered under the lease agreement, and only after the agreement has been registered before the DNPM, and the appropriate operation license (*licença de operação*) has been issued. If additional minerals are discovered, the mining concession must be amended to include the new list of minerals.

Mining activities are regulated by the MME.

Mining Charges

Royalties (mining charges) in the form of a Compensation for the Exploitation of Mineral Resources (*Compensação Financeira pela Exploração de Recursos Minerais* or CFEM) are levied (see also discussion in Section 22.2.8).

4.2.3 Surface Rights

Surface rights in Brazil are separate from mineral rights. Under the mining law, mining rights holders have the right to use and access areas that are planned for exploration or exploitation. Rights of way and easements can also be granted to mining rights holders over public and private lands.

Typically, the mining rights holder enters into an agreement with the affected surface rights holder in return for a compensation fee for the land use. Where disputes arise, a mining rights holder may apply for a local court order to allow a judge to establish the appropriate compensation fee to be paid to the surface rights holder.

4.2.4 Environmental Licencing

Mining activities are subject to mandatory environmental licensing by the Federal or State Environmental Agency, depending on the potential environmental impact. Environmental licenses are granted prior to mine construction, installation, expansion, or operation.

Generally, the environmental licensing is a three-stage process:

- A Preliminary License (LP) must be obtained during planning stage evaluation. An Environment Impact Assessment (EIA) and a closure and remediation plan must be prepared during the LP stage. Public hearings are usually called to present the EIA to the communities and authorities. The LP usually imposes conditions that must be complied with by the mining company. The environmental authority will also set the amount of the environmental compensation, which is a minimum of 0.5% of the projected development investment
- An Installation Licence (LI) is required prior to construction. The holder must present an Environmental Control Plan (PCA) for approval. Once the PCA is approved, the LI is granted and usually has conditions attached specific to the operation. A mining concession can only be granted by the Minister of Mines once the holder has obtained the LI

- An Operations Licence (LO) is granted once construction is complete and inspection by the environmental authorities confirms that the conditions imposed in the LI and the commitments made in the PCA have been kept.

Although the Brazilian legal system provides for two types of titles, one for exploration and one for mining, it does grant security that the holder of an exploration licence can mine any deposit that is discovered within the granted title. The government is required to grant a mining concession to an entity that has explored for, identified a Mineral Resource, obtained DNPM approval of the exploration report, filed applications for a mining concession in a timely manner, and obtained an LI.

Reasons for not granting a mining concession would be on the grounds of public interest, or if the Federal Government considers that it could have a negative effect on certain interests which are more important than mineral exploitation. In the latter instance, in those cases where a final exploration report has already been approved, a mining concession applicant is entitled to be indemnified by the Federal Government for any expenses incurred relating to the completed exploration work.

Brazil has a concept that is termed “environmental conservation units”, which can be created by either the Federal Government, States or Municipalities, and can be either total protection conservation units, where industrial activities such as mining cannot take place; or sustainable use conservation units, where some industrial activities (including mining) may be carried out as long as they comply with regulatory requirements. Every environmental conservation unit in Brazil must have its own management plan that sets out the regulations for the administration and occupation of the unit. The plan includes regulations applicable to the zone that surrounds the unit.

4.2.5 Social Licence

Areas reserved for indigenous populations are designated as “restricted access” or “prohibited” access for mining. The Brazilian Constitution requires that any mining activities in indigenous areas requires prior approval of the Brazilian National Congress. Indigenous communities have the right to receive royalties from any mining in their areas.

In addition to the indigenous communities, there are other communities (*Quilombolas*) that have Constitutional rights to own and occupy specific lands. Mining is permitted in these areas; however, the communities are entitled to compensation, and if the community needs to be relocated for mining purposes, the community must be relocated to land that has similar characteristics to the area that was previously occupied, or be fairly compensated.

4.2.6 Water Rights

All waters are considered to be in the public domain, and are separated into:

- Federal waters: lakes, rivers, and any water courses on lands under Federal authority; those that flow through more than one State; those that serve as a frontier with another country, or flow into or originate in another other country; as well as marginal lands and riparian beaches
- State waters: Groundwater and rivers located entirely within the territory of a single State, unless otherwise classified as a Federal water.

Law 9,433 of 1997 established the National Water Resources Policy (NWRP), created the National Water Resources Management System (NWRMS), and defined a catchment (river) basin as the unit for water resource planning. The law includes the principle of multiple water uses, thereby putting all user categories on an equal footing for access to water resources.

The organizational framework administering water includes the National Water Resources Council (NWRC), State Water Resources Councils (SWRCs), River Basin Committees (RBCs), State Water Resources Management Institutions (SWRIs) and Water Agencies (WAs).

In 2003, to facilitate the management of Brazilian water resources, the country was divided into 12 hydrographic regions; however, these do not coincide with the 27 state political divisions. The NWRC is responsible for resolving disputes over use of water for basins at the Federal level, and for establishing guidelines necessary to implement the institutional framework and instruments contained in the NWRP. The SWRCs are responsible for basins at the State level. The SWRIs are responsible for implementing the guidelines set by the SWRCs. The RBCs and WAs cover the actual water regions, which may be part of more than one State.

4.2.7 Fraser Institute Survey

Amec Foster Wheeler has used the Investment Attractiveness Index from the 2016 Fraser Institute Annual Survey of Mining Companies report (the Fraser Institute survey) as a credible source for the assessment of the overall political risk facing an exploration or mining project in Brazil.

Amec Foster Wheeler has relied on the Fraser Institute survey because it is globally regarded as an independent report-card style assessment to governments on how attractive their policies are from the point of view of an exploration manager or mining company, and forms a proxy for the assessment by industry of political risk in Brazil from the mining perspective.

The Fraser Institute annual survey is an attempt to assess how mineral endowments and public policy factors such as taxation and regulatory uncertainty affect exploration investment.

Overall, Brazil ranked 61 out of the 104 jurisdictions in the survey in 2016.

4.3 Project Ownership

Amec Foster Wheeler was provided with legal opinion that supports that Project ownership is in the name of Votorantim Metais Zinco S.A. An organogram of the Votorantim ownership interest is provided in Figure 4-1.

4.4 Mineral Tenure

For the purposes of this Report, the mineral concessions have been divided into the core tenements, where the known mineral deposits are located and mining operations are occurring, and the surrounding exploration concessions. Figure 4-2 shows the tenement layout for the Project area. The total project area is about 80 km long, and 10 km wide at the widest extent, and covers a significant strike extent of the lithologies that host mineralization at the Morro Agudo Mine and along the Ambrosia Trend. Figure 4-3 is a legend explaining the lithologies that form the backdrop to Figure 4-2.

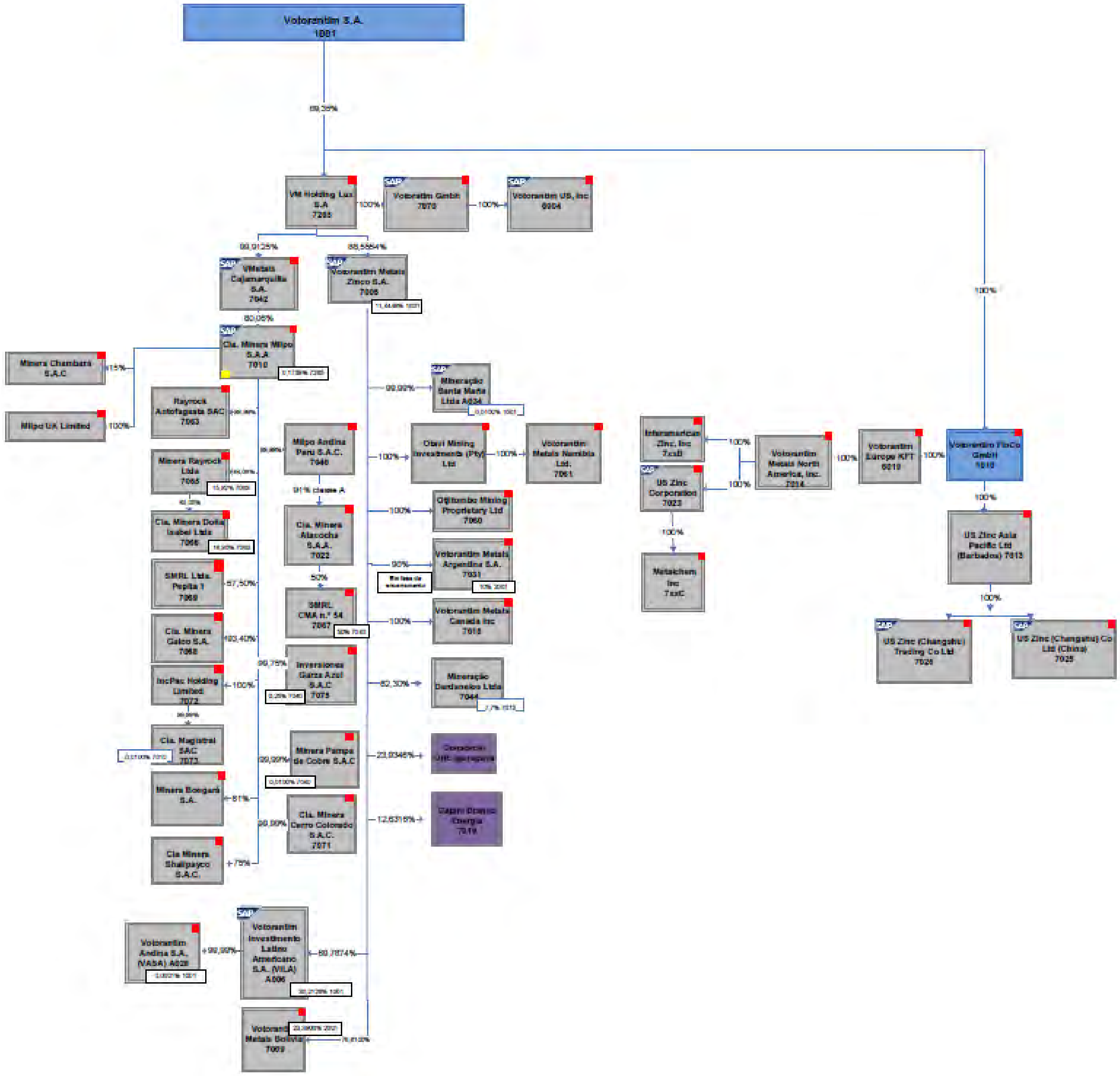
4.4.1 Core Tenements

Votorantim holds two granted mining concessions in the Morro Agudo Mine area, totalling about 828 ha and has a mining concession application for an additional approximately 619 ha. In the Ambrosia Trend area, Votorantim has one granted mining concession (about 999 ha), and two exploration permits (around 1,583 ha). The total area held under granted mining concessions, mining concession applications and exploration permits in the core tenures is about 4,028 ha.

A summary of the core concessions is provided in Table 4-1, and core concession layouts are included as Figure 4-4 and Figure 4-5.

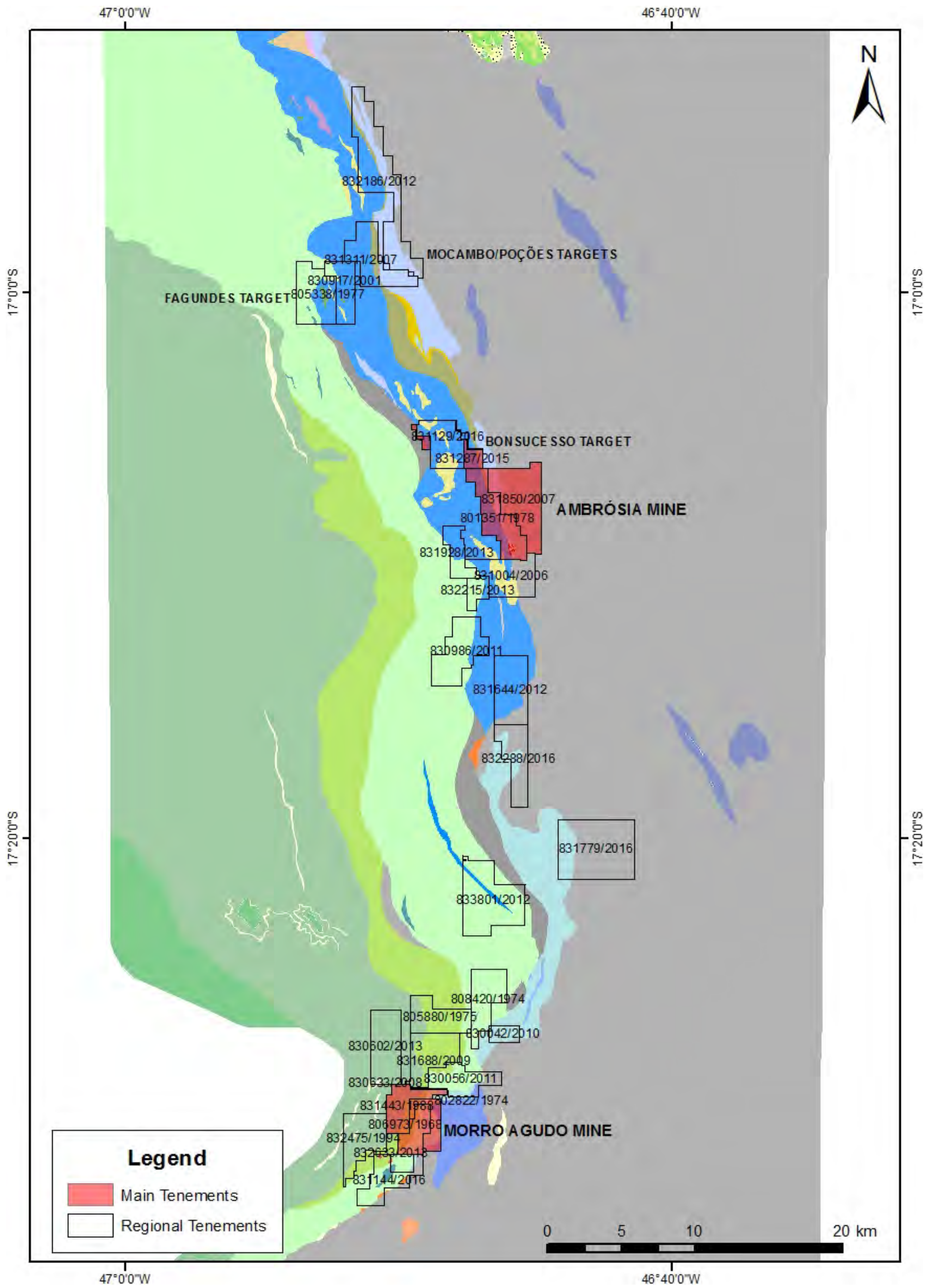
As per mining regulation requirements, certain of the concessions have undergone formal re-evaluations of the Mineral Reserves, or have had modifications to the existing economic extraction plan. In some instances, additional minerals that can be mined have been added to the concession conditions, or have been applied for.

Figure 4-1: Ownership Organogram



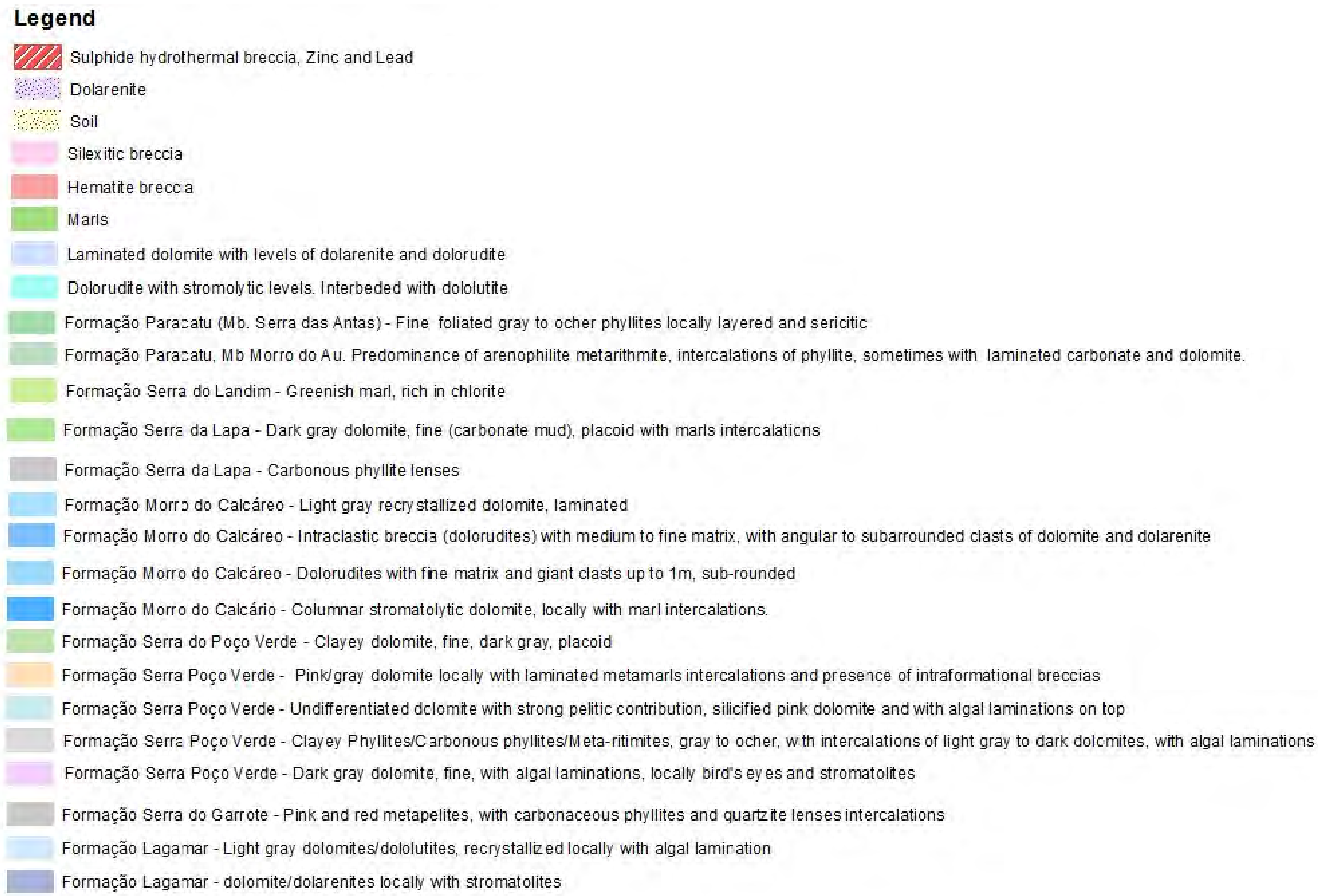
Note: Figure courtesy Votorantim, 2017.

Figure 4-2: Morro Agudo Project Tenure



Note: Figure courtesy Votorantim, 2017.

Figure 4-3: Lithology Key for Figure 4-1

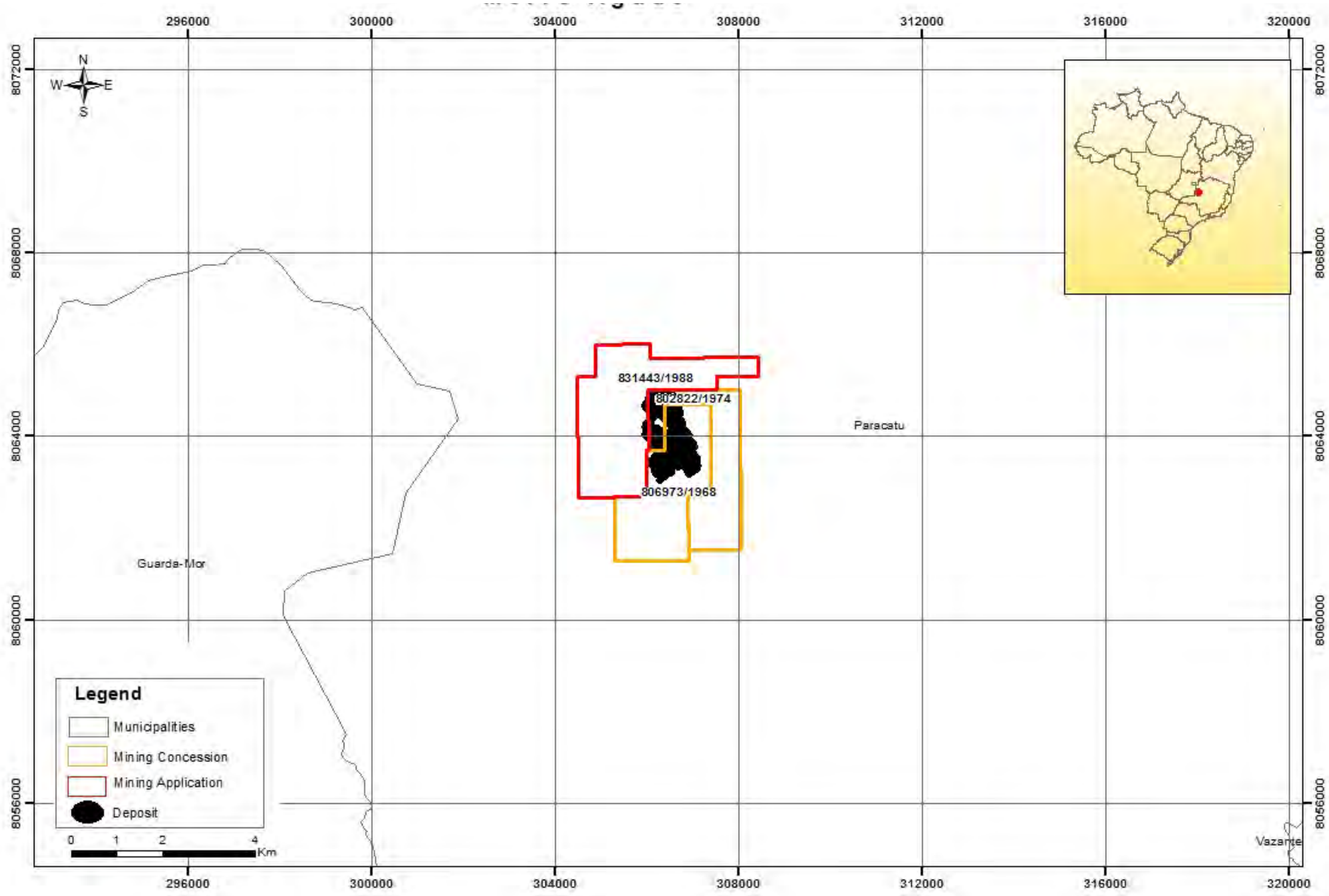


Note: Figure courtesy Votorantim, 2017.

Table 4-1: Mineral Concessions Summary Table

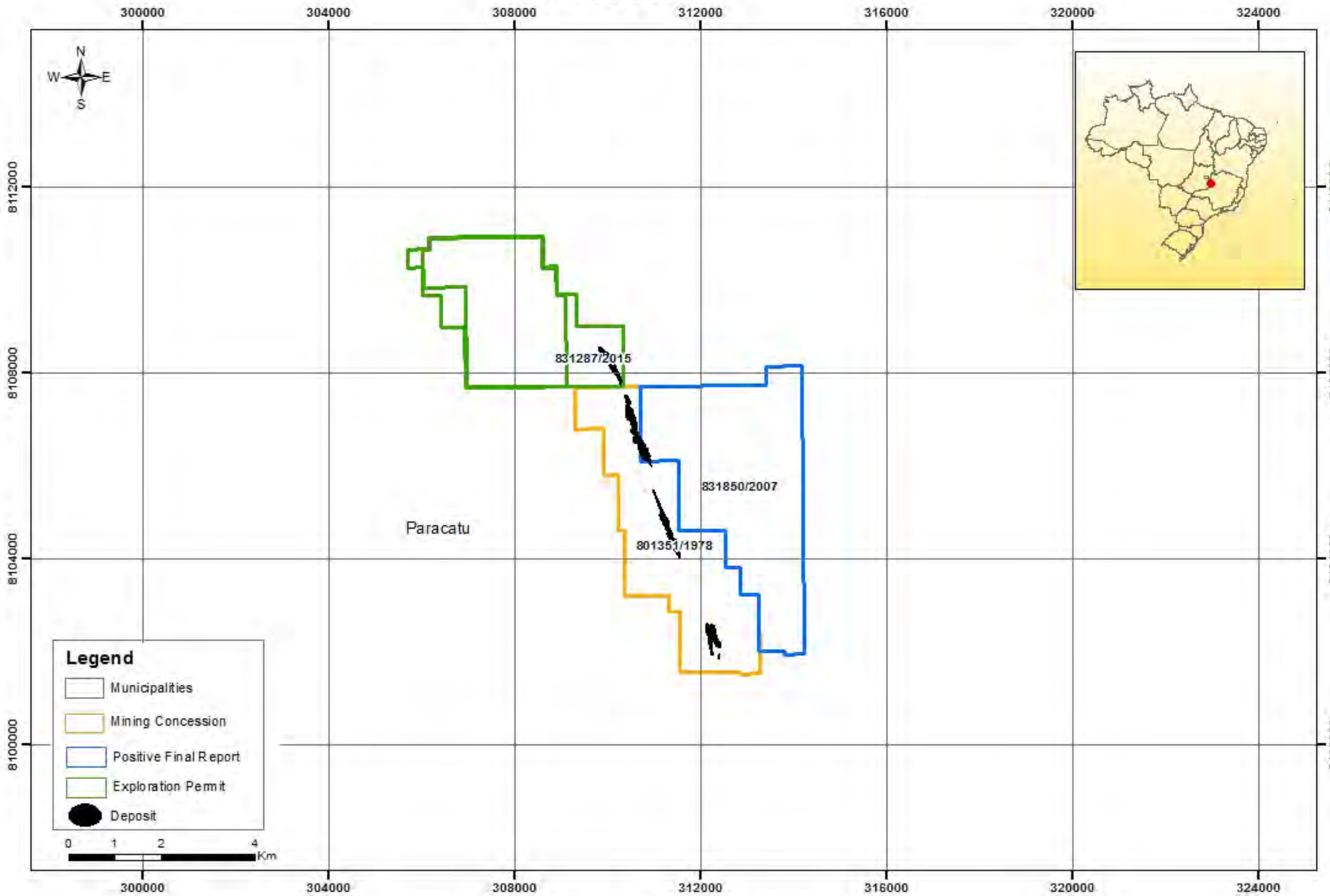
Tenure ID	Holder	Title Type	Minerals	Area (ha)	Date Granted	Expiry Date	Comments
806.973/1968	Votorantim Metais Zinco S.A.	Mining concession	Zinc, lead, limestone, and dolomitic limestone.	464	15 April, 1975		The DNPM approved a re-evaluation of Mineral Reserves on December 2, 2015. An approval to add dolomitic limestone extraction to the approved minerals list was granted 10 July, 2015.
802.822/1974	Votorantim Metais Zinco S.A.	Mining concession	Zinc, lead, limestone, and dolomitic limestone.	363.61	28 July, 2003		The DNPM approved a re-evaluation of Mineral Reserves on October 2, 2013. An approval to add dolomitic limestone extraction to the approved minerals list was granted December 11, 2014.
831.443/1988	Votorantim Metais Zinco S.A.	Mining concession application	Zinc, lead and silver	618.5	—	—	The final exploration report was approved by DNPM on March 7, 2012. On November 6, 2012, Votorantim lodged an application for a mining concession. The DNPM had not issued any decision at the Report effective date, which means that the grant of the mining concession in favor of Votorantim is still pending.
801.351/1978	Votorantim Metais Zinco S.A.	Mining concession	Zinc, lead and cadmium	999.33	20 September, 2001		The DNPM approved a re-evaluation of Mineral Reserves on September 18, 2015. The DNPM also approved a new extraction plan on September 18, 2015. On May 3, 2017, Votorantim formally advised the DNPM that mining activities had begun. The DNPM had, on September 18, 2015, granted Votorantim a three-year extension on the required mining start date, which expires 22 March, 2018. Votorantim applied on May 11, 2017 for permission to add dolomitic limestone to the list of minerals that can be mined under the permit.
831.850/2007	Votorantim Metais Zinco S.A.	Exploration permit	Zinc and lead	1,320.56	2 August, 2015	2 August, 2016	A final exploration report has been lodged with the DNPM, and accepted. Votorantim lodged an application for a mining concession on 1 August, 2017.
831.287/2015	Votorantim Metais Zinco S.A.	Exploration permit	Zinc and lead	262.13	23 June, 2015	23 June, 2018	
				4,028.13			

Figure 4-4: Core Mineral Tenure Plan, Morro Agudo Mine



Note: Figure courtesy Votorantim, 2017.

Figure 4-5: Core Mineral Tenure Plan, Bonsucesso–Ambrosia



Note: Figure courtesy Votorantim, 2017.

4.4.2 Exploration Tenure

Votorantim also holds four exploration applications (about 2,201 ha), 15 exploration authorizations (13,340 ha), three mining concession applications (2,167 ha) and a granted mining concession (1,000 ha) that surround the core tenements. These total approximately 18,708 ha in addition to the core tenements. The locations were included in Figure 4-1, and the tenure details are provided in Table 4-2.

4.5 Surface Rights

Votorantim holds, or has acquired through negotiation, surface rights sufficient to support the current operations at the Morro Agudo and Ambrosia Sul Mines, including the following:

- Mineral concessions 802.822/1974 and 806.973/1968: one surface rights agreement
- Mineral concession 831.443/1988: four surface rights agreements
- Mineral concession 805.141/1976: 11 surface rights agreements
- Mineral concession 802.185/1971: four surface rights agreements
- Mineral concession 001.973/1962: one surface rights agreement

There are no indigenous group stakeholders that may be affected by the Vazante Operations.

Where access is required for regional exploration or drilling programs, negotiations are typically conducted on an individual basis with the affected landowner. If required, judicial action can be invoked to allow surface access.

4.6 Water Rights

Two main water rights are held for the Morro Agudo Project (Table 4-3). Votorantim confirmed that renewal applications have been lodged.

4.7 Royalties and Encumbrances

The financial model in Section 22 includes provision for CFEM payments.

4.8 Property Agreements

Other than the surface rights agreements discussed in Section 4.5, there are no other agreements currently in effect.

Table 4-2: Exploration Tenure Table

Tenure ID	Holder	Title Type	Area (ha)	Minerals	Date Granted	Expiry Date	Comments
830042/2010	Votorantim Metais Zinco S A	Exploration Application	229.91	Zn			waiting for Exploration Authorization
830633/2008	Votorantim Metais Zinco S A	Exploration Application	7.08	Zn			waiting for Exploration Authorization
830986/2011	Votorantim Metais Zinco S A	Exploration Application	1081.17	Zn			waiting for Exploration Authorization
832475/1994	Votorantim Metais Zinco S A	Exploration Application	883.00	Zn			waiting for Exploration Authorization
830056/2011	Votorantim Metais Zinco S A	Exploration Authorization	748.96	Zn	January 5, 2017	January 5, 2020	
830602/2013	Votorantim Metais Zinco S A	Exploration Authorization	1000.00	Zn	March 24, 2014	March 24, 2017	waiting for renewal
831004/2006	Votorantim Metais Zinco S A	Exploration Authorization	917.02	Zn	July 29, 2013	July 29, 2015	waiting for renewal
831129/2016	Votorantim Metais Zinco S A	Exploration Authorization	23.01	Zn, Pb	June 28, 2016	June 28, 2019	
831144/2016	Votorantim Metais Zinco S A	Exploration Authorization	708.75	Pb, Zn	June 28, 2016	June 28, 2019	
831311/2007	Votorantim Metais Zinco S A	Exploration Authorization	912.05	Zn	May 7, 2012	May 7, 2013	waiting for renewal
831644/2012	Votorantim Metais Zinco S A	Exploration Authorization	999.99	Zn	March 24, 2014	March 24, 2017	waiting for renewal
831688/2009	Votorantim Metais Zinco S A	Exploration Authorization	868.20	Zn	February 17, 2017	February 17, 2020	
831779/2016	Votorantim Metais Zinco S A	Exploration Authorization	1999.80	Zn	May 22, 2017	May 22, 2020	
831928/2013	Votorantim Metais Zinco S A	Exploration Authorization	431.27	Zn	March 24, 2014	March 24, 2017	waiting for renewal
832186/2012	Votorantim Metais Zinco S A	Exploration Authorization	1974.67	Cd, Pb	November 7, 2014	November 7, 2017	
832215/2013	Votorantim Metais Zinco S A	Exploration Authorization	256.51	Zn	March 24, 2014	March 24, 2017	waiting for renewal
832288/2016	Votorantim Metais Zinco S A	Exploration Authorization	819.07	Zn	November 21, 2016	November 21, 2019	

Tenure ID	Holder	Title Type	Area (ha)	Minerals	Date Granted	Expiry Date	Comments
832633/2013	Votorantim Metais Zinco S A	Exploration Authorization	129.53	Pb, Zn	March 24, 2014	March 24, 2017	waiting for renewal
833801/2012	Votorantim Metais Zinco S A	Exploration Authorization	1551.09	Zn	March 24, 2014	March 24, 2017	waiting for renewal
805880/1975	Votorantim Metais Zinco S A	Mining Application	764.50	Cd, Pb, Cu, Zn			waiting for Mining Concession
808420/1974	Votorantim Metais Zinco S A	Mining Application	813.90	Pb, Zn, Ba			waiting for Mining Concession
830917/2001	Votorantim Metais Zinco S A	Mining Application	588.97	Pb, Zn			waiting for Mining Concession
805338/1977	Votorantim Metais Zinco S A	Mining Concession	999.98	Cd, Pb, Zn	July 17, 2000		operation not initiated
			18,708.43				

Table 4-3: Water Rights

Authority	Licence	Status	Grant Date	Renewal Date	Renewal Status
SUPRAM-NOR	02053/ 2013–2017	Active	9/12/2013	8/15/2017	Renewable
SUPRAM-NOR	02057/2013–2017	Active	9/12/2013	8/15/2017	Renewable

4.9 Permitting Considerations

Project permitting is discussed in Section 20.

4.10 Environmental Considerations

The environmental considerations relevant to the Project are discussed in Section 20.

4.11 Social License Considerations

The social considerations relevant to the Project are discussed in Section 20.

4.12 Comments on Section 4

The legal opinion and information from Votorantim experts supports the following:

- Votorantim Metais Zinco S A has been duly incorporated, and is a valid corporate entity under the laws of Brazil. The company may conduct business in Brazil and has the requisite power and authority to own property and assets in Brazil
- Votorantim has the rights to acquire, hold, and transfer title in the listed mining concessions, and has the rights to carry out exploration, development, and production with respect to the listed mining concessions
- Mining concessions and mineral claims held in the name of Votorantim Metais Zinco S A are appropriately registered, valid, and are in good standing. The mineral concessions are not subject to outstanding liens or encumbrances, and are not pledged in any way
- Votorantim holds sufficient surface rights for the current mining operations; additional rights will need to be negotiated to support proposed mining at Bonsucesso and Ambrosia Norte
- Sufficient water rights are held to support the Morro Agudo Mine operations.

Votorantim advised that to the extent known, there are no other significant factors and risks that may affect access, title or right or ability to perform work on the Project.

5.0 ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE, AND PHYSIOGRAPHY

5.1 Accessibility

The Morro Agudo Mine site is situated on Traíras Farm, about 45 km south of the municipality of Paracatu. The mine access from Paracatu is via the sealed BR-040 highway, to highway marker km 68, a distance of about 29 km, then 16 km via unsealed roads to the mine itself.

The Ambrosia Trend deposits are situated about 15 km northeast of Paracatu. Access is via MG-188 to the village of Santo Antônio, and thence via unsealed road to Rancho Alegre or Ambrosia Farm.

The closest commercial airport is in Brasilia. Smaller regional airports are available at Paracatu, Patos de Minas, and Vazante.

Additional information on accessibility is included in Section 18 of this Report.

5.2 Climate

The climate in the Project area is classed as humid sub-tropical, with average maximum temperatures of about 30º, and average minimum temperatures of about 13ºC. The hottest months are generally September and October; typically, June and July are the coolest.

The wet season occurs from October to April, with dry months from May to September.

The predominant wind directions are generally northeast to southwest.

Underground mining operations at the Morro Agudo Mine, and open pit operations initiated at the Ambrosia Sul Mine are currently conducted on a year-round basis. It is expected that the open pit and underground operations contemplated for the Ambrosia Norte and Bonsucesso deposits in the PEA will also be year-round.

5.3 Local Resources and Infrastructure

The closest settlement is the municipality of Paracatu. Most mine workers reside in the town, and commute to the mine site.

Goods and services in support of mining operations are generally sourced from Belo Horizonte.

Additional information on infrastructure is provided in Section 18 and Section 20.

5.4 Physiography

Elevations in the general Project area range from 550–630 m.

Dolomite and carbonate rocks tend to occur at lower elevations, and karstic features have developed over these areas, including features such as sinkholes, caves, and collapse structures.

Depending on the underlying lithologies, soils can be thin and acid over metapelites, clayey to sandy over dolomite units, and in areas of flat plateaus, may show greater development to 10–20 m thickness of red–brown clayey soils.

Remnant vegetation typically consists of open savannah (*cerrado*) with gallery-type forest cover in the riparian areas. *Cerrado* is a protected environment where it occurs.

The majority of the region is farmed or used for pasture. The primary food items are rice, beans, soybean, and manioc.

The main water systems are tributaries of the Paracatu River, part of the Sao Francisco River basin. In the Project area, the main streams and water courses include the Morro Agudo, Cercado, and Carrapato streams, which drain into the Traíras Creek, then the Escurinho River, then finally discharging into the Paracatu River. A number of springs are known within the Project area, which also feed the water courses.

5.5 Seismicity

The mining operations are not located in a known regionally seismically active area.

5.6 Comments on Section 5

There is sufficient suitable land available within the mineral tenure held by Votorantim for tailings disposal, mine waste disposal, and installations such as the process plant and related mine infrastructure. All necessary primary infrastructure to support the Morro Agudo Mine has been built on site and is sufficient for the projected life-of-mine (LOM) plan (LOMP); additional infrastructure will be required to support mining activities proposed for the northern deposits along the Ambrosia Trend.

A review of the existing power and water sources, manpower availability, and transport options (see Sections 18 and 20), indicates that there are reasonable expectations that sufficient labor and infrastructure will continue to be available to support declaration of Mineral Resources and the proposed LOMP.

6.0 HISTORY

6.1 Exploration History

A project history is included as Table 6-1.

6.1.1 Morro Agudo Mine

Metal sulphides were discovered at Morro Agudo in 1952 by Mr. Ângelo C. Solis on Traíras Farm, near Paracatu, in the state of Minas Gerais. Shortly afterwards, an artisanal mining operation commenced along the mineralized zone. There are no records available regarding produced tonnages and grades during the artisanal efforts.

The first systematic geological survey efforts were by Companhia Auxiliar de Empresas de Mineração S.A. (AEMSA) which was affiliated with the Sociedad Minero Metalúrgica de Peñarroya (Penarroya), a major French mining company. Penarroya completed the first drill program over the deposit.

In 1973, the state-owned company Metais de Minas Gerais S.A. (METAMIG) acquired the mining rights over the area, and implemented an exploration program project comprising geological mapping at 1:10,000 scale, geochemical sampling, geophysical surveys, and drilling. These programs identified stratiform mineralization hosted in dolomite rocks located west of Calcário Hill.

On July 12, 1974, the state-owned company Mineração Morro Agudo S.A. (MMASA) was formed. Mining rights to Morro Agudo were retained by MMASA. MMASA was subsequently privatized, with shareholding control held by the three major zinc-producing companies in Brazil: Companhia Miniera de Metais (CMM; now part of the Votorantim Group), Companhia Mercantil e Industrial Ingá S.A. and Companhia Paraibuna de Metais S.A.

In 1998, CMM acquired the shares of Companhia Mercantil e Industrial Ingá S. A. and Companhia Paraibuna de Metais S. A, thus obtaining 100% ownership of the Morro Agudo Mine. The operating company name was then changed to Unidade Morro Agudo, a CMM subsidiary.

On May 23, 2005, CMM underwent a further name change to Votorantim Metais Zinco S.A.

Table 6-1: Project History

Year	Operator	Purpose	Work Completed	Comment
1968	Penãrroya	Drilling		Morro Agudo drilling program
1969	U.S. Steel	Surface exploration		Regional geological mapping (Cia Meridional)
1970	CMM (Votorantim Metais)	Drilling	Regional drilling	Focus on gaining stratigraphic understanding
1972	DOCEGEO	Surface exploration	Geological mapping	
1973	Termonoranda	Drilling	Ambrosia Norte initial exploration	Ambrosia Norte deposit discovery
	Metamig		Morro Agudo drilling program	
	ENJEX		Exploratory drilling in Ambrosia Norte	Conducted to define calamine potential
1974–1978	ENJEX/DOCEGEO/CMM (Votorantim Metais)/DNPM	Drilling	Exploratory drilling and mineral potential definition	Regional drilling at the Fagundes, Poções and Morro Agudo prospects and calamine potential definition at Ambrosia Norte
1975	ENJEX/DOCEGEO/CMM (Votorantim Metais)/DNPM	Mine development	Surface works to support shaft sinking	
1976	ENJEX/DOCEGEO/CMM (Votorantim Metais)/DNPM	Mine development	Shaft sinking commenced	
1980–1989	CMM/BSHELL	Drilling	Exploratory drilling and mineral potential definition	Poções, Fagundes and Ambrosia Norte prospects
1988	CMM/BSHELL	Mining	First underground levels developed	Formal underground mining commenced in April
1990–1993	CMM (Votorantim)	Drilling	Exploratory drilling	Regional drilling program for demarcation of new prospective targets in the Morro Agudo region (Morro Agudo, Bento Carmelo, Sucuri)
1994	CMM (Votorantim)	Drilling	Mineral potential definition drilling	Drilling program in general Paracatu region including Morro Agudo, Bento Carmelo, Ambrosia Norte and Fagundes
1995–1997	CMM (Votorantim)	Drilling	Exploratory drilling	Drilling program at Morro Agudo Mine
1998–1999	CMM (Votorantim)	Drilling	Mineral potential definition	Fagundes prospect
2000	CMM (Votorantim)	Drilling	Mineral potential definition	Morro Agudo Mine and Ambrosia Norte prospect

Year	Operator	Purpose	Work Completed	Comment
2001	CMM (Votorantim)	Drilling	Mineral potential definition	Drilling program in Paracatu region (Morro Agudo, Ambrosia Norte and Poções)
	CODEMIG	Geophysics	Aerial MAG-GAMA survey	Covered a large area of the entire Vazante belt (Area 1)
	USTDA	Geophysics	Aerial MAG-GAMA survey	Infill lines over Area 1 block, covering only the carbonate basin between Paracatu and Vazante; a portion of this survey falls within the current Project area
2002–2003	CMM (Votorantim)	Drilling	Exploratory drilling and mineral potential definition	Poções prospect and Morro Agudo Mine
2004–2006	Votorantim	Surface exploration	Exploratory drilling and resource classification. Exploratory auger drilling	Morro Agudo and Fagundes In 2004, CMM was renamed to Votorantim Metais
2007	Votorantim	Surface exploration	Regional scale geological mapping (1:100,000), and local scale mapping (1:20,000), rock, soil, and stream sediment samples	Define potential areas and better understanding of the stratigraphic and metallogenetic context near Morro Agudo Mine
		Drilling	Mineral potential definition	Morro Agudo Mine
2008	Votorantim	Surface exploration	Regional and local-scale mapping (1:100,000 and 1:20,000), rock, soil, and stream sediment samples	Initial exploratory field-work and mineral target definition using geological mapping, rock sampling and geochemical sampling over the Ambrosia, Poções and Fagundes prospect areas
		Drilling	Exploratory drilling and mineral potential definition	Ambrosia, Morro Agudo and Bento Carmelo.
2009	Votorantim	Surface exploration	Regional and local-scale mapping (1:100,000 and 1:20,000), rock samples, soil samples, stream sediment samples	
		Drilling	Exploratory drilling, mineral potential definition and resource clarification	Morro Agudo (deep E block), Retiro and Fagundes. Final Fagundes report submitted to DNPM
		Geophysics	Commencement of aeromagnetic and airborne gravity survey	Ground magnetometric and gravimetric survey over several targets Airborne gravity survey over in Morro Agudo, Bento Carmelo, Sucuri.
2010	Votorantim	Surface exploration	Regional and local-scale mapping (1:100,000 and 1:20,000), soil samples, rock samples, stream sediment samples	Geological mapping and geochemical sampling campaign to define grassroots targets in the Paracatu region
		Drilling	Exploratory drilling and mineral potential definition	Morro Agudo

Year	Operator	Purpose	Work Completed	Comment
2011	Votorantim	Surface exploration	Regional and detail-scale mapping (1:100,000 and 1:5,000), rock, soil, pan concentrate and stream sediment samples	Potential areas definition in Paracatu region
		Drilling	Exploratory drilling and mineral potential definition	Morro Agudo, Poções and Ambrosia. Discovery of Ambrosia Sul
2012	Votorantim	Surface exploration	Regional scale mapping (1:100,000), rock, pan concentrate, soil, and stream sediment samples	Work on the Ambrosia and Paracatu Norte trends. Detail work on Ambrosia Norte and Ambrosia Sul
		Drilling	Exploratory drilling and mineral potential definition	Drilling campaign in Ambrosia trend with a focus in Ambrosia Sul
2013	Votorantim	Surface exploration	Regional, local and detail-scale mapping (1:100,000, 1:20,000 and 1:5,000, rock, pan concentrate, and soil samples	Potential areas definition with a focus on the Paracatu Norte trend. Mineral potential definition along the Ambrosia trend
		Drilling	Exploratory drilling and resource definition drilling	Ambrosia Sul and regional targets
		Geophysics	Ground magnetic survey and commencement of IP surveys	Ground magnetic survey over selected areas. IP survey over the Ambrosia trend to delineate mineralized structures
2014	Votorantim	Surface exploration	Regional, local and detail-scale mapping (1:100,000, 1:20,000 and 1:5,000), rock, pan concentrate, and soil samples	Prospect and anomaly evaluation along the Paracatu Norte trend and detailed exploration on the Ambrosia Trend
		Drilling	Exploratory drilling and mineral potential definition	Ambrosia Trend Discovery of Bonsucesso deposit.
2015	Votorantim	Surface exploration	Regional and local-scale mapping (1:100,000 and 1:20,000), rock, soil, and stream sediment samples	Ambrosia trend, evaluate geologically prospective targets into Paracatu Norte trend
		Drilling	Exploratory drilling, mineral potential definition	Prospects near the Morro Agudo Mine, including the Lapa Azul prospect Evaluation of the Ambrosia Sul and Norte deposits
2016	Votorantim	Surface exploration	Regional and detail-scale mapping (1:100,000 and 1:10,000), rock, soil, and stream sediment samples	Potential target definition with special focus on the Paracatu Norte region. Detail-scale geological mapping of the Fagundes target
		Drilling	Exploratory drilling, mineral potential and resource definition	Bonsucesso.
		Geophysics	IP survey	Bonsucesso and regional targets, including the Poções, and Fagundes prospects

Year	Operator	Purpose	Work Completed	Comment
2017	Votorantim	Surface exploration	Regional, local and detail-scale mapping (1:100,000, 1:20,000 and 1:10,000), rock, soil and pan concentrate samples	Geological mapping along the Ambrosia Trend and at the Lapa Azul prospect
		Drilling	Exploratory drilling, mineral potential and resource definition	Bonsucesso, Morro Agudo–Sucuri trend
		Geophysics	IP survey	Spectral IP survey over Lapa Azul, Lagoa do Sobrado, and Bonsucesso)

6.1.2 Ambrosia Trend

The oxide mineralized cap at Ambrosia Norte was discovered in 1973 by Termonoranda Mining (Noranda). The company drilled 23 holes (3,051 m). Drilling was subsequently conducted by Enjex Mineração Ltda (ENJEX) from 1974–1976 (10 holes for 3,457 m), and, from 1987 onwards, by CMM/Votorantim.

The Ambrosia Sul deposit was discovered in 2011, followed by Bonsucesso in 2014.

Pre-stripping of the Ambrosia Sul open pit commenced in 2016, and the first mill feed material was trucked to the Morro Agudo plant in 2017.

6.2 Production

Votorantim provided a production record for mined ore from the Morro Agudo Mine from 2000 to 2016 (Table 6-2). No reliable information is available for the earlier production period from 1988 to 2000.

Run-of-mine (ROM) production for 2011–2016 is included in Table 6-3.

In recent times, the Morro Agudo plant has processed low-grade material sourced from pillar reclaim, and material from historical tailings deposits. The latter two sources are from materials may not have not been classified as Mineral Resources. Table 6-4 shows the contribution of these materials to mill production for 2012–2016; not all years saw non-classified material being treated. Amec Foster Wheeler notes that there are some inconsistencies in the tonnage data, which have not been fully reconciled; and may partially be attributed to the cumulative effects of rounding of the daily and monthly production data.

The production from the Ambrosia Sul open pit for May and June 2017 is provided in Table 6-4.

6.3 Prior Estimates

Votorantim received exemptive relief from the second part of the definition of “historical estimates” under NI 43-101 in order to disclose a summary of the prior Mineral Resource and Ore Reserve estimates from 2011 to 2015 for the Morro Agudo Project as historical estimates.

Section 1.1 of NI 43-101 defines “*historical estimate*” as follows: “*means an estimate of the quantity, grade, or metal or mineral content of a deposit that an issuer has not verified as a current mineral resource or mineral reserve, and which was prepared before the issuer acquiring, or entering into an agreement to acquire, an interest in the property that contains the deposit*”.

Table 6-2: Morro Agudo Mine Production History (2000–2016)

	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Tonnage	kt	628	613	649	682	812	920	990	990	985	707
Zn Grade	%	5.09	5.30	5.27	5.03	4.86	4.73	4.30	3.99	3.31	3.22
Pb Grade	%	2.06	2.10	1.90	2.17	2.29	2.20	2.03	1.95	1.80	1.49
		2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**			
Tonnage	kt	1,013	970	982	986	996	1,043	994			
Zn Grade	%	2.99	3.03	2.74	2.2	2.53	2.48	2.45			
Pb Grade	%	1.26	0.99	1	0.94	0.94	0.98	0.94			

Table 6-3: Morro Agudo Mine ROM Production (2011–2016)

	Unit	2011	2012	2013	2014	2015	2016
Tonnage	kt	979	990	932	996	1,008	964
Zn Grade	%	3.03	2.74	2.22	2.53	2.48	2.39
Pb Grade	%	0.99	1.00	0.95	0.94	0.98	0.94

Table 6-4: Morro Agudo Mine Production including Non-Classified Material (2011–2016)

	Unit	2010	2011	2012	2013	2014	2015	2016
Tonnage	kt	1,010	979	1,030	979	995	1,007	1,015
Zn Grade	%	2.99	3.03	2.74	2.20	2.53	2.48	2.35
Pb Grade	%	1.26	0.99	1.00	0.94	0.94	0.98	0.92

Table 6-5: Ambrosia Sul Mine Production

	May 2017	June 2017
Tonnes (t)	7,794	26,937
Zn grade (%)	2.48	2.01
Lead grade (%)	0.42	0.20

The relief granted by the Canadian Securities Administrators to Votorantim allows the prior estimates to disclosed as “*historical estimates*” even though Votorantim was the owner of the Morro Agudo Project at the time of the estimates.

These prior estimates are considered by Votorantim to be useful for the purpose of illustrating Votorantim’s ability to replenish Mineral Resources and Ore Reserves during mining activities. Votorantim does not intend to update or verify the prior estimates as current. A portion of the material in the estimates has been mined out.

Table 6-6, Table 6-7, and the accompanying table footnotes summarize the Mineral Resource and Ore Reserve estimates for 2011–2015, and provide, where known, the key parameters, assumptions, and methods that were used by Votorantim staff in preparing the estimates.

The QP has not done sufficient work to classify the prior estimates as current Mineral Resources or Mineral Reserves. Votorantim is not treating the prior estimates as current estimates; the current Mineral Resource estimates are provided in Section 14 of this Report. Note that as this Report presents the results of a preliminary economic assessment of Mineral Resources, there are no Mineral Reserves in Section 15.

Mineral Resource and Ore Reserve estimates were prepared by Votorantim staff, using the guidance and confidence classifications set out in the 2004 edition of the Joint Ore Reserves Committee (JORC) Code (2004 JORC Code). There is no assurance that the prior estimates are in accordance with the Canadian Institute of Mining, Metallurgy and Petroleum (CIM) Definition Standards for Mineral Resources and Mineral Reserves (May 2014; the 2014 CIM Definition Standards) or the CIM Estimation of Mineral Resources and Mineral Reserves Best Practice Guidelines (November 2003; 2003 CIM Best Practice Guidelines), and the prior estimates should not be regarded as consistent with those standards in all aspects.

The prior estimates are supported by internal documentation, but have not been previously disclosed in a technical report under NI 43-101. Votorantim staff performed checks on the supporting data and estimation processes used in the prior estimates as per corporate standards and protocols, which are set out in internal procedures documents. The 2011 Mineral Resource and Ore Reserve estimate was subject to an audit by Snowden Associates, an independent third-party consultant, in 2012.

Mineral Resources were prepared under the supervision of a Competent Person. Software used in the Mineral Resource estimation process included LeapFrog Geo, Datamine™, and ISATIS™. Block models were updated annually, and typically used a 6 m x 6 m x 1 m block size, assuming underground mining using room-and-pillar mining Morro Agudo Mine and the Ambrosia Norte deposit), and conventional open pit mining (Ambrosia Sul Mine). Estimation was performed using ordinary kriging (OK). Confidence classifications assigned were based on an assessment of drill hole spacing, kriging variance, and data quality sourced from quality assurance and quality control (QA/QC) programs. Cut-off criteria and metallurgical recovery assumptions were based on historical data from the Morro Agudo Mine, or factored from the Morro Agudo Mine or the Vazante Operations.

Table 6-6: Prior Mineral Resource Estimates

Confidence Classification	Units	2011	2012	2013	2014	2015
Measured	Tonnage (Mt)	—	—	0.36	-	0.35
	Grade Zn (%)	—	—	7.41	-	5.90
	Grade Pb (%)	—	—	0.25	-	0.52
Indicated	Tonnage (Mt)	—	0.39	0.39	0.33	2.21
	Grade Zn (%)	—	4.34	6.13	4.18	3.60
	Grade Pb (%)	—	1.53	0.84	1.53	1.24
Total Measured and Indicated	***Tonnage (Mt)***	***—***	***0.39***	***0.75***	***0.33***	***2.56***
	Grade Zn (%)	***—***	***4.34***	***6.75***	***4.18***	***3.92***
	Grade Pb (%)	***—***	***1.53***	***0.55***	***1.53***	***1.14***
Inferred	Tonnage (Mt)	2.90	4.04	4.87	6.19	5.96
	Grade Zn (%)	4.43	4.21	4.15	4.18	4.26
	Grade Pb (%)	1.70	1.28	0.70	0.96	0.99

Notes to accompany prior Mineral Resource estimate table:

1. Mineral Resource estimates for the Morro Agudo Mine have an effective date of 31 December of the previous year, such that the 2011 estimate was prepared as of 31 December, 2010, the 2012 estimate was prepared as of 31 December, 2011, the 2013 estimate as of 31 December 2012, the 2014 estimate as of 31 December 2013, and the 2015 estimate as of 31 December, 2014. Mineral Resource estimates for the Ambrosia Sul Mine were first reported in 2013; estimates for 2013 and 2014 have an effective date of 6 September, 2013; the 2015 estimate has an effective date of 22 June, 2015. Mineral Resource estimates for the Ambrosia Norte deposit were first prepared in 2012; the 2012–2015 estimates have an effective date of 30 March each year.
2. Mr Jose A. Lopes, MAusIMM (CP), employed as the Manager of Mineral Resources and Exploration with Votorantim, was the Competent Person responsible for each Mineral Resource estimate, and supervised the Votorantim personnel who prepared the estimates.
3. Mineral Resources were reported exclusive of the Mineral Resources converted to Ore Reserves.
4. Mineral Resources are not Ore Reserves, and do not have demonstrated economic viability.
5. The Mineral Resources for Morro Agudo Mine, and Ambrosia Norte deposit were assumed to be extracted using inclined room-and-pillar methods. The Mineral Resources at the Ambrosia Sul Mine were assumed to be mined by open pit methods.
6. The estimates use varying cut-off criteria. For 2012–2013 at the Morro Agudo Mine, the cut-off was 2.5% Zn+Pb; in 2014 it was NSR > all-in-costs (mining, process, other) of US$34.50/t, and in 2015, it was 2% ZnEq. All Ambrosia Sul estimates used a cut-off of 2% ZnEq. Ambrosia Norte was reported at a cut-off of 2% ZnEq in each year from 2012–2015. ZnEq = ((%Zn * ZnPrice * ZnRecovery) + (%Pb * PbPrice *PbRecovery) / (ZnPrice * ZnRecovery).
7. Metal prices used were variable. For the Morro Agudo Mine, zinc: 2011, US$2,033/t; 2012, US$2,407/t; 2013, US$2,050/t; 2014, US$1,883/t; 2015, US$2,455/t; lead: 2011, US$2,015/t; 2012, US$2,302/t; 2013, US$2,000/t; 2014, US$1,658/t; 2015, US$1,850/t. For Ambrosia Sul, zinc: 2013–2015: US$2,033/t; lead: 2013–2015, US$2,015/t. For Ambrosia Norte, zinc: 2012–2015, US$2,033/t; lead: 2012–2015, US$2,015/t.
8. The zinc metallurgical recovery assumption was 85% for each estimate; lead recovery was assumed at 70%.
9. Mineral Resources were stated as in situ with no consideration for planned or unplanned external mining dilution.
10. Rounding may result in apparent summation differences.

Table 6-7: Prior Ore Reserve Estimates

Confidence Category	Unit	2011	2012	2013	2014	2015
Proved	Tonnage (Mt)	0.12	—	—	0.62	0.61
	Grade Zn (%)	3.18	—	—	3.93	3.93
	Grade Pb (%)	1.54	—	—	0.14	0.20
Probable	Tonnage (Mt)	1.30	0.24	0.54	0.37	0.37
	Grade Zn (%)	3.54	3.31	3.08	3.82	3.80
	Grade Pb (%)	1.52	1.45	1.02	0.21	0.20
Total Proven and Probable	***Tonnage (Mt)***	***1.42***	***0.24***	***0.54***	***0.99***	***0.98***
	Grade Zn (%)	***3.51***	***3.31***	***3.08***	***3.89***	***3.88***
	Grade Pb (%)	***1.52***	***1.45***	***1.02***	***0.17***	***0.20***

Notes to accompany prior Ore Reserve estimate table:

1. Ore Reserves have an effective date of 31 December of the previous year, such that the 2011 estimate was prepared as of 31 December, 2010, the 2012 estimate was prepared as of 31 December, 2011, the 2013 estimate as of 31 December 2012, the 2014 estimate as of 31 December 2013, and the 2015 estimate as of 31 December, 2014.
2. Mr Thiago Nantes, employed as a Long-Term Planning Manager with Votorantim, was responsible for each Ore Reserve estimate, and supervised the Votorantim personnel who prepared the estimates.
3. The estimates were reported using a 2.5% zinc equivalent (ZnEq) cut-off. ZnEq = ((%Zn * ZnPrice * ZnRecovery) + (%Pb * PbPrice *PbRecovery) / (ZnPrice * ZnRecovery).
4. Metal prices used were variable. Zinc: 2011, US$2,033/t; 2012, US$2,407/t; 2013, US$2,050/t; 2014, US$1,883/t; 2015, US$2,455/t; lead: 2011, US$2,015/t; 2012, US$2,302/t; 2013, US$2,000/t; 2014, US$1,658/t; 2015, US$1,850/t.
5. Operating cost assumptions varied by year: 2011: mining cost of US$13.50/t, process cost of US$12.90/t, other costs of US$13.00/t; 2012: mining cost of US$12.90/t, process cost of US$13.50/t, other costs of US$14.00/t; 2013: mining cost of US$13.30/t, process cost of US$14.10/t, other costs of US$13.00/t; 2014: mining cost of US$15.40/t, process cost of US$14.00/t, other costs of US$13.00/t; 2015: mining cost of US$12.70/t, process cost of US$15.10/t, other costs of US$15.00/t.
6. Metallurgical recovery assumptions were 85% for zinc, and 70% for lead.
7. The underground mining method at Morro Agudo Mine was inclined room-and-pillar. The dilution assumptions used in the estimates varied by stope, based on orebody thickness, and on the minimum operational criteria used. On average, operational mining dilution averaged about 20% in the stopes, and about 35% in remnant areas. Mining recovery assumptions included 90% recovery for stopes, and 80% for remnant areas. The open pit assumptions for the Ambrosia Sul Mine were based on conventional open pit mining.
8. Rounding may result in apparent summation differences.

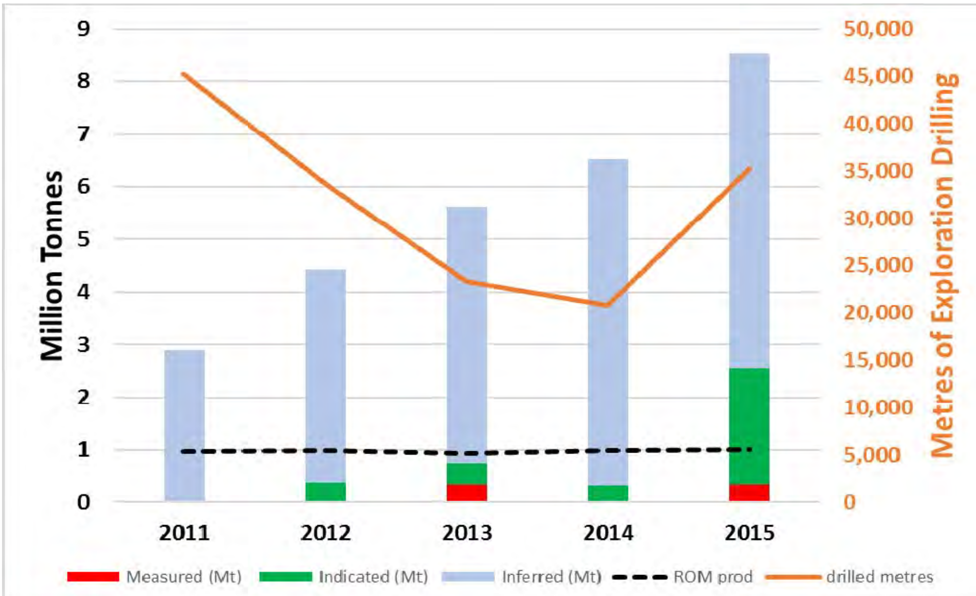
Ore Reserves were prepared under the supervision of an appropriately experienced mining professional who did not have Competent Person status at the time of the estimates. Software used in the Ore Reserve estimation process included Mine 2-4D™ and Deswik™. Mining rooms at the Morro Agudo Mine were assumed to be 12 m wide, x 7 m high, and have an average gradient of about 3%. Cross-cuts were assumed at 4.5 m wide x 4.5 m high, at a similar gradient, and ore drives were assumed at 4.5 m wide x 5 m high, also at a 3% average gradient. The block model was adjusted for operational dilution; dilution assumptions used in the estimate varied by stope, based on orebody thickness, and on the minimum operational criteria used. The mine plan supporting the Ore Reserves assumed a combination of mining of primary stopes, and recovery of rib pillar materials from previously-mined (remnant) areas. A portion of the Ore Reserves were supported by mine plans and mining assumptions that included Mineral Resources; this was allowed under the 2004 JORC Code. On average, operational mining dilution at the Morro Agudo Mine averaged about 20% in the stopes, and about 35% in remnant areas. Underground mining recovery assumptions included 90% recovery for stopes, and 80% for remnant areas.

The Ore Reserves at the Ambrosia Sul Mine, reported in the 2014 and 2015 estimates, were assumed to be mined by conventional open pit methods, in two pit phases. Major assumptions included pit slopes of 65°, minimum mining widths of 8 m, and bench heights of 5 m. A portion of the Ore Reserves were supported by mining assumptions that included Mineral Resources, which was permitted under the 2004 JORC Code.

Ore Reserves also considered other Modifying Factors, including infrastructure, economic, marketing, legal, environmental, social, and governmental factors.

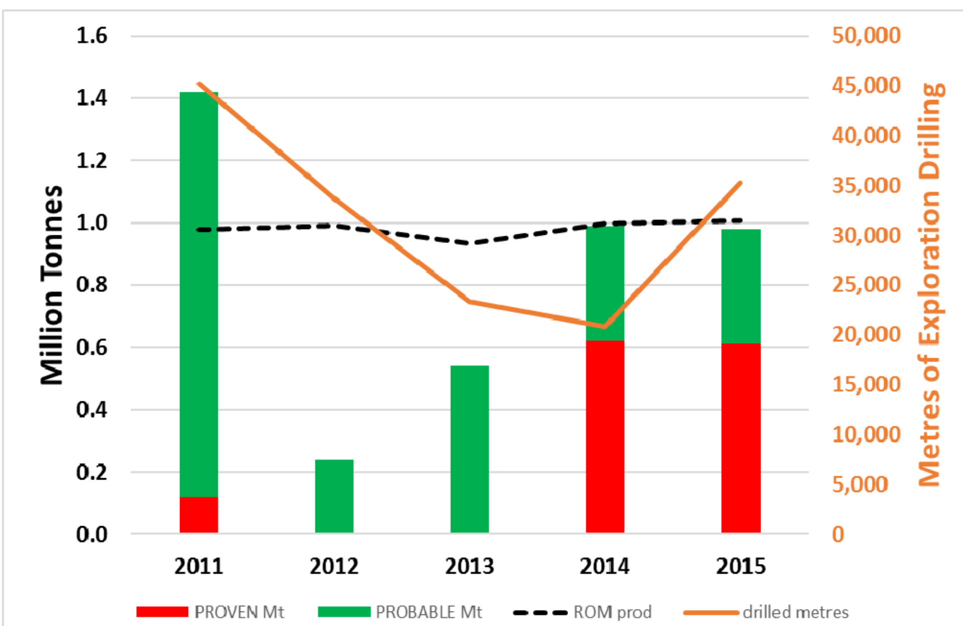
Figure 6-1 is a graphic of the prior estimates that shows the Mineral Resources, drilling completed each year, and the run-of-mine (ROM) production data for each year from 2011 to 2015. Figure 6-2 shows the Ore Reserves against the same drilling and ROM production data.

Figure 6-1: Mineral Resource Prior Estimates, Annual Drilled Metres, and Run-of-Mine Production by Year



Note: Figure prepared by Amec Foster Wheeler, 2017.

Figure 6-2: Ore Reserve Prior Estimates, Annual Drilled Metres, and Run-of-Mine Production by Year



Note: Figure prepared by Amec Foster Wheeler, 2017.

7.0 GEOLOGICAL SETTING AND MINERALIZATION

7.1 Regional Geology

The Morro Agudo and Ambrosia Trend deposits are situated within the Tocantins Province (Almeida et al., 1977), an orogenic system located between the So Francisco Craton, Amazon Craton, and a potential covered third cratonic block in the Paraná watershed. The province is bordered by three orogenic mountain ranges: the Paraguay and Araguaia ranges that border the Amazon Craton, and the Brasília range, which borders the Sao Francisco Craton. The regional geology is shown in Figure 7-1.

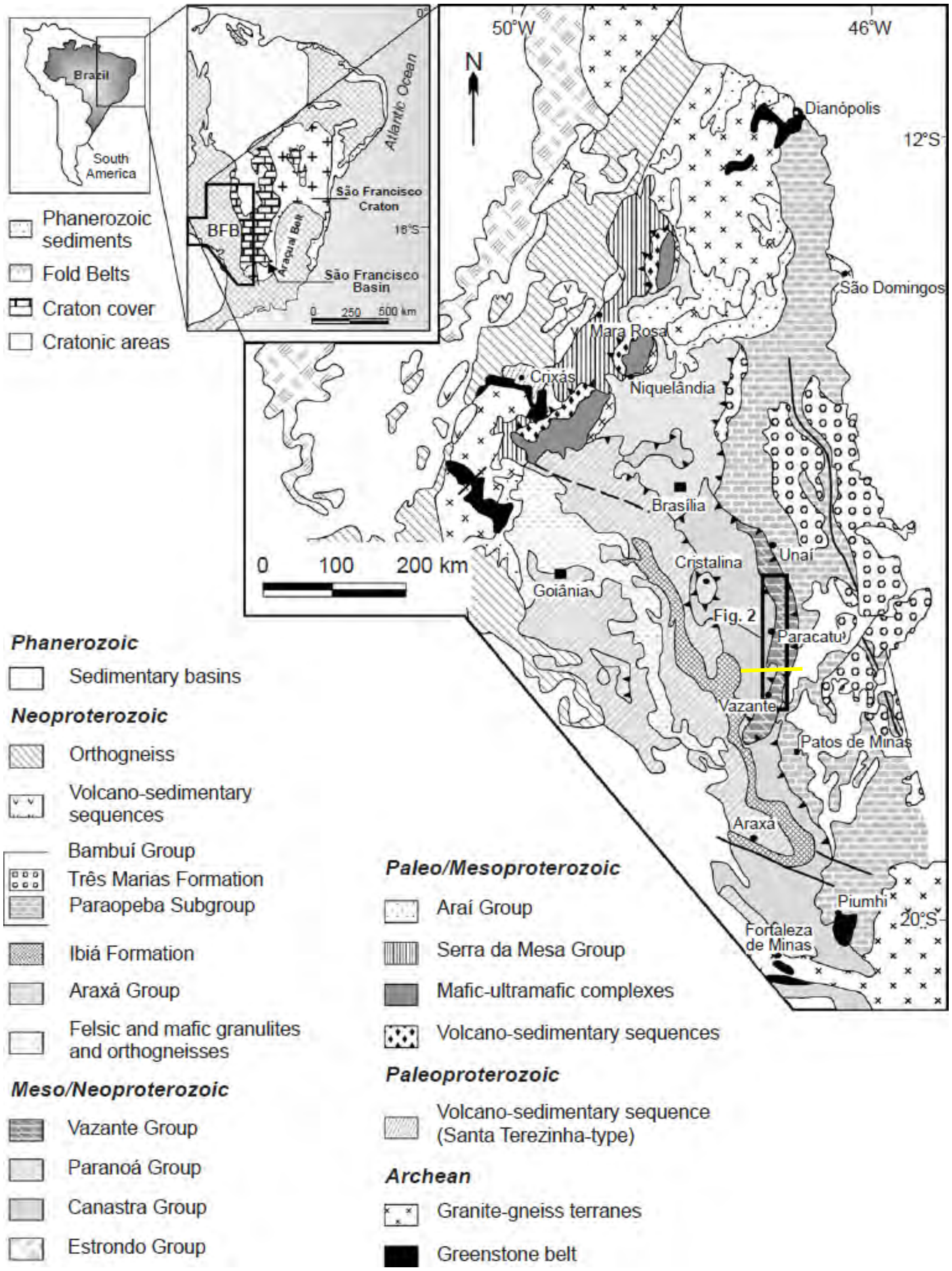
A regional and local geological map is included as Figure 7-2. All known mineralization is hosted by the Meso-Neoproterozoic Vazante Group. Stratigraphy of the Vazante Group is shown in Figure 7-3 (Dardenne, 2000). This stratigraphy is regional in extent and is based on work by CMM in the Paracatu and Unaí region in 1987.

The Vazante Formation was first proposed by Dardenne (1979) to designate a set of pelitic-carbonate units traditionally attributed to the Bambuí Group. The Vazante Formation was split in three sections: basal, intermediate, and top. Later, Dardenne et al. (1998) redefined the Vazante Formation to the Vazante Group which included the Retiro, Lagamar, Serra do Garrote, Serra do Poço Verde, Morro do Calcário, and Serra da Lapa Formations within the Group.

A schematic cross section of the region, showing the contacts between the Vazante, Canastra and Bambuí Groups, is shown on Figure 7-4.

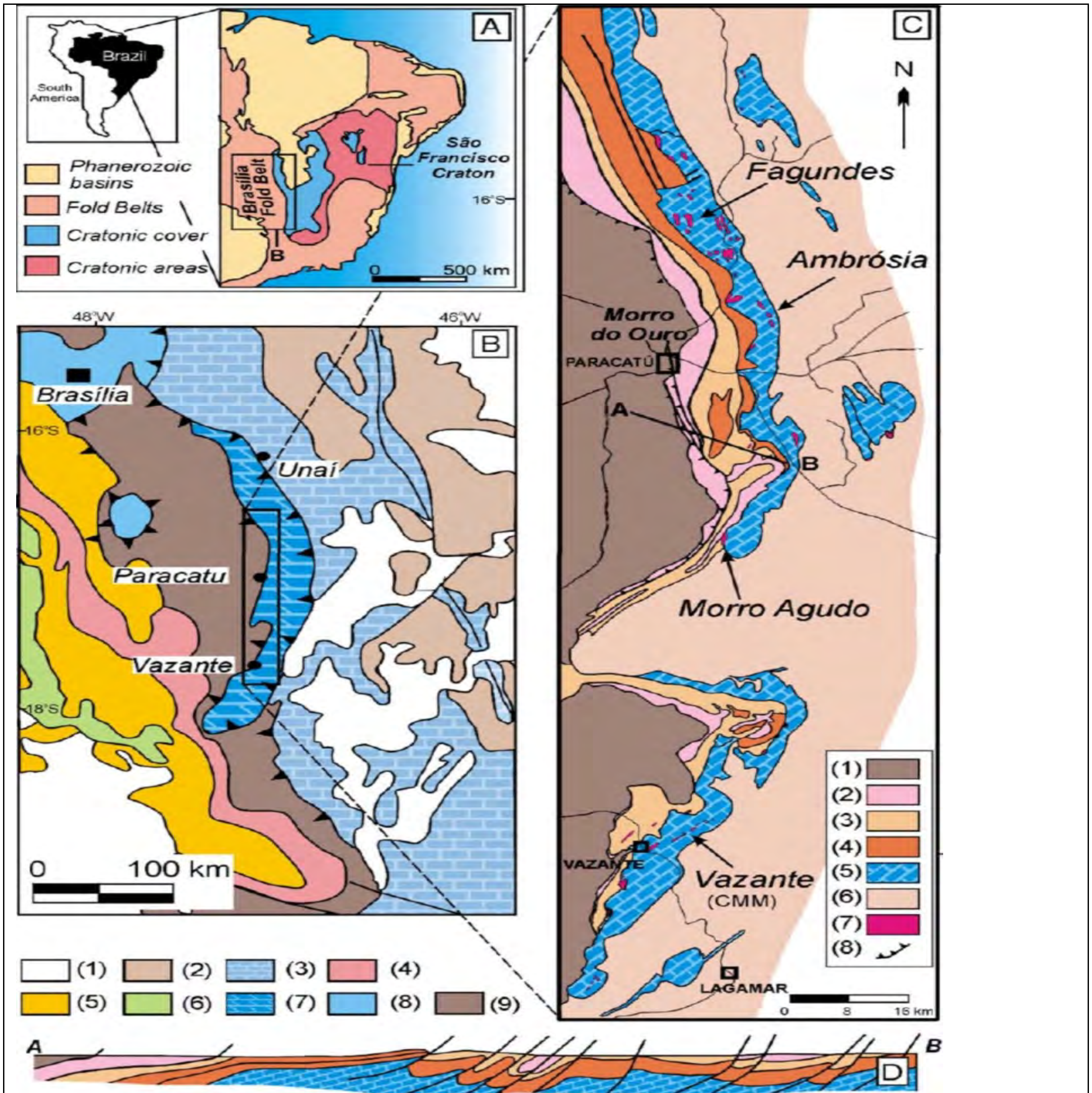
Zinc–lead deposits found in pelitic-carbonate rocks of the São Francisco Craton are considered to be genetically connected to regional compression that forced basinal brines outward and upward along regional structures (Guimarães, 1962; Beurlen, 1974; Iyer et al. 1992; Iyer, 1984). Zinc-lead deposits were deposited along those structures. Major zinc and lead deposits hosted by Vazante Group occur as two major types. The first type is represented by the Vazante zinc silicate deposit, and the second by the Morro Agudo zinc sulphide deposit. These deposit types have distinct lithostratigraphic controls as well as significant differences in terms of hydrothermal (Vazante) and syn-diagenetic (Morro Agudo) origins.

Figure 7-1: Regional Geological Map of the Brasília Fold Belt



Note: Figure from Dardenne, 2000. Yellow line is the approximate position of Figure 7-4.

Figure 7-2: Geological Map of the Brasilia Fold Belt and Sao Francisco Craton



Key:

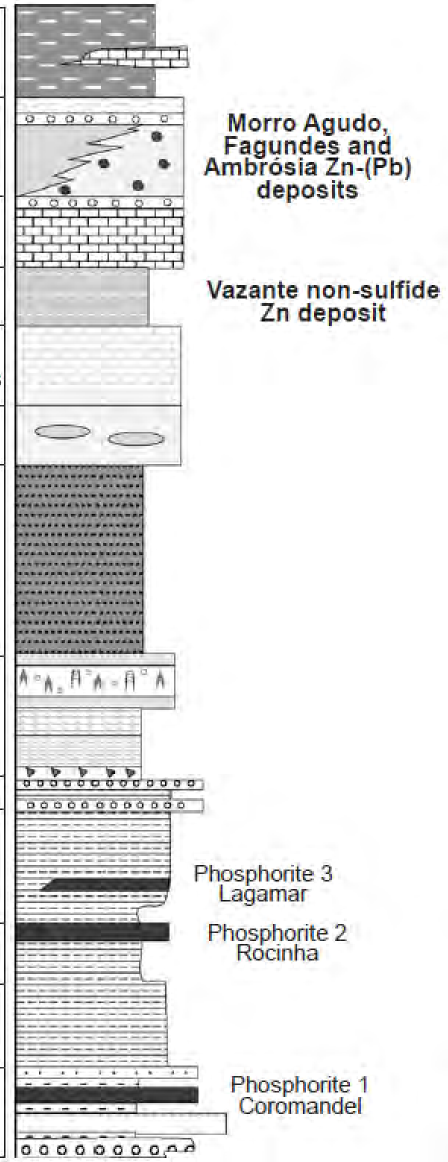
B) 1) Phanerozoic Basins; 2) Bambuí Group, Tres Marias Formation; 3) Bambuí Group, Paraopeba Subgroup; 4) Ibiá Formation; 5) Araxá Group; 6) Felsic and mafic granulite and orthogneiss; 7) Vazante Group; 8) Paranoá Group; 9) Canastra Group

C) 1) Canastra Group, Paracatu Formation; 2) Canastra Group, Serra do Landim Formation; 3) Vazante Group, Serra Da Lapa Member; 4) Vazante Group, Serra do Velosinho Member, Lapa Formation; 5) Vazante Group, Morro do Calcário and Serra do Poço Verde Formations; 6) Vazante Group, Serra Do Garrote Formation; 7) Pb Anomalies.

Note: Figure after Dardenne, 2000; Monteiro et al., 2007.

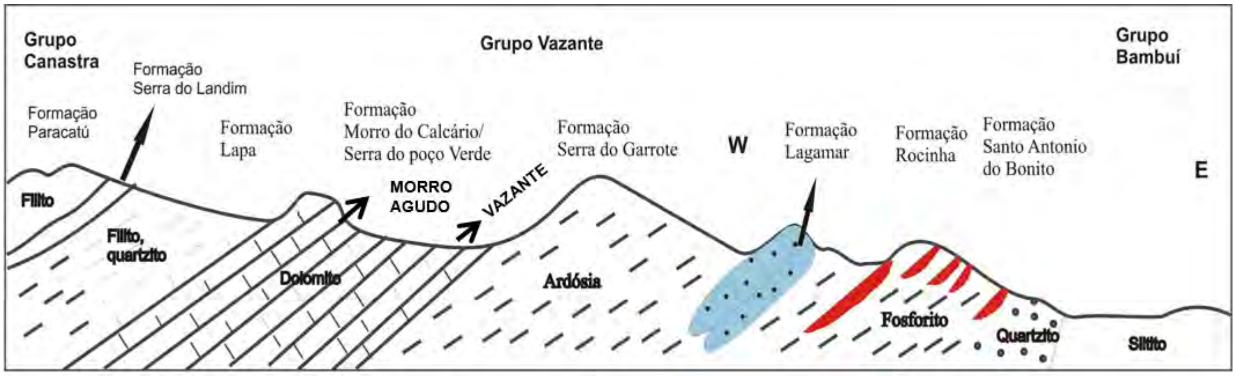
Figure 7-3: Stratigraphic Column

Group	Formation	Member	Description
VAZANTE GROUP	**Lapa**	Serra da Lapa S. Velosinho	Gray carbonate-rich slate, lenses of dolomite, black carbonaceous phyllite
	Morro do Calcário	Upper Pamplona	Stromatolitic bioherm, facies of breccia and dolarenite
	Serra do Poço Verde	Middle Pamplona	Gray and pink dolomite with stromatolitic mats
		Lower Pamplona	Gray and green slate, gray and pink dolomite
		Upper Morro do Pinheiro	Dark gray dolomite with stromatolitic mats and bird's eyes
		Lower Morro do Pinheiro	Light gray to pink dolomite with lenses of breccia and dolarenite
	Serra do Garrote		Gray slate
	Lagamar	Sumidouro	Stromatolitic bioherm Dark gray limestone Dolomitic breccia
		Arrependido	Conglomerate
	Rocinha		Rhythmite
			Dark gray pyritic and phosphatic slate
			Rhytmites
	Sto. Antônio do Bonito		Layers of quartzite, phosphorite, diamictite and slate



Note: Figure after Dardenne, 2000.

Figure 7-4: Schematic Profile of Vazante Group showing Location of Major Mineral Occurrences



Note: Figure adapted from Dardenne et al., 1998. In this figure, Grupo = Group, Formação = Formation., Filito = phyllite, quartzite = quartzite, ardósia = slate, fosforito = phosphorite, siltito = siltstone.

7.2 Morro Agudo Mine

The Morro Agudo zinc and lead deposit comprises a number of concordant stratabound sulphide bodies, non-concordant remobilized sulphide bodies, and intra-formational dolarenites and breccias of the Morro do Calcário Formation.

7.2.1 Lithologies

Mineralization at the Morro Agudo Mine is hosted entirely by the Morro do Calcário Formation which begins with dolomites representing reef stromatolitic deposits with flanks of reworked facies comprising dolarenites and dolorudites. The reef thickness is variable, typically from 100 to 200 m, but they sometimes exceed 650 m thick.

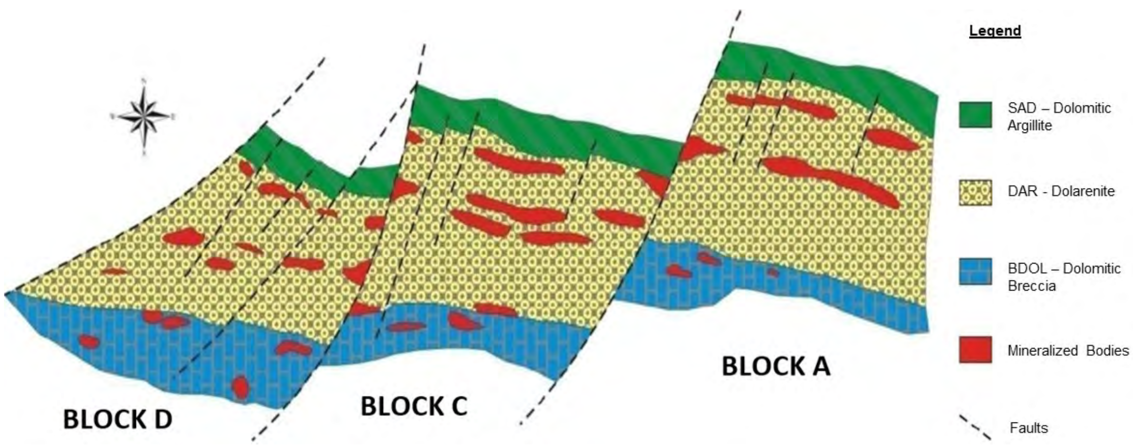
The key lithologies in the mine area are summarized in Table 7-1 and illustrated in Figure 7-4. A cross-section through the deposit is included as Figure 7-5.

The lithologies generally strike northeast overall, varying from N10–20 in the northernmost sector of the mine, to N40–50E in the southern sector. Dips typically average 20° to the northwest.

Table 7-1: Lithological Units, Morro Agudo Mine

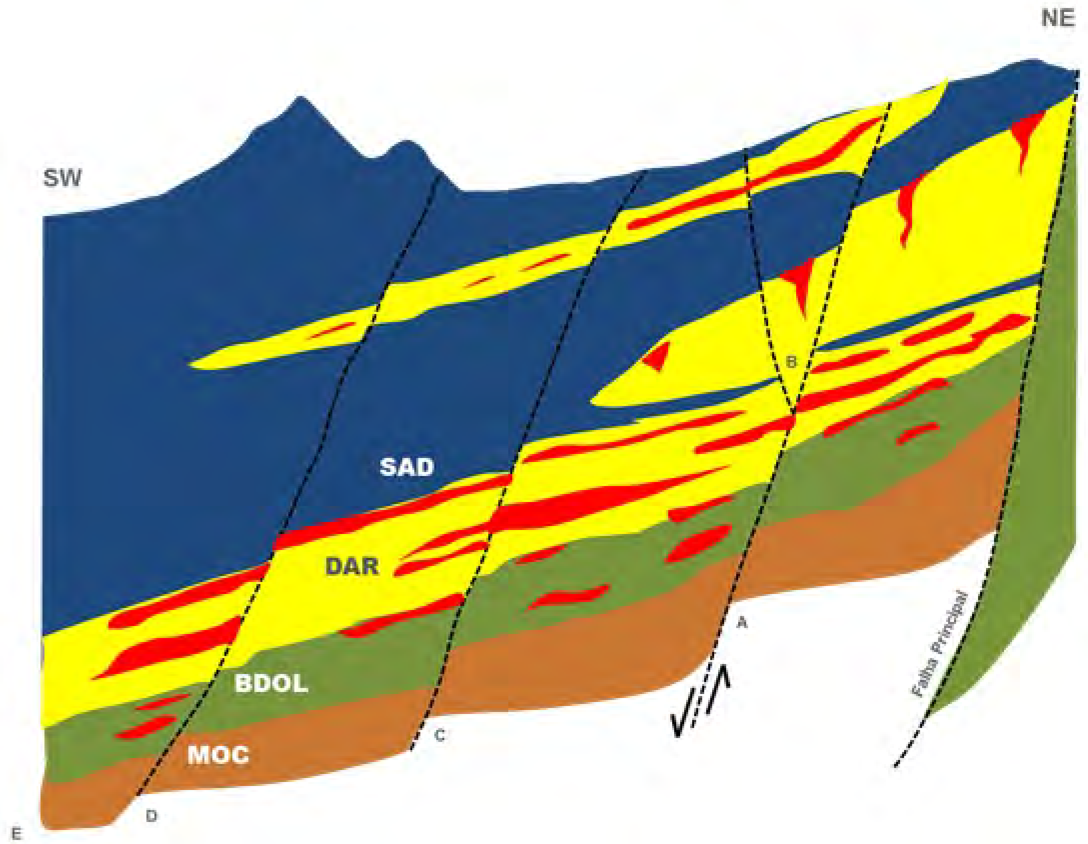
Code	Unit Description
Dolomitic breccia (BDOL)	Gravel-sized dolomite particles (dolorudite): gray breccia of dolomitic matrix, with angular dolomite clasts (sometimes stromatolitic) ranging from 10 cm to 2 m long. Dolorudite occurs on the base of the mineralized sequence. These breccias are composed of angular clasts, angular to rounded, massive, laminated and stromatolitic in a dolomitic matrix, except for the irregular sphalerite pockets in the upper contact.
Dolarenitic breccia (BDAR)	Sand-sized dolomite particles: light gray breccia comprising a dolarenitic matrix with laminated and massive dolomite clasts with angular to locally rounded intraclasts. This unit contains mineralization with high zinc (mainly) and lead grades with little lateral continuity.
Dolarenite (DAR)	Light gray dolarenite, intraclastic, oolitic, oncolytic and peloidal. Dolarenite is the main host rock of sulphide mineralization at the Morro Agudo Mine. This unit has arisen from the lateral and vertical gradation of the dolarenitic breccia. Intraclasts are rounded to ellipsoid, well sorted, smaller than 2 cm, and cemented by dolomite and subordinate quartz. Locally, centimetre- to decimetre-thick layers of nodular black chert occur. Dolomite and quartz are the major mineral types, although the sum of sphalerite, galena, pyrite, fluorite, ankerite, cerussite, barite and calcite account for 45% of the mode, on average.
Dolomitic clay sequence (SAD)	Gray dolomitic marl with millimeter-scale laminations. Millimetre-scale rhythmic interleaving of argillite and dolomitic marl form the rhythmite of this top unit. Dolomite accounts for 80% of the mode, while the remaining corresponds to ankerite, cerussite, barite, quartz, and calcite. Sulphides occur mainly in millimeter- and centimetre-scale carbonaceous levels at the contact with dolarenite. SAD lenses, known as LAB (basal laminate) locally occurs within DAR. These beds vary from a few centimeters to 2 meters in thickness

Figure 7-5: Schematic Geological Plan of the Morro Agudo Mine



Note: Figure courtesy Votorantim, 2017. Note that the mineralized bodies appear to be thinning with depth.

Figure 7-6: Schematic Cross Section through Morro Agudo Mine Area



Note: Figure courtesy Votorantim, 2017. Abbreviations used for geology are explained in Table 7-1.

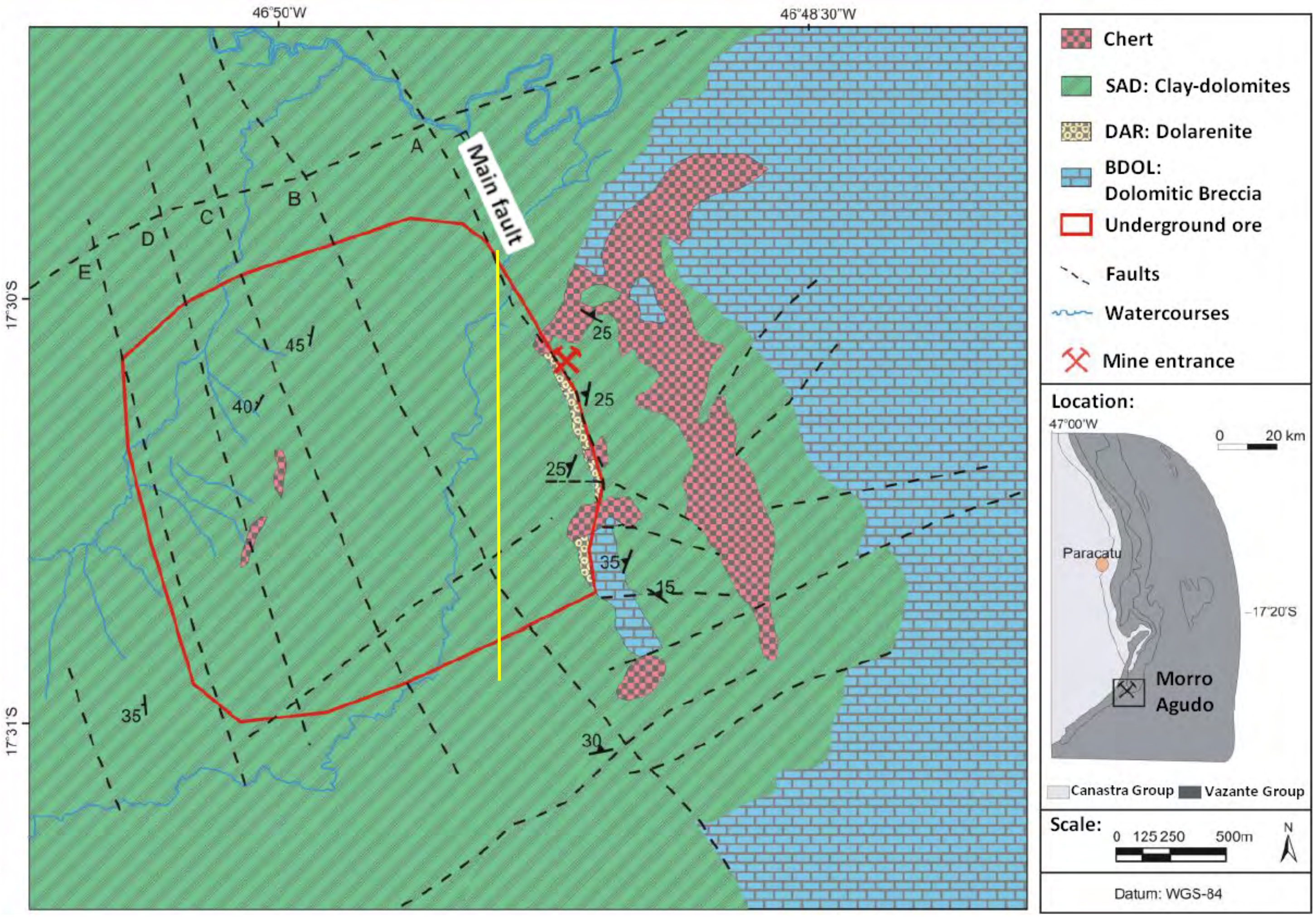
7.2.2 Structure

The deposit is bounded to the northeast by the Main Fault (Falha Principal), which has a N15-20W orientation and 75°SW dip. This fault forms the contact between dolomitic breccia and stromatolitic dolomite, and dolarenite and mineralized breccias. A number of other normal faults have developed, paralleling the Main Fault (Figure 7-7). The faulting has dismembered the deposit into a number of fault blocks, designated A to E.

Block A is the closest to the Main Fault, and Block E is the deepest, and most distant from the Main Fault (refer to Figure 7-5).

A second fault system trending east-west has also been observed. Spacing between faults in this system is in the order of 2 km.

Figure 7-7: Geology Map Showing Faulting



Note: Figure from Neves, 2011. Yellow line is the approximate location of Figure 7-8.

A large number of small-magnitude faults have been encountered in the vicinity of the Main Fault during mining. These secondary faults are spaced in the order of about 4–5 faults per 10 m. Displacements across the faults is typically in the order of centimetres, but can reach as much as 5–6 m.

Due to the close-spacing of the secondary faults, and the amount of alteration, drilling does not always identify these faults. As a result, careful and detailed mapping of the stopes and galleries is required to identify faults that have displacements significant enough to affect mining activities. This mapping is critically important for a thorough understanding of the geological mine structure.

No evidence of folding has been observed to date.

7.2.3 Mineralization

The combined length of the known mineralized bodies is approximately 1,700 m, the width is about 1,200 m, and the bodies have a variable thickness with a maximum of about 10 m. Mineralization is bounded to the northwest by the Main Fault. The western limit has not yet been defined, but drilling has shown continuity of mineralization at depth. Drilling deeper than 1,000 m has shown continuity of mineralization at depth, but with thinner intercepts (1 to 5 m) and lower grades.

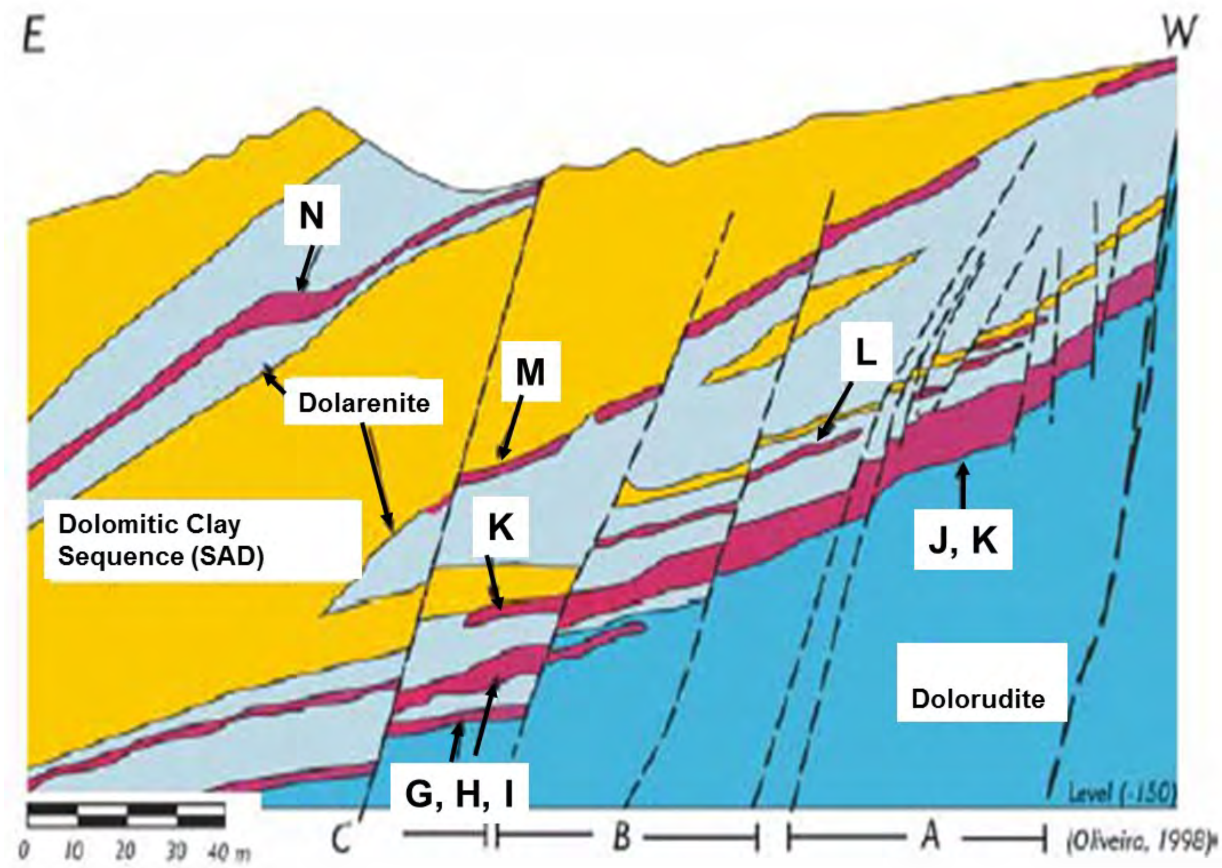
The mineralized bodies are separated from each other by waste intervals of stratified dolarenites at upper and intermediate levels, and by waste breccias at lower levels. Sulphide levels occur as concordant stratabound lenses in dolarenite, and subordinately in dolomitic and dolarenitic breccias, in addition to occurring as late tectonic structure fill (faults/fractures). These sulphide lenses are typically less than 4 m thick, and separated by barren intervals that range from a few centimetres to several metres, depending on the lithology where they are deposited.

Mine geologists have identified eight mineralized strata, denominated from G to N, from the base to the top, respectively that are consistent across the deposit despite being divided by faults (Figure 7-8).

According to Rubo and Monteiro (2010), three episodes of mineralization are identified at the Morro Agudo deposit:

- Event 1: replacement of breccia matrix for chalcedony with very fine to fine-grained sphalerite and other sulphides, mostly preserving the micritic carbonate particles and giving rise to mineralized dolarenites
- Event 2: filling of voids (veins and larger cavities) by fine to coarse-grained sphalerite, pyrite, and galena
- Event 3: Formation of late veins with sulphides cutting the veins that were deposited in the second event.

Figure 7-8: Geological Profile of Morro Agudo Mine



Note: Figure after Oliveira, 1998. Letters indicate the positions of known mineralized bodies.

Mineralization Hosted in Basal Dolomitic and Dolarenitic Breccias (Bodies G, H, I)

Mineralization hosted in breccias occurs as <5 m thick, discontinuous lenses concordant with the dip in the basal part of the deposit. Galena and coarse sphalerite occur in discontinuous and/or sparsely disseminated pockets. Sulphides occur as medium to coarse galena and sphalerite aggregates, or more rarely in the clasts in intraformational breccia matrix (dolomitic/dolarenitic). Usually, sulphides occur replacing carbonate as clast cement and filling up voids (dissolution).

In basal breccias, at least two mineralization stages are recognized. An initial stage is represented by fine-grained sphalerite preferentially occurring along the lamination in laminated dolomite clasts indicating that this mineralization was deposited prior to brecciation or selective clast replacement. The main stage is represented by sphalerite, galena, and pyrite, which occur as coarse crystals, especially on intraclast borders, filling voids (veins and cavities), or along stylolite surfaces in these bodies. White sparry dolomite, quartz, and chalcedony are commonly associated with coarse sulphides.

Dolarenitic Mineralization (Bodies J, K, L, M)

These four mineralized bodies are the most extensive in the deposit, and occur as lenses hosted in dolarenite. The mineralization hosted in dolarenite shows better continuity than the mineralization found in the basal breccia, with lenses more than 10 m thick, with average grades of about 4.5% zinc and 2.5% lead.

This mineralization is hosted in oolitic dolomites cemented by fine to coarse sulphides (especially sphalerite). Body M consists of irregular veins of coarse sphalerite and galena in dolarenites at the top of Morro do Calcário Formation. This mineralization is characterized by total or partial replacement of carbonate cement and intraclasts by fine-grained sphalerite, galena, and pyrite.

Dolarenites contain veins and pockets filled by second generation coarse-grained, brown sphalerite with lesser galena and pyrite.

Stratiform Mineralization (Body N)

This type of mineralization is hosted by dolarenite lenses within the SAD. Mineralization consists of very thinly bedded red/green chert, galena, sphalerite, and pyrite, with massive pyrite levels concordant to host rock lamination.

7.3 Ambrosia Trend

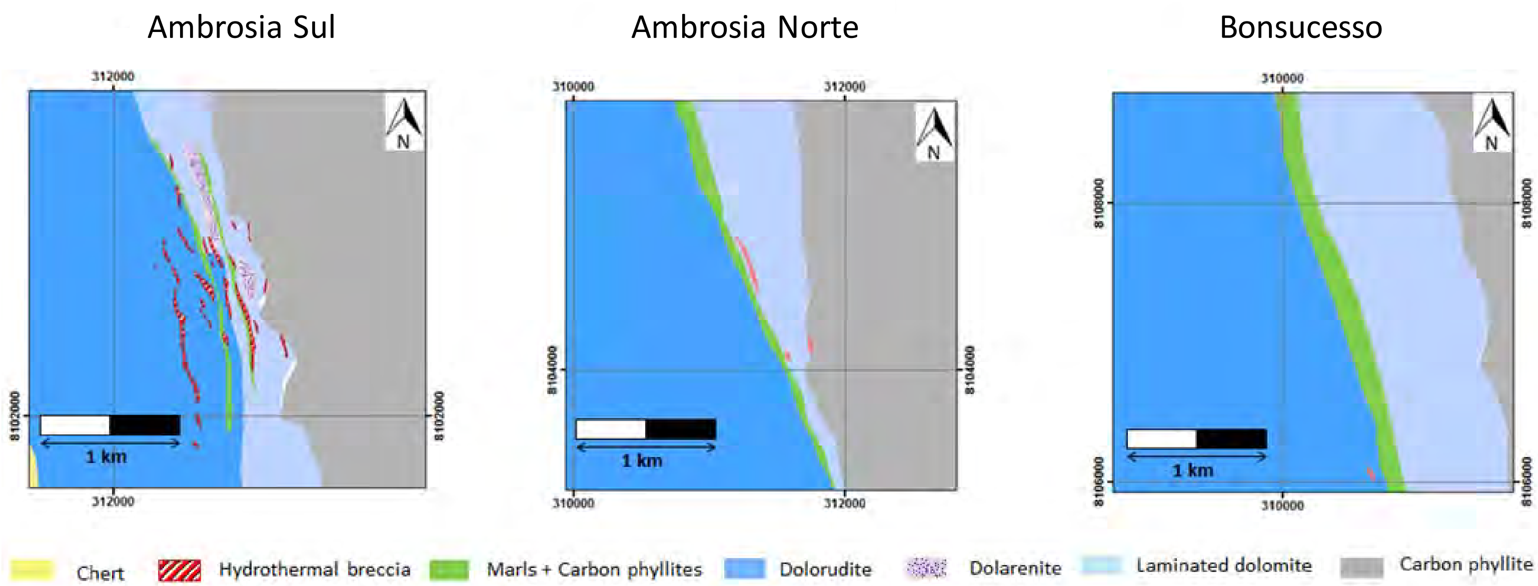
The Ambrosia Trend deposits (Ambrosia Sul, Ambrosia Norte and Bonsucesso deposits) occur in the pelite–carbonate rocks of the Vazante Group in a similar stratigraphic position to Morro Agudo. Lower greenschist facies metamorphism has affected the Vazante Group in the area. When it is possible to recognize sedimentary textures, the prefix “meta” is not used for lithological descriptions.

7.3.1 Lithologies

A simplified geological map for the deposits along the Ambrosia Trend is included as Figure 7-9.

The main lithologies found in the Ambrosia Trend include dolomites, stromatolite dolomites, dolorudites, dolarenites, diamictites, marls, and carbonaceous shale (Table 7-2).

Figure 7-9: Geological Map, Ambrosia Trend



Note: Figure courtesy Votorantim, 2017.

Table 7-2: Lithological Units, Ambrosia Trend

Code	Unit Description
Dolomites (DO)	Carbonate sedimentary rocks, light to dark gray, micritic, recrystallized, with a massive laminated or stromatolite texture
Dolorudites (DT	Poorly sorted, gray, and contain subrounded to angular clasts of varied sizes and shapes. The dolorudites breccias sometimes have a micritic matrix and sometimes they have a dolarenitic matrix with local stromatolite clasts.
Dolarenites (DL)	Gray with fine to medium grained, rounded to subrounded, inequigranular grains, can sometimes be microconglomeratic.
Diamictites (DI)	Light gray to black, matrix-supported breccias consisting of fine-grained carbon matrix with dispersed clasts of pelitic and sometimes carbonaceous rock that display varied shapes and sizes
Marl (MG)	Fine-grained, very thinly bedded marl
Carbon-rich phyllite (FC)	Very fine grained, black, consisting in carbon material, sericite, and quartz. It is commonly folded and hosts pyrite lenses
Hydrothermal dolomite breccia (BH)	Gray, quite dense, with in situ subrounded to angular clasts of dolomitic rock that can vary from mm to cm in scale. These breccias are clast or matrix supported, veined, and contain significant secondary porosity (matrix of the breccia, fractures, veins) filled with white dolomite, quartz, and fine grained, light yellow to colorless sphalerite with a resin-like lustre. Finely-disseminated galena and finely-disseminated to massive pyrite locally occur.
Soil (SO)	Red, brown, ochre and black soil.
Saprolite (SG)	Ochre yellowish saprolites.

The carbonate rocks contain brecciated intervals (hydrothermal dolomitic breccia and variations) that host the mineralization. The facies assemblages suggest deposition in a platform environment.

Some variations of the hydrothermal breccia were identified and differentiated based on texture and mineralogical content:

- DS: Variations of the hydrothermal breccia with random or small mass sulphide disseminations, with sulphide contents in the order of 10% to 50%. Sulphides include pyrite, sphalerite, and galena
- Vein mineralization: Can include zoning, which from the centre out, is white dolomite, galena (rare), sphalerite, pyrite,
- MS: Well mineralized hydrothermal breccia, with sulphide contents >50%. Sulphides include pyrite, sphalerite, and galena
- Massive pyrite: consists almost completely of massive pyrite.

7.3.2 Weathering

A strong weathering profile has developed over zones of weakness such as hydrothermal breccia (with or without mineralization) and vertical fractures. Weathering may be hundreds of metres deep and extend for dozens of metres laterally around karst features where cavities may be filled with disturbed material best described as soil with organic material (roots), magnetic minerals, and abundant clay minerals.

Weathering profiles tend to have different colours, depending on the underlying lithology: profiles over dolomites tend to produce reddish soils; over sulphides, the soil is dark brown; and over pelites, the soil is yellowish.

7.3.3 Structure

Structures identified to date include sedimentary bedding, hydrothermal veins, fractures, and faults.

Sedimentary bedding (S0) is easily recognized in the drill core. These are features marked by lithological differentiation such as pelite and dolomite intercalation, algal lamination, and locally wave marks and planar dissolution levels.

Hydrothermal veins at a micro-scale have irregular characteristics; however, at the macro scale, they tend to show a preferred direction. The mineralogical composition is varied, but usually consists of an association of quartz–silica–dolomite–pyrite–sphalerite–galena.

Veins have been separated into two groups:

- Mineralized veins consisting essentially of sphalerite (locally may also contain galena, pyrite, quartz, silica, and dolomite)
- Non-mineralized veins (lacking sphalerite).

The dominant structural direction is N15W with a very steep dip (>80^{o}). A subordinate low dip angle trend with average direction N79E/37NW appears in the data.

Fractures and faults are both recognized in drill core. Fractures, in general, are rectilinear, constant planes with a variable spacing. Some are filled with quartz–dolomite; some have no filling. Fractures are dominantly found in two main planes, N75E/15NW and N53E/45SE.

Faults can be reverse, normal, or transcurrent, and the reverse and normal types are most commonly recognized:

- Reverse faults have a well-defined pole with attitude N18E/82SE
- Normal faults have a main pole direction of N22W/75NE
- Transcurrent faults have a characteristic sinistral (left-directed) motion. Those faults are identified through the presence of grooves and fault steps along fault plane
- The Ambrosia fault is an nearly bedding parallel original normal fault that later was reactivated as a thrust fault. It extends for 5 km in a N25W direction.

These elements suggest that the structural framework has at least four strain phases (D1, D2, D3 and D4) in direct response to regional compression. That compression is attributed to the closure of the Brasília Fold Belt. The final phase, D4, is marked by the ascension of hydrothermal fluids, reactivation of inverse faults internal to dolomite units, and deposition of mineralized veins along existing structures.

7.3.4 Mineralization

Mineralization is hosted in dolomitic breccias along the Ambrosia Fault. At Ambrosia Norte and Bonsucesso, mineralization is predominantly vein-like, and is associated with brecciated dolomites (Figure 7-10) of the Morro do Calcário Formation. In most cases, there is a single mineralized structure, but occasionally, two or more mineralized structures are present. At Ambrosia Sul, mineralization is controlled by hydrothermal breccias in a flower morphology (Figure 7-11).

There are two types of mineralization associated with the Ambrosia Fault:

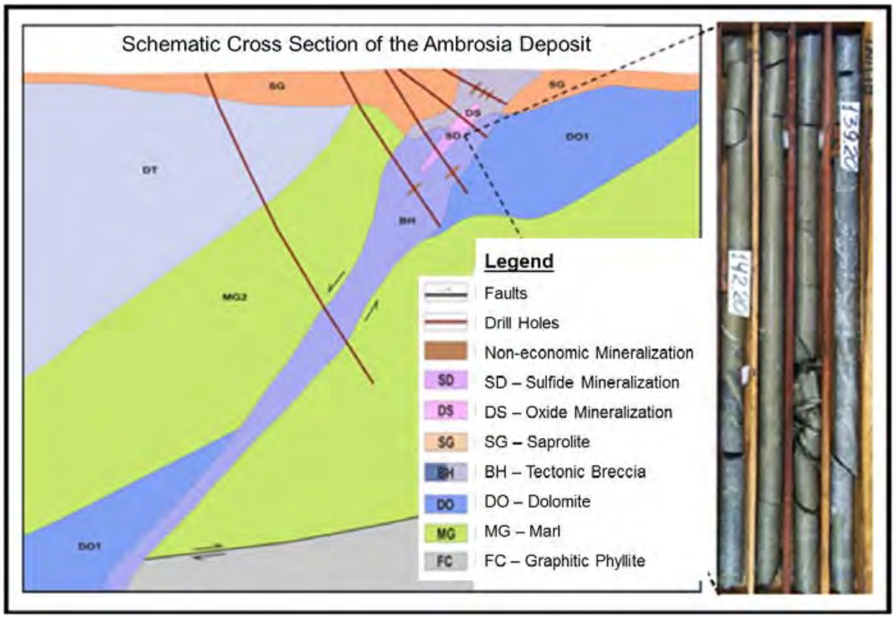
- Oxide mineralization: smithsonite and cerussite. The calamine mineralization (a mixture of the zinc secondary minerals hemimorphite ($Zn_4(Si_2O_7)(OH)_2 \cdot H_2O$) and smithsonite ($ZnCO_3$), was generated by weathering and supergene enrichment of the sulphide mineralization
- Sulphide mineralization: sphalerite and galena. Sulphide mineralization mainly fills microfractures in the rock and is associated with dissolution areas (cavity filling) together with sparry dolomite and pyrite.

The main mineralization stage is represented by the formation of sphalerite and significant concentrations of pyrite with subordinate galena concentrated in thin veinlets and vein networks that cut the recrystallized dolomite. Near the surface, there is a significant concentration of calamine (Monteiro, 2002).

7.4 Prospects/Exploration Targets

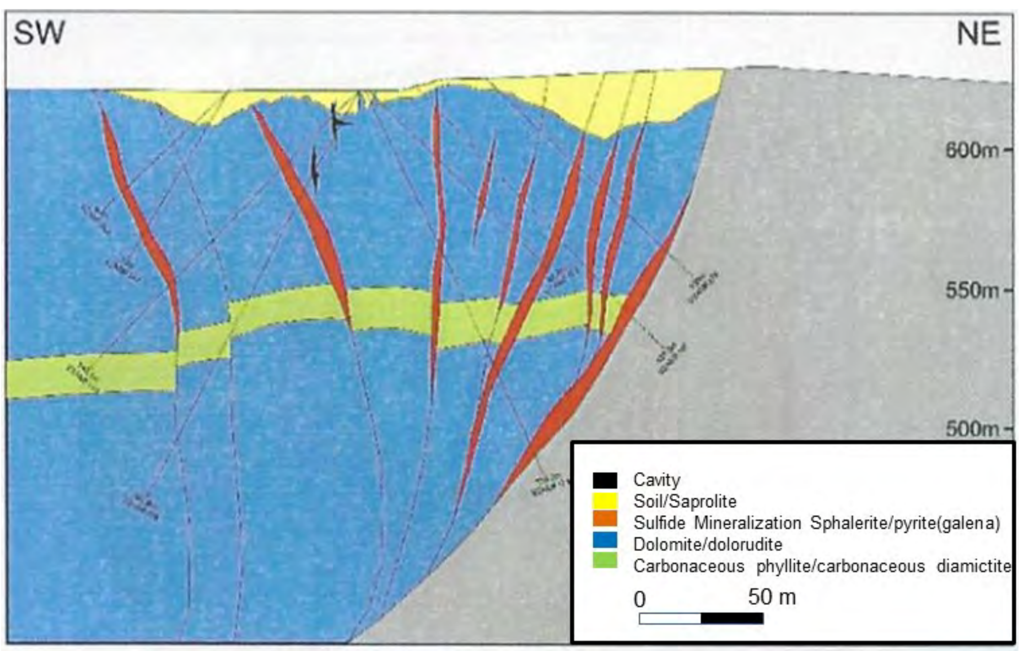
Exploration potential is discussed in Section 9.5.

Figure 7-10: Schematic Cross Section, Ambrosia Norte looking Northwesterly



Note: Figure courtesy Votorantim, 2017.

Figure 7-11: Section 250 N Ambrosia Sul



Note: Figure courtesy Votorantim, 2017.

7.5 Comments on Section 7

The zinc–lead deposits at Morro Agudo and Ambrosia are hosted by Vazante Group carbonates and pelites. The Morro Agudo deposit is hosted by Morro do Calcário Formation, a large dolomite reef. The Ambrosia Trend deposits (Ambrosia Sul, Ambrosia Norte and Bonsucesso) occur in the pelite-carbonate rocks of the Vazante Group in a similar stratigraphic position as Morro Agudo.

The Morro Agudo zinc and lead deposit comprises a number of concordant stratabound sulphide bodies, non-concordant remobilized sulphide (sphalerite and galena) bodies, and intra-formational dolarenites and breccias of Morro do Calcário Formation. The combined length of the known mineralized bodies is approximately 1,700 m and the width is about 1,200 m. Thickness is variable but generally 2 to 5 m with some bodies as thick as 10 m locally.

Mineralization at Ambrosia is predominantly vein-like and is associated with brecciated dolomites. The main mineralization stage consists of sphalerite and significant concentrations of pyrite with subordinate galena concentrated in thin veinlet and vein network that cut the recrystallized dolomite. The mineralization is hosted in a dolomitic breccia generated by hydrothermal fluids that used the Ambrosia Fault as a conduit.

Amec Foster Wheeler concludes that the regional and local geological setting is sufficiently well known to support Mineral Resource estimation and mine planning.

8.0 DEPOSIT TYPES

8.1.1 Deposit Model

The mineralization at Morro Agudo and the Ambrosia Trend are considered to be examples of Irish-type Zn-Pb deposits hosted by carbonate rocks which are a subclass of Mississippi Valley Type deposits. Similar deposits occur in Navan, Lisheen, Tynagh, Silvermines, Galmoy, Ballinalack, Allenwood West in Ireland, and at Troya in Spain.

Irish-style deposits represent a distinctive sub-class of the Mississippi Valley type carbonate-hosted zinc–lead deposit styles, having geological features and genetic models that are hybrids between sedimentary exhalative (SEDEX; also known as clastic zinc–lead deposits) and Mississippi Valley-type (MVT) deposits.

The deposit model description that follows is adapted from Hõy, (1996).

Irish-type deposits typically are hosted by platformal sequences on continental margins which commonly overlie deformed and metamorphosed continental crustal rocks. Known deposits are believed to be Paleozoic in age and younger than their host rocks. They form adjacent to normal growth faults in transgressive, shallow marine platformal carbonates; they are also commonly localized near basin margins.

The host rocks are typically thick, non-argillaceous carbonate rocks that are commonly the lowest pure carbonates in the stratigraphic succession. They can comprise micritic and oolitic beds, and fine-grained calcarenites in a calcareous shale, sandstone, calcarenite succession. Underlying rocks may include sandstones or argillaceous calcarenites and shales.

Deposits are typically wedge shaped, ranging from over 30 m thick adjacent to, or along growth faults, to 1–2 cm bands of massive sulphides at the periphery of lenses. Economic mineralization rarely extends more than 200 m from the faults. Large deposits comprise individual or stacked sulphide lenses that are roughly concordant with bedding. In detail, however, most lenses cut host stratigraphy at low angles. Contacts are sharp to gradational.

Sulphide lenses are massive to occasionally well layered. Typically, massive sulphides adjacent to faults grade outward into veinlet-controlled or disseminated sulphides. Colloform sphalerite and pyrite textures occur locally. Breccias are common with sulphides forming the matrix to carbonate. Sphalerite–galena veins, locally brecciated, commonly cut massive sulphides. More rarely, such as at Navan in Ireland, thin, laminated, graded, and cross-bedded sulphides, with framboidal pyrite, occur above more massive sulphide lenses.

Economic minerals typically include sphalerite, and galena. Minerals that can be associated with mineralization include barite, chalcopyrite, pyrrhotite, tennantite, sulphosalts, tetrahedrite, chalcopyrite, dolomite, calcite, quartz, pyrite, marcasite; siderite, barite, hematite, and magnetite.

Extensive early dolomitization formed an envelope around most deposits that typically extends tens of metres beyond the sulphides. Dolomitization associated with mineralization is generally fine grained, commonly iron-rich, and locally brecciated and less well banded than limestone

8.1.2 Discussion

The Morro Agudo and Ambrosia Trend deposits share some common characteristics, according to Monteiro (2002):

- Dolomitic host rocks
- Mineralization in zones of higher permeability and associated with faults
- Mineralization fluids with temperatures higher than 250° C and salinity moderate to high
- Geochemical signature of zinc, lead, cadmium, germanium, copper, silver, arsenic, cobalt, gold, antimony, nickel, and mercury.

At the Morro Agudo Mine, (Neves, 2011), the mineralization is associated with multiple events. The part of the mineralization that is massive and stratiform displays characteristics that are similar to those of SEDEX deposits. However, the remainder of the deposit show more similarities to the MVT deposits: such as epigenetic ores, including the association with carbonates, strong structural controls, and carbonate–sulphide replacement. Overall, these similarities indicate that the Irish-style deposits are the best analogue.

Table 8-1 summarizes the main characteristics of the deposits.

There is limited information on the deposits in the Ambrosia Trend. Monteiro (2002) identified several similarities to MVT–Irish type deposits at Ambrosia Norte, and characterizes the deposit genesis as two-stage: an early stage in which the fluids are mobilized in association with initial deformation and fracturing; and a late stage with basin fluids expelled in the end of the deformation phase.

Table 8-1: Main Deposit Characteristics of Ambrosia and Morro Agudo

	Morro Agudo Mine	**Ambrosia**
Host rocks	Breccias, dolarenite and dolorudites (Upper Pamplona Member)	Brecciated dolomite (Morro do Calcário Formation)
Mineralization controls	Fault zone (N10W/75SW); stratigraphic control [6,7]	High-angle fault zone (N30W/80SW)
Hydrothermal alteration	Silicification later than the main mineralization	Replacement by sparry dolomite and ankerite, silicification
Mineralization styles	Syndiagenetic to epigenetic	Epigenetic
Types	Stratiform mineralization, breccia mineralization, veins[6]	Veins
Mineralogy	Galena, sphalerite, pyrite, calcite, dolomite, barite, quartz	Pyrite, sphalerite, galena, dolomite, quartz, marcasite, phyllosilicates, apatite
Fluid inclusion results	Salinity: 0-23[6]; TH: 80-283[6]; T: 80-386[6] (stable isotope data)	Salinity: 5-22; TH:122-244[1]
Sulphur source	Two sources: Thermochemical reduction of evaporitic sulphate and hydrothermal[6,7,8]	Hydrothermal [2]

Notes: Table from Monteiro et al (2005). 1) Bettencourt et al. (2001); (2) Monteiro and Bettencourt (2001); (3) Monteiro (1997); (4) Monteiro et al. (1999); (5) Dardenne and Freitas-Silva (1999); (6) Cunha et al., (2000); (7) Misi et al. (1999); (8) Misi et al. (2000)

8.2 Comments on Section 8

The structural and stratigraphic controls are sufficiently well understood to provide useful guides to exploration, Mineral Resource estimation, and mine planning.

The QP considers an Irish-style deposit model to be appropriate to support exploration vectoring.

9.0 EXPLORATION

9.1 Grids and Surveys

All location data within the Project is recorded using UTM SAD69 zone 23S, Meridian Central -45.

A topographic survey was performed over the Ambrosia Sul and Ambrosia Norte deposits, which generated a surface topography grid at a 1 m contour scale.

The regional topographic surface used to reconcile exploration information and 3D software (Leapfrog) is the shuttle radar topography mission (SRTM); contour lines every 5 m were created using GEOSOFT software.

All data on the Project are in UTM SAD69 zone 23S, Meridian Central -45.

9.2 Geological Mapping

Geological mapping programs were completed, as required since 1969. Mapping scales range from regional (1:100,000, 1:75,000, 1:50,000, and 1:20,000) to more local (1:10,000 to 1:5,000), as exploration vectored into targets that warranted the additional level of detailed mapping. Information such as lithology types, gossan and sulphide zinc exposures, alteration zones, and faults and structural data was collected. Votorantim estimates that more than 1,400 outcrops were visited, mapped, and sampled in the Project area from 2007–2017.

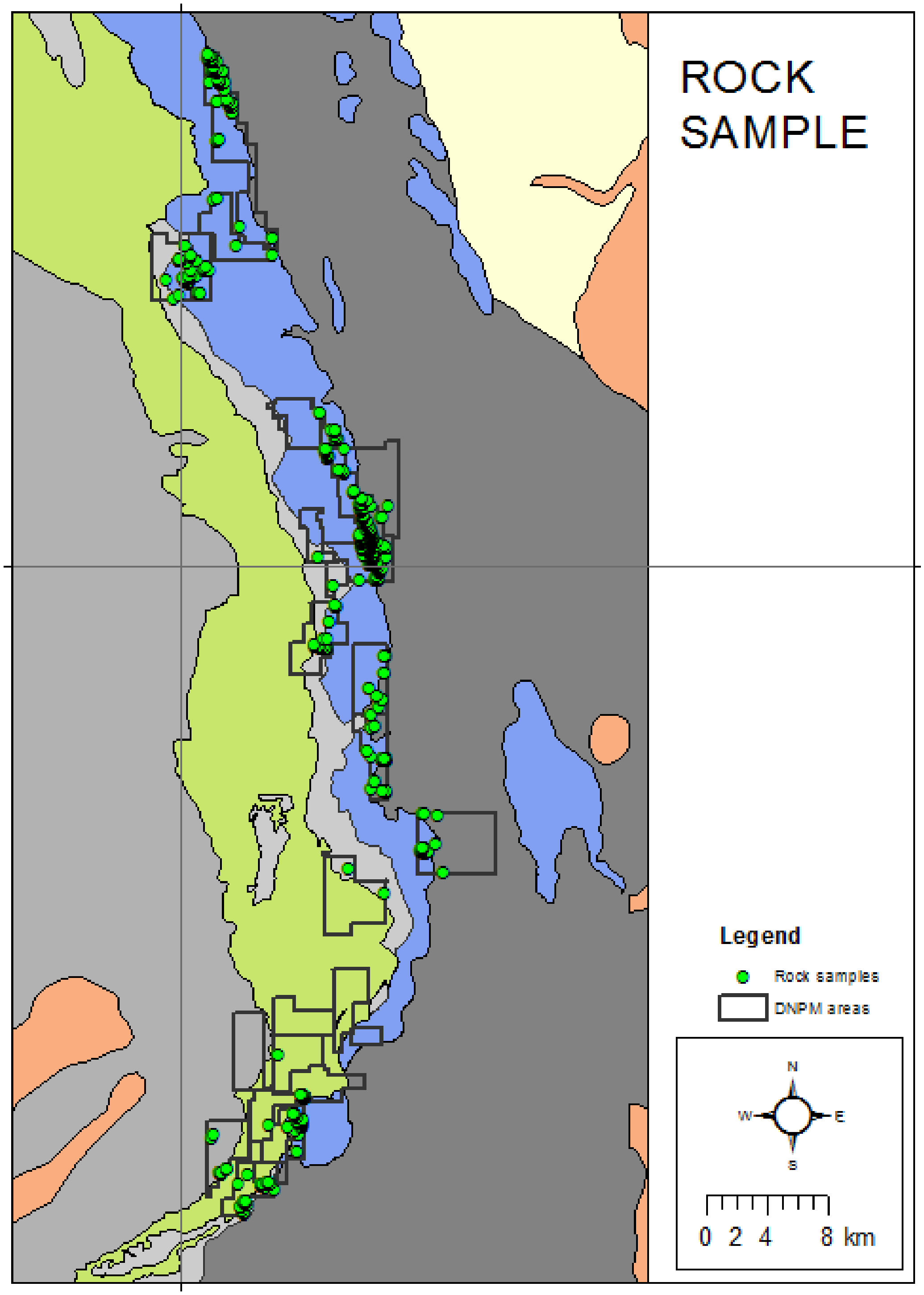
The acquired information is used to guide exploration programs and drill targeting.

9.3 Geochemical Sampling

Geochemical exploration activities included collection of 868 rock chip (Figure 9--1), 53 pan concentrate (Figure 9-2), 158 stream sediment (Figure 9-3) and 3,114 soil samples (Figure 9-4). Figure 9-5 is a lithology key for the backdrop used for the figures.

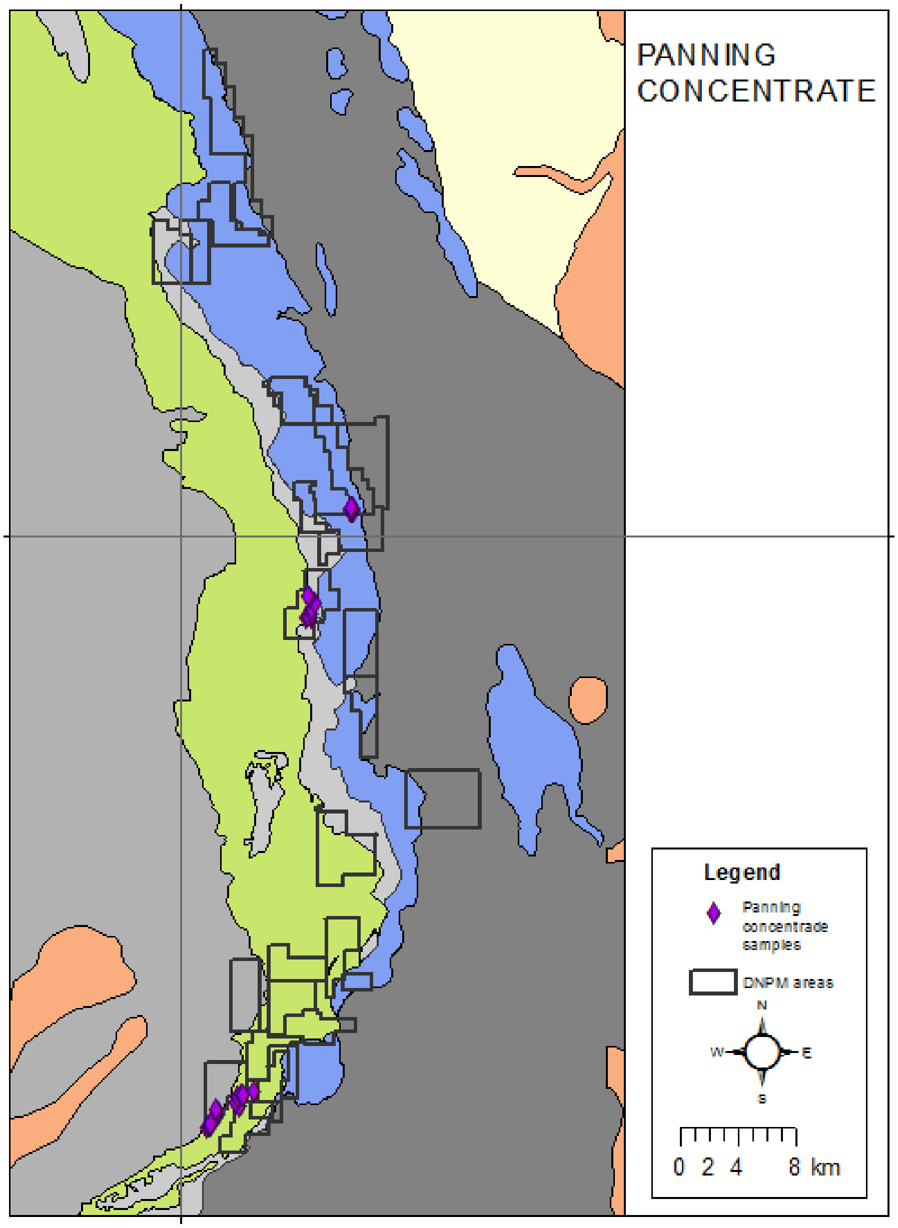
Rock chip sampling mainly focused on outcrops within the Morro do Calcário Formation. Stream sediment sampling was used where stream conditions warranted, primarily southwest of the Morro Agudo Mine and west of the Ambrosia Sul and Norte deposits. Additional stream sediment sampling was performed south of the Bonsucesso deposit, and west of the Poções prospect. Soil sampling, like rock chip sampling, was primarily over areas considered to be underlain by the Morro do Calcário Formation. Results were used to generate drill targets.

Figure 9-1: Location Plan, Rock Chip Sampling



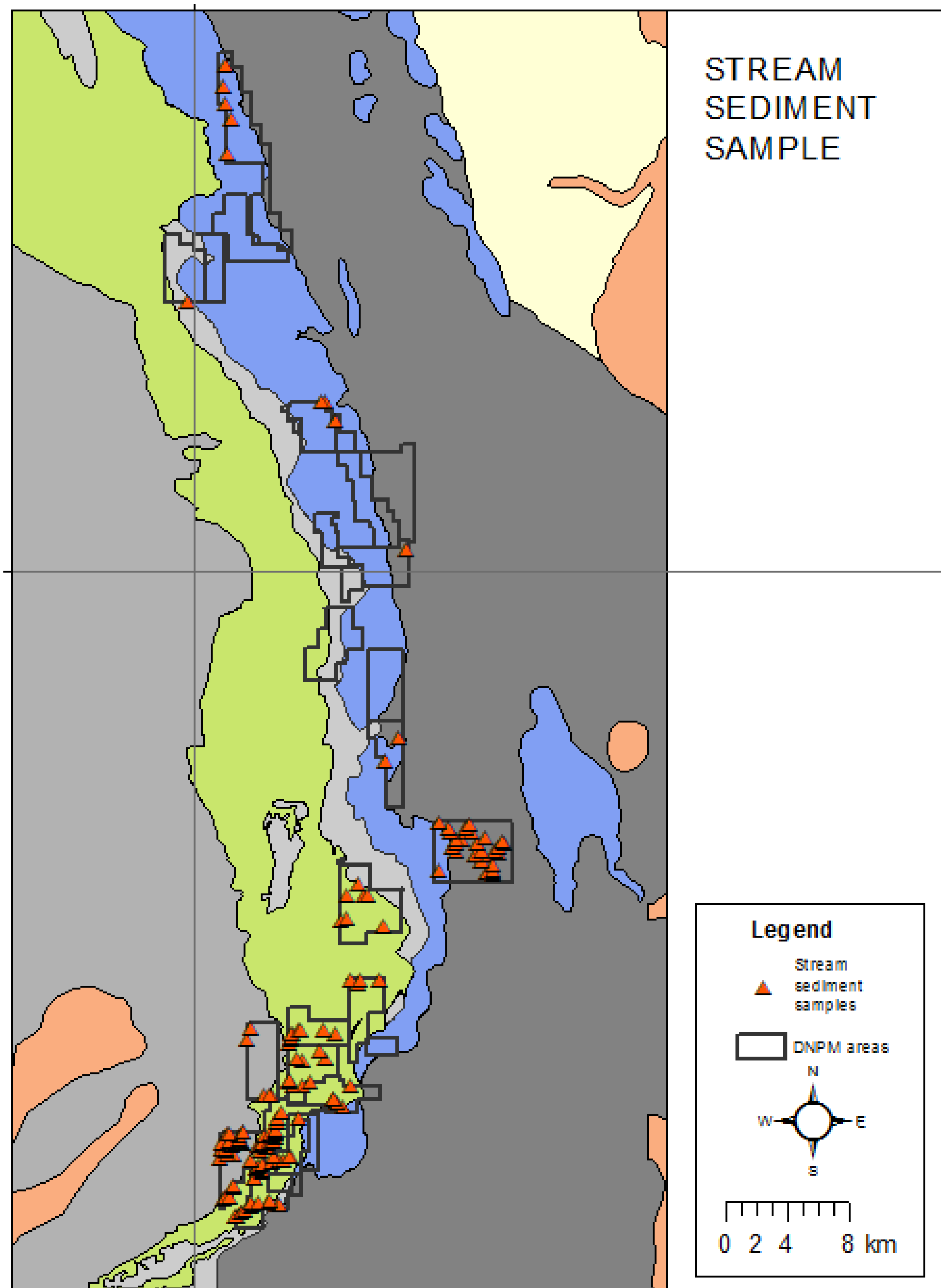
Note: Figure courtesy Votorantim, 2017.

Figure 9-2: Location Plan, Pan Concentrate Sampling



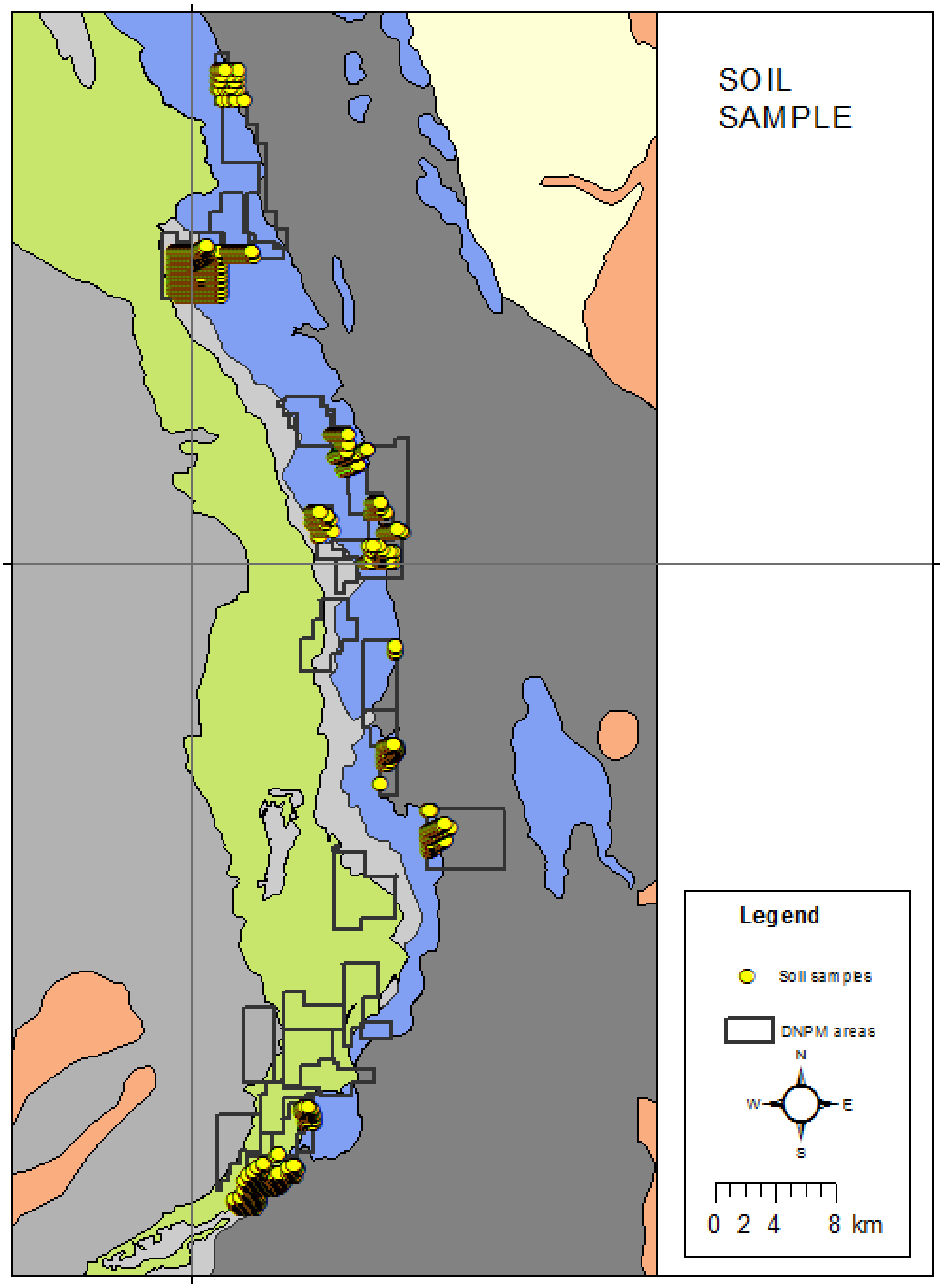
Note: Figure courtesy Votorantim, 2017.

Figure 9-3: Location Plan, Stream Sediment Sampling



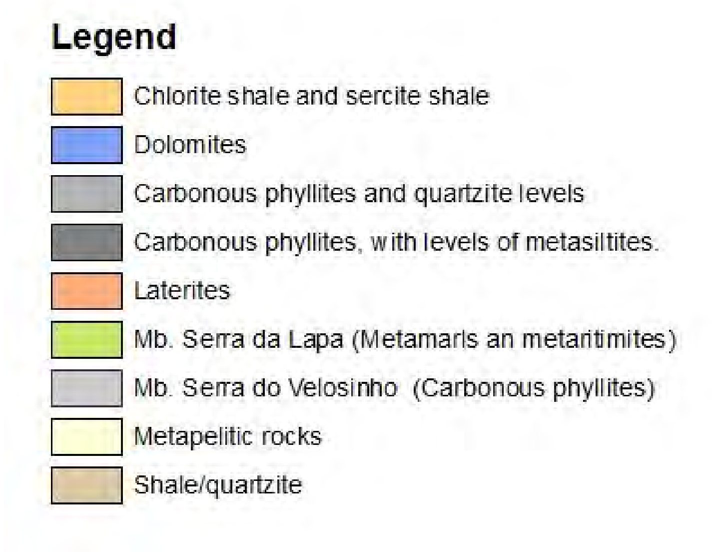
Note: Figure courtesy Votorantim, 2017.

Figure 9-4: Location Plan, Soil Sampling



Note: Figure courtesy Votorantim, 2017.

Figure 9-5: Legend Key for Figure 9-1 to Figure 9-4



Note: Figure courtesy Votorantim, 2017.

9.4 Geophysics

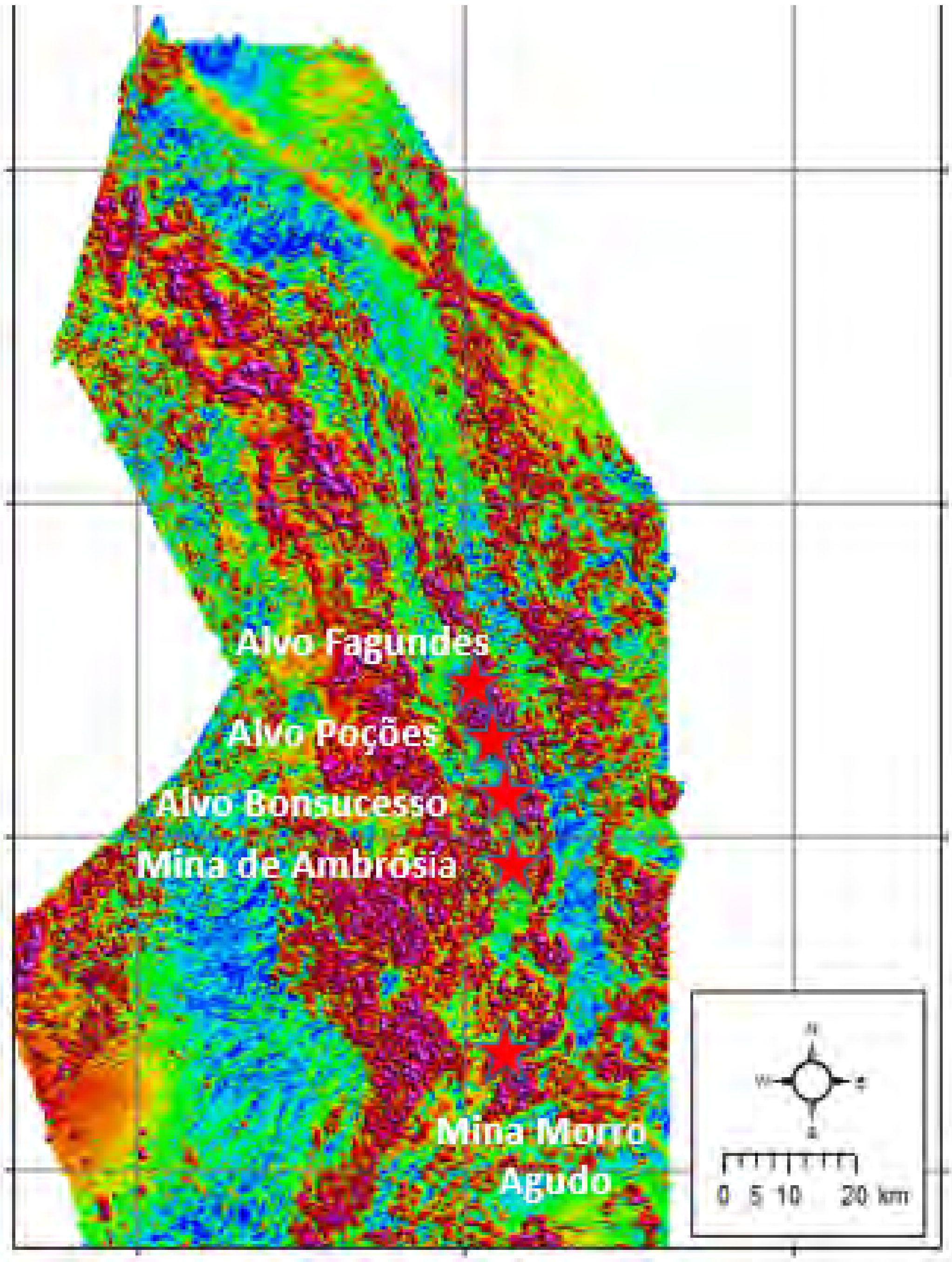
9.4.1 Airborne Surveys

An airborne survey was completed by Lasa, a geophysical contractor, on behalf of Companhia Mineradora de Minas Gerais (COMIG) in 2000–2001. The survey used a fixed wing Islander BN2-A aircraft. The sensor was a magnetic system with caesium vapour, Scintrex CS-3 model, with 10 Hz frequency and a sampling interval of 6 m. Control lines were spaced at 2,500 m, with flight lines at 250 m, and an average flight height of about 100 m. The survey covered about 85,155 linear km.

An airborne geophysical survey was flown by Lasa on behalf of Votorantim in 2010, covering an approximate area of 346.2 km^2. The aircraft used was a Caravan C208 (PR-FAK) with flight lines spaced of 150 m and control lines spaced at 1,500 m. The average flight height was 100 m. The magnetic survey used a Scintrex cesium vapor sensor, model CS-3, with a resolution of 0.001 nT. Gravity data were acquired using the FALCON ™ AGG system.

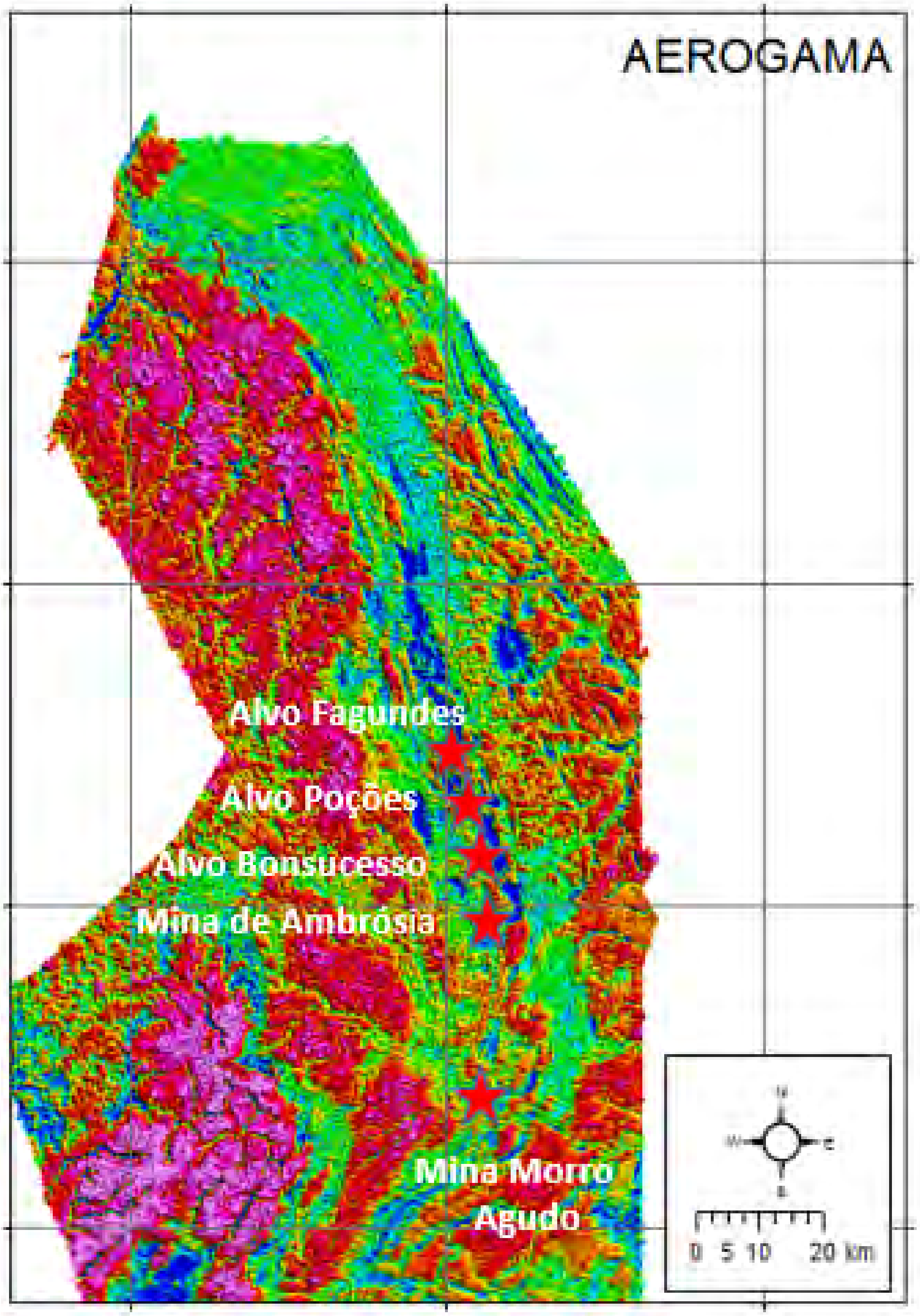
A segment of the survey images over the Morro Agudo Project area is provided in Figure 9-6 (magnetics) and Figure 9-7 (gamma spectroscopy).

Figure 9-6: Regional Magnetometry Image



Note: Figure courtesy Votorantim, 2017, sourced from Brazilian Geological Survey data.

Figure 9-7: Regional Gamma Spectroscopy Image



Note: Figure courtesy Votorantim, 2017, sourced from Brazilian Geological Survey data.

Magnetic survey information was used to delineate fault structures and lineaments that could play a role in localizing mineralized fluids. Gravity data were used in an attempt to differentiate areas of zinc mineralization, as there is a marked gravity difference between the host rocks, and zones of zinc sulphide/willemite mineralization.

9.4.2 Ground Surveys

A surface induced polarization (IP) survey was undertaken in the 1990s that covered tenures from Morro Agudo Mine northward over an approximate 35 km of strike.

A detailed IP survey was completed over the Ambrosia Trend, in particular the areas of the Ambrosia Sul, Ambrosia Norte, and Bonsucesso deposits. This survey added 39 line km of data.

Chargeability and resistivity results are presented in Figure 9-8.

Survey information was used to identify late fault structures that could potentially disrupt mineralization trends.

9.5 Exploration Potential

Regional exploration targets are shown in Figure 9-9.

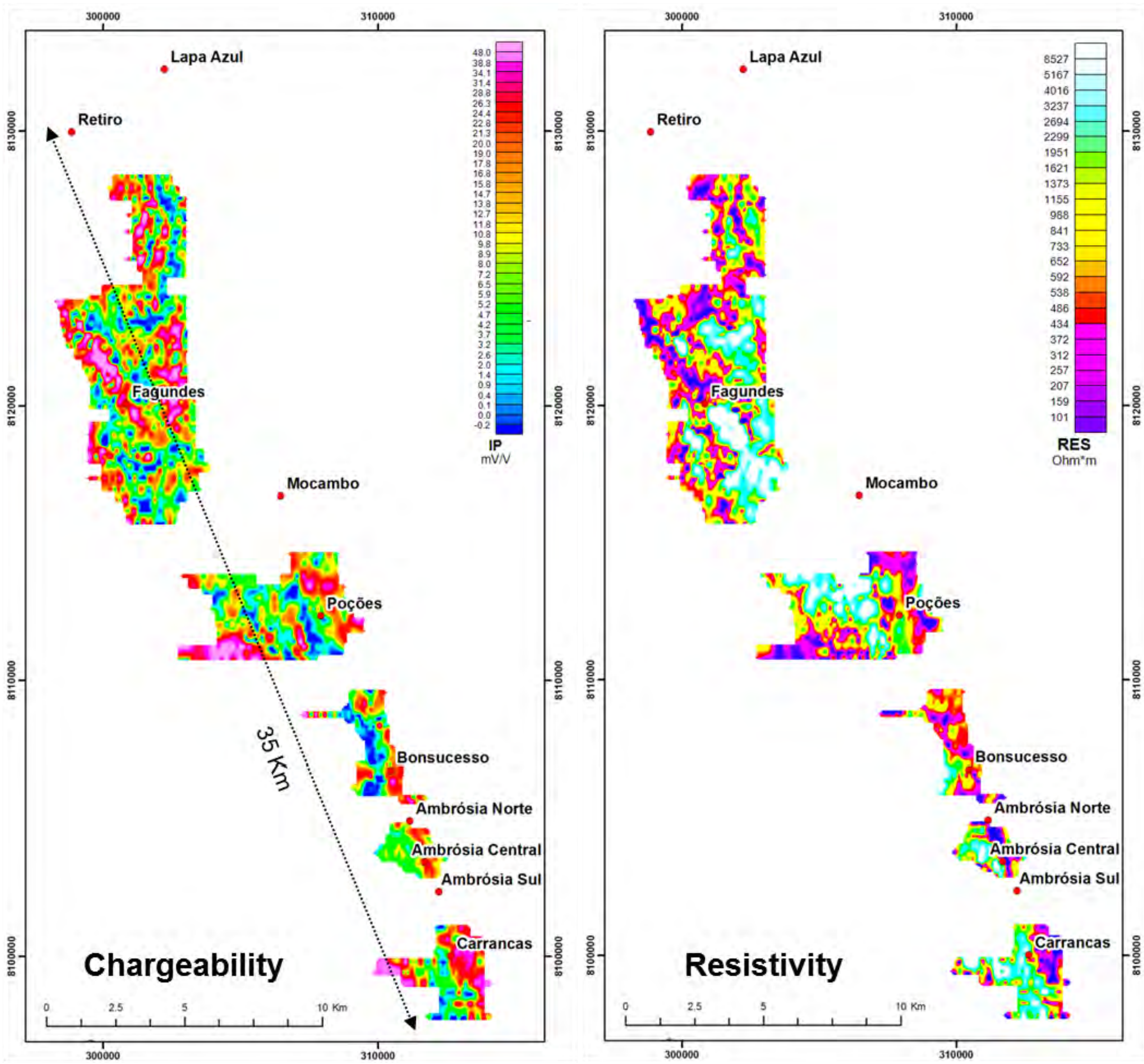
9.5.1 Morro Agudo Mine

Exploration activities are still ongoing in the Morro Agudo Mine area. Drilling in 2016 and 2017 intersected mineralized intercepts outside the current resource model. Figure 9-10 provides the drill collar locations of completed drilling in relation to the resource model. On that figure, drill holes in area 1 are targeting mineralization extensions along known structures. Area 2 is a parallel trend to area 1, and has returned a number of anomalous intercepts. The intention is to complete additional drilling both above and below the known intercepts.

9.5.2 Ambrosia Trend

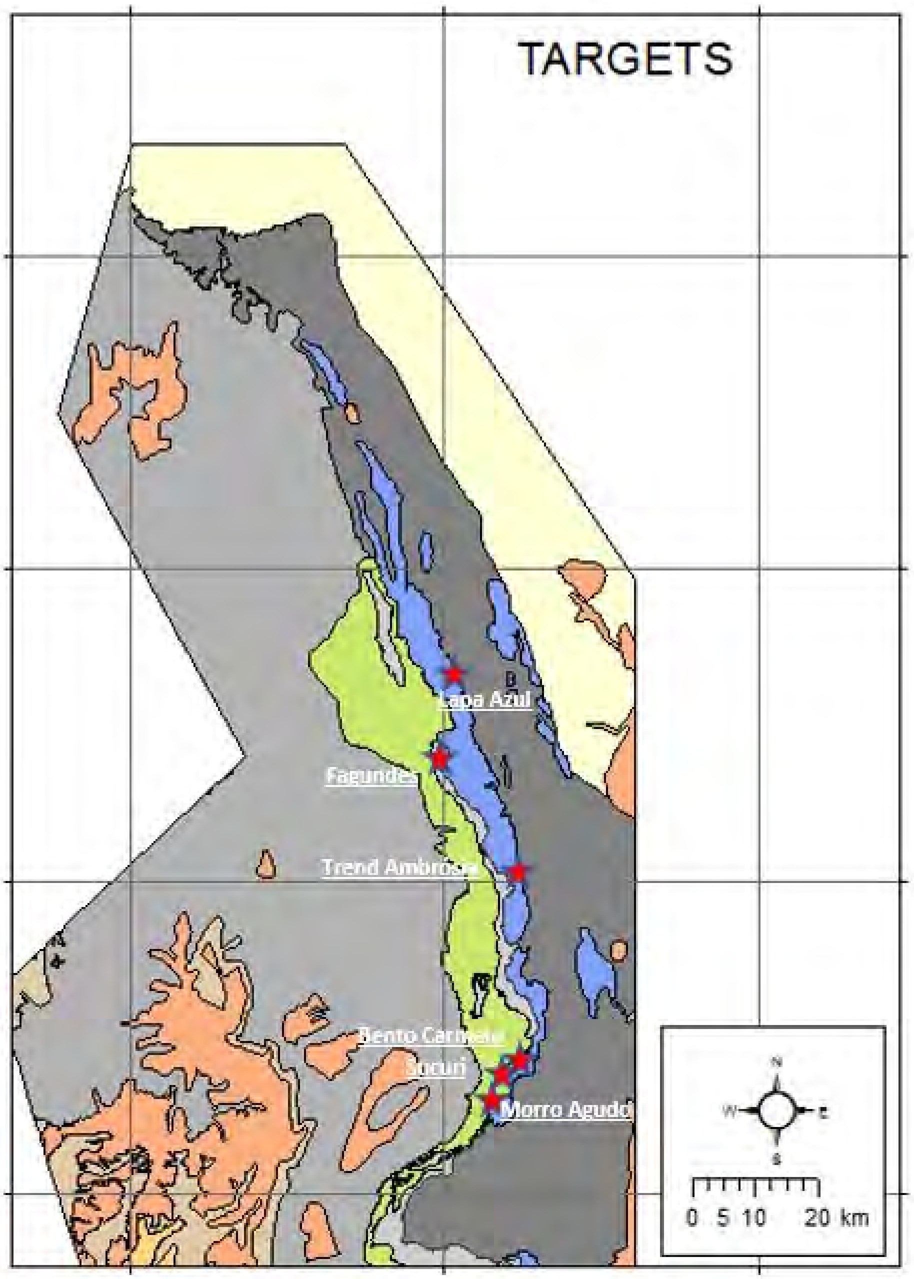
The area referred to by the exploration team as the Ambrosia Trend covers about 11 km of prospective lithologies. Within this area, the Ambrosia Sul, Ambrosia Norte and Bonsucesso deposits have been discovered. Breccia zones identified from mapping programs appear to follow the contact between Serra do Garrote Formation and Morro do Calcário Formation, and represent favourable hosts for mineralization. The Ambrosia Trend remains open to the north and south of the known deposits.

Figure 9-8: Ground IP Survey Results



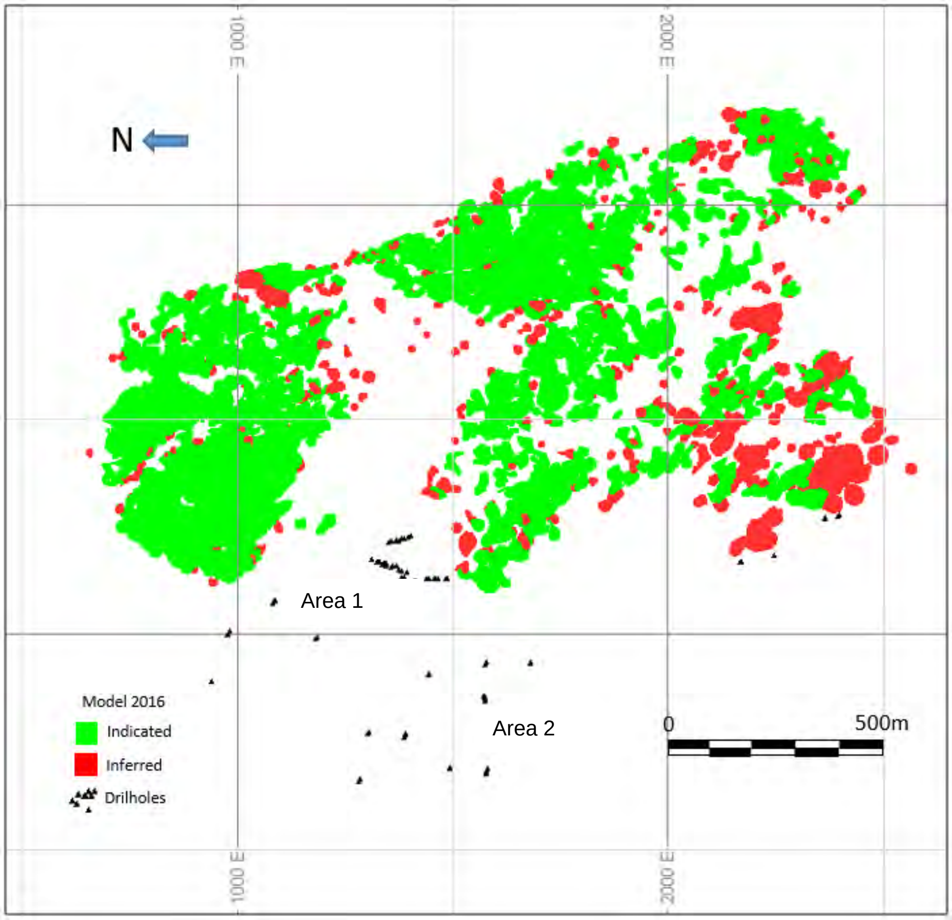
Note: Figure courtesy Votorantim, 2017.

Figure 9-9: Regional Exploration Targets



Note: Figure courtesy Votorantim, 2017. Figure 9-5 is the key to the lithological units used in the figure backdrop.

Figure 9-10: Exploration Drilling, Morro Agudo Mine

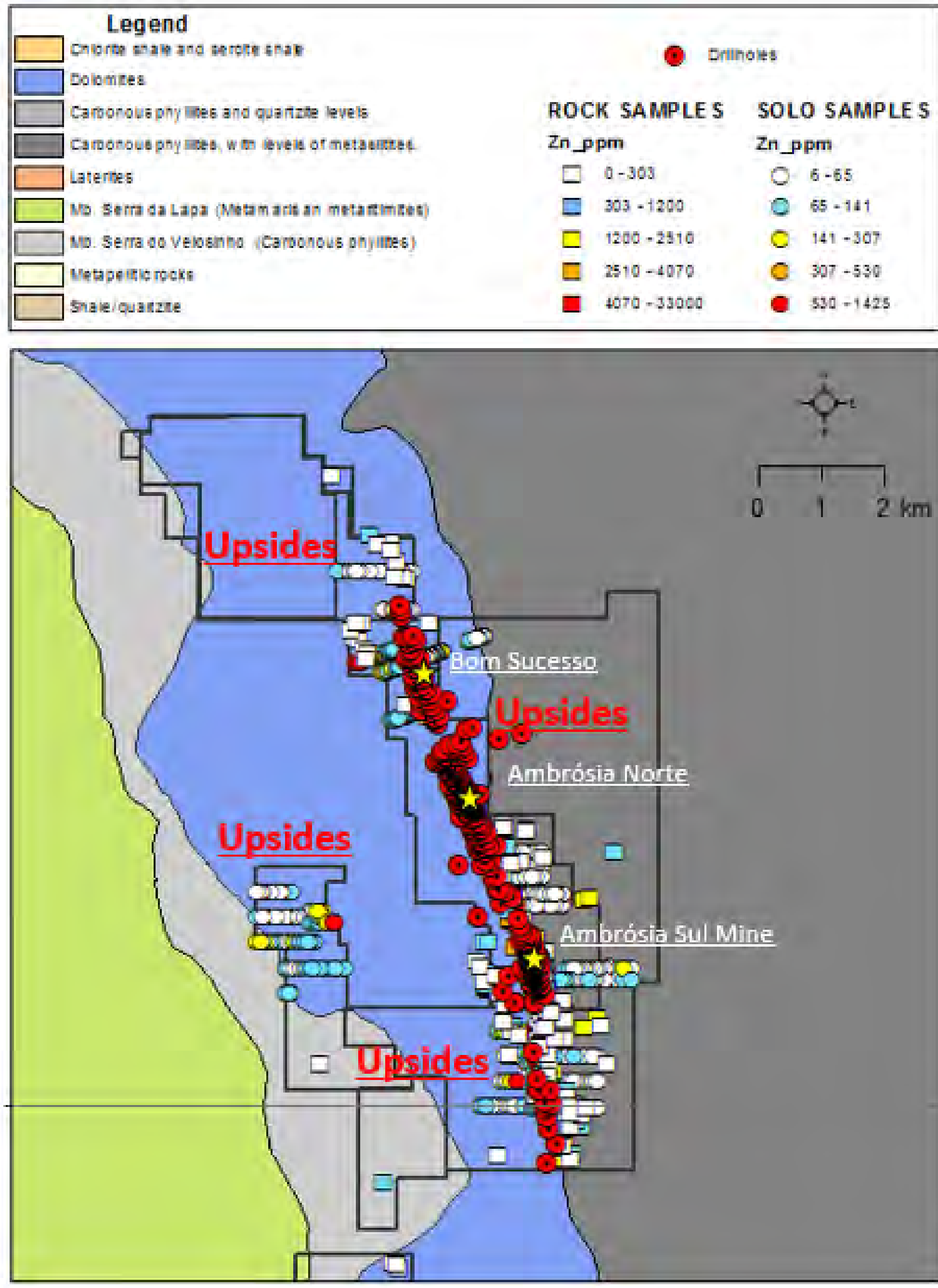


Note: Figure courtesy Votorantim, 2017.

Geochemical sampling identified a number of zinc and lead anomalous areas along the trend (Figure 9-11).

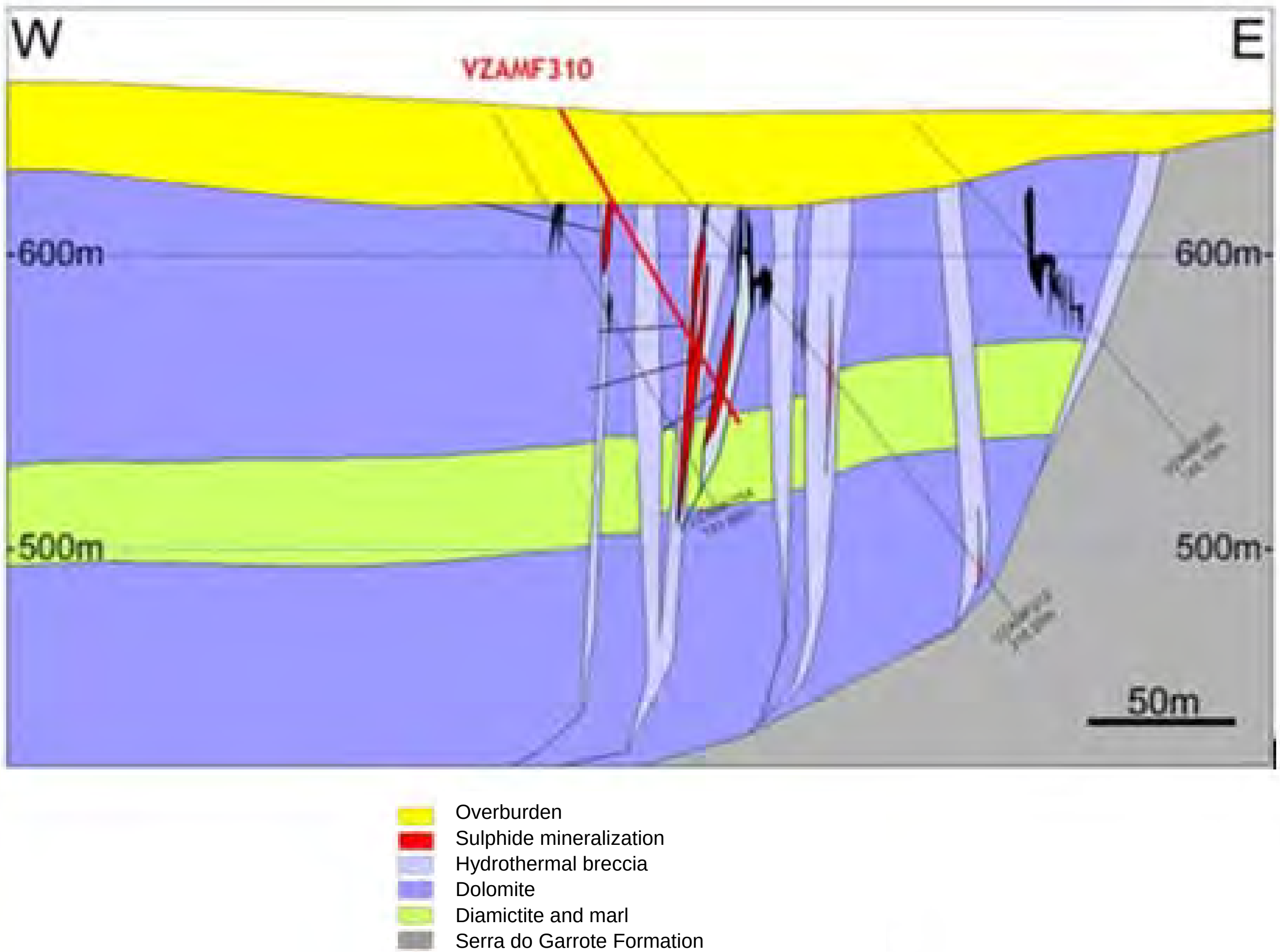
Drilling completed in a number of areas has resulted in visual identification of sphalerite and pyrite in drill core. One of the most prospective zones is located south of the Ambrosia Sul mine, where zones of sulphide mineralization have been encountered (Figure 9-12). Another highly prospective zone is in the area north and south of the Bonsucesso deposit (Figure 9-13).

Figure 9-11: Ambrosia Trend Prospects



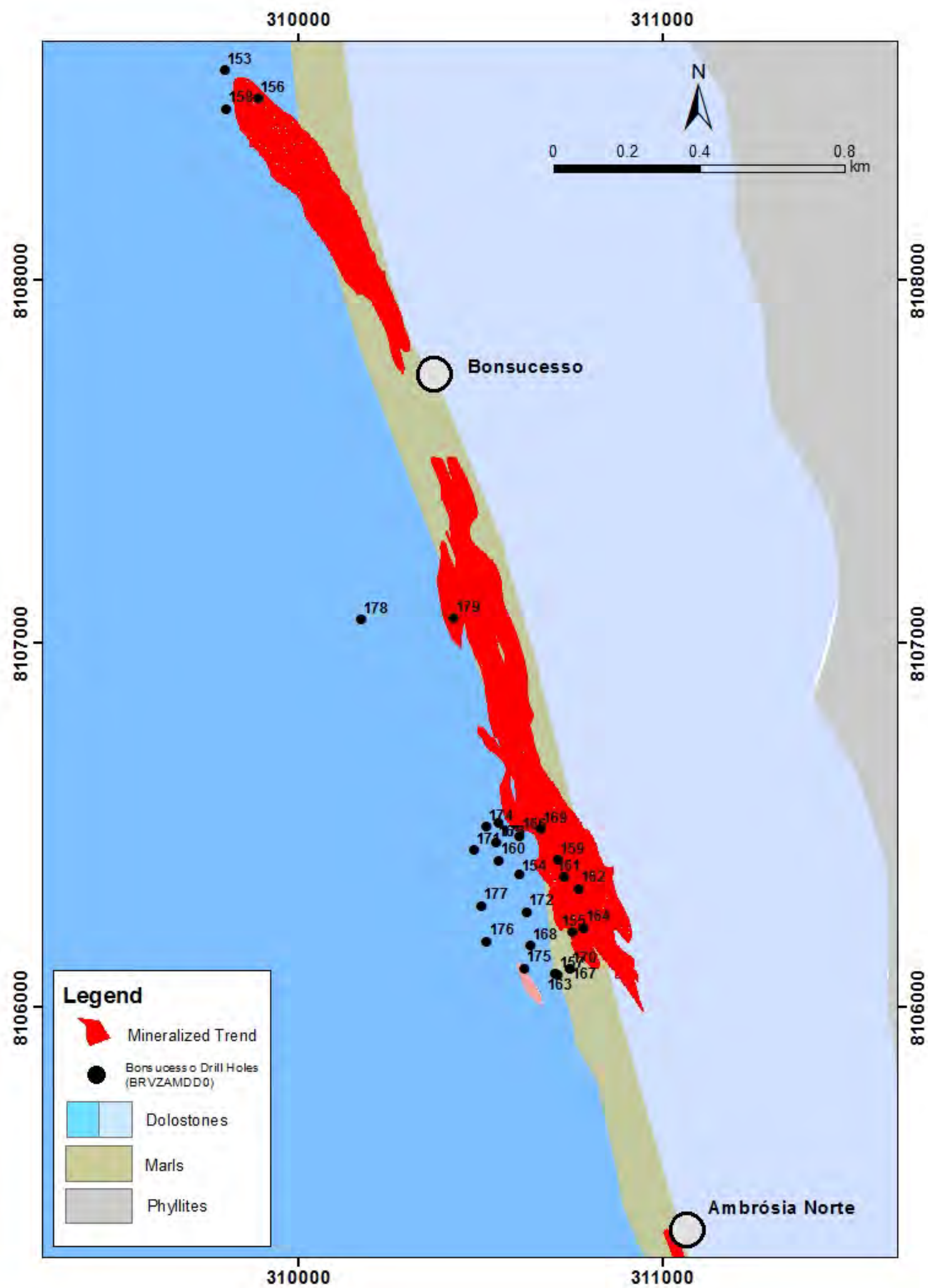
Note: Figure courtesy Votorantim, 2017.

Figure 9-12: Drill Intercept South of Ambrosia Sul Mine



Note: Figure courtesy Votorantim, 2017.

Figure 9-13: Bonsucesso



Note: Figure courtesy Votorantim, 2017.

9.5.3 Sucuri and Bento Carmelo

These prospects were identified in the 1980s, and explored during the 1990s. Initially, the areas were targeted because of anomalous zinc and lead values in dolorudites/dolarenites of the Morro do Calcário Formation, and because of the close proximity of the anomalies to the Morro Agudo Mine (Figure 9-14).

Geophysics and geological mapping identified a tectonic contact, marked by intense shearing and silicification, at the Sucuri prospect within the Serra da Lapa Formation. This zone hosted sphalerite and galena mineralization developed in massive, thin granular dolomites interbedded with metamarls. The setting is considered to be analogous to the northern zone of the Morro Agudo Mine. Mineralization consists of matrix-fill sulphides, and sulphides forming veinlets, and infilling microfractures.

The Bento Carmelo prospect is hosted in dolorudites of the Morro do Calcário Formation. Sulphide mineralization, sphalerite, galena, and pyrite, takes the form of stockworks and cavity fill, and is associated with intense dolomitization,

9.5.4 Fagundes

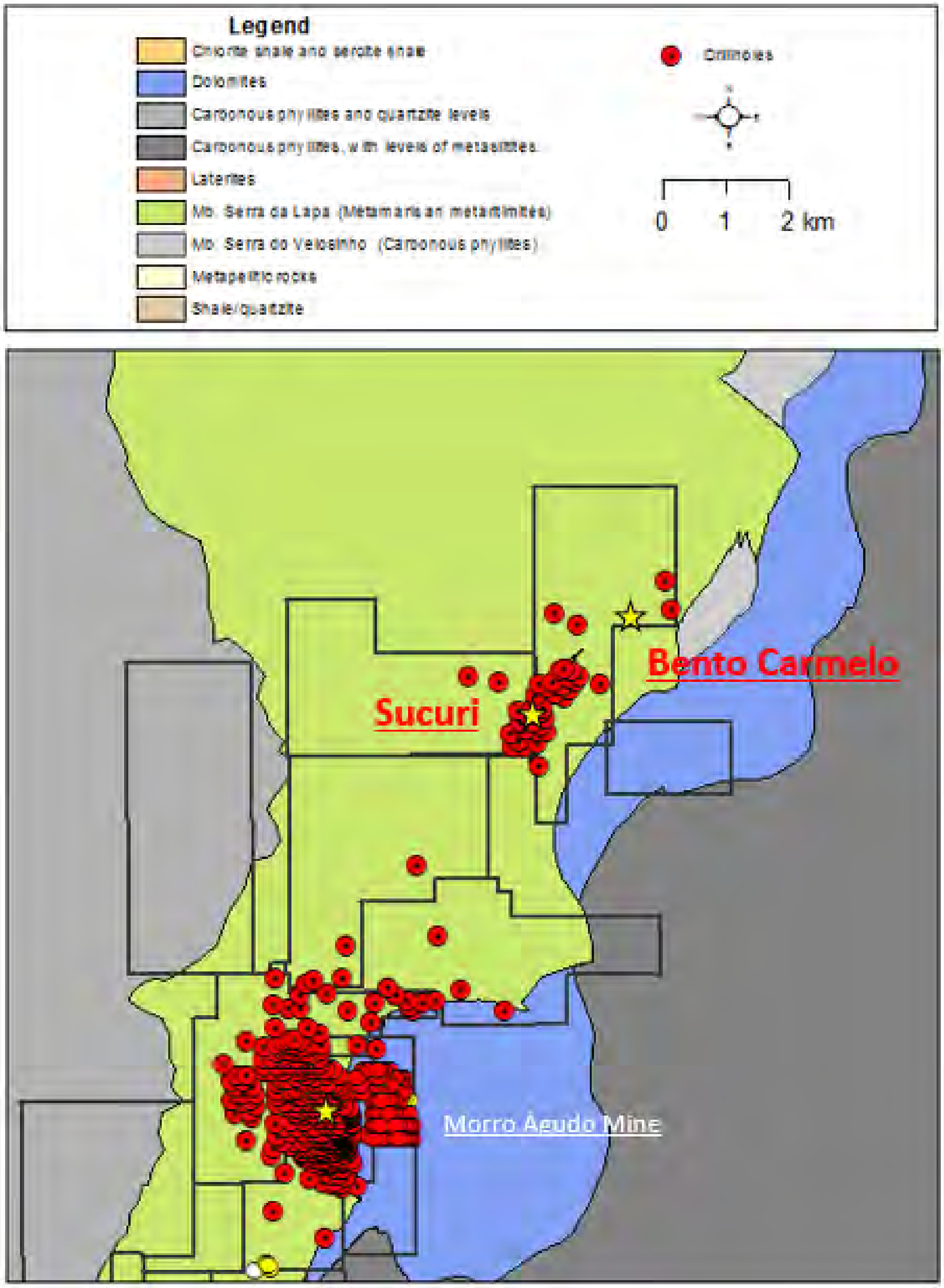
The Fagundes deposit was identified in the 1980s as a site of anomalous zinc and lead values in dolorudites of the Morro do Calcário Formation. Subsequent work programs included geological mapping, soil sampling, and drilling (Figure 9-15). By 2009, 10 mineralized zones had been identified (Figure 9-16). Although previous results suggested that the mineralization was not significant enough to warrant detailed mining studies, more recent results of geophysical surveys and structural geology are promising and will be followed-up in the near future.

Interpretations of IP geophysical data suggest that the mineralized zones are characterized by moderate chargeability (up to 12 mV / V), moderate resistivity (<2000 Ohm * m), and Tau values indicative of subtle contrasts (~ 3 to 4 ms). Sub-vertical discontinuities in the data suggest fault disruptions. Some of the IP data appears to reflect continuity of mineralization in areas that have not been drill tested, with IP anomalies displaying moderate to high chargeability (12 to 18 mV / V), very high resistivity (up to 30,000 Ohm * m, possibly indicative of massive dolomite) and interesting Tau values (between 15 and 25 ms).

All drill holes completed to date were vertical holes, targeted only stratabound mineralization, and were not oriented.

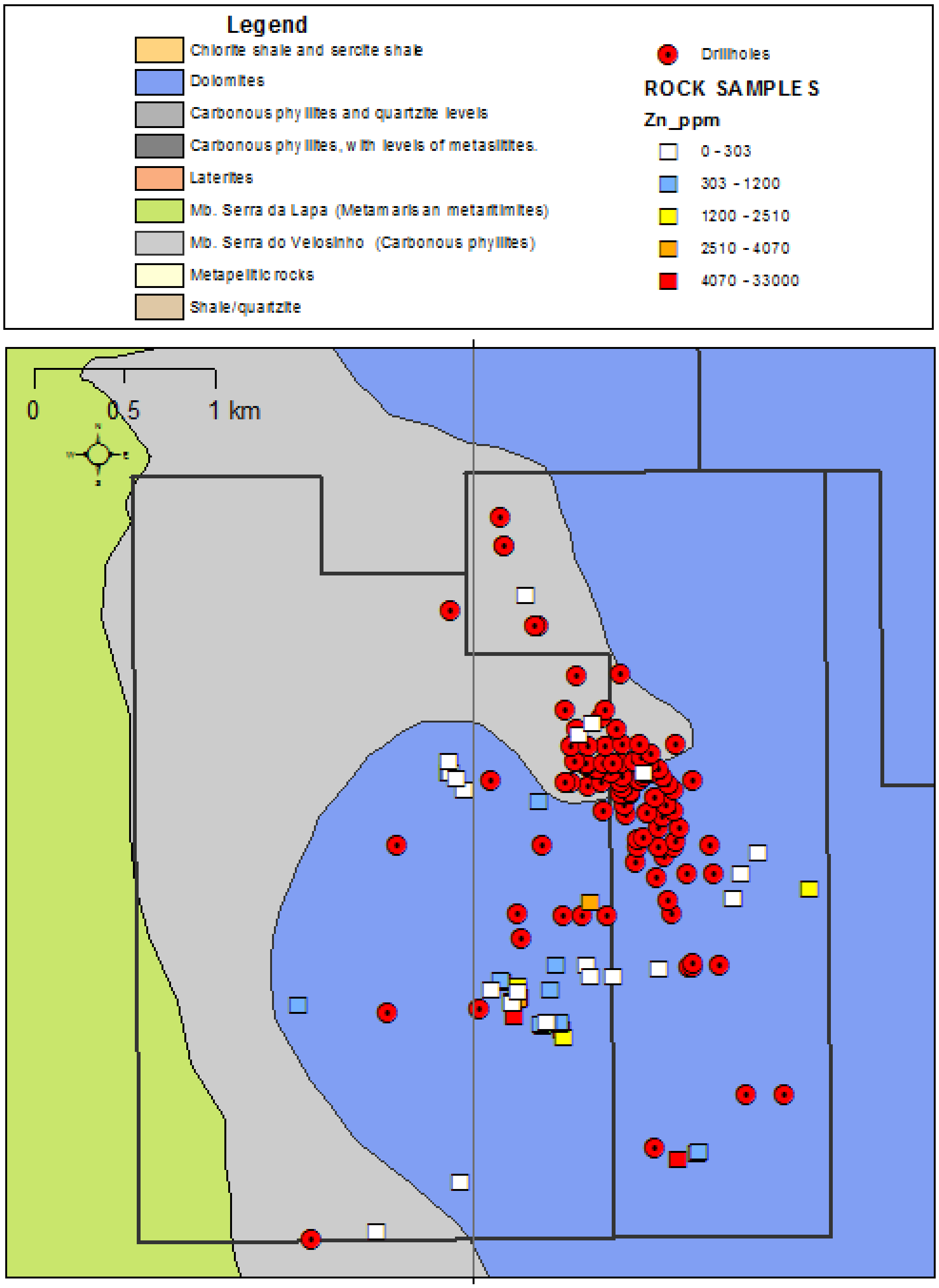
Together, the drilling and geophysical data suggest that the drilling may not have been completed at the most optimal angles to intersect mineralization, and that the original deposit concept of sub-horizontal stacked lenses may not be correct.

Figure 9-14: Sucuri and Bento Carmelo Prospects



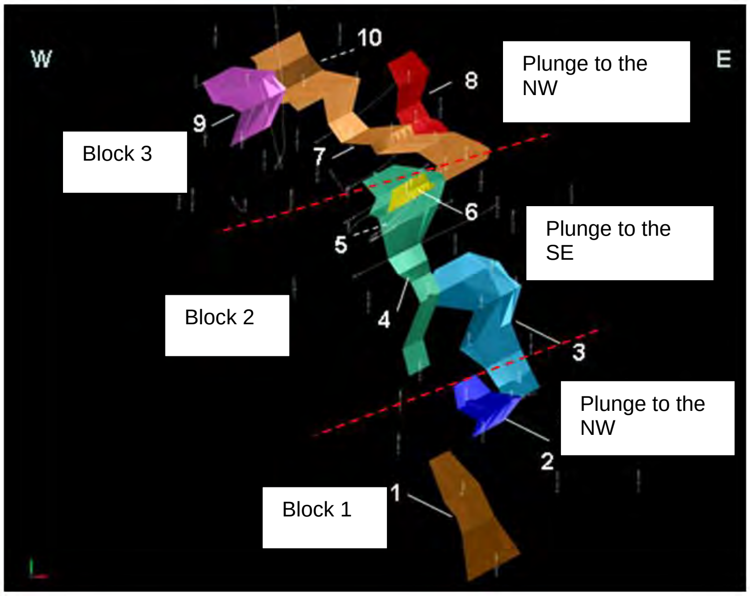
Note: Figure courtesy Votorantim, 2017.

Figure 9-15: Fagundes Deposit



Note: Figure courtesy Votorantim, 2017.

Figure 9-16: Fagundes Mineralized Zones



Note: Figure courtesy Votorantim, 2017.

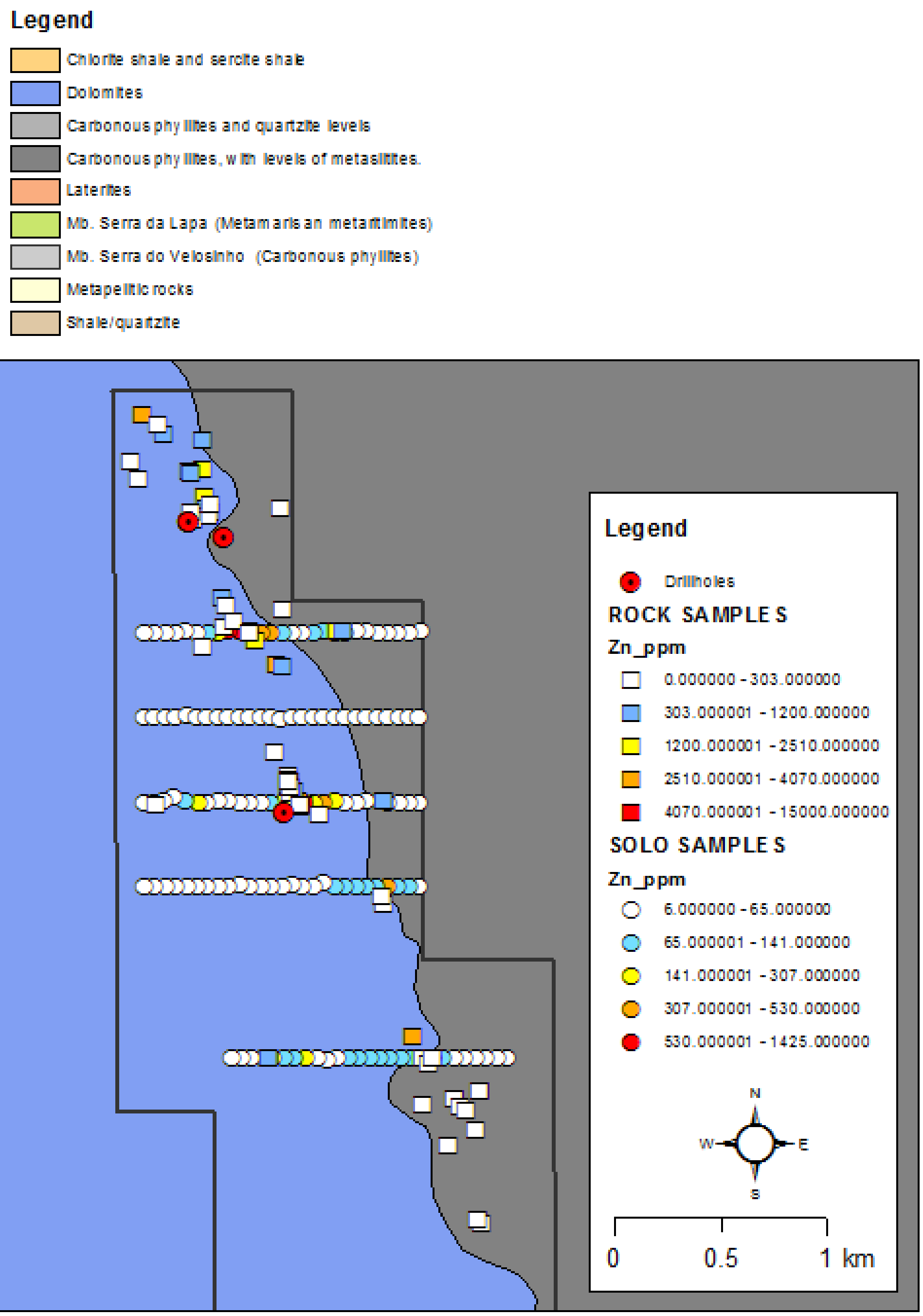
Work is ongoing into the likely orientation of mineralization along strike from the known lenses, and the influence of structural controls on the position, dip, and plunge of potential lenses.

9.5.5 Lapa Azul

Anomalous zinc and lead geochemical samples were noted from a structural window of dolomite in deformed phyllites of the Serra do Garrote Formation (Figure 9-17). Locally, mineralization is laminated, with veins and fractures filled by quartz, dolomite and sphalerite, and very thick silicified marls. Four core holes were completed, which intersected hydrothermal breccia bodies, some of which contained sphalerite and galena.

The prospect area is under re-evaluation of the structural setting to determine if an Ambrosia Sul analogue is appropriate, and determine conceptual mineralization controls. Further drilling is planned. The reanalysis will also be applied to known lead–zinc geochemical anomalies in the area.

Figure 9-17: Lapa Azul Prospect



Note: Figure courtesy Votorantim, 2017.

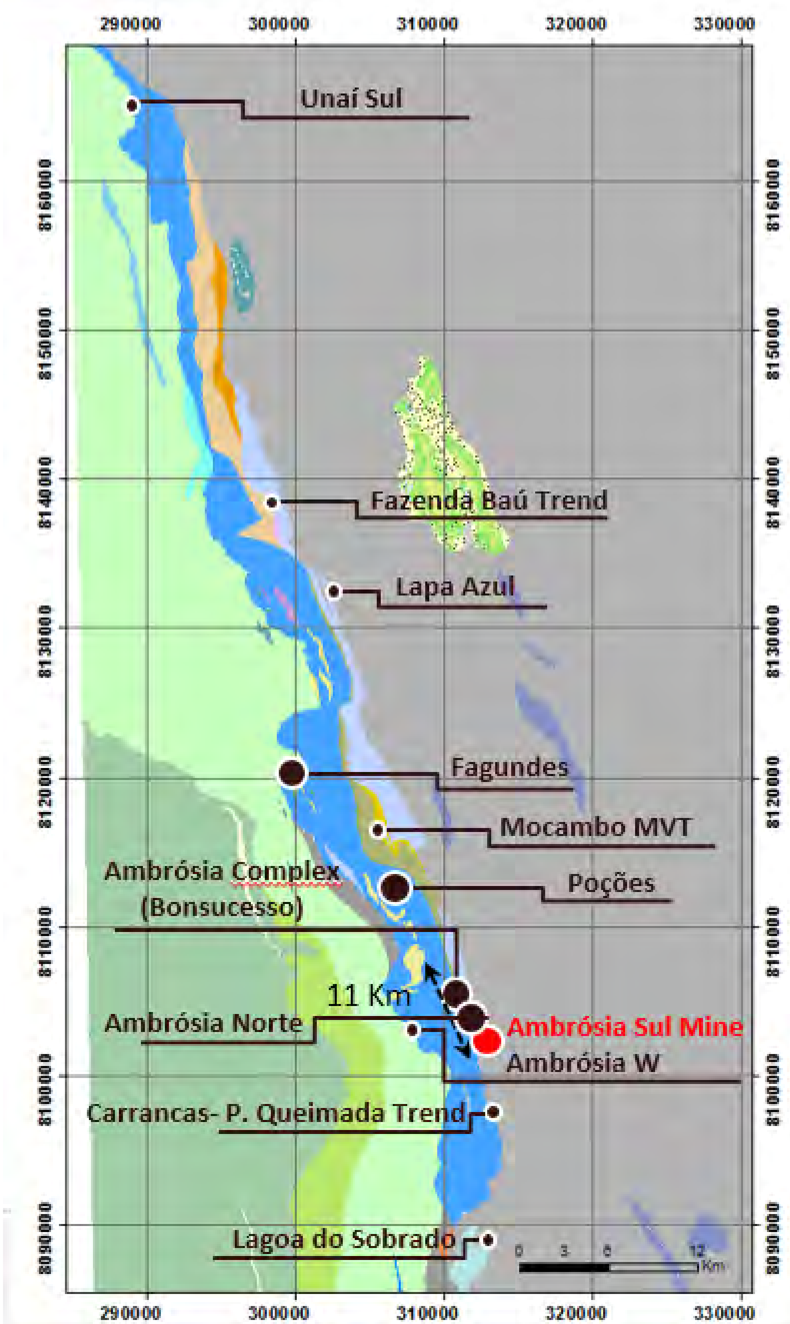
9.5.6 Additional Areas

Figure 9-18 shows the locations of other greenfields exploration projects in the Morro Agudo–Ambrosia area. Each of the named areas has been found to host zinc mineralization but these areas are little explored and plans are to explore each of those areas more thoroughly in the future. Amec Foster Wheeler notes that continuing exploration relies on favourable results so the current plans may change depending on results.

9.6 Comments on Section 9

Local and regional exploration is ongoing with reasonable annual budgets and has discovered not only extensions to the known mineralization but possible new mineralization that may add to the resource base. Surface geological mapping, geochemical sampling, and geophysical surveying are the primary exploration tools all of which are quickly superseded by drilling once a prospective area is discovered. The QP considers the type and amount of exploration to be appropriate for the type of deposit.

Figure 9-18: Exploration Area Locations



Note: Figure courtesy Votorantim, 2017.

10.0 DRILLING

10.1 Introduction

Core drilling using diamond tipped tools has been the primary exploration tool. A regional exploration plan showing drilling completed to date on the Project is provided in Figure 10-1. In total, there are 11,091 holes (276,228.77 m) completed outside the Morro Agudo Mine, including the drilling along the Ambrosia Trend. Drilling is primarily located within lithologies of the Morro do Calcário Formation, the most prospective mineralization host.

10.1.1 Morro Agudo Mine

The first holes drilled at the Morro Agudo Mine were drilled from the surface in 1974. As underground development proceeded, drilling from underground stations became more important until the drilling currently performed at Morro Agudo unit is only from underground stations. A total of 3,670 holes (493,757.31 m) have been drilled at the Morro Agudo Mine. Table 10-1 shows the drilling by year, and Figure 10-2 is a collar location plan for the mine drilling.

10.1.2 Ambrosia Trend

Drilling has been performed on the Ambrosia Trend since 1973. Table 10-2 summarizes drilling at Ambrosia Sul by year, Table 10-3 summarizes drilling at Ambrosia Norte by year, and Table 10-4 summarizes drilling at Bonsucesso by year. Table 10-5 provides a breakdown by operator.

In total, 584 core holes (96,296 m) have been completed. Note that 19 holes (4,329.45 m) are not associated with any of the named deposits.

Figure 10-3 shows the locations of drill holes in the Ambrosia Trend.

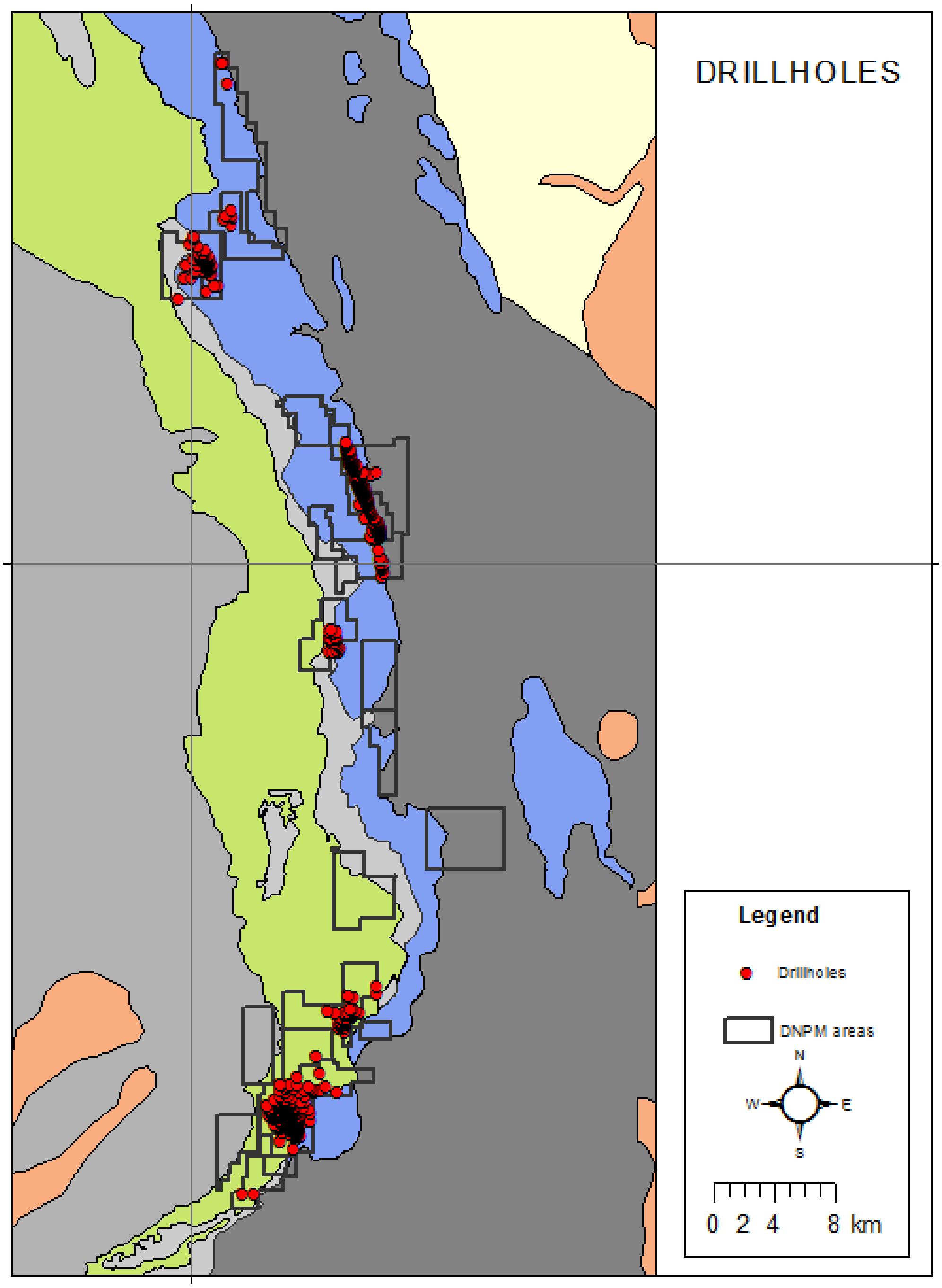
10.2 Drill Methods

10.2.1 Morro Agudo Mine

Since 1974, the following drill contractors have been used:

- Geosol: completed a total of 36 surface holes in 2006, 2008, and 2009
- Willemita Ltda: completed a total of 18 surface holes in 2007, 2008, and 2011
- Morro Agudo Mine: 3,616 holes from surface and underground

Figure 10-1: Regional Drill Hole Collar Location Plan

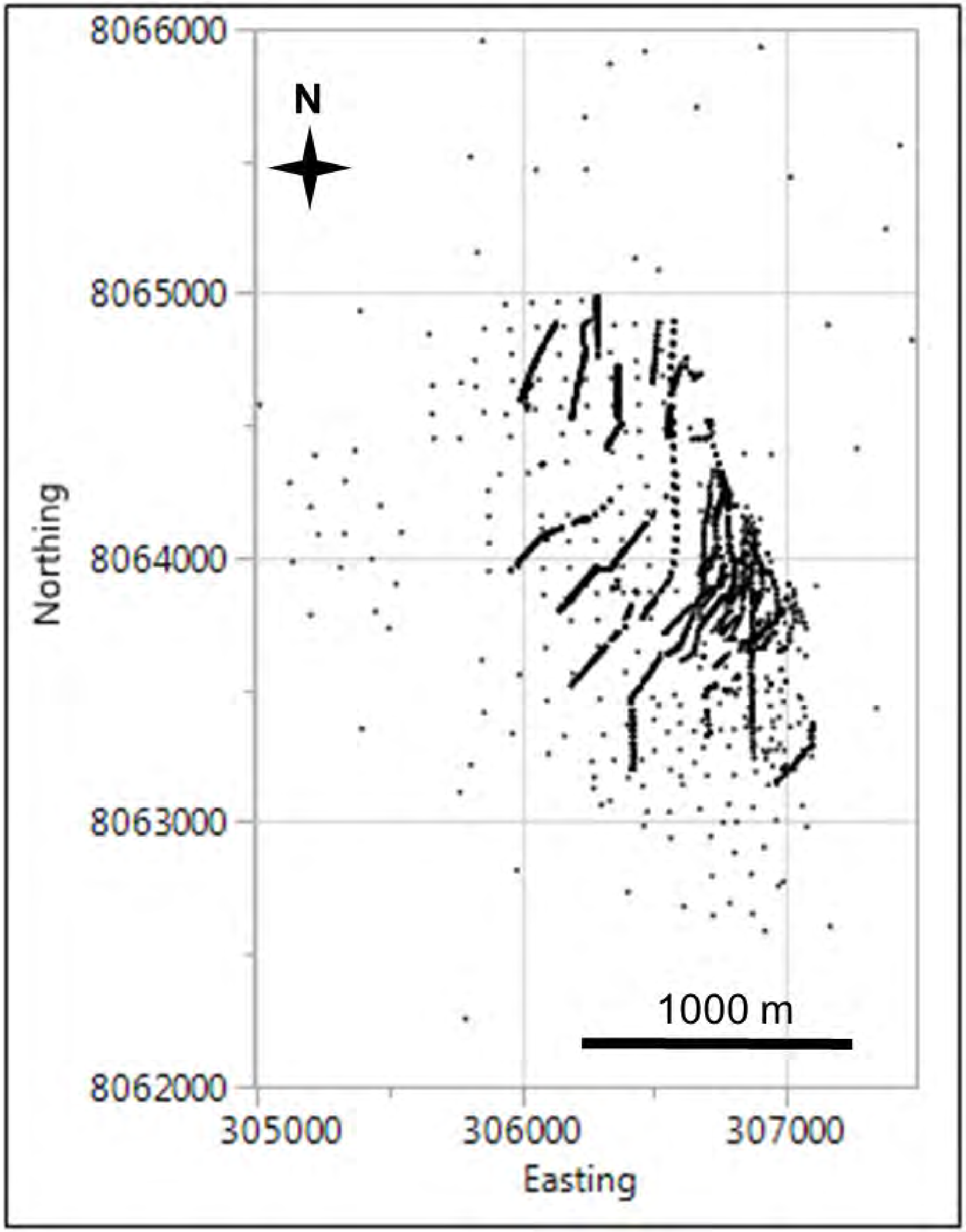


Note: Figure courtesy Votorantim, 2017.

Table 10-1: Morro Agudo Drilling by Year

Year	Number of Holes	Total Metres
1974	85	37,363.45
1975	86	24,838.55
1977	6	3,181.41
1978	2	2,000.00
1979	13	4,692.03
1982	1	63.15
1992	11	539.95
1995	178	15,212.11
1996	128	5,607.70
1997	118	4,203.84
1998	124	4,816.71
1999	234	26,911.90
2000	449	17,607.04
2001	126	14,966.25
2002	114	6,401.90
2003	291	30,322.20
2004	272	38,867.55
2006	55	17,515.85
2007	130	30,402.95
2008	132	33,956.40
2009	80	16,036.98
2010	193	38,444.75
2011	232	44,639.40
2012	189	22,620.04
2013	104	13,573.30
2014	159	12,348.50
2015	124	17,926.00
2016	34	8,697.40
Total	***3,670***	***493,757.31***

Figure 10-2: Morro Agudo Drill Hole Location Plan



Note: Figure prepared by Amec Foster Wheeler, 2017.

Table 10-2: Ambrosia Sul Drilling by Year

Year	Number of Holes	Total Metres
1973	2	239.40
1976	3	1,061.92
2008	3	601.15
2011	1	243.25
2012	59	8,645.15
2013	93	9,465.00
2014	6	1,192.45
2015	38	2,326.80
Total	***205***	***23,775.12***

Table 10-3: Ambrosia Norte Drilling by Year

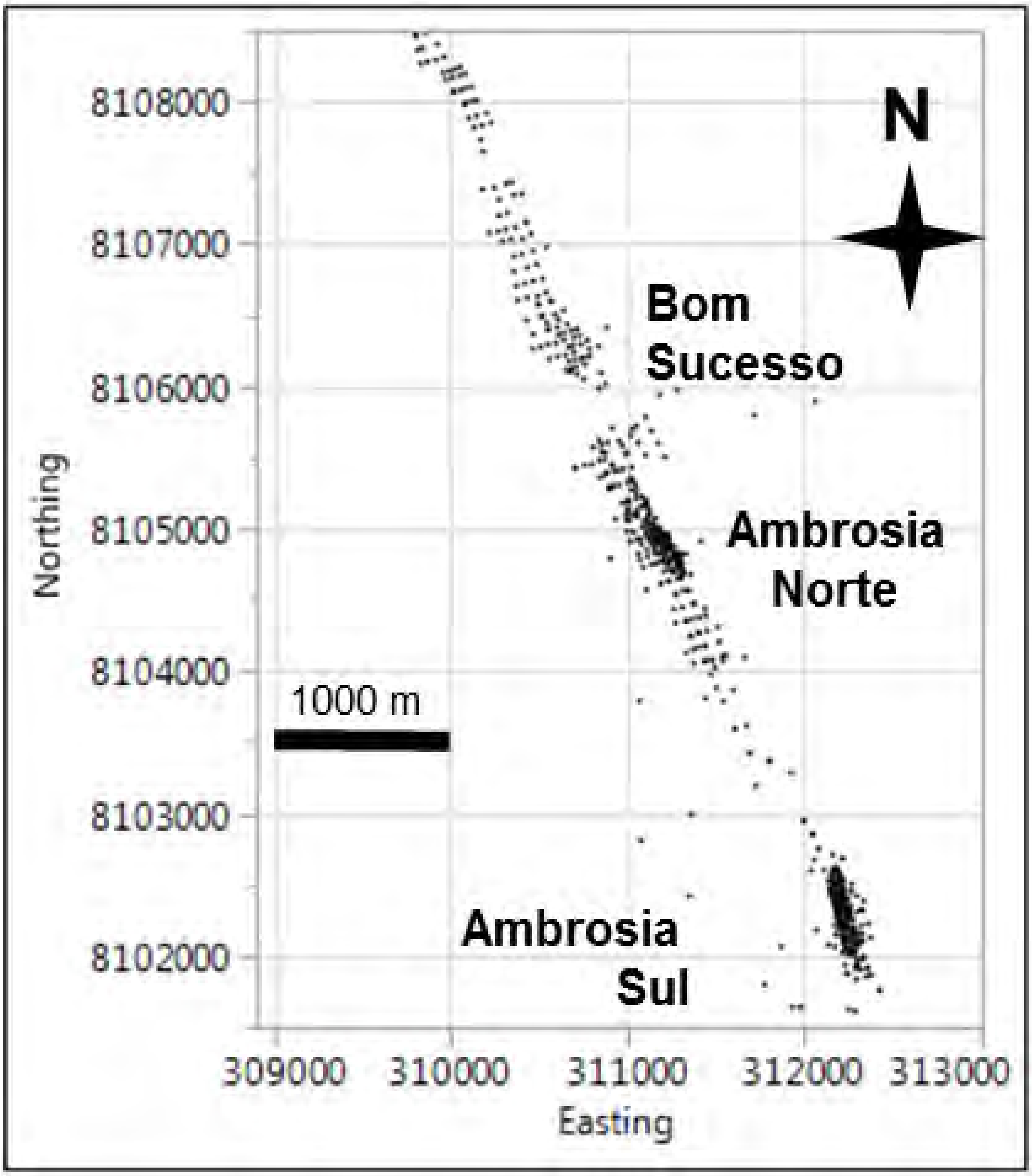
Year	Number of Holes	Total Metres
1973	12	1,829.75
1974	9	981.96
1976	6	2,185.46
1987	36	3,490.15
1988	8	1,285.80
1989	9	1,275.35
1994	7	1,702.15
2000	7	1,954.35
2001	36	8,652.00
2008	19	953.35
2011	8	335.00
2012	35	2,403.75
2013	2	281.70
2014	10	1,953.80
2015	35	5,068.25
2016	16	1,455.25
Total	***255***	***35,808.07***

Table 10-4: Bonsucesso Drilling by Year

Year	Number of Holes	Total Metres
1976	1	210.05
2014	18	5,384.55
2015	32	9,981.80
2016	54	15,669.00
2017	19	5,467.80 *
Total	***124***	***36,713.20***

Note: Information current as of 8 March, 2017

Figure 10-3: Ambrosia Drill Hole Location Map



Note: Figure prepared by Amec Foster Wheeler, 2017.

A large number of drill rigs of various types have been used at the Morro Agudo Mine over the history of the operations, and those have not been documented. Currently, drilling is performed by mine personnel using three drill rigs, one Boart Longyear LM55 and two Boart Longyear LM75 machines.

Core diameters were not recorded, but N-sized core (47.6 mm) was commonly used from the surface and reduced as necessary to B-sized core (36.4 mm). Currently, BQ diameter (36.4 mm) is drilled from underground stations where holes are collared in fresh rock.

Current drill holes start from drill stations that allow hole orientations of 225° azimuth and -90º to +90º inclination. The drill spacing attempts to maintain 18 m x 18 m grids along the mineralization (Figure 10-4).

10.2.2 Ambrosia Trend

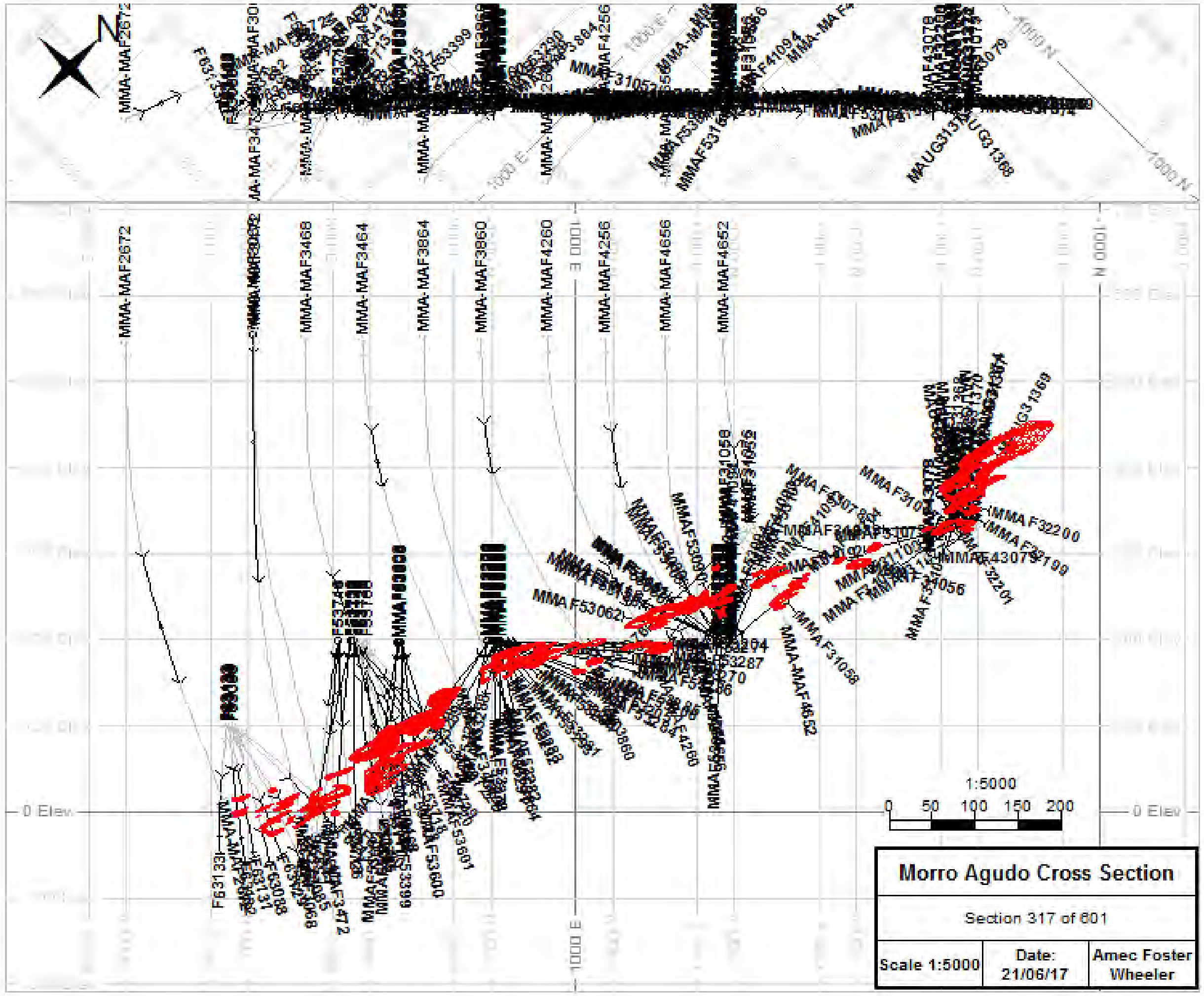
Prior to 2008 (152 holes, 25,049.49 m), no records of drill contractors were maintained for the Ambrosia Trend area. Since then, drilling has been performed by Willemita Ltda. (441 holes, 73,089.95 m) and Geosol (10 holes, 2,486.4 m).

The drill holes typically start with HQ-diameter (65 mm) tools and reduce to NQ-diameter (45 mm) tools as necessary. The drilling is performed according to Votorantim standard operating procedure PO-VM-EXPMIN-002.

No record of the drill machine manufacturer and model was maintained for the drilling in the Ambrosia Trend. The drill rig currently used for drilling is a Maqesonda MACH 1210 MTS.

Drilling programs in a specific area start with a 100 x 100 m grid, located according to favorable geology. The drill spacing is progressively decreased to 50 m and finally to 25 m to increase the confidence level in the area. Most drill holes are inclined at approximately -45º.

Figure 10-4: Typical Drilling Pattern at Morro Agudo



Note: Figure prepared by Amec Foster Wheeler, 2017.

10.3 Logging Procedures

The core handling process for Morro Agudo and the Ambrosia Trend deposits is summarized in the flowchart in Figure 10-5. The recovered core is stored placed in core boxes at the drill by the drill team in charge of the drilling. The boxes are transported to the core shed where the core is logged.

At the core shed, the boxes are arranged in order and checked to verify that all core has been received. After the boxes are checked, the geological description of the drill hole is completed. The geologist logs the lithological intervals in a spreadsheet. The main characteristics of each lithology, rock type, color, texture, and structure are added to spreadsheet per Votorantim's standard operating procedure PO-VM-ZINCO-VZ-GEO-005.

Sulphide mineralogy (pyrite, galena, and sphalerite) is identified and the intensity of mineralization is also logged. The length of each lithological interval, as well as its summarized geological features are also noted on that same spreadsheet. Codes used to describe each lithology are summarized in Table 10-5.

10.4 Recovery

Based on the data provided to Amec Foster Wheeler, core recovery averaged 96.2% at Ambrosia Sul, 91.3% at Ambrosia Norte, and 96.4% at Bonsucesso.

Data for the Morro Agudo Mine were not provided to Amec Foster Wheeler but the rocks are similar to those at the Ambrosia Trend, so similar recoveries are anticipated.

Recovery is considered by Amec Foster Wheeler to be excellent.

10.5 Collar Surveys

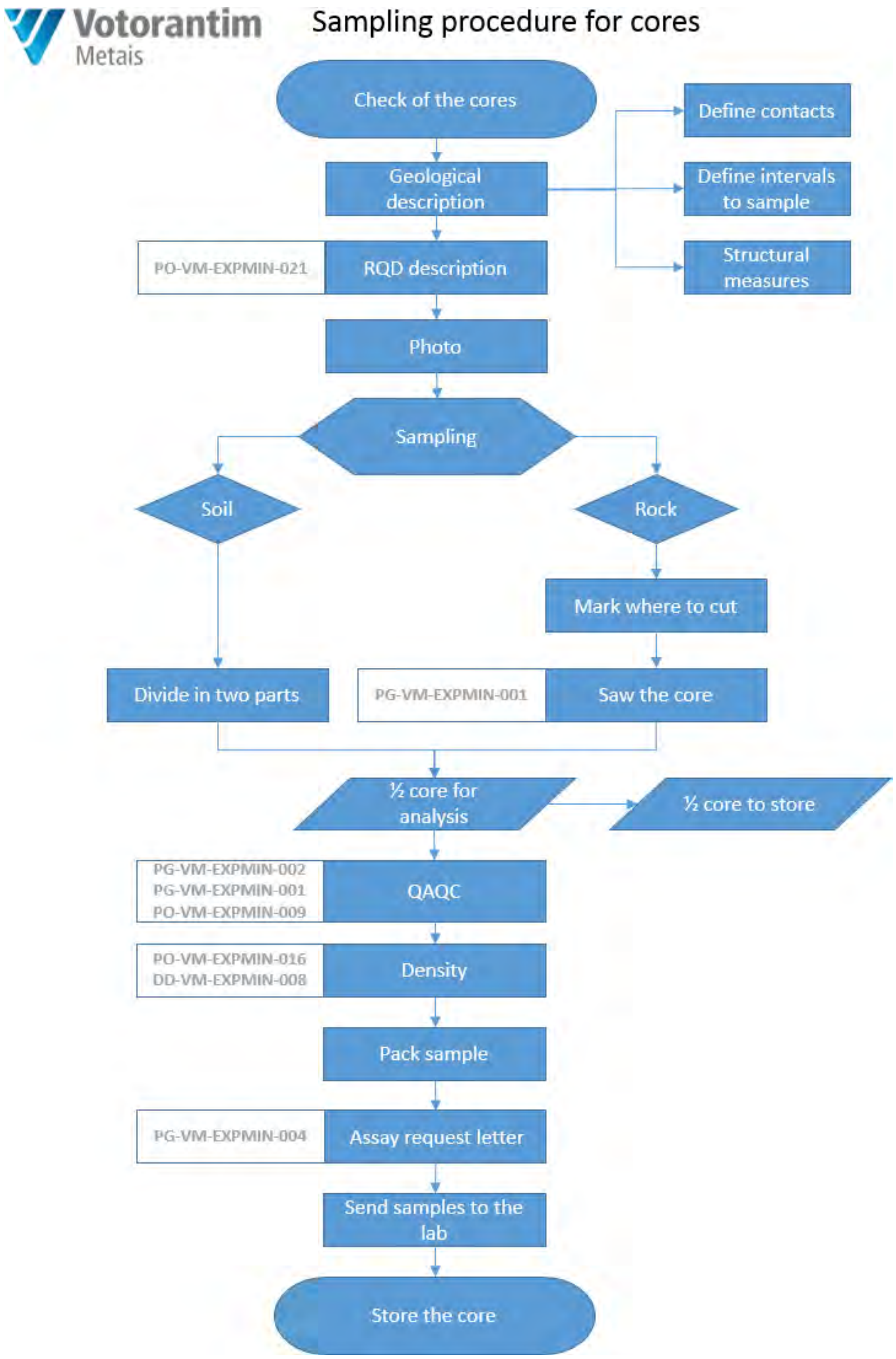
10.5.1 Morro Agudo Mine

All but four of the 3,670 collar locations in the database were determined using total station instruments. The remaining four collar locations were determined using an unspecified GPS instrument.

10.5.2 Ambrosia Trend

Since 1973, total station instruments have been used for the bulk of collar surveying in the Ambrosia Trend; however, after 2011, some of the collar locations were determined using differential GPS (DGPS). Specifics of the instrumentation are not recorded.

Figure 10-5: Core Handling Process Flowchart



Note: Figure courtesy Votorantim, 2017.

Table 10-5: Lithology Codes Used at Morro Agudo and Ambrosia.

Lithology	Code
Soil	SO
Saprolite	SG
Dolomite	DO
Dolorudite	DT
Dolarenite	DL
Diamictite	DI
Hydrothermal Breccia	BH
Sedimentary Breccia	BS
Gossan	GS
Marl	MG
Carbonaceous Phyllite	FC
Phyllite	FI
Chert	CH
Disseminated Mineralization	DS
Massive Mineralization	MS
Zinc Carbonate (oxide Zn)	CBZN
No Recovery	XX
No Recovery	ZZ

10.6 Downhole Surveys

10.6.1 Morro Agudo Mine

At Morro Agudo, a Tropari™ instrument was used for 2,145 downhole surveys from 1979 through 2007. After 2007, a REFLEX Gyro™ has been used for most of the holes (1,295 holes). A Maxibor™ instrument was used for a small number of holes (49) in 2006–2009 and 2011 with a Devitool Peewee™ used for two holes in 2006.

10.6.2 Ambrosia Trend

In the Ambrosia Trend, a Tropari™ instrument was used for 87 downhole surveys from 1987 through 2001. From 2011 through 2017, a REFLEX Gyro™ was used to perform 32 downhole surveys. Maxibor™ instruments were used to perform 410 downhole surveys. In 2008, 16 holes are indicated as not having been surveyed. There are 58 holes from various years that do not have a survey type associated with the downhole survey.

Core orientation is currently accomplished with a REFLEX ACT™ instrument. Prior to 2016, a spear-type instrument was used. Only cores with particular relevance for geotechnical or structural models are oriented.

10.7 Sample Length/True Thickness

In rare cases, sample length equals true thickness. In most cases; however, drill holes intersect mineralization at angles other than 90º. Figure 10-4 showed the drill pattern at the Morro Agudo Mine. Few of the drill holes in that figure show true thickness.

Figure 10-6 shows a typical cross section at Ambrosia Sul. Some of the drill intersections are very near true thickness. Figure 10-7 and Figure 10-8Figure 10-8 are typical cross sections for Ambrosia Norte and Bonsucesso respectively. Many of the drill intercepts are effectively true thicknesses.

10.8 Summary of Drill Intercepts

The Morro Agudo Mine is an active underground mine with a total of approximately 3,670 core holes (refer to Figure 10-2). Most of those holes have intersected mineralization and many have intercepted multiple zones of mineralization. A typical cross section for the mine was included as Figure 10-4, and shows the intercepts for a number of the drill holes at the Morro Agudo Mine.

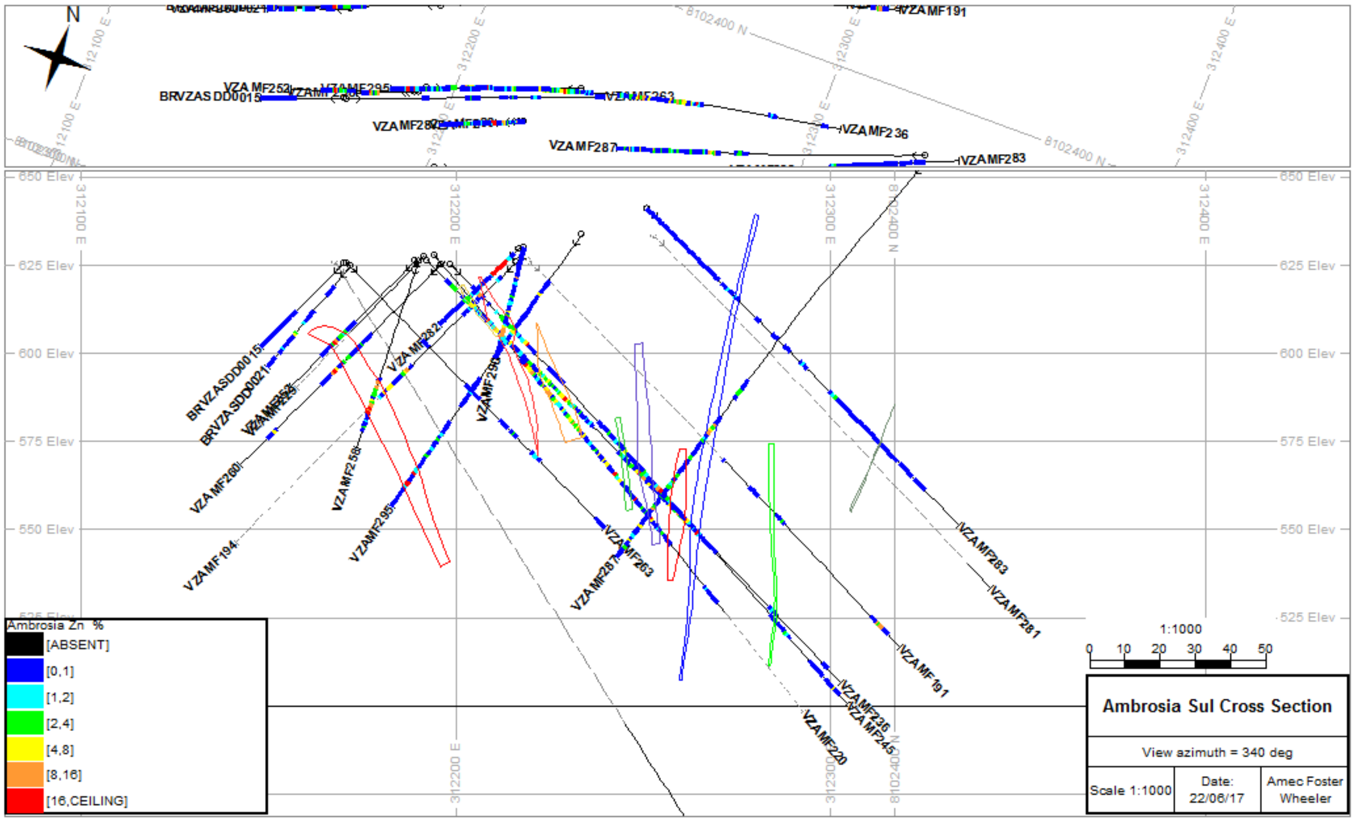
Table 10-6 provides a selected list of drill hole intercepts from the exploration drilling completed at Morro Agudo Mine during 2016–2017. Table 10-7 provides a selected list of drill hole intercepts for the Ambrosia Trend deposits. Table 10-8 includes a selected list of the drill hole intercepts to the north and south of the Bonsucesso deposit area.

10.9 Comments on Section 10

Drilling procedures at Morro Agudo and the Ambrosia Trend are consistent with industry practices. Collar location surveying was done using either total station instruments or DGPS instruments and a mix of instruments were used at Morro Agudo and the Ambrosia Trend for downhole surveying. All of those instruments were considered to be industry-standard instruments at the time they were in use and all are capable of sufficient accuracy and precision to support Mineral Resource estimation and mine planning.

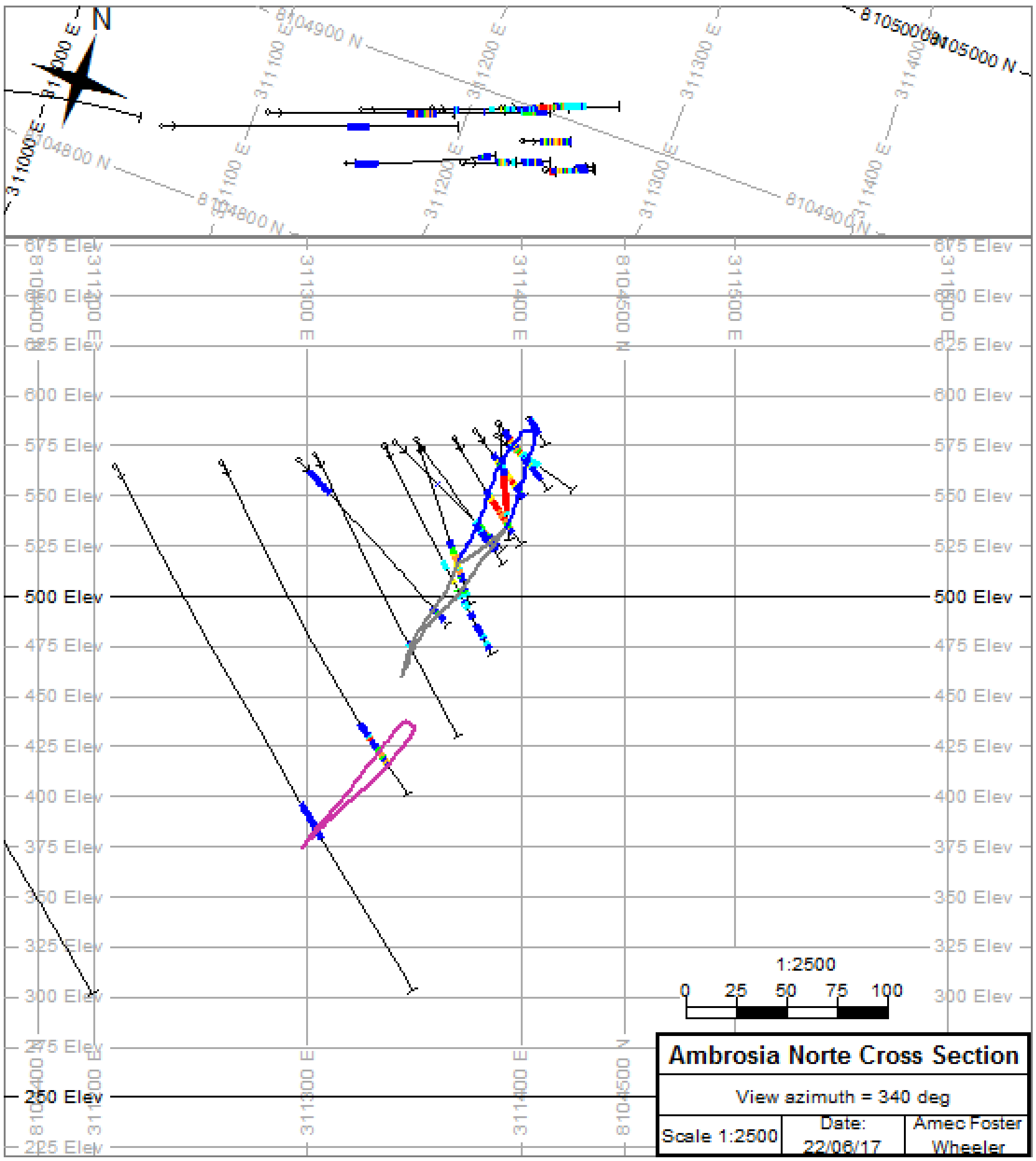
Core recovery is excellent at an average of about 95% overall. Geological logging includes lithology, rock type, colour, texture, and structure. Information is captured in spreadsheets per standard operating procedure PO-VM-ZINCO-VZ-GEO-005. These logs are adequate to support Mineral Resource estimation and mine planning.

Figure 10-6: Ambrosia Sul Cross Section



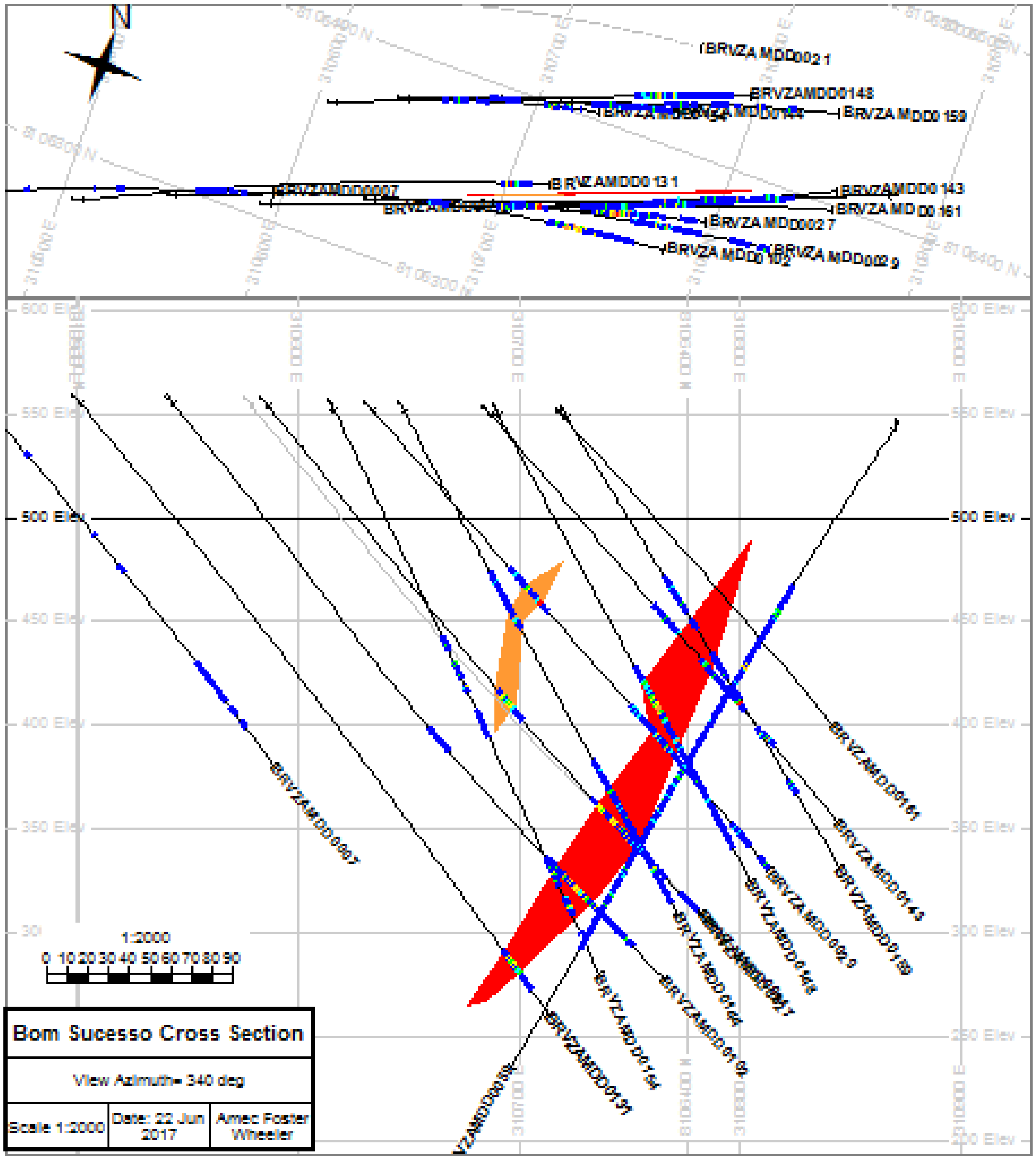
Note: Figure prepared by Amec Foster Wheeler, 2017.

Figure 10-7: Ambrosia Norte Cross Section



Note: Figure prepared by Amec Foster Wheeler, 2017.

Figure 10-8: Bonsucesso Cross Section



Note: Figure prepared by Amec Foster Wheeler, 2017.

Table 10-6: Selected Drill Hole Intercepts, Morro Agudo Mine Exploration Drilling

Drill Hole	Easting	Northing	Elevation	Azimuth (º)	Inclination (º)	Total Depth (m)	Depth From (m)	Depth To (m)	Drilled Intercept (m)	Zn Grade (%)	Pb Grade (%)
MAF3884	938.32	-2089.5	546.08	734.50	34	-72	680.00	685.00	5.00	3.17	0.68
MAF4684	1149.72	-2099.91	544.99	31	-72	760.40	720.05	730.50	10.45	2.74	1.03
MAF9472	2349.90	-1799.82	560.05	30	-71	577.70	501.50	510.60	9.10	4.59	2.21
MAUG73007	1257.66	-1795.6	0.82	198.60	74	-10	147.00	151.00	4.00	1.97	0.02
MAUG73011	1257.66	-1795.57	0.82	102	-56	219.10	99.80	102.00	2.20	0.91	17.38
							122.90	128.90	6.00	1.16	0.43
							135.30	150.30	15.00	3.54	1.52
							157.30	158.30	1.00	2.62	0.50
							190.90	202.40	11.50	3.94	0.10
MAUG73012	1258.15	-1795.89	1.64	109	-46	258.90	180.60	186.60	6.00	3.02	0.86
							222.10	225.10	3.00	2.26	1.43
MAUG73013	1258.03	-1795.7	1.40	239.00	106	-52	199.10	208.10	9.00	4.64	1.31
VZMAF005	949.15	-2194.87	570.63	343	-84	783.45	668.35	673.25	4.90	0.66	0.11
VZMAF010	2273.06	-1931.65	603.05	342	-64	706.75	539.05	543.75	4.70	4.67	1.44
							624.02	633.80	9.78	3.70	0.05
VZMAF011	1500.37	-2327.99	585.83	21	-61	850.90	778.72	788.85	10.13	2.87	0.28
VZMAF017	2190.55	-2036.52	602.47	348	-60	830.00	593.60	598.70	5.10	1.64	0.55
VZMAF019	1695.37	-2355.12	588.12	356	-59	917.90	843.60	848.80	5.20	2.92	0.19
VZMAF021	1597.38	-2442.68	574.16	354	-61	912.90	869.30	883.65	14.35	3.80	1.90
							889.05	893.60	4.55	3.72	7.46
VZMAF024	1498.93	-2543.08	563.03	359	-70	937.15	894.25	904.10	9.85	2.89	3.33
VZMAF028	1397.61	-2404.6	568.40	846.00	6	-61	798.40	803.60	5.20	7.79	3.29
VZMAF036	1187.00	-2494.6	557.17	968.75	38	-62	873.80	878.80	5.00	1.41	0.07

Table 10-7: Selected Drill Hole Intercepts, Ambrosia Trend

	Drill Hole	Easting	Northing	Elevation	Azimuth (º)	Inclination (º)	Depth From (m)	Depth To (m)	Drilled Intercept (m)	Zn Grade (%)	Pb Grade (%)	Ag Grade (g/t)
Ambrosia Sul	BRVZAMDD0028	312128.14	8102884.25	502.88	70.63	-50.77	140.50	143.50	3.00	6.57	0.24	0.60
	BRVZAMDD0030	312092.09	8102871.73	510.51	71.30	-63.60	113.25	115.25	2.00	1.41	0.01	0.25
	BRVZASDD0001	312203.44	8102093.42	612.93	251.96	-44.10	15.40	20.00	4.60	4.26	0.11	0.44
	BRVZASDD0004	312188.97	8102137.49	604.63	250.48	-44.34	27.75	28.95	1.20	10.05	2.25	0.25
	BRVZASDD0006	312182.30	8102243.78	597.65	249.37	-48.67	38.20	43.70	5.50	4.53	0.07	0.25
							70.45	72.85	2.40	3.65	0.02	0.25
	BRVZASDD0007	312228.85	8102156.07	553.59	253.98	-55.50	94.20	102.15	7.95	1.70	0.02	0.58
							94.20	103.85	9.65	1.52	0.01	0.52
	BRVZASDD0008	312175.94	8102397.78	561.73	247.84	-51.95	38.55	44.35	5.80	4.92	0.18	0.25
							82.35	92.75	10.40	5.71	0.06	0.30
	BRVZASDD0009	312226.81	8101993.73	597.51	236.03	-42.88	36.75	38.25	1.50	3.07	0.01	0.25
Ambrosia Norte	BRVZAMDD0060	310999.24	8105435.65	421.10	71.40	-45.20	174.60	176.60	2.00	2.07	0.11	0.3
							185.85	188.80	2.95	4.85	0.05	0.3
	BRVZAMDD0086	310838.47	8105479.81	445.11	69.29	-47.79	137.70	139.40	1.70	1.50	0.03	0.3
	BRVZCNDD0001	311109.37	8105199.60	526.10	71.16	-73.56	33.95	45.80	11.85	15.37	0.64	3.6
	BRVZCNDD0003	311124.97	8105142.37	531.81	73.46	-79.81	28.40	43.20	14.80	1.43	1.27	0.4
	BRVZCNDD0004	311117.91	8105169.67	522.85	69.63	-53.42	44.50	57.75	13.25	5.90	1.31	0.9
	BRVZCNDD0006	311135.75	8105113.15	522.08	69.90	-65.20	42.00	45.00	3.00	1.39	1.47	0.5
							42.00	53.05	11.05	1.86	1.06	1.1
	BRVZCNDD0007	311163.81	8105043.37	532.17	70.88	-55.47	38.10	50.30	12.20	3.13	1.04	1.5
	BRVZCNDD0008	311037.30	8105369.83	514.11	70.53	-60.78	46.30	51.30	5.00	1.33	0.69	0.5
	BRVZCNDD0009	311053.52	8105320.89	520.68	70.85	-68.77	36.90	50.60	13.70	4.25	0.83	0.7
Bonsucesso	BRVZAMDD0007	310577.03	8106307.43	407.44	72.10	-52.85	193.60	194.10	0.50	2.28	0.02	0.3
	BRVZAMDD0008	310579.62	8106508.74	374.22	76.71	-48.96	241.00	242.55	1.55	8.20	0.38	0.3
	BRVZAMDD0011	310684.54	8106550.14	356.17	76.94	-45.07	161.70	162.35	0.65	2.09	0.01	0.3
							196.75	199.20	2.45	12.94	3.88	0.5
							224.30	232.30	8.00	1.23	0.04	0.3

Drill Hole	Easting	Northing	Elevation	Azimuth (º)	Inclination (º)	Depth From (m)	Depth To (m)	Drilled Intercept (m)	Zn Grade (%)	Pb Grade (%)	Ag Grade (g/t)
						243.35	244.55	1.20	7.28	2.48	0.3
						246.90	247.40	0.50	4.84	1.75	0.3
						267.20	273.05	5.85	3.82	0.53	0.3
BRVZAMDD0015	310670.09	8106535.00	450.18	70.57	-48.91	137.60	138.10	0.50	5.94	0.48	1.9
						137.60	138.10	0.50	5.94	0.48	1.9
BRVZAMDD0016	310669.60	8106632.93	418.21	74.27	-51.47	121.35	124.00	2.65	2.02	0.06	0.3
						177.05	178.15	1.10	3.98	0.19	0.4

Table 10-8: Selected Drill Hole Intercepts, Bonsucesso 2017 Drilling

Drill Hole	Easting	Northing	Elevation	Azimuth (º)	Inclination (º)	Drilled Depth	Depth From (m)	Depth To (m)	Drilled Intercept (m)	Zn Grade (%)	Pb Grade (%)
BRVZAMDD0156	309890.3134	8108495	557.908	70	-61.3	334.50	190.95	191.95	1.00	6.99	0.31
BRVZAMDD0157	310710.3163	8106087	551.738	70	-59.8	343.15	298.35	301.00	2.65	2.69	0.32
							285.50	292.95	7.45	8.40	1.03
BRVZAMDD0168	310637	8106166	555	70	-55	335.90	280.80	291.30	10.50	8.50	3.73
BRVZAMDD0169	310663	8106486	552	70	-50	219.70	127.65	131.60	3.95	1.61	0.07
	310663	8106486	552	70	-50	219.70	105.85	107.65	1.80	5.03	0.13
BRVZAMDD0170	310744	8106103	550	70	-47	289.85	-	-	-	-	-
BRVZAMDD0171	310483	8106430	558	70	-50	364.35	310.70	312.00	1.30	12.33	2.59
							291.00	296.70	5.70	1.59	0.33
							178.55	180.60	2.05	1.92	0.21
BRVZAMDD0172	310629	8106260	555	70	-63	337.55	186.10	189.35	3.25	3.30	0.05
							181.60	183.75	2.15	3.72	0.22
							276.00	286.30	10.30	6.16	0.90
BRVZAMDD0178	310174	8107063	562	70	-49	528.98	399.94	410.14	10.20	1.69	0.23
BRVZAMDD0179	310426	8107066	555	70	-51	282.70	206.90	211.32	4.42	2.17	0.17
	310426	8107066	555	70	-51	282.70	197.55	203.64	6.09	5.14	1.92

In rare cases, sample length equals true thickness; however, in most cases drill holes intersect mineralization at angles other than 90°. Trajectories of the drill holes are well constrained with collar and downhole surveying so the fact that few drill holes actually represent true thickness is not considered by Amec Foster Wheeler to be an issue.

Mineralized intercepts at Ambrosia Sul, Ambrosia Norte, and Bonsucesso indicate the potential of all three deposits.

11.0 SAMPLE PREPARATION, ANALYSES, AND SECURITY

11.1 Sampling Methods

After geological logs of a drill hole are completed, the geologist in charge of an individual hole designs the sample intervals for that hole following the Votorantim standard operating procedure PO-VM-EXPMIN-009. The samples respect lithological intervals with a minimum length of 0.50 m and maximum length of 1.50 m. The beginning and the end of each sample coincides with the logged geological contacts. Samples cannot include different lithologies unless the minimum sample length cannot be met. Drill runs with significantly different recoveries are typically not included in the same sample.

Typically, 3 m of not-obviously mineralized hanging wall and footwall (6 m total) are sampled on either side of a mineralized interval to confirm the non-mineralized intervals, which was qualitatively defined by the logging.

Sampling data are stored in the project database and the physical document is stored in the office in a file for each drill hole.

After samples are marked, core is sawn in a dedicated core saw. The left half of the core is sampled. The right side is returned to the core box for storage.

When soil or other loose, weathered material was to be sampled, it was homogenized and quartered. One of the quarters was sent for analysis. The remaining material was returned to the core box.

Samples were then sent to the ALS laboratory in Vespasiano, Minas Gerais, for sample preparation.

11.1.1 Morro Agudo Mine

The Morro Agudo Mine has undergone continuous improvements in sampling, sample preparation, and sample analysis practices, since the 1980s when mining began.

Prior to 2011, the Morro Agudo mine laboratory was used for sample preparation and chemical analysis of exploration and production samples. No quality assurance and quality control (QA/QC) measures were in place at that time. In 2011, a rigorous QA/QC program was implemented and continued to the present time; however, since end of 2015, exploration samples have been prepared and analyzed at ALS Global laboratories.

In 2017, Votorantim began a reanalysis program that included 5–10% of samples analyzed in 2011 and earlier to provide a check on those samples without supporting QA/QC data. Those samples were selected and sent to ALS Global for analysis.

11.2 Density Determinations

11.2.1 Morro Agudo Mine

Historic density data for the Morro Agudo Mine were determined by water-displacement methods, as set out in Votorantim's operational procedure PO-VM-EXPMIN-016-densidade. The formula used is:

Density = dry weight/displaced volume weight

Displaced volume weight = [Volume of Core/Water] – [Initial Volume]

Recently, the Jolly method has been used as the primary method. That procedure calls for weighing the dried sample in air and then again while the sample is submerged in water. Density is then:

Density = dry weight/(dry weight – wet weight)

This procedure is used for all determinations and 1-in-20 samples are then determined with the immersion procedure as a quality control (QC) measure.

Figure 11-1 summarizes all density data for Morro Agudo and Table 11-1 summarizes density data by lithology code.

11.2.2 Ambrosia Trend

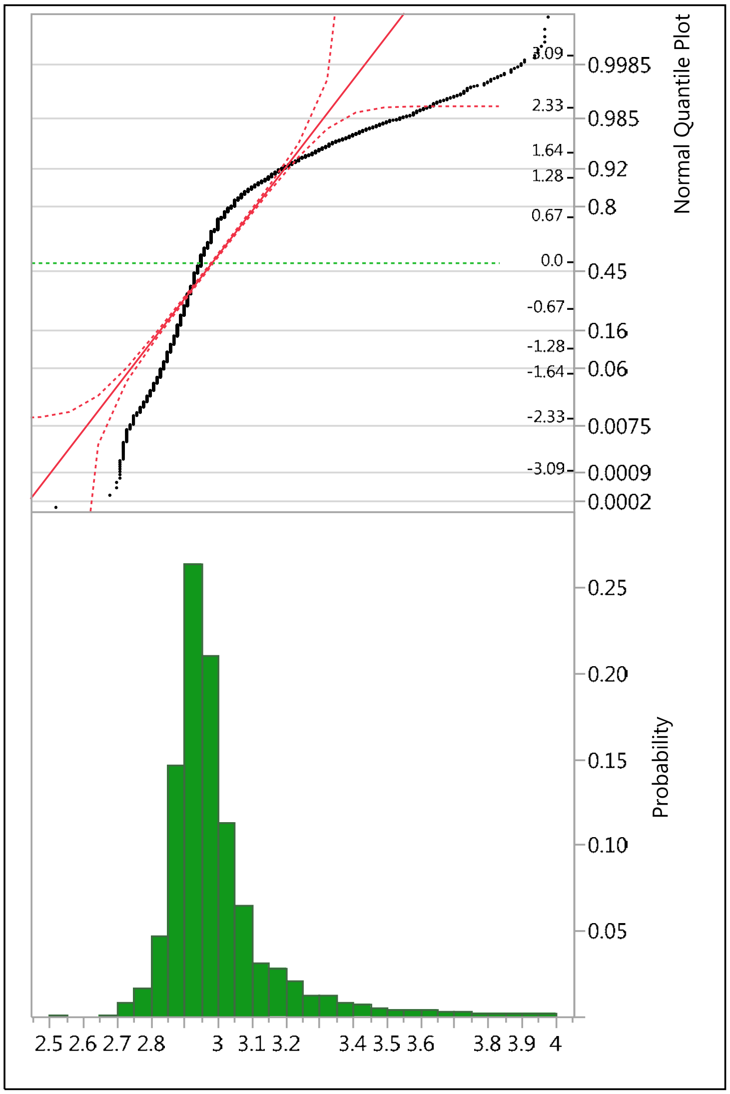
Density in the Ambrosia Trend deposits is measured for every sample interval. The immersion method discussed above (Jolly method) is now used for that; however, the displacement method was used for legacy data. The displacement method is also used as a cross-check every 10 samples. The diamond drilling insures intact cores and eases the definition of the density through these methods.

The similarity of the Jolly and displacement methods is demonstrated by Figure 11-2, a quantile–quantile (Q-Q) plot prepared for the Ambrosia audit performed by Snowden in 2012. The results show no significant difference between the methods.

Ambrosia density data are summarized in the following figures and tables:

- Figure 11-3, Ambrosia Sul summary histogram for all data; Figure 11-4, Ambrosia Norte summary histogram for all data; Figure 11-5, Bonsucesso summary histogram for all data
- Table 11-2, data summary by lithology code; Table 11-3, data summary by lithology code; Table 11-4, data summary by lithology code.

Figure 11-1: Morro Agudo Density Histogram



Summary Statistics	
Mean	2.99
Std Dev	0.153
Std Err Mean	0.002
Upper 95% Mean	2.99
Lower 95% Mean	2.98
N	7781
CV	5.13
Median	2.95
5% Trimmed Mean	2.97
Interquartile Range	0.12
Median Absolute Deviation	0.05

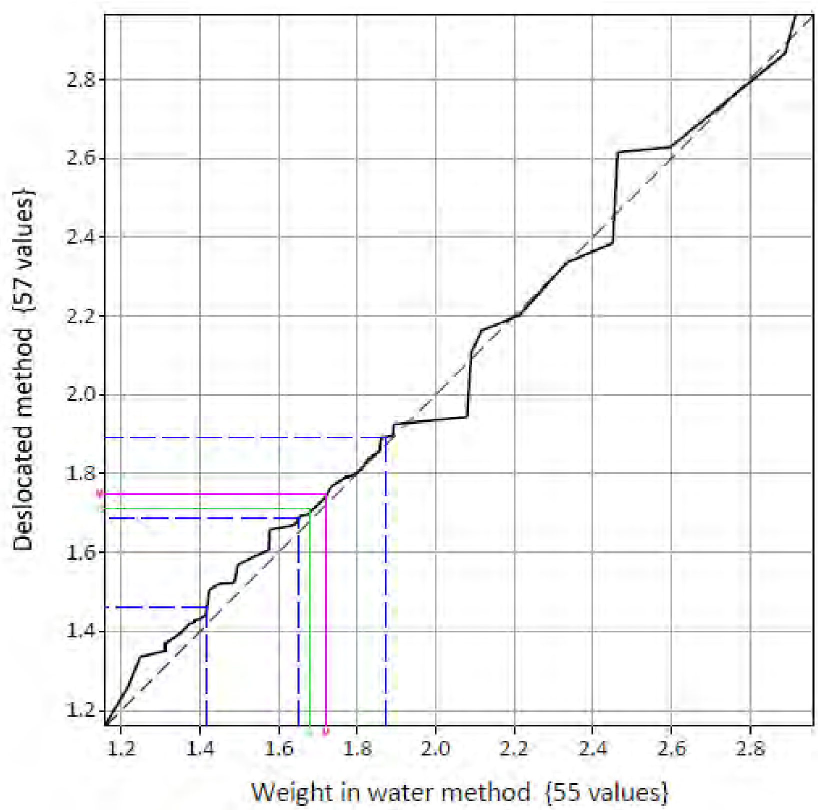
Quantiles		
100.0%	maximum	3.98
99.5%		3.74
97.5%		3.43
90.0%		3.16
75.0%	quartile	3.02
50.0%	median	2.95
25.0%	quartile	2.90
10.0%		2.86
2.5%		2.80
0.5%		2.73
0.0%	minimum	2.52

Note: Figure prepared by Amec Foster Wheeler, 2017.

Table 11-1: Morro Agudo Density by Lithology Code

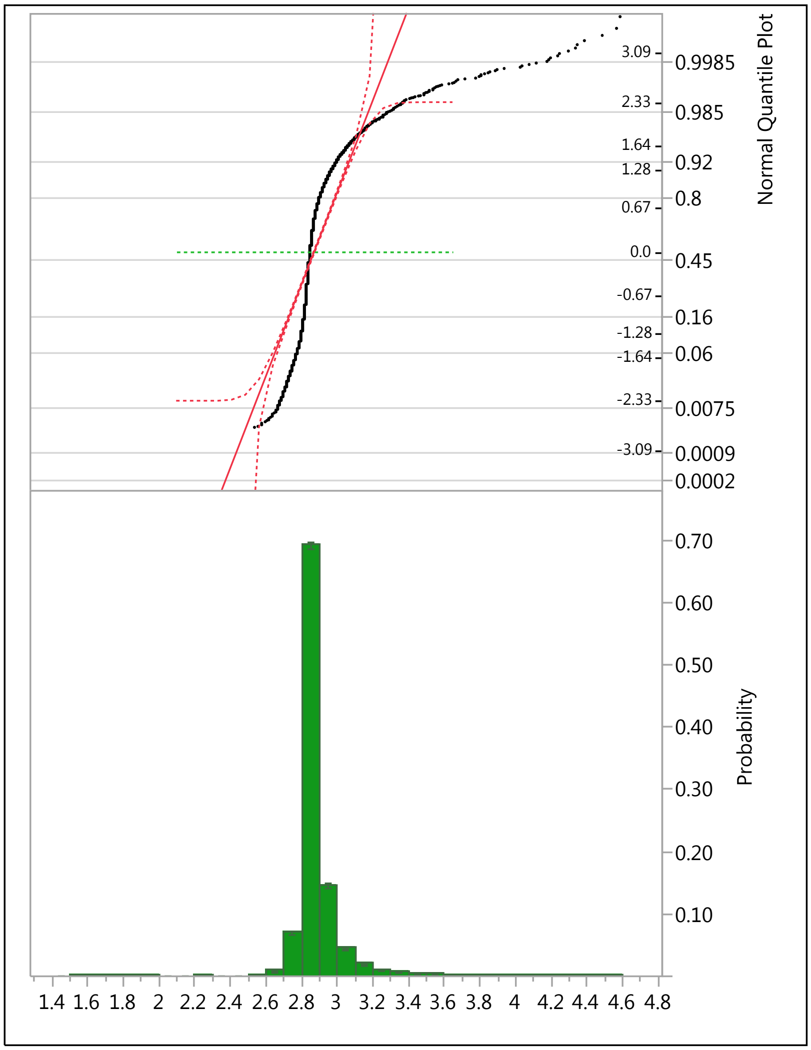
Lithology Code	N	Mean	Std Dev	CV	Minimum	Maximum
DL	5,288	3.00	0.16	5.21	2.52	3.97
DT	2,365	2.96	0.14	4.77	2.68	3.98
FC	16	2.93	0.09	2.94	2.83	3.13
MG	112	2.87	0.12	4.29	2.70	3.39

Figure 11-2: Q–Q Plot Comparing the Jolly (Weight in Water) Method and Displacement Method



Note: Figure from Snowden, 2012.

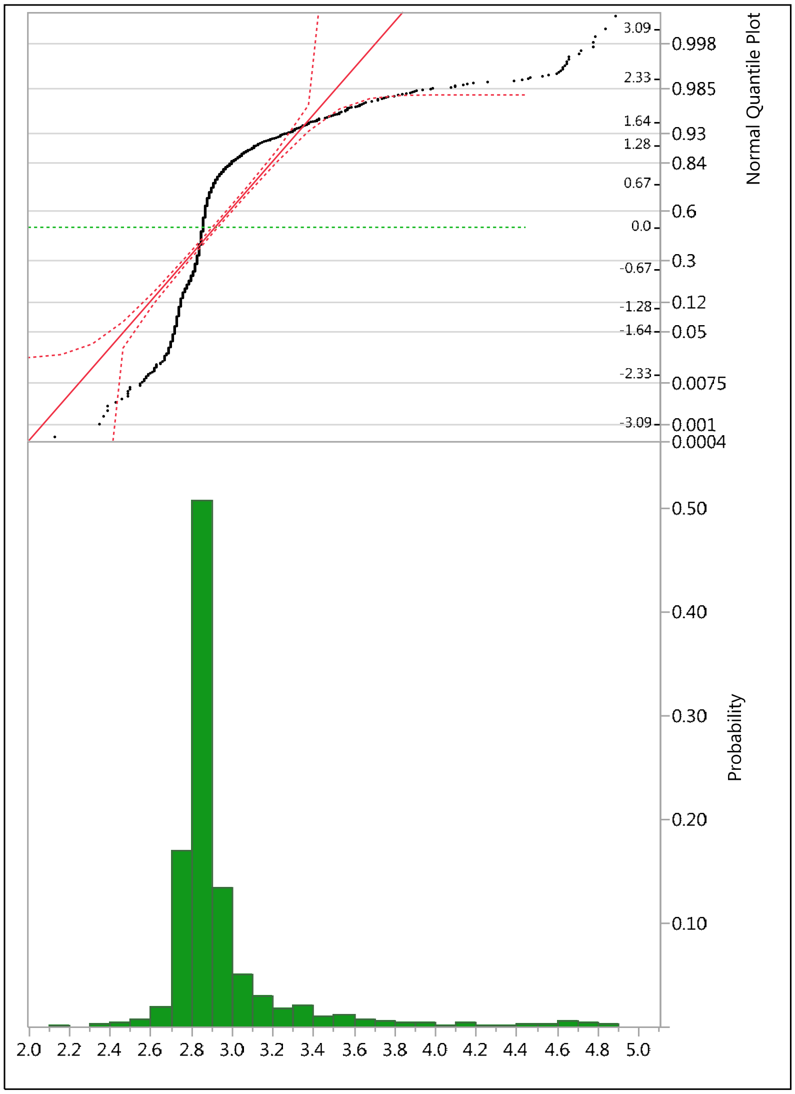
Figure 11-3: Ambrosia Sul Density Histogram



Summary Statistics		Quantiles		
Mean	2.88	100.0%	maximum	4.59
Std Dev	0.140	99.5%		3.58
Std Err Mean	0.002	97.5%		3.18
Upper 95% Mean	2.88	90.0%		2.97
Lower 95% Mean	2.87	75.0%	quartile	2.89
		50.0%	median	2.85
N	7,676	25.0%	quartile	2.83
CV	4.86	10.0%		2.80
Median	2.85	2.5%		2.73
5% Trimmed Mean	2.86	0.5%		2.63
Interquartile Range	0.06	0.0%	minimum	1.51
Median Absolute Deviation	0.03			

Note: Figure prepared by Amec Foster Wheeler, 2017.

Figure 11-4: Ambrosia Norte Density Histogram

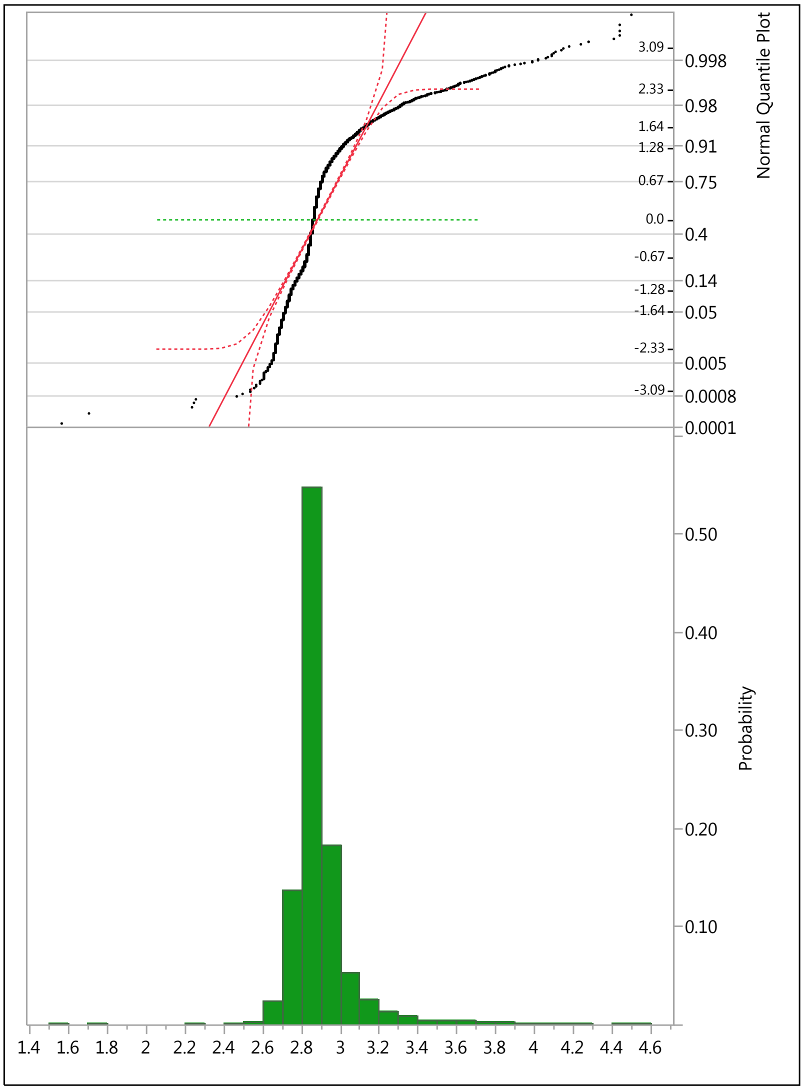


Summary Statistics	
Mean	2.92
Std Dev	0.274
Std Err Mean	0.006
Upper 95% Mean	2.93
Lower 95% Mean	2.91
N	2,029
CV	9.39
Median	2.86
5% Trimmed Mean	2.88
Interquartile Range	0.09
Median Absolute Deviation	0.05

Quantiles		
100.0%	maximum	4.89
99.5%		4.65
97.5%		3.70
90.0%		3.13
75.0%	quartile	2.91
50.0%	median	2.86
25.0%	quartile	2.82
10.0%		2.74
2.5%		2.69
0.5%		2.49
0.0%	minimum	2.13

Note: Figure prepared by Amec Foster Wheeler, 2017.

Figure 11-5: Bonsucesso Density Histogram



Summary Statistics		Quantiles		
Mean	2.89	100.0%	maximum	4.50
Std Dev	0.150	99.5%		3.74
Std Err Mean	0.002	97.5%		3.27
Upper 95% Mean	2.89	90.0%		3.01
Lower 95% Mean	2.88	75.0%	quartile	2.91
N	8,342	50.0%	median	2.87
CV	5.19	25.0%	quartile	2.83
Median	2.87	10.0%		2.75
5% Trimmed Mean	2.87	2.5%		2.69
Interquartile Range	0.08	0.5%		2.65
Median Absolute Deviation	0.04	0.0%	minimum	1.57

Note: Figure prepared by Amec Foster Wheeler, 2017.

Table 11-2: Ambrosia Sul Density Data by Lithology Code

Lith_Code	N	Mean	Std Dev	CV	Minimum	Maximum
CBZN	1	2.21	—	—	2.21	2.21
CH	7	2.66	0.07	2.56	2.58	2.75
DI	70	2.86	0.08	2.91	2.64	3.14
DL	154	2.85	0.07	2.58	2.6	3.37
DO	640	2.84	0.05	1.74	2.67	3.39
DS	127	3.06	0.21	6.76	2.79	3.81
DT	2308	2.85	0.05	1.85	1.85	3.41
FC	130	2.79	0.20	7.23	1.57	4.19
FI	8	2.83	0.09	3.35	2.73	3.03
MG	117	2.79	0.08	2.96	2.54	3.01
MS	31	3.74	0.52	13.87	2.97	4.59
NR	2	2.97	0.16	5.49	2.85	3.08
SO	10	1.76	0.08	4.47	1.65	1.93

Table 11-3: Ambrosia Norte Density by Lithology Code

Lith Code	N	Mean(Density)	Std Dev	CV	Minimum	Maximum
BH	1158	2.97	0.32	10.86	2.13	4.89
CBZN	2	3.35	0.22	6.55	3.19	3.50
DI	16	2.80	0.05	1.86	2.70	2.85
DL	7	2.76	0.07	2.38	2.65	2.83
DO	320	2.86	0.08	2.82	2.49	3.53
DS	128	3.10	0.29	9.23	2.72	4.26
DT	123	2.83	0.06	2.06	2.49	2.99
FC	196	2.77	0.09	3.26	2.57	3.40
FI	5	2.56	0.18	7.11	2.35	2.76
GS	7	1.54	0.54	35.25	1.14	2.71
MG	77	2.71	0.18	6.66	1.72	2.96

Table 11-4: Bonsucesso Density by Lithology Code

Lith Code	N	Mean	Std Dev	CV	Minimum	Maximum
BH	5839	2.92	0.15	5.09	2.47	4.50
DI	3	2.77	0.12	4.19	2.69	2.90
DL	29	2.81	0.05	1.86	2.70	2.90
DO	723	2.85	0.11	3.78	2.61	3.75
DS	25	3.26	0.31	9.62	2.88	3.81
DT	536	2.85	0.05	1.80	2.69	3.23
FC	600	2.74	0.09	3.26	2.54	4.15
MG	576	2.78	0.11	3.85	2.54	3.72
NR	1	2.92	-	-	2.92	2.92

11.3 Analytical and Test Laboratories

Sample preparation and analysis for exploration and mine samples from Morro Agudo were performed at the Morro Agudo Mine from as early as 1987. That laboratory is not and has not been accredited.

Beginning in late 2015, ALS Global was chosen as the primary laboratory. Samples are prepared in Brazil and analyzed in Perú. The ALS Global sample preparation facilities at Vespasiano and Goiânia, Brazil are ISO 9001:2008 accredited. ALS Global analytical facilities in Perú are ISO 9001:2008 and 17025:2005 accredited.

Samples from the Ambrosia Trend have all been prepared and analyzed at ALS Global and predecessor companies to ALS Global.

11.4 Sample Preparation and Analysis

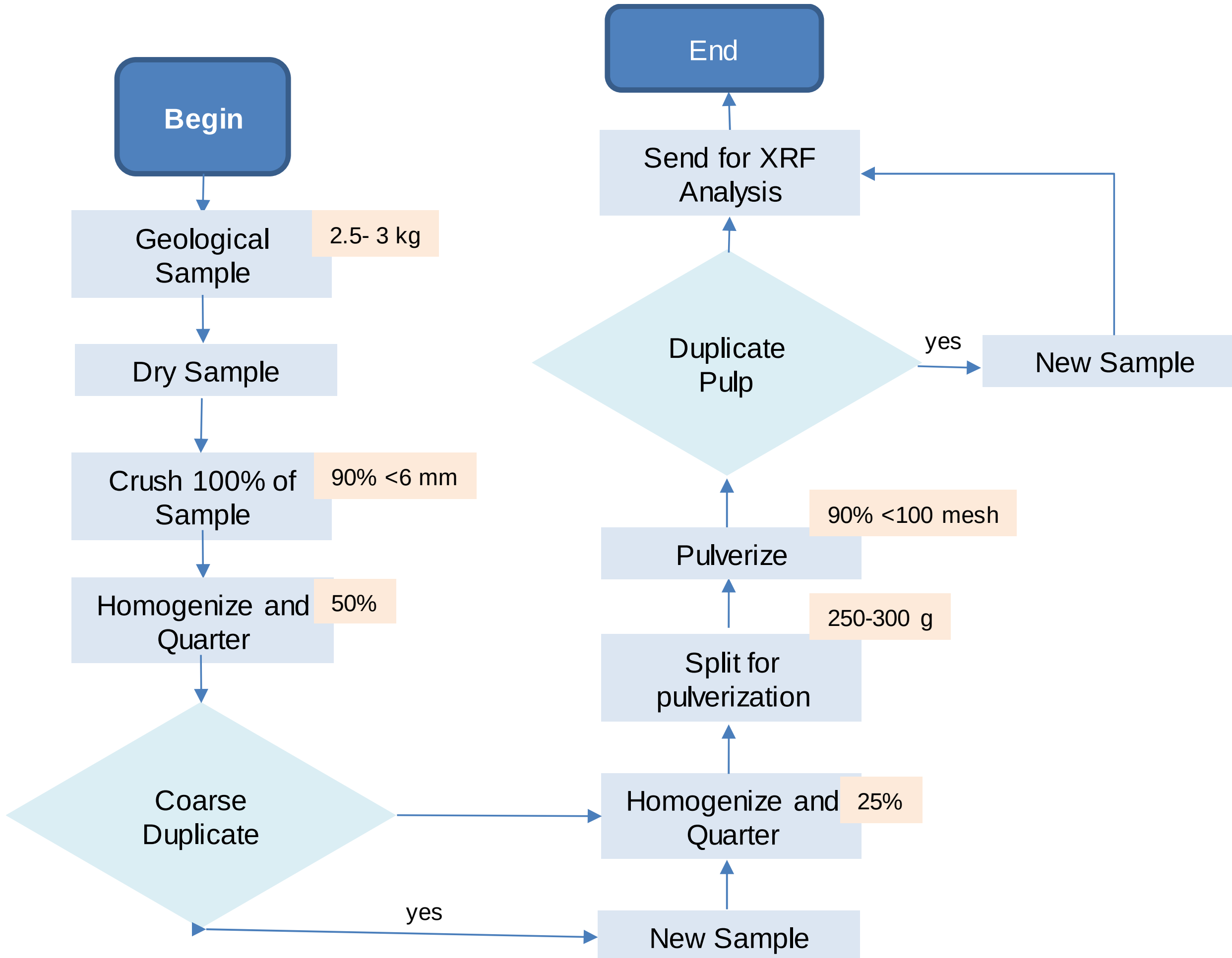
11.4.1 Mine Laboratory

Geology samples analyzed at the Morro Agudo unit laboratory follow the preparation workflow shown on Figure 11-6.

The analytical methods used by the Morro Agudo mine laboratory were X-ray fluorescence (XRF) and atomic absorption (AA). The XRF method required approximately 10 g of <100 mesh powder.

The AA method has better precision and reliability and requires that ~5 grams of <100 mesh pulp be digested in aqua regia. The methodology adopted by the laboratory stipulated that samples with grades above 6% Zn and/or 2.5% Pb, or with a different matrix than the one used for the XRF calibration must be reanalyzed using the AA method. In cases where over limits occur with the AA method, a titrimetric method was used.

Figure 11-6: Morro Agudo Mine Laboratory Sample Preparation Flowchart



Note: Figure modified from Votorantim, 2017.

A Rayny (Shimadzu) EDX-720™ XRF instrument was used for several years. That instrument allows for 15 samples to be loaded and analyzed sequentially with capacity for approximately 100 samples/day. The practical lower detection limits for the XRF are 0.03% for zinc and lead, with upper limits of 6.00% for zinc and 2.50% for lead. The XRF method can determine grades as high as 52.00% Zn and 72% Pb, but precision at those levels is poor, thus the much lower overlimits for both elements. The XRF was calibrated once a year.

Two AA instruments, one purchased in 1987 and the other purchased in 2002 have been used. Capacity is approximately 50 samples per day. Practical lower detection limits are 0.008% for zinc and 0.06% for lead with upper limits of 25.00% for zinc and 35.00% for lead.

11.4.2 ALS Global

Since the end of 2015, all exploration and productions samples have been sent for sample preparation and analysis at ALS Chemex (now ALS Global). Sample preparation uses ALS method PREP-31 as shown on Figure 11-7. The analytical technique is AA following a four-acid digestion (AA62).

11.4.3 Ambrosia Trend Sample Preparation and Analysis

Exploration samples were sent to the ALS Global sample preparation laboratory in Vespasiano and then sent to Lima, Perú for analysis.

The method for chemical analyses used at ALS is inductively coupled plasma atomic emission spectroscopy (ICP-AES), after sample decomposition with aqua regia in a graphite block. The solution is then diluted with deionized water, mixed and analyzed.

Analytical results are corrected by inter-element spectrum interference. Analyzed elements and their detection limits are presented in Table 11-5.

11.5 Quality Assurance and Quality Control

11.5.1 Morro Agudo Mine

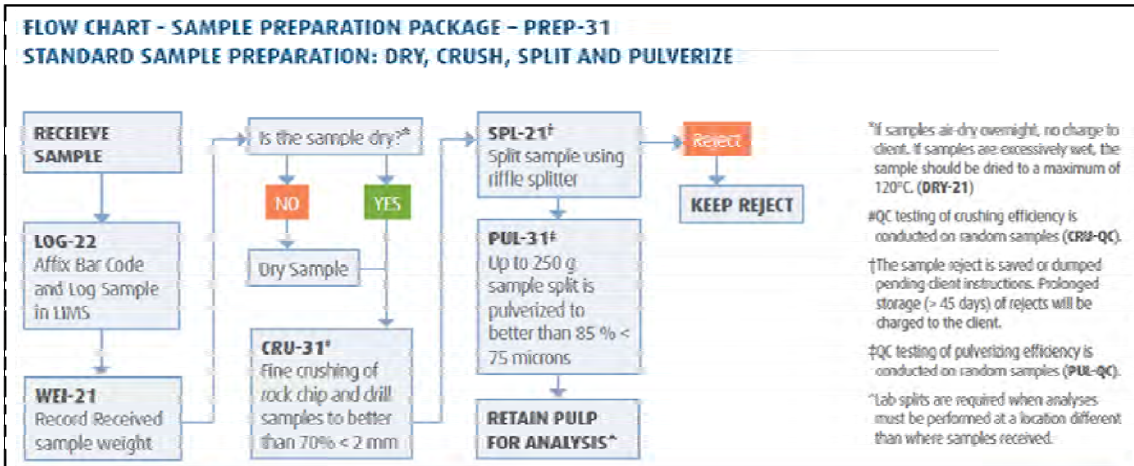
The QA/QC methodology uses standards, field duplicates, pulp duplicates, coarse rejects, blanks, and external check assays (Table 11-6). The program began in early 2011 and continues today (Hilal and Caixeta, 2016).

Standards

Three standards were used:

- VMMA-01: slightly above cut-off, at approximately 3.75% Zn, 0.74% Pb
- VMMA-02: between cut-off and average grades, at approximately 5.97% Zn, 1.04% Pb
- VMMA-03: above average grades, at approximately 11.20% Zn, 4.77% Pb.

Figure 11-7: ALS Global Sample Preparation Flowchart (ALS Method PREP-31)



METHOD CODE	DESCRIPTION
LOG-22	Sample is logged in tracking system and a bar code label is attached.
DRY-21	Drying of excessively wet samples in drying ovens. This is the default drying procedure for most rock chip and drill samples.
CRU-31	Fine crushing of rock chip and drill samples to better than 70% of the sample passing 2 mm.
SPL-21	Split sample using riffle splitter.
PUL-31	A sample split of up to 250 g is pulverized to better than 85% of the sample passing 75 microns.

Note: Figure from ALS Procedure Summary, Revision 01.03, 22 February, 2012.

Table 11-5: Elements Analyzed With the ICP-AES Method

Element	Symbol	Units	Lower Detection Limit	Upper Detection Limit	Default Over Limit Method
Aluminum	Al	%	0.01	50	
Antimony	Sb	ppm	5	10,000	
Arsenic	As	ppm	5	100,000	
Barium	Ba	ppm	10	10,000	
Beryllium	Be	ppm	0.5	1,000	
Bismuth	Bi	ppm	2	10,000	
Boron	B	ppm	10	10,000	
Cadmium	Cd	ppm	0.5	5,000	
Calcium	Ca	%	0.01	50	
Cerium	Ce	ppm	10	10,000	
Chromium	Cr	ppm	1	10,000	
Cobalt	Co	ppm	1	10,000	
Copper	Cu	ppm	1	10,000	Cu-OG46

Element	Symbol	Units	Lower Detection Limit	Upper Detection Limit	Default Over Limit Method
Gallium	Ga	ppm	10	10,000	
Hafnium	Hf.	ppm	10	10,000	
Indium	In	ppm	10	10,000	
Iron	Fe	%	0.01	50	
Lanthanum	La	ppm	10	10,000	
Lead	Pb	ppm	2	10,000	Pb-OG46
Lithium	Li	ppm	10	10,000	
Magnesium	Mg	%	0.01	50	
Manganese	Mn	ppm	5	100,000	
Mercury	Hg	ppm	1	10,000	
Molybdenum	Mo	ppm	1	10,000	
Nickel	Ni	ppm	1	10,000	
Niobium	Nb	ppm	5	2,000	
Phosphorus	P	ppm	10	10,000	
Potassium	K	%	0.01	10	
Rubidium	Rb	ppm	10	10,000	
Scandium	Sc	ppm	1	10,000	
Selenium	Se	ppm	10	1,000	
Silicon	Si	ppm	10	10,000	
Silver	Ag	ppm	0.5	100	Ag-OG46
Sodium	Na	%	0.01	10	
Strontium	Sr	ppm	1	10,000	
Sulphur	S	%	0.01	10	
Tantalum	Ta	ppm	10	10,000	
Tellurium	Te	ppm	10	10,000	
Thallium	Tl	ppm	10	10,000	
Thorium	Th	ppm	20	10,000	
Tin	Sn	ppm	10	10,000	
Titanium	Ti	%	0.01	10	
Tungsten	W	ppm	10	10,000	
Uranium	U	ppm	10	10,000	
Vanadium	V	ppm	1	10,000	
Yttrium	y	ppm	5	10,000	
Zinc	Zn	ppm	2	10,000	Zn-OG46
Zirconium	Zr	ppm	5	500	

Table 11-6: Morro Agudo Mine Quality Controls Samples

	QA/QC Control						
	Insertion	**Insertion Rate**	**Limits**	**Fact or m**	**Factor b**	**Error allowance**	**Assesses**
Standards	0.05	20	2 x standard deviation and 3 x standard deviation			Bias < 5%	Accuracy
Blanks	0.02	50	5 x LPD			< 5% samples	Contamination at preparation
Field duplicates (1/4 core)	0.01	100	0.3	1.35	10 x LPD	< 10% pairs	Sampling quality
Coarse rejects	0.01	100	0.2	1.22	5 x LPD	< 10% pairs	Preparation quality
Pulp duplicate	0.02	50	0.1	1.11	3 x LPD	< 10% pairs	Precision
External check assays	0.02	50				Bias < 5%	Deviation between laboratories accuracy

Note: LPD = practical lower detection limit

Evaluations of the performance for the standards indicated (Table 11-7):

- VMMA-01: Zinc analyses are all within the ±5% bias limit. Lead analyses showed a somewhat higher bias for the Morro Agudo mine laboratory analyses, but do not exceed a 10% bias
- VMMA-02: Both zinc and lead show bias results that are always within the limit of ±5% bias
- VMMA-03: The bias is quite small for zinc, always inside the ±5% limit. Lead analyses sometimes exceed the ±5% limit but do not exceed 10% bias in any case.

Field Duplicates

Replicates (¼ versus ½ core) show some very high error rates for the Morro Agudo mine laboratory analyses.

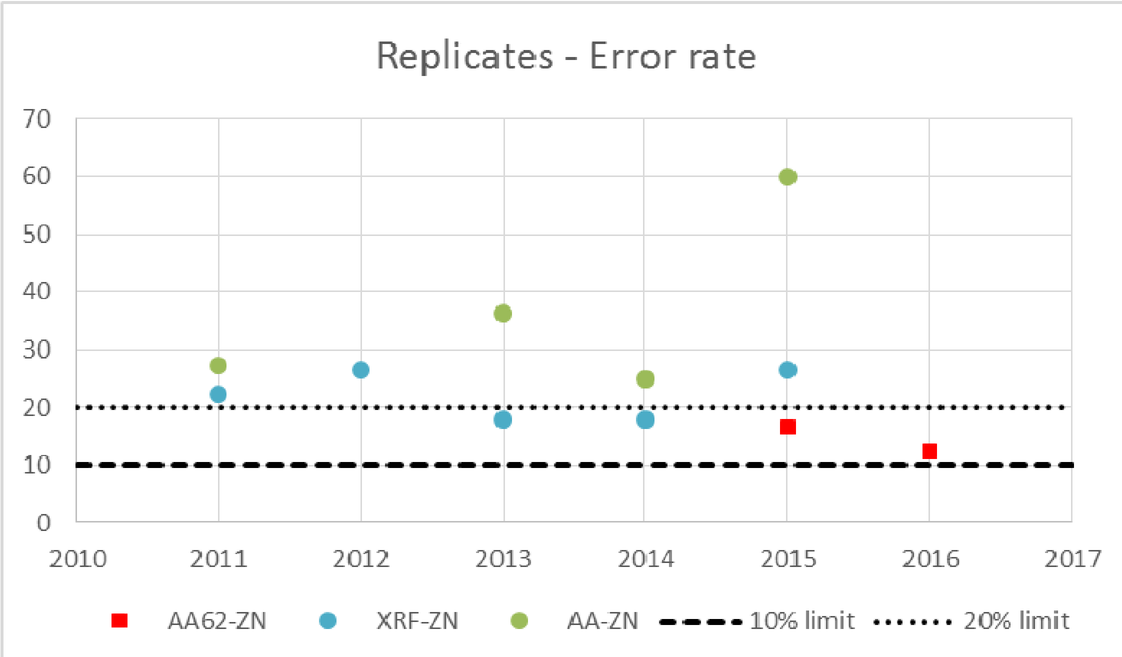
Figure 11-8 is an example control plot, and Table 11-8 summarizes the results by year.

ALS Global analyses (2016) show lower error rates than the Morro Agudo mine laboratory (pre-2016), but they also exceed the 10% rate. This is explained simply by the high variability of analyses when comparing analyses of ¼ core to analyses of ½ core.

Table 11-7: Summary of Standard Biases (2011–2016)

Standard	Method	2011	2012	2013	2014	2015	2016
VMMA-01	AA62-ZN	—	—	—	—	—	1.5%
	AA62-PB	—	—	—	—	—	-1.5%
	Number AA62 samples analyzed	—	—	—	—	—	43
	XRF-ZN	-0.4%	-0.2%	0.4%	—	-0.8%	—
	XRF-PB	9.1%	9.1%	8.9%	—	5.4%	—
	Number XRF samples analyzed	26	33	47	—	43	—
	AA-ZN	—	-0.6%	-2.8%	-1.0%	—	—
	AA-PB	—	6.9%	5.0%	4.0%	—	—
	Number AA samples analyzed	—	70	6	34	—	—
VMMA-02	AA62-ZN	—	—	—	—	0.8%	1.8%
	AA62-PB	—	—	—	—	-5.1%	-3.7%
	Number AA62 samples analyzed	—	—	—	—	10	34
	XRF-ZN	1.5%	—	—	—	-0.2%	—
	XRF-PB	5.1%	—	—	—	2.4%	—
	Number XRF samples analyzed	19	—	—	—	26	—
	AA-ZN	1.5%	1.6%	1.7%	0.2%	—	—
	AA-PB	3.0%	-2.1%	-1.3%	2.1%	—	—
	Number AA samples analyzed	62	107	59	37	—	—
VMMA-03	AA62-ZN	—	—	—	—	—	-0.3%
	AA62-PB	—	—	—	—	—	5.6%
	Number AA62 samples analyzed	—	—	—	—	—	39
	XRF-ZN	5.4%	—	—	—	—	—
	XRF-PB	9.9%	—	—	—	—	—
	Number XRF samples analyzed	28	—	—	—	—	—
	AA-ZN	-1.1%	-1.7%	-2.3%	-2.1%	-2.8%	—
	AA-PB	4.7%	-2.2%	-4.0%	-6.4%	-8.0%	—
	Number AA samples analyzed	69	94	62	30	36	—

Figure 11-8: Analyses of Zn Replicate Data



Note: Figure prepared by Amec Foster Wheeler

Table 11-8: Summary of Replicates Error Rates (2011–2016)

Method	2011	2012	2013	2014	2015	2016
AA62-ZN	—	—	—	—	16.7%	12.5%
AA62-PB	—	—	—	—	33.3%	37.5%
Number AA62 samples analyzed	—	—	—	—	6	24
XRF-ZN	9.5%	5.2%	2.7%	4.5%	11.3%	—
XRF-PB	14.5%	17.2%	17.0%	17.9%	32.1%	—
Number XRF samples analyzed	179	192	112	67	53	—
AA-ZN	27.3%	—	36.4%	25.0%	60.0%	—
AA-PB	30.3%	—	45.5%	31.3%	60.0%	—
Number AA samples analyzed	33	—	22	16	5	—

Coarse Rejects

Coarse reject analyses are available only since 2015 in the analyses from ALS Global. In 2015, zinc has an error rate of 11.1% but there were only nine samples. In 2016, lead had an error rate of 6.7% which is within limits.

Pulp Duplicates

Pulp duplicates were first analyzed in 2015. ALS Global shows good results. XRF results from the Morro Agudo mine laboratory show a very high error rate. However, these values may not be truly representative because they were obtained from only 19 samples (Table 11-9).

Blanks

Blank analyses also started in 2015. The results show no contamination in either 2015 or 2016:

External Check Assays

External check assays were performed at the Morro Agudo mine laboratory in 2011 and 2015 (Table 11-10). In both cases, the second laboratory was ALS Global. The results in 2011 were acceptable, with less than 2.0% bias. In 2015, a higher bias was identified, especially for XRF and lead. This may be due some improper calibration of the XRF, and may also partly be due to the small number of samples analyzed in this check (20 for AA and 29 for XRF).

2017 Resampling Program

In order to increase the confidence in the data from legacy samples within areas that are yet not mined and support upgrading the Mineral Resource confidence classifications within the Morro Agudo deposit, a resampling program started early in 2017. All of the drill holes of this area were located and the condition of the core checked (Figure 11-9). For those in good condition, 203 drill holes were randomly selected, representing approximately 10% of the drill holes within the unmined area.

The core was photographed and the half remaining core was sent to ALS for analysis. QA/QC samples were sent at the insertion rates summarized in Table 11-11.

The first results have shown a good reproduction of the previous analyses (Figure 11-10).

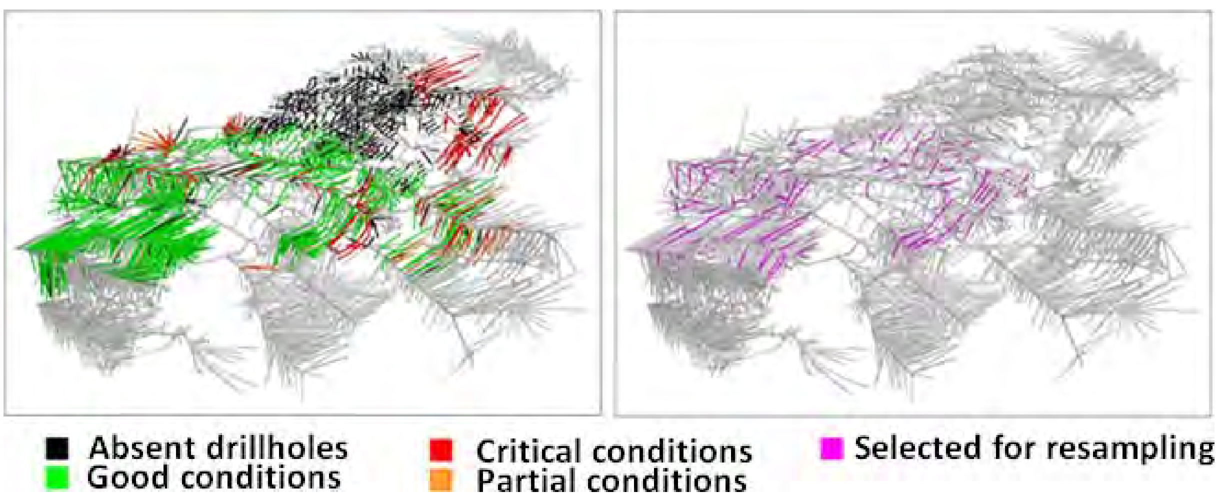
Table 11-9: Summary of Pulp Duplicates Error Rates (2015–2016)

Method	2015	2016
AA62-ZN	0.0%	0.0%
AA62-PB	2.3%	2.3%
Number AA62 samples analyzed	15	44
XRF-ZN	42.1%	—
XRF-PB	42.1%	—
Number XRF samples analyzed	19	—

Table 11-10: Summary of External Check Assay Results (2011; 2015)

Year	Element	Laboratory	# samples	Bias (%)	R2
2011	Zn (%)	ALS Global	224	-1.9	0.9864
	Pb (%)		222	-0.5	0.9905
2015	Zn (%)	ALS Global-XRF	29	-6.5	0.9810
		ALS Global-AAS	20	-2.5	0.9908
	Pb (%)	ALS Global-XRF	29	-14.5	0.9912
		ALS Global-AAS	20	-8.7	0.9964

Figure 11-9: Drill Holes in the Remaining Area (left) and Location of Samples Randomly Selected for Re-assaying (right)

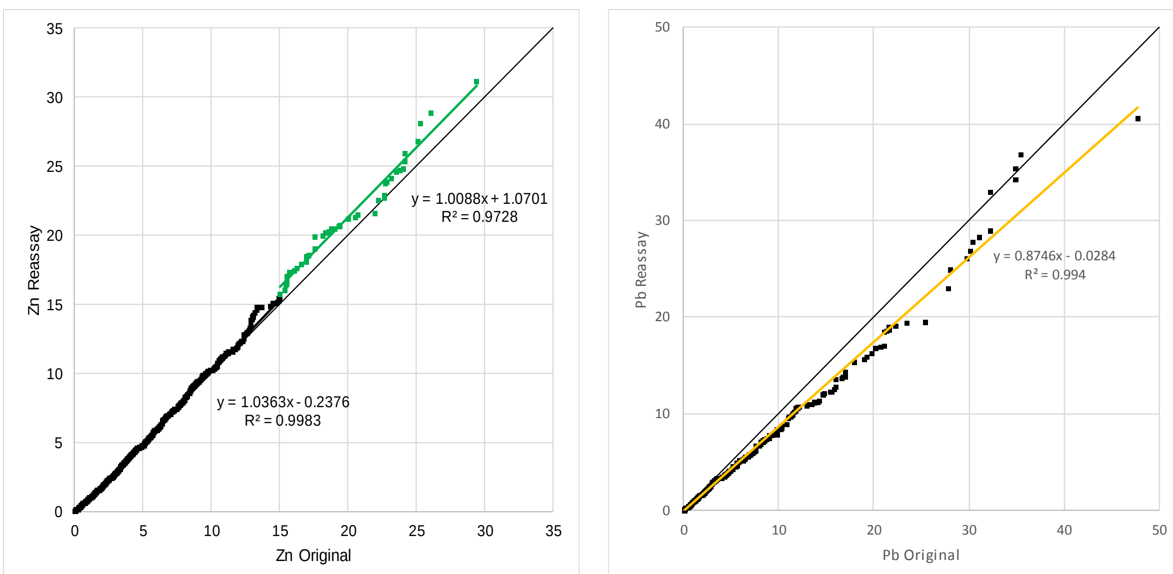


Note: Figure courtesy Votorantim, 2017.

Table 11-11: Details of the QA/QC Samples Inserted in the Resampling Program

QA/QC	Type	Number of Samples	Insertion Rate
	Replicate	33	1.0%
Duplicates	Pulp Duplicate	62	2.0%
	Coarse Reject	65	2.0%
Blanks		64	2.0%
	VMMA-01	54	1.7%
Standards	VMMA-02	54	1.7%
	VMMA-03	54	1.7%
External Check		3,172	100.0%
Total		***3,558***	***12.2%***

Figure 11-10: Q-Q Plots of Results for Resampling Program at Morro Agudo



Source: Votorantim, 2017.

A total of 2,502 sample results were returned. Zinc demonstrates no significant bias below about 13% Zn. Above 13% Zn, there is an absolute bias of about 1% which strongly suggests a change of method and different calibrations above 13% at one of the laboratories. Lead exhibits a proportional bias for all of the grade range sampled (0- 48% Pb). The zinc bias is not considered to be a problem by Amec Foster Wheeler or Votorantim because of the small volumes of high-grade (>10% Zn) remaining in the deposit and the small magnitude of the bias. The lead bias shows that the mine laboratory was biased negatively relative to ALS. That will likely create an underestimate of lead in the Mineral Resource estimate which is conservative, and should be considered as an upside for the project.

11.5.2 Ambrosia Trend

The QA/QC methodology for the Ambrosia Trend programs used standard procedures which includes analyzing standards, replicates (field duplicate samples), pulp duplicate samples, coarse reject duplicate samples, blank samples, and external check assays. The insertion rates are the same as at Morro Agudo (refer to Table 11-6).

Standards

The standards used at Ambrosia Trend include:

- VZASPD02: near cut-off at 3.08% Zn and 0.04% Pb
- MA004: around cut-off, at 2.91% Zn and 0.94% Pb
- VZASPD01: medium grades, at 7.15% Zn and 0.12% Pb
- MA003: medium grades, at 7.56% Zn and 2.74% Pb
- MA001: above average grades, at 16.7% Zn and 6.45% Pb

Table 11-12 summarizes the biases by year and element. Biases are all better than ±5%.

Field Duplicates

Replicate results (¼ versus ½ core) results are summarized in Table 11-13. Error rates for zinc except for 2008 and 2017 are higher than anticipated. Error rated for lead are acceptable prior to 2016 and 2017. The reason for the difference between lead and zinc should be investigated. The large error rates for zinc are likely due to the fact that we are comparing ¼ core to ½ core which adds a very large uncertainty to the analysis.

Coarse Rejects

Zinc results in 2008, 2012, 2013, and 2015 are between 5% and 10% which are acceptable. Lead results for all years except 2017 are <10% which is acceptable (see Table 11-13). For 2017, the rate is about 14% which is being investigated.

Pulp Duplicates

Error rates are all within reasonable limits for these samples (see Table 11-13).

Table 11-12: Summary of Standards Biases

Standards	MA001	MA003	MA004	VZASPD01	VZASPD02
Period	2008–2014	2008–2014	2008–2014	2014–2017	2014–2017
Bias (Zn)	1.7%	1%	0.3%	-0.9%	1.8%
Bias (Pb)	4.5%	1.3%	-4.4%	2.0%	-1.7%
# Samples	150	151	152	375	371

Table 11-13: Summary of Error Rates

		2008	2012*	2013	2014	2015	2016	2017
Replicates	Zn (%)	1.1	18.2	22.9	23.8	14.5	27.0	6.9
	Pb (%)	0.0	12.1	2.1	9.5	6.6	19.0	31.0
	# Samples	95	33	48	21	76	63	29
Coarse rejects	Zn (%)	6.3	11.1	6.3	0.0	9.0	0.0	0.0
	Pb (%)	6.3	2.8	0.0	0.0	1.5	1.8	13.8
	#Samples	16	36	32	22	67	56	29
Pulp duplicates	Zn (%)		0.0	1.2	0.0	1.4	0.0	0.0
	Pb (%)		0.0	0.0	0.0	0.7	0.0	0.0
	#Samples		79	82	44	142	89	46

Note: * Included samples from December 2011

Blanks

Figure 11-12 summarizes blank data by year. In this case, 0.05% Zn and Pb (5x lower detection limit) is considered to be a reasonable limit. A total of 22 of 496 zinc results exceed the limit, but most are <0.1% Zn. No lead results exceed the limit.

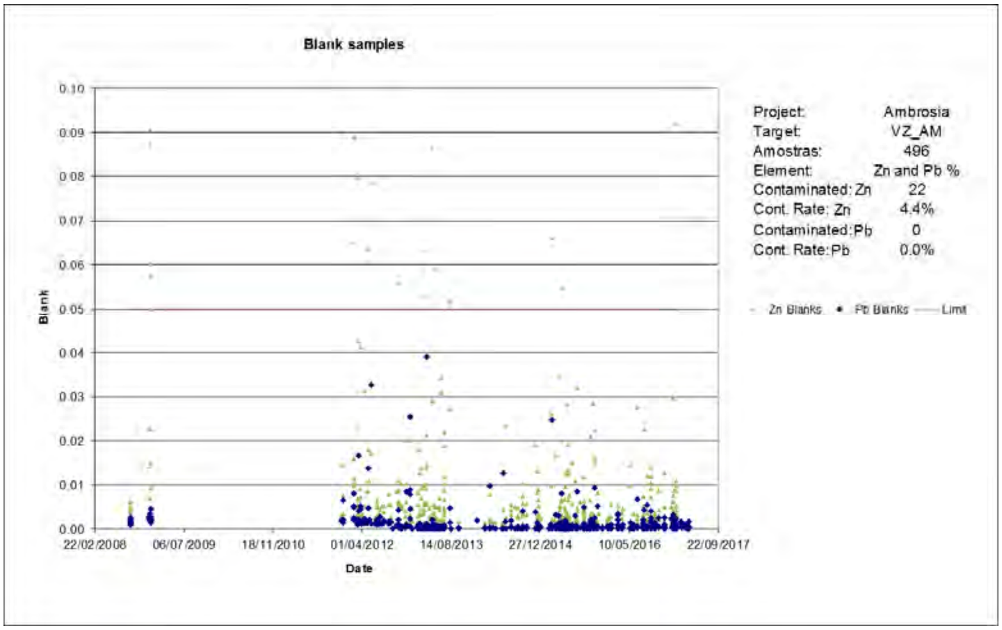
Amec Foster Wheeler considers these results to indicate that contamination is not significant.

External Check Assays

Bias was within acceptable limits during 2016 and to date in 2017:

- Zinc: -1.2% in 2016, -0.2% in 2017; 74 samples analyzed
- Lead: 33.9% in 2016, 0.9% in 2017; 81 samples analyzed.

Figure 11-11: Analyses of Blank Data Year by Year



Note: Figure prepared by Amec Foster Wheeler, 2017.

11.6 Databases

Management of the Morro Agudo and Ambrosia trend databases follows a standard procedure used for all Votorantim databases. At this time, GeoEXPLO™ is the system used to manage the database but Datamine's Fusion™ system is being implemented across the company as an enterprise data management system. Both systems are widely used in the mining industry and both are designed for the mining industry. Both systems are password protected.

A small number of senior people have unlimited access to the database. Most users have much more restricted access and are not allowed to change data once data are loaded into the software.

The data are backed up daily to a local server and to a server in São Paulo. The software has automatic data validation routines implemented that check data entries for consistency.

11.7 Sample Security

Core handling is performed by drill crews and Votorantim personnel. Core is stored and logged at the core sheds at Morro Agudo or Paracatu; these are locked facilities. Chain of custody forms accompany all core or samples wherever they may need to go.

A new core-facility is under construction to better store the legacy drill holes and provide more space for future drilling. This was a response to difficulties encountered when trying to locate core for the 2017 resampling exercise.

11.8 Comments on Section 11

Sample preparation and analysis at the Morro Agudo Mine were performed at the mine laboratory since as at least 1987. That laboratory was not accredited and did not have a significant QA/QC program until about 2011. Check assay results from 2017 indicate that the pre-2011 data are generally adequate. Since late 2015, exploration and production samples are prepared and analyzed at ALS Global which is ISO 9001:2008 and 17025:2005 accredited. The sample preparation protocol was much the same at both laboratories and is adequate for the samples at the Morro Agudo Mine. Sample analysis uses procedures that are widely used in the industry.

Sample preparation and analysis at the Ambrosia Trend used the same procedures at ALS as were used by the Morro Agudo Mine. Amec Foster Wheeler considers sample preparation and analysis at the Morro Agudo Mine and Ambrosia Trend to be adequate to support Mineral Resource estimation and mine planning.

QA/QC procedures were implemented at Morro Agudo in 2011. QC measures constantly improved until late 2015 when exploration and production sample responsibilities were transferred to ALS Global. QC measures include routine analysis of duplicate samples, standard samples, and blank samples to monitor precision, accuracy, and contamination respectively. Check assays at a second laboratory are used to monitor accuracy. Evaluation of QA/QC data at the Morro Agudo Mine indicates that the analytical data, since 2011, are sufficiently precise and accurate to support Mineral Resource estimation and mine planning.

Ambrosia Trend analytical work has included QA/QC since 2008, QA/QC measures at Ambrosia began in about 2008 and improved through 2014 at which time the current program including duplicate, standard, and blank samples was in use. An external laboratory was used in 2016 and 2017 to analyze check samples. Evaluation of the Ambrosia Trend QA/QC data indicate that the analytical data are adequately precise and accurate to support Mineral Resource estimation and mine planning.

Density determinations were completed using water displacement and immersion procedures. Both procedures are widely used in the mining industry. The data are reasonable and adequate to support Mineral Resource estimation and mine planning.

Management of the Morro Agudo Mine and Ambrosia Trend databases follows a standard procedure used for all Votorantim databases. At this time, GeoEXPLO™ is the system used to manage the database but Datamine's Fusion™ system is being implemented across the company as an enterprise data management system. Both systems are widely used in the mining industry and both are designed for the mining industry. Both systems are password protected with a few senior personnel with unlimited access to the database. All other users have significantly restricted access. Backups are performed daily.

Sample security consists largely of storing core and samples in locked facilities and use of chain of custody forms to track core and sample movement. This is acceptable for high-grade zinc deposits.

12.0 DATA VERIFICATION

12.1 Internal Data Verification

12.1.1 Database Integrity

Management of the Morro Agudo Mine and Ambrosia Trend databases follows a standard procedure used for all Votorantim Metais databases. At this time, GeoEXPLO™ is the system used to manage the database but Datamine's Fusion™ system is being implemented across the company as an enterprise data management system. GeoEXPLO™ and Fusion™ have validation rules that prevent the entry of information with errors or that fail to comply with description, sampling, sample delivery and opinion receipt standards. Spreadsheets are the interface with GeoEXPLO™. A completed spreadsheet is loaded the import module (a separate program from the GeoEXPLO™ system), which has the main function of validating the data prior to entry into GeoEXPLO™ and compiling data for the SQL™ Server.

The import module validates the laboratory results which are provided in a standardized format. The validation procedure in the import module checks for errors and if any are found, deactivates the import option. Validation within the import module checks the kind of data (whether it is numerical or text); tests for gaps and overlaps; and uses other tests to check the integrity of the data in the spreadsheet. Once data are validated and loaded, they are available via web interface or exported via database Microsoft Access™ format.

Migration of all exploration and production data to Datamine Fusion® is in progress in order to improve and integrate the Votorantim enterprise database. That migration should be complete, with data validation, by late 2017.

12.1.2 Data Verification

Prior to extracting data for Mineral Resource estimation, internal checks are made to assure that the right information is used in the Mineral Resource estimate. This is made following Votorantim standard operating procedure PO-VM-GRM-001, checking the following items:

- Sample length problems
- Maximum and minimum grade values
- Negative values
- Detection limits/null values
- Drill hole survey

- Sample size
- Gaps
- Overlaps
- Drill hole collars versus topography
- Coordinates Datum
- Verification of mining permission
- Laboratory analysis certificates.

These data are also checked when data are entered into the database. When inconsistencies are discovered, corrective action is required and includes participation by the mine team and the database manager.

12.1.3 Morro Agudo Reassays

In 2017, approximately 3,500 samples were selected from pre-2011 drilling at the Morro Agudo Mine for reassay to verify the assays of those samples. Prior to 2011, QA/QC was not part of the analytical process at the mine. The reassay program demonstrated small biases in the data but Amec Foster Wheeler considers the early data to be sufficiently accurate to support Mineral Resource estimation (see Section 11.5.1).

12.2 External Data Verification

12.2.1 Snowden Audits – Ambrosia (2012, 2014)

The Ambrosia Norte zinc project was audited by Snowden Mining Industry Consultants (Snowden) in 2012 (Snowden, 2012). Snowden reviewed the project for compliance with JORC 2004 guidelines.

In 2014, Snowden completed an audit of Ambrosia Sul.

Snowden did not identify any critical risks but did make a number of recommendations to improve data reliability. Votorantim has evaluated the recommendations and implemented those that were considered by the company to be important.

12.2.2 Amec Foster Wheeler Gap Analysis (2017)

In early 2017, Amec Foster Wheeler completed a gap analysis to identify operational improvement opportunities. No attempt was made to audit and assess the quality of the information provided; however, standard operating procedures and their application were reviewed. Recommendations arising from this analysis are being reviewed and implemented by Votorantim.

12.2.3 Amec Foster Wheeler (2017)

As part of the 2017 QP site visit, high-level reviews of the database and procedures were performed. These included reviews of sampling procedures, geological logging procedures, core drilling and core handling procedures, and QA/QC procedures.

12.3 Comments on Section 12

Data from the Morro Agudo Mine and the Ambrosia Trend deposits have undergone significant scrutiny since 2012. The QP considers the type and amount of data validation to be consistent with modern programs and is of the opinion that the data accurately reflect the original geological logging, data locations, and assay values and that the data will support Mineral Resource estimation and mine planning.

13.0 MINERAL PROCESSING AND METALLURGICAL TESTING

13.1 Introduction

The Morro Agudo Mine, and the Ambrosia Trend deposits, Ambrosia Sul, Ambrosia Norte and Bonsucesso, form a trend of carbonate-hosted lead–zinc sulphide deposits. Historically, all mill feed processed has been from the Morro Agudo deposit. Production commenced from Ambrosia Sul in 2017. Zinc is the main economic metal, supplemented by modest sales of lead, and an agricultural lime co-product recovered from tailings. There is no payable silver by-product in the concentrates produced.

The existing Morro Agudo concentrator has a conventional flowsheet incorporating crushing, grinding and sequential lead and zinc flotation. Metallurgical parameters are derived from a combination of plant operating history, mineralogy, laboratory, and pilot scale flotation testwork and assumptions.

13.2 Metallurgical Testwork

Table 13-1 shows the summary of historical testwork at Morro Agudo Mine and Ambrosia Sul. No testwork is available to report on Ambrosia Norte and Bonsucesso. A test program for Ambrosia Norte/Bonsucesso is currently underway and described in more detail in Section 13.2.4.

13.2.1 SGS Geosol 2014 Test Campaigns

In 2013 and 2014, testwork was completed at SGS Geosol laboratories in Antônio Pereira and Vespasiano, on composite samples from the Morro Agudo Mine and Ambrosia Sul. A total of approximately 25 t of sample material, crushed to -6.25 mm by Votorantim, was delivered to the SGS Geosol laboratory. Table 13-2 shows the head grades for the Ambrosia Sul composite, the low and high lead Morro Agudo Mine composites, and the 50:50 blends of Ambrosia Sul material with the Morro Agudo Mine composites.

Lead and zinc laboratory flotation tests were completed at Antônio Pereira laboratory. Composite samples were further crushed to minus 3 mm and split into 2.0 kg packets for grinding and flotation testwork. Grinding calibration tests were completed on the composites and blends to determine the time required to achieve the target size of 70% passing 44 µm (325 mesh). Samples were ground in a 10” diameter laboratory grinding mill and flotation tests were performed using a Denver, Sub-A, Model D12 cell with measurement and control of air flow.

Table 13-1: Historical Testwork

Year	Laboratory	Testwork Performed
2014	SGS Geosol, Vespasiano and Antônio Pereira, MG, Brazil	Grinding calibration tests, laboratory flotation tests (rougher and cleaner) and pilot plant testwork on composites and blends from Morro Agudo and Ambrosia Sul
2015	TBC	Phase 2 Ambrosia Sul characterization testwork including mineralogy, grinding calibrations and laboratory flotation tests.
2015	UFMG, MG, Brazil	Mineralogical studies on Morro Agudo mill feed, including modal abundance and element deportment.

Table 13-2: Head Grades of Ambrosia Sul and Morro Agudo Composites and blends for 2014 SGS Geosol Testwork

Element	Ambrosia Sul	Morro Agudo Comp 1	Morro Agudo Comp 2	Ambrosia Sul and Morro Agudo Comp 1 blend	Ambrosia Sul and Morro Agudo Comp 2 blend
Pb (%)	0.28	1.14	4.42	0.68	2.33
Zn (%)	5.12	3.11	1.73	4.12	3.42
Fe (%)	1.59	3.38	5.07	2.45	3.2
CaO (%)	25.8	26.5	24.8	25.8	26.4
MgO (%)	18.5	18.0	16.4	18.1	18.4
SiO2 (%)	4.25	2.60	5.53	3.36	5.02
S (%)	3.00	2.70	2.54	2.66	2.83
Cd (ppm)	115	170	138	149	127
Ag (ppm)	<5	<5	<5	<5	<5

Lead Laboratory Flotation Tests

Lead flotation tests were completed on the Ambrosia Sul/Morro Agudo Mine Composite 1 blend using lime as a pH modifier, SIPX as galena collector and MIBC as frother. A range of reagent and chemical conditions were tested, including pH from 8.3 to 10.0, and SIPX addition from 30 to 50 g/t. An alternative collector, AG-585 (a sodium di-isobutyl dithiophosphate), was also tested. For each test, sample pulp was conditioned, before three minutes of roughing time and five minutes of scavenging time.

A SIPX dose of 30 g/t was found optimal, and pH between 9.0 and 9.5 was found to give the most favourable lead recovery, while minimizing zinc losses into the lead concentrate. The lead rougher recovery achieved was approximately 86–88%, and zinc losses to lead concentrate were approximately 4.6 to 6.1%. The lead rougher concentrate grade was from 10 to 12%. An example of a lead rougher scavenger test (AL-05 at pH 9.5) is shown in Table 13-3.

Tests with AG-585 initially yielded poorer metallurgical performance, with a sharp drop in lead rougher concentrate grade, and higher zinc losses in the lead concentrate. This was mostly offset by changing the addition point for the collector. However, it appeared there was no metallurgical advantage in switching from SIPX to AG-585.

In addition, the effect of grind size was tested at 70%, 80% and 90% passing 44 µm by extending grind time. A slight improvement in lead recovery (1.5%) was observed at the finer grind size; however, it is unlikely that this recovery improvement would justify the costs of the finer grind. The standard grind size was set to 70% passing 44 µm for the remaining tests.

The effect of oxidation of mill feed on galena flotation was tested by floating fresh mineralized material versus mineralized material that had been stored for 15 days. Lead recoveries were similar with fresh and oxidized samples, but there was a significant deterioration in lead rougher concentrate grade from 25.5% to 11%. Zinc losses into the lead rougher concentrate also increased from 4.3% to 7.7% of zinc in feed. It should be noted that the range of flotation tests were completed on the oxidized mineralized material, so there is some potential improvement in lead metallurgy that could be realized by treating fresh mineralized material in the Morro Agudo concentrator.

One test was reported that included two stages of cleaning. Lead rougher concentrate was floated for two minutes in the first cleaner, then two minutes in the second cleaner. Overall, a 36.5% Pb concentrate was produced at 53.0% Pb recovery from a feed containing 0.54% Pb. In practice, the overall plant metallurgy would be expected to be somewhat better due to recirculating scavenger and cleaner streams.

Zinc Laboratory Flotation Tests

Zinc rougher and scavenger flotation tests were completed on lead flotation tailings using lime as a pH modifier, $CuSO_4$ as sphalerite activator, PAX as sphalerite collector and MIBC as frother. For each test, sample pulp was conditioned with activator and collector, before five minutes of roughing time and five minutes of scavenging time. Various factors were tested, including pH, activator addition, collector addition and grind size. It was found that zinc recovery improved with increases in both collector and activator. Zinc rougher recovery increased from 73% to 87.3% when the PAX dose was increased from 50 to 100 g/t. In another test series at 70 g/t PAX, the zinc recovery increased from 78.5% to 89.9% when the $CuSO^4$ dose was increased from 40 to 70 g/t. Increasing pH from 8.3 to 11.5 caused a dramatic reduction in zinc recovery from 81% to 50%.

Table 13-3: Example, Lead Rougher Scavenger Test (AL-05 at pH 9.5)

	Pb Grade (%)	Zn Grade (%)	Pb Recovery (%)	Zn Recovery (%)
Feed	0.63%	4.23%	100.0%	100.0%
Pb rougher conc	10.20%	4.74%	88.2%	6.1%
Pb rougher tail	0.08%	4.20%	11.8%	93.9%
Pb scavenger conc	0.49%	4.36%	4.8%	6.3%
Pb scavenger tail	0.05%	4.19%	7.0%	87.6%
Combined Pb rougher + scav conc	5.05%	4.54%	93.0%	12.4%

It was found that reducing the grind size from 70% to 80% and 90% passing 44 µm considerably improved zinc recovery (see Table 13-4). These tests were included 50 g/t $CuSO_4$ and 70 g/t PAX addition into the rougher stage. Note that the recovery in this table is with respect to the zinc circuit feed, and therefore does not account for zinc losses to the lead circuit.

Tests were also undertaken with alternative collector, AG-585. The alternative failed to achieve the recovery and concentrate grades from PAX.

Pilot Plant Testwork

A pilot plant study was completed using the 50:50 blend of Ambrosia Sul and Morro Agudo Mine Composite 2. The goal was to produce final lead and zinc concentrates that met current Morro Agudo plant requirements (50% Pb in lead concentrate, 37.5% Zn in zinc concentrate).

The pilot plant campaign included nine test runs:

- PC-1: lead rougher–scavenger, to establish parameters, test operability of pilot circuit
- PC- 2 and PC-03: lead rougher–scavenger–cleaner at higher pH, to improve lead concentrate grade
- PC-4, 5, 6 and 7: lead rougher–scavenger–cleaner tests followed by zinc rougher–scavenger–cleaner
- PC-8 and 9: lead rougher–scavenger–cleaner tests followed by zinc rougher–scavenger–cleaner using a lower lead grade composite

The PC-1 test was preliminary, and likely did not represent the performance that could be reasonably achieved from the blend.

The pilot plant initially used MIBC frother, but it was found this was not practical to maintain consistent froth properties. MIBC was substituted with Clariant Flotanol D25, an etherpolyalkylene glycol.

Table 13-4: Zinc Rougher Recovery and Concentrate Grade Vs. Grind Size

% passing 44 µm	Zn Concentrate Grade (%)	Zn Recovery (%)
70	55.6	76.3
80	54.4	80.4
90	50.2	86.2

The lead pilot plant results are shown in Table 13-5.

Lead recovery dropped away in test PC-8, reflecting a poorer metallurgical performance at lower lead head grade. Additional lead scavenging capacity was added in PC-9, this restored lead recovery, however significantly dropped lead concentrate grade and increased zinc losses to lead concentrate.

The zinc pilot plant results are shown in Table 13-6. Zinc recovery is shown both with respect to the zinc circuit feed (lead scavenger tailings) and overall. The overall zinc recovery accounts for zinc losses to the lead circuit.

In several tests, zinc concentrate grade far exceeded the current 37.5% specification. The highest overall zinc recovery was achieved in test PC-8, in part due to the low zinc losses to the lead concentrate for the lower lead feed grade material.

13.2.2 Ambrosia Sul Variability Study – Phase 2

Phase 2 of Ambrosia Sul testwork was completed in 2015. Composites were produced from drill cost representatively covering the deposit. These were grouped into mineralogical domains. In addition, diluted composites were produced to represent the periods of mining. The domain and period composite grades are shown in Table 13-7 and Table 13-8 respectively. The average grades for the domain composites were slightly lower than the anticipated LOM production schedule, while the period composites had much lower zinc grade than the proposed schedule.

The modal mineralogy was measured on the period composites to determine proportion of minerals present in the samples. These are shown in Table 13-9.

The mineralogy is similar to that seen at the Morro Agudo Mine, with dolomite the major constituent.

Table 13-5: Lead Pilot Plant Results

Test	Pb Feed Grade (%)	Zn Feed Grade (%)	Concentrate Grade (%)	Lead Recovery (%)	Zinc Recovery (%)
PC-2	2.22	3.2	59.1	89.4	11.2
PC-3	2.2	3.47	60.9	91.9	7.7
PC-4	2.06	3.15	47.8	90.7	10.1
PC-5	2.38	3.11	52.6	90.8	7.6
PC-6	2.23	3.48	51.3	89.7	8.2
PC-7	2.2	3.29	63.7	90	6.5
PC-8	1.21	3.32	58.6	84.6	2.3
PC-9	1.41	3.43	44.3	89.3	12.4

Table 13-6: Zinc Pilot Plant Results

Test	Zn Circuit Feed Grade (%)	Zn Concentrate Grade (%)	Pb in Zn Concentrate (%)	Zn Recovery wrt Zn Circuit Feed (%)	Overall Zn Recovery (%)
PC-4	2.94	53.3	1.28	89	80.0
PC-5	3.00	41.7	2.08	92.2	85.2
PC-6	3.33	34.7	1.20	93.1	85.5
PC-7	3.18	52.6	1.82	92.5	86.5
PC-8	3.30	48.3	1.14	90.3	88.2
PC-9	3.10	47.1	1.09	91.9	80.5

Table 13-7: Ambrosia Sul Phase 2 Composites by Mineralogical Domain

Composites	Zn (%)	Pb (%)
C1	5.67	0.44
C1 AUX	4.96	0.15
C2	2.68	0.04
C2 AUX	2.46	0.05
C3	4.25	0.06
C3 AUX	4.36	0.11
C4	3.6	0.09
CE1	2.46	0.03
CE2	3.76	0.05
E	4.33	0.12
E2	3.76	0.05
E3	2.52	0.04
E4	2.72	0.05
W	7.8	0.42

Composites	Zn (%)	Pb (%)
W2	5.05	0.1
W3	4.84	0.23
Average	4.08	0.13
LOM plan 2018 to 2020	4.83	0.19

Table 13-8: Ambrosia Sul Phase 2 Testing by Period

Period	Zn (%)	Pb (%)
2016	2.08	0.09
2017 half 1	3.26	0.19
2017 half 2	3.11	0.11
2018 half 1	3.65	0.24
2018 half 2	3.86	0.19
2019	2.18	0.05
Average	3.02	0.15

Table 13-9: Modal Mineralogy

Mineral	2016	2017 H1	2017 H2	2018 H1	2018 H2	2019
Dolomite	72	80	73	80	76	85
Galena	Trace	Trace	Trace	Trace	Trace	Trace
Pyrite	0.5	2	1.5	2	3.5	3
Sphalerite	4	7	6	8	8	4
Muscovite	4	0.5	1.5	0.5	1	0.5
Quartz	12	5	8	5	5	4
Goethite	Trace	Trace	Trace	Trace	Trace	Trace
Hematite	Trace	Trace	2.5	Trace	Trace	Trace
Other	7.5	5.5	7.5	3	5	3

Laboratory flotation tests were completed on the domain composites using a lead rougher and scavenger stages, followed by a zinc scavenger stage. The grind size was set to 65% passing 44 µm. A standard reagent suite was used, including lime as pH modifier, MIBC as frother, SIPX as galena collector, copper sulphate as sphalerite activator, and PAX as sphalerite collector. Significant variation was observed in lead rougher metallurgical performance. Only the W composites showed any reasonable potential to make a viable lead concentrate grade, with rougher concentrate grades of approximately 3–7% Pb produced with recoveries between 48% and 82%. Composites with low lead head grade showed no reasonable potential for producing a saleable lead concentrate. The C2, C3, CE1, CE2, E, E2, E3 and E4 composites all produced rougher concentrates below 0.5% Pb at less than 50% recovery, with little likelihood that these could be upgraded to a final concentrate quality. Hence overall lead recovery for those samples is likely to be negligible.

Metallurgical results from zinc rougher flotation tests were much more consistent, with average zinc rougher recovery of approximately 88% and average zinc rougher concentrate grade of approximately 29%. Results for domain concentrates are shown in Figure 13-1.

13.2.3 Morro Agudo 2015 Mineralogy Studies

Mineralogical studies were completed on Morro Agudo mill feed samples in 2015 through Universidade Federal Minas Gerias (UFMG). This included scanning electron microscopy (SEM) using the mineral liberation analyzer (MLA), and electron microprobe tests. These instruments allowed identification of mineral species, and the deportment of metals between minerals.

13.2.4 Proposed Ambrosia Norte/Bonsucesso Test Program

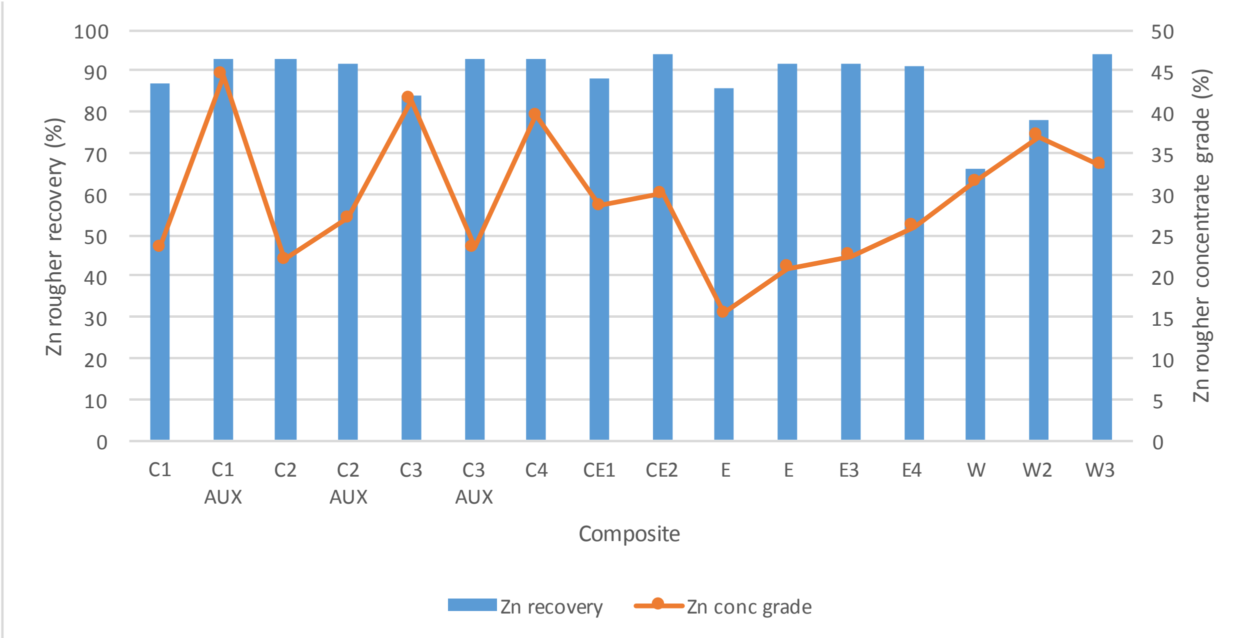
Drill cores for Ambrosia Norte and Bonsucesso have been collected and are currently being prepared for a geometallurgical test program. The test program will include the following elements:

- Bond work index determination
- Grinding calibration tests
- Laboratory flotation tests
- Mineralogy, including modal mineralogy, mineral associations, and mineral grain size.

Sample preparation, Bond work index, grinding calibrations and flotation tests are being completed at the Votorantim Vazante mine site laboratory. Mineralogy using MLA–SEM will be completed at UFMG. Chemical analyses will be completed by ALS Laboratories.

Results are expected by about October 2017, and may lead to some adjustments to metallurgical assumptions.

Figure 13-1: Ambrosia Sul Phase 2 Testwork Zinc Rougher Grade and Recovery



Note: Figure courtesy Votorantim, 2017.

13.3 Recovery

Separate zinc and lead recoveries have been assigned to Morro Agudo, Ambrosia Sul and Ambrosia Norte/Bonsucesso mill feed material. These are based on a combination of historical plant recoveries, metallurgical testwork and assumptions.

Historically, since 2005, the Morro Agudo process plant has reported zinc recoveries in the range of 87% to 91.5%. The 2016 metal balance is shown in Table 13-10.

It should be noted that there is some uncertainty in the 2016 metallurgical balance due to retreatment of historical tailings (Deposit 2; also known as the B2 barragem) in the process plant. Reprocessing of this material commenced in 2015 and has continued through to the first half of 2017. It is estimated that approximately 51,000 t of this historical tailings was reprocessed, with grades of approximately 0.5–3.5 % Zn and 0.3–2.5% Pb. This material potentially affected the accuracy of feed grade measurement, which in turn can lead to uncertainty in recovery estimates. This uncertainty is higher for lead than zinc, due to the relatively higher variation in tailings lead grade compared with ROM mill feed grade.

The forecast recoveries over the LOMP are shown in Table 13-11.

Table 13-10: 2016 Metal Balance

	Tonnage (t x 1,000)	Zn Grade (%)	Pb Grade (%)	Zn Contained Metal (t x 1,000)	Pb Contained Metal (t x 1,000)	Zn Recovery (%)	Zn Recovery (%)
Mill feed	1,015	2.35	0.92	23.8	9.3		
Pb concentrate	15	5.5	50.1		7.7		82.8
Zn concentrate	57	38.2	2.0	21.6		90.6	

Table 13-11:LOMP Recovery Forecast

Year		2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
Mill feed													
Morro Agudo Mine and pillars	t x 1,000	425	517	516	588	—	—	—	—	—	—	—	2,046
	Zn grade (%)	2.56	2.98	2.83	2.80								2.80
	Pb grade (%)	0.86	0.77	0.82	0.80								0.81
Ambrosia Sul	t x 1,000	352	301	81	—	—	—	—	—	—	—	—	734
	Zn grade (%)	5.35	4.33	4.46									4.83
	Pb grade (%)	0.25	0.12	0.17									0.19
Ambrosia Norte and Bonsucesso	t x 1,000	—	—	70	239	704	715	759	751	742	689	405	5,073
	Zn grade (%)			3.44	2.87	3.44	3.51	3.29	3.33	3.37	3.64	3.24	3.39
	Pb grade (%)			0.39	0.68	0.38	0.50	0.52	0.55	0.44	0.42	0.43	0.47
Total mill feed	t x 1,000	777	818	667	827	704	715	759	751	742	689	405	7,853
	Zn grade (%)	3.82	3.48	3.09	2.82	3.44	3.51	3.29	3.33	3.37	3.64	3.24	3.37
	Pb grade (%)	0.58	0.53	0.70	0.77	0.38	0.50	0.52	0.55	0.44	0.42	0.43	0.54
Assigned recoveries													
Morro Agudo Mine and pillars	Zn (%)	90.7	90.7	90.7	90.7								
	Pb (%)	82.9	82.9	82.9	82.9								
Ambrosia Sul	Zn (%)	90.7	90.7	90.7									
	Pb (%)	40.0	20.0	30.0									
Ambrosia Norte and Bonsucesso	Zn (%)			90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	
	Pb (%)			40.0	40.0	40.0	50.0	50.0	50.0	45.0	45.0	45.0	
Total mill feed	Zn (%)	90.7	90.7	90.7	90.5	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.3
	Pb (%)	74.5	77.8	78.9	71.8	40.0	50.0	50.0	50.0	45.0	45.0	45.0	60.4

Note: Totals may not sum due to rounding. Calendar years used are for illustrative purposes

- For zinc, Morro Agudo Mine and Ambrosia Sul recoveries have been set to match the reported 2016 metal balance. Much lower lead recoveries (20–40%) were applied to Ambrosia Sul due to the low lead head grades and indications of metallurgical difficulties in the lead circuit from testwork.
- For Ambrosia Norte and Bonsucesso, as no testwork was available, a nominal 90% Zn recovery was assumed, and lead recovery was set to 40 to 50%. It is possible that lead recovery could improve to levels of around 70% once metallurgical testwork results are completed. However, it is also possible that both zinc and lead recoveries would need to be revised downwards.
- The LOMP does not include future treatment of Deposit 2 historical tailings through the Morro Agudo process plant. Votorantim may assess and restart historical tailings retreatment in future if it deemed economical and practical from an operational perspective.

13.4 Metallurgical Variability

Morro Agudo variability tests were completed using grinding and lead and zinc rougher flotation tests, on mineralization samples collected from anticipated 2015–2016 production. Lead rougher recoveries for samples greater than 0.39% Pb were approximately 84%, with lead rougher concentrate grades of 10% to 13%. For samples in the 0.15% to 0.39% Pb head grade class, recoveries dropped to less than 76%, in conjunction with a substantial fall in lead rougher concentrate grade to less than 2.5% Pb. For the lead head grade class below 0.15% Pb, an average recovery of 63% was achieved with a lead rougher concentrate grade of 0.5% Pb. This indicated that low lead head grade Morro Agudo mill feed material (< 0.4% Pb) would have difficulty achieving the same target metallurgical performance of those feed materials containing close to 1% Pb.

The variability performance of zinc was much more consistent, with head grade ranges less than 1.96% Zn to over 3.89% Zn consistently achieving zinc recoveries of between 88.4% and 92.4%. While there was a decline in zinc rougher concentrate grade, from 19.5% to 10.4%, as head grades fell, it is probable that the Morro Agudo zinc cleaner circuit has sufficient capacity to produce final zinc concentrate grades at consistently high zinc recoveries, for a range of zinc head grades.

Limited variability testwork was completed in the 2015 Ambrosia Sul metallurgical test program, as described in Section 13.2.2. For Ambrosia Sul, metallurgical variability appears much higher for lead than for zinc.

Metallurgical variability for Ambrosia Norte and Bonsucesso needs to be further evaluated once the initial metallurgical test results are received. It is expected that lead recovery will vary significantly with lead head grade and mineralization type, while zinc recoveries will be generally more consistent.

It is possible that variability in Morro Agudo plant metallurgical performance will increase with the additional mill feed sources. This may depend on the ability of the operations to produce consistent qualities and blends from the different satellite mines and the Morro Agudo Mine.

13.5 Deleterious Elements

The Morro Agudo process plant produces clean, low-iron, zinc concentrates. The main impurity in zinc concentrate is dolomite, which contains CaO and MgO. The Morro Agudo concentrator operates at or near these limits, primarily because a lower zinc concentrate grade (about 38%) is targeted to maximize zinc recovery.

The Tres Marias smelter sets limits of 10.8% and 5.8% on these constituents respectively. There are no other known deleterious elements in zinc concentrate.

There are no known deleterious elements in the lead concentrate, and no penalties are applied by customers. Carbonates (containing CaO and MgO) are the main diluents.

Table 13-12 shows the average lead and zinc concentrate compositions produced for 2016.

13.6 Comments on Section 13

The Morro Agudo Mine and Ambrosia Sul mineralized materials contain a simple mineralogical assemblage and responded well to a simple and conventional flowsheet and reagent suite.

Zinc recoveries of approximately 90% are achievable from Morro Agudo Mine and Ambrosia Sul mineralized material containing around 3% Zn. However, insufficient reagent additions or coarse grinds could cause significant deteriorations in zinc recovery. There is potential to significantly increase zinc concentrate grade, if customer requirements favour this.

Lead recoveries are more sensitive to head grade and are more variable. Lead recovery is expected to fall for the satellite deposits at Ambrosia Sul, Ambrosia Norte and Bonsucesso due to lower lead grades.

No metallurgical testwork results are currently available for Ambrosia Norte and Bonsucesso. While it is plausible to believe that metallurgical performance will be similar to that from the Morro Agudo Mine and Ambrosia Sul, this can only be confirmed once testwork is completed. The first round of Ambrosia Norte/Bonsucesso testwork should be completed by about October 2017.

Votorantim has established flotation and mineralogy test procedures that should provide some prediction of problematic mineralization for metallurgical treatment.

Table 13-12: Lead and Zinc Concentrate Compositions for 2016

	Pb Concentrate Actual (%)	Pb Concentrate Spec (%)	Zn Concentrate Actual (%)	Zn Concentrate Spec (%)
Zn	6.0	5–11	38.2	≥ 37.5
Pb	50.4	50–56	2.0	≤ 2.2
CaO	3.1	2–4	10.1	≤ 10.8
MgO	1.5	0.8–2.5	5.9	≤ 5.8
Fe	8.7	9	3.0	≤ 3.0
Moisture	7.2		10.9	

14.0 MINERAL RESOURCE ESTIMATES

14.1 Introduction

Mineral Resource estimates were performed by Votorantim staff for the Morro Agudo Mine, and the Ambrosia Sul, Ambrosia Norte, and Bonsucesso deposits. The following sub-sections discuss the estimation procedures, and resulting estimates.

14.2 Morro Agudo Mine

14.2.1 Supporting Database

The effective date for the Morro Agudo Mine Mineral Resource database is 1 November, 2016.

Due to better survey control, only the underground drill holes have been used for construction of the geological model and for estimation purposes. The mine works with local coordinates or mine grid, the X-axis represents the north–south direction while the Y-axis represents the east–west direction.

14.2.2 Geological Models

The geological model was constructed using Leapfrog Geo.

Lithological Modelling

The following four units were modelled and then offset by the major faults:

- Carbonaceous phyllite (MOC): Footwall unit
- Dolomitic breccia (BDOL): Mineralized host
- Dolarenite (DAR): Mineralized host
- Dolomitic clay sequence (SAD): Hanging wall unit.

After the faulting offsets were incorporated, 15 separate domains were created as shown in Table 14-1.

Mineralization Model

Three mineralized models or grade shells were constructed

- Low: 0% to 0.02% Zn+Pb (non-mineralized or waste shell)
- Mid: 0.02% to 2.3% Zn+Pb (buffer or dilution shell)
- High: >2.3% Zn+Pb (mineralized shell).

Table 14-1: Geological Domains and General Orientation

Block Domain (CLI)	Dip Azimuth (º)	Dip (º)	Domain
BL1	223	21	Domain 1
BL2	250	22	Domain 6
BL3	223	21	Domain 1
BL4	225	22	Domain 2
BL5	230	22	Domain 3
BL6	225	22	Domain 2
BL7	225	22	Domain 2
BL8	225	22	Domain 2
BL9	250	22	Domain 6
BL10	230	22	Domain 3
BL11	240	22	Domain 5
BL12	235	22	Domain 4
BL13	235	22	Domain 4
BL14	240	22	Domain 5
BL15	223	21	Domain 1

Note: CLI is Votorantim's term for a mineralized body.

Votorantim uses the term CLI to refer to mineralized bodies contained within the High domain.

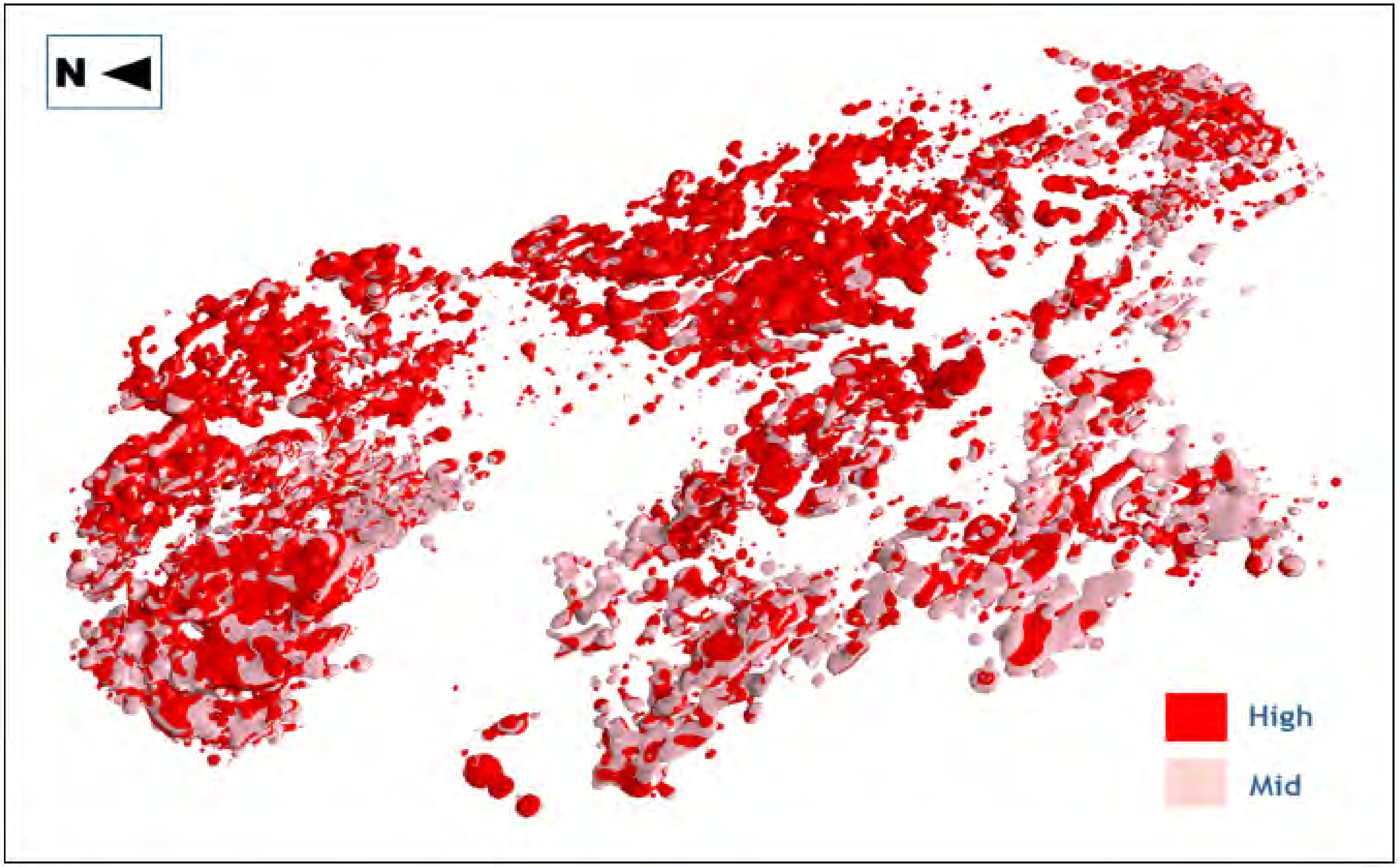
In all three models, the grade shells were restricted by the DAR or BDOL host rocks. Figure 14-1 shows a perspective view of the mineralized (High) and dilution (Med) shells.

The Mid and High mineralized domains were combined with the lithological domains to create the overall geological model (Figure 14-2), which was then used to code the block model. As some of the mineralized solids are extremely small, only solids with a volume larger than 400 m³ were exported to Datamine.

14.2.3 Composites

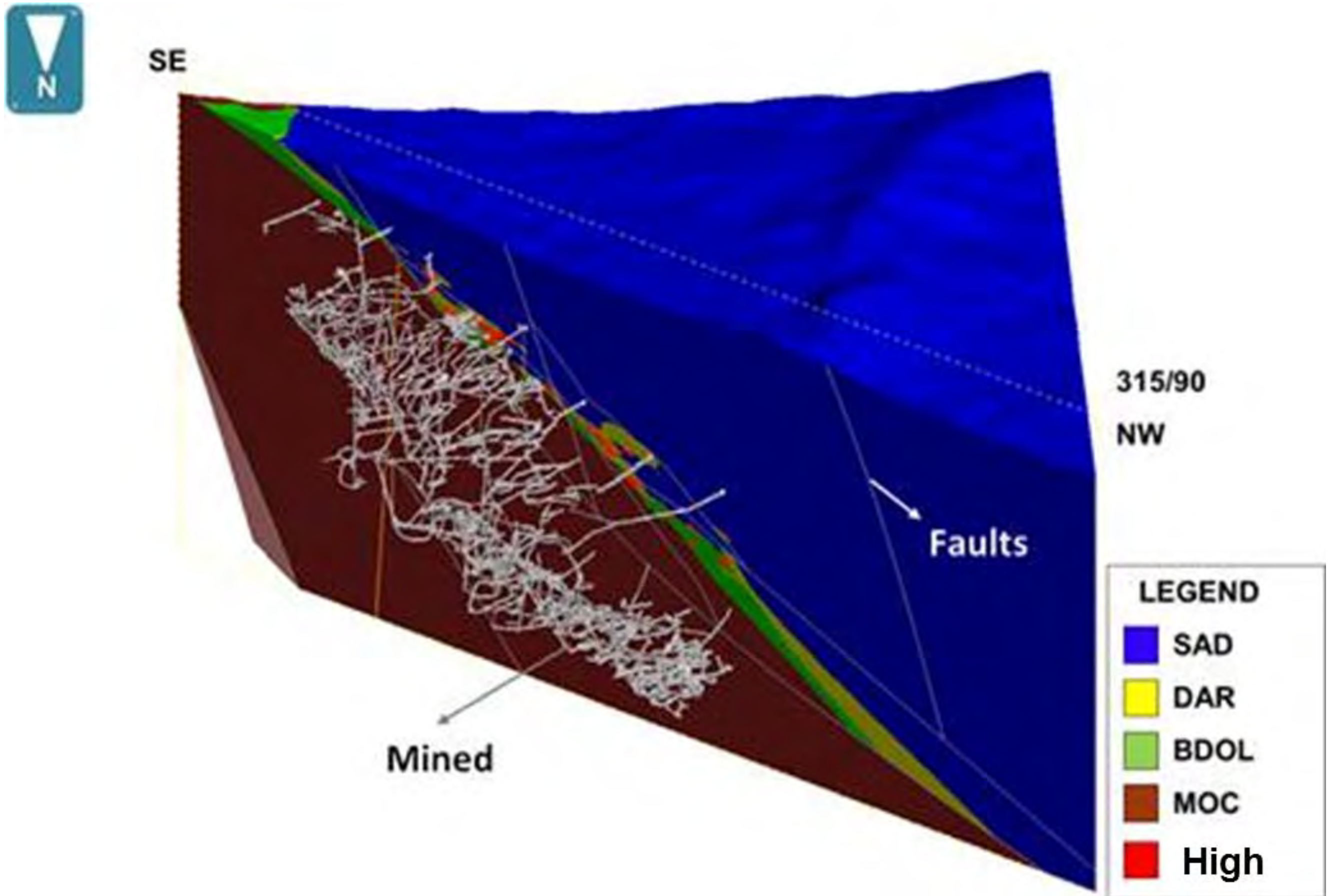
Composites of assay intervals, bounded by the Mid and High mineralized domains were created. The composites have a nominal 1 m length were created with a minimum length of 0.5 m and maximum length of 1.5 m.

Figure 14-1: Perspective View, Mineralization Wireframes



Note: Figure courtesy Votorantim, 2017. Red = High domain, pink = Mid domain. As the view is a perspective view, a scale indicator is not applicable.

Figure 14-2: Combined Lithological Model and Mineralization Model



Note: Figure courtesy Votorantim, 2017. As the view is a perspective view, a scale indicator is not applicable.

14.2.4 Exploratory Data Analysis

Sample Analyses

The composites were coded by mineralized domain and then reviewed in order to determine if further domaining was required. Probability plots for zinc and lead within each domain were constructed.

Where the inflections correspond to different detection limits over time, there is an obvious inflection in the High domain at approximately 2% Zn and a more subtle inflection at about 1% Pb. Similar results were noted in the Mid domain. Amec Foster Wheeler notes that it may be worthwhile to try to better segregate these populations in future models.

Grade Capping/Outlier Restriction

Votorantim reviewed the data and determined that capping was not required, and the influence of high-grade composites would be controlled by using a restrictive search volume during estimation. Studies are currently being carried out to evaluate the impact of applying capping in future models.

Amec Foster Wheeler conducted an independent assessment of capping for the Morro Agudo Mine model, and agrees that capping of zinc grades within these domains is not required. Using outlier restriction should adequately control the influence of high grade composites. However, the Amec Foster Wheeler study did suggest that lead composites may require capping. As lead provides 20% of the revenue at Morro Agudo, there is some risk by not capping the higher-grade composites.

Correlation Analyses

To test for correlation between zinc and lead grades, scatterplots were constructed within the High and Mid domains. These graphs do not show any correlation between zinc and lead; thus, those variables were independently estimated.

Statistical Analyses

Histograms for zinc and lead were produced for the High and Mid domains. The data distribution is asymmetric and positively skewed. The mean values for the High domain are 4.79% Zn and 2.06% Pb.

14.2.5 Density Assignment

Historically, a density value of 3.0 g/cm^3 representing the average of measured density data was applied to all blocks. As density data have not been systematically collected throughout the mining area, it was decided not to estimate density values into the blocks. Based on a recommendation made in 2017 (Amec Foster Wheeler, 2017a), changes were implemented to better reflect local density data variations.

Measured density data were compared to zinc, lead and Zn+Pb assays. The best correlation was observed between density and lead data, especially between lead assays greater than 1% and density, as shown in Figure 14-3. For intervals lacking a density measurement, a density value was calculated using the linear regression equations:

- For Pb <1%: density = 2.961 + 0.04369 Pb
- For Pb >1%: density = 2.9650 + 0.03108 Pb.

Both the measured density and calculated density data were used to estimate density values into the block model.

Scatterplot and quantile–quantile (Q–Q) plots suggest the calculated density is lower than the measured density. Amec Foster Wheeler recommends further studies to improve the calculated density results. Votorantim is also currently considering what methods may be appropriate to further refine the estimated density values.

14.2.6 Variography

Variograms were generated after separating the Morro Agudo deposit into three structural blocks: Block C, Block E, and Remaining Areas (Figure 14-4), for the variables zinc, lead, and density.

Downhole variograms were created to determine the nugget effect for each variable.

Zinc variogram parameters for the three structural blocks are shown in Table 14-2.

14.2.7 Block Model

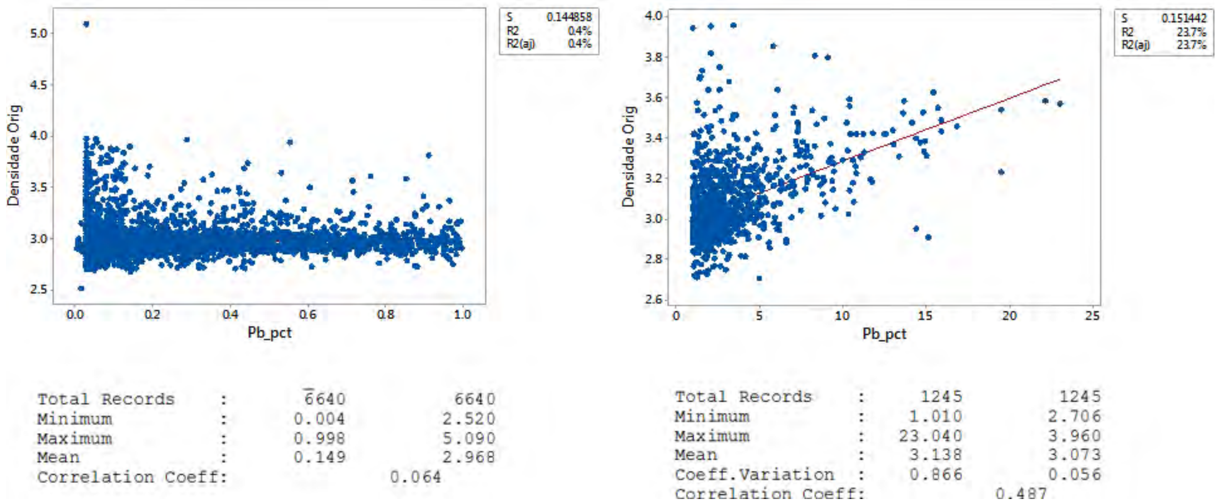
The block model was generated based on the parameters shown in Table 14-3.

14.2.8 Estimation/Interpolation Methods

Ordinary kriging (OK) and nearest neighbor (NN) estimations within Datamine Studio 3 software were performed for zinc, lead, and density. The NN model is used for validation checks.

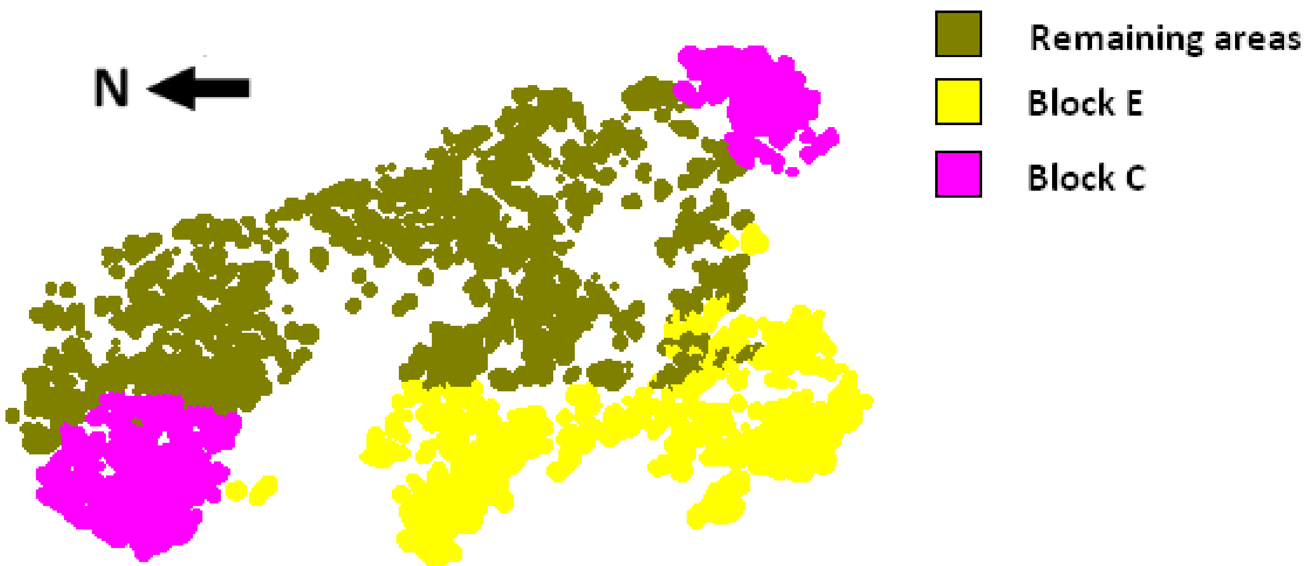
The dimensions of the search ellipsoid were based on the zinc variogram ranges. The estimation was completed using three expanding searches. Separate estimations were completed for the Mid and High domains within each of the three structural blocks. The Mid domain was estimated using the same parameters as the High domain. These same parameters were used to estimate zinc, lead, and density and are shown in Table 14-4.

Figure 14-3: Linear Regression of Lead Assays for Density Prediction



Note: Figure courtesy Votorantim, 2017. Left figure is for lead grades <1%; right figure is for lead grades >1%.

Figure 14-4: Plan View of Structural Blocks Used in Variograms



Note: Figure courtesy Votorantim, 2017. As the view is a perspective view, a scale indicator is not applicable.

Table 14-2: Zinc Variogram Parameters

Zinc - Remaining Areas					
Rotation	Z	Y	X	Nugget effect	0.1
	-40	22	0		
First structure	ST1	ST1PAR1	ST1PAR2	ST1PAR3	ST1PAR4
	1	50	70	1	0.8
Second structure	ST2	ST2PAR1	ST2PAR2	ST2PAR3	ST2PAR4
	1	4	4	1	0.1
Zinc - Block C					
Rotation	Z	Y	X	Nugget effect	0.1
	-40	22	0		
First structure	ST1	ST1PAR1	ST1PAR2	ST1PAR3	ST1PAR4
	1	10	18	1	0.8
Second structure	ST2	ST2PAR1	ST2PAR2	ST2PAR3	ST2PAR4
	1	5	5	1	0.1
Zinc - Block E					
Rotation	Z	Y	X	Nugget effect	0.1
	-40	22	0		
First structure	ST1	ST1PAR1	ST1PAR2	ST1PAR3	ST1PAR4
	1	8	14	1	0.8
Second structure	ST2	ST2PAR1	ST2PAR2	ST2PAR3	ST2PAR4
	1	4	4	1	0.1

Note: Datamine format: ST: structure type; PAR1-3: ranges; PAR4: sill contribution

Table 14-3: Parameters for Block Model Construction

	X	Y	Z
Origin Coordinate	500	-2950	-480
No. of Cells	443	380	1,195
Cell size	6	6	1
Smallest sub-block	0.75	0.75	0.5
Rotation	—	—	—

Table 14-4: Search and Estimation Parameters (Zn, Pb, density)

Remaining Area	**Rotation**	**°1 (Strike)**	**°2 (Dip)**	**°3 (Plunge)**
		-40	22	0
	Search distances	**°1 (X)**	**°2 (Y)**	**°3 (Z)**
		70	50	1.5
	Samples	**SV**	**Min data**	**Max data**
		1	4	16
		2	3	16
		3	1	16
Block C	**Rotation**	**°1 (Strike)**	**°2 (Dip)**	**°3 (Plunge)**
		-45	22	0
	Search distances	**°1 (X)**	**°2 (Y)**	**°3 (Z)**
		40	18	1.5
	Samples	**SV**	**Min data**	**Max data**
		1	4	16
		2	3	16
		3	1	16
Block E	**Rotation**	**°1 (Strike)**	**°2 (Dip)**	**°3 (Plunge)**
		-40	22	0
	Search distances	**°1 (X)**	**°2 (Y)**	**°3 (Z)**
		40	25	1.5
	Samples	**SV**	**Min data**	**Max data**
		1	4	16
		2	3	16
		3	1	16

Density All Domains	**Rotation**	**°1 (Strike)**	**°2 (Dip)**	**°3 (Plunge)**
		-40	22	0
	Search distances	°1 (X)	°2 (Y)	°3 (Z)
		40	25	1.5
	Samples	**SV**	**Min data**	**Max data**
		1	4	24
		2	3	24
		3	1	24

14.2.9 Block Model Validation

After the entire estimation process, the resulting resource model must honour the local geology, mineralization domains, and sample data. To ensure that the result of the estimate was unbiased, Votorantim staff followed internal validation procedures, which include Inferred Mineral Resources in the validations. However, Amec Foster Wheeler included only Measured and Indicated Mineral Resources in validations performed in support of this Report.

Global Bias Checks

The kriged block estimates were checked for global bias by comparing the average grade (with no cut-off) from the estimated model with that obtained from NN estimates. The global biases are within the recommended Amec Foster Wheeler guidelines of ±5% (relative).

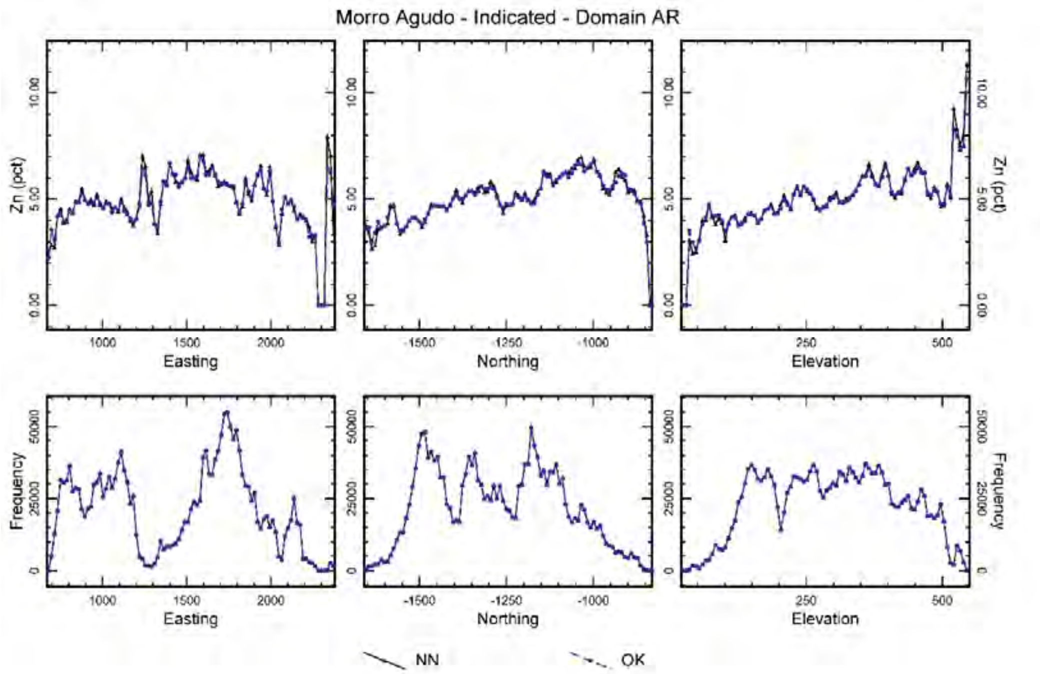
Change of Support Checks

Amec Foster Wheeler completed change of support checks using Herco (based on Hermetian correction (Herco) for change of support calculations (Journel and Huijbregts, 2008) within Indicated blocks contained in the mineralized envelopes. A selective mining unit (SMU) size of 5 m x 5 m x 4 m was used. These checks showed that estimated grades for zinc for Block C and the Remaining Area are acceptable near the economic cut-off; the estimated contained metal agrees within 2% of the Herco-adjusted contained metal.

Local Bias Checks

Checks for local biases for zinc and lead were performed within the mineralized envelopes by creating and analyzing local trends in the grade estimates using swath plots. An example swath plots for Indicated blocks within the Remaining Area is shown in Figure 14-5. These swath plots confirmed the results indicated by the global bias check.

Figure 14-5: Remaining Area – Swath Plots - Zn



Note: Figure prepared by Amec Foster Wheeler, 2017.

Visual Validation

Visual validation comparing the estimated block grades to the composite data was completed by Votorantim and Amec Foster Wheeler. The estimated models compared well with the composite data for both lead and zinc. Figure 14-6 compares the estimated zinc grades to the composite zinc grades.

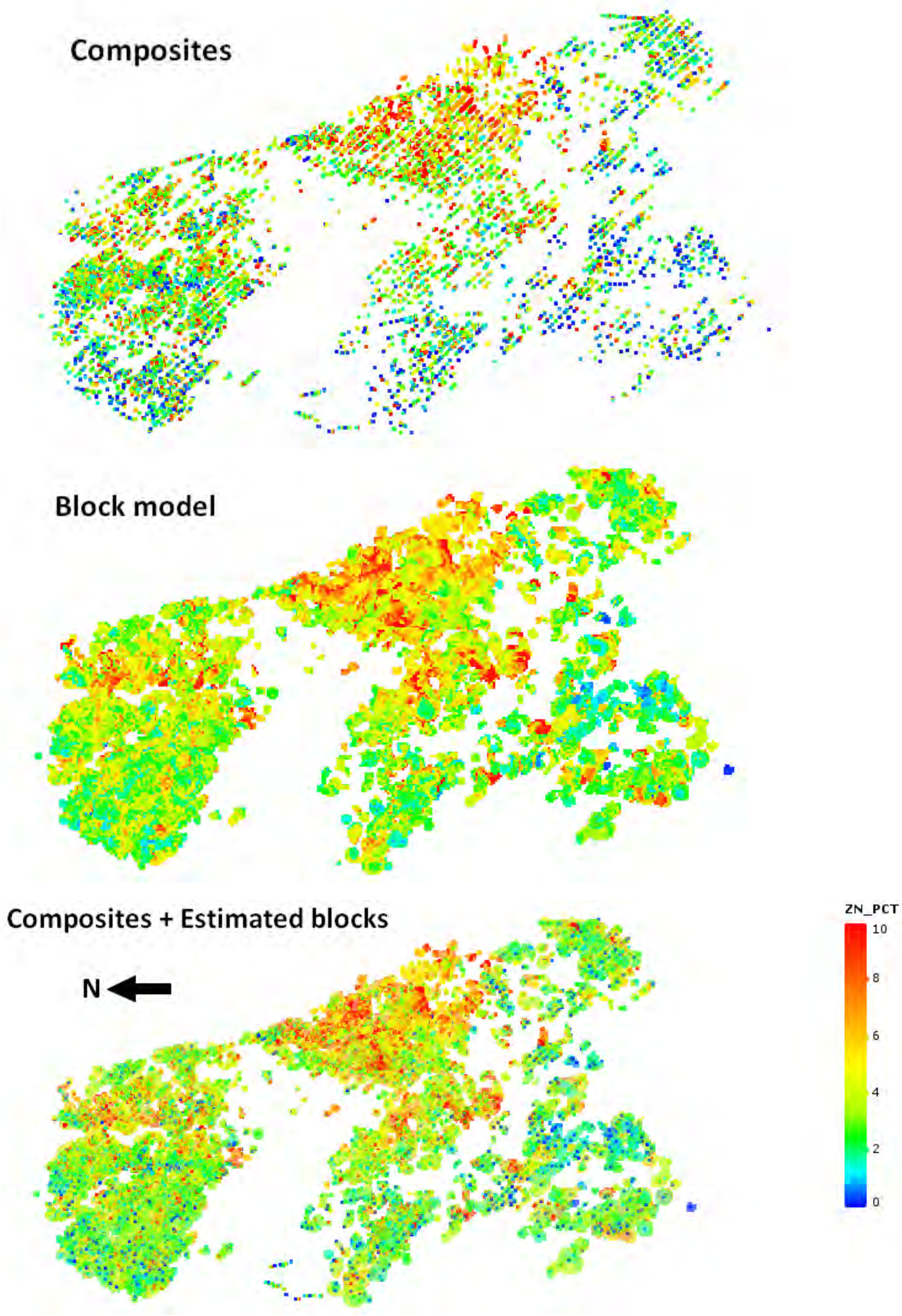
14.2.10 Classification of Mineral Resources

Mineral Resources are classified based on a "Balanced Scorecard" approach. This approach considers four inputs to determine the final classification level. The inputs are:

- Distance from block centroid to nearest sample
- Number of samples used to estimate a block
- Search volume or search pass
- Kriging variance

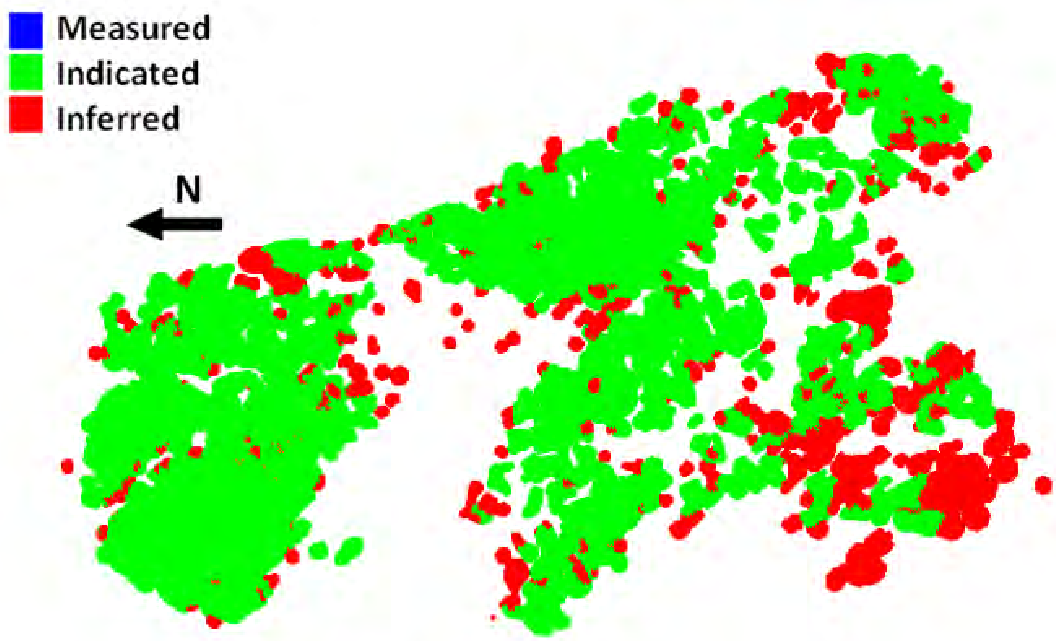
Based on these inputs, the classification shown in Figure 14-7 was determined.

Figure 14-6: Visual Validation of Zinc Estimates



Note: Figure courtesy Votorantim, 2017. As the view is a perspective view, a scale indicator is not applicable.

Figure 14-7: Final Mineral Resource Classification



Note: Figure courtesy Votorantim, 2017. As the view is a perspective view, a scale indicator is not applicable.

A drill hole spacing study was conducted which suggests a drill spacing of 30 m is required to support Indicated Mineral Resources and 50 m for Inferred Mineral Resources.

Amec Foster Wheeler independently classified blocks based on the drill spacing criteria. The resulting tabulation compared closely to Votorantim' s classification, and thus Amec Foster Wheeler accepts the classification of Mineral Resources that was determined by Votorantim.

A detailed reconciliation procedure is planned to be developed to provide additional confidence for the Mineral Resources.

14.2.11 Reasonable Prospects of Eventual Economic Extraction

To meet reasonable prospects of eventual economic extraction assumptions, only the blocks within the High domain are included in the Mineral Resources. Within this domain, a NSR cut-off of US$44.96/t was applied. This cut-off is the all-in cost and is based on an assumed average price of zinc and lead for the next 10 years (see Section 19.2) with a 15% uplift applied to those prices for the purposes of Mineral Resource estimation.

The NSR is calculated as follows:

- If Zn(%)>=0.23, NSR = 23.2357 * Zn(%)
- If Pb(%)>=0.13, NSR = 12.6436 * Pb(%)
- If NSR > = 44.96 (cut-off), NSR = 3.96 (agricultural lime contribution; see Section 24.1).

The NSR calculations include an allocation in US$/t for the zinc premium that is paid by the Tres Marias smelter, which is the average of the 2017–2026 assumed payable premiums. The average value is US$234.72/t.

Areas that have been mined have been removed from the Mineral Resource estimate.

Other assumptions include:

- Zinc price used is US$2,767.00/t (US$1.26/lb), lead price is US$2,235/t (US$1.01/lb)
- Zinc metallurgical recovery is 91%, lead metallurgical recovery is 83%
- Mining cost of US$11.31/t, plant cost of US$11.88/t, maintenance and other costs of US$21.77/t.

14.3 Ambrosia Sul (Ambrosia Trend)

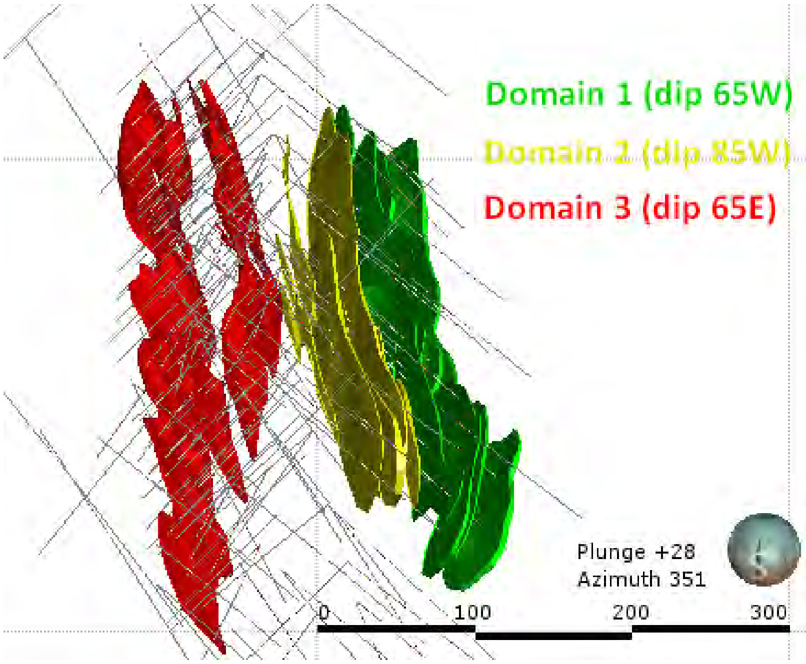
14.3.1 Supporting Database

The effective date for the Ambrosia Sul database is 22 June, 2015. Most of the drill holes were collar surveyed using total station surveying instruments. However, some drill hole collars were surveyed using a handheld GPS unit. The elevations for these drill holes were adjusted by registering the collars to a topographic surface. This is not expected to have an significant impact on the Mineral Resource estimate.

14.3.2 Geological Models

Solids representing the Garrote and Morro do Calcário Formations were constructed. Within these solids, mineralized envelopes were created based on a Zn+Pb cut-off grade of 1%. These grade envelopes were oriented to follow the general north–northwest–south–southeast strike direction of a major fault. The envelopes were subsequently grouped into three structural domains, which were based on typical dip of the envelopes: 65W, 85W and 65E (Figure 14-8).

Figure 14-8: Perspective View of the Mineralized Zones Separated into the Three Structural Domains



Note: Figure courtesy Votorantim, 2017.

14.3.3 Composites

Assay intervals (1,532 samples) inside mineralized zones (wireframes) were composited to a nominal 1.0 m length based on Votorantim's procedure PO-VM-GRM-002.

14.3.4 Exploratory Data Analysis

Sample Analyses

Exploratory data analysis (EDA) was conducted within the mineralized bodies. Histograms show asymmetric distributions for both zinc and lead, with average grades of 5.2% Zn and 0.17% Pb.

Grade Capping/Outlier Restrictions

The population analysis using probability graphs indicates a lognormal distribution. Based on examination of these plots, Votorantim determined there was no need for capping. Amec Foster Wheeler conducted an independent top-cutting analysis and considers the lead grades could be capped or top-cut at around 2% Pb. Votorantim should review this in future models, and consider separate reviews for each domain. As lead does not provide a significant contribution to the overall economics, however, this is not a material issue.

A scatterplot of zinc versus lead indicated a low to moderate correlation.

14.3.5 Density Assignment

Density within the mineralized blocks was calculated based on a linear regression between measured density and Zn+Pb grades. Density values for blocks outside of mineralization were derived from the mean grade of density measurements. The applied density values in g/cm^3 are:

- Mineralization: 0.01690 * (Zn+Pb) + 2.870455
- Waste: 2.84
- Soil: 1.73.

14.3.6 Variography

Separate correlograms were created for zinc and lead based on the structural domains

The main direction of correlograms was along general strike direction (north–northwest–south–southeast), the intermediate direction was along the dip and the lowest continuity was across the mineralized thickness.

14.3.7 Block Model

Block models were constructed as stated in Votorantim's operating procedure PO-VM-GRM-003. Horizontal dimensions were based on drill spacing, and the height was based on bench height for open pit mining. The size of the parent block is 2.0 m wide, 12.5 m long, 5 m high restricted by the mineralized wireframes. Sub-blocks of x = 1.0 m, y = 3.125 m and z = 0.50 m were permitted. The parameters used to generate the block model are summarized in Table 14-5.

14.3.8 Estimation/Interpolation Methods

Ordinary kriging was used to estimate Zn, Pb and density into the block model. Separate estimation (by domain) was performed as outlined in Votorantim' s operating procedure PO-VM-GRM-004.

A local neighborhood study (QKNA) was used to determine the number of samples used in estimation, maximum number of samples per drill holes etc.

The estimation parameters are shown in Table 14-6.

Table 14-5: Ambrosia Sul Block Model Parameters

Parameters	Value (m)	Parameters	Value (m)	Parameters	Value
X Origin	312075	X Cell Size	2.0	Number of Blocks X	210
Y Origin	8101845	Y Cell Size	12.5	Number of Blocks Y	65
Z Origin	480	Z Cell Size	5.0	Number of Blocks Z	35

Table 14-6: Search Parameters for Variable Estimate in the Ambrosia Sul Area

Parameters	Value
Octants	Not used
Max data for estimation	16
Max data per drill hole	3
Min data for estimation	3
Block discretization	2 x 2 x 2

14.3.9 Block Model Validation

Global Bias Checks

To confirm that the result of the estimate was unbiased, Votorantim staff followed internal validation procedures, which include Inferred Mineral Resources in the validations.

Amec Foster Wheeler, however, included only Measured and Indicated Mineral Resources in independent validations performed in support of this Report.

The kriged block estimates were checked for global bias by comparing the average grade (with no cut-off) from the estimated model with that obtained from NN estimates. While the global biases are outside the recommended Amec Foster Wheeler guidelines of ±5% (relative), the OK model is conservative compared to the NN model, thus there is no economic risk presented by these estimations. Amec Foster Wheeler recommends Votorantim review future models in an effort to reduce the bias.

Change of Support Checks

Amec Foster Wheeler completed change of support checks using Herco comparisons within Measured and Indicated blocks contained in the mineralized envelopes. A SMU size of 5 m x 4 m x 4 m was used. These checks showed that estimated grades for zinc within Domain 3 appear to be over-smoothed (estimated model contains more tonnes and less grade compared to the Herco-adjusted model) near the economic cut-off grades of 2.0% Zn+Pb, with the contained metal agreeing within approximately 2% to the Herco-adjusted contained metal.

Local Bias Checks

Checks for local biases for zinc and lead were performed within the mineralized envelopes by creating and analyzing local trends in the grade estimates using swath plots. An example swath plot for Measured and Indicated blocks within Domain 3 for zinc is included as Figure 14-9. The plots confirmed the results indicated by the global bias check.

Visual Validations

Visual validations were also carried out by comparing the composites grades and the estimated block grades. A typical section provided by Votorantim (Figure 14-10) suggest in general the estimates appear to be visually reasonable.

A visual review completed by Amec Foster Wheeler noted one vein (CLI = 3) in Domain 3 was improperly estimated. A section and plan view of the affected vein is shown in Figure 14-10 and Figure 14-11. This issue affects approximately 0.1 Mt of Inferred Mineral Resources. The error was noted and corrected by Votorantim in October 2016; however, at the time the error was identified, mine planning studies were well advanced, and therefore the mine plans were not based on the corrected model. The tabulation of Mineral Resources in Section 14.6 is based on the 2016 corrected model.

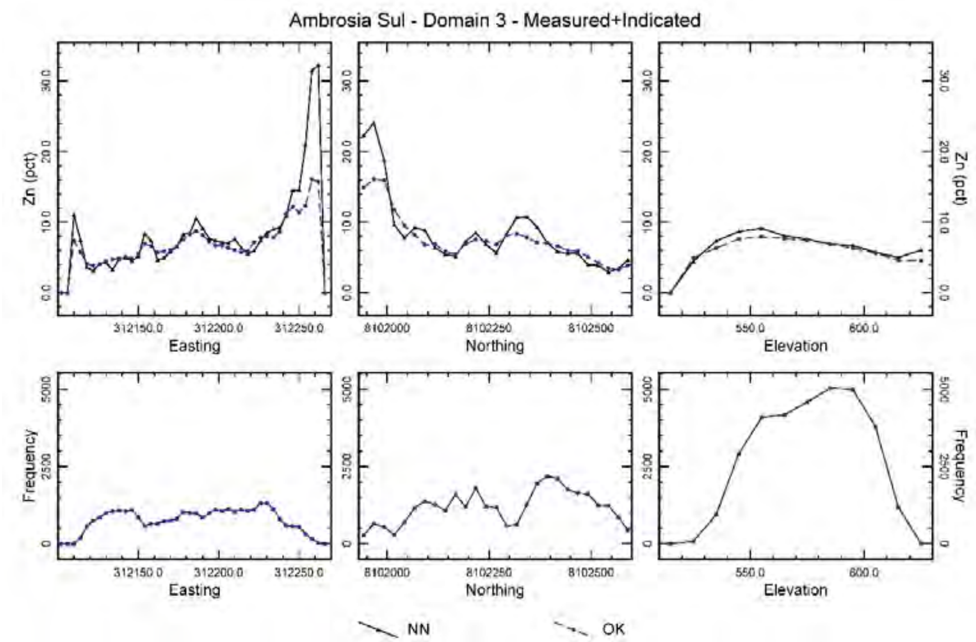
14.3.10 Classification of Mineral Resources

Mineral resources classification was developed according to the requirements of the 2012 JORC code and following Votorantim's standard operating procedure PO-VM-GRM-006. The quality of the supporting data, estimation variance and continuity of mineralization were considered.

Votorantim used the parameters in Table 14-7 to define classification of Mineral Resources. Images for the final classification of the model are presented in Figure 14-12.

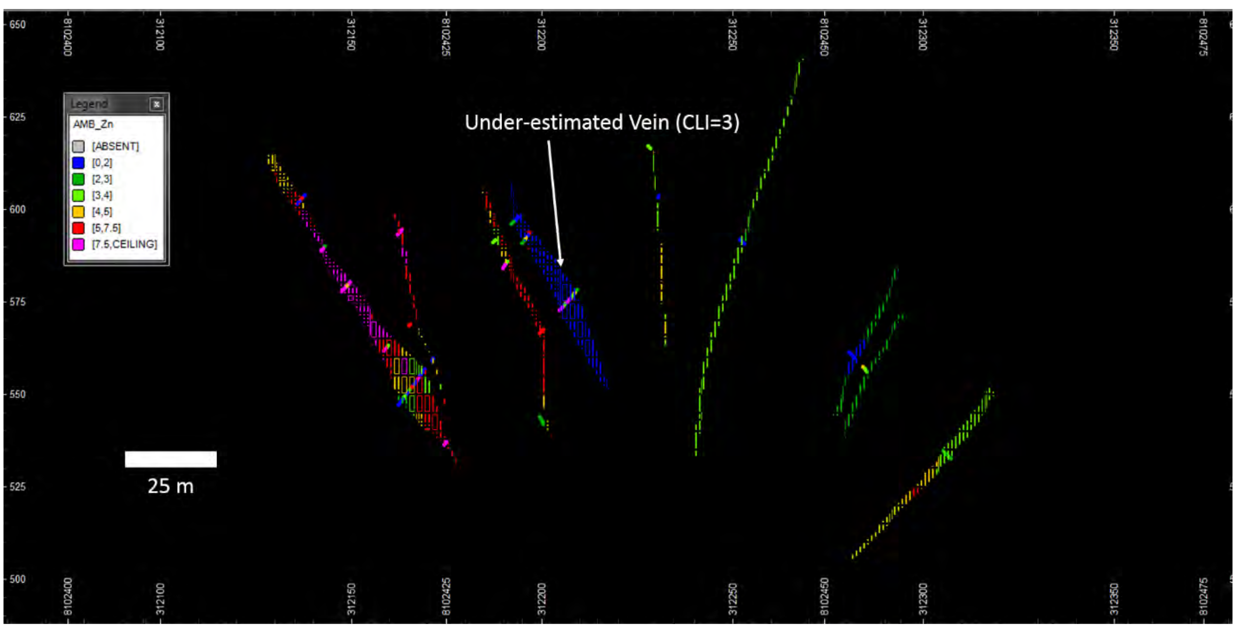
A drill hole spacing study was conducted which suggests a drill spacing of 18 m is required to support Indicated Mineral Resources and 30 m for Inferred Mineral Resources. The spacing for Measured Mineral Resources was less than 10 m. As these spacings are much less than the current drill spacing at Ambrosia Sul, Amec Foster Wheeler is of the opinion the current classification of Mineral Resources at Ambrosia Sul is optimistic. This opinion is supported by the ranges observed in the variogram model.

Figure 14-9: Domain 3 – Swath Plots - Zn



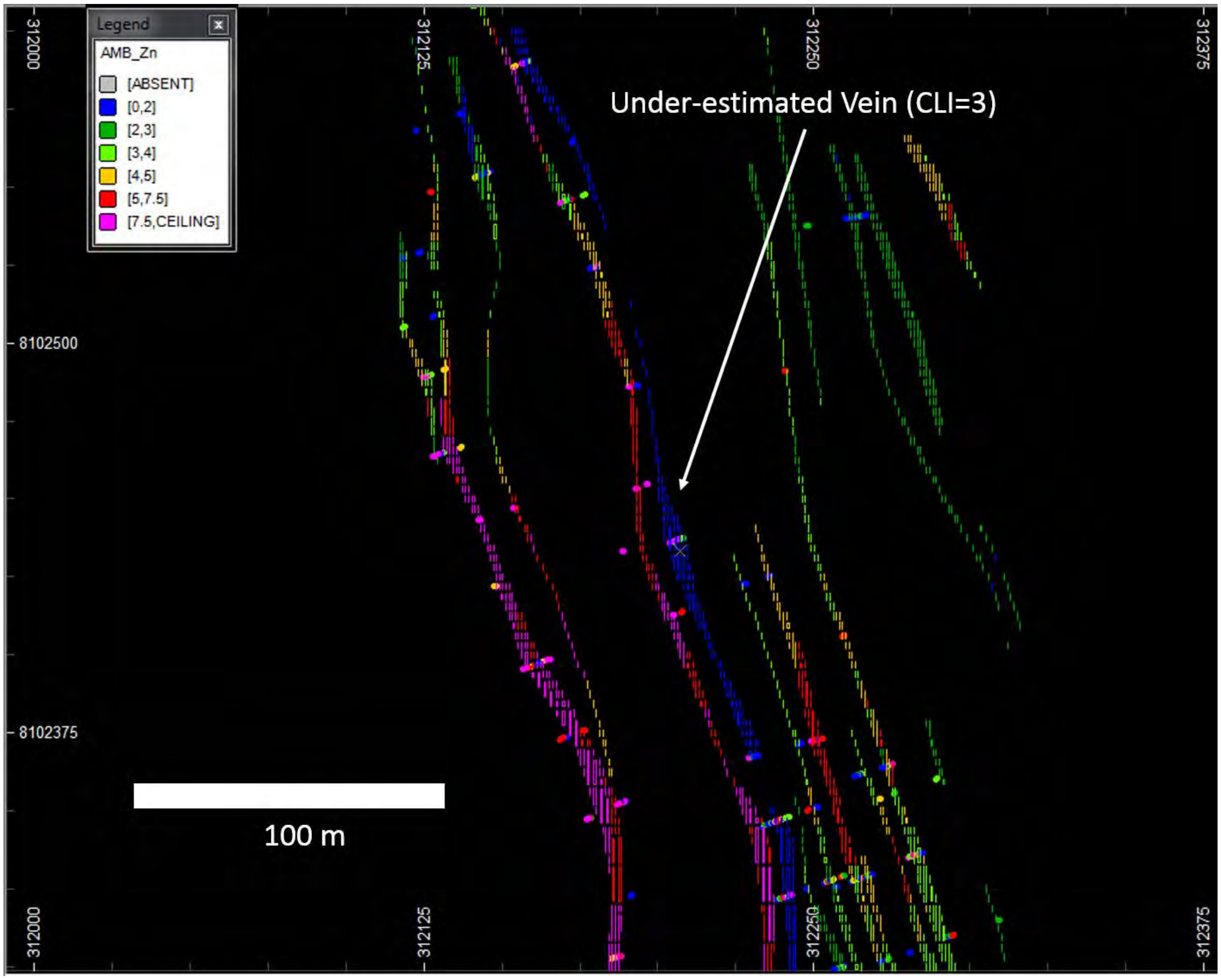
Note: Figure courtesy Votorantim, 2017.

Figure 14-10: Section showing Vein (CLI=3) with Estimation Error



Note: Figure prepared by Amec Foster Wheeler, 2017.

Figure 14-11:Level plan showing Vein (CLI=3) with Estimation Error

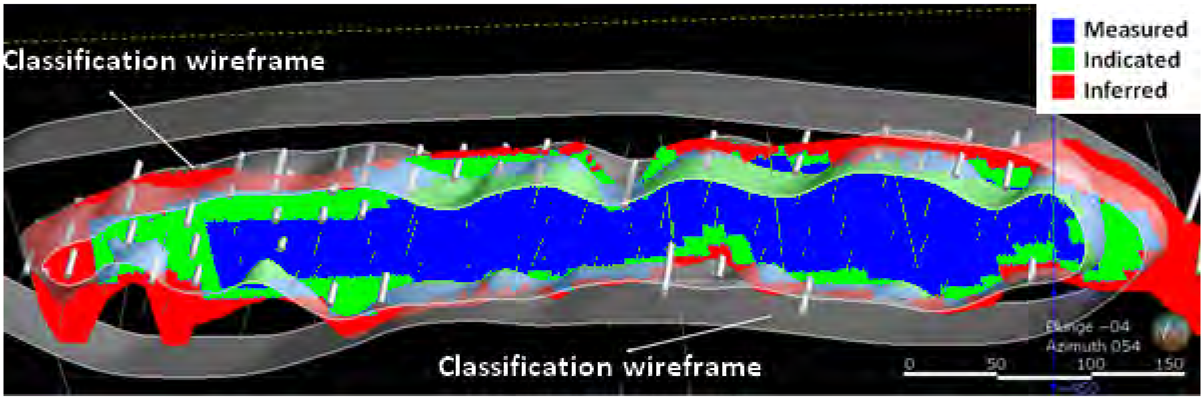


Note: Figure prepared by Amec Foster Wheeler, 2017.

Table 14-7: Mineral Resource Classification Parameters

	Drilling space	Slope of Regression	Kriging Efficiency
Measured	25 x 12.5 m	> 0.7	> 0.3
Indicated	50 x 25 m	> 0.4 and < 0.7	> 0.15 and < 0.3
Inferred	> 50 x 25 m	< 0.4	< 0.15

Figure 14-12:Perspective View - Final Classification



Note: Figure courtesy Votorantim, 2017.

14.3.11 Reasonable Prospects of Eventual Economic Extraction

The Mineral Resources are tabulated based on a pit shell and NSR cut-off values. This cut-off reflects the all-in cost and is based on average price of zinc and lead in the next 10 years plus 15%. The blocks within the pit shell are declared based on a NSR cut-off of US$32.13/t and the blocks outside the pit shell (envisioned to be mined by underground methods) are declared based on a cut-off of US$46.73/t. The NSR calculations are supported by engineering and economic studies. The metal prices are based on average price of zinc and lead in the next 10 years plus a 15% uplift.

The NSR is calculated as follows:

- If Zn(%)>=0.23, NSR = 23.2351 * Zn(%)
- If Pb(%)>=0.13, NSR = 6.0993* Pb(%)
- If NSR >=cut-off, NSR = 3.96 (agricultural lime contribution; see Section 24.1)

The NSR calculations include an allocation in US$/t for the zinc premium that is paid by the Tres Marias smelter, which is the average of the 2017–2026 assumed payable premiums. The average value is US$234.72/t.

Other assumptions include:

- Zinc price used is US$2,767.00/t (US$1.26/lb), lead price is US$2,235/t (US$1.01/lb)
- Zinc metallurgical recovery is 91%, lead metallurgical recovery is 40%
- Open pit assumptions: Mining cost applied is US$5.95/t, plant cost applied is US$11.88/t, maintenance and other costs are US$14.30/t

- Underground assumptions: Mining cost applied is US$15.87/t, plant cost applied is US$11.88/t, maintenance and other costs are US$18.98/t. Costs were derived from those used for the Bonsucesso estimate

14.4 Ambrosia Norte (Ambrosia Trend)

14.4.1 Supporting Database

The effective date for the Ambrosia Norte database is April 14, 2016.

14.4.2 Geological Models

The geological model was constructed using Leapfrog Geo. The modeled units are: soil, dolomites, marl, carbon phyllite and breccia related to the Morro do Calcario Formation and Serra do Garrote Formation.

The mineralized domain was modeled inside the breccia based on a cut-off grade of 2.5% Zn+Pb. A total of eight veins were constructed (Figure 14-13). Votorantim uses the term “corpo” for mineralized bodies at Ambrosia Norte. One of these veins contains oxide and sulphide mineralization while the others contain only sulphide mineralization. The vein containing both oxide and sulphide mineralization was subdivided to separate the different mineralization types as shown in Figure 14-4. For the remainder of this Report, only sulphide mineralization is considered as the oxide mineralization cannot currently be treated through the Morro Agudo mill.

14.4.3 Composites

The drill hole sample intervals were coded by the individual veins and then were composited to a nominal length of 1.00 m, with a minimum length of 0.5 m and maximum of 1.5 m. This created a total of 1,314 composites to be used in estimation of Mineral Resources.

14.4.4 Exploratory Data Analysis

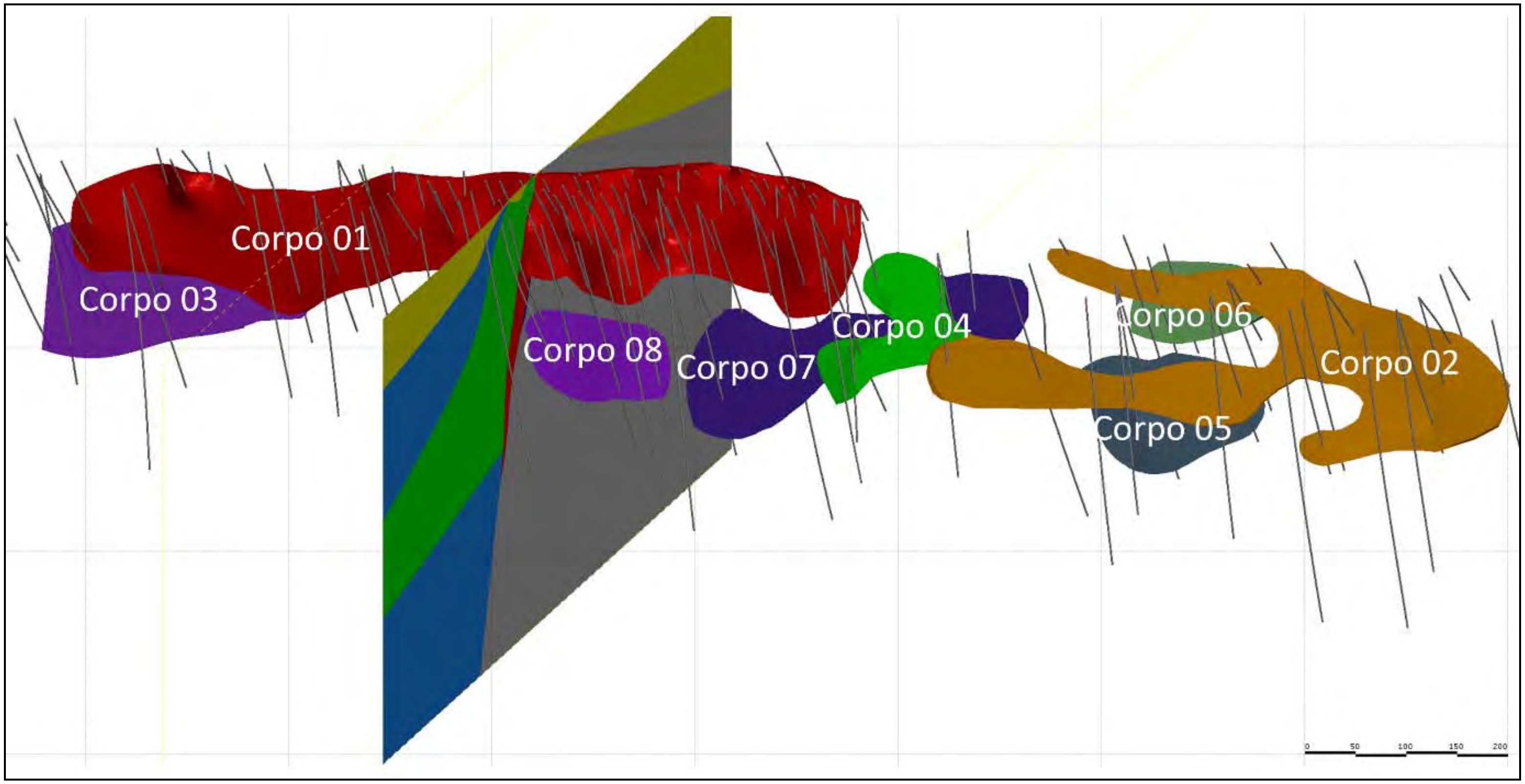
Sample Analyses

Histograms and probability plots were generated for zinc and lead based on sulphide coded composites. The distributions are approximately lognormal in both cases.

Grade Capping/Outlier Restriction

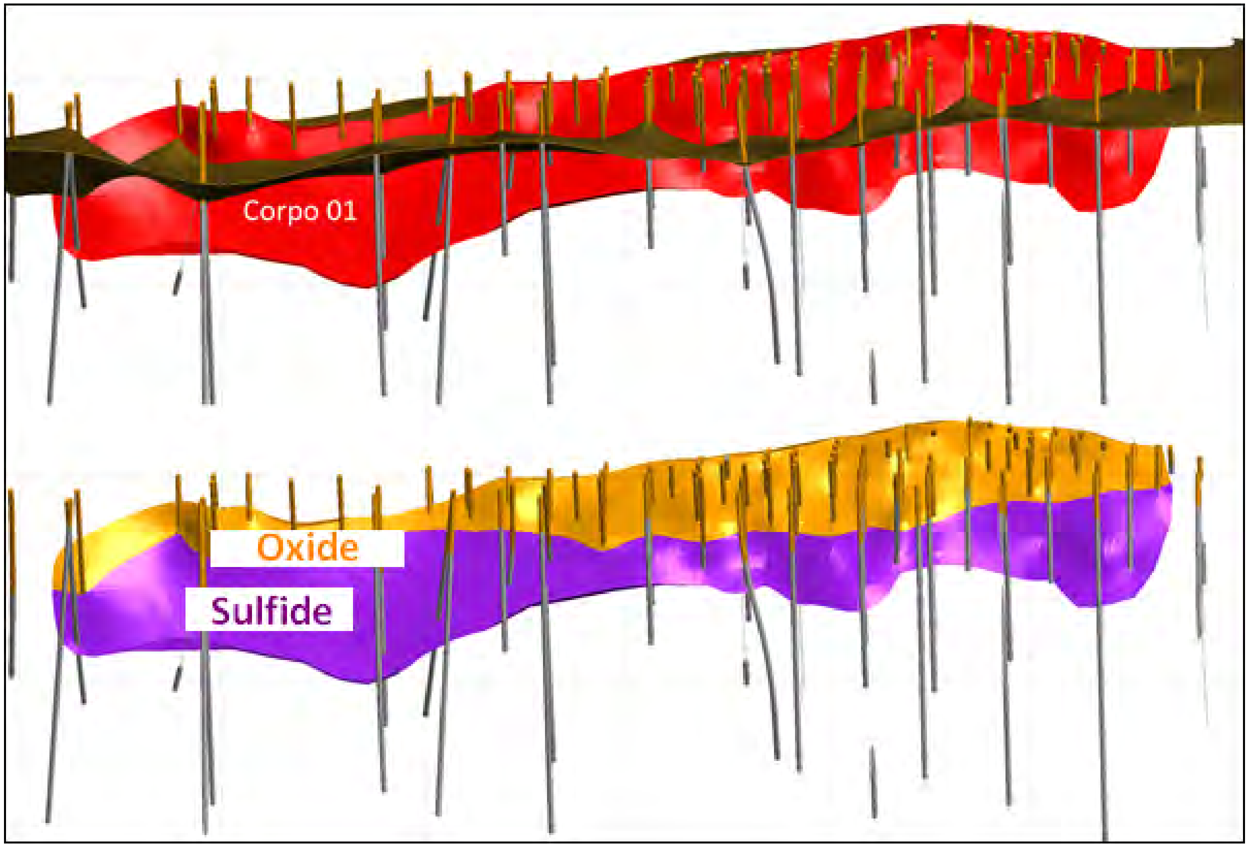
No capping was applied to the assays. Amec Foster Wheeler conducted a top-cutting analysis which suggests capping of 15% for zinc and 4% for lead could be considered. The lack of capping is not considered a risk to Mineral Resources.

Figure 14-13: Veins Modelled inside the Breccia



Note: Figure courtesy Votorantim, 2017.

Figure 14-14: Corpo 1 Weathering Surface Separating the Oxide and Sulphide Mineralization



Note: Figure courtesy Votorantim, 2017. As the view is a perspective view, a scale indicator is not applicable.

14.4.5 Density Assignment

The density was assigned to the blocks according the mineralization type and lithology. These values are summarized in Table 14-8.

14.4.6 Variography

Due to the wide drill spacing of the sulphide composites, it was not possible to generate reliable variograms.

14.4.7 Block Model

The block model was created based on the vein wireframes. The parameters for the block model are presented in Table 14-9. The minimum sub-blocks are 1.0 x 6.25 x 2.5 m.

14.4.8 Estimation/Interpolation Methods

The same estimation strategy was used both for zinc and lead. Each vein was estimated using only the composites coded by the vein. The estimation was made using inverse distance weighting to the second power (ID2) with expanding search ellipses. These estimation parameters are summarized in Table 14-10.

14.4.9 Block Model Validation

To ensure that the result of the estimate was unbiased, Votorantim staff followed internal validation procedures, which include Inferred Mineral Resources in the validations. Amec Foster Wheeler typically includes only Measured and Indicated Mineral Resources in validations; however, as Ambrosia Norte only contains Inferred Mineral Resources Amec Foster Wheeler used that confidence category for validation.

Global Bias Checks

The kriged block estimates were checked for global bias by comparing the average grade (with no cut-off) from the estimated model with that obtained from nearest-neighbour (NN) estimates. The global biases for zinc are within the recommended Amec Foster Wheeler guidelines of ±5% (relative). The global bias for lead is slightly outside the recommended Amec Foster Wheeler guidelines. As the bias is conservative and is for Inferred Resources, this is not seen as a risk, but Amec Foster Wheeler recommends that Votorantim review future models in an effort to improve the lead bias.

Table 14-8: Mean Densities Assigned Based on Modeled Lithotypes

Lithotype	CLI	Density (g/cm^3)
Dolomite	44	2.84
Carbonaceous Phyllite	13	2.73
Marl	37	2.79
Breccia	19	2.84
Soil	30	1.65
Oxide Mineralization	11	2.80
Sulphide Mineralization	1 to 8	3.00

Table 14-9: Block Model Parameters

Parameters	Value (m)	Parameters	Value (m)	Parameters	Value
X Origin	310750	X Cell Size	2.0	Number of Blocks X	495
Y Origin	8103740	Y Cell Size	12.5	Number of Blocks Y	160
Z Origin	100	Z Cell Size	5.0	Number of Blocks Z	136

Table 14-10: Sulphide Mineralization Estimation Parameters

Ellipsoid Axes	Max	Med	Min
	N250/75	N160/0	Complementary
Search ellipsoid (m)	100	50	10
Multipass search	**Incr. factor**	**Min data**	**Max data**
First pass	1x	3	8
Second pass	2x	3	8
Third pass	10 x	3	8
Max per drill hole	—		

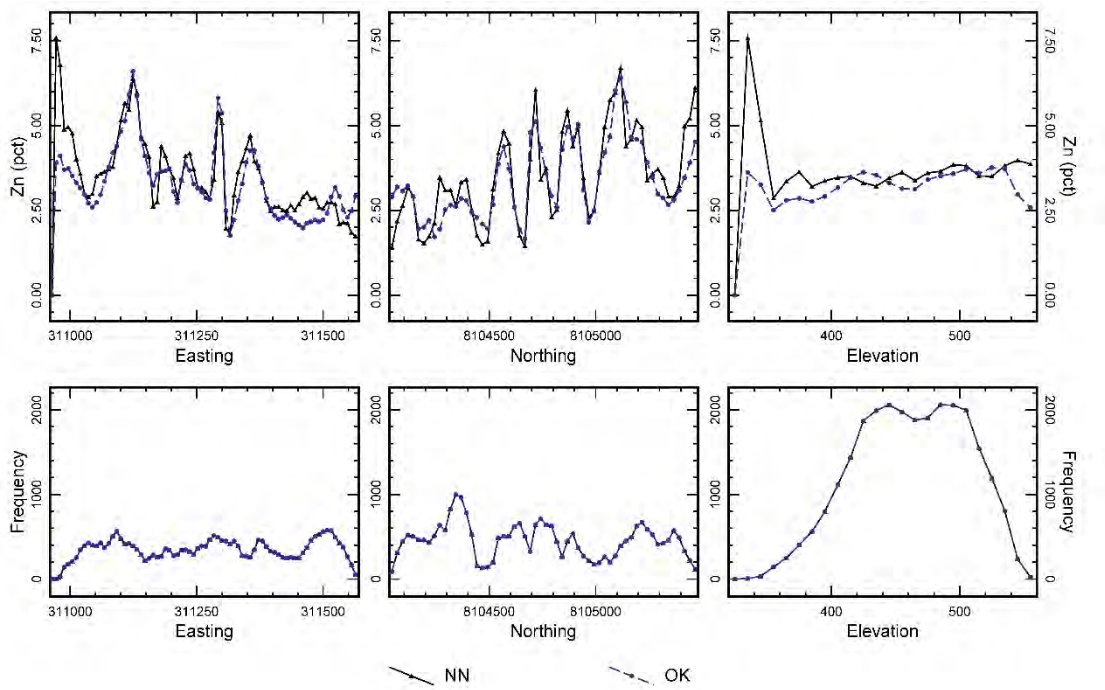
Change of Support Checks

Amec Foster Wheeler did not complete change of support checks for the Ambrosia Norte Inferred Mineral Resources.

Local Bias Checks

Checks for local biases for zinc and lead were performed within the sulphide veins by creating and analyzing local trends in the grade estimates using swath plots. These plots confirm the results indicated by the global bias check. An example swath plot for zinc for Inferred blocks is shown in Figure 14-15.

Figure 14-15: Ambrosia Norte Zinc Swath Plot



Note: Figure prepared by Amec Foster Wheeler, 2017.

Visual Validations

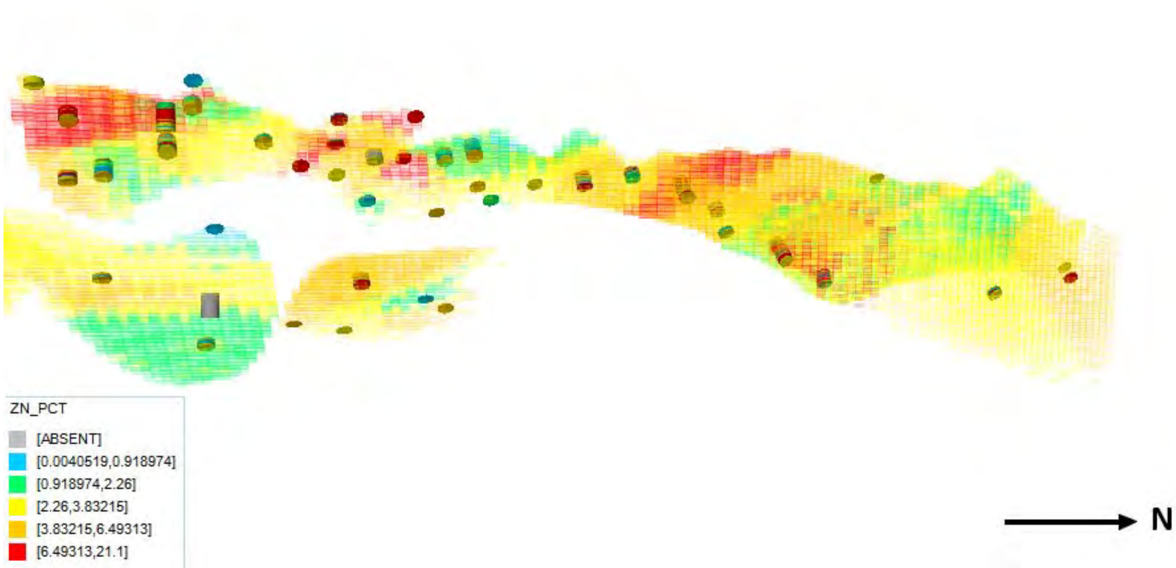
A visual inspection was conducted for zinc along the sulphide-mineralized zones. Figure 14-16 presents the zinc results for the northern part of the deposit.

14.4.10 Classification of Mineral Resources

Geological knowledge and data spacing, quality and continuity were considered as part of Votorantim's classification of Mineral Resources. As the drill hole spacing is 100 m and the boundaries of the mineralization were not extrapolated more than 50 m beyond the last drill hole, all sulphide material was classified as Inferred Mineral Resources.

As all Mineral Resources were classified as Inferred, Amec Foster Wheeler did not conduct a drill hole spacing study. In Amec Foster Wheeler's opinion the classification is reasonable.

Figure 14-16: Visual Validation of Zn Estimates Compared to Zn Composites



Note: Figure courtesy Votorantim, 2017. Lateral view of the northern part of the deposit. As the view is a perspective view, a scale indicator is not applicable.

14.4.11 Reasonable Prospects of Eventual Economic Extraction

No detailed studies have been conducted to determine costs for Ambrosia Norte, so Votorantim applied NSR parameters that were developed for Bonsucesso (see Section 14.5.11).

- If Zn(%)>=0.23, NSR += 23.0761 * Zn(%)
- If Pb(%)>=0.13, NSR += 10.6738 * Pb(%)
- If NSR > = 46.73 (cut-off), NSR = 3.96 (agricultural lime contribution; see Section 24.1).

The NSR calculations include an allocation in US$/t for the zinc premium that is paid by the Tres Marias smelter, which is the average of the 2017–2026 assumed payable premiums. The average value is US$234.72/t.

Other assumptions included:

- Underground mining methods
- Zinc price used is US$2,767.00/t (US$1.26/lb), lead price is US$2,235/t (US$1.01/lb)
- Zinc metallurgical recovery is 91%, lead metallurgical recovery is 70%
- Mining cost applied is US$15.87/t, plant cost applied is US$11.88/t, maintenance and other costs are US$18.98/t.

14.5 Bonsucesso (Ambrosia Trend)

14.5.1 Supporting Database

The effective date for the Bonsucesso database is 25 April, 2017. The collar elevation for drill hole BRVZAMDD0087 (surveyed by handheld GPS) was adjusted to match digital topography.

14.5.2 Geological Models

The geological and mineralization models were completed in Leapfrog Geo. The geology was modeled based on a simplified geological sequence, consisting of the following lithotypes:

- Soil
- Dolomites
- Marl
- Carbonaceous phyllite

- Breccia.

Grade envelopes were developed based on a cut-off grade of 1% Zn+Pb. These envelopes were extended a maximum of 50 m beyond the last drill hole and were bounded by the two breccia units within the overall geological model. The geological model and mineralization model is shown in Figure 14-17.

To better characterize the dilution material, a waste zone was defined surrounding the mineralized envelopes. This consisted of the already-modelled breccia zones and a 3 m buffer zone around the mineralized envelopes in case the mineralization extended outside of, or close to the borders of, the breccia units.

14.5.3 Composites

Assay intervals within the mineralized wireframes were flagged by wireframe code (1 to 17, column COLOUR and CLI). These samples were composited to a length of 1.00 m, accepting minimum lengths of 0.5 m and maximum of 1.5 m, generating 1,249 composite intervals. This procedure is described in Votorantim's standard operating procedure PO-VM-GRM-002.

14.5.4 Exploratory Data Analysis

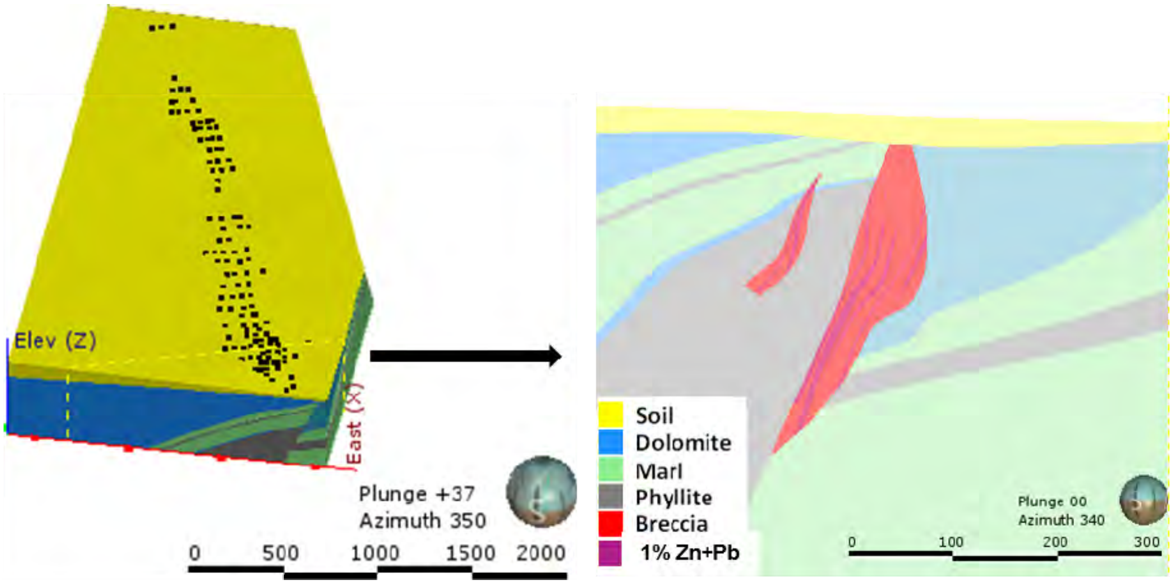
Sample Analyses

The mineralized envelopes were grouped into three domains based on the breccia unit in which they occur. The main breccia, Breccia 1, is divided in the southern part and northern part. Breccia 2, located adjacent to Breccia 1 South contains higher grades than Breccia 1. These regions are illustrated in Figure 14-18.

Grade Capping/Outlier Restriction

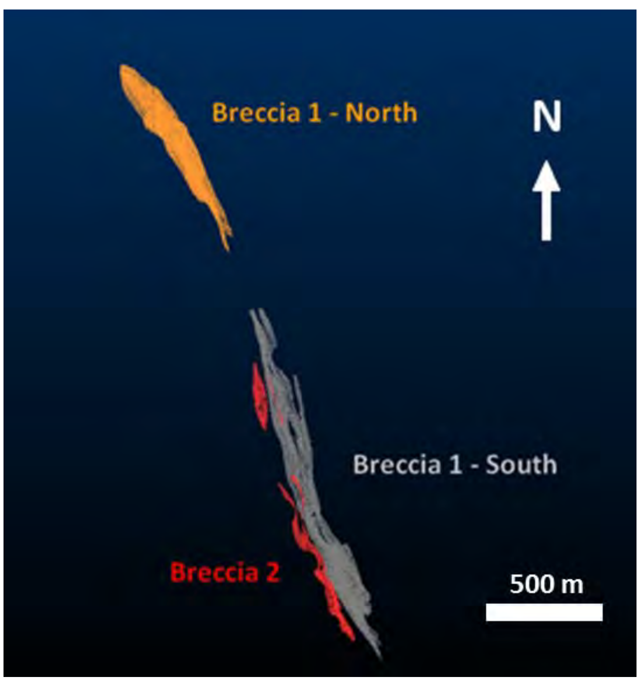
In order to control the influence of the high grades during the estimation, a capping analysis was conducted for each domain. The results are shown in Table 14-11. The capping was applied to composites and not to assays prior to compositing. Amec Foster Wheeler prefers capping is applied to the assay intervals prior to compositing. As the composite interval is similar to the assay intervals, this is not a significant issue. Amec Foster Wheeler completed an independent analysis and agrees with the capping limits determined by Votorantim.

Figure 14-17: Geological Model (perspective view and section view)



Note: Figure courtesy Votorantim, 2017. In the left figure, figure N is to the top of the figure. The drill section is looking to the northwest.

Figure 14-18: Plan View of Mineralized Domains



Note: Figure courtesy Votorantim, 2017.

Table 14-11:Capping Values

Mineralized Envelope	Zn_Pct	Pb_Pct	Density	Buffer	Zn_Pct	Pb_Pct	Density
Breccia 1-S	16.20	5.70	3.90	Breccia 1-S	3.00	1.00	3.30
Breccia 1-N	13.50	3.35	3.90	Breccia 1-N	2.00	0.50	3.60
Breccia 2	32.00	6.50	3.90	Breccia 2	1.80	0.20	3.45

14.5.5 Density Assignment

Where density was unable to be estimated (due to distance from drill holes), an average density was assigned to these blocks based on lithology, using studies undertaken on the Ambrosia Trend in 2012. These values are presented in Table 14-12.

14.5.6 Variography

Variography was conducted for zinc, lead, and density separately within mineralized and buffer domains using correlograms. Drill holes are spaced 100 m along mineralization strike, with some infill drilling to 50 m in the southern area. Due to lack of sufficient data, the three breccia domains were grouped and evaluated as a single population.

14.5.7 Block Model

The block model parameters are shown in Table 14-13. The parent block size is 2 m x 12.5 m x 5 m, with subblocks of 0.5 x 0.5 x 0.5 m permitted to better model regions with the narrow veins.

14.5.8 Estimation/Interpolation Methods

Ordinary kriging was selected to estimate the zinc, lead and density grades within the block model. The estimation of the mineralized domains was made using dynamic ellipsoid rotations (both for search and spatial model). This method requires orientation angles in each block. These angles are extracted from the mineralized wireframes but conditioned by structural data obtained during core logging. These data are subsequently smoothed within Datamine.

Within the mineralized domains, OK was performed incorporating the local orientations discussed above. The estimation plan is summarized in Table 14-14. The estimation domains used were Breccia 1 S, Breccia 1 N, and Breccia 2. The block discretization used was 2 x 2 x 2.

Table 14-12: Average Density Values by Lithology

Lithology	Density (g/cm³)
Dolomite (CLI=144)	2.84
Breccia (CLI=101-102)	2.86
Carbon phyllite (CLI=116)	2.73
Marl (CLI=137)	2.79
Soil (CLI=130)	1.73

Table 14-13: Block Model Parameters

Parameters	Value (m)	Parameters	Value (m)	Parameters	Value
X Origin	309629	X Cell Size	2.0	Number of Blocks X	1268
Y Origin	8105871	Y Cell Size	12.5	Number of Blocks Y	256
Z Origin	175	Z Cell Size	5.0	Number of Blocks Z	80

Table 14-14: Estimation Parameters, Mineralized Domain

Ellipsoid rotation (clockwise)	Z	Y	X
Local anisotropy angles	TRSTRIKE	TRDIP	-
Search ellipsoid (m)	60	60	10
Multipass search	**Incr. factor**	**Min data**	**Max data**
First pass	1x	4	24
Second pass	2x	4	24
Third pass	3x	2	24
Max per drill hole	2		

A visual review of estimated grades in Breccia 2 revealed that, despite capping, isolated high grade composites were excessively smearing high grade estimates into the blocks. In order to control this smearing, Breccia 2 was estimated with a lower capping at 16% Zn and 1% Pb. Then, the high grades above this threshold were estimated without capping but using only the drill holes with at least one composite higher than 16% Zn or 1% Pb (depending on the variable being estimated). Based on Indicator correlograms, the selected high-grade composites were allowed to estimate blocks within 5 m for zinc and 8 m for lead. This approach accounted for the high grades present in drill holes, but controlled the extent of their influence.

The estimation parameters within the buffer domain are detailed in Table 14-15.

Table 14-15:Estimation Parameters, Buffer Domain

Ellipsoid rotation (clockwise)	**Z**	**Y**	**X**
	-25	65	0
Search ellipsoid (m)	60	60	10
Multipass search	**Incr. factor**	**Min data**	**Max data**
First pass	1x	6	24
Second pass	2x	6	24
Third pass	3x	2	24
Max per drill hole	4		

14.5.9 Block Model Validation

After the estimation is complete, the resulting resource model must honor the local geology, mineralization domains, and sample data. To ensure that the result of the estimate was unbiased, Votorantim staff followed internal validation procedures, which include Inferred Mineral Resources in the validations. However, Amec Foster Wheeler included only Measured and Indicated Mineral Resources in validations performed in support of this Report.

Global Bias Checks

The kriged block estimates were checked for global bias by comparing the average grade (with no cut-off) from the estimated model with that obtained from nearest-neighbour (NN) estimates.

The global biases for zinc are within the recommended Amec Foster Wheeler guidelines of ±5% (relative). The global bias for lead is within the recommended Amec Foster Wheeler guidelines in Domain 1, but outside the guidelines for Domain 2. As lead contributes 6% to the economics, this is not seen as a significant risk, but Amec Foster Wheeler recommends Votorantim review future models in an effort to reduce the lead bias.

Change of Support Checks

Hermetian correction (Herco) for change of support comparisons were performed within Measured and Indicated blocks contained in the mineralized envelopes. A SMU size of 5 m x 5 m x 5 m was used. These checks showed that estimated grades for zinc within Domains 1 and 2 appear to be over-smoothed (estimated model contains more tonnes and less grade compared to the Herco-adjusted model) near the economic cut-off grades of 2.0% Zn+Pb, with the contained metal agreeing within approximately 2% to the Herco-adjusted contained metal.

Local Bias Checks

Checks for local biases for zinc and lead were performed within the mineralized envelopes by creating and analyzing local trends in the grade estimates using swath plots. These plots confirm the results indicated by the global bias check. An example zinc swath plot for Indicated blocks within Domain 2 is shown in Figure 14-19.

Visual Inspection

Votorantim conducted a visual validation in several sections to evaluate the grade continuity and check for any inconsistencies. Examples are shown in Figure 14-20 and Figure 14-21. Sample and blocks grades are similar to each other. Breccia 2 high grades are well controlled subsequent to the use of the differentiated estimation strategy.

14.5.10 Classification of Mineral Resources

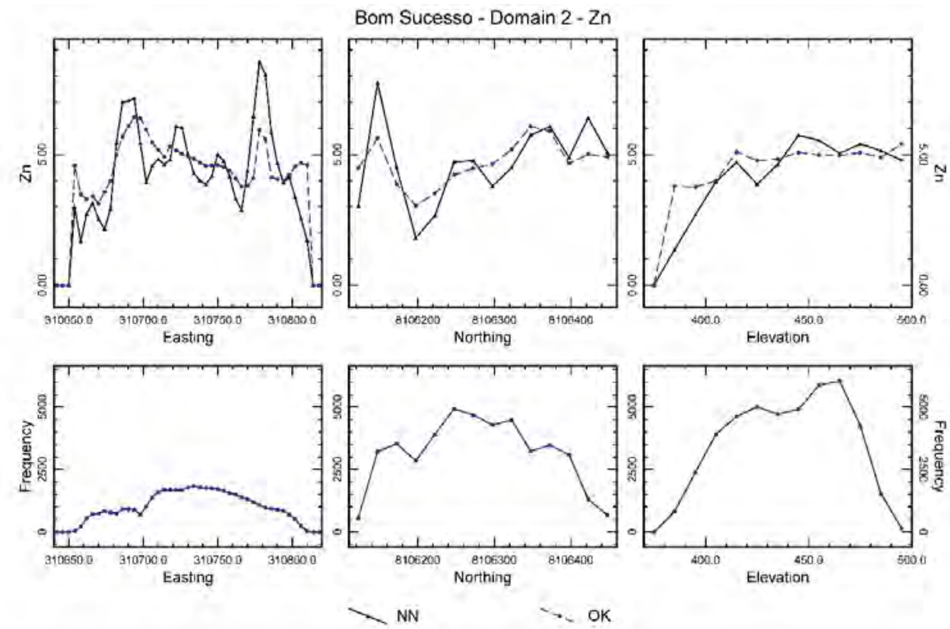
The Resource classification was done based on the drill spacing and on the overall range indicated by the variogram model, which was 60 m.

- Measured spacing: 25 m (around 40% of the range)
- Indicated spacing: 50 m (around 80% of the range)
- Inferred spacing: 100 m (2x the indicated spacing).

As there is no drilling closer than 50 x 50 m, no Measured Mineral Resources are currently defined. Four drill holes within 36 m (half the diagonal of a 50 m grid) of a block were required for Indicated Mineral Resources; the remaining blocks were classified as Inferred. Some manual smoothing was applied. As all data were supported by QA/QC results, no downgrading of the classification was necessary. Votorantim’s classification of Mineral Resources is shown in Figure 14-22.

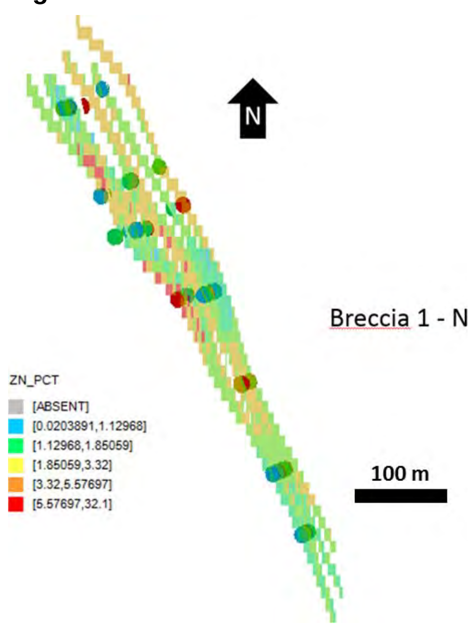
A drill hole spacing study was conducted which suggests a drill spacing of 30 m is required to support Indicated Mineral Resources and 50 m for Inferred Mineral Resources. As these spacings are less than the current drill spacing at Bonsucesso, Amec Foster Wheeler is of the opinion the current classification of Mineral Resources at Bonsucesso may be optimistic. This opinion is supported by the short range of the first structure observed in the variogram model.

Figure 14-19: Bonsucesso – Domain 2 – Zinc Swath Plot



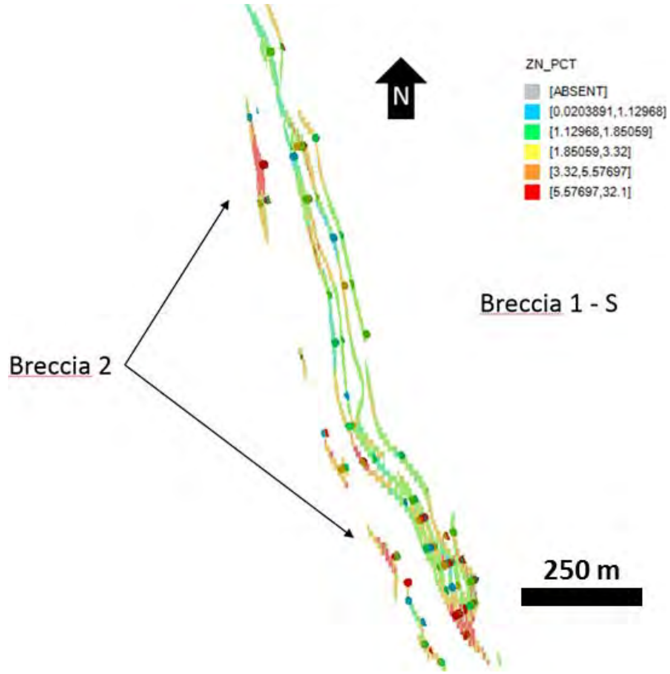
Note: Figure courtesy Votorantim, 2017.

Figure 14-20: Visual Validation Northern Area Zinc Grades (plan view)



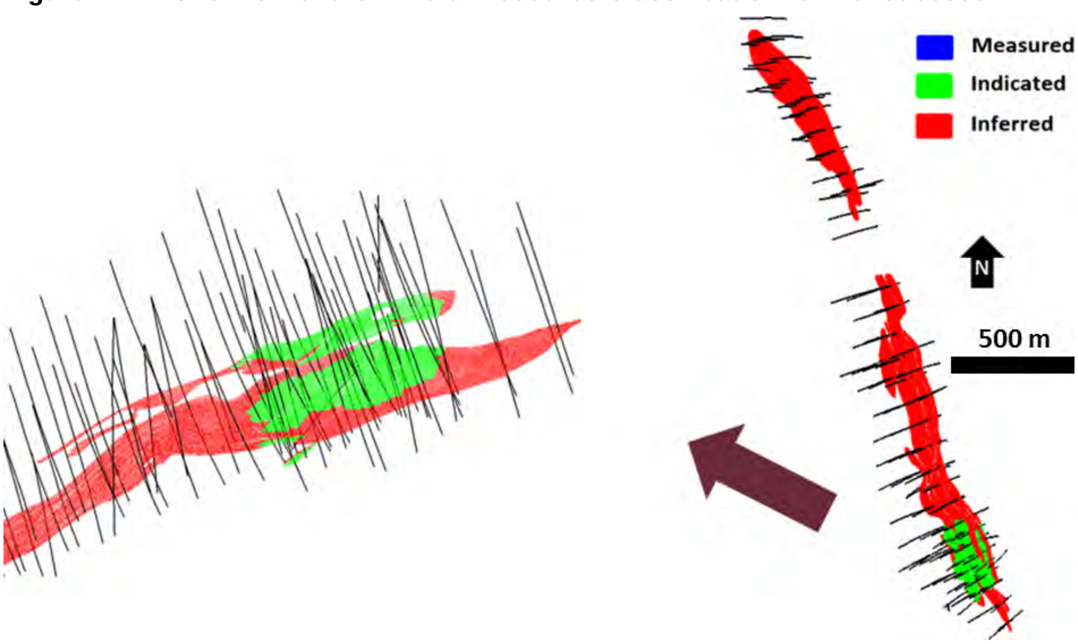
Note: Figure courtesy Votorantim, 2017.

Figure 14-21: Visual Validation, Southern Area Zinc Grades (plan view)



Note: Figure courtesy Votorantim, 2017.

Figure 14-22: Overview of the Mineral Resource Classification for Bonsucesso



Note: Figure courtesy Votorantim, 2017. Note: scale applies to right portion of the figure, left portion is a perspective view looking towards the northeast.

14.5.11 Reasonable Prospects of Eventual Economic Extraction

Mineral Resources were tabulated based on an NSR cut-off of US$46.73/t. This cut-off reflects the all-in cost and is based on average forecast price of zinc and lead over the next 10 years plus a 15% uplift. The NSR calculation was:

- If Zn(%)>=0.23, NSR = 23.0761 * Zn(%)
- If Pb(%)>=0.13, NSR = 10.6738 * Pb(%)
- If NSR > = 46.73 (cut-off), NSR = 3.96 (agricultural lime contribution; see Section 24.1).

The NSR calculations include an allocation in US$/t for the zinc premium that is paid by the Tres Marias smelter, which is the average of the 2017–2026 assumed payable premiums. The average value is US$234.72/t.

Other assumptions included:

- Underground mining methods
- Zinc price used is US$2,767.00/t (US$1.26/lb), lead price is US$2,235/t (US$1.01/lb)
- Zinc metallurgical recovery is 91%, lead metallurgical recovery is 70%
- Mining cost applied is US$15.87/t, plant cost applied is US$11.88/t, maintenance and other costs are US$18.98/t.

No mineralization modeled outside the breccia unit was included in the Bonsucesso resource estimate.

14.6 Mineral Resource Statement

The Mineral Resources were initially classified using the 2012 Joint Ore Reserves Committee (JORC) Code, and reconciled to the 2014 CIM Definition Standards.

Mineral Resource statements have variable effective dates. The Qualified Person for the estimate is Mr Douglas Reid, P. Eng., an Amec Foster Wheeler employee.

14.6.1 Morro Agudo Mine

Mineral Resources for the Morro Agudo Mine are summarized in Table 14-16. All Mineral Resources at the Morro Agudo Mine are assumed to be extracted via underground mining methods.

Table 14-16: Mineral Resource Statement, Morro Agudo Mine

	Tonnage (Mt)	Zn Grade (%)	Pb Grade (%)
Measured	0.00	0.00	0.00
Indicated	3.92	4.01	1.45
Total Measured + Indicated	*3.92*	*4.01*	*1.45*
Inferred	1.30	4.01	1.13

Notes to accompany Mineral Resource table for the Morro Agudo Mine:

1. Mineral Resources have an effective date of 31 December, 2016; Douglas Reid, P.Eng., an Amec Foster Wheeler employee, is the Qualified Person responsible for the Mineral Resource estimate.
2. Mineral Resources are reported within a 2.3% Zn+Pb envelope using a NSR cut-off of US$44.96/t.
3. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.
4. Zinc price used is US$2,767/t (US$1.26/lb), lead price is US$2,235/t (US$1.01/lb). Zinc metallurgical recovery is 91%, lead metallurgical recovery is 83%. Assumed mining cost of US$11.31/t, plant cost of US$11.88/t, maintenance and other costs of US$21.77/t. The NSR calculations include an allocation of US$234.72/t for the zinc premium paid by the Tres Marias smelter.
5. Reported Mineral Resources contain allowances for internal dilution. Mineral Resources are reported on a 100% basis.
6. Zinc and lead grade measurements are reported as percent, tonnage measurements are in metric units. Tonnages are reported as metric tonnes rounded to ten thousand tonnes; all grades are rounded to two decimal places
7. Rounding as required by reporting guidelines may result in apparent summation differences.

14.6.2 Ambrosia Sul (Ambrosia Trend)

Mineral Resources for the Ambrosia Sul deposit are provided in Table 14-17, assuming open pit mining methods, in Table 14-18 assuming underground methods, and a combined open pit and underground estimate is included in Table 14-19. Note that Table 14-17 is not additive to Table 14-19, and Table 14-18 is not additive to Table 14-19.

14.6.3 Ambrosia Norte (Ambrosia Trend)

Mineral Resources for the Ambrosia Norte deposit are provided in Table 14-20. All Mineral Resources at Ambrosia Norte are assumed to be extracted via underground mining methods.

14.6.4 Bonsucesso

Mineral Resources for the Bonsucesso deposit are provided in Table 14-21. All Mineral Resources at Bonsucesso are assumed to be extracted via underground mining methods.

Table 14-17: Mineral Resources Amenable to Open Pit Mining, Ambrosia Sul

	Tonnage (Mt)	Zn Grade (%)	Pb Grade (%)
Measured	0.45	7.42	0.26
Indicated	0.15	7.40	0.39
Total Measured + Indicated	*0.60*	*7.42*	*0.30*
Inferred	0.16	4.93	0.16

Notes to accompany Mineral Resource table assuming open pit mining methods for Ambrosia Sul:

1. Mineral Resources have an effective date of 24 October 2016; Douglas Reid, P.Eng., an Amec Foster Wheeler employee, is the Qualified Person responsible for the Mineral Resource estimate.
2. Mineral Resources are reported within a 1% Zn+Pb envelope using a NSR cut-off of US$32.13/t within a pit shell.
3. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.
4. Zinc price used is US$2,767/t (US$1.26/lb), lead price is US$2,235/t (US$1.01/lb). Zinc metallurgical recovery is 91%, lead metallurgical recovery is 40%. Assumed open pit mining cost of US$5.95/t, plant cost of US$11.88/t, maintenance and other costs of US$14.30/t. The NSR calculations include an allocation of US$234.72/t for the zinc premium paid by the Tres Marias smelter.
5. Reported Mineral Resources contain allowances for internal dilution. Mineral Resources are reported on a 100% basis.
6. Zinc and lead grade measurements are reported as percent, tonnage measurements are in metric units. Tonnages are reported as metric tonnes rounded to ten thousand tonnes; all grades are rounded to two decimal places.
7. Rounding as required by reporting guidelines may result in apparent summation differences.
8. Mineral Resources in this table are not additive to the Mineral Resources in Table 14-19.

Table 14-18: Mineral Resources Amenable to Underground Mining, Ambrosia Sul

	Tonnage (Mt)	Zn Grade (%)	Pb Grade (%)
Measured	0.11	4.33	0.09
Indicated	0.12	5.67	0.22
Measured + Indicated	*0.23*	*5.03*	*0.16*
Inferred	1.16	3.96	0.09

Notes to accompany Mineral Resource table assuming underground mining methods for Ambrosia Sul:

1. Mineral Resources have an effective date of 24 October, 2016; Douglas Reid, P.Eng., an Amec Foster Wheeler employee, is the Qualified Person responsible for the Mineral Resource estimate.
2. Mineral Resources are reported within a 1% Zn+Pb envelope using a NSR cut-off of $46.73/t outside of a pit shell
3. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.
4. Zinc price used is US$2,767/t (US$1.26/lb), lead price is US$2,235/t (US$1.01/lb). Zinc metallurgical recovery is 91%, lead metallurgical recovery is 40%. Assumed underground mining cost of US$15.87/t, plant cost of US$11.88/t, maintenance and other costs of US$18.98/t. The NSR calculations include an allocation of US$234.72/t for the zinc premium paid by the Tres Marias smelter.
5. Reported Mineral Resources contain allowances for internal dilution. Mineral Resources are reported on a 100% basis.
6. Zinc and lead grade measurements are reported as percent, tonnage measurements are in metric units. Tonnages are reported as metric tonnes rounded to ten thousand tonnes; all grades are rounded to two decimal places
7. Rounding as required by reporting guidelines may result in apparent summation differences.
8. Mineral Resources in this table are not additive to the Mineral Resources in Table 14-19.

Table 14-19: Mineral Resource Statement, Ambrosia Sul

	Tonnage (Mt)	Zn Grade (%)	Pb Grade (%)
Measured	0.56	6.83	0.23
Indicated	0.27	6.65	0.32
Measured + Indicated	*0.83*	*6.77*	*0.26*
Inferred	1.32	4.08	0.10

Notes to accompany Mineral Resource Table for Ambrosia Sul:

1. Mineral Resources have an effective date of 24 October 2016; Douglas Reid, P.Eng., an Amec Foster Wheeler employee, is the Qualified Person responsible for the Mineral Resource estimate.
2. Mineral Resources are reported within a 1% Zn+Pb envelope using a NSR cut-off of US$32.13/t within a pit shell and using a NSR cut-off of US$46.73/t outside of a pit shell
3. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.
4. Zinc price used is US$2,767/t (US$1.26/lb), lead price is US$2,235/t (US$1.01/lb). Zinc metallurgical recovery is 91%, lead metallurgical recovery is 40%. Assumed underground mining cost of US$15.87/t, open pit mining cost of US$5.95/t, plant cost of US$11.88/t, maintenance and other costs for underground mining of US$18.98/t, and US$14.30/t for open pit maintenance and other costs. The NSR calculations include an allocation of US$234.72/t for the zinc premium paid by the Tres Marias smelter.
5. Reported Mineral Resources contain allowances for internal dilution. Mineral Resources are reported on a 100% basis.
6. Zinc and lead grade measurements are reported as percent, tonnage measurements are in metric units. Tonnages are reported as metric tonnes rounded to ten thousand tonnes; all grades are rounded to two decimal places
7. Rounding as required by reporting guidelines may result in apparent summation differences.
8. Mineral Resources in this table are not additive to the Mineral Resources in Table 14-17 and Table 14-18.

Table 14-20: Mineral Resource Statement, Ambrosia Norte

	Tonnage (Mt)	Zn Grade (%)	Pb Grade (%)
Measured	0.00	0.00	0.00
Indicated	0.00	0.00	0.00
Measured + Indicated	*0.00*	*0.00*	*0.00*
Inferred	2.16	3.85	0.50

Notes to accompany Mineral Resource Table for Ambrosia Norte:

1. Mineral Resources have an effective date of 14 April, 2016; Douglas Reid, P.Eng., an Amec Foster Wheeler employee, is the Qualified Person responsible for the Mineral Resource estimate.
2. Mineral Resources are reported within a 2.5% Zn+Pb envelope using a NSR cut-off of US$46.73/t.
3. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.
4. Zinc price used is US$2,767/t (US$1.26/lb), lead price is US$2,235/t (US$1.01/lb). Zinc metallurgical recovery is 91%, lead metallurgical recovery is 70%. Assumed underground mining cost of US$15.87/t, plant cost of US$11.88/t, maintenance and other costs of US$18.98/t.
5. Reported Mineral Resources contain allowances for internal dilution. Mienral Resources are reported on a 100% basis.
6. Zinc and lead grade measurements are reported as percent, tonnage measurements are in metric units. Tonnages are reported as metric tonnes rounded to ten thousand tonnes; all grades are rounded to two decimal places
7. Rounding as required by reporting guidelines may result in apparent summation differences.

Table 14-21: Mineral Resource Statement, Bonsucesso

	Tonnage (Mt)	Zn Grade (%)	Pb Grade (%)
Measured	0.00	0.00	0.00
Indicated	2.02	4.15	0.59
Measured + Indicated	2.02	4.15	0.59
Inferred	6.47	3.66	0.51

Notes to accompany Mineral Resource Table for Bonsucesso:

1. Mineral Resources have an effective date of 5 May, 2017; Douglas Reid, P.Eng., an Amec Foster Wheeler employee, is the Qualified Person responsible for the Mineral Resource estimate.
2. Mineral Resources are reported within a 1% Zn+Pb envelope using a NSR cut-off of US$46.73/t.
3. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.
4. Zinc price used is US$2,767/t (US$1.26/lb), lead price is US$2,235/t (US$1.01/lb). Zinc metallurgical recovery is 91%, lead metallurgical recovery is 70%. Assumed underground mining cost of US$15.87/t, plant cost of US$11.88/t, maintenance and other costs of US$18.98/t.
5. Reported Mineral Resources contain allowances for internal dilution. Mineral Resources are reported on a 100% basis.
6. Zinc and lead grade measurements are reported as percent, tonnage measurements are in metric units. Tonnages are reported as metric tonnes rounded to ten thousand tonnes; all grades are rounded to two decimal places
7. Rounding as required by reporting guidelines may result in apparent summation differences.

14.7 Factors That May Affect the Mineral Resource Estimate

Factors that may affect the Mineral Resource estimates include:

- Additional infill and step out drilling
- Changes in local interpretations of mineralization geometry and continuity of mineralization zones
- Density and domain assignments
- Changes to design parameter assumptions that pertain to stope design
- Dilution from internal and contact sources
- Changes to geotechnical, hydrogeological, and metallurgical recovery assumptions
- Changes to the assumptions used to generate the NSR value including long-term commodity prices and exchange rates

14.8 Potentially Recoverable Pillars

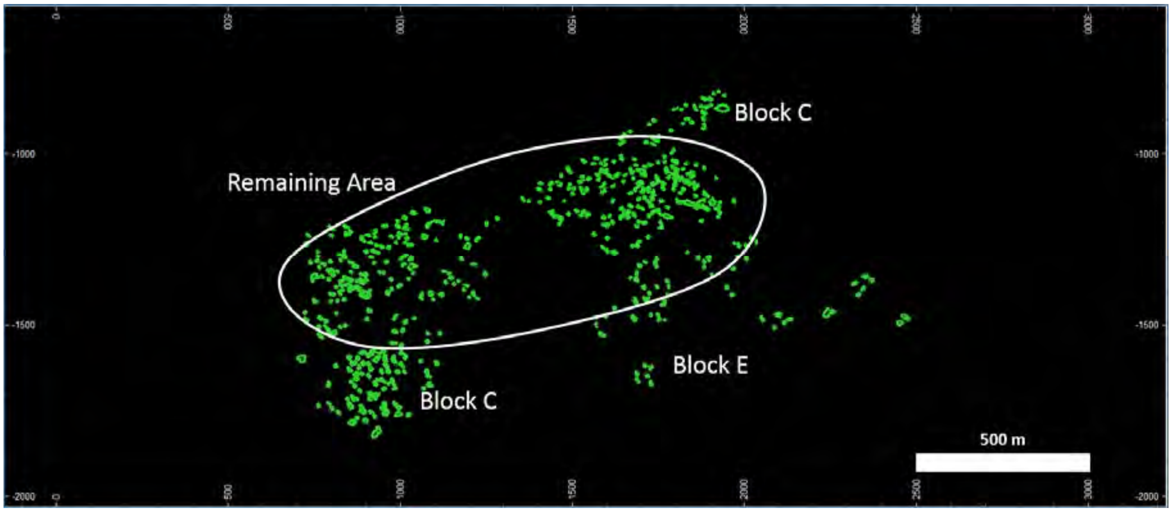
In the areas of former mining activity, the Morro Agudo Mine has remnant pillar material. A portion of these pillars retain mineralization that may be able to be recovered where geotechnical and safety conditions permit. This material represents a source of mill feed that could be mined during periods when the process plant is under utilized.

Votorantim performed a review of the available pillar data, and considers that mineralized pillars located within the Remaining Area domain (Figure 14-23) may be able to be extracted. A small number of mineralized pillars from Block C and Block E may also be able to be extracted.

Votorantim provided Amec Foster Wheeler with supporting data that included a list of all mineralized pillars, which were listed by level. Each pillar had been assigned a specific height, area, volume, and mass, using an approximated average SG of 2.73.

Votorantim also supplied a list of the pillars that would not be amenable to mining. The list of mineralized pillars considered amenable to mining was the result of subtracting the pillars that had to remain from the mineralized pillar total.

Figure 14-23: Area Where Pillar Material May Be Able to Be Recovered



Note: Figure prepared by Amec Foster Wheeler, 2017. White envelope shows general area of proposed pillar recovery.

The Morro Agudo Mine performed a pillar-recovery test mining program on pillar material from the 216 Level, with mining occurring from February–July, 2016, and October 2016–March 2017. During these programs a total of 39,600 t of pillar material, with an average grade of 2.47% Zn, and 0.90% Pb was recovered:

- The lowest average grade, of 1.99% Zn, was returned in February 2016, and the highest average grade, of 2.83% Zn in March, 2016. The overall average grade for the programs was 2.46% Zn.
- The lowest average grade, of 0.67% Pb was returned in June 2016, and the highest average grade of 1.33% Pb was returned in January 2017. The overall average grade for the program was 0.90% Pb.

Votorantim populated the mineralized pillars with zinc and lead grades. The zinc grade applied was the lowest monthly average grade in the test mining program of 2% Zn, and an assigned grade of 0.50% Pb was used.

The pillar material was not segregated in the process plant to provide actual recoveries. An assumed metallurgical recovery was assigned, based on the recoveries assigned to Morro Agudo Mineral Resources, whereby the zinc metallurgical recovery is 91%, and the lead metallurgical recovery is 83%.

Votorantim did not consider metal prices or cut-off grades in the pillar tabulations.

Amec Foster Wheeler reviewed the available information, and concurred that there were reasonable prospects for eventual economic extraction for the list of mineralized pillars considered amenable to mining because:

- All development is in place
- The test mining shows that a portion of material can be safely extracted
- There is a long history of processing of mill feed material from the Morro Agudo Mine through the process plant; the material surrounding the pillars has already been mined and processed
- The average pillar grades from the test mining to date are marginally higher, indicating a degree of conservatism in the pillar estimates. Amec Foster Wheeler notes that the areas in which the potentially recoverable pillars were situated were typically higher-grade than the material being currently mined.

Support for the potential pillar mineability was provided by Mr William Bagnell, P.Eng., who visited a section of the Remaining Area during a site visit to visually inspect current geotechnical ground conditions. Based on the inspection, and the trial mining results, Mr Bagnell considered that the mineralized pillars were potentially mineable.

The mineralized pillars were classified as Inferred Mineral Resources (Table 14-20).

Specific factors that may affect the Mineral Resources for the potentially recoverable pillars include the following:

- Ability to safely enter the mined-out areas
- Geotechnical assumptions
- Assumptions as to the pillar dimensions that can be extracted
- Assumptions as to mineralization grade
- Assumptions as to metallurgical recovery.

14.9 Agricultural Lime

A discussion of the agricultural lime is included in Section 24.1.

14.10 Comments on Section 14

Mineral Resources are reported in accordance with the 2014 CIM Definition Standards.

Table 14-22: Mineral Resource Statement, Potentially Recoverable Pillars

	Tonnage (Mt)	Zn Grade (%)	Pb Grade (%)
Inferred	0.84	2.0	0.5

Notes to accompany Mineral Resource Table for Pillar Material:

1. Mineral Resources have an effective date of 23 November, 2016; Douglas Reid, P.Eng., an Amec Foster Wheeler employee, is the Qualified Person responsible for the Mineral Resource estimate. Mineral Resources are reported on a 100% basis.
2. Mineral Resources within remnant mining pillars are tabulated by level, and have been had been assigned a specific height, area, volume, and mass, using an approximated average SG of 2.73. Grades were assigned based on the results on a trial mining program that ran from February–July 2016, and October 2016 to March, 2017 on material from the 216 Level of the mine.
3. Certain assumptions are based on the Morro Agudo Mine Mineral Resource estimate. Zinc price used is US$2,767/t (US$1.26/lb), lead price is US$2,235/t (US$1.01/lb). Zinc metallurgical recovery is 91%, lead metallurgical recovery is 83%. Development is in place in all areas of planned pillar recovery; plant cost of US$11.88/t, maintenance and other costs of US$21.77/t. The NSR calculations include an allocation of US$234.72/t for the zinc premium paid by the Tres Marias smelter.
4. Zinc and lead grade measurements are reported as percent, tonnage measurements are in metric units.
5. Rounding as required by reporting guidelines may result in apparent summation differences.

15.0 MINERAL RESERVE ESTIMATES

This section is not relevant to this Report.

16.0 MINING METHODS

16.1 Overview

A mine plan at PEA level has been developed for the Morro Agudo Project. The mine plan is partly based on Inferred Mineral Resources that are considered too speculative geologically to have the economic considerations applied to them that would enable them to be categorized as Mineral Reserves, and there is no certainty that the PEA based on these Mineral Resources will be realized. Calendar years used in the mine plan are for illustrative purposes.

The PEA is based on mill feed material to be sourced from the operating underground Morro Agudo Mine, the newly-developed open pit Ambrosia Sul Mine, and the Ambrosia Norte and Bonsucesso deposits that are assumed to be mined using underground mining methods. A subset of the Mineral Resources estimated in Section 14 is used in the mine plan. The PEA mine plan presented includes a full year of production in 2017; however, the PEA financial analysis commences 1 January, 2018.

16.2 Morro Agudo Mine

16.2.1 Mining Method Selection

The primary extraction method at the Morro Agudo Mine is inclined room-and-pillar (Figure 16-1). The deposit dips at approximately at 15–30° from the horizontal, and has a thickness varying between 2–5 m. In the QP's opinion, inclined room-and-pillar mining is the appropriate method for mining a deposit with this orientation and thickness.

The mineralized zones are accessed via a ramp system that is developed in the hanging wall of the deposit. Cross-cuts are then developed into the deposit to access the mineralized material. The ore drives are developed along the strike of the deposit, and stubs are developed to establish pillars and extract the mill feed material.

16.2.2 Geotechnical Considerations

Amec Foster Wheeler was provided with a series of documents and files by Votorantim and its consultants in support of a review of the major geotechnical considerations for the proposed mine plan, and existing conditions at the Morro Agudo Mine.

The Morro Agudo Mine is a mature operation, and staff have a well-developed understanding of the hydrogeology, geology, and mining methods required to safely extract the mineralization. Development and access profiles take advantage of the known hanging wall structural characteristics to minimise ground support requirements.

Figure 16-1: Schematic showing Inclined Room-and-Pillar Mining Method

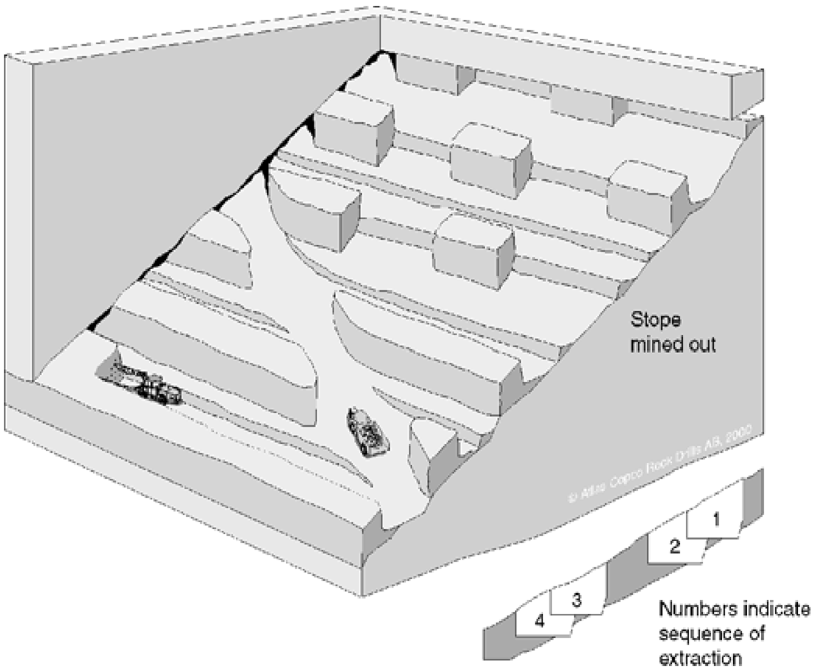


Figure from Atlas Copco Underground Mining Methods Handbook, date unknown.

The main lithological units have been described and modelled with sufficient detail to support geotechnical characterization and evaluation of geotechnical risks related to mining activities. Given the mining methods employed, rock mass conditions and mining depths, it is considered that the rock reinforcement and support types are suitable.

The main type of rock reinforcement and support observed during the underground tour of the Morro Agudo Mine is “no support, unsupported or self-supporting”. Bolting of openings is on an as-required basis. If support is used, it typically consists of resin grouted rebar (typically spot bolted and mesh only if required). Mesh/screen is rarely used; however, on occasions, weld wire mesh can be used where conditions require (typically high worker exposure areas).

Systematic automated instrumentation is installed at the Morro Agudo Mine to monitor convergence or closure monitoring together with displacement monitoring along identified structures. Instrumentation and monitoring will need to be extended as the mine progresses deeper.

The Ambrosia Sul open pit geotechnical conditions are generally satisfactory; however, these conditions reflect the fact that the open pit mine is in the very early stages of mining. Prism monitoring of the Ambrosia Sul open pit is in the initial stages.

A formal geotechnical input into the design and reconciliation process has not been established. Onsite geotechnical support appears to be focused on production/operational and safety requirements. Geotechnical input into the mining methods is provided primarily on an as-required basis by offsite sources (internal to Votorantim, or by third-party external consultants).

No formal check scaling program is in place for accessible underground excavations. Amec Foster Wheeler recommends that routine inspections and check scaling of all underground areas that are routinely accessed is performed on an annual basis, or more frequently where ground conditions warrant.

16.2.3 Backfill

Backfill is in limited use at Morro Agudo and is specified on an operational basis depending upon the deposit geometry.

Backfilling is used in rooms where the thickness of the mineralized material warrants the development of a second lift in that area to access additional material. The backfill material used is uncemented waste rock from development drift excavation.

16.2.4 Ventilation

The ventilation infrastructure to support operations underground at the Morro Agudo Mine is shown in Figure 16-2. The Morro Agudo ventilation infrastructure is essentially at the full extent of development and is not currently planned to have significant expansion going forward. Table 16-1 shows the current ventilation volumes required for underground operations support.

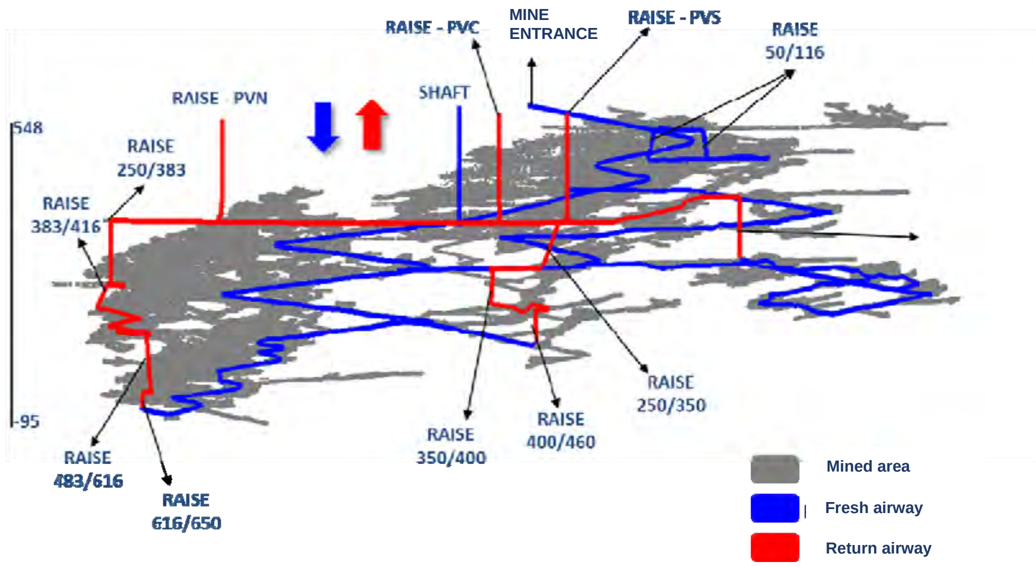
16.2.5 Access

Morro Agudo has two main access points (Figure 16-3):

- Mine portal (entrada da mina)
- Shaft

The primary mine access for material and personnel is the ramp via the portal. The shaft is used primarily for hoisting mill feed and waste material and can be used as an emergency egress if necessary.

Figure 16-2: Morro Agudo Mine Ventilation Network Schematic

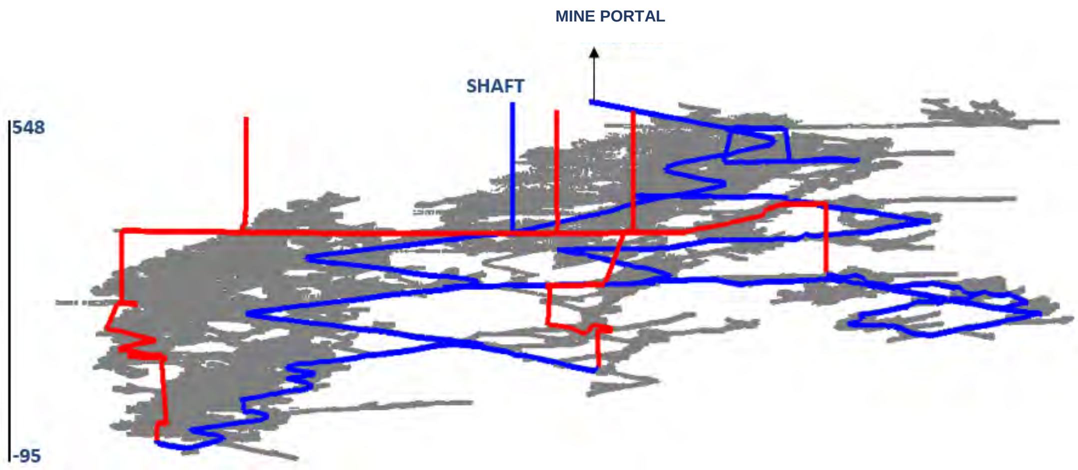


Note: Figure courtesy Votorantim, 2017.

Table 16-1: Mine Ventilation Quantities for Morro Agudo

Type	Name	Volume (m^3/s)	Area (m^2)	Velocity (m/s)
Fresh Air	Entrance	160	26.4	6
	Shaft – 150	34.8	12	2.9
	Shaft – 250	49	17.5	2.8
Return Air	Raise PVS	70	7	13
	Raise PVN	80	4.5	24.5
	Raise PVC	100	7	21.4

Figure 16-3: Morro Agudo Mine Access Points Schematic



Note: Figure courtesy Votorantim, 2017.

16.2.6 Hydrogeology

Water inflows into the Morro Agudo Mine are not a major source of water volume to the mine. The primary water volume is from process water associated with equipment operation and dust control applications.

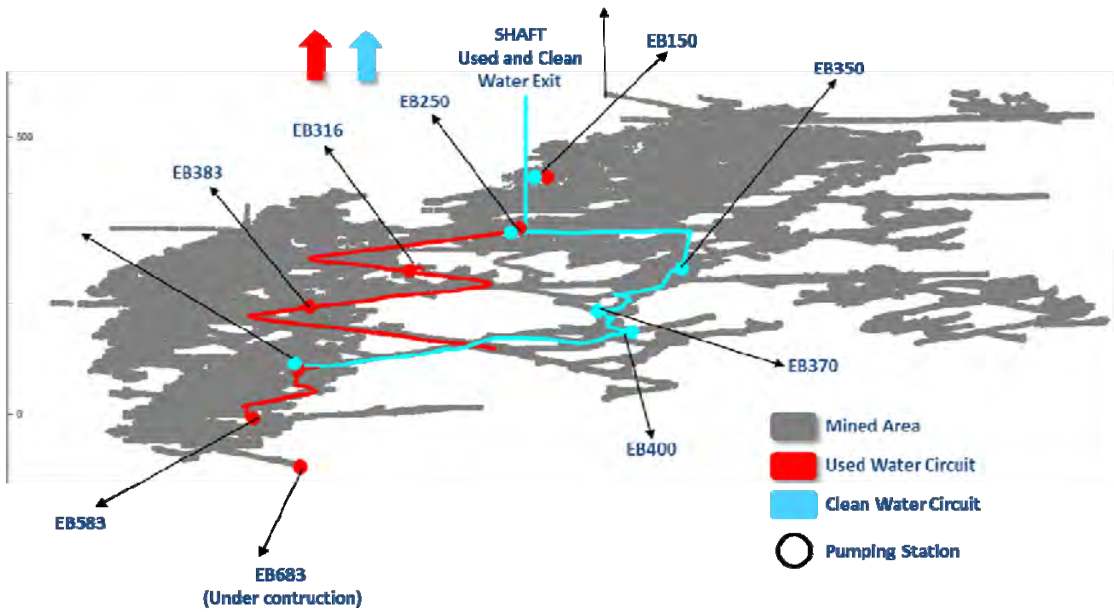
The shaft is the location of the primary dewatering lines for dirty water and the clean water source lines into the mine (Figure 16-4).

16.2.7 Power

Mine ventilation for the Morro Agudo Mine is designed in to comply with Brazilian NR 22 and is based upon whichever is the largest of the following criteria:

- Maximum number of equipment with diesel engines
- Explosives consumption in the mine
- Monthly production tonnages
- Number of mining fronts in operation.

Figure 16-4: Water Lines Schematic



Note: Figure courtesy Votorantim, 2017.

Electrical power has three main points of supply into the underground workings (Figure 16-5):

- Raise SUP/50
- Raise – PVS
- Shaft

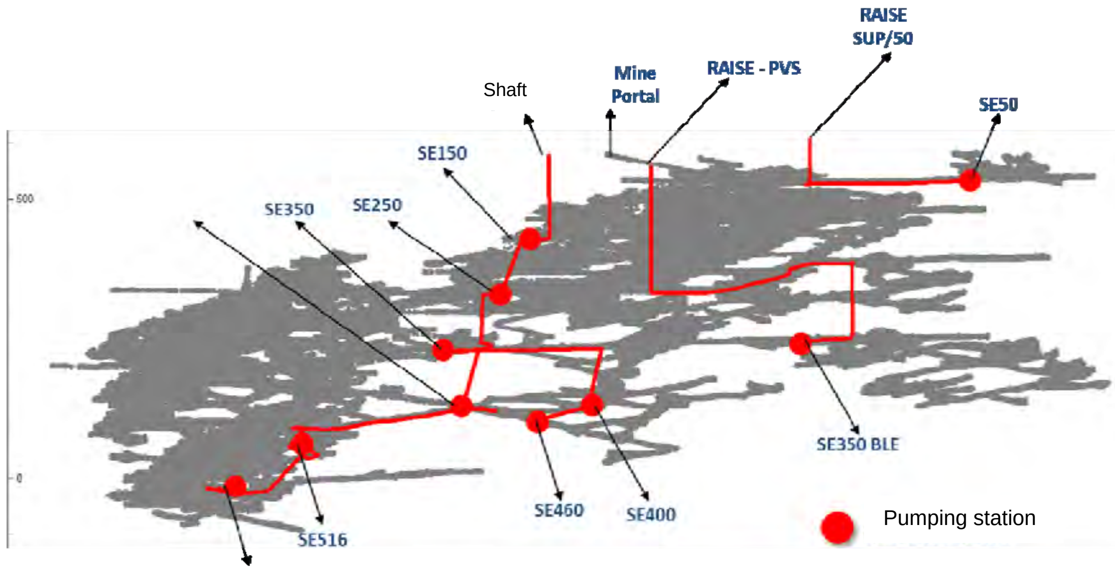
Power is supplied via 4160 V feeders to the underground substations. The substations then supply the mine equipment at 600 V. Mine substations are designed to support mine development equipment (jumbos, compressors) and infrastructure (dewatering pumps and ventilation fans).

16.2.8 Blasting and Explosives

Explosives and blasting accessories are contractor supplied to the Morro Agudo Mine. Explosives used underground are ANFO-based. The lack of significant underground water inflows permit the use of ANFO rather than water-resistant emulsion explosives.

Conventional pyrotechnic detonators are used for the development and production headings. The room and pillar mining method allows similar blasting patterns between waste and mineralized development.

Figure 16-5: Electrical Supply Schematic



Note: Figure courtesy Votorantim, 2017.

16.2.9 Grade Control

Grade control is accomplished using the block model, stope grades developed by the short-range planners, face calls, and production sampling.

Where feasible, production headings are scheduled to provide a uniform head grade to the mill. This may not always be possible as stope sequencing for production and ground control override the head grade requirement.

Production headings are planned by the short-range planning team to maintain the room and pillar layout while maximizing recovery. Dilution may vary in the active heading based upon mineralization thickness and the orientation of the mineralization relative to the heading.

Grade calls are made by geology on a daily basis based upon visual assessment of material in load–haul–dump (LHD) buckets and assessment of visible mineralization on the production face.

16.3 Ambrosia Norte and Bonsucesso

Unless otherwise specified in the text, assumptions presented in this sub-section for the Ambrosia Sul and Bonsucesso deposits are based on direct analogues with, and factoring from, the Morro Agudo Mine, or from Votorantim's Vazante Operations.

16.3.1 Mining Method Selection

The same mine planning assumptions were used for Ambrosia Norte and Bonsucesso. This envisages a bulk mining operation with two mining methods:

- Vertical retreat mining (VRM)
- Sub-level open stoping (SLOS).

A typical layout of vertical retreat and sub-level open stopes is shown in Figure 16-6. The planned minimum mining width is 4 m.

16.3.2 Backfill

Uncemented waste rock backfill will be employed to fill the VRM stopes to provide hanging wall support to reduce mining dilution. The backfill will also provide a mucking floor for the SLOS stopes during mining. It is assumed there will be sufficient waste rock material available from the mine development and surface waste dumps to supply backfill for the life of mine.

The anticipated amount of backfill required on an annual basis is shown in Table 16-2. Backfill requirements are based upon a void fill factor assumption of 65%.

16.3.3 Ventilation

The ventilation quantities planned for the proposed underground mines were benchmarked against existing operations at comparable mines operated by Votorantim in Brazil. The quantities were scaled based upon the annual production tonnage to provide a basis for design. A factor of 0.0004 m^3/t serves as the basis for the estimate. Table 16-3 provides the ventilation assumptions.

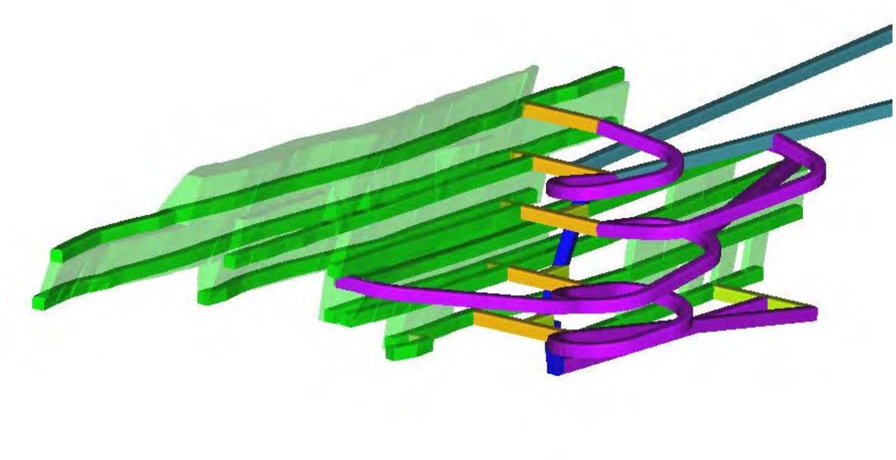
Subsequent design work at later study stages will refine the quantities and the timing of the installation of ventilation infrastructure to support the underground operations.

Underground distribution of the fresh air will be through a series of raises from surface and exhaust air will be returned to surface through the haulage ramp system (Figure 16-7).

16.3.4 Access

The proposed Ambrosia Norte/Bonsucesso underground mines will be accessed through a portal and ramp developed from surface. The ramp will be developed at a -14% nominal grade to provide access to the deposit for mining. Mine levels will be developed at nominal 30 m intervals to support the stoping extraction.

Figure 16-6: Schematic Showing Planned Stoping Arrangement for Ambrosia Norte/Bonsucesso



Note: Figure courtesy Votorantim, 2017. Access cross-cuts to the deposit are shown in yellow, extraction drives in teal and stopes in light green.

Table 16-2: Assumed Backfill Requirements (t x 1,000)

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Ambrosia Sul	—	—	46	155	129	50	22	—	—	—	—
Bonsucesso	—	—	—	—	329	415	472	488	482	448	263
Total	***—***	***—***	***46***	***155***	***457***	***465***	***493***	***488***	***482***	***448***	***263***

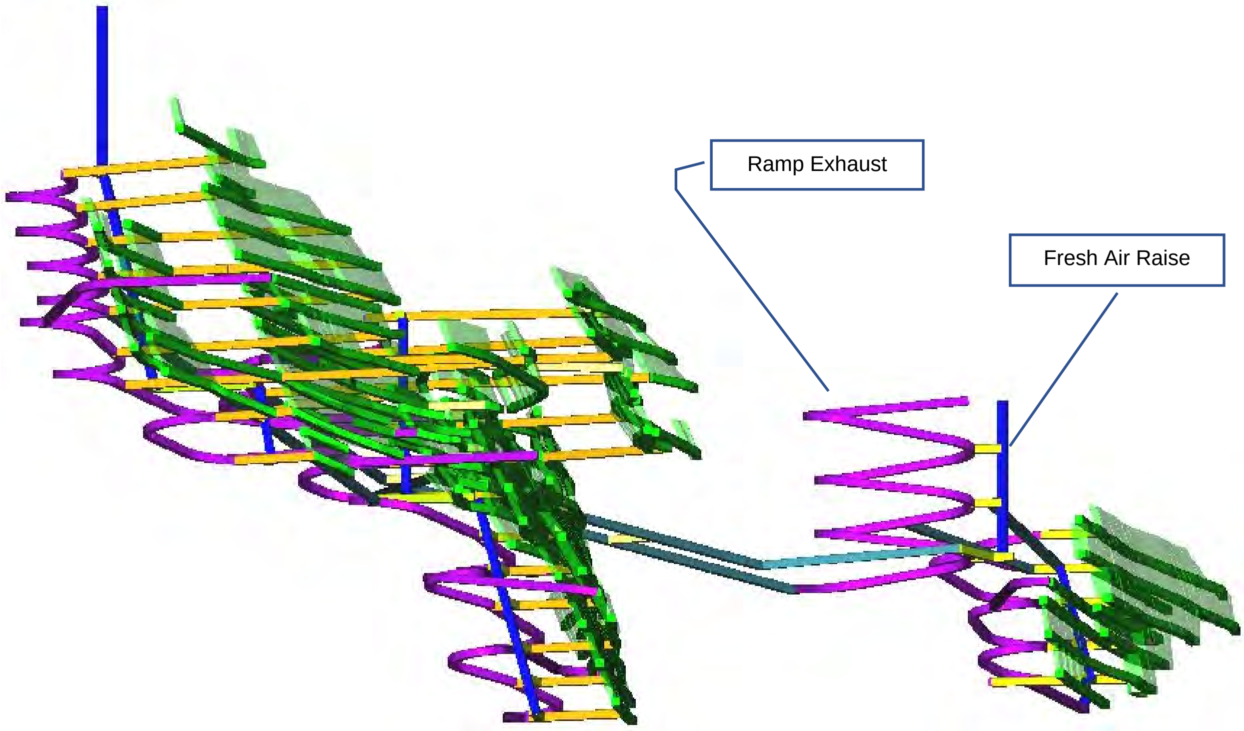
Note: Totals may not sum due to rounding. Calendar years used are for illustrative purposes.

Table 16-3: Ambrosia Norte/Bonsucesso Life of Mine Estimated Ventilation Quantities (m^3/s)

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Vent volume	—	—	28	95	282	286	304	301	297	276	162

Note: Calendar years used are for illustrative purposes.

Figure 16-7: Proposed Ventilation Schematic, Ambrosia Norte/Bonsucesso



Note: Figure courtesy Votorantim, 2017. Fresh air raises are shown in blue, exhaust air is shown in magenta.

16.3.5 Hydrogeology

By analogy with the Morro Agudo Mine, there is assumed to be negligible water inflows.

Dewatering infrastructure and water inflows have not been developed to a level of detail for the PEA study. These quantities and designs will be developed during subsequent study phases.

16.3.6 Power

It is assumed that the current 13.8 kV power supply to the Ambrosia Sul operations will be extended to support development at Ambrosia Norte and Bonsucesso. Bonsucesso will require an extension of the distribution network and an electrical substation.

16.4 PEA Underground Mine Operating Assumptions

Design assumptions within the PEA for each of the underground mines is provided in Table 16-4.

16.5 Ambrosia Sul Open Pit

The Ambrosia Sul open pit is approximately 35 km north of the Morro Agudo plant site. Production and waste rock from the Ambrosia Sul open pit is mined using contract mining equipment operated by Votorantim employees. Truck haulage to the Morro Agudo Mine is undertaken using contract haulage.

16.5.1 Design Considerations

The open pit has the following design parameters:

- Face angle: 85°
- Pit slope: 65°
- Minimum mining width: 8 m
- Bench height: 5 m
- Berm width: 3 m
- Berm interval: 10 m
- Ramp grade: 10 %
- Ramp width: 10 m.

The pit is planned to be developed in two phases. Phase 1 is the main longitudinal development and at completion, will be 673 m long, approx. 100 m wide and 75 m deep. Phase 2 will be a smaller sub-pit that is developed on the east side of the Phase 1 pit and will be 166 m long, 65 m wide and 90 m deep.

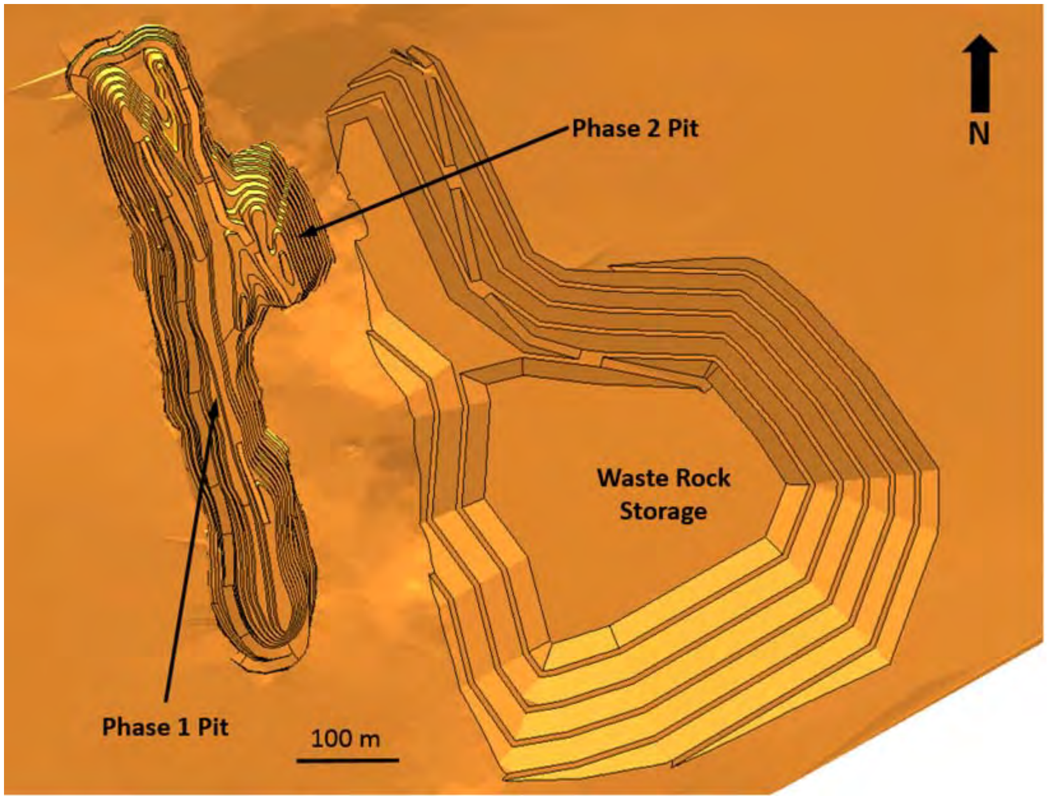
16.5.2 Pit Design

The final pit configuration was based upon a series of NPV runs that were completed so as to maximize the NPV, maximise the amount of mineralization that can be mined, and minimize waste rock extraction. The mineralized material is hosted in discrete structures within the Ambrosia Sul pit envelope. To ensure maximum resource recovery, the veins are planned to be fully extracted during mining and all mineralized material shipped to the Morro Agudo process plant. The final pit layout is presented in Figure 16-8.

Table 16-4: PEA Operating Assumptions for Underground

Category	Area	Design Item	Criteria
Operations	All	Days operating	365 d/a
		Days operating	7 days/week
		Hours operating	6 hours/shift
		Shifts per Day	4 shifts/day
Forecast Production Rate	Morro Agudo	Steady state production	1,100 t/d average
	Ambrosia Norte		350 t/d average
	Bonsucesso		1,750 t/d average
Extraction Percent	Morro Agudo	Room-and-pillar ratio	85% nominal
Ramp	Morro Agudo	Dimension	4.6 mW x 5.0 mH
		Gradient	± 14% nominal
	Ambrosia Norte/Bonsucesso	Dimension	5.0 mW x 5.0 mH
		Gradient	± 14% nominal
Haulage	Morro Agudo	Dimension	4.6 mW x 5.0 mH
		Gradient	± 3%
	Ambrosia Norte/Bonsucesso	Dimension	5.0 mW x 5.0 mH
		Gradient	± 14% nominal
Mining Room	Morro Agudo	Dimension	12 mW x 7 mH
		Gradient	± 3%
Cross-cuts	Morro Agudo	Dimension	4.5 mW x 4.5 mH
		Gradient	± 3%
	Ambrosia Norte/Bonsucesso	Dimension	5.0 mW x 5.0 m mH
		Gradient	± 14% nominal
Ore Drives	Morro Agudo	Dimension	4.5 mW x 5.0 mH
		Gradient	± 3%
	Ambrosia Norte/Bonsucesso	Dimension	5.0 m mW x 5.0 mH
		Gradient	± 3%

Figure 16-8: Final Pit Plan



Note: Figure courtesy Votorantim, 2017.

The selected optimum NPV case was case 54 (Figure 16-9). Subsequent cases provided only incremental gains in NPV and mineralized material, and substantially increased waste rock extraction.

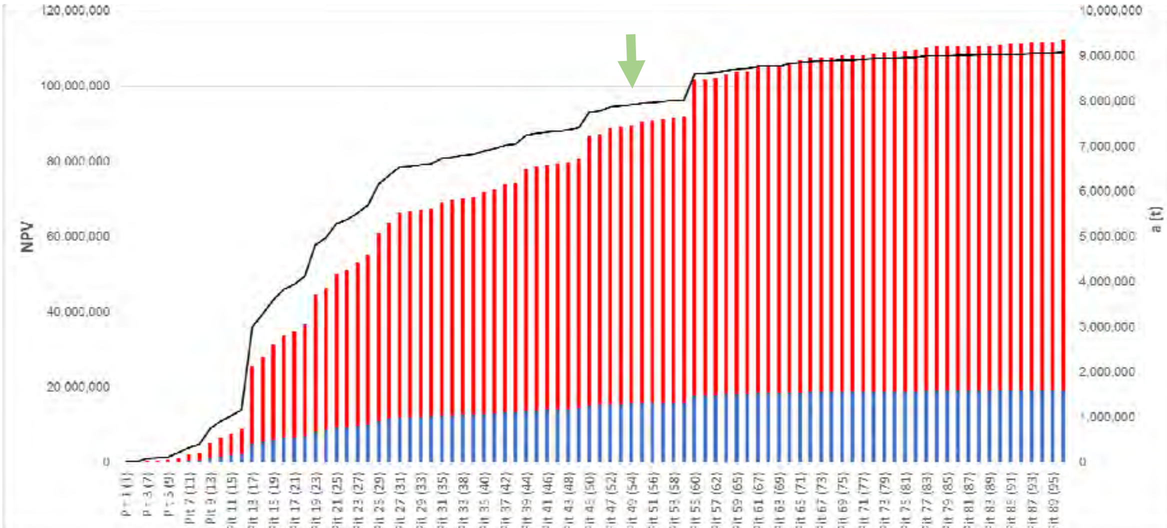
A minimum NSR value of $45.13/t is used as the operational cut-off grade, using the assumptions set out in Table 16-5.

The assumed production plan from the open pit is provided in Table 16-6. Over the open pit LOM, production will be a nominal 870 t/d on average.

16.5.3 Power

Electrical power is provided to the Ambrosia Sul Mine by CEMIG, a regional energy provider in Minas Gerais. CEMIG has a contract to supply the mine through an existing 13.8kV distribution network.

Figure 16-9: Pit Optimization NPV Runs



Note: Figure courtesy Votorantim, 2017.

Table 16-5: NSR Assumptions, Ambrosia Sul Open Pit

Contributor	Units	Unit Rate
Mine cost	US$/t	19.29
Plant costs	US$/t	11.54
Maintenance costs	US$/t	6.33
Other costs	US$/t	7.97
All-in-costs (AIC)	***US$/t***	***45.13***
Sustaining costs	US$/t	8.87
All-in-sustaining costs (AISC)	***US$/t***	***54.00***

Table 16-6: Ambrosia Sul Production Forecast

	Unit	2017	2018	2019	2020
Mill feed	t x 1,000	287	352	301	81
Waste	t x 1,000	2,554	2,535	1,126	90
	t/d nominal	787	964	825	898

Note: Calendar years used are for illustrative purposes. The PEA production shown includes a full year of production in 2017; however, the PEA financial analysis commences 1 January, 2018.

16.5.4 Grade Control

Grade control is accomplished through an integration of the block model, the bench grades developed by the short-range planners, in field calls on the muck pile grade, and production sampling.

Where feasible the production is scheduled to provide a uniform feed grade to the Morro Agudo mill through sequencing of the deposit lenses. Stockpile blending can be used to smooth the feed grade as the pit production is moved to ex-pit stockpiles before haulage to the process plant.

Grade calls are made by geology on a daily basis, based upon visual assessment of material in pit muck piles, loader buckets, and assessment of visible mineralisation on the pit bench faces.

16.6 Proposed Production Schedule

16.6.1 Production Schedule

The planned production schedule is shown in Table 16-7 and Figure 16-10, and uses a subset of the Mineral Resources estimated in Section 14.

Mining will be continuous until 2028, until the subset of the Mineral Resources for the four deposits in the PEA mine plan are depleted.

The LOM also contains 475,000 t of Inferred Mineral Resources associated with pillar recovery in previously mined-areas of the Morro Agudo Mine.

16.6.2 Mining Sequence

The mining sequence is shown in Table 16-8. The primary focus of the mining sequence is to maintain a steady flow of material to the Morro Agudo process plant at an average rate of 1,900 t/d. The pillar recovery material is from the Morro Agudo Mine and is sequenced on a retreat basis from the previously-mined areas.

16.7 Mining Equipment

16.7.1 Morro Agudo Mine

The Morro Agudo Mine is a fully trackless mine using diesel-powered mobile equipment for production and development activities. The mine fleet is appropriately sized to meet production targets for material movement and lateral advance.

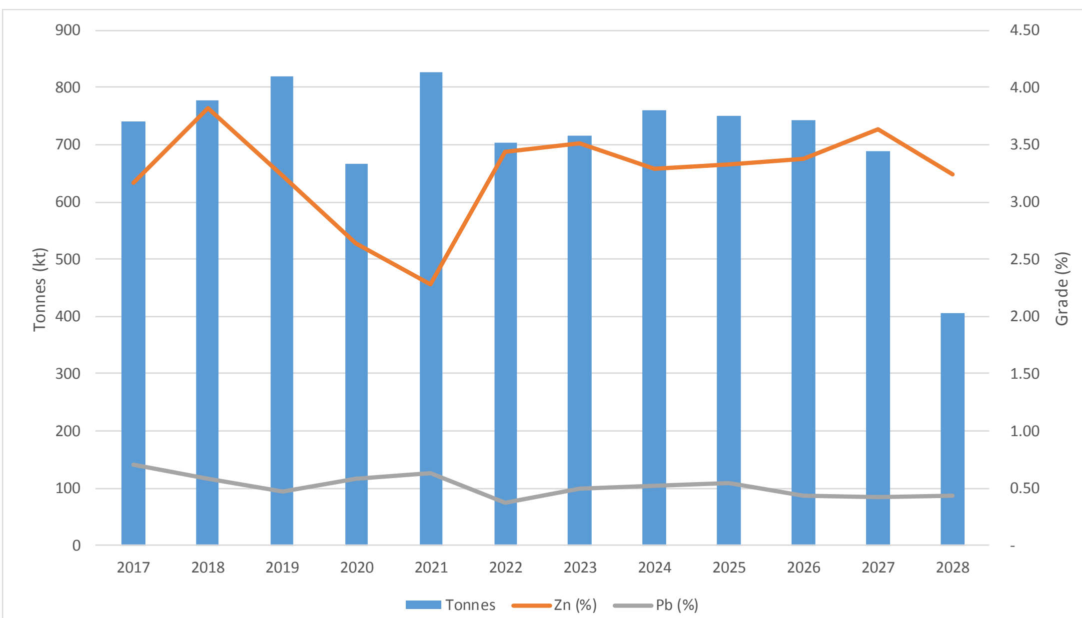
The mine haulage fleet is composed of articulated off highway trucks modified for usage underground. Each truck has a nominal load of 28 t. There are currently six trucks active in the haulage fleet.

Table 16-7: Life of Mine Production from Morro Agudo and Trend Operations

Period	Unit	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Measured													
Tonnes	kt	289	400	233	75	30	—	—	—	—	—	—	—
Zn	%	3.73	4.68	4.42	4.32	4.49	—	—	—	—	—	—	—
Pb	%	0.45	0.44	0.31	1.17	1.49	—	—	—	—	—	—	—
Indicated													
Tonnes	kt	214	148	147	125	158	406	324	38	283	285	140	—
Zn	%	3.24	3.23	3.80	3.75	3.19	3.43	3.63	3.02	3.50	3.41	3.35	—
Pb	%	0.69	0.73	0.63	0.56	0.99	0.42	0.48	0.44	0.60	0.48	0.47	—
Inferred													
Tonnes	kt	237	229	438	467	639	298	392	721	469	457	549	405
Zn	%	2.42	2.72	2.41	2.08	1.95	3.46	3.42	3.31	3.23	3.35	3.71	3.24
Pb	%	1.03	0.74	0.51	0.50	0.50	0.32	0.51	0.52	0.51	0.42	0.41	0.43

Note: Calendar years used are for illustrative purposes. Mineral Resources shown in this table are a subset of the Mineral Resources presented in Section 14. Note that the PEA mine plan shown includes a full year of production in 2017; however, the PEA financial analysis commences 1 January, 2018.

Figure 16-10: Proposed Life of Mine Tonnage and Metal Grades



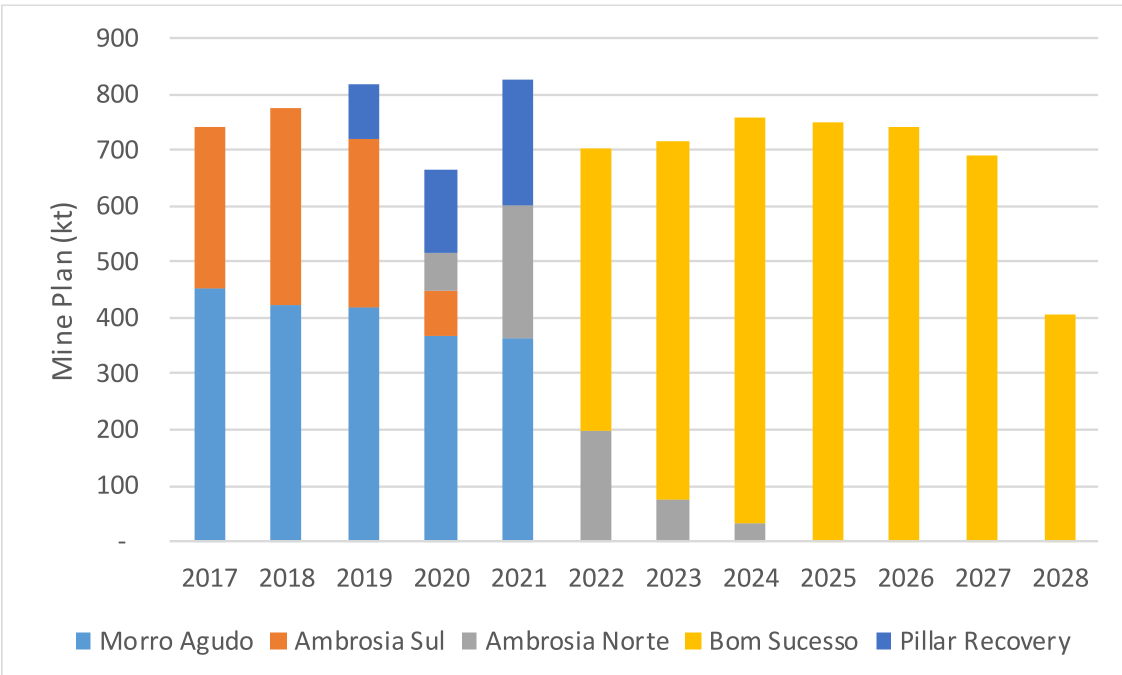
Note: Figure prepared by Amec Foster Wheeler, 2017. Calendar years used are for illustrative purposes. Mineral Resources shown in this figure are a subset of the Mineral Resources presented in Section 14. Note that the PEA mine plan shown includes a full year of production in 2017; however, the PEA financial analysis commences 1 January, 2018.

Table 16-8: Proposed Mining Sequence (t x 1,000)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Morro Agudo Mine	453	425	417	366	363	—	—	—	—	—	—	—
Pillar Recovery	—	—	100	150	225	—	—	—	—	—	—	—
Ambrosia Sul	287	352	301	81	-	—	—	—	—	—	—	—
Ambrosia Norte	—	—	—	70	239	198	77	33	—	—	—	—
Bonsucesso	—	—	—	—	—	506	638	725	751	742	689	405
Totals	***741***	***777***	***818***	***667***	***827***	***704***	***715***	***759***	***751***	***742***	***689***	***405***

Note: Calendar years used are for illustrative purposes. Mineral Resources shown in this table are a subset of the Mineral Resources presented in Section 14. Note that the PEA mine plan shown includes a full year of production in 2017; however, the PEA financial analysis commences 1 January, 2018.

Figure 16-11: Planned Life of Mine Tonnage Distribution by Deposit



Note: Figure prepared by Amec Foster Wheeler, 2017. Calendar years used are for illustrative purposes. Mineral Resources shown in this figure are a subset of the Mineral Resources presented in Section 14. Note that the PEA mine plan shown includes a full year of production in 2017; however, the PEA financial analysis commences 1 January, 2018.

Stope mucking is undertaken by a fleet of 6.4 m^3 load–haul–dump (LHD) units. Each unit has a nominal tramming capacity of 14 t of broken material. There are currently four LHD units in the mine fleet.

The full mine equipment fleet list is provided in Table 16-9 (includes primary production and development equipment and auxiliary support equipment).

16.7.2 Ambrosia Norte and Bonsucesso

The planned equipment fleet for the combined Ambrosia Norte/Bonsucesso operation is shown in Table 16-10.

16.7.3 Ambrosia Sul

The Ambrosia Sul open pit is supplied with a contract fleet of mine equipment. The primary haulage equipment is rigid body highway dump trucks with 48 t capacity. The primary loading equipment is 3.5 m^3 articulated loaders and 1.76 m^3 hydraulic excavators. The mining fleet and support equipment are shown in Table 16-11.

16.8 Comments on Section 16

Infrastructure requirements for Ambrosia Norte/Bonsucesso have been assessed at the PEA level to support underground mining. Additional levels of study with increasing detail will be required going forward.

The mining method selected for the Morro Agudo Mine is appropriate based upon the deposit geometry. The mining method proposed for Ambrosia Norte/Bonsucesso is appropriate based upon the current understanding of the deposit geometry.

Inferred Mineral Resources are included in the mine plan for all deposits in this Report.

Table 16-9: Morro Agudo Mine Equipment Production and Development Fleet

Equipment	Equipment Supplier	Equipment Model	Quantity
Boltec	Atlas Copco	LC -DH	1
Truck	VOLVO	A30F	6
Truck	Conventional	-	2
Pickup	Mitsubishi	L200 Triton	18
Truck	Mercedes	Atego 1726	1
Hydraulic Excavator	VOLVO	EC140BLC	1
Jumbo	Atlas Copco	Boomer 282S	2
Jumbo	Atlas Copco	L1 C	1
Jumbo	Atlas Copco	L1 DH	1
LHD	Atlas Copco	ST14	4
Motorgrader	VOLVO	g930	1
Scissor Lift	DUX	S1 - SLP 5000N	1
Scissor Lift	JCB	540-170	1
Retroexcavator	VOLVO	BL70	1
Scaler	DUX	SN1200	2
Scaler	Normet	Scamec 2000L	2
Scaler	Normet	Scamec 2000M	1
Total			***46***

Table 16-10: Ambrosia Norte/Bonsucesso Proposed Production and Development Equipment Fleet

Equipment	Equipment Supplier	Equipment Model	Quantity
Truck	VOLVO	A30	6
LHD	Caterpillar	R1600G	3
LHD	Caterpillar	R1700G	3
Scaler	DUX	9 meters	2
Boltec	Atlas Copco	Boltec SL	1
Motorgrader	VOLVO	Patrol	1
Jumbo	Atlas Copco	282	2
Simba	Atlas Copco	S7D	2
Scissor Lift	DUX	S1 - SLP 5000N	2
Anfo Loader	DUX	S1-AN/FO	2
Total			**24**

Table 16-11: Ambrosia Sul Primary Production Equipment Fleet

	Equipment	Equipment Supplier	Model	Quantity
Primary Production Fleet	Truck 6 x4	Mercedes Benz	4144	5
	Hydraulic excavator	John Deere	350-LC	2
	Wheel Loader	Volvo	L120F	1
	Wheel Loader	Caterpillar	950-H	1
	Bulldozer	Caterpillar	D6-T	1
	Motor grade	Komatsu	GD655	1
	Water truck 20,000 l	Mercedes Benz	3131	1
	Hydraulic excavator for breaker	Volvo	EC360	1
	Breaker 2,320kg	Bretec	L30	1
	Fuel service truck	Volkswagen	17-190	1
	Subtotal			*15*
Contractor Supplied Stand-by Equipment	Truck 6 x4	Mercedes Benz	4144	1
	Hydraulic excavator	Volvo	EC360	1
	Wheel Loader	Caterpillar	950H	1
	Bulldozer	Caterpillar	D6T	1
	Water truck 20,000l	Volkswagen	31-320	1
	Subtotal			*5*
Support Equipment Fleet	Pickup	Toyota	Hilux	1
	Mechanical horse truck	Mercedes Benz	2640	1
	Semi-trailer 03 axles	Pastre	3 axles	1
	Hydraulic drilling rig	Atlas Copco	Flexroc t40	3
	Subtotal			*6*
	Total			***26***

17.0 RECOVERY METHODS

17.1 Process Flow Sheet

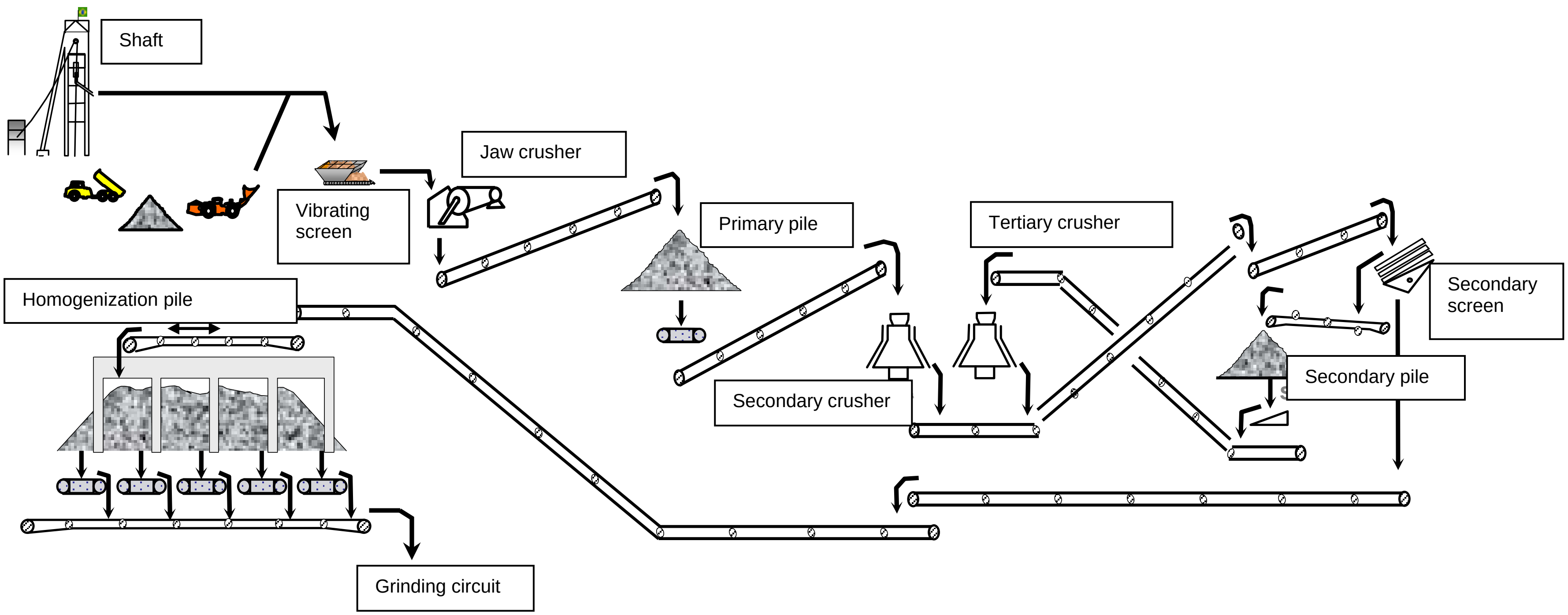
The Morro Agudo mill uses a conventional crushing, grinding and flotation circuit to produce separate lead and zinc sulphide concentrates.

The process flowsheet for the crushing circuit is shown in Figure 17-1. Mineralization is delivered by skip from the mine haulage shaft and stored in a silo ahead of the primary crusher. Mineralized material is withdrawn using a vibratory feeder to the single-axis Nordberg jaw crusher that operates in open circuit. The primary crusher capacity is 1.5 Mt/a but this is not fully utilized due to upstream and downstream constraints. The primary crusher discharge is conveyed to an intermediate stockpile and weighed using a continuous weighing scale. A fixed electromagnet removes metallic material to avoid equipment damage.

Primary crushed material is then processed in open circuit through the Nordberg HP 1352 hydro-cone secondary crusher. The secondary crusher discharge is classified on a double-deck vibrating screen (8 mm and 20 mm). The screen undersize is sent to a homogenizing stockpile, whereas the oversize is directed to the closed crushing circuit in the Metso / Nordberg HP400 hydro-cone tertiary crusher.

The undersize feeds a conveyor belt, which has a continuous weighing scale and automatic sampler. Crusher plant product is analyzed for particle size and zinc, lead and iron assays. The product size is 80% passing 7.2 mm and 100% passing 9.6 mm. Material is discharged to the tripper, which directs flow to the appropriate storage location according to sample content, for blending in the homogenization stack. This helps minimize feed variation to the process plant. The homogenization stockpile capacity is 14,000 t. Five belt feeders under the stockpile reclaim material into two silos ahead of the grinding circuit.

Figure 17-1: Process Flowsheet for Crushing Stage



Note: Figure courtesy Votorantim, 2017

Crushed and blended mineralized material is fed to two parallel grinding circuits, each consisting of one overflow ball mill in closed circuit with hydrocyclones for classification:

- Ball mill 1 is 13.6 ft diameter x 20 ft effective grinding length, has a 1,500 kW motor, is steel lined, and operates at 73% critical speed
- Ball mill 2 is 12 ft diameter x 18.3 ft effective grinding length, has a 900 kW motor, is steel and rubber lined, and operates at 72% critical speed.

Each ball mill is filled to approximately 38% charge with 63.5 mm (2½ ") diameter steel balls.

The Mill 1 circuit includes a battery of 12 Krebs model D10LB 10” cyclones, of which normally nine operate. The circulation rate is approximately 700% of the fresh feed of the mill. The Mill 2 circuit includes a battery of eight Krebs model 8xD10Gmax3061 10” cyclones, of which normally four operate. The circulation rate is approximately 400% of the fresh feed of the mill. Water is added to dilute each cyclone feed, and the resulting cyclone overflow is 40–42% solids. The resulting combined grinding circuit product produces a flotation feed with 65% passing 44 µm (325 mesh) or 80% passing 74 µm. Mill 1 has a capacity of approximately 750,000 t/a and Mill 2 approximately 400,000 t/a of mineralized material.

The lead flotation circuit follows grinding. The pulp is conditioned with sodium amyl xanthate collector to render galena hydrophobic. Most of the galena in feed is recovered in a rougher flotation column cell. The rougher column tails are sent to the scavenger stage, which uses six conventional mechanical flotation cells. The scavenger concentrate is returned to the rougher column feed. Rougher concentrate is treated in a two-stage cleaner circuit. The first cleaner stage is a single flotation column, with first cleaner concentrate reporting to a second cleaner (recleaner) column, that was installed in 2017. Both the first and second cleaner tailings report back to rougher concentrate feed. Previously in 2016, an Eriez stack cell had been installed into the second cleaner duty. The stack cell is currently being tested for alternative duties.

Overall, the lead flotation circuit recovers approximately 80% of the lead in mill feed, at a final lead concentrate grade of approximately 50%. A key objective of the lead flotation circuit is to limit how much lead reports to the zinc concentrate while minimizing zinc losses into the lead concentrate.

Lead scavenger tails are directed to the zinc flotation circuit, where they are mixed in a conditioning tank with copper sulphate (activator) and sodium amyl xanthate (collector). Sphalerite is then recovered in the zinc rougher column cell, with rougher column tails reporting to a bank of eight conventional zinc rougher scavenger cells together with additional copper sulphate and xanthate. Zinc rougher scavenger concentrate is returned to the zinc rougher feed. Zinc rougher concentrate is pumped to the zinc first cleaner column. First cleaner concentrate is directed to a zinc second cleaner, consisting of three conventional flotation cells, which produces the final zinc concentrate. Second cleaner tailings are returned to the zinc first cleaner feed. First cleaner tailings are directed to the zinc cleaner scavenger feed, which consists of two conventional cell banks with a total of four cells. Zinc cleaner scavenger concentrate reports to the zinc first cleaner, while the tailings are sent to the zinc rougher scavenger. The zinc rougher scavenger tailings form the final tailings from the plant. Final zinc concentrate grade is 38–40% zinc with a zinc recovery of approximately 90%.

A zinc regrind mill is available to treat a portion of zinc scavenger concentrate, but this is not currently utilized and is not included in the PEA LOMP.

The milling and flotation flowsheet is shown in Figure 17-2.

17.2 Plant Design

The Morro Agudo plant design has developed since 2003 with a number of debottlenecking and improvement projects. In 2003, mill 2 was installed, increasing the capacity of the plant from approximately 750,000 t/a capacity to 1,150,000 t/a. Flotation columns were installed in the lead and zinc circuit that year. Additional flotation cells were installed to increase lead recovery. In 2016, the Eriez Stack Cell was installed as the lead second cleaner.

Process equipment and design criteria information is shown in Table 17-1.

The plant capacity is significantly in excess of the tonnages to be treated in the PEA LOMP.

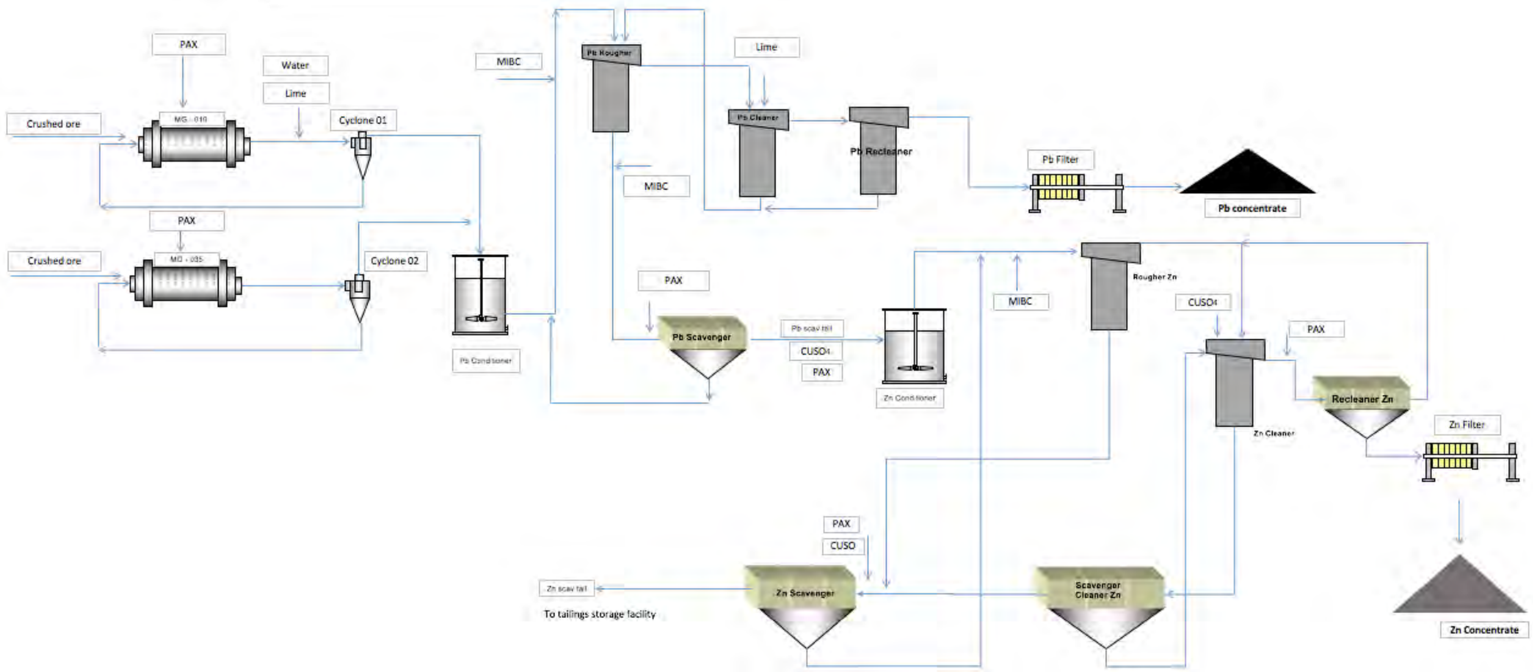
17.3 Product/Materials Handling

The final lead and zinc concentrates are sent to respective vertically mounted plate and frame pressure filters to target moisture contents of 8.5% and 11% respectively. Concentrates are separately held in the concentrate storage yard, then are loaded onto truck by wheel loaders. Zinc concentrate is transported to Votorantim's Tres Marias zinc smelter.

Lead concentrate is packaged in bulk bags and exported to international customers via the Port of Itaguai.

Tailings from the zinc flotation circuit are placed in the tailings storage facility (TSF) and are decanted, dewatered, and reclaimed for sale as a limestone soil amelioration product to local farmers. This is described further in Section 24.

Figure 17-2: Milling and Flotation Flowsheet



Note: Figure courtesy Votorantim, 2017.

Table 17-1: Key Process Equipment

Parameter	Unit	Value
Primary crusher type		Nordberg, jaw
Secondary crusher		Nordberg, cone
Secondary screen type		Double-deck vibrating sieve
Secondary screen aperture - top deck	mm	20
Secondary screen aperture - bottom deck	mm	8
Tertiary crusher type		Nordberg, cone
Tertiary crusher power	kW	298
Homogenization crushed ore stockpile capacity	t	14,000
Vibrating feeders - number of		5
Crusher circuit product size, p100	mm	9.6
Crusher circuit product size, p80	mm	7.2
Crusher plant capacity	t/h	185
Mill 1 throughput capacity	t/h	90
Mill 2 throughput capacity	t/h	50
Ball mill 1 power	kW	1,500
Ball mill 2 power	kW	900
Ball mill 1 diameter and effective grinding length	m	4.1 x 6.1
Ball mill 2 diameter and effective grinding length	m	3.7 x 5.6
Grinding hydrocyclone diameter	mm	250
Grinding circuit product size p80	µm	74
Lead rougher cell type		Column
Lead rougher residence time	min	12
Lead 1st cleaner cell type		Column
Lead 1st cleaner residence time	min	11
Lead 2nd cleaner cell type		1 x Eriez Stack Cell
Lead scavenger cell type		6 x conventional mechanical
Zinc rougher cell type		Column
Zinc rougher residence time	min	71
Zinc 1st cleaner cell type		Column
Zinc 1st cleaner residence time	min	11
Zinc 2nd cleaner cell type		3 x conventional mechanical
Zinc scavenger cell type		8 x conventional mechanical
Zinc cleaner scavenger cell type		4 x conventional mechanical
Nominal lead recovery	%	80%
Nominal zinc recovery	%	90%
Lead concentrate grade	% Pb	50%

Parameter	Unit	Value
Zinc concentrate grade	% Zn	40%
Lead concentrate filter capacity	t/h	2.5
Zinc concentrate filter capacity	t/h	6.5
Lead concentrate moisture	%	8.5%
Zinc concentrate moisture	%	11%

17.4 Energy, Water, and Process Materials Requirements

The Morro Agudo process plant uses approximately 2.5 m^3/t of process water grinding and flotation, but most of this is recycled from tailings water reclaim. Water is obtained from water storage reservoirs I and II. Most process water exits the mill in tailings, which are decanted for water recovery and recycle to water storage reservoirs I and II. Mill make up water comes from site precipitation and catchment into the tailings storage facilities.

Table 17-2 shows the 2015 and 2016 actual and LOM forecast consumption rates for grinding media and flotation reagents.

17.5 Smelter

Zinc concentrates are trucked in bulk approximately 220 km to Tres Marias. The smelter process concentrates from silicate concentrates from Votorantim's Vazante Operations, sulphide concentrates from Morro Agudo and sulphide concentrates from external parties in a ratio of approximately 70%:13%:17%.

The concentrates from the Morro Agudo and Ambrosia Sul Mines are repulsed and leached to dissolve dolomite in concentrate and precipitate gypsum and dissolve magnesium. The sphalerite is then refloated, and blended with external concentrates before roasting. Roasting produces zinc calcine, which is leached, and sulphur dioxide, which is converted into sulphuric acid. Sulphuric acid is used in the leaching process, both to leach carbonates and zinc-bearing species in calcines and concentrates.

Zinc-bearing zinc solution is purified by precipitating iron and gypsum, and using cementation to remove cadmium and copper. Zinc is recovered from purified solution by electrolysis.

Table 17-2: Grinding Media and Flotation Reagent Usages and Forecast

Item	Description	Units	2015	2016	LOM Forecast
60 mm steel balls	Ball mill grinding media	g/t	282	300	382
MIBC	Frother	g/t	26	28	28
Potassium amyl xanthate	Galena and sphalerite collector	g/t	147	192	221
Sodium isopropyl xanthate	Galena collector	g/t	11	1	0
Lime	pH modifier	g/t	1,212	1,245	1,246
Copper sulphate	Sphalerite activator	g/t	87	89	90

The silicate and sulphide circuits in Tres Marias are integrated, with leached solution from the silicate concentrate being mixed into the neutral leaching stage of the sulphide circuit. The concentrates from the Morro Agudo and Ambrosia Sul Mines, and the proposed Morro Agudo Project concentrates, are important for the viability of Tres Marias, as they provide a local and accessible source of sulphide concentrates with low iron, which can be fed in ratio with the Vazante silicate concentrates. This helps produce sufficient sulphuric acid and leach solutions in appropriate ratios to optimize smelter production and economics.

17.6 Comments on Section 17

The Morro Agudo process plant uses a conventional crushing, grinding and flotation circuit, and a conventional lead-zinc circuit reagent scheme to recover lead and zinc concentrates. The Morro Agudo process plant may slightly modify the flowsheet and equipment from time to time, in response to short-term economics and operational needs.

Mill feed is shifting from being sourced solely from the Morro Agudo Mine, to being sourced from a blend of Morro Agudo and satellite mines. Overall throughput rate is dropping below historical tonnage rates, and there are no issues expected with mill capacity.

Power, grinding media and reagent consumables are expected to continue at similar rates per unit mill feed processed.

The Morro Agudo Mine provides, and the Morro Agudo Project will provide an important source of sulphide concentrates that can be treated in ratio with Vazante Operations concentrates to support the economic operation of the Tres Marias smelter.

18.0 PROJECT INFRASTRUCTURE

18.1 Introduction

A site infrastructure image for the Morro Agudo Mine is presented in Figure 18-1. Figure 18-2 shows the infrastructure in place at Ambrosia Sul.

18.2 Road and Logistics

The Morro Agudo Mine is situated about 45 km south of the municipality of Paracatu, whereas the Ambrosia Trend deposits are located about 15 km northeast of Paracatu. Access to the operating sites is via a mix of sealed and unsealed roads. Access within the mineral concessions outside the mining areas is typically over unsealed roads.

The closest commercial airport is in Brasilia. Smaller regional airports are available at Paracatu, Patos de Minas, and Vazante.

Zinc and lead concentrates are trucked about 220 km to the Tres Marias Smelter and 970 km to the Port of Itaguai respectively.

The main supplies for the mine are sourced from either Paracatu or Belo Horizonte.

Internal roadways connect the Morro Agudo Mine and Ambrosia Sul mine components including:

- Underground mine access portal and shaft
- Open pit
- Process plant
- Waste storage facilities
- Tailings storage facilities
- Main offices, administration, and camp.

Internal roadways are also planned for the proposed Ambrosia Norte and Bonsucesso mine, and infrastructure will include:

- Underground mine access portal
- Satellite offices for mining personnel
- Waste storage facility.

18.3 Stockpiles

Stockpiles are discussed in Section 20.4.

Figure 18-1: Project Layout Plan, Morro Agudo Mine Area

Figure from Google Earth, 2017. Satellite backdrop dated 2015.

Figure 18-2: Project Layout Plan, Ambrosia Sul Mine Area

Figure courtesy Votorantim, 2017. Figure is an inclined view taken by a drone. As a scale indicator, the waste rock facility is about 250 m from the southern end of the initial open pit development.

18.4 Waste Rock Storage Facilities

Waste storage facilities are discussed in Section 20.5.

18.5 Tailings Storage Facilities

Tailings storage facilities are discussed in Section 20.6.

18.6 Water Management

Water management is discussed in Section 20.7.

18.7 Built Infrastructure

All infrastructure required for the current mining and processing operations at the Morro Agudo Mine has been constructed and is operational. This includes the underground mine, access roads, powerlines, water pipelines, offices and warehouses, process plant/concentrator, conveyor systems, waste rock facilities, temporary mill feed stockpiles, paste-fill plants, and tailings storage facilities.

Ambrosia Sul is operated as a satellite facility to the Morro Agudo Mine, and has limited infrastructure requirements. These include powerlines, water pipelines, and mine offices, together with the open pit, and waste rock facilities.

Surface infrastructure assumptions for Ambrosia Norte and Bonsucesso have yet to be developed.

18.8 Camps and Accommodation

No accommodation camps are used in support of mining activities. Mine personnel typically commute from the municipality of Paracatu or nearby villages to the operations.

18.9 Power and Electrical

Electricity supply is generated by hydroelectric power stations managed by Votorantim Energia, including Campos Novos, Capim Branco 1 and 2, Picada and Igarapava.

The power supply for the mine and processing facilities is provided entirely via the CEMIG-owned transmission network that serves the Morro Agudo Project. CEMIG is a large regional energy provider throughout Minas Gerais.

18.10 Fuel

Underground fueling and fluids supply to the mobile equipment is provided by service vehicles operating in the mine. Underground equipment that regularly travels to the surface, such as haul trucks and supply trucks, can also be fueled on surface.

18.11 Communications

Communications throughout the Morro Agudo Mine are by radio and telephone. There is a central control room for the underground mine that serves as a command centre in the event of an emergency.

18.12 Comments on Section 18

The Morro Agudo Mine is a mature operation with built infrastructure in place and no plans for future expansion of the existing site infrastructure.

Ambrosia Sul open pit is a short-lived operation with supporting functions and infrastructure being provided by the Morro Agudo site.

The PEA design for Ambrosia Norte/Bonsucesso infrastructure assumes integration with the overall Morro Agudo site for support functions such as engineering, geology, environmental, permitting etc.

Infrastructure requirements for Ambrosia Norte/Bonsucesso have been evaluated to a PEA level to support underground mining activities.

19.0 MARKET STUDIES AND CONTRACTS

19.1 Market Studies

Zinc concentrates from the Morro Agudo and Ambrosia Sul Mines are sold to Votorantim's Tres Marias smelter facility under contract. For the purposes of the PEA, it was assumed that all zinc concentrates would continue to be sold under existing arrangements.

Lead concentrates from the Morro Agudo and Ambrosia Sul Mines are sold to a Chinese smelter under contract. For the purposes of the PEA, it was assumed that all lead concentrates would continue to be sold under existing arrangements.

Agricultural lime recovered from mill tailings is sold under contracts with local famers. For the purposes of the PEA, it was assumed that all tailings would continue to be sold under terms and specifications similar to the existing contracts.

19.2 Commodity Price Projections

Votorantim provided Amec Foster Wheeler with the metal price projections for use in the Report. Votorantim established the pricing using a consensus approach based on long-term analyst and bank forecasts prepared during 2015 and 2016.

Amec Foster Wheeler reviewed the key input information, and considers that the data reflect a range of analyst predictions that are consistent with those in use by Amec Foster Wheeler and industry peers. Based on these sources, Amec Foster Wheeler agrees that Votorantim's price projections are acceptable as long-term consensus prices for use in mine planning and financial analyses for the Morro Agudo Project in the context of this Report.

The long-term price forecasts that are applicable to the Morro Agudo Project are summarized in Table 19-1.

Votorantim has also provided Amec Foster Wheeler with corporate projections for exchange rates for the LOM. These are summarized in Table 19-2, and are also based on an industry consensus view.

Table 19-1: Long-term Consensus Commodity Price Projections

Commodity	Unit	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Mineral Resources
Zn	$/t	2,650	2,723	2,564	2,408	2,338	2,338	2,338	2,338	2,338	2,338	2,338	2,766.93
Pb	$/t	2,067	1,955	1,989	1,956	1,933	1,933	1,933	1,933	1,933	1,933	1,933	2,234.64

Table 19-2: Long-term Consensus Exchange Rate Projections

Period	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
BR$:US$	3.35	3.33	3.36	3.38	3.38	3.38	3.38	3.38	3.38	3.38

19.3 Contracts

19.3.1 Concentrates

Morro Agudo concentrates represent about 13% of the Tres Marias smelter feed tonnage (see also discussion in Section 17.5). The main feed to the smelter is zinc silicate concentrate from Votorantim's Vazante Operations, which is treated in a separate leaching circuit.

The Tres Marias smelter has communicated specifications for zinc concentrate as follows:

- Zn > 37.5 %
- Pb < 2.2 %
- MgO < 5.8 %
- CaO < 10.8 %
- Fe < 3 %.

The Morro Agudo concentrate is pre-treated with acid solution to leach calcium and magnesium carbonates, and this increases the zinc grade from approximately 39%, as delivered at the mine gate, to about 55%. The pre-leached concentrate is then combined with other purchased sulphide concentrates and is roasted, leached and zinc is electrowon. Because the zinc concentrate is treated internally, and due to the design of the process at Tres Marias, the Morro Agudo Project can produce zinc concentrate grades at the mine that are lower in grade (typically 48–56% Zn) than the grades that Amec Foster Wheeler has seen in more typical commercial concentrates elsewhere in the world.

Tres Marias realizes a zinc premium on its zinc metal production due to the quality of its product. This premium is attributed to the Morro Agudo and Ambrosia Sul Mines, for the portion of zinc production realized from those concentrates. The PEA assumes that the zinc premium will continue to be paid over the LOM.

Lead concentrates are shipped via the Port of Itaguai to customers in China. Concentrate is delivered from the mine site to receiving Chinese ports in bulk bags, and each shipment is between 800 and 1,200 t. Contracts are in place with a Chinese smelter.

Votorantim has contracts in place with local farmers to sell agricultural lime recovered from mill tailings. This is discussed further in Section 24.1.

19.3.2 Operations

Currently, a total of 123 contract firms (795 personnel) are employed at the Morro Agudo and Ambrosia Sul Mines. Contractors are used in the process plant, health and safety, management, maintenance, mining, and warehousing areas.

19.4 Comments on Section 19

There are existing sales contracts in place for production from the Morro Agudo and Ambrosia Sul Mines. The PEA assumes that similar contract terms to these will be available over the LOM.

The QPs have reviewed the information provided by Votorantim on marketing, contracts, metal price projections and exchange rate forecasts, and note that the information provided is consistent with the source documents used, and that the information is consistent with what is publicly available on industry norms. An explanation of the integration of the Morro Agudo Project, Vazante Operations and Tres Marias Smelter was provided to support assumptions for zinc payment, treatment costs and assigning the zinc metal premium. The information can be used in mine planning and financial analyses for the Morro Agudo Project in the context of this Report.

Long-term metal price assumptions used in the Report are based on a consensus of price forecasts for zinc and lead estimated by numerous analysts and major banks. The analyst and bank forecasts are based on many factors that include historical experience, current spot prices, expectations of future market supply, and perceived demand. Over a number of years, the actual metal prices can change, either positively or negatively from what was earlier predicted. If the assumed long-term metal prices are not realized, this could have a negative impact on the operation's financial outcome. At the same time, higher than predicted metal prices could have a positive impact.

20.0 ENVIRONMENTAL STUDIES, PERMITTING, AND SOCIAL OR COMMUNITY IMPACT

20.1 Introduction

The main information source for information on the Project environmental considerations was obtained from the monitoring reports, Reports on Environmental Performance or RADA (SSMA Assessoria e Consultoria, 2010), annual hydrological and hydrogeological monitoring report (Votorantim, 2017); water balance for the mine (Votorantim, 2016), environmental impact assessment (EIA) for Ambrosia Sul (SSMA Consultoria Ambiental, 2013) and EIA for Ambrosia Norte (BBM Consultoria Ambiental, 2007) and information related to the Project provided by Votorantim.

20.2 Baseline Studies

20.2.1 Climate

The region is classified as warm (calid) sub-humid ((IBGE, 2005), with 4–5 dry months annually. In the region where the mine is situated, the average temperature varies between 13ºC and 27ºC in the winter and between 18ºC and 30ºC in the summer.

The historical average rainfall is 1,441.5 mm, with more than 80% of this total occurring during the rainy season, which runs from October to March.

The predominant wind directions are northeast to southwest.

20.2.2 Air Quality

Air quality is monitored for 24 hours every six days through the total suspended particles concentration. The EIA for Ambrosia Sul (SSMA, 2013) rated the air quality predominantly as good. Some exceedances were due to emissions from rural properties related to their daily activities, such as the use of firewood as fuel for stoves, soil preparation, planting and harvesting of grains, and emissions from animal treatment and management.

20.2.3 Water Quality

Water quality monitoring includes groundwater, surface, and effluent quality monitoring. Information was sourced from the annual monitoring report for water and effluent quality (Votorantim, 2017). Eight sampling points were established for surface water quality, three for effluents and 11 for groundwater quality:

- Water quality was generally rated as good; however, some monitoring points showed that lead and zinc content could be above applicable Brazilian norms

- Effluent results indicated that lead, dissolved oxygen, nitrate, total dissolved solids, and sulphate readings were above applicable norms. Nitrate levels are being addressed through modifications to the water treatment plant. Metals exceedance issues resulted in an action plan that included measures to ensure that contact water from the process plant does not have the potential to discharge to watercourses.

20.2.4 Hydrology

The Morro Agudo Project is located within the Paracatu River sub-basin of the Sao Francisco River. The local drainage system from the Morro Agudo Mine flows to the Morro Agudo stream that has a minimum flow of about 50 m^3/h and an average flow of approximately 200 m^3/h. Other water courses in the Project area include Cercado stream and the Escurinho and Trairas Rivers.

20.2.5 Biological Considerations

The dominant original vegetation type in the Project area is *cerrado*, a type of tropical savannah.

The EIA for Ambrosia Norte (BBM Consultoria Ambiental, 2007) found 117 species. Most species have a wide geographical distribution in Brazil and South America, thus not were considered endemic, except for the endemic bird of the Cerrado (Satator atricolis). The EIA for Ambrosia South (SSMA Consultoria Ambiental, 2013) identified seven species of endemic birds and one threatened species.

Votorantim has an ecosystem service plan in place that follows the guidelines of the corporate standard PG-VM-HMSQ-060. The conservation status of preserved areas is monitored biannually.

20.2.6 Social and Heritage Considerations

The Morro Agudo Mine is located southeast of the Paracatu municipality, about 45 km from the urban area. Paracatu has a total population of 84,718 (IBGE census, 2010).

20.3 Environmental Considerations/Monitoring Programs

Monitoring programs are established in accordance with the three operation licenses granted to Votorantim. The operation licenses No. 037/2013–2017; 027/2011–2017 and 008/2016–2020 have 61 conditions. The water intake permits (02053/ 2013–2017, 2057/2013 and 00987/2015) have 33 conditions. Table 20-1 shows the key monitoring requirements for each granted operating license.

Table 20-1: Key Monitoring Requirements

N°	Monitoring/Reporting Description	Reporting Frequency
1.	***Operating License No. 037/2013–2017, COPAM Process Nº 004/1979/034/2010***	
	Superficial water quality Compliance through: April 2017 for the first quarter of 2017. Protocol No. E0033863/17 for the 4th quarter of 2016; Protocol No. E0330563/2016 for the 2nd and 3rd quarter of 2016. Protocol No. E0184476/16 for the 1st quarter of 2016	Monthly analysis, Quarterly report.
	Effluent quality Compliance through: April 2017 for the first quarter of 2017. Protocol No. E0033863/17 for the 4th quarter of 2016; Protocol No. E0330563/2016 for the 2nd and 3rd quarter of 2016. Protocol No. E0184476/16 for the 1st quarter of 2016	Monthly analysis and every 6 month for effluents from the laboratory. Quarterly reporting
	Groundwater quality Compliance through: April 2017 for the first quarter of 2017. Protocol No. E0033863/17 for the 4th quarter of 2016; Protocol No. E0330563/2016 for the 2nd and 3rd quarter of 2016. Protocol No. E0184476/16 for the 1st quarter of 2016	Monthly analysis, Quarterly report.
	Minimum flow in Morro Agudo stream Compliance through the annual hydrological and hydrogeological monitoring reports (2015 and 2016).	All year, especially during dry season.
	Air quality monitoring Compliance through: Protocol No. R0021566/2016 for 2015 Protocol for 2016 is not yet submitted (deadline is 15/08/2017).	One in six days. Reports every year.
	Noise levels Compliance through: Protocol No. R0021571/2016 for 2015 Protocol for 2016 has not yet been submitted (deadline is 15/08/2017).	Quarterly. Reports every year.
	Report on management of contaminated areas (condition 7) Compliance through: Protocol No. 07030001279/14 Protocol No. E0449341 / 2015	Yearly
	Report of the Environmental Education Program under COPAM No. 110/2007 Compliance through: Protocol No. E0048999/2016 for 2015 period.	Yearly report.

N°	Monitoring/Reporting Description	Reporting Frequency
	Protocol for 2016 has not yet been submitted (deadline is 15/08/2017).	
	Report on Solid waste Compliance through: Protocol No. E0217587/16 for 2015 Protocol for 2016 has not yet been submitted (deadline is 15/08/2017).	Yearly report.
2.	***Operating License No. 027/2011-2017, COPAM Process Nº 4/1979/035/2011***	
	Superficial water quality	Monthly analysis, Report every six month
	Effluent quality	Monthly analysis, Report every six month
	Groundwater quality	Monthly analysis, Report every six month
	Report of the Environmental Education Program under COPAM No. 110/2007	Yearly report.
3.	***Operating License No. 008/2016-2020, COPAM Process Nº 4/1979/041/20112015***	
	Superficial water quality	Monthly analysis, Report every six month
	Effluent quality	Monthly analysis, Yearly report.
	Groundwater quality	Monthly analysis, Report every six month
	Hydrobiology	Yearly monitoring, Yearly report.
4.	**License No. 2057/2013**	
	Minimum flow in Escurinho River	All year, especially during dry season.
	Pumping flow of 250 m^3/h for lowering of the mine water level.	Weekly

Votorantim commissioned a report on legal compliances in 2016 (Legal Audit, 2016). The following are a summary of the key findings of that report:

- Effluent monitoring results are sent to SUPRAM quarterly, in compliance with the requirements of LO 037/2013–2017; LO 027/2011–2017 and LO 008/2016–2020. Votorantim provided evidence to SUPRAM-NOR of the submission of the monitoring and reporting required under LO 37 for superficial water quality, groundwater quality and effluent quality. Results show compliance for most of the parameters monitored with some specific non-compliances for Morro Agudo stream and the effluent monitoring for lead, zinc, and cadmium. Votorantim stated that sample contamination may have occurred, because upstream monitoring points of the exceedance point were all under regulatory limits. Votorantim has implemented an action plan to review the monitoring process to ensure better reliability in all stages of the monitoring process for 2017. For the effluents, the deviations observed were treated through adjustments in the treatment process and recirculation of affected water

- A hydrological monitoring report for the Morro Agudo stream is submitted annually to SUPRAM-NOR. This report also covers the minimum flow rates in the stream. Condition 1 of Water Permit No. 02057/2013 requires a minimum residual flow to the Escurinho River, set as 70% of the minimum flow over seven days in 10 years of recurrence.
- During a contamination assessment conducted over the Morro Agudo Mine area in 2007, Tecnohidro (2007) identified 23 instances of potential soil and groundwater contamination. Follow-up detailed examinations were conducted (Tecnohidro 2007 and 2008). On 29 August, 2014 under protocol 07030001279/14, Votorantim presented a report documenting the actions taken with regard to the contaminated soil sites. Votorantim stated that the decontamination activities for groundwater would only be conducted once the process plant ceased operation. The Morro Agudo Mine Closure Plan was updated to include appropriate remediation in the post-closure phase
- Concerns were noted with hazardous waste storage, in that storage sites had no secondary containment measures, and that the containment channel had sedimentation at the base, which could lead to the channel overflowing. The Solid Waste Management Plan (G-VN-ZINCO-MA-MA-002) was noted to not include a description of the activities, characterization of waste generated and the preventive or corrective actions as established in Decree 7 404/10
- Noise monitoring during 2014 and 2015 indicated a number of registered noise values above the maximum allowed limit established by Federal Resolution No. 1/90 – CONAMA. Noise attenuators were installed at the underground exhaust ventilation fan outlet to reduce the noise emission levels. Measurements were take of the background noise to identify the natural noise levels. A study is planned for 2017 to mathematically model noise sources by process and equipment type.

Legal reviews should continue monitoring compliance efforts so as to meet regulatory and legal requirements.

20.4 Stockpiles

The PEA assumes that mill feed from the Morro Agudo and Ambrosia Sul Mines, and the planned satellite operations will be fed to the existing crushing circuit and blended in the current homogenization mill feed stockpile ahead of the grinding circuit. This is based on the assumption that there will be no significant mineralogical differences in mill feed sourced from Ambrosia Sul, Ambrosia Norte and Bonsucesso, so that current stockpiling and blending practices will continue over the PEA LOM.

20.5 Waste Rock Storage Facilities

Waste rock generated from the Morro Agudo Mine is typically in above-ground facilities, and on occasion can be stored underground.

The Ambrosia Sul Mine has a soil storage facility, and dolomite waste is stockpiled in a permitted waste rock storage facility. Amec Foster Wheeler visited the waste rock storage facility, as there was concern expressed by Votorantim over water ponding on top due to the high soils or fines content. This could present an issue later in the facility life-cycle when coarser material is placed on top. A recommendation was made to contour the surface to facilitate better drainage prior to placing the next lift.

Typically, the waste generated from mining activity is limestone or dolomite, which is able to neutralize any sulphides, and therefore the facilities are not expected to generate acid drainage or metals leaching.

20.6 Tailings Storage Facility

20.6.1 Introduction

Tailings management at the Morro Agudo Mine consists of three tailings storage facilities (TSFs), denoted as Deposits 1, 2, and 3 (also known as Barragems 1, 2, and 3).

Tailings produced in the lead and zinc circuit are pumped in the form of a slurry to the tailings deposits where they settle. After sedimentation of the solids and depletion of the supernatant water, the tailings are extracted, marketed, and sold as corrective soil/limestone powder to the agricultural sector. Water is recovered in the deposits and returned to the process plant. Embankment raises are not planned for the deposits as increases in the total volume of the reservoirs are not required because of the extraction and sale of the contained tailings as agricultural lime. An aerial photograph showing Deposits 1, 2, and 3 and the limestone stockpiles is included as Figure 20-1.

20.6.2 Tailings Storage Facilities Design Considerations

Embankment designs considered local geological and geotechnical conditions, materials available for construction and economics of the project.

The three deposits were constructed by excavating soils from the reservoir areas to build embankments to contain tailings generated at the process plant. Deposit 2 and Deposit 3 are lined with a 1.5 mm geomembrane. Deposit 1 has no liner.

Tailings have been characterized as “non-dangerous”, and “inert”. Testwork on acid drainage characteristics, including static and kinetic tests, were performed on material from Morro Agudo Mine and Ambrosia Sul and confirmed the non-acid generating nature of these materials.

External embankment slopes of all three deposits are covered in grass, and superficial drainage is directed to drainage channels.

Site Characterisation

As part of site characterization studies, drilling and test pits were undertaken at the embankment foundations and reservoir as part of design studies for all deposits. These investigations were complemented by laboratory testing and analyses on selected samples.

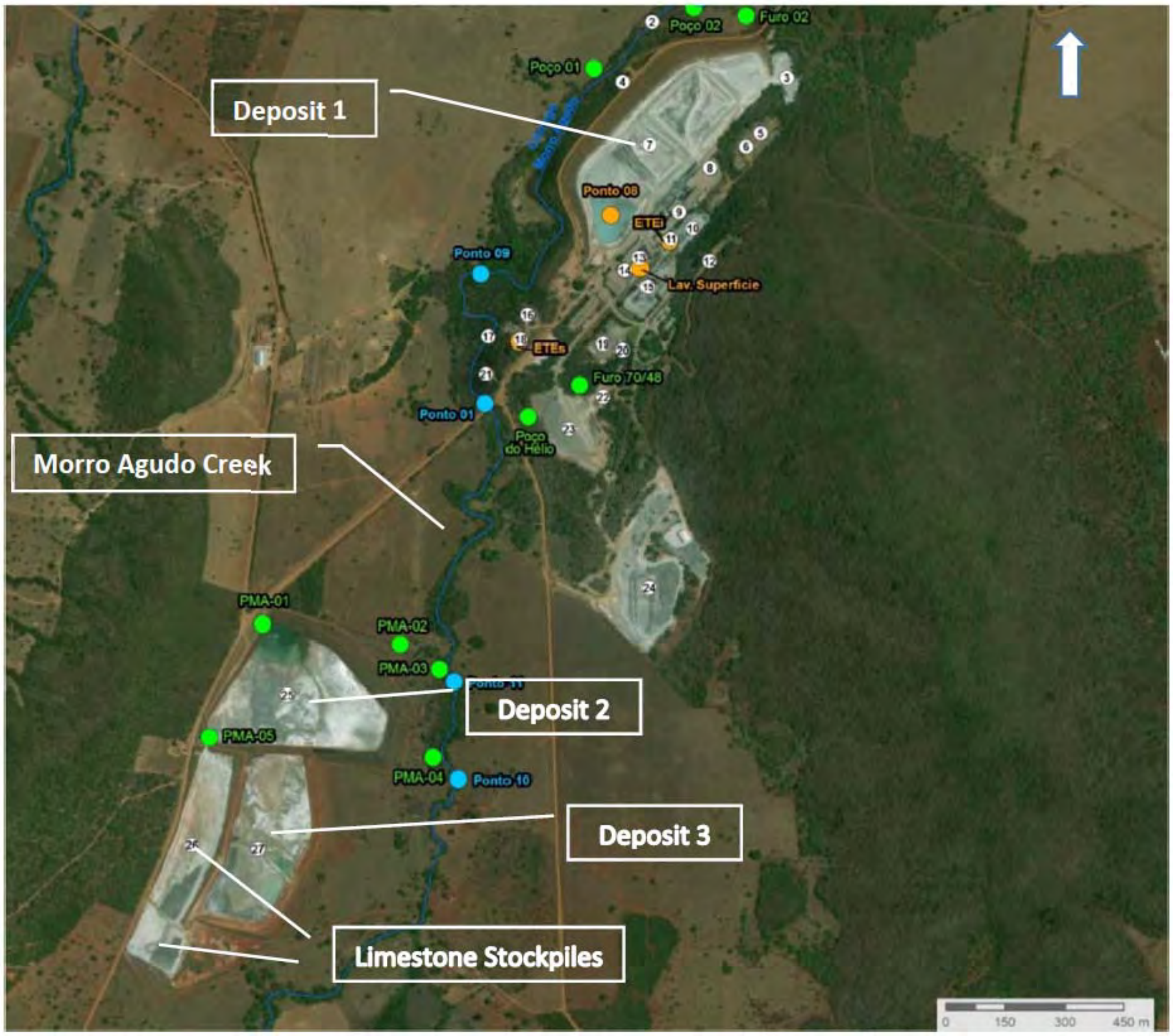
Tailings Characterization

Tailings characteristics were defined by Geoconsultoria (Operation Manual CM26-MO-02, October, 2013). The main characteristics of the tailings in slurry and dried form are provided in Tables 20-2 and Table 20-3 respectively.

Deposit 1

Deposit 1, also referred to as the plant deposit, was designed by Hidroterra and constructed by Brito Construction. No design reports were available for review for Deposit 1. The deposit is located adjacent to the process plant and is divided into four cells. The sub-division of the deposit into cells allows for the deposition, drying and excavation of tailings from within the reservoir for sale. Table 20-4 displays key design characteristics of Deposit 1 and Figure 20-2 displays a plan of the embankment and cells inside the reservoir.

Figure 20-1: General View of Morro Agudo Surface Infrastructure including Tailings Deposits 1, 2,3 and Limestone Stockpiles



Note: Figure prepared by Amec Foster Wheeler, 2017. Google Earth image as backdrop.

Table 20-2: Tailings Slurry Characteristics

Item	Unit	Value
Slurry density	t/m^3	1.16
Solids content	%	18–26
Zinc concentration	ppm	5,400
Lead concentration	ppm	1,600
pH		10.5

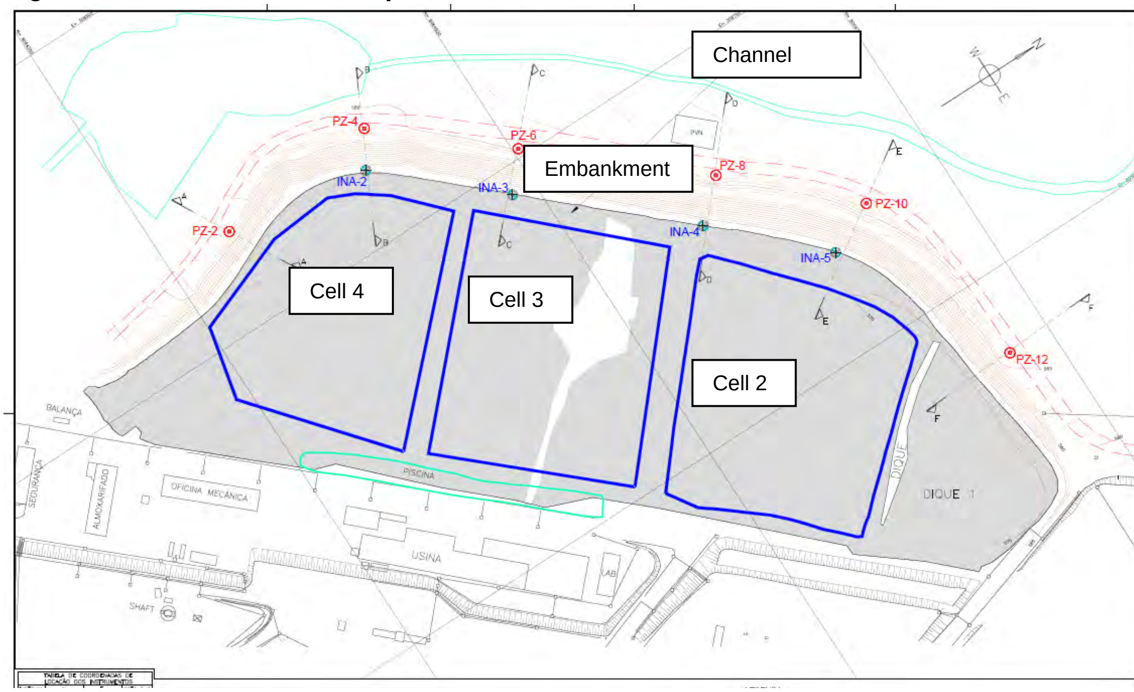
Table 20-3: Dried Tailings Characteristics

Item	Unit	Value
Grain size	% passing #400 Sieve	70
Moisture content	%	8
Deposited dry density	t/m^3	1.6
Solids specific gravity	t/m^3	3.0
Zinc concentration	%	0.54
Lead concentration	%	0.16
CaO concentration	%	7
MgO concentration	%	6

Table 20-4: Deposit 1 Key Design Characteristics

Item	Value
Type of Construction	Compacted Earth Fill
Embankment crest elevation	566.5 m
Embankment volume	200,000 m^3
Embankment length	830 m
Reservoir capacity (estimated)	1,800,000 m3
Reservoir area	173,000 m^2
Maximum dam height	19.5 m
Dam crest width (average)	7 m
Freeboard	1 m
Geomembrane lined	No
Construction phase	1987/1988
Design engineer	Hidroterra

Figure 20-2: Plan View of Deposit 1



Note: Figure courtesy Votorantim, 2017. Grid = 250 m x 250 m.

Deposit 2

Deposit 2 is located approximately 1.5 km to the south and east of the process plant. The deposit was designed by Geoconsultoria in February 2004 (CM09-RT-01 Rev. 0- New Tailings Deposit), and a conceptual report and basic design (CM09-RT-02 Rev. 1- New Tailings Deposit – Basic Design – Technical Report) was completed in in April 2005.

After completion of construction of the embankment, the crest was raised further with a reinforced earth wall to provide for emergency storage of tailings. The design was undertaken by Soloconsult (Technical Report SC0805-30-001-RC-001, Deposit 2 Embankment Raise – Study of the Stability of the Excavation and Raise, 2008).

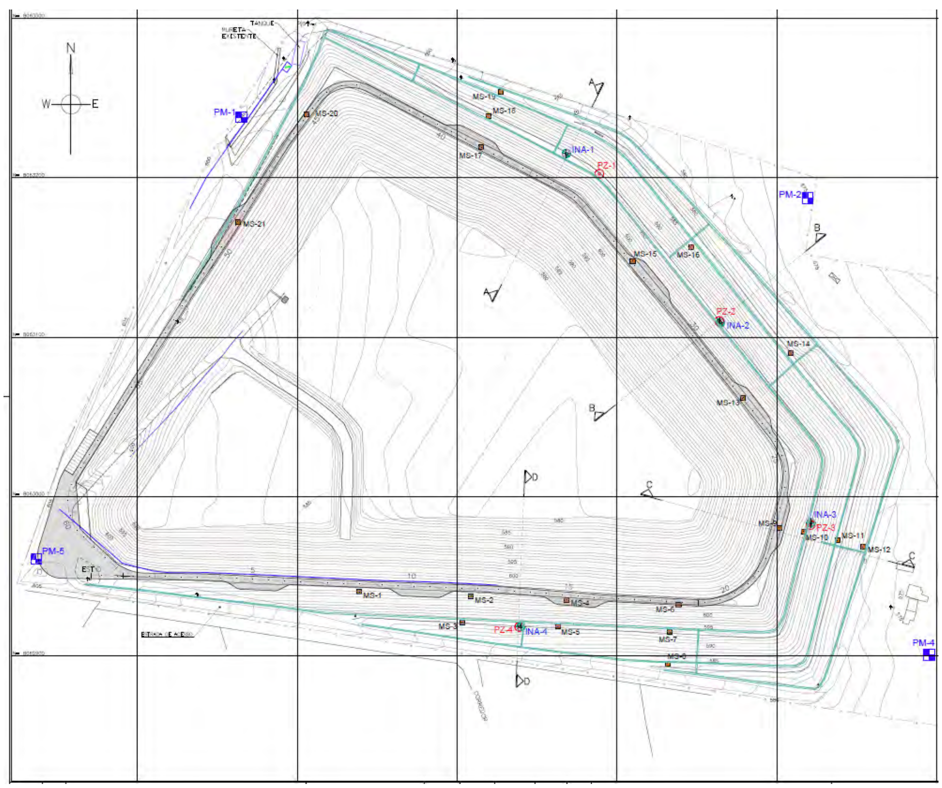
Deposit 2 has a 1.5 mm geomembrane liner underlain by a sand drainage layer and tubing to collect and detect potential leaks in the liner. Flow from this layer is directed to a basin downstream of the dam from where it is pumped back to the reservoir.

Table 20-5 displays key design characteristics for Deposit 2 and Figure 20-3 displays a plan view of the impoundment.

Table 20-5: Deposit 2 Key Design Characteristics

Item	Value
Type of Construction	Compacted Earth Fill, Reinforced Earth Wall
Dam crest elevation	606.5 m
Embankment length	1235 m
Reservoir area	91.64 m^2
Maximum dam height	40 m
Dam crest width (average)	6 m
Freeboard	1 m
Reservoir capacity (estimated)	1,500,000 m^3
Geomembrane lined	Yes
Construction phase	2005
Construction phase – reinforced soil wall	2008
Design engineer (basic design, April 2005)	Geoconsultoria
Design engineer, reinforced earth fill wall, 2008	Soloconsult

Figure 20-3: Plan View of Deposit 2



Note: Figure courtesy Votorantim, 2017. Grid = 100 m x 100 m.

Deposit 2 is subdivided into internal cells by a 3 m wide compacted clay berm. Each cell has a drainage pipe to assist with the identification of defects in the liner should they occur.

Deposit 3

Deposit 3 is located adjacent and to the south of Deposit 2. The detailed design was completed by LPS, a third-party consultant, in 2010 (Report I7255.08004-0200CIV0005, 2010). Similar to Deposit 2, Deposit 3 is geomembrane-lined, and a drainage layer beneath the liner collects any leakage which is then pumped back to the reservoir. Table 20-6 displays key design characteristics of Deposit 3 and Figure 20-4 displays a plan view of the impoundment.

Tailings Containment Structure Stability

The following criteria were adopted in the dam design for all three deposits: NBR nº 13.028, the Brazilian norm for “Elaboration and presentation of tailings dam projects, sedimentation dams and water reservoirs”. Embankment slopes were analyzed based on the following safety factor values:

- FS> 1.5: Long-term condition
- FS> 1.3: End of construction.

Results from stability analyses carried out are considered satisfactory in terms of values for the embankment construction and operational phases. No pseudo static analyses were carried out due to the low seismic activity of the region.

20.6.3 Operation

Operation of Deposit 1 involves the alternating deposition of slurry to one of the four cells within the deposit, while the other cells serve for draining and drying of the tailings to be later excavated, stockpiled, and sold. The cyclone operation must ensure the underflow is deposited near an internal dike, and the overflow be discarded near the crest of the internal dike that is adjacent to the eastern side of the impoundment, forcing the water pond toward the plant site area.

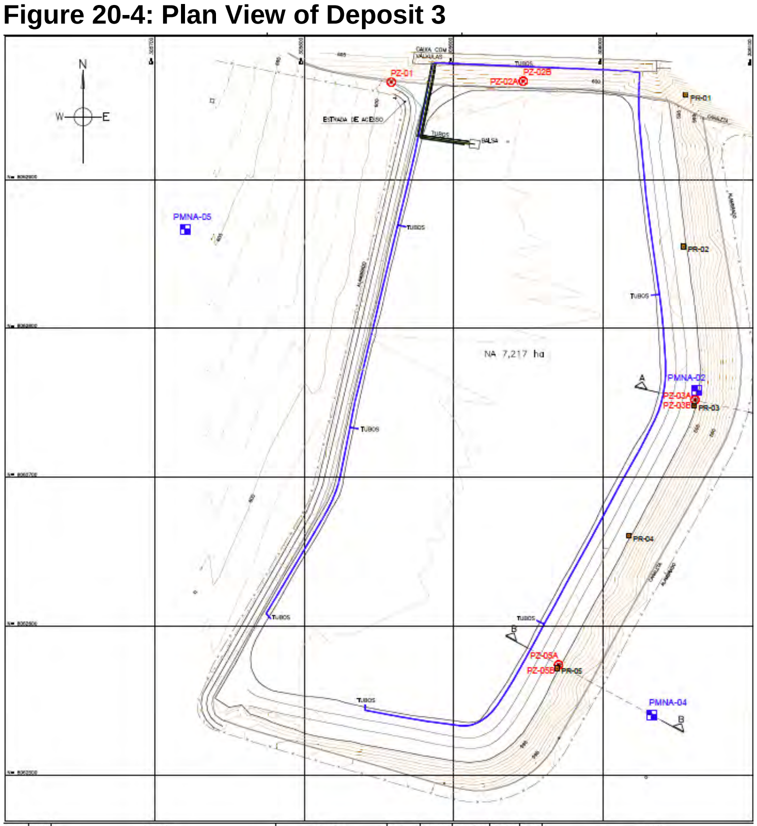
The operation of Deposits 2 and 3 requires the uniform distribution of tailings in the reservoir with water capture at the most distant point possible to the tailings deposition area. Free water is maintained at a minimum where possible in the reservoir.

Water is reclaimed from the active deposit by a floating barge and two centrifugal pumps and returned to the plant via a 10” diameter high-density polyethylene (HDPE) pipeline.

Table 20-6: Deposit 3 Key Design Characteristics

Item	Value
Type of Construction	Compacted Earth Fill
Dam crest elevation	597 m
Embankment length (approx.)	650 m
Maximum dam height	12 m
Embankment volume	231,000 m^3
Reservoir area	73,000 m^2
Dam crest width (average)	20 m
Freeboard	1 m
Reservoir volume (estimated)	500,000 m^3
Reservoir area	73,000 m^2
Geomembrane lined	Yes
Construction phase	2010/2011
Design engineer (basic design, February, 2010)	Soloconsult
Design engineer (detailed design, February 2010)	LPS

Figure 20-4: Plan View of Deposit 3



Note: Figure courtesy Votorantim, 2017. Grid = 100 m x 100 m

20.6.4 Monitoring

Monitoring of instrumentation installed in the embankments of the three deposits are carried out by Votorantim personnel and external consultants. Further details of these inspections are provided in Section 20.6.5. A summary of instruments installed in and around the deposits is provided in Table 20-7.

20.6.5 Dam Safety

Dam Classifications

Tailings deposits 1, 2, and 3 have been classified by Geoconsultoria according to the Brazilian Legislation Art. 3 of COPAM Normative Resolution No. 87, dated 06/17/2005. As per the criterion and the sum of the values of the classification parameters, the deposits are classified as “Class III – high potential for environmental damage”.

With respect to the Canadian Dam Association (CDA, 2013) and results of the dam break study demonstrating the potential for transported tailings to impact the environment up to a distance of 5 km, the deposits are classified as “Very High Risk”.

Due to the “Very High” classification, risk controls in place include dam instrumentation monitoring, carried out by Votorantim on a monthly basis, and annual safety audits undertaken by an external consultant (Geoconsultoria).

Dam Break Study

A dam break study determined the extent of the area that might be impacted as a result of a rupture of the tailings deposits. The calculation was determined using empirical criteria adopted in South Africa and by carrying out a simulation with the software "Tailings Flow Slide Calculator".

South Africa's code is based on data from previous dam breaks relative to the extension of the impacted area with the height of the dam, slope of the ground and water behind the structure. According to this study a maximum distance of 5.0 km would be affected by the failure of the tailings deposit (Geoconsultoria, 2015).

Dam Safety Audits

Dam safety inspections are carried out by Votorantim and Geoconsultoria.

Geoconsultoria undertook annual dam inspections in August 2016, including analysis of instrumentation data up to this date. These reviews, concluded that Deposit 1, Deposit 2, and Deposit 3 embankments demonstrate satisfactory conditions in terms of stability

Table 20-7: TSF Instrumentation

Item	Deposit 1	Deposit 2	Deposit 3
Piezometers	6	4	6
Water Level Indicator	4	4	5
Monitoring Well		5	5
Survey Monuments		21	
Monitoring Period (days)	30	30	30

The Geoconsultoria reviews were provided in:

- Technical Report CM17-RT-37 Rev. 0, August 2016, Technical Safety Audit of Deposit 1 (Plant Site Deposit)
- Technical Report CM17-RT-38 Rev. 0, August 2016, Technical Safety Audit of Deposit 2 (New Deposit)
- Technical Report CM17-RT-39 Rev. 0, August 2016, Technical Safety Audit of Deposit 3.

Additional to the Geoconsultoria safety audits, a “Cross Check” study was carried out by Ausenco Peru (Report 101862-03-RPT-001, February 2017, pages 23-25) in which it was concluded that:

- Tailings deposits at the Morro Agudo Complex are currently stable
- Recommended freeboard (from Operation and Maintenance Manual) of at least 1 m is not maintained, especially during the rainy season
- Erosion was noted around the piping in Deposit 1 at the division between the dam
- Minor cracking was noted in Deposits 1 and 3
- The reinforced earth wall forming the embankment on Deposit 2 is stable with some deformation observed on the downstream side resultant from the geotextile
- The deposits have not been analyzed for pseudo static and post-earthquake conditions
- Tailings in Deposit 1 appear to display levels of lead, zinc, and manganese that exceed limits nominated by Brazilian legislation, in addition to having a high sulphur content.

A more detailed dam break study should be undertaken considering the rheological properties of the tailings.

20.6.6 Closure

Conceptual closure design has been carried out by Golder (Conceptual plan for decommissioning of the Morro Agudo Unit, 2014). The closure plan provides for a tailings cover and surface drainage with the addition of concrete structures for durability.

20.6.7 Future Planning

Embankment raises are not planned for the deposits as increases in the volume of the reservoirs are limited by the extraction and sale of the contained tailings.

20.7 Water Management

The primary purpose of water management is to ensure that the quality and quantity of water sources adjacent the Morro Agudo Project are not impacted by mining activities.

The information for this sub-section was obtained from the water balance provided by Votorantim (2017); the Closure Plan – Conceptual phase and its presentation (Golder, 2016); and the Environmental Impact Study for Ambrosia Norte.

20.7.1 Infrastructure

Tailings dams have a diversion channel to secure the areas upstream and downstream of the dams. Downstream channels have been built considering a 500-year flood, and upstream channels have used the 100-year year flood as the design basis. Channels has been design with a minimum slope of 0.5%.

In general, there are two types of channel designs:

- Diversion channels with steep slopes
- Channels with shallow slopes for other areas.

20.7.2 Water Supply and Water Treatment

Document DD-VM-HSMQ-056-MA-2016 outlines the conceptual water balance for the Morro Agudo Mine. The main source of fresh water is underground mine water with an average pumping flow of 1,760 ML (200 m^3/hr). The process plant is provided with recycled water from Deposits 1 and 2, at an average pumping flow of 2,540 ML (289 m^3/hr).

The mine has a water pumping system which consists of two independent circuits. One is for pumping clean water (groundwater filtration) which is discharged directly into the Morro Agudo stream in order to maintain its flow. The second circuit transports contact water to the industrial effluent treatment plant.

Hydrogeological studies were performed ahead of the commencement of open pit mining at Ambrosia Sul, and were the basis of the projected pumping and dewatering requirements.

In the 2007 EIS for the Ambrosia Norte deposit, water usage was assumed to be 4.1 m^3/day for human consumption, 240 m^3/day for road irrigation, and 50 m^3/day for washing equipment. In total, water consumption rate was established as between 294.1 and 300 m^3/day. A hydrogeological study has commenced to identify what pumping rates and dewatering requirements may be needed to support future mining operations at Ambrosia Norte and Bonsucesso.

20.7.3 Water Monitoring

The approved monitoring plan requires minimum flow, surface, effluents, groundwater and hydrobiological quality monitoring as stated in the three Operating Licenses.

Minimum Flow

A Clean Water project (Protocol No. COPAM R029832, 2011) commenced in 2011 with the purpose of collecting and discharging all non-contact water from the underground mining operations at the Morro Agudo Mine to the Morro Agudo stream. Through this project, Votorantim expects to maintain the minimum flow requirements for the Morro Agudo stream.

In 2016, the Clean Water project discharged an average annual flow of 77.96 m^3/h of clean water into the Morro Agudo stream, thereby maintaining the flow in the stream and contributing to the local biodiversity conservation (Votorantim, 2016).

Surface Monitoring and Effluents

The Water Quality and Effluent Monitoring reports are sent to SUPRAM-NOR on a quarterly basis to comply with LO 037/2013-2017; LO 027/2011-2017 and LO 008/2016-2020:

- LO 037/2013–2017 required eight monitoring stations to be established, monthly analyses, and quarterly reporting
- LO 027/2011–2017 required two monitoring stations for surface water quality and two stations for effluent quality to be established, with reporting to be conducted every six months
- LO 008/2016–2020 required two monitoring stations for surface water quality, and two stations for effluent quality to be established. Monthly analyses were to be conducted, and reporting requirements were every six months for surface water quality, and yearly for effluent quality.

The results of the treated effluent for the 2015–2016 year (January to March) have repeated nonconformities (Legal Audit, 2016), with lead and dissolved oxygen outside accepted parameters. It is recommended that the effluent treatment process be reviewed.

Votorantim provided evidence of submission of monitoring reports for 2015 and 2016.

Groundwater Monitoring

Groundwater monitoring reports are sent to SUPRAM-NOR to comply with LO 37/2013-2017, LO 27/2011-2017 and LO 008/2016–2020:

- LO 37 required 11 monitoring stations, monthly analyses, and quarterly reporting
- LO 27 required five monitoring stations to be established, monthly analyses, and reporting
- LO 008/2016–2020 required six monitoring stations to be established, monthly analyses, and reporting every six months.

Votorantim provided evidence of submission of monitoring reports for 2015 and 2016.

Hydrobiological Monitoring

The LO 008/2016 required that one monitoring station be established in the Morro Agudo stream, with yearly monitoring and reporting. No evidence of the submission of these reports to SUPRAM-NOR was sighted by Amec Foster Wheeler.

20.8 Closure Plan

20.8.1 Introduction

The Closure Plan (conceptual phase) for the Morro Agudo Mine (Golder, 2014) and the Technical Memorandum for Closure Plan update (Golder, 2016) includes the following components:

- Underground mine
- Deposits 1, 2 and 3
- Waste rock storage facility
- Limestone storage facility
- Industrial and administrative areas
- Contaminated areas.

The closure plan and its update (Golder, 2014; 2016) assumed that mine closure would occur in 2024. The 2016 scenario assumes that seven years will be required for progressive closure (2017–2023) and four years for final closure (2024–2027). Pre-closure activities would involve acid drainage generation tests, leaching and solubilisation tests of the waste rock material, modelling of the final conditions of the tailings dams at a feasibility level of study, efficiency tests for the low permeability layer for contaminated areas, hydrogeological modeling for mine recovery, and geo-mechanical studies of the underground mine.

Post-closure monitoring would require six years (conceptually from 2028–2033). Post closure activities would involve monitoring of geotechnical stability, drainage systems, groundwater and surface quality; revegetation; fauna monitoring; and socio-economic programs.

The total closure costs at the time were estimated to be approximately US$ 18.3 million, to be expended from 2019–2033. The margin of error in the accuracy estimate was stated to be ±50% (Technical Memorandum, Golder 2016, pg. 3 Report MT-003_139-555-2063_00-B). Closure costs were not updated between 2014 and 2016, and no provision for inflation was included in the closure estimate.

The Closure Plan for the Morro Agudo Mine was presented to the DNPM during October 2016 under protocol number 0009691.00120298 / 2016-55.

These closure costs do not address the Ambrosia Sul open pit mine, or any additional development along the Ambrosia Trend.

20.8.2 Conceptual Closure Plan

The closure plan (Golder, 2014) established the following activities.

- Contaminated areas
  - Implementation of a low permeability layer
  - Implementation of peripheral drainage channels
  - Revegetation
- Underground mine
  - Disassembly and removal of underground and surface equipment, structures, and cables
  - Sealing of mine entrance
  - Inventory update of equipment and waste
  - Revegetation with grass and native species
- Waste rock storage facilities
  - Contouring

  - Surface drainage system installation
  - Revegetation
- Limestone storage facility
  - Contouring
  - Revegetation with native species
- Industrial and administrative areas
  - Dismantling and removal of mechanical structures, electrical structures, ducts, wiring, among others.
  - Demolition of patios, accesses, masonry, etc.
  - Disposal of inert demolition material at tailings Dam 1.
  - Contouring
  - Low-permeability multilayer cover in contaminated areas.
  - Surface drainage system installation
  - Revegetation with grass and native species.
- Deposits 1, 2 and 3
  - Contouring (1V:2,5:H)
  - Waste material from industrial and administrative area will be discharged on tailings dam
  - Multi-layer cover
  - Surface drainage system installation
  - Revegetation with grass and native species
- Borginho Dam
  - The dam was constructed on the Morro Agudo stream, and is currently used as a water storage dam for livestock
  - Dewatering
  - Fish management, including rescue and relocation of healthy hydrobiological individuals in the Morro Agudo stream.
- Socio-economic programs
  - Communications program, socioeconomic index, environmental education, decommissioning (economic compensation plan for workers) and health and safety.

20.8.3 Ambrosia Sul and Ambrosia Norte

Votorantim advised that conceptual closure plans have been developed for these two deposits. These cover pit closure, closure of the waste rock storage facilities, and demobilization of support structures. The budget estimate is BR$9 million.

20.8.4 Bonsucesso

No conceptual closure plan has been prepared for the Bonsucesso deposit.

20.9 Permitting

The Brazilian legal framework for environmental protection comprises federal, state, and local environmental laws and regulations (see discussion in Section 4.2.4).

Environmental licensing was made mandatory after the Environmental National Policy Law No. 6938 was enacted in 1981, settling three types of license schemes:

- Previous License (LP) for a maximum of five years;
- Installation license (LI) for a maximum of six years; and,
- Operations license (LO) for a maximum of 10 years. Law No. 6938 was amended by laws 11.284/06, 11.941/09, 12.651/12 and Complementary Law 140/11. In addition, in 1986, the National Council for the Environment (CONAMA) passed Resolution No 1/86 which enforced the presentation of a previous EIS and a Report of Impact Study (RIMA).

The environmental licensing process is normally conducted at the state level (by the relevant state environmental agency), and when the project has inter-state impacts, is conducted at the federal level by the Brazilian Environmental Agency (*Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis* or IBAMA).

The environmental framework includes:

- Federal Law No. 6938/1981, which established the National Environmental Policy.
- Federal Constitution 1988, which provides the main framework and provisions for environmental protection in Brazil (*Article 225*).
- Federal Law No. 7735/1989, which created the federal environmental protection agency (*Instituto Nacional do Meio Ambiente e dos Recursos Naturais Renováveis*) (IBAMA).
- Federal Law No. 9605/1998 (Environmental Crimes Act), which addresses criminal and administrative breaches
- Federal Law No. 9985/2000, which established the National System for Conservation Units.

- Federal Law No. 11516/2007, which created the federal agency responsible for the management of federal conservation units (*Instituto Chico Mendes de Conservação da Biodiversidade*) (ICMBio)
- Federal Decree No. 6514/2008, which contains the implementing regulations for the Environmental Crimes Act, and specifically, administrative penalties.
- Federal Law No. 12,305/2010, which establishes the National Policy for Solid Waste.
- Federal Complementary Law No. 140/2011, which co-ordinates the constitutional jurisdiction for protecting the environment and natural resources.
- Federal Law No. 12,651/2012, which established the new Forest Code
- The National Policy on Water Resources, Federal Law No. 9,433/1997
- CONAMA resolution No. 237 which details the procedures and criteria for environmental certification.
- CONAMA Resolution No. 357 (2005), which establishes the conditions and standards for effluent discharges.
- State regulation, COPAM No. 10 (1986) which establishes norms and standards for water quality and effluent discharge.
- State regulation, COPAM No. 01 (1989), which harmonizes the extraction and processing of minerals with the environment.
- State regulation, COPAM No. (1995), which establishes for the publication of the application, granting and renewal of environmental licenses.

Non-compliance with requirements and conditions set out in environmental licenses, under Federal Law No. 9605 (1998) imposes criminal and administrative sanctions on individuals and companies whose conduct and activities cause harm to the environment. The mere demonstration of the damages caused and the existence of causal connection to the polluter's activity is sufficient for polluter liability.

In addition to general rules, the state of Minas Gerais has enacted laws and regulations regarding environmental management of contaminated areas (Minas Gerais, Deliberative Resolution No. 116/2008) that protect soil quality and provide for management of contaminated areas.

The key permits derived from the above regulatory requirements for the Project are listed in Table 20-8.

Environmental licences are valid for a set period. Votorantim must request renewal of the LO 120 days before its expiration date, so that it remains valid until the new and renewed licence is issued (Article 13(4) Complementary Law No. 140/2011).

Table 20-8: Key Permits

Regulatory Authority	Permit Number	Title	Short Description	Grant Date	Duration (validity)	Condition
Morro Agudo Mine						
	Operation License No. 037 / 2013-2017 COPAM Process Nº 004/1979/034/2010	Operating License	Underground mining with humid treatment; treatment units, tailings dam; ancillary facilities	15/08/2013	15/08/2017	Active No evidence of the process for renewal
	Operation License No. 027 / 2011-2017 COPAM Process N o	Operating License	Tailings dam	20/10/2011	20/10/2017	Active
	Operation License No. 008 / 2016 – 2020 COPAM Process Nº	Operating License	Tailings dam	31/03/2016	31/03/2020	Active
Government Counsel of Environmental Policy - COPAM	Operation License No. 725 COPAM Process Nº 004/1979/023/2003 Extended by OF/SUPRAMNOR/No546/2009					
	Operation License No. 023/2010-2014	Operating License	Underground mining.	22/12/2003	22/12/2010	Not active
		Operating License		18/11/2010	18/11/2014	Not active
	Environmental Authorization to Operate AAF No. 03603 / 2012-2016					
	Environmental Authorization to Operate AAF No. 03390 / 2016-2020					
	License No. 02053/ 2013-2017					
	License No. 02057 /2013-2017			19/07/2012	19/07/2016	Not Active
				12/07/2016	12/07/2020	Active
Regional Superintendence of Environmental Regularization - SUPRAM-NOR		Groundwater Water Permit	Lowering of water level in mining. Flow granted: 250 m³/h	12/09/2013	15/08/2017	Active. The resolution requires to renew the permit 90 days prior to its expiration. There is no evidence of permit renewal.

Regulatory Authority	Permit Number	Title	Short Description	Grant Date	Duration (validity)	Condition
Environmental and Sustainability Development Government Secretariat - SEMAD		Superficial Water Permit	Water intake from Escurinho River for industrial and potable purposes Flow granted: 28 l/s	12/09/2013	15/08/2017	Active No evidence of the process for renewal.
	Provisional Authorization for Operation CNPJ No. 42.416.651/0014-21. COPAM Process Nº 4/1979/043/2017 Installation License No. 033/2015 COPAM process No. 4/1979/040/2015					
Ambrosia Trend						
Government Counsel of Environmental Policy - COPAM	Previous License No. 019/2013 COPAM process No. 4/1979/037/2012	Authorization for Operation	Open pit mining, or underground mining in karstic areas with or without treatment, Tailing dams, treatment units, tailings dam; ancillary facilities.	10/04/2017	10/10/2017	Active The documents to obtain the Operating license were filed on February 2017. There is no evidence of a response yet.
	License No.02905/2012	Installation license	Installation license for open pit mining in karstic areas with or without treatment, ancillary facilities, tailings dam for Ambrosia mine.	17/12/2015	17/12/2021	Active
	License No. 00987/2015	Previous license	Previous license for open pit mining in karstic areas with or without treatment, ancillary facilities, tailings dam. Ambrosia South mine.	20/11/2014	20/11/2018	Active
		Previous license	Previous license for open pit mining in karstic areas with or without treatment, ancillary facilities, tailings dam. Ambrosia Norte	16/05/2013	16/05/2017	Not active

Regulatory Authority	Permit Number	Title	Short Description	Grant Date	Duration (validity)	Condition
Environmental and Sustainability Development Government Secretariat - SEMAD		Groundwater permit	Permit to pump groundwater from a well for hydrological studies. Flow granted: 180 m³/h for Ambrosia Norte	04/09/2012	05/09/2014	Not active
		Groundwater permit for four wells.	Permit to pump groundwater from four wells for hydrological studies. Flow granted: 200 m³/h for Ambrosia Sul	29/07/2015	30/07/2017	Active. No evidence of the process for renewal.

Compliance with permitting is monitored as follows:

- Monthly reports of compliance discussed internally by Votorantim legal staff
- Semi-annual evaluations carried out by consulting companies
- Annual audits.

20.10 Considerations of Social and Community Impacts

As part of business strategic planning and the Sustainability Master Plan, Votorantim management, in conjunction with external social experts and consultants, develop and implement Community Development and Engagement Plans with the potentially-impacted communities of its operations surroundings. The involvement of third-party professional assistance for consultation provides an independent view for stakeholders. The objective of these plans is to establish objectives consistent with what Votorantim and the affected communities want to accomplish in social improvements by 2025 and by 2030.

Votorantim monitors socio-economic trends and indexes from different sources, as well as community perceptions and impacts. A three-stage process is used.

The first step is to characterize the region and the communities in areas such education, health and welfare, economic development, social vulnerability, public safety, and youth, among others. This involves interviews with the main community stakeholders and a development of the understanding of community concerns and perceptions.

The second phase, as part of preparation of Community Development and Engagement Plans, the findings of the socio-economic study are shared and discussed with a variety of stakeholders to discuss and prioritize the needs of the surrounding communities and to determine appropriate programs for meeting those needs. These include discussions with community leaders and associations; local small business and cooperatives; educators; youth; private and public sector professional counterparts; environmental organizations; workers' unions; civil society organizations; local human rights institutions; traditional communities, when existing; and Votorantim employees, including those employees in leadership positions.

The third step consists of developing an annual budget and a portfolio of social initiatives sufficient to support the Community Development and Engagement Plans created. Votorantim executes its strategic social investment in alignment with these plans. Processes and efforts to measure effectiveness are in place as part of strategic business plan goals and monitoring status.

In addition, Votorantim encourages employee membership volunteerism in civic and business-related local groups through a structured corporate volunteer program.

20.11 Comments on Section 20

Amec Foster Wheeler recommends that the Legal Audit (2016) document be reviewed to identify any areas where there may be gaps or inconsistencies in permitting, and rectify these. The status of the non-compliances found should also be reviewed.

21.0 CAPITAL AND OPERATING COSTS

21.1 Introduction

The capital and operating cost estimates are at a PEA level of accuracy.

21.2 Capital Cost Estimates

21.2.1 Basis of Estimate

The capital plan for 2018 to 2028 includes:

- Remaining capital to complete Ambrosia Sul
- Mine development for Ambrosia Norte and Bonsucesso
- Sustaining capital and other miscellaneous capital projects.

Capital plans have been developed at a PEA level.

21.2.2 Mine Capital Costs

Mining costs include provisions for fixed and mobile mining equipment fleet, lateral and vertical development, and infrastructure.

Table 21-1 summarizes the projected mining cost.

21.2.3 Process Capital Costs

Negligible process capital is included in the LOMP. This is because the process plant will be operating below rated capacity, and there will be no requirements for expansion or improvement. A portion of the sustaining capital estimate is allocated to the process plant.

21.2.4 General and Administrative Capital Costs

A total of US$17.5 million has been allocated to general and administrative capital costs as follows:

- $12.9 million for safety, health, and environment
- $4.6 million for information technology (IT) systems.

21.2.5 Sustaining Capital

Nominal allowances are included for sustaining capital of approximately US$5 M/a until 2021, then dropping to approximately US$3 M/a as Morro Agudo and Ambrosia Sul Mines are closed. These allocations continue till the last year of mine life.

Table 21-1:Mining Capital Cost Estimate (US$ x 1,000)

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	LOM
Mine equipment	3,877	—	4,122	—	3,117	—	—	—	—	—	—	11,116
Development	6	322	743	925	2,025	1,332	671	—	—	—	—	6,023
Infrastructure	500	1,000	2,000	—	1,000	—	—	1,000	—	—	—	5,500
Total	***4,383***	***1,322***	***6,865***	***925***	***6,142***	***1,332***	***671***	***1,000***	**—**	**—**	**—**	***22,639***

Note: Calendar years used are for illustrative purposes. Totals may not sum due to rounding.

21.2.6 Capital Cost Summary

The overall capital schedule for the LOMP is shown in Table 21-2.

21.3 Operating Cost Estimates

21.3.1 Basis of Estimate

Operating costs forecasts for the Morro Agudo Project were based on a combination of historical costs and scoping level assumptions and estimates.

The Morro Agudo Mine operational areas were historically divided into mine and process. The maintenance department services both the mine and process operational areas. General and administration included general management, laboratory, safety, health and environment, information technology (IT), and other administration services.

Table 21-3 shows a breakdown of 2016 operating costs by area and cost type.

For 2016, costs were considered approximately 32% variable and 68% fixed. Variable costs were predominately in the process plant, including electricity for milling, grinding media and reagents, and services to reclaim tailings for agricultural lime sales. Diesel for the production fleet was the biggest variable cost in the Morro Agudo Mine.

Personnel costs include salaries, social charges (e.g. vacation pay, social security payments etc.) and other employee benefits (e.g. profit sharing, health care, meal vouchers, staff transportation etc.). These were the largest single cost area, and personnel costs were largest in the mining and maintenance departments, in line with personnel numbers.

Table 21-2: Capital Cost Schedule (US$ million)

Item	2018	2019	2020	2021	2022	2023 to 2028	Total
Ambrosia Sul	0.5	0.0	0.0	0.0	0.0	0.0	0.5
Ambrosia Norte/Bonsucesso	4.4	1.3	6.9	0.9	6.1	3.0	22.6
Road scales modernization	0.1						0.1
Safety, health, and environment	1.2	1.2	1.2	1.2	1.2	7.0	12.9
IT	3.7	0.9					4.6
Sustaining capital	4.7	4.8	5.1	5.1	3.0	18.4	41.1
Total capital	***14.6***	***8.2***	***13.1***	***7.2***	***10.3***	***28.4***	***81.7***

Note: Calendar years used are for illustrative purposes. Totals may not sum due to rounding.

Table 21-3: 2016 Morro Agudo Project Costs by Area

	Mine	Process	Maintenance	General & Admin	Total
Variable costs - BR$ M					
Electricity	1.5	7.4	0.5	0.0	9.4
Material supplies	2.5	6.1	0.0	0.0	8.6
Diesel	3.4	1.5	0.1	0.2	5.1
Tailings handling	0.0	5.0	0.0	0.0	5.0
Concentrate freight	0.0	2.2	0.0	0.0	2.2
CFEM	0.0	1.2	0.0	2.2	3.4
Other variable costs	2.3	0.8	0.1	1.1	4.3
Total variable costs	9.6	24.2	0.6	3.5	38.0
Fixed costs - BR$ M					
Personnel	14.7	6.6	13.5	7.7	42.5
Maintenance	17.7	5.8	2.0	0.1	25.6
Services	0.5	0.5	0.3	4.9	6.2
Other fixed costs	2.6	1.2	1.0	2.7	7.5
Total fixed costs	35.5	14.1	16.9	15.4	81.8
Total costs - BR$ M	45.1	38.2	17.5	18.9	119.8
FX - BR$:US$	3.61	3.61	3.61	3.61	3.61
Variable - US$ M	2.67	6.70	0.18	0.98	10.52
Fixed - US$ M	9.84	3.90	4.68	4.27	22.68
Total - US$ M	12.51	10.60	4.85	5.24	33.20

Note: Totals may not sum due to rounding.

Fixed costs in the maintenance cost centre were predominately in the mine, for equipment spares and services, both for mine production and development. For the mill area, the main maintenance fixed costs were for equipment spares and mill reline services.

Other fixed costs in the general and administration area included insurances; third party services (outsourced labour, cleaning, security etc.) and other miscellaneous costs.

Table 21-4 shows unit costs for 2015 and 2016. Unit operating costs were stable from 2015 to 2016 at approximately US$33/t, which included a small provision for concentrate transport in the process costs each year (approx. US$0.60/t). These years had similar ratio of variable to fixed costs.

The basis of future costs is changing compared to historical costs for several reasons:

- Mine production is shifting from single sourcing from the Morro Agudo Mine to a combination of the Morro Agudo Mine and satellite mines
- Mine production from Ambrosia Sul will be by open pit, with a different cost basis to the Morro Agudo Mine
- Ambrosia Norte and Bonsucesso will use different underground mining methods from Morro Agudo Mine
- There will be significant mill feed transport costs from satellite mines to the Morro Agudo process plant
- Overall process plant throughput is significantly reduced from approximately 1.0 Mt/a to between 0.67 and 0.83 Mt/a.

Costs for the Morro Agudo Mine mining, processing, maintenance and general and administration were based on historical costs, by considering the fixed and variable cost components. This applies mainly to years 2018 to 2020. Historical costs continue to provide the basis for process and general and administration costs for remaining years. A separate build-up of mining costs was developed for the current and planned satellite mines.

Forecast variable costs for electricity and consumables are based on anticipated specific consumption rates and unit prices. The electricity unit price forecast is shown in Table 21-5. The 2018 electricity price forecast in BR$/kWh has increased by approximately 45% from 2016 levels of BR$ 0.142/kWh.

Table 21-4: 2015 and 2016 Morro Agudo Unit Costs

	Mine	Process	Maintenance	General & Admin	Total
2015 unit costs					
Tonnes x 1,000 - 2015	1,007	1,007	1,007	1,007	1,007
Variable unit costs US$/t	3.08	7.05	0.21	0.45	10.78
Fixed unit costs US$/t	10.71	3.80	5.00	2.65	22.16
Total unit costs US$/t	13.79	10.84	5.21	3.10	32.94
2016 unit costs					
Tonnes x 1,000 - 2016	1,011	1,011	1,011	1,011	1,011
Variable unit costs US$/t	2.64	6.63	0.17	0.96	10.41
Fixed unit costs US$/t	9.73	3.85	4.63	4.22	22.43
Total unit costs US$/t	12.38	10.48	4.80	5.19	32.84

Note: Totals may not sum due to rounding.

Table 21-5: LOMP Electricity Unit Price Forecast

	2016	2017	2018	2019	2020	2021 to 2029
Electricity price BR$/kWh	0.142	0.338	0.206	0.184	0.194	0.193

Note: Calendar years used are for illustrative purposes.

21.3.2 Mine Operating Costs

Mine operating costs include those costs associated with the excavation of lateral and vertical development headings, production, and transport of mill feed material from the mine, and the infrastructure required to support those operations.

This includes drilling, blasting, ground support, haulage and mine services, as well as permanent infrastructure such as mine dewatering sumps and pumping installations, mine ventilation fans and controls (doors, regulators), and electrical substations to support extension of operations.

Mine costs at the Morro Agudo Mine are well developed based upon historical values from previous years' production and development. Unit costs at the Morro Agudo Mine are expected to rise as production rates decrease and the associated fixed costs can not be reduced proportionally.

Mine costs for Ambrosia Sul are primarily contractor costs associated with the mobile equipment rental and haulage to the Morro Agudo mill and are not subject to high variability.

Ambrosia Norte/Bonsucesso costs have been developed at a PEA level from comparable unit costs from either the Morro Agudo Mine or Votorantim's Vazante Operations. These costs have limited breakdown and are limited to development and production costs, mill feed transport to the Morro Agudo process plant, and other costs. The level of detail on these costs will be need to be further developed in future study stages.

The mining operating cost forecast is included as Table 21-6.

21.3.3 Process Operating Costs

Process costs for the Morro Agudo Project are predominantly variable costs. Electricity is biggest variable cost item, and steel grinding media, mill liner materials and potassium amyl xanthate are the other main consumables costs. Forecast variable costs have been calculated from specific consumption rates and unit prices. Historical consumption rates have been assumed to continue.

Tailings services have been estimated from historical costs, assuming that all future arising tailings production will be dewatered and reclaimed for sale as agricultural lime.

The LOM forecast process operating costs are shown in Table 21-7.

Other mill variable costs include CFEM (see Section 22.2.9).

Process unit costs have increased compared with historical levels, mainly due to increased electricity costs (higher prices), higher tailings unit costs as the proportion of tailings recovered for agricultural lime has increased since 2015, and the higher unit costs contributed by fixed costs as throughput has reduced. The forecast also includes some reallocation of costs that have been historically included in the general and administration area (e.g. parts of CFEM).

21.3.4 General and Administrative Operating Costs

General and administration costs include general administration and management, safety, health and environment, IT, and laboratory services. Cost centres include salaries, social charges and benefits; insurances; and third party services (outsourced labour, cleaning, security etc.).

Overall LOM personnel costs are US$9.9 million, services US$8.0 million and others $2.8 million.

21.3.5 Operating Cost Summary

The schedule of operating costs for the LOMP is shown in Table 21-8. Table 21-9 provides the unit operating cost. Overall LOM unit costs are projected to be US$38.70/t.

Table 21-6: Forecast LOM Costs by Deposit (US$ million)

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total 2018–2028
Morro Agudo	10.0	10.7	10.6	11.1	—	—	—	—	—	—	—	42.5
Ambrosia Sul	7.4	6.7	8.5	—	—	—	—	—	—	—	—	22.6
Ambrosia Norte/Bonsucesso	—	—	2.8	4.6	14.0	14.8	14.0	11.1	10.9	10.1	6.2	88.4
Total	***17.5***	***17.3***	***21.9***	***15.8***	***14.0***	***14.8***	***14.0***	***11.1***	***10.9***	***10.1***	***6.2***	***153.5***

Note: Calendar years used are for illustrative purposes. Totals may not sum due to rounding

Table 21-7:Forecast Process Operating Costs

Cost Area	US$ M	US$/t
Variable		
Electricity	24.9	3.17
Steel grinding balls	3.3	0.43
Potassium amyl xanthate	4.5	0.57
Liner materials	3.8	0.48
Other materials	5.1	0.65
Tailings services	20.5	2.61
Other variable costs	19.8	2.52
Total mill variable costs	81.9	10.42
Fixed		
Personnel	23.3	2.96
Maintenance	19.8	2.52
Services	1.0	0.13
Other	4.2	0.54
Total mill fixed	48.3	6.15
Total mill costs	***130.2***	***16.58***

Note: Totals may not sum due to rounding.

Table 21-8: LOM Morro Agudo Project Operating Cost Forecast (US$ million)

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
Mining variable costs	7.8	7.7	10.6	6.3	9.5	10.3	9.5	6.6	6.4	5.5	3.2	83.5
Mining fixed costs	9.6	9.7	11.1	9.4	4.5	4.5	4.5	4.5	4.5	4.5	3.0	69.8
Process variable costs	8.3	8.4	6.9	8.6	7.3	7.4	7.9	7. 8	7.7	7.1	4.2	81.6
Process fixed costs	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	48.3
General variable costs	0	0	0	0	0	0	0	0	0	0	0	0.0
General fixed costs	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	20.7
Total variable costs	16.1	16.1	17.6	14.9	16.9	17.8	17.4	14.4	14.0	12.7	7.4	165.1
Total fixed costs	15.9	16.0	17.4	15.7	10.8	10.8	10.8	10.8	10.8	10.8	9.3	138.9
Total costs	***32.0***	***32.1***	***34.9***	***30.6***	***27.6***	***28.5***	***28.2***	***25.2***	***24.8***	***23.5***	***16.6***	***304.3***

Note: Calendar years used are for illustrative purposes. Totals may not sum due to rounding.

Table 21-9: Morro Agudo Unit Costs by Area and Total (US$/t)

Unit Costs	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
Mining - Morro Agudo	23.59	20.61	20.64	18.92								20.75
Mining - Ambrosia Sul	21.11	22.15	102.81									30.54
Mining - Ambrosia Norte/Bonsucesso			39.30	19.45	19.89	20.74	18.43	14.80	14.65	14.59	15.31	17.43
Mining - total	*22.47*	*21.18*	*32.56*	*19.07*	*19.89*	*20.74*	*18.43*	*14.80*	*14.65*	*14.59*	*15.31*	*19.52*
Processing	16.33	15.75	17.02	15.66	16.59	16.49	16.14	16.19	16.27	16.72	21.19	16.54
General	2.44	2.33	2.83	2.27	2.67	2.63	2.48	2.50	2.53	2.73	4.65	2.64
Total	***41.23***	***39.25***	***52.41***	***37.01***	***39.15***	***39.86***	***37.05***	***33.50***	***33.46***	***34.04***	***41.15***	***38.70***

Note: Calendar years used are for illustrative purposes. Totals may not sum due to rounding.

21.4 Comments on Section 21

The PEA LOMP includes US$81.7 million of capital, including for mine development for Ambrosia Norte and Bonsucesso and sustaining capital. There is minimal capital allocated in the process area, as it is no longer fully utilized in this plan. Neither is there significant capital allocated to the Morro Agudo Mine, as it is ramping down to end of its life.

Historically, unit operating costs have totally approximately US$33/t, with mine accounting for approximately US$13/t and process about US$11/t. Projected PEA LOM unit costs are approximately US$39/t.

The basis of costs is changing due to ramp-down of Morro Agudo Mine, mill feed supply from satellite deposits mined by open pit and alternative underground mining methods, and a reduction in overall tonnage milled at the Morro Agudo process plant.

Historical variable and fixed costs have been used as the basis for cost projections for the Morro Agudo Mine, process plant and general and administration. These have been adjusted, where appropriate, to reflect changing input prices, particularly electricity. Mining operating costs for Ambrosia Sul, Ambrosia Norte and Bonsucesso have been developed at scoping level, based on internal benchmarks. The combination of historical and benchmark costs is considered a reasonable basis for future costs.

22.0 ECONOMIC ANALYSIS

A mine plan at PEA level has been developed for the Morro Agudo Project. The mine plan is partly based on Inferred Mineral Resources that are considered too speculative geologically to have the economic considerations applied to them that would enable them to be categorized as Mineral Reserves, and there is no certainty that the PEA based on these Mineral Resources will be realized.

The results of the economic analyses discussed in this section represent forward-looking information as defined under Canadian securities law. The results depend on inputs that 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. Information that is forward-looking includes:

- Mineral Resource estimates
- Assumed commodity prices and exchange rates
- The proposed mine production plan
- Projected recovery rates
- Sustaining costs and proposed operating costs
- Assumptions as to closure costs and closure requirements
- Assumptions as to environmental, permitting and social risks.

Additional risks to the forward-looking information include:

- Changes to costs of production from what is assumed
- Unrecognized environmental risks
- Unanticipated reclamation expenses
- Unexpected variations in quantity of mineralised material, grade, or recovery rates
- Geotechnical and hydrogeological considerations during mining being different from what was assumed
- Failure of plant, equipment, or processes to operate as anticipated
- Accidents, labour disputes and other risks of the mining industry.

22.1 Methodology Used

The PEA financial model is a stand-alone model which calculates annual cash flows based on scheduled production from Mineral Resources, assumed processing recoveries, metal sale prices and exchange rates ($US/$BR), projected operating and capital costs and estimated taxes.

The Project has been valued using a discounted cash flow (DCF) approach on a 100% basis. Estimates have been prepared for all the individual elements of cash revenue and cash expenditures for ongoing operations. Cash flows are assumed to occur at the end of each period.

Calendar years used are for illustrative purposes.

22.2 Financial Model Parameters

Votorantim produced a stand-alone PEA financial model for the Morro Agudo Project that was checked and validated by Amec Foster Wheeler. The model included the mine and mill production plans, and all on-site and off-site costs, smelter and refinery payment terms and costs, and estimated taxes. Costs and prices are in real 2018 US dollars and Brazilian Reals.

22.2.1 Mineral Resources and Planned Mine Life

The financial model covers life of mine production from 2018 to 2028. Mineral Resources that support the financial model are as summarized in Section 14.

22.2.2 Metallurgical Recoveries

The financial model includes the projected metal recoveries based on historical performance, metallurgical testwork, and assumptions presented in Section 13.

22.2.3 Smelting and Refining Terms

The financial model assumes sale and treatment of all zinc concentrates at Votorantim's Tres Marias smelter. The assumed conversion cost is US$302/t contained zinc in concentrate, at an overall zinc recovery of 97.0%. Transport costs of approximately $14/dmt are included.

Lead concentrates are sold externally and the financial model includes provision for typical lead treatment charges (US$196 to US$279/dmt concentrate), and transport costs of approximately US$118/dmt. Payment is received for 94% of lead contained in lead concentrate

22.2.4 Metal Prices

Metal prices used were provided in Section 19 (refer to Table 19-1).

Because the zinc concentrate is internally treated at the Tres Marias smelter, a zinc premium is assigned to the mine. This adds revenue of US$205 to US$218/t of recovered zinc at the smelter.

22.2.5 Capital Costs

The financial model includes the LOM capital cost schedule, totalling US$81.7 million (see Section 21.1).

22.2.6 Operating Costs

The financial model includes operating costs outlined in Section 21.2, totalling US$725 million over the LOM.

22.2.7 Working Capital

The financial model includes a schedule of working capital. This includes adjustments for inventories, accounts receivable and accounts payable. There is no net cash generated by working capital changes over the LOM, and it has a negligible effect on mine economics.

22.2.8 Taxes and Royalties

Information on taxation applicable to the Project has been provided by Votorantim.

Corporate Income Tax

Brazilian companies are subject to income tax on their Brazilian and non-Brazilian income.

Corporate income tax, or IRPJ (*Imposto de Renda da Pessoa Jurídica*), is levied on the taxable profits of an entity at a rate of 15.00% (for profits up to approximately $75,000 per year), plus a 10.00% surtax on the excess, which basically provides for a 25.00% tax rate. In addition, the social contribution on profits, or CSLL (*Contribuição Social Sobre o Lucro*), is levied on taxable profits at a 9.00% rate. Thus, the combined applicable rate for income tax (IRPJ plus CSLL) is 34.00%.

Tax losses incurred in one fiscal year may be carried forward indefinitely but the offset with future profits is capped at 30 percent of the taxable income for each year. The carryback of losses is not allowed.

Vazante does not have any special income tax regime and is thus subject to a 34.00% income tax rate, which was considered in the financial model.

Taxable Income

Operating profits are defined as gross operating receipts, less the cost of goods sold or services rendered; commercial, administrative and operating expenses; and other charges, reserves and losses authorized by law. Dividends received from other Brazilian companies and income from premiums on the issuance of new shares is not included in taxable income.

Under the Brazilian system, the taxable basis is the income before income taxes (IRPJ and CSLL), adjusted by add-backs (such as non-deductible expenses) and deductions (such as such as dividend income and equity results from investments).

Depreciation and Amortization

Fixed assets and intangibles are subject to different depreciation and amortization rates according to the useful life of the asset. Accounting and fiscal useful lives may also differ as shown in Table 22-1, and the fiscal useful life is the one used for income tax purposes. For the model, Votorantim calculated an average fiscal depreciation and amortization rate of 6.40%, considering the balances of each category of assets.

Net Operating Losses

Votorantim has not considered any operating or non-operating tax losses in the financial models.

Federal Taxes (PIS and COFINS)

Gross income is subject to the social integration program (*programa de integração social* or PIS) and the social security financing contribution (*contribuição para financiamento de seguridade social* or COFINS) at 1.65% and 7.60% rates respectively, thus for a combined 9.25% rate. These are a non-cumulative (value-added tax type) tax and PIS and COFINS credits may be available. Exports are exempt of PIS and COFINS. The financial model considers the revenue net of such taxes.

State Value-Added Tax (ICMS)

ICMS (*Imposto sobre Circulação de Mercadorias e Serviços*) is a state value-added tax imposed on the supply of goods and services with varying rates according to the state. The ICMS of Minas Gerais state, where Vazante is located, is 18.00%. Supply of goods within Minas Gerais state is subject to 18.00% while sales to other states may be subject to 7.00% (North, Northeast and Central regions and Espírito Santo state) or 12.00% (South and Southeast regions). Exports are exempt of ICMS. The financial model considers the revenue net of ICMS.

Mining Charges (CFEM)

Brazilian companies that hold mining concessions are subject to a royalty payment known as Financial Compensation for the Exploitation of Mineral Resources (*Compensação Financeira pela Exploração de Recursos Minerais* or CFEM), imposed by the Brazilian National Department of Mineral Production (*Departamento Nacional de Produção Mineral* or DNPM).

Table 22-1: Depreciation and Amortization (rate per year)

Asset	Accounting (%)	Tax (%)
Land	0	0
Buildings and other constructions	2	4
Machinery and equipment	5	9
Vehicles	24	24
Furniture and fixtures	10	10
Mines	6	6

Revenues from mining activities are subject to CFEM, based on the sales value of minerals, net of taxes and transportation and insurance expenses. When the produced minerals are used in its internal industrial processes, the amount of CFEM is determined based on deducting the costs incurred to produce them. The rate to be applied varies according to the mineral product (currently 2% for zinc, lead, copper, and silver).

The financial model considers the revenue net of CFEM.

22.2.9 Closure Costs and Salvage Value

The financial model includes total closure costs of US$34 million, mainly allocated in two parcels:

- US$9.3 million in 2024 after the closure of Morro Agudo and Ambrosia Sul Mines
- US$20.1 million in 2029 after closure of all remaining operations.

No salvage value is assumed.

22.2.10 Financing

There are no financing costs in the financial model.

22.2.11 Inflation

Inflation is not included in the financial model.

22.3 Economic Analysis

The economic analysis is based on the production plan provided as Table 22-2.

Over the proposed LOM, the Morro Agudo Project will realize US$719 million in gross revenue, and $588 million in net revenue. Table 22-3 shows the breakdown of revenue between zinc and lead concentrates, and agricultural lime. Zinc concentrate will make up 90% of the net revenue, lead concentrate 5% and sale of agricultural lime 5%.

Table 22-4 shows planned revenue, costs, and cash flow calculations, followed by discounted cash flows and NPV. Over the proposed LOM, the Morro Agudo Project is forecast to earn undiscounted cash flows of $88 million, which results in an NPV of $63 million at a discount rate of 9%. The operation will generate modest free cash flows over most years of the LOM, but will have a negative cash flow in 2020 due to capital investment in the planned Bonsucesso mine.

The net income tax paid over life of mine is forecast at US$69 million.

Considerations of internal rate of return (IRR) are not applicable for the Morro Agudo Project. This is because there is a combination of an existing mining operation with development projects, and the existing mining operation contribution is such that there is a positive cashflow in the first year of the PEA mine plan, i.e. the free cashflow after capital expenditure is positive.

Payback under the assumptions in the PEA is approximately six months. This assumes that all capital expenditure in 2018 will occur at the start of that year.

22.4 Sensitivity Analysis

The sensitivity of NPV was determined against the following parameters:

- Metal prices (all metals)
- Head grade (all metals)
- Site operating costs
- Offsite costs (conversion, treatment and refining charges, transport costs)
- Capital costs.

Table 22-5 shows the summary of NPV for -20% to +20% variations in the above parameters. These are also shown in Figure 22-1.

Table 22-2: Production Plan

Year		2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
Mill feed													
Morro Agudo Mine and pillars	t x 1,000	425	517	516	588	—	—	—	—	—	—	—	2,046
	Zn grade (%)	2.56	2.98	2.83	2.80								2.80
	Pb grade (%)	0.86	0.77	0.82	0.80								0.81
Ambrosia Sul	t x 1,000	352	301	81	—	—	—	—	—	—	—	—	734
	Zn grade (%)	5.35	4.33	4.46									4.83
	Pb grade (%)	0.25	0.12	0.17									0.19
Ambrosia Norte and Bonsucesso	t x 1,000	—	—	70	239	704	715	759	751	742	689	405	5,073
	Zn grade (%)			3.44	2.87	3.44	3.51	3.29	3.33	3.37	3.64	3.24	3.39
	Pb grade (%)			0.39	0.68	0.38	0.50	0.52	0.55	0.44	0.42	0.43	0.47
Total mill feed	t x 1,000	777	818	667	827	704	715	759	751	742	689	405	7,853
	Zn grade (%)	3.82	3.48	3.09	2.82	3.44	3.51	3.29	3.33	3.37	3.64	3.24	3.37
	Pb grade (%)	0.58	0.53	0.70	0.77	0.38	0.50	0.52	0.55	0.44	0.42	0.43	0.54
Assigned recoveries													
Morro Agudo mine and pillars	Zn (%)	90.7	90.7	90.7	90.7								
	Pb (%)	82.9	82.9	82.9	82.9								
Ambrosia Sul	Zn (%)	90.7	90.7	90.7									
	Pb (%)	40.0	20.0	30.0									
Ambrosia Norte and Bonsucesso	Zn (%)			90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	
	Pb (%)			40.0	40.0	40.0	50.0	50.0	50.0	45.0	45.0	45.0	
Total mill feed	Zn (%)	90.7	90.7	90.7	90.5	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.3
	Pb (%)	74.5	77.8	78.9	71.8	40.0	50.0	50.0	50.0	45.0	45.0	45.0	60.4

Mill concentrate production													
	kt Zn metal	27	26	19	21	22	23	23	23	23	23	12	239
Zinc concentrate	Zn grade (%)	40.0	40.0	40.0	40.0	40.0	40.0	40.0%	40.0%	40.0%	40.0%	40.0%	40.0%
	kt Zn conc	67	65	47	53	55	57	56	56	56	56	30	598
	kt Pb metal	3	3	4	5	1	2	2	2	1	1	1	25
Lead concentrate	Pb grade (%)	50.1	50.1	50.1	50.1	50.1	50.1	50.1	50.1	50.1	50.1	50.1	50.1
	kt Pb conc	7	7	7	9	2	3	4	4	3	3	2	51
Limestone co-product (tailings)	t	703	747	613	765	647	655	699	691	683	630	373	7,204

Note: Calendar years used are for illustrative purposes.

Table 22-3: Gross and Net Revenue by Product (US$ million)

Product	Zinc Concentrate	Lead Concentrate	Agricultural Lime	Total
Gross revenue	608	46	64	719
Transport	(8)	(6)	(33)	(47)
Conversion/treatment/refining	(72)	(11)	0	(84)
Net revenue	***528***	***29***	***31***	***588***

Note: Totals may not sum due to rounding.

Table 22-4: Forecast Cashflow (US$ million)

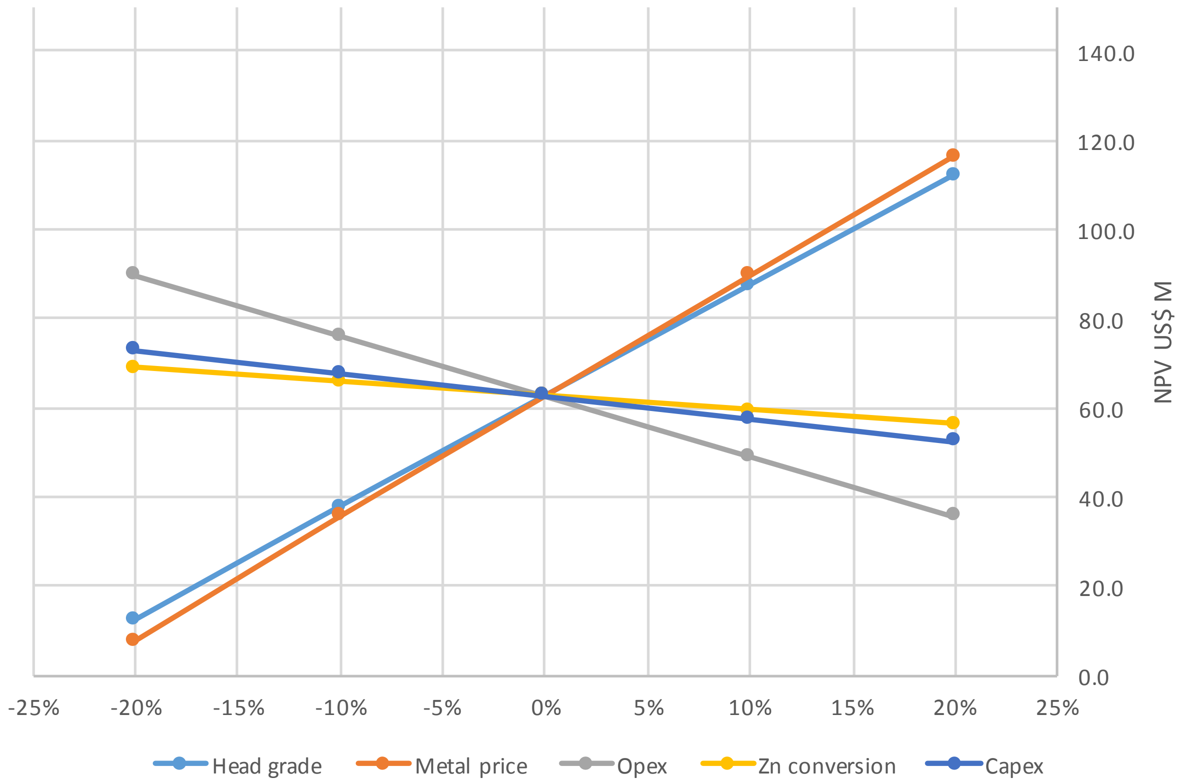
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	Total
Gross payable metal and coproduct	89	82	60	67	62	65	65	66	64	64	35	0	**719**
Offsite costs	(14)	(14)	(11)	(14)	(11)	(12)	(12)	(12)	(12)	(12)	(6)	0	**(131)**
Net revenue	75	68	48	54	51	53	53	53	52	52	29	0	**588**
Operating costs	(32)	(32)	(35)	(31)	(28)	(29)	(28)	(25)	(25)	(23)	(17)	0	**(304)**
Other costs/provisions	(3)	(1)	(1)	(1)	(1)	(1)	(2)	(1)	(1)	(1)	(1)	(0)	**(11)**
EBITDA	40	35	13	22	22	24	24	27	27	27	12	(0)	**273**
Depreciation	(4)	(4)	(5)	(6)	(6)	(7)	(7)	(7)	(8)	(8)	(7)	0	**(69)**
EBIT	36	31	7	17	16	17	17	20	19	20	5	(0)	**204**
Income tax	(12)	(11)	(2)	(6)	(5)	(6)	(6)	(7)	(7)	(7)	(2)	0	**(69)**
Net income	24	20	5	11	10	11	11	13	13	13	3	(0)	**135**
Depreciation	4	4	5	6	6	7	7	7	8	8	7	0	**69**
Provisions	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Working capital	1	0	0	(0)	(0)	0	(0)	(0)	(0)	(0)	(0)	(1)	**0**
Closure	0	(0)	(0)	(0)	(0)	(0)	(9)	(0)	(0)	(3)	(0)	(20)	**(34)**
Capex	(15)	(8)	(13)	(7)	(10)	(6)	(5)	(5)	(4)	(4)	(4)	0	**(82)**
Free cashflow	14	16	(3)	9	6	13	4	15	16	13	6	(21)	**88**
Discounted @ 9%	14	14	(2)	7	4	8	2	8	8	6	2	(8)	
NPV @ 9%	63												

Note: Calendar years used are for illustrative purposes. Totals may not sum due to rounding.

Table 22-5: Sensitivity Analysis (US$ million)

Range	Head Grade (all metals)	Metal Price (all metals)	Operating Cost	Zinc Conversion Cost	Capital Cost
-20%	13	8	90	69	73
-10%	38	36	76	66	68
0%	63	63	63	63	63
10%	87	90	49	60	57
20%	112	117	36	56	52

Figure 22-1: Sensitivity Graph



Note: Figure prepared by Amec Foster Wheeler, 2017.

NPV is most sensitive to changes in metal prices, then head grade. A 20% reduction in metal prices would lead to an NPV of close to zero. NPV is relatively insensitive to capital costs, as remaining capital requirements are comparatively low.

In the event that the Morro Agudo Project would be unable to continue selling agricultural lime co-product, and assuming no change from other base case assumptions, the NPV would drop to US$49 million.

22.5 Comments on Section 22

Over the proposed LOM, the Morro Agudo Project will realize US$719 million in gross revenue, and $588 million in net revenue. Zinc concentrate will make up 90% of the net revenue, lead concentrate 5% and limestone 5%.

Over the proposed LOM, the Morro Agudo Project is forecast to earn undiscounted cash flows of $88 million, which results in an NPV of $63 million at a discount rate of 9%. The operation will generate modest free cash flows over most years of the LOM, but will have a negative cash flow in 2020 due to capital investment in the planned Bonsucesso mine.

NPV is most sensitive to changes in metal prices, then head grade. A 20% reduction in metal prices would lead to an NPV of close to zero. NPV is relatively insensitive to capital costs, as remaining capital requirements are comparatively low. In the event that the Morro Agudo Project would be unable to continue selling agricultural lime co-product, and assuming no change from other base case assumptions, the NPV would drop to US$49 million.

23.0 ADJACENT PROPERTIES

This section is not relevant to this Report.

24.0 OTHER RELEVANT DATA AND INFORMATION

24.1 Agricultural Lime

24.1.1 Introduction

For several years, the Morro Agudo Mine has sold some or all of its flotation tailings to local farmers as a soil modifier. Since 2016, all flotation tailings have been decanted, dried, and reclaimed for sale as agricultural lime.

24.1.2 Specifications

The material is sold under various contracts.

There are specifications to achieve minimum levels of CaO and MgO, while not exceeding limits on cadmium, lead, and moisture. Neutralization potential is also measured to ensure the material will not generate acid rock drainage.

Table 24-1 shows a selection of analyses of the tailings material sold as agricultural lime from 29 June, 2017 to 7 July, 2017 compared with specifications. In all cases, the actual analyses exceeded specifications. This supports the sale of agricultural lime within the current specifications.

24.1.3 Mineral Resource Estimation

The forecast agricultural lime production tonnage was calculated from the forecast of tonnes milled minus the calculated lead and zinc concentrate tonnage forecasts, as follows:

- Tailings tonnes = Mill feed tonnes - Pb concentrate tonnes - Zn concentrate tonnes

Where:

Pb concentrate tonnes = Mill feed tonnes * Pb head grade * Pb recovery / Pb concentrate grade

Zn concentrate tonnes = Mill feed tonnes * Zn head grade * Zn recovery / Zn concentrate grade

Amec Foster Wheeler totalled the proposed mill feed tonnes, and calculated the zinc and lead concentrate tonnes from the formulae above, and subtracted these from the mill feed forecast tonnage for each of the Morro Agudo Mine, Ambrosia Sul, Ambrosia Norte, and Bonsucesso deposits.

Grades for the material are based on the average grades reported from laboratory analyses performed on the June–July 2017 sales batches.

The material is considered to have reasonable prospects of eventual economic extraction because sales contracts are in place, and there is a record of the tailings batches sold meeting contract specifications.

Table 24-1: Selected Limestone Analyses Vs. Specification

Lot #	34	35	36	37	38	Specification
Date analyzed	29-Jun-17	30-Jun-17	03-Jul-17	05-Jul-17	07-Jul-17	
Mass (t)	6,000	6,000	6,000	6,000	6,000	
CaO (%)	28.3	27.8	28.2	27.9	27.8	> 26
MgO (%)	17.8	18	17.9	17.5	18	> 16
Cd (ppm)	16	16	15	17	18	< 20
Pb (ppm)	748	840	680	690	780	< 1,000
% moisture	6.8	6.4	6.5	6.1	6.5	< 10
Neutralization potential	97	95.4	96.2	94.9	96.2	>85
% passing 10#	100	100	100	100	100	100
% passing 20#	99.3	99.5	99	99.1	99.7	> 85
% passing 50%	98.1	97.9	9.8	97.1	97.8	> 82

Table 24-2 summarizes the Inferred Mineral Resources for the agricultural lime material. The QP for the estimate is Mr Douglas Reid, P.Eng., an Amec Foster Wheeler employee.

Factors that may affect the agricultural lime Mineral Resource estimate include:

- Assumptions as to the amount of mill feed tonnes and concentrate produced
- Assumptions that the material to be mined in the future will have similar CaO and MgO contents as those currently produced from the Morro Agudo Mine
- Assumption that the average batch grades are representative of the material that will be produced, and that all contract specifications can be met or exceeded
- Assumption that an agricultural lime market will continue to be available over the planned LOM.

24.1.4 Comment on Agricultural Lime

Agricultural lime co-product revenue has been included in the financial model for future tailings production only. There are historical stocks of Morro Agudo tailings that may, in the future, be analyzed and reclaimed for agricultural lime recovery, provided that the material meets specifications, and is economically viable to transport to customers.

Table 24-2: Agricultural Lime Mineral Resource Statement

	Tonnage (Mt)	CaO (%)	MgO (%)
Inferred	7.2	28.0	17.8

Notes to accompany Mineral Resource table for the agricultural lime estimate:

1. Mineral Resources have an effective date of 31 December 2016; Douglas Reid, P.Eng., an Amec Foster Wheeler employee, is the Qualified Person responsible for the Mineral Resource estimate. Mijneral Resources are reported on a 100% basis.
2. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.
3. Tonnage estimate is based on Mill feed tonnes - Pb concentrate tonnes - Zn concentrate tonnes, where: Pb concentrate tonnes = Mill feed tonnes * Pb head grade * Pb recovery / Pb concentrate grade and Zn concentrate tonnes = Mill feed tonnes * Zn head grade * Zn recovery / Zn concentrate grade
4. Grade estimate is based on the average grades reported from laboratory analyses performed on five agricultural lime sales batches during June–July 2017
5. Sales contracts are in force for the agricultural lime material. Sales batches during June–July 2017 were above contract specifications.
6. Tonnages are reported as metric tonnes; all grades are rounded to one decimal places.
7. Rounding as required by reporting guidelines may result in apparent summation differences.

24.2 Risks and Opportunities

24.2.1 Geology and Exploration

Opportunities

- There may be continuity of mineralization between Ambrosia Norte and Bonsucesso
- Additional mineralization, including higher-grade material, may be identified during infill drilling at Ambrosia Norte and Bonsucesso, and south of the Ambrosia Sul mine
- Infill drilling may support increases in confidence categories for some of the resource blocks at Ambrosia Norte and Bonsucesso, such that this material can potentially be converted to Mineral Reserves
- There are a number of regional exploration targets, that with further work, represent an excellent upside opportunity to potentially add to the resource base

Risks

- Exploration drilling programs are currently restricted in certain areas, in particular in some areas of the Ambrosia Trend. There is a risk that some of the exploration upside potential indicated in this Report may not be tested if the ground cannot be accessed for drill testing.

24.2.2 Mineral Resources

Opportunity

- The Mineral Resource estimate is based only on sulphide mineralization. Oxide mineralization at Ambrosia Norte is not included because it cannot be treated through the Morro Agudo process plant. If a viable treatment route can be identified, this material represents Project upside
- Not all available sill pillars and pillar materials have been tabulated as Mineral Resources. There is upside potential for the Project if some or all of this material can support Mineral Resource estimation.

Risks

- As lead provides 20% of the revenue for the Morro Agudo Mine, there is a metal-at-risk issue from not capping the higher-grade lead composites
- There is a risk for the lead content estimated at Ambrosia Sul because no capping has been employed to restrict the influence of high-grade lead composites
- The drill spacing study completed as part of the Ambrosia Sul resource classification review indicates a much closer drill spacing may be required to support Measured Mineral Resources than is currently assumed by Votorantim. The closer spacing requirement is supported by the variogram ranges. There is a risk that some or all of the Measured Mineral Resources will not have the appropriate drill support until grade control drilling is completed
- The drill spacing study completed as part of the Bonsucesso resource classification review indicates a much closer drill spacing may be required to support Indicated Mineral Resources than is currently assumed by Votorantim. The closer spacing requirement is supported by the variogram ranges
- A number of the Mineral Resource assumptions for reasonable prospects of eventual economic extraction at Ambrosia Norte and Bonsucesso are based on analogues to Morro Agudo, including mining costs and metallurgical recoveries. Actual data collected from the deposits may vary from these assumptions
- The tonnages and grade for the potentially recoverable sill pillars are based on assumptions derived from the Morro Agudo Mine run-of-mine material. Actual data collected from the pillars may vary from these assumptions
- The agricultural lime Mineral Resource estimate may be affected by the amount of mill feed tonnes and concentrate produced; the material to be mined in the future will have similar CaO and MgO contents as those currently produced from the Morro Agudo Mine; average batch grades are representative of the material that

will be produced, and that all contract specifications can be met or exceeded; and that an agricultural lime market will be available over the LOM.

24.2.3 Mine Plan

Opportunities

- The PEA mine plan is based on a subset of the Mineral Resource estimate. The excluded material remains as upside potential.

Risks

- The mine plan assumes that the hydrological and geotechnical setting for the Ambrosia Norte and Bonsucesso deposits is an analogue of that found at Morro Agudo. Actual data collected from the deposits may vary from these assumptions
- The mine plan dilution factor is based upon typical factors for similar types of underground mining operations. If the dilution factor is higher than estimated, there is a risk of higher haulage costs to Morro Agudo process plant from the Ambrosia Trend deposits
- The current Morro Agudo Mine plan has included Inferred Mineral Resources in potentially recoverable pillars within historically-mined areas where the survey information has been lost. The assumptions on these areas in the mine plan may vary from actuals once a 3D survey is completed
- Mine capital and operating costs in years 2020–2021 of the PEA may underestimate the actual requirements during the ramp-up period for the planned Ambrosia Norte and Bonsucesso operations.

24.2.4 Metallurgy and Process

Opportunities

- The lead second cleaner column, which was installed and commissioned in early 2017, may allow a consistent increase in lead concentrate grade to up to 55% Pb. It may also allow Morro Agudo Operations to exceed the lead recovery levels currently assumed in the production plan for lower lead head grade mill feed material, while achieving target lead concentrate specifications
- The zinc regrind mill may allow Morro Agudo to target higher zinc concentrate grades, above the 40% assumed in the LOMP
- There are historical stocks of Morro Agudo tailings that may, in the future, be analyzed and reclaimed for limestone recovery, provided that the material meets specifications and is economically viable to transport to customers. Amec Foster

Wheeler notes that limestone recovery from Deposit 2 may only be possible in conjunction with retreatment in the mill as the lead content likely exceeds limestone specification

- Material within Deposit 2 may provide a source of additional mill feed, if this material can support Mineral Resource and Mineral Reserve estimation
- Excess plant capacity may support higher lead and zinc recoveries and improved concentrate grades.

Risks

- Metallurgical accounting, due to uncertainties arising from the tailings (barrage) treatment through the mill over the last two years
- No metallurgical testwork has as yet been completed on mineralization from Ambrosia Norte and Bonsucesso. Actual testwork results could result in recoveries that are different to the projected recoveries
- The PEA assumes that there will be no significant mineralogical differences in mill feed sourced from Ambrosia Norte and Bonsucesso and that current blending practices will continue. If the mineralogy varies from expectations, there may be additional ROM handling and blending requirements that may potentially result in a minor increase in process operating costs
- There is limited extended assay information on Ambrosia Sul, Ambrosia Norte and Bonsucesso. It may be possible that gangue mineralogy deviates sufficiently from the Morro Agudo Mine assumptions that some or all of the tailings material proposed to be sold will fail to meet limestone specifications (e.g. excess pyrite content, insufficient CaO and MgO). This would affect co-product recovery and may reduce the economic attractiveness of this material
- Production in the LOMP is not sufficient to keep the mill full, and therefore it may be difficult to contain operating costs to economic levels
- The mine plan assumes fixed costs, based on treatment of 1 Mt/a of mill feed. However, the plan has variable annual mill feed rates, which results in throughput ranges from 0.67–0.83 Mt/a. Assumptions from the steady-state production for the ratio between fixed and variable costs may not be applicable to the lower throughput rates. This could result in higher overall costs than currently predicted
- In the event that Tres Marias was unable to process concentrates from the Morro Agudo Project, the process plant would be forced to significantly increase the zinc concentrate target to achieve acceptable specifications for external customers (e.g. >48% Zn). This may result in a reduction in zinc recovery, which might be partially offset by modifications to the flotation circuit albeit at higher capital and operating

costs. In addition, the Morro Agudo Project would be assigned payable factors and treatment charges that are significantly less favourable than those for Tres Marias. For example, it would not receive the smelter premium currently assigned from Tres Marias to the Project, and it would pay much higher transport costs to external customers. The combination of these factors would significantly reduce the profitability of the Morro Agudo Project or potentially render the Project sub-economic

- If Tres Marias is unable to keep the current balance of different feed supplies to control chemistry and costs, then there is a risk that the zinc premium that is assumed to be paid could be reduced, thereby reducing the assumed profitability of the Project, or potentially rendering the Project sub-economic.

24.2.5 Infrastructure

Risks

- Decreases in rainfall may cause lower reservoir and river levels, potentially impacting the ability of the hydroelectric stations to provide sufficient power to meet operational needs.

24.2.6 Tailings

Opportunities

- If historical material in the tailings deposits can support Mineral Resource estimation such that it can be retreated through the plant, or be shown to meet specifications for sale as agricultural lime, there is potential to reduce closure and rehabilitation costs.

Risks

- Tailings deposits 1, 2, and 3 have been classified by Geoconsultoria under the Brazilian Legislation Art. 3 of COPAM Normative Resolution No. 87, dated 06/17/2005. as “Class III – high Potential for Environmental Damage”. In addition, using results of the dam break study demonstrating the potential for transported tailings to impact the environment up to a distance of 5 km, the deposits are classified as “Very High Risk”.

24.2.7 Environmental, Closure, Permitting and Social

Risks

- Closure costs estimated in the 2016 closure plan may be insufficient to accommodate all decommissioning and rehabilitation costs, as they do not appear to include all of the proposed development along the Ambrosia Trend
- Sending general waste to an unlicenced facility carries a potential liability risk if pollution and seepage occur from the waste facility
- Authorization from the competent environmental authorities is required prior to work being conducted that may affect Permanent Preservation Areas (APPs). There is a risk that future approvals to impact APPs may not be granted for mineral concessions where the approval process has not been completed, and this may affect planned work programs such as exploration and drilling activities.

24.2.8 Financial Analysis

- Creation of new taxes, fees, and/or royalties or significant changes to the assumptions as to these in the Report will affect the cashflow estimates
- Hedging is not considered in the financial evaluation, which is performed at the mine level. Votorantim has corporate hedging arrangements in place. Should a future decision be made to implement hedging at the mine level, the cashflow estimates could be affected.

25.0 INTERPRETATION AND CONCLUSIONS

25.1 Introduction

The QPs note the following interpretations and conclusions in their respective areas of expertise, based on the review of data available for this Report.

25.2 Mineral Tenure, Surface Rights, Water Rights, Royalties, and Agreements

Amec Foster Wheeler was provided with legal opinion that supports that Project ownership is in the name of Votorantim Metais Zinco S.A.

25.3 Geology and Mineralization

The Morro Agudo and Ambrosia Trend deposits are classified as examples of Irish-type sedimentary hosted deposits.

The geological setting, mineralization style, and structural and stratigraphic controls are sufficiently well understood to provide useful guides to exploration, Mineral Resource estimation, and mine planning.

25.4 Exploration, Drilling and Analytical Data Collection in Support of Mineral Resource Estimation

Exploration completed to date has resulted in delineation of a number of mineral deposits and exploration targets.

In total, there are 1,003 holes (250,169 m) completed outside the Morro Agudo Mine and the Ambrosia Trend areas. Within the Morro Agudo Mine, there are 3,670 holes (493,757.31 m) of drilling, and within the Ambrosia Trend, 584 core holes (96,296 m) have been completed.

The quantity and quality of the lithological, recovery, collar and downhole survey data collected are consistent with industry standards and are adequate to support Mineral Resource estimation and mine planning.

In some cases, drill intercepts, and thus sample lengths, are perpendicular to the mineralized bodies and the sample length will be equal to the true thickness. In most cases, however, the true thickness is less than the sample thickness because the drill holes intersect the mineralized bodies at oblique angles.

Sampling methods for core samples are consistent with industry practices and adequate to support Mineral Resource estimation and mine planning.

Sample preparation procedures at the mine laboratory and at ALS Global are consistent with typical industry practices at the time the samples were prepared, and are adequate to support Mineral Resource estimation. Sample analysis at the mine laboratory and ALS Global was performed using standard procedures that are widely used in the industry at the time the analyses were performed. In both cases, analytical procedures are adequate to support Mineral Resource estimation and mine planning.

Amec Foster Wheeler considers the QA/QC data collected between 2011 and 2016 at the Morro Agudo Mine to be adequately accurate and precise to support Mineral Resource estimation and mine planning. A re-assay program designed to verify the quality of pre-2011 data was initiated in early 2017. Preliminary results suggest that those data are indeed adequate to support Mineral Resource estimation. QA/QC measures for the deposits on the Ambrosia Trend began in about 2008. Evaluation of the Ambrosia Trend QA/QC data indicate that the analytical data are adequately precise and accurate to support Mineral Resource estimation and mine planning.

The density data determination methods employed at the Project are widely used in the mineral industry, and the procedures are adequate to support Mineral Resource estimation and mine planning.

Sample security procedures met industry standards at the time the samples were collected. Current sample storage procedures and storage areas are consistent with industry standards.

Data collected were subject to validation. Verification is performed on all digitally collected data uploaded to the database, and includes checks on surveys, collar coordinates, lithology data, and assay data. The checks are appropriate, and consistent with industry standards.

External audits and reviews were performed in 2012 and 2017. Votorantim advised that recommendations from these external audits were taken into consideration and applied to improve the resource estimation process.

Amec Foster Wheeler performed a gap analysis in support of this Report. As part of his 2017 site visit, the QP performed high-level reviews of the database and procedures were performed. These included reviews of sampling procedures, geological logging procedures, core drilling and core handling procedures, and QA/QC procedures.

25.5 Metallurgical Testwork

The Morro Agudo Mine and Ambrosia Sul mineralized materials can be processed using a simple and conventional flowsheet and reagent suite. It is assumed that Ambrosia Norte and Bonsucesso materials will have similar recovery behaviours to those seen for Morro Agudo Mine and Ambrosia Sul. While it is plausible to believe that metallurgical performance will be similar to Morro Agudo and Ambrosia Sul, this can only be confirmed once testwork is completed.

Zinc recoveries of approximately 90% are achievable from Morro Agudo and Ambrosia Sul mill feed material containing around 3% Zn. However, insufficient reagent additions or coarse grinds could cause significant deteriorations in zinc recovery. There is potential to significantly increase zinc concentrate grade, if customer requirements favour this.

Lead recoveries are more sensitive to head grade and are more variable. Lead recovery is expected to fall for the satellite deposits at Ambrosia Sul, Ambrosia Norte and Bonsucesso due to lower lead grades.

The Morro Agudo plant produces clean, low-iron, zinc concentrates. The main impurity in zinc concentrate is dolomite, which contains CaO and MgO. There are no other known deleterious elements in zinc concentrate.

There are no known deleterious elements in the lead concentrate, and no penalties are applied by customers.

25.6 Mineral Resource Estimates

Mineral Resource estimation was performed by Votorantim staff. Grade estimates were completed for zinc and lead. Models were created depending on the deposit, of lithology, grade envelopes, and breccia zones.

One metre composites were created for the deposits, based on the most common sampling interval. Density values were assigned to block models based on mineralization type and lithology.

No grade capping was used for the Morro Agudo Mine, Ambrosia Sul, or Ambrosia Norte deposits, but was used for Bonsucesso.

Estimation used OK or ID2 interpolation. The resulting estimate was validated using a combination of visual, swath plot, and Herco checks.

Amec Foster Wheeler reviewed Mineral Resource development, construction, estimation procedures, classification, and statements for the Morro Agudo Project, and conducted independent validation of the block model.

Mineral Resources have been estimated using standard practices for the industry, and conform to the 2014 CIM Definition Standards.

Factors that may affect the Mineral Resource estimates for the mineral deposits include: additional infill and step out drilling; changes in local interpretations of mineralization geometry and continuity of mineralization zones; density and domain assignments; changes to design parameter assumptions that pertain to stope design; dilution from internal and contact sources; changes to geotechnical, hydrogeological, and metallurgical recovery assumptions; and changes to the assumptions used to generate the NSR value including long-term commodity prices and exchange rates.

Factors that may affect the Mineral Resource estimates for the potentially recoverable pillar materials include: ability to safely enter the mined-out portions of the Remaining Area; geotechnical assumptions; assumptions as to the pillar dimensions that can be extracted; assumptions as mineralization grade; and assumptions as to metallurgical recovery.

Factors that may affect the agricultural lime Mineral Resource estimate include: assumptions as to the amount of mill feed tonnes and concentrate produced; assumptions that the material to be mined in the future will have similar CaO and MgO contents as those currently produced from the Morro Agudo Mine; assumption that the average batch grades are representative of the material that will be produced, and that all contract specifications can be met or exceeded; and assumptions that an agricultural lime market will continue to be available over the planned LOM.

25.7 Mine Plan

The PEA is based on mill feed material to be sourced from the operating underground Morro Agudo Mine, the newly-developed open pit Ambrosia Sul Mine, and the Ambrosia Norte and Bonsucesso deposits that are assumed to be mined using underground mining methods.

Mining will be continuous until 2028, until the Mineral Resources for the four deposits are depleted. The primary focus of the mining sequence is to maintain a steady flow of material to the Morro Agudo process plant at an average rate of 1,900 t/d.

25.8 Recovery Plan

The Morro Agudo mill uses a conventional crushing, grinding and flotation circuit to produce separate lead and zinc sulphide concentrates.

The plant capacity is significantly in excess of the tonnages to be treated in the LOMP

25.9 Infrastructure

Morro Agudo is a mature operation with built infrastructure in place and no plans for future expansion of the existing site infrastructure.

Ambrosia Sul open pit is a short life operation with supporting functions and infrastructure being provided by the Morro Agudo site.

The PEA design for Ambrosia Norte/Bonsucesso infrastructure assumes integration with the overall Morro Agudo site for support functions such as engineering, geology, environmental, permitting etc.

Infrastructure requirements for Ambrosia Norte/Bonsucesso have been evaluated to a PEA level to support underground mining activities.

25.10 Environmental, Permitting and Social Considerations

25.10.1 Environmental Considerations

Compilation of the results from monitoring programs, research studies, and public data was completed in 2017 for climate, air quality, noise, hydrology, groundwater, water quality, seismicity, biology, and social setting.

Environmental licensure requires a number of on-going monitoring programs. Votorantim provided documentation that supported that the required 2016 monitoring and reporting was completed, and the reports sent to the relevant regulatory authorities.

25.10.2 Tailings Storage Facilities

There are three TSFs, Deposits 1, 2, and 3. The tailings are extracted, marketed, and sold as corrective soil/limestone powder to the agricultural sector.

25.10.3 Closure

Conceptual closure plans are developed for the Morro Agudo Mine. Closure costs were estimated by Golder in 2014 to be US$ 18.3 million.

25.10.4 Water Management

The approved water monitoring plan requires minimum flow, surface, effluents, groundwater and hydrobiological quality monitoring as stated in the three Operating Licenses.

25.10.5 Permitting Considerations

Operations must adhere to specific federal, state, and local regulations and requirements. The mine holds a number of current permits in support of the current operations. Compliance with permitting is monitored via semi-annual evaluations carried out by consulting companies, and annual audits.

25.10.6 Social Considerations

Community consultations are on-going, and Votorantim has developed Community Engagement Relations Plans.

25.11 Markets and Contracts

Zinc concentrate production from Morro Agudo is sold internally to the Tres Marias smelter, owned by Votorantim. Morro Agudo concentrates represent about 13% of the smelter feed tonnage. Tres Marias realizes a zinc premium on its zinc metal production due to the quality of its product. This premium is attributed to Morro Agudo, for the portion of zinc production realized from its concentrates.

Lead concentrates are shipped via the Port of Itaguai to customers in China. Concentrate is delivered from the mine site to receiving Chinese ports in bulk bags, and each shipment is between 800 and 1,200 t. Contracts are in place with a Chinese smelter.

Votorantim has contracts in place with local farmers to sell limestone recovered from mill tailings.

25.12 Capital Cost Estimates

The PEA LOMP includes US$81.7 million of capital, including for mine development for Ambrosia Norte and Bonsucesso and sustaining capital. There is minimal capital allocated in the process area, as it is no longer fully utilized in this plan. Neither is there significant capital allocated to the Morro Agudo Mine, as it is ramping down to end of its life.

25.13 Operating Cost Estimates

Historically, unit operating costs have totally approximately US$33/t, with mine accounting for approximately US$13/t and process about US$11/t. Projected PEA LOM unit costs are approximately US$39/t.

The basis of costs is changing due to ramp-down of Morro Agudo Mine, mill feed supply from satellite deposits mined by open pit and alternative underground mining methods, and a reduction in overall tonnage milled at the Morro Agudo process plant.

Historical variable and fixed costs have been used as the basis for cost projections for the Morro Agudo Mine, process plant and general and administration. These have been adjusted, where appropriate, to reflect changing input prices, particularly electricity. Mining operating costs for Ambrosia Sul, Ambrosia Norte and Bonsucesso have been developed at scoping level, based on internal benchmarks. The combination of historical and benchmark costs is considered a reasonable basis for future costs.

25.14 Economic Analysis

Under the assumptions in this Report, the Morro Agudo Project shows a positive cash flow over the life-of-mine. The PEA mine plan is achievable under the set of assumptions and parameters presented.

The mine plan is partly based on Inferred Mineral Resources that are considered too speculative geologically to have the economic considerations applied to them that would enable them to be categorized as Mineral Reserves, and there is no certainty that the PEA based on these Mineral Resources will be realized.

25.15 Risks and Opportunities

A number of risks and opportunities were identified by Amec Foster Wheeler staff, and have been discussed in the Report in the relevant discipline areas, and in Section 24.

Opportunities include:

- There may be continuity of mineralization between Ambrosia Norte and Bonsucesso
- Additional mineralization, including higher-grade material, may be identified during infill drilling at Ambrosia Norte and Bonsucesso, and south of the Ambrosia Sul Mine
- Infill drilling may support increases in confidence categories for some of the resource blocks at Ambrosia Norte and Bonsucesso, such that this material can potentially be converted to Mineral Reserves
- There are a number of regional exploration targets, that with further work, represent an excellent upside opportunity to potentially add to the resource base
- The Mineral Resource estimate is based only on sulphide mineralization. Oxide mineralization at Ambrosia Norte is not included because it cannot be treated through the Morro Agudo process plant. If a viable treatment route can be identified, this material represents Project upside
- Not all available sill pillars and pillar materials have been tabulated as Mineral Resources. There is upside potential for the Project if some or all of this material can support Mineral Resource estimation
- The PEA mine plan is based on a subset of the Mineral Resource estimate. The excluded material remains as upside potential
- The lead second cleaner column, which was installed and commissioned in early 2017, may allow a consistent increase in lead concentrate grade to up to 55% Pb. It may also allow Morro Agudo Operations to exceed the lead recovery levels currently assumed in the production plan for lower lead head grade mill feed material, while achieving target lead concentrate specifications
- The zinc regrind mill may allow Morro Agudo to target higher zinc concentrate grades, above the 40% assumed in the LOMP
- There are historical stocks of Morro Agudo tailings that may, in the future, be analyzed and reclaimed for limestone recovery, provided that the material meets specifications and is economically viable to transport to customers. Amec Foster

Wheeler notes that limestone recovery from Deposit 2 may only be possible in conjunction with retreatment in the mill as the lead content likely exceeds limestone specification

- Retreatment of the historical tailings deposit may provide a source of additional mill feed, if this material can support Mineral Resource and Mineral Reserve estimation
- Excess plant capacity may support higher lead and zinc recoveries and improved concentrate grades
- If historical material in the tailings deposits can support Mineral Resource estimation such that it can be retreated through the plant, or be shown to meet specifications for sale as agricultural lime, there is potential to reduce closure and rehabilitation costs.

Risks include:

- Exploration drilling programs are currently restricted in certain areas, in particular in some areas of the Ambrosia Trend. There is a risk that some of the exploration upside potential indicated in this Report may not be tested if the ground cannot be accessed for drill testing
- The drill spacing study completed as part of the Ambrosia Sul resource classification review indicates a much closer drill spacing may be required to support Measured Mineral Resources than is currently assumed by Votorantim. There is a risk that some of the Measured Mineral Resources will not have the appropriate drill support until grade control drilling is completed
- A number of the Mineral Resource assumptions for reasonable prospects of eventual economic extraction at Ambrosia Norte and Bonsucesso are based on analogues to Morro Agudo, including mining costs and metallurgical recoveries. Actual data collected from the deposits may vary from these assumptions
- The tonnages and grade for the potentially recoverable sill pillars are based on assumptions derived from the Morro Agudo Mine run-of-mine material. Actual data collected from the pillars may vary from these assumptions
- The Mineral Resource estimate for agricultural lime may be affected by concentrate production, ability to produce tailings that are at or above specifications, and the continued existence of an agricultural lime market
- The mine plan assumes that the hydrological and geotechnical setting for the Ambrosia Norte and Bonsucesso deposits is an analogue of that found at Morro Agudo. Actual data collected from the deposits may vary from these assumptions
- The mine plan dilution factor is based upon typical factors for similar types of underground mining operations. If the dilution factor is higher than estimated,

there is a risk of higher haulage costs to Morro Agudo process plant from the Ambrosia Trend deposits

- The current Morro Agudo Mine plan has included Inferred Mineral Resources in potentially recoverable pillars within historically-mined areas where the survey information has been lost. The assumptions on these areas in the mine plan may vary from actuals once a 3D survey is completed
- Mine capital and operating costs in years 2020–2021 of the PEA may underestimate the actual requirements during the ramp-up period for the planned Ambrosia Norte and Bonsucesso operations
- Tailings deposits 1, 2, and 3 have been classified by Geoconsultoria under the Brazilian Legislation Art. 3 of COPAM Normative Resolution No. 87, dated 06/17/2005. as “Class III – high Potential for Environmental Damage”. In addition, using results of the dam break study demonstrating the potential for transported tailings to impact the environment up to a distance of 5 km, the deposits are classified as “Very High Risk
- Metallurgical accounting, due to uncertainties arising from the tailings (barrage) treatment through the mill over the last two years
- No metallurgical testwork has as yet been completed on mineralization from Ambrosia Norte and Bonsucesso. Actual testwork results could result in recoveries that are different to the projected recoveries
- The PEA assumes that there will be no significant mineralogical differences in mill feed sourced from Ambrosia Norte and Bonsucesso and that current blending practices will continue. If the mineralogy varies from expectations, there may be additional ROM handling and blending requirements that may potentially result in a minor increase in process operating costs
- There is limited extended assay information on Ambrosia Sul, Ambrosia Norte and Bonsucesso. It may be possible that gangue mineralogy deviates sufficiently from the Morro Agudo Mine assumptions that some or all of the tailings material proposed to be sold will fail to meet limestone specifications (e.g. excess pyrite content, insufficient CaO and MgO). This would affect co-product recovery and may reduce the economic attractiveness of this material
- Production in the LOMP is not sufficient to keep the mill full, and therefore it may be difficult to contain operating costs to economic levels
- The mine plan assumes fixed costs, based on treatment of 1 Mt/a of mill feed. However, the plan has variable annual mill feed rates, which results in throughput ranges from 0.67–0.83 Mt/a. Assumptions from the steady-state production for the

ratio between fixed and variable costs may not be applicable to the lower throughput rates. This could result in higher overall costs than currently predicted

- In the event that Tres Marias was unable to process concentrates from the Morro Agudo Project, mine economics would be affected due to the significantly higher transport and treatment charges, no zinc premium, and lower payable content that would apply to an alternative customer. This could result in a reduction in the assumed profitability of the Project, or potentially rendering the Project sub-economic
- If Tres Marias is unable to keep the current balance of different feed supplies to control chemistry and costs, then there is a risk that the zinc premium that is assumed to be paid could be reduced, thereby reducing the assumed profitability of the Project
- Decreases in rainfall may cause lower reservoir and river levels, potentially impacting the ability of the hydroelectric stations to provide sufficient power to meet operational needs
- Closure costs estimated in the 2016 closure plan may be insufficient to accommodate all decommissioning and rehabilitation costs, as they do not appear to include all of the proposed development along the Ambrosia Trend
- Sending general waste to an unlicenced facility carries a potential liability risk if pollution and seepage occur from the waste facility
- Authorization from the competent environmental authorities is required prior to work being conducted that may affect APPs. There is a risk that future approvals to impact APPs may not be granted for mineral concessions where the approval process has not been completed, and this may affect planned work programs such as exploration and drilling activities
- Creation of new taxes, fees, and/or royalties or significant changes to the assumptions as to these in the Report will affect the cashflow estimates
- Hedging is not considered in the financial evaluation, which is performed at the mine level. Votorantim has corporate hedging arrangements in place. Should a future decision be made to implement hedging at the mine level, the cashflow estimates could be affected.

26.0 RECOMMENDATIONS

26.1 Introduction

Recommendations have been broken into two phases. The Phase 1 recommendations are made in relation to exploration activities, and data gathering activities in support of future mining studies. Recommendations proposed in Phase 2 are suggestions for improvements in current operating procedures, and the program is not contingent on the results of Phase 1 work.

The total cost for the Phase 1 work is about US$32.25 to US$32.34 million. Phase 2 is estimated at about US$0.5–0.6 million.

26.2 Phase 1

26.2.1 Exploration

Votorantim has prepared provisional exploration programs and budgets for near-mine and regional exploration (Table 26-1). The target of the programs is identifying mineralization that can support Mineral Resource estimation, and potential conversion to Mineral Reserves. Expenditures of about US$10 M/a are reasonable considering the numbers of mines, known deposits, and known targets and the quality of the targets.

Amec Foster Wheeler notes that exploration expenditures of this type depend on the results of previous efforts and that the budget for regional exploration may change significantly if new mineralization is discovered.

Mine Areas

Additional drilling at the Morro Agudo Mine is required to improve mineral resource classification locally and possibly identify additional resources in the deposit. The same can be said for Ambrosia Sul which has just begun to be exploited. Ambrosia Norte requires a small amount of drilling to improve Mineral Resource classification. Bonsucesso requires additional drilling to fill gaps in the current knowledge and to explore the northern extension and parallel structures.

Table 26-1: Proposed Exploration Programs

	Units	Morro Agudo Mine	Ambrosia Sul	Ambrosia Norte	Bonsucesso	Regional	Total
Core Drilling	m	30	15	4	20	43	112
Core Drilling	US$ million	4.2	2.1	0.6	2.8	6.1	15.8
Underground Development	US$ million	6.0	—	—	—	—	6.0
Geology	US$ million	0.3	0.3	0.3	0.3	0.6	1.8
Geochemistry	US$ million	0.6	0.3	0.1	0.4	0.9	2.3
Geophysics	US$ million	0.1	0.1	0.1	0.1	0.1	0.5
Permits and Authorizations	US$ million	0.3	0.3	0.3	0.3	0.5	1.5
Support	US$ million	1.7	0.4	0.2	0.5	1.1	4.0
Total Expenditures	***US$ million***	***13.2***	***3.5***	***1.5***	***4.4***	***9.3***	***31.8***

Regional

The Morro Agudo/Ambrosia Trend region has a number of attractive exploration targets at various stages of exploration:

- Fagundes, Sucuri, Poções, and Mocambo are known targets with some drilling that all require additional geophysical surveys to assist with locating drill holes and additional drilling
- Carancas–Queimada Trend, Lapa Azul, Lagoa do Sobrado, Ambrosia W, Unai Sul, and Fazenda Bau Trend are targets requiring additional exploration to identify any additional Mineral Resources that may be present.

Exploration in those areas will take the form of geological mapping, geochemical sampling, geophysical surveys, and possibly drilling if results of the preliminary surveys are favorable.

26.2.2 Mining Studies

Additional information is required to advance some elements of the PEA study to a level that could support future more detailed studies.

Metallurgical Testwork

A metallurgical testwork program on mineralization from the Ambrosia Norte and Bonsucesso deposits is underway.

Once results are to hand, they need to be reviewed to confirm the metallurgical assumptions, including recoverability, concentrate quality, and agricultural lime co-product specifications. The main design parameters need to be confirmed to be consistent with the Morro Agudo process plant.

This program is estimated at US$250,000–US$300,000.

Hydrology

Undertake a hydrogeological study to confirm the hydrogeological assumptions used in the PEA, and perform some testwork using selected drill holes from the planned mine area drill programs.

This program is estimated at US$100,000–US$120,000.

Geotechnical

Undertake a geotechnical review to confirm the rock mass rating and quality assumptions used in the PEA, and perform some testwork using selected drill holes from the planned mine area drill programs.

This program is estimated at US$100,000–US$120,000.

26.3 Phase 2

26.3.1 Mineral Resources

- A detailed reconciliation procedure is planned to be developed to provide additional confidence for the Mineral Resources at Morro Agudo.
- Amec Foster Wheeler conducted an independent top-cutting analysis and considers the lead grades at Ambrosia Sul could be capped or top-cut at around 2% Pb. Votorantim should review this in future models, and consider separate reviews for each domain. As lead does not provide a significant contribution to the overall economics, however, this is not a material issue.
- While the global biases are outside the recommended Amec Foster Wheeler guidelines of ±5% (relative) at Ambrosia Sul, the OK model is conservative compared to the NN model, thus there is no economic risk presented by these estimations. Amec Foster Wheeler recommends Votorantim review future Ambrosia Sul models in an effort to reduce the bias.
- The global biases for zinc at Bonsucesso are within the recommended Amec Foster Wheeler guidelines of ±5% (relative). The global bias for lead is slightly outside the recommended Amec Foster Wheeler guidelines. As the bias is conservative and is for Inferred Resources, this is not seen as a risk, but Amec Foster Wheeler recommends that Votorantim review future models in an effort to improve the lead bias. As lead contributes 6% to the economics, this is not seen

as a significant risk, but Amec Foster Wheeler recommends Votorantim review future models in an effort to reduce the lead bias.

- Amec Foster Wheeler recommends further studies to improve the calculated density results. Votorantim is also currently considering what methods may be appropriate to further refine the estimated density values.

Depending on whether the work performed is done internally or by a third party, the, these programs are estimated at about US$150,000 to US$175,000.

26.3.2 Mine Plan

No formal check scaling program is in place for accessible underground excavations. Amec Foster Wheeler recommends that routine inspections and check scaling of all underground areas that are routinely accessed is performed on an annual basis, or more frequently where ground conditions warrant.

This work should be performed as part of normal operating practice.

There are areas of the Morro Agudo Mine where existing survey information has been lost and actual excavation locations are not fully understood. A 3D survey of these existing areas should be completed to confirm the locations of these openings for mine planning purposes.

This program is estimated at US$10,000–US$20,000.

26.3.3 Recovery Plan

A review should be undertaken of future plant utilisation. There may be an opportunity to scale-back production, or, alternatively, there may be an option to place underutilized equipment on care and maintenance, or shut down older equipment completely.

Deposit 2 should be re-evaluated, and if metal recovery and agricultural lime product information is favourable, then a Mineral Resource estimate should be completed for the material.

These programs are estimated at US$60,000–US$80,000.

26.3.4 Environment, Permitting and Social

Amec Foster Wheeler recommends that the findings outlined in the Legal Audit document be reviewed and addressed as applicable. Where there may be gaps or inconsistencies in permitting, these should be rectified. Where the audit has identified areas of non-compliance, mitigation or control plans should be developed.

An overarching closure plan should be developed for the entire proposed mining operation to ensure that all closure and rehabilitation requirements are fully understood and budgeted. This plan should incorporate elements of the existing plans where still applicable.

These programs are estimated at US$250,000 to $300,000.

26.3.5 Financial Model

The operating structure assumed in the PEA should be further reviewed to ensure that sufficient allocation has been made to reduce costs in line with reducing mill production.

This program is estimated at US$10,000–US$20,000.

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