



# **TECHNICAL REPORT FOR THE CASA BERARDI MINE, NORTHWESTERN QUÉBEC, CANADA**

## **NI 43-101 Report**

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## CAUTIONARY STATEMENT ON FORWARD-LOOKING INFORMATION

This Technical Report contains forward-looking statements within the meaning of the U.S. Securities Act of 1933 and the U.S. Securities Exchange Act of 1934 (and the equivalent under Canadian securities laws), that are intended to be covered by the safe harbor created by such sections. Such forward-looking statements include, without limitation, statements regarding the Company's expectation of the Casa Berardi Mine and its expansions, including estimated capital requirements, expected production, cash costs and rates of return; mineral reserve and mineral resource estimates; estimates of gold grades; and other statements that are not historical facts. We have tried to identify these forward-looking statements by using words such as "may," "might", "will," "expect," "anticipate," "believe," "could," "intend," "plan," "estimate" and similar expressions.

Forward-looking statements address activities, events or developments that Hecla Mining Company expects or anticipates will or may occur in the future and are based on information currently available. All forward-looking statements in this Technical Report are necessarily based on opinions and estimates made as of the date such statements are made and are subject to important risk factors and uncertainties, many of which cannot be controlled or predicted. Material assumptions regarding forward-looking statements are discussed in this Technical Report, where applicable. In addition to, and subject to, such specific assumptions discussed in more detail elsewhere in this Technical Report, the forward-looking statements in are subject to the following assumptions: (1) there being no significant disruptions affecting the operation of the Casa Berardi Mine; (2) the availability of certain consumables and services and other key supplies being approximately consistent with current levels; (3) labour and materials costs increasing on a basis consistent with current expectations; (4) that all environmental approvals, required permits, licenses and authorizations will continue to be held on the same or similar terms and obtained from the relevant governments and other relevant stakeholders within the expected timelines; (5) certain tax rates; (6) the timelines for exploration activities; and (7) assumptions made in Mineral Resource and Mineral Reserve estimates, including geological interpretation grade, recovery rates, metal price assumptions, and operational costs; and general business and economic conditions. Although Hecla management believes that its expectations are based on reasonable assumptions, it can give no assurance that these expectations will prove correct.

Important factors that could cause actual results to differ materially from those in the forward-looking statements include, among others, risks that Hecla's exploration and property advancement efforts will not be successful; risks relating to fluctuations in the price of gold; the inherently hazardous nature of mining-related activities; uncertainties concerning Mineral Reserve and Mineral Resource estimates; uncertainties relating to obtaining approvals and permits from governmental regulatory authorities; and availability and timing of capital for financing exploration and development activities, including uncertainty of being able to raise capital on favorable terms or at all; as well as those factors discussed in Hecla's filings with the SEC including Hecla's latest Annual Report on Form 10-K and its other SEC filings (and Canadian filings) including, without limitation, its latest Quarterly Report on Form 10-Q. Hecla does not intend to publicly update any forward-looking statements, whether as a result of new information, future events, or otherwise, except as may be required under applicable securities laws.

## **CAUTIONARY STATEMENTS TO INVESTORS ON MINERAL RESERVES AND MINERAL RESOURCES**

Reporting requirements in the U.S. for disclosure of mineral properties are governed by the SEC and included in the SEC's Securities Act Industry Guide 7, entitled "Description of Property by Issuers Engaged or to be Engaged in Significant Mining Operations" (Guide 7). Although the SEC has recently issued new rules rescinding Guide 7, the new rules are not binding until January 1, 2021, and at this time the Hecla still reports in the U.S. in accordance with Guide 7. However, Hecla is also a "reporting issuer" under Canadian securities laws, which require estimates of mineral resources and mineral reserves to be prepared in accordance with Canadian National Instrument 43-101 (NI 43-101). NI 43-101 requires all disclosure of estimates of potential mineral resources and mineral reserves to be disclosed in accordance with its requirements. As a result, information in this Technical Report concerning the properties and operations of Hecla has been prepared in accordance with Canadian standards under applicable Canadian securities laws and may not be comparable to similar information for U.S. companies.

Reporting requirements in the United States for disclosure of mineral properties under Guide 7 and the requirements in Canada under NI 43-101 standards are substantially different. This Technical Report contains a summary of certain estimates of the Company, not only of proven

and probable mineral reserves within the meaning of Guide 7, but also of mineral resource and mineral reserve estimates estimated in accordance with the definitional standards of the Canadian Institute of Mining, Metallurgy and Petroleum referred to in NI 43-101. Under Guide 7, the term "reserve" means that part of a mineral deposit that can be economically and legally extracted or produced at the time of the mineral reserve determination. The term "economically", as used in the definition of mineral reserve, means that profitable extraction or production has been established or analytically demonstrated to be viable and justifiable under reasonable investment and market assumptions. The term "legally", as used in the definition of mineral reserve, does not imply that all permits needed for mining and processing have been obtained or that other legal issues have been completely resolved. However, for a mineral reserve to exist, Hecla must have a justifiable expectation, based on applicable laws and regulations, that issuance of permits or resolution of legal issues necessary for mining and processing at a particular deposit will be accomplished in the ordinary course and in a timeframe consistent with Hecla's current mine plans. The terms "measured mineral resources", "indicated mineral resources," and "inferred mineral resources" are Canadian mining terms as defined in accordance with NI 43-101. These terms are not defined under Guide 7 and are not normally permitted to be used in reports and registration statements filed with the SEC in the United States, except where required to be disclosed by foreign law. The term "resource" does not equate to the term "mineral reserve". Under Guide 7, the material described herein as "indicated resources" and "measured resources" would be characterized as "mineralized material" and is permitted to be disclosed in tonnage and grade only, not ounces. The category of "inferred resources" is not recognized by Guide 7. Investors are cautioned not to assume that any part or all of the mineral deposits in such categories will ever be converted into proven or probable mineral reserves. "Mineral Resources" have a great amount of uncertainty as to their existence, and great uncertainty as to their economic and legal feasibility. It cannot be assumed that all or any part of such a "mineral resource" will ever be upgraded to a higher category or will ever be economically extracted. Investors are cautioned not to assume that all or any part of a "mineral resource" exists or is economically or legally mineable. Investors are also especially cautioned that the mere fact that such mineral resources may be referred to in ounces of silver and/or gold, rather than in tons of mineralization and grades of silver and/or gold estimated per ton, is not an indication that such material will ever result in mined ore which is processed into commercial silver or gold.

## DATE AND SIGNATURE

This report titled “Technical Report for the Casa Berardi Mine, Northwestern Québec, Canada” prepared by Hecla Québec Inc. and dated April 1, 2019, was prepared and signed by the following authors:

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## 1.0 SUMMARY

### 1.1 EXECUTIVE SUMMARY

Personnel from Hecla Québec and additional QP's prepared and published a technical Report on the Casa Berardi Mine, located in the Abitibi region of Quebec. The purpose of this report is to support public disclosure of Mineral Resource and Mineral Reserve estimates by Hecla Mining Company as of December 31, 2018. This Technical Report conforms to NI 43-101 Standards of Disclosure for Mineral Projects.

Hecla was established in 1891 and has its headquarters in Coeur d'Alene, Idaho. Hecla acquired Aurizon Mines Ltd. (Aurizon) in June 2013 and renamed the company Hecla Québec. Hecla has an administrative/exploration office in Val-d'Or, Quebec, and an office in Vancouver, British Columbia. Hecla owns 100% of the Casa Berardi property. Prior to Hecla's acquisition in 2013, production had spanned seven years from 2006 to 2013 with Aurizon and ten years from 1988 to 1997 with Inco Gold and TVX. In total, the Casa Berardi Mine complex has more than twenty-three years of mining operation from surface and underground.

The Casa Berardi gold deposits are located along a five kilometer, east-west trending mineralized corridor. The mine has both underground and open pit mining operations and a mineral processing plant of nominal 3,836 tonnes per day (tpd). The Casa Berardi complex has two underground mining operations, the West Mine and the East Mine. Surface facilities at the East Mine include the processing plant, a tailings pond, two-administrative buildings with offices, shops and a warehouse. Underground infrastructure at the East Mine includes a 380 m deep shaft, a decline, and a series of ramp-connected levels. Surface infrastructure at the West Mine includes a 125 tonne per hour paste backfill plant, a cement plant; a dry house with offices, shops, and warehouses, two ventilation raise intakes and a gate house. Underground infrastructure includes a decline from surface and a shaft to the 1,080 m level with corresponding ore and waste passes. The West Mine infrastructure includes the Principal mine area that is developed to provide mine services. A five-kilometers track drift joins the East and West Mines and provides underground access to the Principal mine area.

In a news release dated February 14, 2019, Hecla reported new Mineral Resources and

Mineral Reserve estimates for the Casa Berardi Mine, dated December 31, 2018. The substantial addition of mineral reserves at the West Mine Crown Pillar pit, Principal pit and East Mine Crown pillar pit extension, led Hecla Québec to update the life of mine study for surface and underground operation.

This 43-101 Technical Report summarizes the scientific and technical information that supports the new life of mine plan and the new Mineral Resources and Mineral Reserves for the Casa Berardi Mine as of December 31, 2018. Mineral reserves as of December 31, 2018, are summarized in Table 1-1. It has been prepared by Hecla staff and Qualified Persons based at the Casa Berardi Mine and externally (Table 2-1).

**Table 1-1: Casa Berardi Mineral Reserves December 31, 2018**

Area	Category	Tonnes	Grade (g/t Au)	Contained Ounces
Underground	Proven	739,900	5.3	125,000
Underground	Probable	2,588,300	5.3	442,000
Open Pit	Proven	5,419,700	2.5	438,400
Open Pit	Probable	12,791,800	2.2	901,300
<b>Total</b>	<b>Proven &amp; Probable</b>	<b>21,539,700</b>	<b>2.8</b>	<b>1,906,700</b>

Notes:

1. CIM definitions were followed for mineral reserves.
2. Underground mineral reserves were estimated by Hecla Québec.
3. Open pit mineral reserves were estimated by Hecla Québec support by MDA studies report.
4. Mineral Reserves are estimated at a cut-off grade of 3.5 g/t Au for 113, 124, and 148 zones. A cut-off grade of 3.6 g/t Au for the 123 Zone. A cut-off grade of 3.7 g/t Au for the 118 Zone, and a cut-off grade of 3.8 g/t Au for the 121 Zone.
5. The open pit mineral reserves are estimated at a cut-off grade off 0.67 g/t Au.
6. Underground mineral reserves are estimated using an average long-term gold price of US\$1,200 per ounce and a US\$/C\$ exchange rate of 1.33.
7. Open pit mineral reserves are estimated using an average long-term gold price of US\$ of 1,225 per ounce and a US\$/C\$ exchange rate of 1.30.
8. A minimum mining width of three meters was used for underground and open pit.
9. Totals may not represent the sum of the parts due to rounding.

Mineral Resources, exclusive of Mineral Reserves in Table 1-1, as of December 31, 2018 are summarized in Table 1-2.

**Table 1-2: Casa Berardi Mine, Mineral Resources Exclusive of Mineral Reserves**

Area	Category	Tonnes	Grade (g/t Au)	Contained Ounces
Underground	Measured	1,770,800	5.3	299,300
	Indicated	3,735,800	4.7	562,400
	Measured + Indicated	5,506,700	4.9	861,700
	Inferred	1,911,500	6.8	415,100
Open Pit	Measured	-	-	-
	Indicated	6,059,200	1.8	343,600
	Measured + Indicated	6,059,200	1.8	343,600
	Inferred	3,733,000	2.0	237,100
<b>Total</b>	<b>Measured &amp; Indicated</b>	<b>11,565,900</b>	<b>3.2</b>	<b>1,205,300</b>
<b>Total</b>	<b>Inferred</b>	<b>5,644,400</b>	<b>3.6</b>	<b>652,200</b>

Notes:

1. CIM definitions were followed for Mineral Resources.
2. Underground mineral resources were estimated by Hecla Québec.
3. Open pit mineral resources were estimated by Hecla Québec.
4. Underground mineral resources are estimated at a cut-off grades of 3.2 g/t Au for the West Mine and 3.1 g/t Au for the East Mine.
5. Underground mineral resources are estimated using an average long-term gold price of US\$1,350 per ounce and a US\$/C\$ exchange rate of 1.33.
6. Open pit mineral resources are estimated at a cut-off of 0.67 g/t Au.
7. Open pit mineral resources are estimated using an average long-term gold price of US\$1,225 per ounce and a US\$/C\$ exchange rate of 1.30.
8. Minimum mining widths three meters were used.
9. Mineral Resources are exclusive of Mineral Reserves.
10. Totals may not represent the sum of the parts due to rounding.
11. Mineral Resources which are not Mineral Reserves do not have demonstrated economic viability.

Hecla Québec has been successful in generating new Mineral Resources and converting Mineral Resources to Mineral Reserves. The database used to calculate the mineral resources include historical drill-holes from Inco Gold, TVX and Aurizon in addition to the Hecla Québec drilling data from 2013. The wireframe shells and block model mineral resources estimation were completed using the Gems 6.8 modeling software. The mineral resources in the block model were divided into measured, indicated and inferred categories based on the confidence level of the data and information used to create the models. The mineral reserves estimation shown in Table 1-1, used mining parameters, including costs, to convert a portion of the measured and indicated mineral resources that have an economic viability to mineral reserves. The Mineral Resources are exclusive of Mineral Reserves and are shown in Table 1-2.

Over the year, the Casa Berardi mineral reserves have shown a good tonnage and grade

reconciliation with the mill throughput. Since 2006, the reconciliation indicates the mineral reserves have underestimated tons by 6% and overestimated gold content by 1% compared to the mill feed. These variances are extremely small and confirm the quality of the mineral resource and mineral reserve estimates.

Ground conditions in the mine are poor in areas where there has been extensive extraction as well as in some of the newer areas such as the 118 Zone. Stope stability has been enhanced by reducing the typical stope size, reducing heading size in the mineralized zones, conservative sublevel spacing, and the application of backfill, cemented rock fill and paste fill.

The Life of Mine (LOM) plan includes constant production rate of 4,148 tpd (340 days), achieved by adding open pit material to the mill feed. Open pit mining is feeding the mill since July 2016 and underground mining continues until 2024.

There are Mineral Resources that are not included in the LOM plan as the LOM plan is based solely on Proven and Probable Mineral Reserves.

Mill recovery has averaged 89.1% since the recommencement of operations in 2006 and the 2018 recovery was 87.1%.

### **1.1.1 RECOMMENDATIONS**

The Casa Berardi property continues to have success with definition and exploration drilling programs. Due to recent drilling successes the 2019 open pit long-term plan has significantly improved the LOM of the Casa Berardi Mine compared to 2018. As a result of recent drilling the open pit mineral reserves represent 70% of the total mineral reserves. The main recommendation is to continue surface diamond drilling for open pit mineral reserves, but to emphasize underground drilling to realize the underground potential to increase the grade of the mineral reserves and add more value. Although the underground exploration drilling is a priority for the next years, the open pit mineral reserves are still open along the strike for future extension and extend the life of mine. With fairly consistent yearly mineral reserves replacement, the Casa Berardi Mine can be considered a high-quality asset for Hecla. In addition to diamond drilling, constantly updating the 3D geological model with new data can improve the understanding of the mineralization controls and identify new mineral resources and mineral reserves. Furthermore, collaborative academic research on hydrothermal,

structural, and lithological controls of gold deposition can be very successful to the longer-term development of Casa Berardi.

#### **1.1.1.1 QUALITY CONTROL/QUALITY ASSURANCE PROGRAM – MINE LABORATORY**

The Geology Department at Casa Berardi has developed a set of procedures to build grade standards from sample rejects from the mine. These standards are from a similar host rock as the drill core and should provide improved data for comparison. Casa Berardi will continue to audit external laboratories where this analysis occurs and will constantly review the lab protocols and ensure that inserted blanks and standards are reconciled.

#### **1.1.1.2 METALLURGY**

##### **RECOVERY OF MINERAL TYPES**

Three main groups of minerals are found in the mineralized material at the Casa Berardi Mine; silicates (quartz, albite, muscovite), carbonates (siderite, ankerite and dolomite) and sulphides (pyrite and arsenopyrite with traces of chalcopyrite and pyrrhotite).

There is also gold mineralization found in a graphitic mud rock formation along the Casa Berardi fault plane. The historical recovery data suggest that material classified as “quartz ore” and is dominantly silicates and carbonates have better recoveries than sulphide dominant material, particularly those that contain arsenopyrite. Carbon in graphitic argillite rock at or near the Casa Berardi Fault can be “preg robbing” and influence gold recovery.

##### **GOLD DEPARTMENT IN TAILINGS**

An evaluation with Raman Spectroscopy at the University of Western Ontario indicates that the carbonaceous material of the Casa Berardi Fault is different from carbonaceous material elsewhere in the deposit. The Casa Berardi Fault carbonaceous material is also of higher activity, which can cause preg-robbing if this material is processed with ore. The neighboring graphite fault reports to the mill as dilution in the underground stope. Its concentration varies greatly in the mill feed depending on the magnitude of the dilution from the fault.

Tailings samples from the mill and bottle roll test have been sent to an external laboratory (SGS and URSTM) to quantify the submicroscopic gold content in each carrier mineral. The gold remaining in residue is submicroscopic gold and is predominantly carried by sulphides and iron oxides; mainly attributed to arsenopyrite and pyrite. The

remainder of gold in the residue is generally found in the carbonaceous material. No free gold has been observed under optical microscopy in the residue.

## COMMINUTION

Metallurgical test work was carried out in 2012 by the URSTM laboratory in Rouyn-Noranda on thirteen samples from the 118 and 123 zones. Specific gravity analysis was completed; the values ranged from 2.82 g/cc to 3.16 g/cc with an average of 2.95 g/cc. The Bond Work Index (BWI) was evaluated and is presented in the Table 1-3.

**Table 1-3: Ball Mill Work Index by Underground Zone**

<b>Zone</b>	<b>Ball Mill Work Index (Kw*h/t)</b>
118-06	12.6
118-27	12.2
118-31	13.1
123-02	12
123-04	12.7
123-05	12.1
<b>Average</b>	<b>12.4</b>

SGS Lakefield laboratory performed additional test work to define SAG AXb by the SMC test and ball mill work index (kwh/t) on the main underground zone and East Mine Crown Pillar (EMCP), 134 and 160 pits. Two samples of the SAG feed were also sent for characterization. The results are present in the Table 1-4 with the definition in the database versus other operations in terms of soft, medium or hard ore.

**Table 1-4: Grindability Test Work Done by SGS**

Ore Zones	SAG Mill A X b (SMC test)	Industry Standards	Ball Mill Grindability Index (BMWi kwh/t)	Industry Standards
113	50.7	Medium	12.5	Medium
118-22	40.7	Medium-Hard	9.9	Soft
118-27	38.4	Medium-Hard	12.5	Medium
118-31	46.6	Medium	11.2	Medium-Soft
123-02	40.9	Medium-Hard	9.3	Soft
123-03	41.6	Medium-Hard	11.0	Medium-Soft
123-05	42.4	Medium	11.0	Medium-Soft
124-16	38.3	Medium-Hard	10.9	Medium-Soft
124-22	37.3	Medium-Hard	10.5	Medium-Soft
124-81	35.0	Hard	10.7	Medium-Soft
EMCP	50.5	Medium	12.1	Medium-Soft
	46.7	Medium	12.1	Medium-Soft
	41.9	Medium-Hard	12.9	Medium
Feb 22nd SAG mill feed survey	43.4	Medium	12.0	Medium-Soft
	48.5	Medium		
	44.8	Medium		
Future pit 134				
Ore	41.7	Medium-Hard	12.7	Medium
Ore	48.6	Medium	15.6	Medium-Hard
Ore	36.5	Hard	14.2	Medium
Ore	29.4	Hard	13.4	Medium
Dilution	29.5	Hard	13.6	Medium
Future pit 160				
Ore	35.1	Hard	9.2	Soft
Ore	33.2	Hard	8.3	Soft
Ore	46.0	Medium	8.8	Soft
Dilution	34.8	Hard	8.0	Soft
April 12th SAG mill feed survey				
EMCP plant trial	48.0	Medium	13.0	Medium

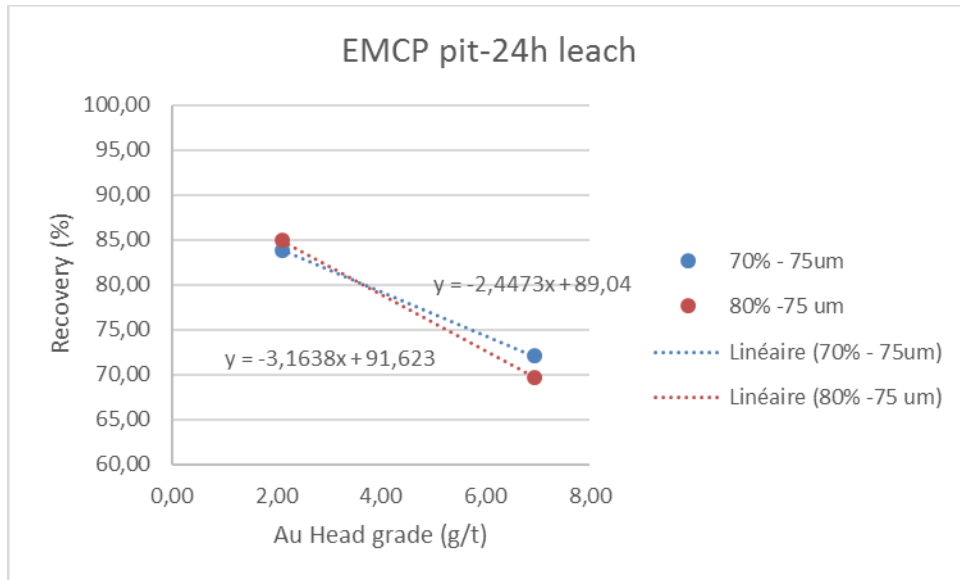
## CYANIDATION

A lot of test work was conducted at three different external laboratories from different zones from the underground and open pit. The three laboratories are the URSTM, FLSmidth and COREM. The representativity of each sample was confirmed by a geologist and the mill metallurgist on site during sampling. Table 1-5 summarizes the results. Ranges are provided when many tests have been conducted on a specific zone. All the cyanidation tests were realized using a carbon in leach method that gives metallurgical results similar to the circuit actually in operation in the mill. This kind of test is mandatory due to the presence of graphitic carbon in almost all mineral resources from the Casa Berardi Mine.

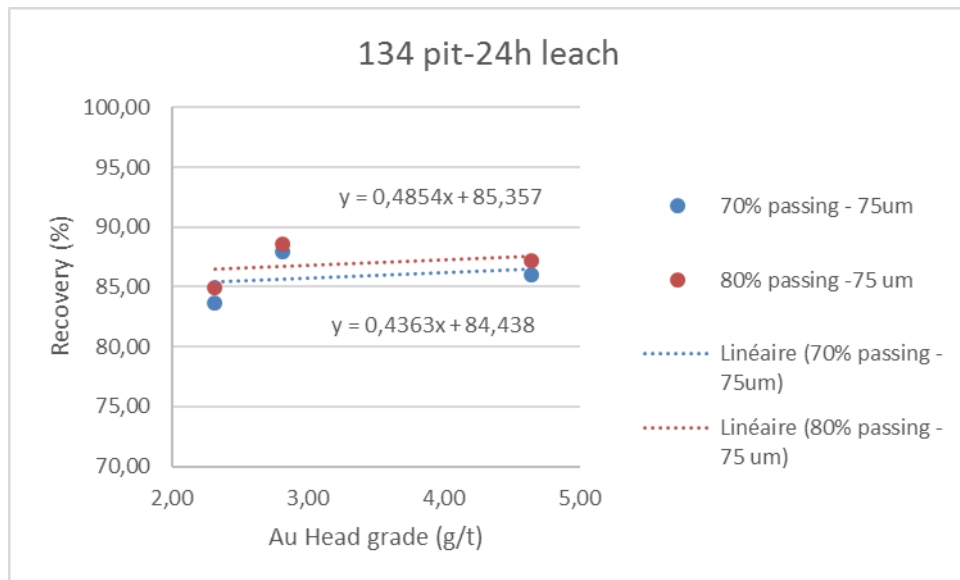
**Table 1-5: Laboratory Test Work Summary**

Zone	Feed Grade (g/t)	Total Recovery (%)	P80 (microns)	Test Work Conducted by
100	8.9	95.3	74	URSTM PU2011-01-581
101	12.0	95.7	70	URSTM PU2011-01-581
103	[6.6 to 14.5]	[89 to 94.5]	80	URSTM PU2011-01-581
109	9.0	92.5	75	URSTM PU2011-01-581
113	9.8	92.2	74	URSTM PU2011-01-581
115	16.6	94.0	91	URSTM PU2011-01-581
118	[4.6 to 8.2]	[74.4 to 92.1]	75	URSTM PU2012-07-731
	[3.9 to 6.2]	[77.6 to 84.2]	[74 to 78]	URSTM PU2011-01-581
	[3.5 to 9.3]	[67.8 to 93.1]	75	FLSmidth P14058AA
123	[4.4 to 10.4]	[70.7 to 82.4]	75	URSTM PU2012-07-731
	6.9	80.3	79	URSTM PU2011-01-581
	[3.9 to 9.8]	[67.8 to 93.1]	75	FLSmidth P14058AA
124	[8.1 to 8.8]	[92.7 to 95.2]	[70 to 79]	URSTM PU2011-06-636
	6.3	91.6	72.0	URSTM PU2008-09-410
160	[1.9 to 3.8]	[87.7 to 91.5]	[72 to 84]	URSTM PU2011-06-636
EMCP pit	5.7	90.0	53	URSTM PU2006-10262
	[2.1 to 7.6]	[70.1 to 94.8]	[51 to 93]	Corem T2211, 48h leach
134 Pit	[2.2 to 4.9]	[76.8 to 90.3]	[48 to 92]	Corem T2211, 48h leach
160 Pit	[2.0 to 6.5]	[82.7 to 94.0]	[66 to 96]	Corem T2211, 48h leach

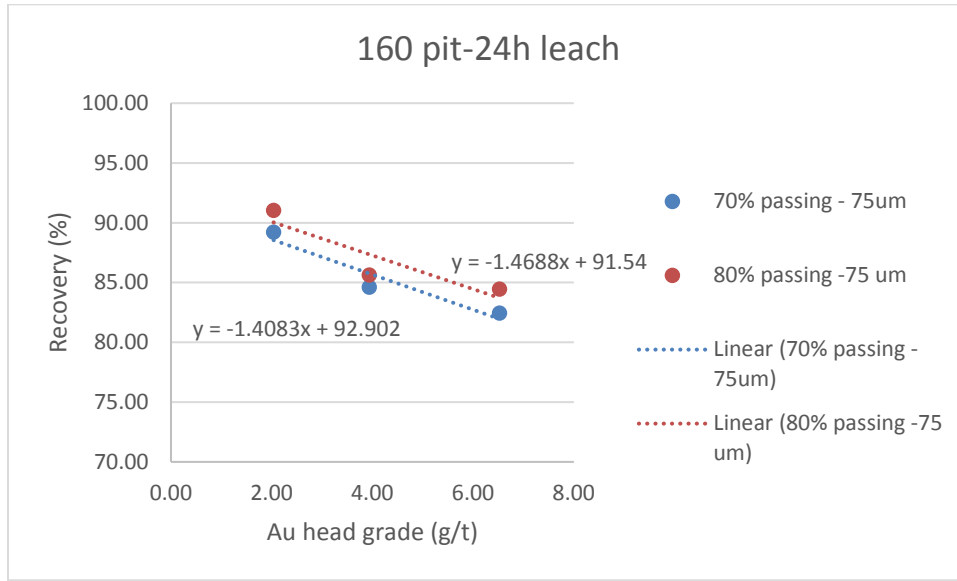
Test work conducted by COREM #T2211 in Québec City on the EMCP 134 and 160 pits with different grinds and head grade had the objective to quantify the gold recovery. The results of 24 hours of leaching are shown in Figure 1.1, Figure 1.2 and Figure 1.3. The regression formula that is used further on in this section for the recovery estimation will be used in mineral reserve calculations is also shown in these figures.



**Figure 1.1: EMCP Pit Test Work, Recovery Modeling**



**Figure 1.2: 134 Pit Test Work, Recovery Modeling**



**Figure 1.3: 160 Pit Test Work, Recovery Modeling**

The recovery models appear in opposition with the typical observation where the recovery increases with grade. There is no clear explanation for this unusual behavior.

### **CYANIDE DESTRUCTION**

One cyanide destruction tank with SO<sub>2</sub>/AIR was restarted with the mill in 2006 and is still in use. However, the 2017 higher throughput at the mill put more pressure on the cyanide destruction circuit. Various cyanide destruction treatment options, including Caro's Acid, SO<sub>2</sub>/AIR and CombinOx® processes, were investigated on a laboratory scale for treatment of slurry effluent samples from the Casa Berardi Mine in Quebec. The mill process water samples were shipped to Cyanco Corporation's laboratory in Sparks, Nevada, in May 2017. The results of SO<sub>2</sub>/AIR testing are shown in Table 1-6. This process remains the most cost-effective treatment in Casa Berardi's case. Adding another tank in the process would support a more stable and flexible operation and should be reviewed for implementation at Casa Berardi.

**Table 1-6: SO<sub>2</sub>/AIR Optimum Results Conducted by Cyanco**

TEST	STREAM	RET'N TIME (hours)	SOLUTION ASSAYS					REAGENT ADDITIONS		
			CN <sub>WAD</sub> (ppm)	*CN <sub>T</sub> (ppm)	Cu (ppm)	Fe (ppm)	pH	SO <sub>2</sub> (g/gCN <sub>WAD</sub> )	Ca(OH) <sub>2</sub> (g/gCN <sub>WAD</sub> )	Cu <sup>2+</sup> (ppm)
	FEED		190.5	200.9	3.95	3.72	11.0			
SO <sub>2</sub> /AIR #7	Treated Slurry	1.0	5.2	13.75	3.06	3.06	8.5	5	1.39	50
	FEED		192.5	205.3	4.51	4.59	10.8			
SO <sub>2</sub> /AIR #8	Treated Slurry	1.0	36.55	49.77	5.21	4.73	8.5	5	1.76	25
	FEED		194.7	219.4	7.95	8.84	11.1			
SO <sub>2</sub> /AIR #9 (Optimum)	Treated Slurry	1.0	7.8	16.72	0.18	3.19	8.5	5.5	2.17	37.5
	FEED		189.8	197.2	4.43	2.69	11.1			
SO <sub>2</sub> /AIR #10	Treated Slurry	0.75	21.5	27.26	16.5	2.06	8.5	5.5	1.62	100
	FEED		198.9	235.8	7.07	13.2	11.0			
SO <sub>2</sub> /AIR #11	Treated Slurry	1.0	26.61	30.55	6.65	1.41	8.1	5.5	-	37.5

\*Calculated Total Cyanide

## 1.1.2 OPERATION DATA

### 1.1.2.1 YEARLY REVIEW

Historic key operation parameters for the last four years of operation are shown in Table 1-7. The throughput has increased regularly during this period following improvement in the process. Availability was lower during 2017 and 2018. This is mainly because longer shutdowns were necessary to implement the improvements.

*Table 1-7: Detailed Yearly Mill Production*

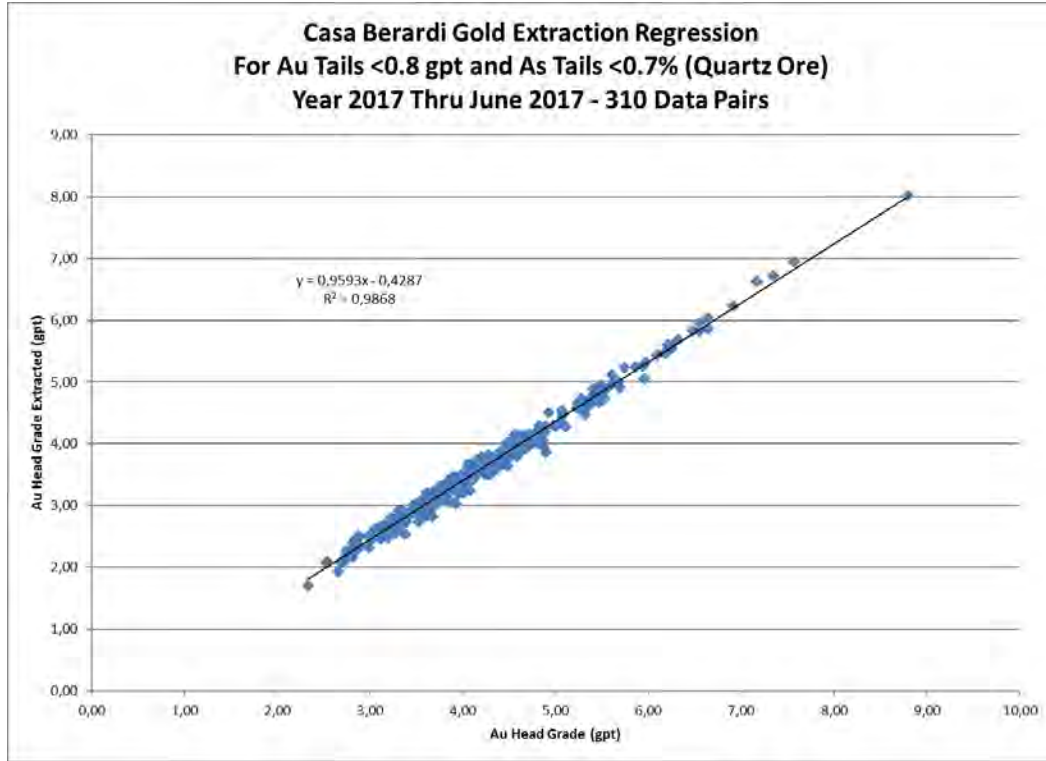
Date	Dry Tonnes Milled (t)	Dry Tonnes / Operating Hour (t/h)	% Passing 200 mesh (%)	Au head Grade (g/t)	Gold Ounces Produced (oz)	Gravimetric Recovery (%)	Total Mill Recovery (%)	Cyanide Consumption (kg/t)	Mill Availability (%)
2015	<b>765,763</b>	95.6	86%	5.96	<b>127,893</b>	35.3%	87.2%	0.82	95.2%
2016	<b>904,998</b>	112.3	84%	5.72	<b>145,973</b>	37.3%	87.7%	0.77	92.8%
2017	<b>1,175,930</b>	153.4	75%	4.77	<b>156,652</b>	37.1%	86.8%	0.67	88.9%
2018	<b>1,248,039</b>	161.0	75%	4.66	<b>162,742</b>	36.5%	87.1%	0.57	89.1%

### 1.1.2.2 HISTORICAL RECOVERY MODEL

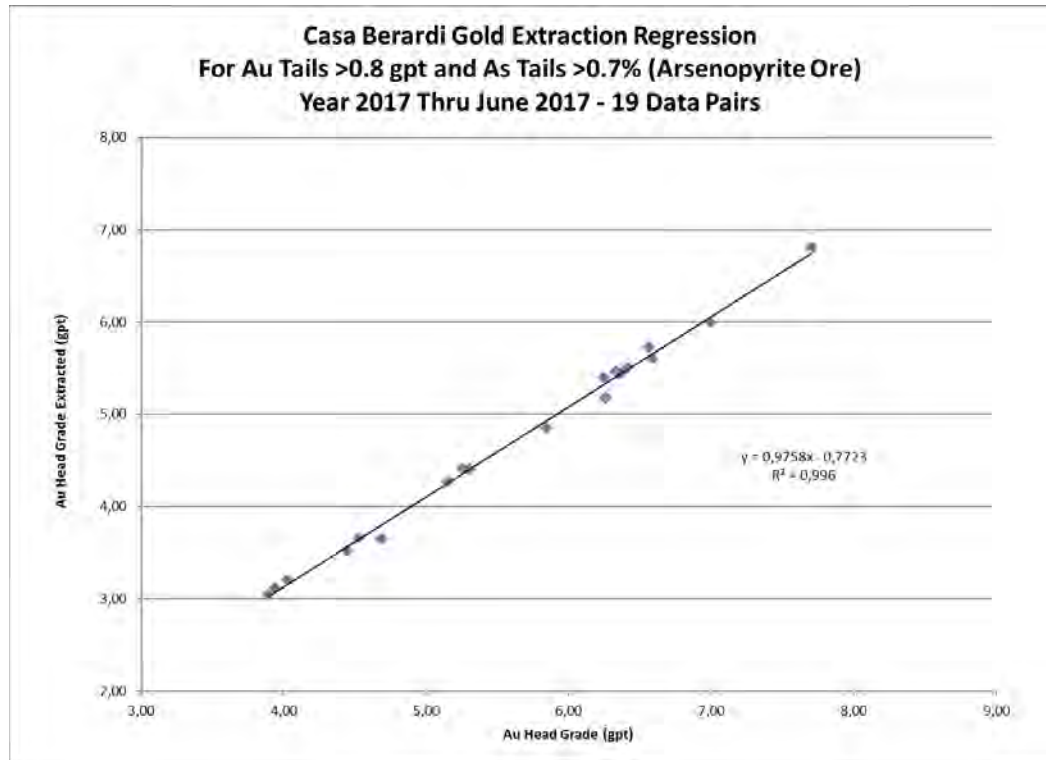
The historical recovery model is used to predict the recovery of the underground ore. Analysis of recovery behavior has demonstrated that two types of mineralization classified as “quartz ore” and “arsenopyrite ore” are clearly different. It has been observed in the plant that the arsenic content of the mineralized material greatly influences the gold recovery. The recovery model of the underground mineral is therefore based on operation periods where the mill was fed with a high underground mineral proportion, from January 2017 to June 2017.

Periods where open pit and underground ores are mixed equally see a dilution of the arsenic grade down to a point where it is very difficult to determine the recovery of the arsenic-bearing zones.

A set of data, where the mill was fed with arsenic mineral type defined as high arsenic content (>0.7 % As) and high tailings (>0.8 g/t), has been selected. The remaining data considered quartz material as another data set. The data sets were adjusted in such a way that the tailings grade has been shifted by 24 h to take into account the residence time in the leaching circuit. Two regressions have been made between the gold grade extracted (g/t) and the gold head grade (g/t) for the two sets of data and are shown on the two different graphics in Figure 1.4 and Figure 1.5. The equation of the regression is the basis of the recovery model.



**Figure 1.4: Quartz Mineral Type Regression**



**Figure 1.5: Arsenopyrite Mineral Type Regression**

### 1.1.2.3 RECOVERY MODELS

#### UNDERGROUND

The historical recovery model gives a good idea of the expected performance in the mill. With the arsenic content measure, it's possible to have a more accurate estimation of the recovery. Two recovery models were obtained and are defined by the following equations:

- Quartz type ore

$$\text{Gold recovery (\%)} = \frac{0.9593 \times \text{Au head grade} - 0.4287}{\text{Au head grade}}$$

- Arsenopyrite type

$$\text{Gold recovery (\%)} = \frac{0.9758 \times \text{Au head grade} - 0.7723}{\text{Au head grade}}$$

The choice to fit which one of the models below to each zone has been approved and verified by the geologist. The data used to compute the model comes from the actual performance of the mill, so it reduces the uncertainty due to variability of the mill feed as the data covers many months of operation. The results obtained from metallurgical testing are therefore not used to predict the recovery for the underground material. Table 1-8 shows which recovery has been applied for each underground zone of the mine plan.

**Table 1-8: Expected Recovery LOM for Underground Zone**

Zone	Expected Recovery (%)	LOM Grade (gt)	Model Used
100	89.93%	7.15	<b>Quartz</b> Model
104	91.54%	9.77	<b>Quartz</b> Model
107	83.27%	3.39	<b>Quartz</b> Model
113	86.79%	4.69	<b>Quartz</b> Model
115	83.85%	3.55	<b>Quartz</b> Model
118	83.03%	5.31	<b>Arsenopyrite</b> Model
121	81.33%	4.75	<b>Arsenopyrite</b> Model
123	84.96%	6.12	<b>Arsenopyrite</b> Model
124	87.65%	5.18	<b>Quartz</b> Model
160	84.81%	3.86	<b>Quartz</b> Model

## OPEN PIT

For the open pits recovery used in the LOM, the data used comes from test work conducted in laboratory.

## EMCP AND EXTENSION PIT

The regression provided in the cyanidation section in Corem's test work, is presented below. The test work was completed on representative samples with different grinds, head grades and with dilution to simulate near a real situation in the pit. We are quite confident the information below will provide a good estimation on the expected recovery in the LOM plan. The model used for the EMCP, is for 70% passing -75 µm and with the mill producing 75% passing -75 µm. The assumption in the recovery is conservative because higher recovery is expected in the mill.

- For 70% passing -75 µm (Coarser)

$$\text{Recovery (\%)} = -2.4473 \times \text{Au Head grade} + 89.04$$

$$\text{Recovery (\%)} \text{ EMCP pit} = 83.7 \% \text{ at } 2.17 \text{ g/t}$$

$$\text{Recovery (\%)} \text{ EMCP pit ext} = 85.8 \% \text{ at } 1.32 \text{ g/t}$$

In addition, after discussion we expect that the actual mill recovery will be 2% higher than 83.7% so 85.7% has been used in the 2019 budget. In the LOM, a conservative 85% for both the EMCP and the EMCP extension has been used.

## 134 PIT

The regression provided in the cyanidation section in Corem's test work is presented below. The test work was completed on representative samples with different grinds, head grades and with dilution to simulate near a real situation in the pit. We are quite confident the information below will provide a good estimation on the expected recovery in the LOM plan.

- For 70% passing -75 µm (Finer)

$$\text{Recovery (\%)} = 0.436 \times \text{Au Head grade} + 84.44$$

$$\text{Recovery (\%)} = 85.26 \% \text{ at } 1.89 \text{ g/t}$$

- For 80% passing -75 µm (Finer)

$$\text{Recovery (\%)} = 0.485 \times \text{Au Head grade} + 85.357$$

$$\text{Recovery (\%)} = 86.27 \% \text{ at } 1.89 \text{ g/t}$$

Both results are in the same range of recovery. Generally, better recovery is expected in the mill versus bottle roll tests. It was therefore decided to use the higher recovery for the 134 Pit; a recovery of 86.2% is used in the LOM plan which is in line with the results of the test work.

### **160 PIT**

The regression provided in the cyanidation section in Corem's test work, is presented below. The test work was completed on representative samples with different grinds, head grades and with dilution to simulate near a real situation in the pit. The information below will provide a good estimation on the expected recovery in the LOM plan and the confidence is appropriate for the precision required.

- For 70% passing -75 µm (Coarser)

$$\text{Recovery (\%)} = -1.4083 \times \text{Au Head grade} + 92.902$$

$$\text{Recovery (\%)} = 90.32 \% \text{ at } 1.83 \text{ g/t}$$

The model uses for the 160 Pit, is for 70% passing -75 µm and with the mill producing 75% passing -75 µm. This size fraction was chosen because it is believed to be more in line with the result expected in the mill with the lower ball mill grindability index. This is a conservative approach.

### **WEST MINE CROWN PILLAR (WMCP) AND PRINCIPAL PITS**

These two open pits are a continuation of underground mineral bodies where gold recoveries are known. With limited information on the recovery for lower-grade ores a conservative approach has been chosen. Geologists confirm that the underground mineralization is similar to the mineral reserve that will be exploited in the open pit. Historical 113 and 124 underground zones have ≈89% of recovery for 5.0 g/t Au head grade. With an expected head grade of 2.4 g/t Au and 2.7 g/t Au for the WMCP and Principal pits, respectively, a

proposed 85% recovery in these pits is a good estimate with the limited information available.

## EXPECTED RECOVERIES

The expected recoveries from the different open pits are presented in Table 1-9 below.

*Table 1-9: Expected Recovery LOM for Open Pit*

Zone	Expected Recovery (%)	LOM Grade (gt)
EMCP - Ext	85.00%	1.32
East Mine Pit - EMCP	85.00%	2.17
134 Pit	86.20%	1.89
160 Pit	90.20%	1.83
West Mine Pit – WMCP	85.00%	2.38
Principal Pit	85.00%	2.65

## 1.1.3 CONCLUSIONS

### 1.1.3.1 MINING

Underground exploration drilling will be focused on the 113, Lower 118, 119, 128, 148 and 160 zones to add new mineral resources. Definition drilling programs to convert mineral resources to mineral reserves in these areas should lead to future underground production.

Several continuous improvement initiatives have been put in place to reduce costs and improve productivity. These initiatives are the telemetry, the electric consumption reduction, the FAM 3 system for jumbo, the automation of the 985 Level.

Recommendations include:

- Continue to pay attention to the mine development progress so that shortfalls in the necessary development are identified and mitigated.
- Finish the rehabilitation of the East Mine and put the infrastructure back in place for production.

### **1.1.3.2 PROCESSING**

The mineral processing at Casa Berardi is based on a classical mill with CIL (carbon in leach) process to recover gold from the ore. This process has been chosen because the mineralized material contains graphitic carbon that has preg-robbing characteristics. The way to lower the effect of preg-robbing is to perform the gold leaching step with the presence of activated carbon as is the case for a CIL circuit.

The mill received ore from the East Mine Crown Pillar (EMCP) open pit from August 2016 to the present. The test work completed on the open pit material was used to estimate the gold recoveries while operating data was used for estimating recoveries of the underground material. A portion of the open pit mineral reserves has no test work. For these parts of the mineral reserve an 85% recovery has been applied based on general historic mill performances. We recommend metallurgical test work on the Principal and WMCP pits to provide indications on the variability of gold recovery and grindability.

LOM projected mill recoveries range from 81.3% to 91.5% for the underground Mineral Reserves and from 85% to 90.2% for the open pit mineral reserves.

### **CRUSHING**

Ore is hauled by truck from the West Mine headframe complex to the crusher dump pocket, which is equipped with a static grizzly and a pneumatic hammer to break any oversize material. Ore passing the grizzly is screened again on the scalping screen. The oversize ore is fed to a jaw crusher and its discharge rejoins the scalping screen undersize. The crushed ore is stored in the ore storage bin.

### **GRINDING**

Ore is conveyed from the storage bin to the semi-autogenous (SAG) mill. The SAG mill feed conveyor is equipped with a scale to monitor and control the ore supply to the SAG mill. Dry quick lime is added from a bin onto the SAG mill feed conveyor for downstream pulp pH control. Mill water is added to the mill feed to pulp the ore. The SAG mill operates in closed circuit with the SAG screen. The SAG mill discharges into the SAG screen pump box and is pumped onto the SAG screen. The SAG screen oversize material is returned to the SAG mill for further reduction and the screen undersize flows to the primary cyclone pump box. The mill feed is sampled on the SAG screen undersize stream.

The ball mill operates in closed circuit with the primary and secondary cyclones. The ball mill discharges in the primary cyclones pump box. The primary cyclone pump box pulp is pumped to the primary cyclone for a first size separation. The totality of the primary cyclone underflow feeds the gravity circuit. The primary cyclone overflow discharges into the secondary cyclone pump box with the gravity concentrator tailings. The secondary cyclones pump box pulp is pumped to the secondary cyclones for the final size separation. The secondary cyclones overflow goes to the trash screen to remove debris and the underflow goes back to the ball mill. The trash screen oversize is sent to the tailings pump and the undersize feeds the production thickener.

### **GRAVITY CIRCUIT**

The gravity circuit feed, coming from the primary cyclone underflow, is split to feed two parallel gravity circuits. Each circuit consists of a vibrating screen and a gravity concentrator. The screen oversize from each circuit reports back to the ball mill and the screen undersize feeds a gravity concentrator. The concentrator's tailings are pumped to the secondary cyclones pump box. The gravity concentrate flows to an intensive cyanidation reactor (Inline Leach Reactor, or ILR) for leaching. To promote gold leaching and control the pH, oxygen peroxide, cyanide and caustic soda are added to the ILR unit from their respective tanks using dosing pumps. The high-grade pregnant gold solution from the ILR unit is pumped to the electrowinning buffer tank and the tailings report to the secondary cyclones pump box.

### **CIL CIRCUIT**

The production thickener is fed with the milled ore pulp coming from the trash screen. Mill water from the thickener overflows in the mill water tank. Process water coming from the tailings pond is added to the mill water tank depending on the demand. The thickener underflow is pumped to the first CIL tank. CIL feed is sampled on the production thickener underflow stream. A carbon-in-leach (CIL) circuit is used to recover gold instead of a carbon-in-pulp (CIP) to hinder preg-robbing due to graphite in the ore and to maximize gold recovery by putting the gold in solution in contact with activated carbon immediately. The circuit comprises seven (7) CIL tanks in series. The pulp overflows from CIL tank #1 to CIL tank #7. To provoke gold leaching, a cyanide solution is added to CIL tank #1 and compressed air is added to each CIL tank. Gold is leached from the ore and adsorbed onto activated carbon. Carbon is added in CIL tank #7 and is pumped periodically in counter-current fashion from CIL tank #7 to CIL tank #1. Screens at the discharge of each CIL tank prevent carbon from

overflowing from tank to tank with the pulp. CIL tank #7 overflows onto a safety screen to recover any fugitive carbon. The safety screen undersize is sampled and goes to the mixing tank. Fine quicklime and copper sulfate are added to the mixing tank to prepare for cyanide destruction. Pulp from the mixing tank is pumped to the cyanide destruction tank in which sulphur dioxide and compressed air is added to destroy residual cyanide with agitation. The pulp is then pumped to the paste backfill plant or the tailings pond. Ferric sulfate is also added to this pump in order to reduce arsenic content in the solution.

## **CARBON CIRCUIT**

The carbon, elution and electrowinning circuits operate in batches unlike the CIL continuous process. Loaded carbon is pumped periodically from CIL tank #1 onto a washing screen. Loaded carbon from the washing screen falls into the loaded carbon tank while the pulp and residual cyanide solution return to CIL tank #1 or #2. When carbon collection is completed, loaded carbon is transferred to the acid washing tank. Hydrochloric acid is added in the acid washing tank and carbon is soaking for two hours to remove inorganic contaminants. When the acid wash is completed, the loaded carbon is rinsed with process water to return to a neutral pH before being transferred to the elution vessel. After elution, eluted carbon is screened and sent either to the calibrated carbon tank or the regenerating kiln. The calibration screen undersize is sent to the carbon fines thickener where flocculant is added. Carbon fines are recovered at the underflow, filtered using a filter press and bagged. At the regenerating kiln, the carbon is heated to burn organic contaminants. The kiln discharges in a quench tank and carbon is pumped back onto the calibration screen. Calibrated carbon is pumped back into CIL tank #7 from the calibrated carbon tank. Fresh carbon is also added to the CIL circuit using the calibration screen after being quenched in an attrition tank. Carbon moves in the circuit using a water eductors system.

## **ELUTION AND ELECTROWINNING CIRCUITS**

The elution circuit uses the ZADRA process. Caustic soda and cyanide are added to process water in the barren solution tank to prepare for elution. The barren solution is pumped through a heat exchanger and a water heater before arriving at the bottom of the elution vessel. Under the right pressure and temperatures conditions in the elution vessel, gold desorbs from the loaded carbon and dissolves in the elution solution. The pregnant solution flows out from the top of the elution vessel through the heat exchanger and cooling battery toward the electrowinning cells. The heat exchanger recovers heat from the pregnant solution to warm

up the barren solution. The cooling battery completes the pregnant solution cooling to a safe temperature and pressure for electrowinning using process water at an ambient temperature. Two (2) electrowinning cells recover dissolved gold from the pregnant solution by deposition on its cathodes plates to form a gold sludge. Barren elution solution is pumped from the electrowinning cells to the barren solution tank. During an elution cycle, elution solution flows continuously through the circuit. A third electrowinning cell, in loop with the ILR buffer tank, is dedicated to the ILR gold solution. When an elution cycle is over, gold sludge is recovered from the electrowinning cells, filtered and dried before being smelted in the induction furnace and poured into gold dorés at the gold room.

Since year 2015 a lot of effort and modifications have been completed in the actual mill in order to be able to process a higher throughput. A non-exhaustive list of improvements includes:

- Installed a remote rock breaker before the crusher, January 2017.
- New NKM screen in carbon in leach tanks, February 2017.
- New flocculant batching system, April 2017.
- Reduced the opening of ball mill discharge screw to increase ball charge, April 2017.
- Changed the SAG steel ball size from 100 mm to 125 mm, April 2017.
- Changed the design of the Sag shell liners and lifters, May 2017.
- Changed the type of the feedwell on the thickener, August 2017.
- Changed the ball mill balls addition to decrease the average balls diameter, September 2017.
- Added a static screen on the carbon in leach to improve the flow capacity of this circuit, September 2017.
- Changed the piping on process water to increase the capacity, November 2017.
- Changed the design of the SAG Mill pulp lifter, May 2018.
- Changed pumps' size in grinding circuit, November 2018.
- Changed the ball mill pinion to increase mill power draw, December 2018.
- Installed a new crusher with higher capacity, December 2018.
- Gradually increased the SAG Mill grate discharge area from 3.1% in November 2016 to 4.0%, December 2018.

These changes have been implemented gradually with the last modification performed at the end of year 2018. With these changes, the mill throughput increased regularly from 2015 to 2018.

As the last changes only occurred at the end of 2018, the entire benefits of these changes will appear from the year 2019.

One last change is projected in 2019, the installation of a new cyanide destruction tank. The actual tank does not prevent the throughput being increased to the projected value for 2019. However, the cyanide destruction process will be more difficult to run as the residence time in the tanks will fall below the recommended value for effective process.

## **THROUGHPUT**

The projected yearly throughput for the mine plan is higher than what has been achieved for 2018. However, some tests were made and the hourly throughput necessary to reach the target has recently been reached for complete days. This is proof that all the equipment in the mill is able to handle such a throughput. With the last changes implemented at the end of 2018, all the remaining mill bottlenecks have been addressed in such a way that projected throughput could be reached in the second quarter of 2019 on a steady base.

## **RISK AND OPPORTUNITY**

During mill operation, it has been observed that the material coming from the open pit contains a smaller proportion of material smaller than 13 mm. Such a condition may impact the capacity of the grinding circuit. However, with all the modifications that have been implemented, there is room for improvement with the actual equipment in place. The risk to see the performances of the mill significantly impacted remains acceptable for the actual mine plan.

## **PROCESSING CONCLUSION**

The mill will be able to process the projected throughput since many improvements have been implemented during the last three years. The ability of the mill to achieve the recovery of all available gold, as predicted by testing has been demonstrated. However, the risk associated with the prediction of available gold identified in Section 13 remains. All the operation parameters, other than the throughput, must remain in the current range.

### **1.1.3.3 PRODUCTION OPTIMIZATION**

Make a request to amend the certificate of authorization and make the necessary modifications to the mill to increase the capacity to 1.6 million milled tonnes per year.

### **1.1.3.4 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS**

The Casa Berardi Mine is in operation and holds a number of authorizations and permits for the various aspects of the operation. Numerous environmental study and characterizations have been carried out to allow the expansion of surface infrastructure and more will have to be completed.

Hecla Québec is committed to operating in compliance with all regulations and standards of good practice for environmental, health and safety and social considerations.

The Mine is planning to obtain other permits, authorizations, approvals and leases for various components of the overall project development work, as required. These applications will be submitted as part of the ongoing process of developing the site and should therefore not impact the project critical path schedule.

Reclamation costs for the project and the LOM plan were evaluated at \$22 million. Actual closure cost estimates for the Casa Berardi Mine is \$16 million with the current infrastructure and existing operations and there is a bond (financial guarantee) in place for this amount.

Hecla has good relations with the local communities and the various stakeholders in the region. To maintain this relationship there is constant consultation with the communities. Since January 2019, Hecla Québec has set up a liaison committee composed of stakeholders from a variety of areas, including municipal, aboriginal, economic, environmental and educational communities. The committee meets quarterly and allows Hecla to keep the committee informed of future projects, while allowing stakeholders to share their views and concerns.

## **1.2 TECHNICAL SUMMARY**

### **PROPERTY DESCRIPTION AND LOCATION**

The Casa Berardi property is located in the Province of Quebec, approximately 95 km north of the town of La Sarre, in the James Bay Municipality. The mine site is located at longitude 79° 16' 46.4" and latitude 49° 33' 56.7".

## LAND TENURE

The property is composed of 339 contiguous designated claims, covering a total area of 17,188.17 ha, and two mining leases, BM 768 and BM 833, covering areas of 397.09 ha and 84.35 ha, respectively. The property area totals 17,669.61.04 ha. Other legal titles include non-exclusive lease BNE 25938 and BNE 45892 for sand and gravel pit. Tailings lease 70218 and two waste dump leases 192410 and 819410. Legal titles are under the name of Hecla Québec.

The Casa Berardi claims are in good standing.

## INFRASTRUCTURE

The surface and underground infrastructure at the East Mine includes the following:

- A nominal 3,836 tpd mill, with the ability to process 4,100 tpd.
- Tailing storage facility with four tailings cells, a polishing pond, a sedimentation pond for settling iron arsenate precipitates, and a process water pond.
- Two-story administrative building with offices, warehouse, dry, laboratory, two heavy equipment maintenance garage, millwright shop, and electrical shop.
- Two core shacks.
- Water pumping station.
- Hoistroom, a headframe, and a 380 m deep shaft (with no hoist).
- Mine access decline and a series of ramp-connected levels.
- Three petrol tanks with pump gas and fuel.
- One mineral stockpile.
- One waste and till-clay pile.

Existing surface and underground infrastructure at the West Mine include the following:

- Backfill plant, including a compressor room and a ventilation raise intake.
- Settling ponds.
- Pumping station.
- A 380 m<sup>2</sup> garage.
- Two dry houses with offices.
- Emergency building for mine rescue and infirmary.

- Warehouse.
- Core storage area.
- Gatehouse.
- Mine access decline providing access to the West Mine and Principal area.
- Hoistroom, headframe, and mine shaft to the 1080 level.
- A 125 tonnes per hour paste backfill plant and a cement plant with tailings feed line from the mill and distribution holes to the underground.
- Mine ventilation fans and mine air heater with ventilation raise to the mine workings.
- One waste rock pile and one ore rock pile.

There is no additional surface infrastructure related to the Principal Mine. A five-kilometre track drift joins the East and West mines and provides access to the Principal Mine at the 280 m level.

The power supply of the site is provided by a 55 km, 120 kV power line, from the town of Normétal.

## **HISTORY**

Before 1974, the Casa Berardi area was explored for base metal deposits. In 1974, the first 13 claims were staked by Inco Gold. The discovery hole was drilled in 1981, and 590 additional claims were staked.

Inco Gold and Golden Knight Resources Inc. (Golden Knight) formed a joint venture to operate the mine. September 12, 1988 marked the official opening of the East Mine, and the commercial production of the West Mine began in 1990. In 1991, TVX Gold Inc. (TVX) acquired Inco Gold's 60% interest in the mine. In 1994, TVX and Golden Knight purchased the remaining interest in the Domex claim block, a part of the Principal (Main) Zone between the West Mine and East Mine, from Teck Corporation. In January 1997, TVX announced the closure of the East Mine due to ground control problems. Two months later, the West Mine was closed. The total combined production for the period from 1988 to 1997 was 3.5 million tonnes at an average grade of 7.1 g/t Au. The total gold recovered during the operating years was 688,400 ounces, with a mill gold recovery rate averaging 87%.

In September 1998, Aurizon signed an agreement and completed the acquisition of all Casa Berardi assets and mining rights.

Aurizon completed exploration diamond drilling programs, feasibility studies, underground development, shaft sinking, and construction.

In early November 2006, Aurizon completed construction and development at the West Mine area and commenced underground mining and milling operations. From November 2006 to May 31, 2013, Aurizon production totaled 4,310,474 tonnes at an average grade of 7.7 g/t Au for a total of 980,548 Au ounces recovered. Commercial production was achieved as of May 1, 2007.

In June 2013, Hecla acquired Aurizon and the company was renamed Hecla Québec, a 100% subsidiary of Hecla. From 2012 to the end of 2016, the Casa Berardi Regional exploration was still under a Joint Venture between Lake Shore Gold and Hecla. In February 2016, Tahoe Resources Inc. purchased Lake Shore Gold, and at the end of 2016, Hecla Mining bought back the Tahoe's 50% interest in exchange of CAN\$5 million and 1% NSR on 227 claims.

From November 2006 to May 31, 2013, Aurizon production totaled 4,310,474 tonnes at an average grade of 7.71 g/t Au for a total of 980,548 Au ounces recovered. From June 1, 2013 to December 31, 2018, Hecla Québec's production totaled 5,197,143 tonnes at an average grade of 5.34 g/t Au for a total gold output of 784,033 ounces. Table 1-10 lists Casa Berardi annual production by year.

**Table 1-10: Casa Berardi Mine Annual Production**

Company	Year	Tonnes Milled	Grade (g/t Au)	Gold oz Contained	Gold oz Recovered	Gold Mill %Recovery
<b>INCO - TVX</b>	<b>1988 - 1997</b>	<b>3,503,367</b>	<b>7.10</b>	<b>791,292</b>	<b>688,424</b>	<b>87.0%</b>
<b>AURIZON</b>	Nov 2006	68,481	8.58	18,891	17,731	93.9%
	2007	545,259	9.78	171,416	159,469	93.0%
	2008	654,398	8.16	171,628	158,830	92.5%
	2009	688,677	7.77	172,013	159,261	92.6%
	2010	722,746	6.76	157,134	141,116	89.8%
	2011	698,123	8.00	179,462	163,845	91.3%
	2012	693,859	6.77	151,059	136,848	90.6%
	May 2013	238,931	6.17	47,394	43,447	91.7%
	<b>Total</b>	<b>4,310,474</b>	<b>7.71</b>	<b>1,068,996</b>	<b>980,548</b>	<b>91.7%</b>
<b>HECLA</b>	June 2013	351,636	6.16	69,652	62,532	89.8%
	2014	750,778	5.90	142,443	128,241	90.0%
	2015	765,763	5.96	146,733	127,893	87.2%
	2016	904,998	5.72	166,499	145,973	87.7%
	2017	1,175,930	4.77	180,373	156,652	86.8%
	2018	1,248,039	4.66	186,844	162,742	87.1%
	<b>Total</b>	<b>5,197,143</b>	<b>5.34</b>	<b>892,545</b>	<b>784,033</b>	<b>87.8%</b>
<b>TOTAL 2006 - 2018</b>		<b>9,507,617</b>	<b>6.42</b>	<b>1,961,541</b>	<b>1,764,581</b>	<b>90.0%</b>
<b>TOTAL 1988 - 2018</b>		<b>13,010,984</b>	<b>6.58</b>	<b>2,752,833</b>	<b>2,453,005</b>	<b>89.1%</b>

Since 1998, a total of 13,010,984 tonnes at an average grade of 6.58 g/t Au have been milled at Casa Berardi for a total gold output of 2,453,005 gold ounces and an average gold recovery of 89.1%.

## GEOLOGY

The Mine is located in the northern part of the Abitibi Subprovince, a subdivision of the Superior Province, the Archean core of the Canadian Shield. The mine area is included in the Harricana-Turgeon Belt, which is part of the North Volcanic Zone.

The regional geology is characterized by a mixed assemblage of mafic volcanic rocks, flysch-type sedimentary iron formations, and graphitic mudrocks that are limited by a large granodioritic to granitic batholith. Structurally, the property is enclosed in the Casa Berardi Tectonic Zone, a 15 km wide corridor that can be traced over 200 km. A network of predominantly east-west ductile high strain or shear zones mainly follow the lithological contacts.

The Casa Berardi Fault is defined by a stratigraphic contact between a graphite-rich sediment sequence at the base of the Taïbi domain, a northern continuous intermediary fragmental volcanic unit, and a southern polymictic conglomerate unit. On the north side of the fault, a thick sequence of very homogeneous wacke belonging to the Taïbi Group is affected by amphibolite grade metamorphism. One kilometre further north is the easterly elongated Recher Batholith, which is part of the northwestern boundary of the Abitibi greenstone belt.

The Casa Berardi Fault strikes east-west and dips 80° to the south. Inside the fault or deformation zone, ductile deformation intensity is heterogeneous. Kinematic indicators observed inside the main foliation, combined with the foliation dip pattern, indicate a possible south-verging thrust movement.

The mineralization system is composed of large, low-sulphide quartz veins and stockworks, and carbonate-mica replacement zones forming a continuous network following the folded pattern of the deformation zones. Each mineralized zone consists of a stacking of plurimetric lenses which are conformable with lithological contacts of foliation planes. Drag fold hinges with steeply plunging elongated axes are a major control on mineralization as they create favourable sites for quartz vein formation. Main vein systems are surrounded by quartz veinlet stockwork mostly developed in strongly carbonate and sericite altered host rocks.

In general, gold occurs as free particles up to a few tens of micrometres in size and as grains attached to or locked in sulphides, including pyrite and arsenopyrite in various proportions depending on the mineralized area.

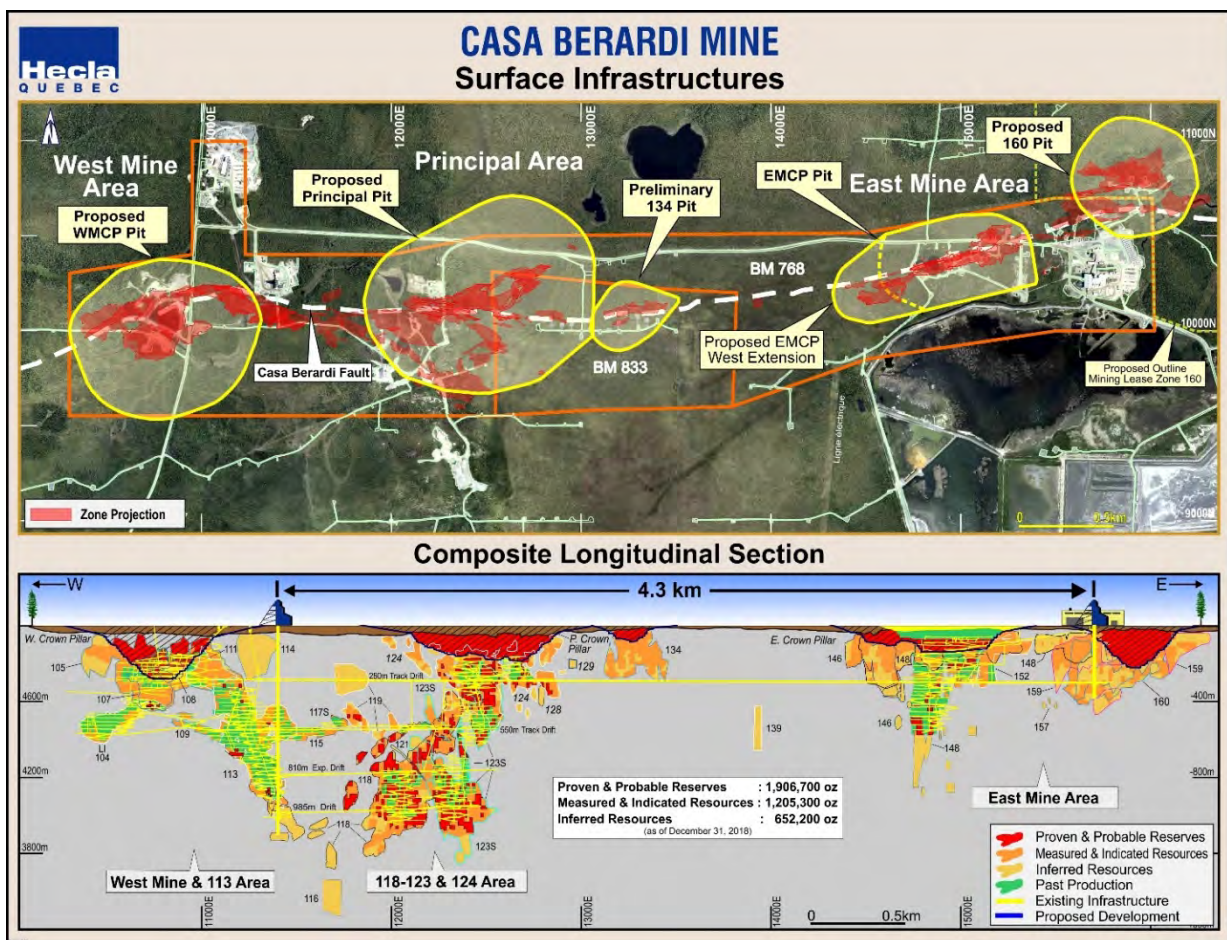
The Casa Berardi gold deposit can be classified as an Archean age, sedimentary-hosted lode gold deposit. Gold mainly occurs south of the Casa Berardi Fault, and sometimes is found on both sides of the fault.

## **MINERAL RESOURCE ESTIMATES**

Mineral Resources take into account the density of drill hole data, geologic, mining, processing and economic constraints, and have been defined within a conceptual stope design, and

therefore are classified in accordance with the 2014 CIM Definition Standards for Mineral Resources and Mineral Reserves and the 2003 CIM Best Practice Guidelines.

The classification of Mineral Resources is guided by the drill hole spacing, which ranges from 15 m to 50 m, by the ranges of variograms, which are between 10 m and 50 m, and by the distance of drill hole composites to block center. The Mineral Resource estimates for the different mineralized zones at Casa Berardi (Figure 1.6) have been carried out using block model grade interpolation techniques.



**Figure 1.6: Casa Berardi Mine Plan View and Composite Longitudinal Section**

### MINERAL RESERVE ESTIMATES

Underground Mineral Reserves are estimated for the Lower Inter, 113, 118, 119, 121,123, 124 zones, parts of the East Mine, as well as, for several smaller zones. Open Pit Mineral Reserves are estimated for the West Mine Crown Pillar, Principal Pit, 134 Pit, East Mine

Crown Pillar Pit, East Mine Crown Pillar Pit Extension and 160 Pit.

Mineral Reserves are classified based on the conversion of Measured Mineral Resources to Proven Mineral Reserves and Indicated Mineral Resources to Probable Mineral Reserves. Inferred Mineral Resources are not used in the Mineral Reserve estimation. Mineral Reserves by zone are presented in Table 1-11.

**Table 1-11: Mineral Reserves by Zone – December 31, 2018**

Zone	Tonnes	Grade (g/t Au)	Contained Ounces
<b>Underground - Proven</b>			
Lower Inter	13,900	7.1	3,200
113	29,900	5.1	4,900
118	215,300	5.2	36,000
123	261,000	4.9	41,000
124	72,900	4.3	10,100
East Mine UG	147,000	6.3	29,900
<b>Total Underground - Proven</b>	<b>739,900</b>	<b>5.3</b>	<b>125,000</b>
<b>Underground - Probable</b>			
Lower Inter	3,900	5.3	0,700
113	23,100	4.1	3,100
118	1,120,100	5.0	180,000
119	35,900	5.6	6,400
121	53,200	4.5	7,700
123	793,400	5.6	141,500
124	473,200	5.3	80,400
East Mine UG	85,400	8.1	22,200
<b>Total Underground - Probable</b>	<b>2,588,300</b>	<b>5.3</b>	<b>442,000</b>
<b>Total Underground Proven + Probable</b>	<b>3,328,300</b>	<b>5.3</b>	<b>567,000</b>
<b>Open Pit - Proven</b>			
West Mine Pit - WMCP	4,470,500	2.5	357,100
East Mine Pit - EMCP	775,400	2.3	56,900
Principal Pit	173,800	4.4	24,400
<b>Total Open Pit - Proven</b>	<b>5,419,700</b>	<b>2.5</b>	<b>438,400</b>
<b>Open Pit - Probable</b>			
West Mine Pit - WMCP	1,312,100	2.0	85,800
EMCP - Extension	777,900	1.3	33,000
East Mine Pit - EMCP	358,500	1.9	22,300
Principal Pit	6,073,800	2.6	507,700
134 Pit	411,900	1.9	25,000
160 Pit	3,857,600	1.8	227,500
<b>Total Open Pit - Probable</b>	<b>12,791,800</b>	<b>2.2</b>	<b>901,300</b>
<b>Total Open Pit Proven + Probable</b>	<b>18,211,500</b>	<b>2.3</b>	<b>1,339,700</b>

Zone	Tonnes	Grade (g/t Au)	Contained Ounces
<b>Grand Total</b>			
<b>Proven</b>	<b>6,159,600</b>	<b>2.8</b>	<b>563,400</b>
<b>Probable</b>	<b>15,380,100</b>	<b>2.7</b>	<b>1,343,300</b>
<b>Proven + Probable</b>	<b>21,539,700</b>	<b>2.8</b>	<b>1,906,700</b>

Notes:

1. CIM definitions were followed for Mineral Reserves.
2. Underground Mineral Reserves were estimated by Hecla Québec.
3. Open Pit Mineral Reserves were estimated by MDA.
4. Mineral Reserves are estimated at a cut-off grade of 3.5 g/t Au for 113, 124, and 148 zones. A cut-off grade of 3.6 g/t Au for the 123 Zone. A cut-off grade of 3.7 g/t Au for the 118 Zone, and a cut-off grade of 3.8 g/t Au for the 121 Zone. A cut-off grade of 0.67 g/t Au for all the pits have been used.
5. Underground Mineral Reserves are estimated using an average long-term gold price of US\$1,200 per ounce and a US\$/C\$ exchange rate of 1.33.
6. A minimum mining width of 3 m was used.
7. Totals may not represent the sum of the parts due to rounding.

Underground Mineral Reserves were estimated based on a longhole stoping mining method without pillars, using a primary-secondary stoping sequence. However, in the East Mine a few stopes will be mined using a cut and fill mining method. All stopes are backfilled after mining using paste fill, cemented rock fill, or unconsolidated waste rock. Tonnes and grades were calculated for each stope, including development inside the stope outline. Estimated underground dilution averages 35% and the average underground extraction is estimated to be 94.5%.

Since 2013, the number of open pit projects has grown from two to six, with the addition of the East Mine Crown Pillar Extension, the 134 Pit, the 160 Pit, and the West Mine Crown Pillar. It is also worth mentioning that the Principal Pit project has grown to more than twice its original size.

East Mine Crown Pillar (EMCP) open pit has been in operation since February of 2016. The Mineral Reserves are contained in the crown pillar left behind by previous underground mining. Open pit optimization and detailed design were updated in March 2017 by BBA. A dilution factor of 30% was applied to open pit mineralization within the pit design. The remaining material to be moved in 2019 is 7,310,293 tonnes total, which includes 1,133,193 tonnes of ore for an overall strip ratio of 5.45:1.

The EMCP expansion project is basically a pushback of the EMCP pit toward the southwest. The mineral reserves contained area are also a crown pillar except there has never been any

underground mining in this area. Consequently, no underground infrastructures are expected to be intercepted and the block model was diluted as internal dilution (12%). Engineering at Casa Berardi then proceeded to add 15% external dilution and a mining recovery of 95%. The Mineral Reserves of the EMCP Pit were based on a cut-off grade of 0.67 g/t Au.

The 134 Zone Pit is situated south-east of the Principal Pit and west of the EMCP Pit. Underground operations haven't mined directly under the proposed pit, so no underground infrastructure is expected to daylight inside the pit design. The block model has an internal dilution factor of 12%, to which Engineering added a 15% external dilution factor and a mining recovery of 95%.

The 160 Zone Pit has the same cutoff grade, dilution and mining recovery factor as the 134 Pit. Here again, no underground infrastructures will be intercepted.

The WMCP Pit project has the same cutoff grade, dilution and mineral recovery factor as the 134 and 160 zone pits. Here, however, we do expect to intercept underground openings in the walls and the pit floor. The pit was designed with some conservative assumptions because of a lack of geotechnical information. Plans are in place to do a geotechnical drilling campaign in order to provide Engineering with the data required to complete slope and waste dump design.

The Mineral Reserves for the Principal Mine Pit were prepared by MDA and presented in a Mining Study completed in January of 2019. The Mineral Reserve estimates included a dilution factor of 0% at zero grade, which was then diluted by Hecla Engineering by 27% and factored by a mining recovery of 95%. The Mineral Reserves were based on a cut-off grade of 0.67 g/t Au.

### **TONNAGE AND GRADE RECONCILIATION: MINERAL RESERVES VERSUS MILL**

Tonnage and grade reconciliation between Mineral Reserves, mine plans and mill production were carried out by Casa Berardi on a stope by stope basis with a monthly and annual compilations. The annual results for 2006 to 2018 are presented in Table 1-12. Tonnes, grades, and gold ounces of block model estimates as well as final design plans are compared to mill production. The comparisons between the mill production and Mineral Reserves relative to mill production and planned mining are shown in Table 1-13. On an annual basis, the variance between the mill production and the Mineral Reserves and the planning, considering

tonnage, grade and contained gold, are very constant with 50 of the 96 data points within  $\pm 5\%$ .

**Table 1-12: Mine-Mill Reconciliation - 2006-2018**

Year	Mineral Reserves			Planned Reserves			Mill		
	Tonnes (000)	Grade Au g/t	Oz (000)	Tonnes (000)	Grade Au g/t	Oz (000)	Tonnes (000)	Grade Au g/t	Oz (000)
2018 PIT	498.1	2.2	35.6	521.6	2.0	33.9	570.1	2.0	36.4
2018 U/G	715.6	6.7	153.6	666.9	6.5	138.4	678.1	6.9	150.4
2017 PIT	365.9	2.8	33.0	463.8	2.8	41.8	468.2	2.9	44.0
2017 U/G	626.8	6.5	130.0	679.8	6.0	131.3	707.7	6.0	136.3
2016 PIT	94.5	2.5	7.6	132.8	2.6	11.1	132.7	2.3	9.7
2016 U/G	676.0	6.0	130.0	717.7	6.1	139.6	772.3	6.3	156.8
2015 U/G	701.6	6.0	136.1	736.7	5.9	139.1	765.8	6.0	146.7
2014 U/G	653.9	6.6	138.6	725.2	5.9	138.2	750.8	5.9	142.4
2013 U/G	571.2	6.3	115.0	583.0	5.8	108.7	590.6	6.2	117.0
2012 U/G	632.2	7.8	157.5	685.5	6.7	148.2	693.9	6.8	151.1
2011 U/G	735.1	8.0	188.2	726.9	7.5	175.3	698.1	8.0	179.5
2010 U/G	683.4	6.8	150.0	670.4	6.7	144.2	722.7	6.8	157.1
2009 U/G	719.6	7.5	173.7	684.6	7.1	155.4	688.7	7.8	172.0
2008 U/G	662.1	8.5	181.7	706.7	8.1	183.0	654.4	8.2	171.6
2007 U/G	548.1	10.4	183.4	579.5	10.2	190.2	545.3	9.8	171.4
2006 U/G	64.0	9.2	18.9	66.6	8.9	19.0	68.5	8.6	18.9
<b>Total</b>	<b>8,948.2</b>	<b>6.7</b>	<b>1,933.0</b>	<b>9,347.7</b>	<b>6.3</b>	<b>1,897.3</b>	<b>9,507.6</b>	<b>6.4</b>	<b>1,961.6</b>

**Table 1-13: Mine-Mill Reconciliation - 2006-2018**

Year	Mill vs. Planned Reserve			Mill vs. Mineral Reserve		
	Tonnes	Grade	Oz	Tonnes	Grade	Oz
2018 PIT	114%	90%	102%	109%	98%	107%
2018 U/G	94%	104%	98%	102%	108%	110%
2017 PIT	128%	104%	133%	101%	104%	105%
2017 U/G	115%	92%	106%	105%	100%	104%
2016 PIT	140%	90%	127%	100%	87%	87%
2016 U/G	117%	106%	124%	109%	105%	114%
2015 U/G	112%	98%	110%	105%	102%	107%
2014 U/G	118%	87%	103%	104%	99%	104%
2013 U/G	103%	98%	102%	101%	106%	108%
2012 U/G	110%	87%	96%	101%	101%	102%
2011 U/G	95%	100%	95%	96%	107%	102%
2010 U/G	106%	99%	105%	108%	101%	109%
2009 U/G	96%	103%	99%	101%	110%	111%
2008 U/G	99%	96%	94%	93%	101%	94%

Year	Mill vs. Planned Reserve			Mill vs. Mineral Reserve		
	Tonnes	Grade	Oz	Tonnes	Grade	Oz
2007 U/G	99%	94%	93%	94%	96%	90%
2006 U/G	107%	94%	100%	103%	96%	99%
<b>Total</b>	<b>106%</b>	<b>96%</b>	<b>101%</b>	<b>102%</b>	<b>102%</b>	<b>103%</b>

## LIFE OF MINE PLAN

Hecla Québec generated a Life of Mine (LOM) plan in February 2019 based solely on the Mineral Reserves for this Technical Report. The LOM plan totals 21.8 million tonnes of ore grading 2.74 g/t Au, to be mined over approximately fifteen years (2019 to 2034).

A summary of the LOM production forecast plan is provided in Table 1-14. This information is averaged and presented for two periods: (1) 2019 to 2023 and (2) 2019 to 2034. From 2019 to 2024, the production will combine underground and open pit operations. Beyond 2024, the production will be exclusively from open pit operations.

*Table 1-14: LOM Production Forecast*

Period	Underground			Open Pit			Total		
	Au oz			Au oz			Au oz		
	Tonnes (000)	Au g/t	Recovered (000)	Tonnes (000)	Au g/t	Recovered (000)	Tonnes (000)	Au g/t	Recovered (000)
<b>5 Year Average (2019-2023)</b>	<b>608</b>	<b>5.35</b>	<b>88.7</b>	<b>792</b>	<b>1.91</b>	<b>42.4</b>	<b>1,400</b>	<b>3.40</b>	<b>131.1</b>
<b>LOM Average (2019-2034)</b>	<b>555</b>	<b>5.30</b>	<b>80.1</b>	<b>1,151</b>	<b>2.28</b>	<b>72.3</b>	<b>1,359</b>	<b>2.74</b>	<b>102.4</b>

In addition to the LOM plan, which is based solely on the Mineral Reserves, Hecla Québec maintains a long-term plan (LTP) which includes the conversion of Mineral Resources to Mineral Reserves in addition to the current Mineral Reserves. The LTP is an internal Hecla document that is used for longer-term planning.

## CAPITAL COST ESTIMATES

Casa Berardi uses the LOM as its planning guide for the operation. The LOM capital costs total \$398 million, summarized in Table 1-15, and include mine development (contractor and company), mine infrastructure, open pit costs, equipment costs, plant expansion, and tailings management.

**Table 1-15: LOM Capital Costs**

Period	Open Pit	Underground	Total
	(\$000)	(\$000)	(\$000)
Five Year Annual Average (2019-2023)	22,144	21,832	43,976
LOM (2019-2034)	294,524	103,678	398,202

## OPERATING COSTS

The 2018 actual and budget operating costs and the 2019 budget operating cost estimate are shown in Table 1-16. Production in 2018 was higher than the 2018 Budget; however, and the total and unit operating costs were also higher than budget.

**Table 1-16: Unit Operating Costs**

Item	Units	2018 Actual	2018 Budget	2019 Budget
Underground Mining	\$/t milled	136.8	144.7	133.6
Pit Mining	\$/t milled	82.7	74.6	69.3
Mill	\$/t milled	20.7	19.7	19.1
Total	\$/t milled	132.6	134.4	121.7
Tonnes milled	t	1,248,039	1,200,210	1,400,000
Total	\$ million	165.5	161.3	170.4

## LOM OPERATING COSTS

The LOM unit operating costs total C\$76.01 per tonne, summarized in Table 1-17. The operating costs are projected to decrease with reductions in the mine development, increased mine output, and open pit mining.

**Table 1-17: LOM Unit Operating Costs**

Period	Mining	Milling	Refining	G&A	Total
	(\$/t)	(\$/t)	(\$/t)	(\$/t)	(\$/t)
Five Year Annual Average (2019-2023)	76.40	19.43	0.34	9.63	105.80
LOM (2019-2034)	52.54	19.17	0.27	4.03	76.01

Over the LOM, from 2019 to 2034, a total of 21.8 million tonnes, at a grade of 2.74 g/t Au, will be milled. For a production of 1.6 million ounces of gold and 400 k ounces of silver, with 0.5 million gold ounces from underground operations and 1.1 million gold ounces from surface operations. This will generate a net revenue of \$2.8 billion. For the same period, capital (CAPEX) and operating (OPEX – underground, open pit and mill) costs will be \$400 million and \$1.6 billion, respectively. For a cumulative net pre-tax cash flow of \$765 million. The All-In Sustaining Cost (AISC) will be \$1243.72 CND/oz or \$935.13US/oz.

The LOM of the Casa Berardi Mine has been greatly enhanced by addition of open pits within the mining lease, which has extended gold production until 2034. There are mineral resources that are not included in the LOM plan, as the LOM plan is based solely on Proven and Probable Mineral Reserves.

### **1.3 CONCLUSIONS AND RECOMMENDATIONS**

In the opinion of the QPs, the Casa Berardi Mine is a long-established operation with a clear understanding of the mining, metallurgical, and infrastructural requirements to successfully extract the Casa Berardi Mineral Reserves. Mining and milling operations are performing as expected, and reconciliation between mine production and the Mineral Resource model is acceptable. This indicates that the data supporting the Mineral Resource and Mineral Reserve estimates were appropriately collected, evaluated, and estimated.

Aside from those risks expressly stated in this and other sections of this report, the QPs are not aware of any other environmental, permitting, legal, title, taxation, socio-economic, marketing, political, mining, metallurgical, infrastructure, permitting, or other factors that could materially affect the Mineral Resources, Mineral Reserves, or LOM plan described in this report.

## 2.0 INTRODUCTION

Personnel at Hecla Québec and some external QP's have prepared a Technical Report on the Casa Berardi Mine, located in the Abitibi region of Quebec. The purpose of this report is to support public disclosure of Mineral Resource and Mineral Reserve estimates by Hecla as of December 31, 2018. This Technical Report conforms to NI 43-101 Standards of Disclosure for Mineral Projects.

Hecla was established in 1891 and has its headquarters in Coeur d'Alene, Idaho. Hecla acquired Aurizon Mines Ltd. (Aurizon) in June 2013 and renamed the company Hecla Québec. Hecla has an administrative/exploration office in Val-d'Or, Quebec and an office in Vancouver, British Columbia. Hecla owns 100% of the Casa Berardi property. Prior to Hecla's acquisition in 2013, production had spanned seven years from 2006 to 2013 with Aurizon and ten years from 1988 to 1997 with Inco and TVX. The Casa Berardi Mine complex have over than twenty-three year of mining operation from surface and underground.

The Casa Berardi gold deposits are located along a five-kilometers east-west mineralized corridor. They include the West Mine, including the Principal area, and the East Mine. In September 1998, Aurizon Mines Ltd. (Aurizon) acquired 100% of Casa Berardi's assets from TVX Gold Inc. (TVX). Prior to Aurizon's acquisition of the mine, production spanned ten years, 1988 to 1997, first by Inco Gold Ltd. (Inco Gold) and then by TVX. During this period, a total of 3.5 million tonnes of ore was mined and 688,400 ounces of gold were recovered in the processing plant. Aurizon reopened the mine in November 2006, achieving commercial production on May 1, 2007. Hecla acquired Aurizon in June 2013 and renamed the company Hecla Québec. From November 2006 to May 31, 2013, Aurizon production totaled 4,310,474 tonnes at an average grade of 7.71 g/t Au for a total of 980,548 gold ounces recovered. From June 1, 2013 to December 31, 2018, Hecla Québec's production totaled 5,197,143 tonnes at an average grade of 5.34 g/t Au for a total gold output of 784,033 gold ounces. Since 1988, a total of 13,010,984 tonnes at an average grade of 6.58 g/t Au have been milled at Casa Berardi for a total of 2,453,005 gold ounces recovered with an average gold recovery of 89.1%.

In a news release dated February 14, 2019, Hecla reported a new Mineral Resources and

Mineral Reserves estimate for the Casa Berardi Complex, as of December 31, 2018. Due to the substantial addition of mineral reserves from the West Mine Crown Pillar Pit, Principal Pit and East Mine Crown Pillar Pit extension, Hecla Québec updated the life of mine study incorporating surface and underground operations.

Currently, the major assets and facilities associated with the mine are the :

- West Mine open pit and underground.
- East Mine open pit and underground.

This 43-101 Technical Report summarizes the scientific and technical information that supports the new mine LOM plan and the new mineral resources and mineral reserves for the Casa Berardi Mine as of December 31, 2018.

## 2.1 SOURCES OF INFORMATION

This report has been compiled and prepared by Hecla Québec and Hecla Mining staff and independent consultants under the supervision of Qualified person as defined by the Canadian National Instrument 43-101. The standards guidelines established by the Canadian Institute of Mining were the reference for the mineral reserves and mineral resources classification. The five Qualified Persons are Jonathan Archambault-Giroux, P.Geo, (OGQ #964), Herman De Los Rios, P.Eng, (OIQ #5009408), Annie Blier, P.Chemist, (OCQ #1995-111), Pierre Roy, P.Eng, (OIQ #45201), and Dean McDonald, PhD, P. Geo (APEGBC #24217). Roles and responsibilities for Qualified Persons are summarized in Table 2-1.

**Table 2-1: List of Qualified Persons (QP)**

Qualified Person	Period worked at Casa Berardi mine site	Responsible for sections in this report
Jonathan Archambault-Giroux	Has worked full time at Casa Berardi Mine since May 2016.	QP for Sections 4-12, 14, 23 Contributed to Sections 1-3, 25-27, Appendices
Herman De Los Rios	Has worked full time at Casa Berardi Mine since January 2007.	QP for Sections 15, 16, 18, 19, 21, 22 Contributed to Sections 25-27, Appendices
Annie Blier	Has worked full time at Casa Berardi Mine since April 2018. Worked full time between June to September 2017.	QP for Sections 20 Contributed to Sections 18, 25, 26
Pierre Roy	Has previously visited the Casa Berardi Mine in February 2019 as a consultant involved in the preparation of this report.	QP for Sections 13, 17 Contributed to Sections 1, 2, 25-27
Dean McDonald	Has been a regular visitor to the mine for the past six years.	QP for Sections 1-3, 24-27, Appendices Contributed to Sections 4-12, 14, 23

Units of measurement used in this report conform to the metric system. All currency in this report is quoted in Canadian dollars (C\$) unless otherwise noted. A list of abbreviations used in this report is provided in Table 2-2.

**Table 2-2: LIST OF ABBREVIATIONS**

Abbreviation	Definition	Abbreviation	Definition
a	annum	kWh	kilowatt-hour
A	ampere	L	Litre
Au	gold	lb	pound
bbl	barrels	LOI	loss on ignition
BQ	drill core diameter of 36.5 mm	L/s	litres per second
btu	British thermal units	m	metre
°C	degree Celsius	M	mega (million); molar
C\$	Canadian dollars	m <sup>2</sup>	square metre
cal	calorie	m <sup>3</sup>	cubic metre
cfm	cubic feet per minute	μ	micron
cm	centimetre	MASL	metres above sea level
cm <sup>2</sup>	square centimetre	μg	microgram
d	day	m <sup>3</sup> /h	cubic metres per hour
dia	diameter	mi	Mile
dmt	dry metric tonne	min	minute
dwt	dead-weight tonne	μm	micrometre
°F	degree Fahrenheit	mm	millimetre
ft	foot	mph	miles per hour
ft <sup>2</sup>	square foot	MVA	megavolt-amperes
ft <sup>3</sup>	cubic foot	MW	megawatt
ft/s	foot per second	MWh	megawatt-hour
g	gram	NQ	drill core diameter of 47.6 mm
G	giga (billion)	oz	Troy ounce (31.1035g)
Gal	Imperial gallon	oz/st, opt	ounce per short ton
g/L	gram per litre	ppb	part per billion
Gpm	Imperial gallons per minute	ppm	part per million
g/t	gram per tonne	psia	pound per square inch absolute
gr/ft <sup>3</sup>	grain per cubic foot	psig	pound per square inch gauge
gr/m <sup>3</sup>	grain per cubic metre	RL	relative elevation
ha	hectare	s	second
hp	horsepower	st	short ton
hr	hour	stpa	short ton per year
Hz	hertz inch	stpd	short ton per day
in.	inch	t	metric tonne
in <sup>2</sup>	square inch	tpa	metric tonne per year

Abbreviation	Definition	Abbreviation	Definition
J	joule	tpd	metric tonne per day
k	kilo (thousand)	US\$	United States dollar
kcal	kilocalorie	USg	United States gallon
kg	kilogram	USgpmV	US gallon per minute volt
km	kilometre	W	watt
km <sup>2</sup>	square kilometre	wmt	wet metric tonne
km/h	kilometre per hour	wt%	weight percent
kPa	kilopascal	yd <sup>3</sup>	cubic yard
kVA	kilovolt-amperes	yr	year
kW	kilowatt		

### **3.0 RELIANCE ON OTHER EXPERTS**

This report has been compiled through the efforts of Hecla Québec Casa Berardi staff under the supervision of Qualified Persons. There has been no reliance on experts who are not Qualified Persons or who have not been supervised by a Qualified Person in the preparation of this report.

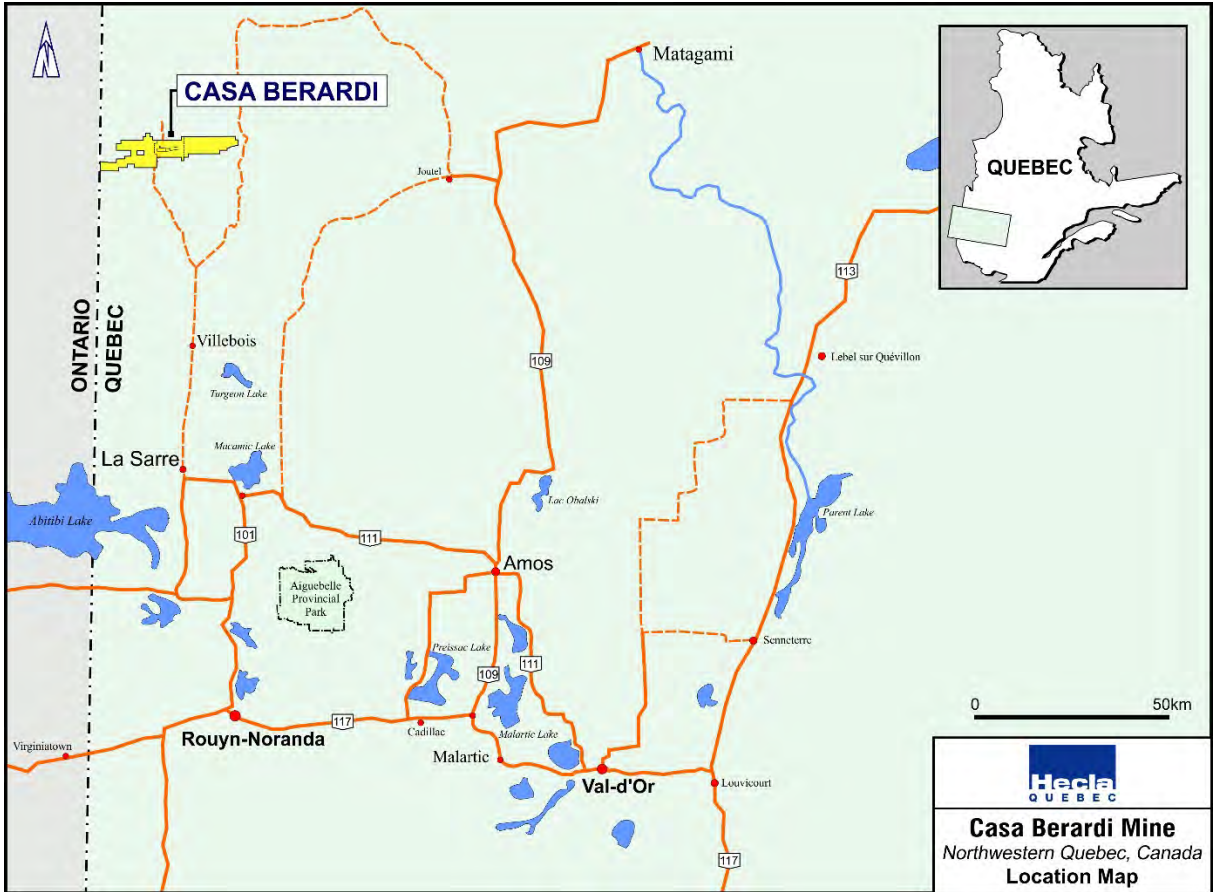
## **4.0 PROPERTY DESCRIPTION AND LOCATION**

The Casa Berardi property is located in the Province of Quebec, approximately 95 km north of the town of La Sarre, in the James Bay Municipality (Figure 4.1). The mine site is located at longitude 79° 16' 46.4" and latitude 49° 33' 56.7". The property is limited to the west by the Quebec/Ontario border and covers parts of Casa Berardi, Dieppe, Raymond, D'estrees, and Puiseaux townships.

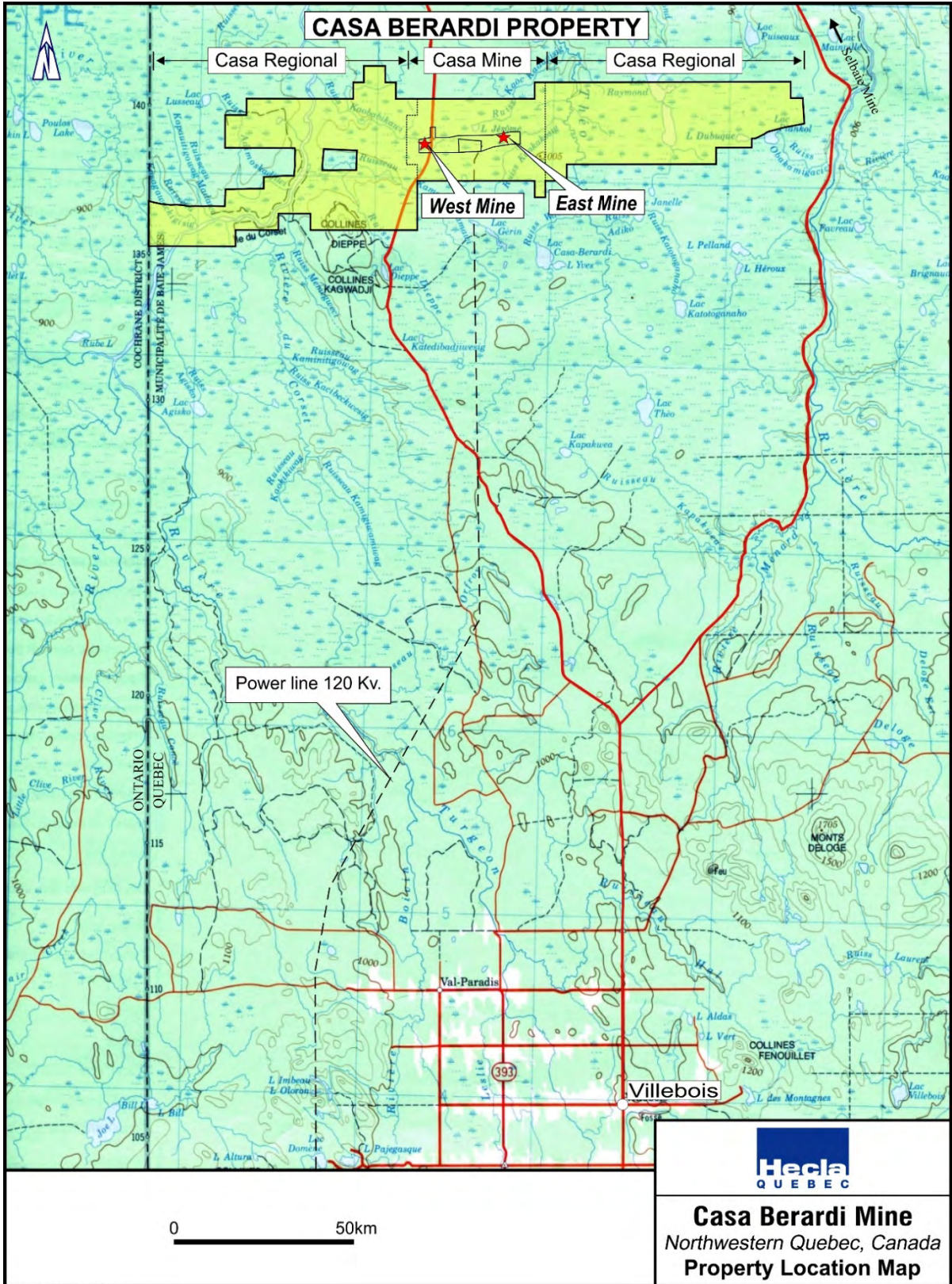
The Casa Berardi property extends east-west for more than 37 km and reaches 3.5 km in width. The immediate mine area covers only a few hectares (Figure 4.2). The gold deposits are located along a five-kilometer, east-west trending mineralized corridor and are included within the East and West mine areas (Figure 4.3).

### **4.1 LAND TENURE**

The property is composed of 339 contiguous designated claims, covering a total area of 17,188.17 ha, and two mining leases, BM 768 and BM 833, covering areas of 397.09 ha and 84.35 ha, respectively. The property area totals 17,669.61.04 ha. Other legal titles include non-exclusive lease BNE 25938 and BNE 45892 for sand and gravel pit. Tailings lease 70218 and two waste dump leases 192410 and 819410. Legal titles are under the name of Hecla Québec.



**Figure 4.1: Location Map of The Casa Berardi Mine in Quebec, Canada**



LOCA\_TOPO\_FEV\_2019.cdrRM

**Figure 4.2: Casa Berardi Location Map**

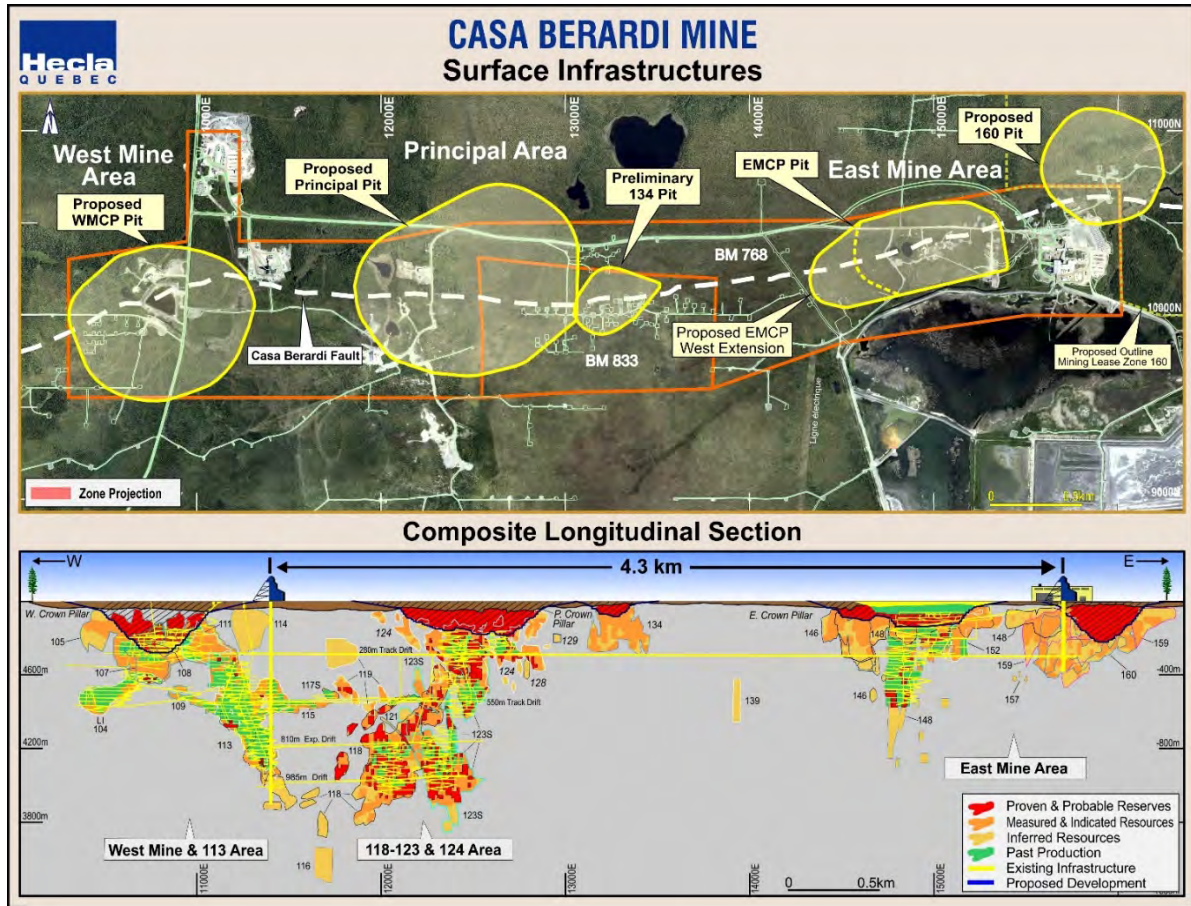
According to Quebec's Mining Act, renewal of claims takes place every two years, with cost depending on area. A mining lease is renewed every year. The claims and mining leases were renewed for amounts of \$708.0 and \$23,718, respectively, in accordance with the 2018 rates set by the government. The Casa Berardi claims are in good standing. The renewal costs are adjusted to the annual inflation rate.

The Mining Act stipulates that titleholders are required to conduct statutory work during the validity period of the claim. Each claim or lease shows excess spending amounts for required works. These amounts are put to the credit of the claims and are expected to cover several years in most cases. The Casa Berardi exploration property has excess work credits of approximately \$10,718,615.

The school taxes to the James Bay School Board and the Lac-Abitibi School Board, totaling \$34,905.01, have been paid for 2018.

The municipal taxes to the James Bay Municipality, the Villebois Municipality, the Dupuy Municipality and the La Sarre Municipality, totaling \$188,136.94, have been paid for 2018.

The Casa Berardi Fault is a major structural zone that hosts a numbers of gold and base metals deposits. Numerous gold showings occur within the Casa Berardi property. The property inside the mining lease BM768 and BM833 is not subject to any royalty and Hecla Québec owns a 100% interest in the Casa Berardi Mine area. Most of the Casa Berardi mine mineral reserves and the processing plant are located inside the mining leases as shown on Figure 4.3. The Casa Berardi property outside the mining leases is owned totally by Hecla Québec. A 1% NSR on 227 claims west of the Casa Berardi Mine was retained by Tahoe Resources Inc.



**Figure 4.3: Mine Plan View Infrastructure with Composite Longitudinal Section**

## 4.2 COMMENTS ON PROPERTY DESCRIPTION AND LOCATION

In the opinion of the QPs, the information discussed in this section supports the declaration of Mineral Resources and Mineral Reserves, based on the following:

- The Project is wholly-owned by an indirectly held Hecla subsidiary;
- Information provided by Hecla land tenure experts supports that the mining tenure held is valid and is sufficient to support declaration of Mineral Resources and Mineral Reserves;
- Hecla holds sufficient surface rights in the Project area to support the mining operations, including access and power line easements;
- Hecla holds the appropriate permits to allow mining operations;
- The appropriate environmental permits have been granted for Project operation;

- At the effective date of this Report, environmental liabilities are limited to those that would be expected to be associated with an operating gold mine where production occurs from underground and open pit sources, including roads, site infrastructure, waste dumps and disposal facilities;
- Hecla is not aware of any significant environmental, social or permitting issues that would prevent continued exploitation of the deposit;
- To the extent known, there are no other significant factors and risks that may affect access, title, or the right or ability to perform work on the property.

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

### **5.1 ACCESSIBILITY**

The Casa Berardi property is located 95 km north of the town of La Sarre, in the James Bay Municipality in the Abitibi region of northwestern Quebec. The nearest commercial airport is located at Rouyn-Noranda. La Sarre can be reached from Rouyn-Noranda via provincial roads 101 and 111. The 38 km all-season gravel road to Casa Berardi branches off from the paved road linking La Sarre and the Selbaie Mine through the village of Villebois. The branch is approximately 21 km north of Villebois. On the property, a gravel road links the East Mine with the West Mine, and a number of exploration roads provide access to the rest of the property from east and west.

### **5.2 CLIMATE**

The mean annual temperature for the area is slightly above the freezing point at 0.8°C. Average July temperature is 16.8°C, and average January temperature is -17.9°C.

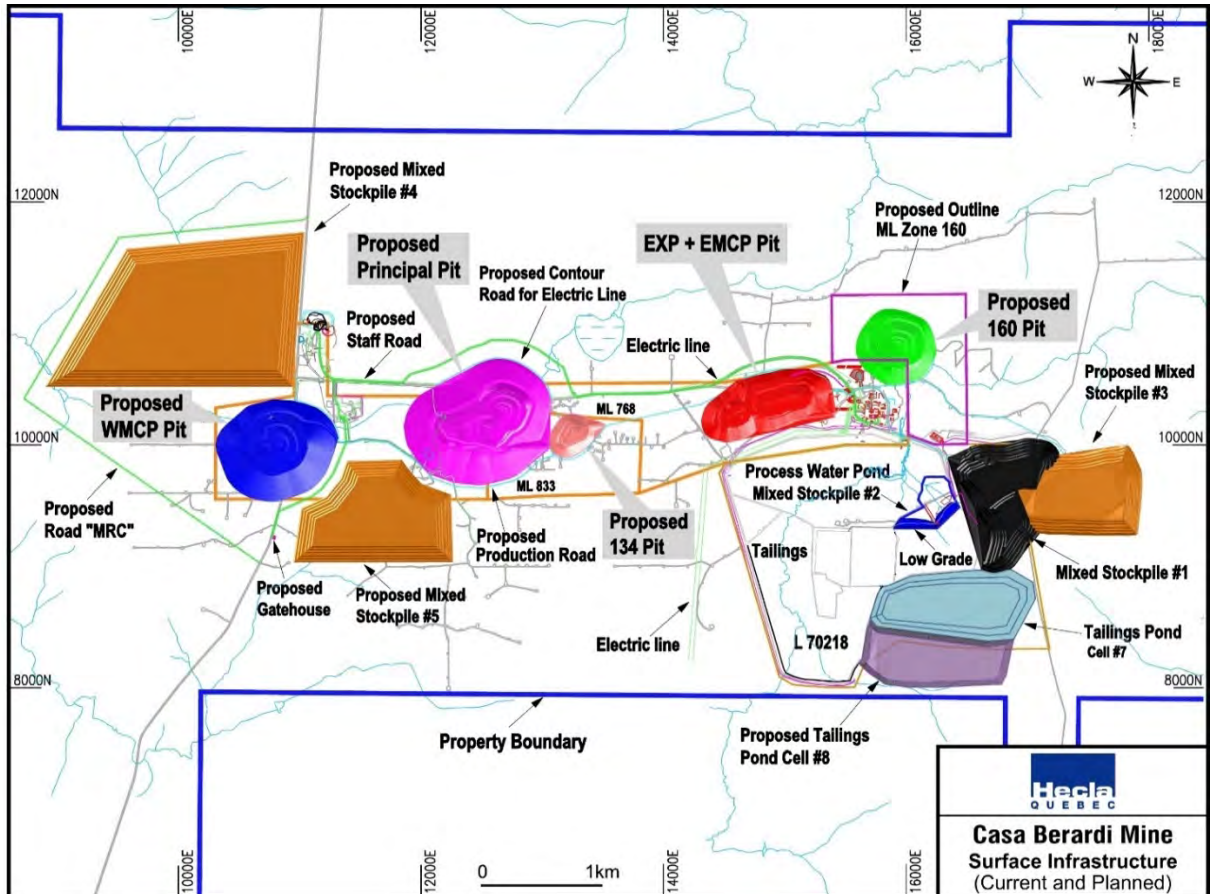
According to the 1961 to 1990 precipitation data, the average annual precipitation is 856 mm. Rain precipitation is highest in September, averaging 113 mm of water. Snow precipitation is registered between October and May, but its peak falls on the period between November and March, when its monthly average reaches 39 mm (expressed in millimeters of water).

### **5.3 LOCAL RESOURCES**

The Abitibi region has a long history of mining activity, and mining suppliers and contractors are locally available. Both experienced and general labour is readily available from the La Sarre area, a municipality of approximately 7,282 inhabitants (2016 census). Hecla Québec and prior owner Aurizon have had success in hiring experienced staff and personnel with good mining expertise despite tight current labour markets experienced industry-wide. The mine enjoys the support of local communities.

### **5.4 INFRASTRUCTURE**

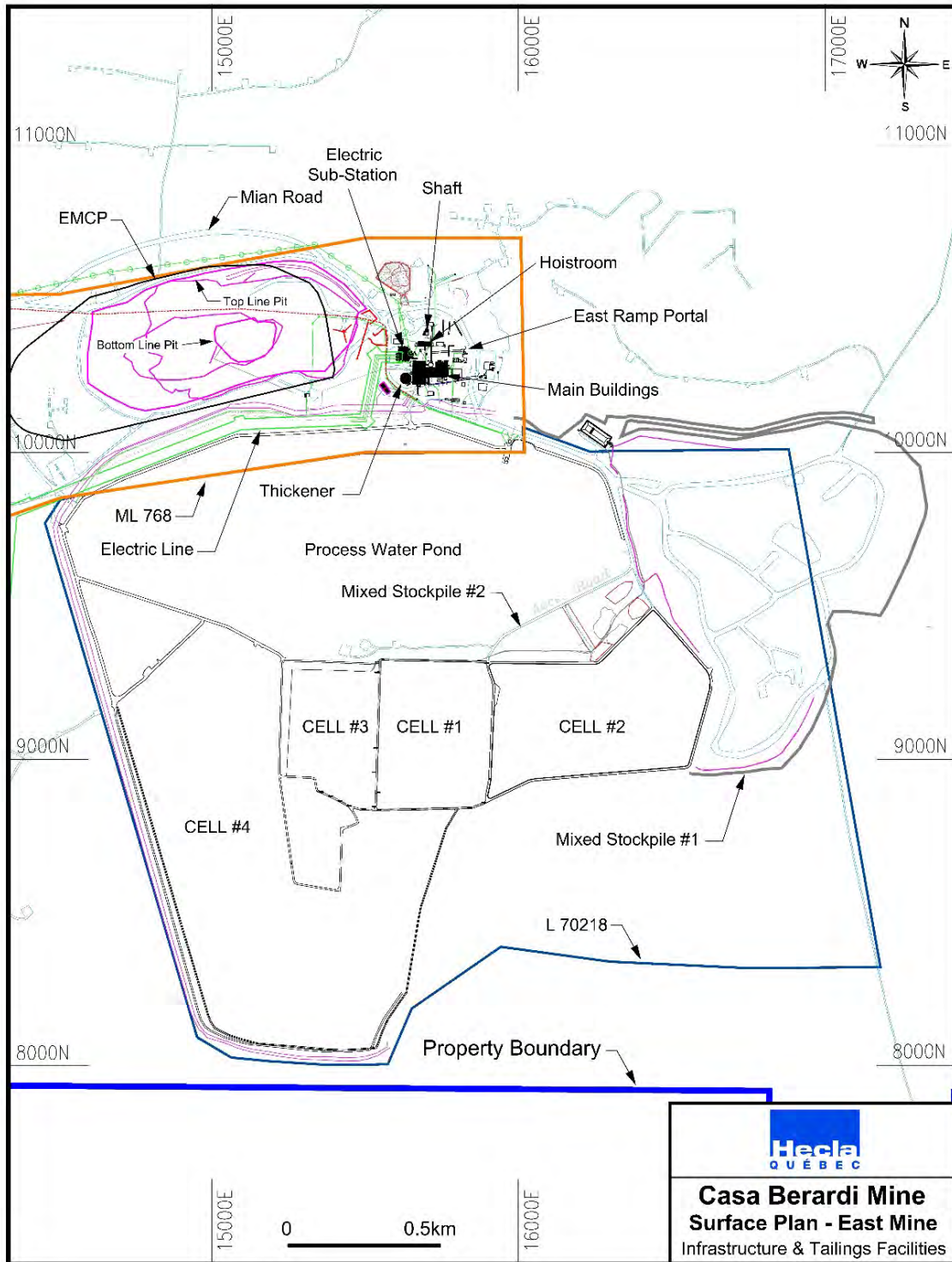
The surface infrastructure at Casa Berardi which includes both West Mine and East Mine is presented in Figure 5.1.



**Figure 5.1: Casa Berardi Surface Infrastructure (Current and Planned)**

The surface and underground infrastructure at the East Mine (Figure 5.2) includes the following:

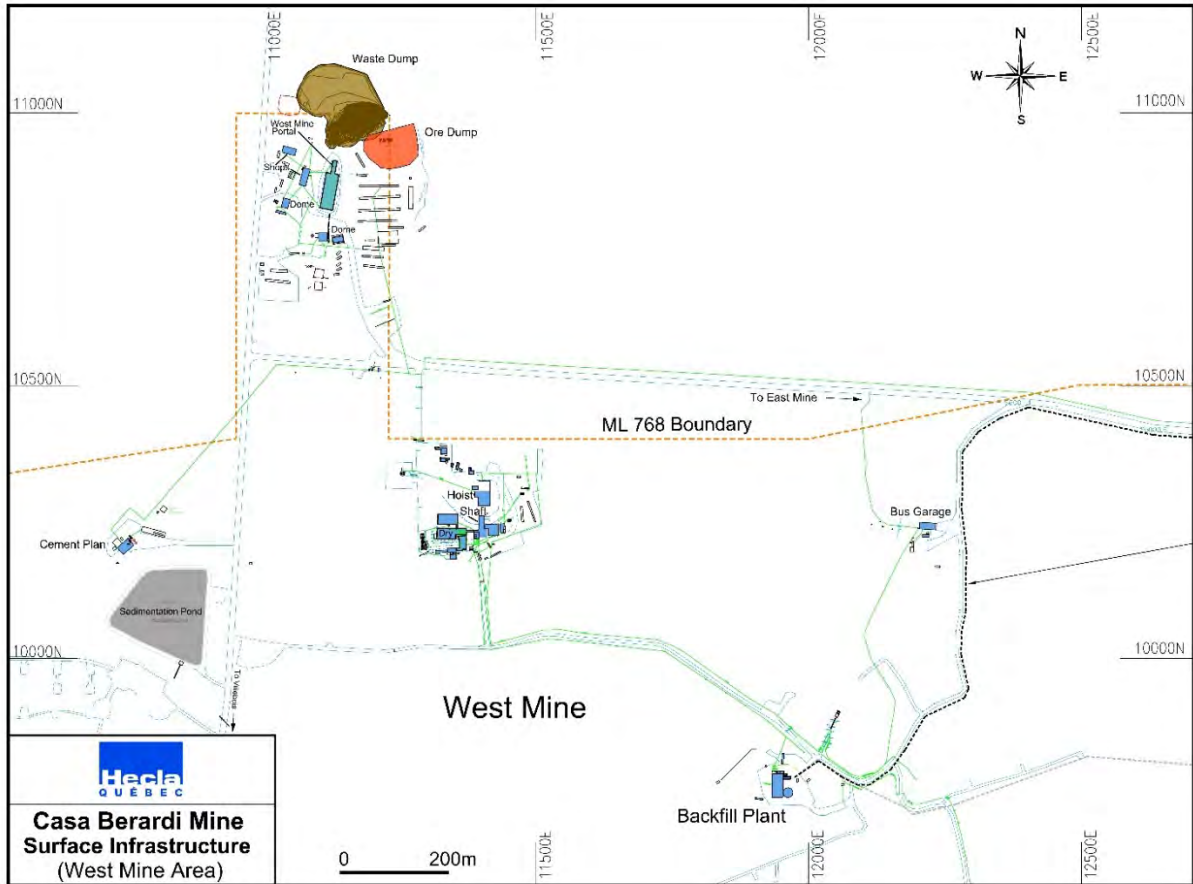
- A nominal 2,200 tpd mill, with the ability to process at rates over 4,125 tpd.
- Tailing storage facility with four tailings cells, a polishing pond, a sedimentation pond for settling iron arsenate precipitates, and a process water pond.
- Two-story administrative building with offices, warehouse, dry, laboratory, two heavy equipment maintenance garage, millwright shop, and electrical shop.
- Two core shacks.
- Water pumping station.
- Hoistroom, a headframe, and a 380 m deep shaft (with no hoist).
- Mine access decline and a series of ramp-connected levels.
- Three petrol tanks with pump gas and fuel.
- One mineralized rock stockpile.
- One waste and till-clay pile.



**Figure 5.2: East Mine Surface Plan View**

Existing surface and underground infrastructure at the West Mine (Figure 5.3) include the following:

- Backfill plant, including a compressor room and a ventilation raise intake.
- Settling ponds.
- Pumping station.
- A 380 m<sup>2</sup> garage.
- Two dry houses with offices.
- Emergency building for mine rescue and infirmary.
- Warehouse.
- Core storage area.
- Gatehouse.
- Mine access decline providing access to the West Mine and Principal area.
- Hoistroom, headframe, and mine shaft to the 1080 level.
- A 125 tonnes per hour paste backfill plant and a cement plant with tailings feed line from the mill and distribution holes to the underground.
- Mine ventilation fans and mine air heater with ventilation raise to the mine workings.
- One waste rock pile and one ore rock pile.



**Figure 5.3: Surface Infrastructure in the West Part of the Mine**

There is no additional surface infrastructure related to the Principal Mine. A five-kilometer track drift joins the East and West Mines and provides access to the Principal Mine at the 280 m level.

The power supply of the site is provided by a 55 km, 120 kV power line, from the town of Normétal.

## **5.5 PHYSIOGRAPHY**

The topography is generally gentle and is mostly characterized by swamps and thick overburden coverage (up to 60 m locally). Elevation varies between 270 MASL and 360 MASL. An esker crosses the property south of the West Mine and was once quarried for gravel. According to the map of ecological regions of Quebec, the area falls within the boreal zone and the spruce and moss domain. The forested zones are characterized mainly by jack pine and spruce and have generally been logged. The mine area is characterized by swamps and is therefore classified as a bare to semi-bare wetland. The Turgeon River crosses the property in its western part, while Raymond Lake is located to the east of the mines.

## **5.6 COMMENTS ON ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE, AND PHYSIOGRAPHY**

In the opinion of the QPs:

- There is sufficient suitable land available within the mineral tenure held by Hecla for tailings disposal, mine waste disposal, and installations such as the process plant and related mine infrastructure.
- A review of the existing power and water sources, manpower availability, and transport options indicate that there are reasonable expectations that sufficient labor and infrastructure will continue to be available to support declaration of Mineral Resources, Mineral Reserves, and the proposed LOM plan.

## 6.0 HISTORY

### 6.1 FROM 1974 TO 1998

Before 1974, the Casa Berardi area was explored for base metal deposits. In 1974, the first 13 claims were staked by Inco Gold. The discovery hole was drilled in 1981, and 590 additional claims were staked. In 1983, a joint venture agreement was reached between Inco Gold and Golden Knight Resources Inc. (Golden Knight). The following years were marked by exploration drilling and, eventually, project engineering and construction. September 12, 1988 marked the official opening of the East Mine, and the commercial production of the West Mine began in 1990 - both under the ownership of Inco Gold/Golden Knight.

In 1991, TVX Gold (TVX) acquired Inco Gold's 60% interest in the Mine. In 1994, TVX and Golden Knight purchased from Teck Corporation the remaining interest in the Domex claim block, a part of the Principal (Main) Zone between the West and the East Mine.

By 1997, 3,769 holes had been drilled on the property for a total of 463,492 m. Approximately 92% of these holes were located in the area between the West Mine and the East Mine. Table 6-1 summarizes the historic drilling programs.

**Table 6-1: Historical Diamond Drilling Casa Berardi Mine**

Project	Location	Drill Holes	Meters
Casa Berardi – Exploration	West Block & East Block	3,759	660,441
Casa Berardi – Mine	Mining lease 768	10,087	1,377,969
	Mining lease 833	544	126,501
<b>Total</b>		<b>14,390</b>	<b>2,164,911</b>

The first Mineral Reserve estimation was published in 1987. Table 6-2 shows the evolution of the Mineral Reserves at the mine from 1987 to 1997.

**Table 6-2: Historical Mineral Resources and Mineral Reserves 1987-1997**

Year	Mineral Resources			Mineral Reserves		
	Tonnes	Gold g/t	Gold oz	Tonnes	Gold g/t	Gold oz
1987				11,106,000	6.8	2,421,000
1988				12,412,000	7.4	2,909,000
1989				9,652,000	7.3	2,251,000
1990				8,934,000	7.1	2,028,000
1991				6,234,000	6.3	1,265,000
1992				6,216,000	6.4	1,275,000
1993				4,767,000	6.2	946,000
1994				4,526,000	6.1	881,000
1995				3,253,000	5.9	620,000
1996				6,199,000	5.5	1,105,000
1997	3,189,000	5.8	591,000			

The historic mineral resources listed in Table 6-2 pre-date NI 43-101 and should not be relied upon. They are being shown only for historical reference. A qualified person has not done sufficient work to validate these mineral resources; they have been superseded by the current Mineral Resource and Mineral Reserves estimates disclosed in Section 14 of this report.

Production began at the East Mine in September 1988 and at the West Mine in April 1990. The total combined production for the period from 1988 to 1997 was 3.5 million tonnes at an average grade of 7.1 g/t Au. The total gold recovered during the operating years was 688,400 gold ounces, with a mill gold recovery rate averaging 87%. Although average statistics are not readily available for daily production, it appears that during the life of operation, the average production rate of the mill was less than 1,800 tpd. Historical annual production is presented in Table 6-3.

**Table 6-3: Historical Mine Production**

Year	Tonnes Milled	Gold g/t	Mill Recovery (%)	Gold oz Recovered
1988	124,057	5.9	88.0	19,025
1989	337,130	5.5	86.4	51,096
1990	361,935	8.9	87.4	88,999
1991	487,769	8.7	86.9	119,015
1992	315,938	9.3	87.1	80,319
1993	306,597	10.0	89.3	86,964
1994	550,638	6.5	86.8	97,518
1995	469,542	4.7	85.7	61,179
1996	498,405	5.4	87.2	76,039
1997	51,356	5.8	87.2	8,270
<b>TOTAL</b>	<b>3,503,367</b>	<b>7.1</b>	<b>87.0</b>	<b>688,424</b>

The maximum annual production of over 550,000 tonnes was achieved in 1994. In the following years, the production fell below 500,000 tonnes. In January 1997, TVX announced the closure of the East Mine due to ground control problems. Two months later, the West Mine was also closed.

## 6.2 AURIZON MINES

The Casa Berardi assets and property were offered for sale in the fall of 1996. In January 1997, Aurizon Mines (Aurizon) expressed interest in a letter to TVX. In September 1998, following the due diligence work, Aurizon signed an agreement and completed the acquisition of all Casa Berardi assets and mining rights.

Following the acquisition of Casa Berardi, Aurizon completed an exploration diamond drilling program more than 76,000 m (50,000 m from surface and 26,000 m from underground). The main objective of the campaign was to increase the gold mineral inventory of the property by drilling prospective sectors below the 400 m level in the West Mine area. The program resulted in the discovery of the 113 Zone and other smaller mineralized bodies.

Using the results of this drilling program as a basis for Mineral Resource estimation, Aurizon issued an internal study in March 2000, which provided positive indications of the economic potential of the West Mine area below the 400 m level.

Following two years of limited exploration drilling activities due to depressed gold prices, Aurizon re-embarked on a surface exploration program that led to the discovery of additional zones east of the 113 Zone.

To increase the confidence level of the Mineral Resources and prove the potential of a mining operation, an underground exploration program was planned and initiated in April 2003 to test the continuity of the mineralization of the 113 Zone. That year, the West Mine ramp was extended 1,074 m from the 450 m level down to the 550 m level, to provide access to the 113 Zone for metallurgical test work and to provide drill bases for in-fill definition drilling. Approximately 44 m of the exploration drift were completed by the year-end, allowing the completion of 1,400 m of definition drilling. A further 21,000 m of surface exploration drilling was completed in the area of the 118 through 120 zones during 2003.

In 2004, \$27.6 million was invested at the Casa Berardi Mine for the construction of the surface foundations and shaft collar, a shaft pilot raise from the 550 m level to surface, 878 m of exploration drifts, 53,100 m of exploration and definition drilling, 102 m of ventilation raising, and 1,590 m of ramping down to the 550 m level. Met-Chem Canada Inc. (Met-Chem) was commissioned to prepare a feasibility study. Aurizon proceeded with the implementation and construction of the West Mine infrastructure.

In 2005, \$43.8 million was invested at Casa Berardi for:

- Completion of two feasibility studies (the Feasibility Study by Met-Chem in January 2005, based upon Mineral Reserves above the 700 m level, and the Updated Feasibility Study in October 2005, incorporating Mineral Reserves down to the 900 m level).
- Construction of a new headframe, hoistroom, ore and waste bins.
- Shaft sinking 290 m down from surface.
- 113 Zone ramp extension 1,200 m down to the 680 m level.
- Access to the Lower Inter Zone down to the 570 m level with the completion of 429 m of ramping and drifting.
- 685 m of drifting and 367 m of ventilation raising.
- Initiation of mill rehabilitation with the refurbishing of the crushing circuits, conveyors and assay laboratory.

- 33,500 m of definition drilling from 137 holes; 19,000 m of surface exploration drilling from 32 holes; and detailed engineering for the shaft and surface infrastructure.

In 2006, an additional \$75.5 million was invested to fund the construction and development. In early November, Aurizon completed construction and development at the West Mine area and commenced underground mining and milling operations.

In 2007, \$16.9 million was invested to fund pre-production up to May 1, 2007, the date of achieving commercial production. From 2008 to 2013, a total of \$297 million was invested in fund development, infrastructure improvements, new equipment, and exploration expenses.

### **6.3 HECLA QUEBEC**

From 2014 to 2018, \$331.1 million was invested by Hecla Québec in fund development, infrastructure improvements, new equipment, and exploration expenses. In 2016 Hecla started the first open pit at Casa Berardi with the East Mine Crown Pillar pit. They invested on underground development ore pass and waste pass to feed the automated haulage truck system in the lower West Mine in the 118 and 123 zones. Infrastructure improvements around the tailings and water treatments facilities were also completed. The years 2017 and 2018 were the highest and third highest diamond drilling campaign since 2006 in exploration, definition and infill drilling.

### **6.4 PRODUCTION**

From November 2006 to May 31, 2013, Aurizon production totaled 4,310,474 tonnes at an average grade of 7.71 g/t Au for a total of 980,548 gold ounces recovered. From June 1, 2013 to December 31, 2018, Hecla Québec's production totaled 5,197,143 tonnes at an average grade of 5.34 g/t Au for a total gold output of 784,033 ounces.

Since 2006, a total of 9,507,617 tonnes at an average grade of 6.42 g/t Au have been milled for a total gold output of 1,764,581 ounces (Table 6-4).

**Table 6-4: Casa Berardi Production 1988 - 2018**

Company	Year	Tonnes Milled	Grade (g/t Au)	Gold oz Contained	Gold oz Recovered	Gold Mill %Recovery
<b>INCO - TVX</b>	<b>1988 - 1997</b>	<b>3,503,367</b>	<b>7.10</b>	<b>791,292</b>	<b>688,424</b>	<b>87.0%</b>
<b>AURIZON</b>	Nov 2006	68,481	8.58	18,891	17,731	93.9%
	2007	545,259	9.78	171,416	159,469	93.0%
	2008	654,398	8.16	171,628	158,830	92.5%
	2009	688,677	7.77	172,013	159,261	92.6%
	2010	722,746	6.76	157,134	141,116	89.8%
	2011	698,123	8.00	179,462	163,845	91.3%
	2012	693,859	6.77	151,059	136,848	90.6%
	May 2013	238,931	6.17	47,394	43,447	91.7%
	<b>Total</b>	<b>4,310,474</b>	<b>7.71</b>	<b>1,068,996</b>	<b>980,548</b>	<b>91.7%</b>
<b>HECLA</b>	June 2013	351,636	6.16	69,652	62,532	89.8%
	2014	750,778	5.90	142,443	128,241	90.0%
	2015	765,763	5.96	146,733	127,893	87.2%
	2016	904,998	5.72	166,499	145,973	87.7%
	2017	1,175,930	4.77	180,373	156,652	86.8%
	2018	1,248,039	4.66	186,844	162,742	87.1%
	<b>Total</b>	<b>5,197,143</b>	<b>5.34</b>	<b>892,545</b>	<b>784,033</b>	<b>87.8%</b>
	<b>TOTAL 2006 - 2018</b>	<b>9,507,617</b>	<b>6.42</b>	<b>1,961,541</b>	<b>1,764,581</b>	<b>90.0%</b>
<b>TOTAL 1988 - 2018</b>	<b>13,010,984</b>	<b>6.58</b>	<b>2,752,833</b>	<b>2,453,005</b>	<b>89.1%</b>	

## 6.5 TOTAL PRODUCTION AT CASA BERARDI SINCE 1988

Since 1998, a total of 13,010,984 tonnes at an average grade of 6.58 g/t Au have been milled at Casa Berardi for a total gold output of 2,453,005 gold ounces and an average gold recovery of 89.1%.

## **7.0 GEOLOGICAL SETTING AND MINERALIZATION**

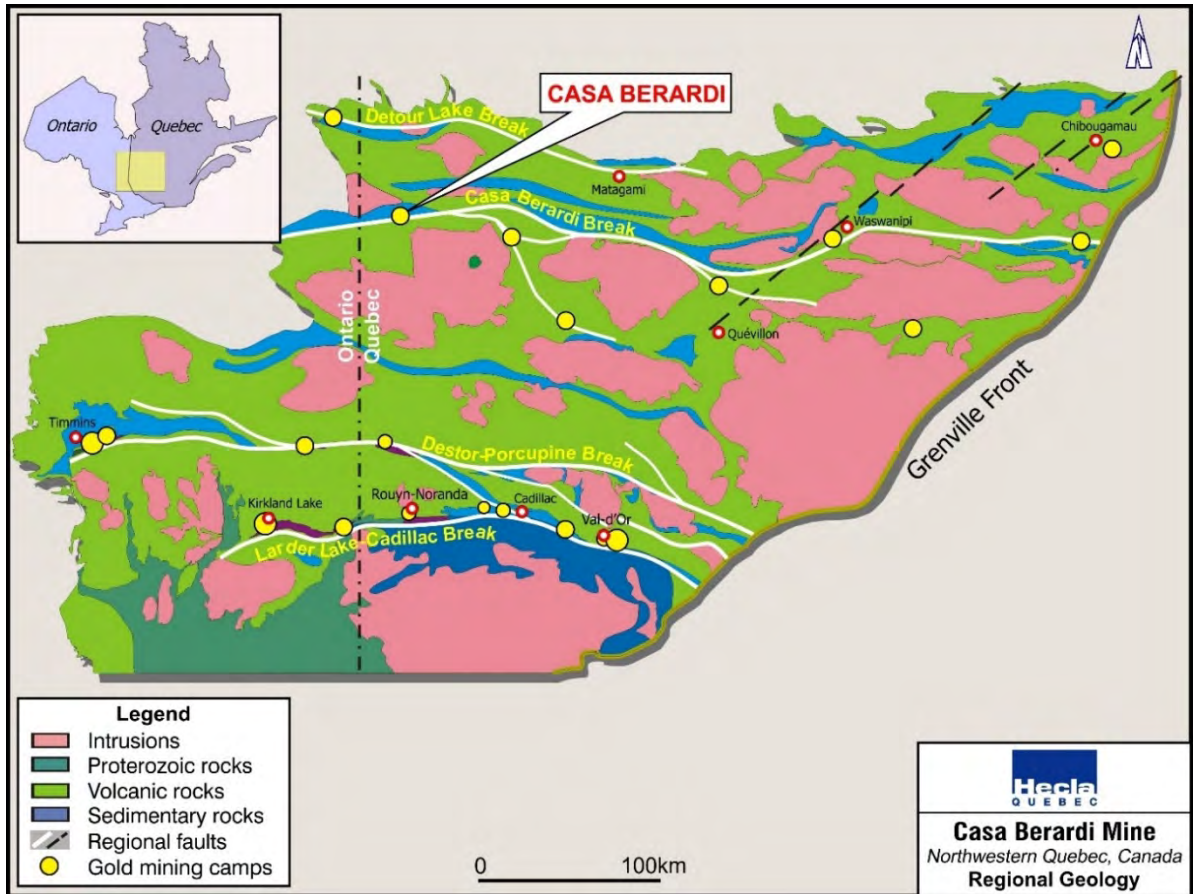
### **7.1 REGIONAL GEOLOGY**

The Casa Berardi Mine is located in the northern part of the Abitibi Subprovince, a subdivision of the Superior Province, the Archean core of the Canadian Shield. The mine area belongs to the Harricana-Turgeon Belt, which is a part of the North Volcanic Zone (Figure 7.1).

The regional geology is characterized by a mixed assemblage of mafic volcanic rocks, flysch- type sedimentary iron formations, and graphitic mudrocks that are limited by a large granodioritic to granitic batholith.

Structurally, the property is enclosed in the Casa Berardi Tectonic Zone, a 15 km wide corridor that can be traced over 200 km. A network of east-west striking ductile, high strain deformation zones are at a low angle to the lithological contacts.

Many significant deposits and past producers of different types are present in the region. Base metals have been produced from the Joutel (Selbaie Mine, Estrades Mine) and Matagami camps. New deposits have been identified 15 km south of Casa Berardi, on the Gemini property. Further east, along the Casa Berardi structural trend, is the former Agnico-Eagle Telbel Mine. Other deposits, with tonnages in the order of one to three million tonnes and grades between 4 g/t Au and 6 g/t Au, have also been outlined on the Douay, Vezza and Desjardins properties.



**Figure 7.1: Regional Geology of Northwestern Quebec, Canada**

## 7.2 PROPERTY GEOLOGY

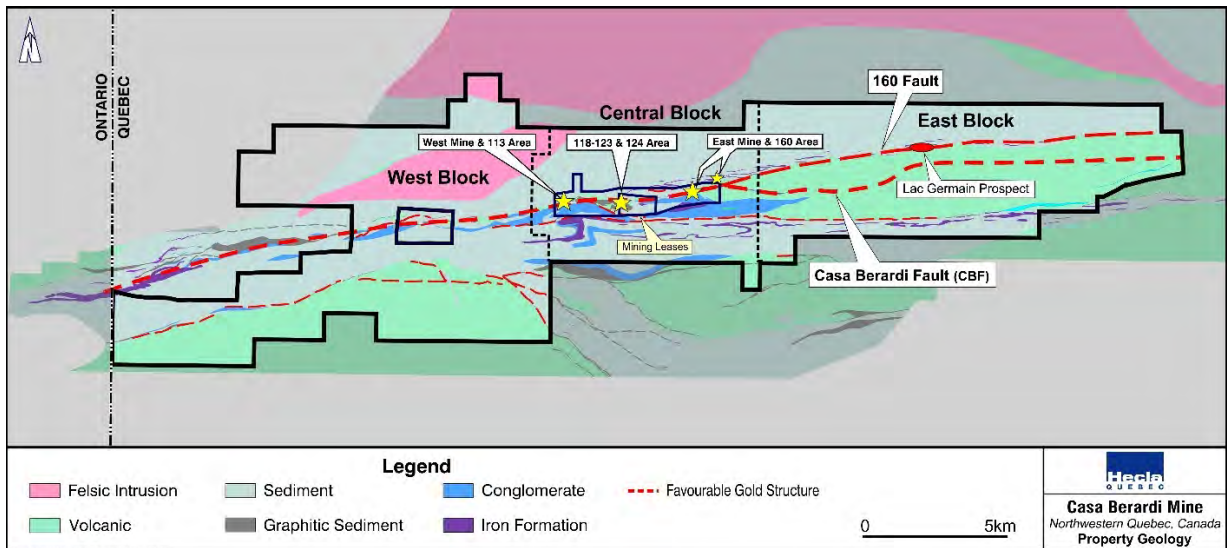
### 7.2.1 STRATIGRAPHIC DIVISIONS

The property's geological environment is centered on the Taïbi volcano-sedimentary domain, which is bounded on the north by the Recher Batholith and on the south by different volcanic domains of tholeiitic to transitional affinity (Figure 7.2). The Dieppe Domain covers half of the southwestern part of the property, and the Turgeon Domain lies immediately south of the eastern half of the property. Intermediate volcanic rocks of the Joutel-Raymond Group are located within the Turgeon Domain. Dieppe volcanism is defined by a thick (up to 100 m) massive flow or volcanic conduit with sub-ophitic textures which indicate a deep volcanic environment with high rates of magma generation. Discontinuous volcanic units characterized by breccias flows, tuffs, and cherty horizons lying in contact with graphitic sediments and conglomerate in the gold deposit area and the eastern volcanic domain that covers the eastern half of the property can both be correlated with the Harricana Group.

The stratigraphic sequence starts with basal mafic volcanism (2,730 Ma to 2,720 Ma). Pyrite-rich graphitic mudrock and the associated chert appear to be synchronous with the volcanism as evidenced by fragmentary hyaloclastic units of different compositions. The main sedimentary event corresponds to a flysch-type sequence deposition. U/Pb dating of the iron formation and conglomerate indicates ages between 2,695 Ma and 2,692 Ma for this event.

Well-defined flysch-type sedimentary units, like magnetite-rich wacke and conglomerate, can be traced over tens of kilometers without significant facies variations. Volcanic units extend for five to fifteen kilometers inside the sediments and form lens-shape structures. Smaller lenses are a few hundred meters wide and are included in the Casa Berardi deformation zone.

Basaltic to andesitic flows, with thickness generally less than 50 m, show normal progression facies from coarse crystalline to massive, amygdalar, and vesicular in lapilli tuffs and tuffs. Flow contacts are identified by graphitic mudrock horizons. Gabbroic sills, which are related to the Dieppe domain, are visible near the flow contacts. The Turgeon volcanism is considered as a distal, near surface, more evolved volcanism environment. Graphitic rocks (in the form of pyritic graphitic mudrock), black chert, wacke, and conglomerate form a 500 m wide structural corridor that coincides with the Casa Berardi Fault.



**Figure 7.2: Casa Berardi Property Geology**

## 7.2.2 STRUCTURES

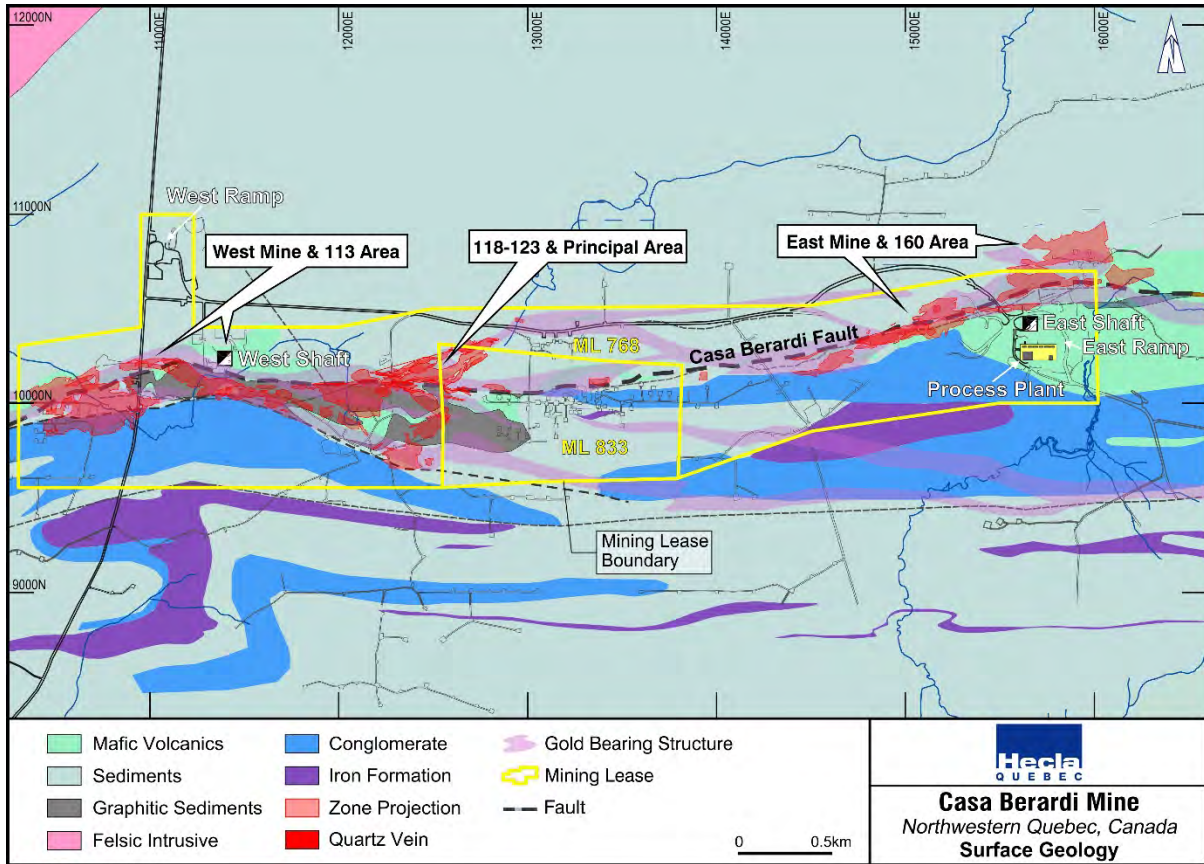
The mafic volcanic units along the Taïbi domain represent in plan-view a lenticular shape corresponding to structural doming. Polarity inversions are recognized in sediments on both sides of their contacts with these units. Tight isoclinal folding forms an asymmetric dome and basin pattern which is well preserved around volcanic units in the iron formations. The main north-south compression event, which is responsible for an 8:1 elongation ratio, is indicated by a strong penetrative east-west foliation.

Two fabrics are observed:

- A constant main penetrative east-west foliation, dipping 60° south.
- A crenulation cleavage with an undefined oblique orientation related to northeast or northwest fold components. A higher strain rate along main sediment-volcanic contacts has resulted in a small-scale complex dome and basin folding and strong stretching mineral lineation with steep opposite plunges.

The Casa Berardi Fault is defined by a stratigraphic contact between a graphite-rich sediment sequence at the base of the Taïbi domain, a northern continuous highly deformed and brecciated mafic fragmentary volcanic unit, and a southern highly deformed polymictic conglomerate unit (Figure 7.3). On the north side of the Casa Berardi Fault, a thick sequence of very homogeneous wacke belonging to the Taïbi Group is affected by an amphibolite metamorphic grade. One kilometre further north is the easterly elongated Recher Batholith, which is part of the northwestern boundary of the Abitibi greenstone belt.

The Casa Berardi Fault strikes east-west and dips 80° to the south. The Casa Berardi Deformation Zone corresponds to a braided network of laminated high strain zones following drag folded contacts of less deformed competent rocks such as mafic volcanic and polymictic conglomerate. The thickness of the affected rock package is used to define a 100 m to 500 m wide corridor that hosts all the mineralized zones explored and developed at Casa Berardi.



**Figure 7.3: Casa Berardi Mine Property Surface Geology**

The main brittle deformation and fault zones that have been developed correspond to the Casa Berardi Fault, bounding the strongly metamorphosed Taïbi flyschic sediments with interlayered, tuffaceous intermediate units to the north and a package of strongly deformed graphitic sediments, conglomerate and mafic volcanic flows to the south.

Inside the fault zone, ductile deformation intensity is heterogeneous. Foliation is uniform in larger competent rock units, such as mafic volcanics and conglomerates. Kinematic indicators observed inside the main foliation, combined with the foliation dip pattern, indicate a south verging thrust movement.

### 7.2.3 ALTERATION AND METAMORPHISM

The regional metamorphism, which is of lower greenschist facies, is locally influenced by a series of syntectonic batholiths with associated thermal aureole. The Recher thermal aureole limit follows the northern boundary of the property located approximately two kilometers from the batholith and the Casa Berardi Fault.

Inside the contact metamorphism halo, the sediments are affected by a quartz-plagioclase-biotite assemblage. In the case of iron-rich sediments, the sediments are affected by a chlorite-chloritoid assemblage. Garnet is locally visible. Mafic volcanics are affected by a plagioclase-tremolite assemblage. Chloritoid, plagioclase, and garnet are porphyroblastic, with chlorite-biotite pressure shadows indicating the synchronicity of crystallization and regional foliation.

### **7.3 MINERALIZATION**

#### **7.3.1 DEPOSITION MODEL**

Some essential conditions were initially present in the Casa Berardi area during the formation of the Harricana-Turgeon volcano-sedimentary belt, preparing conditions for a later gold deposition event.

The Casa Berardi Fault represents an old discontinuity at the top of a mafic volcanic rock in a basement where hydrothermal activity has led to the formation of chert and graphitic mudrock containing large massive pyrite lenses. The 30 to 40 million years old unconformity between the mafic volcanics and the flysch-type sequence is exposed in many places along the Casa Berardi Fault. Iron formations and iron rich sediments are present near the base of the sequence and appear on both sides of the Casa Berardi Fault. The presence of sulphur and iron in the environment is a factor which is highly favorable for gold mobilization.

The tectonic mechanism generated many structural features at different scales, creating a favourable context for the formation of gold deposits. The regional north-south main compression events resulted in tight kilometer-scale isoclinal folding and in bringing the geological units into a vertical position. The Casa Berardi Fault was generated during this stage by a movement at the contact of a graphitic unit. The proximity of large volcanic units, such as the Dieppe and the Joutel-Raymond domain, has formed competent cores inside antiforms. Those competent cores forced oblique movement and generated a polyphase elongated dome and basin folding pattern. This first tectonic stage corresponds regionally to a 50% shortening and happened under ductile conditions at a depth of six to ten kilometers.

High constraint zones, associated with pervasive carbonization, are generally developed where graphitic mudrock horizons are localized at major rock contacts. This combination of

factors acted as a ground preparation for the positioning of vein networks and long veins. The general orientation of the veins and internal structures are generally concordant with the ambient fabric. The veins are localized within the foliation and contain two types of enclaves: foliated host rocks and graphitic planes showing a stylolitic pattern. The vein contacts are usually sharp. The lack of fabric development indicates a late emplacement.

### **7.3.2 STYLES OF MINERALIZATION**

#### **VEINS**

Gold mineralization is essentially located in quartz veining, either in the form of plurimetric veins, small-scale veins, or veinlet networks. Veins are heterogeneous and contain a variable percentage of foliated enclaves showing a laminated appearance. Veins are of different color, texture, and structure. Gold grades are generally correlated with increasing complexity. Different quartz phases have been recognized in mineralized veins to show the following sequence:

- Phase 1: grey quartz, with abundant sulphides and fluid inclusions, comprising more than 50% of mineralized veins.
- Phase 2: mosaic micro-crystalline quartz occurring in higher grade portions of veins.
- Phase 3: non-mineralized coarsely crystallized white quartz which cuts the two others.

The gold bearing vein filling is rarely massive, but often brecciated, micro-brecciated, or laminated. The fracture planes are rich in graphite and muscovite. Veins contain only minor sulphides (1% to 3%), including mainly arsenopyrite, pyrite, and traces of sphalerite, chalcocopyrite, pyrrhotite, tetrahedrite, galena, and gold. Arsenopyrite is the main gold bearing sulphides present in all veins of the deposit.

The granulometric distribution of gold is similar for all locations. According to petrographic compilations, 50% of the gold particles have an average diameter less than 30 µm, and approximately 3% are greater than 100 µm. The gold distribution inside the mineral assemblage varies slightly according to the location of the mineralized zones. In the 113 Zone of the West Mine area the vein mineralization, which is spatially close to the Casa Berardi Fault, gold is mostly free and in contact with arsenopyrite grains (< 10 µm to 0.5 mm). Arsenopyrite is associated with sphalerite and tetrahedrite in clusters, joints,

and in micro-brecciated areas.

In the South West Zone, parts of the Principal area, and some areas of the East Mine mineralization is more common where lenses are adjacent to the Casa Berardi Fault. In these structures the gold distribution is variable and depends on the amount of sulphides in quartz veins and host rocks. Fifty percent (50%) of gold grains that have been observed are inclusions in pyrite and arsenopyrite crystals.

Alteration halos with gold values of above 100 ppb and anomalous values of arsenic and antimony surround most of the mineralized zones along the Casa Berardi Fault. Those halos can be found up to five kilometers away, on both sides of the deposit.

## **STOCKWORKS**

Stockworks are the second style of gold mineralization in the deposit and represent nearly the same volume as the large quartz veins. However, the stockworks are generally non-economic; but are mined with quartz veins when they are economic. Across the deposit, hanging wall stockworks are present in contact with important mineralized quartz veins. From 10% to 20% of the rock volume is composed of centimeter-to decimeter-thick quartz veins with gold values ranging from 1 g/t to 10 g/t Au. Veins of all textures and composition are concordant with host rocks. Foliated and finely bedded rocks are cut by concordant veins. Less deformed basalts or heavily carbonated iron-rich rocks are cut by fracture-controlled vein sets.

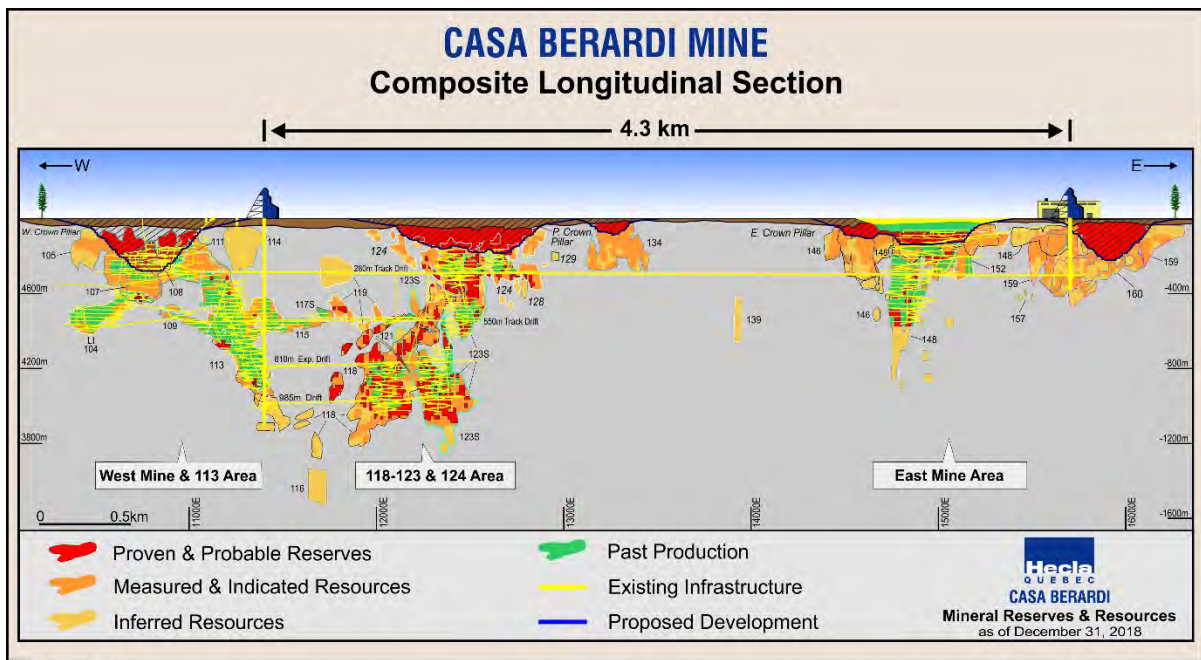
At the deposit scale, the Principal area of the West Mine and the East Mine areas have the stockworks surrounding quartz cores. The stockworks are not limited to the main Casa Berardi Fault and can affect the total width of the deformation zone. as meter to decameter wide mineralization subzones.

In the Principal area of the West Mine, the stockwork extends laterally for 400 m at a 50° western plunge. In the East Mine, the mineralized system extends laterally for 400 m, reaching a depth of 800 m down the dip (Figure 7.4). The system crosses the Casa Berardi Fault at a low angle over 100 m of strike length. Mineralization continues to the west on the south side of the fault and to the east on the north side of the fault.

## BANDED IRON FORMATION

The third type of mineralization is the Banded Iron Formation (BIF) hosted mineralization.

This type of mineralization is found in the 125 and 127 zones of the Principal area, and in the 160 Zone at the eastern extension of the East Mine area. These zones are restricted to the highly sheared, brecciated, and altered ferruginous sediments occurring north of the Casa Berardi Fault. Mineralization occurs within metric to sub-metric quartz veins and stockworks with up to 10% chert-magnetite beds, and shows high sulphide content which consists of pyrite, arsenopyrite, traces of pyrrhotite, and little or no visible gold. These sulphides have replaced the oxide-rich layers which surround the quartz veins and the veinlet stockworks. Strong carbonate and chlorite alteration halos surround the quartz-rich areas.



**Figure 7.4: Composite Longitudinal Section**

### 7.3.3 MINERALIZATION AT THE WEST MINE

The mineralized zones in the vicinity of the underground infrastructure of the West Mine are all located between sections 10,350E and 11,250E, which correspond to the western limit of the Lower Inter Zone and the eastern limit of the 111 Zone, respectively (Figure 7.4). Mineralization occurs at the Casa Berardi Fault (in the 109, 111, 113, NW, NE zones), between the Casa Berardi Fault and the South Fault (in the Inter, Lower Inter and 115 zones), and at the South Fault (in the South West zone).

The mineralization at the West Mine is represented by two main types:

- Low sulphide quartz veins: networks of centimetric to plurimetric quartz veins located south of the Casa Berardi Fault in highly deformed volcanic and sedimentary rocks that are predominantly basalt, wacke, conglomerate, chert, and mudrock.
- Sulphide-rich stockworks: represent the same volume as large quartz veins but have lower grades and are largely unexploited. Hanging wall stockworks are present in contact with important mineralized quartz veins across the deposit.

The modeled mineralization at the West Mine surface pillar are designated the 105 to 114 zones and occur west of the West Shaft and from the surface to level 450. They include stacked quartz veins occurring at the Casa Berardi Fault, above the 330 level in the North West, North East, 111 and 113 zones. Between the Casa Berardi Fault and the conglomerate to the south, the South West (107), South East, and Inter (108) zones have mineralized quartz veins with graphitic and sericitic schist with sulphides inside the South Fault corridor. The orientation of mineralization is mainly east-west with a south dip of 50° to 60°. Mineralization shows visible gold associated with the veins. There is a low content of sulphides, mainly pyrite with traces of arsenopyrite. Mineralization plunges west at 15° is open to the west along the South Fault. Further east, mineralization has a plunge of 20° east and mineralization is open to the south from the 100 level to the 450 level.

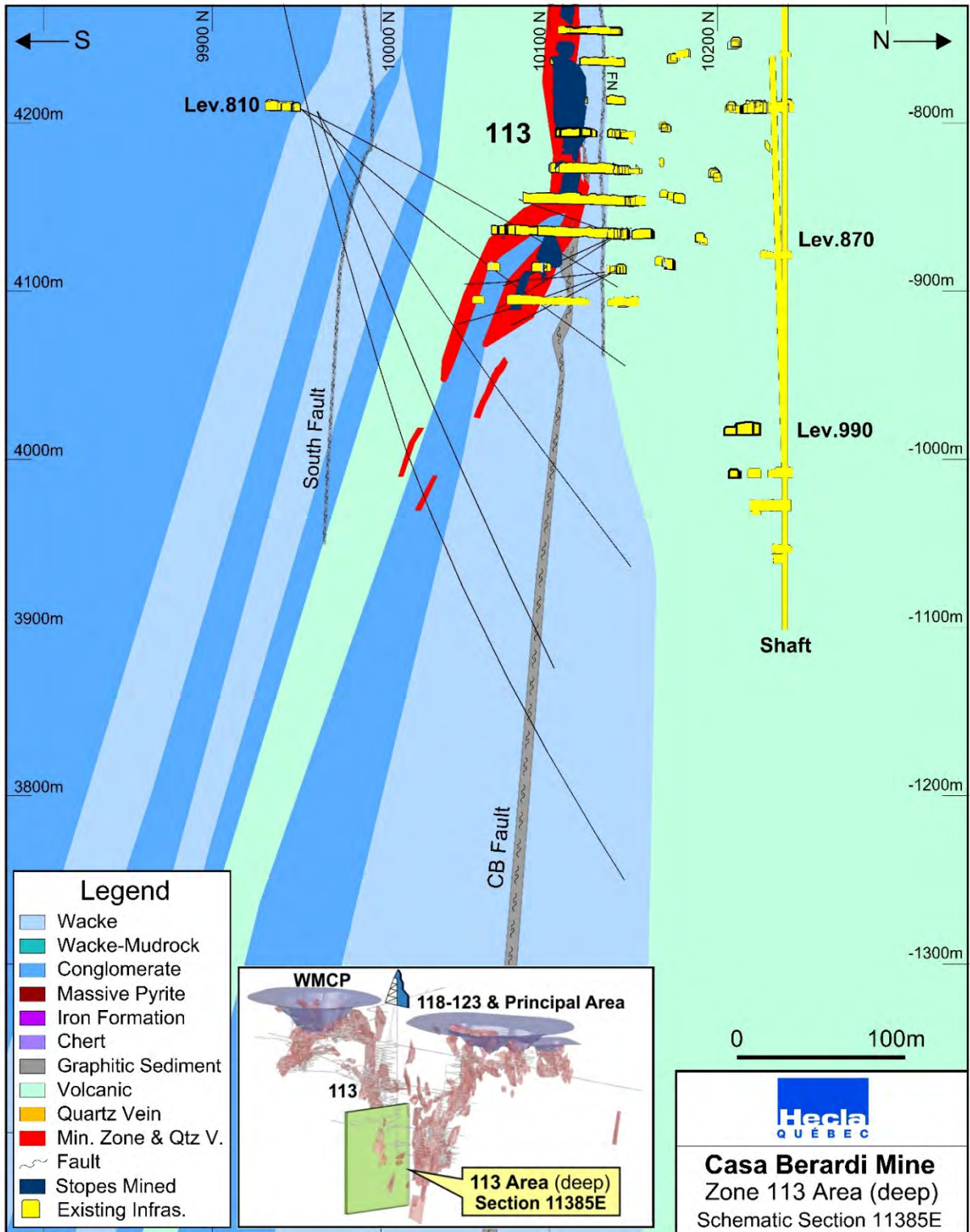
The South West (107-02 and 107-03 lenses) area occur as meter to multi-meter quartz veins stacked along the South Fault and folded near the surface. The strike of the lenses shows variable orientations from east-southeast and dipping to the south at 50° to 60°. The Inter (108-01, 02 and 04 lenses) Zone occurs between the Casa Berardi Fault and the South Fault. The mineralized structure is located at the contact between the graphitic sediments and a mafic volcanoclastic unit. The orientation of the mineralized structures is generally striking

east-southeast with a shallow dip to the south of 5° to 45°. The zones typically extend 150 m along strike and 75 m along the dip. The upper part of the zone is connected to the North East Zone and its lower part connects with the South West Zone. The type of quartz vein and the mineralization is quite similar to the veins found in the Lower Inter Zone.

### **7.3.4 MINERALIZATION ALONG THE CASA BERARDI FAULT**

Mineralized zones such as the North East, North West, 109, and 111 zones occur at the Casa Berardi Fault in the form of metric to plurimetric quartz veins. Veins occur over one thousand feet along strike and from 250 m to 550 m elevation and have a direction which varies from northeast to nearly east-west with a sub-vertical dip. The 109 Zone has a sub-horizontal dip at its western limit and a steeper dip to the east where it connects to the 113 Zone.

The 113 Zone is a mineralized corridor with a width ranging from 20 m to 70 m. The strike length ranges from 150 m at the 250 level to over 400 m at the 550 level. This mineralization strikes east-southeast and dips to the south at 75°. From the 450 to 800 level, the strike varies from east-west to east-southeast, with a sub-vertical dip (Figure 7.5). From the 810 to the 1000 level, mineralization varies from 5 m to 30 m in width and strikes east-west with a sub-vertical dip.



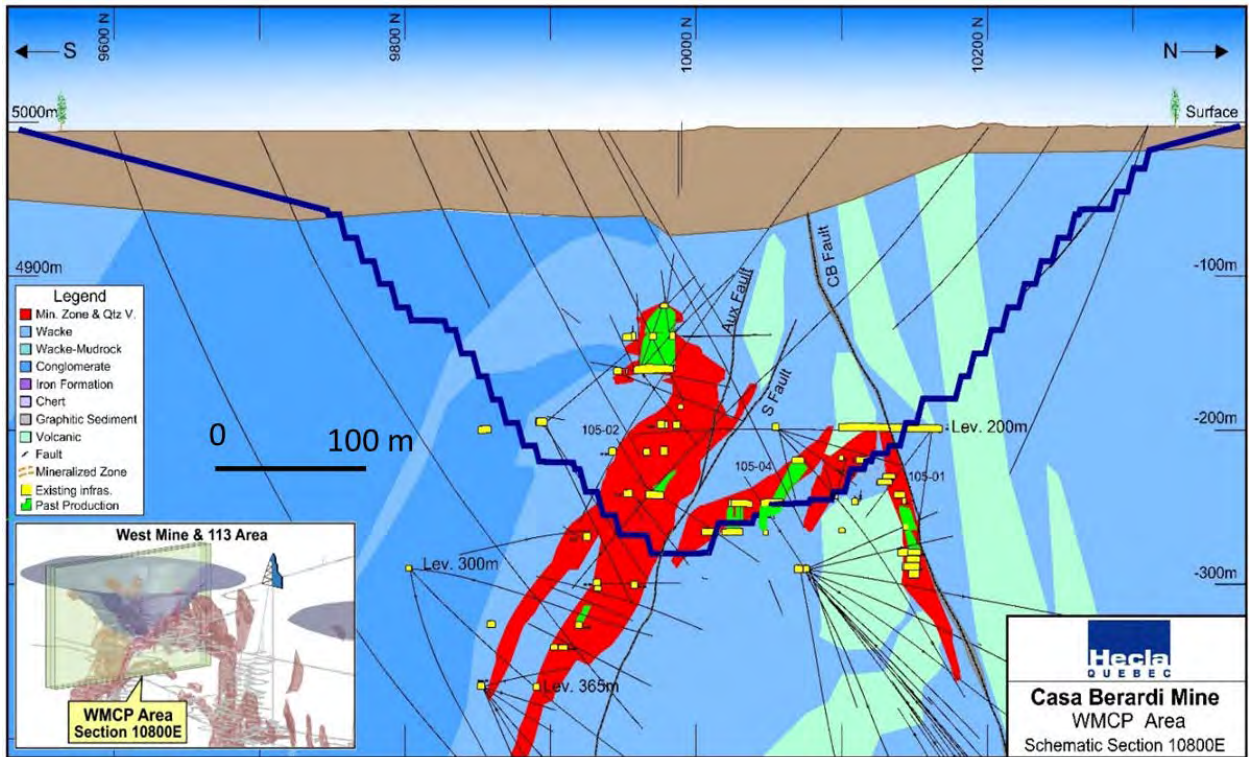
**Figure 7.5: Section 11,385E, West Mine including the 113 Zone and Casa Berardi Fault**

### **7.3.5 MINERALIZATION BETWEEN THE CASA BERARDI AND SOUTH FAULTS**

The Lower Inter, Inter, and 115 zones are relatively flat dipping. The zones plunge at approximately 15° to the west on the flat portions. The zones become steeper and are disrupted by minor thrust faults near the Casa Berardi Fault and near the South and Lower Inter Faults.

The Lower Inter Zone is located between the 375 and 600 levels, and from sections 10,525E to 10,360E. The zone dips at 25° to 45° south and plunges to the west at 15°. The zone is controlled by the Casa Berardi and the Lower Inter faults and lies on top of the folded wacke-basalt contact (Figure 7.6). The thickness of the quartz vein varies from four metres to 50 m, with the maximum thickness observed just underneath the contact of the two faults. The thin sections are observed down-dip, along the Lower Inter Fault, and extend for approximately 200 m. Stacking of quartz veins is observed in a deformation zone that is located at the lithological contact between the footwall mafic volcanic rock and the hanging wall graphitic mudrock.

The Inter Zone is located from sections 10,600E to 10,950E, and from the 150 m level to the 310 m level. The mineralized structure is located at the contact between the graphitic sediments and a mafic volcanoclastic unit. The mineralized structure strikes southeast with a shallow dip to the south (5° to 45°) and extends 150 m laterally and 75 m along dip. Its upper part is connected to the North East Zone where the quartz vein and mineralization are similar to the Lower Inter Zone.



**Figure 7.6: Section 10,800E, West Mine Geology and Mining Infrastructure**

### 7.3.6 MINERALIZATION AT THE SOUTH FAULT

In plan view, the South West and South East zones can be interpreted as a dome that is cut by the South Fault and by the subsidiary Auxiliary Fault. The mineralized system extends 200 m laterally and 300 m along dip, extending from surface to the 300 m level.

The main quartz vein structures are developed at the contact between a conglomerate and a graphitic mudrock and are associated with a large stockwork of disseminated sulphides. The internal vein structure shows variable orientations and is, in many places, brecciated. The economic mineralization extends down dip and is represented by a system of parallel veins which dip at 60°.

### 7.3.7 MINERALIZATION IN THE 118 ZONE

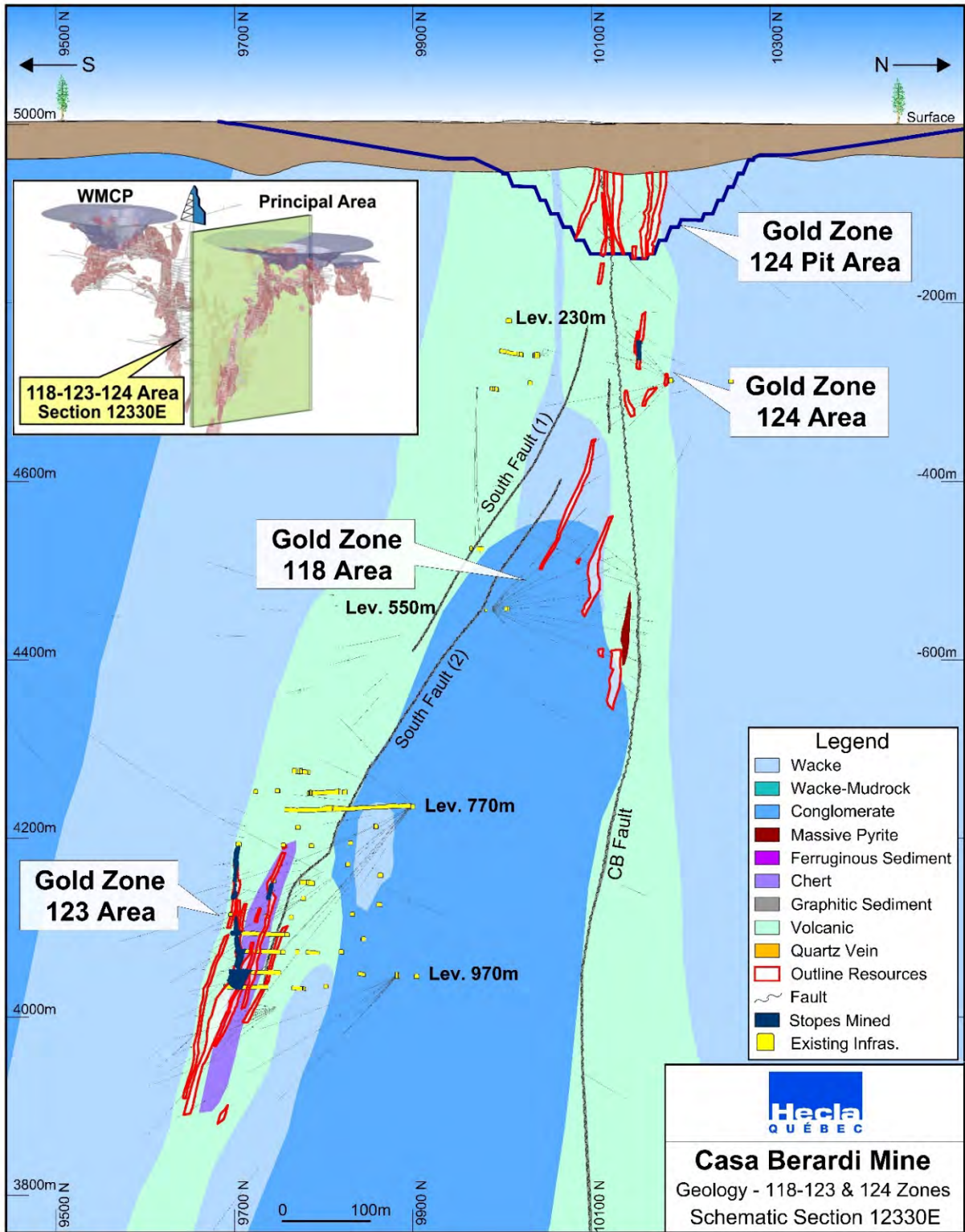
The 118 Zone occurs from section 11,550E to 12,350E, between the 400 m and 1,200 m levels (Figure 7.4). The mineralization occurs within a 20 m to 70 m wide mineralized corridor south of the Casa Berardi Fault (Figure 7.7) and is composed of stacked quartz veins and quartz stockwork within a sequence of volcanic and sedimentary rocks. It has an east-west

strike and dips south at 60° to 80°, with a plunge to the west at a dip varying from 45° to 70°. The lens ranges from three meters to five meters in thickness, strike east-southeast, and dips to the southwest at 70°. Mineralization is open along the west down plunge and to the east.

### **7.3.8 MINERALIZATION IN THE 123 ZONE**

The 123 Zone occurs in the south domain of the Casa Berardi deformation corridor (Figure 7.7). It is located from section 12,200E to section 12,600E, between the 200 and 1,100 levels. The zone consists of quartz veins and stockwork of quartz from approximately one meter to up to 30 m thick, within a sequence of highly deformed and altered volcanic and sedimentary rocks. This zone is south of the highly deformed conglomeratic unit that host the 118 Zone.

The southern contact of the conglomerate is highly sheared and faulted, with minor east-southeast graphitic faults. Mineralization occurs as quartz veins with high sulphide content. Veins are emplaced along thick massive chert bands and massive pyrite that are up to 5 metres in thickness. Mineralization in quartz veins occurs as disseminations and stringers of pyrite, pyrrhotite and arsenopyrite, with fine visible gold and minor disseminations of sphalerite and galena. The zone strikes east-northeast and dips to the south at 60° to 70° and is open at depth.

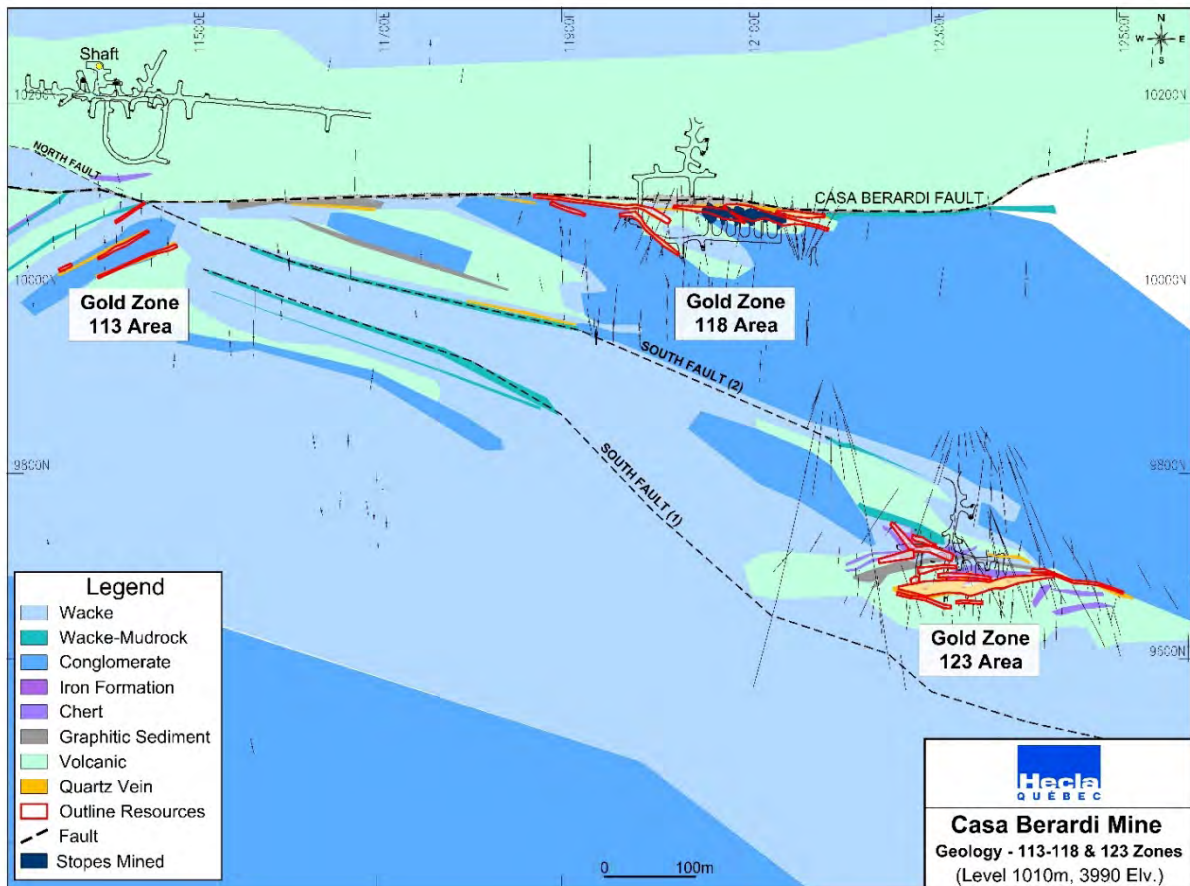


**Figure 7.7: Section 12,330E, Principal Area Geology 118, 123 and 124 Zones**

### 7.3.9 MINERALIZATION IN THE PRINCIPAL MINE AREA

The mineralization in the Principal area of the West Mine has a width of 30 m to 120 m occurs to the north and south of the Casa Berardi Fault and is dominated by the 118 and 123 zones. The 118 Zone extends at depth along the Casa Berardi Fault and the 123 Zone is located in the south domain of the Casa Berardi deformation corridor (Figure 7.8).

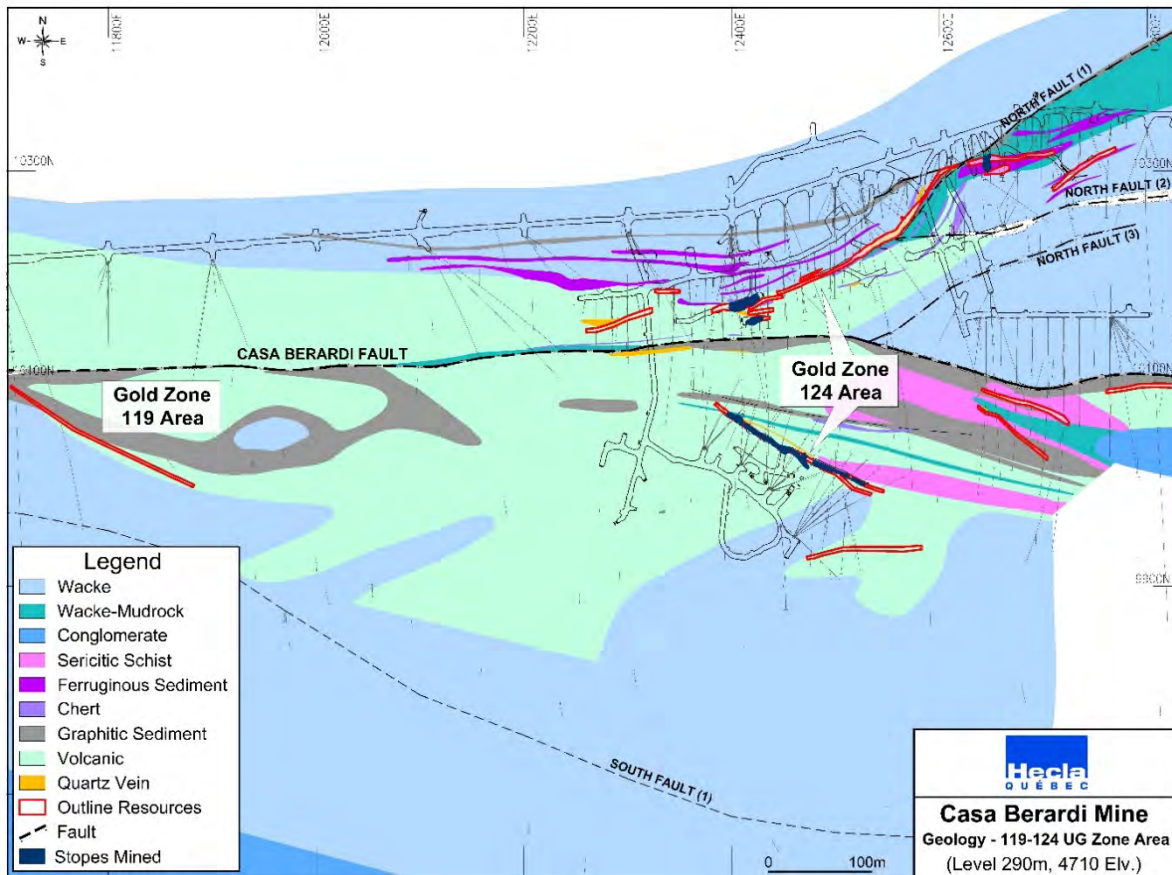
The zones are located from surface down to the 1,050 m level and 600 m to 2,000 m to the east of the West Mine production infrastructure. Gold mineralization occurs within meter to sub-meter quartz veins and stockworks containing fine grained to massive pyrite and arsenopyrite, traces of pyrrhotite, and very minor visible gold. Alteration is mainly chloritization and carbonatization (calcite and ankerite), with sericitization along the quartz veins. Mineralization strikes east-west or east-southeast and dips 70° to 80° to the south.



**Figure 7.8: Plan View of the 1010 Level, Principal Area, including the 118 and 123 Zones**

South of the Casa Berardi Fault, the 124 Zone occurs as stacked, meter-wide, quartz veins near the Casa Berardi Fault (Figure 7.9). It is the up-dip extension of the 118 Zone and occurs on top of the conglomerate. The overall orientation of the zone is east-southeast and dips to the southwest at 50° to 80°. The mineralization plunges to the southeast at 50° and consists of arsenopyrite, pyrite, and visible gold within quartz veins. The 124 Zone corresponds to the structure that connects the north and south domain of the 123 Zone.

The mineralized zones north of the Casa Berardi Fault appear within highly sheared, brecciated and altered ferruginous sediments between or near chert bands with minor magnetite. Gold mineralization occurs within meter to sub-meter quartz veins and stockworks containing fine grained to massive pyrite and arsenopyrite, traces of pyrrhotite, and very minor visible gold. Alteration is mainly chloritization and carbonatization (calcite and ankerite), with sericitization along the quartz veins. The strike varies from east-west to east-northeast with the dip to the south at 70° to near-vertical. The mineralization plunges to the east at 50° and remains open to depth and to the east.



**Figure 7.9: Plan View of the 290 Level, Principal Area including the 124 Zone Lenses**

### 7.3.10 MINERALIZATION IN THE EAST MINE AREA

Mineralization in the East Mine area includes the 148, 152, and 160 zones that are located between sections 14,700E and 16,000E (Figure 7.11). Past production came from stopes in the 148 Zone between surface and the 550 m level. Mining was restricted to two main parallel veins averaging five meters in thickness and not exceeding 150 m in strike length along the Casa Berardi Fault.

Based on geometry, structural and geological contexts, the East Mine mineralized structure can be divided into three depth-related parts:

1. Between surface and the 200 m level, the sedimentary and mafic volcanic units, which are located south of the Casa Berardi Fault, are south dipping and have variable strike directions. Mineralization is composed of quartz vein stockworks of several metres in thickness, within a 30 m wide envelope of

sulphide-rich sericitic schist, which dips 60° to the north. From surface to the 100 m depth, two parallel sub-vertical veins (North Zone and South Zone) compose most of the crown pillar residual mineral resources.

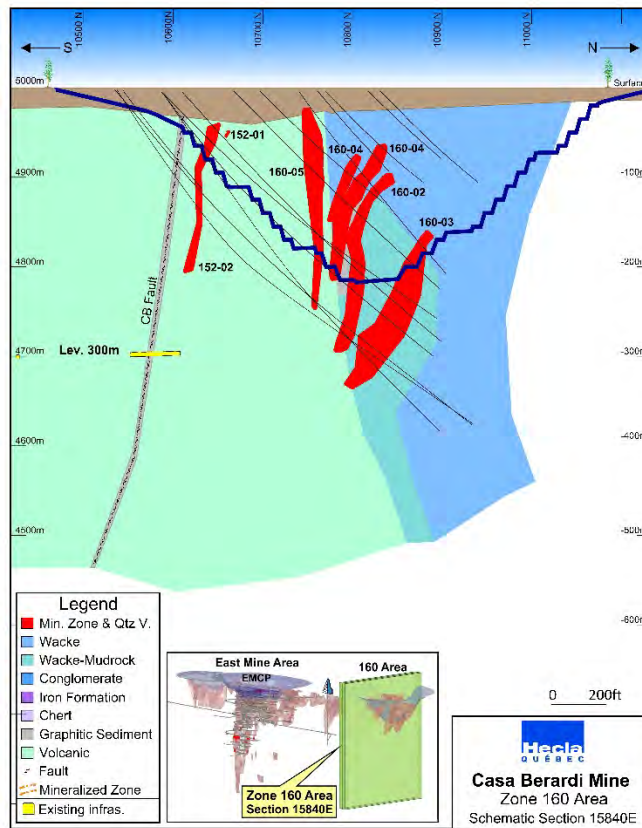
2. Between the 200 m and 550 m levels, the mineralization is restricted to a continuous vertical quartz veins that are parallel to the Casa Berardi Fault. Host rocks, except the narrow graphitic schist layer which controls the fault position, are mafic to intermediate volcanic rocks.
3. Between the 550 m and 900 m levels, the remaining mineral resources are in the south dipping area which is represented by a succession of mudrock layers inside the volcanic sequence. Veins and stockworks are heavily faulted and truncated by the Casa Berardi Fault.

Mineralization of the East Mine Crown Pillar west extension (EMCP Ext) is 30 m south of the Casa Berardi Fault. It is composed of massive veins, vein stockworks and fine disseminations of pyrite and pyrrhotite within highly altered wacke and iron formation north of the conglomerate unit. Little mineralization appears at the Casa Berardi Fault. The mineralization corridor has an east-north-east direction and dips south at 75°. Mineralization still open at depth for future underground exploration drilling.

The underground mineral resources and mineral reserves of the East Mine Crown Pillar pit are located between surface and the 200 m level. The mineralized envelopes are composed of quartz veins and quartz stockwork several meters thick and contain fine disseminated pyrite, arsenopyrite and visible gold. Mineralization appears mainly at the Casa Berardi Fault, with a steep dip to the north. Between the 200 m and 550 m levels, the mineralization is restricted to a continuous 10 meters wide vertical quartz vein which is parallel to the Casa Berardi Fault. Between the 550 m and 900 m levels, the remaining mineral resources are in the south dipping quartz veins that are meter to multi-meter thick, strike east-northeast, with south dips varying from 60° to 85°. Mineralization is opened to depth and along the strike.

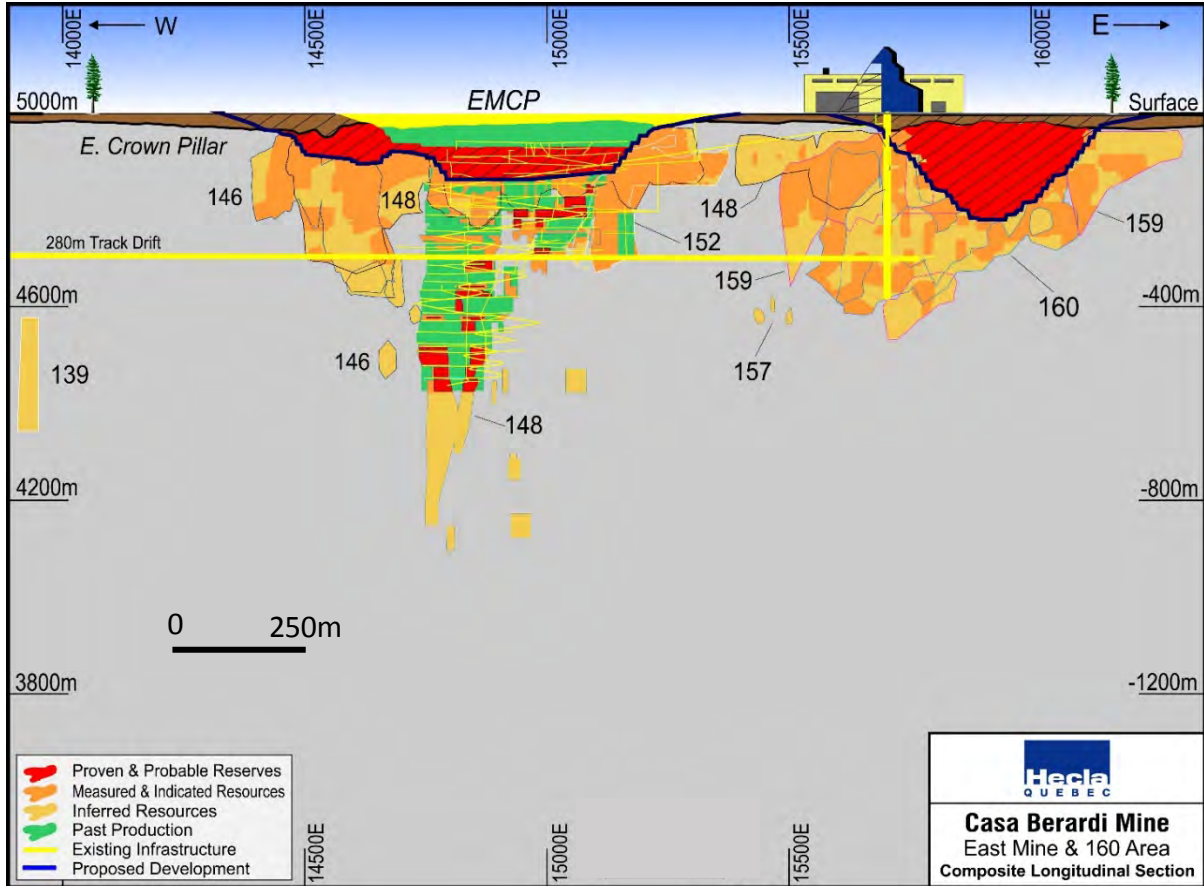
The Cherty Zone and the 160 Zone are located north of the Casa Berardi Fault and have been drilled to a depth of 300 m. The 160 and 159 (Cherty) zones are located between sections 15,700E and 16,000E and are 400 m north of the Casa Berardi Fault. They have a lateral extent of 200 m and a vertical extent of 300 m from surface. The zones have been defined by drilling on 25 m spaced sections.

Mineralization in 160 Zone occurs at or near the folded contact of pyroclastic rocks and fine-grained sediments, mainly wacke, graphitic mudrock and metric to multi-metric ferruginous sediments (Figure 7.10). The orientation of the lenses is generally east-west and dip to the south at 65° to 75°. Mineralization is composed of metric to sub-metric quartz veins and stockworks containing fine pyrite and arsenopyrite, traces of pyrrhotite, and very minor visible gold. Mineralization show a shallow plunge to the west-southwest at 40°. Alteration is mainly chloritization and carbonatization (calcite and ankerite), with sericitization along the quartz veins.



**Figure 7.10: Section 15, 840E, East Mine Geology and Infrastructure - 160 Zone**

The 152 Zone lies to the north of the Casa Berardi Fault. Its vertical extension is 200 m, from section 15,050E to section 15,250E, and from 100 m level to 300 m level, and lateral continuity is over 100 m (Figure 7.11). Stacked quartz veins are concentrated at a folded mafic volcanic wacke contact. The dip and thickness of the mineralization are highly variable. The economic portion of the zone has been mined out in the sub-horizontal sector of the zone.



**Figure 7.11: East Mine Composite Longitudinal Section**

#### 7.4 COMMENTS ON GEOLOGICAL SETTING AND MINERALIZATION

In the QP’s opinion, the geological understanding of the settings, lithologies, structural and alteration controls on mineralization, and mineralization continuity and geometry in the defined mineralized zones is sufficient to support estimation of Mineral Resources and Mineral Reserves. The geological knowledge of the area is also considered sufficiently acceptable to reliably inform mine planning. The mineralization style and setting are well understood and support the declaration of Mineral Resources and Mineral Reserves.

## 8.0 DEPOSIT TYPES

The Casa Berardi gold deposit can be classified as an Archean age, sedimentary-hosted lode gold deposit. Gold deposits of the Archean Abitibi greenstone belt dominantly consist of epigenetic disseminated and vein-hosted deposits, and syngenetic gold-rich massive sulphides (Robert et al., 2005; Monecke et al., 2017). Both types of mineralization could potentially occur within the same deposit in areas where deformation and metamorphism overprint volcanic successions. Deformation and metamorphism can significantly modify the mineralogy and geometry of previously formed ores. Nevertheless, superposition of hydrothermal events, metamorphism and deformation, represent important processes for gold concentration and the formation of world-class gold deposits in greenstone belts and sedimentary rocks in general (e.g. Dubé et al. 2007; Large et al., 2007).

The Casa Berardi gold mining camp in the northern Abitibi greenstone belt contains different styles of mineralization within the same deposit including gold-rich massive sulphides, auriferous pyritic and carbonaceous phyllite and chert, as well as pyrite-arsenopyrite-gold-quartz veins. It is therefore considered an ideal setting to study the effects of superimposed hydrothermal systems and to contribute to better understanding of the Casa Berardi Mine and prospective areas along the extensive Casa Berardi deformation zone.

Although the deposit model was based on research and reports of other experts, the QP has approved the information and deposit type interpretation.

## **9.0 EXPLORATION**

Exploration carried out since June 2013, when Hecla acquired the Casa Berardi property, has mostly consisted of drilling and data compilation and integration, which is described under Section 10 of this report. During autumn 2017, a helicopter-borne Versatile Time Domain Electromagnetic (Vtem™ plus) and Horizontal Magnetic Gradiometer Geophysical survey, totaling 1,587 line-kilometres, was flown over the entire Casa Berardi Regional property.

### **9.1 COMMENTS ON EXPLORATION**

In the QP's opinion:

- The exploration programs completed to date are appropriate to the style of the deposit and prospects;
- Additional drilling has a likelihood of generating further exploration successes.

## 10.0 DRILLING

### 10.1 MINESITE DRILLING

Table 10-1 summarizes exploration and definition drilling programs carried out since 2006 over as well as the 2018 budget. The extensive surface and underground drilling programs have been developed to investigate the West and East Mine areas.

**Table 10-1: Exploration, Definition and Infill Drilling Programs from 2006-2018**

	Year	Surface Exploration (m)	Underground Exploration (m)	Infill Definition (m)	Total (m)
Aurizon	2006	28,304	19,779	24,578	72,661
	2007	10,445	0	20,434	30,879
	2008	1,014	7,043	21,928	29,985
	2009	19,303	16,477	38,787	74,567
	2010	27,974	37,834	32,881	98,689
	2011	35,979	5,552	63,317	104,848
	2012	29,928	13,052	57,894	100,874
	2013	12,906	3,916	16,149	32,971
Hecla	2013	7,650	3,152	24,648	35,450
	2014	20,556	7,068	40,797	68,421
	2015	22,058	6,158	63,016	91,232
	2016	21,185	4,827	56,950	82,962
	2017	32,877	17,326	73,418	123,621
	2018	28,447	15,942	60,023	104,412
	<b>Total</b>	<b>298,626</b>	<b>158,126</b>	<b>594,820</b>	<b>1,051,572</b>

The main exploration and definition drilling programs are summarized below.

#### 2006

Definition drilling was active in the 113 and the Lower Inter zones. Exploration drilling was carried out to follow up on Inferred Mineral Resources in the 118 to 120 zones that were identified by wide spaced drilling from surface. In the Extension of the mineralization contained in the crown pillar of the East Mine were also tested. Exploration of the 122-Deep Zone continued where underground exploration intersected high grade mineralization along the Casa Berardi Fault, 1,000 m below surface and 800 m from the existing infrastructure.

## **2007**

Definition drilling continued in the 113 Zone. The first phase of definition drilling in the Lower Inter Zone was completed. Underground exploration drilling was focused on the 118 to 120 zones.

Zones and surface exploration drilling targeted the 123 Zone, the most significant discovery of mineralization to date outside the Casa Berardi Fault. The 123 Zone is located 350 m south and 900 m east of the existing West Mine infrastructure.

## **2008**

Surface exploration was carried at the East Mine to convert Inferred Mineral Resources into Indicated Mineral Resources. Definition and in-fill drilling programs were conducted in the 113 and Principal area zones.

## **2009**

The budget of exploration, definition and in-fill programs increased substantially in comparison to 2008. Surface exploration drilling was mainly concentrated in the Principal area to increase Mineral Resources and to evaluate open pit and underground potential. Underground exploration was carried out in the 118 and 123 zones from the 810 m level exploration drift. Definition and in-fill drilling were mainly carried out in the 113, 118, 123 and Lower Inter zones.

## **2010**

Surface exploration drilling was mainly concentrated in the Principal area of the West Mine to convert Mineral Resources into Mineral Reserves. Underground exploration was carried out in the 118 and 123 zones from the 810 m level exploration drift. Definition and in-fill drilling were mainly carried out in the Lower Inter, 109, 113, 115, 118, 123 and 124 zones.

## **2011**

The surface exploration program tested the down-plunge of the Lower Inter Zone, the northeast extension of the 118, 123 and 124 zones, the deep down-plunge of the 123 Zone, the potential at depth of the East Mine, and the open pit potential of the 160 Zone. Underground exploration drilling was carried out to verify continuity and extensions of the Principal Mine, primarily in the 118 Zone. Definition and in-fill drilling were

conducted in the 109, 118, 119, 123, and 146 zones.

## **2012**

The surface exploration program was carried out to test the western extension of the 160 Zone, the eastern extension of the Principal area in the West Mine, and the potential at depth of the Lower Inter and 123 zones, and in the East Mine. Underground exploration drilling was conducted to verify continuity and extensions of the Lower Inter, Principal Mine, 118, 140, and 160 zones. Definition and in-fill drilling were planned in the Lower Inter, 113, 109, 111, 115, 118, 123, and 146 zones.

## **2013**

The surface exploration program tested the extension of the 123 and 134 zones. Underground exploration drilling was mainly carried out in 140 and 159 zones. Definition and in-fill drilling were mainly carried out in 113, 115, 118, 119, 123 zones.

## **2014**

The underground exploration targeted the West Mine with the down plunge extension of the 113 Zone, on the 118, 123 and 124 zones in the Principal area and a small campaign was done on the east extension of the Principal area for the 140 Zone. Surface exploration targeted the Principal area east extension with the 134 and 140 zones. Definition and in-fill drilling were done entirely from underground to drill the extension of known mineral reserves-mineral resource near the West Mine on the 113, 118, 123 and 124 zones.

## **2015**

Exploration drilling has targeted the 118, 123, 124 and Lower Inter zone in the West Mine from underground and surface. Drilling continued to target the East Mine potential for the 144 and 157 zones and to test the down plunge of the 148 and 160 zones. Infill and definition drilling were carried mostly in the Principal area on the 118, 123 and 124 zones.

## **2016**

The 2016 surface exploration drilling program continue targeting the West Mine with the 109 and 113 zones below the current infrastructure. From underground the extension of the Lower Principal targeted to the 117 Zone. Infill and definition drilling were carried out mostly in the Principal area including the 118, 123 and 124 zones.

## **2017**

The program in 2017 was the largest drilling campaign since 2006. Exploration drilling has targeted the 123 and 124 zones from underground and surface. A surface exploration campaign was completed on the 134 Zone to test the open pit potential east of the Principal area. The potential for open pit near the West Mine drilled the North West and South West zones in the crown pillar. Infill and definition drilling from surface targeted the East Mine Crown Pillar pit, the 134 Zone and the 160 Zone proposed pit. Underground infill and definition were completed at the Principal area to extend the mineral resources and mineral reserves for the 118, 123 and 124 zones.

## **2018**

Surface and underground drilling continued in 2018. Exploration covered the West Mine, and the East Mine to evaluate both surface and underground target. Surface exploration has targeted the down plunge of the 134 Zone under the proposed pit. Surface drilling also targeted the east extension for underground potential of the 124 Zone. The exploration drilling from surface tested the west extension of the 146 and 148 zones for underground potential. A combination of definition and exploration drilling targeted the West Mine Crown Pillar to better define the pit potential. Underground exploration has continued in the Lower Principal area from the 990 level to test the down plunge of mineralization of the 118 and 123 zones. Infill and definition drilling from surface were mainly designed to define an open pit in the East Mine Crown Pillar, 134 Pit, 160 Pit and West Mine Crown pillar Pit areas. Underground infill and definition drilling were carried out in the Principal area to evaluate the 118, 123 and 124 zones. In 2018 underground definition drilling started in the East Mine from level 300 under the 160 Zone proposed pit to test the down plunge of mineralization for underground mining potential.

## **10.2 CASA BERARDI REGIONAL DRILLING**

### **LAKE SHORE DRILLING 2007-2012**

In September 2007, Aurizon Mines and Lake Shore Gold Inc. (Lake Shore) signed an option agreement by which Lake Shore could acquire a 50% interest in the Casa Berardi Regional property. Lake Shore earned its 50% interest at the end of 2012.

## 2008

In winter 2018, carried out a first drilling program by drilling 12 holes totaling 4,470 m. Ten holes were drilled about 7.5 km east of the East Mine and Mill Complex, this area now being known as the Lac Germain prospect. Two holes, CE-08-06 and CE-08-09, were drilled near Inco Gold's hole 84716-0, two kilometers to the west of this area. In addition, 79 reverse circulation (RC) holes were completed at the same time over the East Block.

The winter 2008 diamond drilling program succeeded in the discovery of the "G Zone" at the Lac Germain prospect. The best intersection in hole CE-08-03 yielded 13.03 g/t Au over 6.45 m (core length or c.l.) within a broader interval of 8.58 g/t Au over 10.4 m (c.l.). This mineralization was located approximately 90 m below a historical value of 11.11 g/t Au over 2.24 m (c.l.) in Inco's hole 84724-0. The G Zone was then subdivided in three sub-zones called G-S Zone, G-Mid Zone and G-N Zone. Gold mineralization was associated with quartz-carbonate-sulphide veins within sedimentary rocks, north of a mafic volcanic package. Higher grade mineralization displayed stronger wall rock alteration and a higher sulphide content, with some quartz and sulphide stringers at a shallow angle to the core axis.

The 79-hole RC drill program was designed to test new areas and to follow up on areas of interest identified via the compilation of previous data. 173 bedrock samples were collected during the RC program and assayed for gold. The location of source of two gold dispersal trains, east of the Theo River, was interpreted near the northern contact between mafic volcanic and sediments. The first dispersal train was located south of Lake Shore's drill holes CE-08-06 and CE-08-09. The second gold train occurs at about 4.1 km east of Lac Germain and 5.1 km east of the Lac Germain prospect.

## 2009

In 2009, Lake Shore drilled 16 holes totaling 6,896 m on the Casa Berardi Regional. Ten of these holes, for 3,656 m, were drilled on the Lac Germain prospect and the six others, for 3,240 m, on the West Block between the West Mine and the Agnico Eagle claim block. The drilling on the Lac Germain prospect extended the G Zone. Hole CE-09-12, to the East, returned 2.33 g/t Au over 7.3 m (c.l.), and hole CE-09-18, to the West, returned 3.04 g/t Au over 6.3 m (c.l.). Drilling on the West Block led to the discovery of a new gold zone in hole CW-09-23 that returned 3.44 g/t Au over 3.9 m (c.l.) in a broader 23.2 metre gold-anomalous interval. Mineralization consisted of ribboned, quartz-ankerite veins with 5%

to 70% pyrite and pyrrhotite and minor arsenopyrite, within a large package of chert-sulphide iron formation in strongly deformed and altered graphitic wacke.

## **2010**

In 2010, Lake Shore drilled 11 holes totaling 4,111 m. Eight holes, for 2,814 m, were drilled on the Lac Germain Prospect and three others targeted aeromagnetic anomalies similar to the one at the Lac Germain prospect. New drilling results on the G Zone included 11.54 g/t Au over 3.9 m (c.l.) in CE-10-30 and 4.75 g/t Au over 1.0 m (c.l.) in hole CE-10-32, both located in the west-central portion of the G Zone. On the eastern end of the G Zone, holes CE-10-29 and CE-10-31 returned several anomalous and high-grade gold intervals, notably 40.2 g/t Au over 0.4 m (c.l.) and 8.4 g/t Au over 1.4 m (c.l.) in hole CE-10-29, and 14.7 g/t Au over 0.5 m (c.l.) in hole CE-10-31.

Hole CE-10-35 that tested a magnetic anomaly to the East of Lac Germain about 5 km east of the Lac Germain prospect failed to intersect gold mineralization. Holes CE-10-36 and CE-10-37 were drilled to test magnetic anomalies at the west end of the East Block. Only one interval in hole CE-10-36 yielded 1.63 g/t Au over 1.0 m (c.l.). Hole CE-10-37 intersected a narrow Qtz vein with one speck of visible gold that yielded no value, and another Qtz vein returned 2.57 g/t Au over 0.8 m (c.l.).

## **2012**

During the summer of 2012, Lake Shore drilled hole CW-12-38 to test the down-dip extension of the gold mineralization intersected in hole CW-09-23. It intersected some gold-bearing mineralization and best intervals were 3.24 g/t Au over 1.5 m (c.l.) and 1.38 g/t Au over 12.4 m (c.l.) including 2.53 g/t Au over 3.1 m (c.l.).

## **10.3 HECLA QUEBEC EXPLORATION - 2016 TO 2018**

### **2016**

From 2012 to the end of 2016, the Casa Berardi Regional was still under a Joint Venture between Lake Shore and Hecla, but no exploration work has been carried out on the field. In February 2016, Tahoe Resources Inc. purchased Lake Shore, and at the end of 2016, Hecla Mining bought back the Tahoe's 50% interest in exchange of CAN\$5 million and 1% NSR on 227 claims.

In 2016, Hecla resumed data compilation and integration to generate drill targets and staked three new claims to add to the property. There is no NSR tied to these new claims.

## **2017**

In 2017, Hecla staked 36 new claims to bring the number of claims to 266. There is no NSR tied to these new claims. In winter 2017, Hecla carried out on the West block, a 6,620 metre drilling program in 19 holes, between the West shaft and the Agnico Eagle property. Also, Hecla's geologists re-logged and sampled, for lithogeochemistry, 47 Lakeshore's drill holes (20,910 metres) from Lac Germain and the West Block. Finally, during Autumn 2017, a helicopter-borne Versatile Time Domain Electromagnetic (vtem™ plus) and Horizontal Magnetic Gradiometer Geophysical survey, totaling 1,587 line-kilometres, was flown over the entire Casa Berardi Regional property.

The 2017 exploration program on Casa Berardi regional program was successful in defining new mineralization to the west of the Casa Berardi Mining Lease. Drilling on the West Block succeeded in discovering new gold mineralization. In hole CBS-17-783, the best assay result was 1.57 g/t Au over 3.5 m and mineralization is related to the 30% pyrite and trace arsenopyrite in a sericitized and silicified wacke. In hole CBS-17-788, two intervals of quartz veins stockwork with up to 10% pyrite and trace arsenopyrite yielded 4.49 g/t Au over 1.0 m (c.l.) and 4.76 g/t Au over 1.7 m (c.l.) at borehole depths of 135 m and 235 m, respectively. Drilling and relogging succeeded in improving the geological model and understanding of the West block and in the Lac Germain, in confirming exploration potential and in delineating exploration targets for 2018.

## **2018**

In 2018, Hecla bought four claims from an individual prospector to bring the number of claims to 270. There is no NSR tied to these claims. During winter of 2018, Hecla drilled 13 follow-up drill holes (4,610 m) on near-surface targets on the West Block and 27 holes (6,656 m) on the Lac Germain prospect. A bridge was built over Theo River to improve access to the Lac Germain area. There were also 46 holes re-logged from previous drilling on the East and West Blocks.

On the West Block, the most significant mineralization was in hole CBS-18-959 that intersected 73.1 metres of chloritized felsic QP volcanic rock with up to 30% pyrite as

semi-massive to massive beds and stringers. Assays returned 1.23 g/t Au over 19.1 m (c.l.) including a massive sulphide section that yielded 3.76 g/t Au over 1.8 m (c.l.).

On the Lac Germain prospect, drilling succeeded in intersecting high-grade and wide gold-bearing mineralized zones. Mineralization was interpreted as six gold-bearing subparallel lenses, LG 1 to LG 6, forming a 100-meter-wide corridor in a sequence of wacke and banded iron formations. These lenses strike  $\approx N70^\circ$  and dip between  $65^\circ$  to  $75^\circ$  to the south. In the LG 1 Zone, hole CBS-18-955 returned 11.31 g/t Au over 3.6 m (c.l.) including 25.30 g/t Au over 1.2 m (c.l.). In the LG 2 Zone, hole CBS-18-940 returned 5.5 g/t Au gold over 4.0 m (c.l.) and hole CBS-18-942 returned an exceptional value of 461.0 g/t Au over 0.6 m (c.l.). In the LG 3 Zone, hole CBS-18-935 and CBS-18-947 returned 5.61 g/t Au over 3.3 m (c.l.) and 4.08 g/t Au over 2.6 m (c.l.). Finally, in the LG 4 Zone wide intersections of 5.22 g/t Au over 6.5 m (c.l.) in CBS-18-955, 3.66 g/t Au over 8.4 m (c.l.) in CBS-18-960 and 5.97 g/t Au over 4.5 m (c.l.) in CBS-18-968, were reported. Gold-bearing mineralization was related to quartz and quartz carbonate veinlets and veins up to 1.5 meter thick. The veins contained minor amounts of pyrite, pyrrhotite and arsenopyrite and gold grades correlated with the amount of arsenopyrite. Visible gold was related to traces of sphalerite and galena.

### **10.3.1 HECLA QUEBEC DRILLING PROTOCOLS**

The classification of drill holes is divided in three categories. The exploration drilling at the Casa Berardi Mine can have a wide range of purpose along the 37 kilometers of the property. Surface and underground exploration drilling are planned inside the mining leases along the strike of known gold occurrences to build future inferred mineral resources. Regional exploration outside the mining lease targeting favorable geoscientific features along the Casa Berardi Deformation Zone. Conversion holes classified as definition and infill drilling occur mainly at the mine site (surface and underground) within the mine areas and are designed to convert and increase the Indicated mineral resources for future mining potential. Condemnation drills holes has been completed to condemn sectors from exploration and built the infrastructure of the Casa Berardi complex.

Drill holes are planned (azimuth, dip, length) by geologists on vertical cross-sections and on vertical longitudinal sections on the Gems software. Drill lines are marked underground (front site and back site) by the mine surveyors. Prior to drilling, a technician verifies the drill rig

alignment on hole set-up. On surface, drill collars are spotted on the field lines with the use of surveying equipment. Usually, two front sites, identified with wood pickets, are used to align the drill rig. Down-hole deviations (azimuth and dip) are measured with Reflex instruments approximately every 50 m along the hole. Complementary with the Reflex survey, a North Seeker Gyro is used when drilling is completed near magnetic rock. This type of survey is not impacted by magnetism and can provide accuracy in defining the down hole drill trace. Once a hole is completed, collars are surveyed by mine surveyors and geology technicians. All drill holes on site are cemented on the total length as far as possible.

Surface diamond drilling is focused during winter to take advantage of the frozen ground (January to April) and minimize the environmental impacts of the drilling. The drills rigs are moved on icy roads using heavy equipment and snowmobiles and are set up on winter drill pads. Surfaces drilling is reduced during summer season to minimize the foot print of gravel road that is built to access the drilling pads. Underground drilling from the West Mine and East Mine are conducted from drill bays, haulage drifts or other accessible drilling platforms. The underground drills are moved with heavy underground equipment and access to the drill is done by service truck or tractor.

Typically, NQ diameter drill core is used for exploration, in-fill, and definition drill holes. In some surface and underground holes, due to difficulties in drilling, usually ground condition problems, the drill core diameter will need to be reduced from NQ to BQ (telescoping).

Once retrieved from core barrel the core is placed in sequential order in core boxes labelled with the hole number. Each run, usually three meters, is identified by a wood block on which the depth of the hole is marked. Missing (not recovered) core is identified by a wood stick indicating the length of the missing section. At the end of each shift, core boxes are transported by the drillers' foreman to the core shack on site. The Hecla technician will sort and open the core box to evaluate the core quality and measure the accumulated core length. Each core box is photographed and link with the log database. An aluminum tag etched with the hole number, box and the contained "from to" is fixed to each core box. After this quality control the geologist make a detail log description of the holes into the Gems logger database.

## 10.4 COMMENTS ON DRILLING

In the opinion of the QP, the quantity and quality of the logging, geotechnical, collar and down-hole survey data collected in the exploration and infill drill programs are sufficient to support Mineral Resource and Mineral Reserve estimation as follows:

- Core logging performed by Hecla staff meets industry standards for exploration on gold deposits;
- Core logging performed prior to Hecla acquiring 100% Project ownership met industry standards at the time of logging;
- Collar surveys for Hecla core holes have been performed using industry-standard instrumentation;
- Collar surveys for drillholes prior to 2013 were performed using methods that were industry-standard for the time;
- Down-hole surveys have been performed using industry-standard instrumentation for the life of the project;
- Drilling practices, logging, collar surveys and down-hole surveys have been periodically reviewed by independent auditors (refer to Section 12);
- Recovery data from core drill programs are acceptable;
- Geotechnical logging of drill core meets industry standards for planned open pit and underground operations;
- Drilling is normally perpendicular to the strike of the mineralization or at an orientation appropriate for the mineralization style;
- Drill orientations are shown in the example cross-sections in Section 7, and are considered to appropriately test the mineralization;
- No factors were identified with the data collection from the drill programs that could affect Mineral Resource or Mineral Reserve estimation.

## **11.0 SAMPLE PREPARATION, ANALYSES AND SECURITY**

### **11.1 SAMPLING METHOD AND APPROACH**

#### **PROCEDURES TO HANDLE DRILL CORE PRIOR TO SAMPLING**

Drill core that resulted from Hecla Québec exploration and definition and infill programs is handled and sampled by LJL contractor technicians with the supervision of Hecla staff. The core is logged by Hecla Québec geologists at the mine core shack. Access to core shack is restricted to geology personnel by the use of magnetic cards that open the core shack door.

Upon receipt of the core boxes from the contractor, core boxes are placed on tables and opened. Core is washed and verified for length accuracy prior to logging. Rock quality designation (RQD) measurements and core recovery measurements are carried out in all surface and underground holes prior to logging. In general, RQD measurements are carried out over three meters lengths, with shorter lengths used in areas of bad ground. This allows better hole to hole interpretations of areas of good and poor RQD values. For a certain period of time between 2008 and 2010, RQD measurements were carried out over much longer lengths with some measurements over 20 m. Such measurements over long lengths are not very useful for rock mechanics purposes to identify zones of bad ground conditions and this practice was stopped. The entire core from underground drilling is photographed and systematic photography of core from surface drilling started in 2008.

The core recovery is generally very good, nearly 100%, with the exception of short intervals within fault zones or highly deformed mudrock. Such intervals are generally marked during drilling and checked later by the geology personnel for depth accuracy and missing sections.

Geological and structural data are described by geologists and entered into a digital logging package. Drill hole logs show hole parameters, core description, and sampling intervals. Core logging is carried out in French. Drill core is stored on mine site, normally in core racks.

#### **CORE SAMPLING**

Sample selection for assaying is determined by Hecla Québec's geologists. This selection is

determined visually based on rock type, alteration, quartz veining, and mineralization. Sample positions are identified, and a commercially printed bar-coded sample tags are placed under the core in the core boxes at the end of each sample. The beginning and end of each sample is also marked on the core with individual sample lengths varying from 0.5 meters to 1.5 meters and most of the samples are 1.0 meter in length. The geologist marks a reference line along the core length for the technician, before sending it to the core saw.

In the case of exploration and definition holes, the selected samples are sawn into two halves by the core shack technician using an electrical core saw equipped with a diamond impregnated blade. One half is placed in a plastic bag with the corresponding tag number. The other half core is returned to core boxes, with the corresponding tag placed at the beginning of the sampled core. Sample tags are stapled to core boxes. The core saw and metallic pans are cleaned between samples. In the case of infill drill holes, the core is not sawn, and the entire sample is sent for assaying. Bags are folded and sealed to prevent spillage during transportation to the laboratory. Each batch of three to four samples is placed in a plastic container for transportation to the mine laboratory or in a burlap bag for transportation to an external laboratory.

The samples are then transported by pick-up truck to the sample receiving facilities of the mine laboratory in the case of in-fill and definition, drilling.

Lithogeochemical data is collected with exploration drilling for rock discrimination. The sampling consists of selecting a representative forty centimeters core sample systematically every thirty to fifty meters or when a lithological change occurs, until a representative compilation of that unit is collected. All samples for lithogeochemical analysis are sent to ALS Geochemistry laboratories in Val-d'Or, Québec.

### **SAMPLING OF UNDERGROUND DEVELOPMENT HEADINGS**

At the Casa Berardi Mine, chip samples are taken to determine the gold value over a given interval of rock in order to align development and exploration activities, estimate the value of mineralized lenses and to reconcile mining with the mill. Along the walls of draw-points, chip samples are taken perpendicular to the stratigraphic and structural trend of the mineralized body. Prior to chip sampling, the intervals to be sampled are geologically mapped in order to delineate changes in lithology, mineralization, alteration and structure.

Chip samples are localized by hip-chain from surveyed anchor points in the mine. The intervals are usually one-meter lengths, though they may range from a minimum of fifty centimeters to a maximum of one-and-a-half meters to respect geological constraints. The beginning and end of the interval are marked at chest-height using yellow spray-paint and are then plotted on the geological map.

Plastic sample bags used to collect the chip samples are prepared with a sample tag and placed at each interval. The bags are sealed for transport to prevent contamination. The sample tag is a scannable, water-resistant tag that is torn from a booklet containing the sample number, the date and location of the sample as well as identifying the sampler and containing other notes and sketches that they might have taken. The sample number is used to track the sample at the assay laboratory and in our database.

## **11.2 SAMPLE PREPARATION AND ANALYSIS**

Over time, core samples from exploration drilling have been assayed at a number of different laboratories:

- 2004, 2005 and part of 2006: SGS in Rouyn-Noranda.
- 2006: Mine laboratory, SGS, Techni-Lab and Swastika Labs.
- 2007: Mine laboratory and Techni-Lab.
- 2008: Mine laboratory and Lab-Expert laboratory in Rouyn-Noranda.
- 2009 to 2018: Mine laboratory and Swastika Labs.

On-site exploration drilling samples go to external labs. The exploration drilling samples are sent for preparation and analysis to Swastika Laboratories Ltd. in town of Swastika, Ontario. Check assays samples were sent to ALS Geochemistry laboratories in Val-d'Or, Québec. Swastika and ALS have no material relationship with Hecla Québec.

### **MINESITE LABORATORY**

A laboratory at the mine is used to assay most of samples generated at the mine including underground production headings, infill and definition drilling. Preparation and gold analysis in completed on-site with Hecla staff. The mine laboratory is not ISO certified.

Upon arrival at the mine laboratory, samples are sorted by number and checked according to the sample shipment list. All samples are dried in the oven for a few hours. When dried,

samples are crushed in a jaw crusher and transported by a conveyor belt onto a rotary splitter. All samples are entirely crushed to 80% pass in 6.3 mm. Jaws are cleaned with compressed air and flushed with barren core. Whole core samples weigh approximately 10 kg. Approximately 200 to 250 g of material is split from crushed materials and pulverized to a 95% minus 150 mesh or 85% minus 200 mesh sample pulp. Approximately 600 g of the remaining crushed sample (coarse reject) is returned into the original plastic bag in order to minimize manipulation and storage; the remaining coarse reject is sent to the mill.

The pulp is laid down on a piece of rubber and mixed for homogenization. A 15 g sub-sample is then collected from the previous subsample and weighed for assay. Each 15 g sample is analyzed with an Atomic Absorption Spectrometer (AAS). All results, reported in grams per tonne, are sent electronically to Hecla Québec. No final paper copies of assay results are generated from the mine laboratory.

### **SWASTIKA LABORATORIES**

Exploration drilling samples from underground and surface were sent to the external Swastika laboratory. Swastika has no material relationship with Hecla Québec and has been accredited by the Canadian Association for Laboratory Accreditation Inc in meeting requirements of ISO/IEC 17025:2005 for various gold assay protocols.

Sample submissions are divided into work orders that contains identifier, batch number, sample numbers, date, weight, elements, and analyses required. Each batch is made up of 63 samples, which comprise 52 Hecla samples and 11 laboratory quality control samples. Each batch starts with a blank and a standard, which is followed by 19 Hecla Québec samples. Duplicates are taken every 10 samples and are placed at the end of the batch. A bar coding system is use and sample receipt reconciliation notice are transmitted by email.

After the receiving, samples are dried in two ovens at 80° Celsius. All samples are entirely crushed to 80% passing 1.7 mm with a jaw crusher and split with a rotary splitter. Jaws are cleaned with compressed air and flushed with barren limestone. Approximately 1 kg of crushed sample is entirely pulverized to 90% minus 107 microns. All pulverized materials are poured onto a rubber mat and then into Kraft bags for weighing. Pulverizer bowl and rings are cleaned with compressed air and flushed with barren silica sand. A 30 g of pulverized material is collected from the previous subsample and weighed for assay. Each 30 g sample

is analyzed with an Atomic Absorption Spectrometer (AAS) and finish with a second run by gravimetric finish for those with gold results above 10 g/t Au.

All the remaining pulverized material (pulp) were sent back to the Casa Berardi mine for storage and quality control. A 5% selection of crushed sample material (reject) are sent back to the mine site for quality control and the remaining reject material is discard by Swastika laboratory.

#### **EXTERNAL DATA VERIFICATION 2014**

RPA reviewed cross-sections, longitudinal sections, and plan views of different zones, especially those of the 118, 123 and 124 zones, and found the interpretation of the mineralization to be generally well done. RPA has reviewed the database and found it relatively well managed. Core logs are stored in a common file location and are in order. Holes are easy to find.

RPA also reviewed the available QA/QC data for the Casa Berardi deposit. This included reviews of blank, CRM, pulp reject and check assays.

#### **INTERNAL DATA VERIFICATION**

All drill hole data (geological interpretations, examination of drill logging, review of sampling procedures and assay data checks) are initially entered by geologists in a Microsoft Access database (located on a local server) using a logging program (Gems Logger) developed by Gems and transferred daily into a SQL database (SQL server). The Microsoft Access logging interface and GEMS have many validation tools which include cross-checks drill collar position checks, downhole survey data reviews, for overlapping and missing intervals, duplicate sample IDs and for distance-length validations based on the drill hole total length. Additionally, the database administrator personally validates every import to verify that all data has been correctly imported and that no data is missing

### **11.3 HECLA QUEBEC QA/QC PROGRAM**

#### **DATABASE**

The QA/QC database contains certificate numbers, dates, sample numbers, original assays, duplicate assays, standard assays, standard types, and laboratories used for assaying.

Numerous macros have been created to generate printable reports to provide quick evaluation of check assays.

## **PROTOCOL**

Hecla Québec's QA/QC protocol consists of:

A certified reference material (CRM or commercial standard) is inserted systematically at every 25<sup>th</sup> sample. Several standards, from different suppliers and with different qualities, are used.

Since early 2009, about 5% of the original pulp (pulp #1) from the mine laboratory or the Swastika laboratory has been sent to the ALS Chemex laboratory in Val-d'Or for reanalysis. Prior to 2009, about 10% of the original pulps were sent for re-assay. Samples with grades greater than 1 g/t Au are selected for check analysis. The sample numbers for the reanalysis are the same as for the original assays.

Currently, about 5% of coarse rejects (from the mine laboratory or the Swastika laboratory) are sent to the ALS Chemex laboratory in Val-d'Or for a reanalysis. Samples with grades greater than 1 g/t Au are selected. A second pulp is prepared from this coarse reject (Pulp #2). The sample numbers for the reanalysis are the same as for the original assays. Since October 2018 the intervals selected for reanalysis are focused on the mineralized zones of development drilling. Blanks are inserted by the geologist while core logging. Blanks consist of exploration core from barren material that has been previously assayed.

## **DUPLICATES**

Between 2009 and 2018, 28,974 duplicate samples were inserted within the regular sample sequence. The relative difference ranges from 0% to 20% with an average relative difference of 1.83%. This relative difference value might be linked to nugget effect, errors resulting from misapplication of procedure at the core shack and laboratory. In 2018, 5,231 duplicate samples were inserted within the regular sample sequence. A total of 565 or 10.80% original samples returned grades equal or greater than ten times the detection limit (0.1 g/t) out of 5,231.

## **MINE LABORATORY – ORIGINAL VERSUS DUPLICATE ASSAYS**

Only the assays from development drilling programs discussed here. Duplicate assays of

exploration programs are not available because most duplicate studies returned low grade values and or do not represent a significant population.

Table 11-1 presents the number of duplicate assays carried out over the last nine years, the mean grade of original assays, and the mean grade of duplicate assays. The difference between the mean grade of original assays and the mean grade of duplicate assays is acceptable at less than 2%. The correlation between original assays and duplicate assays is very good for the mine and Swastika laboratories (Figure 11.1).

**Table 11-1: Casa Berardi Mine QA/QC Program, Duplicate Assays**

Year	Original laboratory	Number of Duplicates	Mean Grade of Original Assays Au g/t	Mean Grade of Duplicates Assays Au g/t	Difference %
2009	Mine	309	6.29	6.26	-0.5
	Swastika	958	5.88	5.79	-1.5
	ALS-Chemex	32	6.21	6.17	-0.6
2010	Mine	965	5.22	5.14	-1.5
	Swastika	631	2.09	2.11	1
2011	Mine	1,162	5.26	5.29	0.6
	Swastika	1,114	2.48	2.46	-0.8
2012	Mine	1,707	7.47	7.5	0.4
	Swastika	847	0.561	0.563	0.4
2013	Mine	1,588	6.64	6.6	-0.6
	Swastika	578	0.341	0.349	2.3
2014	Mine	1382	6.37	6.38	0.2
	Swastika	1244	0.994	0.993	-0.1
2015	Mine	2045	11.25	11.34	0.8
	Swastika	1816	0.68	0.69	1.5
2016	Mine	1827	8.18	8.05	-1.6
	Swastika	462	0.45	0.45	0
2017	Mine	1994	5.15	5.14	-0.2
	Swastika	2731	1.024	1.228	20
2018	Mine	1744	4.83	4.75	-1.7
	Swastika	3023	0.208	0.208	0

### ORIGINAL VERSUS CHECK ASSAYS – PULPS #1

Since early 2010, approximately 5% of original pulps (Pulp #1) were sent for re-assay at ALS Chemex laboratory in Val-d'Or. Samples with grades above 1 g/t Au are generally selected. Sample numbers for re-assays are the same as for original assays. All the laboratories used fire assay with an AAS or gravimetric finish.

A comparison between original assays and check assays of the 2009 to 2018 programs is provided in Table 11-2. The Table shows the number of assays from original laboratories and the mean grades of original and check assays.

A comparison of original assays from the mine laboratory with the check assays at ALS Chemex shows that the mean grade of ALS Chemex assays is generally higher than the mean grades of original assays; however, the difference is less than 2%. For the 0-20 g/t subset the difference is higher than 2% (Figure 11.2). Correlation between Swastika and ALS Chemex is good for grades lower than 8 g/t Au (Figure 11.3); however, a small bias seems to appear, ALS Chemex being slightly higher than Swastika.

**Table 11-2: Casa Berardi QA/QC Program - Check Assays Pulp #1**

Year	Laboratories	Number of assays	Mean Grade original Assays Au g/t	Mean Grade check Assays Au g/t	Difference %
2009	Mine vs. ALS-Chemex	534	11.98	12.32	2.8
	Mine vs. ALS-Chemex 0-50 g/t Threshold	518	10.14	10.22	0.8
	Swastika vs. ALS-Chemex	187	5.3	5.23	-1.4
2010	Mine vs. ALS-Chemex	744	9.77	9.97	2.1
	Mine vs. ALS-Chemex 0-50 g/t Threshold	723	7.56	7.6	0.6
	Swastika vs. ALS-Chemex	87	4.89	5.05	3.2
2011	Mine vs. ALS-Chemex	918	7.05	7.18	1.8
	Mine vs. ALS-Chemex 0-50 g/t Threshold	90	5.25	5.32	1.3
	Swastika vs. ALS-Chemex	87	4.89	5.05	3.2
2012	Mine vs. ALS-Chemex	1,234	6.31	6.57	4
	Mine vs. ALS-Chemex 0-50 g/t Threshold	1,216	5.08	5.29	4
	Swastika vs. ALS-Chemex	61	2.89	2.76	-4.7
2013	Mine vs. ALS-Chemex	1170	6.54	6.6	0.9
	Mine vs. ALS-Chemex 0-50 g/t Threshold	1152	5.43	5.49	1.1
	Swastika vs. ALS-Chemex	50	3.34	3.72	11.4
2014	Mine vs. ALS-Chemex	1179	7.63	7.65	0.2

Year	Laboratories	Number of assays	Mean Grade original Assays Au g/t	Mean Grade check Assays Au g/t	Difference %
	Mine vs. ALS-Chemex 0-50 g/t Threshold	1163	6.66	6.7	0.6
	Swastika vs. ALS-Chemex	169	2.73	2.86	4.7
2015	Mine vs. ALS-Chemex	1471	8.49	8.54	0.6
	Mine vs. ALS-Chemex 0-50 g/t Threshold	1443	6.83	6.88	0.7
	Swastika vs. ALS-Chemex	180	3.493	3.495	0.07
2016	Mine vs. ALS-Chemex	1427	7.23	7.33	1.4
	Mine vs. ALS-Chemex 0-50 g/t Threshold	1407	6.11	6.14	0.5
	Swastika vs. ALS-Chemex	68	1.73	1.85	6.9
2017	Mine vs. ALS-Chemex	1023	5.31	5.37	1.1
	Mine vs. ALS-Chemex 0-50 g/t Threshold	1018	5.03	5.09	1.2
	Swastika vs. ALS-Chemex	85	1.738	2.017	16.1
2018	Mine vs. ALS-Chemex	788	5.7	5.8	1.75
	Mine vs. ALS-Chemex 0-50 g/t Threshold	779	4.49	4.69	4.45
	Swastika vs. ALS-Chemex	653	2.93	3.18	8.5

## ORIGINAL VERSUS CHECK ASSAYS – PULPS #1 VERSUS PULPS #2

Approximately 5% of original coarse rejects are sent for re-assay at ALS Chemex laboratory in Val-d'Or. Sample numbers for re-assays are the same as for original assays. Samples with a grade above 1 g/t Au are generally selected. A second pulp was prepared at the secondary laboratory from original rejects (Pulp #2).

A comparison between Pulps #1 and Pulps #2 is presented in Table 11-3. The mean grade of ALS Chemex assays (Pulps #2) is generally very close to the mean grade of original assays, the difference between the two being less than 5%. Correlation between Pulps #1 and Pulps #2 is generally good for the overall set of data; however, the 0 to 20 g/t subset shows higher variability (Figure 11.4 and Figure 11.5).

**Table 11-3: QA/QC Program - Check Assays - Pulp #1 Versus Pulp #2**

Year	Laboratories	Number of assays	Mean Grade of Original Assays Au g/t	Mean Grade of Check Assays Au g/t	Difference %
2009	Mine vs. ALS-Chemex	473	6.39	6.35	-0.7
	Swastika vs. ALS-Chemex	232	4.79	4.84	1
2010	Mine vs. ALS-Chemex	708	5.24	5.23	-0.3
	Swastika vs. ALS-Chemex	76	2.5	2.78	11.3
2011	Mine vs. ALS-Chemex	788	5.02	5.26	4.5
	Swastika vs. ALS-Chemex	72	2.18	2.51	13.2
2012	Mine vs. ALS-Chemex	1,135	4.95	5.14	3.7
	Swastika vs. ALS-Chemex	82	2.46	2.5	1.6
2013	Mine vs. ALS-Chemex	1,103	6.05	6.17	2
	Swastika vs. ALS-Chemex	45	3.78	4.07	7.7
2014	Mine vs. ALS-Chemex	1178	7.49	7.37	-1.6
	Swastika vs. ALS-Chemex	163	2.29	2.43	6
2015	Mine vs. ALS-Chemex	1473	7.48	7.65	2.3
	Swastika vs. ALS-Chemex	204	3.82	3.65	-4.5
2016	Mine vs. ALS-Chemex	1347	6.54	6.73	3
	Swastika vs. ALS-Chemex	293	2.33	2.49	7
2017	Mine vs. ALS-Chemex	1055	4.93	5.01	1.6
	Swastika vs. ALS-Chemex	45	1.92	1.67	-13
2018	Mine vs. ALS-Chemex	801	6.04	5.79	-4
	Swastika vs. ALS-Chemex	430	3.35	3.31	-1.2

### ASSAYING OF CERTIFIED REFERENCE MATERIALS (STANDARDS)

Between 2009 and 2018, Casa Berardi submitted 21,624 samples to, ALS and Swastika Labs for gold analysis. These primary samples were accompanied by 865 CRMs. These samples represent approximately a 4% insertion rate for CRMs over nine years and approximately 10% of the 2009 to 2018 sample database. No significant bias is evident CRM results for 2009 to 2018. Table 11-4 summarizes the differences between the measured value and the true or expected value of the standard and represents an estimate assay accuracy and precision.

**Table 11-4: Casa Berardi QA/QC Program, Certified Reference Materials**

Standard #	Nominal Value $\pm 95\%$ Confidence Limit	Laboratory	Year	Number of Assays	Average	Difference %
6Pa	1.65 $\pm 0.04$	SGS	2004	6	1.37	-17.1
6Pb	1.422 $\pm 0.026$	SGS	2004	72	1.39	-2.2
			2005	43	1.53	7.8
7Pa	3.00 $\pm 0.06$	SGS	2004	95	2.95	-1.5
			2005	32	2.97	-0.9
10Pb	7.15 $\pm 0.11$	Mine	2008	74	6.97	-2.5
			2009	217	7.08	-1
			2010	367	7.08	-1
			2011	55	7.06	-1.3
		Swastika	2009	117	7.21	0.8
			2010	173	7.13	-0.3
			2011	25	7.13	-0.3
15H	1.019 $\pm 0.007$	Mine	2011	226	0.99	-2.9
			2012	459	1.01	-1
			2013	104	1.02	0.1
		Swastika	2011	51	1	-2
			2012	115	1.01	-1
			2013	18	1	-1.9
15Pa	1.02 $\pm 0.02$	Lab-Expert	2008	16	1.22	19.5
		Mine	2007	61	1.05	3.2
			2008	130	1.01	-1.2
			2009	181	1.01	-0.7
			2010	275	1	-2
			2011	95	1.01	-0.9
		Swastika	2009	86	1.01	-1.2
			2010	163	0.99	-2.9
2011	24		1.01	-0.9		
15Pb	1.06 $\pm 0.02$	Mine	2007	4	0.95	-10.4
			2010	81	1.05	-0.9
		Swastika	2010	48	1.07	1.9
18C	3.52 $\pm 0.05$	Mine	2011	269	3.44	-2.3
			2012	619	3.48	-1.1
			2013	502	3.48	-1.1
		Mine	2014	249	3.48	1.21
		Swastika	2011	74	3.51	-0.1
			2012	142	3.46	-1.7

Standard #	Nominal Value $\pm 95\%$ Confidence Limit	Laboratory	Year	Number of Assays	Average	Difference %	
			2013	87	3.51	-0.3	
			2014	79	3.48	1.21	
18Pa	3.36 $\pm 0.05$	Mine	2006	116	3.33	-0.8	
			2007	33	3.33	-0.8	
		SGS	2004	62	3.27	-2.7	
			2005	61	3.11	-7.5	
			2006	39	3.12	-7.2	
18Pb	3.63 $\pm 0.3$	Swastika	2006	27	3.63	7.9	
		Techni-Lab	2006	78	3.3	-1.8	
		Lab-Expert	2008	3	3.79	4.5	
		Mine	2007	99	3.56	-2	
			2008	28	3.45	-4.8	
50P	0.727 $\pm 0.021$	SGS	2004	110	0.73	0.5	
			2005	72	0.77	6.5	
			2006	49	0.79	8.4	
		Swastika	2006	7	0.72	-0.6	
		Techni-Lab	2006	49	0.77	6.5	
51P	0.430 $\pm 0.013$	Mine	2006	138	0.48	10.6	
			2007	89	0.45	3.9	
		Techni-Lab	2006	16	0.52	21.8	
52P	0.183 $\pm 0.07$	Mine	2007	1	0.44	140.4	
		SGS	2005				
			2006	3	0.22	18.4	
Swastika	2006	1	0.21	12.9			
Techni-Lab	2006	3	0.2	9.3			
61D	4.76 $\pm 0.07$	Mine	2008	67	4.64	-2.4	
		Swastika	2009	180	4.74	-0.4	
			2010	394	4.73	-0.6	
		2011	207	4.67	-1.9		
61Pa	4.46 $\pm 0.08$	SGS	2004	12	3.72	-16.6	
			2005	23	4.25	-4.8	
62C	8.79 $\pm 0.10$	LaboMine	2011	407	8.63	-1.8	
			2012	482	8.72	-0.8	
			2013	63	8.78	-0.1	
			2015	216	8.73	0.68	
			2017	1	3.02	191.06	
		Swastika	2011	125	8.93	1.6	
			2012	128	8.79	0.1	

Standard #	Nominal Value $\pm 95\%$ Confidence Limit	Laboratory	Year	Number of Assays	Average	Difference %
			2015	39	8.67	1.35
			2016	66	8.68	1.32
62D	10.50 $\pm 0.33$	LaboMine	2013	341	10.56	0.6
			2014	379	10.54	-0.41
			2015	297	10.55	-0.52
		Swastika	2013	86	10.91	3.9
			2014	151	10.83	-3.01
			2015	225	10.83	-3.08
62E	9.13 $\pm 0.41$	Swastika	2017	204	9.04	0.96
			2018	344	9.25	-1.27
62Pa	9.64 $\pm 0.14$	Lab-expert	2008	1	9.38	-2.7
		Mine	2006	113	9.25	-4
			2007	106	9.41	-2.4
			2008	12	9.42	-2.3
		SGS	2004	31	9.31	-3.5
			2005	71	9.45	-2
			2006	44	9.26	-3.9
		Swastika	2006	23	9.46	-16.5
Techni-Lab	2006	93	9.14	-5.2		
62Pb	11.33 $\pm 0.17$	Mine	2007	10	9.46	-16.5
		SGS	2004	86	10.47	-7.6
			2005			
204	1.043 $\pm 0.039$	LaboMine	2013	401	1.05	0.7
			2014	361	1.05	-0.26
			2015	535	1.04	0.54
			2016	482	1.05	-0.19
			2017	85	1.15	-9.09
			2018	129	1.04	0.16
		Swastika	2013	77	1.02	-2.2
			2014	140	1.02	2.10
			2015	270	1.02	2.13
			2016	69	1.03	1.63
			2017	55	1	4.45
			2018	43	1.04	-0.07
207	3.472 $\pm 0.13$	LaboMine	2014	121	3.49	-0.58
			2015	460	3.50	-0.73
			2017	2	1.6	117
			2018	1	1.61	116.65

Standard #	Nominal Value $\pm 95\%$ Confidence Limit	Laboratory	Year	Number of Assays	Average	Difference %
		Swastika	2014	48	3.49	-0.63
			2015	266	3.48	-0.13
			2016	65	3.46	0.33
			2017	196	3.43	1.22
			2018	2	3.47	0.06
208	9.248 $\pm 0.0438$	LaboMine	2016	465	9.40	-1.59
			2017	282	9.33	-0.84
			2018	171	9.33	-0.88
		Swastika	2017	30	8.95	3.28
			2018	38	9.24	0.04
209	1.580 $\pm 0.044$	LaboMine	2016	14	1.58	-0.05
			2018	439	1.59	-0.83
		Swastika	2017	185	1.62	-2.49
			2018	132	1.57	0.37
214	3.030 $\pm 0.082$	LaboMine	2016	67	3.04	-0.43
			2017	521	3.01	0.53
			2018	537	3.03	0.14
		Swastika	2017	168	2.93	3.44
			2018	176	2.99	1.36
215	3.54 $\pm 0.097$	LaboMine	2016	414	3.54	0.13
			2017	1	2.95	20
		Swastika	2017	4	3.51	1
			2018	352	3.5	1.11
221	1.06 $\pm 0.04$	Swastika	2017	152	1.11	-4.81
			2018	356	1.07	-1.25
		LaboMine	2018	1	1.16	-8.62
228	8.73 $\pm 0.28$	LaboMine	2017	334	8.89	-1.8
			2018	340	8.81	-0.93
		Swastika	2017	157	8.4	3.98
			2018	128	8.69	0.48

The standard results generally range within  $\pm 2\%$  of the true value, which is considered to be an acceptable range. In general, the mean grade of standard assays is within  $\pm 2SD$  (standard deviation) of the nominal values which is acceptable for commercial laboratories for gold analyses.

Standards assayed in 2018 were plotted against time to visualize the distribution relative to

the nominal values and to the  $\pm 2SD$  confidence limits. Graphs are presented in Figures 11.6 to 11.15. In general, standard assays are comparatively well distributed relative to the nominal values and to  $\pm 2SD$  nominal values.

## BLANKS

Out of the 2,355 local blank samples assayed during the year 2018 drilling campaigns at Casa Berardi, 968 returned values below the detection limit and 2,313 returned values slightly higher than detection but within acceptable limits. 42 samples failed or 1.78% with relatively low background values (Figure 11.16).

### 11.4 MINE LABORATORY QA/QC PROGRAM

All assays, reported in grams per tonne, are sent electronically to Hecla Québec. No final paper copies of assay results are generated from the mine laboratory.

The mine laboratory has its own QA/QC program including the analysis of one blank sample, one CRM (standard), and one duplicate in every 24 samples. Results of the mine laboratory QA/QC program are provided to the Geology Department, which compiles them into graphs. In 2018, the mine laboratory used a total of eight standards (Table 11-5).

**Table 11-5: Casa Berardi Mine Laboratory Program, Certified Reference Materials**

Type	Nominal value Au g/t	Mean grade Au g/t	Difference %	Number of Assays
OxE143	0.621	0.63	1.45	356
SH82	1.333	1.33	0.23	352
OxK119	3.604	3.6	0.39	220
SL76	5.96	5.97	0.17	335
OxN134	7.667	7.67	0.09	376
Sp73	18.17	18.22	0.44	352
OxJ120	2.365	2.36	0.63	173
CRM OXIDE	2.58	2.58	0	78

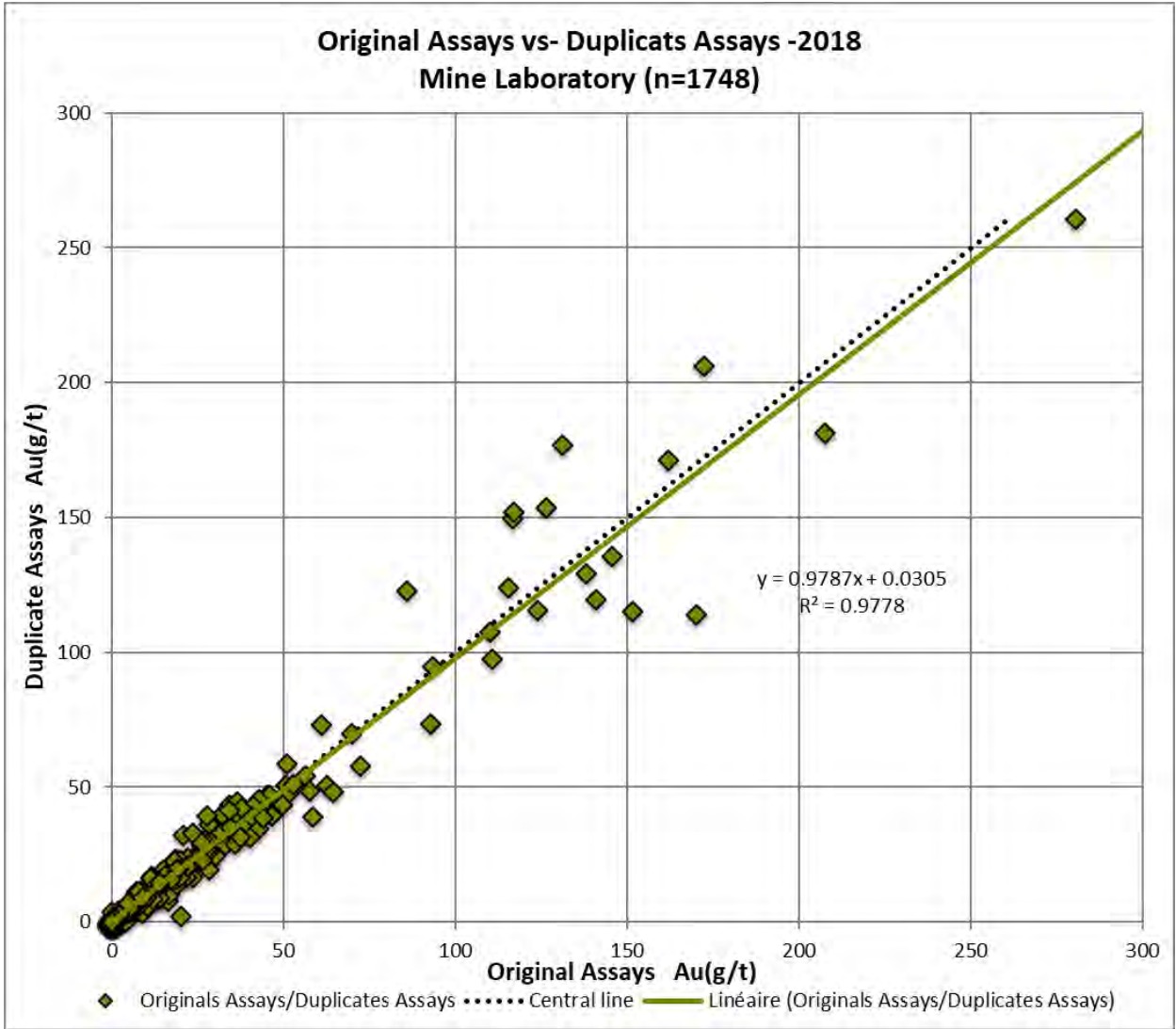
## **QA/QC - CONCLUSIONS**

The QA/QC program at the Casa Berardi Mine and property is adequate and the assay results within the database are suitable for use in a Mineral Resource estimate.

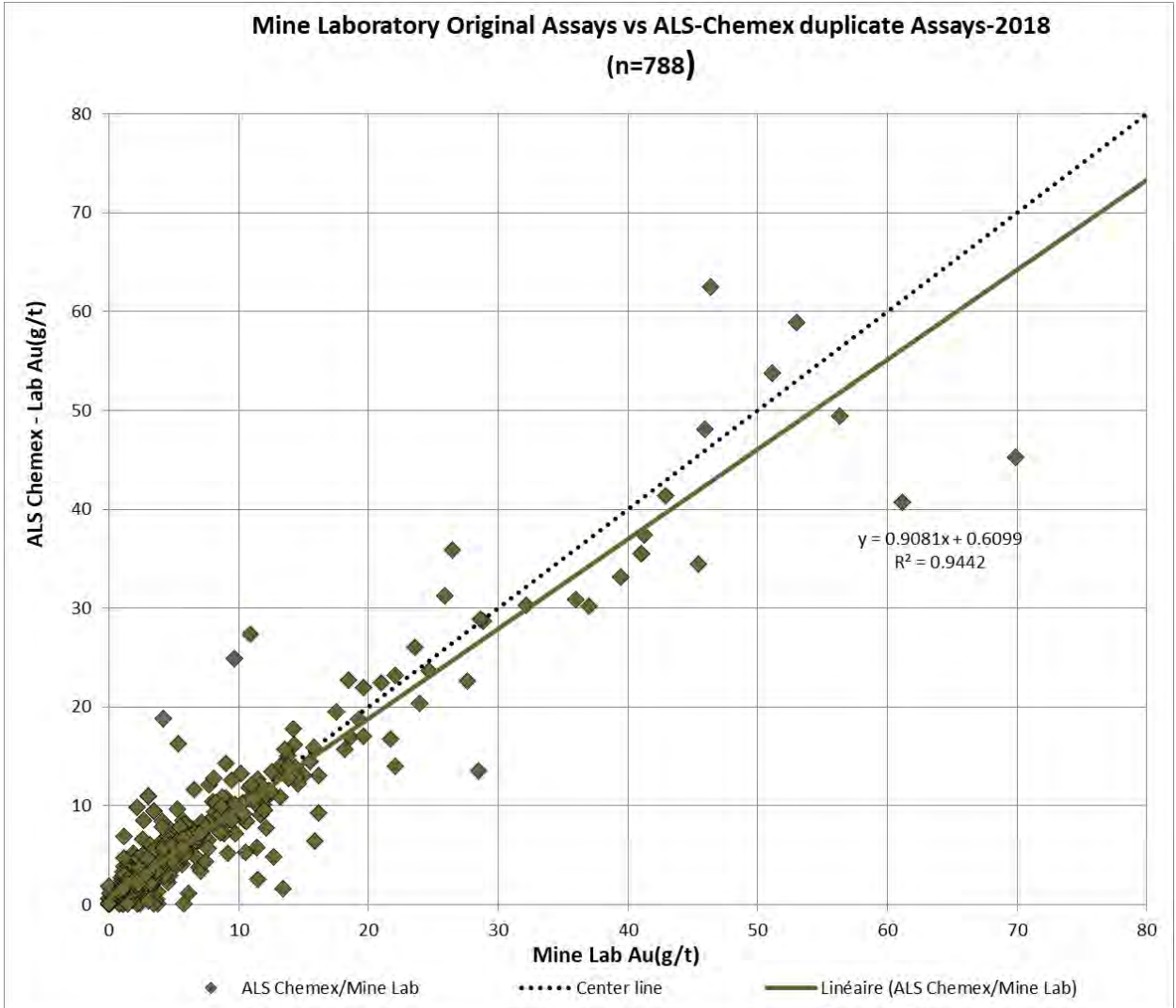
1. The results from the blank samples imply that there is minimal cross sample contamination.
2. Results of the CRM analysis demonstrate that assay values are sufficiently accurate to be used in mineral resource estimation.
3. The sequential insertion of duplicate and blank samples has inhibited a focus of the QA/QC analysis on samples that will inform grade estimates.
4. Quality control data has been revised and documented since 2009-2018.

Casa Berardi Mine considers that the analytical QA/QC results provide sufficient confidence in assay values for their use in the estimation Mineral Resources. Mineral Reserve estimation, and mine planning.

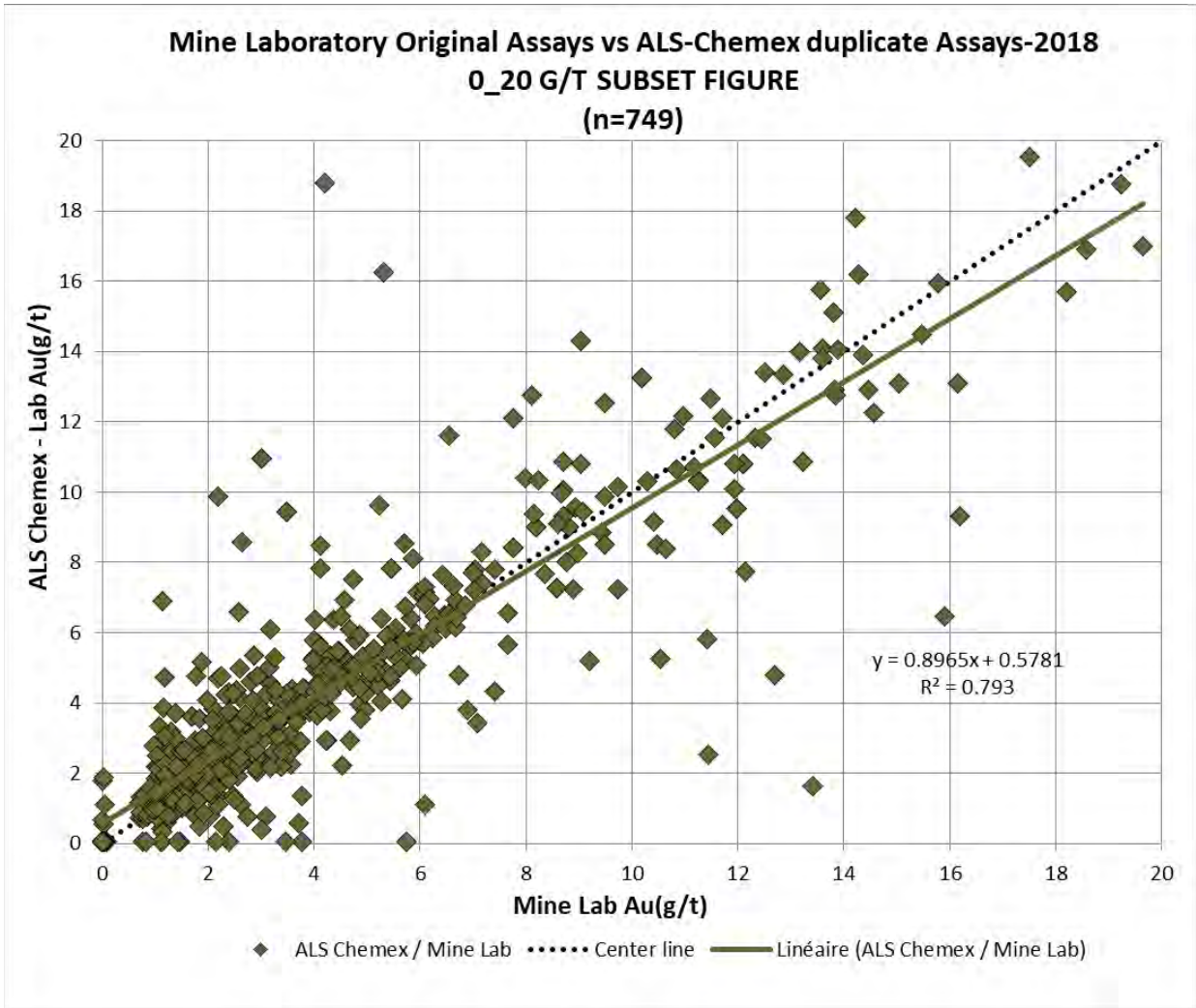
**QA/QC GRAPHS**



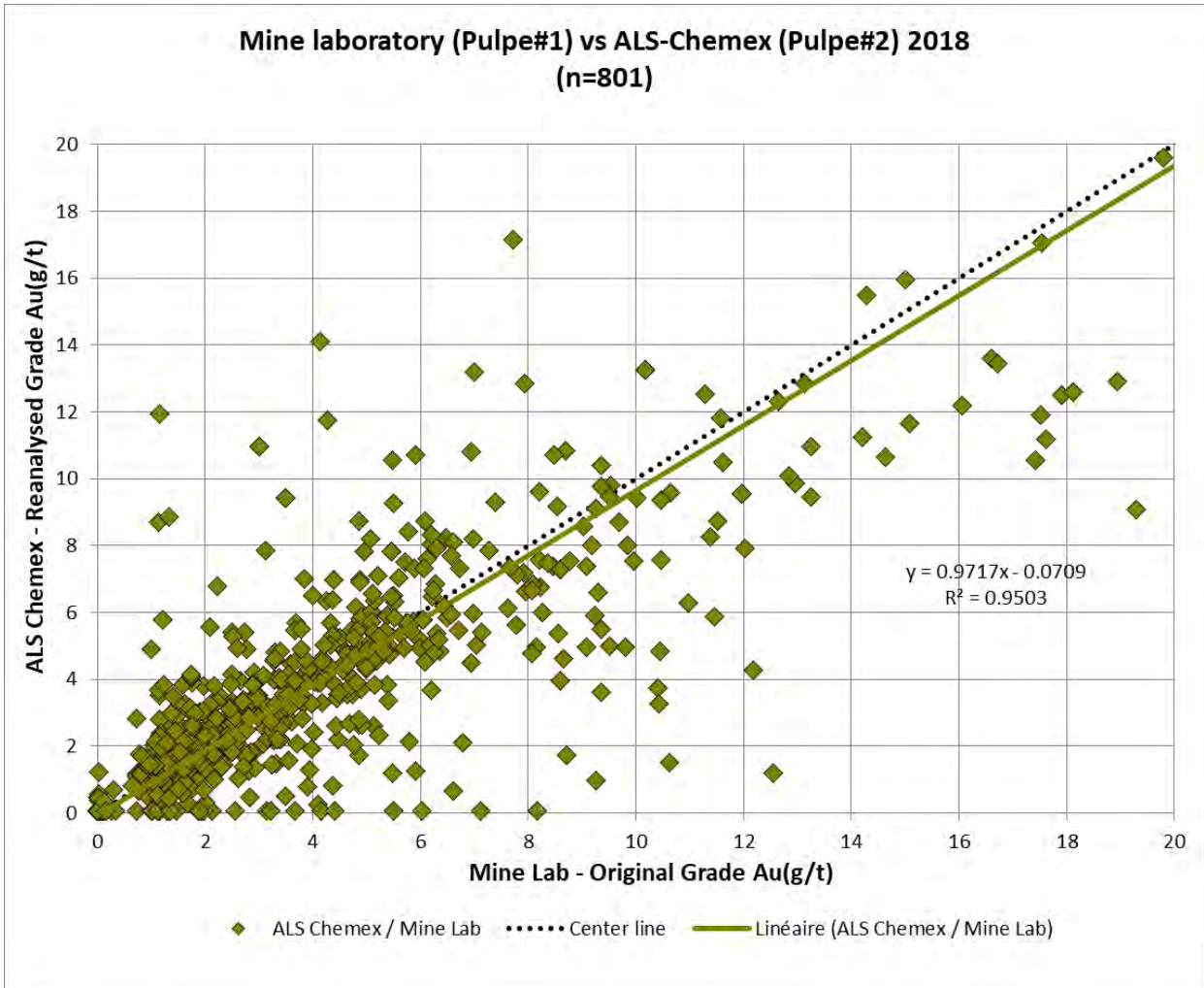
**Figure 11.1: Original Assays Versus Duplicate Assays - Mine Lab - 2018**



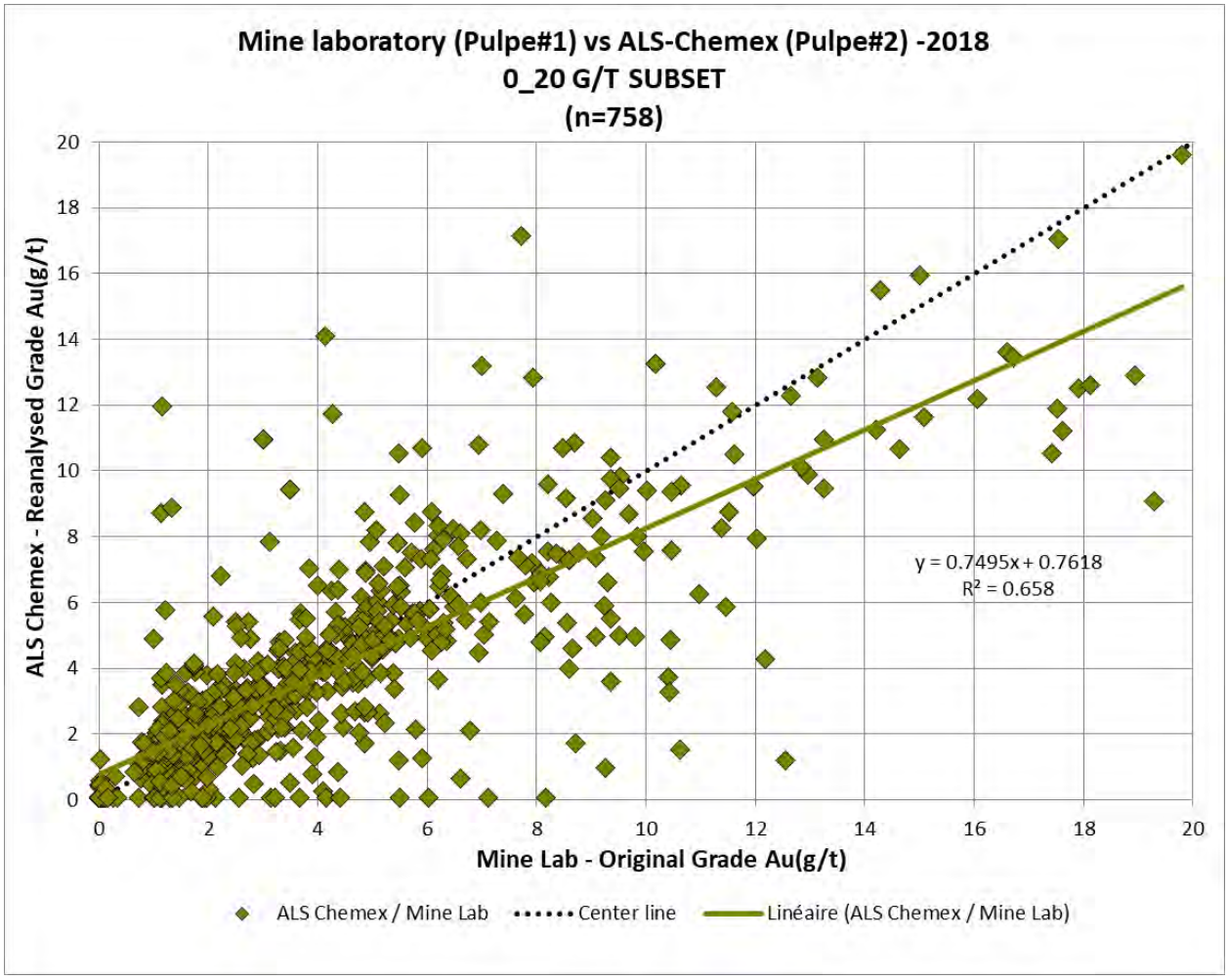
**Figure 11.2: Mine Laboratory Original Assays Versus ALS-Chemex Duplicate Assays - 2018**



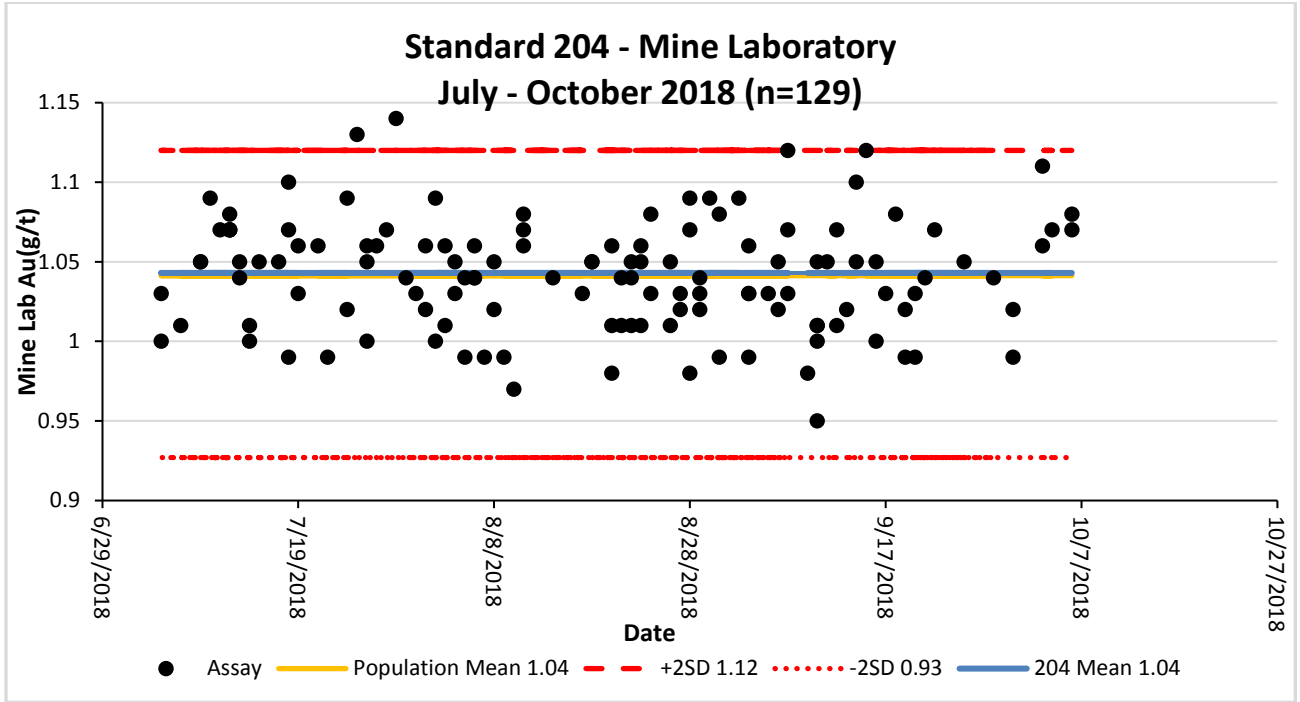
**Figure 11.3: Mine Laboratory Original Assays Versus ALS-Chemex Duplicate Assays - 2018 - 0\_20 G/T Subset Figure**



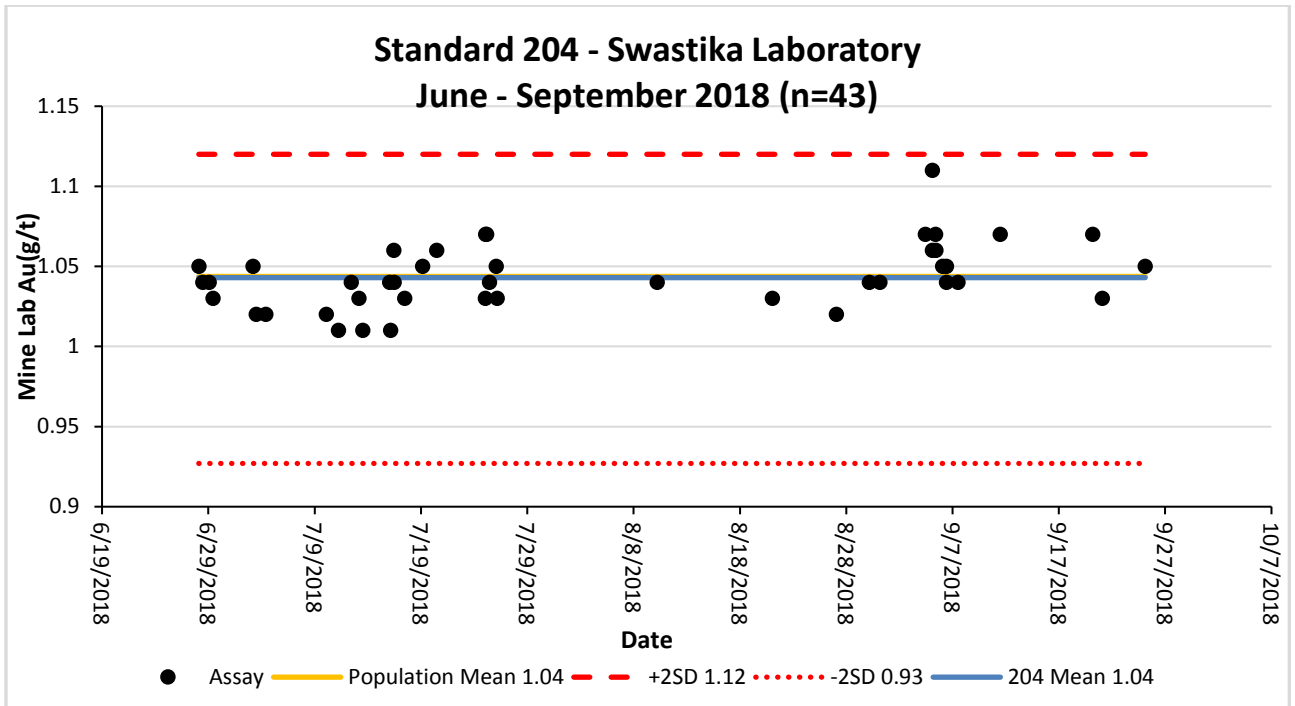
**Figure 11.4: Mine Laboratory Pulps #1 Versus ALS-Chemex Pulps #2**



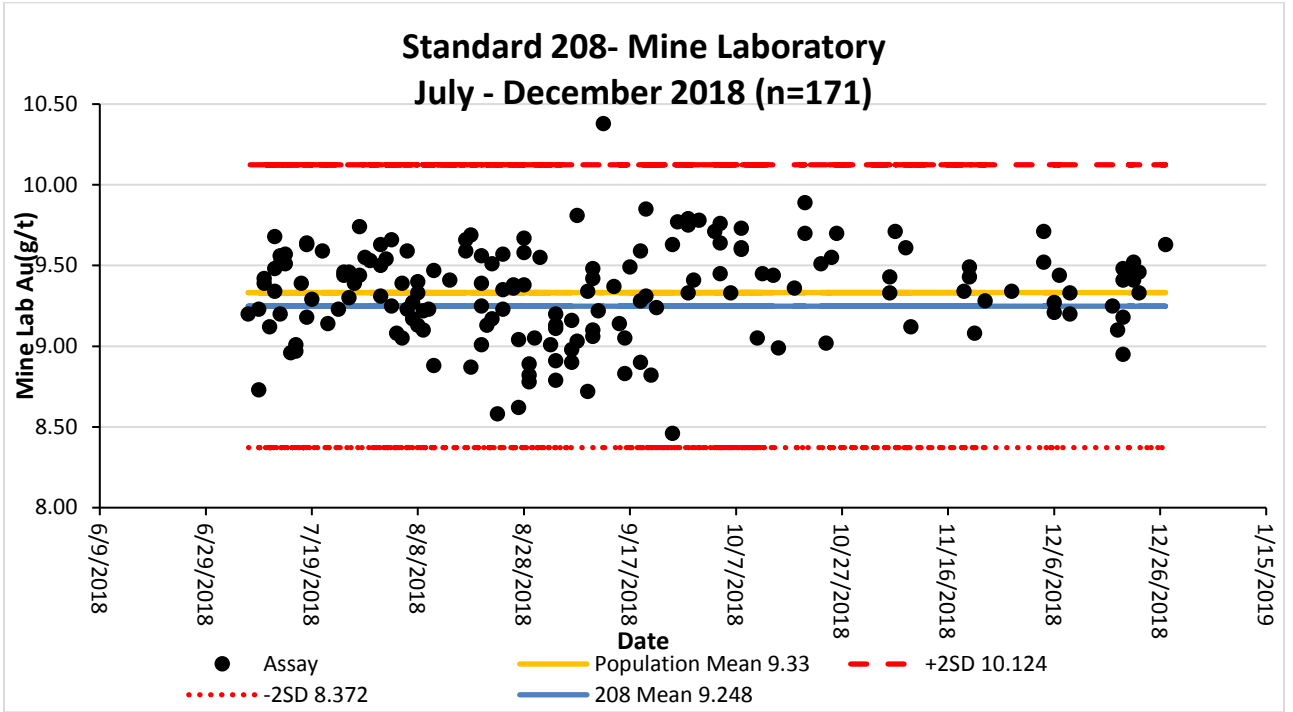
**Figure 11.5: Mine Laboratory Pulps #1 Versus ALS-Chemex Pulps #2 - 2-19 - 0\_20 G/T Subset**



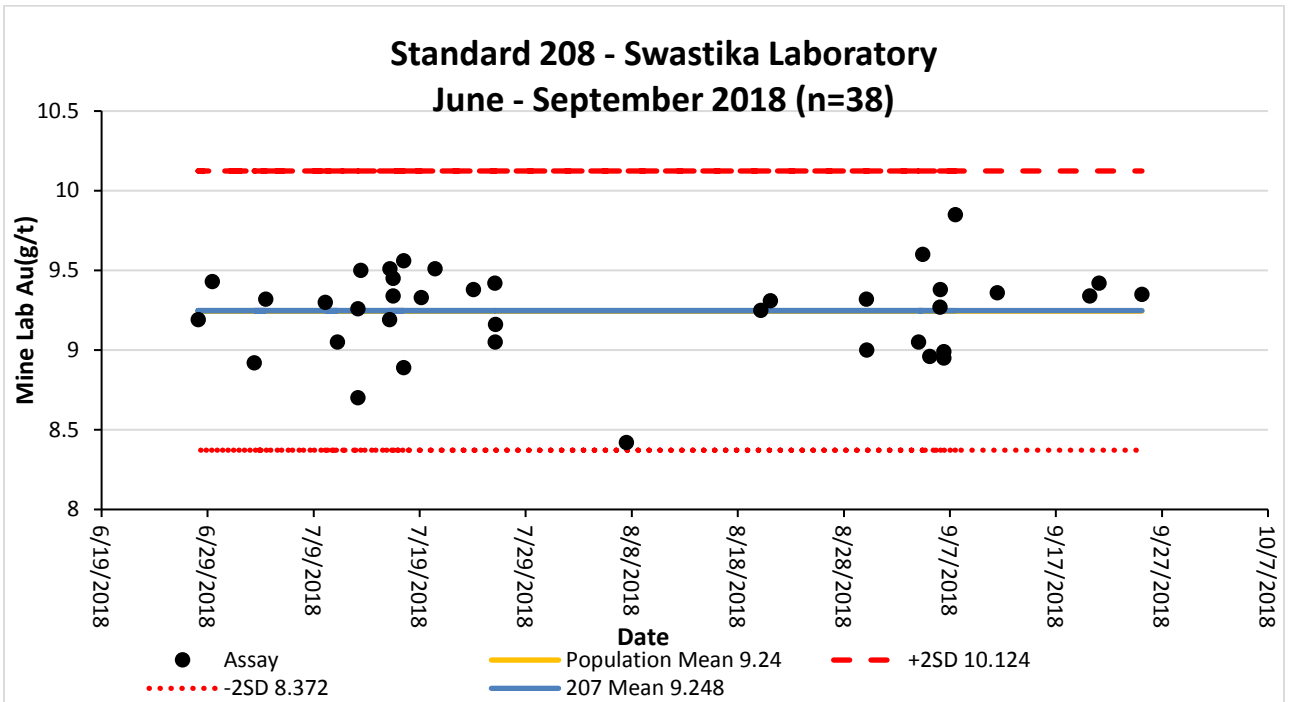
**Figure 11.6: Standard 204 - Mine Lab - 2018**



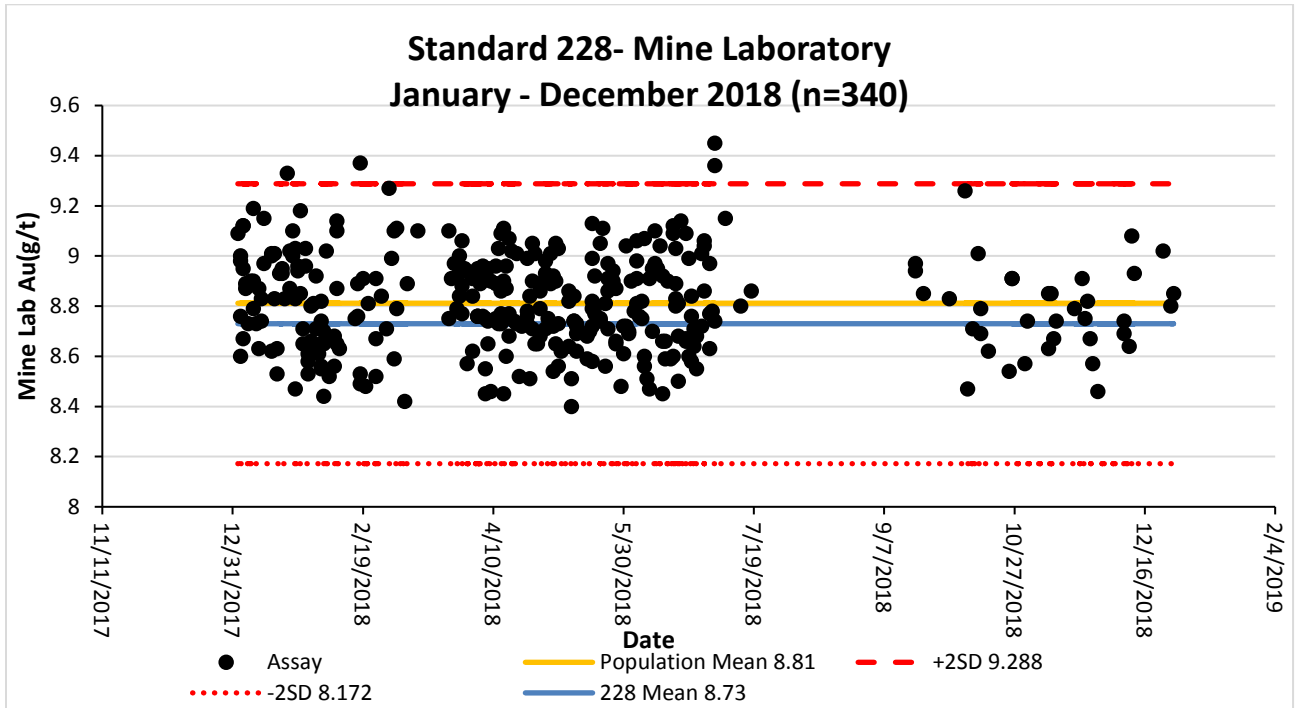
**Figure 11.7: Standard 204 - SWASTIKA LAB - 2018**



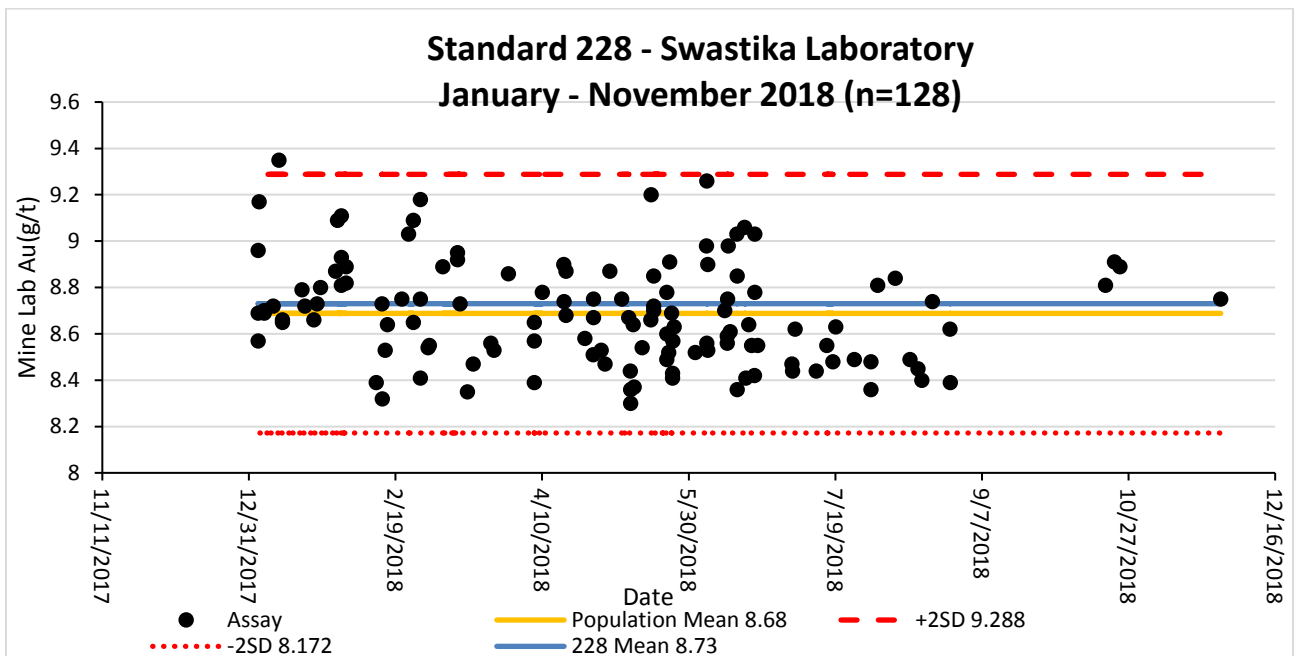
**Figure 11.8: Standard 208 - MINE LAB - 2018**



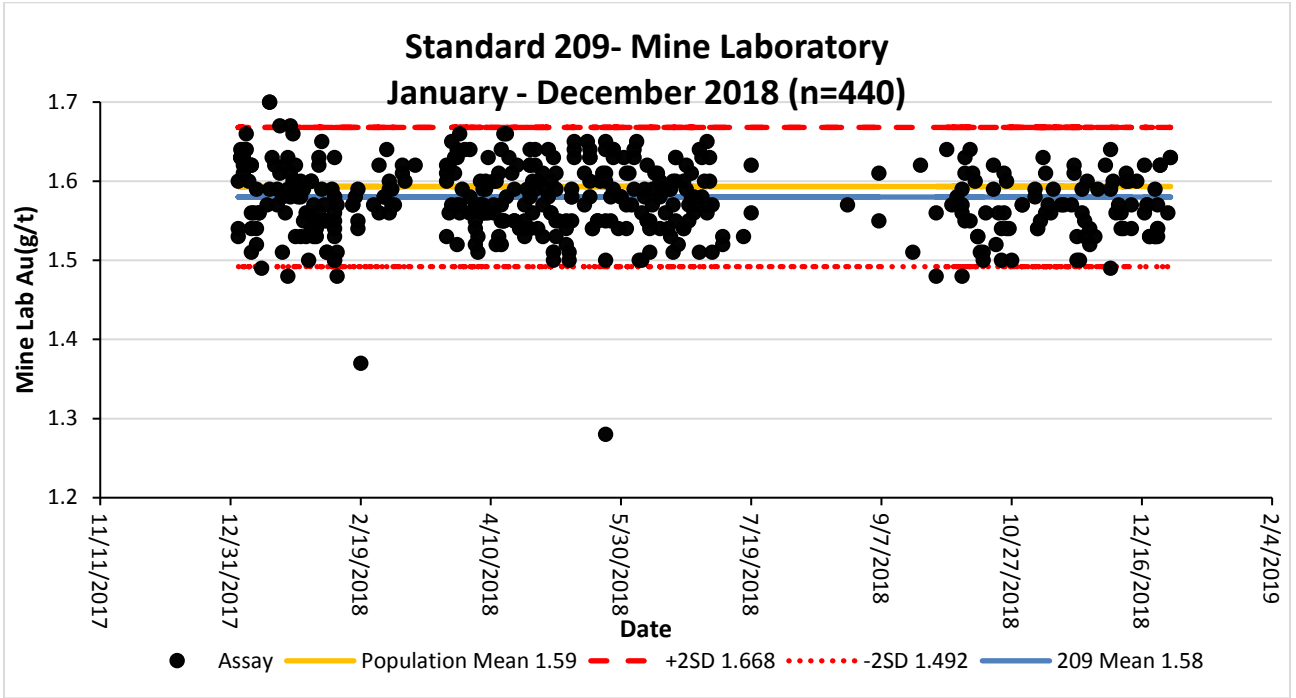
**Figure 11.9: Standard 208 - SWASTIKA LAB - 2018**



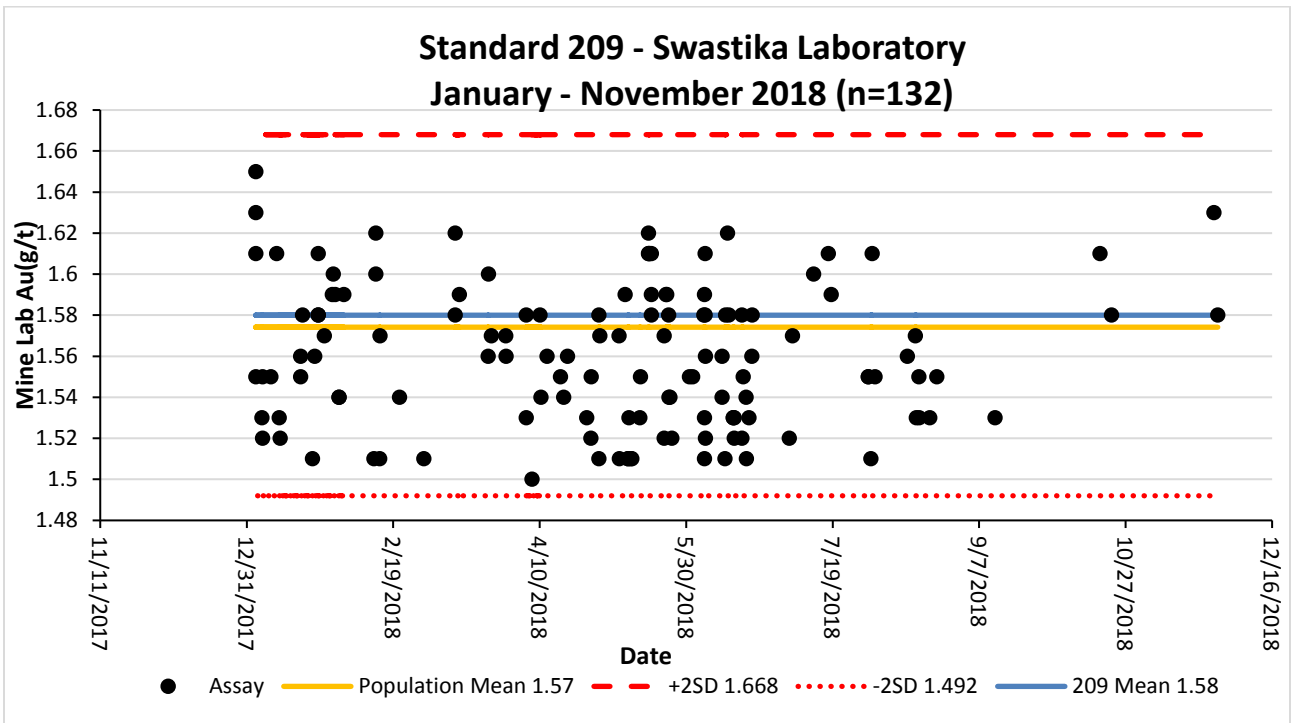
**Figure 11.10: Standard 228 - MINE LAB - 2018**



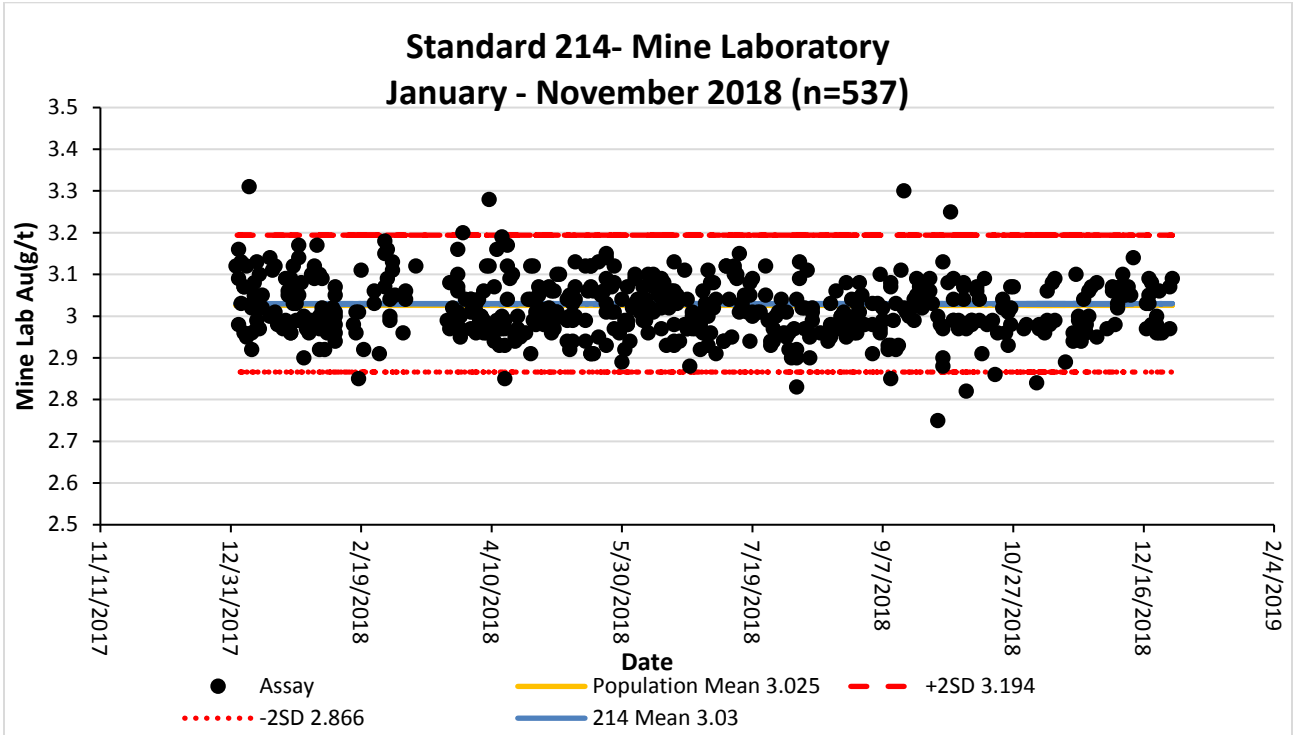
**Figure 11.11: Standard 228 - SWASTIKA LABORATORY - 2018**



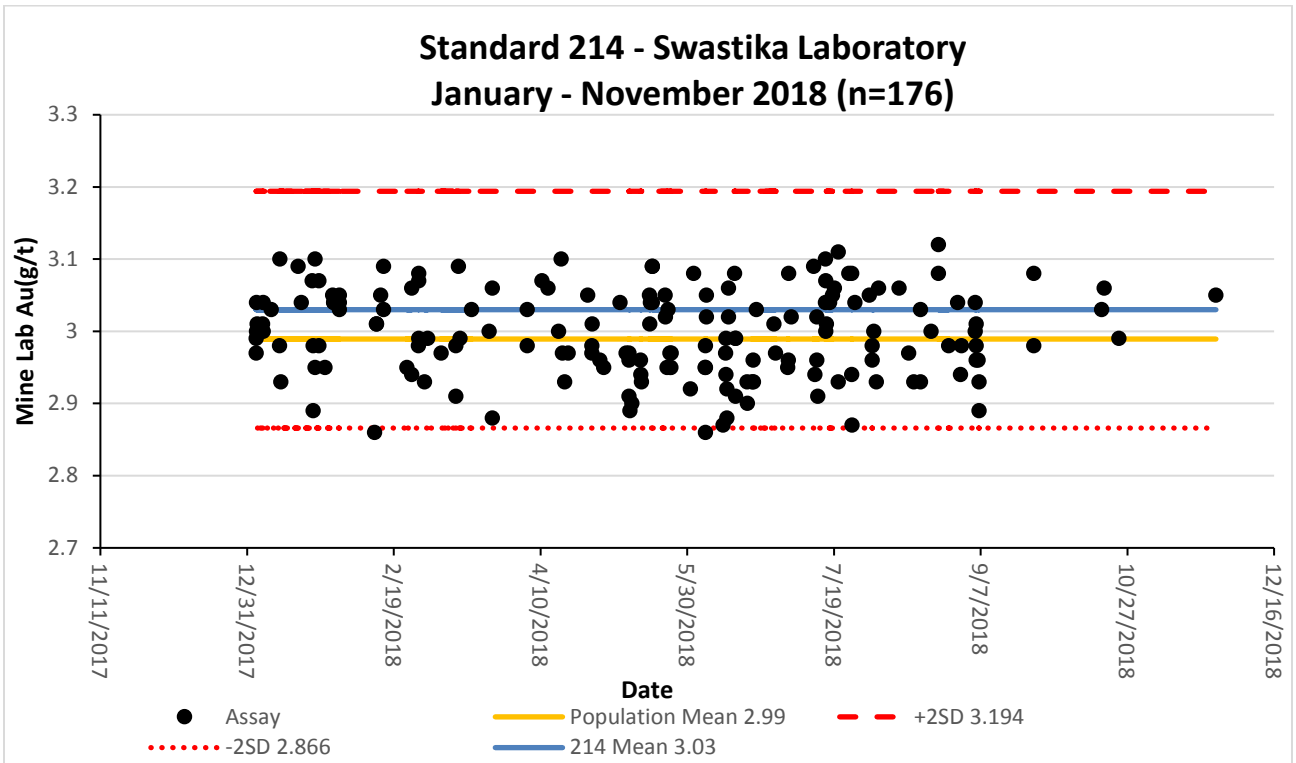
**Figure 11.12: Standard 209 - MINE LAB - 2018**



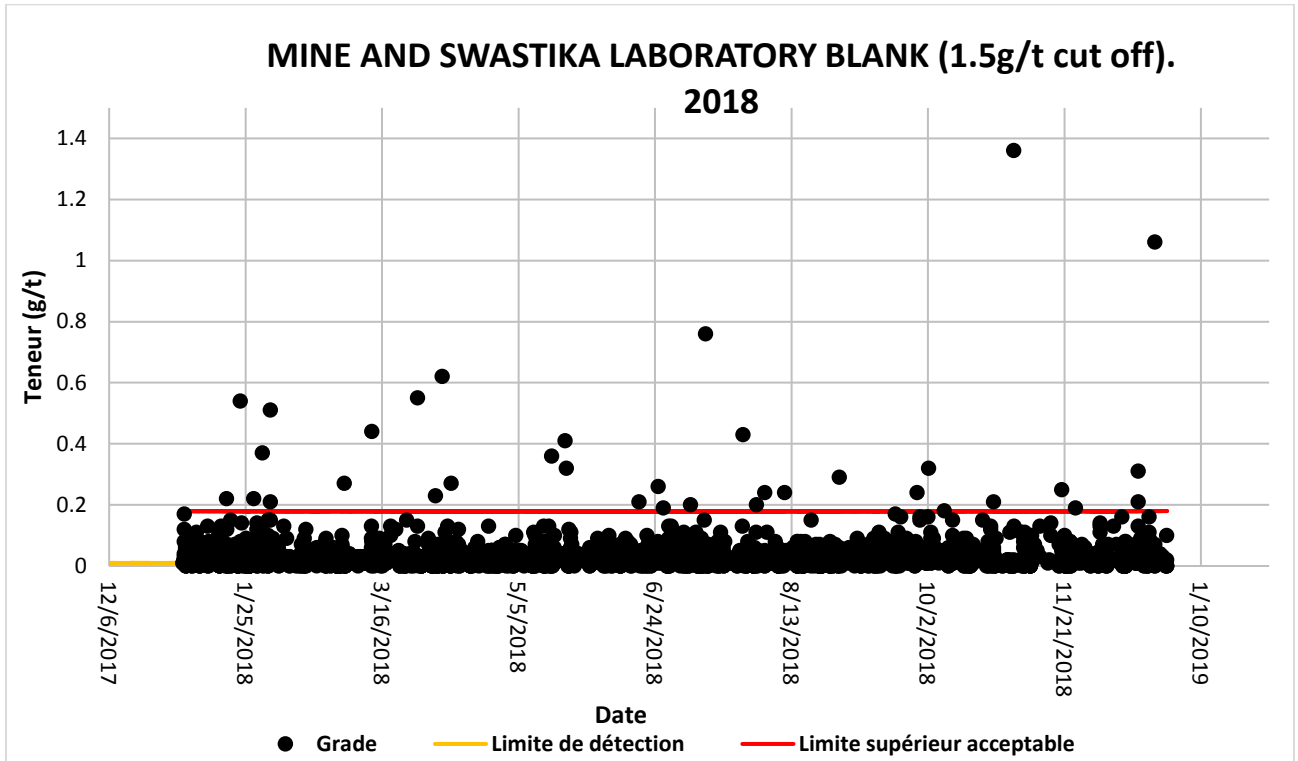
**Figure 11.13: Standard 209 - SWASTIKA LABORATORY - 2018**



**Figure 11.14: Standard 214 - MINE LAB - 2018**



**Figure 11.15: Standard 214 - SWASTIKA LAB - 2018**



*Figure 11.16: Blank - Mine and SWASTIKA LABORATORY - 2018*

## 11.5 COMMENTS ON SAMPLE PREPARATION, ANALYSES, AND SECURITY

In the QP's opinion, the sample preparation, analyses, and security are acceptable, meet industry-standard practice, and are adequate for Mineral Resource and Mineral Reserve estimation and mine planning purposes, based on the following:

- Face chip sampling covers sufficient area and is adequately spaced to support mine planning;
- Drill sampling is adequately spaced to first define, then infill, gold anomalies to provide prospect-scale and deposit-scale drill data;
- Sample collection and handling of core is undertaken in accordance with industry standard practices, with procedures to limit potential sample losses and sampling biases;
- Sample intervals in core are considered to adequately represent the true

thicknesses of mineralization. Not all drill material may be sampled depending on location and alteration;

- Sample preparation for samples that support Mineral Resource estimation has followed a similar procedure since 1998. The preparation procedure is in line with industry-standard methods for gold deposits;
- Exploration and infill core programs are analyzed by independent laboratories using industry-standard methods for gold and silver analyses. Current run-of-mine sample analyses are performed by the mine laboratory;
- Limited information is available on the QA/QC for the pre-1998 drill programs; however, sufficient programs of reanalysis have been performed that the data can be accepted for use in estimation (refer to Section 12);
- Typically, drill programs include the insertion of blank, duplicate and standard samples. The QA/QC program results do not indicate any problems with the analytical programs, therefore the analyses from the core drilling are suitable for inclusion in Mineral Resource and Mineral Reserve estimation;
- Data collected are subject to validation, using in-built program triggers that automatically check data upon import to the database;
- Verification is performed on all digitally-collected data on import to the main database, including checks on surveys, collar coordinates, lithology data, and assay data. The checks are appropriate and consistent with industry standards;
- Sample security relies on the fact that the samples are always attended or locked in the on-site logging or sampling facilities. Chain-of-custody procedures consist of filling out sample submittal forms that are sent to the laboratory with sample shipments and shipment tracking to ensure that all samples are received by the laboratory;
- Current sample storage procedures and storage areas are consistent with industry standards.

## **12.0 DATA VERIFICATION**

### **12.1 DRILL-HOLE DATABASE**

#### **EXTERNAL VERIFICATION**

The Casa Berardi project's geological data were verified by Rosco Postle Associates Inc (RPA) in 2014 following the release of the December 2013 Mineral Reserve and Mineral Resource estimate. Since 2014, the geological data were verified on site with the Hecla Québec staff.

In 2014, RPA reviewed the database and found it well managed. Core logs are stored in a common file location and are in order. Drill holes are easy to find in the database. RPA reviewed the quality assurance/quality control (QA/QC) database and assay certificates and found them to be well maintained. Geological and mineral control interpretation on cross-sections, longitudinal sections, and plan views of the different zones, especially those of the 118, 123 and 124 zones, were found to be generally well done.

#### **INTERNAL DATABASE VERIFICATION**

Geovia GEMS version 6.8 is the software used to perform mineral resources estimations, manage drill hole data and generate 3D Wireframe models. Drill hole data are stored on a SQL server, of which regular back-ups are performed as well as an annual backup to a separate Microsoft Access database.

Drill core descriptions are entered with GemLogger, a Microsoft Access data collection interface developed by Geovia. Drill hole data are stored in separate tables; drill hole collar data are entered in the "HEADER" table and down-hole deviation tests are entered in the "SURVEY" table. This software performs a first-pass validation by flagging data-entry errors such as overlapping from-to intervals and non-unique sample numbers. Pick-lists are employed where possible to maintain a consistent nomenclature in geology and mineral zones interpretation.

Validation of the lithological logs is done when the geology is interpreted in section and plan. The logs are further validated by comparison against historical drill data and geochemical samples. The lithochemical analyses are used to complement both the initial drill core

descriptions and gold analyses. This data is compiled and used to be able to better understand and interpret the lithological units and their associated alteration as an exploration tool to target potential mineralization.

Assay sample results are imported to the SQL database after being validated with the LabLogger software, a purpose-built sample management interface developed by Geovia. When a QA/QC sample fails validation, the importation is halted, and the user warned. The software also warns the user of non-unique sample numbers. Once imported, geologists reconcile the assay results with their logs and adjust if necessary.

Single-shot down-hole deviation tests are manually transcribed using the GemLogger interface. When available, Multi-shot results are imported using the Reflex SProcess software. An adjustment for magnetic declination of  $-12.5^{\circ}$  is applied to all azimuth measurements. Gyroscopic down hole surveys are used where local magnetic interference has produced questionable survey results.

When possible, surface drill collar locations as well azimuth and inclination data are surveyed. Survey data are manually entered and compared with the planned parameters. The geologist who planned the hole tags it as completed after having integrated and validated new data. Any changes to a hole tagged completed are saved in the “MODIF” table. The data is visually reviewed during modeling. A similar procedure is employed for underground drilling, in which case the azimuth is surveyed before the drilling begins, and the drill collar location is derived mathematically.

During 2018, a total of 4,767 duplicate sample assays combined with 3,451 pulp check assays and 2,355 blank sample assays were completed to support the quality control of Casa Berardi Mine. All reports from the internal laboratory and Swastika lab included approximately 10% of check analyses that confirmed the grade and overall quality of the assaying.

The data verification, lithological data, quality assurance/quality control (QA/QC) database, assay protocols and others information used to report the December 31, 2018 mineral resources have been supervised by Jonathan Archambault-Giroux; he is of the opinion that the drill-hole database is valid and conforms to industry standards and can support public disclosure of Mineral Resources and Mineral Reserves.

## 12.2 COMMENTS ON DATA VERIFICATION

The process of data verification for the Project has been performed by external consultant firms from 1998 to 2014, as well as by Hecla personnel. Since 2014, all data verification has been done by project staff as the data are being collected and imported into the GemLogger database. The 2018 check on the GemLogger databases and workspaces found no serious deficiencies.

Hecla considers that a reasonable level of verification is completed, and that no material issues would have been left unidentified from the programs undertaken. External reviews of the database have been undertaken in support of acquisitions, support of feasibility-level studies, and in support of Mineral Resource and Mineral Reserve estimates, producing independent assessments of the database quality. No significant problems with the database, sampling protocols, analytical flow sheets, check analysis program, or data storage were noted. Drill data are verified prior to Mineral Resource and Mineral Reserve estimation using various automated and manual checks.

The QP is of the opinion that the data verification programs undertaken on the data collected from the Project adequately support the geological interpretations, validate the analytical and database quality, and support the use of the data in Mineral Resource and Mineral Reserve estimation and in mine planning. No significant sample biases were identified from the QA/QC programs undertaken (see Section 11), and sample data collected adequately reflect deposit dimensions, true widths of mineralization, and the style of the deposit.

## 13.0 MINERAL PROCESSING AND METALLURGICAL TESTING

### 13.1 INTRODUCTION

The Casa Berardi Mine ore processing plant originally commenced production in September 1988 and production was suspended in September 1997. During this initial production period, the plant processed 3.5 million tonnes of ore with an average grade of 7.1 g/t Au and an average mill gold recovery of 87%. A total of 688,400 oz Au were recovered.

The production restarted in early November 2006, and commercial production was achieved as of May 1, 2007. Since 2006, a total of 9,507,617 tonnes at an average grade of 6.42 g/t Au have been milled at Casa Berardi for a gold output of 1,764,581 ounces. The gold recovery averaged 90.0%. Annual production from 2006 to 2018 is presented in Table 13-1.

**Table 13-1: Casa Berardi Annual Production**

Year	Tonnes (t)	Grade (g/t)	Recovery (%)	Ounces Recovered (oz)
2006	68,481	8.58	93.9%	17,731
2007	545,259	9.78	93.0%	159,469
2008	654,398	8.16	92.5%	158,830
2009	688,677	7.77	92.6%	159,261
2010	722,746	6.76	89.8%	141,116
2011	698,123	8.00	91.3%	163,845
2012	693,859	6.77	90.6%	136,848
2013	590,567	6.16	90.5%	105,978
2014	750,778	5.90	90.0%	128,241
2015	765,763	5.96	87.2%	127,893
2016	904,998	5.72	87.7%	145,973
2017	1,175,930	4.77	86.8%	156,652
2018	1,248,039	4.66	87.1%	162,742
<b>Total</b>	<b>9,507,617</b>	<b>6.42</b>	<b>90.0%</b>	<b>1,764,581</b>

The mill received ore from the East Mine Crown Pillar (EMCP) open pit from August 2016 and subsequent years. Ongoing plant operations demonstrate the levels of gold recovery to be expected from the underground ores LOM projected mill recoveries range from 81.3% to 91.5% for the underground Mineral Reserves and from 85% to 90.2% for the open pit mineral reserves.

## 13.2 METALLURGICAL TESTING

### MINERAL COMPOSITION

The mineral composition of different sources of material has been determined and the results are presented in Table 13-2 and Table 13-3.

**Table 13-2: Mineralogy Analysis with DRX on CIL Feed 11 May 2015**

	Quartz	Albite	Muscovite	Chlorite	Rutile	Siderite	Ankerite	Dolomite	Graphite	Arsenopyrite	Pyrite	Gypsum	Alunite	Total
XRD mineralogy	38.8	4.7	13.8	8.7	2.1	3.1	9.9	8.2	N/A	N/A	8.4	0.2	2.3	99.9
Corrected mineralogy	32.3	7.6	14.8	2.3	0.3	7.6	7.2	8.9	0.3	3.4	12.9	1.3	1	100

**Table 13-3: Element Analysis by Zone**

Zone	Graphitic carbon (%)	Ca (%)	Fe (%)	Ni (ppm)	Ag (ppm)	Zn (ppm)	As (%)	Sb (ppm)	Cu (ppm)	Pb (ppm)	S (%)
LI-Centre	1.85	2.1	3.8	302	1.68	205	0.24	6.1	50.2	83	2.0
115	0.85	2.9	3.5	310	4.91	194	0.24	3.9	76.7	92.5	0.8
LI-Nord	1.77	2.0	3.8	260	1.89	129	0.3	4	52.9	51.4	1.9
LI-Sud	1.46	2.1	3.6	387	16.5	182	0.45	5.4	52	72.5	1.4
113-INF	0.95	1.1	3.2	341	1.86	251	0.5	4.4	52.7	18.5	1.5
113-SUP	0.5	1.0	3.1	334	2.41	137	0.5	2.8	37.9	124	1.2
109	0.74	1.6	3.7	282	0.84	129	0.58	5	44.5	27.1	1.6
113-Est	1.02	1.8	3.9	378	2.5	344	0.64	5.3	62.4	31.4	1.7
118-06	1.01	2.6	6.6	244	0.77	85.4	0.91	10.2	59.7	16.7	1.9
123	1.07	2.4	17.1	265	2.58	124	1.11	37.7	54.9	34.6	12.6
118	1.03	3.2	7.8	160	2.22	131	1.81	26.6	53.2	41	3.2

Three main groups of minerals are found in the ore at the Casa Berardi Mine; silicates (quartz, albite, muscovite), carbonates (siderite, ankerite and dolomite) and sulphides (pyrite and arsenopyrite with traces of chalcopyrite and pyrrhotite).

There is also gold mineralization found in a graphitic mud rock formation along the Casa Berardi Fault plane.

## **GOLD DEPARTMENT IN TAILINGS**

An evaluation with Raman spectroscopy at the University of Western Ontario indicates that the carbonaceous material of the Casa Berardi Fault is different from carbonaceous material elsewhere in the deposit. The Casa Berardi fault carbonaceous material is also of higher activity, which can cause preg-robbing if this material is processed with ore. The neighboring graphite fault reports to the mill as dilution in the underground stope. Its concentration varies greatly in the mill feed depending on the magnitude of the dilution from the fault.

Tailings samples from the mill and bottle roll test have been sent to an external laboratory (SGS and URSTM) to quantify the submicroscopic gold content in each carrier mineral. The gold remaining in residue is submicroscopic gold and is predominantly carried by sulphides and iron oxides; mainly attributed to arsenopyrite and pyrite. The remainder of gold in the residue is generally found in the carbonaceous material. No free gold has been observed under optical microscopy in the residue.

## **COMMINUTION**

Metallurgical test work was carried out in 2012 by the URSTM laboratory in Rouyn-Noranda on thirteen samples from the 118 and 123 zones. Specific gravity analysis was completed; the values ranged from 2.82 g/cc to 3.16 g/cc with an average of 2.95 g/cc. The Bond Work Index (BWI) was evaluated and is presented in the Table 13-4: Ball Mill Work Index by Underground Zone.

***Table 13-4: Ball Mill Work Index by Underground Zone***

<b>Zone</b>	<b>Ball Mill Work Index (Kw*h/t)</b>
118-06	12.6
118-27	12.2
118-31	13.1
123-02	12
123-04	12.7
123-05	12.1
<b>Average</b>	<b>12.4</b>

SGS Lakefield laboratory performed additional test work to define SAG AXb by the SMC test and ball mill work index (kwh/t) on the main underground zone and EMCP, 134 and 160 pits.

Two samples of the SAG feed were also sent for characterization. The results are present in the table 13-5 below with the definition in the database versus other operations in terms of soft, medium or hard ore.

**Table 13-5: Grindability Test Work Done by SGS**

Ore Zones	SAG Mill A X b (SMC test)	Industry Standards	Ball Mill Grindability Index (BMWi kwh/t)	Industry Standards
113	50.7	Medium	12.5	Medium
118-22	40.7	Medium-Hard	9.9	Soft
118-27	38.4	Medium-Hard	12.5	Medium
118-31	46.6	Medium	11.2	Medium-Soft
123-02	40.9	Medium-Hard	9.3	Soft
123-03	41.6	Medium-Hard	11.0	Medium-Soft
123-05	42.4	Medium	11.0	Medium-Soft
124-16	38.3	Medium-Hard	10.9	Medium-Soft
124-22	37.3	Medium-Hard	10.5	Medium-Soft
124-81	35.0	Hard	10.7	Medium-Soft
EMCP	50.5	Medium	12.1	Medium-Soft
	46.7	Medium	12.1	Medium-Soft
	41.9	Medium-Hard	12.9	Medium
Feb 22nd SAG mill feed survey	43.4	Medium	12.0	Medium-Soft
	48.5	Medium		
	44.8	Medium		
Future pit 134				
Ore	41.7	Medium-Hard	12.7	Medium
Ore	48.6	Medium	15.6	Medium-Hard
Ore	36.5	Hard	14.2	Medium
Ore	29.4	Hard	13.4	Medium
Dilution	29.5	Hard	13.6	Medium
Future pit 160				
Ore	35.1	Hard	9.2	Soft
Ore	33.2	Hard	8.3	Soft
Ore	46.0	Medium	8.8	Soft
Dilution	34.8	Hard	8.0	Soft
April 12th SAG mill feed survey				
EMCP plant trial	48.0	Medium	13.0	Medium

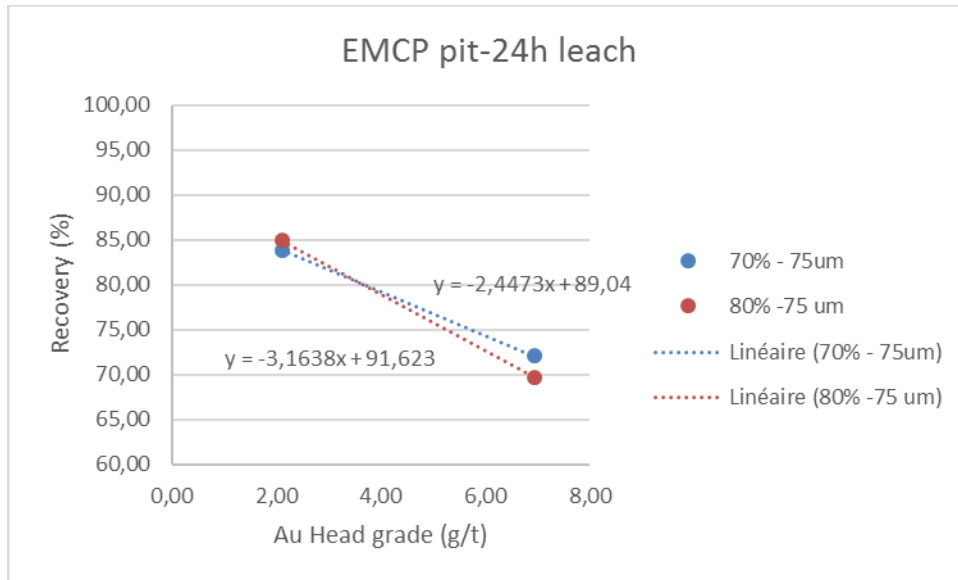
## CYANIDATION

A lot of test work was conducted at three different external laboratories from different zones from the underground and open pit. The three laboratories are the URSTM, FLSmidth facility and COREM. The representativity of each sample was confirmed by a geologist and the mill metallurgist on site during sampling. Table 13-6 summarizes the results. Ranges are provided when many tests have been conducted on a specific zone. All the cyanidation tests were realized using a carbon in leach method that gives metallurgical results similar to the circuit actually in operation in the mill. This kind of test is mandatory due to the presence of graphitic carbon in almost all mineral resources from the Casa Berardi Mine.

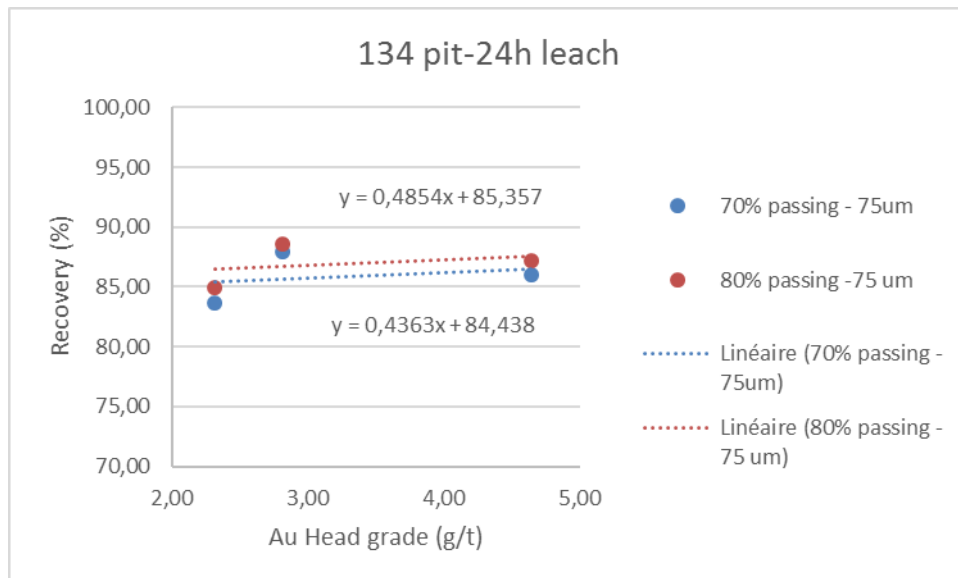
**Table 13-6: Laboratory Test Work Summary**

Zone	Feed Grade (g/t)	Total Recovery (%)	P80 (microns)	Test Work Conducted by
100	8.9	95.3	74	URSTM PU2011-01-581
101	12.0	95.7	70	URSTM PU2011-01-581
103	[6.6 to 14.5]	[89 to 94.5]	80	URSTM PU2011-01-581
109	9.0	92.5	75	URSTM PU2011-01-581
113	9.8	92.2	74	URSTM PU2011-01-581
115	16.6	94.0	91	URSTM PU2011-01-581
118	[4.6 to 8.2]	[74.4 to 92.1]	75	URSTM PU2012-07-731
	[3.9 to 6.2]	[77.6 to 84.2]	[74 to 78]	URSTM PU2011-01-581
	[3.5 to 9.3]	[67.8 to 93.1]	75	FLSmidth P14058AA
123	[4.4 to 10.4]	[70.7 to 82.4]	75	URSTM PU2012-07-731
	6.9	80.3	79	URSTM PU2011-01-581
	[3.9 to 9.8]	[67.8 to 93.1]	75	FLSmidth P14058AA
124	[8.1 to 8.8]	[92.7 to 95.2]	[70 to 79]	URSTM PU2011-06-636
	6.3	91.6	72.0	URSTM PU2008-09-410
160	[1.9 to 3.8]	[87.7 to 91.5]	[72 to 84]	URSTM PU2011-06-636
EMCP pit	5.7	90.0	53	URSTM PU2006-10262
	[2.1 to 7.6]	[70.1 to 94.8]	[51 to 93]	Corem T2211, 48h leach
134 Pit	[2.2 to 4.9]	[76.8 to 90.3]	[48 to 92]	Corem T2211, 48h leach
160 Pit	[2.0 to 6.5]	[82.7 to 94.0]	[66 to 96]	Corem T2211, 48h leach

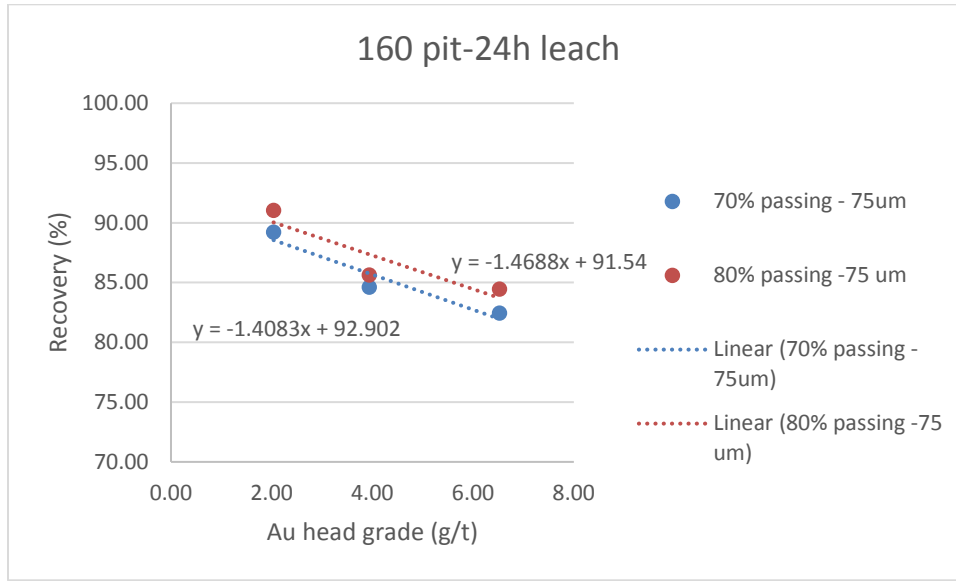
Test work conducted by COREM #T2211 in Québec City on EMCP 134 and 160 pits with different grinds and head grade had the objective to quantify the gold recovery. The results of 24 hours of leaching are shown in Figures 13.1, Figure 13.2, and Figure 13.3. The regression formula that is used further on in this section for the recovery estimation that will be used in mineral reserve calculations is also shown in these figures.



**Figure 13.1: EMCP Pit Test Work, Recovery Modeling**



**Figure 13.2: 134 Pit Test Work, Recovery Modeling**



**Figure 13.3: 160 Pit Test Work, Recovery Modeling**

The recovery models appear in opposition with the typical observation where the recovery increased with grade. There is no clear explanation for this unusual behavior.

### CYANIDE DESTRUCTION

One cyanide destruction tank with SO<sub>2</sub>/AIR was restarted with the mill in 2006 and is still in use. However, the 2017 higher throughput at the mill put more pressure on the cyanide destruction circuit. Various cyanide destruction treatment options, including Caro's Acid, SO<sub>2</sub>/AIR and CombinOx® processes, were investigated on a laboratory scale for treatment of slurry effluent samples from the Casa Berardi Mine in Quebec. The mill process water samples were shipped to Cyanco Corporation's laboratory in Sparks, Nevada, in May 2017. The results of SO<sub>2</sub>/AIR testing are shown in Table 13-7. This process remains the cost-effective treatment in Casa Berardi's case. Adding another tank in the process would support a more stable and flexible operation and should be reviewed for implementation at Casa Berardi.

**Table 13-7: SO<sub>2</sub>/AIR Optimum Results Conducted by Cyanco**

TEST	STREAM	RET'N TIME (hours)	SOLUTION ASSAYS					REAGENT ADDITIONS		
			CN <sub>WAD</sub> (ppm)	*CN <sub>T</sub> (ppm)	Cu (ppm)	Fe (ppm)	pH	SO <sub>2</sub> (g/gCN <sub>WAD</sub> )	Ca(OH) <sub>2</sub> (g/gCN <sub>WAD</sub> )	Cu <sup>2+</sup> (ppm)
	FEED		190.5	200.9	3.95	3.72	11.0			
SO <sub>2</sub> /AIR #7	Treated Slurry	1.0	5.2	13.75	3.06	3.06	8.5	5	1.39	50
	FEED		192.5	205.3	4.51	4.59	10.8			
SO <sub>2</sub> /AIR #8	Treated Slurry	1.0	36.55	49.77	5.21	4.73	8.5	5	1.76	25
	FEED		194.7	219.4	7.95	8.84	11.1			
SO <sub>2</sub> /AIR #9 (Optimum)	Treated Slurry	1.0	7.8	16.72	0.18	3.19	8.5	5.5	2.17	37.5
	FEED		189.8	197.2	4.43	2.69	11.1			
SO <sub>2</sub> /AIR #10	Treated Slurry	0.75	21.5	27.26	16.5	2.06	8.5	5.5	1.62	100
	FEED		198.9	235.8	7.07	13.2	11.0			
SO <sub>2</sub> /AIR #11	Treated Slurry	1.0	26.61	30.55	6.65	1.41	8.1	5.5	-	37.5

\*Calculated Total Cyanide

## OTHER TESTS

On site test work was conducted by SNF Canada in April 2017 to screen for the most promising flocculant to thicken the ore coming from the pit EMCP in the mill at different dosages and feed percent solids. The results are shown in Table 13-8. The best results with a high settling rate and a low turbidity in the overflow are at 14% solids in the feed and 20 g/t of the best flocculant. This information supported the change to an auto-diluting feedwell which was installed later that year.

**Table 13-8: Summary of Settling Test**

#	Product	Dosage	Solid % Feed Thickener	Sedimentation Rate	Compaction	Turbidity of the Overflow
	Flomin	(g/t)	(%)	(m/h)	(ml)	NTU
1	aucun	0	24	1.7	407	36
2	4115 SSH	13	24	2.3	240	28
3	920 MC	13	24	2.8	225	33
4	905 MC	13	24	2.7	219	22
5	913 VHM	13	24	0.3	225	25
6	905 MC	8	24	1.8	237	57
7	905 MC	13	24	2.8	225	33
8	905 MC	17	24	3.2	213	20
9	905 MC	25	24	3.5	209	16
10	905 MC	34	24	2.6	214	5
11 (propose with feed well)	905 MC	20	14	12.3		31
12	905 MC	20	19	5.8		27
13	905 MC	20	27	1.4		13
14	905 MC	20	33	0.4		35
16	905 MC	20	37	0.17		53
17	905 MC	0	37	0.06		420

### MISCELLANEOUS TEST WORK

Other test work has been conducted but didn't prove that the new proposed flowsheet could be economically viable. Below is a summary:

- Investigate the gold recovery by cyanidation both with and without oxidative pre-treatment using Albion Leach® technology. SGS received a range of samples generated from the current Casa Berardi mill operation and historic mill tailings samples in July 2010.
- The Gold Recovery Enhancement Project with flotation and regrind for the Casa Berardi operation. It includes the results of the test work done on the zone 118 bulk sample to date at SGS Lakefield in November 2013.
- The adaptation of the BIOX® Outotec cultures through the various test work stages to zone 118, zone 123 and 118,123 "50/50" blend samples was successful, evidenced by high extents of sulphide oxidations achieved in the program in August 2016.

### 13.3 OPERATION DATA

#### YEARLY REVIEW

Historic key operation parameters for the last four years of operation are shown in Table 13-9. The throughput has increased regularly during this period following improvement in the process. Availability was lower during 2017 and 2018 mainly because longer shutdowns than usual were necessary to implement the improvements.

*Table 13-9: Detailed Yearly Mill Production*

Date	Dry Tonnes Milled (t)	Dry Tonnes / Operating Hour (t/h)	% Passing 200 mesh (%)	Au head Grade (g/t)	Gold Ounces Produced (oz)	Gravimetric Recovery (%)	Total Mill Recovery (%)	Cyanide Consumption (kg/t)	Mill Availability (%)
2015	<b>765,763</b>	95.6	86%	5.96	<b>127,893</b>	35.3%	87.2%	0.82	95.2%
2016	<b>904,998</b>	112.3	84%	5.72	<b>145,973</b>	37.3%	87.7%	0.77	92.8%
2017	<b>1,175,930</b>	153.4	75%	4.77	<b>156,652</b>	37.1%	86.8%	0.67	88.9%
2018	<b>1,248,039</b>	161.0	75%	4.66	<b>162,742</b>	36.5%	87.1%	0.57	89.1%

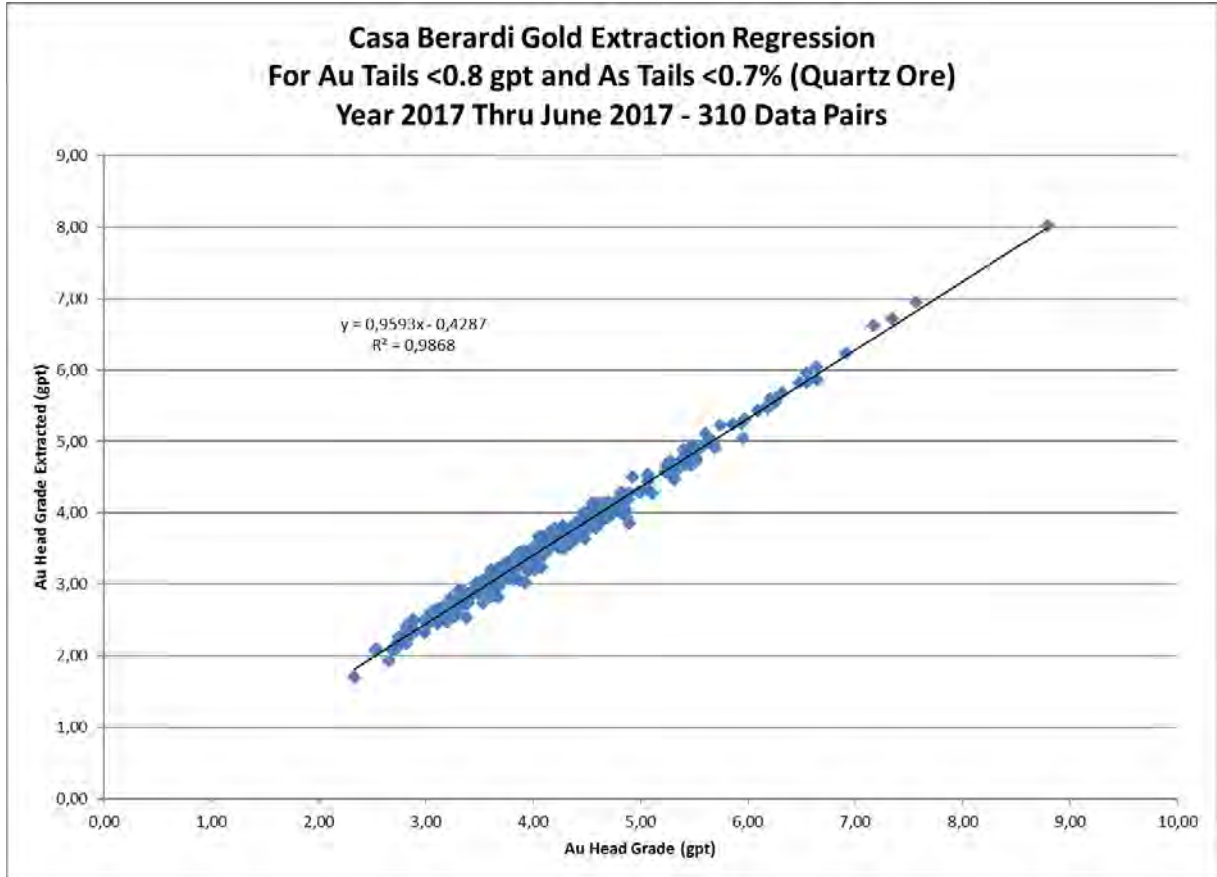
#### HISTORICAL RECOVERY MODEL

The historical recovery model is used to predict the recovery of the underground ore. Analysis of recovery behavior has demonstrated that two types of mineralized material classified as “quartz ore” and “arsenopyrite ore” are clearly different. It has been observed in the plant that the arsenic content of the mill feed greatly influences the gold recovery. The recovery model of the underground material is therefore based on operation periods where the mill was fed with a high proportion of underground material from January 2017 to June 2017.

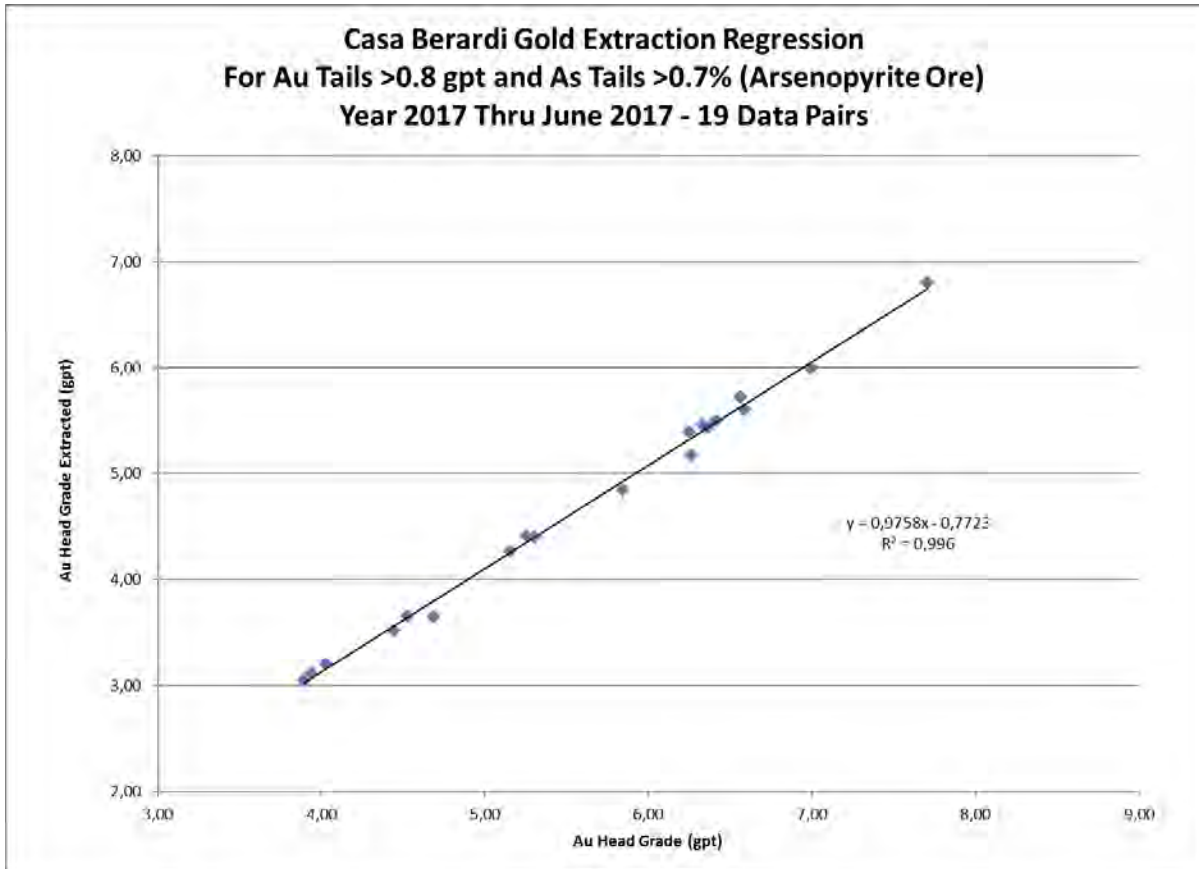
Periods where open pit and underground ores are mixed equally see a dilution of the arsenic grade down to a point where it is very difficult to define the recovery for the arsenic bearing zones and this is why they were excluded.

A set of data, where the mill was fed with arsenic ore type defined as high arsenic content (> 0.7% As) and high tailings (>0.8 g/t), has been selected. The remaining data set was considered as quartz ore. The data sets were adjusted in such a way that the tailings grade has been shifted by 24 hours to take into account the residence time in the leaching circuit. Two regressions have been made between the gold grade extracted (g/t) and the gold head

grade (g/t) for the two sets of data and are shown on the two different graphics in Figure 13.4 and Figure 13.5. The equation of the regression is the basis of the recovery model.



**Figure 13.4: Quartz Mineral Type Regression**



**Figure 13.5: Arsenopyrite Mineral Type Regression**

## 13.4 RECOVERY MODELS

### UNDERGROUND

The historical recovery model gives a good idea of the expected performance in the mill. With the arsenic content measure, it's possible to have a more accurate estimation of the recovery.

Two recovery models were obtained and are defined by the following equations:

- Quartz type ore

$$\text{Gold recovery (\%)} = \frac{0.9593 \times \text{Au head grade} - 0.4287}{\text{Au head grade}}$$

- Arsenopyrite type

$$\text{Gold recovery (\%)} = \frac{0.9758 \times \text{Au head grade} - 0.7723}{\text{Au head grade}}$$

The choice to fit which one of the models below to each zone has been approved and verified by the geologist. The data used to compute the model comes from the actual mill performances, so it reduces the uncertainty in the variability in the mill feed because the data covers many months of operation. The results obtained from metallurgical testing earlier are therefore not used to predict the recovery for the underground ore. Table 13-10 shows which recovery has been applied for each underground zone of the mine plan.

**Table 13-10: Expected Recovery LOM for Underground Zone**

Zone	Expected Recovery (%)	LOM Grade (gt)	Model Used
100	89.93%	7.15	Quartz Model
104	91.54%	9.77	Quartz Model
107	83.27%	3.39	Quartz Model
113	86.79%	4.69	Quartz Model
115	83.85%	3.55	Quartz Model
118	83.03%	5.31	Arsenopyrite Model
121	81.33%	4.75	Arsenopyrite Model
123	84.96%	6.12	Arsenopyrite Model
124	87.65%	5.18	Quartz Model
160	84.81%	3.86	Quartz Model

## OPEN PIT

For the open pit gold recovery used in the LOM, the data used comes from test work conducted in laboratory.

## EMCP AND EMCP EXTENSION PIT

The regression provided in the cyanidation section in Corem’s test work, is presented below. The test work is done on representative samples with different grinds, head grades and with dilution to simulate near a real situation in the pit. We are quite confident the information below will provide a good estimation on the expected recovery in the LOM plan. The model use for the EMCP, is for 70% passing -75 µm and with the mill producing 75% passing -75 µm. The assumption in the recovery is conservative because higher recovery is expected in the mill.

- For 70% passing -75 µm (Coarser)

$$Recovery (\%) = -2.4473 \times Au \text{ Head grade} + 89.04$$

*Recovery (%) EMCP pit = 83.7 % at 2.17 g/t*

*Recovery (%) EMCP pit ext = 85.8 % at 1.32 g/t*

In addition, after discussion we expect that the actual mill recovery will be 2% higher than 83.7%. 85.7% has been used in the 2019 budget. In the LOM, a conservative 85% for both the EMCP and the EMCP extension has been used.

### **134 PIT**

The regression provided in the cyanidation section in Corem's test work, is presented below. The test work is done on representative samples with different grinds, head grades and with dilution to simulate near a real situation in the pit. We are quite confident the information below will provide a good estimation on the expected recovery in the LOM plan.

- For 70% passing -75 µm (Finer)

$$\text{Recovery (\%)} = 0.436 \times \text{Au Head grade} + 84.44$$

$$\text{Recovery (\%)} = 85.26 \% \text{ at } 1.89 \text{ g/t}$$

- For 80% passing -75 µm (Finer)

$$\text{Recovery (\%)} = 0.485 \times \text{Au Head grade} + 85.357$$

$$\text{Recovery (\%)} = 86.27 \% \text{ at } 1.89 \text{ g/t}$$

Both results are in the same range of recovery. Generally, better recovery is expected in the mill versus bottle roll tests. It was therefore decided to use the higher recovery for the 134 Pit, 86.2% of recovery is used in the LOM plan which is in line with the results of the test work.

### **160 PIT**

The regression provided in the cyanidation section in Corem's test work, is presented below. The test work was done on representative samples with different grinds, head grades and with dilution to simulate near a real situation in the pit. The information below will provide a good estimation on the expected recovery in the LOM plan and the confidence is appropriate for the precision required.

- For 70% passing -75 µm (Coarser)

$$\text{Recovery (\%)} = -1.4083 \times \text{Au Head grade} + 92.902$$

$$\text{Recovery (\%)} = 90.32 \% \text{ at } 1.83 \text{ g/t}$$

The model uses for the 160 Pit, is for 70% passing -75 µm and with the mill producing 75% passing -75 µm. We decided to use this sized fraction because it will be more in line with the result expected in the mill and with the lower ball mill grindability index. It's a conservative approach.

### WMCP AND PRINCIPAL PIT

These two open pits are a continuation of underground mineral body. With little information on the recovery for lower grade a conservative approach has been chosen. Geologists confirm that the underground mineralization is similar to the body that will be exploited in the open pit. Historical 113 and 124 underground zones give ≈89% of recovery for 5 g/t Au head grade, with 2.4 g/t Au and 2.7 g/t Au of head grade for the WMCP and Principal pit respectively, the 85% of recovery is a good estimate with little information available.

### EXPECTED RECOVERIES

The expected recoveries from the different open pits are presented in Table 13-11 below.

**Table 13-11: Expected Recovery LOM for Open Pit**

Zone	Expected Recovery (%)	LOM Grade (gt)
EMCP - Ext	85.00%	1.32
East Mine Pit - EMCP	85.00%	2.17
134 Pit	86.20%	1.89
160 Pit	90.20%	1.83
West Mine Pit – WMCP	85.00%	2.38
Principal Pit	85.00%	2.65

### **13.5 CONCLUSIONS AND RECOMMENDATIONS**

The test work done on open pit material was used to estimate the recovery while operating data was used for underground material. A part of the mineral reserves are related to open pit where no test work has been done. For these parts of the mineral reserve an 85% recovery has been applied based on general historic mill performances. A higher risk on recovery is present for this material but remains acceptable since the operation experience on which the recovery prediction is based compensates for this.

For the future, the following recommendation is made:

- With the goal of increasing the knowledge on principal and WMCP pits, we recommend that more test work be conducted. This will facilitate the definition of future recovery with precision for these pits and have an indication of the variability of gold recovery and grindability of the material.

### **13.6 COMMENTS ON MINERAL PROCESSING AND METALLURGICAL TESTING**

Industry-standard studies were performed as part of process development and initial Casa Berardi mill design. Subsequent production experience and focused investigations, as well as marketing requirements, have guided mill expansions and process changes.

Test work programs, both internal and external, continue to be performed to support current operations and potential improvements.

The QP has reviewed the information provided by Hecla, as summarized in Section 13, and has performed a review of the reconciliation data available to verify the information used in the LOM plan. Based on these checks, in the opinion of the QP, the metallurgical test work and reconciliation and production data support LOM planning:

- Industry standard and appropriate metallurgical testing procedures consistent for the deposit's mineralogy have been consistently used by Casa Berardi staff for optimizing and improving mill process capabilities and performance;
- Numerous external and internal studies have been conducted from feasibility studies to the date of this report which have been used to develop and optimize the

existing flowsheet;

- The samples used in the test work are considered representative of mill feed types across the deposit;
- LOM projections are based on production results and informed by metallurgical test data that is updated in the model forecasts each year;
- Mill metallurgical results and forecasts are consistent with the deposit mineralogy and the process circuit used;
- Metallurgical and production models were developed from metallurgical sampling and testing. The methodologies, process and data used in making recovery projections are unbiased and provide sound projections;

## 14.0 MINERAL RESOURCE ESTIMATE

### 14.1 SUMMARY

Mineral Resource estimates for the Mine as at December 31, 2018, are presented in Tables 14-1 and 14-2. Total Measured and Indicated Mineral Resource, exclusive of Mineral Reserves, are estimated to be 11,565,900 tonnes at 3.2 g/t Au containing 1,205,300 gold ounces. Inferred Mineral Resources total 5,644,400 tonnes at 3.6 g/t Au for 652,200 gold ounces. The underground portion of Measured and Indicated Mineral Resources represent 47% of the total Measured and Indicated Mineral Resources.

Mineral Resources are classified based on the density of drill hole data and the continuity of the auriferous zones. This classification complies with the 2014 Canadian Institute of Mining, Metallurgy and Petroleum (CIM) Definition Standards for Mineral Resources and Mineral Reserves and the 2003 CIM Best Practice Guidelines. The classification of Mineral Resources at Casa Berardi is guided by the drill hole spacing, which ranges from 15 m to 50 m and by the ranges of variograms, which are between 10 m and 50 m. It also takes into consideration the distance of drill hole composites to block center which is an attribute generated in the Gems software at the time of grade interpolation (Mean Distance of Samples to Block Center or MeanDist).

For each lens, a polygon was created around blocks that were estimated based on drill hole composites with an average mean distance of 25 m. The mineral resources were classified as follows:

- Measured Mineral Resources: blocks inside the 25 m mean distance polygon in addition to local development that confirmed the continuity of mineralization.
- Indicated Mineral Resources: blocks inside the 25 m mean distance polygon.
- Inferred Mineral Resources: blocks outside the 25 m mean distance polygon, up to generally a maximum of 35 m mean distance, and rarely up to 50 m mean distance.

Each block of the model was assigned classified as a Measured, Indicated, or Inferred Mineral Resource. The location of the Mineral Resource zones is presented on Figure 14.1.

**Table 14-1: Casa Berardi Mineral Resources Exclusive of Mineral Reserves**

Classification Mine - Zone	Tonnes	Gold g/t	Gold oz
<b>Measured Mineral Resources</b>			
100 Lower Inter	110,400	5.8	20,700
103 South West	224,200	4.2	30,200
101 North West	41,600	6.4	8,600
104	-	-	-
108 Inter	800	3.6	100
109	14,300	6.1	2,800
111	13,000	4.2	1,800
113	363,400	6.3	73,500
115	13,700	5.4	2,400
116	-	-	-
117	5,300	4.1	700
118	273,600	4.4	38,600
119	-	-	-
121	-	-	-
123	305,100	4.9	47,900
124	232,500	4.9	36,900
146	-	-	-
148	173,100	6.3	35,200
152	-	-	-
157	-	-	-
<b>Total Underground</b>	<b>1,770,800</b>	<b>5.3</b>	<b>299,300</b>
105 West Mine open pit	-	-	-
124 Principal open pit	-	-	-
134 Open pit	-	-	-
148 East Mine open pit	-	-	-
146 East Mine extension open pit	-	-	-
160 Open pit	-	-	-
<b>Total Open Pit</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>Total Measured Resources</b>	<b>1,770,800</b>	<b>5.3</b>	<b>299,300</b>

Classification Mine - Zone	Tonnes	Gold g/t	Gold oz
<b>Indicated Mineral Resources</b>			
100 Lower Inter	76,700	5.1	12,600
103 South West	115,400	4.1	15,100
101 North West	-	-	-
104	-	-	-
108 Inter	600	3.5	100
109	63,500	7.9	16,000
111	128,800	5.0	20,500
113	441,300	5.0	70,800
115	41,800	5.9	7,900
116	-	-	-
117	-	-	-
118	1,042,200	4.4	147,000
119	97,800	4.6	14,400
121	17,400	4.5	2,500
123	678,000	4.2	91,800
124	821,100	5.0	131,100
146	-	-	-
148	126,200	4.6	18,800
152	85,100	5.1	13,800
157	-	-	-
<b>Total Underground</b>	<b>3,735,800</b>	<b>4.7</b>	<b>562,400</b>
105 West Mine open pit	-	-	-
124 Principal open pit	-	-	-
134 Open pit	1,196,700	1.5	59,300
148 East Mine open pit	-	-	-
146 East Mine extension open pit	-	-	-
160 Open pit	4,862,600	1.8	284,300
<b>Total Open Pit</b>	<b>6,059,200</b>	<b>1.8</b>	<b>343,600</b>
<b>Total Indicated Mineral Resources</b>	<b>9,795,100</b>	<b>2.9</b>	<b>906,000</b>
<b>Total Measured + Indicated</b>	<b>11,565,900</b>	<b>3.2</b>	<b>1,205,300</b>

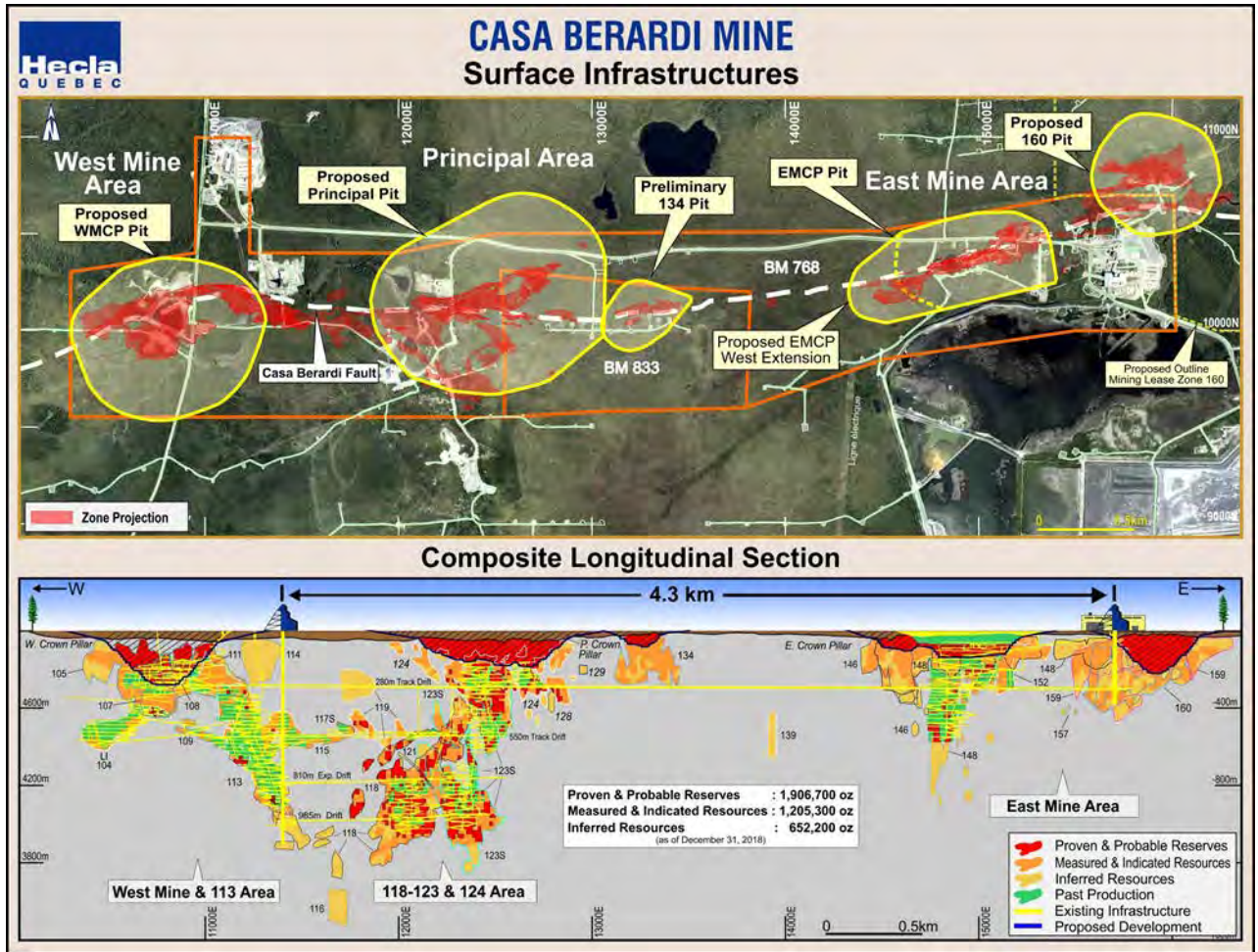
Classification Mine - Zone	Tonnes	Gold g/t	Gold oz
<b>Inferred Mineral Resources</b>			
100 Lower Inter	4,800	14.8	2,300
103 South West	0	0.0	0
101 North West	0	0.0	0
104	115,100	6.6	24,500
108 Inter	0	0.0	0
109	0	0.0	0
111	0	0.0	0
113	0	0.0	0
115	0	0.0	0
116	216,000	13.2	91,500
117	0	0.0	0
118	420,200	5.0	68,100
119	160,500	5.6	29,100
121	11,500	3.7	1,400
123	306,000	5.1	50,600
124	430,000	6.0	82,500
146	66,700	6.4	13,800
148	156,000	9.1	45,600
152	15,000	8.2	4,000
157	9,600	5.4	1,700
<b>Total Underground</b>	<b>1,911,500</b>	<b>6.8</b>	<b>415,100</b>
105 West Mine open pit	185,700	1.9	11,600
124 Principal open pit	843,000	2.6	71,700
134 Open pit	274,900	1.6	14,000
148 East Mine open pit	17,500	1.2	600
146 East Mine extension open pit	0	0.0	0
160 Open pit	2,412,000	1.8	139,200
<b>Total Open Pit</b>	<b>3,733,000</b>	<b>2.0</b>	<b>237,100</b>
<b>Total Inferred Mineral Resources</b>	<b>5,644,400</b>	<b>3.6</b>	<b>652,200</b>

**Table 14-2: Casa Berardi Summary Mineral Resources Exclusive of Mineral Reserves**

Area	Resource Category	Tonnes	Gold g/t	Gold oz contained
Underground	Measured	1,770,800	5.3	299,300
	Indicated	3,735,800	4.7	562,400
	<b>Measured + Indicated</b>	<b>5,506,700</b>	<b>4.9</b>	<b>861,700</b>
	Inferred	1,911,500	6.8	415,100
Open pit	Measured	-	-	-
	Indicated	6,059,200	1.8	343,600
	<b>Measured + Indicated</b>	<b>6,059,200</b>	<b>1.8</b>	<b>343,600</b>
	Inferred	3,733,000	2.0	237,100
<b>Total</b>	<b>Measured + Indicated</b>	<b>11,565,900</b>	<b>3.2</b>	<b>1,205,300</b>
<b>Total</b>	<b>Inferred</b>	<b>5,644,400</b>	<b>3.6</b>	<b>652,200</b>

Notes:

1. CIM definitions were followed for Mineral Resources.
2. Underground mineral resources were estimated by Hecla Québec.
3. Open pit mineral resources were estimated by Hecla Québec.
4. Underground mineral resources are estimated at a cut-off grades of 3.2 g/t Au for the West Mine and 3.1 g/t Au for the East Mine.
5. Underground mineral resources are estimated using an average long-term gold price of US\$1,350 per ounce and a US\$/C\$ exchange rate of 1.33.
6. Open pit mineral resources are estimated at a cut-off of 0.67 g/t Au.
7. Open pit mineral resources are estimated using an average long-term gold price of US\$1,225 per ounce and a US\$/C\$ exchange rate of 1.30.
8. Minimum mining widths three meters were used.
9. Mineral Resources are exclusive of Mineral Reserves.
10. Totals may not represent the sum of the parts due to rounding.
11. Mineral Resources which are not Mineral Reserves do not have demonstrated economic viability.



**Figure 14.1: Casa Berardi Mine Composite Plan and Longitudinal View**

The mineral resource estimates at Casa Berardi were carried out using block model grade interpolation techniques. Mineral resource estimates at Casa Berardi were effectuated by the mine staff except for the block model of the Principal Mine surface pillar which was estimated by RPA.

Table 14-3 compares the December 31, 2018 Mineral Resources with the December 31, 2017 estimate. Gains and losses are essentially explained by:

- Geological reinterpretation of mineralized zones after drilling programs.
- Conversion of Inferred Mineral Resources into Indicated or Indicated into Measured Mineral Resources.
- Conversion of Mineral Resources into Mineral Reserves.
- Mining depletion.

- Subtraction of low-grade mineral resources (below cut-off grade).

**Table 14-3: Comparison of December 31, 2018 Versus December 31, 2017 Mineral Resources Exclusive of Mineral Reserves**

Classification Mine - Zone	December 31, 2018			December 31, 2017			Gain (Loss)	
	Tonnes	Gold g/t	Gold ounces	Tonnes	Gold g/t	Gold ounces	Tonnes	Ounces
<b>Measured</b>								
100 Lower Inter	110,400	5.8	20,700	128,200	5.4	22,400	-17,800	-1,700
103 South West	224,200	4.2	30,200	918,600	5.1	151,800	-694,400	-121,600
101 North West	41,600	6.4	8,600	41,600	6.4	8,600	-	-
104	-	-	-	-	-	-	-	-
108 Inter	800	3.6	100	-	-	-	800	100
109	14,300	6.1	2,800	14,300	6.1	2,800	-	-
111	13,000	4.2	1,800	13,000	4.2	1,800	-	-
113	363,400	6.3	73,500	373,800	6.2	74,500	-10,400	-1,000
115	13,700	5.4	2,400	13,700	5.4	2,400	-	-
116	-	-	-	-	-	-	-	-
117	5,300	4.1	700	4,500	3.5	500	800	200
118	273,600	4.4	38,600	111,300	4.6	16,300	162,300	22,300
119	-	-	-	-	-	-	-	-
121	-	-	-	-	-	-	-	-
123	305,100	4.9	47,900	114,400	4.3	15,900	190,700	32,000
124	232,500	4.9	36,900	98,200	5.1	16,000	134,300	20,900
134	-	-	-	-	-	-	-	-
146	-	-	-	-	-	-	-	-
148	173,100	6.3	35,200	173,100	1.1	5,900	-	29,300
152	-	-	-	-	-	-	-	-
157	-	-	-	-	-	-	-	-
160	-	-	-	-	-	-	-	-
<b>Underground</b>	<b>1,770,800</b>	<b>5.3</b>	<b>299,300</b>	<b>2,004,400</b>	<b>4.9</b>	<b>318,800</b>	<b>-233,600</b>	<b>-19,500</b>
105 West Mine pit	-	-	-	-	-	-	-	-
124 Principal pit	-	-	-	-	-	-	-	-
134 open pit	-	-	-	-	-	-	-	-
148 East Mine pit	-	-	-	-	-	-	-	-
146 East Mine extension pit	-	-	-	-	-	-	-	-
160 open pit	-	-	-	-	-	-	-	-
<b>Open Pit</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>Total Measured</b>	<b>1,770,800</b>	<b>5.3</b>	<b>299,300</b>	<b>2,004,400</b>	<b>4.9</b>	<b>318,800</b>	<b>-233,600</b>	<b>-19,500</b>
<b>Indicated</b>								
100 Lower Inter	76,700	5.1	12,600	81,600	5.0	13,000	-4,900	-400
103 South West	115,400	4.1	15,100	528,000	3.8	65,200	-412,600	-50,100
101 North West	-	-	-	-	-	-	-	-
104	-	-	-	-	-	-	-	-

Classification Mine - Zone	December 31, 2018			December 31, 2017			Gain (Loss)	
	Tonnes	Gold g/t	Gold ounces	Tonnes	Gold g/t	Gold ounces	Tonnes	Ounces
108 Inter	600	3.5	100	225,700	4.0	28,700	-225,100	-28,600
109	63,500	7.9	16,000	63,500	7.9	16,000	-	-
111	128,800	5.0	20,500	135,600	4.9	21,200	-6,800	-700
113	441,300	5.0	70,800	450,900	5.0	71,700	-9,600	-900
115	41,800	5.9	7,900	42,800	5.8	8,000	-1,000	-100
116	-	-	-	-	-	-	-	-
117	-	-	-	3,100	4.7	500	-3,100	-500
118	1,042,200	4.4	147,000	1,231,000	4.4	172,200	-188,800	-25,200
119	97,800	4.6	14,400	-	-	-	97,800	14,400
121	17,400	4.5	2,500	25,500	5.4	4,400	-8,100	-1,900
123	678,000	4.2	91,800	693,000	4.3	96,800	-15,000	-5,000
124	821,100	5.0	131,100	1,028,600	5.2	172,500	-207,500	-41,400
134	-	-	-	1,028,400	1.6	53,400	-1,028,400	-53,400
146	-	-	-	-	-	-	-	-
148	126,200	4.6	18,800	126,200	4.6	18,800	-	-
152	85,100	5.1	13,800	85,100	5.1	13,800	-	-
157	-	-	-	-	-	-	-	-
160	-	-	-	3,552,200	2.1	239,400	-3,552,200	-239,400
<b>Underground</b>	<b>3,735,800</b>	<b>4.7</b>	<b>562,400</b>	<b>9,301,100</b>	<b>3.3</b>	<b>995,700</b>	<b>-5,565,300</b>	<b>-433,300</b>
105 West Mine pit	-	-	-	-	-	-	-	-
124 Principal pit	-	-	-	-	-	-	-	-
134 open pit	1,196,700	1.5	59,300	37,500	2.4	2,900	1,159,200	56,400
148 East Mine pit	-	-	-	-	-	-	-	-
146 East Mine extension pit	-	-	-	-	-	-	-	-
160 open pit	4,862,600	1.8	284,300	673,900	2.6	56,000	4,188,700	228,300
<b>Open Pit</b>	<b>6,059,200</b>	<b>1.8</b>	<b>343,600</b>	<b>711,400</b>	<b>2.6</b>	<b>58,900</b>	<b>5,347,800</b>	<b>284,700</b>
<b>Total Indicated</b>	<b>9,795,100</b>	<b>2.9</b>	<b>906,000</b>	<b>10,012,500</b>	<b>3.3</b>	<b>1,054,600</b>	<b>-217,400</b>	<b>-148,600</b>
<b>Total Measured + Indicated</b>	<b>11,565,900</b>	<b>3.2</b>	<b>1,205,300</b>	<b>12,016,900</b>	<b>3.6</b>	<b>1,373,400</b>	<b>-451,000</b>	<b>-168,100</b>

Notes:

1. CIM definitions were followed for Mineral Resources.
2. Underground mineral resources were estimated by Hecla Québec.
3. Open pit mineral resources were estimated by Hecla Québec.
4. Underground mineral resources are estimated at a cut-off grades of 3.2 g/t Au for the West Mine and 3.1 g/t Au for the East Mine.
5. Underground mineral resources are estimated using an average long-term gold price of US\$1,350 per ounce and a US\$/C\$ exchange rate of 1.33.
6. Open pit mineral resources are estimated at a cut-off of 0.67 g/t Au.
7. Open pit mineral resources are estimated using an average long-term gold price of US\$1,225 per ounce and a US\$/C\$ exchange rate of 1.30.
8. Minimum mining widths three meters were used.
9. Mineral Resources are exclusive of Mineral Reserves.
10. Totals may not represent the sum of the parts due to rounding.
11. Mineral Resources which are not Mineral Reserves do not have demonstrated economic viability.

RPA is of the opinion that there is no known permitting, legal, taxation, socio-economic, marketing, political, or other relevant factors that could materially affect the Mineral Resource estimates.

## 14.2 DATABASE

The current mineral resource estimate is based on data available as of December 2018. The software used for the mineral resource estimate is Gemcom 6.8 version. The mineral resource solids, dilution envelopes and block models were built by using the diamond drill hole and chip sample workspaces, “Drillholes” and “RAINURE” respectively. They both have the same structure, detailed in Table 14-4. The database was created by merging files from various sources (Hecla Québec/Aurizon, Inco Gold and TVX).

**Table 14-4: Database Structure**

Table		Main Fields
Header	Main table	Hole Name, Easting, Northing, Elevation, Azimuth, Dip, Length, Hole Type, Date Started, Date Finished, Logged By
Survey	Deviation tests	Distance, Azimuth, Dip, MAG Azimuth, Type of survey, Mag, Mag dip, gravity
RQD	RQD survey	From, To, Length, RQD%
Litho_0	Geology main table	From, To, Rock_type, Tittle, Rockcode, Description, Level, Veins, Colour, Deformation, Alteration, Mineralization
Litho_1	Geology sub-table	From, To, Rock_type, Tittle, Rockcode, Description, Level, Veins, Colour, Deformation, Alteration, Mineralization
Litho_2	Geology sub-table	From, To, Rock_type, Tittle, Rockcode, Description, Level, Veins, Colour, Deformation, Alteration, Mineralization
Assays	Gold assay results and density	From, To, Sample No, Certificate no, Certificate date, OR_TRA (gold assays), lab duplicates from pulp and rejects, Density, Rock_Code, Block_Code, Solid Name, AU_COUPE (gold cutted)
Qc_assay	Quality checks for assays	DISTANCE, Sample No, Certificate no, Certificate date, OR_TRA (gold assays), lab duplicates from pulp and rejects, primary and secondary labs, Density, standard used
XRF	XRF assays (CONTAMINANTS)	From, To, Sample no, Certificate date, As, Fe, S...
Inters_Grp	Underground intersects for block models	From, To, LOCATION (X,Y,Z), LENGTH, AU,ROCK_CODE,COMP_ID, SOLID_NAME, BLOCK_CODE, LONG_AU, DENSITÉ, LONG DENS,AU NS,

		LONG_AU_NS,AS, LONG_AS, AU_COUPE, DATE
Inters_Pit	Pit intersects for block models	From, To, LOCATION (X,Y,Z), LENGTH, AU, ROCK_CODE, COMP_ID, SOLID_NAME, BLOCK_CODE, LONG_AU, DENSITE, LONG_DENS, AU_NS, LONG_AU_NS, AS, LONG_AS, AU_COUPE, DATE

### 14.3 DENSITY DETERMINATION

#### METHODOLOGY OF DENSITY DETERMINATIONS ON DRILL CORE

Historically TVX used a density of 2.77 t/m<sup>3</sup> for Mineral Reserve estimation. The same density factor was used in their mill operation. Several density determination programs have been carried out since 1999. Density determinations were conducted on pieces of whole core prior to crushing for assaying using the “Immersion in water” method. As rocks at Casa Berardi are non-porous, no wax coating was applied to core samples. Tests were effectuated at different laboratories and determined the densities in mineralized and non-mineralized rock, various lithologies and most of the mineralized lenses. The density database contains approximately 7,850 records, a total of 2,908 were taken within the mineralized lenses.

The Table 14-5 presents a summary of the density determinations by zone.

**Table 14-5: Density Determinations by Zone**

<b>Open Pit Zone</b>	<b>Number</b>	<b>Mean (t/m<sup>3</sup>)</b>	<b>Minimum (t/m<sup>3</sup>)</b>	<b>Maximum (t/m<sup>3</sup>)</b>
105	46	2.68	2.57	2.84
134	34	2.69	2.45	3.47
146	46	2.68	2.55	2.8
148	246	2.67	2.13	2.99
152	47	2.77	2.55	2.93
159	16	2.77	2.66	2.97
160	308	2.69	2.38	3.03
124	162	2.86	2.53	3.45
<b>Total</b>	<b>905</b>	<b>2.72</b>	<b>2.13</b>	<b>3.47</b>
<b>Underground Zone</b>	<b>Number</b>	<b>Mean (t/m<sup>3</sup>)</b>	<b>Minimum (t/m<sup>3</sup>)</b>	<b>Maximum (t/m<sup>3</sup>)</b>
107	15	2.69	2.58	2.84
109	106	2.72	2.55	3.04
111	17	2.65	2.57	2.8
113	449	2.73	2.37	3.78
115	115	2.67	2.16	2.99
118	442	2.81	2.51	4.15
119	82	3.01	2.59	4.6
121	93	2.86	2.52	4.31
123	270	2.85	2.36	4.17
124	251	2.85	2.35	3.45
152	5	2.83	2.78	2.87
160	108	2.69	2.38	3.03
100 Lower Inter	50	2.67	2.51	2.92
<b>Total</b>	<b>2003</b>	<b>2.79</b>	<b>2.16</b>	<b>4.6</b>
<b>Total Open pit - Underground</b>	<b>2908</b>	<b>2.77</b>	<b>2.13</b>	<b>4.6</b>

## 14.4 GEOLOGICAL INTERPRETATION

Hecla Québec carried out the geological interpretation and correlation of lenses on 1:250 scale on vertical sections spaced at 15 m, 20 m, 25 m, or 50 m, and on plan views spaced at 10 and 20 m. Drill hole spacing ranges from 10 m to 50 m. In general, the drill hole spacing is sufficiently dense to confidently interpret and correlate the mineralized systems from section to section. Drill holes and chip sample data, along with underground mapping were used to build the solids. Once modeled, the lenses are projected onto various levels to verify their continuity and to check the interpretations. Adjustments on sections and plans were made when necessary, in order to have a consistent interpretation.

### MINIMUM WIDTH AND CUT-OFF GRADE USED FOR INTERPRETATION

The geology staff created mineralized envelopes based on a general 4.0 g/t Au cut-off grade for the underground mineral resources and 1.0 g/t Au cut-off for the open pit mineral resources evaluation, using, in both cases, a minimum true width of three meters. Some lower grade areas are incorporated for the sake of continuity. Assay results from drill holes and chips samples are often higher than cut-off grades. In addition to often being stratigraphically constrained, sharp contacts between economic and non-economic grades are noted. The open pit mineral resource envelopes are usually wider than and can contain several underground envelopes. The open pit mineral resource envelopes are usually modeled from surface to a depth of 350 m (Elevation 4,650) while the underground mineral resources are modeled from surface with no lower limit. To avoid duplication of tonnage and grade, the pit-shell is used to discriminate the open pit from the underground envelopes.

### WEST MINE UNDERGROUND

West Mine underground mineral resources were modeled between sections 11,350E and 11,600E. Zones mined with remaining mineral resources are the Lower Inter, Inter, South West, 109, 111, 113 and 115 zones.

### LOWER INTER ZONE

Mineralization at the Lower Inter Zone (LI) occurs between sections 10,350E and 10,825E and between elevations 4,400 m and 4,600 m and is constrained to the south of the Casa Berardi Fault. It is characterized by two envelopes; a high-grade core based on a 4 g/t Au cut-off grade which was sub-divided into several domains for grade interpolation

due to changes in dip and strike and an outer low-grade envelope based on a 1 g/t Au cut-off grade.

### **109, 111, 113 AND 115 ZONES**

Mineralization at the 109, 111, 113, and 115 zones occurs between sections 10,825E and 11,600E and from surface to elevation 3,800 m and is constrained to the south of the Casa Berardi Fault. Six mineralized lenses were interpreted for the 109 Zone, twelve for the 113 Zone (including the 111 Zone), and eight lenses for the 115 Zone.

### **SOUTH WEST (SW) ZONE**

In the South West (SW), mineralization occurs between sections 10,600E and 10,900E and from elevation 4,600 m to 4,900 m and is associated with the South Fault as well as a secondary graphitic fault south of the Casa Berardi Fault. Five lenses were modeled in the 107 and 108 zones.

### **WEST MINE SURFACE PILLAR**

Mineralization at the West Mine Crown Pillar (WMCP) occurs between sections 10,340E and 11,450E and from elevation 4,650 m to the 5,000 m (surface). Six lenses were modeled which include parts of the upper levels of the 111, 113, South-West and Inter zones as well as where the North-West and North-East zones meet the Casa Berardi Fault.

The lenses 105\_01, 105\_06 and 114\_01 regroup most of the mineralized zones at the Casa Berardi Fault, 105\_04 contains all of the 'Inter' zones within the secondary graphitic faults and 105\_02 captures all of the mineralization associated with the South Fault.

## **14.5 PRINCIPAL MINE UNDERGROUND**

The Principal Mine consists of the 116, 117, 118, 119, 123 and 124 zones.

### **116 ZONE**

The 116 Zone occurs between section 11,630E and 11,730E from elevation 3,510 m to 3,670 m. It consists of a single lens north of the Casa Berardi Fault.

### **117 ZONE**

The 117 Zone occurs between section 11,680E and 11,770E from elevation 4,470 m to 4,530 m and is a single lens associated with the South Fault.

### **118 ZONE**

The 118 Zone occurs between section 11,565E and 12,465E and between elevation 3,730 m to 4,650 m. The 118 consists of 32 lenses associated with the Casa Berardi Fault.

### **119 ZONE**

The 119 Zone occurs between section 11,700E and 12,100E, from elevation 4,390 m to 4,810 m. It consists of seven lenses associated with a secondary graphitic fault splay south of, and rejoining, the 123 Zone.

### **123 ZONE**

The 123 Zone (including the 121 and 128 zones) occurs between section 12,000E and 12,800E and from elevation 3,750 m to 4,850 m. These zones contain 16 lenses located south of the Casa Berardi Fault.

### **124 ZONE**

The 124 Zone occurs between 11,940E and 12,930E and from the bedrock surface to elevation 4,400 m. The zones contain 28 lenses north and south of the Casa Berardi Fault and associated with a secondary graphitic fault.

## **14.6 PRINCIPAL MINE PIT**

Mineralization in the Principal Pit area occurs between sections 11,950E and 13,000E and between elevation 4,650 m to the bedrock surface. Thirty-nine lenses were modeled in the Principal and include almost all of the 122 and 124 Zones remodeled with a 1.0 g/t cut-off grade.

### **134 OPEN PIT**

Mineralization at 134 occurs between sections 13,100E and 13,440E and from elevation 4,710 m to the bedrock surface. Seven lenses were modeled to the east of the Principal Mine pit associated with the Casa Berardi Fault.

### **EAST MINE UNDERGROUND**

Underground mineralization at the East Mine occurs from section 13,100E to 13,440E from elevation 4,710 m to the bedrock surface. Thirty-seven lenses were modeled with the 146, 148 and 152 zones (34 lenses) occurring along the Casa Berardi Fault and the 157 Zone (3 lenses) occurring south of the Casa Berardi Fault.

### **EAST MINE CROWN PILLAR OPEN PIT**

Mineralization in the East Mine Crown Pillar (EMCP) area occurs from section 14,400E to 15,440E from elevation 4,710 m to the surface bedrock. Twenty-three lenses were modeled to assess the surface East Mine pillar. This assessment locally included zones from the underground mineral resource.

### **160 OPEN PIT**

Mineralization occurs from section 15,480E to 16,320E and from elevation 4,650 m to the bedrock surface. Fifteen lenses were modeled in the area, including the 159 and 160 Zones. The 159 Zones are associated with the Casa Berardi Fault; the 160 Zones are located north of the Casa Berardi Fault.

## 14.7 CUT-OFF GRADE FOR REPORTING MINERAL RESOURCES

### UNDERGROUND MINERAL RESOURCES

The cut-off grade used by Hecla Québec for underground Mineral Resources are based on the following parameters and show in Table 14-6 below:

- Gold Price US\$1,350/oz.
- Exchange Rate 1.33.
- Mill Recovery Specific by Zone (Table 14-6).
- Mining Cost \$157.21 C\$/tonne.

The cut-off grade is therefore calculated by the following equations:

- Gold price:  $US\$1350/oz \times C\$1.33/US\$1.00 = C\$1,795.5$ .
- Revenue per unit gold:  $C\$1,795.5 \div 31.1035 \text{ g/oz} = C\$57.73 \times \text{Mill recovery}$ .
- Cut-off grade = Operating costs / Revenue per unit gold.

**Table 14-6: Mineral Resources Cut-Off Grade Estimation**

Zone	Mill Recovery %	Gold Cut-Off Grade g/t	Revenue US\$/Ounces	Mining Cost C\$	Exchange Rate
100	90.00%	3.03	1,350.00 \$	157.21 \$	1.33 \$
103	83.30%	3.27	1,350.00 \$	157.21 \$	1.33 \$
107	85.20%	3.2	1,350.00 \$	157.21 \$	1.33 \$
108	85.20%	3.2	1,350.00 \$	157.21 \$	1.33 \$
113	86.80%	3.14	1,350.00 \$	157.21 \$	1.33 \$
116	83.00%	3.28	1,350.00 \$	157.21 \$	1.33 \$
117	83.00%	3.28	1,350.00 \$	157.21 \$	1.33 \$
118	83.00%	3.28	1,350.00 \$	157.21 \$	1.33 \$
119	83.00%	3.28	1,350.00 \$	157.21 \$	1.33 \$
121	81.30%	3.35	1,350.00 \$	157.21 \$	1.33 \$
123	85.00%	3.2	1,350.00 \$	157.21 \$	1.33 \$
124	87.60%	3.11	1,350.00 \$	157.21 \$	1.33 \$
128	85.00%	3.2	1,350.00 \$	157.21 \$	1.33 \$
129	85.00%	3.2	1,350.00 \$	157.21 \$	1.33 \$
139	85.00%	3.2	1,350.00 \$	157.21 \$	1.33 \$
146	87.00%	3.13	1,350.00 \$	157.21 \$	1.33 \$
148	87.00%	3.13	1,350.00 \$	157.21 \$	1.33 \$
157	87.00%	3.13	1,350.00 \$	157.21 \$	1.33 \$
159	87.00%	3.13	1,350.00 \$	157.21 \$	1.33 \$
160	87.00%	3.13	1,350.00 \$	157.21 \$	1.33 \$

#### 14.8 CUT-OFF GRADE FOR REPORTING OPEN PIT MINERAL RESOURCES

A conservative cut-off grade of 0.67 g/t Au was used when estimating open pit Mineral Resources inside the pit shell optimized by Mine Development Associates (MDA) of Reno, Nevada. Open pit mineral resources are estimated using an average long-term gold price of US\$1,225 per ounce and a US\$/C\$ exchange rate of 1.3.

#### 14.9 BLOCK MODELING AND MINERAL RESOURCE ESTIMATION

Grade capping was carried out to minimize the impact of very high-grade assays on the mineral resource estimate. Each zone that represented part of the present estimate was treated separately and used a different high-grade capping value. Statistical distributions of original assays within the mineralized envelopes were plotted in the form of histograms and a log-normal assay distribution capping factors were determined by Hecla Québec from these histograms and statistical reports. Cutting curves were also used to some extent in determining the capping factors for the 113 and Lower Inter zones.

Capping factors were applied to raw assays prior to compositing. This approach is used to prevent the high-grade assays from being smeared over two composites. The Table 14-7 presents the capping factors used in the various estimates.

**Table 14-7: Capping Factor**

Zone	Underground (UG) Open pit (PIT)	Capping factor on Drill Core Au g/t	Capping factor on Chip Sample Au g/t
107	UG	18.5	42
INTER	UG	18	18
105	PIT	28	28
105	PIT	7	7
105	PIT	19	19
105	PIT	No capping	No capping
114	PIT	16	16
LI	UG	120	120
LI	UG	30	30
109	UG	45	45
111	UG	175	100
113	UG	35	35
113	UG	50	50
113	UG	14	14
113	UG	17	17

Zone	Underground (UG) Open pit (PIT)	Capping factor on Drill Core Au g/t	Capping factor on Chip Sample Au g/t
113	UG	No capping	No capping
115	UG	100	100
115	UG	50	50
116	UG	No capping	No capping
117	UG	35	35
118	UG	12	12
118	UG	45	43
118	UG	40	40
118	UG	15	15
118	UG	38	38
118	UG	24	24
118	UG	No capping	No capping
118	UG	50	40
118	UG	40	44
118	UG	24	24
118	UG	65	65
118	UG	25	25
118	UG	34	34
118	UG	No capping	No capping
118	UG	14	14
119	UG	20	20
119	UG	No capping	No capping
119	UG	11	11
119	UG	13	13
119	UG	12	12
121	UG	30	30
123	UG	70	36
123	UG	77	68
123	UG	64	40
123	UG	42	42
123	UG	39	40
123	UG	12	12
123	UG	11	11
123	UG	19	19
123	UG	16	16
123	UG	No capping	No capping
123	UG	14	14
124	UG	No capping	No capping

Zone	Underground (UG) Open pit (PIT)	Capping factor on Drill Core Au g/t	Capping factor on Chip Sample Au g/t
124	UG	64	64
124	UG	64	17
124	UG	75	75
124	UG	30	20
124	UG	No capping	No capping
124	UG	66	66
124	UG	19	19
124	UG	9999	9999
124	UG	35	35
124	UG	15	15
124	UG	45	45
124	UG	45	45
124	UG	45	48
124	UG	45	16
124	UG	45	20
124	UG	30	30
124	UG	45	45
128	UG	18	18
129	UG	No capping	No capping
134	PIT	16	16
134	PIT	No capping	No capping
134	PIT	17	17
134	PIT	9	9
134	PIT	16	16
134	PIT	1.5	1.5
139	UG	No capping	No capping
148	UG	50	50
152	UG	20	13
152	UG	20	20
152	UG	8	8
122	PIT	15	No capping
124	PIT	50	No capping
124	PIT	9	No capping
124	PIT	No capping	No capping
124	PIT	7	No capping
125	PIT	35	No capping
125	PIT	45	18
125	PIT	15	No capping

Zone	Underground (UG) Open pit (PIT)	Capping factor on Drill Core Au g/t	Capping factor on Chip Sample Au g/t
125	PIT	12	No capping
126	PIT	15	No capping
127	PIT	75	No capping
146	PIT	No capping	No capping
146	PIT	16	No capping
146	PIT	8	No capping
146	PIT	1.3	No capping
148	PIT	36	36
148	PIT	50	50
148	PIT	20	20
148	PIT	36	36
148	PIT	18	18
148	PIT	12	12
148	PIT	10	10
148	PIT	5	5
148	PIT	3	3
148	PIT	No capping	No capping
148	PIT	18	18
148	PIT	1.5	1.5
152	PIT	10	10
152	PIT	5.3	5.3
152	PIT	50	50
152	PIT	3.7	3.7
152	PIT	4.5	No capping
159	PIT	19	19
160	PIT	27	27
160	PIT	1.5	1.5
160	PIT	1.5	1.5

#### 14.10 MINERAL RESOURCE ESTIMATION METHODOLOGY

The Mineral resource model was built using a block model and 3-D wireframe mineral zone interpretations built for underground and/or open-pit evaluation. . Also modeled were the main graphitic Casa Berardi Fault, the overburden (the basal till and clay), and the mining voids (development and as-built stopes using designs and CMS surveys. Block models used for underground mineral resource are undiluted; block models for pit evaluation are diluted. The approach for generating the capping factors and the composites are the same.

#### **14.11 UNDERGROUND EXTRACTION DATA AND COMPOSITING**

After validation of the solids and of the database, extraction of the intersects is performed to determine the capping and to composite the sample grade. Capping of the grade is performed in the ASSAYS table in the field AU\_COUPE. The gold value for the total vein intersect is calculated to be archived in the INTERS\_GRP table in a later process, with the rock code, solid name and block code. At the definition and stope drilling stage, information can be duplicated, and part of the previous drilling is excluded in the on-going mineral resource process. The duplicated diamond drill holes are archived in a key index to permit the exclusion of the outdated data during the mineral resource process.

#### **14.12 UNDERGROUND BLOCK MODELS**

All underground block models have the same block dimensions: 2.5 m for column size, 1.25 m for row size and 5 m for level size.

#### **14.13 UNDERGROUND MINERAL RESOURCE METHODOLOGIES**

Initially, all interpreted mineral zone solids are loaded to verify that they are contained within the block model limits. Blocks within the model are tagged with the block code from solid, the % of block within solid evaluated, and the density associated with the block code of the solid. Evaluation of the grade is done by the interpolation of the gold content from the point areas. The model attributes 'MEANDIST' (Mean distance for sample used) and 'NB\_COMPS' (Number of points used for the estimate) written to the blocks, for future classification of the mineral resource. The method used for grade estimation is squared inverse distance with oriented ellipses and spheres. A total of 206 ellipses and spheres were used to interpolate the underground mineral resources.

#### **14.14 UNDERGROUND MINERAL RESOURCES CLASSIFICATION**

The classification of the lenses of the block model is based on the density of drill hole data and the continuity of the auriferous zones. The classification complies with the Canadian Institute of Mining, Metallurgy and Petroleum Definition Standards for Mineral Resources and Mineral Reserves dated May 10, 2014 (CIM definitions). The classification of Mineral Resources at Casa Berardi is guided by the drill hole spacing, which ranges from 15 m to 50 m and by the ranges of variograms, which are between 10 m and 50 m. It also takes into consideration the distance of drill hole composites to block centers which is an attribute generated in the GEMS software at the time of grade interpolation (Mean Distance of Samples

to Block Centers or MeanDist).

Generally, for each lens, a polygon was created around blocks that were estimated based on drill hole composites with an average MEANDIST of 25 m. The mineral resources were classified as follows:

- (1) Measured Mineral Resources: blocks inside the 25 m MeanDist polygon + local development that confirmed the continuity of mineralization.
- (2) Indicated Mineral Resources: blocks inside the 25 m MeanDist polygon.
- (3) Inferred Mineral Resources: blocks outside the 25 m MeanDist polygon, up to generally a maximum of 35 m MeanDist, and rarely up to 50 m MeanDist.

Each block of the model was therefore classified as a Measured, Indicated, or Inferred Mineral Resource.

#### **14.15 OPEN PIT EXTRACTION DATA AND COMPOSITING**

After validation of the solids and surfaces used for the open-pit model areas, extraction of drill hole intersects is performed for the mineral resource and dilution envelopes to determine the capping and to composite the sample grades. The solids and surfaces used to code the model include the 1.0 g/t cut-off envelopes for mineral resources, the 10 m dilution shells surrounding the mineral lenses, the Casa Berardi Fault, the topographic surface and till, clay and bedrock surfaces.

Only the drill holes are used for grade estimation into the open-pit block models to avoid over estimation with the underground chip samples. Precedence is given to the mineral resource envelopes. The rock codes, solid names, block-codes are extracted into the assay table. Capping of the grade is performed in the assays table and used in the sample compositing. The duplicated diamond drill holes are archived in a key index to permit the exclusion of the outdated data during the mineral resource estimation process.

#### **14.16 OPEN PIT BLOCK MODELS**

Open pit block models used for the estimation the mineral resource and mineral reserve are diluted block models. The West Mine Crown Pillar, 134, East Mine Crown Pillar and 160 pits have block dimensions of 2.5 m x 2.5 m x 2.5 m; the Principal pit block model uses a block size of 2.5 m x 2.5 m x 5.0 m. All the open pit mineral resources have a diluted block model

except for the Principal pit. The diluted block models have three folders: one for the diluted mineralized material (ROCK), one for the mining excavation including the previous underground mining voids (Excavation) and one for the overburden materials (Overburden).

#### **14.17 OPEN PIT MINERAL RESOURCE METHODOLOGIES**

Initially, all the solids and surfaces used to code the open-pit model are loaded to verify that they are all contained within the block model limits. For the pit estimations, a vertical limit for block modeling was established to limit the assessment of an open-pit shell to depth. For the West Mine Crown Pillar Pit (WMCP) and 134 Pit, the lower limit is elevation 4,677 m. For the East Mine Crown Pillar Pit, the lower limit is elevation 4,702 m. For the 160 Pit block model, the elevation lower limit is 4,552 m elevation. Blocks within the block model are tagged with the block code from solids, the % of block within the solid evaluated, and the density associated with the block code of the solid. Evaluation of the grade is done by the interpolation of the gold content from the point area composite files, mainly the field 'AU\_COUPE', the results being saved in the field 'AuCut' of the block models. Evaluation of the fields 'MEANDIST' (Mean distance for sample used) and 'NB\_COMPS' (Number of points used for the estimate) is also written to the blocks, for the future classification of the mineral resource. The method used for grade estimation is square inverse distance with oriented ellipses and spheres. A total of 64 ellipses and spheres were used to interpolate the pit mineral resources. XRF was included on the in the block models to assess the arsenic content of the different lenses where data was available.

#### **14.18 OPEN PIT MINERAL RESOURCES CLASSIFICATION**

The classification of the lenses of the pit block model is the same as the underground block models based on the density of drill hole data and the continuity of the auriferous zones. The classification complies with the Canadian Institute of Mining, Metallurgy and Petroleum Definition Standards for Mineral Resources and Mineral Reserves dated May 10, 2014 (CIM definitions). The classification of Mineral Resources at Casa Berardi is guided by the drill hole spacing, which ranges from 15 m to 50 m, and by the ranges of variograms, which are between 10 m and 60 m. It also takes into consideration the distance of drill hole composites to block centers which is an attribute generated in the GEMS software at the time of grade interpolation (Mean Distance of Samples to Block Centers or Mean Distance).

For each lens generally, a polygon was created around blocks that were estimated based on

drill hole composites with an average MEANDIST of 25 m. The mineral resources were classified as follows:

- Measured Mineral Resources: blocks inside the 25 m mean distance polygon + local development that confirmed the continuity of mineralization.
- Indicated Mineral Resources: blocks inside the 25 m mean distance polygon.
- Inferred Mineral Resources: blocks outside the 25 m mean distance polygon, up to generally a maximum of 35 m mean distance, and rarely up to 50 m mean distance.

As stated initially, all the diluted block models built by Hecla Québec at the mine comes from an initial undiluted block model that is being diluted with the use of scripts in Gemcom. In the diluted block models, only the blocks with more than 25% of mineralized material show classification, the other block with less than 25% of mineralized material are not classified.

#### **14.19 PRINCIPAL MINE OPEN PIT**

In 2010, a block model (124\_PIT10JUL) was built by RPA for the Principal mine surface pillar. A total of 40 mineralized zones were modelled in the Principal area of the West Mine by the Mine staff. The mineralized system extends towards the overburden-rock interface and the mineralized zones are close enough to each other to allow open pit mining. The block size is 2.5 m east-west (X) by 2.5 m north-south (Y) by 5.0 m vertical (Z). Hecla staff provided in 2018 the mineral resource model to MDA for open pit optimization and design.

#### **14.20 CAVITY MONITORING SURVEYS OF MINED-OUT STOPES IN GEMS DATABASE**

Volumes of mined-out stopes are evaluated from a cavity monitoring survey (CMS) system by the engineering department. The determination of dilution rates and mining extraction factors on a stope by stope basis is based on the CMS. This work is carried out by the geology department using the Promine software. In order to determine tonnes and grades of underbreak, overbreak, and dilution material in one system, all CMS have been recently imported into GEMS. CMS information imported into Gemcom are now valid solids and available for comparative studies.

#### **14.21 MINERAL RESOURCE VALIDATION**

Hecla Québec personnel conducted sporadic on-screen visual inspection of block models with diamond drill hole assays and composites on plans and vertical sections after interpolation

and classification of the block models. In addition, statistical comparisons of grade estimates and nearest-neighbor estimates, along with swath/trend plots, were used to validate the West Mine Crown Pillar open-pit grade models. All interpolation reports were saved to validate the interpolation and to verify the blocks not interpolated. To avoid duplication in the accounting of mineral resources, only the underground mineral resources that are outside of an open-pit design are being considered for the underground evaluation and only the pit mineral resources within the pit design are considered for the pit mineral resources. The block of the underground block models has been evaluated to assess the % of block within the pit design. Where no underground mineral resources were evaluated with the pit, the mineral resource below the pit was reported as open-pit mineral resource.

#### **14.22 COMMENTS ON MINERAL RESOURCE ESTIMATES**

The QP is of the opinion that the Mineral Resources for the Project, which have been estimated using core drill data, have been performed to industry best practices, and conform to the requirements of CIM (2014). The QP is not aware of any environmental, permitting, legal, title, taxation, socio-economic, marketing, political, or other relevant factors that would materially affect the Mineral Resource estimate.

## 15.0 MINERAL RESERVES

Underground Mineral Reserves are estimated for the Lower Inter, 113, 118, 119, 121, 123, 124 zones, the East Mine, as well as, several smaller zones. Underground Mineral Reserves were estimated for a longhole stoping mining method without pillars, using a primary-secondary stoping sequence. Excepting a portion of the East Mine, which will be mined using a cut and fill method. All stopes are backfilled after mining using paste fill, cemented rock fill, or unconsolidated waste rock.

Open Pit Mineral Reserves are estimated for the West Mine Crown Pillar, Principal Pit, 134 Pit, East Mine Crown Pillar, East Mine Crown Pillar Extension and 160 Pit.

Measured Mineral Resources were converted to Proven Mineral Reserves, and Indicated Mineral Resources were converted to Probable Mineral Reserves. Inferred Mineral Resources were not converted to Mineral Reserves. Mineral Reserves as of December 31, 2018 are summarized in Table 15-1.

**Table 15-1: Mineral Reserves - December 31, 2018**

Area	Category	Tonnes	Grade (g/t Au)	Contained Ounces
Underground	Proven	739,900	5.3	125,000
Underground	Probable	2,588,300	5.3	442,000
Open Pit	Proven	5,419,700	2.5	438,400
Open Pit	Probable	12,791,800	2.2	901,300
<b>Total</b>	<b>Proven &amp; Probable</b>	<b>21,539,700</b>	<b>2.8</b>	<b>1,906,700</b>

Notes:

1. CIM definitions were followed for Mineral Reserves.
2. Underground Mineral Reserves were estimated by Hecla Québec.
3. Open Pit Mineral Reserves were estimated by MDA using a gold price of \$1,225 per ounce and a US\$/C\$ exchange rate of 1.3.
4. Mineral Reserves are estimated at a cut-off grade of 3.5 g/t Au for 113, 124, and 148 zones. A cut-off grade of 3.6 g/t Au for the 123 Zone. A cut-off grade of 3.7 g/t Au for the 118 Zone, and a cut-off grade of 3.8 g/t for the 121 Zone. A cut-off grade of 0.67 g/t Au for all the pits have been used.
5. Underground Mineral Reserves are estimated using an average long-term gold price of US\$1,200 per ounce and a US\$/C\$ exchange rate of 1.33.
6. A minimum mining width of 3 m was used.
7. Totals may not represent the sum of the parts due to rounding.

Underground and open pit Mineral Reserves detailed by zone are presented in Table 15-2.

**Table 15-2: Mineral Reserves by Zone - December 31, 2018**

Zone	Tonnes	Grade (g/t Au)	Contained Ounces
<b>Underground - Proven</b>			
Lower Inter	13,900	7.1	3,200
113	29,900	5.1	4,900
118	215,300	5.2	36,000
123	261,000	4.9	41,000
124	72,900	4.3	10,100
East Mine UG	147,000	6.3	29,900
<b>Total Underground - Proven</b>	<b>739,900</b>	<b>5.3</b>	<b>125,000</b>
<b>Underground - Probable</b>			
Lower Inter	3,900	5.3	0,700
113	23,100	4.1	3,100
118	1,120,100	5.0	180,000
119	35,900	5.6	6,400
121	53,200	4.5	7,700
123	793,400	5.6	141,500
124	473,200	5.3	80,400
East Mine UG	85,400	8.1	22,200
<b>Total Underground - Probable</b>	<b>2,588,300</b>	<b>5.3</b>	<b>442,000</b>
<b>Total Underground Proven + Probable</b>	<b>3,328,300</b>	<b>5.3</b>	<b>567,000</b>
<b>Open Pit - Proven</b>			
West Mine Pit - WMCP	4,470,500	2.5	357,100
East Mine Pit - EMCP	775,400	2.3	56,900
Principal Pit	173,800	4.4	24,400
<b>Total Open Pit - Proven</b>	<b>5,419,700</b>	<b>2.5</b>	<b>438,400</b>
<b>Open Pit - Probable</b>			
West Mine Pit - WMCP	1,312,100	2.0	85,800
EMCP - Extension	777,900	1.3	33,000
East Mine Pit - EMCP	358,500	1.9	22,300
Principal Pit	6,073,800	2.6	507,700
134 Pit	411,900	1.9	25,000
160 Pit	3,857,600	1.8	227,500
<b>Total Open Pit - Probable</b>	<b>12,791,800</b>	<b>2.2</b>	<b>901,300</b>
<b>Total Open Pit Proven + Probable</b>	<b>18,211,500</b>	<b>2.3</b>	<b>1,339,700</b>
<b>Grand Total</b>			
<b>Proven</b>	<b>6,159,600</b>	<b>2.8</b>	<b>563,400</b>
<b>Probable</b>	<b>15,380,100</b>	<b>2.7</b>	<b>1,343,300</b>
<b>Proven + Probable</b>	<b>21,539,700</b>	<b>2.8</b>	<b>1,906,700</b>

Notes:

1. CIM definitions were followed for Mineral Reserves.
2. Underground Mineral Reserves were estimated by Hecla Québec.
3. Open Pit Mineral Reserves were estimated by MDA using a gold price of \$1,225 per ounce and a US\$/C\$ exchange rate of 1.3.

4. Mineral Reserves are estimated at a cut-off grade of 3.5 g/t Au for 113, 124, and 148 zones. A cut-off grade of 3.6 g/t Au for the 123 Zone. A cut-off grade of 3.7 g/t Au for the 118 Zone, and a cut-off grade of 3.8 g/t for the 121 Zone. A cut-off grade of 0.67 g/t Au for all the pits have been used.
5. Underground Mineral Reserves are estimated using an average long-term gold price of US\$1,200 per ounce and a US\$/C\$ exchange rate of 1.33.
6. A minimum mining width of 3 m was used.
7. Totals may not represent the sum of the parts due to rounding.

The variation in the underground Mineral Reserves, between December 31, 2017 and December 31, 2018, was due to mining without replacement of mineral reserves, primarily in the 123 Zone. The surface Mineral Reserves increased substantially with the addition of the West Mine Crown Pillar Pit.

Mineral Reserve estimations were based on the Mineral Resource 3D block models. Stope shapes are created based on the individual zone and lens geometries. The stope shapes are based on 15 m spaced sections, which are extrapolated along strike. Preliminary development designs are created to allow for an economic assessment of the areas to be mined. The mineral resources within the stope shapes are exported to Excel and estimates of the dilution and the extraction are applied. Mining Engineers then assess the economic prospects for each stope. Based on engineering judgement, some lower grade areas will be included where the development required is common to other areas. In these cases, even though the low-grade block would not have supported all the required development alone, a block becomes economical considering the shared development. Similarly, the evaluation of extraction method or ground conditions, may result in lower-grade blocks being included in the Mineral Reserve estimate.

The 118 Zone consists of several lenses and mining is in progress in the 22, 27 and 31 lenses, using transverse and longitudinal stoping. Current production is situated between the 950 and 1030 levels. From the 790 level, the 118 Zone's internal ramp system and mining levels are accessible. The 118\_06 and 118\_10 lenses are being developed for longitudinal stoping. Paste fill is available in the 118 Zone. The 118 Zone may continue below the 1050 level, but further exploration is required in this area.

The 123 Zone lies approximately 250 m to the south of the 118 Zone. The 123 Zone is accessed via an internal ramp system and mining levels from the 790 level. The 123 Zone consists of several sub-parallel lenses. Paste fill is also available in the 123 Zone below the 470 level.

The 124 Zone is located in the upper portion of the West Mine. It consists of several sub-parallel lenses, which are currently mined from the underground, below the 170 level. The upper portion of the 124 Zone, extending from surface to the 185 level, is planned for open pit mining. Paste fill is not available in the Principal area of the West Mine.

The 113 Zone is located slightly to the west of the West shaft. Currently, there is no active mining in the 113 Zone. Drilling is underway to define the 113 Zone at depth (e.g. below the 950 level). Ground conditions are poor. Paste fill is available below the 570 level in the 113 Zone.

For the 113, Lower Inter, 118, 119, 121, 123 and 124 zones, the mineralized envelopes were divided into standard stope dimensions of 20 m vertically and 15 m along strike. Hanging wall and footwall stope limits were delineated from the mineralized wireframe envelope. Tonnage and grade were calculated for each stope, including ore development within the stope outline. Dilution and extraction factors were applied on a stope by stope basis, as dictated by the review of the stope conditions and planned mining.

The East Mine Underground Mineral Reserves are based on a plan to re-establish access to old workings and to mine pillars and levels left behind during previous operations. Stope sizes are not standardized. Planned mining methods include longhole stoping (e.g. top and bottom cuts are accessible) and cut and fill methods (e.g. Where only undercuts are accessible). Approximately one-third of the East Mine Mineral Resource ounces have been converted to Mineral Reserves, with the remainder tied up in areas related ground stability issues or in stopes that are at or below cut-off grade.

The use of compatible mine planning and geology software packages allows for direct access to the Mineral Resource block models, which in turn optimizes mine design review and revision process.

## **15.1 OPEN PIT MINING**

Since 2013, the number of open pit projects has grown from 2 to 6, with the addition of the East Mine Crown Pillar Extension, the 134 Pit, the 160 Pit, and the West Mine Crown Pillar. In addition to these new open-pit mineral reserves, the mineral reserves for the Principal Pit

have more than doubled since the original mineral reserve statement in 2011.

### **EMCP/EMCP EXTENSION**

The EMCP pit is currently in operation with a planned tonnage of 1879 tonnes/day. The bottom of the pit started 2019 at elevation 4,922.5 and will reach the 4,885 m bench by the end of the year. The final elevation of the ultimate pit is expected to be at elevation 4,862.5 which is planned to be completed in Q3 of 2020.

### **134 PIT**

The 134 Pit project is located to the South-East of the Principal Pit project. The two pits are separated by a 20 m pillar. This project was evaluated as a stand-alone entity. However, it is expected that the 134 and the Principal pits will eventually merge as drilling is completed in the area. The 134 open-pit will not intersect any underground workings. A dewatering program will be required to control water inflow from runoff and from the rock mass. Overburden removal for this pit is planned for Q1 of 2020 and mining will begin Q1 of 2021.

### **160 PIT**

The 160 open-pit project is located northeast of the mill. The 160 Lens is currently the most easterly identified lens on the property. Further drilling is required to determine the potential for a connection between the EMCP (148 and 152 zones) and the 160 pit projects. Overburden removal for the 160 Pit is planned to start in Q1 of 2021. The project is planned to last for 5 years, ending in Q3 of 2025. This project will not intersect any underground workings. Pumping will be required to manage surface run off and rock mass inflows. Mining of the pit will require relocating the existing high-grade stockpile and to divert a creek.

### **WEST MINE CROWN PILLAR PIT**

The West Mine Crown Pillar Pit (WMCP) project is the most westerly pit in the mineral reserves. Prior to starting this project, surface infrastructures (e.g. a cement plant and access roads) will have to be redesigned and/or relocated and environmental issues (e.g. creek diversion) and an extension of the present claim boundary will have to be addressed. This project will intersect multiple underground excavations. The development of this pit is planned to coincide with the end of underground mining in the West Mine area. If the start date is advanced, underground infrastructures will have to be relocated. The overburden removal is planned for Q1 of 2023 and owing to the quantity of material removal will take three years.

Mining the WMCP mineral reserve will take approximately four years, at a rate of 1,400,000 t/yr.

## PRINCIPAL PIT

Once underground mineral reserves have been depleted in the upper section of the 123 and 124 zones, mining of the Principal Pit will begin. The pit is designed to 185 m from surface. Environmental and engineering issues will need to be addressed before project start-up, as the overburden in the western part of the proposed pit contains an esker. The pit will intercept underground workings, which will provide drainage for surface runoff and rock mass inflows. The pumping will be handled by the existing underground pumping system.

## 15.2 CUT-OFF GRADE

The cut-off grade used for reporting Mineral Reserves is based on the following parameters:

- Gold price: US\$1,200/oz.
- Exchange rate of C\$1.33/US\$1.00.
- Metallurgical recovery by zone as shown in Table 15-3.
- Cut-off grades vary by zone as shown in Table 15-3.

**Table 15-3: Cut-Off Grade by Zone U/G**

Zone	Recovery	COG with Development (g/t)
113 inf	86.80%	3.53
118	83.00%	3.69
123	85.00%	3.61
100 (LI)	89.90%	3.4
121	81.30%	3.77
124	87.60%	3.5
148 (East ug)	87.00%	3.57
119	83.00%	3.69

When the grade of the Mineral Reserves is close to the cut-off grade, a more detailed review is completed taking into consideration the anticipated costs and revenues and using a gold price equivalent to the current market price.

Individual stopes were evaluated using the cut-off grade for the applicable zone, after dilution and extraction factors had been applied. If necessary, cut-off grades were calculated for

individual blocks with cost estimates modified accordingly.

## 15.3 DILUTION AND EXTRACTION

### UNDERGROUND MINING

Internal dilution is defined as material below the cut-off grade included within a mining block. It represents areas included within the mineral resource envelopes for continuity and areas outside of the mineral resource envelope required to optimize the mining geometry. Internal dilution is intended to be mined with the ore and is included in mineral reserve estimate of a stope.

External dilution is defined as unplanned and uneconomic material coming from the periphery of a mining block. It includes material from the hanging wall or footwall and from exposure of backfill in adjacent stopes. The estimation of underground external dilution is based on 12 years of underground operating experience and is expressed as percentage, calculated as:

$$\text{Dilution \%} = (\text{waste tonnes} / \text{ore tonnes}) \times 100.$$

The average total dilution from internal and external sources for the underground Mineral Reserves is 35% (Table 15-4).

Extraction is the proportion of the diluted mineral reserve which is expected to be extracted by mining. The extraction by zone is shown in Table 15-4. The average extraction is estimated to be 94.5%. Timely placement of backfill and other measures to control stope deterioration are key to achieving high extraction rates in this pillarless mining scenario.

Dilution has been estimated on a stope by stope basis considering the planned mining and conditions in the given areas. The dilution estimates reflect the expected conditions in the mature mining areas. For new zones, the estimates are based historical data from similar mining conditions. The East Mine dilution estimate is based on historical mining in the East Mine from 1987-1997 and data from the 124 Zone with comparable mining conditions.

A review of drill hole and block model grades immediately outside stope outlines indicates that

mineral boundaries are generally gradational, ranging from 0.5 g/t Au to 1.0 g/t Au at stope boundaries, instead of being sharply cut. A grade of 0.5 g/t Au has been applied to hanging wall/footwall dilution in all zones.

For the East Mine, extraction factors of 92.5% for longhole stopes and 55% for cut and fill stopes were applied. These lower extraction rates consider potential ground control issues due to mining in proximity to historic stopes with non-consolidated backfill.

**OPEN PIT MINING**

In open pit mining, internal dilution is defined as material below the cut-off grade within the mineral resource envelope. It can also be partially estimated by comparing the envelope geometry to bench geometry, as benches are square vertical blocks and the mineral zones dip at angles of between 45° to 70°.

External dilution, in open pit mining, is defined as below grade material that is mixed with ore during the blasting process or picked up by the excavators at the contact between the mineralized package and the waste matrix.

The East Mine Crown Pilar (EMCP) open pit has been operating since January of 2016. The dilution estimates for the EMCP are based upon this recent mining experience. For subsequent pits, dilution estimates will reflect the historical values and experience from the EMCP.

For open pit mining, an extraction factor of 95% is used. This factor has been used since 2016.

**Table 15-4: Dilution and Extractions Estimates**

<b>Zone</b>	<b>Dilution (%)</b>	<b>Extraction (%)</b>
113	31	94.5
Lower Inter	45	94.5
148	43	87
118	35	94.5
119	33	94.5
121	40	94.5
123	28	94.5
124	48	94.5
<b>Average Underground</b>	<b>35</b>	<b>94.5</b>
West Mine Pit - WMCP	27	95
EMCP - Extension	27	95

<b>Zone</b>	<b>Dilution (%)</b>	<b>Extraction (%)</b>
East Mine Pit - EMCP	27	95
Principal Pit	27	95
134 Pit	27	95
160 Pit	27	95

#### **15.4 ESTIMATION METHODOLOGY – OPEN PIT PROJECTS**

For each of the open pit projects, described in the following paragraphs, MDA generated, and optimized pit shells based on the block models prepared by Hecla Québec's geology department. Surpac scripts were used code materials and surfaces within the block model (i.e. overburden material types and bedrock contact). The pit shells were generated using Whittle (Version 4.7). A cut-off grade of 0.67 g/t Au was used. Slope angles and other design criteria are discussed in Section 16 (Mining Methods).

#### **ESTIMATION METHODOLOGY – EAST MINE CROWN PILLAR OPEN PIT**

In March 2017, BBA updated the East Mine Crown Pillar (EMCP) open pit in the LOM plan. The scope of work was to review and update the break-even cut-off grade, the open pit optimization parameters and Whittle pit shells, open pit design parameters (road widths, working widths, etc.), ultimate pit and mining phase designs, and Life-of-Mine planning with review of strategic options.

At that time, Mineral Reserves were estimated for the pit design based on a cut-off grade of 0.81 g/t Au, and the following inputs for pit optimization:

- Gold price of C\$1568 per ounce.
- Gold selling cost of C\$4.41 per ounce
- Mining Cost (Overburden) of C\$5.58 per tonne.
- Mining Cost (Ore) of \$C7.14 per tonne.
- Mining Cost (Waste) of \$C7.8 per tonne
- Processing cost of \$19.00 per tonne ore.
- Metallurgical recovery of 90.5%.
- Mining Dilution of 30%.
- Sustaining Capital (Tailings) cost of C\$2.83 per tonne milled.

- G&A cost of \$4.06 per tonne milled.
- Rehabilitation costs of C\$1.39 per tonne milled.
- Other period costs of C\$0.97 per tonne milled.

The mining costs were also locally increased by 33% for areas within 10 m of historic mine workings. These parameters were used as a basis for subsequent open pit studies.

### **ESTIMATION METHODOLOGY – PRINCIPAL OPEN PIT**

In September 2018, MDA estimated the Principal open pit Mineral Reserves, using updated economic parameters, based on a block model developed by Hecla Quebec (geology) department. A pit optimization was run by MDA, and an open pit design was prepared based on this information.

Mineral Reserves were estimated for this pit design based on a cut-off grade of 0.67 g/t Au, and the following inputs:

- Processing cost of \$19.00 per tonne ore.
- G&A cost of \$4.06 per tonne ore.
- Metallurgical recovery of 85%.
- Gold price of C\$1592.5 per ounce.
- Dilution of 12% (Internal) and 15% (External).

### **ESTIMATION METHODOLOGY – EAST MINE CROWN PILAR EXTENSION OPEN PIT**

In August 2018, Mine Development Associates (MDA) estimated the EMCP Extension open pit Mineral Reserves, using updated economic parameters and an updated block model developed by the Hecla Quebec mine geology department. The pit optimization was run by MDA and an open pit design was prepared based on this information.

Mineral Reserves were estimated for this pit design based on a cut-off grade of 0.67 g/t Au, and the following inputs:

- Processing cost of \$19.00 per tonne ore.
- G&A cost of \$4.06 per tonne ore.
- Metallurgical recovery of 85%.
- Gold price of C\$1592.5 per ounce.

- Dilution of 12% (Internal) and 15% (External).

#### **ESTIMATION METHODOLOGY – 134 ZONE OPEN PIT**

In February 2018, MDA estimated the 134 open pit Mineral Reserves, using updated economic parameters, and an updated block model developed by the Hecla Quebec mine geology department. A pit optimization was run by MDA and an open pit design was prepared based on this information.

Mineral Reserves were estimated for this pit design based on a cut-off grade of 0.67 g/t Au, and the following inputs:

- Processing cost of \$19.00 per tonne ore.
- G&A cost of \$4.06 per tonne ore.
- Metallurgical recovery of 86.2%.
- Gold price of C\$1592.5 per ounce.
- Dilution of 12% (Internal) and 15% (External).

#### **ESTIMATION METHODOLOGY – 160 ZONE OPEN PIT**

In February 2018, MDA estimated the 160 Zone open pit Mineral Reserves, using updated economic parameters and an updated block model developed by the Hecla Quebec mine geology department. A pit optimization was run by MDA and an open pit design was prepared based on this information.

Mineral Reserves were estimated for this pit design based on a cut-off grade of 0.67 g/t Au, and the following inputs:

- Processing cost of \$19.00 per tonne ore.
- G&A cost of \$4.06 per tonne ore.
- Metallurgical recovery of 90.2%.
- Gold price of C\$1592.5 per ounce.
- Dilution of 12% (Internal) and 15% (External).

#### **ESTIMATION METHODOLOGY – WEST MINE CROWN PILAR OPEN PIT**

In January 2019, MDA estimated the open pit Mineral Reserves, using updated economic parameters and an updated block model developed by the Hecla Quebec mine geology department. A pit optimization was run by MDA and an open pit design was prepared based on this information.

Mineral Reserves were estimated for this pit design based on a cut-off grade of 0.67 g/t Au, and the following inputs:

- Processing cost of \$19.00 per tonne ore.
- G&A cost of \$4.06 per tonne ore.
- Metallurgical recovery of 85.0%.
- Gold price of C\$1592.5 per ounce.
- Dilution of 12% (Internal) and 15% (External).

### **15.5 COMPARISON TO PREVIOUS ESTIMATES**

The 2018 Mineral Reserves represents an overall increase of 8,956,400 tonnes and 413,200 ounces as compared to the Mineral Reserves in 2017. This variation is due to the following:

- Gains: 10,161,000 tonnes at 1.81 g/t Au for 591,800 ounces.
- Losses: 1,204,600 tonnes at 4.6 g/t Au for 178,600 ounces.

A summary of gains and losses is shown in Table 15-5.

From 2017 to 2018, Mineral Reserves underground decreased due to mining in the Lower Inter, 113, 118, 123 and 124 zones. Underground Mineral Reserves were expanded in the 119 and 121 zones. Over the same period, Mineral Reserves increased in the all of the open pits (i.e. West Mine, EMCP Ext, East Mine, Principal, 134 and 160).

**Table 15-5: Change in Mineral Reserves 2017 to 2018**

Zone	December 31, 2018			December 31, 2017			Change	
	Tonnes (000)	Au g/t	Oz (000)	Tonnes (000)	Au g/t	Oz (000)	Tonnes (000)	Oz (000)
Lower Inter (LI)	14	7.1	3.2	7	11.1	2.4	7	0.8
113	30	5.1	4.9	39	4.9	6.1	-9	-1.2
118	215	5.2	36	300	5.8	55.5	-85	-19.5
119	-	-	-	-	-	-	-	-
121	-	-	-	-	-	-	-	-
123	261	4.9	41	379	5.7	69.5	-118	-18.5
124	73	4.3	10.1	86	4.2	11.5	-13	-1.4
East mine U/G(148)	147	6.3	29.9	147	6.3	29.9	-	-
West Mine – Open Pit	4,471	2.5	357.1	-	-	-	4,471	357.1
EMCP Ext – Open Pit	-	-	-	-	-	-	-	-
East mine – Open Pit	775	2.3	56.9	1,183	2.6	97.1	-408	-40.2
Principal – Open Pit	174	4.4	24.4	89	6.3	18	85	6.4
134 – Open Pit	-	-	-	-	-	-	-	-
160 – Open Pit	-	-	-	-	-	-	-	-
<b>Total Proven Mineral Reserves</b>	<b>6,160</b>	<b>2.8</b>	<b>563.4</b>	<b>2,230</b>	<b>4.4</b>	<b>290</b>	<b>3,930</b>	<b>273.4</b>
Lower Inter (LI)	4	5.3	0.7	24	8.7	6.6	-16	-5.9
113	23	4.1	3.1	33	4.1	4.3	-10	-1.2
118	1,120	5	180	1,123	5.1	183.7	-3	-3.7
119	36	5.6	6.4	-	-	-	36	6.4
121	53	4.5	7.7	50	4.5	7.1	3	0.6
123	793	5.6	141.5	1,178	6.1	232.3	-385	-90.8
124	473	5.3	80.4	533	5.3	90	-60	-9.6
East mine U/G(148)	85	8.1	22.2	85	8.1	22.2	-	-
West Mine – Open Pit	1,312	2	85.8	-	-	-	1,313	85.8
EMCP Ext – Open Pit	778	1.3	33	-	-	-	77	33
East mine – Open Pit	359	1.9	22.3	465	2.3	35	106	12.7
Principal – Open Pit	6,074	2.6	507.7	3,072	3.6	352.4	3,002	155.3
134 – Open Pit	412	1.9	25	324	2.1	21.9	88	3.1
160 – Open Pit	3,859	1.8	227.5	3,468	2	225.7	391	1.8
<b>Total Probable Mineral Reserves</b>	<b>15,381</b>	<b>2.7</b>	<b>1,343.3</b>	<b>10,355</b>	<b>3.6</b>	<b>1,181.20</b>	<b>5,026</b>	<b>162.1</b>
<b>Total Proven and Probable Reserves</b>	<b>21,541</b>	<b>2.8</b>	<b>1,906.7</b>	<b>12,585</b>	<b>3.7</b>	<b>1,471.20</b>	<b>8,956</b>	<b>435.5</b>

## 15.6 RECONCILIATION

Tonnage and grade reconciliation between Mineral Reserves, mine plans and mill production are carried out by Hecla Québec on a stope by stope basis with a monthly and annual compilations. The annual results for 2006 to 2018, as well as, the comparisons between the mill production and Mineral Reserves and mill production and planned mining are shown in Table 15-6 and Table 15-7. The same information on a monthly basis for 2018 is shown in Table 15-8 and Table 15-9. Tonnes, gold grades, and gold ounces for the block model estimates and the final design plans are compared to mill production.

On an annual basis, the variance between the mill production and the Mineral Reserves and the planning, considering tonnage, grade and contained gold, are very constant with 50 of the 96 data points within  $\pm 5\%$ .

**Table 15-6: Mine-Mill Reconciliation - 2006 to 2018**

Year	Mineral Reserves			Planned Reserves			Mill		
	Tonnes	Grade	Oz	Tonnes	Grade	Oz	Tonnes	Grade	Oz
	(000)	Au g/t	(000)	(000)	Au g/t	(000)	(000)	Au g/t	(000)
2018 PIT	498.1	2.2	35.6	521.6	2.0	33.9	570.1	2.0	36.4
2018 U/G	715.6	6.7	153.6	666.9	6.5	138.4	678.1	6.9	150.4
2017 PIT	365.9	2.8	33.0	463.8	2.8	41.8	468.2	2.9	44.0
2017 U/G	626.8	6.5	130.0	679.8	6.0	131.3	707.7	6.0	136.3
2016 PIT	94.5	2.5	7.6	132.8	2.6	11.1	132.7	2.3	9.7
2016 U/G	676.0	6.0	130.0	717.7	6.1	139.6	772.3	6.3	156.8
2015 U/G	701.6	6.0	136.1	736.7	5.9	139.1	765.8	6.0	146.7
2014 U/G	653.9	6.6	138.6	725.2	5.9	138.2	750.8	5.9	142.4
2013 U/G	571.2	6.3	115.0	583.0	5.8	108.7	590.6	6.2	117.0
2012 U/G	632.2	7.8	157.5	685.5	6.7	148.2	693.9	6.8	151.1
2011 U/G	735.1	8.0	188.2	726.9	7.5	175.3	698.1	8.0	179.5
2010 U/G	683.4	6.8	150.0	670.4	6.7	144.2	722.7	6.8	157.1
2009 U/G	719.6	7.5	173.7	684.6	7.1	155.4	688.7	7.8	172.0
2008 U/G	662.1	8.5	181.7	706.7	8.1	183.0	654.4	8.2	171.6
2007 U/G	548.1	10.4	183.4	579.5	10.2	190.2	545.3	9.8	171.4
2006 U/G	64.0	9.2	18.9	66.6	8.9	19.0	68.5	8.6	18.9
<b>Total</b>	<b>8,948.2</b>	<b>6.7</b>	<b>1,933.0</b>	<b>9,347.7</b>	<b>6.3</b>	<b>1,897.3</b>	<b>9,507.6</b>	<b>6.4</b>	<b>1,961.6</b>

**Table 15-7: Mine-Mill Reconciliation – 2006 to 2018**

Year	Mill versus Planned Reserve			Mill versus Mineral Reserve		
	Tonnes	Grade	Oz	Tonnes	Grade	Oz
2018 PIT	114%	90%	102%	109%	98%	107%
2018 U/G	94%	104%	98%	102%	108%	110%
2017 PIT	128%	104%	133%	101%	104%	105%
2017 U/G	115%	92%	106%	105%	100%	104%
2016 PIT	140%	90%	127%	100%	87%	87%
2016 U/G	117%	106%	124%	109%	105%	114%
2015 U/G	112%	98%	110%	105%	102%	107%
2014 U/G	118%	87%	103%	104%	99%	104%
2013 U/G	103%	98%	102%	101%	106%	108%
2012 U/G	110%	87%	96%	101%	101%	102%
2011 U/G	95%	100%	95%	96%	107%	102%
2010 U/G	106%	99%	105%	108%	101%	109%
2009 U/G	96%	103%	99%	101%	110%	111%
2008 U/G	99%	96%	94%	93%	101%	94%
2007 U/G	99%	94%	93%	94%	96%	90%
2006 U/G	107%	94%	100%	103%	96%	99%
<b>Total</b>	<b>106%</b>	<b>96%</b>	<b>101%</b>	<b>102%</b>	<b>102%</b>	<b>103%</b>

**Table 15-8: Mine-Mill Reconciliation - 2018**

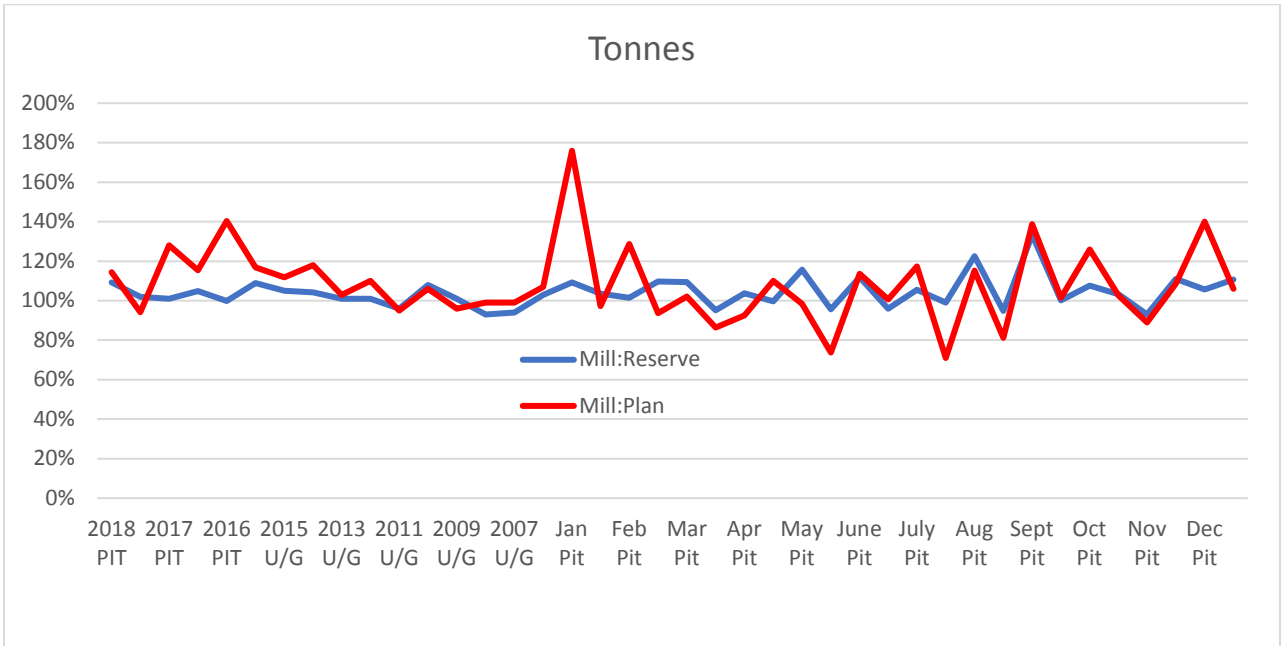
Year	Mineral Reserves			Planned Reserves			Mill		
	Tonnes	Grade	Oz	Tonnes	Grade	Oz	Tonnes	Grade	Oz
	(000)	Au g/t	(000)	(000)	Au g/t	(000)	(000)	Au g/t	(000)
Jan Pit	25.1	3.1	2.5	40.4	3.2	4.2	44.2	2.6	3.7
Jan U/G	52.5	5.6	9.5	49.3	5.7	9.1	51.0	5.2	8.6
Feb Pit	32.7	2.6	2.8	41.5	2.2	2.9	42.1	2.0	2.7
Feb U/G	55.6	7.4	13.3	47.5	7.2	11.0	52.1	7.3	12.2
Mar Pit	50.3	2.7	4.3	46.9	3.4	5.1	51.3	3.2	5.3
Mar U/G	52.8	6.1	10.4	47.9	5.9	9.0	45.6	6.3	9.2
Apr Pit	61.5	2.4	4.7	54.8	2.4	4.2	56.8	2.4	4.4
Apr U/G	58.9	6.6	12.6	64.9	5.9	12.3	64.7	6.0	12.6
May Pit	48.5	2.1	3.2	41.2	1.8	2.4	47.7	1.8	2.7
May U/G	58.5	7.5	14.2	45.1	6.9	9.9	43.1	7.5	10.3
June Pit	36.6	2.8	3.3	37.1	2.3	2.7	41.5	2.3	3.1
June U/G	45.2	8.5	12.3	47.5	7.4	11.2	45.5	8.5	12.5
July Pit	49.7	2.5	4.0	55.3	1.4	2.4	58.4	1.4	2.7
July U/G	61.2	5.9	11.6	43.8	5.8	8.1	43.4	7.0	9.7
Aug Pit	41.8	1.7	2.3	39.3	1.6	2.0	48.1	1.5	2.4
Aug U/G	43.6	6.1	8.5	37.3	6.7	8.0	35.4	8.3	9.4
Sept Pit	38.1	2.4	2.9	39.7	2.1	2.7	52.9	2.2	3.7
Sept U/G	38.7	7.0	8.7	39.2	6.8	8.6	39.3	8.6	10.8
Oct Pit	39.1	1.3	1.7	45.7	1.4	2.1	49.2	1.4	2.2
Oct U/G	68.9	6.5	14.3	68.4	6.3	13.8	70.7	7.0	15.9
Nov Pit	53.0	1.4	2.4	50.7	1.2	2.0	47.2	1.1	1.7
Nov U/G	37.0	7.9	9.4	36.2	7.7	8.9	40.2	7.3	9.4
Dec Pit	21.8	2.2	1.5	28.9	1.5	1.4	30.6	1.9	1.8
Dec U/G	70.2	6.6	14.8	67.2	6.6	14.2	74.4	6.5	15.6
Invent Jan	63.9	1.0	2.0	63.9	1.0	2.0	63.9	1.0	2.0
Invent Dec	(86.90)	2.3	(6.50)	(86.90)	2.3	(6.50)	(86.90)	2.3	(6.50)
Development	95.6	6.1	18.6	95.6	6.1	18.6	95.6	6.1	18.6
<b>Total</b>	<b>1,213.8</b>	<b>4.8</b>	<b>189.2</b>	<b>1,118.5</b>	<b>4.5</b>	<b>172.3</b>	<b>1,248.0</b>	<b>4.7</b>	<b>186.8</b>

**Table 15-9: Mine-Mill Reconciliation - 2018**

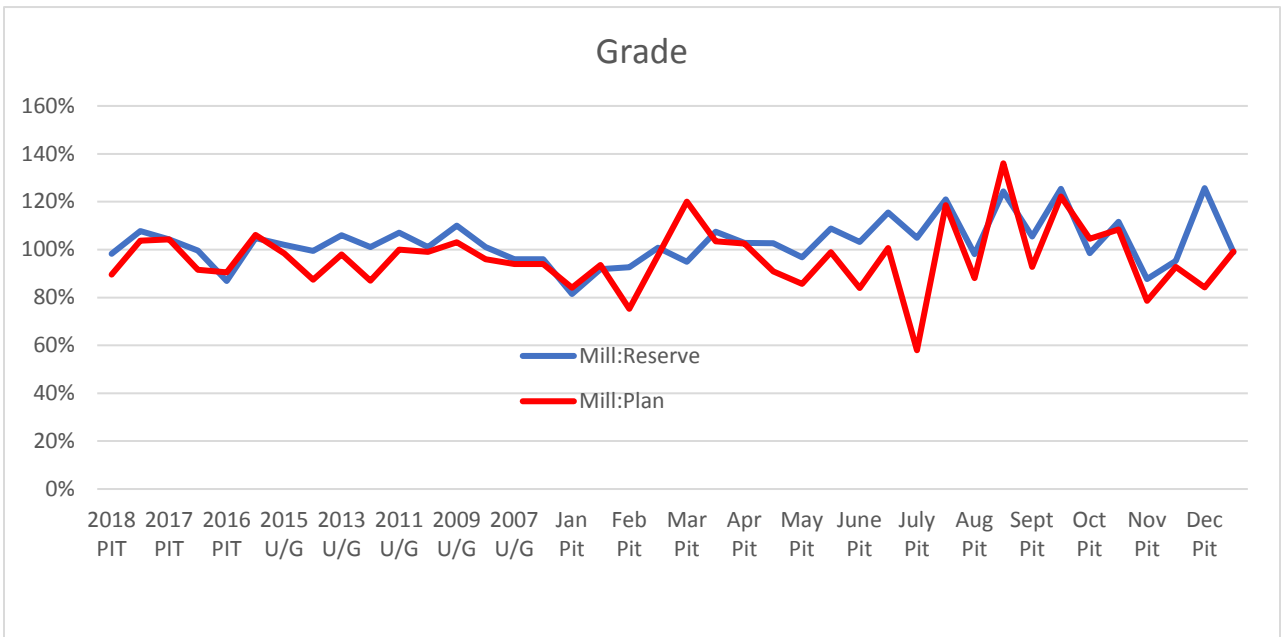
Year	Mill vs. Planned Reserve			Mill vs. Mineral Reserve		
	Tonnes	Grade	Oz	Tonnes	Grade	Oz
Jan Pit	176%	84%	148%	109%	81%	89%
Jan U/G	97%	94%	91%	104%	92%	95%
Feb Pit	129%	75%	97%	101%	93%	94%
Feb U/G	94%	98%	91%	110%	101%	111%
Mar Pit	102%	120%	123%	109%	95%	104%
Mar U/G	86%	103%	89%	95%	107%	102%
Apr Pit	92%	103%	95%	104%	103%	107%
Apr U/G	110%	91%	100%	100%	103%	102%
May Pit	98%	86%	84%	116%	97%	112%
May U/G	74%	99%	73%	96%	109%	104%
June Pit	114%	84%	95%	112%	103%	115%
June U/G	101%	101%	101%	96%	115%	111%
July Pit	117%	58%	68%	105%	105%	111%
July U/G	71%	119%	84%	99%	121%	120%
Aug Pit	115%	88%	102%	123%	98%	120%
Aug U/G	81%	136%	110%	95%	124%	118%
Sept Pit	139%	93%	129%	133%	105%	141%
Sept U/G	101%	122%	124%	100%	125%	126%
Oct Pit	126%	105%	132%	108%	98%	106%
Oct U/G	103%	108%	111%	103%	112%	115%
Nov Pit	89%	79%	70%	93%	88%	82%
Nov U/G	109%	93%	101%	111%	95%	106%
Dec Pit	140%	84%	118%	106%	126%	133%
Dec U/G	106%	99%	105%	111%	99%	110%
<b>Total</b>	<b>103%</b>	<b>96%</b>	<b>99%</b>	<b>105%</b>	<b>103%</b>	<b>108%</b>

The annual and monthly comparisons for the variations on tonnage, grade, and contained ounces are shown graphically in Figure 15.1, Figure 15.2 and Figure 15.3. The monthly variance between the mill production and the Mineral Reserves and mine plan has a larger range than the annual average as demonstrated in Table 15-9 and in the Figure 15.1, Figure 15.2 and Figure 15.3.

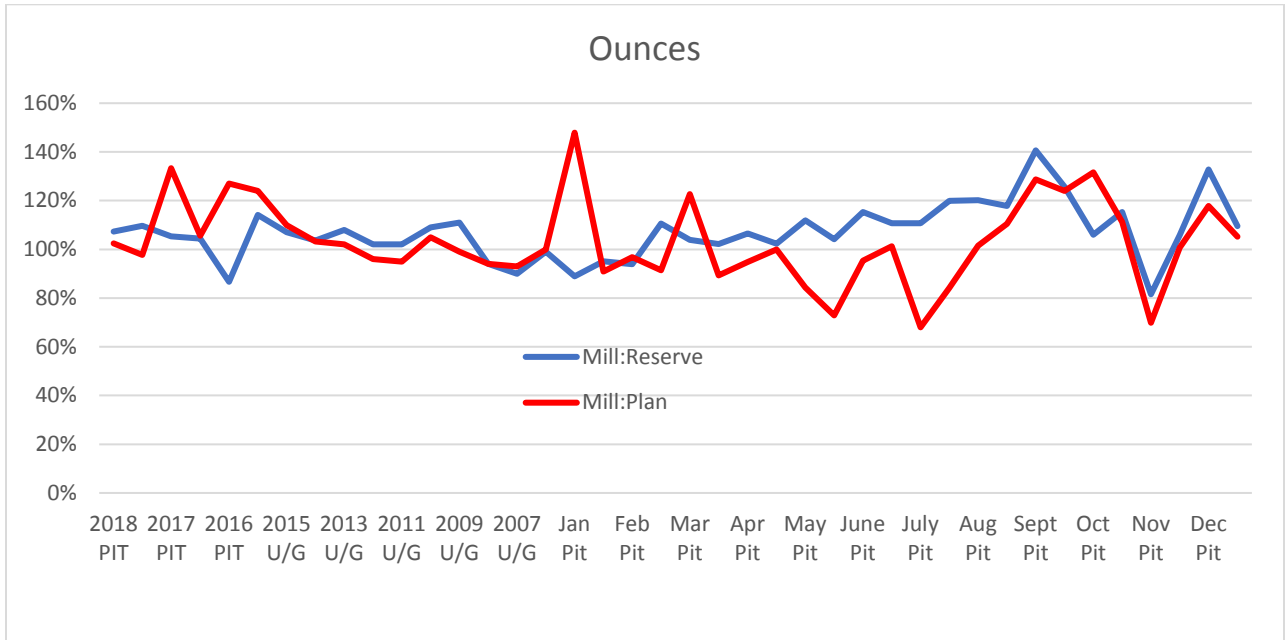
Hecla Québec is of the opinion that there is a good reconciliation between the Mineral Reserves, the mine planning, and the actual production. These records allow the reconciliation over time on a stope by stope basis and/or on a zone by zone basis to be examined. Based upon the reconciliation results, Hecla Québec is of the opinion that the Mineral Reserve estimation and mine planning are reliable.



**Figure 15.1: Tonnage Reconciliation 2006-2018 Annual and 2018 by Month**



**Figure 15.2: Grade Reconciliation 2006-2018 Annual and 2018 by Month**



**Figure 15.3: Contained Gold Reconciliation 2006- 2018 Annual and 2018 by Month**

### 15.7 MINERAL RESERVE COMMENTS

The Mineral Reserves have been estimated in an appropriate manner with suitable modifying factors applied to the Mineral Resource estimates in the preparation of the Mineral Reserve estimates.

Hecla Québec is of the opinion that there is no known permitting, legal, taxation, socio-economic, marketing, political, or other relevant factors that could materially affect the Mineral Reserve estimates.

### 15.8 COMMENTS ON MINERAL RESERVE ESTIMATES

In the opinion of the QP, Mineral Reserves for the Project, which have been estimated using core drill data, appropriately consider modifying factors, have been estimated using industry best practices, and conform to the CIM Definition Standards (2014). The QP is not aware of any issue to which the mineral reserve estimates could be materially affected by mining, metallurgical, infrastructure or other relevant factors.

## **16.0 MINING METHODS**

### **16.1 MINING OPERATIONS - UNDERGROUND**

INCO Gold operated the East Mine from 1988 to 1991. From 1991 to 1997, TVX operated the East and West underground mines. In 2006, Aurizon Mines (Aurizon) restarted underground operations at the West Mine. Operations under Aurizon continued until the acquisition of Casa Berardi by Hecla in 2013. Since 2013, Hecla Québec has operated the West Mine and in late 2017 began the rehabilitation of the East Mine.

Initially, both mines were developed as trackless operations, with all material transported to surface via ramp. In 1995, a track drift and the East Shaft were completed to connect the East and West Mines.

In 2006, the 5.5 m diameter West Mine shaft was sunk to the 795 m level, and ramp and level development were completed to access mining zones. In 2013, the West Mine shaft was deepened to the 1080 m level.

As of December 2018, the majority of underground mining is in the 118, 123 and 124 zones. These three zones also represent the bulk of the underground Mineral Reserves.

### **MINE DESIGN**

The mine design and planning processes reflect the past mining experience at the West and East Mines. The following design criteria are used by Hecla Québec:

- 2018 cut-off grade varies by zone from 3.4 g/t Au to 3.8 g/t Au.
- Production rate: target approximately 2,000 tpd of ore.
- Production and development crews work two ten-hour shifts, seven days per week, 365 days per year. The crew rotation is seven days on, seven days off.
- The mill operates two 12-hour shifts, seven days per week, 365 days per year.
- Crews work 5 days in-4 days off and 4 days in-5 days off rotation.
- Ramp and shaft access to the mining areas.
- Ramp dimensions: 4.5 m wide x 4.5 m high.
- Sublevel spacing: 20 m.
- Standard stope dimensions: 20 m high, 15 m strike-length, up to 20 m thick.
- Minimum mining width of three meters.

- Haulage drift dimensions: 4.5 m wide x 4.5 m high.
- 2.7 m diameter ore and waste passes.
- 3.35 m diameter ventilation raises.

## **WEST MINE AND PRINCIPAL AREA**

The current Mineral Reserves at Casa Berardi comprise seven zones in the West Mine including the and Principal area (Figure 16.1). These zones are spread over a distance of 200 m perpendicular to strike, 1,500 m to 2,000 m along strike and from surface to 1,090 m below surface. The 118, 123 and 124 zones form the bulk of the Mineral Reserve tonnage.

The zones vary in thickness, ranging from over 50 m to less than three metres (e.g. minimum mining width). In general, the zones are subvertical (e.g. 55° to 85°). However, the Lower Inter and 109 zones are relatively shallow dipping (i.e. less than 45°).

A combination of longitudinal and transverse blasthole stoping is used at the Casa Berardi Mine, depending on mineral zone geometry (width and attitude) and development requirements. Timely delivery of backfill plays a crucial role in controlling dilution and maintaining the short stoping cycle, but this mining approach since 2006 has proven to be safe and reliable.

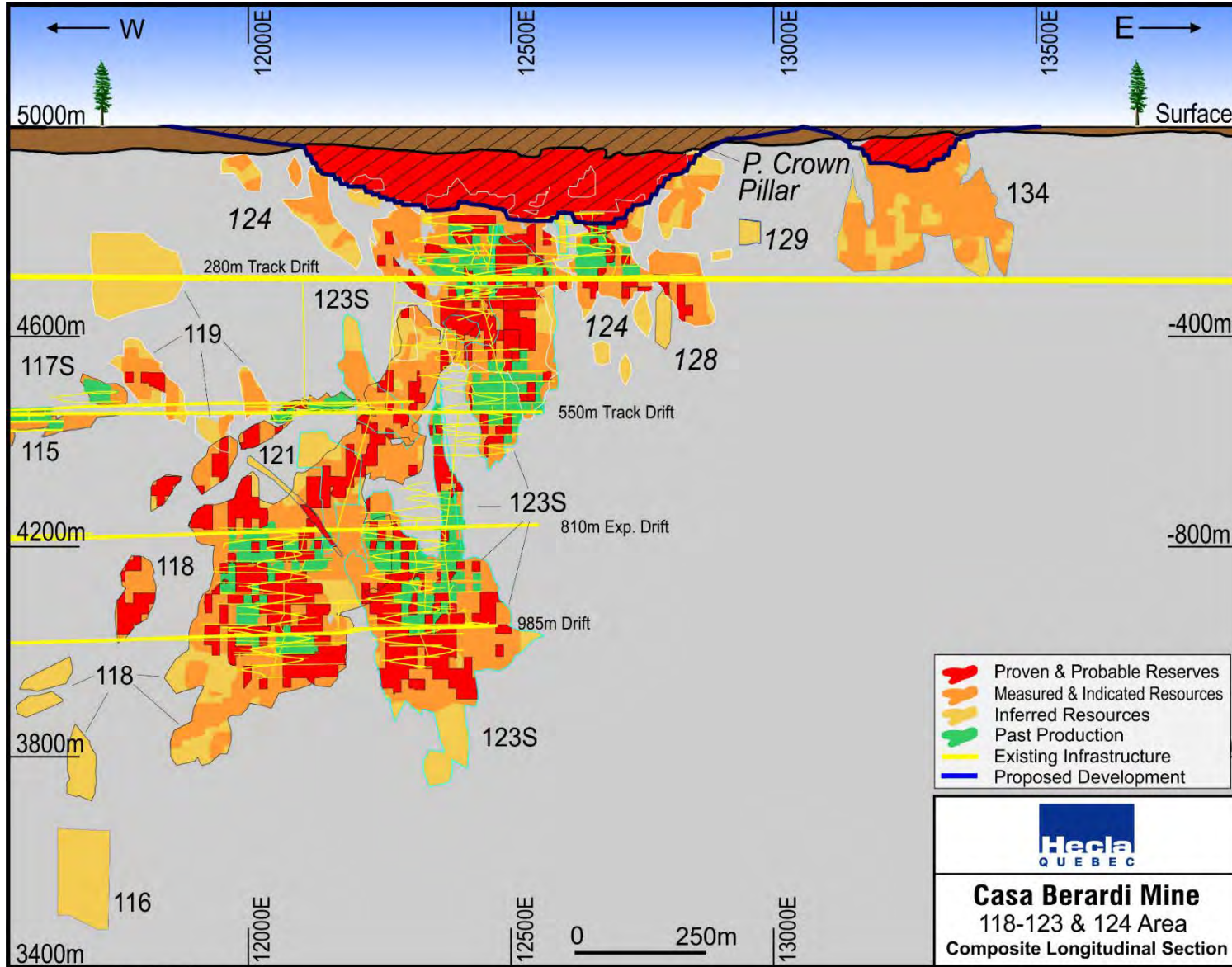


Figure 16.1: Longitudinal View of 118 to 124 Zones

## **TRANSVERSE METHOD**

The transverse mining method is used in areas with wide mineralization (i.e. 10 m wide or more) and good access from nearby development (i.e. haulage drift and multiple draw points). In wide areas (i.e. greater than 20 m), stopes are subdivided into smaller panels and mined in sequence from the hanging wall to the footwall.

Stopes are nominally 15 m long by 20 m high (i.e. floor to floor), oriented in a transverse manner to the strike of the ore, and are mined using an alternating primary and secondary sequence (Figure 16.2). Overcut and undercut draw points provide access to the top and bottom of the stope. Secondary support of Super Swellex and 0-gauge mine straps is installed in the back and sidewalls of the overcut. The support pattern varies based on sequence and adjacent mining (e.g. primary versus secondary stopes). Ring drilling is carried out using a production 75 mm top hammer longhole drill. A Machines Roger V-30 boring head is used to drill 30 inch bore holes as slot raises in the stopes. The long hole drill pattern is designed to contour the stope geometry by using smooth blasting techniques to control wall sloughing and dilution.

After blasting, the broken ore is removed from the stope through the undercut drift, using a remote-controlled load-haul-dump (LHD) unit, and loaded to a truck or hauled to an ore pass. When mining is completed, the stope is backfilled with paste fill or cemented rock fill (CRF) for primary stopes and unconsolidated waste rock for secondary stopes. Stope sequencing varies depending on zone.

The transverse method allows a variety of mining activities to take place in a series of closely grouped primary and secondary stopes at the same time. The stopes are in different stages of the cycle, from production drilling, blasting, and mucking through to the final backfill placement.

Full utilization of this method requires at least three to four production sublevels to be fully developed and operational in order to avoid production bottlenecks. To allow time for the cemented rockfill and paste backfill to cure, the primary stopes are mined at least two lifts ahead of the secondary stopes.

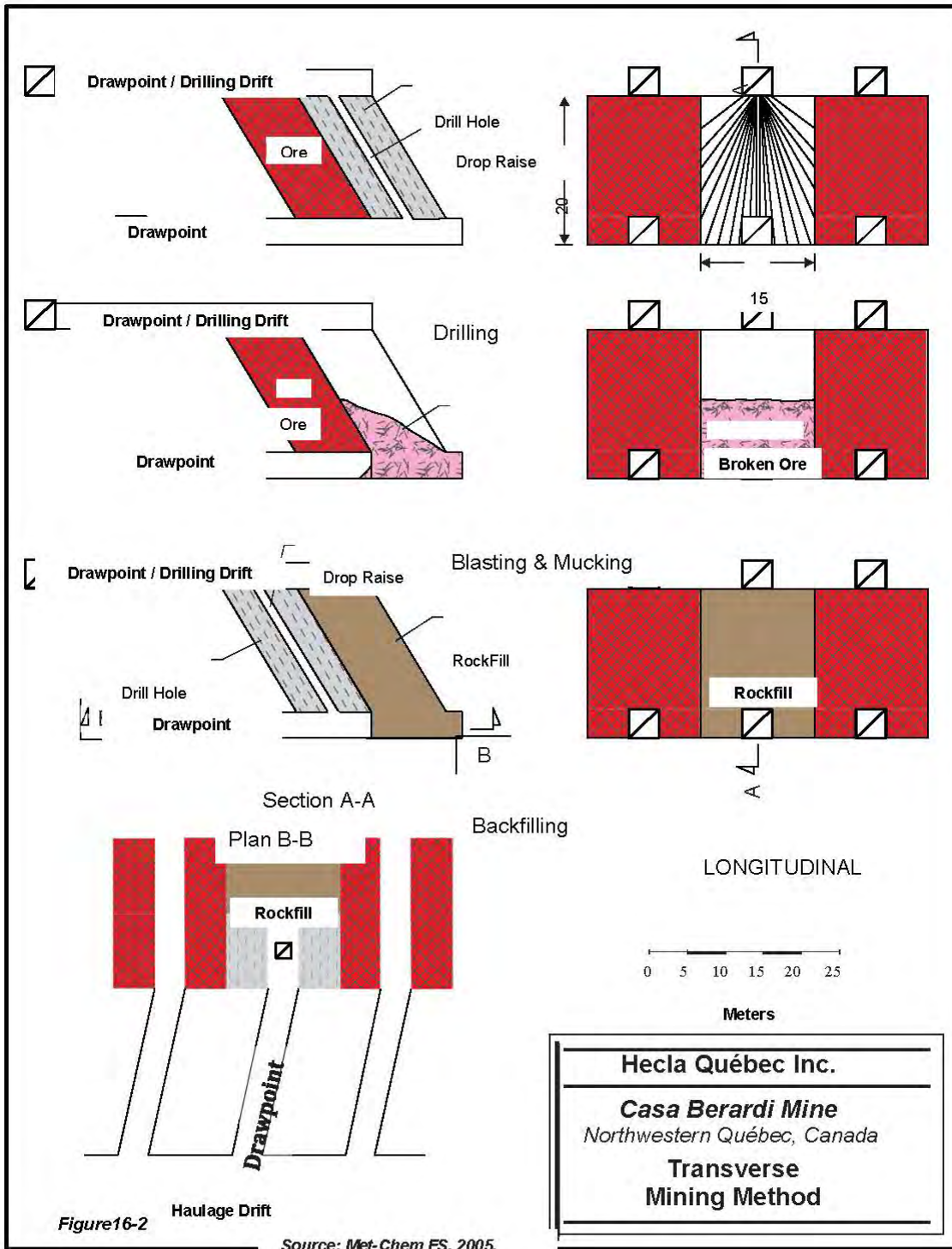


Figure 16-2

Source: Met-Chem FS, 2005.

**Figure 16.2: Traverse Mining Method**

## **LONGITUDINAL METHOD**

The blasthole longitudinal mining method is used in areas with narrow mineralization or minimal development infrastructure (e.g. sill development). Oriented along strike, longitudinal stoping is retreated back towards the access. Once a stope is mined, it is backfilled with paste fill or a combination of CRF and unconsolidated waste. For stopes mined using the AVOCA method, unconsolidated waste or rockfill is used as backfill.

Waste development requirements for the longitudinal method are lower than those for the transverse method, as accesses are within the ore on each level, and serve as overcuts and end-muck draw points for subsequent stopes. Productivity per level (e.g. sequence and access flexibility) is much lower, as only one (i.e. abutment access) or two (i.e. central access) stopes can be mined simultaneously.

## **STOPE SIZE**

In general, stope dimensions reflect standard development practices (e.g. draw points on 15 m centres and 20 m sub level spacing). When necessary, stope dimensions at Casa Berardi have been reduced in response to local ground conditions (e.g. 113 Zone), to sequencing / operational issues and to avoid exposing unconsolidated rockfill.

The average stope size for the various zones is shown in Table 16-1. With an average stope size is 4,900 tonnes, accordingly a large number of work places (e.g. 12 stopes per month) are required to sustain the 2,000 tpd production rate. Mine planning for these stopes must take into consideration the full stoping cycle, including providing time for backfill curing. The underground mine relies on production from multiple levels and stopes in several zones at any given time.

**Table 16-1: Tonnage per Stope**

Zone	Tonnes	Stopes Blocks	Tonnes per Stope
Lower Inter	17,800	6	2,967
113	53,000	10	5,300
118	1,335,500	264	5,059
119	35,900	8	4,488
121	35,900	8	4,488
123	1,054,400	196	5,380
124	546,100	121	4,513
East Mine UG	232,400	68	3,418
<b>Total</b>	<b>3,328,300</b>	<b>679</b>	<b>4,902</b>

The typical stoping cycle for Casa Berardi is shown in Table 16-2.

**Table 16-2: Typical Stope Delays and Activity Duration**

Description	Delay/Duration
Stope Preparation	8-10 days
Stope Blasting & Mucking	3-5 days
Stope Filling	7-10 days
Stope Curing	14 days (minimum)
Stope Drilling	2 x 300 m (drill) / day

## **EAST MINE MINING METHOD**

The East Mine is accessed by a decline from surface to the 550 level. At the 300 level, a track drift connects the East and West Mines. The East shaft is used for a portion of underground services. The hoist has been removed and access via the manway is not currently possible.

In 1997, a partial failure of the Dynatec Plug at the 275 level occurred and resulted in a chimney failure of the Casa Berardi Fault to surface. At which time, a ruling from the Commission de la Santé et de la Sécurité au Travail (CSST) suspended underground mining activities at the East Mine. In 2017, based on a technical report and mining plan, presented to the CNESST, mining activities restarted. These activities include the rehabilitation of the ramp from surface to the 550 m level; development of two exploration drifts at the 300 m and 485 m levels; diamond drilling of the 148 and 160 zones; ramp development below the 550 m level and stope preparation between the 500 m and 550 m levels.

In 1992 and 1997 chimney failures along the Casa Berardi Fault resulted in the creation of

two craters on surface. Underground, in the 148 Zone mining beneath these craters was isolated by a series of hydrostatic barricades installed between the 90 m and 250 m levels. Historically, the containment of overburden and surface water from the area surrounding the craters has been the main issue for the restart of underground production from the East Mine.

The mining of the overlying East Mine Crown Pillar (EMCP) open pit has eliminated the risk of overburden inflow and of the accumulation of surface water in the craters. However, the overburden stripping and exposure of sand and rock filled stopes has significantly decreased the delay required for the transmission of surface water (e.g. intense rainfall events and spring thaw) to the underground East Mine. Surface and ground water infiltrating into the East Mine drain primarily via the unconsolidated sand and rock fill of the mined stopes. Since 2017, measures have been put in place to control the drainage and pump the water to maintain a dewatered condition. There is no evidence that of a significant volume of water is contained behind the hydrostatic barricades.

## **16.2 GROUND STABILITY**

A history of ground instability and incidents related to mining in proximity to the Casa Berardi Fault at the East and West Mines has highlighted the importance of addressing rock mechanics issues for mining at Casa Berardi. The specific incidents are described in previous technical reports.

### **GROUND CONDITIONS**

Ground instability is primarily related to the Casa Berardi Fault system. Lithologies south of the Casa Berardi Fault are composed of relatively weak sediments with a frequent occurrence of schistose and graphitic rocks exhibiting weak contacts. Generally, the rock types vary from massive to fractured and heavily deformed in areas where the mineralization occurs along or near the main structural discontinuities.

### **GROUND TESTING AND ANALYSIS**

Systematically, RQD estimation is carried out on all core from diamond drilling and development faces in mineralized material are mapped by the Geology Department. The design and approval process for all development headings and stopes includes the analysis of these data on a case-by-case basis.

In situ stress measurements, carried out in 1999 by CANMET, fall within the lower range of the regional trends measured in other hard rock mines of the Abitibi District. Given the relatively weak nature of the rock units at Casa Berardi (i.e. uniaxial compressive strengths of less than 100 MPa) there is little evidence of high stress - related failures. Although at depth and in specific zones (i.e. 118-06 Zone) there is evidence of convergence or squeezing ground deformation. In general, ground stability issues are related to poor ground conditions near faults and gravity-driven wedge failures.

## **OPERATING PRACTICES**

Hecla Québec has responded to concerns related to safety and stability of mine openings with the following actions:

- Reducing open stope time to a minimum - mucking out is followed immediately by backfilling. Prioritize critical stopes for rapid mucking out in order to minimize exposure of the Casa Berardi Fault. The cement slurry and paste fill plants operate year-round to supplying cemented backfill to the mine.
- Limiting development in the Casa Berardi Fault (i.e. graphite and graphic sediments) by developing perpendicular rather than parallel to the fault.
- Using pre-support (i.e. spilling) and support (i.e. fibre-reinforced shotcrete arches with mine straps, Super Swellex and Super Split Set) with shortened development specifically adapted to fault conditions.
- Installed recessed cable bolts for hanging wall support, if required, due to ground conditions or development-stope geometry.
- Implementing proactive bolting of walls and intersections using long SuperSwellex bolts or cable bolts with mesh straps where required by poor ground conditions or large spans.
- Controlling of development length (transverse stoping) and heading size (longitudinal stoping) to minimize the creation of overhangs relative to mineral zone geometry in stope top cuts and undercuts.
- Modifying production drilling for narrow (<5 m widths) using 2.5" diameter drill holes with a 1.5 m x 1.5 m drill pattern.
- Changing the drift back profile to an arch configuration to improve the stability of the back.

- Using of standard stope dimensions (average of 15 m strike length, 20 m high, and up to 20 m thick) based on past experience and best practices.
- Application of tight fill. The stope sequence is from the bottom towards the top of each mining horizon / zone, leaving no voids.
- Locating permanent infrastructure in more stable ground (i.e. in massive volcanic rocks located to north of the Casa Berardi Fault).

The ground support measures to maintain drift stability are in accordance with commonly accepted practices for the ground conditions. The selected typical stope size and sublevel spacing are conservative, reflect historical best practices and help in maintaining stability and minimizing dilution. Secondary support is evaluated on a stope-by-stope basis in order to mitigate unravelling and exposing faults and weaker lithologies or dilution problems.

### **16.3 UNDERGROUND DEVELOPMENT**

Development openings have been sized to meet the requirements of safety and regulation standards, to accommodate selected mining equipment, and to meet the ventilation network requirements.

- Ramp dimensions: 4.5 m wide x 4.5 m high.
- Haulage drift dimensions: 4.5 m wide x 4.5 m high.

### **GROUND SUPPORT**

Ground control measures are applied systematically to ensure safe workplaces, limit dilution and overbreak, and stabilize weak rock masses, particularly in the vicinity of the main fault zones.

The following ground control measures are applied:

- Cable bolting or connectable Super Swellex bolts: in intersections and large spans to provide long term ground stability.
- Intersection geometry: limiting intersections to 3-way intersection and avoiding the creation of 4-way intersections.
- Preferential development orientation: minimizing development parallel to major structure or fault (i.e. silling out along the fault) by developing perpendicular to major structure wherever possible.

- Use of test holes confirm the position and width of the Casa Berardi Fault. Based on this information zones of the installation of spiling and shortened development round support with fibre-reinforced shotcrete are identified. This support is applied an additional 2 m before and beyond the fault.
- Test holes, shotcrete, spiling and other specialized ground support requirements are integrated in the weekly mine planning in order to ensure that potentially unstable conditions are supported in a rapid and timely manner.

Mine personnel identify potentially unstable joints and abnormal conditions as they are exposed. These situations are evaluated on an individual basis and where required the ground support (e.g. varying support types, pattern and length) is modified to stabilize the potential instability. Information regarding ground conditions is communicated on a daily basis through the ground control logbook.

## **DEVELOPMENT PERFORMANCE**

Mine development performance has fallen short of the plan in recent years. In 2018 long term plan for the operation, the failure to meet development targets was identified as a significant issue. Development performance improved considerably in 2017. In 2018, there were contract development crews in place in East Mine for exploration drift development and rehabilitation of the main ramp.

The mine development advance is shown in Table 16-3

***Table 16-3: 2011-2018 Development Performance***

<b>Year</b>	<b>Plan (m)</b>	<b>Actual (m)</b>
2011	11,881	8,330
2012	11,727	8,681
2013	12,542	11,182
2014	14,374	11,417
2015	13,292	11,764
2016	12,959	11,812
2017	11,382	11,556
2018	10,070	8,851

## **16.4 BACKFILL**

Backfill is required for maximum mineral extraction and for maintaining the stability stopes. Three types of backfill re used at Casa Berardi Mine: 1) unconsolidated waste (rockfill), 2) cemented rockfill and 3) paste fill. Rockfill is used in secondary stopes and for AVOCA longitudinal mining. Cemented rockfill and paste fill are used in primarily stopes, for initial mining horizons which will be eventually redeveloped through the paste fill.

The development waste material is used for rockfill and cemented rockfill. Transport of the rock fill to the stopes is by LHDs or trucks. In addition to the stability provided by the rockfill, the use of waste material allows for optimization of the hoisted waste tonnage and of equipment utilization by coordinating backfilling in proximity to development areas.

Cemented rockfill (CRF) is available throughout the West Mine, including areas above the 470 Level where paste fill is not available. A surface plant produces the cement slurry in batches, which is transferred underground, via a series of boreholes and lateral piping, to either a portable cement mixer or directly to the mix pit location.

A continuous, gravity-driven paste fill plant was constructed in 2013. The paste fill network can supply paste to the 113 (lower), 118, and 123 zones, below the 470 level. The advantages of paste fill include:

- Reducing the use of mobile equipment for fill transportation.
- Allowing better development performance through backfill.
- Providing better flexibility in the mining sequence.
- Allowing recovery and subsequent filling of caved stopes.

## **16.5 MINE EQUIPMENT**

There is an extensive fleet of production, development, and support equipment, as well as, fixed plant equipment at the Casa Berardi Mine.

The major equipment is summarized in Table 16-4.

**Table 16-4: Underground Mine Equipment List**

Unit	Number
MT426 haul truck	2
AD30 Caterpillar haul	11
LHD R1600	12
LHD R1300 3.5 yd3	2
LHD EJC 210	1
Jumbo 2 boom	5
Jumbo single boom	2
Long hole drills	5
Cement/service/utility	20
Lift deck units	12
Tractors and land	42
Locomotives	1
Grader	3
Surface loader forklifts	4

## 16.6 MINE INFRASTRUCTURE

Mine infrastructure is located in two main areas, the West and East Mines. The production and ventilation shafts, shops, waste dumps and ore stockpiles, cement plant, paste fill plant and ramp portal are located at the West Mine. The mill and administration building, crusher, East Mine production shaft (not currently in use), warehouse, and shops are located at the East Mine. Figures 16.3 and Figure 16.4 illustrate each location.

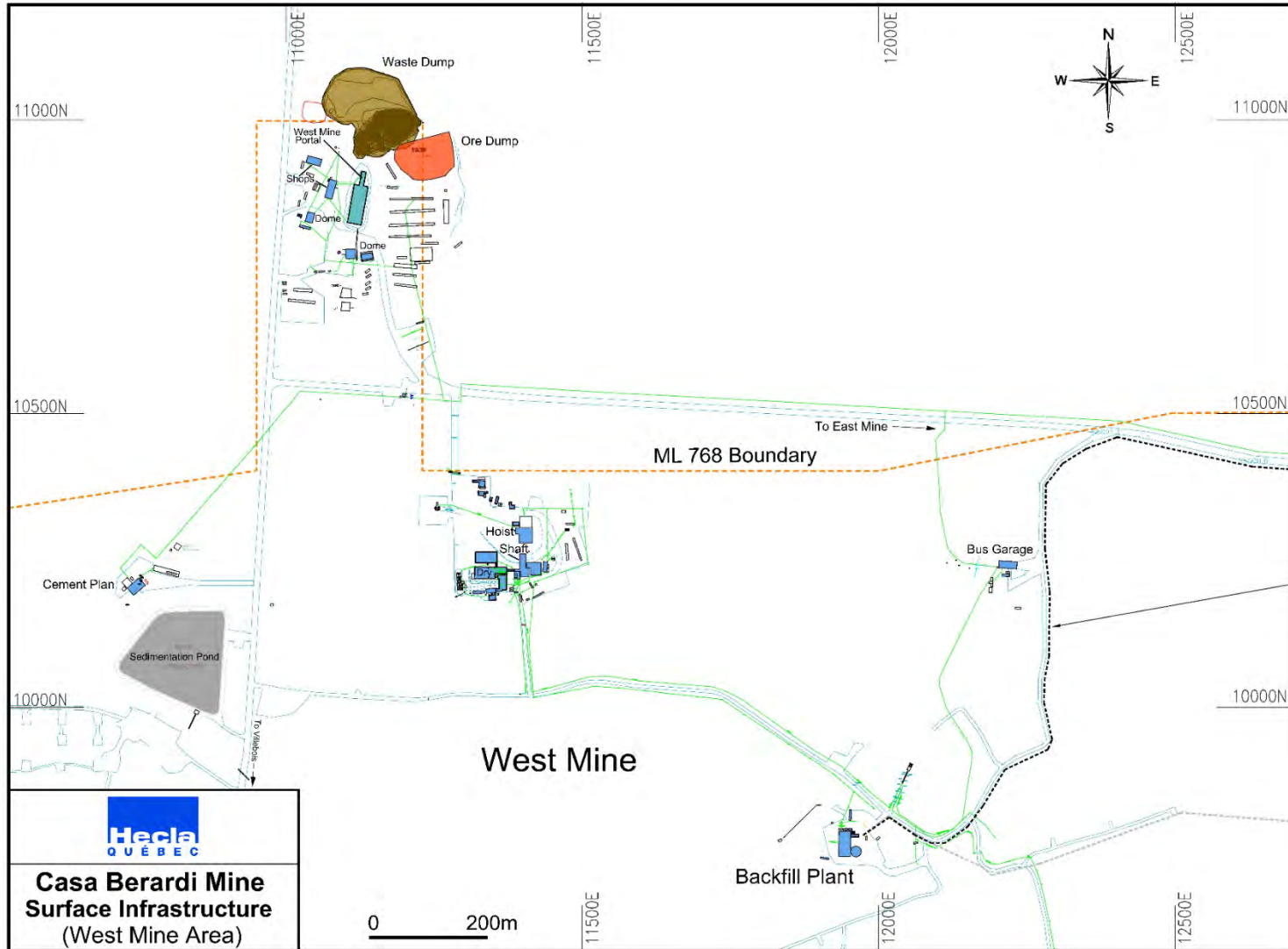
### WEST MINE SHAFT

Prior to restarting operations in 2006, the shaft at the West Mine was developed. The shaft is positioned outside the faults and beyond the zone of stress influence due to mining. The shaft design was deepened to the 1080 m level in 2013 and has been operational since 2015.

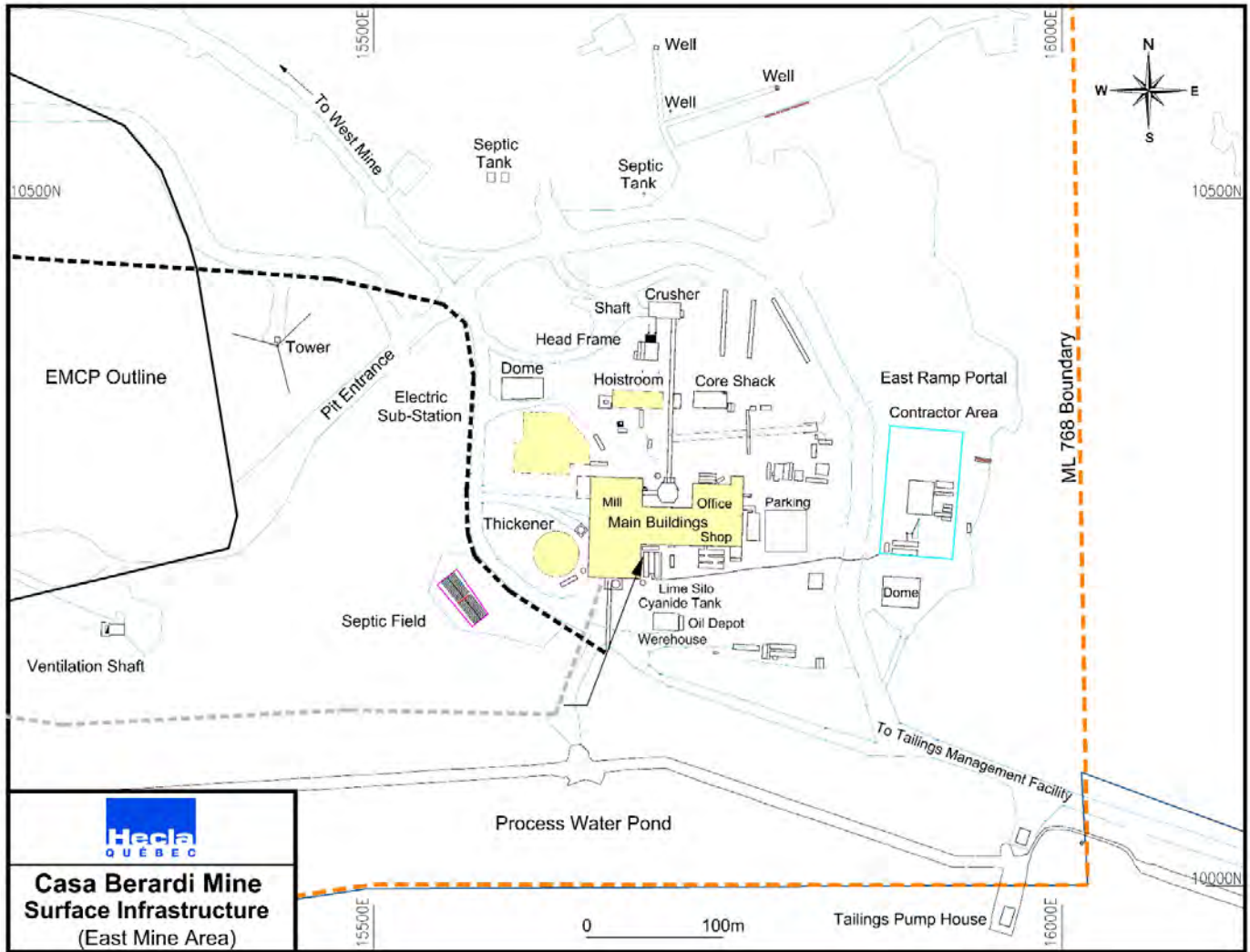
The shaft is a circular 5.5 m diameter shaft with a 42 m deep concrete shaft collar anchored in bedrock. Shaft stations are located at the 280, 550, 690, 795, 880, 1010, and 1030 levels. There are three skip loading stations at the 720, 835 and 1055 levels, a loading pocket at the 880 Level and a spill pocket at 1080 Level.

The shaft is concrete-lined and equipped with a steel structure that divides the shaft into four compartments. Two compartments are allocated for the 12 tonnes skips, each with a cage at

the top. The third compartment intended for a service cage for personnel and material is not in use. The fourth compartment consists of a manway and a service area for pipes and electrical cables. The headframe is conventional steel construction, 57 m high, incorporating a skip dump arrangement with ore and waste storage bins. The ore bin capacity is 1,200 tonnes and the waste bin capacity is 370 tonnes.



**Figure 16.3: West Mine Surface Infrastructure**



**Figure 16.4: East Mine Surface Infrastructure Ore and Waste Pass Systems**

## **ORE AND WASTE PASS SYSTEMS**

The ore and waste pass systems were sized and located according to the production requirements of the 113 and Lower Inter zones. Ore and waste passes are 2.4 m in diameter. The Lower Inter Zone ore and waste pass system terminates on the 570 level, where ore and waste are transferred by truck to the 113 Zone ore and waste handling system. The ore and waste pass systems in the 113 Zone terminates at a chute on the 690 level, where material is transferred by truck to a rock-breaker-grizzly. The grizzly discharge goes through a surge bin into the 720 level loading pocket of the shaft and is hoisted to surface. A rock-breaker-grizzly for ore and waste is in operation on the 795 level feeding a loading pocket on the 835 level. For the 124 Zone, all the material is brought to the surface by trucks. Ore and waste are transported to their respective dumps by LHD. Oversize material is handled by a rock breaker or moved to a suitable location for secondary blasting.

For the 118 and 123 zones, ore and waste passes terminate on 985 automated drift. The ore pass connection in the 123 Zone (550 to 985 levels) will be completed in 2019. Two automated trucks transport material from the automated chutes to automated rock breaker on 985 Level. This fully-automated level is controlled from surface. The ore and waste pass systems on 985 Level terminate at the 1055 loading pocket. From the 1055 Level loading pocket, ore and waste are skipped to surface.

## **VENTILATION**

The ventilation network design was based on physical mine configurations and accounted for the size of production, installed horse power on diesel equipment, number of people and simultaneous activities underground. The East Mine is ventilated from the West Mine via the track drift that connects the two mines.

The main ventilation raises for mine air distribution system are 3.35 m in diameter, excavated by a raise climber (Alimak) from the lower levels of each zone and connected with main airways. Raise ventilation access drifts (up to 10 m long) are excavated on each level/sublevel during raise development and connected to the main haulage drifts when required. A ventilation schematic circuit is presented in Figure 16.5.

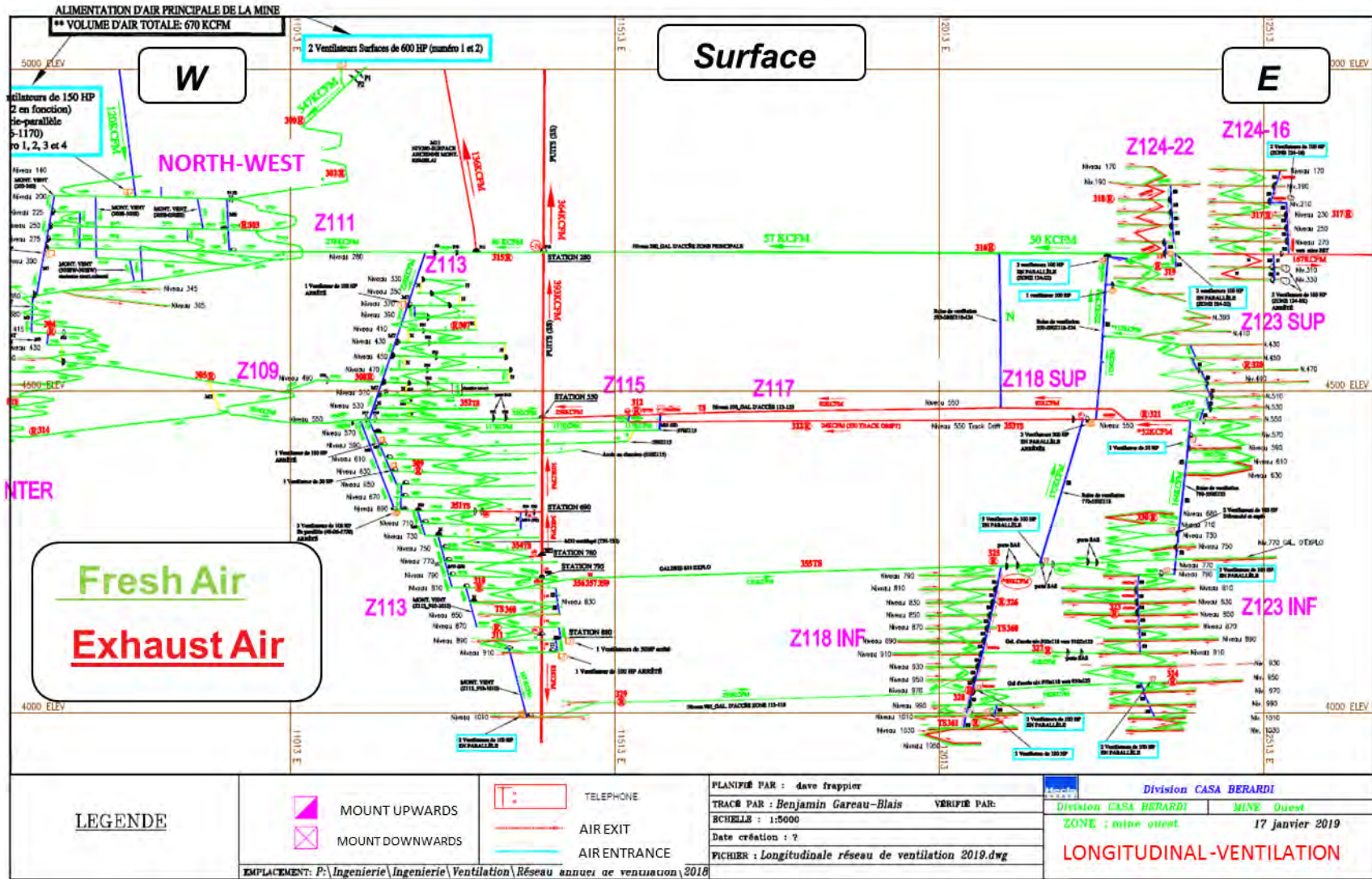


Figure 16.5: West Mine - Ventilation Schematic Circuit

The mine requires 220 m<sup>3</sup>/s of air (465,000 cfm) at full production capacity. The ventilation network installations at the mine consist of:

- The West Mine fresh air intake system consists of two main ventilation systems.
- The first one, a high pressure, ventilation system installed at the portal of the West Mine. This system consists of two fans in parallel, which deliver 600,000 cfm of fresh air. The fan station is equipped with a salvaged mine air heating system from the East Mine. The operating static pressure is 12 - 13 in of water.
- The second system has four 150 hp fans, which provide 260,000 cfm airflow at an operating static pressure of 8.5 in of water. Typically, two of the four fans are operated series to provides 130,000 cfm.
- An air lock system in the West Mine ramp entrance.
- The shaft acts a ventilation exhaust raise.
- Numerous airflow regulators, booster fans, and ventilation raises.

## **MAINTENANCE FACILITIES**

The main fixed equipment, either on surface or underground, such as the hoist, compressors, ventilators, GEHO pumps, and the cement plant, are covered by an integrated preventive maintenance program. Daily maintenance and parts replacement are done on site. Major equipment overhauls are conducted off-site in specialized maintenance shops.

The maintenance of mobile equipment, used on surface and underground, is done in a building located near the mill at the East Mine. This building includes a maintenance shop, warehouse, offices, a change room, and a communications system. The existing surface shop is well equipped (compressed air, lifting equipment, cranes, and welding facilities) and large enough to accommodate equipment employed at the site.

The warehouse is located nearby and facilitates the delivery of parts and materials for maintenance and repairs. Spare tires are stored on a nearby pad. The change room and sanitation facilities are located on the second floor of the building.

In an effort to improve the maintenance time and displacement of equipment, Hecla Québec has installed an underground garage on the 550 Level, in 2010.

Another underground garage was completed in 2014 on the 810 Level, close to the 118 and 123 zones.

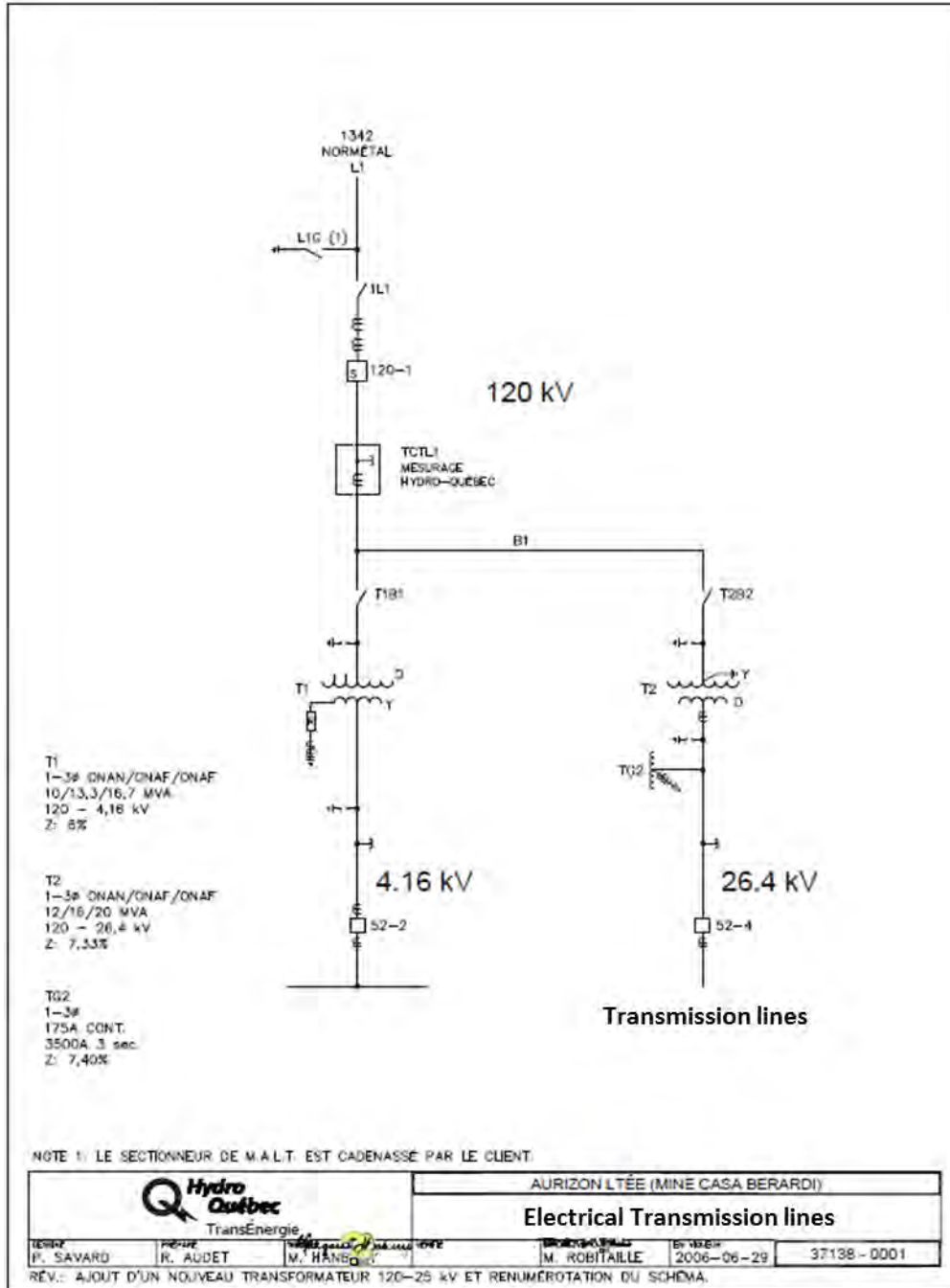
## **POWER**

Electrical power is supplied to site by Hydro-Québec through a 120 kV line from the town of Normetal (55 km to the South-West). Two main transformers are installed in the main substation, located at the East Mine site. The East Mine site is supplied by a 120kV/4.16kV - 16MVA transformer (T1) and the West Mine site is supplied by a 120kV/25kV - 20MVA transformer (T2) as shown on the electrical single-line diagram (Figure 16.6).

The East Mine site distribution network covers the mill, the East Mine, the EMCP open pit and the East facilities and garage.

The West Mine site employs a 25kV line network covering the West Mine portal main ventilation fan, the headframe, hoist, shaft collar, the compressor buildings, West facilities and a 5kV transformer to supply 1,000 kVA to underground substations in the mining areas. A 25kV underground station supplies 1,000 kVA to substations in the 118 and 123 Zones.

Underground power distribution is via cables installed in the shaft or in the ramp. The power supply in the province of Québec is very reliable. Hecla Québec provides backup power for the West Mine headframe (135 kW), the surface garage (350 kW), the mill (525 kW), and the West Mine backfill plant (200 kW).



**Figure 16.6: Casa Berardi Mine - Main Station 120kV Flow Sheet**

## 16.7 OPEN PIT MINING OPERATIONS

Open pit operations begun in January 2016, in the East Mine Crown Pillar (EMCP) pit, at Hecla Québec's Casa Berardi Mine. In addition to the EMCP, this report considers the planned Principal, 160 Zone, 134 Zone, EMCP Expansion, and West Mine Crown Pillar (WMCP) open pit mines. These pits involve both the recovery of crown pillars above

underground mining (i.e. EMCP, WMCP and Principal pits) and the mining of zones that have not been exploited underground (i.e. 134, 160 and EMCP Expansion pits).

## **MINING METHOD**

The current mining method used in the EMCP pit is described in the following paragraphs. This method will be used for the mining of subsequent open pits. Mining method and design considerations that are specific to the other planned will be discussed later. Material is being mined using conventional open pit mining methods, based on a truck/shovel operation. The rock is drilled, blasted, and loaded by hydraulic shovels into trucks, which deliver the material to a stockpile located near the primary crusher, approximately 700 m from the pit.

Waste materials generated by mining include overburden (i.e. peat, clay, till and sand), waste rock (i.e. clean and low-grade mineralized) and backfill from stopes intercepted during mining (i.e. unconsolidated sand and rock fill). The overburden material is removed and hauled to the Mixed Waste Dump. Peat is stored separately for restoration-revegetation. Better quality clay has been used for tailings dams, isolation levees and reclamation projects (e.g. cover of tailings in preparation for revegetation). Clean waste rock is used for surface infrastructure work such as roads, levees, tailings dams and foundations for civil engineering constructions. A portion of the clean waste rock is crushed and screened to provide aggregates for roadway construction and maintenance, and for use as abrasives in icy weather conditions. Low-grade mineralized waste rock is used to prevent erosion of final slopes in the overburden and for the construction of the Mixed Waste Dump. Stope backfill is hauled to the Mixed Waste Dump.

## **OPEN PIT DESIGN**

Initial open pit designs employed 5 m high mining benches, with a catch berm positioned every three benches (i.e. 15 m). In practice, a bench height of 7.5 m, with a catch bench positioned after every second bench is used. This design change does not modify the overall pit geometry. It allows greater flexibility on blast tonnage and greater control on pre-shear blasting and excavation of final pit walls. The EMCP pit was planned in phases, with additional overburden stripping and pushbacks.

## **SLOPE PARAMETERS - OVERBURDEN**

Overburden slope parameters are based on recommendations from previous geotechnical and mining studies (Golder, 2009) and (BBA, 2011). The overburden slope parameters vary

as function of material type:

- Slopes in clay: 4H:1V (14.1°) – 3H:1V (18.4°).
- Slopes in till: 2H:1V (26.6°).

In 2018, Hecla Québec re-evaluated the 4H:1V slope angle in the clay material based on in-situ observations and data from previous geotechnical characterizations using Rocscience's Slide 7.0 software (Hecla Internal Report - Design Pente EMCP, 2018). Based on this analysis, the use of 4H:1V slopes in clay were shown to be conservative and 3H:1V slopes were shown to be stable. As a result, the east and south overburden slopes of the EMCP pit were excavated according to Golder's (2009) recommendation (i.e. 4H:1V in clay). However, north and west slopes were excavated using a 3H:1V slope in the clay. inclinometers and prisms installed in the overburden confirm the stability of 3H:1V slope in the clay material. All overburden slopes are covered with a 1 m thickness of waste rock to prevent erosion.

Experience gained from the excavation of overburden in the EMCP Pit has shown that information related to the bedrock-overburden contact was limited to drill hole locations. Although, the surface topography was relatively flat, the bedrock contact varies significantly across the site and particularly above the Casa Berardi Fault. At this location the bedrock forms a valley which varies from approximately 40 m below surface at the west end of the site to 50 m below surface at the east end. On either side of the fault, the bedrock elevation is higher, rising to 20 m below surface on the south side. The variation in the expected contact position (i.e. overburden thickness and topo bench elevation) has required the engineering personnel to modify the design in order to compensate for higher or lower pit wall positions.

The overburden slope parameters, for the EMCP Expansion Pit will be identical to those used in the EMCP Pit, including the 3H:1V (18.4°) slope in the clay. For the 134, 160, WMCP and Principal pit projects, the designs are based on a 4H:1V (14.1°) slope in the clay, a 2H:1V (26.6°) slope in the till and a 6H:1V (9.5°) in the sand (Principal and 134 pits).

## **SLOPE PARAMETERS - ROCK**

The slope parameters for the final pit wall in the rock are:

- An Inter Ramp Angle (IRA) of 52.5°.
- A Bench Face Angle (BFA) of 75°, over a 15 m height or two 7.5 m high benches.

- A 7.5 m wide catch berm every 15 m in elevation.

The rock slope parameters, used in the EMCP Pit, are identical to those for the EMCP Expansion, 134, 160 and WMCP pit projects. Rock slopes in the Principal Pit will be slightly flatter with an IRA of 50° due to reduced BFA of 70°.

## **RAMP DESIGN**

Ramps were designed with a nominal 10% centerline gradient. Switchbacks were designed with a centerline gradient of 8%, in order to prevent the inside curvature gradient from becoming excessive. Ramp widths assume the use of rigid-body haul trucks with a width of 5.6 m, although articulated trucks are planned to be used for overburden and may be used in other areas as needed. A 22 m width was used for ramps with two-way traffic. This provides for a running width of three times the truck operating width and includes a 1.6 m high safety berm. In the lower portions of the pit designs, where the stripping ratio is minimal, ramps were narrowed to 17 m for one-lane traffic use.

## **UNDERGROUND WORKINGS**

Since the summer of 2017, the EMCP open pit has intercepted underground opening in the pit floor. These opening include unfilled drifts and raises, as well as backfilled stopes. Stope backfill is unconsolidated sand and rockfill. These excavations are for the most part isolated from the accessible areas of the underground East Mine by a series of hydrostatic barricades. The EMCP Pit was designed for simultaneous surface and underground operations by ensuring a minimum 50 m pillar between the final south wall of the open pit and the main ramp underground. Procedures are in place for the definition of safety perimeters for specific mining activities (e.g. drilling, loading and excavating) and for the movement of vehicles and personnel in proximity to these excavations or their remaining crown pillars. The use of C-ALS surveys and production drilling data (e.g. breakthrough locations) are used confirm the survey data and 3D models of the underground excavation. To date, no problems have been encountered related to the underground excavations. An incremental ore mining cost has been planned to cover the cost of excavating the backfill.

The EMCP Expansion, 134 and 160 open pit projects will not intersect any underground excavations. These open pits are considered to have no impact on simultaneous underground operations and do not require any special precautions to be taken.

The WMCP Pit project will intercept underground infrastructure (i.e. drifts, ramp, raises and backfilled stopes). The West Mine underground decline will be intercepted. Special precautions will have to be taken as the openings might create rock mechanics issues. There will also be underground openings daylighting near the bottom of the pit (infrastructures and stopes), which will create a need to manage geotechnical perimeters. However, Hecla open pit personnel are already dealing with this kind of issues in the EMCP Pit. Here again, underground operations will be completed before open pit operations start disrupting underground infrastructures.

The Principal Pit project will intersect underground excavations in the bottom of the pit. Underground operations are planned to end in 2024 and overburden removal is planned to start in 2028. Therefore, there will not be any impact on underground operations.

### **OPEN PIT MINING EQUIPMENT**

Mining equipment is operated and maintained by a contractor. The current equipment fleet is summarized in Table 16-5.

**Table 16-5: Mine Equipment List Open Pit**

<b>Unit</b>	<b>Number</b>
Cat 740 Articulated Trucks	10
Cat 773 Rigid-body Trucks	10
Komatsu 1250 Excavator	1
Komatsu 800 Excavator	2
Cat 365 Excavator	1
Cat 349 Excavator (Rock	2
Cat 336 Excavator	2
Cat D8 Bulldozer	1
Cat D6 Bulldozer	1
Cat 14H Grader	1
DX 800 Drill	3
DX 1500 Drill	1
Cat 980 Loader	1
Cat 966 Loader	1
Manitou Telescopic Handler	1
Water Truck	1
Fuel Truck	1
Blasting Cube Truck	1
Light Tower	5

## **GEOTECHNICAL / HYDROGEOLOGICAL CONSIDERATIONS**

Of the planned pit projects, the Principal pit project requires the analysis of additional considerations. The Principal pit is located in the vicinity of an esker surrounded by wetlands. Hecla Québec retained the services of Golder (2010) to perform a geotechnical investigation to provide a slope stability analysis of the overburden in the Principal pit sector.

The general soil stratigraphy encountered in the boreholes vary from east to west, grading from an esker, composed mainly of granular material, to a stratified cohesive deposit over glacial till. The esker has been identified over more than 75 km, with a north-south orientation. The geotechnical study (Golder, 2010) confirmed the occurrence of the esker within the vicinity of the proposed pit, where the thickness may reach more than 50 m. However, this study did not allow the identification of the esker limits, nor the variations of the lithologies and hydraulic properties within the esker.

The presence of the esker in the vicinity of the pit may result in large inflows and potential groundwater contamination of the esker during project operations. The primary source of potential contamination being in the leaching of metals into groundwater, mainly arsenic, from the waste rock pile. Consequently, it is essential to examine existing methods to control groundwater flow at an early stage in the project. It will then be possible to identify the technical characteristics and financial resources required in the project for pit inflow control. A fieldwork program to address these groundwater control options may include:

- Seismic-refraction survey.
- Monitoring well installation.
- Soil sampling and characterization.
- Hydrogeology characterization.

Based on this information, a conceptual model of the esker groundwater flow system could be elaborated. The technical feasibility of potential groundwater control scenarios, selected according to the results of the fieldwork and data interpretation, will be examined using a numerical groundwater flow model. The model will allow for the validation of design scenarios, the estimation of potential inflows, and identification of potential environmental impacts.

## **MATERIAL MANAGEMENT**

Over the LOM, open pit operations will generate 256,191,881 tonnes of material. This material will be of different types (i.e. overburden, ore, and low-grade mineralized and clean waste) and will be extracted from up to three different open pits at any one time. These pits will be at different stages of development. Some will be stripping overburden, while others will be extracting ore and rock waste. Mature pit projects will see clean waste rock production diminish as the strip ratios decrease towards the bottom of these pits.

Owing to the complexity of handling different types of material that have different properties, a sound production plan needs to be backed up with a sound waste management program. The long-term plan requires balance to the extraction plan to cater to the needs for different types of materials. Shortage in any type of material when it is needed could have negative effects on the mine plan if critical infrastructure cannot be put into place in time. Correcting these shortages, will also increase costs which would be difficult to control. Accordingly, the construction of dump infrastructures has been scheduled to start when building materials are available, as opposed to starting when a need for storage arises.

## **WASTE ROCK CHARACTERIZATION**

Maxxam Analytical Laboratory performed the following tests on waste rock samples:

- Acid generation potential.
- Metal content (partial digestion).
- Leaching according to EPA-1311 test method (acetic acid).
- Leaching according to EPA-1312 test method (nitric and sulphuric acid – acid rain).
- Leaching according to CTEU-9 test method (water).

Based on these analyses, the waste rock has been identified as non-acid generator but has been classified as “leachable” according to the Quebec *Directive 019* criteria. However, the contents measured are below the criteria for the classification as a high-level risk mining waste.

The waste rock has been classified in two distinct categories, clean and low-grade mineralized. Clean waste rock can be used for construction, but low-grade mineralized cannot. Low-grade mineralized waste rock is defined as the 10 m envelope of material

surrounding the mineralization. This material must be buried with either clay or clean waste rock, at the Mixed Waste Dump, to prevent it from being in contact with the air.

## **WASTE DUMP LOCATIONS AND CONSTRUCTION**

The following criteria have been used for the selection of potential waste rock and overburden storage sites:

- Avoid material storage over the esker area.
- Avoid material storage over wetlands (loading capacity).
- Avoid material storage in streams and surface water bodies.
- Limit transport distance within the mining pit.

The Mixed Waste Dumps #1 and #2 have been designed as an engineered waste disposal complex capable of containing low cohesive material (i.e. clay materials). The dump uses a crown shape infrastructure, that act as recipient for the clays. Low-grade mineralized waste rock and till are used to build containment cells within the crown. Each cell is accessed by a series of temporary roadways and dumping fronts, constructed using waste rock. These temporary infrastructures are ultimately buried in clay or covered by clean waste rock, as the waste dump is finally capped. The last step before full reclamation. The construction of the waste dump is strictly controlled in order to allow for uniform deposition of waste materials in 1 m lifts over its entire footprint.

In addition to the existing Mixed Waste Dumps #1 and #2, located to the southeast of the EMCP Pit, Mixed Waste Dumps #3 and #5 are planned, one next to the existing dumps, the others between the WMCP and Principal pits and to the north of the WMCP Pit.

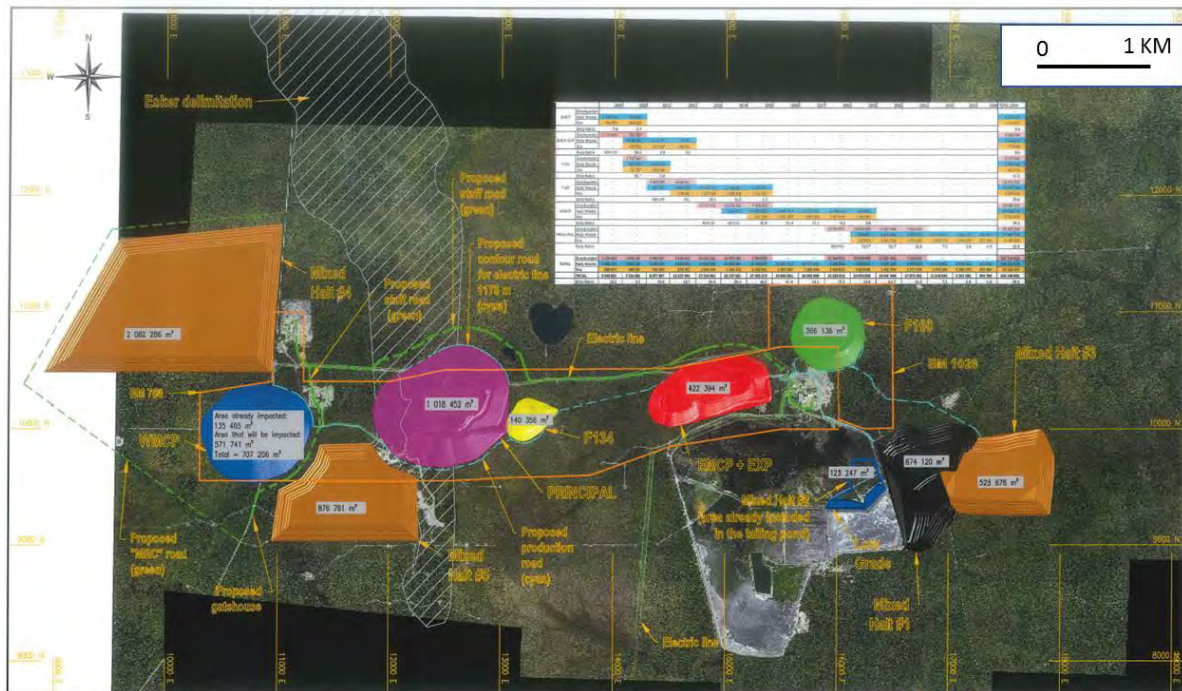


Figure 16.7 is a general plan of the Casa Berardi site. It indicates the location of the actual dump complex (i.e. Mixed Waste Dumps #1 and #2) and the proposed dump sites (i.e. Mixed Waste Dumps #3, #4 and #5). Whenever possible, waste will be used to backfill the open pits that have been completed. The plan is to fill the EMCP Pit starting in the fourth quarter of 2020. Material extracted from the Principal Pit will be used to fill the 134 Pit, initially, and the WMCP Pit to approximately half of its capacity. The filling of open pits will depend on the timing of their completion and on the haulage distances between the dump site and the active pit. Table 16-6 describes the dumping sequence as a function of material type for each open pit project.

**Table 16-6: Dumping Sequencing**

Area	Material	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
EMCP	Overburden																
	Rock Waste	MH1	MH1														
EMCP-EXP	Overburden	MH1	MH3														
	Rock Waste		MH1, MH3 *	EMCP fill	EMCP fill												
F134	Overburden		MH1														
	Rock Waste		MH3	EMCP fill													
F160	Overburden			MH3	MH3												
	Rock Waste			MH3	MH3	EMCP fill	EMCP fill	EMCP fill									
WMCP	Overburden					MH4	MH4	MH4									
	Rock Waste						MH4	MH4	MH4	MH4	MH4	MH4					
PRINCIPAL	Overburden										MH5	MH5	WMCP fill	WMCP fill			
	Rock Waste											F134 fill	F134 fill	WMCP fill	WMCP fill	WMCP fill	WMCP fill

\*: 19% MH1; 81% MH3

The design criteria for the waste dumps are to:

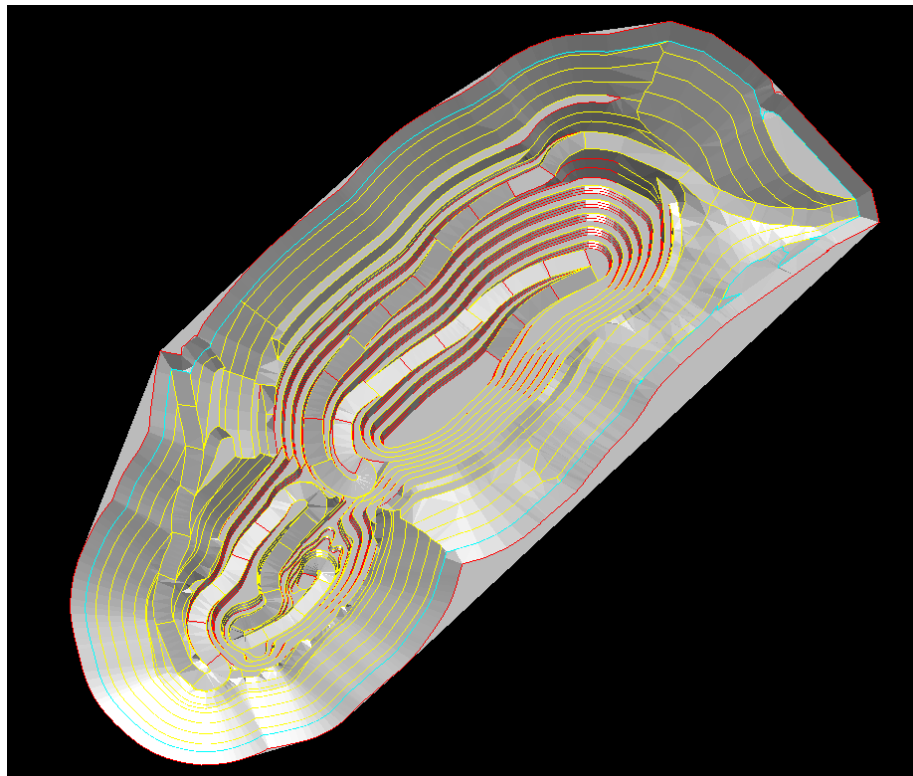
- Maximize dump capacity based on the bearing capacity of the ground, in order to reduce the environmental impact of the waste dump footprints to the site.
- Whenever possible, backfill completed open pits. It must be noted that hauling distances have a major impact on the economic viability of the open pit projects. Some open pits will be left unfilled, owing to uneconomical hauling distances.
- Optimize the pit scheduling to allow waste materials generated by mining to be used for the dump site infrastructure (e.g. access roads).
- When backfilling open pits that intersect underground excavations, use only free-draining materials (e.g. waste rock and not overburden).

## OVERVIEW OF PIT PROJECTS EMCP EXTENSION PIT

The EMCP Extension pit project design is based on:

- Slopes in clay: 3H:1V (18.4°).
- Slopes in till: 2H:1V (26.6°).
- Slopes in rock: Inter Ramp Angle (IRA) of 52.5°.
- No underground excavations will be intercepted.
- Geotechnical considerations: Casa Berardi Fault will intersect the final West Wall.
- Mining to be carried out in a single phase.

An isometric view of the ultimate EMCP and EMCP Extension pits is shown in Figure 16.8.



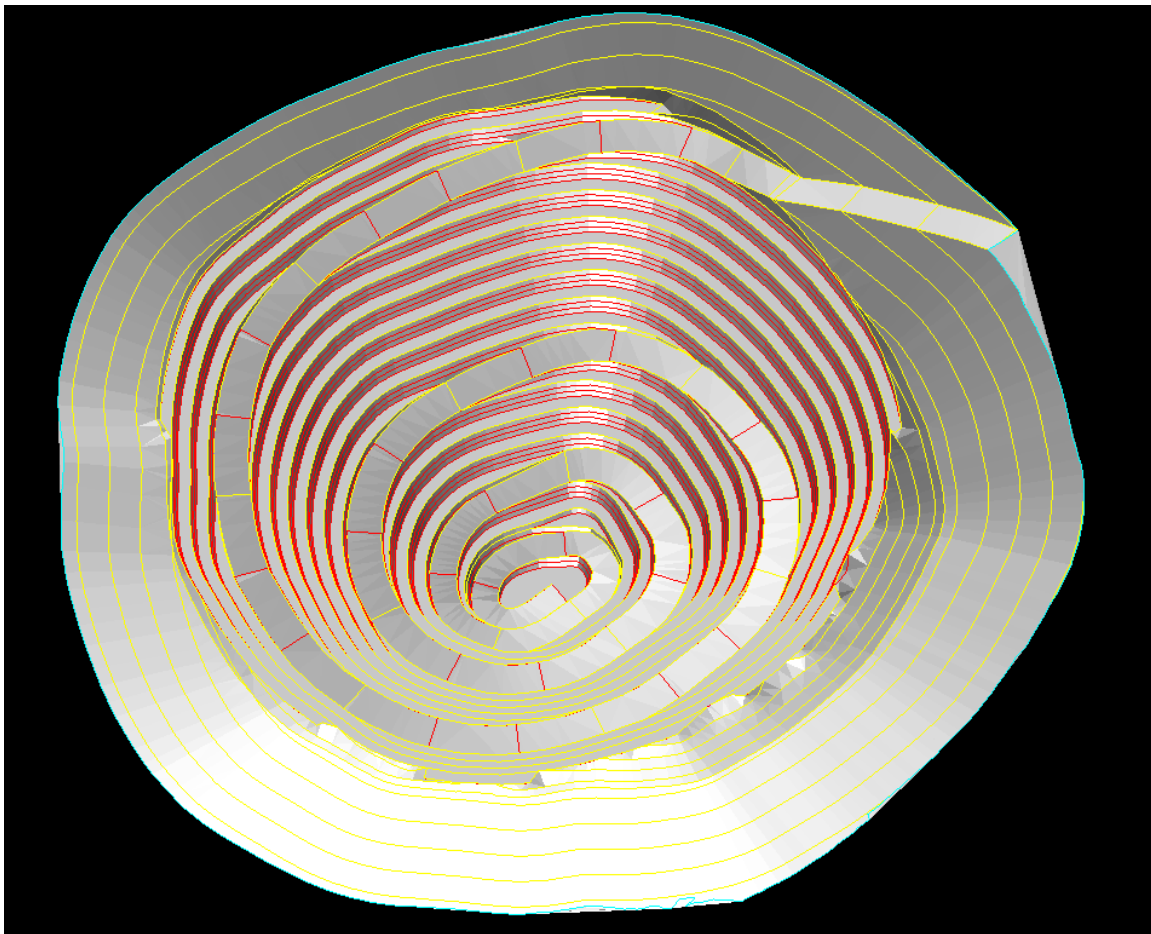
**Figure 16.8: Isometric View of the EMCP and EMCP Extension Pit Project (Ultimate Pit Shell)**

## 160 PIT

The 160 Pit project design is based on:

- Slopes in clay: 4H:1V (14.1°).
- Slopes in till: 2H:1V (26.6°).
- Slopes in rock: Inter Ramp Angle (IRA) of 52.5°.
- No underground excavations will be intercepted.
- Mining to be carried out in a single phase.

An isometric view of the ultimate 160 pit is shown in Figure 16.9.



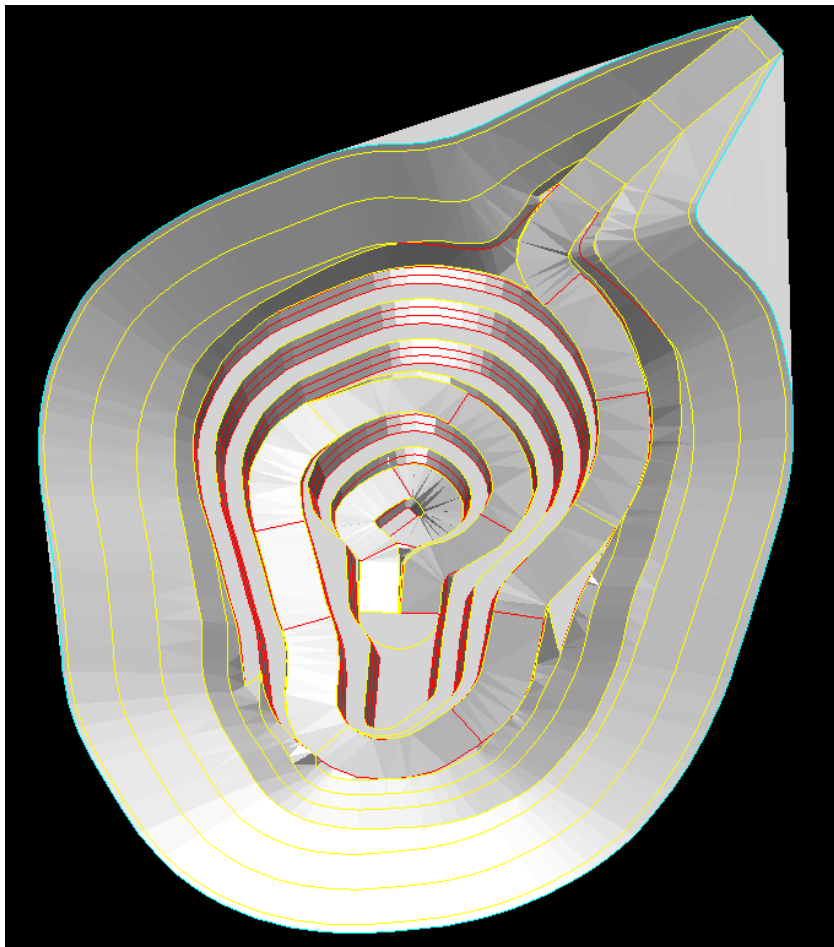
*Figure 16.9: Plan View of the 160 Pit Project*

## 134 PIT

The 134 Pit project design is based on:

- Slopes in clay: 4H:1V (14.1°).
- Slopes in till: 2H:1V (26.6°).
- Slopes in rock: Inter Ramp Angle (IRA) of 52.5°.
- No underground excavations will be intercepted.
- Mining to be carried out in a single phase.

An isometric view of the ultimate 134 pit is shown in Figure 16.10.



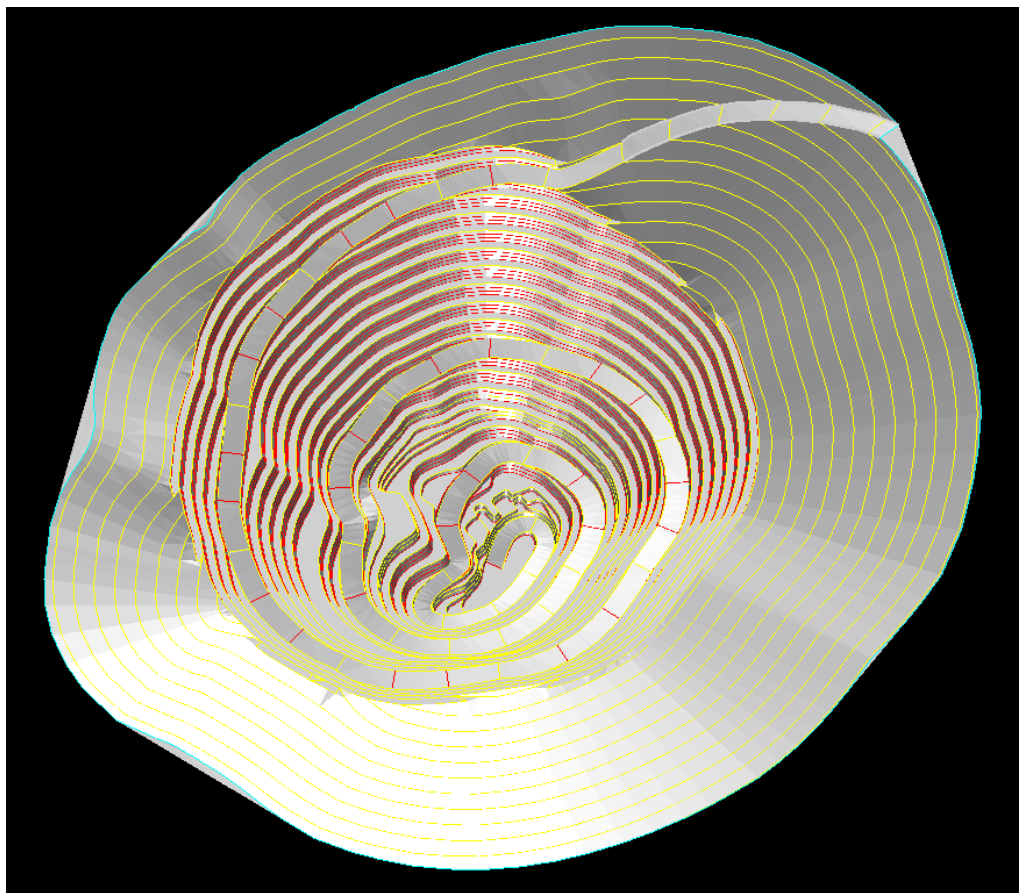
**Figure 16.10: Isometric View of the 134 Pit Project (Ultimate Pit Shell)**

## WMCP PIT

The WMCP Pit project design is based on:

- Slopes in clay: 4H:1V (14.1°).
- Slopes in rock: Inter Ramp Angle (IRA) of 52.5°.
- Underground excavations, including the main ramp, will be intercepted in the east and north walls.
- Geotechnical considerations: Casa Berardi and Auxiliary Faults will intersect the final west and north-east Wall.
- Mining of this pit occur following the completion of underground mining (2024).

The plan view of the optimized WMCP Pit is shown in Figure 16.11.



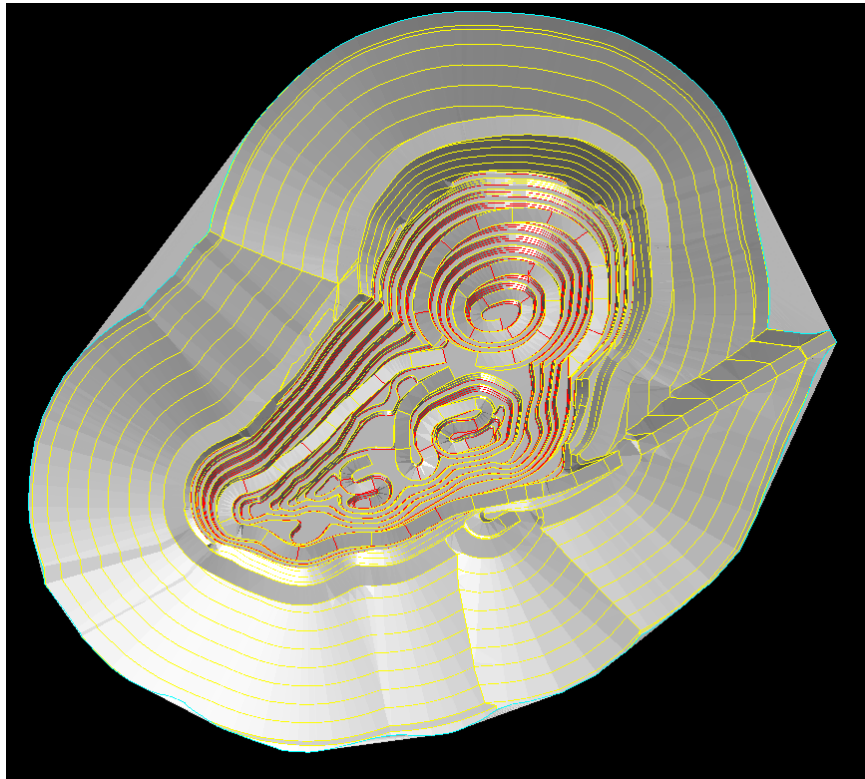
**Figure 16.11: Isometric View of the WMCP Pit Project (Ultimate Pit Shell)**

## PRINCIPAL PIT

The Principal Pit project design is based on:

- Slopes in clay: 4H:1V (14.1°).
- Slopes in till: 2H:1V (26.6°).
- Slopes in sand: 6H:1V (9.5°).
- Slopes in rock: Inter Ramp Angle (IRA) of 50°.
- Underground excavations will be intercepted in the pit bottom.
- Geotechnical considerations: excavation in proximity to an esker; inflow and contamination controls.
- Mining of this pit occur following the completion of underground mining (2024).
- Mining will be carried in three phases: Phase 1 – The center of the deposit; Phase 2 – A pushback to the east; and Phase 3 – A pushback to the west.

The plan view of the optimized Principal Pit is shown in Figure 16.12.



**Figure 16.12: Isometric View of the Principal Pit Project (Ultimate Pit Shell)**

## 16.8 LIFE OF MINE PLAN

Hecla Québec generated a Life of Mine (LOM) plan in February 2019 based solely on the Mineral Reserves for this Technical Report. Long term plan (LTP) is an internal Hecla document and is not used in 43-101 Technical Report since it contains inferred mineral resources.

The mine and mill complex were designed to produce and process 1,400,000 tonnes of ore per year at a rate of 3,836 tpd. Difficult ground conditions and bottlenecks in stope preparation (mainly in mine development) have limited the underground production to 730,000 tonnes per year (2,000 tpd). The 2018 total production was approximately 3,419 tpd. The LOM plan forecasts a 1,986 tpd production rate from underground in 2019 decreasing to 1,538 tpd in 2022. After 2024, the production will be exclusively from open pit production with a maximum production rate of 3,836 tpd.

The LOM plan totals 21.8 million tonnes of ore grading 2.74 g/t Au, to be mined over approximately fifteen years (2019 to 2034).

A summary of the LOM production forecast plan is provided in Table 16-7. This information is averaged and presented for two periods: (1) 2019 to 2023 and (2) 2019 to 2034. From 2019 to 2024, the production will combine underground and open pit operations. Beyond 2024, the production will be exclusively from open pit operations.

**Table 16-7: LOM Production Forecast**

Period	Underground			Open Pit			Total		
	Au oz			Au oz			Au oz		
	Tonnes (000)	Au g/t	Recovered (000)	Tonnes (000)	Au g/t	Recovered (000)	Tonnes (000)	Au g/t	Recovered (000)
5 Year Average (2019-2023)	608	5.35	88.7	792	1.91	42.4	1,400	3.40	131.1
LOM Average (2019-2034)	555	5.30	80.1	1,151	2.28	72.3	1,359	2.74	102.4

Silver production is estimated as 24% of the gold production based upon operating records and the silver revenue is included in the LOM plan financial analysis.

The LOM underground development schedule is shown in Table 16-8.

**Table 16-8: LOM Development Schedule**

Zone	2019 (m)	2020 (m)	2021 (m)	2022 (m)	2023 (m)
Alimak Raise (Vert)	254	-	-	-	-
Conv Raise (Vert)	101	220	177	104	139
<b>Grand Total Ver.</b>	<b>355</b>	<b>220</b>	<b>177</b>	<b>104</b>	<b>139</b>
Opex Dev. Ore	1,788	2,285	1,249	959	519
Opex Dev. Waste	2,432	4,616	2,483	1,777	1,188
Capex Dev (No Ramp)	2,980	2,502	2,885	1,975	2,162
Ramp Dev	2,049	1,559	1,122	908	826
Exploration Dev	439	700	500	500	-
<b>Grand Total Hor.</b>	<b>9,688</b>	<b>11,662</b>	<b>8,239</b>	<b>6,119</b>	<b>4,695</b>
<b>TOTAL HOR. (m/day)</b>	<b>26.5</b>	<b>31.9</b>	<b>22.6</b>	<b>16.8</b>	<b>12.9</b>

## 16.9 LONG TERM PLAN

Hecla Québec's planning practice includes the development of a Long-Term Plan (LTP). The LTP is based upon the Mineral Reserve plus a portion of the Mineral Resources. It is an internal Hecla document and is used a guide for management's long-term production planning and expectations. The LTP includes operating cost requirements for the additional tonnes mined (i.e. Mineral Resources), as well as, capital provisions for development, mine

infrastructure and equipment for exploitation of the Mineral Reserve and for conversion of the Mineral Resources that were included within the LTP. If mine production does not extend beyond the known Mineral Reserves, these costs would be less than the amount included in the LTP.

## **16.10 COMMENTS ON MINING METHODS**

In the opinion of the QP:

- The mining methods used are appropriate to the deposit style and employ conventional mining tools and mechanization;
- The LOM plan has been appropriately developed to maximize mining efficiencies, based on the current knowledge of geotechnical, hydrological, mining and processing information on the Project;
- The equipment and infrastructure requirements required for life-of-mine operations are well understood. Conventional underground mining equipment is used to support the underground mining activities.
- The underground equipment fleet is standard to the industry and has been proven on site.
- The predicted mine life to 2034 is achievable based on the projected annual production rate and the Mineral Reserves estimated.

## **17.0 RECOVERY METHODS**

### **17.1 INTRODUCTION**

The gold extraction from the mill feed will be performed in the current operating mill. Historical operation and performance data of the mill was covered in Section 13. This information in combination with metallurgical test results are used to predict mill recovery performances. These performances are based on the current plant as of January 1, 2019.

### **17.2 PROCESS DESCRIPTION**

The process at Casa Berardi is a classical mill with CIL (carbon in leach) process to recover gold from the ore. This process has been chosen because some mill feed contains graphitic carbon that has a preg-robbing effect. The way to lower the effect of preg-robbing is to perform the gold leaching step with the presence of activated carbon as is the case for a CIL. Figure 17.1 below shows the flowsheet of the mill:



## **CRUSHING**

Ore is hauled by truck from the West Mine headframe complex to the crusher dump pocket, which is equipped with a static grizzly and a pneumatic hammer to break any oversize material. Ore passing the grizzly is screened again on the scalping screen. The oversize ore is fed to a jaw crusher and its discharge rejoins the scalping screen undersize. The crushed ore is stored in the ore storage bin.

## **GRINDING**

Ore is conveyed from the storage bin to the semi-autogenous (SAG) mill. The SAG mill feed conveyor is equipped with a scale to monitor and control the ore supply to the SAG mill. Dry quick lime is added from a bin onto the SAG mill feed conveyor for downstream pulp pH control. Mill water is added to the mill feed to pulp the ore. The SAG mill operates in closed circuit with the SAG screen. The SAG mill discharges into the SAG screen pump box and is pumped onto the SAG screen. The SAG screen oversize material is returned to the SAG mill for further reduction and the screen undersize flows to the primary cyclone pump box. The mill feed is sampled on the SAG screen undersize stream.

The ball mill operates in closed circuit with the primary and secondary cyclones. The ball mill discharges in the primary cyclones pump box. The primary cyclone pump box pulp is pumped to the primary cyclone for a first size separation. The totality of the primary cyclone underflow feeds the gravity circuit. The primary cyclone overflow discharges into the secondary cyclone pump box with the gravity concentrator tailings. The secondary cyclones pump box pulp is pumped to the secondary cyclones for the final size separation. The secondary cyclones overflow goes to the trash screen to remove debris and the underflow goes back to the ball mill. The trash screen oversize is sent to the tailings pump and the undersize feeds the production thickener.

## **GRAVITY CIRCUIT**

The gravity circuit feed, coming from the primary cyclone underflow, is split to feed two parallel gravity circuits. Each circuit consists of a vibrating screen and a gravity concentrator. The screen oversize from each circuit reports back to the ball mill and the screen undersize feeds a gravity concentrator. The concentrator's tailings are pumped to the secondary cyclones pump box. The gravity concentrate flows to an intensive cyanidation reactor (Inline Leach

Reactor, or ILR) for leaching. To promote gold leaching and control the pH, oxygen peroxide, cyanide and caustic soda are added to the ILR unit from their respective tanks using dosing pumps. The high-grade pregnant gold solution from the ILR unit is pumped to the electrowinning buffer tank and the tailings report to the secondary cyclones pump box.

## **CIL CIRCUIT**

The production thickener is fed with the milled ore pulp coming from the trash screen. Mill water from the thickener overflows in the mill water tank. Process water coming from the tailings pond is added to the mill water tank depending on the demand. The thickener underflow is pumped to the first CIL tank. CIL feed is sampled on the production thickener underflow stream. A carbon-in-leach (CIL) circuit is used to recover gold instead of a carbon-in-pulp (CIP) to hinder preg-robbing due to graphite in the ore and to maximize gold recovery by putting the gold in solution in contact with activated carbon immediately. The circuit comprises seven CIL tanks in series. The pulp overflows from the #1 CIL tank to the #7 CIL tank.

To provoke gold leaching, a cyanide solution is added to the #1 CIL tank and compressed air is added to each CIL tank. Gold is leached from the ore and adsorbed onto activated carbon. Carbon is added in the #7 CIL tank and is pumped periodically in counter-current fashion from the #7 CIL tank to the #1 CIL tank. Screens at the discharge of each CIL tank prevent carbon from overflowing from tank to tank with the pulp. The #7 CIL tank overflows onto a safety screen to recover any fugitive carbon. The safety screen undersize is sampled and goes to the mixing tank. Fine quicklime and copper sulfate are added to the mixing tank to prepare for cyanide destruction. Pulp from the mixing tank is pumped to the cyanide destruction tank in which sulphur dioxide and compressed air is added to destroy residual cyanide with agitation. The pulp is then pumped to the paste backfill plant or the tailings pond. Ferric sulfate is also added to this pump in order to reduce arsenic content in the solution.

## **CARBON CIRCUIT**

The carbon, elution and electrowinning circuits operate in batches unlike the CIL continuous process. Loaded carbon is pumped periodically from the #1 CIL tank onto a washing screen. Loaded carbon from the washing screen falls into the loaded carbon tank while the pulp and residual cyanide solution return to the #1 or #2 CIL tank. When carbon collection is completed, loaded carbon is transferred to the acid washing tank. Hydrochloric acid is added in the acid

washing tank and carbon is soaking for two hours to remove inorganic contaminants. When the acid wash is completed, the loaded carbon is rinsed with process water to return to a neutral pH before being transferred to the elution vessel. After elution, eluted carbon is screened and sent either to the calibrated carbon tank or the regenerating kiln. The calibration screen undersize is sent to the carbon fines thickener where flocculant is added. Carbon fines are recovered at the underflow, filtered using a filter press and bagged. At the regenerating kiln, the carbon is heated to burn organic contaminants. The kiln discharges in a quench tank and carbon is pumped back onto the calibration screen. Calibrated carbon is pumped back into the #7 CIL tank from the calibrated carbon tank. Fresh carbon is also added to the CIL circuit using the calibration screen after being quenched in an attrition tank. Carbon moves in the circuit using a water eductors system.

### **ELUTION AND ELECTROWINNING CIRCUITS**

The elution circuit uses the ZADRA process. Caustic soda and cyanide are added to process water in the barren solution tank to prepare for elution. The barren solution is pumped through a heat exchanger and a water heater before arriving at the bottom of the elution vessel. Under the right pressure and temperatures conditions in the elution vessel, gold desorbs from the loaded carbon and dissolves in the elution solution. The pregnant solution flows out from the top of the elution vessel through the heat exchanger and cooling battery toward the electrowinning cells. The heat exchanger recovers heat from the pregnant solution to warm up the barren solution. The cooling battery completes the pregnant solution cooling to a safe temperature and pressure for electrowinning using process water at an ambient temperature.

Two electrowinning cells recover dissolved gold from the pregnant solution by deposition on its cathodes plates to form a gold sludge. Barren elution solution is pumped from the electrowinning cells to the barren solution tank. During an elution cycle, elution solution flows continuously through the circuit. A third electrowinning cell, in loop with the ILR buffer tank, is dedicated to the ILR gold solution. When an elution cycle is over, gold sludge is recovered from the electrowinning cells, filtered and dried before being smelted in the induction furnace and poured into gold dorés at the gold room.

### **MAJOR EQUIPMENT LIST**

The Table 17-1 presents the major equipment list and their respective characteristics.

**Table 17-1: Major Equipment List**

<b>Equipment</b>	<b>Characteristics</b>
<b>Crushing</b>	
Grizzly Screen	Static, 5 X 4.2 meter with 500 mm X 500 mm opening
Rock Breaker	Hydraulic hammer
Scalping Screen	Vibrating, 1.5m X 2. m with 89 mm opening and 11.2 kW motor
Jaw Crusher	762 mm X 1400 mm opening with 150 hp motor
Ore Storage Bin	14 m diameter with 19 m high with 3000 tonnes capacity
<b>Grinding</b>	
SAG Mill	5.5 m diameter X 2.7 m EGL with 1130 kW motor
SAG Screen	Vibrating, 1.8m X 2.9 m with 5 mm X 16 mm opening and 2 X 3, 7 kW motors
Ball Mill	4.0 m diameter X 5.3 m Length with 1325 kW motor
Primary cyclone	660 mm diameter Tega/Krebs, 1 operating 1 standby
Secondary cyclones	250 mm diameter Tega, 5 operating, 3 standby
Trash Screen	Vibrating, 1.2 m X 2.4 m with 20 mesh opening and 3.7 kW motor
<b>Gravity Circuit</b>	
Gravity screens	Vibrating, 1.2 m X 3.66 m with 1.5 mm X 8.8 mm opening and 2 X 3 kW motors
Gravity Concentrators	Two (2) 762 mm diameter Knelson concentrator
Intensive Leach Reactor	2.27 m larger X 4.4 m Length Gekko Leach unit with tanks
Gravity Electrowinning cell	3.26 m <sup>3</sup> cells with 8 cathodes
<b>Carbon in Leach</b>	
Production Thickener	34 m diameter with high rate type feedwell
CIL Tanks	Seven (7) 700 m <sup>3</sup> capacity tanks
CIL Agitators	One 3.45 m diameter double impeller with 37 kW motor for each tank
CIL Screens	two (2) Westech 4 m <sup>2</sup> and three (3) Westech 3.8 m <sup>2</sup> screens
Safety Screen	Vibrating, 1.2 m X 2.4 m with 20 mesh opening and 3.7 kW motor
Tailings Mixing Tank	One (1) 27m <sup>3</sup> capacity tank with 30 kW agitator
Cyanide Destruction Tank	One (1) 322 m <sup>3</sup> capacity tank with 149 kW agitator
<b>Carbon Circuit</b>	
Loaded Carbon Washing	Vibrating, 1.2 m X 2.4 m with 20 mesh opening and 3.7 kW motor
Loaded Carbon Tank	One 5.5 t of carbon capacity
Acid Washing Tank	One 5.5 t of carbon capacity
Carbon Calibration Screen	Vibrating, 1.2 m X 2.4 m with 16 mesh opening and 3.7 kW motor
Carbon Calibrated Carbon Tank	One (1) 15,8 m' capacity tank
Regenerating Kiln	0 76 m diameter 7 3 m Length with 350kWof heating capacity
Carbon Fines Thickener	One 5 m diameter with high rate type feedwell
Carbon Fines Filter Press	One 23.5 m of filtration with 20 chambers
<b>Elution</b>	
Elution Vessel	One (1) 1.68 m diameter tank 5.5 t carbon capacity
Water Heater	870 kW capacity water heater
Barren Solution Tank	One 153 m <sup>3</sup> capacity tank
Electrowinning Cells	Two (2) 4.53m <sup>3</sup> cells with 12 cathodes each
<b>Refinery</b>	
Filter Press	One 24.8m <sup>2</sup> of filtration with 21chambers
Induction Furnace	One 750 lbs capacity with 125 kW

### 17.3 DESIGN CRITERIA

The Table 17-2 presents the design criteria for the Casa Berardi process plant.

**Table 17-2: Design Criteria**

Criteria	Value	Units
<b>General</b>		
Plant throughput	1.4	Mta
Average Feed Grade	2.8	g/t
Average Overall Au Recovery	86.7	%
Crushing Plant Availability	75.0	%
Process Plant Availability	93.0	%
Hourly operating plant throughput	172.0	t/h
<b>Crushing</b>		
Opened side setting	114	mm
Closed side setting	75	mm
Crushing P80	80	mm
<b>Grinding</b>		
Grinding P80	91.5	µm
Bond Mill Work Index	12.6	kWh/t
JK SimMet Breakage Parameters Axb	41.5	
SAG Mill Steel Balls Consumption	0.416	kg/t
SAG Mill Steel Balls Dimension	125	mm
Ball Mill Steel Balls Consumption	0.6	kg/t
Ball Mill Steel Balls Coarse Ball Proportion	70	%
Ball Mill Steel Balls Coarse Ball Dimension	38	mm
Ball Mill Steel Balls Fine Ball Proportion	30	%
Ball Mill Steel Balls Fine Ball Dimension	32	mm
<b>Gravimetry</b>		
Gravimetric gold recovery	36.5	%
<b>Carbon in Leach</b>		
Number of Stage	7	
Pulp density	50	%
Calculated Residence time	20	h
Carbon Concentration	24	g/l
Pulp pH	11	
Pulp cyanide (NaCN) concentration	450	ppm
<b>Gold Recovery</b>		
Elution capacity	5.5	t
Elution cycle time	20	h
Elution frequency	1	#/d
Loaded carbon grade	2,564	g/t
Barren carbon grade	342	g/t
Elution temperature	135	°C
Elution pressure	380	kPa
Elution solution flow	1	BV/h
<b>Cyanide Destruction</b>		

Criteria	Value	Units
Effluent cyanide concentration (WAD NaCN)	<10	ppm
<b>Reagents</b>		
<b>Consumption</b>		
Quick Lime	1.05	kg/t
Cyanide	0.55	kg/t
Caustic Soda	0.22	kg/t
Ferric Sulfate	1.72	kg/t
Fine Quick Lime	0.81	kg/t
Copper Sulfate	0.23	kg/t
Chloric Acid	0.03	kg/t
Sulphur Dioxide	1.02	kg/t

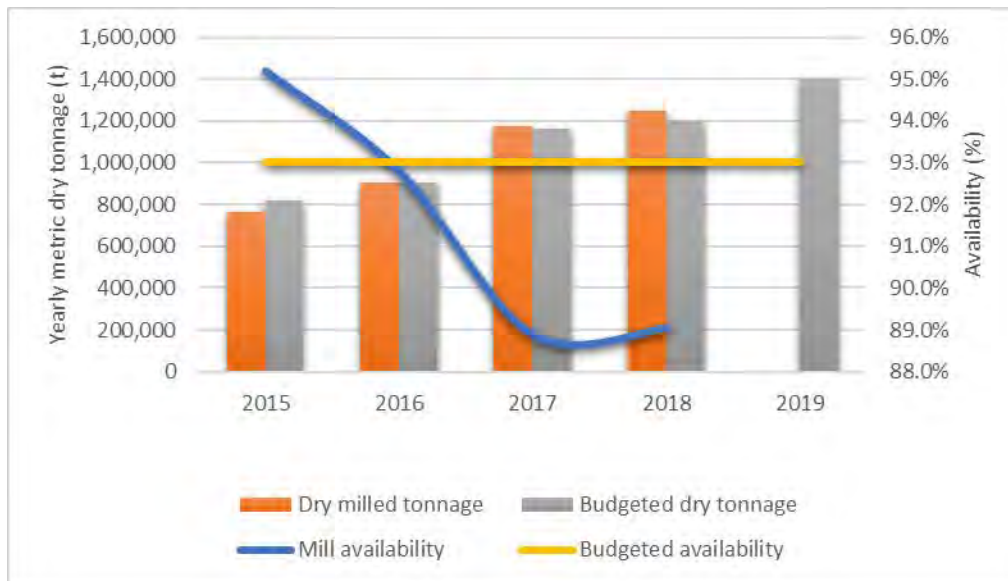
## 17.4 EXPECTED PERFORMANCES

Since year 2015 a lot of effort and modifications have been completed in the actual mill in order to be able to process a higher throughput. A non-exhaustive list of improvements includes:

- Installed a remote rock breaker before the crusher, January 2017.
- New NKM screen in carbon in leach tanks, February 2017.
- New flocculant batching system, April 2017.
- Reduced the opening of ball mill discharge screw to increase ball charge, April 2017.
- Changed the SAG steel ball size from 100 mm to 125 mm, April 2017,
- Changed the design of the SAG shell liners and lifters, May 2017.
- Changed the type of the feed well on the thickener, August 2017.
- Changed the ball mill balls addition to decrease the average balls diameter, September 2017.
- Added a static screen on the carbon in leach to improve the flow capacity of this circuit, September 2017.
- Changed the piping on process water to increase the capacity, November 2017.
- Changed the design of the SAG Mill pulp lifter, May 2018.
- Changed pumps' size in grinding circuit, November 2018.
- Changed the ball mill pinion to increase mill power draw, December 2018.

- Installed a new crusher with higher capacity, December 2018.
- Gradually increased the SAG Mill grate discharge area from 3.1% in November 2016 to 4.0%, December 2018.

These changes have been implemented gradually with the last modification performed at the end of year 2018. With these changes, the mill throughput increased regularly from 2015 to 2018. Figure 17.2 below shows the throughput evolution for that period:



**Figure 17.2: Throughput Evolution**

As the last changes only occurred at the end of 2018, the entire benefits of these changes will occur in 2019 and subsequent years.

One last change, projected in 2019, is the installation of a new cyanide destruction tank. The actual tank does not prevent the throughput being increased to the projected value for 2019. However, the cyanide destruction process will be more difficult to run as the residence time in the tanks will fall below the recommended value for effective process.

## RECOVERY

The gold recovery is based on a model that was developed from metallurgical testing and mill performances. The model predicts the gold recovery based on mineral types and different parameters as described in Section 13. The recovery is based on grinding product that is 75%

finer than 75 µm which will likely be reached with the mill.

The residence time of the carbon in leach process has been reduced as the mill throughput has increased since 2015. A review of the tank dissolution behavior shows that despite the reduced leaching time, it is enough to complete the leaching of available gold with the throughput projected for year 2019.

## **THROUGHPUT**

The projected yearly throughput based on the mine plan is higher than what has been achieved for the whole of 2018. However, some tests were made and the hourly throughput necessary to reach the target has been achieved for complete days. This is proof that all the equipment in the mill is able to handle this increased throughput. With the last changes implemented at the end of 2018, all the remaining mill bottlenecks have been addressed in a way that projected throughput could be reached in the second quarter of 2019 on a steady basis.

### **17.5 RISK AND OPPORTUNITY**

During mill operation, it has been observed that the mineral coming from the open pit contains a smaller proportion of material smaller than 13 mm which may impact the capacity of the grinding circuit. However, with all the modifications that have been implemented at the mill, there is room for improved performance with the actual equipment in place. The risk the performances of the mill will be significantly impacted remains acceptable and should not impact the actual mine plan.

### **17.6 CONCLUSIONS**

The current mill will be able to process the projected throughput since many improvements have been implemented during the last three years. The ability of the mill to achieve the recovery of all available gold as predicted by testing with comparable conditions has been demonstrated. However, the risk of predicting the percentage of available gold identified has been identified in Section 13. All the other operation parameters, other than the throughput, will remain in the same range as they have been in recent years.

### **17.7 COMMENTS ON RECOVERY METHOD**

The process plant is operational, and there is production history that allows for a reasonable

assessment of plant performance in a production setting. Metallurgical and production models were developed from extensive baseline sampling and are further adjusted annually to account for process and metallurgical improvements and changes. The QP has reviewed the methodologies used and the data uses and considers the projection process and methods used are unbiased and provide sound projections.

The QP has reviewed the information in this section provided by Hecla and considers that there are no data or assumptions in the LOM plan that are significantly different from previous plant operating experience, previous production throughputs and recoveries, or the Project background history.

In the opinion of the QP, the current process facilities are appropriate to the mineralization types provided from the mine. The flowsheet, equipment and infrastructure are expected to support the current life-of-mine plan.

## **18.0 PROJECT INFRASTRUCTURE**

The Casa Berardi Mine is in operation and has developed infrastructure to support the operations. There are well maintained gravel and paved roads that access the site and there is a network of roads on the site to service the mine sites and various facilities. The mine has developed water sources for the operation and power is supplied from the grid.

The current surface and underground infrastructures at Casa Berardi, including both the West and East mines are presented and discussed in Section 5.

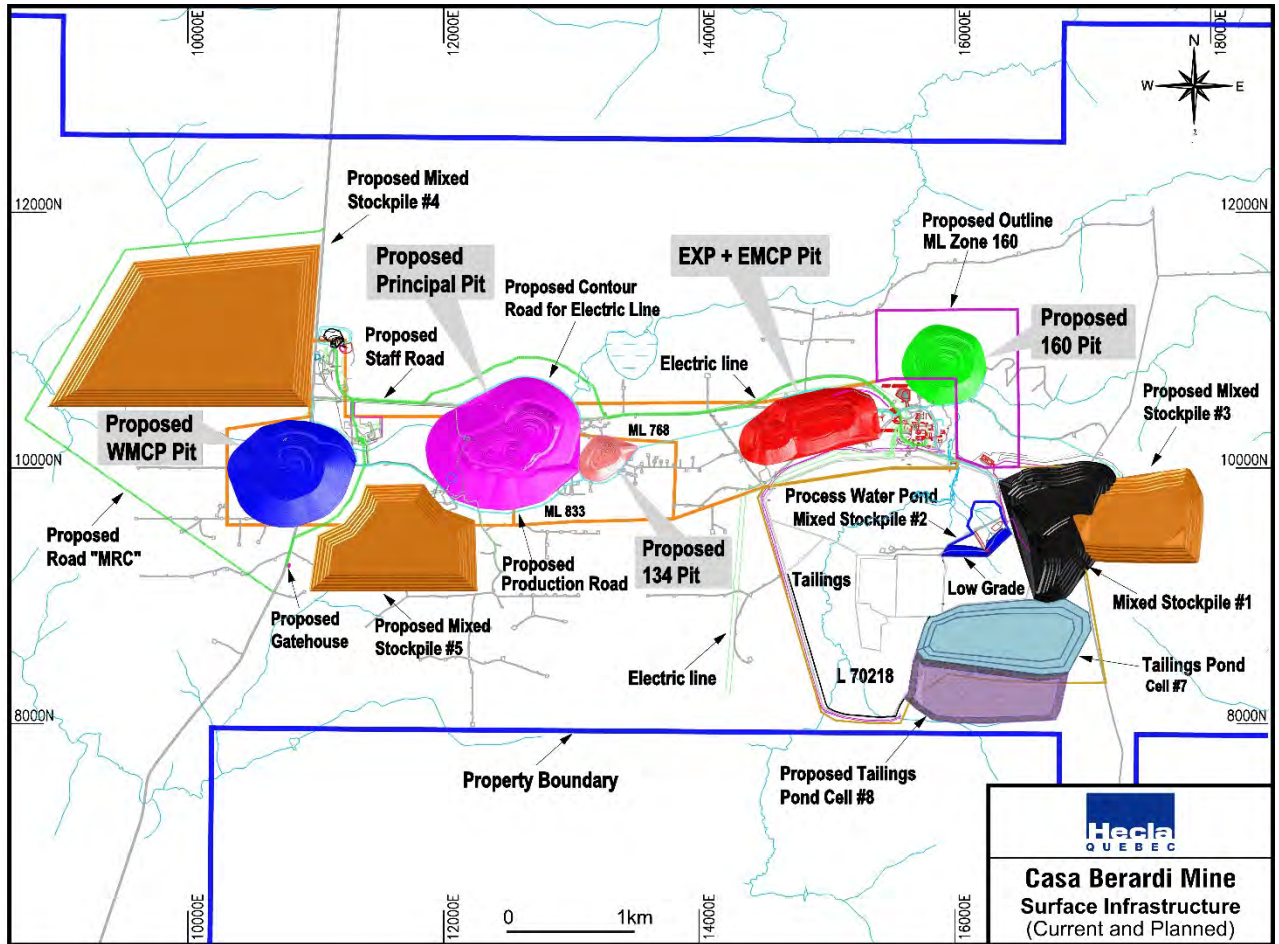
### **ROADS AND LOGISTICS**

The 38 km all-season gravel road to Casa Berardi branches off from the paved road linking La Sarre and the Selbaie Mine through the village of Villebois. The branch is approximately 21 km north of Villebois.

On the property, a gravel road links the East Mine and the West Mine, and several exploration roads provide access to the rest of the property to the east and west. A production road and a staff road are in use as discussed in Section 5. The staff road will be relocated to the south side of the future West Mine Crown Pillar (WMCP) pit in 2023 (as presented in Figure 18.1).

### **MINE LAYOUT**

The current and planned major infrastructure areas are presented on Figure 18.1.



**Figure 18.1: Surface Infrastructure (Current and Planned)**

## TAILINGS MANAGEMENT AND FACILITIES

The site includes an existing tailing storage facility (TSF) with four tailings cells, a polishing pond, a sedimentation pond for settling iron arsenate precipitates, and a process water pond (Figure 18.2).



**Figure 18.2: Surface Plan Tailings and Waste Rock Facilities**

Approximately 15% of the mine tailings are used in the mine backfill cycle. Tailings not used for backfill are placed on the surface at the TSF. Permits are in place for mine water management and operation of the TSF. The monitoring system associated with the TSF includes surface and groundwater monitoring, water level monitoring, geochemical and geotechnical monitoring and inspections. An OMS (operation, maintenance and surveillance) manual has been developed for the TSF.

Tailings deposition is currently on-going in the #4 Cell. The #1, #2 and #3 cells are no longer used for deposition. These cells are at their design capacity and are currently in the process of progressive reclamation.

In 2010, the #4 Cell was constructed through the construction of a dyke. Dyke enhancements were required as part of the previous LOM plans and the first enhancement of the #4 Cell was made in 2012. Since that time, many enhancements and raises were done for the #4 Cell and the next lift is scheduled for 2019.

To accommodate life of mine tailings and water management a new #7 Cell will be constructed in 2019. To accommodate the current LOM, several enhancements (raises) of the #4 and #7 cells will occur.

After the revision of the tailing's deposition and fill plan for the cells in the existing TSF, (including the future #7 Cell ) by Wood in 2019 based on the LOM; it has been concluded that an additional cell will be required in 2031 for tailings management. The proposed tailings pond #8 Cell is presented in Figure 18.1 and Figure 18.2. Given the mine permitting history at Casa Berardi and the good standards of practice proposed by Hecla Québec, there should not be significant impediments to obtaining any necessary permits for expanding required tailings storage facilities.

### **WASTE ROCK MANAGEMENT AND STOCKPILES**

Waste rock is stored on surface and its ongoing characterization since 2008 indicated that it is not acid generating. The Casa Berardi Mine site has a certificate of authorization for the storage of waste rock on surface. Based upon the large demand for rock fill at the site, a large part of underground waste rock is be disposed in the underground as backfill for mining operations and another part for construction of drilling accesses in swampy terrain.

Most of the waste rock produced from underground mine operations, remains underground with limited amounts brought to surface for use in construction projects, such as for dams and roads.

Although, waste rock produced from open pit operations are and will continue to be stored on surface. Waste rock and overburden (till, clay and organics) from EMCP open pit are stored on surface at two locations, in mixed #1 and #2 stockpiles (Figure 18.2). These will not likely have sufficient space to store the volume of waste rock should all the open pits be exploited in the current LOM. The current LOM will require additional waste rock storage locations on-site. For the operation of the 134 Pit , a request has been made for the construction of a mixed #3 Stockpile. Waste rock and overburden stockpile locations are showed on Figures 18.1 and 18.2. Additional locations will be required for the current LOM and the proposed open pits. The proposed mixed #4 and #5 stockpiles are presented in Figure 18.1.

Given the mine permitting history at Casa Berardi and the good standards of practice proposed by Hecla Québec, there should not be significant impediments to obtaining any

necessary permits to expand waste rock piles and TSF capacities as required for the LOM. The use of open pits for waste and tailings management is under study, this could reduce the surface storage requirements.

### **OTHER WASTES**

All other wastes (hazardous materials) produced at the site are disposed of in accordance with regulatory requirements and legislation. No addition or modification will be necessary for future operations.

### **WATER SUPPLY**

Water management (mine, surface and tailings) and effluent treatment are presented in section 20.

Fresh water supply is from groundwater production wells and groundwater collected in a series of underground seep collection areas.

### **WATER USE**

Groundwater is utilized at the site for underground operations, the paste backfill plant, the cement plant, the East and West Mine areas (plant site facilities – potable water).

The primary source of water for the mill operation is the reclaim water from the process water pond (recycled water) and fresh water use at the mill is very limited.

### **POWER AND ELECTRICAL**

Electrical power is supplied to the site by a 55 km, 120 kV power line from the town of Normétal. The electrical line will be relocated south of the future WMCP pit in 2023.

### **FUEL**

Three fuel tanks are located near the East Mine Crown Pillar (EMCP) Pit as discussed in Section 5. They will be moved closer to the eventual WMCP and Principal pits in 2023 to optimize operational functionality and cost.

### **COMMENTS ON INFRASTRUCTURE**

In the opinion of the QP, the existing and planned infrastructure are appropriate to support the current life-of-mine plan to 2034.

## **18.1 COMMENTS ON INFRASTRUCTURE**

In the opinion of the QP, the existing infrastructure is appropriate to support the current life-of-mine plan to 2034.

## **19.0 MARKET STUDIES AND CONTRACTS**

### **19.1 MARKET STUDIES**

Hecla Quebec currently has a refining agreement with Asahi Refining whereby the refined gold and silver is refined and credited to Hecla Quebec's account at Asahi. The doré bars produced at the Casa Berardi Mine are refined at Asahi's facilities located in Brampton, Ontario, Canada.

Gold and silver bullion is sold through commercial banks or metal traders via a sale contract at spot prices. Settlement of funds from bullion sales occurs two business days after the contract date.

The terms and conditions of the refining and bullion sales contracts are typical and consistent with standard industry practice and would be similar to contracts for the supply of gold elsewhere in North America.

### **19.2 COMMODITY PRICE PROJECTIONS**

The gold price used in the calculation of estimated mineral resources and mineral reserves is determined by Hecla's corporate office in Coeur d'Alene, Idaho, USA. The economic analysis performed in the life of mine plan assumes a gold price of US\$1,300 per troy ounce and a CAD/USD exchange rate of 1.33.

Gold mineral reserves are estimated using a price of US\$1,200 per troy ounce, while gold mineral resources are estimated using a price of US\$1,350 per troy ounce. The difference in prices is the result of a longer historical period used as the basis for the mineral resource estimation.

### **19.3 CONTRACTS**

The Casa Berardi Mine is in operation and has been in operation for several years. There are numerous contracts in place for items including the operation of the East Mine Crown Pillar open pit, service contracts related to the operation, underground mine development contracts and contracts for supplies. These are usual contracts for an operating mine.

#### **19.4 COMMENTS ON MARKET STUDIES AND CONTRACTS**

In the opinion of the QP:

- Hecla is able to market the doré produced from the Project;
- Metal prices are set by Hecla management and are appropriate for the mine life projections.

## **20.0 ENVIRONMENTAL STUDIES, PERMITTING, AND SOCIAL OR COMMUNITY IMPACT**

### **20.1 ENVIRONMENTAL CONSIDERATIONS**

The Casa Berardi Mine is in operation and was the subject of environmental studies and reviews prior to the start of operations. There were also studies for the EMCP Pit. The primary mine wastes produced at the site are tailings and waste rock. Tailings and waste rock disposal are discussed in Section 18.

Hecla Québec is committed to operating in compliance with all regulations and standards of good practice for environmental, health and safety. In this regard, Hecla Québec has developed and approved corporate policies for environment and health and safety practices and has prepared a detailed management plan in an effort to continuously improve its environment and health and safety performance. An EMS (Environmental Management System) is currently in place.

Hecla Québec participates in the Towards Sustainable Mining (TSM) initiative of the Mining Associations of Canada and the Quebec Mining Association. In 2016, the Quebec Mining Association evaluated the Sustainable Mining Development initiative on the Casa Berardi Mine site. An action plan has been put in place for the six protocols of the initiative, including tailings management, Aboriginal and community outreach, biodiversity conservation management, energy use and greenhouse gas (GHG) emissions management, safety and health, and crisis management planning. Since then, Hecla Québec has continued to work on the implementation and improvement of management systems. An external audit is planned for 2020. The initiative will stimulate performance while ensuring that the main risks of mining activities are managed responsibly at mine facilities.

The design of the mine to meet current standards and the implementation of the proposed environmental and health and safety practices assures that the mine is prepared to meet future challenges. The proposed design is flexible and allows for modifications to improve performance when where necessary.

In addition to the EMCP Pit, the current LOM include additional pits. The volume of water being introduced to the site that will require handling and likely treatment will increase as more of the esker is mined and additional opens pits are brought into operation. To accommodate the planned increases in the site water, balance a water treatment plant is scheduled for 2021.

## **20.2 WATER MANAGEMENT AND EFFLUENT TREATMENT**

### **WATER MANAGEMENT**

Casa Berardi has a positive water balance and discharge water. All the water is managed and handled by the TSF and release to environment by the process water pond. The final effluent from Casa Berardi discharges into the Kaakakosig Creek.

Figure 20.1 shows a simplified water management diagram of the Casa Berardi mine site.

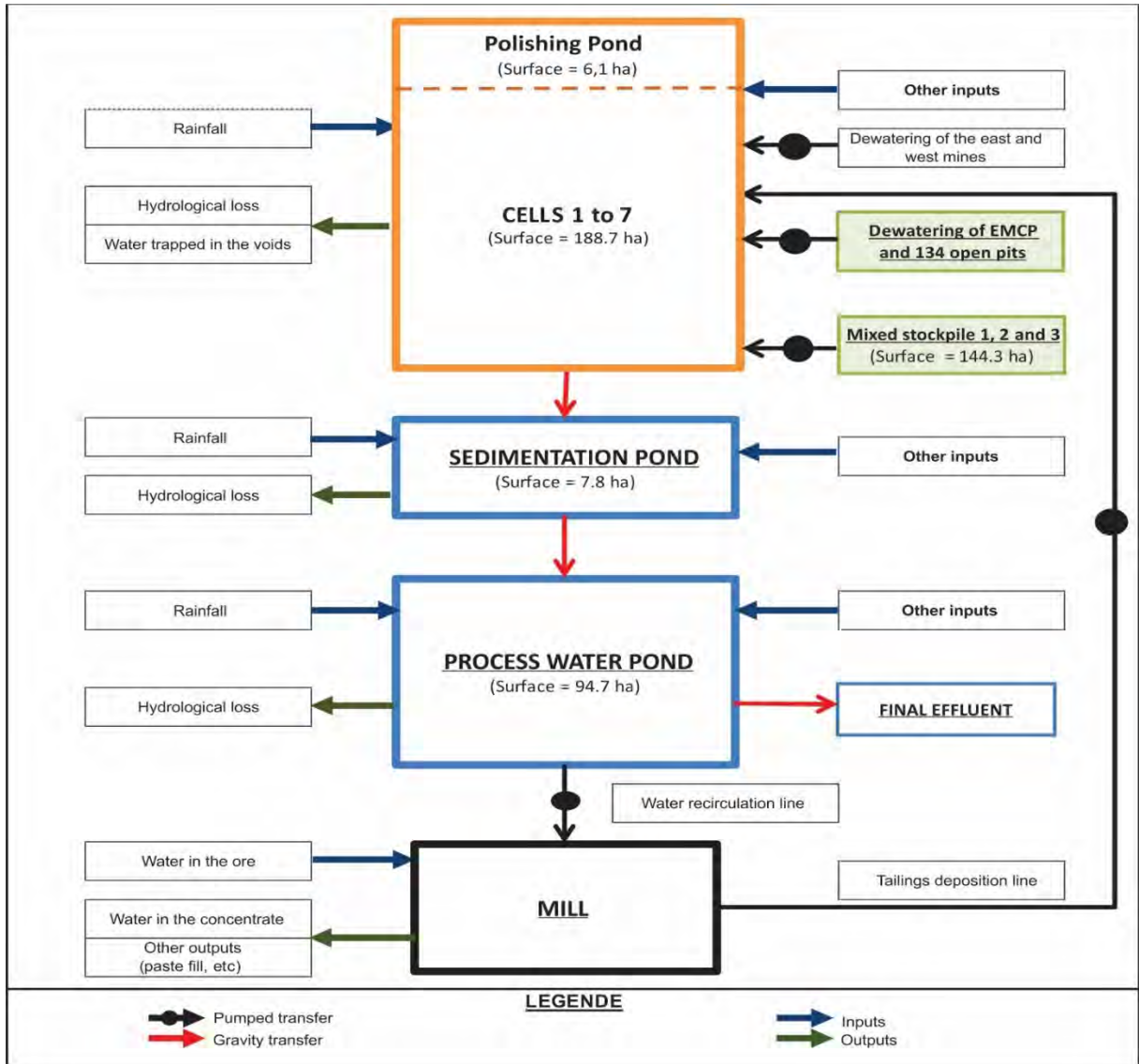
### **MINE WATER MANAGEMENT**

Mine water pumped from the mine dewatering systems from the east and west underground mines is pumped to the surface and treated with ferric sulphate to precipitate arsenic prior to be discharged into the cells of the TSF.

The EMCP Pit currently drains to the east underground where it is pumped to the surface.

The mixed stockpiles contact water is collected and pumped to the TSF.

Where practical, the non-contact water is diverted from the site by ditches and all fresh water drainage into the TSF, mixed stockpiles and the EMCP Pit has been diverted away from the basins to minimize contamination of clean surface drainage and discharge to the fresh water courses throughout the site.



**Figure 20.1: Water Management**

## TSF WATER MANAGEMENT

Tailings slurry may contain elevated levels of cyanide, cyanide metal complexes, cyanide degradation products (CNO, CNS, and NH<sub>3</sub>), and arsenic. The primary concerns with discharge are elevated levels of these constituents, which could exceed effluent standard and/or cause effluent toxicity.

The operation uses the SO<sub>2</sub>/AIR process for cyanide destruction in the slurry discharge before release to the TSF. Ferric sulphate is added in the slurry at the exit of SO<sub>2</sub>/AIR process. This

effectively eliminates soluble arsenic, cyanide, and cyanide metal complexes from the discharge. The SO<sub>2</sub>/AIR process does produce elevated levels of thiocyanate (CNO). This compound is not likely to be present at toxic levels, however, as the compound naturally degrades in the tailings pond, ammonia is formed. Storage of the water in the tailing ponds, polishing pond, and process water pond assists in nitrification of the water to reduce ammonia levels.

The site is permitted to discharge treated water year-round with no volume limitation. Actual treated water discharge is typically limited to the spring and late fall due to freezing conditions in winter and the demand for process water in summer. Approximately 2 million m<sup>3</sup> of process pond water that is not recycled at the mill is discharged annually into the Kaakakosig Creek.

The final effluent from the Casa Berardi Mine meets Canada Metal and Diamond Mining Effluent Regulations (MDMER) and the limits of Quebec *Directive 019* for the mining industry discharge. A monitoring program is in place for the surface and the underground water. Regular monthly monitoring of acute toxicity during periods of discharge of final effluent is carried out as required by applicable regulations.

## **ENVIRONMENTAL EFFECTS OF TREATED EFFLUENT**

As required by MDMER, EEM (Environment Effect Monitoring) studies are conducted on a regular basis. Monitoring studies started in 2007 and is still in progress. A total of six cycle studies are included in the monitoring process and studies are generally conducted every three years. To date four cycle studies have been completed. The fifth cycle study is scheduled for 2021.

### **20.3 REGULATORY CHANGE AND ENVIRONMENTAL PERMITS**

#### **REGULATORY CHANGE**

Since August 2018, the Quebec territory north of the 49<sup>th</sup> Parallel is no longer subject to the Regulation respecting compensation for adverse effects on wetlands and bodies of water under the Environment Quality Act. The Casa Berardi Mine site is therefore exempt from monetary compensation for wetland loss for its future expansion projects.

#### **ENVIRONMENTAL PERMITS**

All necessary regulatory permits required for the operation of the Casa Berardi Mine since its

construction, transferred or issued to Hecla Québec, are listed below.

The depollution attestation was issued by the MELCC in November 2011 and is currently under renewal.

## 20.4 EXISTING PERMITS – EAST MINE

### EXTRACTION AND PROCESSING OF ORE AT THE CASA BERARDI SITE:

- Authorization certificate issued on December 23, 1992, (7610-10-01-70016-23) under section 22 of the *Environment Quality Act (R.S.Q., c. Q-2)* (the EQA) to TVX and Golden Knight Resources Inc. (Golden Knight). Modified on February 19, 1998. Conceded to Aurizon Mines on September 14, 1998. Modified on September 10, 2001. Modified on September 14, 2006. Modified on December 19, 2007. Modified on July 29, 2010. Modified on November 21, 2011. Modified on August 3, 2016. Modified on October 17, 2016. Modified on August 25, 2017.
- Certificate for the industrial waste water reduction systems issued on November 11, 2011, under section IV.2 of the EQA.
- Authorization certificate issued on May 9, 2012, under section 22 of the EQA to Aurizon for increase and extend cell #4 dyke. Modified on February 5, 2014. Modified on August 12, 2015. Modified on October 21, 2015.
- Authorization certificate for exploitation of the East Mine crown pillar pursuant to section 22 of the *Environment Quality Act*. Issued by the MDDELCC on October 29, 2015. #7610-10-01-70017-43.
- Authorization certificate for taking water and development of the installation to keep the open pit dry pursuant articles 31.75 and 31.95 of the *Environment Quality Act*. Issued by MDDELCC on January 12, 2016. #7610-10-01-70016-47.
- Authorization certificate for Build and operate cell #7 of the tailings pond on an area of 63 hectares pursuant to article 30 of the *Environment Quality Act*. Issued by the MELCC on February 8, 2019. #7610-10-01-70016-23.
- Certificate of Authorization issued on February 25, 2016 #7610-10-01-70016-49 pursuant to section 22 of the *Environment Quality Act* at Hecla Quebec for the operation of a crushing and sieving sterile rocks.

- Certificate of Authorization issued on June 23, 2016 #7610-10-01-70016-48 pursuant to section 22 of the *Environment Quality Act* at Hecla Quebec for the raising of the dyke process water.
- Certificate of Authorization issued on January 13, 2017 #7610-10-01-70016-50 pursuant to section 22 of the *Environment Quality Act* at Hecla Québec for the use of potentially leachable waste rock in the mixed dump 1.
- Certificate of Authorization issued on April 5, 2017 #7610-10-01-70016-51 under article 22 of the *Environment Quality Act* at Hecla Quebec for the raising of the cell #4 of the tailings pond.
- Certificate of Authorization issued on August 15, 2017 #7610-10-01-70016-52 under article 22 of the *Environment Quality Act* at Hecla Quebec for the raising of cell #4 of the tailings pond.
- Certificate of Authorization issued on December 19, 2017 #7610-10-01-70016-53 under section 22 of the *Environment Quality Act* at Hecla Quebec for the closure of cell #2 of the tailings pond at the Casa Berardi mine site.
- Certificate of Authorization issued on December 19, 2018 #7610-10-01-01-70016-51 under section 30 of the *Environment Quality Act* at Hecla Quebec for the raising of cell #4 of the tailings pond.

## **OPERATION OF A QUARRY**

- Certificate of Authorization issued on August 7, 1995 #7610-10-01-70016-24 under section 22 of the *Environment Quality Act* to TVX Gold Inc. for the operation of a clay borrow pit, assigned on September 14, 1998 to Aurizon Mines Ltd.
- Certificate of Authorization issued on August 7, 1995 #7610-10-01-70016-25 under section 22 of the *Environment Quality Act* to TVX Gold Inc. for the operation of a quarry, surrendered on September 14, 1998 to Aurizon Mines Ltd.
- Certificate of Authorization issued on May 10, 2013 #7610-10-01-70016-25 under section 22 of the Aurizon Mines *Environmental Quality Act* for the operation of a quarry.
- Certificate of Authorization issued on September 18, 1995 #7610-10-01-70016-26 pursuant to section 22 of the *Environment Quality Act* at Les Mines Casa Berardi for the operation of a Clay Bench, surrendered on September 14, 1998 to Aurizon

Mines Ltd.

#### **DIVERSION OF THE KAAKAKOSIG CREEK**

- Authorization certificate issued on February 19, 1990, under section 22 of the *EQA* to TVX.
  - Assignment of the authorization certificate issued on September 14, 1998, to Aurizon concerning the authorization certificate issued under section 22 of the *EQA* to TVX. Modified on February 5, 2014.

#### **CONSTRUCTION AND USE OF STORAGE AREA FOR HAZARDOUS WASTE**

- Authorization certificate issued on January 18, 1991, under section 22 of the *EQA* to Casa Berardi Mines.
  - Assignment of the authorization certificate issued on June 19, 1992, to TVX and Golden Knight, concerning the authorization certificate issued under section 22 of the *EQA* to Casa Berardi Mines on January 18, 1991.
  - Assignment of the authorization certificate issued on September 14, 1998, to Aurizon, concerning the authorization certificate issued under section 22 of the *EQA* to Casa Berardi Mines on January 18, 1991.

#### **OPERATION OF A CEMENT AND CONCRETE PLANT**

- Authorization certificate issued on November 6, 1995, under section 22 of the *EQA* to Casa Berardi Mines.
  - Assignment of the authorization certificate issued on September 14, 1998, to Aurizon concerning the authorization certificate issued under section 22 of the *EQA* to Casa Berardi Mines on November 6, 1995. Modified on February 5, 2014.
- Authorization issued on November 10, 2004, under section 32 of the *EQA* to Aurizon for installation of two pipelines (fire and water supply to the mine) from the Koababikawi Creek. Modified on February 5, 2014.

#### **CONSTRUCTION OF A WATER INTAKE AND INSTALLATION OF A FIRE PUMPING STATION AT NO NAME LAKE**

- Authorization issued on July 4, 2005, under section 32 of the *EQA* to Aurizon.

- Modification of the permit issued on September 22, 2005, for the permit issued under section 32 of the *EQA* to Aurizon on July 4, 2005. Modified on February 5, 2014.

#### **INSTALLATION OF DUST FILTER AND WET COLLECTOR**

- Authorization issued on April 7, 2008 #7610-10-01-70016-32, under Article 48 of the *EQA* Aurizon. Modified on February 5, 2014.

#### **TREATMENT OF OIL / WATER SEPARATOR**

- Authorization certificate issued on June 26, 2008 #7610-10-01-70016-33 under section 22 of the *EQA* to Aurizon.
  - Modification of the permit issued on June 26, 2008 under section 22 of the *EQA* to Aurizon on December 18, 2009. Modified on February 5, 2014.
- Authorization certificate issued on August 26, 2011 under section 22 of the *EQA* to Aurizon for treatment of oil/water separator exit.
  - Modification of the permit issued on June 7, 2013, under section 22 of the *EQA* to Aurizon for treatment of oil/water separator exit. Modified on February 5, 2014.

#### **CONSTRUCTION OF WASTE WATER TREATMENT**

- Authorization certificate issued on August 15, 2006, under section 22 of the *EQA* to Aurizon.
- Authorization issued on November 3, 2009, under section 32 of the *EQA* to Aurizon.

#### **UNDERGROUND PUMPING STATION**

- Authorization certificate issued on April 2, 2012, under section 31 of the *Règlement sur le captage des eaux souterraines* (Groundwater Catchment Regulation) to Aurizon.
- Authorization certificate issued on November 28, 2014, under section 31 of the *EQA* to Hecla Québec for increased groundwater abstraction at the East Mine at 123 cubic meters per day.

#### **SURFACE DRILLING – CONSTRUCTION OF TEMPORARY ROADS IN HUMID AREAS**

- Authorization certificate issued on December 17, 2010, under section 22 of the

*EQA* to Aurizon for the construction of an exploration access.

- Authorization certificate issued on February 28, 2011, under section 22 of the *EQA* to Aurizon for the construction of an exploration access.
- Certificate of authorization issued on December 15, 2014 #7610-10-01-70016-46 under section 22 of the *Environment Quality Act* at Hecla Québec for the construction of eight drill holes and access to unwooded peatland.

#### **ACCESS ROAD IN HUMID AREA**

- Authorization certificate issued on March 14, 2013, under section 22 of the *EQA* to Aurizon for the construction of a permanent access in humid area.

#### **DEWATERING AND BACKFILL POND**

- Authorization certificate issued on January 14, 2014, under section 22 of the *EQA* to Hecla Québec for dewatering and backfill pond at Casa Berardi east.
- Assignment of the authorization certificates issued on February 5, 2014, to Hecla Québec concerning the authorization certificates issued under section 22 of the *EQA* to Casa Berardi Mines.

### **20.5 EXISTING PERMITS – WEST MINE**

#### **OPERATION OF CASA BERARDI – WEST MINE**

- Authorization certificate issued on July 2, 1992, under section 22 of the *Environment Quality Act* (R.S.Q., c. Q-2) to TVX and Golden Knight for the operation of the Casa Berardi West Mine, disposed of on September 14, 1998 at Aurizon Mines Ltd., as amended on October 27, 2000, amended on February 21, 2001, as amended on February 5, 2014.

#### **25 KV POWER LINE IN PEAT BOG**

- Authorization certificate issued on January 26, 2006, under Article 22 of the *EQA* to Aurizon for the construction of a 25 kV power line in a peat bog. Modified on February 5, 2014.

#### **ROAD IN PEAT BOG**

- Authorization certificate issued on July 20, 2007, under section 22 of the *EQA*

to Aurizon.

### **SURFACE DRILLING – CONSTRUCTION OF TEMPORARY ROADS IN HUMID AREAS**

- Authorization certificate issued on April 9, 2008, under section 22 of the *EQA* to Aurizon.
- Authorization certificate issued on July 17, 2009, under section 22 of the *EQA* to Aurizon.
- Authorization certificate issued on January 14, 2010, under section 22 of the *EQA* to Aurizon.
- Certificate of Authorization issued on February 24, 2012 #7470-10-01-00006-03 pursuant to section 22 of the *Environment Quality Act* at Aurizon Mines Ltd. for the construction of access and peatland and swamp platforms for mineral exploration drilling.
- Certificate of Authorization issued on June 28, 2013 #7470-10-01-00006-04 pursuant to section 22 of the *Environment Quality Act* at Aurizon Mines Ltd. for the construction of access in the middle wet for cementing a drill hole at the Casa Berardi Mine site.
- Authorization certificate issued on December 19, 2013 under section 22 of the *EQA* to Hecla Québec.

### **OIL / WATER SEPARATOR**

- Authorization certificate issued on October 17, 2007, under section 22 of the *EQA* to Aurizon for the installation of an oil/water separator at the West Mine. Modified on February 5, 2014.
- Authorization certificate issued on January 13, 2009 under section 22 of the *EQA* to Aurizon for Gabriel Aubé contractor's garage. Modified on February 5, 2014.
- Authorization issued on June 17, 2011 under section 22 of the *EQA* to Aurizon for the operation of oil-contaminated condensate treatment.
  - Modification of authorization issued on November 21, 2013 under section 22 of the *EQA* to Hecla Québec.

### **ORE STOCKPILE**

- Authorization certificate issued on June 30, 2010, under section 22 of the *EQA*

to Aurizon. Modified on December 20, 2016.

### **WASTE WATER TREATMENT**

- Authorization issued on September 21, 2011 under section 32 of the *EQA* to Aurizon. Modified on October 2014.

### **SHOTCRETE PLANT**

- Authorization issued on September 26, 2012 under section 22 of the *EQA* to Aurizon. Modified on February 5, 2014.

### **WATER**

- Authorization issued on April 2, 2012 #7610-10-01-70017-39 pursuant to section 31 of the Aurizon Mines Groundwater Abstraction Regulations, for the abstraction of groundwater at the West Mine.
- Authorization issued on December 18, 2014 #7610-10-01-70017-44 pursuant to section 31.75 of the *Environment Quality Act* at Hecla Quebec for the increase of groundwater abstraction at the West Mine.
- Authorization issued on December 18, 2014 #7610-10-01-70017-45 pursuant to section 32 of the *Environment Quality Act* at Hecla Québec for the development of a distribution network for potable water.
- Authorization issued on October 11, 2017 #7610-10-01-70017-46 under section 31.75 of the *Environment Quality Act* at Hecla Quebec for water withdrawal and development a new well for drinking and industrial water at the West Mine.

### **PASTE BACKFILL PLANT**

- Authorization issued on October 29, 2012 under section 22 of the *EQA* to Aurizon. Modified on March 7, 2013. Modified on February 5, 2014.

### **SEPTIC INSTALLATION**

- Authorization issued on July 26, 1987 #7610-10-01-70017-21 under section 32 of the *Environmental Quality Act* to Inco Ltd for the septic installation of the Golden Pond West Project, Township Casa Berardi.
- Authorization issued on September 10, 1987 #7610-10-01-70017-22 under section 32 of the *Environment Quality Act* to Inco Ltd for the septic installation

(Project C) of the Golden Project Pond West, Casa Berardi township.

In addition to these permits and approvals, the following environmental permits were also obtained:

- Régie du bâtiment du Québec – Permit for fuel storage, Permit #439564-5 issued May 05, 2005. Valid until June 30, 2019.
- Lease for the waste stockpile of the West Mine having a surface area of five hectares and renewable on October 14 of each year. Valid until October 14, 2019.
- Lease for the tailings storage area having a surface area of 431,867 ha and renewable on June 1 of each year. Valid until May 31, 2019.
- Non-exclusive lease #25938 for the exploitation of sand and gravel. Renewable March 31 of each year. Valid until March 31, 2019.
- Mining lease #768 renewed on April 29, 2018. Valid until April 28, 2028.
- Mining lease #833 renewed on December 18, 2015. Valid until December 17, 2025.
- Lease for 25 kV power line outside mining lease valid as long as Hecla Québec needs it.
- Lease for access for 25 kV power line valid as long as Hecla Québec requires it.
  - Lease of 400 m<sup>2</sup> for an industrial purpose. Renewable February 1<sup>st</sup> of each year. Valid until February 1, 2020.

#### **ADDITIONAL APPROVALS REQUIRED**

All new permits for the mine are being prepared under the direction of the on-site environmental coordinator. Given the mining history at Casa Berardi and the good standards of practice proposed by Hecla Québec, there should not be significant impediments to obtaining any necessary permits.

List of some future additional environmental and permitting approvals are described below. Each new pit needs the following permits:

- Certificate of Authorization.
- Water withdrawal authorization.

- Wildlife habitat modification.
- Closure and reclamation plan revision.
- Forestry permit for deforestation activities.
- Mining lease (160).
- Authorization for a project near water (160, Principal and WMCP).
- Lease and authorization for the new mixed stockpiles and new TSF cell.
- An EIA could be triggers for the new cell of the TSF.

Each new mixed stockpile and TSF cell requires the following permits:

- Lease and authorizations.

## **20.6 MINE RECLAMATION AND CLOSURE**

The last reclamation and closure plan was submitted on January 14, 2014 and approved by the Ministère de l'Énergie et des Ressources Naturelles (MERN) and the Ministère de l'environnement et Lutte contre les changements climatiques (MELCC) on June 2015. Also, submitted on May 16, 2016, were complementary documents for the restoration and closure plan of the Casa Berardi Mine site to include the exploitation of the EMCP open pit of the East Mine. The complementary document was approved by the MERN on September 21, 2017. As required every five years by the MERN, a review of the restoration and closure plan will be submitted by September 2019.

The mine reclamation and closure plan include:

- Decommissioning of the surface infrastructure.
- Dismantling of all surface structures, with sales/recycling of assets and disposal of wastes.
- Grading and vegetation of all disturbed areas.
- Capping/sealing of all mine access points in accordance with regulatory standards.
- Grading of the tailings dykes followed by direct vegetation of the tailings dams.
- Description of the financial guarantee, the amount of which corresponds to the anticipated costs of the restoration work.
- The closure period will include five years of monitoring activities.

Since August 2013, mining regulations require that financial guarantees cover all the restoration costs including dismantling of the headframes and buildings and sealing of all openings. The amount of this guarantee, which is in the form of a surety bond, corresponds to the total estimated costs for the restoration of the entire actual mine site. The guarantee is provided in three instalments within two years of the date of reclamation plan approval.

The estimated costs for reclamation and closure costs for Casa Berardi are \$15,708,304.76. The current amount of the bond is \$15,393,047.38, a final instalment of \$315,257.38 is scheduled for September 21, 2019.

This cost estimate covers the existing operations and current infrastructures but does not include future open pits rehabilitation/closure costs. The rehabilitation costs for the future #7 and #8 cells, proposed mixed stockpiles and other open pits, are estimated at approximately \$6.6 million and have been included in the present LOM cash flow. The cost estimate for the reclamation of the site for the LOM project, through till 2034 is \$22 million.

## **20.7 COMMUNITY AND SOCIAL ASPECTS**

The Abitibi region is a well-known mining region. The mining industry is a key activity to the regional economic development. The region has a wealth of trained miners, and redevelopment of the mine has been seen by most residents as a positive activity providing employment and tax revenue for the region. Maintaining the durability of the mining operation secures Hecla Québec's involvement in the region. For example, Hecla Québec contributed over \$500,000 in donations and sponsorships in 2018 to various organizations in the region.

Hecla Québec has developed a community engagement policy and an integrated social responsibility policy and has a good relationship with stakeholders. Since January 2019, the site has set up a liaison committee composed of stakeholders from a variety of areas, including municipal, Aboriginal, economic, environmental and educational communities.

There are no significant First Nations issues related to the mine operation or regional exploration activities. Hecla Québec and the Council of the Abitibiwinni First Nation have signed a memorandum of understanding (MOU) in November 2018 on Hecla Québec's exploration and mining activities in the Casa Berardi Mine area. Under the MOU, the parties will start a negotiation process for a possible collaboration agreement on various topics, such as employment, training and business opportunities for members of the Abitibiwinni

community.

## **COMMENTS ON ENVIRONMENT, PERMITTING AND SOCIAL AND COMMUNITY ASPECTS**

In the opinion of the QP, the environmental, permitting and social aspects are being appropriately managed and planned to support the current life-of-mine plan to 2034.

### **20.8 COMMENTS ON ENVIRONMENTAL STUDIES, PERMITTING, AND COMMUNITY IMPACT**

In the opinion of the QP:

- Hecla has sufficiently addressed the environmental impact of the operation, and subsequent closure and remediation requirements that Mineral Resources and Mineral Reserves can be declared, and that the mine plan is appropriate and achievable. Closure provisions are appropriately considered. Monitoring programs are in place.
- Hecla has developed a communities' relations plan to identify and ensure an understanding of the needs of the surrounding communities and to determine appropriate programs for filling those needs. The company appropriately monitors socio-economic trends, community perceptions and mining impacts.
- Permits held by Hecla for the Project are sufficient to ensure that mining activities are conducted within the regulatory framework required by regulations.
- There are no currently known environmental, permitting, or social/community risks to the Mineral Resources or Mineral Reserves.

## 21.0 CAPITAL AND OPERATING COSTS

### 21.1 CAPITAL COSTS

Unless otherwise noted, all dollar amounts are presented in Canadian Dollars, and all other measurements are metric values.

Casa Berardi uses the LOM as the planning guide for the Operation. The LOM capital costs total \$398 million, (Table 21-1) and include mine development (contractor and company), mine infrastructure, open pit costs, equipment costs, plant expansion, and tailings management.

*Table 21-1: LOM Capital Costs*

Period	Open Pit	Underground	Total
	(\$000)	(\$000)	(\$000)
Five Year Annual Average (2019-2023)	22,144	21,832	43,976
LOM (2019-2034)	294,524	103,678	398,202

Mine development costs are based upon operating experience, current development contracts, and the LOM development schedule. Open pit costs include mobilization of the open pit contractor, overburden stripping, and capitalized stripping costs.

### 21.2 OPERATING COSTS

The 2018 actual and budget operating costs and the 2019 budget operating cost estimates are shown in Table 21-2. Production in 2018 was higher than the 2018 Budget and the total operating cost was also higher than budget. Unit operating costs exceeded the budget; however, in the future operating costs are projected to decrease with reductions in the mine development, increased mine output, and open pit mining.

**Table 21-2: Unit Operating Costs**

Item	Units	2018 Actual	2018 Budget	2019 Budget
Underground Mining	\$/t milled	136.8	144.7	133.6
Pit Mining	\$/t milled	82.7	74.6	69.3
Mill	\$/t milled	20.7	19.7	19.1
Total	\$/t milled	132.6	134.4	121.7
Tonnes milled	t	1,248,039	1,200,210	1,400,000
Total	\$ million	165.5	161.3	170.4

### 21.3 LOM OPERATING COSTS

The LOM operating costs are shown in Table 21-3 and the LOM unit operating costs are shown in Table 21-4.

**Table 21-3: LOM Operating Costs**

Period	Mining	Milling	Refining	G&A	Total
	(\$000)	(\$000)	(\$000)	(\$000)	(\$000)
Five Year Annual Average (2019-2023)	106,962	136,029	475	13,481	148,124
LOM (2019-2034)	1,142,688	416,989	5,933	87,729	1,653,339

**Table 21-4: LOM Unit Operating Costs**

Period	Mining	Milling	Refining	G&A	Total
	(\$/t)	(\$/t)	(\$/t)	(\$/t)	(\$/t)
Five Year Annual Average (2019-2023)	76.40	19.43	0.34	9.63	105.80
LOM (2019-2034)	52.54	19.17	0.27	4.03	76.01

### 21.4 MANPOWER

The current manpower for the Casa Berardi Mine-Mill complex is summarized in Table 21-5. The table includes company and contractor employees. It includes the company workforce for mine development and production, ground support, diamond drilling, mechanical and electrical work plus open pit, construction, and site security.

**Table 21-5: Workforce Summary 2019 Budget**

<b>Department</b>	<b>Company</b>	<b>Contractor</b>	<b>Total</b>
Mine	315	51	366
Mill	61	45	106
Electric	45	1	46
Maintenance	121	7	128
Technical Services	40	33	73
Open Pit	13	167	180
Environment	3	-	3
Admin (HR, Safety, Purchasing)	51	5	56
Val-d'Or Corporate	19	23	42
<b>Total</b>	<b>668</b>	<b>332</b>	<b>1000</b>

## 21.5 COMMENTS ON CAPITAL AND OPERATING COSTS

The QP has reviewed the capital and operating cost provisions for the LOM plan that supports Mineral Reserves and considers the basis for the estimates, including mine budget data, vendor quotes, and operating experience, to be appropriate to the known mineralization, mining and production schedules, marketing plans, equipment replacement, and maintenance requirements. Appropriate provision has been made in the estimates for the expected mine operating usages including labor, fuel, power, closure, and environmental considerations. Capital cost estimates include appropriate Owner, sustaining and contingency estimates.

## **22.0 ECONOMIC ANALYSIS**

### **22.1 METHODOLOGY AND ASSUMPTIONS**

#### **METHODOLOGY USED**

The results of the economic analysis to support Mineral Reserves represent forward-looking information that is subject to a number of known and unknown risks, uncertainties and other factors which may cause actual results to differ materially from those presented here.

Forward-looking statements in this Report include, but are not limited to, statements with respect to future metal prices and concentrate sales contracts, the estimation of Mineral Reserves and Mineral Resources, the realization of Mineral Reserve estimates, the timing and amount of estimated future production, costs of production, capital expenditures, costs and timing of the development of new mineral zones, permitting time lines for the tailings storage expansion requirements for additional capital, government regulation of mining operations, environmental risks, unanticipated reclamation expenses, title disputes or claims and limitations on insurance coverage.

Additional risk can come from actual results of current reclamation activities; conclusions of economic evaluations; changes in Project parameters as mine and process plans continue to be refined, possible variations in mineral reserves, grade or recovery rates; geotechnical considerations during mining; failure of plant, equipment or processes to operate as anticipated; shipping delays and regulations; accidents, labor disputes and other risks of the mining industry; and delays in obtaining governmental approvals.

#### **ASSUMPTIONS**

To support declaration of Mineral Reserves, Hecla prepared an economic analysis at mineral reserve prices to confirm that economics based on the Mineral Reserve could repay life-of-mine operating and capital costs.

The Project was further evaluated on an undiscounted basis and using a 5% discount rate. Metal prices used in this evaluation are presented in Table 22-1 and represent current prices at the time of the report.

**Table 22-1: Assumptions Summary**

	<i>Unit</i>	LOM 2019 to 2034
Gold Prices	US\$	\$1,300.00
Silver Prices	US\$	\$15.50
Exchange Rate	USD/CAD	1.33
Gold Prices - Can\$	CAN\$	\$1,729.00
Silver Prices - Can\$	CAN\$	\$20.62

## 22.2 CASH FLOW

Throughout the LOM (2019 to 2034), 21.8 million metric tonnes of ore will be processed at the mill. The average mill recoveries are estimated at 86%, resulting in 1.6 million recovered gold ounces (underground: 0.5 million ounces, surface: 1.1 million ounces). Silver production is estimated at 24% of gold production based on historical data. A summary of the Production and Revenues for the LOM is presented in Table 22-2; Operating Costs and Cash Flows are summarized in Table 22-3; and Capital and Cumulative Net Cash Flow is summarized in Table 22-4.

**Table 22-2: Production and Revenues**

	<i>Unit</i>	Five Year Annual Average (2019 to 2023)	LOM TOTAL (2019 to 2034)
<b>PRODUCTION:</b>			
Tonnes milled	<i>Tonnes</i>	1,400,000	21,750,834
Grade	<i>Grams/Tonne</i>	3.40	2.74
Recovery	%	86.11%	85.93%
Gold recovered	<i>Ounces</i>	131,264	1,638,217
Silver recovered	<i>Ounces</i>	31,795	394,621
<b>REVENUES: (in Thousands)</b>			
Gold revenue	CAN\$	\$226,956	\$2,809,000
Silver revenue	CAN\$	\$665	\$8,118
<b>TOTAL REVENUES</b>	<b>CAN\$</b>	<b>\$227,611</b>	<b>\$2,817,118</b>
Treatment charges	CAN\$	(\$475)	(\$5,933)
<b>NET REVENUE</b>	<b>CAN\$</b>	<b>\$227,136</b>	<b>\$2,811,185</b>

**Table 22-3: Operating Costs and Cash Flow**

	<i>Unit</i>	<b>Five Year Annual Average (2019 to 2023)</b>	<b>LOM TOTAL (2019 to 2034)</b>
<b>OPERATING COSTS: (in Thousands)</b>			
<b>MINE - UNDERGROUND:</b>			
Production drilling	CAN\$	\$2,253	\$11,263
Stope preparation	CAN\$	\$13,213	\$70,223
Extraction (drill and blast)	CAN\$	\$3,657	\$19,896
Mucking	CAN\$	\$3,140	\$17,179
Backfill	CAN\$	\$1,562	\$8,724
Hoisting	CAN\$	\$1,243	\$6,740
Surface hauling - UG	CAN\$	\$782	\$4,258
Services - Underground	CAN\$	\$11,541	\$60,440
Services - Mechanical/Surface	CAN\$	\$17,845	\$97,152
Services - Electrical	CAN\$	\$8,298	\$59,543
Services - Technical (Eng. Geo. I.T.)	CAN\$	\$5,185	\$27,550
Administration (adm, HR, H&S)	CAN\$	\$10,001	\$65,337
Val-d'Or office	CAN\$	\$3,480	\$22,390
<b>SUB-TOTAL UNDERGROUND</b>	<b>CAN\$</b>	<b>\$82,200</b>	<b>\$470,695</b>
<b>PITS:</b>			
<b>SUB-TOTAL PITS</b>	<b>CAN\$</b>	<b>\$37,232</b>	<b>\$753,010</b>
<b>MILL:</b>			
Milling	CAN\$	\$25,993	\$407,721
Backfill plant	CAN\$	\$1,304	\$6,710
Environmental	CAN\$	\$1,213	\$9,267
<b>SUB-TOTAL MILL</b>	<b>CAN\$</b>	<b>\$28,510</b>	<b>\$423,698</b>
<b>TOTAL OPERATING COSTS</b>	<b>CAN\$</b>	<b>\$147,942</b>	<b>\$1,647,403</b>
<b>OPERATING CASH FLOW</b>	<b>CAN\$</b>	<b>\$79,194</b>	<b>\$1,163,782</b>

**Table 22-4: Capital and Cumulative Net Cash Flow**

	<i>Unit</i>	<b>Five Year Annual Average (2019 to 2023)</b>	<b>LOM TOTAL (2019 to 2034)</b>
<b><i>CAPITAL COSTS: (in Thousands)</i></b>			
Capitalized development	CAN\$	\$10,714	\$58,595
East Mine	CAN\$	\$1,977	\$9,883
Open Pits	CAN\$	\$13,924	\$187,230
Studies - Future open pits	CAN\$	\$160	\$160
Mine infrastructures	CAN\$	\$2,177	\$11,832
Buildings, mill, backfill plant	CAN\$	\$3,763	\$19,367
Equipment, and machinery	CAN\$	\$4,284	\$10,361
Taillings storage facility	CAN\$	\$5,417	\$67,331
Restoration	CAN\$	\$0	\$25,000
Definition drilling (MEV)	CAN\$	\$2,110	\$8,439
<b>TOTAL CAPITAL COSTS</b>	<b>CAN\$</b>	<b>\$44,526</b>	<b>\$398,198</b>
<b><i>PRE-TAX NET CASH FLOW (undiscounted)</i></b>			
Provincial mining taxes	CAN\$	(\$4,973)	(\$53,874)
Federal and provincial income taxes	CAN\$	-	-
<b>AFTER-TAX NET CASH FLOW (undiscounted)</b>	<b>CAN\$</b>	<b>\$29,695</b>	<b>\$711,711</b>
<b>NPV (5%) BEFORE-TAX CASH FLOW</b>	<b>CAN\$</b>	<i>n/a</i>	<b>\$471,202</b>
<b>NPV (5%) AFTER-TAX CASH FLOW</b>	<b>CAN\$</b>	<i>n/a</i>	<b>\$432,043</b>

Details for estimates of operating and capital costs are presented in Section 21. The average unit costs for the project are presented in Table 22-5:

**Table 22-5: Unit Costs**

	<b>Cost per tonne (CAN\$)</b>	<b>Cost per tonne (US\$)</b>	<b>Cost per ounce (CAN\$)</b>	<b>Cost per ounce (US\$)</b>
Operating costs	\$75.74	\$56.95	\$1,005.61	\$756.10
Capital costs	\$18.31	\$13.77	\$243.07	\$182.76
Silver by-credits			(\$4.96)	(\$3.73)
All-in Sustaining Cost			\$1,243.72	\$935.13

## 22.3 SENSITIVITY ANALYSIS

This section presents a sensitivity analysis of cumulative net cashflow using the following variables:

- Metal prices.
- Operating costs.
- Capital costs.

Table 22-6 illustrates the sensitivities applied to each parameter studied.

**Table 22-6: Sensitivities Applied**

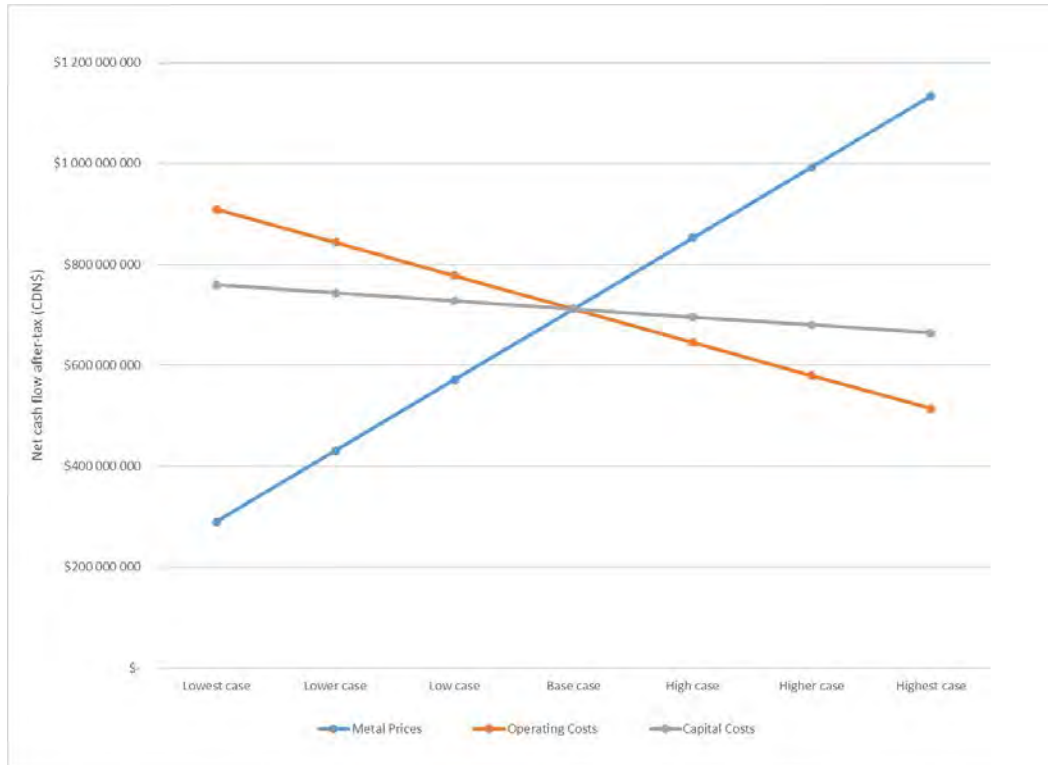
Parameter	Lowest Case	Lower Case	Low Case	Base Case	High Case	Higher Case	Highest Case
Metal Prices	-15%	-10%	-5%	0%	5%	10%	15%
Operating Costs	-12%	-8%	-4%	0%	4%	8%	12%
Capital Costs	-12%	-8%	-4%	0%	4%	8%	12%

The base case reflects current gold, silver and exchange rates (US/CDN). The assumptions used in the base case are presented in Table 22-7.

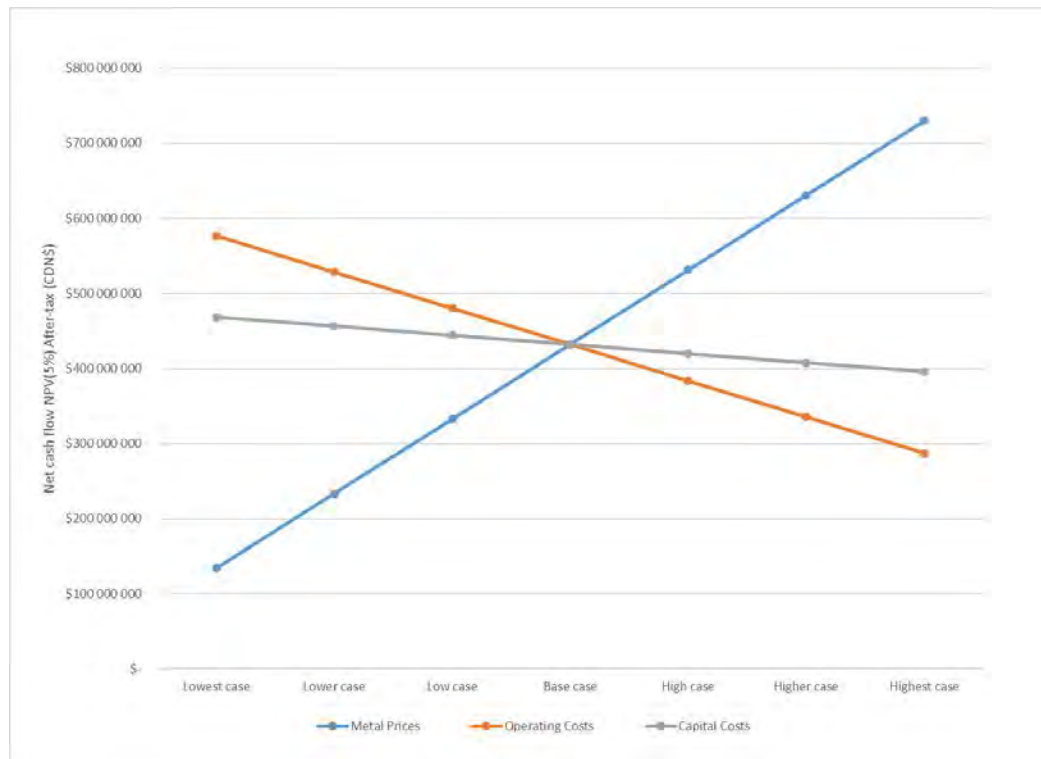
**Table 22-7: Assumption Used for Base Case**

	Unit	LOM 2019 to 2034
Gold Prices	US\$	\$1,300.00
Silver Prices	US\$	\$15.50
Exchange Rate	USD/CAD	1.33
Gold Prices - Can\$	CAN\$	\$1,729.00
Silver Prices - Can\$	CAN\$	\$20.42

A comparison of results for the various cases using undiscounted values are illustrated in Figure 22.1, while discounted values are presented in Figure 22.2.



**Figure 22.1: Net Cash Flow Sensitivities - Undiscounted**



**Figure 22.2: Net Cash Flow Sensitivities – NPV (5%)**

The project is most sensitive to changes in the metal prices, most significantly gold, with discounted cash flows in the lowest scenario being \$134 million and discounted cash flows in the highest scenario being \$730 million.

## **22.4 TAXES AND ROYALTIES**

Mining companies doing business in Quebec are primarily subject to federal income tax, Quebec provincial income tax and Quebec Mining Duties.

The provincial mining tax rate varies between 16% and 28% depending on the profit margin. The minimum effect of this tax is approximately \$53 million undiscounted and \$39.2 million discounted at 5% over the life of the mine.

Federal and Provincial income taxes were not included in the economic model's cash flow analysis. Hecla Quebec has cumulative net operating tax losses carry-forward amounts, in addition to interest expense deductibility, which are expected to be utilized to offset the project's future taxable income. The federal and provincial income tax rates are 15% and 11.5%, respectively.

There are currently no royalties payable to third parties.

## **22.5 COMMENTS ON ECONOMIC ANALYSIS**

The QP has reviewed the financial analysis and confirm that the Project has positive economics until the end of mine life, which supports Mineral Reserve declaration.

The QP notes the following:

- Gold price assumptions used to evaluate Casa Berardi mineral reserves and economics are conservative, utilizing a base case gold price significantly less than the three-year trailing average. Sensitivity analysis indicates that the mine plan maintains a positive NPV even with a 20% decrease in metal prices compared to the base case.
- The grade of the Casa Berardi mineral deposit is not uniform and has distinct higher- and lower-grade areas. This provides opportunities to defer the mining of lower-grade areas and prioritize production from higher-grade areas in the event of decreased metal prices or higher economic cutoff grade.
- There is upside for the Project if some or all of the Inferred Mineral Resources

estimated for the Project can be upgraded to higher confidence Mineral Resource categories.

## 23.0 ADJACENT PROPERTIES

Most of the Casa Berardi property is bordered by other properties that are explored by different owners (Figure 23.1).

At the western limit of the property, Agnico-Eagle Mines Ltd. (Agnico) owns two claim blocks covering 1,800 ha. The main exploration work on the Dieppe properties had been carried out by Noranda Exploration and its Joint Venture partners from 1974 to 1991. No exploration work was carried out between 1992 and 2009. Agnico acquired the Dieppe property in 2009 from Virginia Gold Mines and drilled 30 holes for 9,596 metres in 2010 and 2011. No exploration work has been carried out since that time. The Dieppe claims straddle the Casa Berardi Fault for ten kilometres, and the geological setting and styles of gold mineralization are similar to those at Casa Berardi. No economic gold mineralization or gold resource have been defined.

Propriétés Estrades (Qc), a subsidiary of Galway Metals Inc., owns a large property that covers the eastern extension of the Casa Berardi Fault, but most importantly the gold-rich volcanogenic massive sulphide Estrades deposit. The Estrades deposit was previously mined in 1990-91, via a 200 metre deep ramp, and production totaled 174,946 tonnes at 12.9% Zn, 6.4 g/t Au, 1.1% Cu and 172.3 g/t Ag. In September 2018, RPA released a 43-101 Mineral Resource Estimate for the Estrades deposit that is summarized in Table 23-1.

**Table 23-1: Mineral Resource Summary for the Estrades Deposit**

Category	Tonnes	Zn (%)	Cu (%)	Pb (%)	Au (g/t)	Ag (g/t)
Indicated	1,497,000	7.2	1.06	0.6	3.55	122.9
Inferred	2,199,000	4.72	1.01	0.29	1.93	72.9

Resources Yorbeau Inc. owns a 100% interest in the Caribou property located at the east end of the Casa Berardi property and west of the Estrades Deposit. Part of the property is under a Joint Venture agreement with First Quantum Minerals. The property hosts the Caribou Deposit, a thin but high-grade massive sulphide lens, in which ten holes yielded a weighted average of 2.8% Cu, 6.9% Zn, 1.1 g/t Au and 53 g/t Ag over an average length of 1.8 metres. The property has been poorly explored for gold-only mineralization.

Resources Yorbeau Inc., lamgold Corporation and Vale Canada Ltd. own interest in two claim

blocks, due South of the Casa Berardi property, that form together the Gemini-Turgeon property. Over the years, three main Cu-Zn massive sulphide horizons have been discovered on the property and one other zone intersected 9.5 g/t Au over 6.0 metres. No mineral resource has been delineated on the property, and exploration work has been sparse since 2008.

Since 2014, Exploration Midland Inc. (Midland) has acquired several claim blocks to the North, the East and to the South of Casa Berardi. They refer to the Adam, La Peltrie, Mistouac and Turgeon projects, the latter being the closest to Casa Berardi. In the area showed on the Figure 23.1 map, Midland has carried out helicopter-borne Magnetometer-VTEM surveys on the southern part of La Peltrie in 2017, and Mistouac and Turgeon in 2018 and some Ore Vision IP surveys. No drilling has been reported yet.

In 2016, Balmoral Resources Ltd. (Balmoral) staked the Highway 810 property north of Casa Berardi that covers 105,100 ha. Since 1958, prior to Balmoral involvement, exploration work had been sparse in the area except in 1985-86 when Teck Explorations drilled 84 diamond drill holes and 259 overburden RC drill holes. Few anomalous precious and base metal occurrences have been reported. To date, Balmoral has only filed a 120 line-kilometre IP survey.

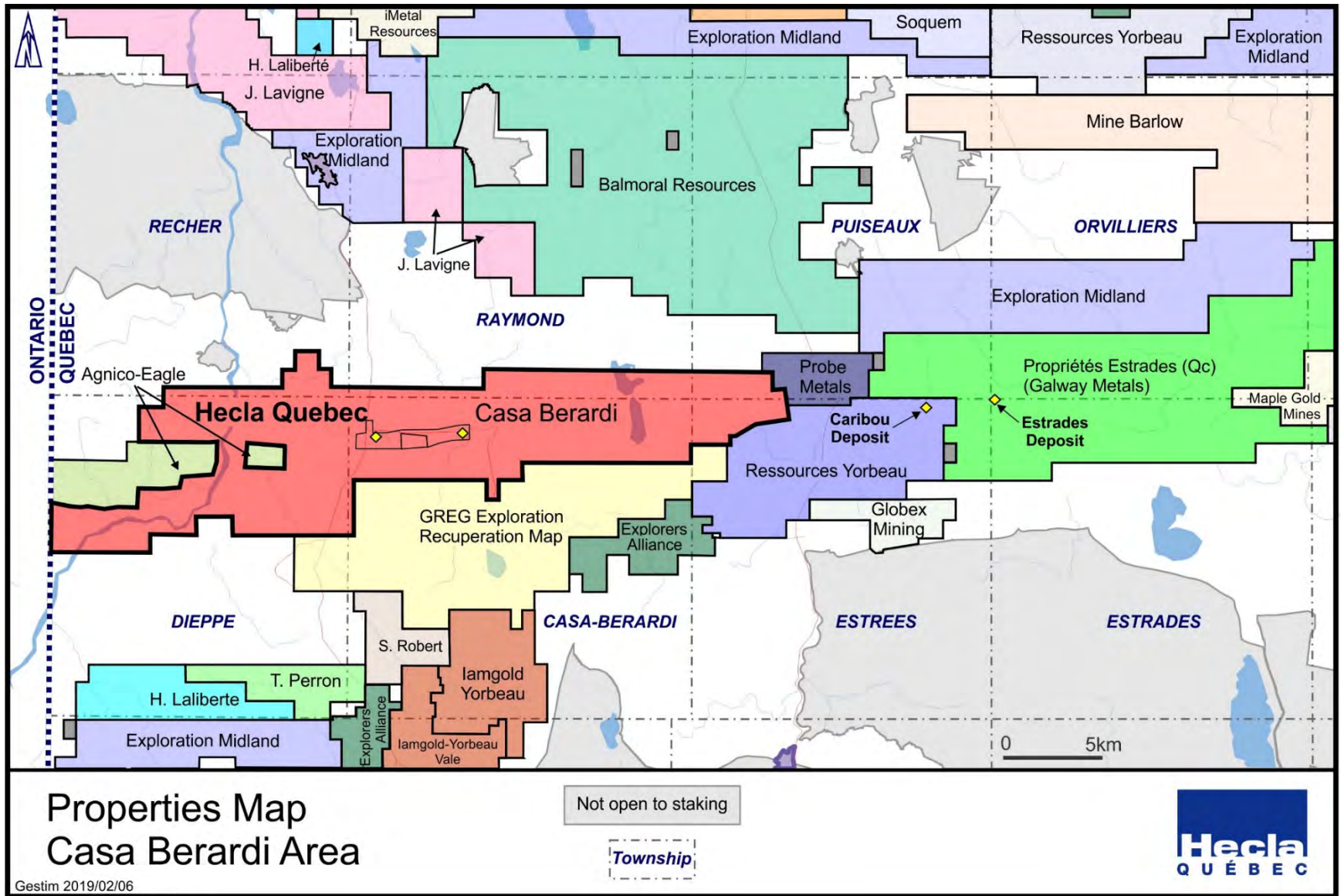
At the eastern end of Hecla Québec's property, Probe Metals Inc. (Probe), formerly Adventure Gold Inc., owns the Casagosik property. The property doesn't encompass any gold occurrence. In 2011, Probe carried out a ground magnetometer survey and some IP surveys in 2013, 2015 and 2017.

Explorers Alliance Corporation owns two claim blocks south of the Casa Berardi property, named respectively Cancor Extension and Casa Berardi North property (CBN), the latter being the closest to the Casa Berardi property. Prior to Explorers Alliance, claims in this area were held by several companies that carried out ground geophysical surveys and diamond drilling. Explorers Alliance, with sometimes some JV partners, has carried out ground and helicopter-borne geophysical surveys and diamond drilling. Several gold intersections, ranging from 1,0 g/t to 6.1 g/t Au and from 0.4 to 10.5 metres, have been reported at and near the Glen Auden Zone, but no gold resource is reported. Explorers Alliance hasn't reported any work has since 2012.

Golden Retriever Exploration Group (GREG) and Recuperation MAP own in partnership a property adjoining the southern boundary of the Casa Berardi property. Exploration on this claim block started in 1958, but the property has been mainly explored from the end of the 70s to the middle of the 90s. Work consisted in various ground geophysical surveys and some drilling. The property has been quite inactive until the actual owners started acquiring claims in 2010. Since, GREG has carried out helicopter-borne Magnetometer-EM surveys. No significant gold occurrences are reported.

Mine Barlow Inc. is a private company that explore exclusively to develop Iron ore deposits.

Other small claim blocks, owned by prospectors as individual or group, reported very limited activity.



**Figure 23.1: Significant Claims in the Casa Berardi Area**

## **24.0 OTHER RELEVANT DATA AND INFORMATION**

Hecla Québec is not aware of any additional information or explanation about Casa Berardi Mine that is necessary to make this Technical Report understandable and not misleading.

## 25.0 INTERPRETATION AND CONCLUSIONS

Casa Berardi Mine has produced more than 1,764,500 ounces from 2006 through 2018. Since 2006, over 1,051,500 meters of drilling were completed on surface and underground to increase the mineral resources and mineral reserves and to better understand the key geological controls. Based on this drilling, the total proven and probable mineral reserves at the Casa Berardi Mine, as December 31, 2018, are 21.5 million tonnes, averaging 2.8 g/t Au with 1.9 million ounces of gold. These mineral reserves are contained in the West Mine, the Principal area of the West Mine and the East Mine. Mineral reserves are summarized in Table 25-1. The mineral resources exclusive of the mineral reserves comprise measured and indicated mineral resources of 11.6 million tonnes, averaging 3.2 g/t Au, with 1.2 million ounce of gold and inferred mineral resources of 5.6 million tonnes at 3.6 g/t Au with 652,200 ounces gold (Table 25-2).

**Table 25-1: Casa Berardi Mineral Reserve - December 31, 2018**

Area	Category	Tonnes	Grade (g/t Au)	Contained Ounces
Underground	Proven	739,900	5.3	125,000
Underground	Probable	2,588,300	5.3	442,000
Open Pit	Proven	5,419,700	2.5	438,400
Open Pit	Probable	12,791,800	2.2	901,300
<b>Total</b>	<b>Proven &amp; Probable</b>	<b>21,539,700</b>	<b>2.8</b>	<b>1,906,700</b>

Notes:

1. CIM definitions were followed for mineral reserves.
2. Underground mineral reserves were estimated by Hecla Québec.
3. Open pit mineral reserves were estimated by Hecla Québec support by MDA studies report.
4. Mineral Reserves are estimated at a cut-off grade of 3.5 g/t Au for 113, 124 and 148 Zones. A cut-off grade of 3.6 g/t Au for the 123 Zone. A cut-off grade of 3.7 g/t Au for the 118 Zone, and a cut-off grade of 3.8 g/t for the 121 Zone.
5. The open pit mineral reserves are estimated at a cut-off grade off 0.67 g/t Au.
6. Underground mineral reserves are estimated using an average long-term gold price of US\$1,200 per ounce and a US\$/C\$ exchange rate of 1.33.
7. Open pit mineral reserves are estimated using an average long-term gold price of US\$ of \$1,225 per ounce and a US\$/C\$ exchange rate of 1.30.
8. A minimum mining width of three meters was used for underground and open pit.
9. Totals may not represent the sum of the parts due to rounding.

**Table 25-2: Casa Berardi Mine, Mineral Resources Exclusive of Mineral Reserves  
December 31, 2018**

Area	Resource Category	Tonnes	Grade (g/t Au)	Contained Ounces
Underground	Measured	1,770,800	5.3	299,300
	Indicated	3,735,800	4.7	562,400
	Measured + Indicated	5,506,700	4.9	861,700
	Inferred	1,911,500	6.8	415,100
Open Pit	Measured	-	-	-
	Indicated	6,059,200	1.8	343,600
	Measured + Indicated	6,059,200	1.8	343,600
	Inferred	3,733,000	2.0	237,100
<b>Total</b>	<b>Measured &amp; Indicated</b>	<b>11,565,900</b>	<b>3.2</b>	<b>1,205,300</b>
<b>Total</b>	<b>Inferred</b>	<b>5,644,400</b>	<b>3.6</b>	<b>652,200</b>

Notes:

1. CIM definitions were followed for Mineral Resources.
2. Underground mineral resources were estimated by Hecla Québec.
3. Open pit mineral resources were estimated by Hecla Québec.
4. Underground mineral resources are estimated at a cut-off grades of 3.2 g/t Au for the West mine and 3.1 g/t Au for the East Mine.
5. Underground mineral resources are estimated using an average long-term gold price of US\$1,350 per ounce and a US\$/C\$ exchange rate of 1.33.
6. Open pit mineral resources are estimated at a cut-off of 0.67 g/t Au.
7. Open pit mineral resources are estimated using an average long-term gold price of US\$1,225 per ounce and a US\$/C\$ exchange rate of 1.30.
8. Minimum mining widths three meters were used.
9. Mineral Resources are exclusive of Mineral Reserves.
10. Totals may not represent the sum of the parts due to rounding.
11. Mineral Resources which are not Mineral Reserves do not have demonstrated economic viability.

Hecla Québec has been successful in generating new mineral resources and converting mineral resources to mineral reserves. Accordingly, we recommend continuing the estimation using parameters and a methodology similar to those used for the current mineral reserves. Since 2006, the reconciliation shows that the model has underestimated tonnage by 6% and overestimated gold content by 1% compared to the mill feed. These variances are extremely small and confirm the quality of the mineral resources and mineral reserves estimation.

Mill recovery has averaged 89.1%, since the recommencement of operations in 2006, and the 2018 recovery was 87.1%.

The trial studies and operating data with open pit material was used to estimate the open pit recovery while operating data was used for underground material. For a portion of the open pit mineral reserves no trials have been completed. For these parts of the mineral reserve an 85% recovery has been applied based on overall historic mill performances. The recovery rate is more uncertain is for this material, but the value based on operational experience is considered acceptable and compensates any uncertainty.

In the future, the following recommendation is made:

- With the goal of increasing the knowledge on Principal and WMCP pits, we recommend that additional trials be conducted. It will be easier to define future recovery with precision for these pits and have an indication of the variability of gold recovery and grindability of the mineral body.

The current actual mill will be able to process the projected throughput due to the many improvements have been implemented during the last three years. The ability of the mill to achieve the recovery of all available gold, as predicted by testing with comparable conditions has been demonstrated. However, there remains a risk associated with the prediction of the percentage of available gold. All the other operational parameters, other than the throughput, must remain in the same range as they have been in recent years.

Over the LOM, 2019-2034, a total of 21.8 Mt, at a grade of 2.74 g/t Au, will be milled. For a production of 1.6 million ounces of gold and 400 k ounces of silver, with 0.5 million ounces from underground operations and 1.1 million ounces for surface operation. This will generate a net revenue of \$2.8 billion. For the same period, capital (CAPEX) and operating (OPEX-underground, open pit and mill) costs will be \$400 million and \$1.6 billion, respectively. For a cumulative net pre-tax cash flow of \$765 million. The All-In Sustaining Cost (AISC) will be \$1243.72 CND/oz or \$935.13US/oz.

The LOM of the Casa Berardi Mine has been greatly enhanced by addition of open pits within the mining lease, which has extended gold production until 2034. There are mineral resources that are not included in the LOM plan, as the LOM plan is based solely on proven and probable Mineral Reserves.

## **26.0 RECOMMENDATIONS**

### **26.1 GEOLOGY**

The Casa Berardi Mine has been successful over the years at renewing and increasing its mineral resources through exploration and definition drilling. The main recommendation is to continue diamond drilling along the 37 km of the Casa Berardi property for additional economic targets to extend the life of mine (LOM).

The Casa Berardi property continues to have success with its exploration drilling programs. The addition of open pit mining to the long-term plan has significantly improved the life of mine of Casa Berardi compared to 2018. The main recommendation is to continue underground diamond drilling to increase the grade and tonnage of the mineral reserves and add more value to the LOM. Although the underground exploration drilling is a priority for the next years, surface mineral reserves are open for extension along the strike and have the potential to extend the life of mine. Based on the December 31, 2018 mineral reserves, the Casa Berardi complex can be considered as high-quality asset for Hecla. In addition to diamond drilling, a 3D geological model updates can improve the understanding of the mineralization controls. Furthermore, collaborative academic research on hydrothermal and lithological controls on gold mineral zone formation could contribute to the long-term plan of Casa Berardi.

### **26.2 BLOCK MODEL UPDATES**

The following block models should be updated and improved:

- Underground East Mine model: The addition and confirmation of potential high-grade lenses in this sector can add significant value to this project and improve the LOM for the East Mine.
- All open pit blocks: These models should be updated on regular basis, following each diamond drilling campaign, in order to improve economic value to these projects.
- 134 and EMCP Expansion pit projects: The mineral resource model beneath the current pit shells should be updated. The addition of new mineral reserves in these areas would improve the cumulative cashflow, as well as adding tonnage and ounces.
- WMCP pit project: There is currently a gap in mineral resources in the crown pillar

area. This area is presently considered as waste in the LOM. Conversion of waste to additional mineral resources would improve the cumulative cashflow and project NPV.

- Principal pit project: This block model was last updated in 2010. New drilling information needs to be added to the present mineral resource model to better define the existing mineral reserves package.

### **26.3 QUALITY CONTROL/QUALITY ASSURANCE PROGRAM – MINE LABORATORY**

The geology department needs to develop a formalized set of procedures to improve Hecla Québec's quality control/quality assurance program. In conjunction with these procedures, it is recommended to continue regular laboratory visits to review the protocols and to ensure their application. To ensure a continued high standard of quality control, the compilation of blanks, standards and check assays for both the Casa Berardi and the external laboratories.

### **26.4 OPEN PIT OPERATIONS**

#### **OVERBURDEN SLOPE DESIGN (CLAY)**

The initial slope design in clay called for 4H:1V slopes. However, recent geotechnical back-analyses indicate that 3H:1V slopes in clay are stable. The pit designs for the 134, the 160 and the Principal open pit projects are based on the 4H:1V recommendation. The positive economic impact of having a steeper slope angle in the clay is important and needs to be investigated.

#### **GEOTECHNICAL DRILLING**

Geotechnical drilling is required for the WMCP pit project and the #4 & #5 mixed waste dumps. At the WMCP Pit, drilling is required to determine the composition of overburden within WMCP Pit footprint, in order to optimize the overburden slope design. The existing pit design assumes that all overburden material is clay and that 4H:1V slopes will be excavated. This is a conservative assumption as the overburden likely contains a mixture of clay and till. The presence of till would allow for steeper slopes (e.g. 2H:1V). Additional geotechnical data is required for the waste dump sites to determine design bearing capacity. Ideally, before finalizing the waste dump locations condemnation holes should be drilled to ensure that no

mineral resources are being sterilized.

## **HYDROGEOLOGY STUDIES FOR WMCP AND PRINCIPAL PROJECTS**

Hydrogeology will be a key element of the Principal Pit project. The presence of an esker in the overburden and an aquifer in the crown pillar area will require Hecla engineering to provide detailed solutions for the potential water inflows. The WMCP Pit project will require operations to divert a creek. Data from additional studies will be required to allow Hecla to engineer solutions and to better estimate costs.

### **26.5 UNDERGROUND MINING**

The continued success of underground production is dependent on respecting the development targets and scheduling. Underground, significant gains have been made through automation and continuous improvement initiatives. Future initiatives will target improving the use of telemetry on underground equipment and systems; reducing and optimizing electrical consumption; and ventilation on demand (VOD). In addition to these recommendations, a continued diamond drilling campaign is critical to the continued development of Casa Berardi as high-quality underground asset.

The following areas are recommended as targets for underground diamond drilling:

- Lower extension of 113, 118 and 119 zones in the Principal area of the West Mine and the east extension of the upper lenses of the 128 Zone.
- Extension along the east-west strike of the 160 and 148 zones of the East Mine.

### **METALLURGY**

As with underground operations, much of the success in the mill can be attributed to continuous improvement. As of 2019, Hecla Québec will continue working on optimizing the milling process in order to improve the yearly throughput capacity to 1.6 million tonnes. For the future, given that 70% of the mineral reserves are related to open pits where no milling trial has been done, the following recommendation is made:

- With the goal of increasing the knowledge on Principal and WMCP pits, we recommend that more trials be conducted. It will be easier to define future recovery with precision for these pits and to have an indication of the variability of gold recovery and grindability throughout the mineral body.

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## 28.0 CERTIFICATES OF QUALIFIED PERSONS

### JONATHAN ARCHAMBAULT-GIROUX

To accompany the report entitled: Technical Report for the Casa Berardi Mine, Northwestern Québec, Canada, dated effective December 31, 2018 (the Technical Report).

I, Jonathan Archambault Giroux, P.Geol, residing in Amos, Québec, Canada, do hereby certify that:

- 1) I am the Superintendent Geology, for Hecla Québec Casa Berardi Mine, with an office at 659, 2e Rue Est, La Sarre, Québec, J9Z 2Y9 Canada;
- 2) I graduated with a B.Sc. in Science (Geology) from Université du Québec à Montréal in 2004. I have practiced my profession continuously since 2004. I have worked in the gold mining industry in Québec, Canada for a total of 14 years since my graduation;
- 3) I am a Professional Geologist registered with the Ordre des Géologues du Québec (OGQ), registration number 964;
- 4) I have read the definition of “qualified person” set out in National Instrument 43-101 – *Standards of Disclosure for Mineral Projects* (NI 43-101) and certify that by virtue of my education, affiliation to a professional association and past relevant work experience, I fulfill the requirements to be a “qualified person” for the purposes of NI 43-101;
- 5) I have worked full time at Casa Berardi and have made regular site visits;
- 6) I am not independent of the company as independence is described by Section 1.5 of NI 43-101;
- 7) I am an author of the Technical Report and responsible for Sections 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, and 23 of the Technical Report; and contributed to Sections 1, 2, 3, 15, 25, 26, 27 of the Technical Report;
- 8) I have been employed by Hecla since May 15, 2016. I have been supervised the geology department include the exploration programs and the resource and reserve estimates;
- 9) I have read NI 43-101 and the Sections of the Technical Report for which I am responsible have been prepared in compliance with NI 43-101 and Form 43-101F1; and
- 10) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Sections of the Technical Report for which I am responsible for contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

La Sarre, QC. Canada  
April 1, 2019

**(Signed & Sealed) “Jonathan Archambault Giroux”**  
Jonathan Archambault Giroux, P.Geol.  
Superintendent Geology  
Hecla Québec Casa Berardi

## HERMAN DE LOS RIOS

To accompany the report entitled: Technical Report on the Casa Berardi Mine, Northwestern Quebec, Canada, dated effective December 31, 2018 (the Technical Report).

I, Herman De Los Ríos, P.Eng, residing in La Sarre, Québec, Canada, do hereby certify that:

- 1) I am the Superintendent-Engineering at the Casa Berardi Mine, for Hecla Québec, with an office at 659 2eme Rue Est, La Sarre, QC, J9Z 2Y9, Canada;
- 2) I graduated with a B.Sc. in Science (Mine Engineering) from Atacama University in 1988, I have practiced my profession continuously since 1989. I am a professional engineer with 30 years of experience in the Canadian and Chilean mining industry.
- 3) I am a Professional Engineer registered with the <<Ordre des Ingénieurs du Québec>>, registration number 5009408;
- 4) I have read the definition of “qualified person” set out in National Instrument 43-101 – *Standards of Disclosure for Mineral Projects* (NI 43-101) and certify that by virtue of my education, affiliation to a professional association and past relevant work experience, I fulfill the requirements to be a “qualified person” for the purposes of NI 43-101;
- 5) I have personally inspected the Casa Berardi Mine and continue to do so on an ongoing basis as a function of my normal duties with the company.
- 6) I am not independent of the company as independence is described by Section 1.5 of NI 43-101;
- 7) I am an author of the Technical Report and responsible for Sections 15,16,18,19,21, and 22; and contributed to Sections 25, 26 and 27 of the Technical Report;
- 8) I have worked at the Casa Berardi Mine since January 7, 2007;
- 9) I have read NI 43-101 and the Sections of the Technical Report for which I am responsible have been prepared in compliance with NI 43-101 and Form 43-101F1; and
- 10) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Sections of the Technical Report for which I am responsible for contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

La Sarre, QC. Canada  
April 1, 2019

**(Signed & Sealed) “Herman De Los Ríos”**

Herman De Los Ríos, P.Eng.  
Superintendent- Engineering  
Hecla Québec, Mine Casa Berardi

## **ANNIE BLIER**

To accompany the report entitled: Technical Report for the Casa Berardi Mine, Northwestern Québec, Canada dated effective December 31, 2019 (the Technical Report).

I, Annie Blier, Chemist, residing Rouyn-Noranda, Québec, Canada, do hereby certify that:

- 1) I am the Director, Sustainable Development and Partner Relations, for Hecla Québec, with an office at 1010, 3<sup>e</sup> Avenue Est, Val d'Or, Québec, J9P 0J6 Canada;
- 2) I graduated with a B.Sc. in Science (Chemistry) from Sherbrooke University in 1993, MSc in Environment, from University of Sherbrooke, 1995. I have practiced my profession continuously since 1995. I have worked at operating mines in Canada and worked on exploration and development programs in the U.S., Canada, Mexico, Africa, Suriname and Brazil. I have extensive experience with base and precious metal deposits such as the Casa Berardi;
- 3) I am a Professional Chemist registered with the Association of Ordre des chimistes du Québec (OCQ), registration number 1995-111;
- 4) I have read the definition of "qualified person" set out in National Instrument 43-101 – *Standards of Disclosure for Mineral Projects* (NI 43-101) and certify that by virtue of my education, affiliation to a professional association and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101;
- 5) I have personally inspected the Casa Berardi Mine and continue to do so on a weekly basis as a function of my normal duties with the company.
- 6) I am not independent of the company as independence is described by Section 1.5 of NI 43-101;
- 7) I am an author of the Technical Report and responsible for Section 20 of the Technical Report; and contributed to Section 18 of the Technical Report;
- 8) I have been employed by Hecla Quebec since April 2017 and have made weekly site visits to Casa Berardi since that time. I have been closely involved in the review of exploration programs, resource and reserve estimates and related external audits;
- 9) I have read NI 43-101 and the Sections of the Technical Report for which I am responsible have been prepared in compliance with NI 43-101 and Form 43-101F1; and
- 10) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Sections of the Technical Report for which I am responsible for contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Val d'Or, QC. Canada  
April 1, 2019

**(Signed & Sealed) "Annie Blier"**

Annie Blier, chemist.  
Director Sustainable Development and  
Partner Relations  
Hecla Québec

## PIERRE ROY

To accompany the report entitled: Technical Report for the Casa Berardi Mine, Northwestern Québec, Canada, dated effective December 31, 2018 (the Technical Report).

I, Pierre Roy, ing , M.Sc., P.Eng., residing in Quebec City, Quebec, Canada, do hereby certify that:

- 1) I am Senior Metallurgist, Mineral Processing specialist with Soutex inc. at 357 Jackson, Québec, QC, Canada, G1N 4C4;
- 2) I graduated with a B.Sc. in Mining Engineering from University Laval, Québec City in 1986, M.Sc. in Mining Engineering, from University Laval, Québec City in 1986. I have practiced my profession continuously since 1981. I have practiced my profession continuously since 1988. I have over 30 years' experience in Metallurgical Engineering. I have been involved in mineral processing since my graduation from University working in Canada. My experience is principally in ore processing and in environment management for the gold, base metal and iron ore industry. Prior to joining Soutex in 2005, I worked for Inmet Mining Corporation at Troilus mine for 9 (nine) years as Metallurgist and Environmental Director, Placer Dome at Kiena Mine for 6 (six) years and at CRM (Centre de recherche minérale du Québec) for 2 (two) years. I have had no prior involvement with the property which is the subject of the Technical Report;
- 3) I am registered as a Professional Engineer in the Quebec province in Canada (Member #45201) and in the Ontario province in Canada (Member #100110987);
- 4) I have read the definition of "qualified person" set out in National Instrument 43-101 – *Standards of Disclosure for Mineral Projects* (NI 43-101) and certify that by virtue of my education, affiliation to a professional association and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101;
- 5) I have personally inspected the Casa Berardi Mine on February 12 to 14th 2019;
- 6) I am an author of the Technical Report and responsible for Sections 13 and 17, and parts of Sections 1, 2 , 25, 26, and 27 of the Technical Report;
- 7) I am independent of the Issuer applying the test set out in Section 1.5 of NI 43-101;
- 8) I have read NI 43-101 and the Sections of the Technical Report for which I am responsible have been prepared in compliance with NI 43-101 and Form 43-101F1; and
- 9) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Sections of the Technical Report for which I am responsible for contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Quebec City, QC. Canada  
April 1, 2019

**(Signed & Sealed) "Pierre Roy"**

Pierre Roy, ing., M.Sc., P.Eng  
Senior Metallurgist and specialist  
Soutex Inc.

## DEAN MCDONALD

To accompany the report entitled: Technical Report for the Casa Berardi Mine, Northwestern Quebec, Canada, dated effective December 31, 2018 (the Technical Report).

I, Dr. Dean W.A. McDonald, P.Geol., residing in Vancouver, British Columbia, Canada, do hereby certify that:

- 1) I am the Senior Vice President, Exploration for Hecla Mining Company, with an office at Suite 970, 800 West Pender Street, Vancouver, British Columbia, V6C 2V6 Canada ;
- 2) I graduated with a B.Sc. in Science (Geology) from McMaster University in 1981, MSc in Science, from University of New Brunswick, 1984, PhD in Science (Mineral Deposits), from University of Western Ontario, 1990. I have practiced my profession continuously since 1981. I have worked at operating mines in Canada and worked on exploration and development programs in the U.S., Canada, Mexico, Australia, Argentina and Chile. I have extensive experience with base and precious metal deposits such as the Casa Berardi;
- 3) I am a Professional Geologist registered with the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC), registration number 24217;
- 4) I have read the definition of “qualified person” set out in National Instrument 43-101 – *Standards of Disclosure for Mineral Projects* (NI 43-101) and certify that by virtue of my education, affiliation to a professional association and past relevant work experience, I fulfill the requirements to be a “qualified person” for the purposes of NI 43-101;
- 5) I have personally inspected the Casa Berardi Mine and continue to do so on an ongoing basis as a function of my normal duties with the company.
- 6) I am not independent of the company as independence is described by Section 1.5 of NI 43-101;
- 7) I am an author of the Technical Report and responsible for Sections 1, 2, 3, 24, 25, 26, 27 and Appendices of the Technical Report; and contributed to Sections 4 through 12, 14 and 23 of the Technical Report;
- 8) I have been employed by Hecla since September 1, 2006 and have made regular site visits to Casa Berardi since that time. I have been closely involved in the review of exploration programs, resource and reserve estimates and related external audits;
- 9) I have read NI 43-101 and the Sections of the Technical Report for which I am responsible have been prepared in compliance with NI 43-101 and Form 43-101F1; and
- 10) As of the effective date of the Technical Report, to the best of my knowledge, information and belief, the Sections of the Technical Report for which I am responsible for contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Vancouver, B.C. Canada  
April 1, 2019

**(Signed & Sealed) “Dean McDonald”**

Dean McDonald, PhD, P.Geol.  
Senior Vice President  
Hecla Mining Company

## APPENDIX I

### MINERAL CLAIMS FOR CASA BERARDI MINE

Project	Titre	Claim	Record Data	Expiry Date	Renewal Date	Area (Ha)
Casa Berardi Mine	BM	768	1988-04-29	2019-04-28	2019-04-28	397.09
Casa Berardi Mine	BM	833	1995-12-18	2019-12-17	2019-12-17	84.35
Casa Berardi Mine	CDC	1097901	2002-09-11	2021-05-09	2021-03-09	55.85
Casa Berardi Mine	CDC	1097902	2002-09-11	2021-05-09	2021-03-09	55.85
Casa Berardi Mine	CDC	1097903	2002-09-11	2021-05-09	2021-03-09	55.85
Casa Berardi Mine	CDC	1097904	2002-09-11	2021-05-09	2021-03-09	55.85
Casa Berardi Mine	CDC	1097905	2002-09-11	2021-05-09	2021-03-09	55.85
Casa Berardi Mine	CDC	1097906	2002-09-11	2021-05-09	2021-03-09	55.85
Casa Berardi Mine	CDC	1097930	2002-09-11	2021-05-09	2021-03-09	55.84
Casa Berardi Mine	CDC	1097931	2002-09-11	2021-05-09	2021-03-09	55.84
Casa Berardi Mine	CDC	1097932	2002-09-11	2021-05-09	2021-03-09	55.85
Casa Berardi Mine	CDC	1097957	2002-09-11	2021-05-09	2021-03-09	55.83
Casa Berardi Mine	CDC	1097958	2002-09-11	2021-05-09	2021-03-09	55.83
Casa Berardi Mine	CDC	1097959	2002-09-11	2021-05-09	2021-03-09	55.83
Casa Berardi Mine	CDC	1097960	2002-09-11	2021-05-09	2021-03-09	55.83
Casa Berardi Mine	CDC	1097961	2002-09-11	2021-05-09	2021-03-09	55.83
Casa Berardi Mine	CDC	1097962	2002-09-11	2021-05-09	2021-03-09	55.83
Casa Berardi Mine	CDC	1097963	2002-09-11	2021-05-09	2021-03-09	55.83
Casa Berardi Mine	CDC	1097964	2002-09-11	2021-05-09	2021-03-09	55.83
Casa Berardi Mine	CDC	1097965	2002-09-11	2021-05-09	2021-03-09	55.84
Casa Berardi Mine	CDC	1097966	2002-09-11	2021-05-09	2021-03-09	55.84
Casa Berardi Mine	CDC	1097967	2002-09-11	2021-05-09	2021-03-09	55.84
Casa Berardi Mine	CDC	1097968	2002-09-11	2021-05-09	2021-03-09	55.84
Casa Berardi Mine	CDC	1097991	2002-09-11	2021-05-09	2021-03-09	55.82
Casa Berardi Mine	CDC	1097992	2002-09-11	2021-05-09	2021-03-09	55.82
Casa Berardi Mine	CDC	1097993	2002-09-11	2021-05-09	2021-03-09	55.82
Casa Berardi Mine	CDC	1097994	2002-09-11	2021-05-09	2021-03-09	55.82
Casa Berardi Mine	CDC	1097995	2002-09-11	2021-05-09	2021-03-09	55.82
Casa Berardi Mine	CDC	1097996	2002-09-11	2021-05-09	2021-03-09	55.82
Casa Berardi Mine	CDC	1097997	2002-09-11	2021-05-09	2021-03-09	55.83
Casa Berardi Mine	CDC	1097998	2002-09-11	2021-05-09	2021-03-09	55.83
Casa Berardi Mine	CDC	1097999	2002-09-11	2021-05-09	2021-03-09	55.83
Casa Berardi Mine	CDC	1098000	2002-09-11	2021-05-09	2021-03-09	55.83
Casa Berardi Mine	CDC	1098001	2002-09-11	2021-05-09	2021-03-09	55.83
Casa Berardi Mine	CDC	1098002	2002-09-11	2021-05-09	2021-03-09	55.83
Casa Berardi Mine	CDC	1098041	2002-09-11	2021-05-09	2021-03-09	55.86

Project	Titre	Claim	Record Data	Expiry Date	Renewal Date	Area (Ha)
Casa Berardi Mine	CDC	1098074	2002-09-11	2021-05-09	2021-03-09	55.87
Casa Berardi Mine	CDC	1098085	2002-09-11	2021-05-09	2021-03-09	55.86
Casa Berardi Mine	CDC	1098086	2002-09-11	2021-05-09	2021-03-09	55.86
Casa Berardi Mine	CDC	1098087	2002-09-11	2021-05-09	2021-03-09	55.86
Casa Berardi Mine	CDC	1098088	2002-09-11	2021-05-09	2021-03-09	55.86
Casa Berardi Mine	CDC	1098089	2002-09-11	2021-05-09	2021-03-09	55.86
Casa Berardi Mine	CDC	1098090	2002-09-11	2021-05-09	2021-03-09	55.86
Casa Berardi Mine	CDC	1098091	2002-09-11	2021-05-09	2021-03-09	55.86
Casa Berardi Mine	CDC	1098092	2002-09-11	2021-05-09	2021-03-09	55.86
Casa Berardi Mine	CDC	1098093	2002-09-11	2021-05-09	2021-03-09	55.86
Casa Berardi Mine	CDC	1098094	2002-09-11	2021-05-09	2021-03-09	55.86
Casa Berardi Mine	CDC	1098095	2002-09-11	2021-05-09	2021-03-09	55.86
Casa Berardi Mine	CDC	1098109	2002-09-11	2021-05-09	2021-03-09	42.75
Casa Berardi Mine	CDC	1098110	2002-09-11	2021-05-09	2021-03-09	40.23
Casa Berardi Mine	CDC	1098111	2002-09-11	2021-05-09	2021-03-09	40.48
Casa Berardi Mine	CDC	1098112	2002-09-11	2021-05-09	2021-03-09	40.74
Casa Berardi Mine	CDC	1098113	2002-09-11	2021-05-09	2021-03-09	42.26
Casa Berardi Mine	CDC	1098114	2002-09-11	2021-05-09	2021-03-09	43.76
Casa Berardi Mine	CDC	1098115	2002-09-11	2021-05-09	2021-03-09	51.18
Casa Berardi Mine	CDC	1098124	2002-09-11	2021-05-09	2021-03-09	29.58
Casa Berardi Mine	CDC	1098125	2002-09-11	2021-05-09	2021-03-09	4.98
Casa Berardi Mine	CDC	1098126	2002-09-11	2021-05-09	2021-03-09	20.03
Casa Berardi Mine	CDC	1098127	2002-09-11	2021-05-09	2021-03-09	16.16
Casa Berardi Mine	CDC	1098128	2002-09-11	2021-05-09	2021-03-09	13.4
Casa Berardi Mine	CDC	1098129	2002-09-11	2021-05-09	2021-03-09	12.86
Casa Berardi Mine	CDC	1098130	2002-09-11	2021-05-09	2021-03-09	12.32
Casa Berardi Mine	CDC	1098131	2002-09-11	2021-05-09	2021-03-09	0.16
Casa Berardi Mine	CDC	1098132	2002-09-11	2021-05-09	2021-03-09	9.35
Casa Berardi Mine	CDC	1098133	2002-09-11	2021-05-09	2021-03-09	5.78
Casa Berardi Mine	CDC	1098134	2002-09-11	2021-05-09	2021-03-09	2.62
Casa Berardi Mine	CDC	1098135	2002-09-11	2021-05-09	2021-03-09	11.42
Casa Berardi Mine	CDC	1098136	2002-09-11	2021-05-09	2021-03-09	29.04
Casa Berardi Mine	CDC	1098141	2002-09-11	2021-05-09	2021-03-09	6.06
Casa Berardi Mine	CDC	1098142	2002-09-11	2021-05-09	2021-03-09	48.61
Casa Berardi Mine	CDC	1098149	2002-09-11	2021-05-09	2021-03-09	55.82

## MINERAL CLAIMS FOR CASA BERARDI REGIONAL

Titre	Claim	Record Data	Expiry Date	Renewal Date	Area (Ha)
CDC	48842	2004-12-16	2020-12-15	2020-10-15	55.89
CDC	48843	2004-12-16	2020-12-15	2020-10-15	55.89
CDC	48844	2004-12-16	2020-12-15	2020-10-15	55.89
CDC	48845	2004-12-16	2020-12-15	2020-10-15	55.89
CDC	48846	2004-12-16	2020-12-15	2020-10-15	55.89
CDC	48847	2004-12-16	2020-12-15	2020-10-15	55.89
CDC	48848	2004-12-16	2020-12-15	2020-10-15	55.89
CDC	48849	2004-12-16	2020-12-15	2020-10-15	55.89
CDC	48850	2004-12-16	2020-12-15	2020-10-15	55.89
CDC	48851	2004-12-16	2020-12-15	2020-10-15	55.89
CDC	1097832	2002-09-11	2021-05-09	2021-03-09	55.89
CDC	1097833	2002-09-11	2021-05-09	2021-03-09	55.9
CDC	1097834	2002-09-11	2021-05-09	2021-03-09	55.9
CDC	1097835	2002-09-11	2021-05-09	2021-03-09	55.9
CDC	1097836	2002-09-11	2021-05-09	2021-03-09	55.9
CDC	1097837	2002-09-11	2021-05-09	2021-03-09	55.9
CDC	1097840	2002-09-11	2021-05-09	2021-03-09	55.89
CDC	1097841	2002-09-11	2021-05-09	2021-03-09	55.89
CDC	1097842	2002-09-11	2021-05-09	2021-03-09	55.89
CDC	1097843	2002-09-11	2021-05-09	2021-03-09	55.89
CDC	1097844	2002-09-11	2021-05-09	2021-03-09	55.89
CDC	1097845	2002-09-11	2021-05-09	2021-03-09	55.89
CDC	1097846	2002-09-11	2021-05-09	2021-03-09	55.89
CDC	1097847	2002-09-11	2021-05-09	2021-03-09	55.89
CDC	1097848	2002-09-11	2021-05-09	2021-03-09	55.89
CDC	1097849	2002-09-11	2021-05-09	2021-03-09	55.89
CDC	1097851	2002-09-11	2021-05-09	2021-03-09	55.88
CDC	1097852	2002-09-11	2021-05-09	2021-03-09	55.88
CDC	1097853	2002-09-11	2021-05-09	2021-03-09	55.88
CDC	1097854	2002-09-11	2021-05-09	2021-03-09	55.88
CDC	1097855	2002-09-11	2021-05-09	2021-03-09	55.88
CDC	1097856	2002-09-11	2021-05-09	2021-03-09	55.88
CDC	1097857	2002-09-11	2021-05-09	2021-03-09	55.88
CDC	1097858	2002-09-11	2021-05-09	2021-03-09	55.88
CDC	1097859	2002-09-11	2021-05-09	2021-03-09	55.88
CDC	1097860	2002-09-11	2021-05-09	2021-03-09	55.88
CDC	1097861	2002-09-11	2021-05-09	2021-03-09	55.88
CDC	1097862	2002-09-11	2021-05-09	2021-03-09	55.88
CDC	1097863	2002-09-11	2021-05-09	2021-03-09	55.88
CDC	1097864	2002-09-11	2021-05-09	2021-03-09	55.88
CDC	1097865	2002-09-11	2021-05-09	2021-03-09	55.88
CDC	1097866	2002-09-11	2021-05-09	2021-03-09	55.88
CDC	1097867	2002-09-11	2021-05-09	2021-03-09	55.87
CDC	1097868	2002-09-11	2021-05-09	2021-03-09	55.87

Titre	Claim	Record Data	Expiry Date	Renewal Date	Area (Ha)
CDC	1097869	2002-09-11	2021-05-09	2021-03-09	55.87
CDC	1097870	2002-09-11	2021-05-09	2021-03-09	55.87
CDC	1097871	2002-09-11	2021-05-09	2021-03-09	55.87
CDC	1097872	2002-09-11	2021-05-09	2021-03-09	55.87
CDC	1097873	2002-09-11	2021-05-09	2021-03-09	55.87
CDC	1097874	2002-09-11	2021-05-09	2021-03-09	55.87
CDC	1097875	2002-09-11	2021-05-09	2021-03-09	55.87
CDC	1097876	2002-09-11	2021-05-09	2021-03-09	55.87
CDC	1097877	2002-09-11	2021-05-09	2021-03-09	55.87
CDC	1097878	2002-09-11	2021-05-09	2021-03-09	55.87
CDC	1097879	2002-09-11	2021-05-09	2021-03-09	55.87
CDC	1097880	2002-09-11	2021-05-09	2021-03-09	55.86
CDC	1097881	2002-09-11	2021-05-09	2021-03-09	55.86
CDC	1097882	2002-09-11	2021-05-09	2021-03-09	55.86
CDC	1097883	2002-09-11	2021-05-09	2021-03-09	55.86
CDC	1097884	2002-09-11	2021-05-09	2021-03-09	55.86
CDC	1097885	2002-09-11	2021-05-09	2021-03-09	55.86
CDC	1097886	2002-09-11	2021-05-09	2021-03-09	55.86
CDC	1097895	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097896	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097897	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097898	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097899	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097900	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097907	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097908	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097909	2002-09-11	2021-05-09	2021-03-09	55.86
CDC	1097910	2002-09-11	2021-05-09	2021-03-09	55.86
CDC	1097911	2002-09-11	2021-05-09	2021-03-09	55.86
CDC	1097912	2002-09-11	2021-05-09	2021-03-09	55.86
CDC	1097913	2002-09-11	2021-05-09	2021-03-09	55.86
CDC	1097914	2002-09-11	2021-05-09	2021-03-09	55.86
CDC	1097915	2002-09-11	2021-05-09	2021-03-09	55.86
CDC	1097916	2002-09-11	2021-05-09	2021-03-09	55.86
CDC	1097917	2002-09-11	2021-05-09	2021-03-09	55.86
CDC	1097918	2002-09-11	2021-05-09	2021-03-09	55.86
CDC	1097919	2002-09-11	2021-05-09	2021-03-09	55.86
CDC	1097920	2002-09-11	2021-05-09	2021-03-09	55.86
CDC	1097921	2002-09-11	2021-05-09	2021-03-09	55.86
CDC	1097922	2002-09-11	2021-05-09	2021-03-09	55.86
CDC	1097925	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1097926	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1097927	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1097928	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1097929	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1097933	2002-09-11	2021-05-09	2021-03-09	55.85

Titre	Claim	Record Data	Expiry Date	Renewal Date	Area (Ha)
CDC	1097934	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097935	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097936	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097937	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097938	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097939	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097940	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097941	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097942	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097943	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097944	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097945	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097946	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097947	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097948	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097949	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097950	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097951	2002-09-11	2021-05-09	2021-03-09	55.85
CDC	1097952	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1097953	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1097954	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1097955	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1097956	2002-09-11	2021-05-09	2021-03-09	55.83
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CDC	1097970	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1097971	2002-09-11	2021-05-09	2021-03-09	55.84
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CDC	1097973	2002-09-11	2021-05-09	2021-03-09	55.84
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CDC	1097975	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1097976	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1097977	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1097978	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1097979	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1097980	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1097981	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1097982	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1097983	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1097984	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1097985	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1097986	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1097987	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1097988	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1097989	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1098003	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1098004	2002-09-11	2021-05-09	2021-03-09	55.83

Titre	Claim	Record Data	Expiry Date	Renewal Date	Area (Ha)
CDC	1098005	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1098006	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1098007	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1098008	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1098009	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1098010	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1098011	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1098012	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1098013	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1098014	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1098015	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1098016	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1098017	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1098018	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1098019	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1098020	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1098021	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1098022	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1098023	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1098024	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1098025	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1098026	2002-09-11	2021-05-09	2021-03-09	55.83
CDC	1098027	2002-09-11	2021-05-09	2021-03-09	55.82
CDC	1098028	2002-09-11	2021-05-09	2021-03-09	55.82
CDC	1098029	2002-09-11	2021-05-09	2021-03-09	55.82
CDC	1098030	2002-09-11	2021-05-09	2021-03-09	55.82
CDC	1098031	2002-09-11	2021-05-09	2021-03-09	55.82
CDC	1098032	2002-09-11	2021-05-09	2021-03-09	55.82
CDC	1098033	2002-09-11	2021-05-09	2021-03-09	55.82
CDC	1098034	2002-09-11	2021-05-09	2021-03-09	55.82
CDC	1098035	2002-09-11	2021-05-09	2021-03-09	55.82
CDC	1098036	2002-09-11	2021-05-09	2021-03-09	55.82
CDC	1098037	2002-09-11	2021-05-09	2021-03-09	55.82
CDC	1098038	2002-09-11	2021-05-09	2021-03-09	55.82
CDC	1098039	2002-09-11	2021-05-09	2021-03-09	55.82
CDC	1098040	2002-09-11	2021-05-09	2021-03-09	55.82
CDC	1098042	2002-09-11	2021-05-09	2021-03-09	55.82
CDC	1098043	2002-09-11	2021-05-09	2021-03-09	55.82
CDC	1098044	2002-09-11	2021-05-09	2021-03-09	55.82
CDC	1098045	2002-09-11	2021-05-09	2021-03-09	55.82
CDC	1098061	2002-09-11	2021-05-09	2021-03-09	29.17
CDC	1098062	2002-09-11	2021-05-09	2021-03-09	25.83
CDC	1098063	2002-09-11	2021-05-09	2021-03-09	25.11
CDC	1098064	2002-09-11	2021-05-09	2021-03-09	25.33
CDC	1098065	2002-09-11	2021-05-09	2021-03-09	25.36
CDC	1098066	2002-09-11	2021-05-09	2021-03-09	55.77

Titre	Claim	Record Data	Expiry Date	Renewal Date	Area (Ha)
CDC	1098067	2002-09-11	2021-05-09	2021-03-09	55.88
CDC	1098068	2002-09-11	2021-05-09	2021-03-09	25.81
CDC	1098069	2002-09-11	2021-05-09	2021-03-09	27.82
CDC	1098070	2002-09-11	2021-05-09	2021-03-09	28.54
CDC	1098071	2002-09-11	2021-05-09	2021-03-09	38.86
CDC	1098072	2002-09-11	2021-05-09	2021-03-09	55.87
CDC	1098076	2002-09-11	2021-05-09	2021-03-09	4.89
CDC	1098077	2002-09-11	2021-05-09	2021-03-09	14.3
CDC	1098078	2002-09-11	2021-05-09	2021-03-09	16.88
CDC	1098079	2002-09-11	2021-05-09	2021-03-09	36.16
CDC	1098080	2002-09-11	2021-05-09	2021-03-09	38.65
CDC	1098081	2002-09-11	2021-05-09	2021-03-09	36.52
CDC	1098082	2002-09-11	2021-05-09	2021-03-09	36.82
CDC	1098083	2002-09-11	2021-05-09	2021-03-09	50.28
CDC	1098084	2002-09-11	2021-05-09	2021-03-09	55.86
CDC	1098096	2002-09-11	2021-05-09	2021-03-09	55.86
CDC	1098104	2002-09-11	2021-05-09	2021-03-09	25.51
CDC	1098105	2002-09-11	2021-05-09	2021-03-09	13.04
CDC	1098106	2002-09-11	2021-05-09	2021-03-09	5.21
CDC	1098107	2002-09-11	2021-05-09	2021-03-09	6.93
CDC	1098108	2002-09-11	2021-05-09	2021-03-09	40.38
CDC	1098118	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1098119	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1098120	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1098121	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1098122	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1098123	2002-09-11	2021-05-09	2021-03-09	55.84
CDC	1098137	2002-09-11	2021-05-09	2021-03-09	34.6
CDC	1098138	2002-09-11	2021-05-09	2021-03-09	9.95
CDC	1098143	2002-09-11	2021-05-09	2021-03-09	52.13
CDC	1098144	2002-09-11	2021-05-09	2021-03-09	43.22
CDC	1098145	2002-09-11	2021-05-09	2021-03-09	36.24
CDC	1098146	2002-09-11	2021-05-09	2021-03-09	7.95
CDC	1098147	2002-09-11	2021-05-09	2021-03-09	9.91
CDC	1098150	2002-09-11	2021-05-09	2021-03-09	55.82
CDC	1098151	2002-09-11	2021-05-09	2021-03-09	55.82
CDC	1098152	2002-09-11	2021-05-09	2021-03-09	55.82
CDC	1098153	2002-09-11	2021-05-09	2021-03-09	55.82
CDC	1098157	2002-09-11	2021-05-09	2021-03-09	55.89
CDC	1098158	2002-09-11	2021-05-09	2021-03-09	55.89
CDC	1098159	2002-09-11	2021-05-09	2021-03-09	55.89
CDC	1098160	2002-09-11	2021-05-09	2021-03-09	36.25
CDC	1098161	2002-09-11	2021-05-09	2021-03-09	30.31
CDC	1134230	2005-11-04	2021-05-09	2021-03-09	7.97
CDC	1134231	2005-11-04	2021-05-09	2021-03-09	5.78
CDC	2438781	2016-03-30	2020-03-29	2020-01-27	55.82

<b>Titre</b>	<b>Claim</b>	<b>Record Data</b>	<b>Expiry Date</b>	<b>Renewal Date</b>	<b>Area (Ha)</b>
CDC	2443561	2016-04-27	2020-04-26	2020-02-24	7.99
CDC	2449153	2016-06-15	2020-06-14	2020-04-14	55.89
CDC	2491530	2017-05-04	2021-05-03	2021-03-03	55.84
CDC	2491531	2017-05-04	2021-05-03	2021-03-03	55.81
CDC	2491532	2017-05-04	2021-05-03	2021-03-03	55.8
CDC	2491533	2017-05-04	2021-05-03	2021-03-03	55.8
CDC	2491534	2017-05-04	2021-05-03	2021-03-03	55.84
CDC	2491535	2017-05-04	2021-05-03	2021-03-03	55.84
CDC	2491536	2017-05-04	2021-05-03	2021-03-03	55.84
CDC	2491537	2017-05-04	2021-05-03	2021-03-03	55.84
CDC	2491538	2017-05-04	2021-05-03	2021-03-03	55.84
CDC	2491539	2017-05-04	2021-05-03	2021-03-03	55.83
CDC	2491540	2017-05-04	2021-05-03	2021-03-03	55.83
CDC	2491541	2017-05-04	2021-05-03	2021-03-03	55.83
CDC	2491542	2017-05-04	2021-05-03	2021-03-03	55.83
CDC	2491543	2017-05-04	2021-05-03	2021-03-03	55.83
CDC	2491544	2017-05-04	2021-05-03	2021-03-03	55.83
CDC	2491545	2017-05-04	2021-05-03	2021-03-03	55.83
CDC	2491546	2017-05-04	2021-05-03	2021-03-03	55.83
CDC	2491547	2017-05-04	2021-05-03	2021-03-03	55.83
CDC	2491548	2017-05-04	2021-05-03	2021-03-03	55.83
CDC	2491549	2017-05-04	2021-05-03	2021-03-03	55.83
CDC	2491550	2017-05-04	2021-05-03	2021-03-03	55.83
CDC	2491551	2017-05-04	2021-05-03	2021-03-03	55.82
CDC	2491552	2017-05-04	2021-05-03	2021-03-03	55.82
CDC	2491553	2017-05-04	2021-05-03	2021-03-03	55.82
CDC	2491554	2017-05-04	2021-05-03	2021-03-03	55.82
CDC	2491555	2017-05-04	2021-05-03	2021-03-03	55.82
CDC	2491556	2017-05-04	2021-05-03	2021-03-03	55.82
CDC	2491557	2017-05-04	2021-05-03	2021-03-03	55.82
CDC	2491558	2017-05-04	2021-05-03	2021-03-03	55.82
CDC	2491559	2017-05-04	2021-05-03	2021-03-03	55.82
CDC	2491560	2017-05-04	2021-05-03	2021-03-03	55.82
CDC	2491561	2017-05-04	2021-05-03	2021-03-03	55.82
CDC	2491562	2017-05-04	2021-05-03	2021-03-03	55.82
CDC	2491563	2017-05-04	2021-05-03	2021-03-03	55.82
CDC	2491564	2017-05-04	2021-05-03	2021-03-03	55.82
CDC	2491565	2017-05-04	2021-05-03	2021-03-03	55.82
CDC	2491566	2017-05-04	2021-05-03	2021-03-03	55.82
CDC	2491567	2017-05-04	2021-05-03	2021-03-03	55.81
CDC	2491568	2017-05-04	2021-05-03	2021-03-03	55.81
CDC	2491569	2017-05-04	2021-05-03	2021-03-03	55.81