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NI 43-101 Technical Report
Updated Preliminary Economic Assessment
Santa María Silver Project
Santa Bárbara, Chihuahua, Mexico

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1. SUMMARY

This report has been prepared on behalf of Golden Minerals Company ("Golden Minerals") for the Santa María silver-gold project (the "Project") located in the southeastern part of the Municipality of Santa Bárbara, State of Chihuahua, Mexico. Project mineral rights are held by Minera de Cordilleras S. de R.L. de C.V. (Minera Cordilleras) a Mexican wholly-owned subsidiary of Golden Minerals.

This report has been prepared as an updated Preliminary Economic Assessment Technical Report ("PEA") according to Canadian National Instrument 43-101 ("NI 43-101") for the purposes of including additional drilling and updated Mineral Resource estimate results, and for summarizing all data collected by Minera Cordilleras in a PEA prepared by Tetra Tech for the Santa María property.

1.1 Summary of Key Project Components

The scope of this PEA is to review the geologic Resource Estimates by updating the geologic and block models based on updated drilling information, and to develop a conceptual mine plan for the Project and subject that plan to a conceptual economic analysis using assumed parameters. The primary purpose of the study is to evaluate the potential economics of the Project in the context of minimizing initial capital investment requirements in alignment with Golden Minerals' corporate objective. The following bullets highlight the key Project components and decision making for this study:

- Tetra Tech's revision of the geologic interpretation including cross sections at 10-m spacing along the vein strike; re-creation of the block models including assay results for the 2018 drilling campaign; and re-evaluation of Mineral Resources.
- This study assumes toll milling at a processing plant in Parral;
  - The current Mineral Resources tonnage is insufficient to support the initial capital required to construct a dedicated processing facility. Toll milling has the added benefits of fixing operating costs and reducing the complexity of Project infrastructure and requirements.
- Mining methods used for the assessment include both cut and fill and sub-level stoping;
  - Cut and fill is a common vein mining method and was chosen over shrinkage stoping because of shrinkage stoping's production limitations, sub-optimal ore recovery, and lead time to production. Sub-level stoping was chosen for thicker areas because of the reduced mining cost compared to cut and fill. Newly available lower-cost long-hole drills have reduced the capital requirements of sub-level stoping.
- One ramp has been selected vs. two to reduce waste development costs.
  - The two mineralized vein shoots currently identified will be connected on level by vein drifts for access and vein sampling as the mine progresses. The ramp would be an extension of the current ramp and would be accessed from the existing portal. Wall slashing and some equipment modification are required to use the current ramp access path.
- It is assumed that several pieces of mining equipment warehoused at Golden Minerals' Velardeña project will be available for use at Santa María;
  - Because of this, minimal mining equipment purchases are required by Golden Minerals. This underscores that this PEA has been suited to Golden Minerals' specific set of corporate circumstances.

- The assessment assumes the sale of a bulk Ag and Au concentrate as opposed to lead or zinc concentrates because of the relatively low Pb content of the material and the material's amenability to produce relatively high-grade bulk concentrate.
- The economic model assumes power would be generated onsite through purchased diesel generators.
  - CFE (*Comisión Federal de Electricidad*) provided a cost estimate to install power at the mine which would require that a section of source lines be upgraded as well. The cost estimate was used as the basis of a trade-off study that suggested better economic performance for onsite power generation given the proposed mine life.

1.2 Summary of Project Risks

Through the scoping study process and trade-offs, several Project risks have been identified.

- This PEA has incorporated Indicated and Inferred Resources. Inferred Resources are inherently risky, speculative, and do not have demonstrated value. Inferred Resources have been in part estimated in mineralized shoots from wide spaced drilling and by extrapolation. Significant variances in location, shape, grade and tonnage of Inferred Resources are likely;
- The PEA mine plan has been tailored to specific circumstances unique to Golden Minerals that involve leasing equipment from other wholly-owned subsidiaries and toll milling. If equipment availability and toll mill capacity change, the results of the PEA could be adversely affected;
- This PEA is not intended to be used as an operating plan and is only intended for understanding relevant factors that could lead to potential economic viability;
- Santa María Resource expansion is limited by the concession boundaries, but additional land acquisition has opened potential to increase Resources with exploration and development of other identified mineralized structures, such as the Santa María 2, Norte and Cervantes;
- At present, there is insufficient data to suggest water produced from dewatering the mine will require treatment. Samples collected in existing workings indicate treatment is not required. Samples have not been collected from deeper extents of the Resource. Capital has been accounted for in the PEA to allow for a lined settling pond but not a mechanical treatment system. To fully understand the risks if water quality is such that treatment is required, it is recommended that Golden Minerals collect samples from deeper within the Resource, analyze the potential water quality, and engage a local environmental consultant to estimate the cost of a passive treatment system using locally sourced labor and materials; and
- It is crucial that achievable concentrate grades are marketable. Recoveries for Ag and Au have been adjusted based on the metallurgical testing to meet generalized minimum concentrate grade requirements, but a contract is not currently in place. Further optimization of recovery, concentrate grade and associated penalties should be conducted.

1.3 Location, Property Description & Ownership

The Santa María silver-gold project is located in the La Unión Mining District ("La Unión") southeast of the city of Santa Bárbara, located along the "San Francisco del Oro-Santa Bárbara" a major mining district in the State of Chihuahua, **Figure 1-1.** The Project is located 19 km from the center of the city of Santa Bárbara and approximately 39 km from the center of the city of Parral, a moderate sized, full service regional center of commerce. Golden Minerals controls 95.10-hectares in four mineral concessions through its subsidiary Minera Cordilleras which has the right to acquire the concessions' rights from the current holders.

Figure 1-1: Location Map

1.4 Geology & Mineralization

The local geologic setting can be described as the sedimentary rocks of the Parral Formation, which are constituted from the base by an alternating sequence of flysch, shales, limestones, sandstones, siltstones and marls of the Aptian-Albian age Parral Formation; these rocks have been affected by intrusive rocks of the Laramide orogeny resulting in a sequence of metamorphized rocks with silicification and skarns, along the northeastern foothills of the Sierra Madre Occidental ("SMO") within the sub-province of *Sierras y LLanuras ("SLL")* in the geologic province of the *Faja Ignimbrítica Mexicana* ("FIM")[1] and partially covered by the most recent rhyolites of the Upper Volcanic Series ("UVS") of the SMO.

[1] *Servicio Geológico Mexicano (SGM). Carta Geológico-Minera Hoja Santa Bárbara G13-A57. Chihuahua y Durango. Explicación – Resúmen.*

Santa María is located within the historical mining area denominated *La Unión* District which lies adjacent to the west of a major regional outcropping of an igneous stock of Laramide orogeny age (42.1 Ma) with monzonitic-granodiorite composition. Numerous andesitic stocks and dikes occur within the area which may be considered as apophysis of the granodioritic intrusive.

Geology of the property is dominated by metamorphosed sedimentary rocks of the Parral Formation, rhyolites, granodioritic intrusive and a post-mineral basaltic cap on the eastern edge. The Santa María vein deposits are hosted by rhyolitic dikes. The veins are observed cutting the Parral Formation and Tertiary rhyolite dikes. The property geology is depicted in **Figure 1-2**.

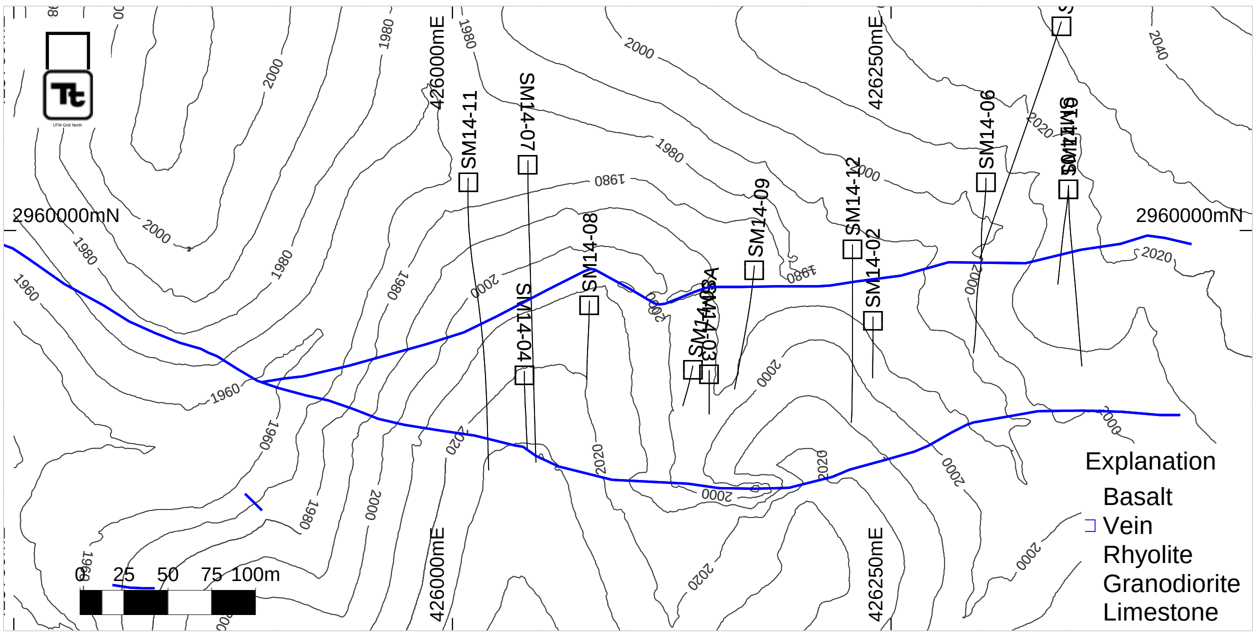


Figure 1-2: Property Geology Map

The primary Santa María vein deposit generally strikes in east-west direction and it gently curves following the outcropping of the host rock, a rhyolite dike along a surface extension of about 750 m. The current drilled demonstrated down dip extent is 260 m and remains open at depth and along strike. The vein occurs hosted by a rhyolitic dike which appears to be associated with a fault zone cutting rocks of the Parral Formation. Breccia textures filled by quartz gangue are common in the vein. The vein varies in width between 1 and 4 meters with an average width of about 2 meters. The vein deposit dips to the north varying between 75 and 85 degrees. In underground workings, occasional post mineral normal faults can be observed to locally offset the vein deposit.

A second vein, the Santa María Dos, branches out from the western part of the Santa María structure following an eastern strike with a slight northern inflexion; its outcrop shows an approximate extension of 600 meters. This Santa María Dos mineralized structure appears to be hosted by a probable fault zone cutting rocks of the Parral Formation and crossing some granodiorite stocks and dikes.

The deposit type consists of an epithermal quartz - calcite mineralized structures system. Typical banded epithermal mineralized textures are observed in underground workings and drill core. Brecciated textures filled by quartz and calcite are common. Concentrations of galena and sphalerite with associated presence of silver minerals may indicate an exposure at medium to high elevation within the epithermal mineralized system.

1.5 Exploration, Drilling, Sampling & QA/QC

Exploration by Minera Cordilleras consists of surface and underground geologic mapping and channel sampling. A total of 2,186 underground channel samples were collected for analysis. Channels were taken within existing underground development that spans approximately 575 m east to west and 110 m down dip. Samples are spaced between five and 15 meters apart with few spaced more than 25 meters apart due to access and to explore the vein strike, but are spaced one to four meters apart in areas that are accessible and potentially prospective for mining.

The Project database contains a total of 59 diamond drill holes, totaling 9,922.61m, drilled by Minera Cordilleras. Surface drill holes are NQ and BQ size with either plastic or steel surface casing. Drilling was completed by Maza Diamond Drilling S.A. de C.V. of Sinaloa, Mexico utilizing a portable rig with a 500-m depth maximum. Drilling was completed by Minera Cordilleras in 2014, 2016, 2017 and 2018 drilling campaigns, including underground and surface drilling for exploration, expansion and recognizance of mineralized ore shoots, and to increase Resource classification.

According to observations by Tetra Tech during the previous site visit and data review, the sample preparation, analyses and security procedures implemented by Minera Cordilleras meet standard practices. The data collected is of adequate quality and reliability to support the estimation of Mineral Resources. Only Project level staff are involved with the selection, preparation and delivery of samples to the laboratory. Historic sampling by previous operators is not considered current and is therefore not described in this section. The Project database contains results collected from both drill core and channel sampling.

The Project is located well off main roads and is guarded by a caretaker who lives in a mine building near the mine entrance while the site is active. Samples awaiting delivery to the ALS preparation facility in Chihuahua are placed in a locked building overnight. Samples are delivered to ALS Minerals in Chihuahua City, Chihuahua, Mexico ("ALS Chihuahua") by Minera Cordilleras staff by road as needed, typically every two weeks.

Minera Cordilleras' quality assurance (QA) measures involve the use of standard practice procedures for sample collection for both drill core and channel sampling as described above; and include oversight by experienced geologic staff during data collection. Quality control (QC) measures implemented by Minera Cordilleras include in-stream sample submittal of standard reference material, blank material and duplicate sampling.

1.6 Mineral Processing & Metallurgical Testing

Samples of oxide and sulfide material were subjected to scoping level metallurgical testing at Golden Minerals' Velardeña Mine laboratory in September 2014. This test work indicated that the oxide material is amenable to direct cyanide leaching. The sulfide material underwent flotation testing to concentrate the precious metals into lead and zinc concentrates. The results of this flotation testing indicate the potential to produce a relatively low-grade lead concentrate with a relatively high silver content, as well as a high-grade zinc concentrate.

Pilot scale flotation process test work was undertaken from September 10 to October 16, 2015 on mixed material. In this test, the aim was to produce a concentrate with high silver content.

Additional samples of the sulfide material were subject to laboratory flotation testing by SGS in October 2016 to evaluate production of a bulk silver bearing concentrate as opposed to the production of separate lead and zinc concentrates.

Golden Minerals engaged RDi Inc. in January 2017 to perform additional rougher and cleaner flotation test work on the same composite as used in the October 2016 SGS testing. This test work evaluated the impacts of alternative reagent suites as well as grind sizes.

It is currently envisioned the mixed and sulfide material will undergo toll processing. Additional test work specific to the selected mill facilities flowsheet capabilities is necessary to establish a higher level of confidence regarding anticipated operating parameters as well as grade and recovery values.

1.7 Mineral Resource Estimation

Mineral Resources have been estimated for the Santa María and Santa María Dos mineralized structures using a sub blocked block model. Grade attributes have been estimated using Ordinary Kriging.

Estimated Mineral Resources for the Santa María project are shown in **Table 1-1**. Resources are shown with tonnage and grade, with a cutoff grade applied to AgEq accounting for recoveries for Ag and Au.

Table 1-1: Mineral Resource Estimate

Classification	Cutoff Grade AgEq g/t	Tonnes	Ag g/t	Au g/t	AgEq g/t	Ag toz (M)	Au toz (k)	AgEq toz (M)
Measured	180	42,000	271	0.83	333	0.37	1.13	0.45
Indicated	180	170,000	291	1.04	368	1.59	5.70	2.01
Inferred	180	261,000	272	0.90	346	2.30	7.61	2.92

NOTES:
(1) Cutoff grade and Ag equivalent calculated using metal prices of $16.63 and $1,238 per troy ounce of Ag and Au with a ratio of 74:1, the three year trailing average as of the end of May 2018;
(2) Cutoff applied to diluted Ag equivalent blocks grades using recoveries of 90% and 80% Ag and Au;
(3) Reported Indicated Mineral Resources are equivalent to mineralized material under SEC Industry Guide 7, Inferred Mineral Resource is not a recognized category under SEC Industry Guide 7; and
(4) Columns may not total due to rounding.

1.8 Mining

Although Indicated Resources have been estimated for the Project, this preliminary economic assessment includes Inferred Mineral Resources that are too speculative for use in defining Reserves. Standalone economics have not been undertaken for the indicated Resources and as such no Reserves have been estimated for the Project.

A preliminary mine plan has been generated for the PEA. The existing underground facilities would be used to gain access to the new underground Resources using the current adit on the western end of the property. The mine plan includes 308 Ktonnes of mill feed from stoping activities using two mining methods, namely cut and fill and sublevel stoping. **Table 1-2** summarizes the tonnage, grade, dilution and vein width for the potential mill feed included in the PEA.

Table 1-2: Potentially Minable Resource Tonnage Sub-Divided by Mining Method

Mining Method	Average Vein Thickness (m)	Estimated Dilution	Tonnes Diluted	Grade Ag g/t Diluted	Grade Au g/t Diluted
Cut and Fill	1.84	11%	129,705	345	0.71
Sub Level Stoping	2.55	12%	178,316	322	0.83
Both Methods	2.18	11.5%	308,021	331	0.78

1.9 Economic Analysis

The following preliminary economic analysis includes Measured, Indicated and Inferred Mineral Resources. Mineral Resources are not Mineral Reserves and do not have demonstrated economic viability. This preliminary economic assessment also includes Inferred Mineral Resources that are too speculative for use in defining Reserves.

Project cost estimates and economics developed in the Technical-Economic Model (TEM) are prepared monthly for the life of mine (LoM) as based on the selected portion of the total Project Resource. Based upon design criteria presented in this report, the level of accuracy of the estimate is considered scoping level. Economic results are summarized in **Table 1-3**. The analysis suggests the following conclusions, assuming no debt:

- Mine Life: five years;
- Post-Tax Net Present Value (NPV5%): US$10.6 million, IRR: 159%;
- Payback (Post-Tax): 10 months; and
- Taxes: US$1,395 thousand.

Table 1-3: TEM Results

Description	Unit Cost ($/t-milled)	Total Value ($000s)
NSR	$146.27	$45,055
Land Acquisition	($2.97)	($915)
Net Revenue	**$143.30**	**$44,140**
Operating Costs		
Mining	$49.31	$15,188

Description	Unit Cost ($/t-milled)	Total Value ($000s)
Processing	$43.26	$13,324
G&A	$1.34	$412
Lease	$0.75	$230
Operating Costs	**$94.65**	**$29,154**
Operating Margin	**$48.65**	**$14,986**
Capital Costs		
Mining	-	$370
Infrastructure	-	$525
Owner Costs	-	$316
Capital Costs	-	**$1,211**
Estimate of Tax		
Federal Tax	-	$0
Special Mining Tax	-	($1,170)
Precious Metals Tax	-	($225)
Estimate of Tax	-	**($1,395)**
Cash Flow	-	$12,380
NPV $_{5\%}$	-	**$10,593**
IRR	-	**159.3%**
Payback (months)	-	10

Technical assumptions used in the economic analysis are presented in **Table 1-4**. All costs are in US dollars. A ratio of USD1.00: MXN20.00 is used, where applicable. Market prices reflect current conditions. Taxes are estimated using the current tax code. Results reflect an 5% hurdle rate. No debt is assumed.

Table 1-4: General Assumptions

Description	Units	Value
Market Prices		
Gold	$/oz	$1,238
Silver	$/oz	$16.63
Taxes		
Federal Tax*	%	30.0%
Special Mining Tax	%	7.5%
Precious Metals Tax	%	0.5%
Financial		
Discount Rate	%	5.0%

*Not applied due to Net Operating Losses.

Mine and process plant production summaries over the LoM are shown in **Table 1-5** and **Table 1-6**, respectively. These schedules are discussed in detail in other sections of this report.

Table 1-5: RoM Summary

Description	Units	Value
Run of Mine	kt	308
RoM Grades		
Gold	g/t	0.78
Silver	g/t	331
Contained Metal		
Gold	koz	7.7
Silver	koz	3,282

Table 1-6: Process Summary

Description	Units	Value
Concentrate (dry)	kt	12
Payable Metal Recoveries		
Sulfide		
Gold	%	83%
Silver	%	91%
Transition		
Gold	%	56%
Silver	%	77%
Doré		
Oxide		
Gold	%	85%
Silver	%	73%
Recovered Metals		
Sulfide		
Gold	koz	2.7
Silver	koz	1,439
Transition		
Gold	koz	0.5
Silver	koz	232
Oxide		
Gold	koz	2.9
Silver	koz	1,023

1.10 Interpretations and Conclusions

The Santa María Project is located east of the San Francisco-Santa Bárbara mining district in operation since colonial times and it has shown drill intercepts with high-grade mineralization which may indicate lesser risks for development including circumstances that are uniquely suited for the benefit of Golden Minerals.

Drill hole and channel samples have been collected and analyzed using industry standard methods and practices and are sufficient to characterize grade and thickness and support the estimation of Measured, Indicated and Inferred Mineral Resources. This preliminary economic assessment includes Measured, Indicated, and Inferred Mineral Resource estimates, suggesting that further studies and advancement of the Project to pre-feasibility may be warranted.

Tetra Tech suggests developing underground drifting and crosscutting to confirm mineral concentration extensions and continuity at the same time bulk mineralized material may be extracted for milling.

1.11 Recommendations

Given the preliminary economic assessment using Indicated and Inferred Resources shows the Project could produce positive economic results, the following recommendations are suggested:

- Further explore the Project to increase tonnage and confidence of the currently defined Resources;
- Develop underground drifts at one or two levels below the currently accessible mine workings to confirm the mineral intercepted and taking bulk samples from the mineralized structure deposits;
- Engage a local environmental consultant to determine permitting costs and timelines;
- Perform additional metallurgical testing characterization; and
- Following additional drilling and potential Resource expansion, reassess the Project's economic potential through an updated PEA or begin to collect and analyze the data required to allow for the definition of Reserves.
  - Develop underground drifts and crosscuts to confirm both mineral deposits, the Santa María and the María Dos, as well as other identified mineralized structures, thickness and grade distributions. The underground access may also allow for easier access to deeper drilling. The mineralized material may be processed to recover some of the exploration costs.
  - Additional studies and work are required to advance the Project to a preliminary feasibility study (PFS), and Reserve estimates include but are not limited to:
    - Geotechnical drilling and stability analysis;
    - Hydrogeologic drilling and analysis;
    - Waste rock geochemical determination;
    - Improved closure cost estimation;
    - Base line environmental studies and permitting;
    - Improved estimation for site infrastructure requirements;
    - Surface water management analysis and handling requirements;
    - Computer optimized stope selection and scheduling

A breakdown of estimated costs for these activities is provided in Section 26.0.

2. INTRODUCTION

This report has been prepared on behalf of Golden Minerals Company for the Santa María silver Project held by Minera de Cordilleras S. de R.L. de C.V., a wholly-owned subsidiary of Golden Minerals.

This report has been prepared for the purposes of: detailing exploration and drilling data collected by Minera Cordilleras, summarizing the results of an independent estimation of Mineral Resources by Tetra Tech, and presenting the findings of a PEA using the updated Resource estimate.

Technical information including locations, orientations, mapping and analytical data has been supplied by Minera Cordilleras, and has, in part, been verified through spot checking conducted by Tetra Tech authors of this report while visiting the Project. Information pertaining to title, environment, permitting and access has also been supplied by Minera Cordilleras, and the authors of this report have relied on the experts supplying this information. Introductory summaries pertaining to infrastructure, location, geology and mineralization have been partially sourced from a report on the property by the *Servicio Geológico Mexicano* from 1985 and have been cited where appropriate.

The Santa María Project site was inspected on January 14, 2016 by Dante Ramirez.

The inspections by Mr. Ramirez entailed observations of trial mining, a review of the availability and condition of mining equipment, observations of the current ramp, discussions regarding potential strategies for stoping, development and ventilation, observations of current surface infrastructure, and general observations of the current environmental conditions.

2.1 Units of Measure

All references to dollars in this report are to US dollars (US$) unless otherwise noted. Distances, areas, volumes, and masses are expressed in the metric system unless indicated otherwise.

For this report, common measurements are given in metric units. All tonnages shown are in Tonnes of 1,000 kilograms, and precious metal grade values are given in grams per tonne (g/t), precious metal quantity values are given in troy ounces (toz). To convert to English units, the following factors should be used:

- 1 short ton = 0.907 tonne (T);
- 1 troy ounce = 31.1035 grams (g);
- 1 troy ounce/short ton = 34.286 grams per tonne (g/t);
- 1 foot = 30.48 centimeters (cm) = 0.3048 meters (m);
- 1 mile = 1.609 kilometer (km); and
- 1 acre = 0.405 hectare (ha).

2.2 Abbreviations

The following is a list of abbreviations used in this report.

Abbreviation	Unit or Term
2D	two-dimensional
3D	three-dimensional
Ag	silver
As	arsenic
Au	gold
°C	degrees Celsius
cm	centimeter
cm^3	cubic centimeters
CONAGUA	National Water Commission *(Comisión Nacional del Agua)*
Cu	copper
CUSTF	Change in Forestry Land Use *(Cambio de uso del suelo en terrenos forestales)*
ER	Risk Study *(Estudio de Riesgo)*
ETJ	Technical Justification Study *(Estudio Técnico-Justificativo)*
g	gram
g/t	grams per tonne
g/cm^3	grams per cubic centimeter
Golden Minerals	Golden Minerals Company
GxT	grade multiplied by thickness
ha	hectare
ID	identification
IMMSA	Industrial Minera México, S.A.
INAH	National Institute of Anthropology and History *(Instituto Nacional de Arqueología e Historia)*
kg	kilogram
km	kilometer
km^2	square kilometers
km/hr	kilometers per hour
LAU	Comprehensive Environmental License *(Licencia Ambiental Única)*
LGDFS	General Law of Sustainable Forestry Development (*Ley General de Desarrollo Forestal Sustentable*)
LGEEPA	General Law of Ecological Equilibrium and Environmental Protection *(Ley General del Equilibrio Ecológico y la Protección al Ambiente)*
LGPGIR	General Law for the Prevention and Comprehensive Waste Management *(Ley General para la Prevención y Gestión Integral de los Residuos)*
m	meter
M	million
MIA	Environmental Impact Statement *(Manifestación de Impacto Ambiental)*
Minera Cordilleras	Minera de Cordilleras S. de R.L. de C.V.

Abbreviation	Unit or Term
mm	millimeter
mm/yr	millimeters per year
Mya	million years before present
NOM	Official Mexican Standard *(Norma Oficial Mexicana)*
NI 43-101	Canadian Securities Administrators' National Instrument 43-101
NOM-120-SEMARNAT-1997	Mexican Official Standard
NSR	Net Smelter Return
Pb	Lead
PEA	Preliminary Economic Assessment
PFS	Preliminary Feasibility Study
PMLU	Post-Mining Land Use
PPA	Accident Prevention Plan
ppm	parts per million
PROFEPA	Federal Bureau of Environmental Protection
Project	Santa María
QA/QC	quality assurance/quality control
Sb	antimony
SEDENA	Secretariat of National Defense *(Secretaría de la Defensa Nacional)*
SEMARNAT	Secretariat of Environment and Natural Resources (2001-) *(Secretaría de Medio Ambiente y Recursos Naturales [2001*-))
SMT	Special Mining Taxes
t	metric ton
toz	troy ounces
tpd	tonnes per day
US$	United States dollars
V	volt
Zn	zinc
/	per

3. RELIANCE ON OTHER EXPERTS

The authors are relying on statements by Golden Minerals concerning legal and environmental matters included in Sections 4.0 and 5.0 of this report.

The authors are relying on statements and documents provided by Warren Rehn, President and Chief Executive Officer of Golden Minerals; Aaron Amoroso, Senior Exploration Geologist; Matthew Booth, Consultant Geologist; Joaquín Rodríguez, Exploration Manager for Minera Cordilleras; and Jorge Garcia, Accountant for Minera Williams, regarding:

- Limitations of environmental liabilities associated with past operations,
- Characterization of discharged water quality,
- Compliance requirements to continue exploration activities,
- Permitting requirements to initiate mining,
- Location of the concession and standing,
- Surface access agreements,
- Leasing, royalty and purchase agreements relating to the concessions, and
- Project costs.

4. PROPERTY DESCRIPTION AND LOCATION

The Santa María silver-gold project is located within the "La Unión" historical mining district southeast of Santa Bárbara in the State of Chihuahua, **Figure 4-1**. The property is located 19 km from the center of the town of Santa Bárbara and approximately 39 km from the center of the city of Parral, a moderate-sized, full-service regional center of commerce.

Figure 4-1: Location Map

The site is accessed from Santa Bárbara by traveling northwest out of town for 4 km on paved roads. The route goes east at IMSA's Santa Bárbara mine tailings dam on a well-kept public dirt road for 7.5 km and then heads south towards the village of Chicanaya. The route continues 7.5 km south on dirt ranch roads to access the site. The last 7.5 km of the route are unmarked, and the route frequently deviates from the primary heading at several junctions, making finding the site without prior experience difficult. The entrance to the mine can be located using the following coordinate: latitude 26°45'37"N, longitude 105°44'45"W (WGS84).

The mineral rights are held by four mineral concessions totaling 95.0998 hectares (234.81 acres). **Figure 4-2** shows the claim block in reference to the mine development. **Table 4-1** details the concessions controlled by Minera Cordilleras.

According to Mr. Warren Rehn, Golden Minerals holds the exclusive right to acquire the Santa María claims under two separate option agreements as follows:

- The first option agreement was acquired in August 2014, and it holds the rights to acquire from Mr. Joaquín Rolando Chávez González the Santa María claim, T-216632 at a total purchase price of $1.74 M due on April 2022, of which payments of $824,000 have been made. Subsequently, on July 13, 2017, Golden Minerals and Mr. Joaquín Rolando Chávez re-negotiated the remaining payments, for which two additional payments were made for $75,000 and $100,000 in 2018, after which the balance to acquire all the mineral rights by Golden Minerals has been established as $645,000. On July 17, 2018 the fifth amendment of the contract was executed by Minera Cordilleras making an anticipated payment of $100,000 to Mr. Joaquín Rolando Chávez and negotiating a discount of $20,000 on the balance due for the agreed-upon payment for the mineral rights, which as of this date is $525,000.

- The second option agreement was contracted with Mr. José Alfredo Cervantes Rivera and was acquired on August 4, 2017, under which Golden Minerals holds the right to purchase the María T-226591, María II Fraction 1 T-230200 and María III T-231703 claims for $0.70 million paid over a period of four years. $50,000 was paid upon signing the option agreement, and variable payments are due every six months for the duration of the contract in order to acquire a 100% interest, upon which it will be subject to a 2% Net Smelter Royalty (NSR) for the concessions related to that option. This option was also re-negotiated, and as of August 4, 2018 $570,000 must be paid in order to acquire 100% interest.

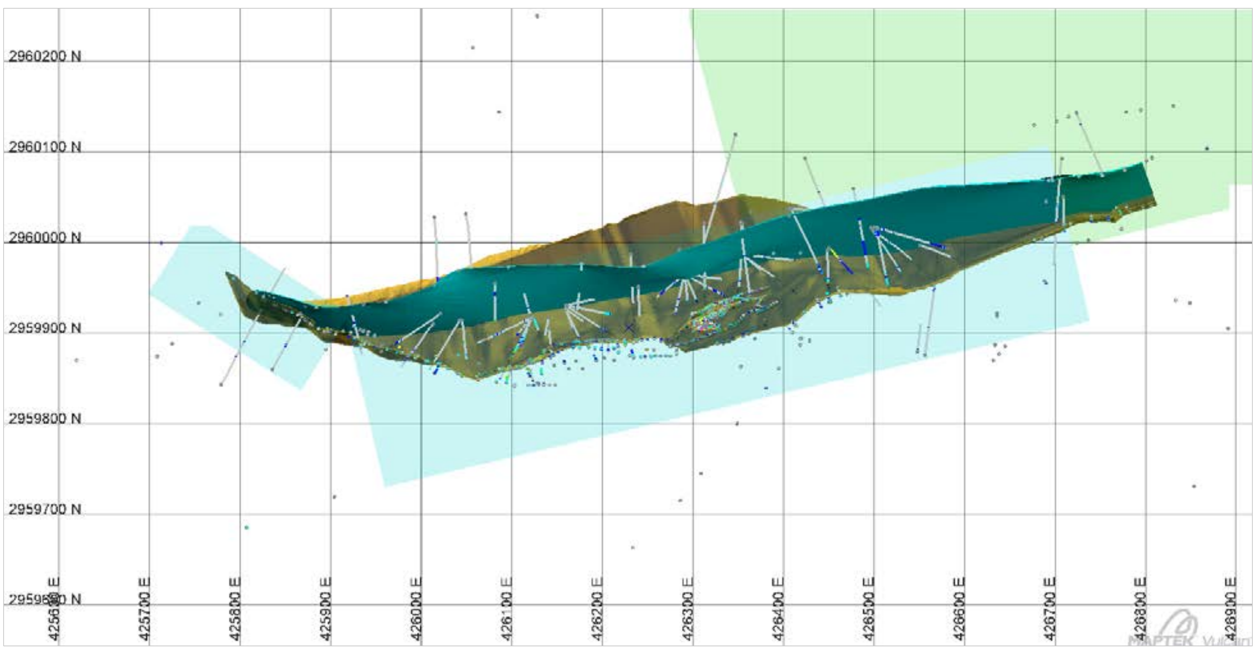


Figure 4-2: Map of Concession Boundary

Table 4-1: List of Concessions Controlled by Minera Cordilleras

Concession	Title #	Concession Holder	Expiry (Good Standing)	Surface Right Secured	Minera Cordilleras' Arrangement	Hectares
Santa María	216532	Joaquín Rolando Chávez	16-May-52	No	Option to Purchase from holder	17.9668
María	226591	José Alfredo Cervantes Alcaraz	1-Feb-06	No	Option to Purchase from holder	10.8394
María II Fracción I	230200	José Alfredo Cervantes Alcaraz	30-Jul-07	No	Option to Purchase from holder	24.3262
Martia III	231703	José Alfredo Cervantes Alcaraz	14-Apr-08	No	Option to Purchase from holder	41.9674
					Total	95.0998

4.1 Environmental and Permitting

There are unmitigated remnants of a minor historic vat leaching operation on the property as well as waste rock disposal areas located in and around water drainages that have partially been utilized for recent waste rock disposal. Minera Cordilleras is in discussions with regulators regarding the waste disposal area and a permit application has been submitted to cover these areas of disturbance.

Based on correspondence with Minera Cordilleras it is the author's understanding that environmental liabilities related to previous operations are not the responsibility of the current or future operator. Although this is the understanding, it is recommended that the company work directly with regulators to identify and document each case on the property where there could be a potential liability.

Minera de Cordilleras has engaged a local environmental contractor to characterize the discharge water quality which has been determined to be within acceptable limits for acidity and mineral content.

The most likely plan of operation if the Project were to be constructed would entail the mining of a relatively small tonnage accessed through the existing ramp and would not include onsite milling facilities.

The following outlines the general framework for permitting a mine in Mexico and the required permits. The Santa María property is in the exploration and Resource stage and is not considered an advanced property. Many of the permits discussed herein apply to the construction stage and are not currently being pursued.

4.1.1 Mexican Permitting Framework

Environmental permitting of the mining industry in Mexico is mainly administered by the federal government body SEMARNAT, the federal regulatory agency that establishes the minimum standards for environmental compliance. Guidance for the federal environmental requirements is largely held within the General Law of Ecological Equilibrium and Environmental Protection (*Ley General del Equilibrio Ecológico y la Protección al Ambiente*, or LGEEPA). Article 28 of the LGEEPA specifies that SEMARNAT must issue prior approval to parties intending to develop a mine and mineral processing plant. An environmental impact statement (by Mexican regulations called a *Manifestación de Impacto Ambienta*l, or "MIA") must be filed with SEMARNAT for its evaluation and, if applicable, further approval by SEMARNAT through the issuance of an Environmental Impact Authorization; the document specifies approval conditions where works or activities have the potential to cause ecological imbalance or have adverse effects on the environment. Further requirements for compliance with Mexican environmental laws and regulations are supported by Article 27 Section IV of the *Ley Minera* and Articles 23 and 57 of the *Reglamento de la Ley Minera*. Article 5 Section X of the LGEEPA authorizes SEMARNAT to provide the approvals for the works specified in Article 28. The LGEEPA also contains articles for soil protection, water quality, flora and fauna, noise emissions, air quality, and hazardous waste management.

The National Water Law (*Ley de Aguas Nacionales*) provides authority to the National Water Commission (*Comisión Nacional del Agua* or CONAGUA), an agency within SEMARNAT, to issue water extraction concessions, and specifies certain requirements to be met by applicants.

Another important piece of environmental legislation is the General Law of Sustainable Forestry Development (*Ley General de Desarrollo Forestal Sustentable* – LGDFS). Article 117 of the LGDFS indicates that authorizations must be granted by SEMARNAT for land use changes to industrial purposes. An application for change in forestry land use (CUSTF) must be accompanied by a technical study that supports the Technical Justification Study (*Estudio Técnico-Justificativo* – ETJ). In cases requiring a CUSTF, an MIA for the change of forestry land use is also required.

Mining projects also must include a Risk Study (ER) and an Accident Prevention Plan (PPA) from SEMARNAT.

The General Law for the Prevention and Comprehensive Waste Management (*Ley General para la Prevención y Gestión Integral de los Residuos* – LGPGIR) also regulates the generation and handling of hazardous waste coming from the mining industry. The LGPGIR also regulates the generation and handling of hazardous waste coming from the mining industry. Guidance for the environmental legislation is provided in a series of Official Mexican Standards (*Norma Oficial Mexicana* – NOMs). These regulations provide specific procedures, limits and guidelines and carry the force of law.

4.1.2 Project Permitting Requirements

There are many environmental permits required to advance the Project to operation. Most of the mining regulations are at a federal level through SEMARNAT, but there are also a number regulated and approved at state and local level. Three SEMARNAT permits are required prior to construction: MIA, ER, and CUSTF, which are described below.

Preventive Report (*Informe Preventivo*) – Based on local environmental characteristics and according to regulations, an Exploration Program for the Santa María project is not required to present a MIA Report, but a Preventive Report was presented by Golden Minerals through the title holder to SEMARNAT's local office in the City of Chihuahua (*Delegación Federal Chihuahua*) on May 11, 2017. The Preventive Report was presented for a drilling program including 32 drill sites and roads of access, and it was approved for a duration of 36 months from November 5, 2017.

Environmental Impact Manifest (MIA) – Regulations within Mexico require that an MIA be prepared by a third-party contractor for submittal to SEMARNAT. The MIA must include a detailed analysis of climate, air quality, water, soil, vegetation, wildlife, cultural resources and socio-economic impacts.

Study of Risk (ER) – A second required permit is a Risk Study (*Estudio de Riesgo* - ER). This study identifies potential environmental releases of hazardous substances and evaluates the risks of establishing methods to prevent, respond to, and control environmental emergencies.

Land Use Change (CUSTF) – The third permit is Change in Forestry Land Use (*Cambio de Uso de Suelo en Terrenos Forestales* - CUSTF). In Mexico, all land has a designated use. The CUSTF is a formal instrument for changing the designation to allow mining on these areas. The CUSTF study is based on the Forestry Law and its regulations. It requires that an evaluation be made of the existing conditions of the land including a plant and wildlife study, an evaluation of the current and proposed use of the land and related impacts on natural resources, and an evaluation of the reclamation and revegetation plans. The establishment of agreements with all affected surface land owners is also required.

4.1.2.1 Other Registrations and Permits

A project-specific comprehensive environmental license (*Licencia Ambiental Única* – LAU) stating the operational conditions to be met is issued by SEMARNAT when the agency has approved the project operations.

A construction permit is required from the local municipality and an anthropological release letter is required from the National Institute of Anthropology and History (INAH).

An explosives permit is required from the Ministry of Defense (SEDENA) before construction begins. Water discharge and usage must be granted by CONAGUA.

Operations involving collection, shipping, and/or storage services as well as reuse, recycling, treatment, incineration, and/or final disposal systems for hazardous waste require the operator to register as a hazardous waste generator with SEMARNAT, with a copy sent to the *Procuraduría Federal de Protección al Ambiente* (PROFEPA). Once the company is registered with PROFEPA as a hazardous waste generator, SEMARNAT assigns the company an environmental registry number that must appear on all reports that are filed with the authority. The key permits and the stages at which they are required are summarized in **Table 4-2**.

Table 4-2: Key Permitting Requirements

Permit	Required Prior to this Mining Stage	Agency
Environmental Impact Statement - MIA	Construction/Operation/Post-Operation	SEMARNAT
Land Use Change - CUSTF	Construction/Operation	SEMARNAT
Technical Justification Study - ETJ	Construction (Includes Conceptual Design)	SEMARNAT
Risk Study - ER	Construction/Operation	SEMARNAT
Construction Permit	Construction	Local Municipality
Explosive & Storage Permits	Construction/Operation	SEDENA
Anthropological Release	Construction	INAH
Water Use Concession	Construction/Operation	CONAGUA
Water Discharge Permit	Operation	CONAGUA
Unique Environmental License	Construction, Six Months Prior to Operation	SEMARNAT
Accident Prevention Plan	Operation	SEMARNAT
Hazardous Waste Generator	Operation	SEMARNAT/PROFEPA

4.2 Significant Risk Factors

The claims are located on a private ranch and land that is in process of being titled to *Mancomún, Chicanaya,* and *Los Solices*. Although the mineral rights are independent of the surface rights, access to the claim block is granted through an agreement between the current concession holder and the ranch and *Mancomún* that do not have direct interests in the mineral concession.

As stated above, there are unmitigated remnants of minor historic activities on the property including waste rock disposal areas located in and around water drainages that have partially been utilized for recent waste rock disposal. Minera Cordilleras is in discussions with regulators regarding the waste disposal area and a permit application has been submitted to cover this area of disturbance.

The author is unaware of any other significant risk factors that may affect access, title, right or ability to perform work on the property.

5. ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE AND PHYSIOGRAPHY

5.1 Accessibility and Surface Rights

The property is located 19 km from the center of the city of Santa Bárbara and approximately 39 km from the center of the city of Parral and is accessed by paved and dirt roads. Parral is a moderate sized, full service regional center of commerce with full service repair shops and heavy equipment dealers. Legal access to the concession is granted through an agreement between Joaquín Chavez Gonzalez (concession holder) and a private ranch owner and *Mancomún, Chicanaya,* and *Los Solices* (pending title to surface).

5.2 Physiography

The Project site is moderate to steeply undulating with large hills, representing a physiographic transition from mountains in the west to plains in the east. Drilling and historic mine roads cross most of the property and all drill hole collars are accessible. Property elevations range from 1,950-2,090 m above mean sea level (amsl). Current mine access is located at around 1,955 m amsl. The vegetation of the property is characterized by drought-tolerant scrubby bushes, relatively small trees and limited grasses.

5.3 Climate

The nearest available climate data sourced from the National Meteorological Service is for San Francisco del Oro and is shown in **Figure 5-1**. The average daily temperature for San Francisco del Oro is 17.7°C and the total average annual precipitation is 332 mm. The length of the operating season is year-round; access to the site may be temporarily inhibited during major rain events due to unimproved access roads crossing numerous drainages.

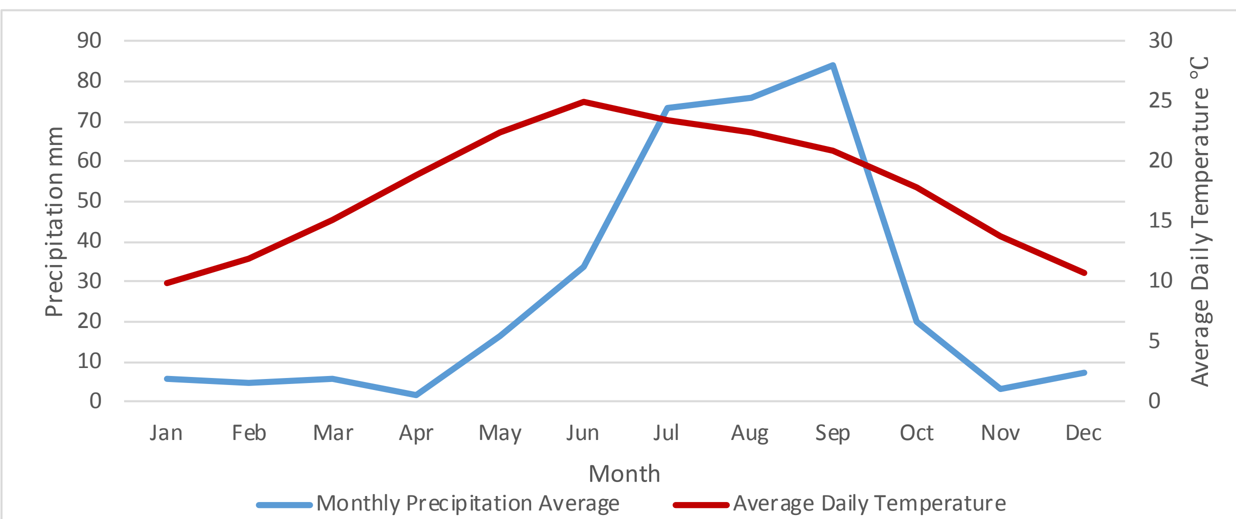


Figure 5-1: Climate Data for San Francisco del Oro

5.4 Local Resources and Infrastructure

Currently, mine ventilation fans are powered by a portable diesel generator. Water required for mining operations could be sourced from mine dewatering. Drinking water would require treatment or confirmation of drinking quality, but could be sourced from the installation of a well or trucked from nearby flowing streams. Experienced miners and laborers could be sourced from Santa Bárbara and the region and would not require onsite housing. Qualified mine management and technical staff could be sourced from the region in general and could commute daily from Parral. The property is in the exploration and resource stage and is not considered an advanced property; however, the most likely plan of operation would entail the mining of relatively small tonnage and would not include onsite milling facilities and therefore tailing storage would not be necessary. Land is available for lesser amounts of waste disposal.

6. HISTORY

The following discussion of historic tonnages and grades extracted from the mine has not been independently verified and is not considered a current assessment of Mineral Resource grade or expected tonnage, and has been included to provide an accurate property history.

The Santa María project, historically known as La Unión Mine, dates to 1658. The earliest known operator of this property is the Minas De Iguala Company who operated the property in the 1940's. Minas De Iguala constructed the existing shafts and on vein drifts and is thought to have been the mine's most significant producer, extracting exclusively oxide ores. Production data from this period is not available.

In the 1980's the property was leased to Victor Arias who reportedly exploited approximately 20,000 tonnes of near surface oxide material at an estimated grade of 2 Au g/t and 200 Ag g/t.

The property was subsequently leased to Gustavo Durán, Mining Engineer from 2009 to 2011, during which time a ramp was completed to virgin material below the 50 meter Level. Although Gustavo Durán completed the ramp, for unknown reasons his lease was terminated before completing any substantial stope development. From 2009 to 2011 it is estimated Gustavo Durán extracted 40,000 tons of residuals and backfill waste left by historic operators, at an estimated grade of 1-1.15 Au g/t and 150-200 Ag g/t. The material was processed exclusively by cyanidation.

The Project was inactive from 2011 until the involvement of Minera Cordilleras in 2014.

In February - March 2016, September - October 2016, and June 2017, Minera Cordilleras conducted small-scale selective non-mechanized trial mining and milling totaling 7,098 tonnes grading 337 Ag g/t and 0.78 Au g/t. The trial mining was completed by local contract miners using mining equipment owned by Golden Minerals. The material mined was a mixture of oxide and sulfide mineral types. Recoveries of 73% and 50% for Ag and Au were achieved. Concentrates were sold as a combined bulk Ag/Au concentrate. Results from trial mining and milling have been used to inform this study, but grades and recoveries are not indicative of the Project in general.

6.1 Previous Resource Estimates

Resources were estimated previously by Tetra Tech with an effective date of April 2015 and were updated with an effective date of March 2017. The Resources shown are considered historic. Cutoff grade assumptions of previous estimates are also no longer valid due to changes in metal price assumptions and additional information pertaining to cost assumptions and recoveries.

6.1.1 April 2015

The Indicated and Inferred Mineral Resources estimated at that time are shown in **Table 6-1** and **Table 6-2** below, as well as the mineral type portions for each Resource class.

Table 6-1: Previous Indicated Diluted Mineral Resources (April 2015)

Mineral Type	Cutoff Grade AgEq g/t	Tonnes	Grade Ag g/t	Grade Au g/t	Grade AgEq g/t	Grade Pb%	Grade Zn%	Troy Ounces Ag	Troy Ounces Au	Troy Ounces AgEq	Dilution%
Oxide + Mixed	165	84,000	283	1.1	346	0.6	1.2	762,000	3,000	933,000	10
Sulfide	165	2,000	193	2.0	316	1.5	2.4	12,000	0	20,000	8
All	165	86,000	280	1.1	345	0.6	1.2	774,000	3,000	953,000	10

NOTES:
(1) Reported Indicated Mineral Resources are equivalent to mineralized material under SEC Industry Guide 7
(2) Mineral Resources are reported as diluted Tonnes and grade
(3) Ag Equivalent cutoff grade assumes a Ag:Au ratio of 60:1, using $24/troy ounce Ag and $1,420/troy ounce Au
(4) Columns may not total due to rounding

Table 6-2: Previous Inferred Diluted Mineral Resources (April 2015)

Mineral Type	Cutoff Grade AgEq g/t	Tonnes	Grade Ag g/t	Grade Au g/t	Grade AgEq g/t	Grade Pb%	Grade Zn%	Troy Ounces Ag	Troy Ounces Au	Troy Ounces AgEq	Dilution%
Oxide + Mixed	165	54,000	295	1.1	358	0.7	1.0	510,000	2,000	619,000	19
Sulfide	165	252,000	316	1.3	393	0.6	1.0	2,563,000	10,000	3,187,000	9
All	165	306,000	312	1.2	387	0.6	1.0	3,072,000	12,000	3,806,000	11

NOTES:
(1) Inferred Mineral Resource is not a recognized category under SEC Industry Guide 7
(2) Mineral Resources are reported as diluted Tonnes and grade
(3) Ag Equivalent cutoff grade assumes a Ag:Au ratio of 60:1, using $24/troy ounce Ag and $1,420/troy ounce Au
(4) Columns may not total due to rounding

6.1.2 March 2017

The Indicated and Inferred Mineral Resources estimated at that time are shown in **Table 6-3** below, as well as the mineral type portions for each Resource class.

Table 6-3: Diluted Mineral Resource Estimate

Classification	Cutoff Grade Recovered AgEq g/t	Tonnes	Ag g/t	Au g/t	AgEq g/t	Ag toz (M)	Au toz (k)	AgEq toz (M)	Dilution %
Indicated	175	180,000	304	1.4	404	1.73	8.1	2.31	10%
Inferred	175	120,000	343	1.0	411	1.37	3.9	1.64	19%

NOTES:
(1) Mineral Resources are reported as diluted Tonnes and grade;
(2) Cutoff grade and Ag equivalent calculated using metal prices of $17.3 and $1,222 per troy ounce of Ag and Au with a ratio of 70.6:1, the three year trailing average as of the end of December 2016;
(3) Cutoff applied to diluted Ag equivalent blocks grades using recoveries of 90% and 80% Ag and Au;
(4) Reported Indicated Mineral Resources are equivalent to mineralized material under SEC Industry Guide 7, Inferred Mineral Resource is not a recognized category under SEC Industry Guide 7; and
(5) Columns may not total due to rounding.

7. GEOLOGICAL SETTING AND MINERALIZATION

Portions of the following geologic descriptions have been translated and adapted from the 1985 publication by *Servicio Geológico Mexicano* authored by Chávez Espinoza and Sánchez. The remaining descriptions come from observations made during Minera Cordilleras' exploration activities.

7.1 Regional Geology

The Project site is in the *Sierra Madre Occidental* (SMO) volcanic province and is on the border between the states of Chihuahua and Durango physiographic provinces. The property is situated on the southern extent of the *Mesa Central* metallogenetic province which includes the Parral-Santa Bárbara-San Francisco del Oro mining districts.

The SMO province is comprised of two primary sequences of igneous rocks. The upper series (UVS) is dominated by calc-alkaline volcanic rocks with associated rhyolitic intrusions and ignimbrites. The lower series (LVS) contains abundant andesites. Large sinters were formed from the recirculation of meteoric waters heated by the thick volcanic sequence often associated with basaltic lava flows. In addition, there are large stretches of acidic volcanic domes of Miocene to Upper Eocene age.

The eastern and central portions of the SMO province are characterized by sedimentary rocks of marine origin, including calcareous shales and limestones. The limestone layers are thinly bedded, fine-grained and light to dark. The limestones are often folded and intruded by felsic plutons. Folding occurs on a scale of up to regional folds greater than 500 m. The limestones are middle to upper Cretaceous in age.

7.2 Local Geology

The local geologic setting is represented by rocks of the Parral Formation, which consist of sedimentary rocks, shales and limestones of the *Grupo Mezcalera* of Lower Cretaceous age which were covered by Eocene volcanic rocks and intruded by porphyry monzonite and granodiorite stocks and dikes. The pre-existing rocks were structurally arranged by regional scale extensional block faulting and folding by Oligocene volcanic events with intrusions of hypabyssal origin including mineralizing fluids that were emplaced in the region. Tertiary granodioritic and monzonitic intrusive bodies and dikes affected locally the Parral Formation rocks causing metamorphic skarns and hornfels with associated mineralization. The local geology is depicted in **Figure 7-1**, and has been adapted by GSM Map G13-A57.

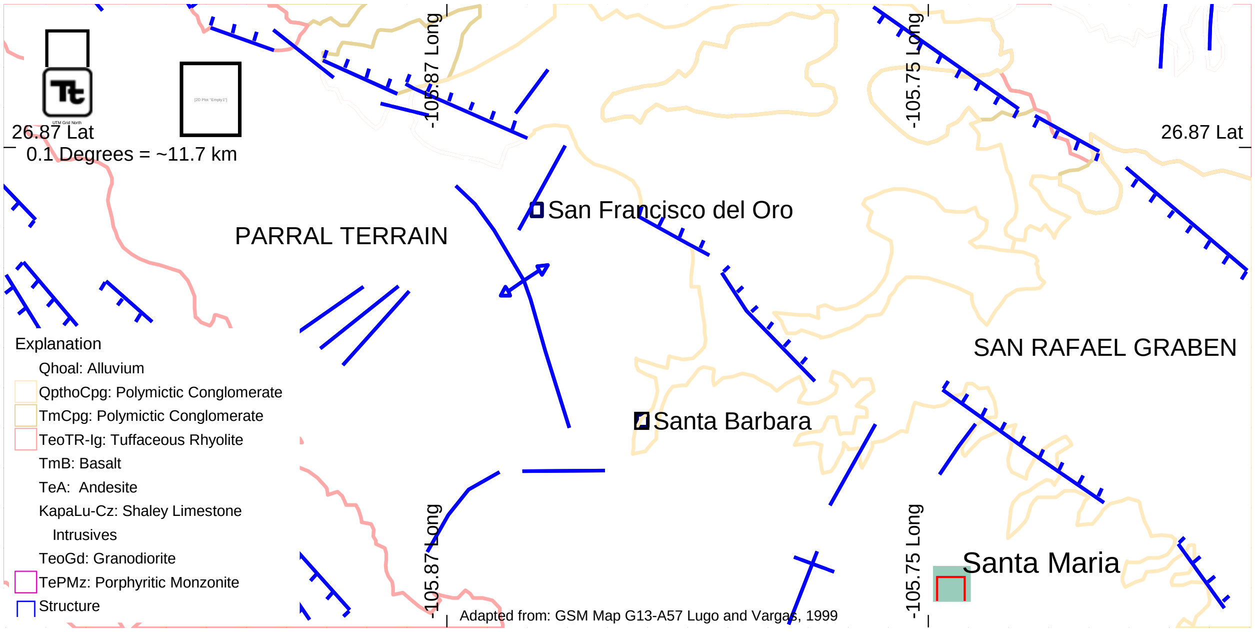


Figure 7-1: Local Geology Map

7.3 Property Geology

The geology of the property is dominated by rocks of the Parral Formation, rhyolites, granodioritic intrusive and a post-mineral basaltic cap on the eastern edge. The Santa María mineral deposits are hosted in and adjacent to a rhyolitic dike and granodioritic rocks. Veins are observed hosted by skarns and silicified limestones of the Parral Formation and the Tertiary rhyolite dike. The property geology is depicted in **Figure 7-2**.

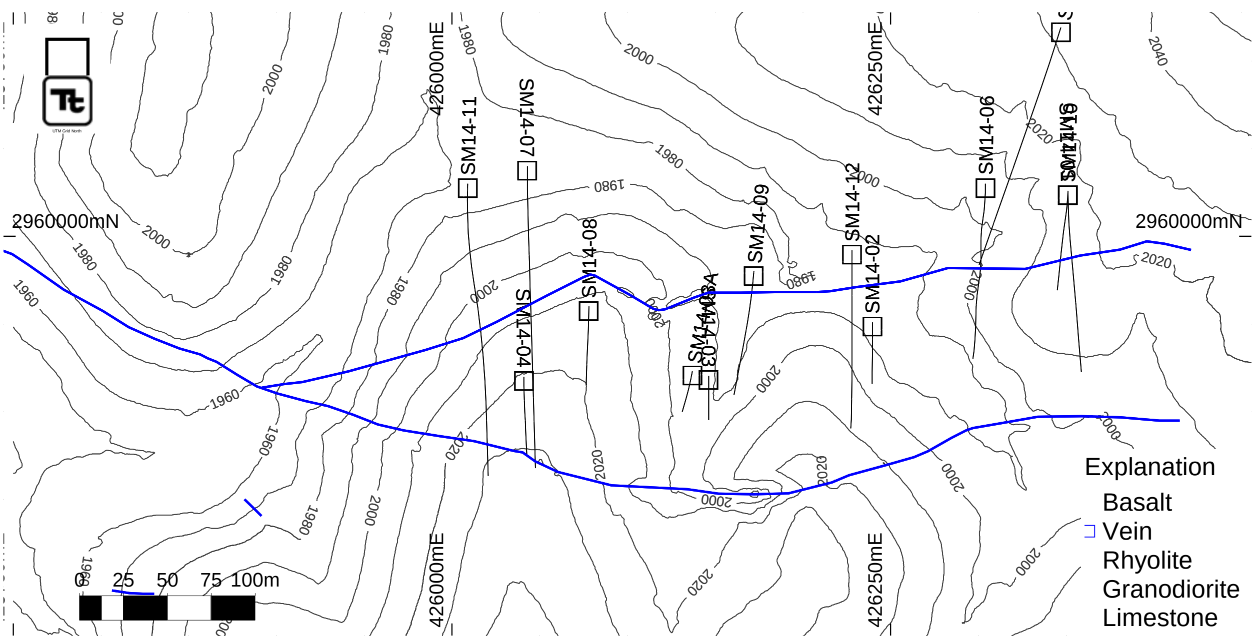


Figure 7-2: Property Geology Map

7.4 Property Mineralization

7.4.1 Santa María Main Vein

The primary Santa María vein gently curves following the contact of the associated rhyolite dike and can be traced on surface for 1,150 m. The current demonstrated down dip extent is 260 m and remains open at depth and along strike.

The vein occupies a fault zone near the contact between the Parral Formation sediments and the Tertiary dike. Breccia textures healed by quartz gangue are common in the vein. The vein varies in width between 1 and 4 meters with an average width of 2 meters. The dip of the vein is north varying between 75 and 85 degrees. In the underground workings, occasional post mineral normal faults can be observed to offset the mineralization locally. Drill holes SM 18-03 and SM 17-04 appear to have intercepted a mineralized bulk zone with higher grades.

At surface the vein is oxidized, and oxidation extends irregularly to ~75 meters depth. In the easternmost portion of the vein sulfide mineralization is preserved in the footwall of a cross-cutting fault. Oxide portions of the vein are characterized by strong iron oxides including goethite and hematite. The observed sulfide minerals are galena and sphalerite with rare occurrences of acanthite and ruby silver sulfosalts.

7.4.2 Santa María Dos Vein

The Santa María Dos vein is a hanging wall splay from the Santa María Main vein. It diverges from the Main vein close to the entrance of the Santa María decline and can be traced along surface for 1,050 m. The vein has been drilled down-dip for approximately 200 m where it intersects the Main Vein. The Santa María vein is open along strike to the east.

The vein appears to occupy a fault zone near the contact between Parral Formation limestones and an east-west striking diorite dike. The vein varies in width from 0.25 to 3.5 m and average width is around 1 m. The vein dips to the south varying between 65 and 85 degrees.

At surface the vein appears as a narrow, oxidized banded and brecciated quartz vein. Oxidation is variable. In the west it extends to 40 m depth, and in the east up to 150 m depth. Oxide parts of the vein are characterized by iron oxides including goethite and hematite, and in the sulfides zone of the vein sulfide minerals are dominated by pyrite with minor galena and sphalerite.

7.4.3 North Vein

The North vein crops out approximately 350 m north of the Main vein and can be traced along surface for 350 m. The western extension is covered by post-mineral basalts. The vein varies in width from 0.15 to 2.2 m with an average of 0.8 m. The vein has been explored by several small prospect pits.

The vein has a northeast strike and is steeply dipping (80^{o} to the NW or SE depending on the vein limb). The vein appears to be offset by a NW striking fault. The host rocks are the Parral Formation limestones.

At surface the vein is a narrow oxidized banded and brecciaed quartz vein with variable oxidation and rare pyrite.

A total of 38 chip-channel samples were collected from the North Vein (**Table 7-1**)

Table 7-1: North Vein Channel Samples

Sample	East	North	From (m)	To (m)	Thickness (m)	Au_ppm	Ag_ppm	Cu_%	Pb_%	Zn_%
129364	426805	2960410	0	0.3	0.3	0.01	20.00	0.00	0.02	0.01
129365	426819	2960411	0	0.2	0.2	0.14	14.00	0.00	0.01	0.02
129469	426664	2960262	0	0.62	0.62	0.02	10.00	0.00	0.01	0.02
129487	426725	2960350	0	0.3	0.3	0.07	24.00	0.00	0.02	0.02
129496	426791	2960390	0	0.29	0.29	0.05	49.00	0.00	0.05	0.04
129528	426821	2960412	0	0.15	0.15	0.31	33.00	0.00	0.03	0.05
129529	426894	2960421	0	0.28	0.28	0.00	1.00	0.00	0.01	0.01
129538	426954	2960443	0	0.42	0.42	3.01	26.00	0.00	0.01	0.02
129544	426943	2960441	0	0.36	0.36	0.33	37.00	0.00	0.01	0.01
SMS-01	426724	2960312	0	0.4	0.4	0.04	37.00	0.00	0.01	0.04
SMS-01	426724	2960312	0.4	1.2	0.8	0.31	196.00	0.03	0.41	1.09
SMS-01	426724	2960312	1.2	2.2	1	0.05	69.00	0.00	0.03	0.03
SMS-39	426664	2960263	0	0.6	0.6	0.15	103.00	0.01	0.06	0.04
SMS-39	426664	2960263	0.6	1.25	0.65	0.02	36.00	0.00	0.00	0.02
SMS-39	426664	2960263	1.25	1.95	0.7	0.01	7.00	0.00	0.01	0.01
SMS-40	426681	2960278	0	0.86	0.86	0.17	91.00	0.00	0.03	0.10
SMS-40	426681	2960278	0.86	1.29	0.43	0.01	11.00	0.00	0.00	0.01
SMS-41	426702	2960295	0	0.69	0.69	0.06	65.00	0.00	0.04	0.03
SMS-41	426702	2960295	0.69	1.23	0.54	0.06	41.00	0.00	0.04	0.06
SMS-41	426702	2960295	1.23	1.51	0.28	0.03	19.00	0.00	0.04	0.02
SMS-42	426719	2960351	0	0.52	0.52	0.04	34.00	0.00	0.01	0.01
SMS-42	426719	2960351	0.52	1.37	0.85	0.03	20.00	0.00	0.01	0.01
SMS-43	426724	2960351	0	0.54	0.54	0.06	31.00	0.00	0.04	0.02
SMS-43	426724	2960351	0.54	0.89	0.35	0.06	44.00	0.00	0.02	0.01
SMS-43	426724	2960351	0.89	1.69	0.8	0.05	29.00	0.00	0.02	0.02
SMS-44	426763	2960378	0	0.33	0.33	0.03	55.00	0.00	0.04	0.48
SMS-44	426763	2960378	0.33	0.78	0.45	0.06	13.00	0.00	0.02	0.04
SMS-45	426753	2960372	0	0.38	0.38	0.43	13.00	0.00	0.01	0.01
SMS-45	426753	2960372	0.38	0.81	0.43	0.80	14.00	0.00	0.02	0.02
SMS-46	426777	2960388	0	0.77	0.77	0.01	19.00	0.00	0.02	0.02
SMS-46	426777	2960388	0.77	1.05	0.28	0.07	127.00	0.00	0.04	0.04
SMS-46	426777	2960388	1.05	1.59	0.54	0.00	53.00	0.00	0.03	0.04
SMS-47	426824	2960404	0	0.41	0.41	0.37	15.00	0.00	0.01	0.01
SMS-47	426824	2960404	0.41	0.73	0.32	0.28	14.00	0.00	0.01	0.01
SMS-56	426925	2960434	0	0.4	0.4	0.39	5.00	0.00	0.01	0.02
SMS-56	426925	2960434	0.4	0.78	0.38	0.00	4.00	0.00	0.01	0.01
SMS-57	426912	2960430	0	0.35	0.35	0.06	12.00	0.01	0.01	0.02
SMS-57	426912	2960430	0.35	0.72	0.37	0.15	4.00	0.00	0.01	0.01

Sampling returned grades up to 3.01 g/t Au, 196 g/t Ag, 0.41% Pb and 1.09% Zn.

7.4.4 Cervantes Vein

The Cervantes vein crops out 450 m to the east of the Santa María vein system and has been mapped and sampled over a 900 m strike length.

The vein varies in width from 0.25 to 1.3 m with an average of 0.6m. The vein is explored by several prospect pits and shafts and in the center of the system, and an 80 m long tunnel has been developed on the vein exploring an area where sulfide mineralization occurs.

The vein has a north-south strike and dips steeply (80°) to the west within a narrow fault zone within the Parral Formation limestones. On the surface the vein is a narrow banded and brecciated quartz-calcite vein and with variable oxidation. Adjacent to the small mine, the vein has a northeast strike and is steeply dipping (80° to the NW or SE depending on the vein limb). The vein appears to be offset by a NW striking fault. The host rocks are the Parral Formation limestones. The vein contains moderate iron oxides and iron oxide staining. However, the vein cropping out above the small mine working contains significant sulfides including sphalerite, galena and pyrite.

A total of 27 chip-channel samples were collected from the Cervantes Vein (**Table 7-2**).

Table 7-2: Cervantes Vein Channel Samples

Sample_ID	East	North	From (m)	To (m)	Thickness (m)	Au_ppm	Ag_ppm	Cu_%	Pb_%	Zn_%
129363	427136	2960118	0	0.40	0.4	0.07	6.00	0.00	0.02	0.02
129535	427028	2960514	0	0.68	0.68	0.04	2.00	0.00	0.01	0.01
129536	427011	2960542	0	0.38	0.38	0.03	9.00	0.00	0.04	0.09
129537	427010	2960542	0	0.25	0.25	0.02	11.00	0.00	0.10	0.10
129547	426981	2960608	0	0.50	0.5	0.17	16.00	0.00	0.02	0.06
129603	426972	2960714	0	0.26	0.26	0.11	26.00	0.00	0.08	0.08
129604	426949	2960761	0	0.68	0.68	0.01	7.00	0.00	0.01	0.02
129605	426932	2960799	0	0.48	0.48	0.04	5.00	0.00	0.01	0.02
129606	426919	2960831	0	0.50	0.5	0.10	207.00	0.00	0.03	0.04
129714	427174	2960015	0	0.40	0.4	0.14	115.00	0.03	1.22	2.05
129726	427062	2960328	0	0.35	0.35	0.96	124.00	0.13	3.74	2.17
129727	427061	2960331	0	0.42	0.42	1.01	185.00	0.23	5.63	19.52
129728	427058	2960344	0	0.43	0.43	0.34	105.00	0.09	2.84	3.15
SM-650	427164	2960030	0	0.45	0.45	0.02	4.00	0.00	0.01	0.06
SM-650	427164	2960030	0.45	0.65	0.2	0.28	106.00	0.01	0.07	0.24
SM-651	427145	2960081	0	0.58	0.58	1.58	130.00	0.11	3.84	1.25
SM-651	427145	2960081	0.58	0.78	0.2	0.07	63.00	0.01	0.23	0.47
SMS-17	427064	2960335	0	0.75	0.75	0.08	20.00	0.00	0.02	0.24
SMS-17	427064	2960335	0.75	0.99	0.24	0.57	134.00	0.24	3.27	0.35
SMS-17	427064	2960335	0.99	1.24	0.25	0.17	71.00	0.04	0.92	1.59
SMS-58	426987	2960563	0	0.17	0.17	0.05	19.00	0.00	0.04	0.06

Sample_ID	East	North	From (m)	To (m)	Thickness (m)	Au_ppm	Ag_ppm	Cu_%	Pb_%	Zn_%
SMS-58	426987	2960563	0.17	0.35	0.18	0.09	60.00	0.00	0.02	0.05
SMS-71	426965	2960732	0	0.60	0.6	0.02	3.00	0.00	0.01	0.01
SMS-71	426965	2960732	0.60	0.83	0.23	0.03	22.00	0.00	0.17	0.06
SMS-71	426965	2960732	0.83	1.28	0.45	0.01	2.00	0.00	0.01	0.04
SMS-72	426913	2960854	0	0.30	0.3	0.01	8.00	0.00	0.01	0.04
SMS-72	426913	2960854	0.30	0.78	0.48	0.10	30.00	0.00	0.03	0.05

Surface sampling returned grades up to 1.58 g/t Au, 207 g/t Ag, 0.25% Cu, 5.64% Pb and 19.52% Zn.

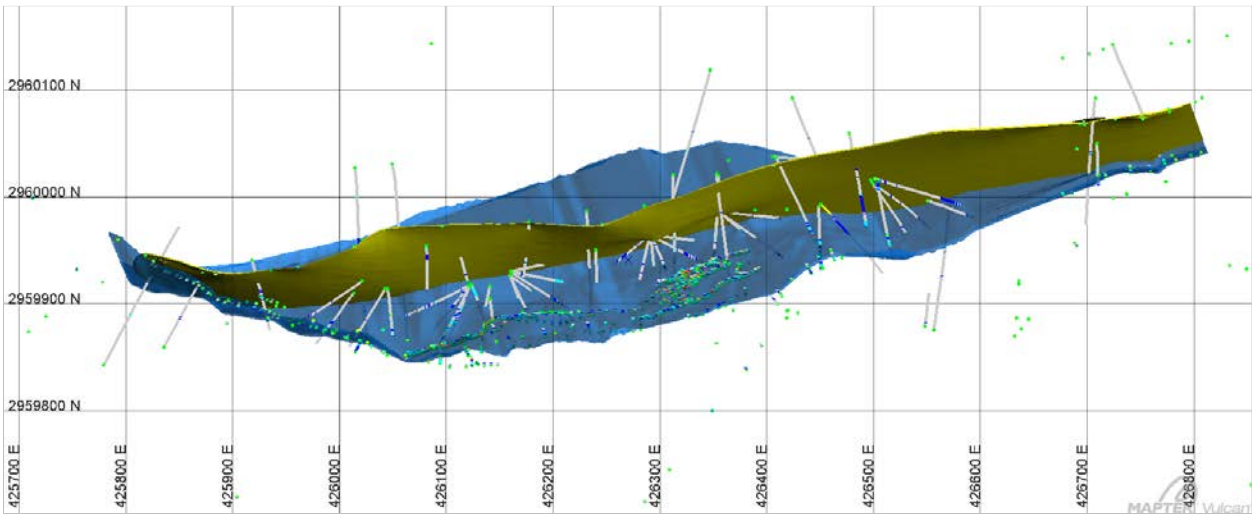


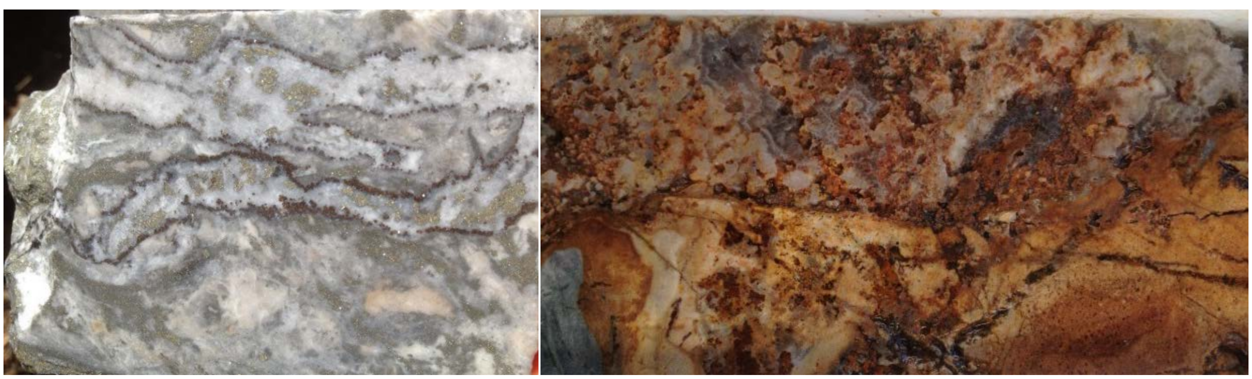
Figure 7-3: Santa María vein deposits, with the Main vein in cyan and the Dos vein in yellow.

8. DEPOSIT TYPES

The Santa María deposit type can be described as an epithermal quartz - calcite vein system. Typical banded epithermal textures are observed in underground workings and drill core. Brecciated mineral textures filled by quartz and calcite are common. Low concentrations of galena and sphalerite and the presence of silver minerals indicate an elevated level of exposure within the epithermal system. **Figure 8-1** shows typical epithermal mineralized textures encountered at Santa María in drill core specimens.

It is common for epithermal deposits to have higher-grade lineation trends internal to the structure's plane often related to regional structures or preferential host lithologies. Drilling, sampling, and modeling of results indicate that mineralized shoots within the structures have high angle rakes. Modeling has defined two such shoots.

Exploration programs have been planned in the context of mineralized structures, assuming the Santa María and Santa María Dos deposits are approximately planar and follow the general structural trends observed on the surface and throughout the underground workings. Successful exploration drilling down-dip of the workings supports the assumption that the mineralized structures follow oriented structural trends.



Sulfide Mineralization from SM14-09 — Oxidized Mineralization Near Surface from SM14-09

Figure 8-1: Epithermal Deposit Textures in Drill Core Specimens

9. EXPLORATION

Exploration by Minera Cordilleras consists of surface and underground geologic mapping and channel sampling. No known geophysical surveys have been completed to date. Historic exploration by previous operators, except for on mineralized structure drifting, is not known. The Chihuahua regional office of the *Servicio Geológico Mexicano* (SGM) generated a property report in 1985 which describes generalities of the geology and references the collection of confirmatory channel sampling.

Locations for the collection of channel samples were chosen by the Project geologist during mapping. Underground channel samples are located within existing deposit drifts. Channels were marked on the structure by the geologist and collected as close to perpendicular to strike as feasible during sampling. Using a rock hammer, five-pound sledge hammer and chisel, samples weighing at least 2 kg were collected in a bucket and then transferred to a transparent plastic bag labeled with a sample number. For samples located on the drift back, the sampler stood on a ladder and a tarp was placed under the sample area to catch the sample chips. The material on the tarp was then funneled into the sample bucket and again transferred to a labeled plastic bag. Both the bucket and tarp were cleaned between each sample collection. Coordinates of underground sample locations were initially tape surveyed by a geologist using a sighting compass and were corrected to align with the survey of the drift when completed by transit survey. Each sample location was not independently surveyed.

A total of 2,286 underground channel samples were collected for analysis and are included in the Santa María database. Channels were taken within existing development that spans approximately 575 m east to west and 110 m down dip. Samples were spaced between 5-15 meters, with few spaced more than 25 meters apart due to access for exploring the vein strike but spaced 1-4 meters apart in areas that were potentially prospective for mining. A summary of the significant high-grade channel samples is shown below in **Table 9-1**.

Significant channel sample results indicate the deposits host higher grade areas preferential to metal deposition and these areas can be observed throughout levels as mineral shoot domains. The results also demonstrate in some areas sampling "nugget effect" is significant, meaning erratic high or low-grade values can be observed inside or outside of generalized shoot trends.

Table 9-1: Significant High-Grade Deposit Intervals

Channel ID	From	To	Width	Ag >500 g/t	Au g/t	Deposit
SM-100	0	2	2.0	2500	1.0	Santa María
SM-101	0	2	2.0	899	1.3	Santa María
SM-107	0	2.15	2.2	1115	1.3	Santa María
SM-113	0.35	1.7	1.4	579	2.2	Santa María
SM-182	0	1.7	1.7	1353	4.0	Santa María
SM-186	0	2	2.0	658	0.9	Santa María
SM-208	0	1.8	1.8	504	1.1	Santa María
SM-230	1.1	2.5	1.4	525	0.6	Santa María
SM-241	0	2.4	2.4	594	1.4	Santa María
SM-249	0	2.35	2.4	1284	1.5	Santa María
SM-250	0	2.65	2.7	922	1.5	Santa María

Channel ID	From	To	Width	Ag >500 g/t	Au g/t	Deposit
SM-253	0	1.63	1.6	561	1.5	Santa María
SM-262	0.8	2.75	2.0	621	0.8	Santa María
SM-269	0	1.5	1.5	520	0.5	Santa María
SM-287	0	2.9	2.9	523	0.7	Santa María
SM-288	0	2.9	2.9	559	1.3	Santa María
SM-290	0	2.5	2.5	509	0.9	Santa María
SM-292	0	1.45	1.5	1744	2.4	Santa María
SM-293	0	2.2	2.2	1029	1.9	Santa María
SM-296	0	3.03	3.0	535	1.4	Santa María
SM-298	0	2.4	2.4	903	1.5	Santa María
SM-300	0	1.5	1.5	991	1.8	Santa María
SM-301	0	0.95	1.0	2094	2.3	Santa María
SM-307	0	1.75	1.8	681	0.6	Santa María
SM-311	0	0.95	1.0	2500	3.6	Santa María
SM-312	0	1.2	1.2	955	0.9	Santa María
SM-318	0	1.25	1.3	754	0.4	Santa María
SM-321	0	1.65	1.7	533	2.6	Santa María
SM-323	0	2.4	2.4	559	0.6	Santa María
SM-340	5	7.2	2.2	1094	0.8	Santa María
SM-346	1.3	3.9	2.6	790	0.8	Santa María
SM-359	0.2	2.6	2.4	536	1.1	Santa María
SM-360	0.8	3.3	2.5	591	0.9	Santa María
SM-367	0.5	3.8	3.3	635	1.0	Santa María
SM-392	1	2.2	1.2	1175	1.8	Santa María
SM-398	1.7	2.4	0.7	1184	2.4	Santa María
SM-400	0.8	1.8	1.0	1653	2.6	Santa María
SM-418	0.8	2.7	1.9	569	2.2	Santa María
SM-434	1.2	2.3	1.1	597	2.4	Santa María
SM-435	0.9	1.9	1.0	1005	2.8	Santa María
SM-438	0	2.8	2.8	614	3.7	Santa María
SM-439	0	1.6	1.6	530	1.1	Santa María
SM-452	0	1.75	1.8	519	0.5	Santa María
SM-470	0.4	1.5	1.1	618	1.1	Santa María
SM-480	0.5	2.4	1.9	762	0.9	Santa María
SM-486	0.8	2.6	1.8	762	0.9	Santa María
SM-487	1.1	2.93	1.8	823	0.9	Santa María
SM-488	0.85	2.7	1.9	759	0.8	Santa María
SM-489	0.8	2.4	1.6	752	1.1	Santa María

Channel ID	From	To	Width	Ag >500 g/t	Au g/t	Deposit
SM-493	0.15	3	2.9	584	1.2	Santa María
SM-494	1.06	2.46	1.4	1261	3.5	Santa María
SM-496	0	2.18	2.2	694	1.9	Santa María
SM-497	0	1.65	1.7	607	1.1	Santa María
SM-498	0.58	2.42	1.8	601	1.5	Santa María
SM-499	0	1.49	1.5	1584	2.6	Santa María
SM-500	0.45	1.95	1.5	845	2.4	Santa María
SM-504	0	2.58	2.6	1099	2.0	Santa María
SM-507	0	1.9	1.9	1127	2.1	Santa María
SM-520	0.8	1.85	1.1	693	1.0	Santa María
SM-521	0.65	2.5	1.9	774	1.4	Santa María
SM-526	1	2.25	1.3	598	1.1	Santa María
SM-527	0.9	2.5	1.6	1022	4.0	Santa María
SM-528	0.6	2.2	1.6	839	1.5	Santa María
SM-534	0.5	2.41	1.9	604	1.4	Santa María
SM-535	0.6	2.25	1.7	1278	4.0	Santa María
SM-536	0.7	2.5	1.8	721	0.5	Santa María
SM-537	0	2.5	2.5	1086	1.0	Santa María
SM-546	0.6	1.8	1.2	594	1.5	Santa María
SM-549	0	1.75	1.8	935	1.5	Santa María
SM-550	0	1.59	1.6	627	1.8	Santa María
SM-553	0	1.7	1.7	773	1.0	Santa María
SM-554	0	1.55	1.6	1149	0.9	Santa María
SM-555	0	0.6	0.6	2100	1.5	Santa María
SM-556	0.15	1.1	1.0	1256	1.2	Santa María
SM-563	0	3.13	3.1	684	1.4	Santa María
SM-574	0.2	2.4	2.2	796	1.6	Santa María
SM-607	1.58	2.84	1.3	694	3.2	Santa María
SM-610	0	0.4	0.4	891	0.6	Santa María
SMS-94	0	1.3	1.3	648	1.88	Santa María

10. DRILLING

The Project database contains 59 surface and underground drill holes, totaling 9,922.61 m, drilled during four campaigns in 2014, 2016, 2017, and 2018 by Minera Cordilleras. Surface drill holes are NQ size with either plastic or steel surface casing. Drilling was completed by Maza Diamond Drilling S.A. de C.V. of Sinaloa, Mexico utilizing a portable rig with a 500 m maximum depth.

In 2016 Minera Cordilleras completed 24 drill holes from underground using Boart Longyear LM30 and LM75 drill rigs, totaling 2,190.1 m. The purpose of the underground drilling was primarily to delineate the mineralized shoots and increase Resource classification. Two of the holes (SM16-18 and SM16-19) targeted the vein east of the known strike extension at the time and intersected significant high-grade mineralization.

In 2014 Minera Cordilleras completed 13 drill holes with total drilled depth of 2,884.50 m, and in 2017 Minera Cordilleras completed 14 drill holes with total drilled depth of 3,305.90 m; while in 2018 a total of 8 drill holes were completed with total depth of 1,542 m.

Surface drill hole collar locations were surveyed by handheld GPS and then by a professional surveyor with the aid of a Differential GPS. Underground drill collars were surveyed using a Total Station. Drill hole orientations were established by measurements of casing using a field compass and then down hole surveyed using a magnetic Reflex instrument.

Figure 10-1 shows the locations and orientations of the drill holes relative to the surface topography and underground development. Drill hole orientations have been inclined to target the vein as perpendicular to strike and dip as practically possible given the surface terrain and access.

Table 10-1: Locations and orientations of drill holes

Surface / Underground	Hole ID	Easting	Northing	Elevation	Total Depth	Initial Azimuth	Initial Dip	No. of Surveys
Surface	SM14-01	426,351	2,960,026	2,019	181	180	-57	3
Surface	SM14-02	426,239	2,959,950	1,998	124	180	-73	2
Surface	SM14-03	426,146	2,959,920	2,006	86.4	180	-73	1
Surface	SM14-03A	426,137	2,959,923	1,999	150	190	-81	2
Surface	SM14-04	426,041	2,959,920	2,028	174	180	-75	3
Surface	SM14-05	426,347	2,960,119	2,033	321	197	-65	4
Surface	SM14-06	426,304	2,960,030	2,009	263	180	-65	6
Surface	SM14-07	426,043	2,960,040	1,987	296.5	180	-58	3
Surface	SM14-08	426,078	2,959,960	2,006	208.5	180	-79	3
Surface	SM14-09	426,172	2,959,980	1,988	229	185	-73	4
Surface	SM14-10	426,351	2,960,026	2,019	240	180	-77	4
Surface	SM14-11	426,009	2,960,030	1,973	297.3	182	-55	3
Surface	SM14-12	426,228	2,959,992	1,985	312.35	180	-72	5
Surface	SM17-01	426,451	2,959,994	2,028	300	137	-75	8
Surface	SM17-02 SM17-03	426,424	2,960,093	2,043	241.5	160	-70	4

Surface / Underground	Hole ID	Easting	Northing	Elevation	Total Depth	Initial Azimuth	Initial Dip	No. of Surveys
Surface	SM17-03 SM17-04 SM17-04	426,497	2,960,016	2,030	252	146	-75	7
Surface	SM17-04 SM17-05	426,449	2,959,992	2,027	117.9	180	-56	4
Surface	SM17-05	426405	2,960,038	2,031	220	94	-69	8
Surface	SM17-06	426,709	2,960,050	2,005	138	180	-70	4
Surface	SM17-07	426,708	2,960,093	2,011	258	190	-60	6
Surface	SM17-08	426,504	2,960,015	2,030	174	172	-64	6
Surface	SM17-09	426,551	2,959,997	2,027	241.5	112	-78	5
Surface	SM17-10	426,499	2,960,013	2,030	350	125	-78	7
Surface	SM17-11	426,501	2,960,017	2,030	261	105	-70	5
Surface	SM17-12	426,556	2,959,876	2,007	350	7.5	-68	9
Surface	SM17-12A	426,548	2,959,879	2,007	102	7.5	-66	2
Surface	SM17-15	426,724	2,960,143	2,008	300	160	-64	7
Surface	SM18-01	426,477	2,960,058	2,040	270	167	-70	7
Surface	SM18-02	426,043	2,959,914	2,021	200	210	-73	6
Surface	SM18-03	426,409	2,960,037	2,031	150	155	-55	5
Surface	SM18-04	426,013	2,959,910	2,016	186	220	-71	7
Surface	SM18-05	425,918	2,959,941	1,960	150	165	-65	7
Surface	SM18-06	426,021	2,959,922	2,016	261	232	-76	8
Surface	SM18-07	425,836	2,959,860	1,953	125	30	-45	6
Surface	SM18-08	425,779	2,959,843	1,953	200	30	-45	6
Underground	SM16-01	426,123	2,959,918	1,900	171.56	158	-68	5
Underground	SM16-02	426,121	2,959,916	1,900	91	208	-26	3
Underground	SM16-03	426,121	2,959,917	1,900	115.5	221	-62	1
Underground	SM16-04	426,120	2,959,917	1,900	106.2	244	-47	3
Underground	SM16-05	426,122	2,959,917	1,900	104.8	203	-41	3
Underground	SM16-06	426,160	2,959,927	1,904	60	152	-43	1
Underground	SM16-07	426,161	2,959,930	1,904	96	104	-53	1
Underground	SM16-08	426,161	2,959,930	1,904	81.2	122	-30	1
Underground	SM16-09	426,160	2,959,928	1,904	98.7	123	-67	2
Underground	SM16-10	426,159	2,959,928	1,904	87	151	-67	2
Underground	SM16-11	426,293	2,959,960	1,897	63	158	-54	2
Underground	SM16-12	426,294	2,959,963	1,894	69	120	-37	1
Underground	SM16-13	426,290	2,959,961	1,895	63.65	196	-28	1
Underground	SM16-14	426,295	2,959,964	1,896	101	100	-60	1
Underground	SM16-15	426,289	2,959,963	1,895	102	234	-65	1
Underground	SM16-16	426,353	2,959,984	1,885	60	187	-35	1

Surface / Underground	Hole ID	Easting	Northing	Elevation	Total Depth	Initial Azimuth	Initial Dip	No. of Surveys
Underground	SM16-17	426,356	2,959,986	1,885	86	130	-64	3
Underground	SM16-18	426,357	2,959,985	1,885	83	127	-29	3
Underground	SM16-19	426,357	2,959,987	1,885	96	99	-52	1
Underground	SM16-20	426,120	2,959,922	1,904	50.1	347	0	2
Underground	SM16-21	426,354	2,959,985	1,885	122.5	184	-63	3
Underground	SM16-22	426,160	2,959,931	1,904	123	81	-66	1
Underground	SM16-23	426,292	2,959,961	1,895	90	177	-66	1
Underground	SM16-24	426,293	2,959,966	1,895	60	31	-43	1

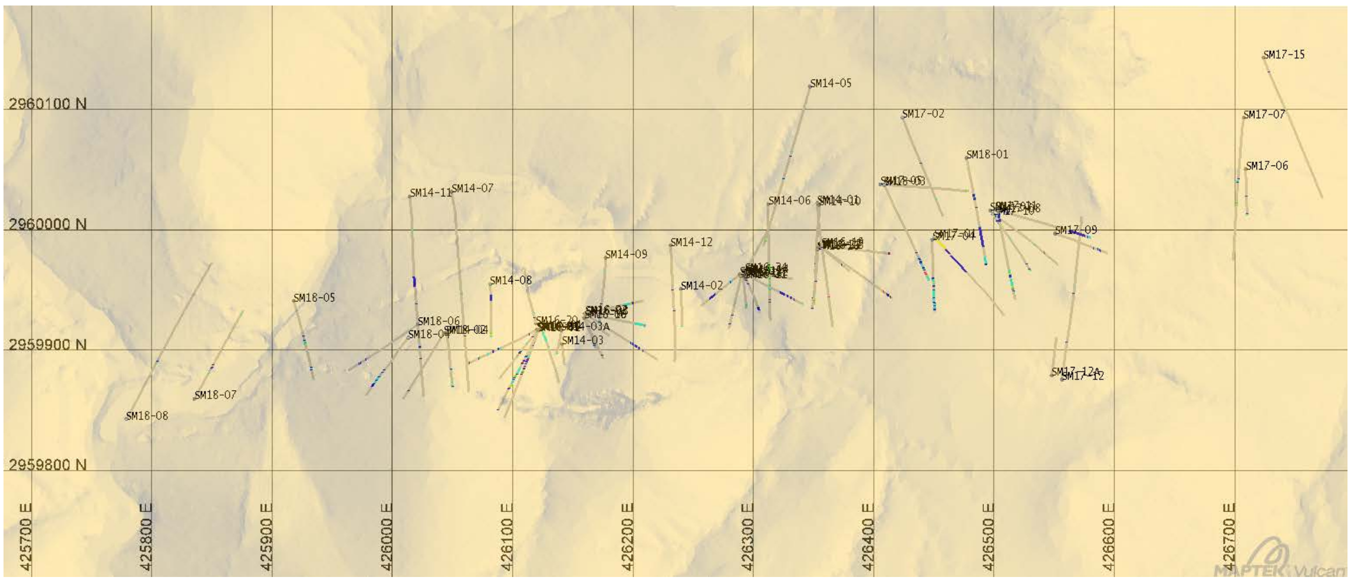


Figure 10-1: Drill Hole Location Map

11. SAMPLE PREPARATION, ANALYSES AND SECURITY

Data summarized in this section and utilized for estimation of Resources has been collected by Minera Cordilleras staff. The sample preparation, analyses and security procedures implemented by Minera Cordilleras meet standard practices. The data collected is of adequate quality and reliability to support the estimation of Mineral Resources. Only Project level staff are involved with the selection, preparation and delivery of samples to the laboratory.

Historic sampling by previous operators is not considered current and has therefore not been described in this section. The Project database contains results collected from both drill core and channel sampling.

11.1 Sample Preparation

In this section drill core and channel sampling are discussed.

11.1.1 Drill Core

Diamond drill core is transported from the rig to the core preparation site, located at the mine entrance, by truck. Following geotechnical logging by field assistants, geologists log the core and select sample intervals. Sample intervals are selected only where the geologist anticipates mineralization to exist. In practice the core is extensively sampled in both the hanging wall and footwall about the primary deposit intervals but is not sampled continuously from top to bottom. Drill core that is selectively un-sampled can be considered waste; however, no numeric value or null place holder is inserted into the Project database. Sample selection begins and terminates at alteration or lithologic contacts, constrained to a minimum length of 20 cm and maximum of 1.5 m. During the process of sample selection, the geologist draws a centerline to guide the core cutters. The center line is rotated by the geologist to align with the apex of observable vein structures to minimize sample selection bias.

A sample sheet is provided to the core cutters containing sample numbers and *from*, *to* intervals. In addition to a cut sheet the sample number and meters are annotated on the white plastic core box using a marker, **Figure 11-1**. Sample numbering begins where the previous sample batch left off. The core cutters have been instructed to cut the core down the marked centerline using an electric powered wet diamond saw, and to always place the right-hand portion of the cut core in the sample bag. Sections of broken core or low recovery are carefully divided to reduce bias; however, these sections are inherently less reliable than sections of competent core. The core cutters write the sample number using a marker on a transparent plastic bag and tie off the bag using twine when complete. A tear-away sample tag system has not been implemented but is recommend in the future. Five samples are grouped and placed in a large rice sack. The beginning and ending number of the five samples contained in the sack is written on the outside of the bag. The sack is tied shut with twine when full.

Figure 11-1: Drill Core Sampling

11.1.2 Channels

The Project database contains only underground channel sampling, and no surface samples have been collected. The geologist first maps the structures and veins underground; following mapping, the geologist uses a can of red spray-paint to mark channel sample lines spaced along the strike of the drift. Channel samples are selected only in mappable mineralized structures and do not include hanging-wall or foot-wall waste samples. Samples are initiated and terminated based on observable vein styles or mineral type difference across the deposit. Sample lengths are dictated by structural thickness with a minimum of 20 cm with no defined maximum, but do not typically exceed 2 m in length.

Field assistants, often with sampling experience at nearby operations, are recruited to assist with channel sample collection. Under the supervision of a geologist, the samplers are instructed to fully chip away the entire painted portion of the channel sample indicated by the geologist. Using a rock hammer, chisel and five-pound sledge hammer, one sampler chips the vein while another sampler holds a bucket to capture the sample, **Figure 11-2**. The material in the bucket is then poured into a transparent plastic sample bag annotated with the sample number that is painted on the wall by the geologist. The bucket is then tapped out and wiped out by hand. For hard to reach samples, samplers utilize a ladder to access the drift back while a helper positions a tarp on the ground to catch the chiseled material. The tarp is then funneled into the sampling bucket. Both the bucket and tarp are cleaned between the collection of samples. Preparation, analyses, and security of channel and drill hole sampling are the same from placing the material in a transparent plastic bag onward.

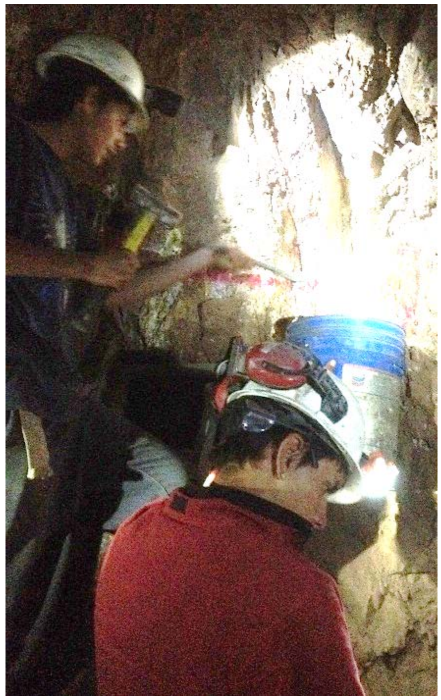


Figure 11-2: Channel Sample Collection

11.2 Security

The Project is located well off main roads and is guarded by a caretaker who lives in a mine building near the mine entrance while the site is active. Samples awaiting delivery to the ALS preparation facility in Chihuahua are placed in a locked building overnight. Samples are delivered to ALS Minerals in Chihuahua City, Chihuahua, Mexico (ALS Chihuahua) by Minera Cordilleras staff by road as needed, typically every two weeks.

11.3 Analyses

Sample batches are delivered to ALS Chihuahua for preparation and then shipped to Vancouver, British Columbia, Canada (ALS Vancouver) for analysis. The ALS Vancouver laboratory is independent of Golden Minerals and Minera Cordilleras and is ISO 17025-accredited, the accreditation of ALS Vancouver encompasses preparation processes completed at ALS Chihuahua.

Samples are initially analyzed for Au using fire assay with atomic absorption spectroscopy finish (AA24) with rerun for values exceeding 10 g/t Au using fire assay with gravimetric finish (GRA22).

Samples are also initially analyzed for Ag, Pb, Zn, Cu, and 32 additional elements using aqua regia inductively coupled plasma - atomic emission spectroscopy (ICP41) with rerun for values exceeding 100 g/t Ag, and 1% Pb, Zn, Cu analyzed by *ore grade* aqua regia inductively coupled plasma - atomic emission spectroscopy (OG46).

Analysis flow is further described in graphic form in **Figure 11-3**.

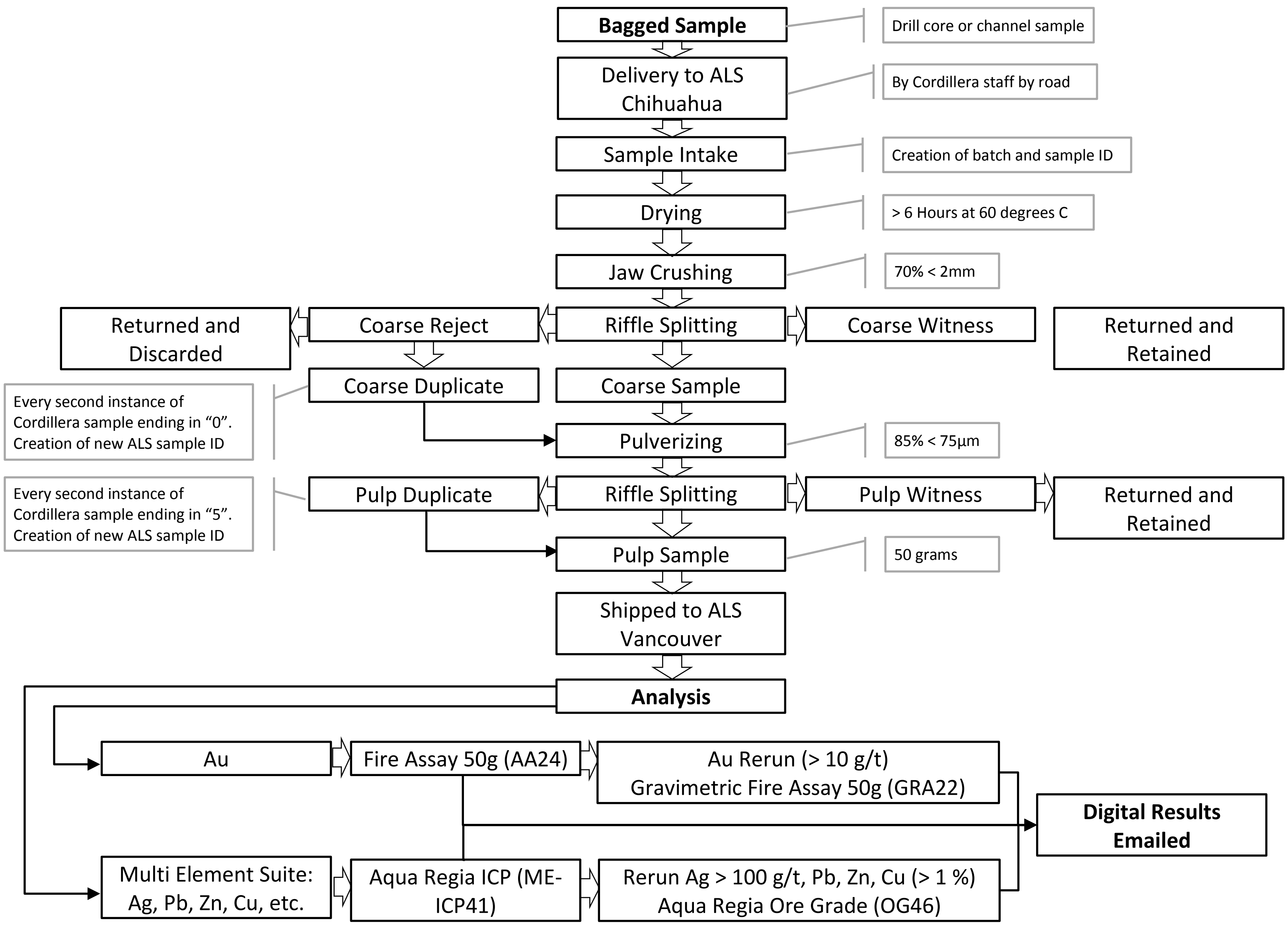


Figure 11-3: Sample Analysis Flow Diagram

11.4 Quality Assurance and Quality Control for Sample Analysis

Minera Cordilleras' quality assurance (QA) measures involve the use of standard practice procedures for sample collection for both drill core and channel sampling as described above, and include oversight by experienced geologic staff during data collection. Quality control (QC) measures implemented by Minera Cordilleras include in-stream sample submittal of standard reference material, blank material and duplicate sampling.

The insertion of control samples is dictated by the last digit of the sample ID number; the sequence is independent of the drill hole or channel sample set and is continuous through the sampling campaign. For example, the first instance of a drill core sample id ending in "0" is a blank sample and is placed in a sample bag rather than a collected core sample. On the next instance of a "5" the lab is instructed on the sample submittal sheet to create and test a fine duplicate following pulverizing. On the next instance of a "0" the lab is instructed to create a coarse duplicate at the crushing stage. On the next instance of "5" a low grade standard sample is placed in the sample bag instead of a collected sample and the next "0" a high-grade standard. The same order described above was utilized for the channel sampling campaign; however, the submittal was conducted on sample id's ending in "0" only. The effective QC submittal for the drill core campaign is 1 control sample for 10 collected samples and 1 control sample for 50 for the channel sample campaign.

11.4.1 Quality Control Sample Performance

QC sample performance was generally tracked throughout the campaign by Minera Cordilleras staff and no key issues were observed, but results suggest standard control sample strategies could be refined. It is recommended that standard reference material with a grade closer to the Resource average for Ag be sourced and tested more frequently to provide a consistent baseline.

As part of this report, QC sample performance was reviewed. Relevant QC sample performance is summarized below. Six standard references were implemented for testing, with the certified values for each shown in **Table 11-1** below. Information regarding certified values for one of the low-grade standards was not located but the test results show consistent values. In addition, standard M2-87438 which is above the rerun limit was initially tested twice, but not rerun by the lab due to an insufficient sample following initial testing.

Table 11-1: Au Standard Reference Material Certified Values

Standard	Source	Standard Grade g/t	95% Confidence Interval	Standard Deviation	Tested Count	Tested Mean
Unknown	Unknown	0.2			6	0.2
M2-87439	Minera Cordilleras Custom (Tested by SGS)	9.06	0.023	0.029	2	
M4-87438	Minera Cordilleras Custom (Tested by SGS)	1.24	0.025	0.032	2	1.19
SE-44	RockLabs	0.61	0.006	0.017	21	0.6027
SP-49	RockLabs	18.34	0.120	0.340	51	17.954
OxC72	RockLabs	0.205	0.003	0.008	42	0.2024

Table 11-2: Ag Standard Reference Material Certified Values

Standard	Source	Standard Grade g/t	95% Confidence Interval	Standard Deviation	Tested Count	Tested Mean
Unknown	Unknown	0.2			6	0.2
M2-87439	Minera Cordilleras Custom (Tested by SGS)	378.6	5.09	6.504	2	
M4-87438	Minera Cordilleras Custom (Tested by SGS)	1.78	0.086	0.110	2	2.05
SE-44	RockLabs	NA	NA	NA	6	0.48
SP-49	RockLabs	60.2	1	2.5	51	60.1
OxC72	RockLabs	0.205	0.003	3	42	0.54

Standard performance was determined through methods suggested by RockLabs of Auckland, New Zealand and provided in a Microsoft Excel™ template on their website for plotting standard performance. The RockLabs analytical spreadsheet defines accuracy as the tested mean (in stream), at the laboratory in question, minus certified mean over the certified mean. Precision is defined as the percentage of standard deviation over the tested mean. For both precision and accuracy, outliers more than three times the tested standard deviation are ignored for performance assessment and identified for review.

When compared to two standard deviations of the assigned values, as commonly but improperly done, the results falsely indicate poor performance; however, using the performance assessment determinations defined by RockLabs, which establishes failure thresholds based on standard deviations calculated from sampling of the laboratory in question, the standards perform well except for ore grade reruns in sample SP-49 which perform poorly for both high-grade gold and low-grade silver. The deficient performance has little bearing because very few samples have grades that trigger the Au rerun. Standard results are shown in **Table 11-3**. By the above defined limits, an outlier in most cases is considered a batch failure. One outlier has been observed in the review of submitted standards. The failure rate observed is not unusual for a program of this size; however, it is suggested that the failure be investigated further to determine if batch reruns are necessary.

Table 11-3: Au Standard Reference Material Control Analysis

Standard	Count	Accuracy (% of Assigned)	Precision (% Relative Std Dev)	Outliers
?	6	NA	NA	NA
M2-87439	2	NA	NA	NA
M4-87438	2	-4	0	0
OxC72	21	-1.3	2	0
SE-44	21	-0.5	2.7	0
SP-49	51	-2.1	2.7	1

Table 11-4: Ag Standard Reference Material Control Analysis

Standard	Count	Accuracy (% of Assigned)	Precision (% Relative Std Dev)	Outliers
?	6	NA	NA	NA
M2-87439	2	NA	NA	NA
M4-87438	2	15.2	38.9	0
OxC72	21	NA	NA	NA
SE-44	21	NA	NA	NA
SP-49	51	0.3	6.3	2

The blank material has been sourced from barren coarse sand. The performance of the blank material shows very few failures. Failures observed (two gold and two silver) are minor and most likely a result of very small amounts of gold and silver in the blank material and low-end instrumentation precision, and not a result of contamination given the grades of the prior samples **Figure 11-4** shows blank performance for both gold and silver.

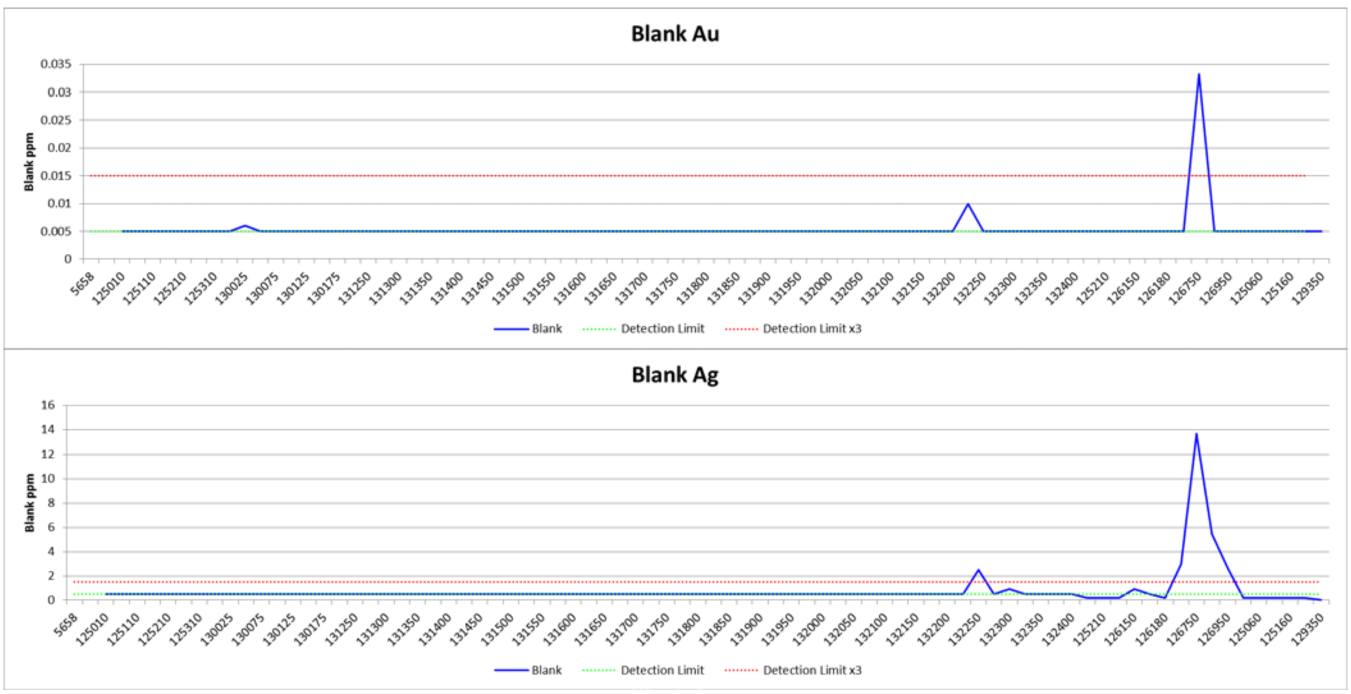


Figure 11-4: Blank Control Analysis

The performance of the fine and coarse duplicates shows good reproducibility. Poor reproducibility in coarse duplicate sample pair sample, 125131 and 125130, for both gold and silver was investigated and determined to be caused by nugget effect.

Figure 11-5 shows coarse duplicate performance for Au and Ag. **Figure 11-6** shows fine duplicate performance for Au and Ag.

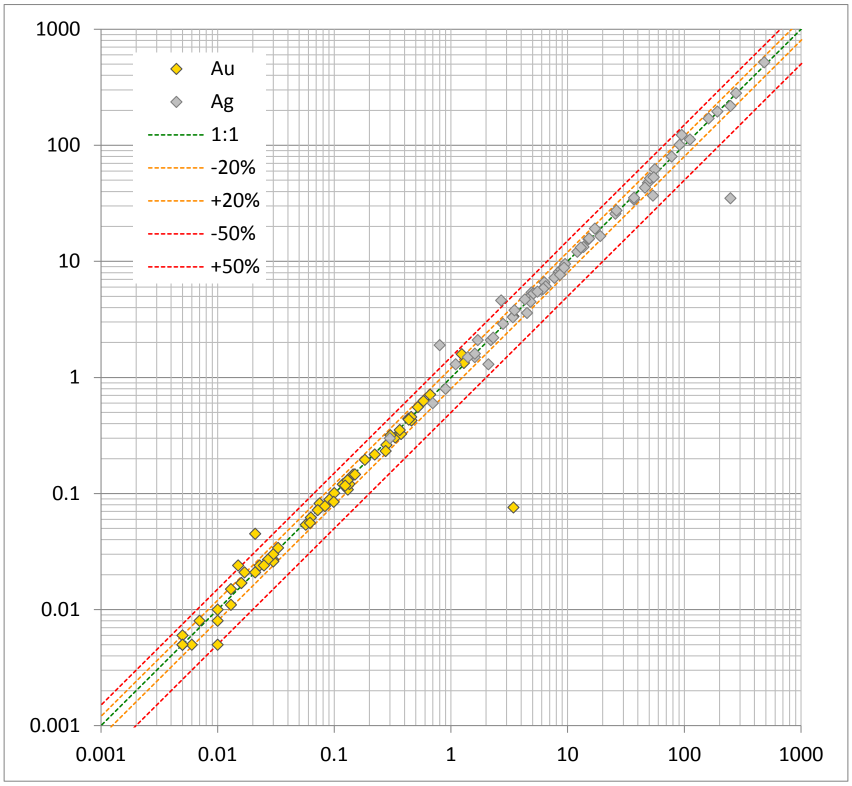


Figure 11-5: Coarse Duplicate Analysis

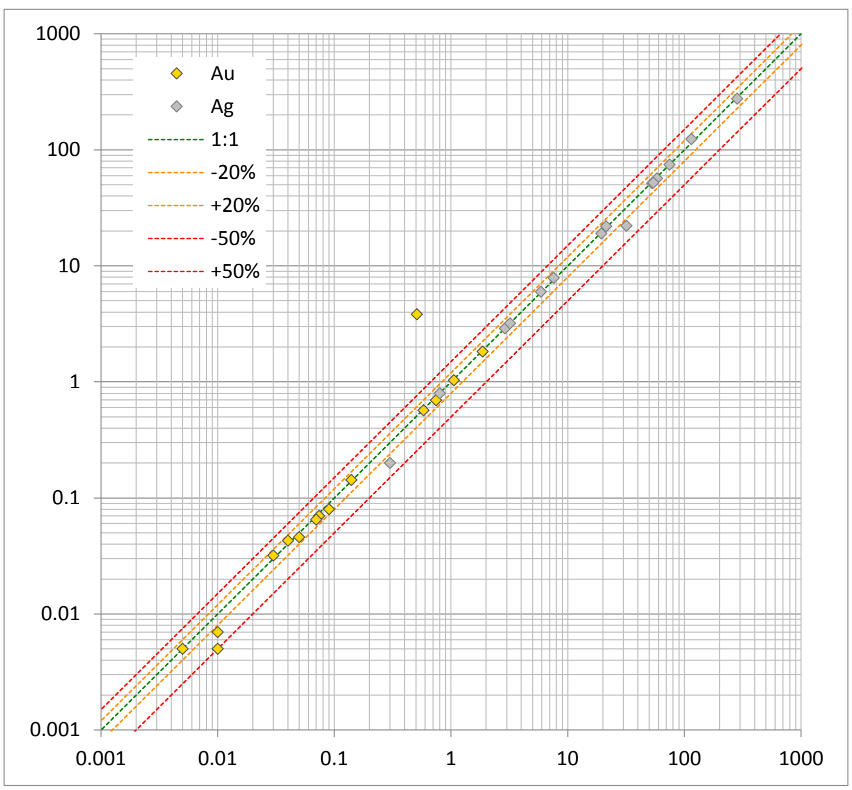


Figure 11-6: Fine Duplicate Analysis

12. DATA VERIFICATION

The quality of data collected by Minera Cordilleras meets industry standard practice and is sufficient to support the estimation of Mineral Resources.

The following section describes steps taken by the author of this report to verify data provided by the company. Data verification conducted during the previous site visit included observations of drill hole collar locations and orientations, drill core, channel sample locations, channel sample collection, underground mine accesses, on mineralized structure drifts and stopes, stockpiled oxide material from waste backfill mucking. The deposit was witnessed in underground workings and at the surface but was not traversed in its entirety. Confirmatory sampling of drill core was not completed due to the sparseness of mineral intervals; the author did not want to eliminate the physical record of previously halved core for the purposes of verification.

Drill hole collars and their orientations were observed in the field using a compass and handheld global positioning system (GPS). Verification of collar locations and orientations were found to correspond to those provided by Minera Cordilleras.

Core boxes containing mineralized intervals of the following drill holes SM14-04 and SM14-09 were made available for visual review. The textures observed are typical of epithermal veins including banding of quartz and sulfide minerals, quartz flooding, brecciation and oxidation. In addition to visually reviewing core on site, the author has reviewed core photos of mineral intervals and spot checked the assay database provided with assay certificates from the laboratory.

As part of the data verification, 18 channel samples were selected to be re-sampled and submitted to ALS for analysis. The samples were chosen by the author of this report and were collected on the ramp and the East side of the 1890 m level. The collection of the samples from within the mine was witnessed by the author. The samples were delivered to ALS Chihuahua where the sample preparation facility was toured. The original samples from the Project database are compared to the check samples in **Figure 12-1**; the chart axes have been log base 10 transformed. The results of the verification sampling correspond well to those provided by Minera Cordilleras.

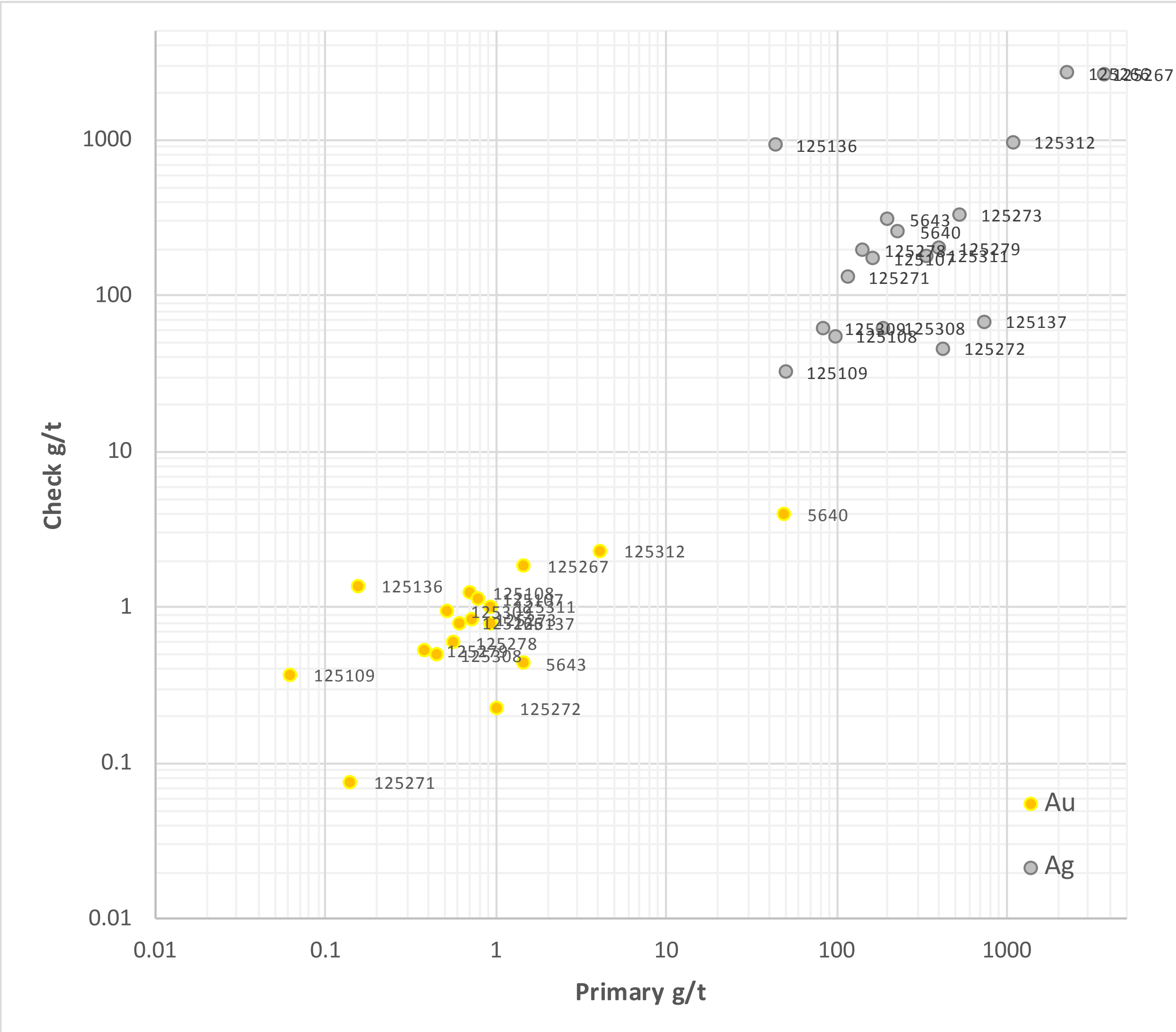


Figure 12-1: Au Check Channel Samples

In addition to re-sampling of channels, a stock pile of approximately 75 tonnes of historic waste backfill mucked out of the mine by a LHD (Load, Haul, Dump) was tested with five randomly selected samples, shoveled and bagged by the author and submitted to ALS for analysis. The results of the five samples are included in **Table 12-1** below. Although the material was sourced from the property, the results are neither representative of the virgin material or the property, nor do they represent expected grades of Resources or potential future mining operations, but they do confirm the presence of mineralized material on the property.

Table 12-1: Stock Pile Samples from Mucked Waste Backfill

Sample ID	Description	Au g/t	Ag g/t	Pb %	Zn %	Cu %	As %
M6	Mucked backfill waste stockpile random	1.7	109	0.23	0.36	0.022	0.084
M7	Mucked backfill waste stockpile random	0.5	187	0.21	0.43	0.016	0.066
M8	Mucked backfill waste stockpile random	0.7	221	0.28	0.52	0.020	0.077
M9	Mucked backfill waste stockpile random	1.6	289	0.52	0.66	0.034	0.127
M10	Mucked backfill waste stockpile random	0.9	211	0.39	0.98	0.026	0.087

13. MINERAL PROCESSING AND METALLURGICAL TESTING

Samples of oxide and sulfide material were subjected to scoping level metallurgical testing at Golden Minerals' Velardeña Mine laboratory in September 2014. This test work indicated that the oxide material is amenable to direct cyanide leaching. The sulfide material underwent flotation testing to concentrate the precious metals into lead and zinc concentrates. The results of this flotation testing indicate the potential to produce a relatively low-grade lead concentrate with a relatively high silver content, as well as a high-grade zinc concentrate.

Pilot scale flotation process test work was undertaken from September 10 to October 16, 2015 on mixed material. In this test, the aim was to produce a concentrate with high silver content.

Additional samples of the sulfide material were subject to laboratory flotation testing by SGS in October 2016 to evaluate production of a bulk silver-bearing concentrate as opposed to the production of separate lead and zinc concentrates.

Golden Minerals engaged RDi Inc. in January 2017 to perform additional rougher and cleaner flotation test work on the same composite as used in the October 2016 SGS testing. This test work evaluated both the impacts of alternative reagent suites as well as grind sizes.

Golden Minerals expanded the Resource base in 2018. Currently, the oxides constitute 37% of the total Resource and mixed ore and sulfides account for 19% and 44% of the total Resources, respectively.

RDi recently completed additional scoping level metallurgical test work on all three ore types (i.e., oxides mixed and sulfides). It is currently envisioned that all three ore types will undergo toll processing. The oxide ore will by cyanide leached for silver extraction whereas mixed and sulfide material will be floated to produce a saleable concentrate, and the flotation tailings can be cyanide leached for additional silver recovery or sent to the tailings pond. Additional test work would be required to optimize the process parameters and to establish a higher level of confidence regarding anticipated grade and recovery values.

13.1 2014 Testing Program

13.1.1 Oxide Material Testing

Preliminary whole ore leach test work on oxide material suggests it is possible to achieve leach recoveries of 80% and 79% for gold and silver respectively within 48 hours. The results of this testing are shown below in **Table 13-1**.

Table 13-1: Cyanide Leach Extraction vs. Retention Time

Retention Time (Hours)	Recovery %	
	Au	Ag
24	80.0	74.7
48	80.0	79.0
72	83.6	77.8

Details pertaining to reagent consumption, dosage, and particle size were not included in the provided summary of test work. Hence, additional test work was undertaken in 2018 to determine the reagent consumptions for the PEA.

13.1.2 Sulfide Material Testing

Preliminary flotation test work was focused on making marketable lead and zinc concentrates. This test work suggests it is possible to recover the gold and silver into lead and zinc concentrates. The final cleaner concentrate grades produced in this test work are shown below in **Table 13-2**.

Table 13-2: Final Cleaner Concentrate Grades

Product	Grade Au g/t	Grade Ag g/t	Grade Pb%	Grade Zn%	Grade Cu%	Grade Fe%	Grade As%	Grade Sb%
Pb Concentrate	72.0	50,094	22.89	9.01	0.98	9.51	5.90	0.89
Zn Concentrate	1.6	1,926	0.23	49.16	0.28	3.10	0.02	0.11

Concentrate market terms have not yet been investigated. Indications from this initial test work are that the lead concentrate contains significant amounts of arsenic and antimony as well as a relatively low lead content, which may adversely affect the commercial terms. The high silver content of the lead concentrate suggests that it could potentially be marketable as a silver bearing bulk concentrate rather than as a traditional lead product.

The test work indicates the zinc product is a relatively high-grade concentrate, and the marketability may not depend on the precious metal content.

No details were provided at the time of writing regarding the specific test work conditions such as reagent dosage, retention time, and grind size.

13.2 2015 Mixed Material Pilot Processing

Pilot scale tests were performed in the time periods of September to October 2016, February to March 2016, and June of 2017, on mixed material from the Santa María project at the Silveyra Mill in Parral. Over the course of the testing, approximately 7,098 tonnes of material were processed to produce a bulk concentrate for metallurgical and marketing purposes. The silver head grade averaged 337 Ag g/t. Silver recovery averaged 73% at a concentrate grade of 8,897 Ag g/t. Gold head grade averaged 0.78 Au g/t and recovery averaged 50% at a concentrate grade of 14 Au g/t.

Recoveries from the pilot processing from September to October 2016 are shown below on a measurement periods, rather than daily basis, in **Figure 13-1**.

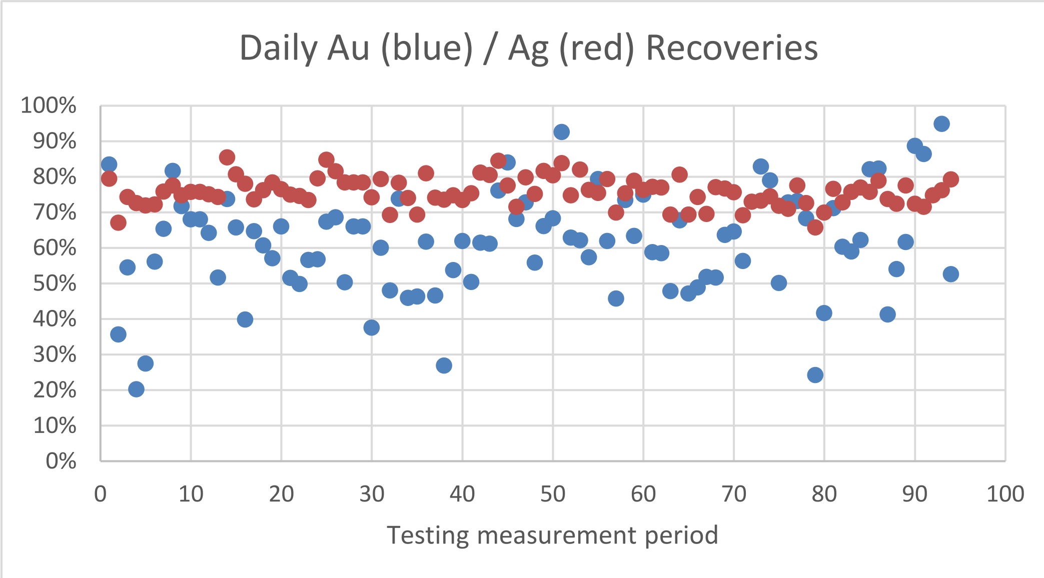


Figure 13-1: Pilot Scale Gold and Silver Recoveries

13.3 2016 SGS Testing Program

13.3.1 Rougher Flotation Testing

Following the completion of the bulk mixed material pilot production, three sulfide flotation lab-scale trials were performed by SGS in 2016. The first of these trials attempted to suppress pyrite and zinc recovery to the bulk concentrate, while the second trial attempted to maximize gold recovery. In doing so, the latter trial resulted not only in an improvement to gold recovery, but also yielded a better silver grade/recovery curve. These results are shown below in **Table 13-3** and **Table 13-4** respectively.

Table 13-3: Bulk Concentrate Rougher Flotation with Suppression of Pyrite

Product	Weight %	Grade				Recovery %			
		Au g/t	Ag g/t	Pb %	Zn %	Au	Ag	Pb	Zn
Conc 1	3.0	12.6	8,016	10.4	6.2	21.6	61.7	52.2	9.8
Conc 1-2	5.6	8.8	5,168	6.8	5.2	28.0	73.9	63.6	15.4
Conc 1-3	7.3	7.3	4,220	5.7	5.0	30.6	79.0	69.7	19.5
Conc 1-4	9.0	6.2	3,546	4.9	4.8	32.0	81.7	73.1	22.8
Conc 1-5	10.7	5.4	3,043	4.2	4.5	33.1	83.6	75.7	25.8
Conc 1-6	12.6	4.8	2,631	3.7	4.3	34.4	85.2	78.0	29.1
Tails	87.4	1.3	65.9	0.2	1.5	65.6	14.8	22.0	70.9
Calculated Head	100	1.75	390	0.60	1.88	100	100	100	100

Table 13-4: Bulk Concentrate Rougher Flotation with Enhanced Zinc and Pyrite Recovery

Product	Weight %	Grade				Recovery %			
		Au g/t	Ag g/t	Pb %	Zn %	Au	Ag	Pb	Zn
Conc 1	4.9	11.76	6,453	2.6	5.07	37.2	70.6	66.7	13.7
Conc 1-2	8.4	8.47	4,290	1.79	4.51	46	80.5	78.7	21
Conc 1-3	10.7	7.51	3,620	1.56	4.47	51.8	86.3	87	26.4
Conc 1-4	12.8	6.72	3,112	1.35	4.29	55.3	88.5	90	30.2
Conc 1-5	14.4	6.26	2,817	1.23	4.19	57.9	90	92.2	33.1
Conc 1-6	15.7	5.95	2,609	1.15	4.14	60.1	91.1	93.9	35.8
Tails	84.3	0.7	47.5	0	1.4	39.9	8.9	6.1	64.2
Calculated Head	100	1.55	450	0.6	1.88	100	100	100	100

The third test evaluated the effect of a specialty collector, known as Max Gold, to supplement the reagents used in the second test. This resulted in further improvement to gold recoveries, while having negligible impact on the resulting concentrate silver grades compared to the second test. This suggests that a sizable portion of the gold in the rougher feed is present in liberated form at a grind size of P_{80} 200 mesh. The results of this testing are shown below in **Table 13-5**.

Table 13-5: Bulk Concentrate Rougher Flotation with the Addition of Max Gold Collector

Product	Grade		Recovery, %	
	Au g/t	Ag g/t	Au	Ag
Conc 1	11.59	3,981	55.8	77.6
Conc 1-2	9.9	3,260	63.7	85
Conc 1-3	8.9	2,872	67.4	88.3
Conc 1-4	8.3	2,677	69.3	89.9
Conc 1-5	7.8	2,472	70.9	91.2
Conc 1-6	7.7	2,365	74.3	92
Tails	0.5	35.1	25.7	8
Calculated Head	1.52	376	100	100

13.3.2 Cleaner Flotation Testing

The results of the 2014 cleaner lead/zinc flotation test work, coupled with the 2016 bulk rougher flotation results, suggested that improvements to the silver grade/recovery response may be possible with the implementation of cleaner flotation. The results of this test work are shown below in **Table 13-6**.

Table 13-6: SGS 2016 Bulk Concentrate Cleaner Flotation Test Results

Product	Grade		Recovery, %	
	Au g/t	Ag g/t	Au	Ag
Rougher Conc (calc)	9.1	3,031	77.1	92.6
1st Cl Conc (calc)	14	5.105	63.5	83.1
2nd Cl Conc	16.2	6.019	55.3	73.7
Rougher Tailings	0.4	35.1	22.9	7.4
1st Cl Tailings	3.4	670	13.5	9.6
2nd Cl Tailings	7.4	2,322	8.3	9.3
Calculated Head	1.49	416	100	100

13.4 2017 RDi Testing Program

13.4.1 Sulfide Material Rougher Flotation Testing

Testing by RDi in January 2017 evaluated the impact of a longer retention time, reagent selection, and grind size on the rougher flotation response on the same composite, averaging a head grade of approximately 450 g/t Ag, as used in the 2016 SGS test program. The results for the rougher flotation concentrates produced after a 9-minute-long retention time are shown below in **Table 13-7**.

Table 13-7: RDi Rougher Flotation Conditions and Results

Test	Primary Grind, P_{80} mesh	Reagents	Concentrate Grade		Recovery, %		
			Au g/t	Ag g/t	Wt.	Au	Ag
FT-1	150 mesh	PAX, AP404	12.51	3,532	13.1	87.4	94.9
FT-2	200 mesh	PAX, AP404	12.36	3,402	13.4	87.7	92.5
FT-3	270 mesh	PAX, AP404	12.94	2,604	12.7	88.7	95.2
FT-4	200 mesh	PAX, AP404, $CuSO_4$	10.86	3,048	13.9	86.8	96.0
FT-5	200 mesh	PAX, AP404, Sulfidization	11.60	2,816	14.2	89.4	96.4
FT-6	200 mesh	PAX, 3477	11.11	3,017	15.2	90.6	97.4
FT-7	200 mesh	A31, 3418A	8.96	2,419	18.2	86.9	97.2

This test program indicated that there is a benefit to a longer retention time based on the elevated Ag recoveries. Additionally, test FT-1 and FT-2 indicated that the rougher flotation response is similar at 150 mesh to that obtained at the finer grind size of 200 mesh. This has positive implications with respect to the proposed toll mill facility as Golden Minerals' management indicates the facility is at present configured to produce a rougher flotation feed of 150 mesh.

With respect to reagent selection, this testing indicated that the selection used in the SGS test work is likely to produce lower concentrate grades, as exhibited by the higher mass recovery in FT-7, than alternative reagent suites. The elevated recovery results obtained in FT-6 indicated that a combination of PAX and 3477 represented the most favorable selection for increasing Au and Ag recovery, and thus were selected for use in the later cleaner flotation testing. However, as the results obtained with 3477 are still comparable to AP404, both are worthwhile for inclusion in future test work.

13.4.2 Sulfide Material Cleaner Flotation Testing

Subsequent test work by RDi evaluated two additional cleaner flotation trials performed with a modified reagent suite at two separate rougher feed grind sizes. The results of this testing are shown below in **Table 13-8** and **Table 13-9** for a feed size P_{80} of 150 mesh and 200 mesh respectively.

Table 13-8: RDi Cleaner Flotation Test FT-8 at 150 Mesh Feed

Product	Grade Au g/t	Grade Ag g/t	Recovery % Wt.	Recovery % Au	Recovery % Ag
Rougher Concentrate (calculated)	10.18	3,099	14.9	87.7	95.5
1st Cleaner Concentrate (calculated)	13.61	4,426	9.6	75.8	88.2
2nd Cleaner Concentrate	15.10	5,164	7.8	68.4	83.7
Rougher Tailings	0.25	25.4	85.1	12.3	4.5
1st Cleaner Tailings	3.90	669	5.3	11.9	7.3
2nd Cleaner Tailings	7.10	1,209	1.8	7.4	4.5
Calculated Head	1.73	482	100	100	100

Table 13-9: RDi Cleaner Flotation Test FT-9 at 200 Mesh Feed

Product	Grade Au g/t	Grade Ag g/t	Recovery % Wt.	Recovery % Au	Recovery % Ag
Rougher Concentrate (calculated)	10.99	3,258	13.6	88.3	96.2
1st Cleaner Concentrate (calculated)	14.78	4,957	8.3	72.7	89.7
2nd Cleaner Concentrate	15.80	5,666	7.1	65.8	86.7
Rougher Tailings	0.23	20.4	86.4	11.7	3.8
1st Cleaner Tailings	5.00	569	5.3	15.6	6.5
2nd Cleaner Tailings	9.20	1,065	1.3	7.0	3.0
Calculated Head	1.70	461	100	100	100

This test work represented open circuit conditions and included no provision for a regrind stage. Based on input from Golden Minerals obtained after the completion of this testing, the toll mill facility has an anticipated grind size of 150 mesh, no regrinding capacities, and currently intends to include only one stage of cleaner flotation. However, the toll mill already includes capacities for the recirculation of the cleaner flotation tailings back into the rougher flotation feed. As such, in operation the plant would be operating under locked cycle rather than open circuit conditions.

13.4.3 Anticipated Locked Cycle Response

Considering this configuration, RDi attempted to estimate an anticipated locked cycle response for this material based on the results of both the rougher and cleaner flotation test work. For the rougher flotation response, it was assumed that RDi test FT-1 at 150 mesh would represent the best baseline. Combined with this, cleaner flotation test FT-8 was used as a baseline for a 1st cleaner flotation response. From here, it is assumed that approximately 50% of the Au and Ag found in the 1st cleaner flotation tailings would be re-recovered in the rougher concentrate, and that the resulting downstream 1st cleaner concentrate grade would remain identical to that of open circuit conditions. Overall, this is anticipated to produce a final sulfide Au and Ag recovery of 80% and 90% respectively at a concentrate grade of approximately 4,500 g/t Ag and 13.6 g/t Au regardless of the specific feed grade processed. Follow up testing under locked cycle conditions would be required to confirm these assumptions.

13.5 2018 RDi Testing Program

The scoping level metallurgical study in 2017 did not address the processing of the oxide material. Since the recent Resource update Indicated the proportion of oxide ore accounted for 37% of the total Resource, Golden Minerals Company contracted RDi to undertake additional scoping level metallurgical testing with the objective of testing oxide, mixed/transition and sulfide ores to determine precious metal extractions.

RDi undertook leaching and flotation testing of four composite samples. Two composites were oxide ore and one each of mixed and sulfide ores. The highlights of the test results Indicated the following:

- The head analyses of composite samples, given in Table 13.10, Indicated silver grades ranged from 222 g/mt to 286 g/mt Ag and the gold grades ranged from 0.72 g/mt to 0.99 g/mt Au. The oxide composites contained no sulfide sulfur while the mixed composite contained 1.0% $S_{sulfide}$ and the sulfide composite contained 1.8% $S_{sulfide.}$ The sulfide composite also contained a significant amount of lead and zinc (i.e., 1.1% Pb and 2.0% Zn).
- Bond's ball mill work-indices, given in Table 13.11, were calculated using indirect method due to insufficient sample available for testing. The BW_i ranged from 15.9 kwh/st to 25.2 kwh/st thereby indicating the ores were relatively hard.
- The oxide samples responded favorably to cyanide leaching. The test data, summarized in Table 13.12, indicated gold and silver extractions of 78.5% to 88.2% and 61.5% to 79%, respectively. The precious metals continued to leach for the entire 72 hours of leach time.
- The results for rougher flotation of the mixed and sulfide ore are given in Table 13.13. The flotation process recovered 60.6% of the gold and 81.2% of the silver in the rougher concentrate for the mixed ore and 89.9% of gold and 95.8% of silver for the sulfide ore.
- The flotation tailings were cyanide leached to determine if one could extract additional values. The leach process recovered 74.8% of gold and 74% of silver from the flotation tailings of mixed ore and 53.3% of gold and 71.8% of silver from the sulfide ore (Table 13.14).
- The rougher flotation concentrate grade assayed 1586 g/t Ag to 2942 g/t Ag. These results were similar to the concentrate grade achieved in 2017 RDi testing (Table 13.7). Two stages of cleaner flotation should produce a concentrate assaying over 5 kg/t as was the case in earlier testing.

- Precious metal extraction of the oxide composite appears to be size dependent. The finer the grind, the higher the extraction. Gold and silver extractions increased by approximately 4% and 10% respectively, for both composites as the grind size increased from P_{80} of 100 to 200 mesh.
- Cyanide consumption decreased by 55% to 60% with 4 hours of pre-aeration with lime. Addition of lead nitrate did not improve silver extraction.

Table 13-10: Head Analyses of Composite Samples Including ICP

Element	Oxide 1	Oxide 2	Mixed	Sulfide
Au, g/mt	0.720	0.741	0.919	0.988
Ag, g/mt	369	293	303	368
Sulfide S %	<0.01	<0.01	1.01	1.78
Sulfate S %	0.04	0.04	0.83	1.82
Total S %	0.04	0.04	1.83	3.60
%				
Al	2.58	1.94	2.87	2.09
Ca	2.72	4.04	5.09	7.31
Fe	2.56	1.86	2.56	2.46
K	3.27	2.40	3.78	2.72
Mg	0.16	0.06	0.23	0.12
Na	0.06	0.04	0.09	0.06
Ti	0.06	0.04	0.08	0.06
ppm				
As	1340	1560	2320	2930
Ba	502	478	552	471
Bi	<10	<10	<10	<10
Cd	18	36	261	199
Co	5	4	7	4
Cr	143	94	113	122
Cu	207	242	452	435
Mn	586	594	627	746
Mo	2	1	<1	<1
Ni	5	<5	12	11
Pb	2040	2790	5840	10800
Sr	126	103	134	132
V	216	167	48	28
W	55	63	165	230
Zn	4600	6240	15700	19900

Table 13-11: Indirect BWi Results

Sample	BWi (kWh/st)
Oxide 1	25.19
Oxide 2	15.92
Mixed	20.50
Sulfide	23.24

Table 13-12: Oxide Composites Leach Results

Sample	Conditions	Extraction %		Residue Grade		Calc Head Grade		NaCN Consumption (kg/mt)	Lime Consumption (kg/mt)
		Au	Ag	Au (g/mt)	Ag (g/mt)	Au (g/mt)	Ag (g/mt)		
Oxide 1	100 mesh	81.9	61.5	0.10	126.8	0.57	329.7	1.198	2.375
Oxide 1	200 mesh	86.0	70.4	0.08	100.2	0.54	338.3	1.675	2.233
Oxide 1	200 mesh Pre-Aeration	78.5	64.9	0.12	125.4	0.57	357.3	0.663	2.671
Oxide 1	200 mesh Lead Nitrate	86.1	71.4	0.08	91.0	0.54	318.3	1.498	2.199
Oxide 2	100 mesh	84.6	68.4	0.12	101.2	0.80	320.6	0.660	1.757
Oxide 2	200 mesh	88.2	78.3	0.10	72.8	0.81	335.3	1.257	1.779
Oxide 2	200 mesh Pre-Aeration	85.4	79.0	0.10	66.6	0.066	316.6	0.544	2.156
Oxide 2	200 mesh Lead Nitrate	87.0	74.6	0.10	87.8	0.74	345.2	1.139	1.769
Mixed	200 mesh	65.7	78.5	0.27	69.6	0.798	323.9	2.036	2.519

Table 13-13: Flotation Test Results

Product	Cumulative Flotation Time, min	Cumulative Recovery %			Cumulative Grade	
		Wt.	Au	Ag	Au g/t	Ag g/t
Mixed Comp (Test 1)						
Conc. 1	3	3.7	43.0	60.9	9.60	5150
Conc. 2	6	6.5	55.2	77.4	6.93	3680
Conc. 3	9	8.6	60.6	81.2	5.80	2942
Cal. Feed	-	100.0	100.0	100.0	0.82	310
Sulfide Comp (Test 2)						
Conc. 1	3	7.6	66.7	76.0	10.56	2890
Conc. 2	6	13.3	84.6	92.7	7.71	2028
Conc. 3	9	17.5	89.9	95.8	6.20	1586
Cal. Feed	-	100.0	100.0	100.0	1.21	291

Table 13-14: Sulfide and Mixed Composites Leach Results

Sample	Particle Size	Extraction %		Residue Grade		Calc Head Grade		NaCN Consumption (kg/mt)	Lime Consumption (kg/mt)
		Au	Ag	Au (g/mt)	Ag (g/mt)	Au (g/mt)	Ag (g/mt)		
Mixed	200 mesh	65.7	78.5	0.27	69.6	0.798	323.9	2.036	2.519
Mixed Float Tails	200 mesh	74.8	74.0	0.09	16.6	0.35	63.9	0.973	2.274
Sulfide Float Tails	200 mesh	53.3	71.8	0.07	4.2	0.15	14.9	1.573	1.657

13.6 Bulk Concentrate Specifications

Input from Golden Minerals indicates that a bulk silver gold concentrate with a silver grade of 4,500 Ag g/t could be acceptably marketed and conceptual market terms have been provided for the PEA. Bulk concentrate production is not rare in Mexico but is less prevalent than a conventional lead or zinc concentrate therefor smelter terms are case dependent.

The composition of a bulk concentrate sample produced during the pilot plant trial for selected components is shown below in **Table 13-15**.

Table 13-15: Mixed Material Concentrate Composition

Product	Unit	Value
Au	g/t	14.0
Ag	g/t	9,773
Pb	%	2.8
Zn	%	5.9
S	%	9.3
As	%	0.81
Sb	%	0.177
F	%	0.420
Bi	%	0.010
Fe	%	9.6
SiO2	%	40.1
Al2O3	%	3.7
Insolubles	%	51.7

Given that the above table illustrates the composition of a higher-grade concentrate from mixed material, it is unknown how this will vary compared to that of a lower Ag grade sulfide concentrate. An analysis of penalty constituents such as Zn, As, Sb, F, and Bi has not been performed on any materials generated in the recent cleaner flotation studies, thus it is currently unknown what impact this may have on the resulting smelter penalties.

The incorporation of the cyanidation leach of the flotation tailing for the sulfide and the mixed ores has resulted in several processing options. The recoveries were calculated based on the following assumptions:

- The cleaner flotation process with recycling of process streams will recover 92% of gold and 95% of silver from the rougher concentrate.
- The concentrate grade will be similar to that obtained in open-cycle cleaner flotation tests.
- The leach process will extract same amount of gold and silver from the combined rougher and cleaner flotation tailing as the rougher tailing.

The estimated gold and silver recoveries for the various processing options are given in **Table 13-16**.

Table 13-16: Estimated Gold and Silver Recoveries for Different Processing Options

ORE	FLOTATION PROCESS			LEACH PROCESS		FLOTATION + LEACH	
	Recovery %		Grade, g/t Ag	Extraction %		Recovery %	
	Au	Ag		Au	Ag	Au	Ag
Oxide[1]	-	-	-	85.2	73.1	-	-
Mixed/Transition	55.8	77.1	>4500	33.1	17.0	88.9	94.1
Sulfides	82.7	91.0	>4500	9.2	6.5	91.9	97.5

NOTES:
(1) Average of six tests at P_{80} of 200 mesh for the two composites.
(2) Cyanide Consumption will be 0.60 kg/t and lime consumption will be 2.4 kg/t initially and will reduce to 1.2 kg/t eventually.

14. MINERAL RESOURCE ESTIMATES

Mineral Resources have been estimated for the Santa María and Santa María Dos mineralized structures using a sub blocked block model. Grade attributes have been estimated using Ordinary Kriging.

Estimated Mineral Resources of Santa María project are shown in **Table 14-1**. Resources are shown with diluted tonnage and grade, with a cutoff grade applied to AgEq accounting for recoveries of Ag and Au.

Table 14-1: Diluted Mineral Resource Estimate

Classification	Cutoff Grade Recovered AgEq g/t	Tonnes	Ag g/t	Au g/t	AgEq g/t	Ag toz (M)	Au toz (k)	AgEq toz (M)
Measured	180	42,000	271	0.83	333	0.37	1.13	0.45
Indicated	180	170,000	291	1.04	368	1.59	5.70	2.01
Inferred	180	261,000	272	0.90	346	2.30	7.61	2.92

NOTES:
(1) Cutoff grade and Ag equivalent calculated using metal prices of $16.63 and $1,238 per troy ounce of Ag and Au with a ratio of 74:1, the three year trailing average as of the end of May 2018;
(2) Cutoff applied to diluted Ag equivalent blocks grades using recoveries of 90% and 80% Ag and Au;
(3) Reported Indicated Mineral Resources are equivalent to mineralized material under SEC Industry Guide 7, Inferred Mineral Resource is not a recognized category under SEC Industry Guide 7; and
(4) Columns may not total due to rounding.

14.1 Input Data

The Project database contains 2,528 samples from surface drilling, 942 from underground drilling, 2,186 underground channel samples, and 322 surface samples. **Figure 14-1** shows the location of all input data intervals as Ag g/t in plan-view for both drill holes and channels before on vein selections were made.

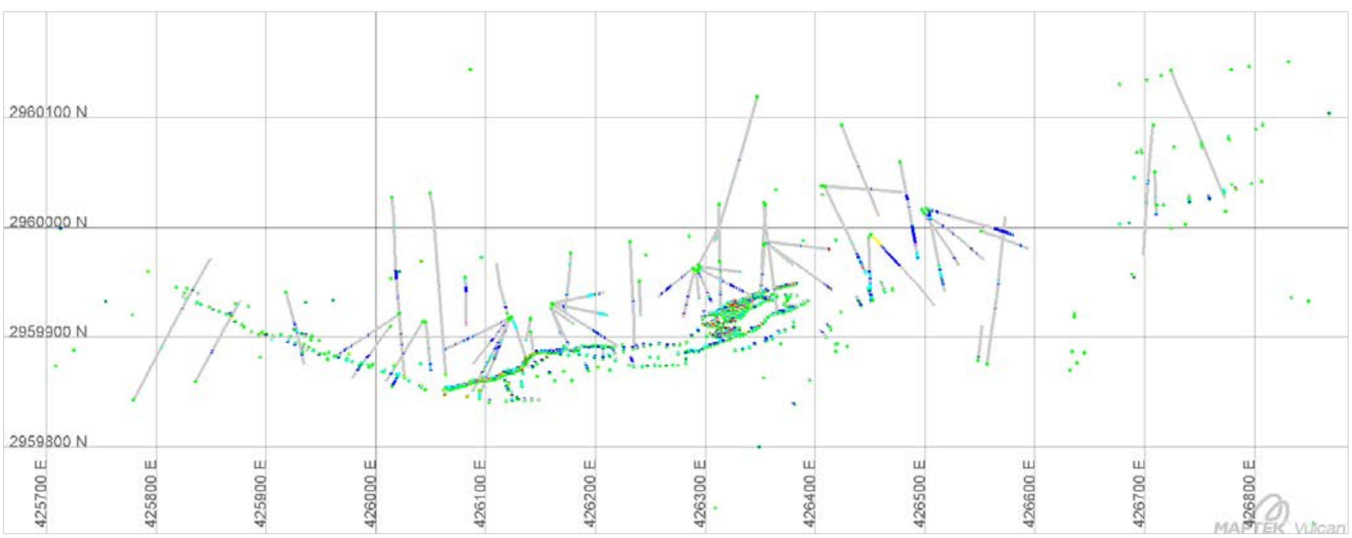


Figure 14-1: Plan View Map Input Data Intervals

14.2 Grade Capping

Assay intervals from the combined drill hole and channel sample database identified as being on the Santa María or Santa María Dos veins were analyzed as a natural log transformed population to determine upper grade limits. Upper limits were applied to raw assay prior to compositing. The upper limit chosen for Ag was 2500 g/t and 15 g/t for Au, population analysis for Pb and Zn suggest capping was not necessary. **Figure 14-2** and **Figure 14-3** show probability plots for Ag and Au respectively.

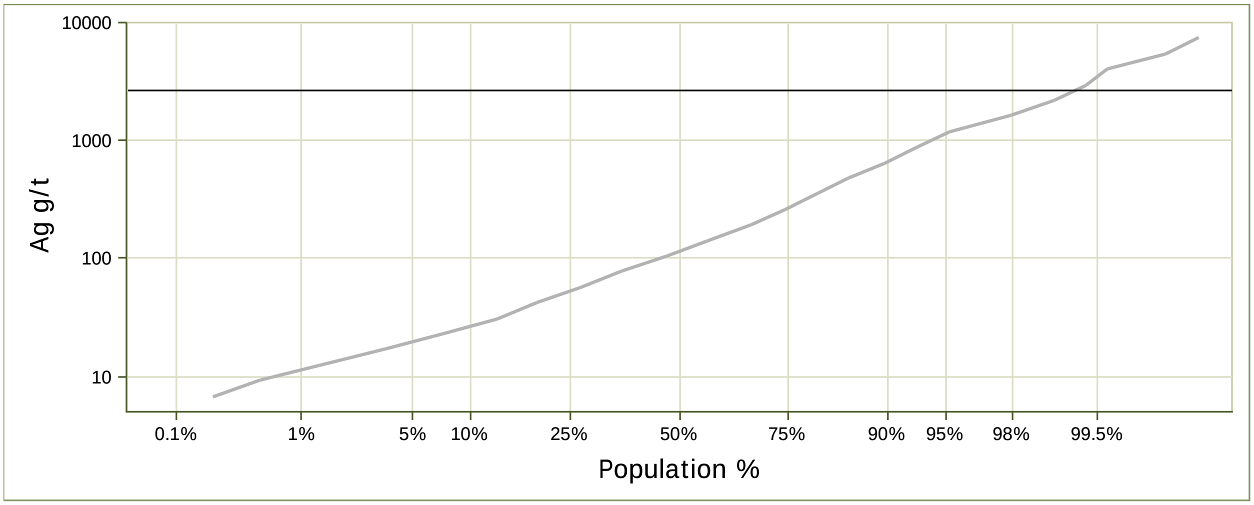


Figure 14-2: Upper Limit Analysis Ag Probability Plot

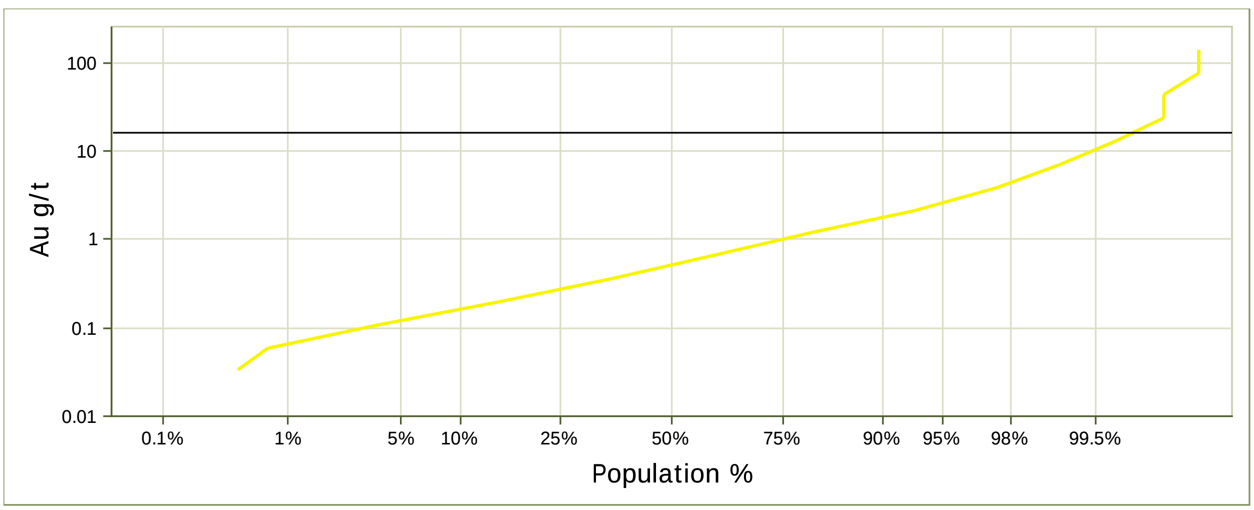


Figure 14-3: Upper Limit Analysis Au Probability Plot

14.3 Compositing

Drill holes were composited on a 0.5-meter intervals. Composites were also broken at the boundary of the modeled mineralization. If a composite was less than 0.1 meters, it was combined and weighted with the adjacent composite.

14.4 Mineralized Structures Modeling

The Santa María and Santa María Dos veins are interpreted as epi-thermal deposits that were flooded into structurally prepared fault and fracture zones, and on the normal geologic contact between rhyolite and limestone formations. Initial vein intervals representing the general contact was provided by Minera Cordilleras as an attribute in the Project database.

Modeling of the mineralized structures was conducted on sections at every 10-meter intervals. These sections were reviewed in 3D within the context of the surface geologic and vein mapping, underground development mapping, drill hole intercepts, and core photos provided by the company. Hanging wall and footwall data of the high-grade material was developed on these sections. The hanging wall and footwall data was then fed into a triangulation modeling method using grids. The grids were used to create a 3D wireframe of the mineralized structures. The mineralized structure model assumes a continuous traceable vein structure as suggested in the level mapping; however, complexities regarding local vein splays have not been captured in the model and represent both estimation risk and potential upside. The assumption of vein continuity also presents an estimation risk. This risk has been mitigated by 3D visual review, but without on vein drifting, actual continuity cannot be known.

The triangulations were spot checked against observed drill hole and composites and determined to be suitably similar.

The mineralized solid extended to the surface. Surface sampling and mapping indicate the structure is continuous on the surface. The vein solid was limited down dip by an approximate 150 m convex orthogonal buffer and limited along strike at the extent of the last channel sample to the west and to the east. The Santa María Dos vein was limited in the up-dip direction using the Santa María upper limits and was then terminated at the intersection with the Santa María vein down-dip. **Figure 14-4** shows the resulting mineralized structure solids, with the Santa María in blue and the Santa María Dos in yellow.

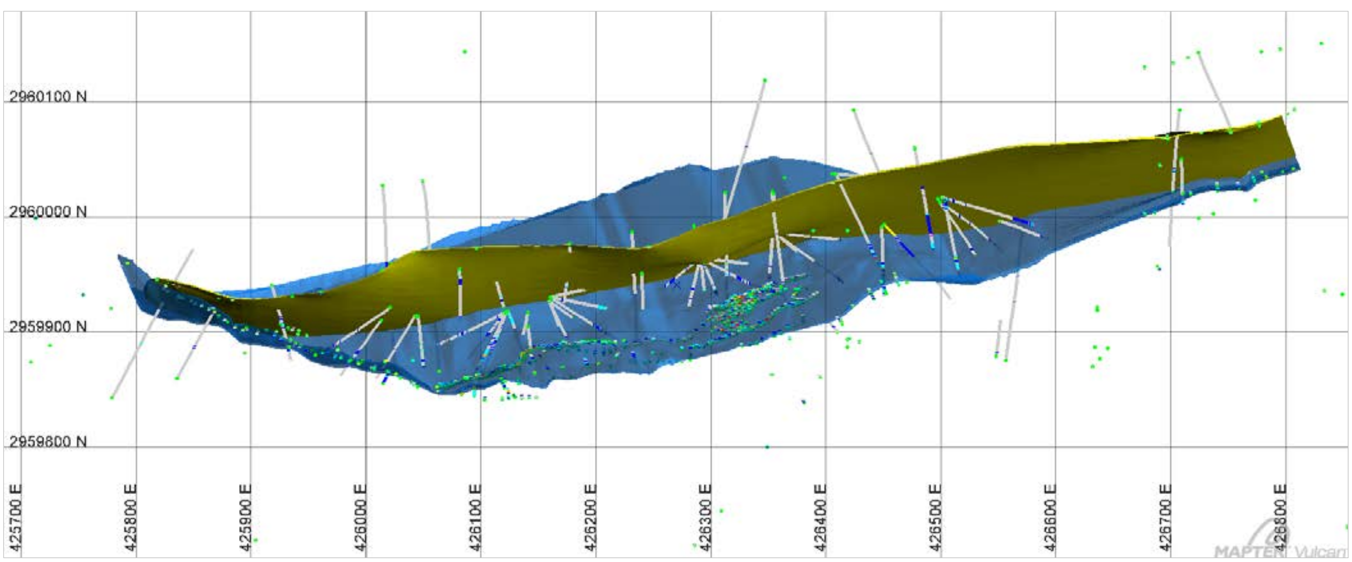


Figure 14-4: Mineralized Solid Models Plan-View, Santa María in blue and Santa María Dos in yellow

14.4.1 Mineral Type Boundaries

Triangulated solids were constructed to represent the intersection of the Santa María and Santa María Dos mineralized structures and the modeled boundaries of the oxide, transition (sulfide/oxide mix), and sulfide material. The solids where constructed based on a review of core photos, underground vein mapping and geochemical analysis. The surfaces were used to flag the block model with a mineral type designation. **Figure 14-5** is a long section looking south showing the bottom of the oxide zone in orange and the top of the sulfide zone in blue (cyan).

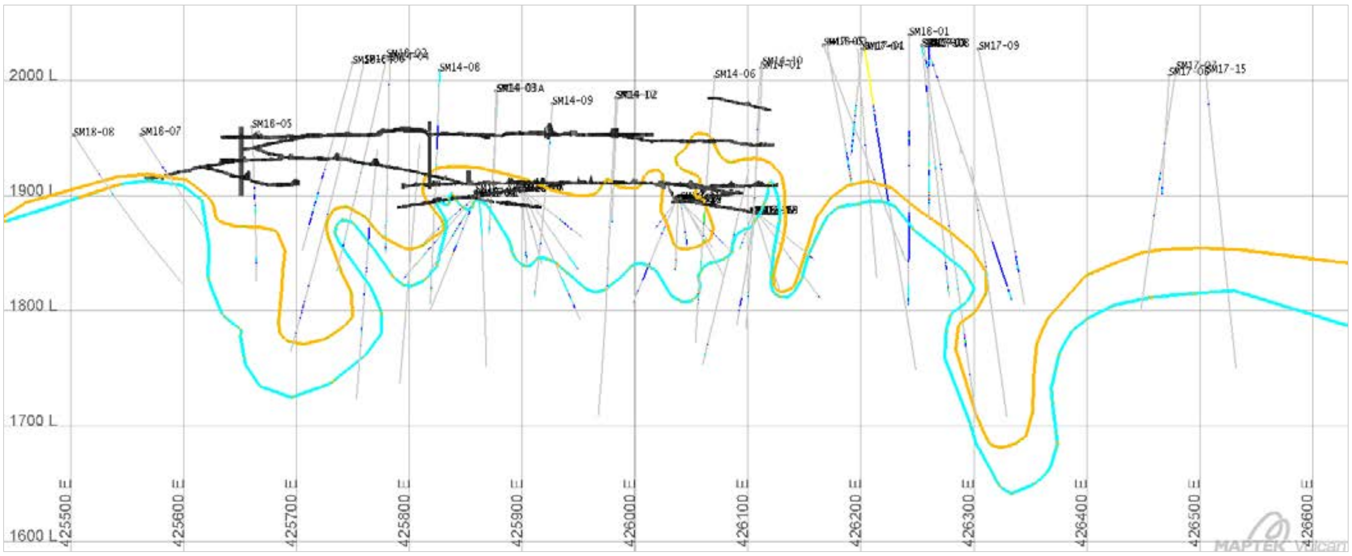


Figure 14-5: Long-Section of Mineral Type Surfaces

14.4.2 Boundary Exclusions

Material mined by Minera Cordilleras was removed from the Resource tabulation. In addition, Resource reporting has been limited to within the claim boundary by adding a claim designation to the block model.

14.4.3 Density Determination

Minera Cordilleras' geologists have made 1,528 specific gravity measurements from drill-core using the Archimedes method, the core was not coated, because no substantial porosity or vugs were observed. The data was reviewed, and 2 erroneous readings were removed (SG values of 23.2 g/cm^3 and 6.9 g/cm^3).

Measured on vein intervals were grouped by mineral type and averaged. Based on averages, oxide material was assigned a value of 2.56 g/cm^3, mixed 2.64 g/cm^3, and sulfide 2.66 g/cm^3. There is relatively minimal variation due to geology, the largest impact on specific gravity is the presence or absence of sulfide minerals, and therefore each interval was assigned a mineral type (oxide, mixed or sulfide) to see the impact on oxidation on the specific gravity.

The difference in SG in this report vs the previous Resource estimation includes additional samples collected during recent exploration work. There is also a better understanding of the ore zone based on geochemistry and relogging. Some erroneous values were corrected in the database based on the relogging and understanding of the ore zone.

Further work will include sending a select group of samples for additional measurements be made with a paraffin wax or epoxy coating to confirm the initial measurements.

14.5 Estimation Methods and Parameters

Mineral Resources have been estimated for the Santa María and Santa María Dos vein structures using a block model oriented in the best fit plane of the vein. Grade attributes have been estimated using Ordinary Kriging.

14.5.1 Variography and Search

The grade distance relationship was investigated using natural log transformed directional variography on composited vein intervals. Experimental and modeled variograms are shown in **Figure 14-6**, nugget and sill portions have not been relativized to a total sill of 1 or 100% to correspond with the graphical output presented in **Figure 14-6**.

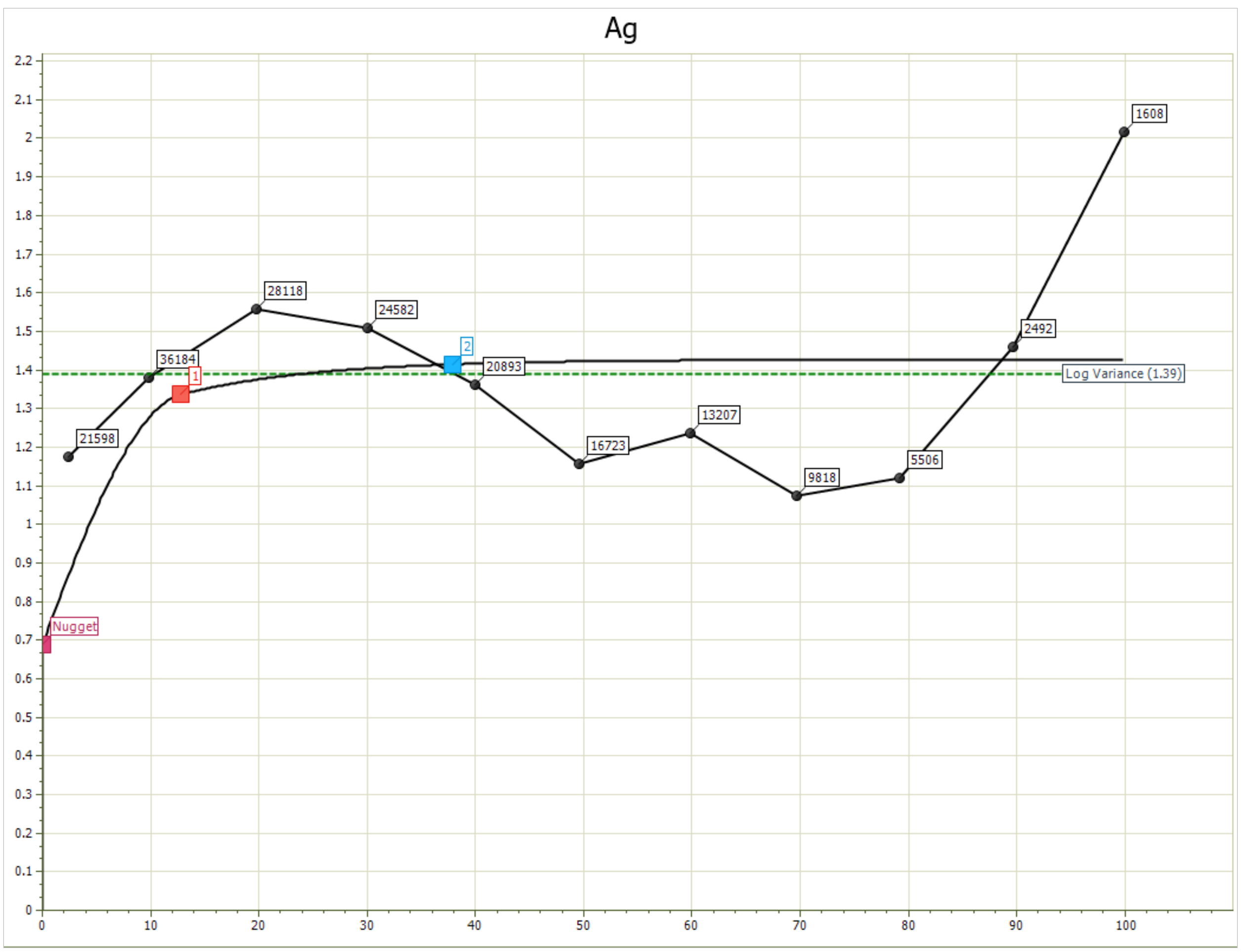


Figure 14-6: Natural Log Transformed Directional Variography

Although grade distance relationships were investigated and used as a guide, the ultimate search distances, classifications, orientations and anisotropies implemented were based on visual review of the vein and professional judgment.

A sub-blocked block model was created to provide a good block fill for the narrow-mineralized structure. Blocks outside of the mineralized structure were allowed to be up to 10x10x10 meters in size (parent block size). The sub-blocked blocks within the mineralized structure model were allowed to be as small as 0.5x0.5x0.5 meters.

Grade attributes were estimated in three passes from small to large. Estimation was completed using Ordinary Kriging. Metal attributes were only estimated inside of the modeled vein wireframes. A fourth pass was run to fill remaining blocks within the vein model wireframes that were not estimated in the first three passes.

Table 14-2 details the search ellipses and run parameters. The search ellipse within the mineralized boundary was determined by block. Each block was flagged with a dip and dip direction that followed along the vein to account for grade anisotropy. The dip and dip direction were used as anisotropic search to orient the search ellipses. Therefore, each search ellipse is dynamic and on a per block basis. This method accounts for the curves in the mineralized structure model, where a fixed search dip and dip direction may not provide as accurate of an estimation.

Table 14-2: Pass Parameters and Classification

Pass	Major Axis	Semi Major	Minor Axis	Limit per Hole	Comp Min	Comp Max
1	25	15	25	4	3	10
2	50	30	50	4	2	8
3	100	50	100	4	1	6
4	250	125	250	2	1	4

14.5.2 Resource Classification

Block classification was completed by a boundary polygon which was constructed by assessing:

- Number of holes used to estimate the block
- Distance to the nearest sample
- Proximity to current development

Blocks within the Measured classification polygon are required to have samples from 4 different holes or channel samples, have a closest sample within 15 meters, and are within 15 meters in elevation of the deepest advance of the development. The Indicated classification polygon requires samples from 3 different holes and a nearest sample of 30 meters. All other blocks on vein were classified as Inferred. Blocks in the Dos vein were also classified as Inferred. **Figure 14-7** shows the classified polygon shapes.

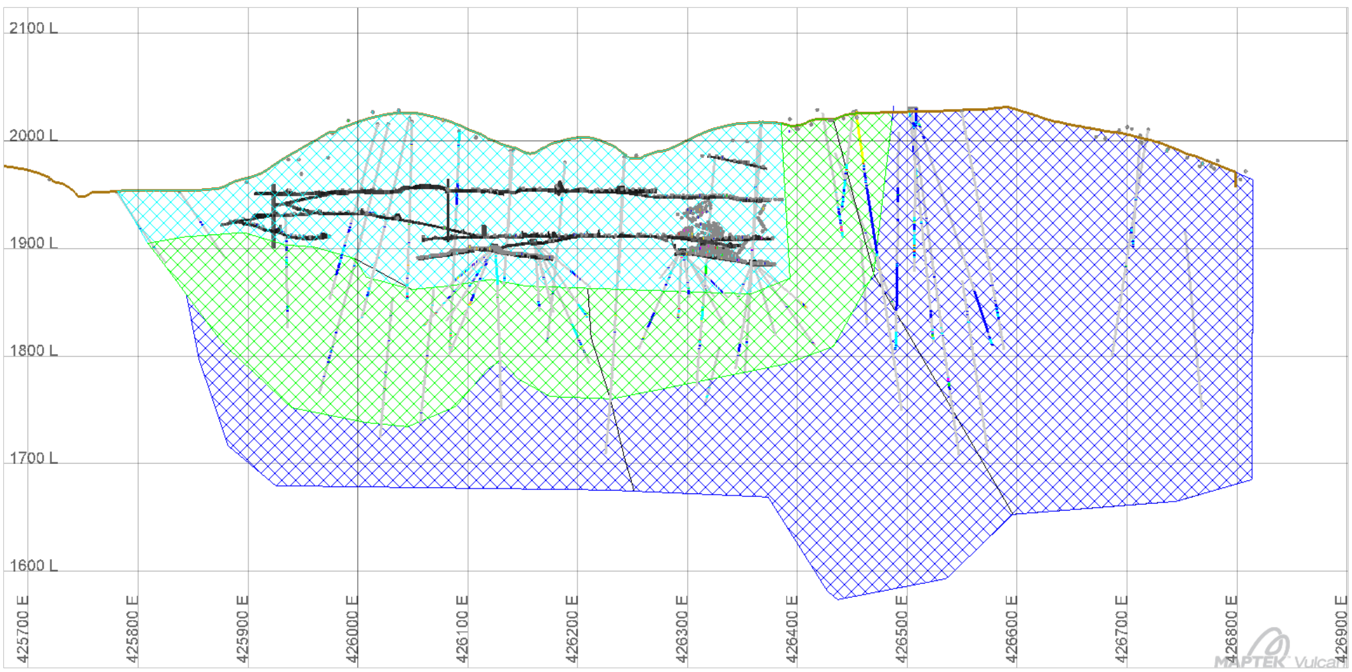


Figure 14-7: Classification Long Section Santa María Mineralized Structure

14.5.3 Dilution

Grade and thickness estimation was completed as undiluted. Where the vein thickness is less than 1 meter, dilution will occur when mining the material.

14.5.4 Cutoff Grade

Cutoff grade has been calculated as recovered Ag equivalent using Ag and Au prices, metallurgical recoveries and reasonable cost assumption. Metal value from Pb and Zn have not contributed to the calculation of Ag equivalent. The base case cutoff grade has been calculated using the three-year trailing average prices for Ag and Au, as of 2018, as mandated by the United States Securities and Exchange Commission (SEC).

Oxide and mixed mineral types have been grouped as one process stream and sulfide material as another. A reasonable assumption of oxide toll milling cost in the local area is $40/t, and $35/t for sulfide toll milling; all other costs and recoveries are assumed independent of mineral type. The final cutoff grade has been calculated using a reasonable oxide toll milling scenario and a sulfide toll milling scenario, weighted by the approximate portion of oxide plus mixed material to sulfide material. **Table 14-3** shows the base case cutoff grade cost and price assumptions. The costs used for Resource cutoff may not align to those estimated in the mining study portion of this report.

Table 14-3: Cutoff Grade Assumptions

Assumption	Base Case
Ag Price $/troy ounce	16.63
Au Price $/troy ounce	1,238
Ag:Au Ratio	74
Mining $/t	55
Mill $/t Oxide	40
Mill $/t Sulfide	35
Trucking $/t	5
Ag Metallurgical Recovery	90%
Ag Metallurgical Recovery	80%
Cutoff Grade AgEq	180

An ideal cutoff grade would involve the use of a net smelter return (NSR) calculation, however, at the time of writing this technical report there is no smelter contract in place and additional metallurgy testing is required. Therefore, an NSR cutoff is recommend, but has not yet been implemented for reporting.

14.6 Statement of Resources

Estimated Mineral Resources are of Santa María project are shown in **Table 14-4**. Resources are reported at a cutoff of 180 g/t silver equivalent (AgEq).

Table 14-4: Mineral Resource Estimate

Classification	Cutoff Grade Recovered AgEq g/t	Tonnes	Ag g/t	Au g/t	AgEq g/t	Ag toz (M)	Au toz (k)	AgEq toz (M)
Measured	180	42,000	271	0.83	333	0.37	1.13	0.45
Indicated	180	170,000	291	1.04	368	1.59	5.70	2.01
Inferred	180	261,000	272	0.90	346	2.30	7.61	2.92

NOTES:
(1) Cutoff grade and Ag equivalent calculated using metal prices of $16.63 and $1,238 per troy ounce of Ag and Au with a ratio of 74:1, the three year trailing average as of the end of May 2018;
(2) Cutoff applied to diluted Ag equivalent blocks grades using recoveries of 90% and 80% Ag and Au;
(3) Reported Measured and Indicated Mineral Resources are equivalent to mineralized material under SEC Industry Guide 7, Inferred Mineral Resource is not a recognized category under SEC Industry Guide 7; and
(4) Columns may not total due to rounding.

Mineral type portions for Measured and Indicated Mineral Resource class are shown in **Table 14-5** and the Inferred class is shown in **Table 14-6**. Measured, Indicated and Inferred Mineral Resource are shown at a range of cutoff grades as grade-tonnage curves in **Figure 14-8** and **Figure 14-9**.

Table 14-5: Measured+Indicated Mineral Resource Estimate by Mineral Type

Mineral Type	Cutoff Grade Recovered AgEq g/t	Tonnes	Ag g/t	Au g/t	AgEq g/t	Ag toz (M)	Au toz (k)	AgEq toz (M)
Oxide + Mixed	180	138,000	270	1.06	348	1.2	9.39	1.54
Sulfide	180	74,000	320	0.89	385	0.76	2.1	0.92

NOTES:
(1) Cutoff grade and Ag equivalent calculated using metal prices of $16.63 and $1,238 per troy ounce of Ag and Au with a ratio of 74:1, the three year trailing average as of the end of May 2018;
(2) Cutoff applied to diluted Ag equivalent blocks grades using recoveries of 90% and 80% Ag and Au;
(3) Reported Measured and Indicated Mineral Resources are equivalent to mineralized material under SEC Industry Guide 7; and
(4) Columns may not total due to rounding.

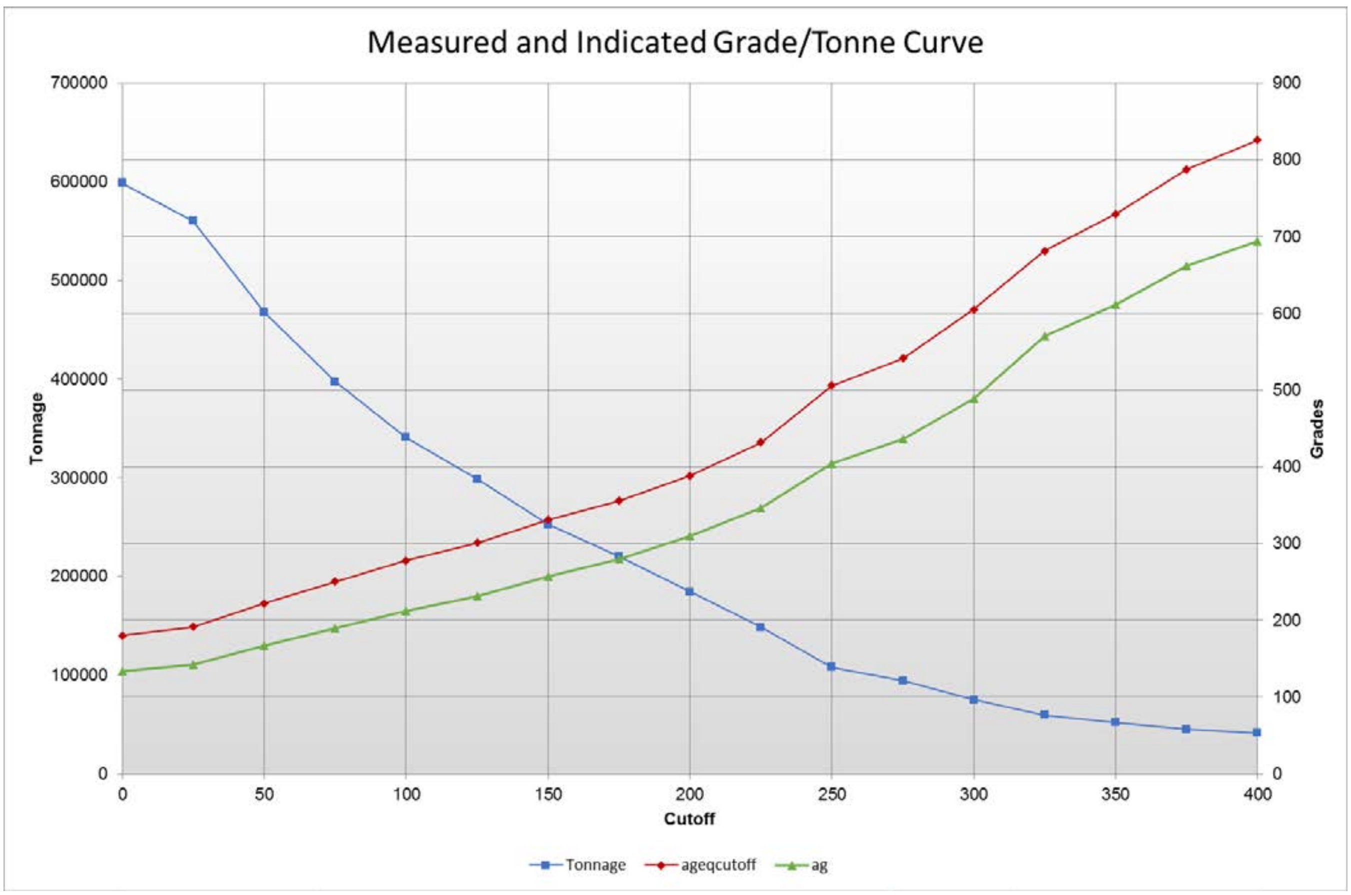


Figure 14-8: Grade Tonnage Measured and Indicated Resources

Table 14-6: Inferred Mineral Resource Estimate by Mineral Type

Mineral Type	Cutoff Grade Recovered AgEq g/t	Tonnes	Ag g/t	Au g/t	AgEq g/t	Ag toz (M)	Au toz (k)	AgEq toz (M)
Oxide + Mixed	180	140,000	289	0.87	365	0.87	3.92	1.65
Sulfide	180	122,000	252	0.99	326	0.99	3.64	1.27

NOTES:
(1) Cutoff grade and Ag equivalent calculated using metal prices of $16.63 and $1,238 per troy ounce of Ag and Au with a ratio of 74:1, the three year trailing average as of the end of May 2018;
(2) Cutoff applied to diluted Ag equivalent blocks grades using recoveries of 90% and 80% Ag and Au;
(3) Reported Indicated Mineral Resources are equivalent to mineralized material under SEC Industry Guide 7; and
(4) Columns may not total due to rounding.

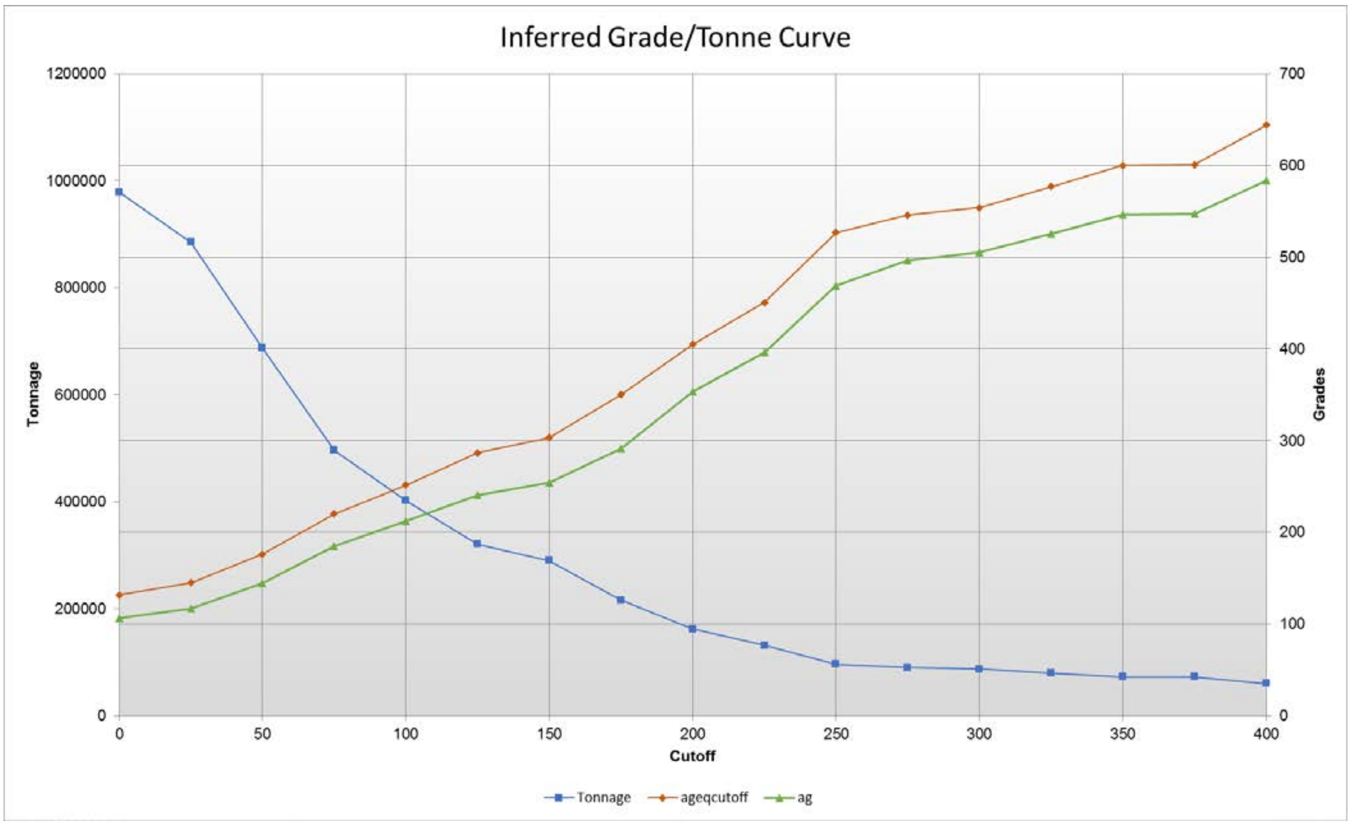


Figure 14-9: Grade Tonnage Inferred Resources

14.7 Model Verification

Resource estimations have been verified by visual review, population analysis, and statistical analysis. Long-section review of composite and block grades verify the estimation respects the input data. Resource tabulation was completed in Vulcan™ software. **Figure 14-10, Figure 14-11**, and **Figure 14-2** below show long sections of the estimated model.

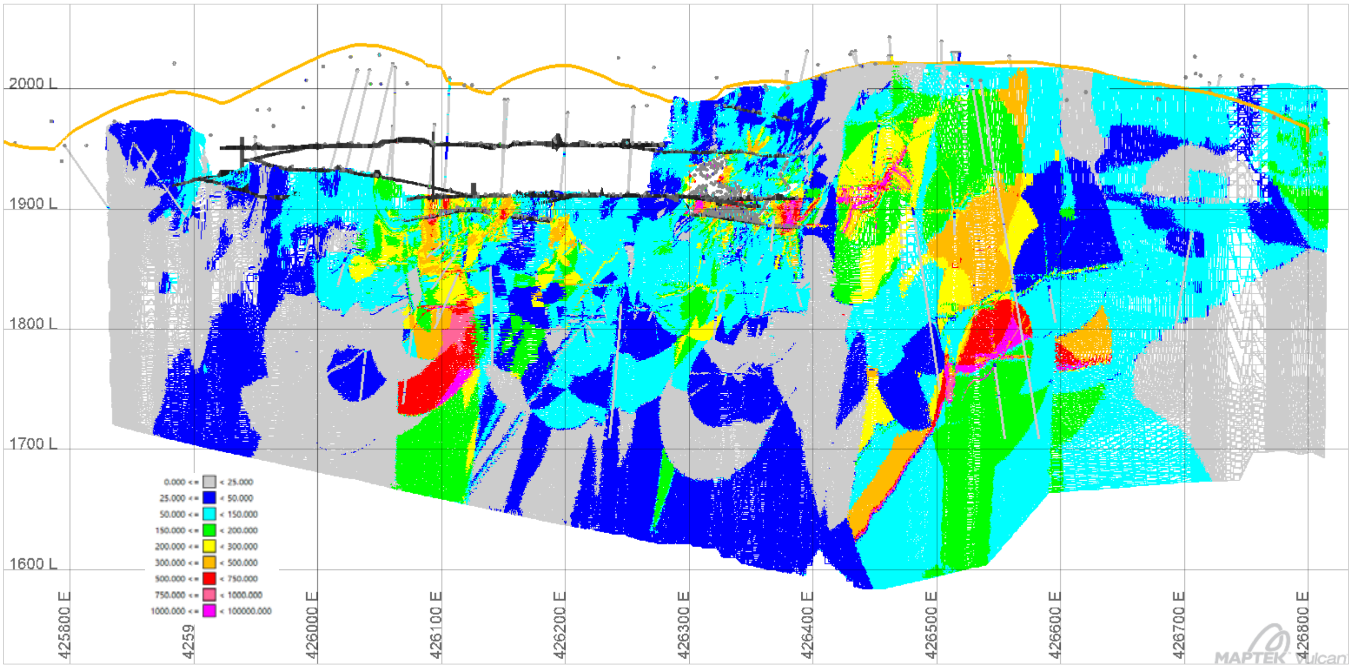


Figure 14-10: Long Section of Estimated Grades for the Santa María Vein-All Ag Values

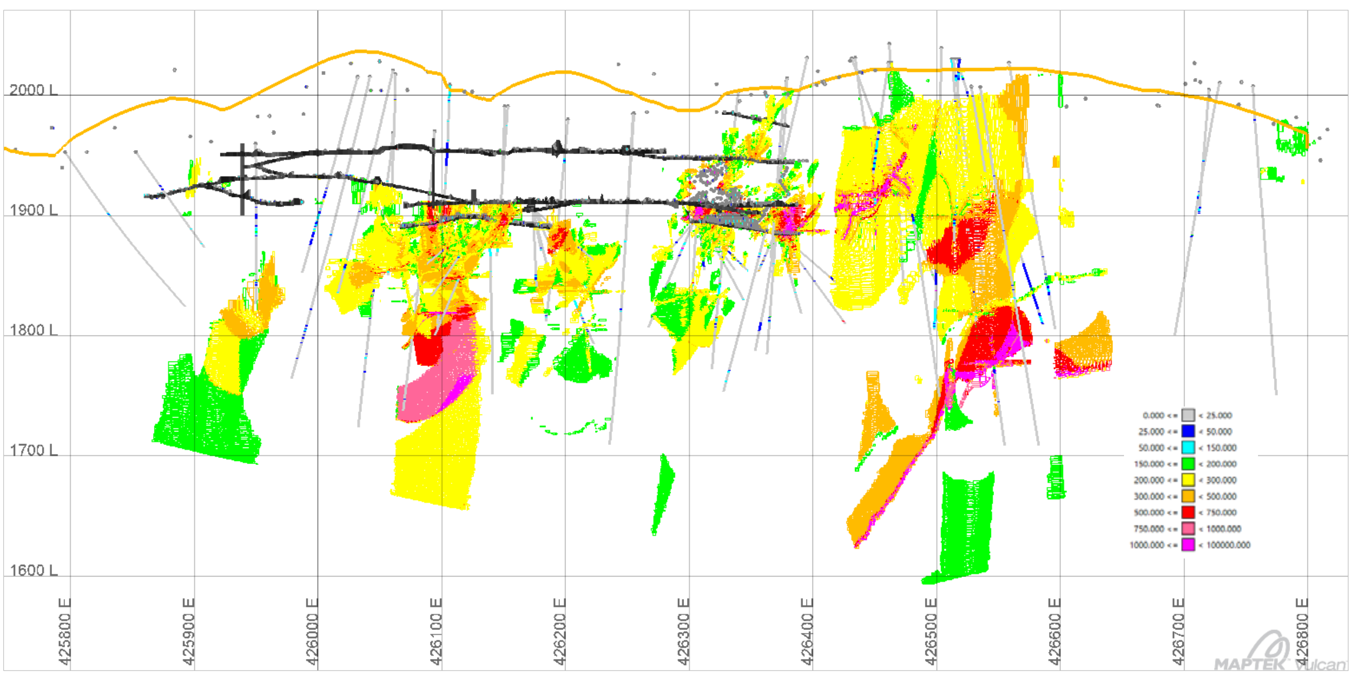


Figure 14-11: Long Section of Estimated Grades for the Santa María Vein showing AgEq values above the 180 AgEq Cutoff.

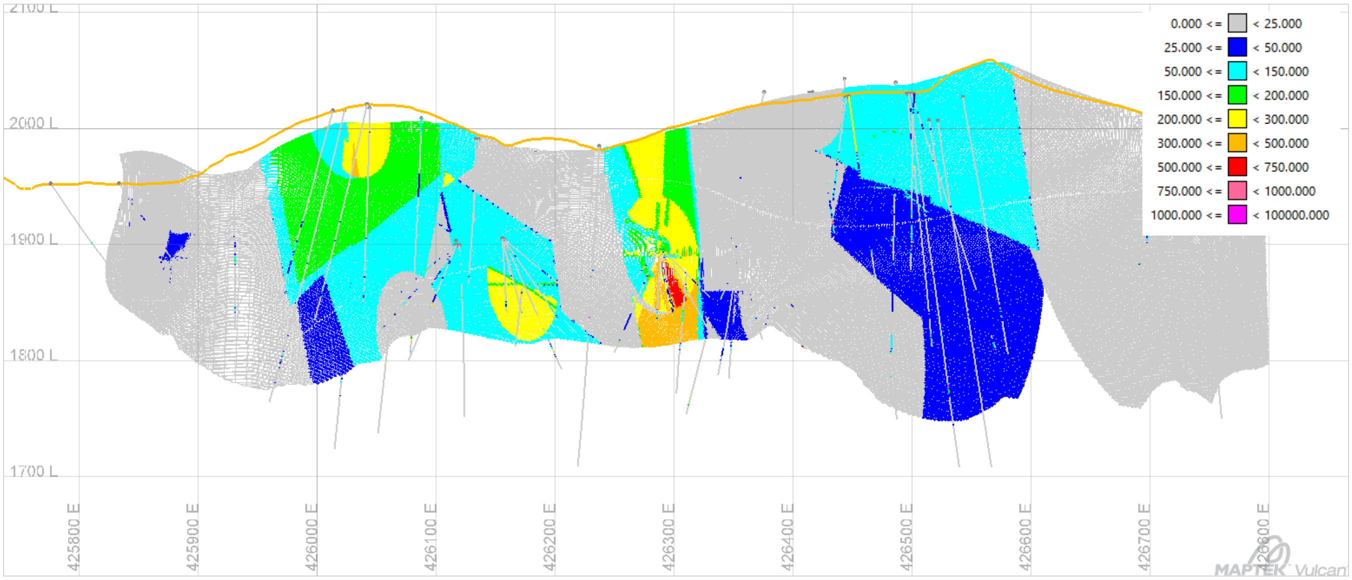


Figure 14-12: Long Section of Estimated Grades for the Santa María Dos Vein showing Ag values.

14.8 Relevant Factors

The Inferred sulfide Resources are primarily extrapolated down dip from drill hole intersections. The bottom of the deposit has not yet been observed and there is no known geologic reason why the mineralized structure would terminate beyond the current drilling or continue at a lower grade, but it is possible the grades observed so far represent a range of preferred elevation for deposition of metal. If this is the case, additional deeper drilling could decrease current estimation of Inferred sulfide Resources. Additional drilling is recommended to demonstrate the down dip continuation of the deposit's structure and grade, however, at present the down-dip portion of the structure is restricted by the claim boundary.

An additional factor that could materially affect the Mineral Resources, if subsequently converted to Reserves and mined, is the inability to precisely predict the true shape of mineralized chutes. The geologic controls dictating the extents of the mineralized shoots are not well defined. Interpolation and extrapolation of channel and drill hole samples represent an approximation of mineralized shoot shape but will fall short of predicting the shape exactly.

There are no additional environmental, permitting, legal, title, taxation, socio-economic, marketing, political, or other relevant factors that the author of this report is aware of that could materially affect the Mineral Resource estimate. Many of the above factors require further investigation. It is possible that, with detailed investigation, complications with any or all the above-mentioned factors could arise, but currently no material complications are known.

15. MINERAL RESERVE ESTIMATES

Though Indicated Resources have been estimated for the Project, this preliminary economic assessment includes Inferred Mineral Resources that are too speculative for use in defining Reserves. Standalone economics have not been undertaken for the Indicated Resources and as such no Reserves have been estimated for the Project.

16. MINING METHODS

Though Indicated Resources have been estimated for the Project, this preliminary economic assessment includes Inferred Mineral Resources that are too speculative for use in defining Reserves. Standalone economics have not been undertaken for the Indicated Resources and as such no Reserves have been estimated for the Project.

A preliminary mine plan has been generated for the PEA. The existing underground facilities would be used to gain access to the new underground Resources using the current adit on the western end of the property. The mine plan includes 308 Ktonnes of mill feed from stoping activities using 2 mining methods, namely cut and fill and sublevel stoping.

Table 16-1 summarizes the tonnage, grade, dilution and vein width for the potential mill feed included in the PEA sourced from stopping.

Table 16-1: Potentially Minable Resource Tonnage Sub-Divided by Mining Method

Mining Method	Average Vein Thickness (m)	Estimated Dilution	Tonnes Diluted	Grade Ag g/t Diluted	Grade Au g/t Diluted
Cut and Fill	1.84	11%	129,705	345	0.71
Sub Level Stoping	2.55	12%	178,316	322	0.83
Both Methods	2.18	11.5%	308,021	331	0.78

NOTE: Estimated dilution includes material from minimum mining width adjustments and dilution skin.

16.1 Geotechnical Conditions

No geotechnical investigation was available for this PEA. A visual observation of the rock conditions showed that the rock is expected to be rated good to excellent, with no use of rock support of any sort in the existing historic workings. Recent trial mining was also accessed during the site visit showing no visible evidence of rock falls from either hanging or footwalls. This preliminary economic assessment has assumed that good rock conditions would continue for expanding the mine to depth, however this needs confirmation through conducting a geotechnical study.

16.2 Mining Conditions

The mining conditions for the Santa María deposit are narrow vein hard rock. The true width of the vein planned for mining (prior to dilution) varies from 0.6 m to 3.7 m. Two vein systems are part of this conceptual analysis, the Santa María and the Santa María Dos veins. The depth of mining is planned to be between 100 and 380 m below surface or at elevations between 1910 and 1580 amsl.

16.2.1 Mining Methods

For the preliminary economic assessment, two mining methods were selected, Sublevel Stoping and Cut and Fill. The decision to mine using one method or the other is based upon which method provides the best diluted Net Smelter Return (NSR). This is preliminary and should be refined based on better understanding of dilution, mining costs, recoveries and smelter terms. **Figure 16-1** shows cut and fill stopes in green and sub level stopes in purple.

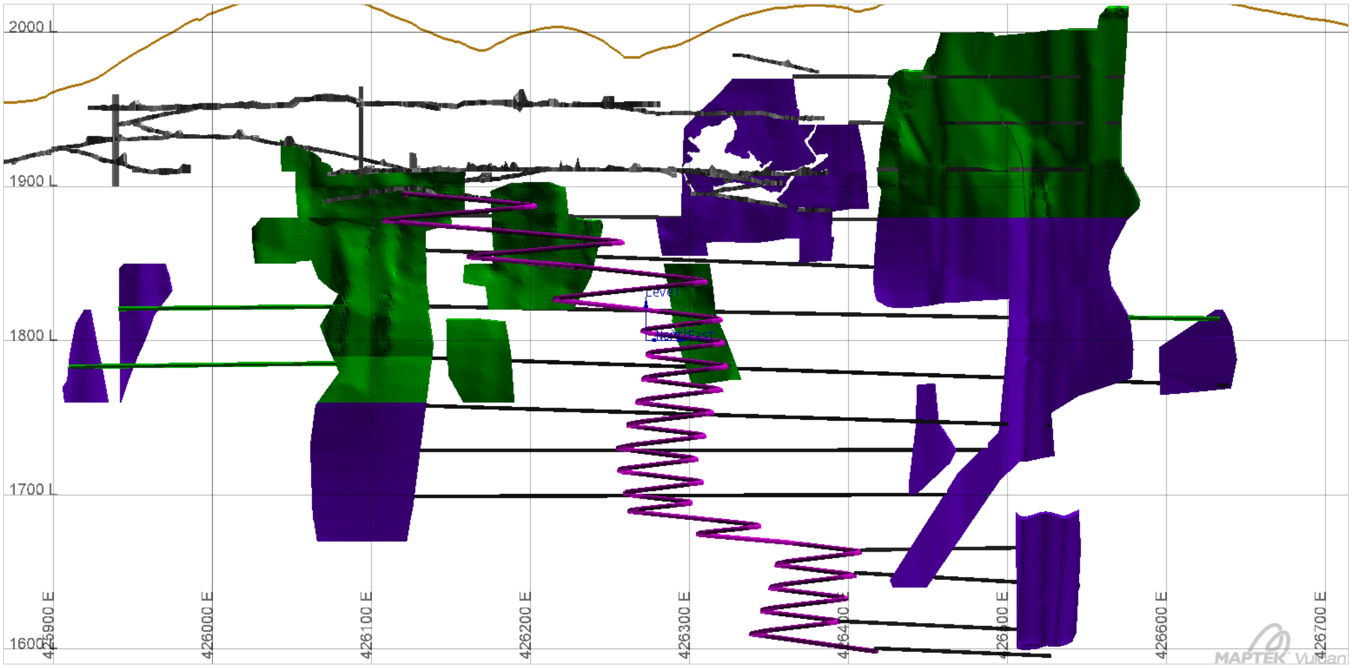


Figure 16-1: Distribution of Stopes by Mining Type

16.2.1.1 Sublevel Stoping (Long Hole Stoping)

Sublevel stoping has been envisaged as overhand longitudinal retreat. The stopes will be developed through driving drifts spaced 30 m apart along the vein from crosscuts off the main ramp. These drifts will form the base of the stopes, from which blasted material will be mucked and will be the main levels forming the mine. In between the main levels one or two sublevel will be driven which will be used to access stopes for drilling of production blast holes. Sublevels will be driven along the vein either directly off crosscuts from the main ramp or by access raise from the main levels. As such blast hole drilling equipment would be required to be capable of being hoisted up 1.5 by 1.5 m access raise. The driving of sublevels will be done by jackleg and slusher. The sublevels will be spaced 10 to 15 m apart from which both upholes and down holes could be drilled. The stope sequencing will be such that blasted material will be dropped to the main level from which it will be mucked using a narrow scooptram (1.6 m wide). Sill and rib pillars would be left between stopes to maintain regional stability.

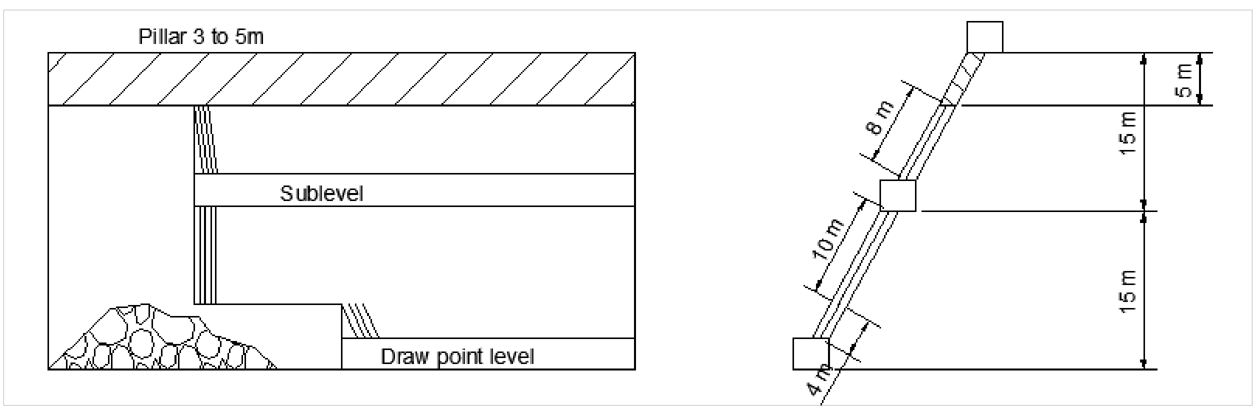


Figure 16-2: Conceptual Sublevel Stoping Method.

16.2.1.2 Cut and Fill (Cut and fill)

Cut and fill mining has been considered as a combination of mechanized drill and blast and jackleg mining. The method may use both overcut and undercut blasting. The stope would first be developed to extents by driving a drift along the vein using either jackleg or jumbo drilling. From this level undercuts and/or overcuts will be blasted successively. Due to the narrow nature of the deposit and because minimal fill material is available, it has been assumed that waste rock will need to be blasted to act as fill. This would come from hanging wall of the vein, blasted in separate blasts from the vein.

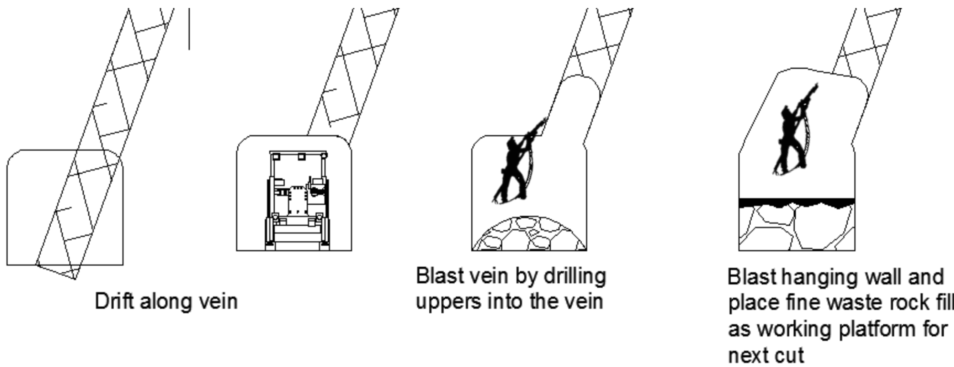


Figure 16-3: Concept for Cut and Fill Method in Narrow Vein with Waste Blast to Create Fill

16.2.2 Stope Delineation

To establish preliminary criteria for stope delineation, a brief evaluation was conducted based on limited available data gathered during the site visit. Visual assessment of the core and comparison with other operations was used to preliminary assign stope design criteria. **Table 16-2** below summarizes the design criteria.

Table 16-2: Stope Design Criteria

Design Aspect	Value Assigned	Units	Notes
RMR	60 to 80	N/A	Based on visual assessment of selection of core
Hydraulic radius used for stope sizing	7.5	m	
Stope height max (sublevel stoping)	25 to 27	m	Depends on pillar width
Stope length max (sublevel stoping)	40	m	3m rib pillar on strike between stopes
Stope vertical spacing	30	m	Sill pillar to sill pillar
Sublevel vertical spacing	15	m	
Max blast hole length	10	m	
Cut and fill max void height	No limit		
Cut and fill maximum length	120	m	
Cut and fill minimum mining width	1	m	
Sublevel stoping minimum mining width	1.5	m	

16.2.2.1 Dilution

Dilution is estimated to be less for cut and fill than for sublevel stoping. The following criteria for dilution were used for the PEA.

CUT AND FILL MINING

- Minimum mining width of 1 m
- Addition of 0.1 m on both sides of mineralized vein, so a total of 0.2 m of dilution added to mineralized width
- Note cut-and-fill mining is assumed to be carried out by split blasting of ore and waste

SUBLEVEL STOPING

- Minimum mining width of 1.5 m
- Addition of 0.3 m to vein width to establish diluted mining width

16.3 Mining Operations

Mining operations have been considered as drill and blast, muck and haul operations. Drilling will be done using jumbo rigs, jackhammers and long holes drills depending on the application. Mucking will be via scooptram with potential for some slusher mucking for sublevel development. Hauling will be by truck.

Explosives used will be a combination of ammonium nitrate as ANFO and cartridged explosives. Emulsion may be required for charging of upholes in sublevel stoping and cut and fill.

Mucking from stopes will be done along the main levels, with scooptrams running back to the ramp to muckbays or directly into haul trucks. Haul trucks will be loaded at intersections where the back has been slashed to allow the scoop bucket adequate height to dump into trucks.

Backfilled rock will be dumped into muckbays or directly into stopes. Muckbays will need to be slashed to allow adequate height (3.2 m) for truck load bodies to tip.

Mining supervision will be undertaken through provision of a production supervisor and a blaster on every shift. In addition, services personnel such as mechanics, welders, surveyors, drivers, geologists and assayers will be available on each shift.

A total of 68 personnel has been estimated for underground staff with an additional 12 persons as day staff. Security has been assumed to be carried out by contract security firm.

16.4 Mine Development

Where possible, existing development has been used to plan for the PEA. The existing mine access is at roughly 26°45'37.31"N, 105°44'45.13"W at an elevation of 1950 m amsl. This access has dimensions of roughly 2.5 H by 2.5 W at the narrowest areas. Some widening of the existing access has been considered for the PEA. In addition, some ramp intersections may need to be slashed or altered to enable a wider turning radius, to avoid the need for maneuvering and possibly reverse driving in parts of the existing ramp.

16.4.1 Main Access

Figure 16-4 shows the preliminary design of the ramp to access the new proposed underground workings. The Santa María Dos vein would be accessed from both the existing development, which intersects the vein on the eastern end of the Resources, and the new ramp via cross cuts.

The ramp has been designed for a maximum grade of 15%. The designed ramp has an overall length of 2,885 m for a change in height of 300 m.

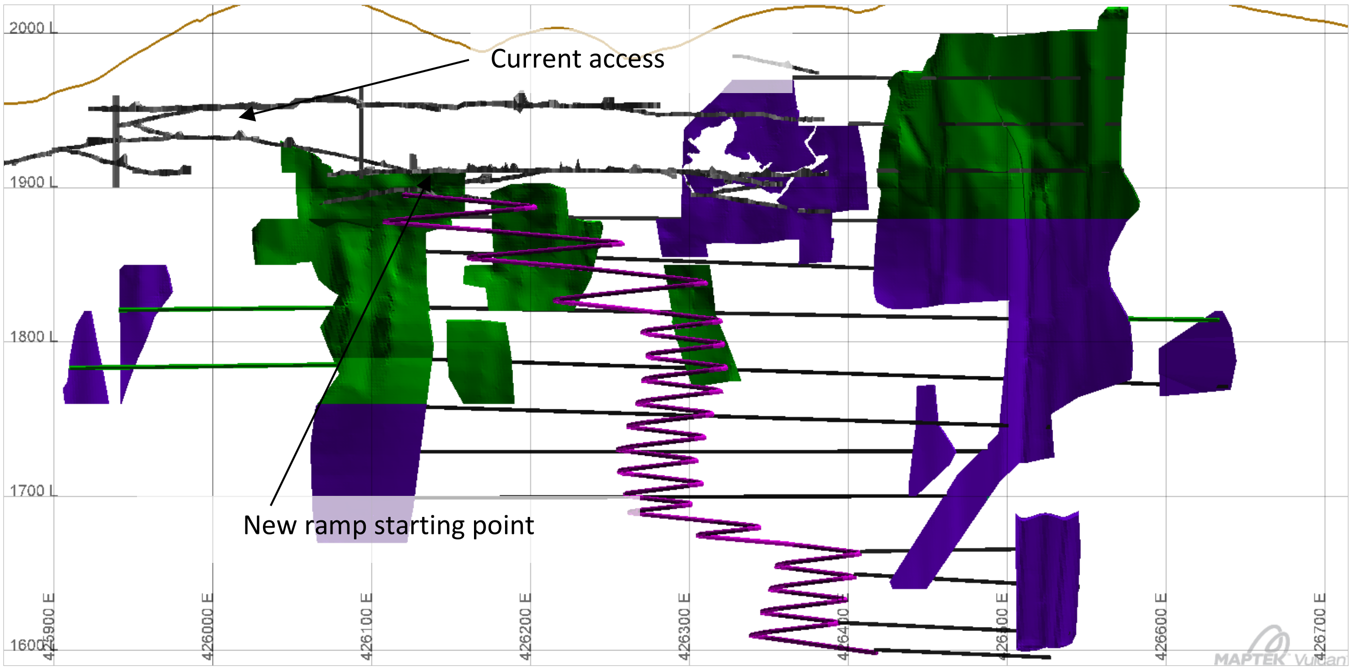


Figure 16-4: W-E Long Section Viewed from South to North Showing Designed Ramp Access

The ramp has been considered as 3 X 3 m dimensions on profile as shown in **Figure 16-5**.

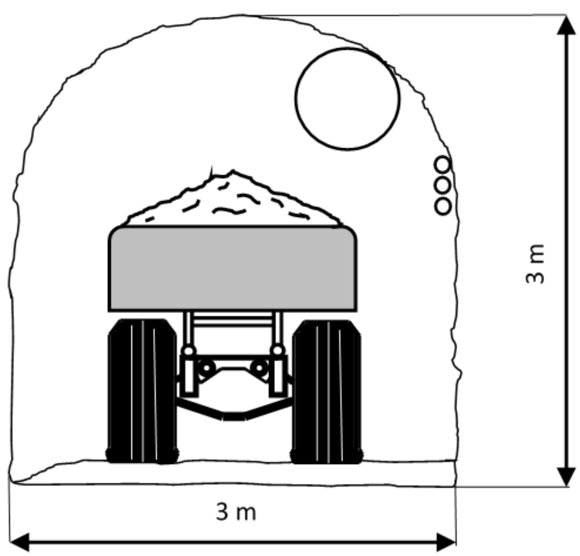


Figure 16-5: Ramp Profile Showing Haul Truck Clearance

16.4.2 Lateral Access

Lateral access to stoping areas have been spaced at 30 m apart. Additional sublevels for stopes would be driven as needed from the main lateral access or as in the case of sublevel stoping from raise access, using jackleg and slusher techniques. Lateral development would be driven as 2.5 by 2.5 m along the vein. This has been done to allow additional sampling of the vein as the lateral access is driven to allow further outline of Resources.

Additional lateral development will include drifts for connection with ventilation raises, muck bays, sumps and bays for mining infrastructure such as electrical distribution, refuge bays and maintenance areas.

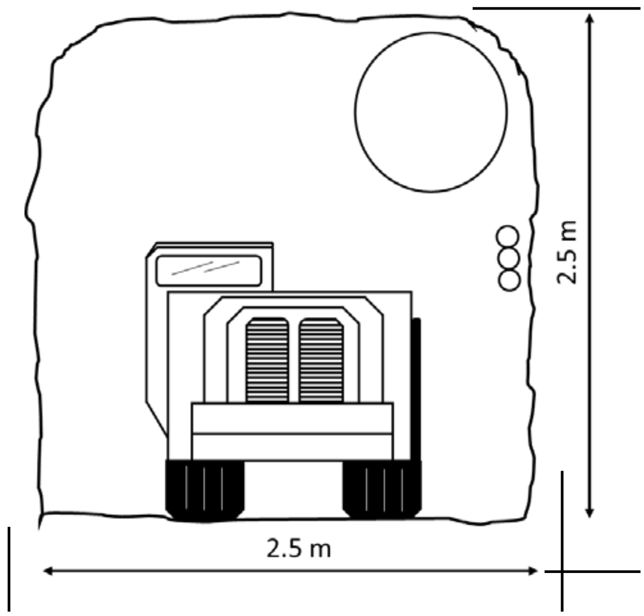


Figure 16-6: Lateral Development Profile Showing Scooptram Clearance

16.5 Mining Equipment Fleet

This PEA considers the use of a largely existing fleet from the Velardeña mine, wholly owned by Golden Minerals. For sublevel stoping, a longhole drill will need to be purchased, which has been included in the capital cost estimate. New jacklegs will also need to be purchased for the operation. The list of equipment available and to be purchased is included in **Table 16-3**.

Table 16-3: Mining Equipment List

Type	Currently Owned or To Be Purchased	Manufacturer Details	Number	Capacity/Size
Jacklegs	To be purchased	Not selected	6	102 CFM
Jumbo drill	Currently owned	Atlas Copco T1D	1	1.3 m width
Jumbo drill	Currently owned	Atlas Copco S1D	1	1.75 m width
Long hole drill	To be purchased	PHQ1036 Drill Sled	1	450 CFM
Scooptram	Currently owned	Sandvik LH203	2	2 yd^3 bucket /1.48 m wide
Mining trucks	Currently owned	JCI 704 (Joy Machinery)	3	5 yd^3 box / 1.55 m wide

Type	Currently Owned or To Be Purchased	Manufacturer Details	Number	Capacity/Size
Surface loader	Currently owned	Unknown	1	Not specified
Scraper	Currently owned	Not selected	2	Not specified
Kubota	Currently owned	Kubota RTV 900	3	Various
Light vehicles	Currently owned	Various	3	Various
Compressor	Currently owned	Sullair	1	1,000 CFM
ANFO charger	To be purchased	Not selected	1	Not known

16.6 Underground Infrastructure

In this section dewatering and ventilation infrastructure is discussed, as well as refuge and escape ways.

16.6.1 Dewatering

Dewatering will be required for production produced water and for ground water ingress. A provision has been made in the operating cost for the cost of pumping. Water will be pumped out of the mine using piping installed in the main ramp and will be discharged on surface into a settling pond. Current infrastructure exists for dewatering, which will be upgraded as necessary over the mine life.

16.6.2 Ventilation

A detailed investigation into ventilation requirements has not been carried out, but provision has been made on the operating cost and the mine plan for ventilation infrastructure. At this stage the main ramp has been considered as the main exhaust airway with a tie in to an existing raise as a fresh air intake. The exhaust airway will be further developed to depth using conventional drill and blast raising with connections at each main level underground. A second ventilation raise will be needed for the eastern end of the mining. This new raise will be approximately 400 additional meters in length, as shown in **Figure 16-7**.

The ventilation raises are currently planned as 1.5 m by 1.5 m in section.

Golden Minerals has existing ventilation equipment including a 75 HP main fan and various auxiliary fans. These would be moved to Santa María for installation at the mine.

Preliminary ventilation calculations based on equipment needs and effective brake horsepower, show that roughly 50,000 CFM is required and that a main fan to provide this flow of 75 HP as currently owned by Golden Minerals should be adequate. The preliminary ventilation calculations are shown in **Figure 16-8**.

An additional ventilation shaft may need to be installed once mining extends to depth. It is recommended that further ventilation modeling is undertaken to evaluate this.

As the mine plan deepens, redundant ventilation connections will be sealed off using either a cement brick wall or some other means of sealing.

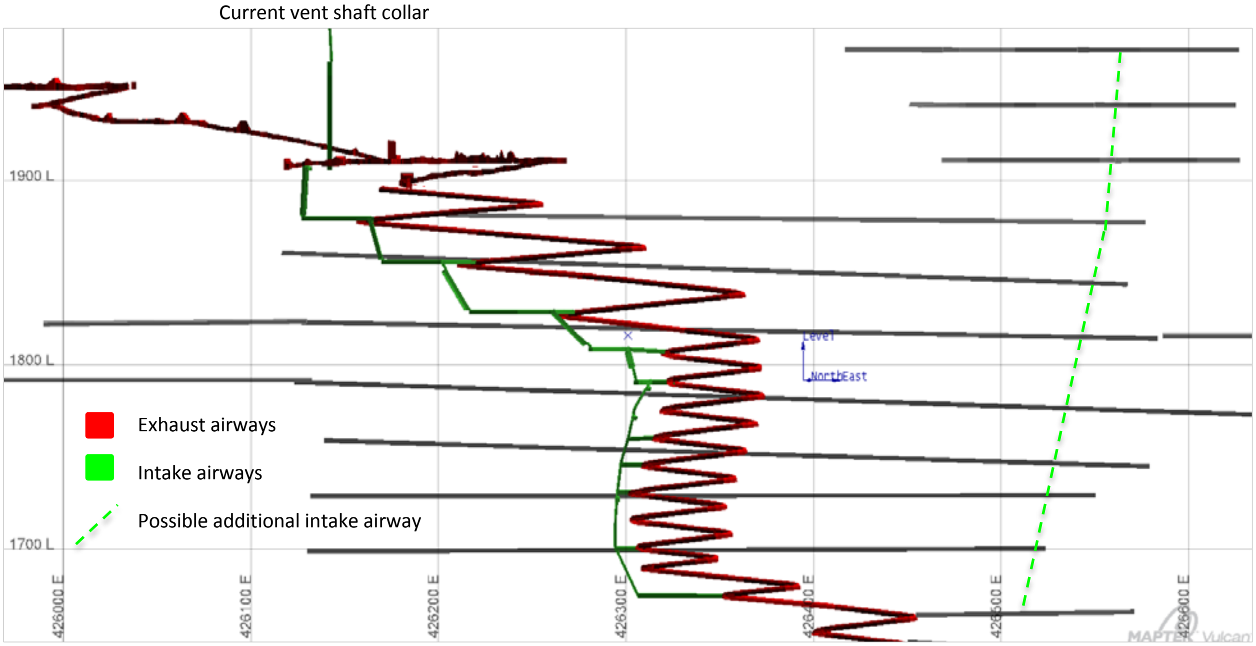


Figure 16-7: Proposed Ventilation Circuit

FRESH AIR RAISE HEAD

$P_s = \frac{KPLQ^2}{5.2a^3}$

K= *70* Friction Factor (untimbered, with rock bolts and mesh)

P= *20* ft
L= *1152* ft
A= *25* sq ft (of unrestricted airway)
Q= *50,000* cfm req'd
P_s = 4.96 in. w.g.

$P_v = (Q/4000A)^2$ = **0.25** in w.g.
$P_t = P_s + P_t$ = **5.21** in w.g.
fan HP = $\frac{QP_t}{6350}$ = **41.04** bhp
@ 70% efficiency = **59** bhp

5 ft × 5 ft
FRESH AIR RAISE
or
FAR diam

Figure 16-8: Preliminary Ventilation Calculations

16.6.3 Refuge and Escape Ways

The exhaust ventilation raise could be fitted such that the airway can be reversed and become an intake airway. This could then also be fitted with ladder ways to provide an emergency escape way. A mobile refuge chamber will be purchased which will be installed underground within 300 m of any working face. The ideal location is in the crosscut to the ventilation raise.

16.7 Mining Production Schedule

A conceptual mining schedule has been prepared based on stope outlines, stope development, lateral and ramp development requirements. The mine life spans 5 years of production with a preproduction period of 3 months in year -1.

The following constraints have been applied to generate the mining schedule:

- Three-month preproduction during which only the ramp will be driven.
- Ramp advance rate maximum of 3 m per day
- Lateral drift advance of maximum of 3 m per day per lateral drift
- Vertical advance of 1.5 m per day for raise mining
- Maximum production of 150 tonnes per day from a single stope
- Maximum of 20 m of vein shot in a single cut and fill stope per day
- Maximum of 5 m strike length of stope blasted in a sublevel stope per day

Table 16-4: Mining Schedule

Item	Units	Totals / Average	Year 1	Year 2	Year 3	Year 4	Year 5
Ramp development meters	m	2,885	906	1,089	890	-	-
Lateral development meters	m	7,184	1,230	2,164	2,156	1634	-
Ventilation raise	m	913	326	392	195	-	-
Long hole stope access raises	m	435	45	186	129	75	-
Muck bays in ramp	m	188	60	73	55	-	-
Ventilation links and infrastructure	m	255	60	60	60	60	15
Mill feed from stope development	tonnes	44,720	7,515	19,793	9,907	7504	-
Mill feed from stoping	tonnes	263,301	22,267	63,088	72,202	84,422	21,323
Total Tonnes	tonnes	308,021	29,782	82,881	82,109	91,926	21,323
Average Tonnes per day	tonnes	218	165	232	228	256	175
Total waste rock	tonnes	171,807	40,135	57,712	47,198	26762	-
Stoping from sub-level	tonnes	137,876	7,562	36,302	43,134	40,876	10,002
Stoping from cut and fill	tonnes	92,114	14,705	26,786	29,067	43,546	11321
Grade Au	g/t	0.78	0.85	0.74	0.80	0.79	0.71
Grade Ag	g/t	331	477	369	327	268	271
Ounces Au mined	toz	7,713	817	1,972	2,103	2,334	487
Ounces Ag mined	toz	3,281,869	456,307	984,106	862,253	793,360	185,843

16.8 Mining Costs

A preliminary estimate of mining costs has been generated based on information supplied by Golden Minerals staff on current labor and consumable costs as well as industry cost data.

These costs are presented in **Table 16-5** and rely on the following principle assumptions:

- Fuel costs of US$ 1.05 per liter or US$3.96 per gallon
- Ammonium nitrate prill of US$1.03 per kg.
- Labor rates varying between MEX$60 to MEX$800 per hour based on data supplied by Golden Minerals staff
- Labor burden of 35% based on data supplied by Golden Minerals staff
- 2 shifts of 9 hours each per day

Table 16-5: Mining Costs Estimated for the PEA

Mining Costs USD$ ($000s)	Year 1	Year 2	Year 3	Year 4	Year 5	Total	Cost/tonne mill feed
Power	$271	$762	$790	$677	$225	$2,725	$8.85
Supplies	$852	$2,189	$1,518	$305	$35	$4,899	$15.90
Labor	$1,120	$1,500	$1,538	$1,537	$512	$6,207	$20.15
Maintenance of service equipment	$50	$68	$68	$65	$21	$272	$0.88
Other costs	$176	$324	$294	$222	$70	$1,086	$3.53
Total	**$2,469**	**$4,843**	**$4,208**	**$2,806**	**$863**	**$15,189**	**$49.31**
Cost per tonne mill feed	$82.30	$58.35	$51.32	$30.50	$41.10	$49.31	

17. RECOVERY METHODS

It is currently envisioned that both mixed and sulfide materials will undergo toll-milling at a facility with sulfide flotation circuits. Per information provided by the facility, the maximum total throughput for the flotation circuit is 250 tonnes per day. The flotation circuit contains both lead and zinc flotation but will be operated as to produce a bulk sulfide silver gold bearing concentrate. A preliminary block flow diagram depicting the process is included as **Figure 17-1.**

The oxide ore will be cyanide leached at the toll-milling facility. The option for processing mixed and sulfide tailings in the leach circuit exists to improve the recovery of gold and silver as indicated by testwork.

The diagram provided by the toll mill facility does not explicitly state if the flotation cell sizes are given in cubic feet, nor if these dimensions are on a per cell, or per bank of cell, basis. It is assumed that dimensions reflect cubic feet. While it has been omitted in **Figure 17-1** for clarity sake, there is also an existing zinc flotation circuit downstream of the lead circuit at the toll mill. While this remains unutilized in the proposed flowsheet, its existence allows for more flexibility with respect to the use of alternative flowsheets should the need arise.

In the event further test work indicates that regrinding is necessary, at present there is no regrind mill in the proposed facility. The inclusion of a regrind mill, most likely in the form of a small tower mill due to generally smaller footprints, would incur additional CAPEX not currently evaluated within the economic analysis. This additional unit CAPEX for such a regrind mill could be on the order of 300k USD. Similarly, no analysis has been performed to evaluate if the secondary ball mill could be repurposed to serve as a regrind mill. This analysis cannot be performed at present due to the absence of comminution test work, as well as greater details regarding all the existing ball mills in the toll mill facility.

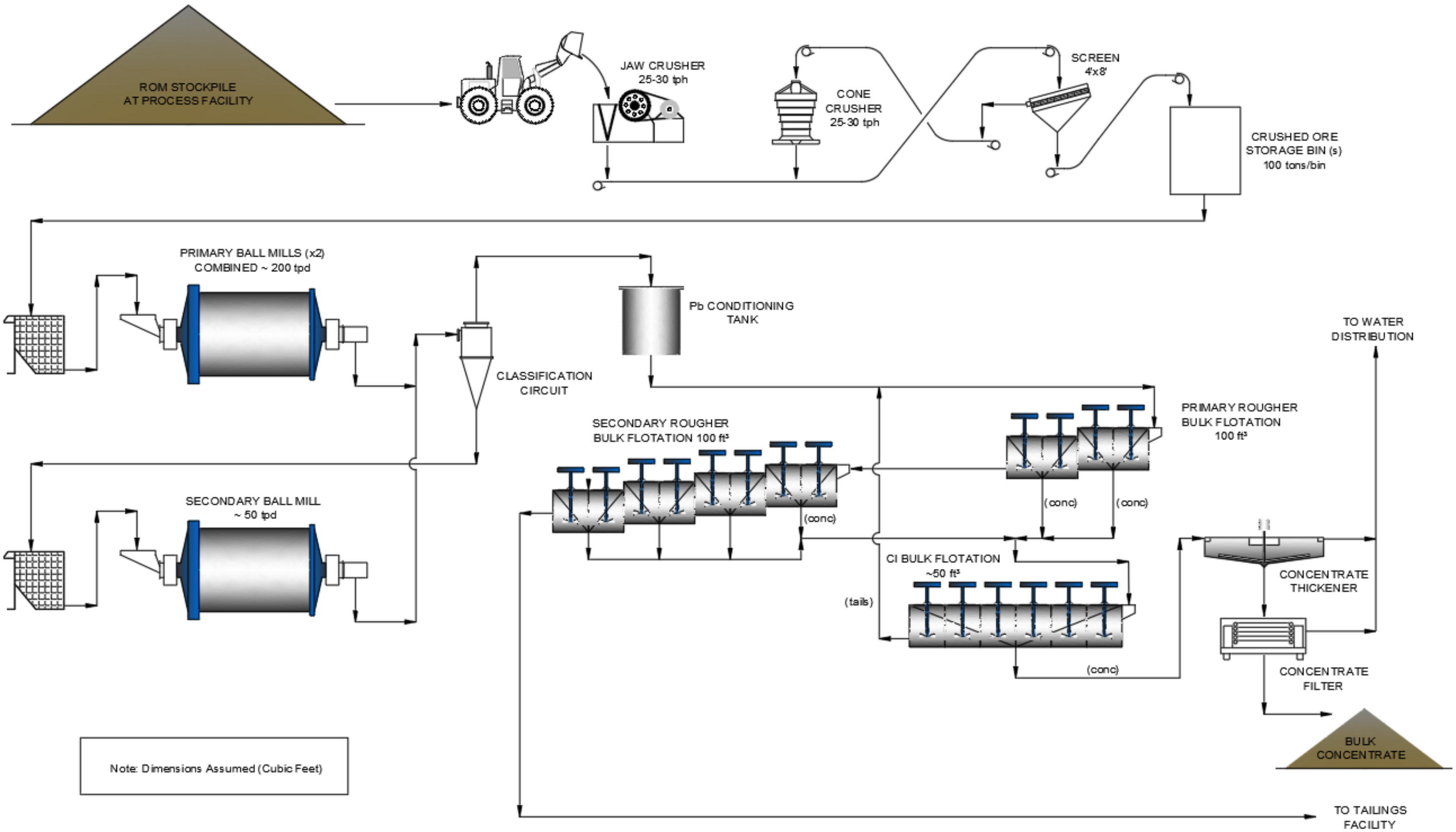


Figure 17-1: Simplified Process Flow Diagram

18. PROJECT INFRASTRUCTURE

The planning of infrastructure for the potential operation at Santa María is based on a mining only concept with offsite toll milling for processing. For the PEA the following infrastructure has been considered necessary for the mine site. Proposed layout of infrastructure is shown in **Figure 18-1**.

18.1 Access Road

The access road to the mine site is in reasonable condition but will require grading prior to startup of operations and likely at regular intervals subsequent. The current access road leads all the way to the mine site, passing numerous ranches on the way. One significant river crossing is required, which is currently crossed via a ford type crossing. No improvement of this is planned which may create periodic mine access issues, but not expected to be significant.

18.2 Mill Feed Stockpile

Underground mining trucks will deliver rock above cutoff grade to a mill feed stockpile. From this stockpile a surface loader will load tipper trucks operated by a contractor that will transport the mill feed to the toll mill in Parral.

18.3 Waste Rock Storage

Tetra Tech has provisionally considered waste could be deposited at the western end of the existing waste rock pad, which forms the access to the mine portal. It is expected some waste rock may be re-handled for disposal underground into open stopes or as fill material in cut and fill stopes.

18.4 Equipment Maintenance Shop

An existing covered area exists at the portal for equipment maintenance. Tetra Tech expects a larger area will be needed to provide space for mining equipment during maintenance. As such, the area to the west of the portal, adjacent to the hill side to the south of the main access road could be used.

An underground maintenance facility may be warranted at a later stage of mining, which could use redundant levels for use as underground shops.

18.5 Explosives Storage

Tetra Tech understands that Golden Minerals has existing permitted storage for explosives at Santa María. At this point it is assumed that this is adequate for operational purposes.

18.6 Offices

Offices for management and administration will be required at the mine site. Some relatively flat areas to the west of the portal along the access road could be prepared for mobile offices.

18.7 Weighbridge

It is recommended that Golden Minerals install a weigh bridge at the mine site. This will allow tracking of mill feed from the mine site to the toll mill in Parral.

18.8 Water Management Structures

The mine access portal occurs in a valley which had flowing water at the time of the site visit. Tetra Tech has recommended a water management structure is constructed between this stream and the road accessing the portal to mitigate the risk of flood waters entering the mine.

18.9 Contact Water Treatment

Contact water from the mine will be discharged into a settling pond at the far western end of the surface operations. After settling, and potential treatment if needed, water will be discharged into the stream channel which runs through the surface operating area.

18.10 Substation Or Generator Laydown

Depending whether grid power or generator power is needed, either a substation or a generator laydown will be required. This is expected to be ideally placed near the portal. In the case of generators, consideration around the interaction of exhaust emissions from the generators and intake ventilation must be made.

Figure 18-1: Project Site Infrastructure

19. MARKET STUDIES AND CONTRACTS

19.1 Markets

Markets for the potential bulk Ag and Au concentrate include metal brokers and possibly direct sales to smelters. The concentrate indicated by the test work is relatively common within the Mexican mining industry. No market studies have been undertaken with the bulk concentrate assumptions used in the PEA and no contract is in place for the material at this point.

Golden Minerals has previously sold various concentrates to Transamine (a metal broker) at other Mexican operations and for purposes of the PEA, it is assumed that Golden Minerals will be successful in securing a buyer for the bulk concentrate. There is risk however that actual contract terms will differ from the assumed payable terms used in the PEA and could adversely affect potential Project economic performance.

20. ENVIRONMENTAL STUDIES, PERMITTING AND SOCIAL OR COMMUNITY IMPACT

This section characterizes the available environmental baseline data for the Project area, makes suggestions for additional studies that would provide a basis for the mine permitting efforts, describes the major environmental permits that would likely be required for the Project, and identifies potential significant social or community impacts. As previously discussed in this report, the Santa María property is in the exploration and Resource stage and is not considered an advanced property. For this reason, extensive environmental studies have not been conducted. Most of information presented herein was summarized from a recently completed *Manifestación de Impacto Ambiental*, (MIA [CFFGA, 2016]), which is discussed as part of the permitting process. Many of the required permits discussed herein apply to the construction stage and are not currently being pursued.

20.1 Mexican Permitting Framework

Environmental permitting of the mining industry in Mexico is mainly administered by the federal government body SEMARNAT, the federal regulatory agency that establishes the minimum standards for environmental compliance. Guidance for the federal environmental requirements is largely held within the General Law of Ecological Equilibrium and Environmental Protection (*Ley General Del Equilibrio Ecológico y la Protección al Ambiente*, or LGEEPA). Article 28 of the LGEEPA specifies that SEMARNAT must issue prior approval to parties intending to develop a mine and mineral processing plant. An environmental impact statement (by Mexican regulations called a MIA must be filed with SEMARNAT for its evaluation and, if applicable, further approval by SEMARNAT through the issuance of an Environmental Impact Authorization; the document specifies approval conditions where works or activities have the potential to cause ecological imbalance or have adverse effects on the environment. Further requirements for compliance with Mexican environmental laws and regulations are supported by Article 27 Section IV of the Ley Minera and Articles 23 and 57 of the *Reglamento de la Ley Minera*. Article 5 Section X of the LGEEPA authorizes SEMARNAT to provide the approvals for the works specified in Article 28. The LGEEPA also contains articles for soil protection, water quality, flora and fauna, noise emissions, air quality, and hazardous waste management.

The National Water Law (*Ley de Aguas Nacionales*) provides authority to the National Water Commission (*Comisión Nacional del Agua* or CONAGUA), an agency within SEMARNAT, to issue water extraction concessions, and specifies certain requirements to be met by applicants.

Another important piece of environmental legislation is the General Law of Sustainable Forestry Development (*Ley General de Desarrollo Forestal Sustentable* - LGDFS). Article 117 of the LGDFS indicates that authorizations must be granted by SEMARNAT for land use changes to industrial purposes. An application for change in forestry land use (CUSTF), must be accompanied by a technical study that supports the Technical Justification Study (*Estudio Técnico-Justificativo* - ETJ). In cases requiring a CUSTF, a MIA for the change of forestry land use is also required.

Mining projects also must include a Risk Study (ER) and an Accident Prevention Plan (PPA) from SEMARNAT. This is discussed in more detail below.

The General Law for the Prevention and Integrated Waste Management (*Ley General para la Prevención y Gestión Integral de los Residuos* - LGPGIR) also regulates the generation and handling of hazardous waste coming from the mining industry. The LGPGIR also regulates the generation and handling of hazardous waste coming from the mining industry. Guidance for the environmental legislation is provided in a series of Official Mexican Standards (*Norma Oficial Mexicana* - NOMs). These regulations provide specific procedures, limits and guidelines and carry the force of law.

20.2 Project Permitting Requirements

There are many environmental permits required to advance the Santa María project into production. Most of the mining regulations are at a federal level through SEMARNAT, but there are also a number regulated and approved at state and local level. There are three SEMARNAT permits that are required prior to construction; MIA, CUSTF and ER, which are described below.

Environmental Impact Manifest – Regulations within Mexico require that an MIA be prepared by a third-party contractor for submittal to SEMARNAT. The MIA must include a detailed analysis of climate, air quality, water, soil, vegetation, wildlife, cultural resources and socio-economic impacts. An MIA has recently been completed for the Project which adequately defines existing Resources, evaluates potential impacts and outlines potential mitigation measures. A brief description of environmental resources and impacts identified in the MIA are outlined in Section 20.3 below.

Under the MIA process, public consultation is solicited by promulgating a summary of the MIA to the public through newspapers or any electronic media. The entire MIA is evaluated by the environmental authorities (federal, state, and municipal), which includes consideration of public comments and opinions regarding the Project. The MIA either may be rejected if it does not meet minimum requirements, or federal, state and municipal authorities may require the proponent to make corrections to the MIA. Proof of local community support for a Project is required to get a final MIA approved.

SEMARNAT or the project proponent may arrange public meetings. Any person can request a public meeting within 10 days of the publication of the MIA summary. Once SEMARNAT receives the request, it has 5 days to respond. The project proponent has another 5 days to publish a response to public concern. After that, the public has 10 days to file a request for a copy of the entire MIA from SEMARNAT. Once the entire MIA is available to the public, anyone can propose, in writing, changes to the MIA, including changes to designs and mitigations.

Preventive Report (*Informe Preventivo*) – Based on local environmental characteristics, which consist of flat land and low hills with natural grass, and according to Regulations, an **Exploration Program for the Santa María** project is not required to present a MIA Report at this stage of the project's exploration, and only needs to present a Preventive Report, which was presented by Golden Mineral through the title holder to SEMARNAT's local office in the City of Chihuahua (*Delegación Federal Chihuahua*) on May 11, 2017. The Preventive Report was presented for environmental impacts during a drilling program consisting of 32 drilling sites and roads of access, and it was approved for a duration of 36 months from November 05, 2017. Upon completion of the program, the titleholder most report to the Chihuahua Delegation the results of the measurements of prevention and mitigation proposed in the Preventive Report.

Study of Risk (ER) – A second required permit is a Risk Study (*Estudio de Riesgo* – ER). A study is developed to obtain this permit. This study identifies potential environmental releases of hazardous substances and evaluates the risks to establish methods to prevent, respond to, and control environmental emergencies. Since the proposed Project is primarily to advance underground mining with no onsite milling or processing, SEMARNAT may not require and extensive ER.

Land Use Change (CUSTF) – The third permit is Change in Forestry Land Use (*Cambio de Uso del Suelo en Terrenos Forestales* – CUSTF). In Mexico, all land has a designated use. The CUSTF is a formal instrument for changing the designation to allow mining on these areas. The CUSTF study is based on the Forestry Law and its regulations. It requires that an evaluation be made of the existing conditions of the land, including a plant and wildlife study, an evaluation of the current and proposed use of the land and impacts on natural resources and an evaluation of the reclamation and revegetation plans. The establishment of agreements with all affected surface land owners is also required.

20.2.1 Other Registrations and Permits

A Project-specific comprehensive environmental license (*Licencia Ambiental Única* – LAU), which states the operational conditions to be met, is issued by SEMARNAT when the agency has approved the Project operations.

A construction permit is required from the local municipality and an anthropological release letter is required from the National Institute of Anthropology and History (INAH).

An explosives permit is required from the Ministry of Defense (SEDENA) before construction begins. Water discharge and usage must be granted by CONAGUA.

The key permits and the stages at which they are required are summarized in **Table 20-1**.

Table 20-1: Key Permitting Requirements

Permit	Required Prior to this Mining Stage	Agency
Environmental Impact Statement - MIA	Construction/Operation/Post-Operation	SEMARNAT - Completed
Land Use Change - CUSTF	Construction/Operation	SEMARNAT
Technical Justification Study - ETJ	Construction (Includes Conceptual Design)	SEMARNAT
Risk Study - ER	Construction/Operation	SEMARNAT
Construction Permit	Construction	Local Municipality
Explosive & Storage Permits	Construction/Operation	SEDENA
Anthropological Release	Construction	INAH
Water Use Concession	Construction/Operation	CONAGUA
Water Discharge Permit	Operation	CONAGUA
Unique Environmental License	Construction, Six Months Prior to Operation	SEMARNAT
Accident Prevention Plan	Operation	SEMARNAT
Hazardous Waste Generator	Operation	SEMARNAT/PROFEPA

20.3 Environmental Baseline

The following environmental baseline conditions of major Resource areas are primarily summarized from the MIA, which has been developed for the Project (CFFGA, 2016).

20.3.1 Project Location

The Santa María Project is located southeast of the Santa Bárbara mining district in Chihuahua. The property is located 19 km from the center of the town of Santa Bárbara and approximately 39 km from the center of Parral, a moderate sized, full service regional center of commerce. The Project area is located within a 1.4829-hectare area called *San Miguel de Chicanaya*. The MIA fully recognizes the development of mining projects for silver and other minerals in the Santa Bárbara region, and specifically in the *San Miguel Chicanaya* area, is economically beneficial to the region.

20.3.2 Climate

The Project is in a temperate, semi-arid region. Based on meteorological data available for San Francisco del Oro, the average temperature ranges between 12 ° C and 18 °C with an average annual temperature of 17.7 °C. The temperature in the coldest months generally range between 3° C and 18 °C and during the warmest months, temperatures are generally being less than 22 °C. The average annual precipitation is 332 mm. The length of the operating season could be year-round; however, access to the site could be temporarily inhibited during large rain events, due to potential flooding of the major river crossing. Precipitation and temperature data from the National Meteorological Service for San Francisco del Oro and is shown in Figure 20-1.

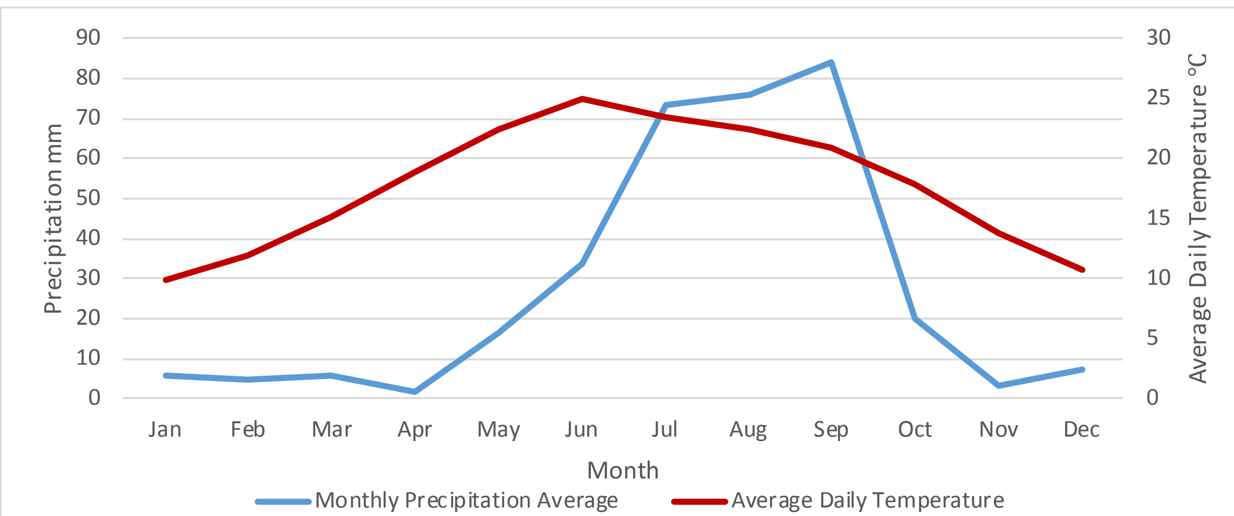


Figure 20-1: Climate Data for San Francisco del Oro

20.3.3 Soils

Soils in the region vary in their development depending on vegetation type, climate and relief. In general, soils in the area are poorly developed, lack distinct horizonation and are low in organic matter. Much of the soils in the region have been impacted by wind and water erosion caused by lack of vegetative cover, overgrazing by livestock, and stripping of vegetation for roads or mine development.

20.3.4 Surface Water

The watersheds in the area occur within Hydrologic Region No. 24 called Bravo Conchos, which is not considered to be in a region of hydrologic priority in Chihuahua. Streams within the immediate region are generally first, second and third order streams. Streams in the Project area are intermittent or ephemeral 2nd order streams which flow to larger tributaries in the R. Florido watershed. The proposed Project is not expected to use a large amount of surface water.

20.3.5 Groundwater

The primary aquifer within the Project area is called the "Parral – Valley of the Summer". The aquifer is not considered an important supply of water to the region compared to larger surface water developments from the Parral dam and the Talamantes dam. Dewatering of the current mine workings are discharged to a surface drainage but is not expected to impact aquafer supply or other users.

Minera de Cordilleras has engaged a local environmental contractor to characterize the groundwater quality which is being discharged. Sampling to characterize groundwater quality has shown that the groundwater that is currently being pumped is of acceptable quality for a discharge permit according to regulations specified by National Water Quality Standards (NOM-001-SEMANART-1996). Applicable water quality standards by designated use are shown in **Table 20-2** and **Table 20-3**; and groundwater quality sampled from the Project discharge in 2014 is shown in **Table 20-4**.

Table 20-2: Maximum Permissible Limits for Basic Contaminants

(NOM-001-SEMARNAT-1996)																				
	Rivers						Natural and Artificial Reservoirs				Coastal Waters						Groundwater			
Parameter	Agricultural Irrigation		Public Urban Use		Protection of Aquatic Life		Agricultural Irrigation		Public Urban Use		Fisheries and Navigation		Recreation		Estuaries		Agricultural Irrigation		Wetlands	
mg/L unless otherwise noted	M.A.	D.A.	M.A.	D.A.	M.A.	D.A.	M.A.	D.A.	M.A.	D.A.	M.A.	D.A.	M.A.	D.A.	M.A.	D.A.	M.A.	D.A.	M.A.	D.A.
Temperature °C	NA	NA	40	40	40	40	40	40	40	40	40	40	40	40	40	40	NA	NA	40	40
Oil and Grease	15	25	15	25	15	25	15	25	15	25	15	25	15	25	15	25	15	25	15	25
Floating Materials	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent
Sedimentary Solids	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	NA	NA	1	2
Total Suspended Solids	150	200	75	125	40	60	75	125	40	60	150	200	75	125	75	125	NA	NA	75	125
Biochemical Oxygen Demand	150	200	75	150	30	60	75	150	30	60	150	200	75	150	75	150	NA	NA	75	150
Total Nitrogen	40	60	40	60	15	25	40	60	15	25	NA	NA	NA	NA	15	25	NA	NA	NA	NA
Total Phosphorous	20	30	20	30	5	10	20	30	5	10	NA	NA	NA	NA	5	10	NA	NA	NA	NA

MA (Monthly Average), DA (Daily Average)

Table 20-3: Maximum Permissible Limits for Heavy Metals and Cyanide

(NOM-001-SEMARNAT-1996)																				
	Rivers						Natural and Artificial Reservoirs				Coastal Waters						Groundwater			
Parameter	Agricultural Irrigation		Public Urban Use		Protection of Aquatic Life		Agricultural Irrigation		Public Urban Use		Fisheries and Navigation		Recreation		Estuaries		Agricultural Irrigation		Wetlands	
mg/L unless otherwise noted	M.A.	D.A.	M.A.	D.A.	M.A.	D.A.	M.A.	D.A.	M.A.	D.A.	M.A.	D.A.	M.A.	D.A.	M.A.	D.A.	M.A.	D.A.	M.A.	D.A.
Arsenic	0.2	0.4	0.1	0.2	0.1	0.2	0.2	0.4	0.1	0.2	0.1	0.2	0.2	0.4	0.1	0.2	0.2	0.4	0.1	0.2
Cadmium	0.2	0.4	0.1	0.2	0.1	0.2	0.2	0.4	0.1	0.2	0.1	0.2	0.2	0.4	0.1	0.2	0.05	0.1	0.1	0.2
Cyanides	1.0	3.0	1.0	2.0	1.0	2.0	2.0	3.0	1.0	2.0	1.0	2.0	2.0	3.0	1.0	2.0	2.0	3.0	1.0	2.0
Copper	4.0	6.0	4.0	6.0	4.0	6.0	4.0	6.0	4.0	6.0	4.0	6.0	4.0	6.0	4.0	6.0	4.0	6.0	4.0	6.0
Chromium	1.0	1.5	0.5	1.0	0.5	1.0	1.0	1.5	0.5	1.0	0.5	1.0	1.0	1.5	0.5	1.0	0.5	1.0	0.5	1.0
Mercury	0.01	0.02	0.005	0.01	0.005	0.01	0.01	0.01	0.005	0.01	0.005	0.01	0.01	0.02	0.01	0.02	0.005	0.01	0.005	0.01
Nickel	2	4	2	4	2	4	2	2	2	4	2	4	2	4	2	4	2	4	2	4
Lead	0.5	1	0.2	0.4	0.2	0.4	0.5	0.5	0.2	0.4	0.2	0.4	0.5	1	0.2	0.4	5	10	0.2	0.4
Zinc	10	20	10	20	10	20	10	10	10	20	10	20	10	20	10	20	10	20	10	20

MA (Monthly Average), DA (Daily Average)

Table 20-4: December 2014 Groundwater Quality

Parameter	Units	Results
Total Arsenic	mg/L	0.068
Total Cadmium	mg/L	ND
Total Cyanide	mg/L	ND
Total Copper	mg/L	ND
Total Chromium	mg/L	ND
Total Mercury	mg/L	ND
Total Nickel	mg/L	ND
Total Lead	mg/L	0.02
Total Zinc	mg/L	0.21
Total Kjeldahl Nitrogen	mg/L	ND
Total Phosphorous	mg/L	0.0455
Settleable Solids	mL/L	< 0.1
Total Suspended Solids	mg/L	< 10.5
Chemical Oxygen Demand	mg/L	80.8
Biochemical Oxygen Demand	mg/L	< 39.6
Total Dissolved Solids	mg/L	474
Fecal Coliforms	MPN/100 ml	6.8

ND = not detected - below the method detection limit
mg/L = milligrams per liter
mL/L - milliliters per liter
MPN = most probable number of colony forming bacteria

20.3.6 Vegetation

The primary vegetation type within the region is dominated by scrub oak, other oak shrub and oak forest with occurrences of various oak species of the genus Quercus. This vegetation type is in a transition zone between coniferous forests which occur at higher elevations and wetter forests in the east. Plant cover varies from very dense areas to areas with sparser vegetation. The immediate area of the Project site is generally devoid of vegetation because of prior surface disturbance from mining.

20.3.7 Socio-Economics

The primary socio-economic driver in the region is mining for gold, silver copper, zinc and fluorite. Historically, mining has been the main economic factor driving employment and business activity in the region and specifically in the municipality of Santa Bárbara.

20.4 Summary of Potential Environmental Impacts

A summary of potential environmental and socio-economic impacts identified by the current Project MIA is presented in **Table 20-5** below.

Table 20-5: Summary of Environmental Impacts by Resource

Resource	Degree of Potential Impact	Description
Surface and Groundwater	Low Impact	The Project is not expected to affect surface water supply or quality. There is some potential impact to groundwater from mining activities and dewatering.
Soils	Moderate to High Impact	The area is currently impacted from previous disturbance of soils and is generally devoid of vegetation. Project activities will continue to impact soil erosion and compaction.
Air	Low Impact	Potential emission of dust, particulates and air pollutants from machinery or vehicles during all phases of the Project. These impacts expected to be minor. Noise and vibrations generated by machinery and vehicles ca be mitigated with appropriate measures.
Flora	Low Impact	No environmentally sensitive species as defined by NOM-059-SEMARNAT-2010 were found in the Project area.
Landscape (Visual)	Moderate Impact	The Project will have moderate impacts to visual Resources because of its high visibility. The fragility to the visual Resource is potentially high.
Socio-Economic or Community Impacts	Moderate (positive) Impact	The Project will have moderately positive impacts to the socio-economics of the area, particularly in the municipality of Santa Bárbara because the Project could supply reliable jobs.

20.4.1 Mine Dewatering Activities

Dewatering of the current mine workings are discharged to a surface drainage. Information provided during the site visit indicated that the rate of dewatering was approximately 10 liters per second (L/s). Minera de Cordilleras has engaged a local environmental contractor to characterize the groundwater quality, which is being discharged. Available data from December of 2014 shows that all water quality standards are being met. It is assumed that the source of this current discharge is from workings, which exist in zones considered to have oxide mineralization. However, as the Project progresses, mining could be expanded into zones considered to have sulfide materials. For this reason, it is unknown if the groundwater from these zones would be of similar quality and quantity. There is some risk to the Project if dewatering activities from these lower zones would produce water that does not meet water quality standards and would require treatment prior to discharge.

In general, acid generation and/or metal leaching (ARD/ML) can form by the natural oxidation of sulfide minerals exposed to air and water. Activities that involve the excavation of rock with sulfide minerals can accelerate the process because it increases the exposure of sulfide minerals to air, water, and microorganisms. The drainage produced following contact with these minerals after the oxidation process may be neutral to acidic, with or without dissolved heavy metals, but will always contains sulfate. The potential to produce acidic conditions or not is based on several factors which include:

- The total concentration of sulfur (as sulfide) in the mineral;
- The surface area of exposure to sulfide bearing rock;

- The length of exposure; and
- The Net Neutralization Potential (NNP) of the ore and host rock, which is also based on mineralogy.

As the Project progresses through the prefeasibility and feasibility process, it is recommended that further studies to characterize the water quality and geochemistry of the ore and host rock in the sulfide zones be conducted. However, based on Tetra Tech's understanding of the probable plan of operation, the risk that future activities would produce groundwater of degraded quality would be low. This assumed minimal risk is based on the following:

- Mining in these zones is only expected for a few years and the time of exposure of residual sulfides to oxygen and water would be very short;
- Most high sulfide materials would be extracted and removed with the ore;
- The host rock is likely to have a slightly positive or positive neutralization potential (NNP).

20.5 Reclamation and Closure

A reclamation and closure plan has not been developed. Reclamation and closure plans are only developed and appropriate for advanced stage properties. As this Project progresses through the feasibility and mine planning process, a conceptual reclamation and closure plan can be developed. By Mexican law, mining may be initiated under a conceptual closure plan with detailed closure plans being developed later in the Project. Based on Tetra Tech's understanding of the probable plan of operations for the Santa María project, a reclamation and closure plan would contain the following components:

- Analysis and engineering of closure design and costs;
- Demolition and disposal of surface facilities and buildings;
- Sealing of adits, shafts and other mine openings;
- Geochemical stabilization of any mine waste;
- Well abandonment;
- Site grading plan;
- Hauling, dumping and spreading of plant growth medium (PGM);
- Revegetation;
- Installation, monitoring, and maintenance of erosion, sediment, and dust control best management practices;
- Post-closure monitoring and maintenance;
- Demonstration of bond release (i.e. performance criteria).

20.5.1 Reclamation and Closure Costs

For the Santa María Project, it is assumed that most of closure and reclamation activities will include the demolition of surface facilities and buildings, site grading, hauling dumping and spreading PGM and installation of storm water systems. It is assumed all waste rock will be disposed underground and that there will be no on-site milling and processing or associated storage facilities for tailings. It is further assumed existing access roads to the Project site will not require reclamation. Based on these activities, Tetra Tech conducted a Class 5 closure and reclamation cost estimate for the Santa María Silver Project using the AACE (2012) Estimate Classification System – As Applied in the Mining and Mineral Processing Industries.

The estimated deterministic cost to demolish and remove surface facilities and buildings, seal a mine portal and reclaim mine-related surface disturbance following cessation of mining activities is approximately $158,000 USD in 2016 dollars. This cost equates to approximately $25,600/acre of surface disturbance based on the overall Project disturbance of approximately 2.5 hectares. This estimated per acre closure and reclamation cost was derived by averaging closure and reclamation costs estimated by Tetra Tech Inc. (Tetra Tech) and Golder Associates Inc. between 2014 and 2016 for proposed mine and two operating mines located in Mexico. No location factors were applied to the cost estimate for approximate labor, equipment and material costs in Chihuahua, Mexico.

20.5.2 Cost of Potential Groundwater Treatment

As discussed in Section 20.4.1, Tetra Tech considers a minimal risk for groundwater pumped from sulfide zones in the mine to become degraded by ARD. However, if this water does not meet water quality standards as specified by NOM-001-SEMARNAT-1996 and NOM-157-SEMARNAT-2009, a treatment system may be required. For this reason, Tetra Tech estimated the cost of a small passive water treatment system to treat mine-influenced water (MIW). The capital cost estimate to construct a passive water treatment system capable of treating 10 L/s of MIW using an up-flow biochemical reactor and aerobic polishing wetland would be $1.4 M without indirect costs. Operation and maintenance costs are not included; however, the estimated design life of the facility is approximately 25 years. The capital cost estimate was derived by scaling-down recent internal cost estimates to treat 14 L/s of MIW.

21. CAPITAL AND OPERATING COSTS

All costs and economic results are presented in U.S. dollars. Quantities and values are presented using metric units unless otherwise specified. No escalation has been applied to capital or operating costs. Technical economic tables and figures presented in this section require subsequent calculations to derive subtotals, totals, and weighted averages. Such calculations inherently involve a degree of rounding. Where these occur, they are not considered to be material.

21.1 Capital Costs

LoM capital cost requirements are estimated at $1.2 million as summarized in **Table 21-1**. Initial capital of $1.0 million is required to commence operations and a sustaining capital of $188 thousand.

Table 21-1: Capital Cost Estimate

Description	Initial Capital ($000s)	Sustaining Capital ($000s)	Total Capital ($000s)
Mining	$370	$0	$370
Infrastructure	$525	$0	$525
Owner's Costs	$128	$188	$316
Total	**$1,023**	**$188**	**$1,211**

21.2 Operating Costs

LoM operating costs are summarized in **Table 21-2** at $94.65/tonne-milled.

Table 21-2: Operating Cost Estimate

Description	LoM Cost ($000s)	Unit Cost ($/t-milled)
Mining	$15,188	$49.31
Processing	$13,324	$43.26
G&A	$412	$1.34
Lease	$230	$0.75
Total	**$29,154**	**$94.65**

21.3 Mining Costs

A preliminary estimate of mining costs has been generated based on information supplied by Golden Minerals staff on current labor and consumable costs as well as industry cost data.

The life of mine average cost is $49.31 per tonne mined. This cost is sensitive to the duration of mining as much of the cost is fixed and based on time as opposed to production. A shorter duration to mine the same material will reduce cost per tonne.

These costs are presented in **Table 21-3** and rely on the following principle assumptions:

1) Fuel costs of US$ 1.05 per liter or US$3.96 per gallon
2) Ammonium nitrate prill of US$1.03 per kg.
3) Labor rates varying between MEX $60 to MEX $800 per hour based on data supplied by Golden Minerals staff.
4) Labor burden of 35% based on data supplied by Golden Minerals staff
5) 2 shifts of 9 hours each per day.

Table 21-3: Mining Costs Estimated for the PEA

Mining costs USD$ ($000s)	Year 1	Year 2	Year 3	Year 4	Year 5	Total	Cost/ tonne mill feed
Power	$271	$762	$790	$677	$225	$2,725	$8.85
Supplies	$852	$2,189	$1,518	$305	$35	$4,899	$15.90
Labor	$1,120	$1,500	$1,538	$1,537	$512	$6,207	$20.15
Maintenance of service equipment	$50	$68	$68	$65	$21	$272	$0.88
Other costs	$176	$324	$294	$222	$70	$1,086	$3.53
Total	**$2,469**	**$4,843**	**$4,208**	**$2,806**	**$863**	**$15,189**	**$49.31**
Cost per tonne mill feed	$82.30	$58.35	$51.32	$30.50	$41.10	$49.31	

22. ECONOMIC ANALYSIS

The following preliminary economic assessment includes Measured, Indicated and Inferred Mineral Resources, Mineral Resources are not Mineral Reserves and do not have demonstrated economic viability. This preliminary economic assessment also includes Inferred Mineral Resources that are too speculative for use in defining Reserves.

Project cost estimates and economics developed in the Technical-Economic Model (TEM) are prepared monthly for the life of mine (LoM) as based on the selected portion of the total Project Resource. Based upon design criteria presented in this report, the level of accuracy of the estimate is considered scoping level. Economic results are summarized in **Table 22-4**. The analysis suggests the following conclusions, assuming no debt:

- Mine Life: five years;
- Post-Tax Net Present Value (NPV5%): US$10.6 million, IRR: 159%;
- Payback (Post-Tax): 10 months; and
- Taxes: US$1,395 thousand.

22.1 Inputs & Assumptions

Technical assumptions used in the economic analysis are presented in **Table 22-1**. All costs are in US dollars. A ratio of USD1.00: MXN$20.00 is used, where applicable. Market prices reflect current conditions. Taxes are estimated using the current tax code. Results reflect an 5% hurdle rate. No debt is assumed.

Table 22-1: General Assumptions

Description	Units	Value
Market Prices		
Gold	$/oz	$1,238
Silver	$/oz	$16.63
Taxes		
Federal Tax*	%	30.0%
Special Mining Tax	%	7.5%
Precious Metals Tax	%	0.5%
Financial		
Discount Rate	%	5.0%

*Not applied due to Net Operating Losses.

Mine and process plant production summaries over the LoM are shown in **Table 22-2** and **Table 22-3**, respectively. These schedules are discussed in detail in other sections of this report.

Table 22-2: RoM Summary

Description	Units	Value
Run of Mine	kt	308
RoM Grades		
Gold	g/t	0.78
Silver	g/t	331
Contained Metal		
Gold	koz	7.7
Silver	koz	3,282

Table 22-3: Process Summary

Description	Units	Value
Concentrate (dry)	kt	12
Payable Metal Recoveries		
Sulfide		
Gold	%	83%
Silver	%	91%
Transition		
Gold	%	56%
Silver	%	77%
Doré		
Oxide		
Gold	%	85%
Silver	%	73%
Recovered Metals		
Sulfide		
Gold	koz	2.7
Silver	koz	1,439
Transition		
Gold	koz	0.5
Silver	koz	232
Oxide		
Gold	koz	2.9
Silver	koz	1,023

22.2 Technical Economic Results

Technical-economic results are presented in **Table 22-4**. Given current conditions, positive cash flow is projected to occur in 10 months.

Table 22-4: TEM Results

Description	Unit Cost ($/t-milled)	Total Value ($000s)
NSR	$146.27	$45,055
Land Acquisition	($2.97)	($915)
Net Revenue	**$143.30**	**$44,140**
Operating Costs		
Mining	$49.31	$15,188
Processing	$43.26	$13,324
G&A	$1.34	$412
Lease	$0.75	$230
Operating Costs	**$94.65**	**$29,154**
Operating Margin	**$48.65**	**$14,986**
Capital Costs		
Mining	-	$370
Infrastructure	-	$525
Owner Costs	-	$316
Capital Costs	-	**$1,211**
Estimate of Tax		
Federal Tax	-	$0
Special Mining Tax	-	($1,170)
Precious Metals Tax	-	($225)
Estimate of Tax	-	**($1,395)**
Cash Flow	-	$12,380
NPV 5%	-	**$10,593**
IRR	-	**159.3%**
Payback (months)	-	10

22.3 Sensitivity

Project sensitivity to metal price is shown in **Table 22-5**.

Table 22-5: Sensitivity to Metal Prices

Metal	High	Base	Low
Au	$1,362	$1,238	$1,114
Ag	$18.30	$16.63	$14.96
$NPV_{5\%}$	$11,590	$7,016	$2,936
IRR	196%	146%	85%

23. ADJACENT PROPERTIES

Utilizing publicly available search tools on the *Sistema de Administración Minera* (SIAM) website, the names of title holders for the surrounding claims were determined. Through cursory searches of the title holders' names, the following associated mining companies are believed to hold titles surrounding the claim: Grupo Mexico S.A. de C.V., Industrias Peñoles, S.A. de C.V., Minera Platte River Gold, S. de R.L. de C.V. The Grupo Mexico exploration claims are generally contiguous with Grupo Mexico's Santa Bárbara operations.

No publicly available information regarding results of adjacent properties were located. The SGM web portal *Geo Info Mex*, shows the historic *El Estandarte* mine as an adjacent property to the west as well as the historic *Santa Niño* mine.

24. OTHER RELEVANT DATA AND INFORMATION

Relevant data and information has been included within the respective sections.

25. INTERPRETATION AND CONCLUSIONS

The Project is not free of risk but has several unique circumstances that are uniquely suited to benefit Golden Minerals.

Drill hole and channel samples have been collected and analyzed using industry standard methods and practices and are sufficient to characterize grade and thickness and support the estimation of Indicated and Inferred Mineral Resources. Preliminary economic assessment using Indicated and Inferred Mineral Resource estimates suggest that further study and advancement of the Project to pre-feasibility may be warranted.

25.1 Geology and Resources

Drill hole and channel samples have been collected and analyzed using industry standard methods and practices and are sufficient to characterize grade and thickness and support the estimation of Mineral Resources. However, to confirm the Resource estimates and increase the level of certainty Tetra Tech recommends developing underground drifts and crosscuts along the vein deposits to define "ore shoots", mineralized structures, and continuity. These workings may be partially financed by shipping economic mineralization to the Parral Mill for processing.

25.1.1 Significant Risk Factors

Significant Project risks include those discussed in the Resource section regarding the true shape of mineralized shoots and the consistency of areas above cutoff vs. those that are below. Difficulty in defining these areas could directly affect the Project's amenability to mine planning and successful operations.

Conversion of Inferred Resources to Indicated or Measured classification in vein deposits is historically more expensive when compared to more massive deposit types, and it is rarely advantageous to delay Project progression until the Project has been completely explored and Reserves defined.

For the type of mineral deposits at the Santa María project, Tt recommends following the exploration with underground development, drifting and crosscutting; the economic investment for these workings may be mitigated by processing any mineralized material produced during the workings.

The claim's boundary limits the Project Resource upside, prohibiting any significant increases beyond what has been stated in this report.

25.2 Mining

Currently Tetra Tech finds underground mining is feasible, though productivities will be subject to narrow vein constraints. The following risks have been identified that require further work to de-risk the potential mining venture.

25.2.1 Risk Factors

25.2.1.1 Geotechnical and Hydrogeological Evaluation

Since no formal study has been completed on the geotechnical conditions, this remains a Project risk that could result in safety concerns, cost escalation or more challenging mining conditions than currently anticipated.

25.2.1.2 Ventilation

No formal ventilation study has been conducted and though during the initial mining no issues are expected, a ventilation study should be conducted to ensure Golden Minerals is prepared for additional ventilation requirements for the deeper mining.

25.2.1.3 Equipment Requirements

The PEA found that there is strong possibility that the increase in haul truck cycle time over the mine life will result in the need for additional trucks to maintain productivity.

It is also possible that larger trucks could be required later in the mine life. The cost and benefits of using larger trucks later in the mine life should be studied in detail considering the costs required to enlarge the underground development to accommodate larger trucks.

25.2.2 Opportunities

The following opportunities should be further evaluated by Golden Minerals for pursuing mining at Santa María.

25.2.2.1 Expansion of Sublevel Stoping

Upon confirmation of the rock quality through a geotechnical study, Golden Minerals could investigate the possibility of mining narrower than considered in the PEA, using sublevel stoping techniques. There are some precedents for narrow vein mining of veins narrower than 1 m. In addition, if rock conditions allow, the sublevel interval could be increased to reduce mining costs for sublevel stoping.

25.2.2.2 Slashing of Existing Ramp to 3 x 3 m or More

The risk relating to reduced cycle time of haul trucks could be mitigated through slashing of the current access drifts such that a larger haul truck can be used in the mine. The larger haul truck is available in the current fleet owned by Golden Minerals, providing an opportunity to mitigate production risk when as the mine deepens.

25.2.2.3 Processing of Low Grade from Vein Drifts

Where stope development is done on the vein to access economically feasible stoping areas, vein material mined as part of required access development could be selected for processing at a lower cutoff. Golden Minerals will need to confirm recoveries and mill capacity to ensure that this does make economic sense.

26. RECOMMENDATIONS

Given that the preliminary economic assessment, using Indicated and Inferred Resources, indicates the Project could produce positive economic results, the following are suggested:

- Further explore the Project to increase tonnage and confidence of the currently defined Resources;
- Underground development along the mineralized structures is recommended to determine widths, grades, and mineralization distribution. Increase certainty on the Mineral Resources and conversion into Mineral Reserves.
- Engage a local environmental consultant to determine permitting costs and timelines;
- Perform additional metallurgical testing characterization; and
- Following additional drilling and potential Resource expansion, reassess the Project's economic potential through another PEA or begin to collect data and analyze the data required to allow for the definition of Reserves.
  - Additional studies and work required to advance the Project to a preliminary feasibility study (PFS) and Reserves includes but is not limited to:
    - Complement the exploration programs with additional underground developments along the Santa María and SM-Dos veins;
    - Geotechnical drilling and stability analysis;
    - Hydrogeologic drilling and analysis;
    - Waste rock geochemical determination;
    - Improved closure cost estimation;
    - Base line environmental studies and permitting;
    - Improved estimation for site infrastructure requirements;
    - Surface water management analysis and handling requirements;
    - Computer optimized stope selection and scheduling

Generalized cost to advance the Project to pre-feasibility are summarized in **Table 26-1**.

Table 26-1: Approximated Costs of Recommended Work

Recommendation	Cost Range ($000s)
Drilling for Class Conversion	$250-400
Drilling for Expansion	$100-250
Development Ramping	$100-200
Development Drifting	$100-200
Metallurgical Testing	$50-100
Environmental Consulting	$70-150
Environmental Testing	$50-100
Mining Related Studies	$100-200
PFS Study	$200-300
Total	**$1,020-1,900**

26.1 Geology and Resources

It is recommended drilling continues for purposes of class conversion, Inferred to Indicated, as well as along-strike extension and expansion. Exploration underground through development, drifts and crosscuts, is recommended to confirm the drilling programs, define the mineralized zones (widths and grades), and confirm the mineralized structures continuity. These workings may elevate some of the Mineral Resources to Reserves.

It is recommended that mineral leases are secured for concessions where down-dip expansion potential exists. Without additional concessions, significant Resource expansion is limited.

26.2 Metallurgy and Process

It is recommended additional sulfide flotation test work be performed on a full range of expected Resource grade material. It is also recommended future confirmation test work be performed under conditions and configurations compatible with the toll milling facility.

To confirm the assumptions regarding anticipated locked cycle responses, it is recommended a locked cycle flotation test be performed on the sulfide material.

In parallel with further testing of sulfide material, it is recommended that samples of oxide material be subjected to the same reagents as used on sulfide material to evaluate the oxide's potential amenability to flotation. To date, no dedicated oxide samples have undergone flotation testing, although some cyanidation testwork has been performed to establish preliminary oxide metallurgical recoveries. In the event the oxide material appears amenable to flotation, this should be followed by locked cycle testing.

26.3 Mining

26.3.1 Geotechnical and Geohydrological Evaluation

Tetra Tech recommends Golden Minerals commissions a geotechnical and hydrogeological study to confirm rock conditions for the underground mining. The extension of mining to depth needs to be evaluated in terms of potential rock stress issues.

26.3.2 Ventilation

It is recommended ventilation requirements are re-evaluated and that in particular the feasibility of using existing ventilation raise infrastructure is evaluated. Potential heat loads from deeper mining may require additional ventilation to create acceptable working conditions.

26.3.3 Equipment Requirements

The PEA showed a strong possibility that a fleet of 2 small underground trucks (5 yd^3 capacity) may be inadequate as cycle times increase with depth of mining. More detailed equipment productivity analysis is suggested.

In addition, Golden Minerals should confirm the suitability of the suggested longhole drill or seek alternative models.

26.4 Environmental and Permitting

It is recommended that a local environmental consulting firm, experienced in permitting and societal issues in the area, be retained to assist in baseline and background work that will be required as inputs into the feasibility and mine planning process. Additional work that shall be conducted, at a minimum, includes:

- Continued characterization of groundwater quality to include extracting samples from the sulfide zones of the mine;
- Surface water features and streams in the mine should also be characterized for water quality to support continued mine planning for environmental concerns;
- A small number of core samples of both host rock and from the ore vein should be submitted for initial static geochemical testing for acid base accounting (ABA). Dynamic humidity cell tests would not be recommended;
- Preventive Report (*Informe Preventivo*, or IP). At the beginning of the permitting process, SEMARNAT should visit the site to recommend whether an IP only, or an IP and an MIA will be needed for the mine preparation and production stage. This report is intended to provide general information about the Project and determine requirements of an MIA, and on what basis (regional or specific); and
- Clarify with current regulatory authorities where activities by previous operators on the property could be the liability of the current or future operator.

27. REFERENCES

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28. DATE AND SIGNATURE PAGE

CERTIFICATE OF AUTHOR
Leonel López C.P.G., Associate Principal Geologist of Tetra Tech
Principal Mining Consultant of Tetra Tech
350 Indiana Street, Suite 500
Golden, Colorado 80401
Telephone: 303-217-5700

I, **Leonel López, CPG, SME-RM**, of Golden, Colorado do hereby certify:

a) I am currently employed as Associate of Tetra Tech located on 350 Indiana Street, Suite 500 Golden, Colorado 80401.
b) This certificate applies to the Technical Report titled "NI 43-101 Technical Report Updated Preliminary Economic Analysis Santa Maria Silver Project Santa Bárbara, Chihuahua, Mexico", effective and issued on September 14, 2018.
c) I am a Professional Geologist (PG-2407) in the State of Wyoming, USA, a Certified Professional Geologist (CPG-08359) in the American Institute of Professional Geologists, an SME Founding Registered Member (#1943910), a registered Geological Engineer (Cédula Profesional #1191) in the Universidad Nacional Autónoma de México, a member of the Society of Economic Geologists, and a member of the Geological Society of America.
d) I graduated from the Universidad Nacional Autónoma de México with the title of Ingeniero Geólogo in 1966 and subsequently have taken numerous short courses in Economic Evaluation and Investment Decision Methods at Colorado School of Mines, and other technical subjects in related professional seminars. I have practiced my profession continuously since 1966.
e) I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) and certify that by reason of my education, affiliation with a professional association and relevant work experience, I fulfill the requirements of a "qualified person" for the purposes of NI 43-101.
f) I have not visited or inspected the subject property, but I am familiar with the region having worked in the past in the areas of San Francisco del Oro, Parral and Santa Bárbara, Chihuahua in Mexico.
g) I participated and am responsible for sections 7-9, and portions of sections 1, 2, 3, 4, 5, 6, 10, 11, 12, 14, 20, 24,25,26 and 27 of this Technical Report.
h) I satisfy all the requirements of independence according to NI 43-101.
i) I have read NI 43-101, Form 43-101 F1, and the Companion Policy to NI 43-101 (43-101 CP) and this Technical Report has been prepared in compliance with NI 43-101, Form 43-101 F1, and 43-101 CP.
j) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.
k) I consent to the filing of the Technical Report with any stock exchanges or other regulatory authority and any publication by them, including electronic publication in the public company files on the websites accessible by the public, of the Technical Report.

Dated November 8, 2018

"Leonel López, CPG, SME-RM" - Signed
Signature of Qualified Person

Leonel López, CPG, SME-RM
Print name of Qualified Person

CERTIFICATE OF AUTHOR

Guillermo Dante Ramirez-Rodriguez, PhD, MMSAQP,
Principal Mining Engineer of Tetra Tech
350 Indiana Street, Suite 500
Golden, Colorado 80401
Telephone: 303-217-5700

I, **Guillermo Dante Ramirez-Rodriguez, PhD, MMSAQP**, of Golden, Colorado do hereby certify:

a) I am a Principle Mining Engineer with Tetra Tech, Inc. with a business address of 350 Indiana St., Suite 500, Golden, CO 80401.

b) This certificate applies to the Technical Report titled "Preliminary Economic Assessment NI 43-101 Technical Report, Santa María Silver Project, Santa Bárbara, Chihuahua, Mexico" (Technical Report), effective and issued on September 14, 2018. I have a Bachelor's degree in Mining and Metallurgical Engineering from the University of Zacatecas School of Mines in Mexico, and a Master and Doctorate degrees in Mining and Earth Systems Engineering from the Colorado School of Mines, in the United States of America. I am a QP member for the Mining and Metallurgical Society of America (Member No. 01372QP). I have over 31 years of professional experience since my graduation in 1987. I am a "Qualified Person" for purposes of National Instrument 43-101 (the "Instrument").

c) I inspected the property on January 14th, 2016.

d) I am responsible for Section, 2, 3, 16, 18, 20-22, 24, 27, as well as portions of sections 1, 4, 25, and 26 of the Technical Report.

e) I satisfy all the requirements of independence according to NI 43-101.

f) I have had no prior involvement with the Property that is the subject of the Technical Report.

g) I have read the Instrument, and the parts of the Technical Report that I am responsible for have been prepared in compliance with the Instrument.

h) As of the date of this certificate, to the best of my knowledge, information and belief, the parts of the Technical Report that I am responsible for contain all scientific and technical information that is required to be disclosed to make the technical report not misleading.

i) I consent to the filing of the Technical Report with any stock exchanges or other regulatory authority and any publication by them, including electronic publication in the public company files on the websites accessible by the public, of the Technical Report.

Dated November 8, 2018

"Guillermo Dante Ramírez-Rodríguez PhD, MMSAQP"
Signature of Qualified Person

Guillermo Dante Ramírez-Rodríguez PhD, MMSAQP
Print name of Qualified Person

CERTIFICATE OF AUTHOR

Deepak Malhotra, Ph.D.
President of Pro Solv Consulting LLC
15450 W. Asbury Ave.
Lakewood, Colorado 80228
Telephone: 720-261-2450

I Deepak Malhotra, Ph.D., do hereby certify that:

a) I am currently employed as President by Pro Solv Consulting LLC, 15450 W. Asbury Ave., Lakewood, Colorado 80228

b) This certificate applies to the Technical Report titled "Preliminary Economic Assessment NI 43-101 Technical Report, Santa María Silver Project, Santa Bárbara, Chihuahua, Mexico" (Technical Report), effective and issued on September 14, 2018. I graduated with an M.S. in Metallurgical Engineering and a Ph.D. n Mineral Economics from the Colorado School of Mines in 1974 and 1978, respectively. I have worked as a metallurgist/mineral economist for a total of 45 years and have been involved with the preparation of numerous reports, feasibility studies, and NI 43-101 documents. I am a Registered Member of the Society for Mining, Metallurgy, and Exploration, Inc. (SME) and the Canadian Institute of Mining (CIM). I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.

c) I have not visited and inspected the subject property.

d) I am responsible for sections 13, 17 and 19, as well as portions of sections 1, 25, 26 and 27 of this Technical Report.

e) I satisfy all the requirements of independence according to NI 43-101.

f) I have not had prior involvement with Golden Minerals on the property that is the subject of the Technical Report.

g) I have read NI 43-101, Form 43-101 F1, and the Companion Policy to NI 43-101 (43-101 CP) and this Technical Report has been prepared in compliance with NI 43-101, Form 43-101 F1, and 43-101 CP.

h) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

i) I consent to the filing of the Technical Report with any stock exchanges or other regulatory authority and any publication by them, including electronic publication in the public company files on the websites accessible by the public, of the Technical Report.

Dated November 8, 2018

"Deepak Malhotra, Ph.D." - Signed
Signature of Qualified Person

Deepak Malhotra, Ph.D.
Print name of Qualified Person