Sabina GOLD & SILVER CORP.

National Instrument (NI) 43-101 Technical Report 2021 Updated Feasibility Study for the Goose Project at the Back River Gold District Nunavut, Canada

QUALIFIED PERSONS:

Denis Thibodeau, P.Eng.
John Morton Shannon, P.Geo.
Dinara Nussipakynova, P.Geo.
Jacinta Klabenes, P.Eng., PE
Maurice Mostert, F.Aus.IMM
Neda Farmer, P.Eng.
Stacy Freudigmann P.Eng., F.Aus.IMM
Ben Peacock, P.Eng.
Richard Cook, P.Geo.
Amber Blackwell, P.Geo.
Michael Dawson, P.Eng.
Vincy Benjamin, P.Eng., PMP
John Kurylo, M.Sc. P.Eng.
Shervin Teymouri, P.Eng., M.Eng.

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Knight Piésold CONSULTING · srk · DT ENGINEERS · canenco · AMC consultants mine smarter · MP Mining Plus · Sacré-Davey

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28.7 Stacy Freudigmann, P.Eng., F.Aus.IMM. 28-7
28.8 Ben Peacock, P.Eng 28-8
28.9 Richard Cook, P.Geo. (Limited) 28-9
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28.13 John Kurylo, M.Sc, P.Eng. 28-13
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Acronyms, Abbreviations, and Units of Measure

$	Canadian dollar
2 x 2	two-week-on, two-week-off
2-D	two-dimensional
3-D	three-dimensional
AA	atomic absorption
AAS	atomic absorption spectroscopy
Ag	silver
ALS	ALS Global
AMC	AMC Mining Consultants (Canada) Ltd.
AN	ammonium nitrate
ANFO	ammonium nitrate fuel oil
ARD	acid rock drainage
ASPPR	Arctic Shipping Pollution Prevention Regulations
Au	gold
AWPPA	*Arctic Waters Pollution Prevention Act*
BIF	banded iron formation
BMA	bulk mineral analysis
BML	Base Metallurgical Laboratories Ltd.
BRJV	Back River Joint Venture
BV	Bureau Veritas
BWi	Bond ball mill work index
Canenco	Canenco Consulting Corp.
CAPEX	capital expenditure or capital cost
CA-TIMS	chemical abrasion thermal ionization mass spectrometry
CCA	capital cost allowance
CCME	Canadian Council of Ministers for the Environment
CDE	Canadian Development Expenses
CEE	Canadian Exploration Expenses
CESCC	Canadian Endangered Species Conservation Council
CF	cut-and-fill
CHP	combined heat and power
CIL	carbon-in-leach
CIM	Canadian Institute of Mining, Metallurgy and Petroleum
CIM Definition Standards	*CIM Definition Standards for Mineral Resources & Mineral Reserves*
CIP	carbon-in-pulp
CIRNAC	Crown-Indigenous Relations and Northern Affairs Canada
CN	cyanide
CN_{WAD}	weak acid dissoluble cyanide
COG	cut-off grade
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPP	Canada Pension Plan

CRF	cemented rockfill
CRM	certified reference material
CSS	closed side setting
$CuSO_4$	copper sulphate
d	day
D1	Large scale folding and down-warping of volcanic margins
D2	Later uplift causing foliation development
D3	Formation of a sub-vertical foliation
Datamine	Datamine Studio RM (Version 1.6)
DEXRT	dual energy X-ray transmission
DF	drift-and-fill
DFO	Department of Fisheries and Oceans
DIF	deep iron formation
DO	dissolved oxygen
DPM	Dundee Precious Metals Inc.
DT	DT Engineers Ltd.
DWT	deadweight tonnage
EA	Environmental Assessment
ECCC	Environment and Climate Change Canada
EI	Employment Insurance
elution	carbon stripping
EM	electromagnetic
EPCM	engineering, procurement, and construction management
ERD	Explosives Regulatory Division
ERT	emergency response team
FA	fire assay
FAR	fresh-air raise
FEIS	Final Environmental Impact Statement
FLS	FLSmidth
G&A	general and administrative
GST	Goods and Services Tax
g/t	grams per tonne
genset	diesel-fired reciprocating engine generator sets
GNWT	Government of the Northwest Territories
GPS	Global Positioning System
GRAV	gravimetric
GRG	gravity recoverable gold
GTC	ground temperature cables
h	hour
HCl	hydrochloric acid
$HClO_4$	perchloric acid
HDPE	high-density polyethylene

HF	hydrogen flouride
HLEM	horizontal-loop electromagnetic
HNO_3	nitric acid
Homestake Mineral	Homestake Mineral Development Company Ltd.
HTO	Hunters and Trappers Organization
ICP	inductively coupled plasma
ICP-MS	inductively coupled plasma mass spectrometry
ID^2	inverse distance squared
ID^3	inverse distance cubed
IFR	Instrument Flight Rules
IIBA	Inuit Impact and Benefit Agreement
IOL	Inuit-Owned Lands
IP	induced polarization
IRR	internal rate of return
ITC	investment tax credit
JDS	JDS Energy & Mining Inc.
K	hydraulic conductivity
kg	kilogram
KIA	Kitikmeot Inuit Association
Kinross	Kinross Gold Corp.
Kit	Kit Resources Ltd.
km	kilometre
Knight Piésold	Knight Piésold Ltd.
kPa	kilopascal
kPag	kilopascal gauge
kV	kilovolt
kW	kilowatt
kWh	kilowatt hour
L	litre
LA	laser ablation
LA-ICP-MS	laser ablation inductively coupled plasma mass spectrometer
lb	pound
LCPn, LCPs	LCP North, LCP South
LDL	lower detection limit
LG	Lerchs–Grossman
LHD	load-haul-dump
$LiBO_2$	lithium metaborate
LiDAR	light detection and ranging
LIF	lower iron formation
Loc1, Loc2	Locale 1, Locale 2
LOM	life of mine
LSA	Local Study Area

m	metre
m^3	cubic metre
masl	metres above sea level
µm	micrometre (micron)
MCC	motor control centre
MCRP	Mine Closure and Reclamation Plan
MDMER	Metal and Diamond Mining Effluent Regulations
MineSight	Hexagon Mining MineSight™
Miramar	Miramar Mining Corporation
ML	million litres
ML/ARD	metal-leaching/acid rock drainage
MLA	Marine Laydown Area
mm	millimetre
Mm^3	million cubic metres
Moz	million troy ounces
MP	Mining Plus
MPa	million pascal
MPC	mine production composites
MS	mass spectrometer
MSO	mineable shape optimizer
Mt	million tonnes
Mt/a	million tonnes per annum
MW	megawatt
MWh	megawatt hour
NaCN	sodium cyanide
NI 43-101	National Instrument 43-101
NIRB	Nunavut Impact Review Board
NIS	near-infrared spectroscopy
NLCA	Nunavut Land Claim Agreement
NN	nearest neighbour
NPAG	non-potentially acid generating
NPC	Nunavut Planning Commission
NPV	net present value
$NPV_{5\%}$	net present value at a 5% discount
NPVS	NPV Scheduler
NRC	Natural Resources Canada
NSR	net smelter return
NTI	Nunavut Tunngavik Inc.
NTKP	Naonaiyaotit Traditional Knowledge Project
NMR	Nunavut Mining Regulations
NWB	Nunavut Water Board
NWT	Northwest Territories

OK	ordinary kriging
OPEX	operating expenditure
oz	troy ounce
P_{80}, P_{95}	80% passing
Pa	pascal
PAG	potentially acid generating
$PbNO_3$	lead nitrate
PCS	plant control system
PDC	process design criteria
PEA	Preliminary Economic Assessment
Pocock	Pocock Industrial
Port	Marine Laydown Area
ppb	parts per billion
PPCF	post pillar cut and fill
ppm	parts per million
pre-ox	pre-oxidation
Project	Goose Project
psi	pounds per square inch
PST	provincial sales tax
PwC	PricewaterhouseCoopers
pXRF	portable X-ray fluorescence
QA/QC	quality assurance/quality control
QEMSCAN	quantitative evaluation of minerals by scanning electron microscopy
QFP	quartz-feldspar porphyry dykes
QP	Qualified Person
RAR	return-air raise
RMR	rock mass rating
RO	reverse osmosis
ROM	run-of-mine
ROQ	run of quarry
RPA	Roscoe Postle Associates Inc.
RPD	relative paired difference
RQD	rock quality designation
RSA	Regional Study Area
RSG	RSG Global Consulting Pty Ltd.
Sabina	Sabina Gold & Silver Corp.
SARA	*Species at Risk Act*
SDE	Sacré-Davey Engineering
SG	specific gravity
SGS	SGS Mineral Services
SL	Slave deposit
SMBS	sodium metabisulphite

SO_2	sulphur dioxide
SRK	SRK Consulting (Canada) Inc.
Stea	Stea Surficial Geology Services
STP	sewage treatment plant
SWP	saline water pond
t/d	tonnes per day
TC	Transport Canada
TDEM	time-domain electromagnetic
TDS	total dissolved solids
Technical Report	the present report
TEU	twenty-foot equivalent unit
TF	tailings facility
TK	Traditional Knowledge
TMS	trace mineral search
TOMRA	TOMRA Systems ASA
TS	tailings storage
TSF	tailings storage facility
TSL	TSL Laboratories
TSS	total suspended solids
UCS	uniaxial compressive strength
UDL	upper detection limit
UIF	upper iron formation
Updated Feasibility Study	the present report
URF	unconsolidated rockfill
US$	United States dollar
UV	ultra-violet
VC	variability composite
VEC	valued ecosystem components
VHF	very-high frequency
VTEM	versatile time-domain electromagnetic
WBS	work breakdown structure
WCB	Workers Compensation Board
WGM	Watts, Griffis and McOuat Limited
WIR	winter ice road
WRSA	waste rock storage area
XRF	X-ray fluorescence

1 SUMMARY

This *National Instrument 43-101 (NI 43-101) Technical Report, 2021 Updated Feasibility Study for the Goose Project at the Back River Gold District, Nunavut, Canada* (Technical Report or Updated Feasibility Study) presents the scope, design features, and economic viability of the Goose Project (Project) in southwestern Nunavut. In 2020, Sabina Gold & Silver Corp. (Sabina) commissioned Sacré-Davey Engineering (SDE) to lead the compilation of this report which supersedes the 2015 JDS Energy & Mining Inc. (JDS) *Technical Report for the Initial Project Feasibility Study on the Back River Gold Property, Nunavut, Canada*.

All dollar figures quoted in this Technical Report refer to Canadian dollars ($) unless otherwise noted.

The following companies contributed to this Technical Report:

- SDE—on-site infrastructure, logistics, capital costs, operating costs, financial analysis, and report preparation
- Mining Plus (MP)—Mineral Reserves estimate, mining, capital costs, and operating costs
- DT Engineers Ltd. (DT)—off-site infrastructure, camp, and balance of plant
- Canenco Consulting Corp. (Canenco)—processing and metallurgy
- AMC Mining Consultants (Canada) Ltd. (AMC)—geology and Mineral Resources
- SRK Consulting (Canada) Inc. (SRK)—water management infrastructure, tailings deposition approach, as well as surface geotechnical and permafrost considerations
- Knight Piésold Ltd. (Knight Piésold)—mine geomechanics, tailings disposal, water management planning, environment, geochemistry, and mine closure.

1.1 Project Concept

The Updated Feasibility Study consists of open pit and underground mining at the Goose Site that will feed a 3,000 t/d whole-ore leach process plant increasing throughput to 4,000 t/d in Year 2. Open pit mining will begin two years prior to mill commissioning to generate a stockpile of mill feed. The mill will then operate for 15 years of production. The plan is designed to produce doré bullion at an average of approximately 287,000 oz of gold per year in the first five years and approximately 223,000 oz of gold per year over the life-of-mine (LOM). A total of 18.7 Mt of ore is planned to be mined at a mill head grade of 6.0 g/t and a projected gold recovery of 93.4%. A total of 3.35 Moz of gold is projected to be recovered over the LOM.

The Project will be constructed over a 36-month period at an initial capital cost of $610 million. Thickened tailings will be stored in open pits as they become available, with the first open pit (Echo) mined out before any ore processing (and associated tailings deposition) takes place.

Although Mineral Resources for both the Goose and George sites are reported here, only the Goose Site resources are considered for the feasibility level mining assessment, as documented in this Technical Report.

1.2 Property Location and Access

The Property lies approximately 520 km northeast of Yellowknife, Northwest Territories (NWT), 225 km east of the closed Lupin gold mine, 50 km southeast of Glencore Plc's Hackett River Project, 285 km south of Agnico Eagle's Hope Bay Project (Doris), and 95 km southeast of the southern end of Bathurst Inlet.

The Property is currently accessed and supplied by air, using a combination of both seasonal ice and all-weather airstrips at the Goose Site. During the construction phase and throughout the LOM, in the summer open-water season ocean-going vessels will transport most equipment, supplies, and fuel to Sabina's port, the Marine Laydown Area (MLA or the Port) on the southern portion of Bathurst Inlet. Materials will then be transported to the Goose Site by tractor-trailers and road tankers using winter ice roads (WIR). Employees will work on a fly-in/fly-out shift-rotation basis and be housed in fully catered camps.

1.3 Property Ownership and History

The Property is 100% controlled by Sabina and is subject to net smelter return (NSR) royalties on the Goose and George sites, payable to various third parties. Additionally, an income-tax-deductible net profit royalty is payable to the Crown.

Since exploration began in 1982, the Property has had several owners under both joint venture and direct ownership, with various operators: Homestake Mineral Development Company Ltd. (Homestake Mineral) supported periods of intensive exploration from 1987 to 1996; Kit Resources Ltd. (Kit) from 1997 to 1998; Kinross Gold Corp. (Kinross); and Miramar Mining Corporation (Miramar) from 1999 to 2005. Dundee Precious Metals Inc. (DPM) operated from 2005 up to 2009, when Sabina purchased the Property. Since taking ownership, Sabina has explored the Property with several multi-faceted campaigns. To date there has been no recorded gold production from any of the Property's deposits.

1.4 Geology and Mineralization

The Property displays structurally controlled gold mineralization, which is largely strata bound, within broad zones of sulphidized iron formation associated with quartz veins, silicification, and shearing. The gold mineralization occurs within silicified and variably sulphidized iron formation and, to a lesser extent, meta-sedimentary units that commonly have a spatial association with narrow porphyritic felsic dykes, wherever these units are present. Gold Mineral Resources are estimated within two principal areas of the Back River Property: the Goose and George sites. This Updated Feasibility Study focuses on advancing the Goose Site only and does not incorporate the George Mineral Resources for economic analysis.

The Goose Site consists of six main deposits that contain predominantly structurally controlled gold mineralization: Goose Main, Echo, Umwelt, Llama, Llama Extension and Nuvuyak. Gold mineralization is predominantly hosted within the lower iron formation (LIF) and, to a much lesser extent, the underlying sediments. The Goose Main, Umwelt, Llama, Llama Extension, and Nuvuyak deposits are associated with anticlinal structures that have been structurally thickened and disrupted, and cut by axial-plane parallel felsic dykes, which apparently trace in close proximity with fluid pathways that are related to mineralization.

The Echo deposit is associated with secondary open folding of iron formation and a cross-cutting felsic dyke. Mineralization is spatially associated with the felsic dyke.

Nuvuyak, a 2018 discovery, is a continuation of the central antiform from the Goose Main deposit and continues through an area of secondary cross-folding down plunge. The gold mineralization is predominantly hosted in polyphase-folded LIF stratigraphy. The tight to isoclinal central antiform geometry is very similar to that of the Goose Main deposit.

The George Site consists of six main deposits: LCP North (LCPn), LCP South (LCPs). Locale 1 (Loc1), Locale 2 (Loc2), GH, and Slave (SL). Gold mineralization is located within oxide iron formations near the stratigraphic base of this unit. Less significant gold mineralization is also hosted within a silicate iron formation. Gold-bearing zones are associated with sulphide concentrations in the iron formation and are commonly accompanied by increased quartz veining and attendant alteration of the surrounding rocks.

In addition, the Boulder and Boot prospects similarly consist of folded Beechey Lake sedimentary rocks with intercalated iron formations. The Del prospect contains the same folded sedimentary rocks as the other areas but lacks any observed iron formation horizons.

1.5 Metallurgy

Multiple historical testwork programs have been undertaken, including comminution, process mineralogy, mineral sorting, and gold recovery by gravity concentration, flotation, and cyanidation. Significant mineralogical characterization studies, focusing on gold occurrence in various mineral samples across the deposits, have also been undertaken.

In early 2013, a comprehensive test program was conducted to further assess the metallurgical performance of the mineralization to support the Prefeasibility Study. A subsequent and more-detailed test program to support the Initial Feasibility Study on the Property commenced in late 2013 and concluded mid-2014 (JDS, 2015b). Additional testing programs were completed from 2016 to 2020 to provide additional information to support this Technical Report. The additional testing focused on ultrafine grindability, tailings characteristics using composite samples, and variability characterization between and within ore zones. In 2020, a gap analysis was undertaken, and further optimization on the detoxification process was performed, as well as additional variability programs on Umwelt mineralization using the current optimized flowsheet parameters to update the recovery prediction.

The testwork indicated that, similarly to the historical testwork, the mineral samples collected responded well to gravity concentration and cyanidation and showed a high degree of consistency. The previously developed process flowsheet was used to test the mine plan composites and Umwelt mineralized zones. Other engineering data were also generated, including tailings settling and viscosity, oxygen uptake and detoxification data. The 2020 test results were comparable to the results produced from the historical test programs.

Based on the current and historical test results, a combination of gravity separation and cyanide leach processes is proposed for the Project. The concentrate from the gravity separation circuit will be leached separately.

The 2020 key result parameters are summarized as follows:

- A primary grind 80% passing (P_{80}) of approximately 50 μm
- Gravity recovery, followed by:
  - Pre-oxidation of the gravity tailings for 16 h at 50% solids
  - Leach of the pre-oxygenated gravity tailings for 48 h at 50% solids; pH 11; dissolved oxygen (DO) above 20 ppm; 20 g/t $PbNO_3$; a NaCN concentration of 500 ppm; the last NaCN addition at 24 h, and the level of CN allowed to drift down to the 48 h termination.
- The average overall gold recovery for the Umwelt variability composites tested with the current flowsheet is 93.4%. After solution losses, the process design criteria gold recovery for the Umwelt mineralization is estimated at 92.9%.

For the detoxification circuit the key process parameters are as follows:

- SO_2 to weak acid dissoluble cyanide ratio (CN_{WAD}) at 5.0:1
- $CuSO_4$ addition at 20 mg/L
- Retention time at 90 min
- pH at 9.0
- Pulp density at 45%
- Target DO of 8 ppm.

Testwork results were used to determine the metallurgical recoveries for each of the deposits, as shown in Table 1-1.

Table 1-1: Gold Recovery Projections

Mineral Zone	Estimated Gold Recovery (%)
Umwelt	92.9
Llama	92.0
Goose Main	95.0
Echo	95.0
George	95.0
LOM	93.4

Source: Canenco, 2020.

1.6 Mineral Resource Estimate

The Property contains an estimated Measured and Indicated Resource of 33.5 Mt at 5.88 g/t Au, containing 6.32 Moz Au, and an Inferred Resource of 13.8 Mt at 6.44 g/t Au containing 2.86 Moz (Table 1-2). Mineral Resources are reported for both the Goose and George sites. However, this Updated Feasibility Study focuses on advancing the Goose deposits: Llama, Llama Extension, Umwelt, Echo, Nuvuyak, and Goose Main.

Table 1-2: Summary of Mineral Resources as of 31 December 2020

Resource Classification	Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)
Measured	9,707	5.75	1,796
Indicated	23,745	5.93	4,525
Measured and Indicated	33,452	5.88	6,321
Inferred	13,794	6.44	2,856

Source: AMC, 2020.

Notes: CIM Definition Standards for Mineral Resources & Mineral Reserves (CIM, 2014) was used for reporting the Mineral Resources.
The Qualified Person is Dinara Nussipakynova, P.Geo., of AMC.
Measured and Indicated Mineral Resources are inclusive of Mineral Reserves.
Metal price: US$1,550/oz for gold.
Exchange rate: C$1.31:US$1.00 exchange rate.
Process Recovery: Goose deposits is 93% and for George deposits is 95%.
COG: for Goose and George deposits, open pit is 1.4 g/t Au; Goose deposits underground is 3.0 g/t Au; George deposits underground is 3.5 g/t Au.
Goose Mineral Resources deposits are Goose Main, Umwelt, Echo, Llama, Llama Extension, and Nuvuyak.
George Mineral Resources deposits are LCPn, LCPs, Loc1, Loc2, GH, and SL.
Open pit Mineral Resources are constrained by an optimized pit shell using gold price and exchange rate stated above.
The George underground Mineral Resources were estimated within mineral domains expanded to a minimum horizontal width of 2 m.
Drilling results for Goose Main, Echo, Llama Extension and Nuvuyak are up to 15 November 2020.
Drilling results for Umwelt are up to 16 October 2020.
Drilling results for Llama and all George deposits are up to 31 December 2013.
The numbers may not add due to rounding.

The open pit Mineral Resources for the Goose deposits are reported within conceptual open pit designs at a 1.4 g/t Au cut-off. The underground Mineral Resources are reported at a 3.0 g/t Au cut-off.

The open pit Mineral Resources for the George deposits are reported within conceptual open pit designs at a 1.4 g/t Au cut-off. The underground Mineral Resources are reported at a 3.5 g/t Au cut-off, with the wireframes expanded to a minimum 2 m mining width.

In both cases a gold price of US$1,550/oz and an exchange rate of C$1.31:US$1.00 were used.

The Mineral Resource estimate is based on geologic block models that incorporated the following data within the mineralization wireframes:

- 722 drill holes (for a total of 234,168 m and 126,341 assays) at the Goose Site on the Llama, Llama Extension, Umwelt, Echo, Nuvuyak, and Goose Main deposits
- 633 drill holes (for a total of 120,981 m and 43,892 assays) at the George Site on the LCPn, LCPs, Loc1, Loc2, GH, and SL deposits.

Mineralized domains were constructed to constrain the estimates using a gold threshold of 0.3 g/t for most deposits at the Goose Site and all deposits at the George Site. Capping was employed where required and varied by deposit. Data density allowed for Measured Mineral Resources to be classified at the Goose Main, Llama, and Umwelt deposits. Indicated Mineral Resources were reported at Goose Main, Echo, Llama, Umwelt, and the

George deposits, with Inferred Mineral Resources reported for all deposits, including Llama Extension and Nuvuyak.

1.7 Mineral Reserve Estimate

The Mineral Reserve estimate for the Property is based on the Mineral Resource estimate that AMC completed for the Llama, Umwelt, Goose Main, and Echo deposits, with an effective date of 31 December 2020.

The Mineral Reserves were developed by examining each deposit to determine the practical mining method. Cut-off grades (COG) were then estimated based on appropriate mine design criteria and the adopted mining method. Llama, Umwelt, Goose Main, and Echo will be mined via both open pit and underground methods. A truck-and-shovel method was chosen for open pit mining. The underground methods chosen were drift-and-fill (DF) for Llama and Goose Main, cut-and-fill (CF) for Umwelt, and longhole stoping for Echo. For the purposes of this Updated Feasibility Study, no Mineral Reserves are reported from the George Site as the George deposits are not part of this study.

The estimated Proven and Probable Mineral Reserves total 18.7 Mt at 5.97 g/t Au, containing 3.6 Moz Au (Table 1-3).

Table 1-3: Summary of Estimated Mineral Reserves (as of 15 January 2021)

Area	Classification	Diluted Tonnes ('000s)	Diluted Grade (Au g/t)	Contained Au (oz '000s)
Total Open Pit	Proven	7,471	5.42	1,302
	Probable	2,412	4.80	372
Total Underground	Proven	537	7.21	124
	Probable	8,272	6.73	1,790
Total Back River Property	Proven	8,008	5.54	1,426
	Probable	10,684	6.29	2,162
Total Proven and Probable	**Open Pit & Underground**	**18,692**	**5.97**	**3,588**

Source: MP, 2021.

The Mineral Reserve estimation takes into consideration on-site operating costs (e.g., mining, processing, site services, freight, and general and administrative [G&A]), geotechnical analysis, metallurgical recoveries, and selling costs. In addition, the Mineral Reserves incorporate allowances for mining recovery and dilution, and overall economic viability.

1.8 Mining Operations

Two years of pre-production are planned (Year −2 and Year −1) with 15 years of production (Year 1 through Year 15). Simultaneous open pit and underground mining is projected to provide the process plant feed at the following rates:

- 0.9 Mt/a in Year 1 (1 year)—mill ramp-up year, reaching 3,000 t/d in Q4 Year 1
- 1.2 Mt/a in Year 2 (1 year)—mill upgrade, increasing production rate to 4,000 t/d in Q4 Year 2
- 1.5 Mt/a from Year 3 (remaining mine life).

Annual mine production of ore and waste is profiled to peak at 12.2 Mt/a from the open pits, with a LOM waste-to-ore stripping ratio of 10:1. Ore production from underground mining will peak at 0.8 Mt/a, and will supplement the feed from the open pits. To optimize Project cash flow, the run-of-mine (ROM) ore is planned to be segregated into high-, medium-, and low-grade stockpiles located adjacent to the processing plant. The high-grade stockpile contains material greater than 8 g/t Au. The medium-grade stockpile contains material between 5 and 8 g/t Au. The low-grade stockpile contains material below 5 g/t Au but above the respective COG. These stockpiles will also serve to buffer mill processing from mining production. The ore production schedule is shown in Table 1-4.

Table 1-4: Run-of-Mine Ore Production Schedule for Open Pit and Underground Mining

Deposit	Unit	Pre-Production	Years 1 to 5	Years 6 to 10	Years 11 to 15	Total
Open Pit						
Echo	t ('000s)	260	-	-	-	260
Umwelt	t ('000s)	1,900	800	-	-	2,700
Llama	t ('000s)	-	1,840	-	-	1,840
Goose Main	t ('000s)	-	940	2,780	1,370	5,090
Underground						
Umwelt	t ('000s)	-	2,110	2,680	2,420	7,210
Llama	t ('000s)	-	750	20	-	770
Goose	t ('000s)	-	-	420	110	530
Echo	t ('000s)	-	-	290	-	290
Overall						
Total Ore Mined	t ('000s)	2,170	6,440	5,910	4,190	18,690
Plant Feed	t ('000s)	-	6,500	7,300	4,900	18,690
Head Grade	g/t Au	-	7.4	5.3	5.1	6.0
Recovery	%	-	93	94	94	93.4
Average Annual Mined Metal	oz ('000s)	0	309	248	160	239

Source: MP, 2021.

The underground mining areas are scheduled to target higher grade material to be delivered from the Umwelt and Llama deposits early in the mine life.

Mining will begin at the Goose Site in Year −2 at the Echo pit to provide waste rock for construction and enable the stockpiling of ore prior to the start of plant processing. Open pit mining will then transition sequentially to the Umwelt, Llama, and Goose Main pits. Open pit mining will be completed during Year 12. Underground mining will commence in Year −1 with the Umwelt decline. Underground ore production at Umwelt will begin in Year 1 and will continue into Year 15. The remaining underground deposits are mined in parallel with the Umwelt underground, but in the following sequence: Llama, Goose, and finally Echo.

Open pit mining operations will use a fleet comprising 7 m^3 shovels, a 10 m^3 front-end loader, 4 m^3 excavators, and 64-tonne haul trucks. This fleet will be supplemented by drills, graders, and track and rubber-tire dozers. A 5 m bench height was selected for mining in ore and waste, with overall 20 m effective bench heights based on a quadruple-bench configuration.

Underground mining operations will be carried out using DF, CF, and longhole stoping mining methods and will use a combination of two-boom jumbos, longhole production drills, 14-tonne load-haul-dump (LHD) vehicles, and 45-tonne haul trucks.

1.9 Recovery Methods

The process plant was designed to produce gold doré using conventional crushing, grinding, gravity concentration, pre-oxidation, gold leaching by cyanidation, gold adsorption by carbon-in-pulp (CIP), and gold recovery from loaded carbon and gravity concentrate. Cyanide destruction of the tailings will be by sodium metabisulphite (SMBS). The overall design philosophy uses proven equipment with a simple and conventional single-line process flow that can be operated and maintained effectively in an Arctic environment.

The nameplate expansion of the process plant from 3,000 t/d to 4,000 t/d is planned for Year 2 of operations. The existing process plant equipment has been selected to allow for expansion with reduced rework.

The process plant includes the following:

- Three-stage crushing circuit reducing ROM mineralized material to P_{80} approximately 9.5 mm
- Fine ore stockpile (feeding the mill) with a live capacity of 2,000 tonnes
- Grinding and gravity circuit comprising a ball mill (P_{80} approximately 106 µm), a fine grind mill (P_{80} approximately 50 µm), and three centrifugal gravity concentrators
- Cyanide leaching and carbon adsorption circuit
- Carbon stripping and reactivation circuit
- Gold electrowinning and refining circuit producing bullion
- Tailings handling circuit, including cyanide destruction with sodium metabisulphite SMBS and thickening.

The plant expansion includes:

- Additional tertiary crusher
- Additional secondary grinding mill, being fed a P_{80} of approximately 212 µm
- Pump, classification, and material handling capacity upgrades.

1.10 Project Infrastructure

1.10.1 Existing Infrastructure

Goose Site

In past years, Sabina's team has prepared a 4 km network of roads around the Goose plant site, with access roads that tie the exploration camp site to the quarry sources, Echo pit, the plant site, and the Umwelt decline location. In past years, over 1 ML of fuel were stored. Sabina has a fully functional airstrip that is 4,500 by 100 ft that can cater to a loaded (~22,000 kg) C-130 Hercules. There are two seasonally operational ice airstrips that will carry larger loads if needed. These ice strips have been used in previous years. Sabina has been operating from a

150-person exploration camp with kitchen, dining, and recreational facilities. The camp has all the necessary potable water and incinerator ancillary systems to support its operations. The Goose site is also equipped with two fully functional 12 x 18 m workshops, and work can be performed year-round. Adequate quarry sources have been identified, and sufficient laboratory testing was completed to check the potentially acid generating (PAG) and non-potentially acid generating (NPAG) characteristics. Sabina has invested in a fleet of equipment to assist in earthwork, mining, and process plant construction.

MLA Site

The MLA (Sabina's Port) has a fully functional and efficient 40-person camp with kitchen and dining facilities. There is a 3,000 ft gravel airstrip that is completely operational. For receiving sea freight there is a fully functional unloading pad with roll-on roll-off equipment to support the undertakings, and a laydown area that can accommodate approximately 800 containers. Additionally, the camp facility is supported by a 12 x 18 m workshop to support logistics and a similar workshop for the WIR program. Sabina has successfully operated three sealift programs and one WIR program. In 2019, Sabina successfully constructed and operated a 172 km WIR and has the necessary equipment and support infrastructure to run future programs. During the 2019 campaign, Sabina also built a 10 ML fuel tank farm with containment at the MLA. The Updated Feasibility Study includes additional storage capacity for 30 ML prior to commissioning with a further 15 ML to be installed during mine operations, for a total of 55 ML of capacity at the MLA. Sabina has invested in an equipment fleet to assist in logistics support and WIR requirements.

1.10.2 Planned Infrastructure

Due to the Property's remoteness, significant infrastructure is required for freight, power generation, and worker accommodation. Both the MLA and Goose sites will have bulk fuel storage tanks; laydown yards; diesel power plants; maintenance shops; accommodation camps; water and domestic waste management facilities; and satellite communications. Existing all-weather airstrips will be used at the Goose and MLA sites. In winter these sites will be connected by a WIR. All-weather roads allow for year-round access within each site.

The major infrastructure related to the mining and processing operations at the Goose Site includes the process plant; tailings storage (TS); waste rock storage areas (WRSA); water-management drainage and storage ponds; and haul roads and equipment to service the open pit and underground mines. The central administration block will be at the Goose Site.

The MLA will support the seasonal trans-shipment and staging of construction and operational freight. Because access to the Property is seasonal, the types and capacities of the Project infrastructure need to be able to store and transport the required quantities of equipment, materials, and supplies. Diesel will be received and stored in tanks at the MLA, providing sufficient capacity for peak operating needs of power generation and mobile equipment for one year. Similarly, subsequent annual requirements for consumables, such as processing reagents, maintenance materials, and bulk supplies, will be stored in heated or cold storage warehouses, laydown yards, and sea containers.

The installed power-generating capacity will be 18 MW at the Goose Site and 0.675 MW at the MLA. Buildings and facilities at the Goose Site will be heated by heat recovered from the power plant, as well as electric and oil-fired heating systems. The underground mine air will, where required, be heated by a dedicated diesel-fired furnace.

The accommodation complexes will be modular units constructed off-site. The construction phase at the Goose Site will accommodate approximately 500 workers. The construction and operation phases at the MLA will require accommodations for up to approximately 40 workers.

The Property is located within the permafrost region; therefore, infrastructure that is particularly sensitive to differential settlement, such as the process plant and fuel storage tanks, will be built on competent bedrock. Less-sensitive structures and linear surface elements, such as roads, pipelines, and airstrips, will be built on overburden soils and include an appropriate thermal protection layer.

1.11 Tailings Management

The Project will produce a total of 18.7 Mt (15 Mm^3) of tailings over the LOM. As part of this Updated Feasibility Study all the Goose Site tailings will be deposited into the Echo, Umwelt, and Llama pits. Therefore, no large tailings dams are planned for the Project. The move from employing a purpose-built tailings storage facility (TSF) to tailings deposition in pits is a change from the 2015 Feasibility Study. Tailings will be thickened in the process plant and placed sub-aqueously within the pit TS to minimize ice entrainment. The tailings in the Echo Pit will eventually be covered with waste rock, while the tailings in the Umwelt and Llama Pits will have water covers. The Goose Main pit will not be required for tailings disposal, and instead will be the final repository for saline water generated on the Property.

1.12 Waste Rock Management

Over the LOM, approximately 100 Mt of waste rock will be produced from underground and open pit mining, including unconsolidated overburden. Waste rock is categorized as being either PAG or NPAG.

Waste rock will be identified, segregated, and deposited as appropriate during the mining operation. Rock required for constructing pads, roads, and other infrastructure will be sourced from the available NPAG waste rock. The execution plan for Goose is based on sourcing this construction material from the pre-production phase of mining.

Generally, waste rock will be placed in its final location, and configuration within WRSA constructed near the source pits. As per the approved current permit, the closure strategy is for the waste rock to freeze; PAG material will be capped with a 5 m thick NPAG cover.

1.13 Water Management

Water management planning covers all phases of the Project from construction through operations to final closure and considered variations in possible climatic and operational conditions. The MLA does not require water management infrastructure beyond best management practices.

Three types of water will be managed at the Goose Site as follows:

- Contact water—surface water runoff that contacts disturbed areas. This includes runoff from WRSAs, ore stockpiles, open pits, and infrastructure rockfill pads.

- Saline water—groundwater inflows from underground developments that extend below the basement permafrost and open pit mining where a talik zone is present.
- Non-contact water—all other surface runoff that does not contact disturbed areas.

Contact water will be used to meet process water requirements to the extent possible, so that make-up water withdrawals from Goose Lake are minimized. The handling of contact water is also influenced by tailings disposal plans and the suitability of the water for discharge to the environment.

Non-contact water diversions will be constructed to minimize the volume of contact water on site.

The volume of saline water requiring temporary storage on surface will be reduced using reverse osmosis (RO) so that it is less than the available storage, until the final repository (Goose Main pit) becomes available.

Previous mine plans and corresponding water and load balances completed for the Project (JDS, 2015; SRK, 2015a, 2020) did not require discharge of contact water during the construction or operation phases. Under the current mine plan, water is required to be discharged during operations. This is due to the mining of two open pits during the construction phase without concurrent processing (which consumes reclaim water) or the construction of a surface purpose built impoundment TSF (that can provide temporary storage, required) that excess contact water from the open pits and WRSAs will require discharge to the environment. During operations, RO treatment of the saline water will now generate a significant surplus of freshwater. Hence, the discharge of contact water will be required in most years during the operation phase.

An Excel-based annual water balance was developed for the Goose Site to establish water-management plans for construction, operation, and closure phases of the mine.

Water-management facilities associated with the Goose Site will include the following:

- A freshwater intake in Goose Lake, related pipelines, and the water treatment plant.
- A primary pond for storing process water and collecting Umwelt WRSA runoff.
- A saline water pond (SWP) for the temporary storage of saline water and brine from the RO plant.
- An ultra-high recovery RO plant including pre-treatment and subsequent polishing to reduce the volume of saline water to be managed temporarily at surface.
- Event ponds at the Echo and Llama WRSAs and plant site.
- Freshwater diversions intended to minimize the volume of contact water requiring management.
- Surface diversions to temporarily redirect flows around mining areas.
- Barges, temporary intakes, and pipelines associated with lake dewatering (Llama and Umwelt Lakes) and reclaiming water from the primary pond and tailings facilities (TF).
- A water-treatment system in the process plant to treat elevated concentrations of ammonia, arsenic, and copper in reclaim water may be required in Years 6 through 15 of operation.
- Local management of site runoff from development areas during active construction.

Key aspects of water management (lake dewatering, contact water management, and saline water management) are described below.

Lake Dewatering During Construction

Both Llama Lake (natural capacity 0.96 Mm^3) and Umwelt Lake (natural capacity 0.24 Mm^3) will be dewatered to Goose Lake in the open-water season of Year −1 in advance of open pit mining. It is assumed that 50% of the lake water volume will be suitable for direct discharge to Goose Lake via Umwelt Lake. The remaining 50% is assumed to have total suspended solids (TSS) concentrations above the discharge limit and will be treated in a modular water treatment plant. Effluent will be discharged to Umwelt Lake and ultimately flow into Goose Lake.

Contact Water Management

Based on geochemical evaluations of previous mine plans, SRK (2015a) predicted the water quality for runoff from the ore stockpile, tailings beach, WRSAs, pit walls, and pit high walls (applicable to post-closure). Only the tailings beach was found to exceed the discharge limits in Schedule 4 of the Metal and Diamond Mining Effluent Regulations (MDMER) for arsenic. This was a factor in deciding to permanently submerge the tailings at all locations with a 5 m deep water cover.

The annual water balance shows that during each year in construction, there will be a surplus of contact water requiring discharge to the environment. During this period, discharges will occur from the plant site pond and Echo pit and Echo WRSA pond. Water reporting to the Umwelt pit during this period will be pumped to the primary pond for storage, with no discharge required. During operations, contact water from event ponds will be managed in the Echo TF (Years 1 to 3 only), the Umwelt TF or the primary pond. No discharges of contact water will be required in Years 1 and 2. Between Years 3 and 13, an average of 300,000 m^3 of contact water will be discharged to the environment following water treatment for ammonia, arsenic, and copper, as described in Section 20.6.10. In Year 14 and 15, surplus contact water contained in the Umwelt TF and/or primary pond will be pumped to the Llama TF to assist in flooding.

Saline Water Management

Groundwater inflows to the Llama, Umwelt, and Goose Main underground mines are expected to occur where underground workings extend below the permafrost. Groundwater will also flow into the Llama pit due to the presence of an open talik in the dewatered Llama Lake. The groundwater is estimated to be hyper-saline (salinity of 51‰ to 73‰) with $CaCl_2$ and NaCl as the dominant salts, and with salinity increasing with depth (Rescan ERM, 2015). Estimated concentrations of arsenic (0.008 to 0.047 mg/L), boron (2.5 to 5.3 mg/L), iron (0.9 to 8 mg/L), and zinc (0.18 to 1.0 mg/L) are noted due to their naturally enriched concentration relative to the Canadian Council of Ministers for the Environment (CCME) (2015) guidelines for the protection of freshwater aquatic life. This chemistry and elevated salinity increase with depth, which is commonly observed in permafrost environments.

Knight Piésold extrapolated groundwater inflows from SRK's (2015b) previous work to develop saline groundwater estimates for the current mine plan. The geometry of the Llama underground, Llama pit, and Goose Main underground have not changed materially since the previous feasibility study, but the length of time over which each of these have been mined has increased. The higher year-inflow values applied to the additional years of mining.

The Umwelt underground is the main source of groundwater inflows at the Project, previously representing more than 50% of the saline water produced over the LOM. The Umwelt underground has increased in size and depth in the Updated Feasibility Study, and thus groundwater inflows can be expected to increase accordingly. Knight

Piésold reviewed the mine development plan for the Umwelt underground and assigned groundwater inflow estimates to each year based on the previous groundwater inflows.

Considering freshwater inputs into the temporary storage locations, without treatment approximately 7.1 Mm^3 of saline water will require management. This exceeds the available temporary storage in the SWP (1.79 Mm^3) and the Llama TF (4 Mm^3 excluding tailings and freshwater inputs), and hence ultra-high recovery RO water treatment will reduce the volume of saline water (brine, following treatment) requiring temporary storage up to 4.4 Mm^3. As early as Q3 Year 12 through Year 13, the brine and supernatant water mixture in the Llama TF will be transferred to the Goose Main pit. The contents of the SWP will be transferred to the Goose Main pit in Year 14, allowing for the pond to be decommissioned in Year 15. The Goose Main pit will have received approximately 5.9 Mm^3 of brine, saline water, and tailings supernatant by the end of Year 14, compared to its capacity of 17.3 Mm^3. Hence additional storage will be available for saline water and brine, if needed.

1.14 Environmental Studies, Permitting, and Social or Community Impact

Sabina has an established sustainable development policy, and has staff dedicated to the environmental and social performance of the Project, including at the executive level. The environmental team conducts environmental monitoring at the Project sites, and actively maintains permits and approvals covering the existing and proposed facilities required for mine development.

Extensive baseline studies were carried out between 2010 and 2014, leading to the submission of a Final Environmental Impact Statement (FEIS) to the Nunavut Impact Review Board (NIRB) in 2015 (Sabina, 2015). Additional baseline and monitoring programs have been underway since that time to establish a robust pre-development data set to which future environmental monitoring during mine development can be compared.

Sabina has obtained all necessary approvals and permits required for constructing and operating the Project. The major approvals and permits include:

- Project Certificate No. 007 (NIRB, 2017)
- Type A Water Licence 2AM-BRP1831 (Nunavut Water Board [NWB], 2018) and other Type B water licences covering exploration activities
- *Fisheries Act* Authorization for serious harm to fish and fish habitat (Fisheries and Oceans Canada, 2018) and other Letters of Authorization for minor in-water works
- Completion of the Schedule 2 process under the Metal and Diamond Mining Effluent Regulations (Minister of Justice, 2020)
- Commercial leases KTCL-18D001, KTCL-18D002, and KTCL-18D003 covering the mine, MLA, and winter road (Kitikmeot Inuit Association, 2018)
- Land use permits from Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC)
- Various approvals under the Canadian *Navigation Protection Act* from Transport Canada.

Sabina and the Kitikmeot Inuit Association finalized an Inuit Impact and Benefit Agreement (IIBA) in April 2018. The parties entered a 20-year benefit and land tenure agreement under a framework agreement setting out rights and obligations with respect to surface land access on Inuit-owned land on the Project. Additionally, these agreements provide Inuit of the Kitikmeot Region with financial and socioeconomic benefits, including training, jobs, initiatives to create additional opportunities outside of the mining industry, shared ownership in Sabina, and a 1% net smelter royalty on future production from the proposed mine on the Goose Site.

These are comprehensive milestone agreements that provide the long-term certainty of tenure required to de-risk, finance, develop, and ultimately mine at Back River. The IIBA also commits Sabina to providing various socioeconomic opportunities throughout the Kitikmeot Region, including preferential employment; contracting; the formation and terms of an Inuit Environmental Advisory Committee; training for local Inuit people; continued implementation of a Kitikmeot-focused donation policy; and the payment of all applicable taxes and royalties to governing bodies. The IIBA is managed by a joint committee of appointed members from both Sabina and the Kitikmeot Inuit Association, dedicated to ensuring implementation of the terms contained within.

Sabina has continued to maintain long-standing relationships in Nunavut, and within the Kitikmeot Region in which the Project is situated, with the communities potentially affected by the Project: the Kitikmeot Inuit Association, Nunavut's Institutes of Public Government, the Government of Nunavut, and federal regulatory agencies. Consultation records are maintained in a database.

An Interim Closure and Reclamation Plan was approved by the NWB under the Type A Water Licence, and the financial security is posted to CIRNAC for water-related closure costs and the Kitikmeot Inuit Association for land-based reclamation activities associated with the Project. The amount of security required was agreed upon during the regulatory phase in 2018. The Preliminary Closure and Reclamation Plan has been updated as part of this Technical Report to reflect changes to the mine plan, and closure costs have similarly been reviewed and indexed for inflation (Knight Piésold, 2021).

1.15 Capital and Operating Costs

1.15.1 Capital Cost Estimation

The initial capital cost estimate is $610 million, as summarized in Table 1-5. Costs are expressed in Q4 2020 Canadian dollars, with no escalation.

Table 1-5: Summary of CAPEX by WBS Level 1 Category

CAPEX	Initial ($ million)	Sustaining ($ million)	LOM ($ million)
Mining[1]	56	348	404
On-Site Development	6	3	9
Ore Crushing and Handling	28	0	28
Process Plant	91	13	104
On-Site Infrastructure (Goose)	97	5	102
Off-Site Infrastructure	2	-	2
MLA	19	4	23
Tailings	5	-	5
Indirect Costs[2]	177	4	181
EPCM	6	-	6
Owner's Costs	68	-	68
Reclamation	-	42	42
Subtotal	554	419	973
Contingency	56	-	56
Total CAPEX	**610**	**419**	**1,029**

Source: SDE, 2021.
Notes: [1] Includes labour and equipment.
[2] Explosives, fuel, maintenance spares, and consumables.
Numbers may not add due to rounding.

Capital cost estimates were developed using engineering calculations and measurements based on three-dimensional (3-D) models or engineering drawings as applicable, applying directly related Project experience, and the use of general industry factors. Wherever possible, the estimates used in this Project were obtained from engineers, contractors, and suppliers who have provided similar services to existing operations and demonstrated success in executing the plans set forth in this study.

The capital estimates include all pre-production mining activities in Years −3, −2 and −1, and are based on Owner-performed construction and mining. All equipment on site is owned by Sabina. The capital estimate is based on the execution plans described in this Technical Report. Sunk costs and Owner's reserve were not considered in the capital estimate. The sustaining capital estimate is based on required underground development; mining equipment acquisition and rebuilds; and mining infrastructure installations as per the mine plan. The sustaining capital also includes a nameplate capacity expansion of the process plant to 4,000 t/d in Year 2 of operation.

1.15.2 Operating Cost Estimation

The average LOM unit operating cost is estimated at $141/t processed, summarized in Table 1-6.

Table 1-6: OPEX Summary

OPEX	LOM ($ million)	Tonnes Processed[2] ($/t)
Open Pit Mining[1]	355	18.97
Underground Mining[1]	715	38.22
Processing	693	37.06
Site and Offsite Services Including Freight	450	24.04
G&A, Camp, and Owner's Costs	415	22.21
Total OPEX	**2,627**	**140.50**

Source: SDE, 2021.
Notes: [1] Average LOM open pit mining cost amounts to $4.16/t mined at a 10:1 strip ratio; average LOM underground mining cost amounts to $81/t mined.
[2] Mining costs are averaged over total mine production.

The following list summarizes the key Project assumptions used to develop the operating cost estimate:

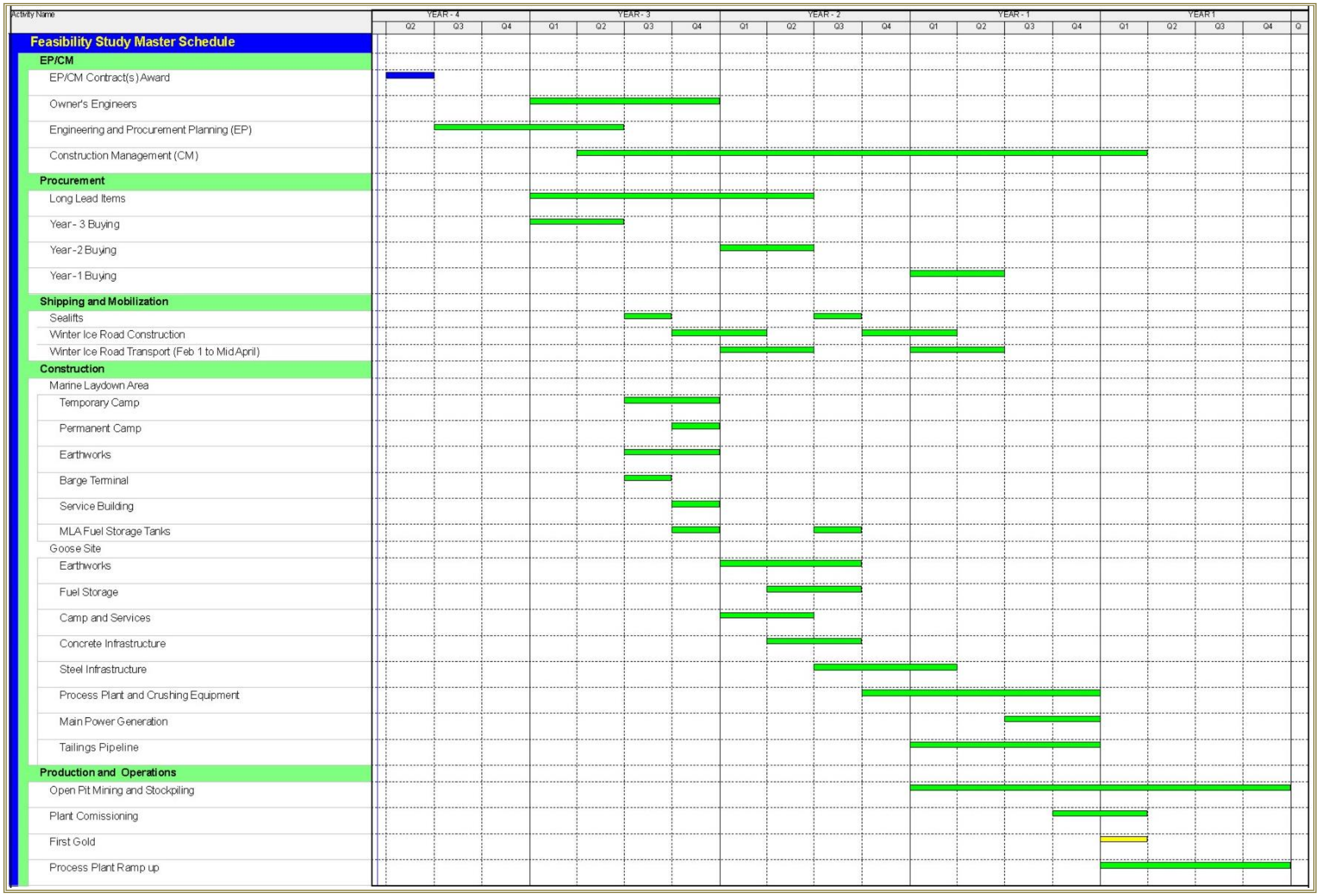
- Mining operations will be performed by the Owner using Owner-purchased equipment.
- Electrical power will be generated at site using fuel delivered to MLA at the price of $0.91/L for power generation and $0.95/L for mobile equipment, yielding an estimated LOM power cost of $0.26/kWh.
- The process plant will process 3,000 t/d expanding to 4,000 t/d in Year 2 (~1.1 Mt/a) of ore.
- The mine will use a peak total workforce of approximately 580 people, including all contract labour.

1.16 Project Execution and Development

The Project execution plan and general Project development schedule consider the seasonality of transporting freight. Procurement and staging of equipment, materials, and fuel at the respective east- and west-coast ports needs to take place at least 8 to 12 months before anticipated arrival at the Goose Site. The MLA is planned to receive sealift materials in the summer open-water period of August and September. Materials would then be stored until the WIR is operational between January and April. Fixed-wing aircraft landing at the Goose Site will support construction and operations activities by delivering passengers and select bulk materials.

1.17 Project Execution Schedule

The Project execution schedule is shown in Figure 1-1.



Source: SDE, 2021.

Figure 1-1: Key Schedule Milestones

1.18 Economic Analysis

An engineering economic model was developed to estimate the Project value and investment return. Pre-tax estimates of Project values were prepared for comparative purposes, and post-tax estimates were developed to indicate the application of tax to project evaluation. Sensitivity analyses are prepared to provide insight on variations in metal prices, grades, operating costs, and capital costs and to determine their relative importance as Project value drivers.

This Technical Report contains forward-looking information resulting from projected mine production rates and resulting forecast cash flows. The gold grades are based on sufficient sampling that is expected to be reasonably representative of the realized gold grades from actual mining operations.

The following factors could affect the results and cause actual results to differ materially from those presented in this economic analysis:

- Ability to secure major equipment and skilled labour.
- Ability to secure financing as contemplated.
- Ability to achieve assumed mine production rates at the assumed grade.

Other economic factors include the following:

- Discount rate of 5% (sensitivities using other discount rates have been calculated for each scenario).
- Costs based on nominal 2020 Canadian dollar values.
- No application of inflation values.
- Values are presented on a 100% Ownership basis and management fees, head office overheads, or financing costs were not contemplated in the economic analysis.
- Exclusion of all pre-development and sunk costs (e.g., exploration and resource definition costs; engineering field work and studies costs; environmental baseline study costs).
  Note: pre-development and sunk costs are used in tax calculations.
- Gold price of US$1,600/oz.
- Estimated third-party net smelter royalties.
- Exchange rate of C$1.31:US$1.00.
- Nunavut mineral royalties have been estimated and are included with income taxes. The Crown royalty is levied on a mine-by-mine basis and is equal to the lesser of 8% of the net value of mine output during a fiscal year, and an escalating rate from 0% to 14% on incremental levels of net value of the mine output during a fiscal year. Nunavut mineral royalties are deductible from income taxes.
- The Back River gold production considered in this study is grandfathered and subject to federal royalties under the Nunavut mineral royalties.

- Federal tax rate of 15%, and a 12% Nunavut rate were used to estimate future income taxes.
- Canadian Exploration Expense (CEE) and Canadian Development Expense (CDE) tax pools were used with appropriate opening balances to calculate income taxes.
- Specific capital cost allowance (CCA) rates were applied and used to calculate the appropriate CCA the Company can claim during the entire life of the Project.

Pre-tax and post-tax financial performance is summarized in Table 1-7. Pre-tax results provide a point of comparison with similar projects and are not intended to represent a measure of absolute economic value.

Table 1-7: Summary of Economic Results

Category	Unit	Value (US$)	Value (C$)
Net Revenues—Post Royalty Payments	$ million	5,091	6,669
Operating Costs	$ million	2,006	2,627
Cash Flow from Operations	$ million	3,085	4,042
Initial Capital Costs[1]	$ million	466	610
Sustaining Capital Costs	$ million	320	419
Cash Cost[2]	US$/oz	679	890
All-In Sustaining Cash Costs[3]	US$/oz	775	1,015
Net Pre-Tax Cash Flow	$ million	2,304	3,018
Pre-Tax $NPV_{5\%}$	$ million	1,308	1,713
Pre-Tax IRR	%	33.3	
Pre-Tax Payback	years	2.3	
Total Taxes	$ million	757	992
Net Post-Tax $NPV_{5\%}$	$ million	860	1,126
Post-Tax IRR	%	27.7	
Post-Tax Payback	years	2.35	

Source: SDE, 2021.
Notes: [1] Includes pre-production and contingency.
[2] (Refining Costs + Insurance + Transport Costs + Third Party Royalties + Operating Costs) / Payable Au oz.
[3] (Refining Costs + Insurance + Transport Costs + Third Party Royalties + Operating Costs + Sustaining Capital Costs)/Payable Au oz.

A sensitivity analysis was conducted on post-tax net present value (NPV) at a 5% discount ($NPV_{5\%}$) for individual parameters, including the gold price, foreign exchange rate, operating costs, and capital costs. The results are shown in Table 1-8 to Table 1-10. The Project proved to be most sensitive to changes in the US$:C$ exchange rate, gold price, head grade and recovery. The Project showed least sensitivity to operating and capital costs.

The Project was also evaluated using various discount rates to determine the effect on Project NPV. The Project NPV declines as the discount rate increases.

Table 1-8: Pre-Tax NPV$_{5\%}$ and IRR Sensitivity Results to Gold Price and Exchange Rate

NPV 5% ($ million)		Au Price (US$/oz)				
IRR (%)		1,000	1,300	1,600	1,900	2,200
C$ to US$	0.95	(379)	178	601	1,005	1,407
		-6.8%	9.3%	18.4%	25.7%	32.2%
	0.90	(263)	283	721	1,146	1,570
		-2.4%	11.7%	20.7%	28.1%	34.6%
	0.85	(132)	397	854	1,304	1,752
		1.6%	14.2%	23.1%	30.6%	37.2%
	0.80	2	523	1,005	1,481	1,958
		5.1%	16.8%	25.7%	33.3%	40.0%
	0.76	93	625	1,126	1,626	2,125
		7.3%	18.8%	27.7%	35.4%	42.2%
	0.70	261	821	1,367	1,912	2,455
		11.2%	22.5%	31.6%	39.4%	46.4%
	0.65	408	1,004	1,590	2,176	2,760
		14.4%	25.7%	34.9%	42.9%	50.0%
	0.60	576	1,215	1,851	2,484	3,117
		17.9%	29.2%	38.6%	46.8%	53.9%

Source: SDE, 2021.

Table 1-9: Post-Tax NPV$_{5\%}$ and IRR Sensitivity Results to CAPEX and OPEX

NPV 5% ($ million)		CAPEX						
IRR (%)		-15.0%	-10.0%	-5.0%	0.0%	+5.0%	+10.0%	+15.0%
OPEX	-15.0%	1,371	1,343	1,315	1,286	1,258	1,230	1,201
		35.3%	33.5%	31.9%	30.5%	29.1%	27.8%	26.6%
	-10.0%	1,318	1,290	1,261	1,233	1,205	1,176	1,148
		34.3%	32.6%	31.0%	29.6%	28.2%	27.0%	25.8%
	-5.0%	1,265	1,236	1,208	1,180	1,151	1,123	1,095
		33.3%	31.6%	30.1%	28.7%	27.3%	26.1%	25.0%
	0.0%	1,211	1,183	1,155	1,126	1,098	1,070	1,041
		32.3%	30.7%	29.1%	27.7%	26.5%	25.3%	24.1%
	+5.0%	1,158	1,130	1,101	1,073	1,045	1,017	987
		31.3%	29.7%	28.2%	26.8%	25.6%	24.4%	23.3%
	+10.0%	1,105	1,076	1,048	1,020	992	963	934
		30.3%	28.7%	27.2%	25.9%	24.7%	23.5%	22.4%
	+15.0%	1,051	1,023	995	967	938	909	880
		29.2%	27.7%	26.3%	25.0%	23.8%	22.6%	21.6%

Source: SDE, 2021.

Table 1-10: Post-Tax $NPV_{5\%}$ and IRR Sensitivity Results (Grade and Recovery)

NPV 5% ($ million)		Au Grade						
IRR (%)		-15.0%	-10.0%	-5.0%	0.0%	+5.0%	+10.0%	+15.0%
Recovery	-15.0%	381	501	617	730	842	955	1,067
		13.9%	16.4%	18.7%	20.9%	22.9%	24.9%	26.8%
	-10.0%	501	624	743	862	982	1,100	1,219
		16.4%	18.8%	21.1%	23.3%	25.3%	27.3%	29.2%
	-5.0%	617	743	868	995	1,120	1,245	1,370
		18.7%	21.1%	23.4%	25.6%	27.6%	29.7%	31.6%
	0.0%	730	862	995	1,126	1,258	1,390	1,522
		20.9%	23.3%	25.6%	27.7%	29.9%	31.9%	33.9%
	+5.0%	842	982	1,120	1,258	1,397	1,535	1,673
		22.9%	25.3%	27.6%	29.9%	32.0%	34.1%	36.1%
	+10.0%	955	1,100	1,245	1,390	1,535	1,680	1,826
		24.9%	27.3%	29.7%	31.9%	34.1%	36.2%	38.2%
	+15.0%	1,067	1,219	1,370	1,522	1,673	1,826	1,977
		26.8%	29.2%	31.6%	33.9%	36.1%	38.2%	40.2%

Source: SDE, 2021.

1.19 Mine Closure

An updated mine closure plan was prepared for the Updated Feasibility Study (Knight Piésold, 2021).

Mine closure activities will take place immediately following operations and are expected to involve two years of active closure and five years of passive closure, followed by a post-closure monitoring period of approximately five years—or as required. Closure was a key consideration in the Project design: progressive reclamation mitigates long-term risks and reduces overall costs by using staff and equipment effectively during operations, as well as avoiding the double handling of waste rock.

Activities that will be initiated and/or completed during operations include off-site backhaul of hazardous or recyclable materials and equipment; capping waste rock; and backfilling open pits and underground workings as they become available.

The first two years of active closure after operations will involve the demolition and disposal of structures and equipment that will no longer be used.

In terms of pit/TF closures, the Echo pit will have been subsumed by the Goose WRSA; the Umwelt TF will already have a water cap over the tailings; and Goose pit will be filled passively by runoff. The Llama TF will be filled through active pumping, breaching the diversion berms around the former pit, and possibly by switching off the tailings thickener to increase the quantity of water in tailings discharged to the Llama TF in the final two years of operation.

The remaining WRSAs and landfills will be covered with 5 m of NPAG waste rock and shaped to minimize erosion and maintenance. Roads, pads, and airstrips will be maintained as required, and the natural drainage will be restored as the infrastructure becomes obsolete.

As equipment and materials become obsolete, they will also be landfilled. Similarly, as active closure transitions into passive closure, water diversion and retention structures will be breached.

Monitoring will be carried out during the closure and post-closure phases to verify that closure activities are being undertaken as described in the Closure and Reclamation Plan, and closure objectives are being met. The monitoring programs include geotechnical monitoring to verify freeze-back of WRSAs and annual geotechnical inspections of all TFs, all WRSAs, open pit high walls, all contact and non-contact water storage ponds, diversion structures, and any other surface infrastructure elements possibly affecting permafrost.

Water quality monitoring will continue through the active and passive closure phases, to be systematically scaled back, with ultimate cessation once there have been at least five years of water quality monitoring that confirms that the final closure objectives have been met. Aquatic effects monitoring will be carried out in accordance with the requirements of the Type A Water Licence. Cessation of this monitoring will occur when a five-year period has elapsed showing the system has achieved the stated closure objectives. A final biological monitoring study will also be conducted, and a final interpretive report will be submitted to Environment and Climate Change Canada (ECCC) within three years of ceasing mine production, in accordance with the MDMER.

1.20 Interpretation and Conclusions

Based on the findings reported here, it can be concluded that the Project will be economically viable under the base case financial parameters. Several Project risks were identified, and mitigating strategies integrated into the mine design or suggested for ongoing execution.

1.21 Recommendations

It is recommended that the Project be advanced to production through the normal process of financing, detailed engineering, and construction. Estimated costs for engineering and construction are included in the capital cost of this Updated Feasibility Study. Ongoing risk mitigation efforts should be undertaken on a continuous basis throughout the Project development, construction and into production.

2 INTRODUCTION

The Goose Project (the Project) at the Back River Gold District (the Property) is an advanced-stage gold exploration project, in southwestern Nunavut, Canada. It is approximately 520 km northeast of Yellowknife, Northwest Territories (NWT); 50 km southeast of Glencore Canada Corporation's Hackett River Silver–Zinc Project; 285 km south of Agnico Eagle Mines Limited's Hope Bay Project (Doris); and 95 km southwest of Bathurst Inlet. Sabina Gold & Silver Corp. (Sabina) owns 100% of the Project.

Sabina commissioned Sacré-Davey Engineering (SDE) to lead the preparation of this National Instrument 43-101 (NI 43-101) technical report, *NI 43-101 Technical Report: 2021 Updated Feasibility Study for the Goose Project at the Back River Gold District, Nunavut, Canada* (Technical Report or Updated Feasibility Study), which supersedes the JDS Energy & Mining Inc. (JDS) *Technical Report Initial Project Feasibility Study on the Back River Gold Property, Nunavut, Canada* (JDS, 2015b). Other companies providing expertise and support in the preparation of this Technical Report are AMC Mining Consultants (Canada) Ltd. (AMC), Mining Plus (MP), Canenco Consulting Corp. (Canenco), DT Engineers Ltd. (DT), Knight Piésold Ltd. (Knight Piésold), and SRK Consulting (Canada) Inc. (SRK).

This Technical Report follows the Canadian Securities Administrators' NI 43-101 and Form 43-101F1 guidelines. The Mineral Resource and Mineral Reserve statements reported here were prepared in compliance with the Canadian Institute of Mining, Metallurgy and Petroleum's (CIM) *Estimation of Mineral Resources and Mineral Reserves Best Practice Guidelines* (CIM, 2019).

2.1 Qualifications and Responsibilities

The results of this Technical Report do not depend on any prior agreements concerning the conclusions, and there are no undisclosed understandings regarding any future business dealings between Sabina and the Qualified Persons (QP).

The following individuals, by virtue of their education, experience, and professional association, are considered QPs as defined in the NI 43-101, and are members in good standing with appropriate professional institutions or associations. The QPs are solely responsible for their specific Technical Report sections, shown in Table 2-1.

2.2 Site Visit

In accordance with NI 43-101 guidelines, Table 2-2 shows the site visit details for the QPs. All QP site visits were accompanied by Sabina employees.

Table 2-1: Qualified Persons' Responsibilities

Qualified Person, Credentials	Company	Years of Relevant Experience	Description of Relevant Experience	QP Responsible for Section(s)
Denis Thibodeau, P.Eng.	SDE	35	• Civil Engineer with significant experience in the development of northern and permafrost infrastructure • Specific relevant mining experience includes the contributions to three mining projects in Nunavut, another in Northern Quebec	1.0–1.2, 1.10, 1.15–1.17, 1.20, 1.21, 2, 3, 18.1, 18.1.1, 18.1.5, 18.1.7, 18.1.8, 18.2, 18.2.1, 18.2.7, 18.2.8; 21 (excluding 21.1.3, 21.1.14, and 21.2.3), and 24-26
John Morton Shannon, P.Geo.	AMC	45	• Mine geology, mineral exploration, and property evaluation. • Experience in base metal and gold mines in Ireland, Zambia, Canada, and Papua New Guinea; has been Chief Geologist on two very large gold mines, in different cultural and geological environments. • Led or authored parts of numerous Technical Reports.	1.3–1.4, portions of 3, 4–11, and 23
Dinara Nussipakynova, P.Geo.	AMC	28	• Mineral exploration and mine geology, specifically Mineral Resource estimation. • Database management, geological interpretation, and Mineral Resource estimation and reporting.	1.6, 12, and 14
Jacinta Klabenes, P.Eng. PE	MP	10	• Experience in determining applicable Mining Methods for underground and surface mines	1.8, 1.12, 16, and 18.2.9
Maurice Mostert, FSAIMM	MP	20	• Experience in signing off JORC and SAMREC documents as QP for underground gold mines. Signed off JORC, SAMREC, and NI 43-101 compliant Reserve Estimates.	15, 21.1.3 (underground mining), and 21.2.3 (underground mining), and 1.7 and contributed to 3, 18, 22, and 25
Neda Farmer, P.Eng.	MP	22	• Involved with determining operating and capital costs for operating surface mines.	21.1.3 (open pit portion), and 21.2.3 (open pit portion)
Stacy Freudigmann P.Eng., FSAIMM	Canenco	24	• Senior process and metallurgical production and technical positions in mining operations in Canada and Australia. • Consultant for over ten years; performed metallurgical management, process management, project management, cost estimation, scheduling and economic analysis work for numerous engineering studies and technical reports in South America, Europe, Asia Pacific, USA, and Canada.	1.5, 1.9, 13, and 17

Qualified Person, Credentials	Company	Years of Relevant Experience	Description of Relevant Experience	QP Responsible for Section(s)
Ben Peacock, P.Eng.	Knight Piésold	12	• Rock mechanics for open pit and underground mines. • Experience includes design input for projects from scoping to detailed design, as well as ongoing support for operating mines.	Portions of 16 relating to Rock Mechanics
Richard Cook, P.Geo.	Knight Piésold	24	• Environmental assessment and permitting in Nunavut. • Water-quality modelling and assessments. • Mine closure planning.	1.11, 1.13, 1.14, 1.19, 20, and 21.1.14
Amber Blackwell, P.Geo.	Knight Piésold	9	• Geochemical evaluations. • Water balances and water-quality modelling. • Mine closure planning.	18.1.4, Portions of Section 18 and 20 related to geochemistry
Michael Dawson, P.Eng.	DT Engineers	15	• Design, construction, and commissioning of greenfield mining sites. • Electrical and controls lead for several prefeasibility and feasibility studies and NI 43-101 reports.	Portions of 1.10, 16.3.8, 18.2.2 to 18.2.6, 18.2.10, 18.3, and 18.4
Vincy Benjamin, P.Eng. PMP	Sabina	21	• Design, construction, and commissioning of mining sites. • Experience includes approximately two years of site-specific project management and WIR program execution. • Project management/engineering with extensive experience, executing projects in the mining, and oil and gas industries. • Experience in a broad range of areas including project management, project execution planning and risk management/ mitigation. • Broad technical knowledge in the areas of mechanical and piping systems, and construction practices and procedures.	Section 18.5.
John Kurylo, M.Sc, P.Eng.	SRK	10+	• QP Responsibility/Role: water management infrastructure, and inputs to waste management (tailings and waste rock) aspects. • Geotechnical engineer with experience in project design, geotechnical and civil infrastructure construction, waste management, and mine closure. • Primary design areas include civil infrastructure, foundation design, tailings and water dams, waste storage facilities, and numerical modelling (stability and deformation). Worked on various base-metal, precious-metal, coal, industrial mineral, liquefied natural gas, and civil infrastructure projects located in the UK, Europe, Central Asia, South America, Scandinavia, Africa, and North America.	Portions of 1.11, 18.1.2, 18.1.3,18.1.6, 18.2.11 and water management infrastructure inputs to Table 25-3.

Qualified Person, Credentials	Company	Years of Relevant Experience	Description of Relevant Experience	QP Responsible for Section(s)
Shervin Teymouri, P.Eng., BASc., M.Eng.	SDE	14	• Mine project economic analysis. • Economic modelling for numerous NI 43-101 reports.	1.18, 19, and 22

Table 2-2: Site Visit Description

Qualified Person	Company	Site Visit Date	Accompanied by	Description of Inspection
Denis Thibodeau, P.Eng.	SDE	20 and 21 October 2020	Jaymes Maxwell and Jaymes Dircks	Inspection of ponds and proposed Goose processing site for soil and ground quality.
John Morton Shannon, P.Geo.	AMC	27 and 28 August 2012	Nicole Lasanen, James Maxwell, Wes Carson	Visited Goose and George sites. Geology overview, core facilities, drilling, sampling, core handling, data collection and handling and selected core
Dinara Nussipakynova, P.Geo.	AMC	20 and 21 October 2020	James Maxwell	Review Goose site, geology overview, core facilities, and selected core
Jacinta Klabenes, P.Eng., PE	MP	20 and 21 October 2020	James Maxwell and Jaymes Dircks	General terrain and planned locations for open pit/underground mines, onsite equipment, Umwelt Boxcut, core shed
Maurice Mostert, FSAIMM	MP	20 and 21 October 2020	James Maxwell and Jaymes Dircks	General terrain and planned locations for open pit/underground mines, onsite equipment, Umwelt Boxcut, core shed
Ben Peacock, P.Eng.	Knight Piésold	23 to 30 April 2014	James Maxwell	Review of geomechanical and hydrogeological site investigation program, including drill core and site tour.
Amber Blackwell, P.Geo.	Knight Piésold	4 to 24 August 2017	James Maxwell	Conducted geomechanical and hydrogeological site investigation program for the Umwelt underground.
Richard Cook, P.Geo.	Knight Piésold	21 and 22 October 2020	Jaymes Dirks and James Maxwell	Visited the Goose Site, including the camp, airstrip, existing quarry, Echo deposit area, plant site, and Umwelt deposit and pond area.
John Kurylo, M.Sc, P.Eng.	SRK	21 and 22 October 2020	Jaymes Maxwell and Jaymes Dircks	General terrain and various areas of Goose site including: exploration camp, future camp/ plant site, airstrip, existing quarry, Echo area, Goose Neck area and Umwelt Area.

Note: No other QPs have visited the site.

2.3 Units, Currency, and Rounding

This Technical Report uses the International System of Units (metric system) except for troy units used in the mining industry: for example, the troy ounce (oz), used to report the mass of precious metals.

All dollar figures are quoted in Canadian dollars ($) unless otherwise noted.

This Technical Report includes information that required subsequent calculations to derive subtotals, totals, and weighted averages. Such calculations inherently involve a degree of rounding, and consequently introduce a small margin of error. Where these occur, the QPs do not consider them to be material.

2.4 Sources of Information

This Technical Report is based on information collected by SDE and individual QPs during site visits, discussions with Sabina personnel, public information, and additional information provided by Sabina. The QPs have no reason to doubt the reliability of the information provided by Sabina.

3 RELIANCE ON OTHER EXPERTS

The QPs have relied on the work of the experts listed in Table 3-1. To the extent permitted under NI 43-101, the QPs disclaim responsibility for the relevant content of the Technical Report.

Table 3-1: QPs Extent of Reliance

Expert or Organization	Report or Statement	Extent of Reliance
Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) lease and claims—only documentation portions reviewed	Documents listing and summarizing lease and claims status.	Full Reliance
Merle Keefe—Manager of Environment for Sabina	Written Opinion forming Sections 4.5, 4.6, and 4.7	Full Reliance
Mike Shamro—SDE	Written Opinion forming Section 24	Full Reliance
PricewaterhouseCooper (PwC)	Taxation advice	Full Reliance

4 PROPERTY DESCRIPTION AND LOCATION

4.1 Location

The Property is located at 65° N latitude, 107° W longitude in southwestern Nunavut, a territory of Canada (Figure 4-1). It is approximately 520 km northeast of Yellowknife, NWT. Nearby mining operations include: the closed Lupin Mine, 225 km west, which is currently owned by Mandalay Resources Corporation; Glencore Canada Corporation's Hackett River Silver–Zinc Project, 50 km northwest; and Agnico Eagle Mines Limited's Hope Bay Project (Doris), 285 km north.

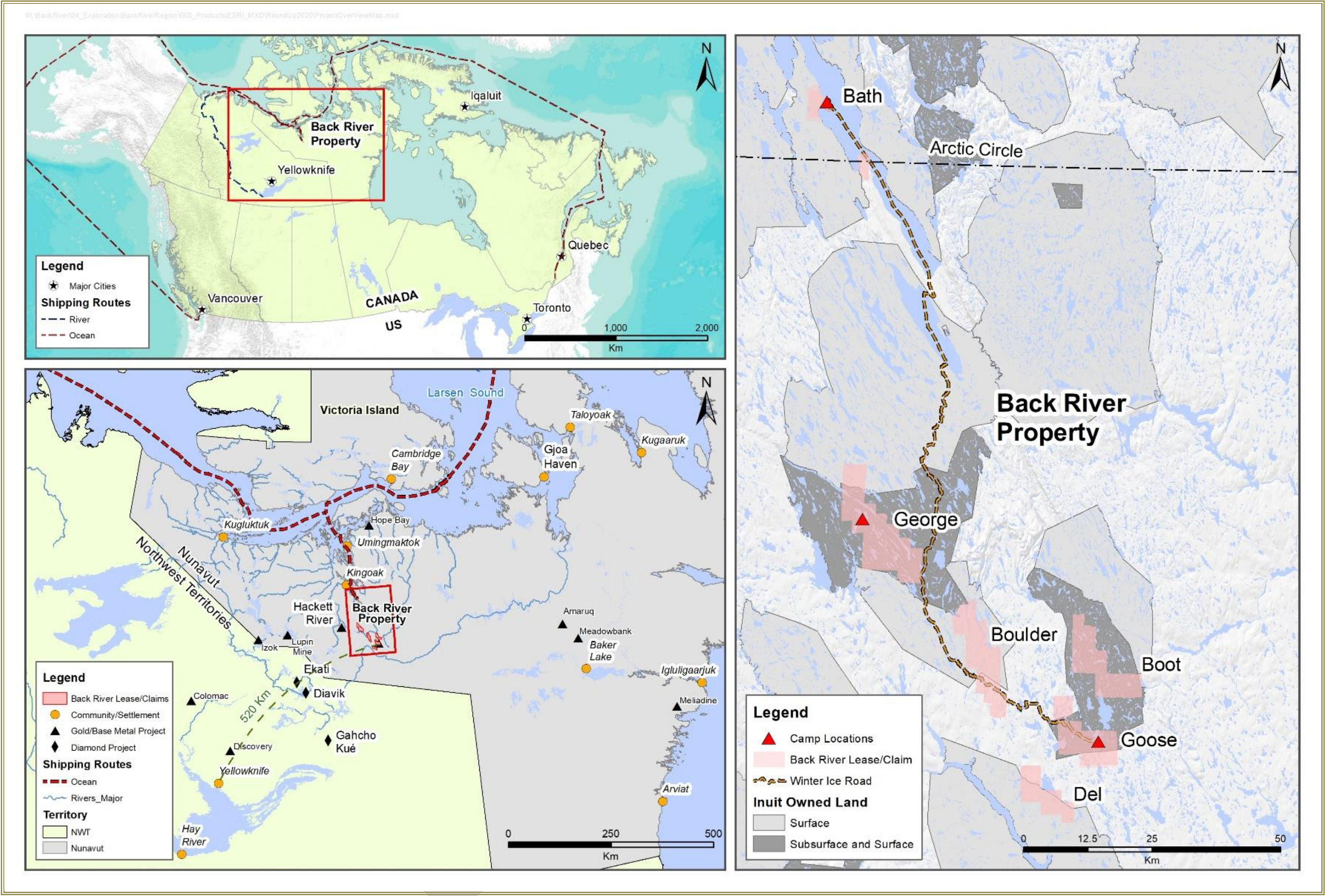
4.2 Mining Rights in Nunavut

Nunavut mining and exploration activities are regulated by Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC). This federal department ensures compliance with the Canada Mining Regulations across the territory. There are three main types of mineral interests under the Canada Mining Regulations: a mineral claim; a prospecting permit; and a mineral lease, also referred to as mining lease.

Under the Nunavut Land Claim Agreement (NLCA) enacted in 1993, the mineral rights for about 2% of the territory have been entrusted to the Inuit. The Designated Innuit Organization (territorial umbrella) under the NLCA is Nunavut Tunngavik Inc. (NTI); it negotiates terms and conditions for those blocks that are not under federal jurisdiction. None of the deposits considered in this study fall into the classification of Inuit-Owned Lands (IOL).

The Property comprises 54 federal mining leases and 10 federal mineral claims covering approximately 58,374 hectares (144,245 acres). The Property is divided into three main sites: Goose, George, and Bath. The Bath Site is the port location at the Marine Laydown Area (MLA). There are also three exploration prospects included in the above total: Boot, Boulder, and Del. All the tenure is in good standing; a description of the mineral tenure type, size, and ownership is shown in Table 4-1.

Figure 4-2 shows Sabina's claim and lease map of the Property.



Source: Sabina, 2021.

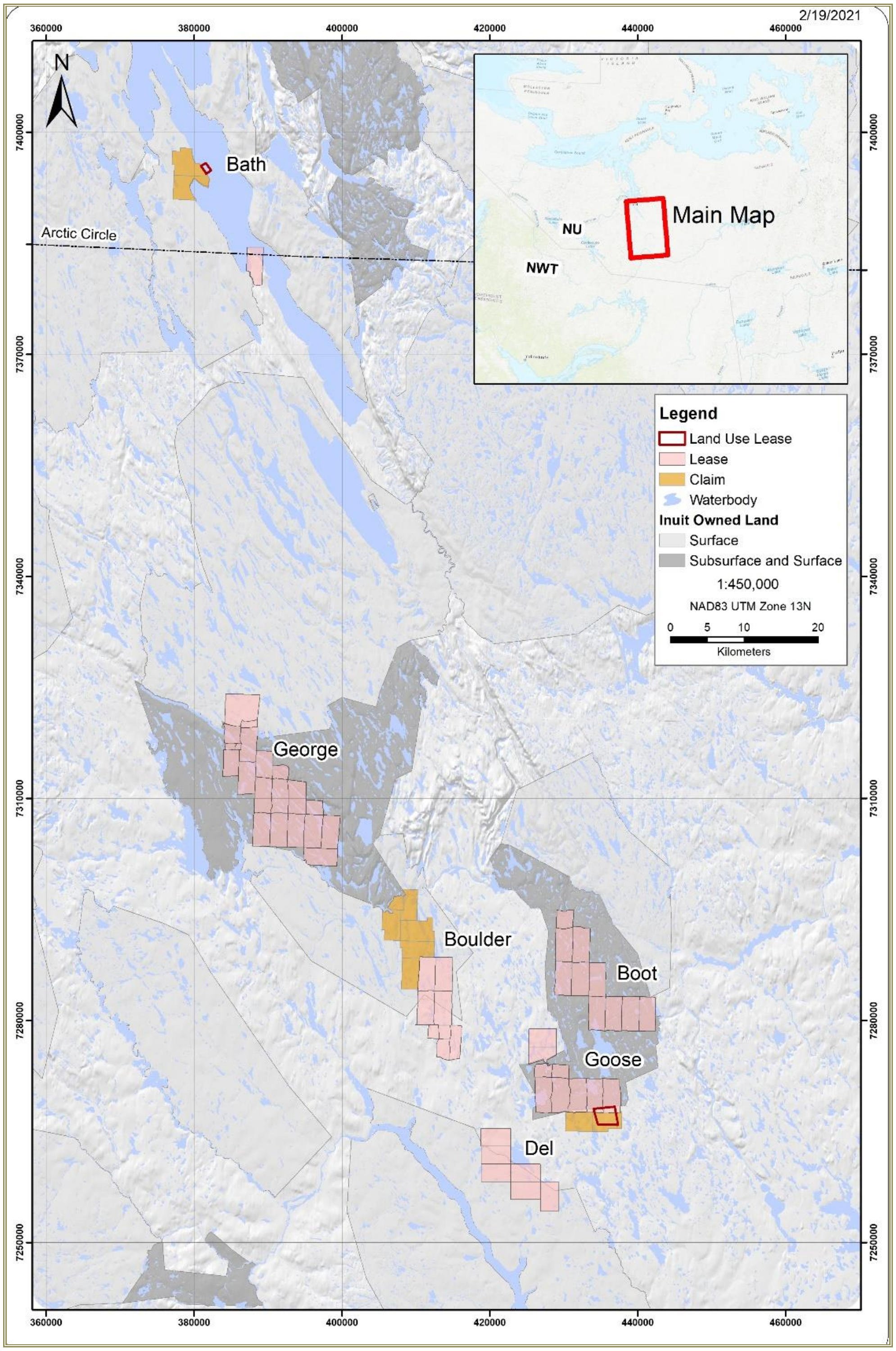
Figure 4-1: Back River Property Location

Table 4-1: Mineral Tenure Status

Project/Prospects	Tenure Name	Area (hectare)	Tenure Type	Status as of 30 October 2020	Expiry Date
Goose	3694	417.60	Federal Mining Leases (9)	100% in good standing	16-Oct-2039
	3695	409.95			16-Oct-2039
	3696	1,076.87			16-Oct-2039
	3697	1,100.94			16-Oct-2039
	3698	1,072.82			16-Oct-2039
	3699	1,003.21			16-Oct-2039
	3700	1,083.74			16-Oct-2039
	5750	922.00			19-May-2039
	5751	614.00			19-May-2039
	101400	1,007.72	Federal Mineral Claims (2)	100% in good standing	23-Sep-2021
	100756	1,125.25			25-Sep-2023
George	3562	69.48	Federal Mining Leases (20)	100% in good standing	9-Nov-2036
	3598	394.16			28-Dec-2037
	3599	821.11			28-Dec-2037
	3600	1,008.88			28-Dec-2037
	3601	1,097.91			28-Dec-2037
	3602	1,027.90			28-Dec-2037
	3603	1,078.08			28-Dec-2037
	3604	450.01			28-Dec-2037
	3605	1,036.80			19-Dec-2039
	3606	1,074.04			19-Dec-2039
	3607	1,033.97			19-Dec-2039
	3608	1,057.61			19-Dec-2039
	3649	1,046.92			19-Dec-2039
	3650	200.08			28-Dec-2037
	3651	1,042.06			28-Dec-2037
	3653	1,074.84			19-Dec-2038
	3677	536.53			16-Oct-2039
	3729	111.01			16-Oct-2039
	3730	749.88			16-Oct-2039
	5707	1,865.06			25-Nov-2036
Boulder	3466	300.28	Federal Mining Leases (8)	100% in good standing	18-Nov-2036
	3557	1,012.12			30-Dec-2038
	3558	1,051.37			30-Dec-2038
	3559	1,048.54			30-Dec-2038
	3560	1,099.53			30-Dec-2038
	3691	259.81			16-Oct-2039
	3692	456.49			16-Oct-2039
	3693	670.56			16-Oct-2039

Project/Prospects	Tenure Name	Area (hectare)	Tenure Type	Status as of 30 October 2020	Expiry Date
	100179	448.98	Federal Mineral Claim (6)	100% in good standing	4-Oct-2022
	100180	997.93			4-Oct-2022
	100174	1,167.82			4-Oct-2022
	100177	1,248.42			4-Oct-2022
	100176	1,282.12			4-Oct-2022
	100175	1,249.81			4-Oct-2022
Boot	3552	1,029.12	Federal Mining Leases (10)	100% in good standing	30-Dec-2038
	3553	1,036.00			30-Dec-2038
	3554	1,092.65			30-Dec-2038
	3555	1,014.38			30-Dec-2038
	3609	1,081.32			30-Dec-2038
	3612	1,079.70			30-Dec-2038
	3613	1,024.26			30-Dec-2038
	3678	1,060.68			16-Oct-2039
	3679	1,001.60			16-Oct-2039
	3724	541.47			16-Oct-2039
Del	5800	959.49	Federal Mining Leases (6)	100% in good standing	12-Oct-2039
	5801	955.24			12-Oct-2039
	5802	959.17			12-Oct-2039
	5803	958.36			12-Oct-2039
	5804	958.06			12-Oct-2039
	5805	972.62			2-Oct-2039
Bath	5152	982.39	Federal Mining Lease (1)	100% in good standing	10-Mar-2029
	100758	1,462.83	Federal Mineral Claims (2)	100% in good standing	25-Sep-2024
	100757	1,300.78			25-Sep-2024
Total		**58,374.33**		**100% in good standing**	

Source: Sabina, 2021.



Source: Sabina, 2021.

Figure 4-2: Sabina Mineral Claim and Lease Map

4.3 Mineral Tenure

There are six lease/claim groups included in the Property. These comprise federal mining leases and federal mineral claims, as shown in Table 4-1 and Figure 4-2. A registered Canadian land surveyor has surveyed the mining leases, and they do not require filing of annual assessment work. However, an annual fee of $2.50/hectare is required to maintain the existing leases in good standing for the duration of the initial 21-year lease period. As a result of the new Nunavut Mining Regulations (NMR), payments increase to $5.00/hectare for subsequent 21-year lease renewal periods. The mineral claims were originally marked with pickets along claim boundaries, with claim posts at claim corners. On 30 January 2021, in an update to the NMR, existing mineral claims were converted to a predefined grid cell network and grouped with an assignment of a new claim number. Also, as the result of the updated regulation assessment work rates commence at $45 per grid cell in respect of the first year beginning on the day on which the claim is converted and escalating variably over a period of up to 30 years.

All leases and claims are 100% owned by Sabina and are currently in good standing. Annual reports were delivered to the Kitikmeot Inuit Association, CIRNAC, the Nunavut Impact Review Board (NIRB), and the Nunavut Water Board (NWB) as per the terms and conditions of authorizations issued for work done on the Property.

4.4 Surface Rights in Nunavut

NTI, the organization that coordinates and manages Inuit responsibilities set out in the Nunavut Agreement, has delegated surface rights administration in the Kitikmeot Region to the Kitikmeot Inuit Association. The Kitikmeot Inuit Association administers the surface rights associated with the Project (subject to the exclusions previously referenced).

Sabina has various forms of surface tenure:

- The Goose Site commercial lease, KTCL-18D001
- The Bath Site commercial lease (port location), KTCL-18D002
- The Winter Road commercial lease, KTCL-18D003
- The George Site advanced exploration leases, KTAEL-18C001.

In addition, Sabina also holds surface lands proposed for activities outside of the IOL parcels. The Project holds two federal land use leases registered with CIRNAC, under 30-year terms, supporting further development and operational activities. Both federal land use leases are in good standing and listed in Table 4-2.

- Lease No.: 076G/9-1-2, commencing 1 May 2019
- Lease No.: 076J/12-7-2 commencing 15 August 2018.

Table 4-2 Federal Land Use Lease Status

Project	Tenure Name	Area (hectare)	Tenure Type	Status as of 30 October 2020	Expiry Date
Goose	076G/9-1-2	646.34	Federal Land Use Lease	100% in good standing	30-Apr-2048
Bath	76J/12-7-2	93.80		100% in good standing	14-Aug-2048
Total		**740.14**			

Source: Sabina, 2020.

4.5 Underlying Agreements

The Property is subject to net smelter return (NSR) royalties payable to various third parties. In 2011, Sabina completed the purchase of some of these royalties on the Property. The remaining NSR royalties that would apply to the Goose and George sites are:

- Goose Site: 0.7% NSR payable on the first 400,000 oz of gold production, increasing to 4.25% on gold production over 400,000 oz.
- George Site: 1.15% NSR on the first 800,000 oz of gold production, increasing to 4.25% on gold production over 800,000 oz.

In 2018, the Company completed a definitive framework agreement with the Kitikmeot Inuit Association that provides the commercial leases authorizing mine development and operations; it is a comprehensive agreement that sets out rights and obligations with respect to surface land access on Inuit-owned land at the Project. The framework agreement includes an Inuit Impact and Benefit Agreement (IIBA) and other obligations required by the Nunavut land claims agreement, with certain key provisions:

- A renewable 20-year term.
- Surface access rights for exploration, development, mine construction, and mine operations activities.
- Certain payments for such rights, including:
  - Annual payments to Kitikmeot Inuit Association of $0.5 million until the year Sabina makes a production decision on its Project, following which the annual payments rise to $1.0 million. The pre-production payments of $0.5 million have been paid on each of 30 May 2018, 10 January 2019, and 10 January 2020 subsequent to year-end.
  - Issuance to Kitikmeot Inuit Association of 6.7 million common shares of Sabina (issued on 6 June 2018 at a share price of $1.66 for total consideration of $11.1 million).
  - Grant to Kitikmeot Inuit Association of a 1% net smelter royalty on future production at Back River.
  - An initial investment of $4 million into regional wealth-creation initiatives in the Kitikmeot.

In addition to the described private royalties, under the NMR, an annual royalty of up to 13% of the net value of mine production is payable to the federal government for any mine production on mining leases or claims held prior to the NA. Under NMR, the royalty is based on defined profits multiplied by a royalty rate, which is the lesser of 13% of the net value of mine output during a fiscal year, and an escalating rate from 0% to 14% on incremental levels of the net value of the mine output. The output value is generally the profits from both mining and processing operations, with the deduction of a processing allowance, and deductions for capital and development. The calculations of royalties under NMR are not subject to the rules in the Canadian *Income Tax Act*; however, any royalties paid are deductible for income tax purposes under the *Act*.

All royalties on the Property are discussed in this section; however, gold production and associated royalties for the George Site are not included in the mine plan or financial model for this Updated Feasibility Study. Third-party royalties are estimated to average approximately 4.8% over the life-of-mine (LOM) for the Goose Site and are included in the economic model in this Updated Feasibility Study.

4.6 Permits and Authorizations

A complete list of existing permits and authorizations for the Project is included in Table 4-3.

Table 4-3: Summary of Sabina Permits (as of 29 October 2020)

Authorization No.	Expiry (Year-Month-Day)	Agency	Description
PC No. 007	N/A	NIRB	Back River Project NIRB Project Certificate
2AM-BRP1831	2031-12-31	NWB	Back River Type A Water License
N/A	2038-06-31	Kitikmeot Inuit Association	Inuit Impact and Benefit Agreement
KTCL-18D001	2038-04-20	Kitikmeot Inuit Association	Commercial Lease—Goose
KTCL-18D002	2038-04-20	Kitikmeot Inuit Association	Commercial Lease—MLA
KTCL-18D003	2038-04-20	Kitikmeot Inuit Association	Commercial Lease—Winter Road
KTAEL-18C001	2023-04-20	Kitikmeot Inuit Association	Advanced Exploration Lease—George
LUL-XX	5 years from Effective Date	Kitikmeot Inuit Association	Land Use Licence as per Kitikmeot Inuit Association Framework Agreement
KTL312C004	2020-04-25	Kitikmeot Inuit Association	Wishbone-Malley Exploration Activities (renewal submitted)
N2018F0021	2023-10-29	CIRNAC	CAT Train Beechey Lake Area
N2017F0016	2022-07-20	CIRNAC	CAT Train connecting Bathurst Inlet - Back River Project
N2016C0011	2021-10-26	CIRNAC	Back River Exploration Activities
N2018F0017	2023-10-11	CIRNAC	WIR Back River Project
Lease No. 76J/12-7-2	2048-08-14	CIRNAC	Marine Environment Land Lease—adjacent to MLA
Lease No. 76J/9-1-2	2048-04-26	CIRNAC	Goose Lake Tailings Storage Facility
2BE-GOO2028	2028-02-18	NWB	Goose Water Licence (Type B)
2BE-GEO2025	2025-05-29	NWB	George Water Licence (Type B)
2BE-MLL1722	2022-06-29	NWB	Wishbone-Malley Water Licence (Type B)
2BC-BRP1819	2019-04-30	NWB	Type B Development Works Water Licence (Replaced by Type A)
12-HCAA-CA7-00007	2031-12-31	DFO	*Fisheries Act* Authorization—Back River Project
18-HCAA-00185	N/A	DFO	Letter of Authorization—Gander Culvert
18-HCAA-00971	N/A	DFO	Letter of Authorization—MLA
18-HCAA-01626	N/A	DFO	Letter of Authorization—WIR
12-HCAA-CA7-00007	N/A	DFO	Letter of Authorization—Rascal Stream Diversion
04 009 19R-M	2020-12-31	NRI	Back River Project Scientific Research License
2012-600767-002	N/A	TC	*Navigation Protection Act*—MLA Discharge Pipeline Authorization
2012-600767-003	N/A	TC	*Navigation Protection Act*—MLA Intake Pipeline Authorization
2012-600767-006	N/A	TC	*Navigation Protection Act*—MLA Lightering Barge Authorization
2012-600767-004	N/A	TC	*Navigation Protection Act*—Umwelt Lake Dewatering Authorization
2012-600767-005	N/A	TC	*Navigation Protection Act*—Llama Lake Dewatering Authorization

Source: Sabina, 2020

Notes: DFO = Department of Fisheries and Oceans Canada; NIR = New Inspection Regime; TC = Transport Canada; WIR = winter ice road.

4.7 Environmental Liabilities

There are no known unbonded environmental liabilities on the Property.

4.7.1 Inspections and Monitoring

The Property is inspected on an annual basis by the permitting agencies, landowner, and regulators. To date, no orders have been issued.

4.7.2 Environmental Assessment/Permit Process

The primary environmental review and approval process that applies to the Project is now complete. Sabina has obtained the major permits required for construction and operation at the Back River Property. Detailed information on the permitting process can be found in Section 20.

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

5.1 Accessibility

The Property, which consists of the Goose and George sites, is approximately 520 km northeast of Yellowknife, NWT and is predominantly accessed by fixed-wing aircraft. The Goose Site is shown in Photo 5-1. A winter ice road (WIR) is constructed during the winter months between the Goose Site and the MLA at the Bath Site on Bathurst Inlet, to transport goods brought into the MLA during the summer shipping season. The WIR distance between the MLA and Goose sites is approximately 172 km (combined distance on land and marine and lake ice). Under normal conditions, the WIR is operational from approximately early February to mid-April, or ±10 weeks. This may vary from year to year depending on winter ice conditions. The location of and access to the Property are shown in Figure 4-1.

An airstrip has been constructed at the Goose site and has been expanded to serve a variety of aircraft sizes to accommodate passengers and freight, including the ATR-72, De Havilland Dash 7, L-188 Electra, and the C-130 Hercules. These aircraft types and capacities are shown in the passenger and freight Section 24.1.3.

5.2 Climate and Physiography

The region is characterized by long dark winters and short summers. Typically, the ground is covered in snow from October to June, and during that time lakes are covered with ice up to 3 m thick which allows for on-ice activities such as diamond drilling and airstrip construction and use. The mean annual temperature is approximately −10.5°C, with a mean temperature of 6°C in summer and −26.5°C in winter. The mean annual precipitation ranges from 200 to 300 mm (PEG, 2010). The average elevation is approximately 288 masl, with gently rolling topography.

The Property lies north of the tree line in the West Kitikmeot region of Nunavut. Vegetation cover around the Goose and George sites is classed as "unvegetated surface" and the Bath site lies in the "tundra, high shrub" (PEG, 2010). Vegetation is present in the form of low shrubs of willow, birch, Labrador tea, and mountain cranberry, with lichen common.

Outcrop distribution is highly variable; it predominantly occurs on the tops or flanks of hills, while the valleys are commonly filled with glacial overburden. At the Goose site, overburden depths in drill holes range from 0 to 42 m, with an average of approximately 10 m.

5.3 Local Resources and Infrastructure

The existing camps source goods and services from northern-based suppliers, mainly in Yellowknife, NWT, and Edmonton, Alberta.

The exploration programs employ northern Nunavut residents from the Kitikmeot communities of Gjoa Haven, Taloyoak, Cambridge Bay, Kugaaruk, and Kugluktuk. These residents have been employed as geotechnicians, camp labourers, prospectors, core cutters, equipment operators, and site support.

The existing Goose camp is a 150-person all-season camp consisting of sleeping units, dry and mess facilities, offices, a core-processing facility, heavy-equipment storage facilities, a warehouse, and an engineered bermed fuel farm. The Goose camp is powered by two diesel-powered generators—400 kW and 433 kW—which are backed up by one 175 kW diesel-powered generator. An all-weather road connects the Goose camp to the airstrip, and dirt trails are present around the camp. Additionally, road networks extend approximately 3 km west of camp, supporting development activities for planned future infrastructure. Two maintenance shops are also located at the camp, along with a fuel storage facility of thirteen 75,000 L double-walled enviro-tanks. Photo 5-1 shows the existing Goose camp as of 2018 with the road to the all-weather airstrip in the background and Photo 5-2 shows the expanded all-weather airstrip as of 2020 with Goose camp in the background, and connecting roads.

Source: Sabina, 2018.

Photo 5-1 Existing Goose Camp (Looking West)

Source: Sabina, 2020.

Photo 5-2: Expanded All-Weather Airstrip as of 2020

The existing George camp contains a 58-person all-season camp consisting of sleeping units, dry and mess facilities, offices, a core-processing facility, a maintenance shop, a bermed fuel farm, and four prefabricated sleeper trailers. A 530 m long gravel airstrip at the George camp is used by short take-off and landing aircraft such as the Twin Otter. Dirt trails exist at the George camp site. Two 225 kW diesel-powered generators provide power for the site. The bulk fuel storage facility at the George camp uses two 75,000 L double-walled steel enviro-tanks. Photo 5-3 shows the George camp with the all-weather airstrip in the foreground.

Source: Sabina, 2015.

Photo 5-3: Existing George Camp (Looking East)

The existing MLA camp at the Bath Site contains a 40-person all-season camp consisting of sleeping units, dry and mess facilities, an office unit, a maintenance shop, a bermed fuel farm, and a desalinization plant. A 3,000 ft long gravel airstrip is located at the MLA camp for use by short take-off and landing aircraft. Two 60 kW diesel-powered generators provide power for the site. The bulk fuel storage facility at the MLA camp uses seven 30,000 L double-walled steel enviro-tanks. In addition, a 10 ML fuel tank was constructed at the MLA. Photo 5-4 shows the MLA camp with the all-weather airstrip in the foreground.

The Goose and George camps are currently operated on a seasonal basis, with exploration and construction programs typically commencing in Q1–Q2 and concluding in Q3–Q4 of each year. The MLA camp is proposed to operate on a seasonal basis twice a year in support of incoming fuel, freight, and equipment from marine vessels in summer, and outgoing fuel, freight, and equipment with tractor trailers in the winter.

Source: Sabina, 2018.

Photo 5-4: Existing MLA Camp (Looking West)

5.4 Surface Rights

Sabina has various forms of surface tenure that are listed and discussed in Section 4.4. In addition, Sabina holds surface lands outside of the IOL parcels containing proposed surface activities. The Project holds two federal land use leases registered with CIRNAC, under 30-year terms, supporting further development and operational activities. Both federal land use leases are in good standing and listed in Table 4-2. This will be sufficient for the envisaged mining project.

6 HISTORY

Comprehensive summaries of historical work on the Property were compiled in previous technical reports by Watts, Griffis and McOuat Limited (WGM) (WGM, 2005), Coffey Mining (2009), and Roscoe Postle Associates Inc. (RPA, 2011). In addition, the 2012 Preliminary Economic Assessment (PEA) technical report (SRK, 2012) and the 2015 Feasibility Study (JDS, 2015a, 2015b) compile and present a complete list of historical work and ownership history. The following information was sourced from these documents and is summarized in Table 6-1 and Table 6-2.

6.1 Ownership

The Back River Project formed under the Trigg, Woollett, Olsen Consulting Limited-founded Back River Joint Venture (BRJV) group, which retained ownership from 1982–2008. During this time, various companies and individuals acquired and relinquished their interests in the BRJV. At times, these entities were also the operators. A summary of significant Property historical milestones is presented in Table 6-1.

Table 6-1: Historical Ownership Milestones

Dates	Milestones
1982	BRJV formed. Funding was primarily provided by private interests comprising a group of investors including J. G. Greenough, Gold Bar Development Ltd., and Andromeda Investments Ltd. (GGA)
1985	F. W. Hill (Hill) and Esso Minerals Canada (Esso) joined as investors and operators.
1985 to 1986	Kerr-McGee Corp. acquired interest in BRJV and was operator in 1986. The Goose Site claims were staked.
1987 to 1996	Homestake Mineral Development Company Ltd. (Homestake) earned into BRJV, acquiring Esso's remaining 26.25% in 1989 and purchasing 100% of the interest held by GGA's successor. In 1991 Homestake became operator, completing regional exploration and shifting focus to the Goose Site.
1997 to 1998	Arauco Resources Corporation (later changed name to Kit Resources) acquired 100% interest in BRJV.
1999 to 2002	Kinross Gold Corp. (Kinross) started to earn into BRJV and became operator, conducting exploration programs at the George and Goose sites. At the end of 2002, Kinross commissioned WGM to complete a NI 43-101 report.
2003 to 2004	Miramar Mining Corporation (Miramar) finalized an option agreement with Kinross and became operator in 2004.
2005 to 2008	Dundee Precious Metals (DPM) acquired the option to earn the 60% interest from Miramar and became primary operator. By 2006, DPM purchased the remaining Project interest from Kinross.
2009	Sabina purchased the Back River Property from DPM and has remained owner and operator until present.

Source: Compiled from WGM (2005), Coffey Mining (2009), SRK (2012), AMC (2013), and JDS (2015a).

In 2009, Sabina successfully became 100% owner and operator of the Back River Property. Since 2009, some changes have been made to lease and claim status augmenting property boundaries, which are summarized in Section 4.

The Del claims, which are part of the current Back River Property, were not part of the initial property staked by the BRJV. In 1986, Bow Valley Industries owned the Del claims, but dropped them after a small and unsuccessful drilling program (Cater et al., 2009). The area remained inactive until Dundee Precious Metals Inc. (DPM) staked 12 claims in 2008. The Del claims were sold to Sabina in 2009 as part of the Back River Property.

6.2 Exploration Work

Table 6-2 summarizes the exploration work carried out by the various operators since the BRJV was founded in 1982, through to Sabina's purchase in 2009.

Table 6-2: Historical Exploration Summary

Operator	Period	Exploration Completed	Drill Holes Completed	Reports or Studies Completed
Trigg, Woollett, Olsen Consulting Limited on behalf of BRJV	1982	Reconnaissance exploration	-	-
BRJV	1983–1985	Gridding, geological mapping, sampling, exploration drilling, and aeromagnetic surveys	36	-
Hill and Esso	1985	Airborne magnetics and electromagnetic surveys	-	-
Bow Valley	1986	Soil sampling at Del prospect, trenching, exploration drilling	11	-
Kerr-McGee Corp.	1986	Exploration drilling	31	-
Homestake Mineral Development Company Ltd.	1987–1996	Geological mapping, panel and till sampling, exploration and infill drilling, geochemical study, geophysics, legal surveying	656	Prefeasibility Study and Feasibility Study (George)
Kit Resources	1997–1998	Geological mapping, sampling, exploration, and infill drilling	184	Resource Estimate (George)
Kinross Gold Corp.	1999–2002	Spectral induced polarization (IP)/resistivity survey, till sampling, geological mapping, channel sampling, soil sampling, exploration, and infill drilling	126	Resource Estimate and Conceptual Study (Goose)
Miramar Mining Corporation	2003–2004	Exploration and infill drilling	41	NI 43-101 Report
Dundee Precious Metals	2005–2008	Trench sampling, geological mapping, exploration and infill drilling, structural analysis, airborne magnetic, electromagnetic, and radiometric surveys, geochemistry, and rock samples	186	NI 43-101 Report and Mineral Resource estimate

Source: Summary by AMC (2015), based on table provided by Sabina.

6.3 Historical Estimates

Mineral resource estimates were carried out in the periods of historical exploration. RSG Global Consulting Pty Ltd. (RSG) completed the most recent historical Mineral Resource estimate, for DPM, in September 2007, with an effective date of 30 July 2007.

The QP has not done sufficient work to classify the historical estimate as current Mineral Resources, and Sabina is not treating the historical estimate as current Mineral Resources, nor relying on it. The following observations are made regarding the 2007 Mineral Resource estimate:

- It was prepared in accordance with the *CIM Estimation of Mineral Resource and Mineral Reserves Best Practice Guidelines*; therefore, it is a reliable record of the historical Mineral Resources as of 30 July 2007.
- It targeted a high-grade, low-tonnage, underground mining operation.
- It was classified using a historical version of the *CIM Definition Standards for Mineral Resources & Mineral Reserves* (CIM Definition Standards) (2005).

The historical mineral resource estimate is summarized in Table 6-3.

Table 6-3: 2007 Historical Mineral Resource Estimate

Resource Category	Tonnes ('000s)	Gold Grade (g/t)	Gold (oz '000s)
Indicated	3,415	10.9	1,193
Inferred	3,556	10.2	1,162

Source: Summary by AMC based on table provided in RSG (2007).

Notes: CIM Definition Standards (2005) were used for reporting the Mineral Resources.
Mineral Resources are reported at a zero cut-off within wireframes determined by a 5.0 g/t Au threshold
Estimate used drilling results to 30 July 2007.

6.4 Production

There has been no mining production from any of the deposits on the Property.

7 GEOLOGICAL SETTING AND MINERALIZATION

7.1 Regional Geology

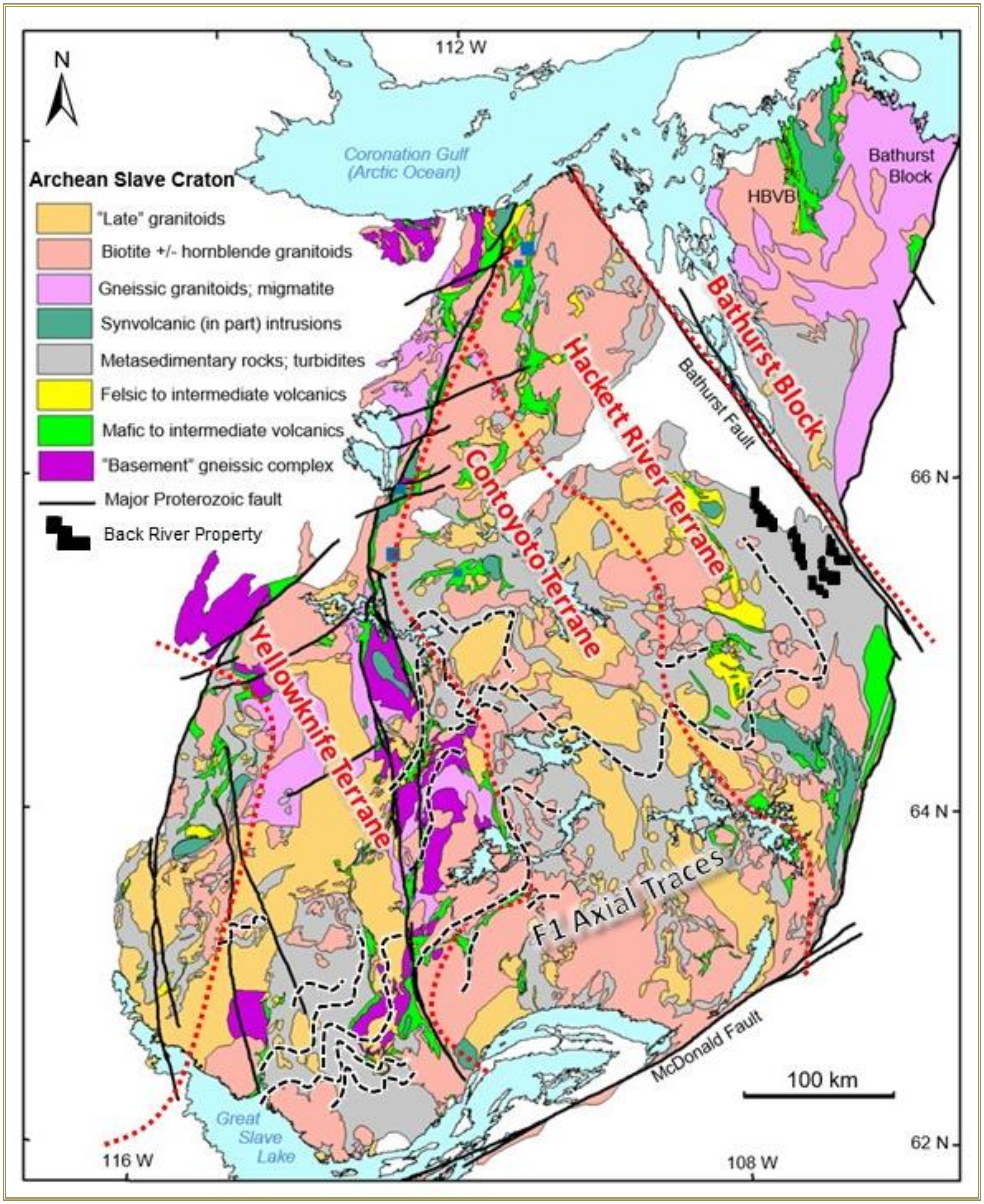
The Property is situated in the eastern portion of the Archean Slave craton known as the Hackett River terrane; a structural domain predominantly composed of the meta-sedimentary and meta-volcanic rocks of the Archean Yellowknife Supergroup (2.7–2.6 Ga) and widespread syn- to late-kinematic granitoids (Bleeker & Hall, 2007) (Figure 7-1).

The Yellowknife Supergroup belongs to the collection of supracrustal rocks that are contiguous across the entire Slave Province. The Yellowknife Supergroup stratigraphy marks the transition to calc-alkaline and intercalated volcaniclastic arc-like sequences and subsequent development of thick turbidite sediments following a rifting event of the Central Slave Basement Complex (Bleeker & Hall, 2007; Haugaard et al., 2017).

In the area of the Property, the Yellowknife Supergroup is divided into three major sequences: a lower volcanic sequence termed the Hackett River Group; an interfingering, coeval volcanic sequence referred to as the Back River Group; and an overlying sedimentary sequence called the Beechey Lake Group, also known as the Burwash Formation elsewhere in the Slave Province (Bleeker & Hall, 2007; Frith & Percival, 1978). Younger, Proterozoic sedimentary rocks of the Goulburn Group unconformably overlie the Beechey Lake Group in the northeast region of the Slave Province (Bleeker & Hall, 2007).

The Beechey Lake Group consists mainly of immature greywacke turbidite deposits, mudstones, and intercalated iron formations. Detrital zircons from Beechey Lake turbidites sampled from Hackett River, George Lake, and High Lake north of the Goulburn unconformity give an average minimum age of deposition of approximately 2.695–2.620 Ga (Villeneuve, 2001). Importantly, the iron formation horizons within the broader Burwash Formation are host to the significant gold occurrences on the Property, and other deposits, including the Lupin Mine operated from 1982–2004, which produced 3.36 Moz of gold, grading 8.9 g/t (Harron, 2012).

The regional structure is dominated by the interference of two major Archean deformation events resulting in considerable crustal shortening following the closure of the Burwash Basin (Bleeker & Beaumount-Smith, 1995). The deformational event, identified as D1, produced regional, large-scale upright, tight folds generally trending northeast–southwest (Bleeker & Hall, 2007). A cross-cutting plutonic suite, known as the Defeat Suite (ca. 2.63–2.62 Ga), provides a minimum age for the D1 deformation in the central Yellowknife Terrane (Davis and Bleeker, 1999). Continued shortening and cross-folding (D2) affected the entire Slave Craton beginning about 2.6 Ga (Bleeker & Hall, 2007). The F2 folding and accompanying strong cleavage is predominantly north–south to northwest–southeast trending. This deformation led to overthickening of the crust, increased temperatures of the lower crust, and subsequent extension, culminating in a broad granite magmatic event about 2.595–2.585 Ga across the craton (Davis and Bleeker, 1999).



Source: Sabina, 2020.

Note: Simplified Slave craton geology modified from Bleeker & Hall (2007) and Stubley (2012).

Figure 7-1: Slave Province Geology

7.2 Property Geology

The geology of the Goose Site, George Site, Boot, Boulder, and Del prospects is summarized in Sections 7.2.1 to 7.2.5, respectively. An outline of the Property stratigraphy is shown in Table 7-1. A geological map of the Property is shown in Figure 7-2.

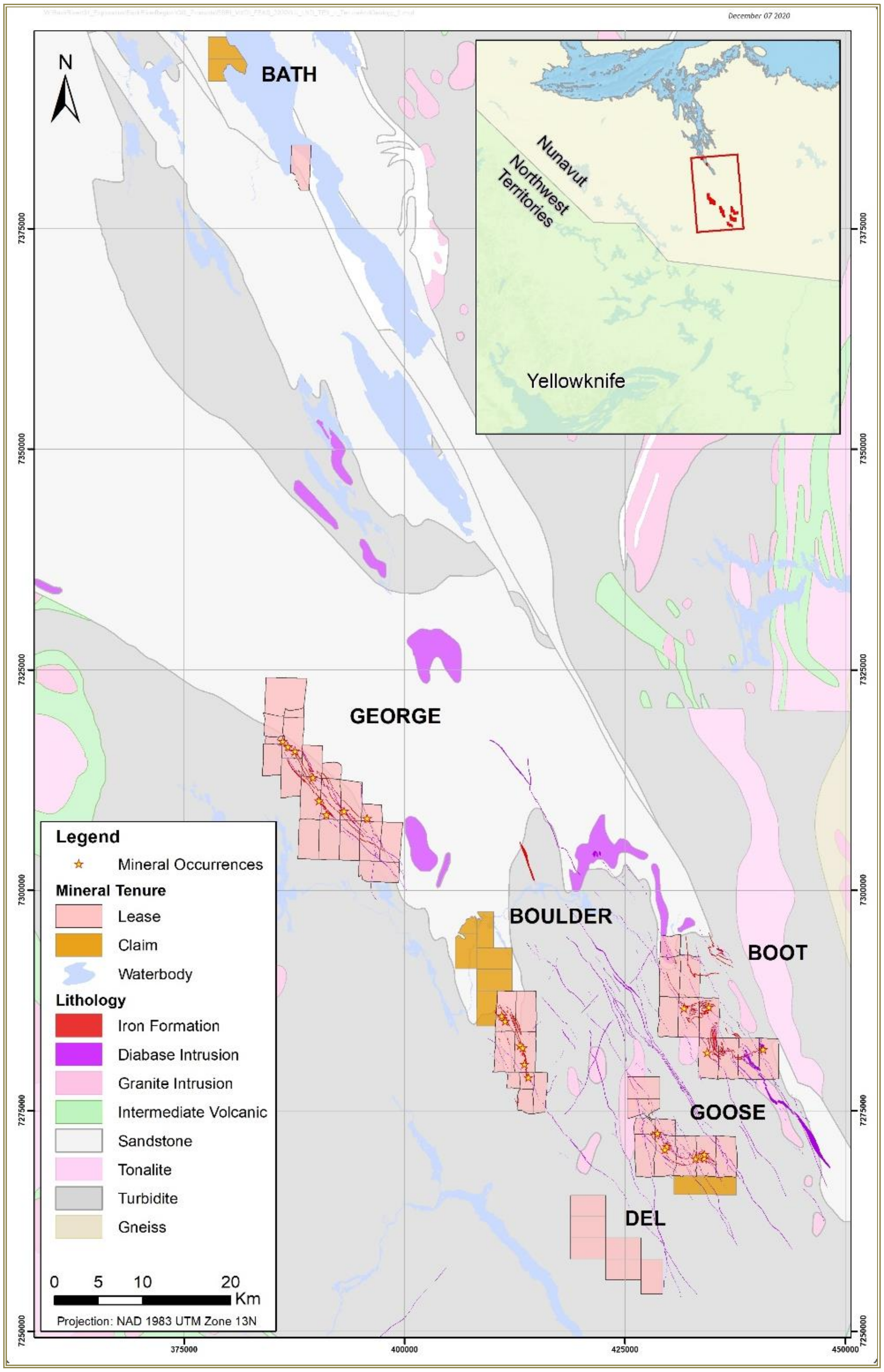
Broadly, the Goose and George sites, and Boot and Boulder prospects all similarly consist of folded Beechey Lake sedimentary rocks. The unconformably overlying Proterozoic sediments of the Goulburn Group extend southward, and partially cover the eastern and northern portions of the George and Boulder properties, respectively, obscuring a portion of what is believed to be one continuous iron formation basin approximately 50 km in extent.

The Del prospect contains the same folded sedimentary rocks as the other areas but lacks any observed iron formation horizons.

Table 7-1: Stratigraphy of the Back River Property

Age	Group	Sub-Group	Rock Types
Proterozoic	Goulburn	-	Clastic sediments with interbedded carbonates
Archean	Regan Intrusive Suite	-	Granitic to dioritic plutons and dyke equivalents
	Yellowknife Supergroup	Beechey Lake Group	Turbidite sediments, greywacke, mudstone, and iron formation
		Back River Group	Felsic to intermediate flows, tuffs, and breccia
		Hackett River Group	Felsic to mafic volcanic flows, tuffs, and chemical sediments

Source: Sabina, 2015.



Source: Sabina, 2020.

Figure 7-2: Back River Property Geology

7.2.1 Goose Site Geology

The Goose Site includes the Llama, Llama Extension, Umwelt, Echo, Nuvuyak, and Goose Main deposits; it has a consistent stratigraphic model that can be applied to all deposits. The folded Beechey Lake turbiditic meta-sediments, including oxide and silicate banded iron formation (BIF) horizons have been broken down into a modelled stratigraphy consisting of, from oldest to youngest: the lower sediments that contain a subordinate interbedded deep iron formation (DIF); the lower iron formation (LIF); the middle mudstone, the upper iron formation (UIF); and the upper sediments (Figure 7-3). This sequence is cut by quartz-feldspar porphyry dykes (QFP) and later gabbroic dykes.

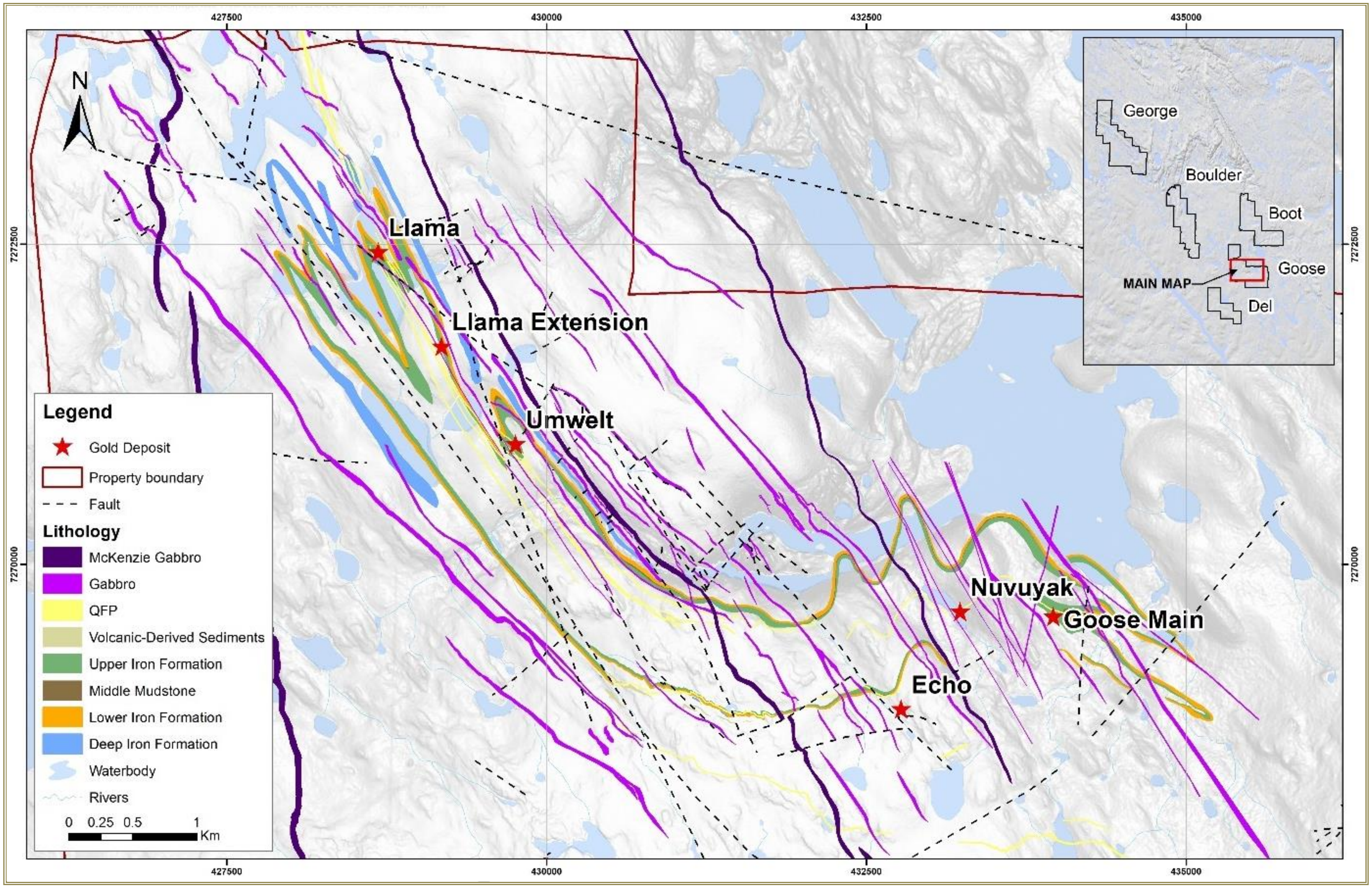
The DIF is typically a broad zone of thinly interbedded silicate iron formation beds within a clastic sediment-dominated unit between 40 m and 80 m below the LIF. The lower sediment, where drilled, is massive greywacke with quartz veining and increased alteration proximal to gold structures and the main overlying host LIF unit. The LIF is an oxide-facies iron formation that is typically strongly magnetic, with well-defined millimetre- to centimetre-scale magnetite-chert banding. Typically, 5 m to 8 m thick, this unit is strongly altered, and interrupted by centimetre - to metre-scale quartz veining and silicification in proximity to mineralized structures.

In the deposit areas the iron formation is thickened by folding 3 to 5 times, with thicknesses in fold hinges greater than 50 m. The host LIF is separated from the UIF by a thin, metre-scale, middle mudstone unit. The consistency of this mudstone makes it a successful marker horizon, helping to establish stratigraphic positioning when mapping and drilling at the Goose Site. Above this mudstone unit, the overlying UIF is an interbedded silicate iron formation and greywacke package, typically 40 m to 50 m thick, that grades into the interbedded greywacke and siltstone package of the upper sediments.

A single axial plane-parallel QFP dyke bisects the main antiformal structure at the Goose Main and Nuvuyak deposits. To the north, at the Umwelt, Llama, and Llama Extension deposits, QFP dykes are identified as multiple intrusions of varying thicknesses (typically <1 m to 5 m) but continue to generally follow the antiformal/synformal axial planes. At the Echo site, a single QFP dyke cross cuts the LIF along the southern limb of the Goose synclinorium. These felsic units are variably porphyritic, with mm-scale quartz and plagioclase phenocrysts in a fine-grained groundmass of plagioclase, white mica, and quartz. Locally, these QFP units can be moderately foliated and veined.

All units are intruded by late gabbroic dykes.

Gold mineralization is concentrated within the LIF unit; however, the lower sediments, middle mudstone, and the UIF are also known to contain mineralization, particularly proximal to well-mineralized LIF.



Source: Sabina, 2020.

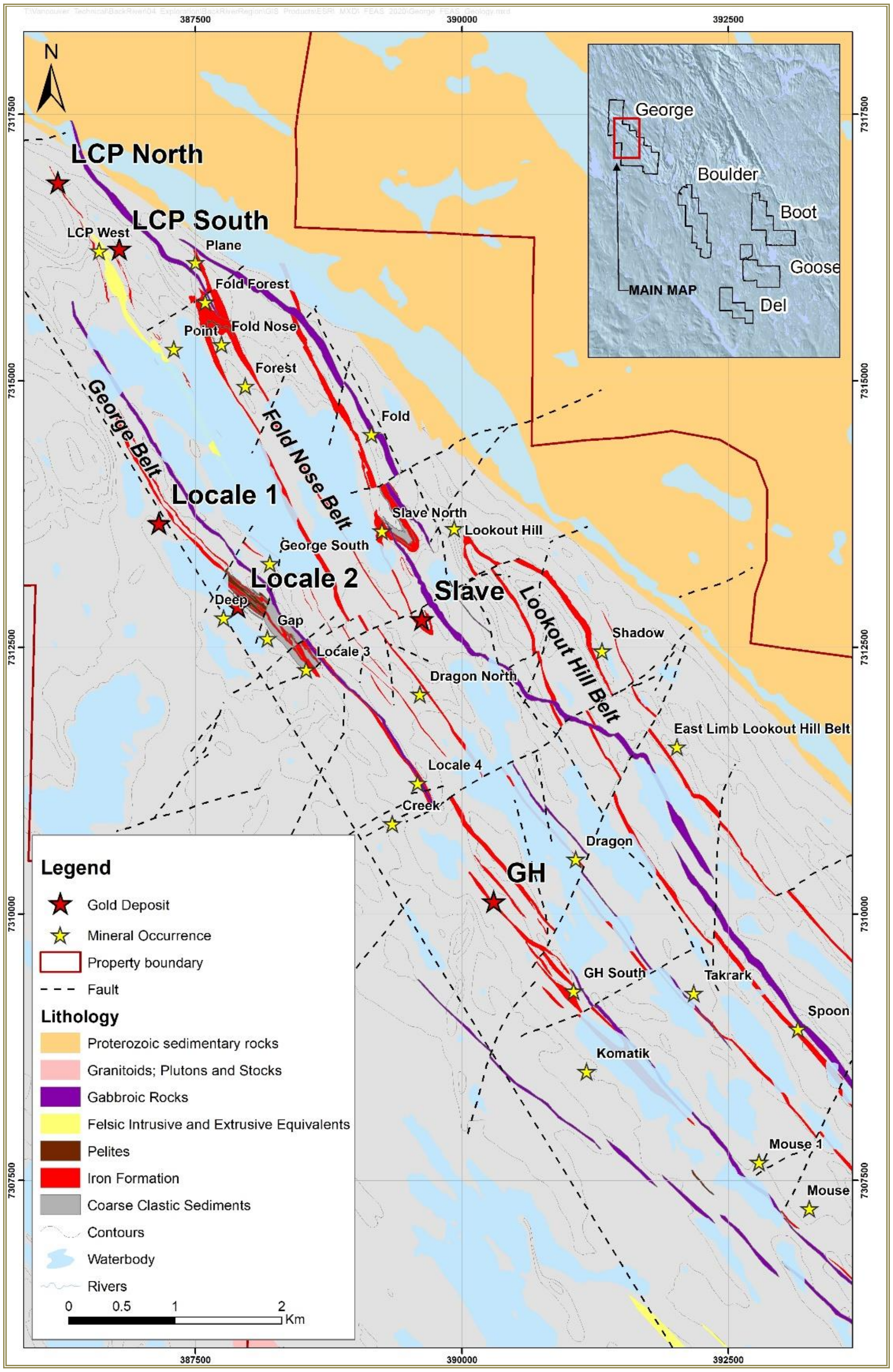
Figure 7-3: Goose Site Geology

At the Goose Site, three stages of deformation are identified and locally referred to as Archean events D1–D3, while two relatively minor Proterozoic stages, D4 and D5, have little obvious significance. The collective interference of the Archean deformation events has resulted in a doubly plunging synclinorium. The D1 event, responsible for development of the main synclinorium, is defined by upright, tight, symmetrical folds with sub-horizontal axes that have a minor associated fabric at variable orientations due to secondary folding. Timing can be constrained to be pre-2.62 Ga (Bleeker & Hall, 2007). The later D2 event has folded the main synclinorium, producing pronounced cross-folds in the eastern half of the property. Typically, D2 consists of large- to small-scale close to tight folds creating the dominant cleavage, oriented between 330° and 350°. This D2 event has been suggested to occur about 2.6 Ga. The effect of the D3 event is subject to ongoing interpretation and has been suggested to contribute to the doubly plunging nature of the synclinorium; however, recent structural work has indicated this folding may have occurred before D2, since the prominent S2 cleavage has a relatively consistent orientation across the property indicating it has been changed less by later folding.

7.2.2 George Site Geology

The George Site includes the LCP North (LCPn), LCP South (LCPs), Locale 1 (Loc1), Locale 2 (Loc2), GH, and Slave (SL) deposits. The geology for all deposits is presented in this section; however, this Updated Feasibility Study update focuses on the Llama, Llama Extension, Umwelt, Echo, Nuvuyak, and Goose Main deposits at the Goose Site. The George Site similarly sits within the Beechey Lake Group stratigraphy, where greywacke, mudstone, and iron formation are the dominant lithologies (Figure 7-4). Beechey Lake Group rocks are cut by felsic to intermediate sills, dykes, and small intrusions, all of which might belong to the Regan Intrusive Suite. The largest of these intrusions outcrops on the west side and immediately northwest of the George Site as an elongate, sheared, quartz-feldspar porphyry. Unconformably overlying the Archean rocks are Proterozoic Goulburn Group sedimentary rocks, exposed on the north and east margins of the George Site area, with scattered remnants of basal unconformity material exposed elsewhere. Northwest–trending gabbroic dykes intrude all the above-mentioned rocks. A summary of the dominant lithological units is shown in Table 7-1.

Iron formations in the George Site area are dominated volumetrically by the oxide facies (magnetite-chert-grunerite), with subordinate silicate facies (chert-grunerite-chlorite). In places, the dominantly oxide facies iron formation grades laterally into silicate facies, primarily as a function of magnetite depletion. Iron carbonate is present in both oxide- and silicate-facies iron formation. Iron formation occurs in three distinct fold belts named, from west to east, the George Belt, the Fold Nose Belt, and the Lookout Hill Belt (Figure 7-4). The relationship between these spatially separate domains has not been clearly established; however, common stratigraphy within the three belts suggests that they might represent one continuous sequence of iron formation that has been separated and repeated by faulting and folding. The prevailing structural and geological trends on the George Site are northwest to southeast. The Archean rocks have been affected by at least two early fold-deformation episodes, with a third fold event also deforming the overlying Proterozoic Goulburn Group.



Source: Sabina, 2020.

Figure 7-4: George Site Geology

7.2.3 Boulder Prospect Geology

At the Boulder prospect, oxide iron formation forms a 10 km linear north–south trend and is hosted by a package of mixed turbidites of the Beechey Lake Group (Figure 7-5).

Proprietary and government airborne geophysical surveys suggest that the iron formation on the Boulder prospect is continuous with the iron formation exposed at the George Site; however, between the two properties the iron formation is overlain by a thick (up to 300 m) sequence of flat-lying Proterozoic Goulburn Group sedimentary rocks. The main iron formation stratigraphic package (Figure 7-5) is continuous over most of the area; however, it is extremely variable in relative proportions of detrital and chemical components. The main iron formation package contains up to four distinct oxide-rich units interbedded with mudstone, greywacke, and locally intermediate to felsic volcaniclastic units. Mineralogically, the iron formation is relatively consistent throughout the area, both along and across strike. The iron formation is considered to have been deposited under oxide facies conditions and typically consists of magnetite-chlorite-chert and minor hornblende. Subtle variations occur in the relative abundances of these minerals.

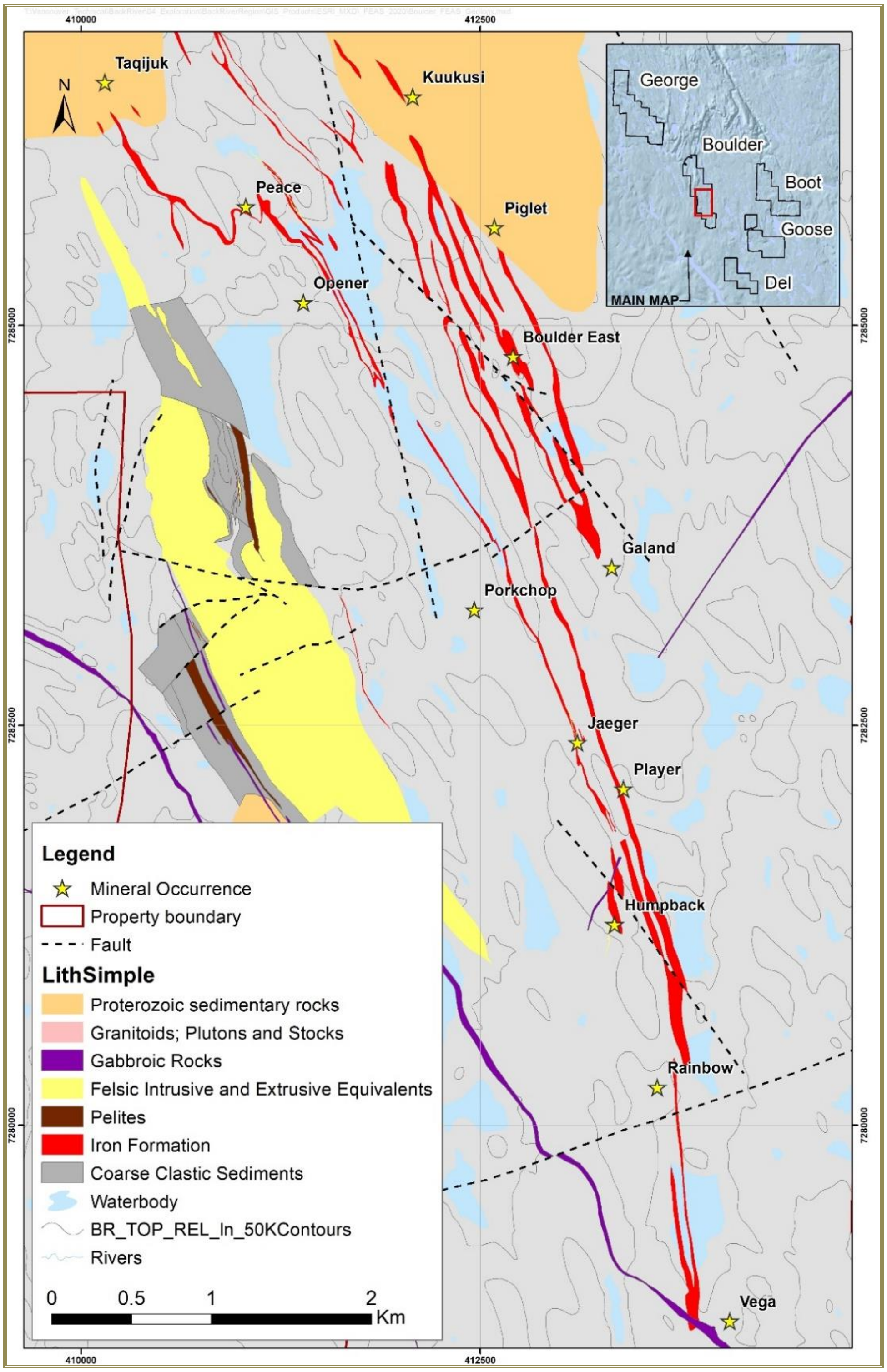
7.2.4 Boot Prospect Geology

As elsewhere on the Property, the Boot prospect comprises multiple-kilometre strike lengths of tightly folded oxide iron formation within mixed clastic sediments. The main iron formation unit is continuous across the Boot prospect, although the stratigraphy changes strike sharply at junctures in the northwest, centre, and southeast portions of the prospect (Figure 7-6). Minor felsic and intermediate dykes and plutons are present; the most significant of these is the Rusty Ring dioritic pluton, which intrudes the central/southwestern part of the prospect area. Generally northwest-trending gabbroic dykes intrude the Archean stratigraphy, while the much younger (ca. 1.3 Ga) Mackenzie diabase dykes cut all lithologies.

Iron formation units at the Boot prospect are dominated volumetrically by oxide facies (magnetite-chert-grunerite) with subordinate silicate facies (chert-grunerite-chlorite). In many locations, oxide iron formation is heavily sediment-bearing and is similar to the sediment-rich UIF at the Goose Site. The Boot prospect hosts some of the best-exposed and visually well-developed iron formations within the entire Property. Abrupt transitions between sedimentation styles are noted at the Boot prospect, with thin-bedded sediment sequences capped with iron formation overlain by thick-bedded, coarse-sandy sediments.

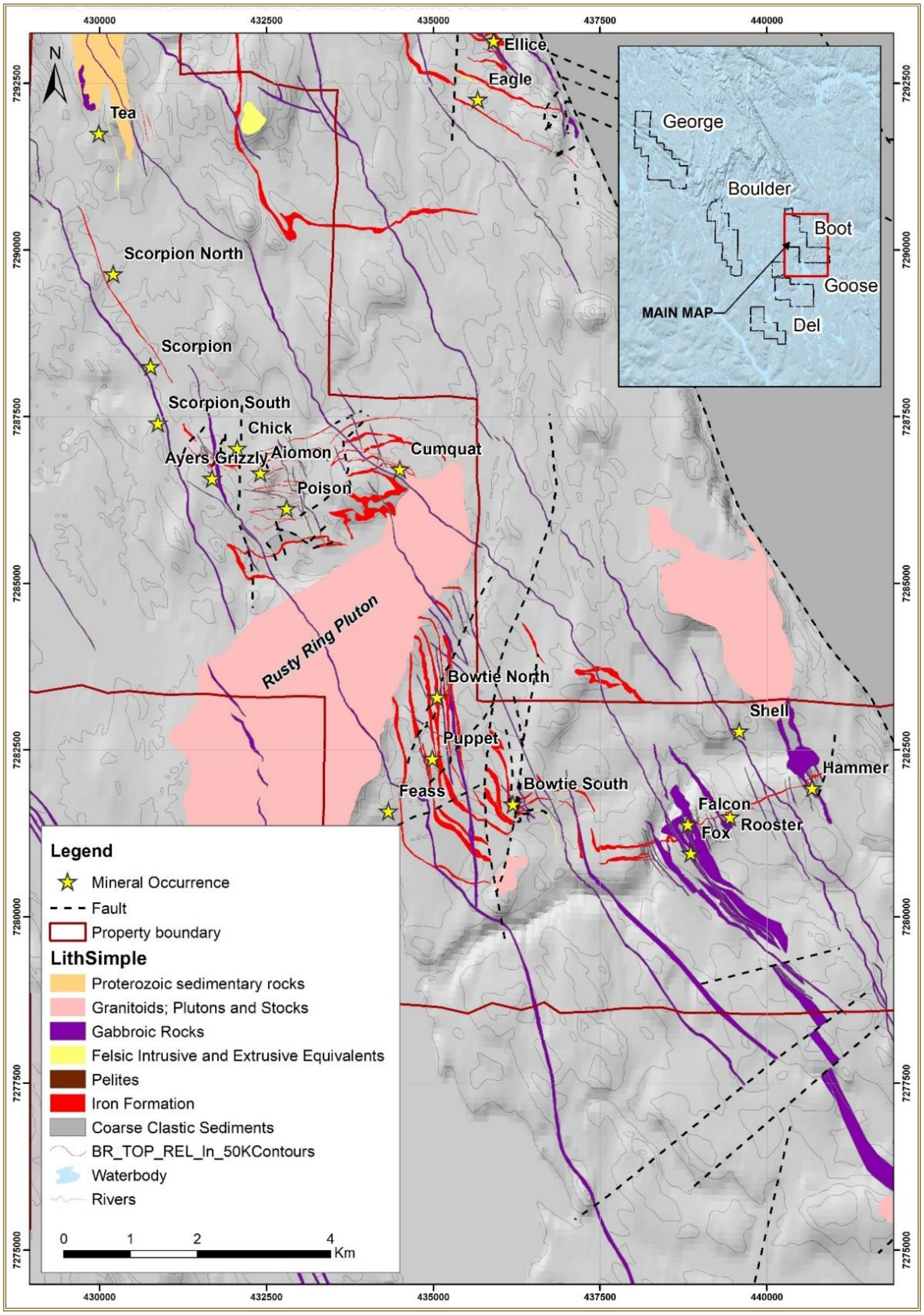
7.2.5 Del Prospect Geology

The Del prospect, located 17 km southwest of the Goose camp, is the only prospect on the Property that is not known to host iron formation stratigraphy (Figure 7-7). It is dominated by clastic sedimentary rocks with turbiditic sequences interbedded with mudstone. The rocks are steeply dipping and isoclinally folded. The Del prospect exhibits similar structural fabrics and relationships suggesting that the same D1 and D2 events responsible for the Goose Site mineralization affected this area. The main mineralized zone at the Del prospect lies within a northwest-trending structural zone associated with a broad halo of disseminated sulphides.



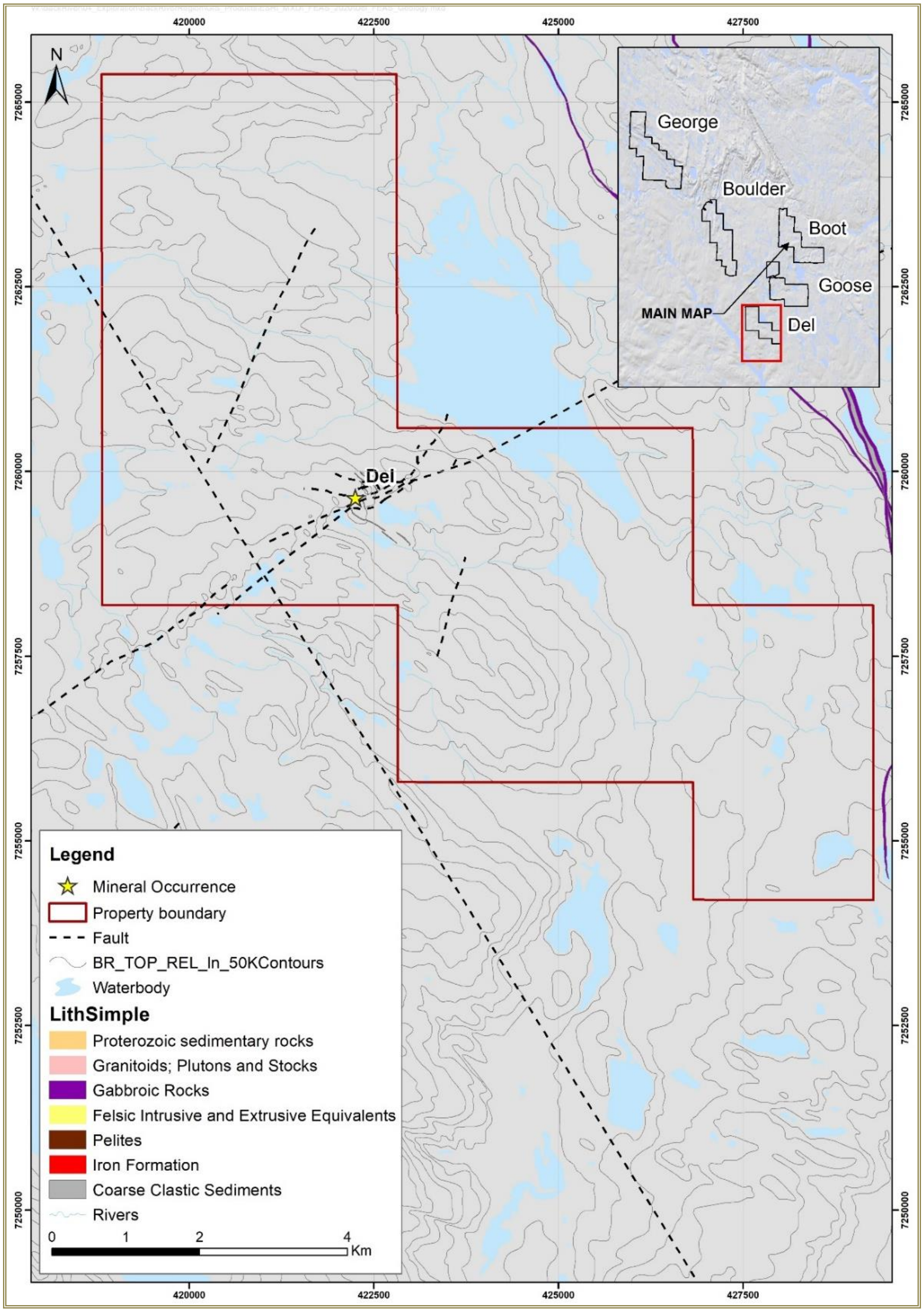
Source: Sabina, 2020.

Figure 7-5: Boulder Prospect Geology



Source: Sabina, 2020.

Figure 7-6: Boot Prospect Geology



Source: Sabina, 2020.

Figure 7-7: Del Prospect Geology

7.3 Property Mineralization

Gold mineralization on the Property is spatially correlated to iron formation stratigraphy, and as a result, the mineralization geometry is relatively continuous along the plunging antiform/synform structures; however, within the modelled mineralized zones, gold grades can be variable. Further details on the mineralization at the Property are provided in the subsections below. Table 7-2 and Table 7-3 show the orientation, length along strike, average down-dip dimension, and mean true thickness of the mineralization by deposit. Generally, the mineralized zones at the Goose Site lie beneath 4 m to 10 m of overburden, while all the zones at the George Site outcrop.

Table 7-2: Goose Site Mineralization Estimated Dimensions by Deposit

Deposit	Folded	Trend of Fold Axes (°)	Plunge of Fold Axes (°)	Dip of Fold Axial Plane (°)	Dip	Strike Length (m)	Average Vertical Height (m)	Mean True Thickness (m)
Llama	Yes	145	25	75	E	1,115	220	12
Llama Extension	Yes	145	20	65	E	590	120	12
Umwelt	Yes	135	25	60	E	1,700	240	15
Echo	Yes	145	63	75	S	410	350	6
Nuvuyak	Yes	346	30	78	E	400	300	15
Goose Main	Yes	285	20	70	W	650	250	15

Source: Sabina, 2020.

Note: Mineralization subcrops for all deposits except for Llama Extension and Nuvuyak, the tops of which are at 425 m and 460 m below surface, respectively.

Table 7-3: George Site Mineralization Estimated Dimensions by Deposit

Deposit	Folded	Dip Direction (°)	Dip (°)	Strike Length (m)	Average Vertical Height (m)	Mean True Thickness (m)
LCPn	No	238	85	750	220	3
LCPs	No	248	85	525	190	3
Loc1	No	240	75	1,050	300	3
Loc2	Yes[1]	220	75	670	350	3
GH	No	230	80	480	200	2
SL	Yes[1]	230	70	600	180	4

Source: Sabina, 2020.

Note: [1] Mineralization folded but modelled as individual planes. Mineralization for all deposits comes to surface under overburden.

7.3.1 Goose Site Mineralization

Llama and Llama Extension Deposits

Gold mineralization is hosted in both iron formation and clastic sedimentary lithologies, as well as rarely within quartz veins in the QFP dykes. Late gabbro dykes are known to post-date the timing of gold mineralization and do not host economic concentrations of gold. Banded oxide-facies iron formation, consisting of chert + grunerite + magnetite, hosts most of the known gold mineralization. Silicate-facies iron formation consisting of actinolite +

chert + grunerite, and locally interbedded clastic sediments hosts relatively lesser gold concentrations. Clastic sediments consisting of greywacke, siltstone, and mudstone are noted to be mineralized, but typically return low levels of gold, with locally elevated gold assays related to veining. In some cases, felsic dykes have been proven to host gold; however, to date the amount is considered relatively insignificant and associated with mineralized veining.

Gold mineralization is best characterized as an event of quartz veining and sulphidization related to folding and possible faulting along structural planes of weakness. Mineralization is observed to occur within quartz veins and alteration mineral-grain boundaries in all lithology types except for the gabbros, it consists of pyrrhotite ± arsenopyrite ± pyrite and free gold. Gold-mineralized quartz veining occurs commonly within the interpreted axial plane-parallel structural corridor. Replacement sulphidization of host lithology is also recognized within the Llama and Llama Extension gold zones, where pyrrhotite ± arsenopyrite (including loellingite) ± pyrite replaces magnetite and grunerite to varying degrees.

Oxide-facies iron formation is noted to have the highest level of sulphidation of all lithologies. Sulphidation is most intense proximal to deformation corridors. Silicate-facies iron formation is noted to have less sulphidization, but it similarly correlates with proximity to deformation within the structural corridor. Relatively low sulphidization of silicate iron formation facies is interpreted to result from less-abundant primary and metamorphic iron-rich minerals. Mineralization in clastic sediment lithologies is generally limited to quartz veins, typically accompanied by arsenopyrite disseminated in wall rock. Gold mineralization of this style is best observed proximal to areas of deformation, typically occurring at or near contacts with iron formation.

Umwelt Deposit

Similar to the Llama deposit, gold mineralization at the Umwelt deposit is focused within a structural corridor that is axial plane parallel. Gold mineralization is strongly associated with quartz veining and sulphidized iron formation lithologies, most commonly associated with arsenopyrite ± pyrrhotite ± pyrite. Pyrite and pyrrhotite are the most common sulphides in the Umwelt deposit, with pyrrhotite becoming significantly more prominent as the gold-mineralized zone plunges to the southeast. Arsenopyrite is the most common sulphide associated with visible gold, occurring as fine- to coarse-grained, euhedral, individual masses of crystals, occasionally located preferentially along banding planes, trailing along fractures, as vein halos, or as clusters along vein margins. Pyrrhotite appears as two textures within the deeper portions of this deposit; in the first, pyrrhotite is fine-grained and appears to be locally replacing magnetite in zones of intense sulphidization; the second texture is coarse-grained, and more blebby in nature. This second texture is later than the magnetite-replacement pyrrhotite and clusters along fine fractures, within veins, and along vein margins. Gold-mineralized zones are characterized by sulphide and silica alteration including quartz flooding, accompanied by shearing and veining. Visible gold is locally present, especially when sulphides are greater than 10% and when coarse-grained arsenopyrite and pyrrhotite are present.

Echo Deposit

Gold mineralization at the Echo deposit is concentrated in, but is not limited to, the lower contact of the iron formation with interbedded sediments. Brittle deformation is prominent at the contact; there is also a moderate amount of shearing present locally. A poorly mineralized QFP intrudes proximal to the structurally influenced contact and is interpreted to be closely related to the timing of gold mineralization. Alteration consists of varying amounts of grunerite + chlorite + quartz + calcite ± biotite. Mineralization associated with higher gold values (up to 120 g/t Au) consists of pyrrhotite + pyrite + arsenopyrite occurring with quartz veining, as well as replacement of the host rocks. The overall sulphide content ranges from trace to 10% over 0.5 m.

Banded-silicate iron formation consisting of actinolite + grunerite + quartz ± tremolite hosts most of the known gold mineralization. Oxide iron formation is similarly mineralized, but forms only a minor portion of the host. Clastic sediment lithologies appear to be less-favourable hosts and appear to be best-mineralized within areas of deformation that occur at contacts with iron formation. Because the area is largely covered by overburden, the relationship between the Goose Main deposit and the Echo zone is not well understood. This area has potential for the development of additional gold targets.

Nuvuyak Deposit

Discovered in 2018, the Nuvuyak deposit is located approximately 850 m along strike and 1,000 m down plunge of the Goose Main deposit. The central antiform extends from the Goose Main deposit and continues through an area of intense D2 cross folding that had previously been drill tested, recovering encouraging mineralization. At the Nuvuyak deposit, the central QFP dyke continues to follow the axial-planar structural zone, and gold mineralization is predominantly hosted in polyphase-folded LIF stratigraphy. The tight- to isoclinal-antiform geometry is very similar to that of the Goose Main deposit. Gold mineralization consists of pyrrhotite mineralization within fractures, replacement zones in brecciated host rock, and veins with locally rich arsenopyrite zones and abundant visible gold. Sulphide mineralization is associated with quartz veining, shearing, and moderate to strong amphibole and chlorite alteration.

Goose Main Deposit

Most of the observed gold mineralization at the Goose Main deposit is associated with quartz veins, silicification, and shearing. Gold mineralization occurs within silicified and variably sulphidized iron formation and, to a lesser extent, mixed iron formation and meta-sedimentary units located in the underlying central greywacke, modelled as DIF. Observed sulphide minerals include pyrite, arsenopyrite, and pyrrhotite. Gold mineralization is associated with accessory chlorite, carbonate, hornblende, and grunerite. Visible gold is locally present, especially when sulphides are greater than 10% and when coarse-grained arsenopyrite is present.

The deposit is within the Goose antiform structure, which is situated within a greater-than-500 m-wide corridor of widely spaced, sub-parallel, north- to northeast-trending, southeast-dipping, normal faults that have up to 30 m of left-lateral displacement and a down-dropping of individual fault blocks of up to 75 m.

Approximately 60% of the gold mineralization occurs within the LIF (sulphidized-oxide iron formation), and the remaining 40% occurs in the core of the underlying central greywacke and DIF. Very-minor gold and sulphide mineralization is developed in the UIF. Visible gold is common and typically occurs as sub-millimetre-sized grains, although larger aggregates of up to several millimetres are not uncommon. Visible gold is typically spatially associated with pyrrhotite and/or pyrite in the presence of arsenopyrite. Late D2 deformation appears to be a key gold-mineralizing event, where existing partially or wholly discordant quartz veins acting as fluid pathways are commonly boudinaged, reoriented parallel to S0 to S1 foliation, and gold-mineralized.

7.3.2 George Site Mineralization

Gold mineralization in the Loc1 and Loc2 deposits is hosted primarily in the LIF, within 10 to 12 m of the western edge of the western limb of a slightly overturned, tight Loc1–Locale 4 syncline. Some gold mineralization is also hosted in the UIF at the Loc1 and Loc2 deposits. The gold deposits at LCPn, LCPs, GH, and SL are within oxide iron formation in the limbs of tight isoclinal folds. Less-significant mineralization is also hosted within silicate iron formation and surrounding sediments.

A spatial correlation exists between ductile shears and Loc1, Loc2, LCPn, LCPs, and GH, but the timing relationship with gold genesis has not been determined. There is a close spatial association between gold and iron formation, and other rock types adjacent to mineralized iron formation typically lack gold mineralization. The gold-bearing zones coincide with sulphide-bearing portions of the iron formation. Sulphidation of the BIF is common, but concentrations of gold coincide with sulphide-bearing zones that are associated with cross-cutting, late quartz veins. The sulphide mineralogy associated with the gold comprises pyrrhotite or pyrite, arsenopyrite, loellingite, and minor amounts of chalcopyrite. The sulphides are generally disseminated within veins, along vein margins within host rocks, or might be concentrated in specific bands within the iron formation. Pyrrhotite and pyrite typically replace magnetite and amphiboles forming sulphidized bands. Hornblende is the dominant amphibole in the mineralized iron formation, with little or no grunerite. Where both amphiboles are present, grunerite is partially replaced by hornblende. Along-strike from the mineralized zones, the sulphide-bearing, hornblende-rich mineralized iron formation passes into a sulphide- and gold-poor unmineralized iron formation that comprises grunerite + quartz ± magnetite ± minor amounts of hornblende. These characteristics are also present at the Goose deposits.

At least three quartz vein sets are present at the George Site. Two of the quartz vein sets are steeply dipping: one set is oriented sub-parallel to the iron formation stratigraphy, and the other is nearly perpendicular. The third set is sub-horizontal. All three sets of quartz veins are more abundant within the iron formation units than in the surrounding sediments. Not all quartz veins are gold-bearing or associated with sulphides. The quartz veining-associated gold mineralization and alteration occur late in the brittle-ductile shearing structural history.

7.3.3 Boulder Site Mineralization

Mineralization at the Boulder prospect is similar to that identified at the Goose and George sites, occurring as pyrrhotite, pyrite, and arsenopyrite with the arsenopyrite being more closely associated with gold mineralization. Sulphides are typically associated with silicification or quartz veins, and form either massive pods or disseminated euhedral crystals within chloritic vein selvages or within the adjacent wall rock. Additional work is required to further characterize mineralization at the Boulder Prospect.

7.3.4 Boot Prospect Mineralization

Mineralization at the Boot prospect is also similar to that identified at the Goose and George sites. Pyrrhotite, pyrite, and particularly arsenopyrite are associated with gold mineralization. Sulphides are typically associated with silicification or quartz veins, and form either massive pods or disseminated euhedral crystals, within chloritic vein selvages or within the adjacent wall rock. Additional work is required to better describe the nature and range of mineralization styles relating to the LIF and other rock types at the Boot prospect.

7.3.5 Del Prospect Mineralization

At the Del prospect, mineralization is primarily hosted within deformed clastic sediments. Interpretations of the mineralization have determined two generations of gold bearing quartz veins. Conformable quartz veins and cross-cutting, irregular quartz veins and pods associated with a broad sulphidization halo. Arsenopyrite, and to a lesser extent pyrite and pyrrhotite, are the dominant sulphides.

8 DEPOSIT TYPES

The gold deposits at the Property are hosted by sulphidized oxide and silicate iron formation rocks, and clastic sediments that are cut by barren and sulphide-bearing quartz veins. Analogous deposits occurring in this region of the Arctic include the Lupin Mine approximately 225 km west of the Property (Bullis et al, 1994), the Meliadine district at Rankin Inlet (Carpenter et al., 2005), and the Meadowbank deposit north of Baker Lake (Sherlock et al., 2004).

Within Canada, BIF-hosted gold deposits commonly occur within Archean-aged greenstone belts, typical of the shield areas of northern Ontario, Quebec, NWT, and Nunavut. Generally, BIF host rocks are thinly banded sedimentary rocks with alternating iron-rich and cherty (siliceous) layers.

In BIF-hosted gold deposits, gold mineralization is commonly associated with quartz veining, shearing, and zones of hydrothermal alteration suphidizing the host silicate and oxide iron formations (mainly pyrite, pyrrhotite, and/or arsenopyrite). Gold mineralization is mainly located along shear zones associated with tightly folded and structurally complex BIF horizons that provide favourable chemical and structural traps. This understanding is being applied in the current exploration strategy for the Property.

9 EXPLORATION

9.1 Introduction

This section discusses all exploration and associated work carried out by Sabina from 2016 to 2020, according to activity. Drilling is discussed in Section 10, and a summary of the historical exploration work completed prior to Sabina's ownership is discussed in Section 6.

Since acquiring the Property in 2009, Sabina has completed many surface-exploration campaigns, primarily in support of extensive drill programs, and to further improve the regional geological model. The activities are summarized by year in Table 9-1. Exploration was initially focused on the Goose Site but was rapidly expanded to encompass other regional target areas. This resulted in additional discoveries across the Property. All the exploration carried out by Sabina is documented in various Technical Reports (JDS, 2015a, 2015b; SRK, 2012; Tetra Tech, 2013, 2014).

Table 9-1: Summary of Sabina's Exploration Work

Year	Explored Areas	Exploration Activities
2009	Goose Site	Mapping, magnetics, IP, and horizontal-loop electromagnetic (HLEM) surveys
2010	Goose Site	Geological mapping and sampling, magnetometer and HLEM ground survey, mineralogical study
2011	Goose Site	Geological mapping and sampling, time-domain electromagnetic (TDEM) and IP ground survey, mineralogical study, TDEM borehole surveys
	George Site	Magnetometer and HLEM ground survey
2012	Goose & George Sites	Grab sample program, metamorphic gold genesis study
	Goose Site	Till orientation study, mafic intrusion geochemistry and structural study, regional mapping
2013	George Site	Geological mapping, metamorphic grade study, geochemical sampling
	Boot & Boulder Prospects	Geological mapping (1:1000 and 1:5000), geochemical sampling
	Regional	Regional-scale work off-Property to provide wider geological context for the deposits
2014	Goose Site	IPower 3D® geophysical survey, felsic dyke geochemical characterization study
	George Site	Surface mapping, follow-up metamorphic study
2015	Goose Site	Ground magnetics survey, regional mapping, and sampling
	Boulder Prospect	Ground magnetics survey
	Goose & George Sites & Boulder Prospect	Pulp material selected for regional trace element study
2016	Goose Site & Boulder Prospect	Regional mapping and sampling, till sampling, historical core review, HLEM geophysical ground survey (Goose Site)
	George Site	Geological mapping, historical core review
2017	Goose Site & Boulder Prospect	Regional mapping and sampling, HLEM geophysical ground survey
2018	Boulder Prospect	Geological mapping and sampling, till-sampling grid extension, bulk till sampling, sampling for geochronology study
	Goose Site	Geological mapping and sampling, bulk till sampling, sampling for geochronology study
	George Site	Geological mapping and sampling, bulk till sampling, sampling for geochronology study
	Boot Prospect	Geological mapping and sampling, sampling for geochronology study

Year	Explored Areas	Exploration Activities
2019	Goose Site	Goose Main trench study
	Del Prospect	Geological mapping and sampling
2020	Goose & George Sites & Del Prospect	Regional versatile time-domain electromagnetic survey
	Goose Site & Del Prospect	Geological mapping and sampling

Source: Sabina, 2020.

9.2 Exploration Activity 2016–2020

9.2.1 Overview

Since 2016, annual field exploration activities have routinely included geological mapping, rock sampling, and detailed core review. In addition, a till-sampling program was completed in 2016 and expanded upon in 2018, across multiple areas of the Property. During the 2018 till-sampling program, an updated Property-wide surficial map was produced to support planning of future till-sampling programs. The field program in 2019 focused on a localized mechanical overburden-stripping program within the Goose Main deposit. Concurrently, detailed structural and vein studies were conducted on outcrop- and drill-hole scale to help advance the gold mineralization model. An airborne geophysical survey was completed in 2020 across the Goose and George sites, and the Del prospect, to aid in structural interpretation and targeting. These field programs and geoscience initiatives have helped refine the gold depositional and structural model that has led to improved targeting and deposit expansion.

In this section the exploration activities are described and quantified, and in Section 9.3 the sampling procedures are described where applicable.

9.2.2 Geological Mapping and Sampling

Geological mapping is an important component of Project advancement and is carried out annually. A Property-wide mapping initiative was completed in 2012 (Bernoilles et al., 2012), establishing the regional map that has been refined in subsequent field programs. Since 2016, the priority has been on detailed lithologic relationships and structural evidence for development and confirmation of the depositional history. Over this time, the geological database has increased by approximately 15%.

During 2016, Sabina carried out several exploration activities that included a reconnaissance mapping and prospecting program as follow-up to the geochemical anomalies previously outlined by a surficial sampling program (conducted by Dundee in 2007) at the George Site, at the south portion of the Boulder prospect, and at the Goose Site. In all, 149 samples were collected for fire assay (FA) and four-acid multi-element analysis. This program identified strong mineralization from a grab sample within the iron formation at the Humpback target that assayed up to 24.86 g/t Au.

In 2017, a brief field season focused on reconnaissance mapping and prospecting at the Goose Site and Boulder prospect. A total of 124 grab samples were collected from outcrop, subcrop, and felsenmeer localities and sent for FA and four-acid multi-element analysis. An important observation from this work includes identification of felsic dyke felsenmeer blocks on surface, creating a continuous trend. The trend proved to be traceable over several kilometres and can be used as a proxy for outcrop.

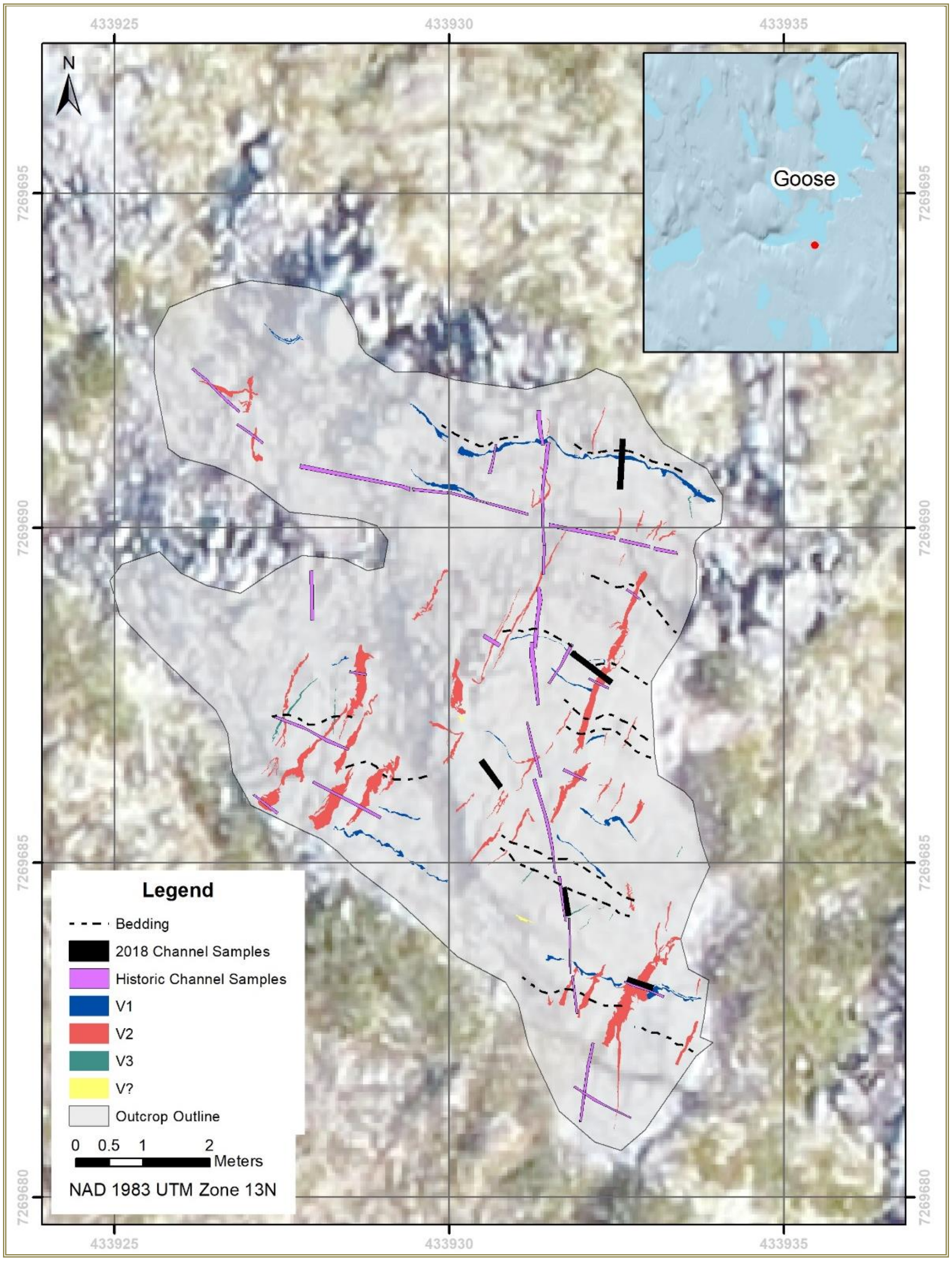
The primary focus of the 2018 field program remained geological mapping and sampling at the Boulder prospect, but reconnaissance mapping was also conducted at the George and Goose sites, and the Boot prospect. In all, 64 surface grab samples were collected during the mapping program and sent for FA and four-acid multi-element inductively coupled plasma (ICP) analysis at SGS Mineral Services (SGS), Burnaby, BC. Most geochemical samples were taken at the Boulder prospect as part of the prospectivity assessment. The highest grab sample assays sourced from the Humpback zone include 15.68 g/t Au, 10.66 g/t Au, and 10.63 g/t Au.

Mapping at the Goose Site was focused on a detailed outcrop study of vein generations and relationships. The result was a 1:200 scale map (Figure 9-1) that presented an interpretation of multi-generational quartz veining in correlation with regional structures. In total, three different quartz vein generations (V_1, V_2, V_3) were identified. Additionally, key stratigraphic and structural features were investigated to support new stratigraphic observations made during the 2018 Nuvuyak drilling.

Sabina made a reconnaissance trip to the Del prospect in 2019, to review the nature of veining, and strain, in the Del sediments. Only one sample was taken, returning weakly elevated gold mineralization of 160 ppb within a veined and chlorite-altered medium-grained clastic sediment.

During the 2020 summer program, geological mapping and sampling were primarily focused on the Goose Site, with additional regional fieldwork excursions to the Del prospect. Traverses were planned, to investigate 2020 versatile time-domain electromagnetic (VTEM) geophysical responses, and to explore key areas for target advancement or model confirmation. In all, 28 grab samples were taken during the 2020 fieldwork; all were analyzed for gold by FA and by a trace element suite by ICP-MS using a four-acid digest method. The analytical work was carried out by ALS Global (ALS), in Vancouver. One sample from the Del prospect returned a significant result of 2.94 g/t Au; however, all remaining samples contained <1 g/t Au.

From 2016 to 2020, Global Positioning System (GPS)-enabled Trimble Juno 3B devices continued to be used to map outcrop/subcrop exposures and to collect all data points, including samples, station points, and structural measurements. The current mapping database includes over 13,000 outcrop polygons and 25,000 data points across the Property.



Source: Sabina, 2020.

Note: Veins are coloured according to their generation classification.

Figure 9-1: Detailed Map of Outcrop Near Goose Main Deposit

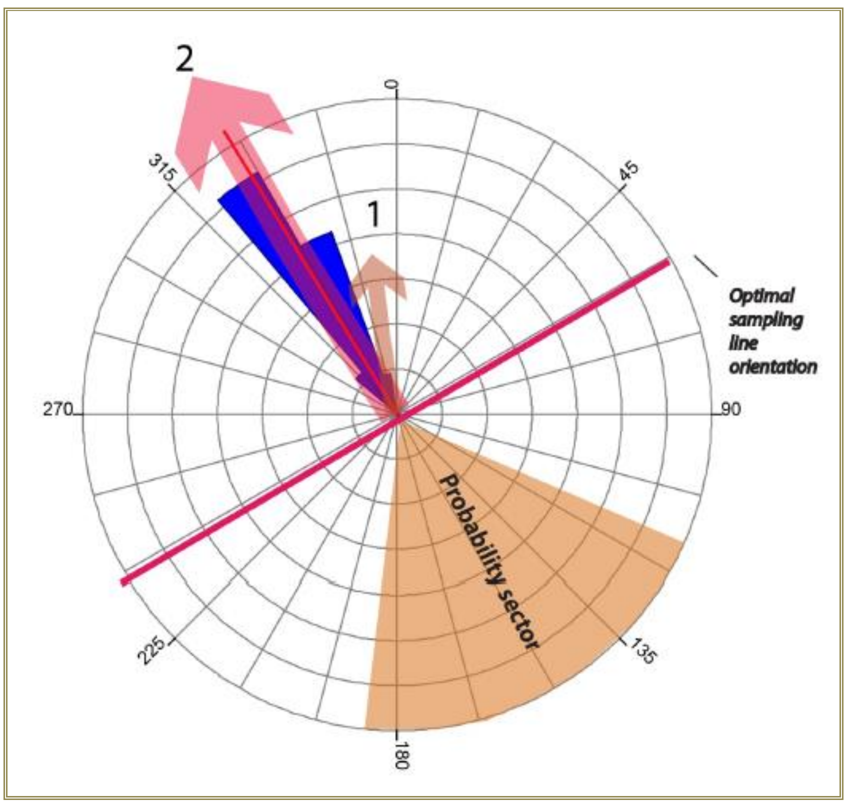
9.2.3 Surficial Mapping

The Geological Survey of Canada previously mapped the surficial environment within the Back River Region at 1:1,000,000 scale (Aylsworth & Shilts, 1989; Prest et al., 1968).

Stea Surficial Geology Services (Stea) in Nova Scotia produced updated surficial maps in 2018 using high-resolution (1 m) light detection and ranging (LIDAR) orthophotographs (Stea, 2018). The LIDAR images covered up to approximately 60% of the Goose, Boulder, and George sites, and freely available panchromatic band SPOT 4 and 5 satellite imagery at 10 m resolution was used to supplement the uncovered areas.

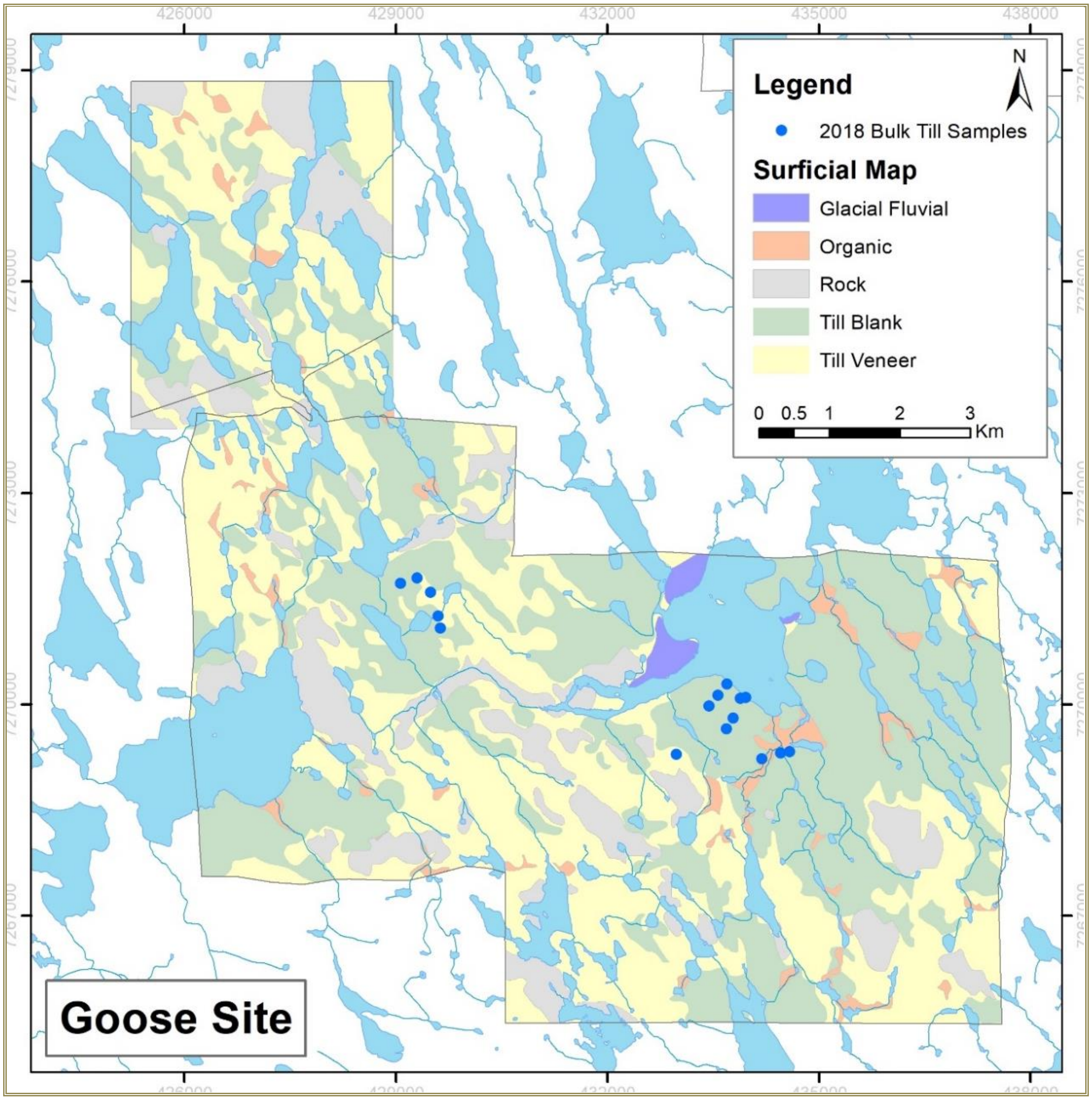
The predominant ice-flow directions are defined as north-northwestward, with an early phase characterized by flow features trending 340° to 350°, and a more-prominent northwestward flow at 310° to 330°, as seen in the rose diagram in Figure 9-2. The probability sector in Figure 9-2's rose diagram denotes an area of potential up-ice sources: the tan arrow, 1, is an older northward flow, and the larger, pink arrow, 2, is the main erosive ice-flow phase (N =134).

Glacial flow trends were identified in the photo imagery from flow-parallel landforms at large scales (i.e., drumlins, and crag-and-tail hills), then confirmed by field ground-truthing and small-scale glacial striae measurements. Surficial maps of the Goose Site, Boulder prospect, and George Site are compiled in Figure 9-3 to Figure 9-5.



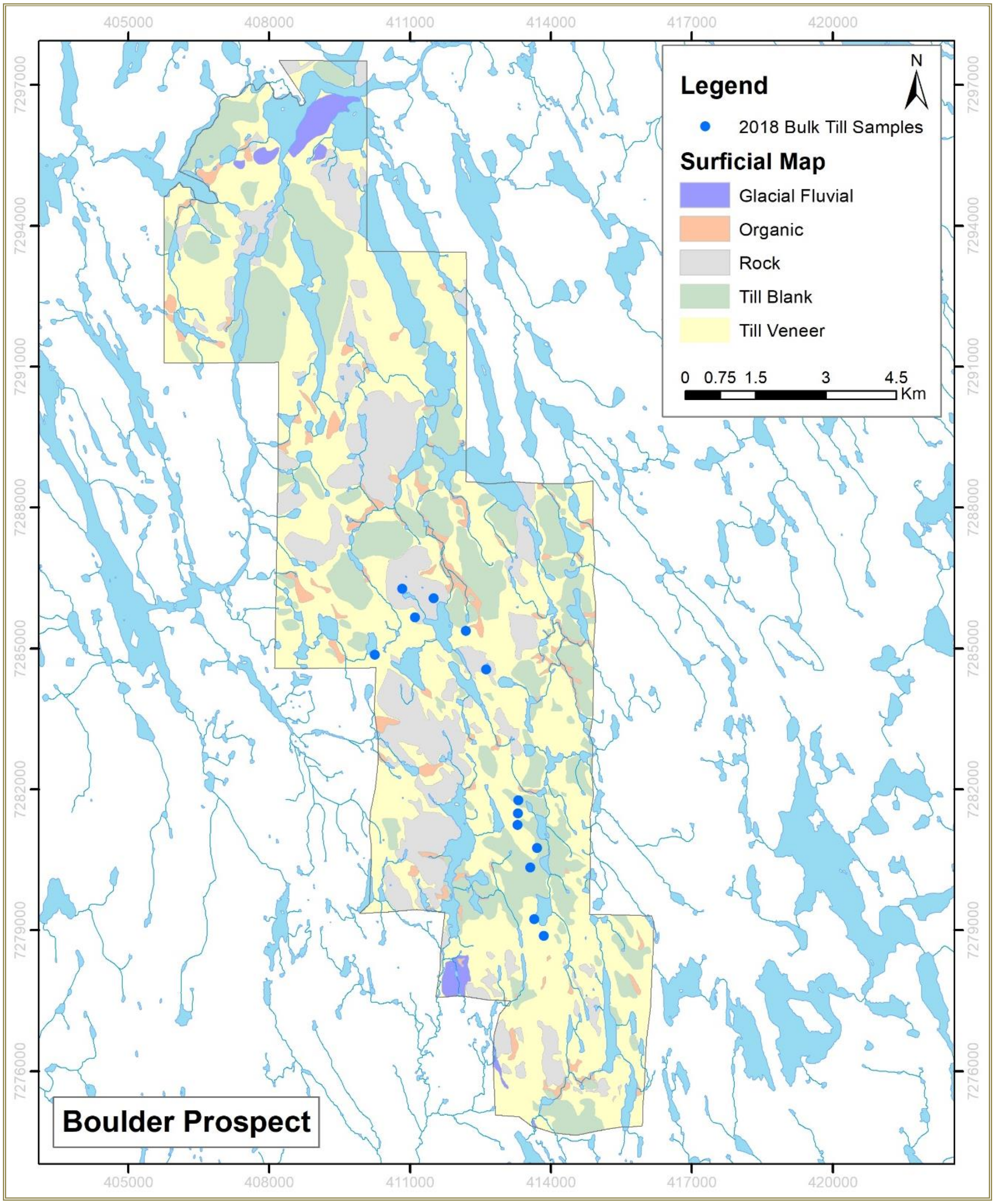
Source: After Stea, 2018.

Figure 9-2: Rose Diagram of Ice-Flow Directional Indicators for Goose, Boulder, and George



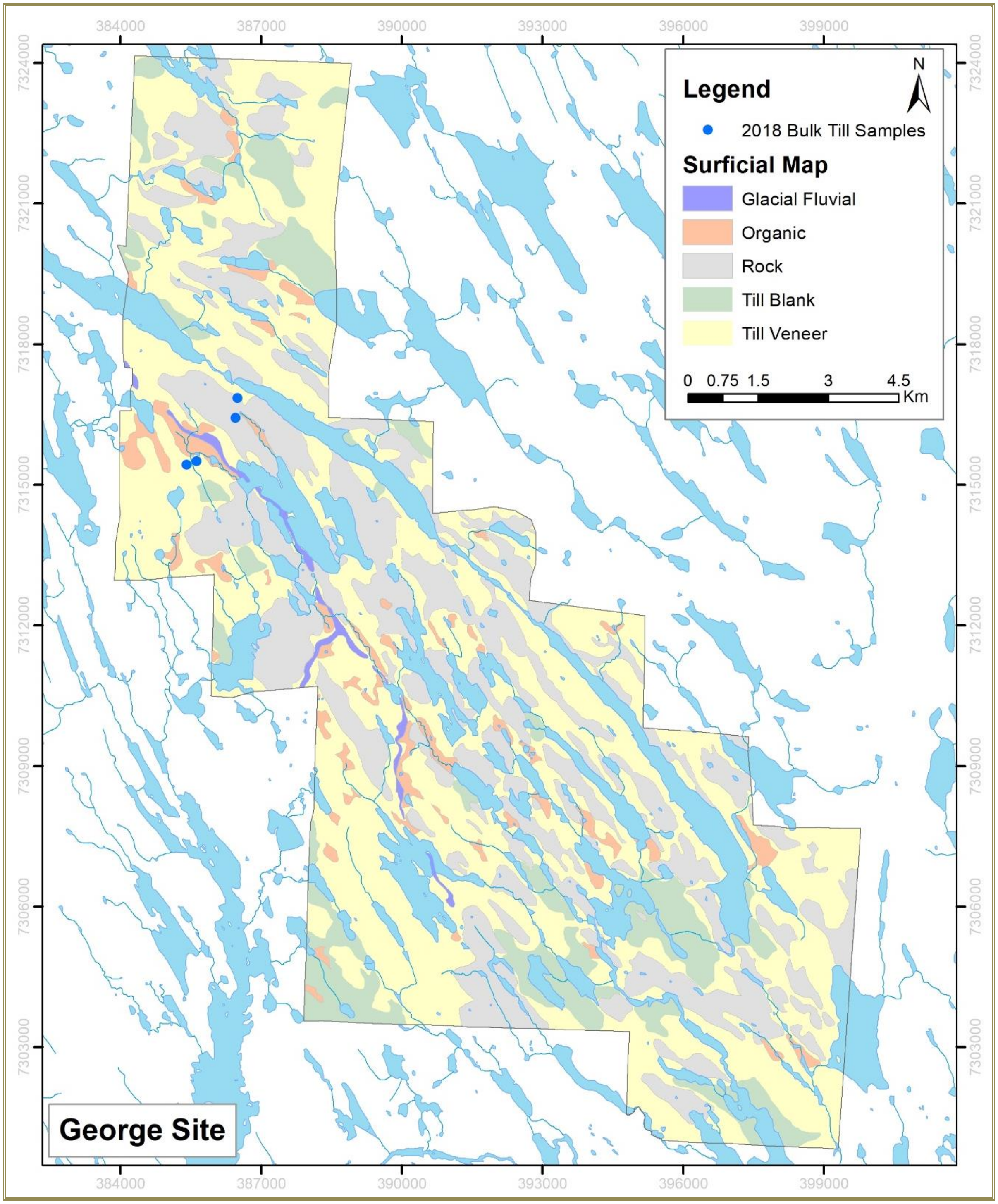
Source: After Stea, 2018.

Figure 9-3: Surficial Map of Goose Site



Source: After Stea, 2018.

Figure 9-4: Surficial Map of Boulder Prospect



Source: After Stea, 2018.

Figure 9-5: Surficial Map of George Site

9.2.4 Surficial Sampling

Till samples collected in 2016 included 403 samples from Goose Site and 288 samples from the Boulder prospect. Samples were submitted for laboratory gold analysis by FA with atomic absorption (AA) finish and arsenic analysis by ICP at SGS Burnaby. On-site arsenic analysis was done by portable X-ray fluorescence (pXRF) device.

On-site interpretation of pXRF results for field follow-up or infill was done by applying a 30° up-ice plume-distribution model to samples yielding anomalously high arsenic values.

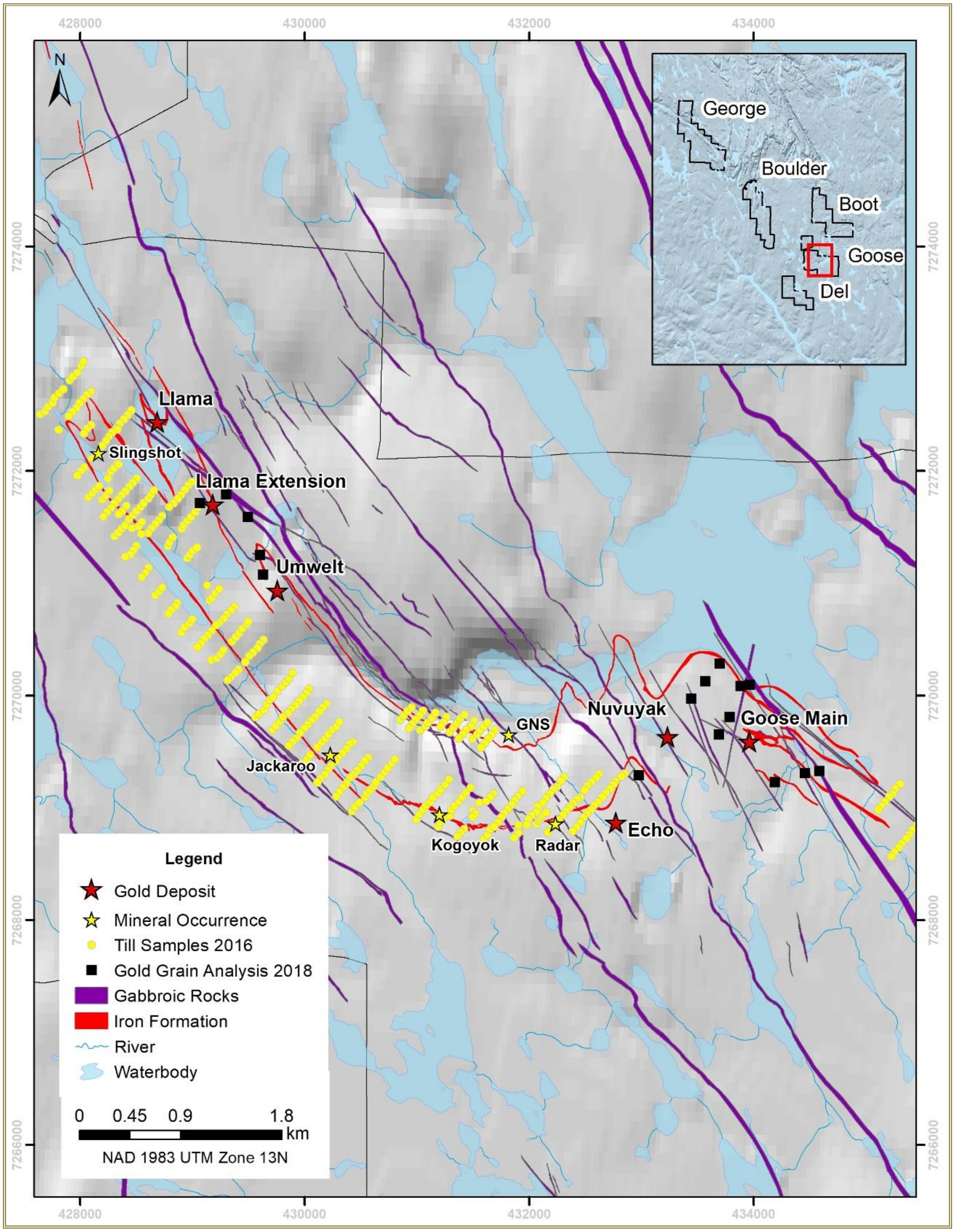
The till-sampling grid at the Goose Site was oriented 050°, perpendicular to the ice-flow direction. At the Goose Site, sampling grids were planned at several select areas, including western Goose Site (encompassing the Slingshot to Jackaroo targets), central Goose Site (encompassing the Kogoyok to radar and GNS targets), and southeastern Goose Site (south of the Goose Tail targets), as shown in Figure 9-6.

Similarly, the sampling grid at the Boulder prospect was oriented 050°. The grid lines were spaced approximately 100 m apart, with sampling sites every 50 m (Figure 9-7). Generally, ground conditions characterized by flat or gently sloping hills with little outcrop exposure makes till sampling a strong technique for exploration in the area. Several arsenic dispersal trains were recognized in pXRF data down-ice of the Vega and Humpback targets.

In 2018, a follow-up program was designed to extend and infill the 2016 Boulder survey. This extension consisted of 294 samples at 100 m line spacing, and 50 m spaced samples (Figure 9-7).

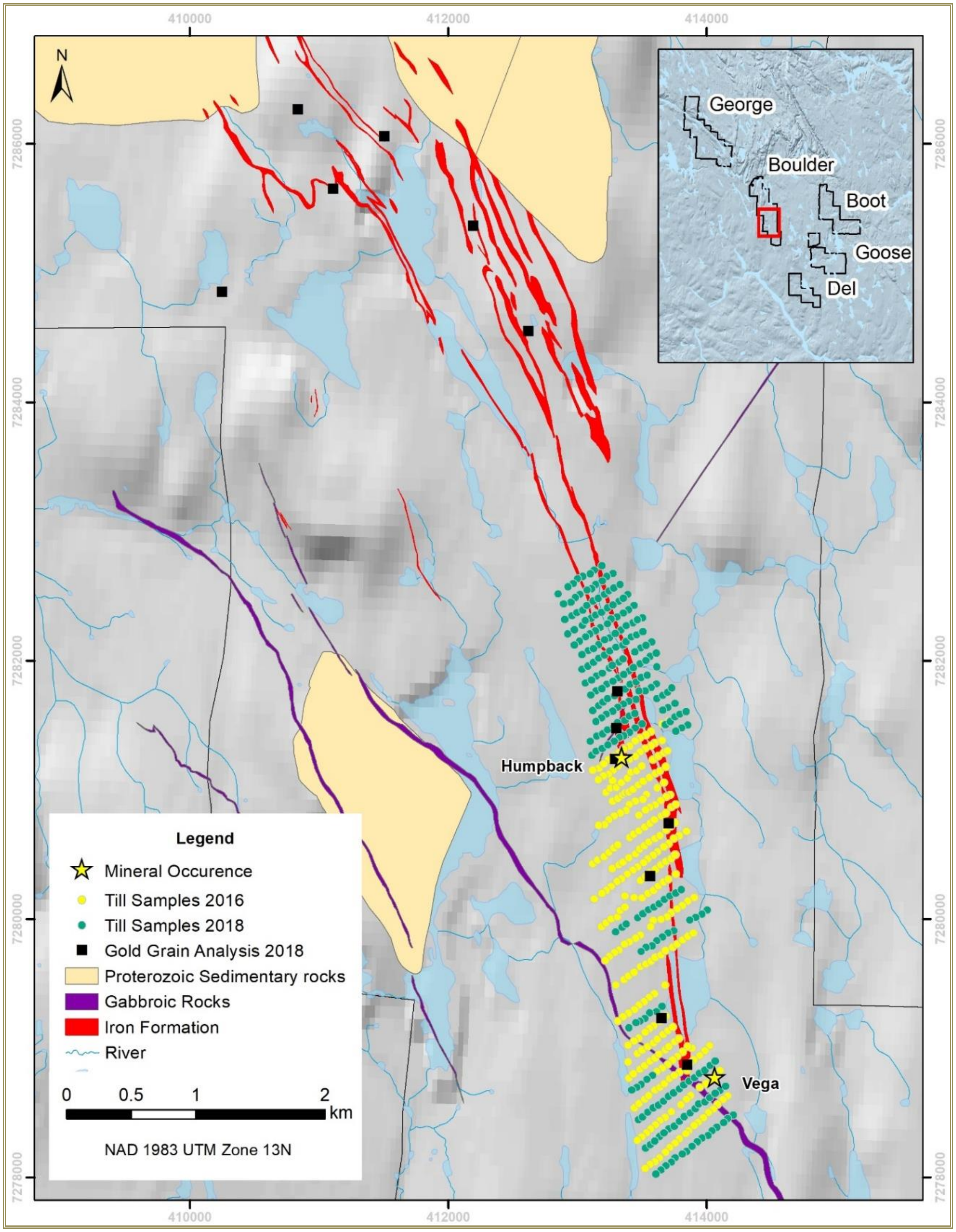
Concurrently, a bulk till-sampling survey was completed, consisting of 32 samples, each 8 kg to 12 kg (shown in Figure 9-6 Figure 9-7), and gold grain analysis carried out at Overburden Drilling Management, Ottawa, Ontario. Results of this survey confirmed that the Goose Site is dominated by thicker till areas compared to the Boulder prospect and George Site, based on the small number of observed gold grains from the Goose samples compared to other sites.

Like rocks samples, all till-sample location data were captured using the Trimble Juno 3B GPS-enabled hand-held devices.



Source: Sabina, 2020.

Figure 9-6: Till Samples Collected on the Goose Site during 2016 and 2018



Source: Sabina, 2020.

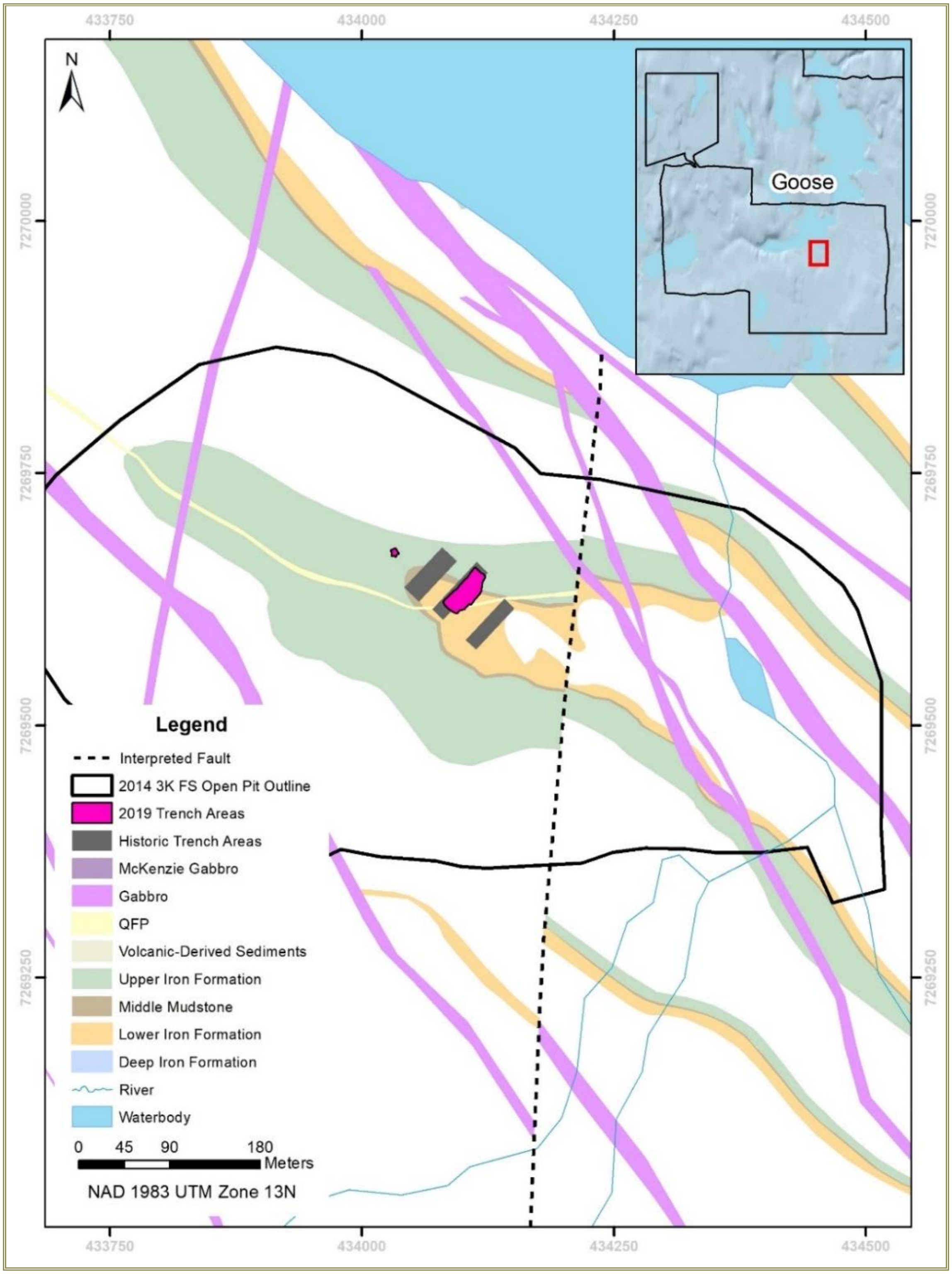
Figure 9-7: Till Samples Collected at the Boulder Prospect during 2016 and 2018

9.2.5 Mechanical Overburden Stripping

Sabina mechanically excavated two trenches during 2019 using a Caterpillar 320C LU excavator and a Caterpillar 730 rock truck. Trench A, approximately 20 m by 50 m, and a smaller exposure (Trench B), approximately 5 m by 5 m, exposed part of the Goose Main deposit for detailed mapping and sampling (Figure 9-8). The trenches were mapped in detail with a focus on veining, mineralization, lithology, and structural relationships. Grab samples were selected to test gold content and trace-element variation across lithologies and vein orientations. These grab samples were typically less than 30 cm long and were extracted using a handsaw. Wall rock and vein material were separated as best as possible and submitted to SGS Burnaby for FA and four-acid multi-element digestion. In all, 19 samples were submitted.

DPM previously excavated a portion of the Trench A site in 2005, resulting in a basic geological map and channel samples. Samples collected along a strongly mineralized trench yielded assay results greater that 10 g/t Au over 2 m, with the highest assay of 89.56 g/t over 0.99 m. This is supported by similar, highly anomalous assay results obtained in 2019 of 260.54 g/t Au for a mineralized vein.

The excavated exposures showed a high level of complex folding. Folding of the major units can be attributed to numerous deformational events that may not always be discernable in drill core. The first of these deformation events, D1, creates shallowly plunging fold hinges and nearly vertical stratigraphy. The second event, D2 cross-folding, folds both bedding and the F1 folds, forming steeply plunging fold hinges. In addition, boudinaged chert nodules create locally irregular deformed bedding. The complexity of bedding at outcrop scale helps explain the difficulty in attributing hinges and deformed bedding in drill core to any one deformation event.



Source: Sabina, 2020.

Figure 9-8: Trench Locations

9.2.6 Geochronology

In 2018, nine samples listed in Table 9-2 and shown in Figure 9-9 were sent to the Pacific Centre for Isotopic and Geochemical Research facility at the University of British Columbia for U-Pb isotope analysis, with an additional three samples submitted as part of a follow-up program in 2019, making 12 samples altogether.

The greywacke samples from the Goose and George sites, and Boulder Prospect, were sent for U-Pb laser ablation (LA) ICP mass spectrometer (MS) analysis (LA-ICP-MS), where a minimum of 100 grains were analyzed and dated. Zircons were extracted, hand picked, and mounted to polished grain mounts. Cathodoluminescence was used for imaging analysis prior to LA analysis.

The intrusive samples were analyzed by chemical abrasion thermal ionization mass spectrometry (CA-TIMS), where a minimum of four single grains are analyzed. For magmatic age determinations, LA typically gives 2 standard deviations precisions in the range of ±1% to 2%, whereas CA-TIMS precision is in the range of 0.1% to 0.2%.

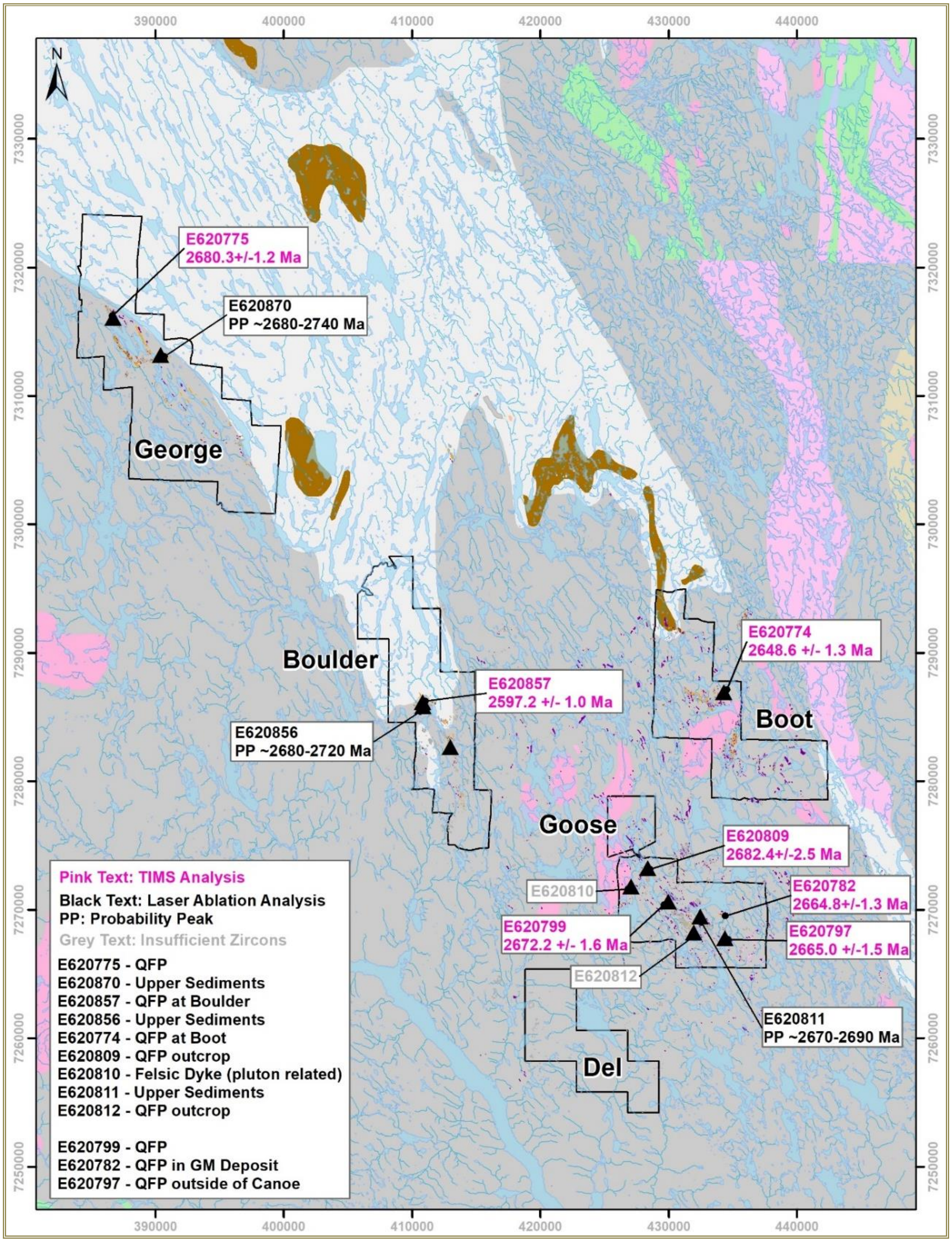
Additionally, four arsenopyrite-bearing samples were submitted to the Geological Survey of Canada for rhenium–osmium analysis dating (Table 9-2). Rhenium–osmium geochronology of gold-associated arsenopyrite and arsenopyrite within QFP intrusions helps determine timing of mineralization in relation to known technothermal events. Other significant BIF deposits that have employed similar techniques include the Homestake Gold Deposit, South Dakota (Morelli et al., 2010), and the Meliadine Gold District, Nunavut (Lawley et al., 2015).

Table 9-2: Geochronology Sample Summary

Sample	Area	Lithology	Analysis	Grains	Age (Ma)	Lab	Au (ppm)
E620810	Goose	Felsic Dyke	U-Pb TIMS	INS	-	UBC	-
E620811	Goose	Greywacke	U-Pb LA-ICPMS	72	2,670–2,690	UBC	-
E620812	Goose	QFP	U-Pb TIMS	INS	-	UBC	-
E620856	Boulder	Greywacke	U-Pb LA-ICPMS	67	2,680–2,720	UBC	-
E620870	George	Greywacke	U-Pb LA-ICPMS	68	2,680–2,740	UBC	-
E620809	Goose	QFP	U-Pb TIMS	5	2,682.4 ± 2.5	UBC	-
E620774	Boot	QFP	U-Pb TIMS	3	2,648.6 ± 1.3	UBC	-
E620857	Boulder	QFP	U-Pb TIMS	5	2,597.2 ± 1.0	UBC	-
E620775	George	QFP	U-Pb TIMS	5	2,680.3 ± 1.2	UBC	-
E620797	Goose	QFP	U-Pb TIMS	7	2,665.0 ± 1.5	UBC	0.083
E620782	Goose	QFP	U-Pb TIMS	8	2,664.8 ± 1.3	UBC	0.015
E620799	Goose	QFP	U-Pb TIMS	6	2,672.2 ± 1.6	UBC	0.022
18GRO-001	Goose	Aspy	Re-Os TIMS	4	2,582 ± 18	GSC	138.30
18GRO-004	Goose	Aspy	Re-Os TIMS	5	2,609 ± 9	GSC	0.62
18GRO-005[1]	Goose	Aspy	Re-Os TIMS	5	2,581 ± 37	GSC	112.90
18GRO-005R[1]	Goose	Aspy	Re-Os TIMS	5	2,508 ± 75	GSC	112.90
18GRO-007[1]	Goose	Aspy	Re-Os TIMS	5	2,602 ± 41	GSC	393.40

Source: Sabina, 2020.

Notes: [1] Samples for which selected analyses were used to formulate average age.
INS = insufficient zircons recovered for analysis; R = represents a re-run sample.



Source: Sabina, 2020.

Figure 9-9: Location of Geochronology Samples

9.2.7 Structural Studies

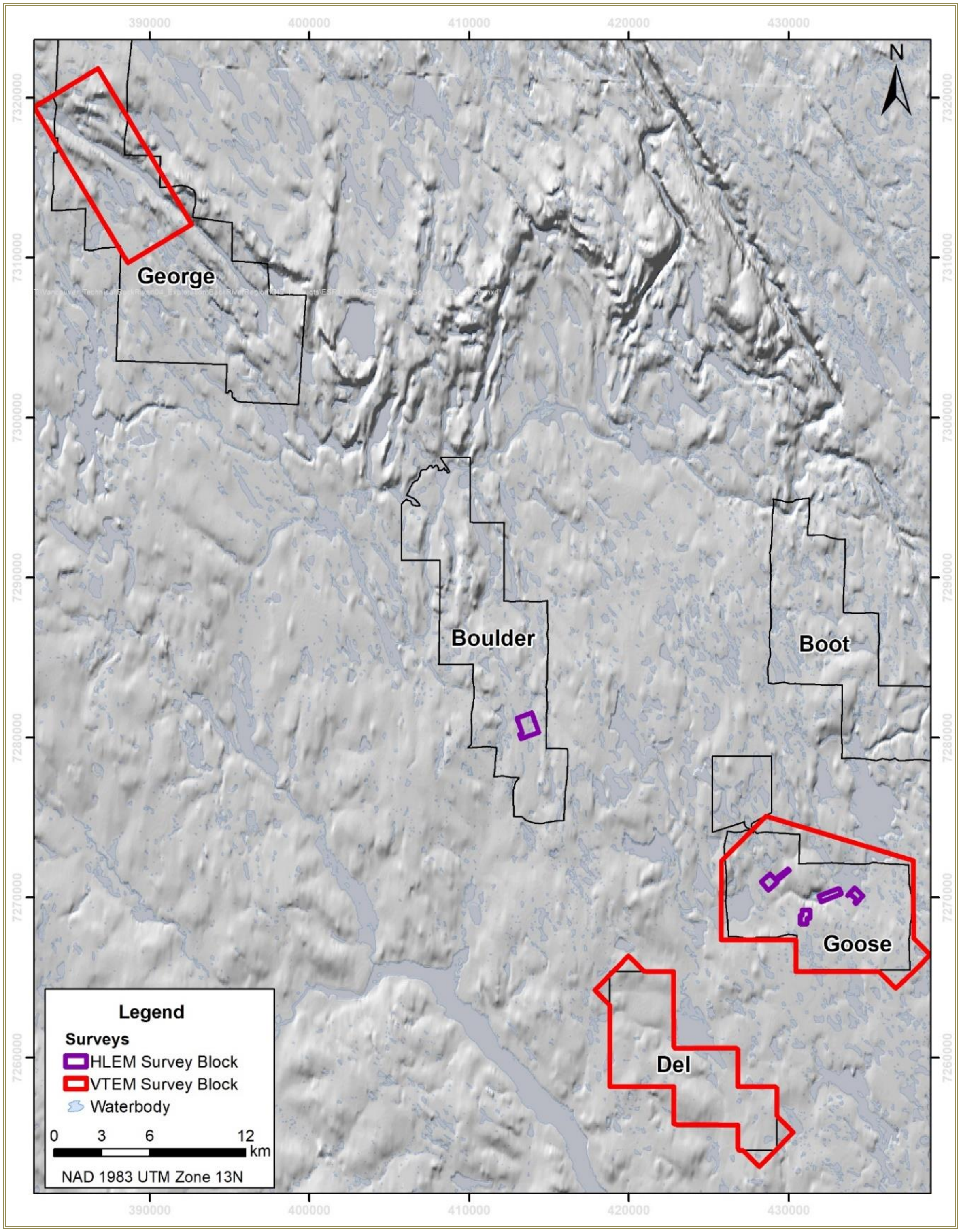
A two-phase structural program using two structural geology consultants was completed in 2019, with the goals of refining the structural framework of the Goose Site, interrogating the Goose 3-D model, and evaluating the drilling and mapping structural database. In phase one of this program, Dr. Chris Siron audited the structural database of the Goose Site. He concluded that the structural data and the current 3-D model support the interpretation of the iron formation geometry at the Goose Site. In phase two, Dr. Doug Mackenzie was contracted to confirm and update the structural framework and paragenetic sequence of the Goose Site deposits by reviewing key oriented drill holes and supplementary outcrop and trench exposures. Dr. Mackenzie's review generally agreed with the framework put forward by previous workers.

9.2.8 Ground HLEM Survey

In 2016 and 2017, Aurora Geosciences was contracted to conduct ground horizontal loop electromagnetic (HLEM) surveys over five small grids with variable line spacing (50–120 m) to identify and locate bedrock conductors. In all, 48.4-line km were surveyed, as shown in Figure 9-10. The results of the HLEM survey generated a number of electromagnetic (EM) responses that were coincident with known iron formation horizons of interest, assisting in advancing exploration targeting.

9.2.9 Airborne VTEM Survey

In 2020, Sabina contracted Geotech Airborne Geophysical Surveys to carry out a helicopter-borne VTEM geophysical survey over the Goose and George sites, and Del prospect, areas shown in in Figure 9-10. The purpose of this survey was to model the EM responses of major gold deposits at the Goose Site and compare them to other regional responses to support exploration and target prioritization. The surveys totalled 2,064-line km. The Del prospect and Goose Site survey areas were flown in a southwest to northeast (45°) orientation, with line spacing of 150 m and 100 m, respectively. The George Site was flown in a 59° direction at 100 m line spacing. Results from this survey include multiple elevated and anomalous responses at the Goose and George sites that are currently under review. As part of this review, these anomalies will be modelled in 3-D for comparison to known geology and responses of other techniques at known deposits. Additional follow-up work will be required to assess the prospectivity of the VTEM results and validity of the method.



Source: Sabina, 2020.

Figure 9-10: Location of Geophysical Surveys

9.3 Sample Collection and Handling Procedures

Sabina staff carried out any sampling from 2016 to 2020; sampling procedures are summarized in the following subsections. Other types of samples taken in previous years include trench channel sampling, lake sediment sampling, metamorphic sampling, soil sampling, till sampling, samples for geochronology, and thin-section work. The trench sampling, soil sampling, and lake sediment sampling procedures are summarized in SRK (2012). Metamorphic sampling and thin-section collection are summarized in JDS (2015a).

9.3.1 Surface Sampling

This description refers to the grab samples that were collected on the Property from 2016–2020 and discussed in Section 9.2.2. Grab samples were collected from iron formation, felsic dykes, mineralized quartz veins, or any other rock types identified as potential hosts, or displaying interesting characteristics. The location of each sample was established using a hand-held GPS unit with an accuracy of ±7 m. Representative samples were collected for whole-rock analysis in a similar fashion, from the least-altered examples of relevant or uncertain lithologies. Rock samples between 1 kg and 3 kg were collected, and a unique sample number was assigned and recorded on an aluminum tag affixed in the field to a representative sample. The sample number was then recorded on the bag using a waterproof felt marker, in the sampler's hand-held Trimble Juno 3B mapping computer, and in a sample booklet. A brief description of the sample, including rock type, mineralization, and any other relevant data, was also recorded in the sampler's hand-held Trimble Juno 3B. Samples were bagged and sent by air to Yellowknife, and then transported by road to the main analytical laboratory contracted for that year.

9.3.2 Till Sampling

This section relates to the 2018 till-sampling program, where procedures were established with Stea's input as part of the 2018 surficial map program (see Section 9.2.2). An evaluation of the surficial material established the best practice and relevant methods for the various surficial units encountered. It was determined that active and inactive frost boils provided the best sampling media to be representative of the basal till and/or local bedrock. Furthermore, the prevalence of frost boils across the properties allowed for a consistent procedure to be implemented. If a well-defined frost boil could not be found, the sample was recorded as a "dug hole," or a sample was not taken. The bulk till and detailed till-sampling surveys followed the procedures outlined below:

1. Till-sampling locations were predetermined on a grid system; however, in the field the actual sample location was adjusted to target well-defined frost boils. Samplers identified and recorded if the frost boil was active or not active.
2. Once the sample location was selected, a hole was dug. In an active frost boil the total depth could have been as little as 5 cm, whereas in a less-active frost boil, especially when differentiation or horizon development has started, 30 cm was more typical.
3. Targeted material was a silty sand grain-sized material that is dominated by local lithologies and typically had a light grey to bluish-grey colour.
4. The samples were pre-screened in the field using 4 mm mesh—this was necessary to reduce overall weight (i.e., the pebble concentration).
5. Two samples were taken, a 4 kg sample for aqua regia analysis and a 1 kg to 2 kg sample for on-site X-ray fluorescence (XRF) testing.

6. Because of the silty nature of the till, the water retention was high (and was unexpected). Best practice was to use 9" by 12" cloth bags, double bagged in a plastic poly bag. Once back in camp, cloth bags were extricated from plastic poly bags and allowed to dry to avoid additional freight charges and charges at the lab for excess drying.
7. Quality assurance/quality control (QA/QC) procedures were followed, with a standard inserted every 20 samples and a field duplicate taken every 20 samples.

Till samples for the till extension and infill survey were sent to a Bureau Veritas Canada (BV) lab in Vancouver for processing and analysis. Each sample was weighed, dried, and sieved to 63 µm (230 mesh). This grain size was selected to attain the largest proportion of silt-sized particles from each sample. No pulverizing took place in the sample preparation process. Following screening, a 50 g aliquot of the minus fraction was sent for aqua regia digestion with an ICP finish, for a total analysis of 37 elements.

10 DRILLING

10.1 Introduction

The Property has been drilled by various operators since 1985. All drilling carried out on the Property is diamond core, predominantly NQ diameter, although some drilling of BQ size was completed in 1992. More recently, HQ core has been drilled for the purpose of collecting metallurgical samples and geomechanical testing. From 1985 to present, a total of 568,408 m of core has been drilled at Back River. Since 2009, Sabina has drilled 322,939 m of core, in 1,073 drill holes. Table 10-1 summarizes the drilling grouped by site or prospect. The period 2009–2015 has been described in the 2015 Technical Report (JDS, 2015).

Table 10-1: Drilling Summary by Year

Target	Unit Type	Pre-Sabina	2009–2015	2016	2017	2018	2019	2020	Subtotal Sabina	Total
George Site	Drill Holes	798	163	-	-	-	-	-	163	961
	Metres	146,440	37,092	-	-	-	-	-	37,092	183,532
Goose Site	Drill Holes	324	717	19	24	39	10	21	830	1,154
	Metres	78,023	211,826	2,746	12,603	22,456	7,065	8,095	264,791	342,814
Boot Prospect	Drill Holes	100	29	-	-	-	-	-	29	129
	Metres	12,224	6,195	-	-	-	-	-	6,195	18,419
Boulder Prospect	Drill Holes	38	47	-	-	4	-	-	51	89
	Metres	8,172	13,476	-	-	1,385	-	-	14,861	23,033
Del Prospect	Drill Holes	11	-	-	-	-	-	-	-	11
	Metres	610	-	-	-	-	-	-	-	610
Grand Total	**Drill Holes**	**1,271**	**956**	**19**	**24**	**43**	**10**	**21**	1,073	**2,344**
	Metres	**245,469**	**268,589**	**2,746**	**12,603**	**23,841**	**7,065**	**8,095**	**322,939**	**568,408**

Source: Sabina, 2020.

Note: All holes are surface diamond drill holes. Holes listed are for exploration, Mineral Resource, geomechanical, and metallurgical purposes, but do not include geotechnical (site investigation) holes or trenches. Historical holes have been reassigned to the appropriate deposits and all restarted holes are included in totals.

Table 10-2: Drilling Detail by Prospect and Year

Target	Unit Type	Pre-Sabina	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Subtotal Sabina	Total
George Site																
Loc1	Drill Holes	198	-	-	-	20	8	-	-	-	-	-	-	-	28	226
	Metres	31,659	-	-	-	5,518	1,373	-	-	-	-	-	-	-	6,891	38,550
Loc2	Drill Holes	186	-	-	-	11	20	-	-	-	-	-	-	-	31	217
	Metres	43,929	-	-	-	3,328	6,323	-	-	-	-	-	-	-	9,651	53,580
LCPn	Drill Holes	71	-	-	-	4	4	-	-	-	-	-	-	-	8	79
	Metres	10,456	-	-	-	864	311	-	-	-	-	-	-	-	1,175	11,631
LCPs	Drill Holes	39	-	-	-	6	43	-	-	-	-	-	-	-	49	88
	Metres	11,356	-	-	-	1,336	6,555	-	-	-	-	-	-	-	7,891	19,247
GH	Drill Holes	69	-	-	-	-	-	-	-	-	-	-	-	-	-	69
	Metres	10,915	-	-	-	-	-	-	-	-	-	-	-	-	-	10,915
SL	Drill Holes	39	-	-	-	-	-	-	-	-	-	-	-	-	-	39
	Metres	5,331	-	-	-	-	-	-	-	-	-	-	-	-	-	5,331
Other	Drill Holes	196	-	-	-	21	26	-	-	-	-	-	-	-	47	243
	Metres	32,794	-	-	-	6,216	5,268	-	-	-	-	-	-	-	11,484	44,278
George Total	**Drill Holes**	**798**	**-**	**-**	**-**	**62**	**101**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**163**	**961**
	Metres	**146,440**	**-**	**-**	**-**	**17,262**	**19,830**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**37,092**	**183,532**
Goose Site																
Llama	Drill Holes	1	1	58	30	64	64	-	-	-	-	1	-	-	218	219
	Metres	83	269	15,391	10,191	16,598	14,492	-	-	-	-	440	-	-	57,381	57,464
Llama Extension	Drill Holes	-	-	-	-	-	-	-	-	-	6	10	2	4	22	22
	Metres	-	-	-	-	-	-	-	-	-	3,780	6,359	1,447	2,053	13,639	13,639
Umwelt	Drill Holes	3	-	58	63	49	67	1	-	-	11	8	1	14	272	275
	Metres	605	-	16,155	34,127	27,801	9,329	521	-	-	6,847	3,355	569	4,473	103,177	103,782
Echo	Drill Holes	-	11	24	-	-	18	25	-	-	1	2	-	-	81	81
	Metres	-	2,651	4,154	-	-	3,963	8,832	-	-	548	1,183	-	-	21,331	21,331
Nuvuyak	Drill Holes	-	-	-	-	-	-	-	-	-	-	12	6	-	18	18
	Metres	-	-	-	-	-	-	-	-	-	-	8,737	4,380	-	13,117	13,117

Target	Unit Type	Pre-Sabina	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Subtotal Sabina	Total
Goose Main	Drill Holes	294	-	5	3	16	12	3	-	-	-	1	1	1	42	336
	Metres	73,347	-	906	570	3,315	2,413	1,251	-	-	-	170	669	785	10,079	83,426
Other	Drill Holes	26	15	19	37	13	54	5	2	19	6	5	-	2	177	203
	Metres	3,988	3,726	3,925	9,143	5,279	14,873	1,570	381	2,746	1,428	2,212	-	784	46,067	50,055
Goose Total	**Drill Holes**	**324**	**27**	**164**	**133**	**142**	**215**	**34**	**2**	**19**	**24**	**39**	**10**	**21**	**830**	**1,154**
	Metres	**78,023**	**6,646**	**40,531**	**54,031**	**52,993**	**45,070**	**12,174**	**381**	**2,746**	**12,603**	**22,456**	**7,065**	**8,095**	**264,791**	**342,814**
Boot Prospect																
	Drill Holes	100	-	-	-	-	29	-	-	-	-	-	-	-	29	129
	Metres	12,224	-	-	-	-	6,195	-	-	-	-	-	-	-	6,195	18,419
Boulder Prospect																
	Drill Holes	38	-	-	-	10	37	-	-	-	-	4	-	-	51	89
	Metres	8,172	-	-	-	2,441	11,035	-	-	-	-	1,385	-	-	14,861	23,033
Del Prospect																
	Drill Holes	11	-	-	-	-	-	-	-	-	-	-	-	-	-	11
	Metres	610	-	-	-	-	-	-	-	-	-	-	-	-	-	610
Grand Total	**Drill Holes**	**1,271**	**27**	**164**	**133**	**214**	**382**	**34**	**2**	**19**	**24**	**43**	**10**	**21**	**1,073**	**2,344**
	Metres	**245,469**	**6,646**	**40,531**	**54,031**	**72,696**	**82,130**	**12,174**	**381**	**2,746**	**12,603**	**23,841**	**7,065**	**8,095**	**322,939**	**568,408**

Source: Sabina, 2020.

Notes: All holes are surface diamond drill holes. Holes listed are for exploration, Mineral Resource, geomechanical, and metallurgical purposes, but do not include geotechnical (site investigation) holes or trenches. Historical holes have been reassigned to the appropriate deposits and all restarted holes are included in totals.

10.2 Summary of Drilling Activity

Drilling carried out by Sabina from 2009 to 2015 has been previously discussed in Technical Reports that are referenced in the descriptions below; drilling from 2016 on is described for the first time in this report, and thus in more detail.

10.2.1 Years 2009–2015

A complete description of the drilling carried out in 2009, 2010, and 2011 is available in the 2012 PEA Technical Report (SRK, 2012), summarized in Table 10-1 of that report. Highlights of the 2009 to 2011 drilling include the discovery of the Llama, Umwelt, and Echo deposits.

In 2012, Sabina completed 214 diamond drill holes at the Property, totalling 72,696 m of core. Drilling was largely focused on the Goose Site, primarily targeting the Umwelt and Llama deposits. Drilling also took place on the George Site and at the Boulder prospect. A complete description of the 2012 drilling is presented in the 2013 Prefeasibility Study Technical Report (Tetra Tech, 2013), including cross-sections and plan views for each of the main deposits.

In 2013, Sabina completed 382 diamond drill holes at the Property, totalling 82,130 m of core. Drilling was largely focused on the Goose Site, testing Llama, Umwelt, and regional targets. Drilling also took place on the George Site, and at the Boot and Boulder prospects. A complete description of the 2013 drilling is discussed in detail in the 2014 Technical Report (Tetra Tech, 2014), along with plans and cross-sections of the significantly drilled deposits (Llama, Umwelt, Echo, Loc2, LCPs).

In 2014, Sabina completed 34 diamond drill holes at the Property, totalling 12,174 m of core. Drilling was focused on the Goose Site, primarily targeting the Echo deposit. A complete description of the 2014 drilling is discussed in detail in the 2015 Feasibility Study (JDS, 2015a), with an effective date of 20 May 2015.

In 2015, Sabina completed two diamond drill holes, totalling 381 m, at the Goose Site. One exploration drill hole at Hivogani was drilled approximately 1,400 m southwest of the Goose Main deposit, to target a broad IP anomaly. The other exploration hole at Nalaot, approximately 250 m west of the Echo deposit, was drilled to follow up on an earlier drill hole that returned 4.52 g/t Au over 5.00 m.

10.2.2 Year 2016

Sabina completed 19 diamond drill holes, totalling 2,746 m, at various exploration targets across the Goose Site. Most of the drilling was focused on the Kogoyok target, but four holes were also drilled in the convergence target, three in the Hackles target, and two at the Hivogani target.

10.2.3 Year 2017

Sabina completed 24 drill holes, totalling 12,603 m, at the Goose Site. Nine holes were drilled into the Umwelt Vault Zone for a total of 5,685 m, to infill and extend the high-grade mineralization trend. Two of the exploration drill holes served a dual purpose, with a portion of each hole logged and sampled for geomechanical purposes.

Six holes, totalling 3,780 m, were drilled into the Llama Extension deposit in a series of step-outs to test the continuity of the mineralizing structure down plunge of the existing Llama resource. Many of the step-outs intersected significant mineralization, including 17GSE516B, which assayed 9.48 g/t Au over 38.55 m, including 14.43 g/t Au over 14.43 m, and 52.83 g/t Au over 1 m. The farthest extension hole, 17GSE524, encountered the mineralizing structure 525 m down plunge of the resource, at a vertical depth of approximately 600 m, indicating the deposit remains open at depth.

Two exploration holes were drilled at Kogoyok, totalling 688 m, to follow up on the felsic dyke and LIF intersection lineation identified at surface and in 2016 drill holes.

Other exploration targets included Echo, Convergence, and Goose Neck, where one hole was drilled into each target.

10.2.4 Year 2018

Sabina completed 36 exploration and three geochemical drill holes at the Goose Site, for a total of 22,456 m. Four holes, totalling 1,385 m, were drilled on the Boulder prospect into the Vega and Rainbow targets. The holes were designed either to test structural geometries and geophysical anomalies, or to follow up on anomalous gold values in rock and till samples.

Ten holes, totalling 6,359 m, were drilled to extend and infill the Llama Extension deposit over 400 m of strike length. The Llama Extension drilling principally focused on expanding the up-plunge extent of the mineral zone towards the known Llama underground resource.

One hole was drilled through each of the Llama and Umwelt deposits, 440 and 347 m, respectively, to test the geometry and mineralization of the DIF below a known high-grade ore body.

Four holes were drilled into the Vault Zone within the Umwelt deposit, for a total of 2,801 m, to infill the high-grade mineralization trend. Three holes, totalling 207 m, were also drilled in the proposed Umwelt open pit, and sent for geochemical analysis to determine if the waste rock would be suitable for use as construction material during Project development.

Twelve holes were drilled into the Nuvuyak deposit, for a total of 8,737 m, including the discovery hole (18GSE545) that intersected 11.58 g/t over 39.50 m. Subsequent drilling extended the mineralized trend approximately 190 m along strike and provided insights into the deposit geometry and mineralization controls.

Two holes, totalling 1,417 m, were drilled into the Hook target to test favourable mineralization trends. Six of the holes designed to test the Nuvuyak deposit also intersected the Hook stratigraphy and helped constrain the geometry of the LIF in the Hook target, as well as intersecting significant zones of gold mineralization.

Two holes were drilled in the upper sediments west of Nuvuyak, totalling 574 m, to determine the position of the axial planar QFP after it is folded by D2, and to test for a second anticline.

Two holes were drilled at Echo, totalling 1,183 m, to extend the mineralization down plunge of the known resource.

One 221 m-deep exploration hole was drilled in the limb of the synclinorium west of the Umwelt pit to target an HLEM and magnetic anomaly.

One hole was drilled to 170 m, at Goose Main, to test the mineralization at the outer margins of the planned open pit.

10.2.5 Year 2019

Sabina drilled 10 exploration holes at the Goose Site, totalling 7,065 m, including two wedges. Four holes and two wedges were drilled into the Nuvuyak deposit and the D2 fold hinge between the Nuvuyak and Hook target, for a total of 4,380 m. These holes extended high-grade mineralization both up and down plunge to give the Nuvuyak deposit a total tested strike length of approximately 370 m. Hole 19GSE564, also extended mineralization approximately 100 m down dip from the hinge of the Nuvuyak anticline into the western limb.

Two holes were drilled into the Llama Extension, for a total of 1,447 m, to test opportunities for expansion and continuity within areas of higher-grade mineralization within the trend. One hole was drilled up plunge of the Llama Extension in an untested 150 m gap, and the other was completed to test the continuity of higher-grade mineralization in several surrounding holes.

One hole (19GSE569) was drilled to 569 m, to test the continuity of the high-grade corridor up plunge of the Vault Zone within the Umwelt deposit.

One 669 m hole was drilled into the D2 fold hinge between the Hook target and the Goose Main deposit.

10.2.6 Year 2020

Sabina drilled 21 diamond drill holes at the Goose Site, totalling approximately 8,095 m. The primary focus of the 2020 drilling program was to delineate and detail the nature of the high-grade structure at Umwelt, and to test its continuity between the bottom of the planned open pit and the Vault Zone. The high-grade structure is roughly coincident with the intersection of the easternmost Umwelt QFP, and the LIF in the eastern limb of the Umwelt anticline. Fourteen holes were drilled into this high-grade trend between the base of the planned open pit and the most up-plunge hole at the Vault Zone (19GSE569).

One hole was drilled to follow up on high-grade assays (up to 18.00 g/t Au over 10.04 m) from the Hook-Nuvuyak D2 fold hinge. Hole 20GSE580 was drilled up dip and up plunge of 19GSE566 and 19GSE566W2, to intercept the intersection of the QFP and LIF, closer to the anticline hinge.

Two holes were drilled to test geophysical anomalies defined by the 2020 VTEM geophysical survey. The first hole was drilled in the Jackaroo target area, south of Umwelt, and intersected discrete zones of moderate pyrrhotite mineralization in clastic sediments. The second hole was drilled in the Hackles target to test both a geophysical anomaly and the location of the Hackles QFP. The hole intersected the QFP near the top of the hole, and up to 5% pyrrhotite in iron formation and clastic sediments throughout.

Since 2016, drill-hole deviations have been measured with a downhole gyro system, and collars are surveyed using a Differential Global Positioning System.

Highlights of the 2016–2020 drilling include the following:

- Discovery of the Llama Extension deposit followed by infill drilling that resulted in an Inferred Mineral Resource
- Infill and optimization drilling at the Umwelt deposit, which converted portions of Inferred and Indicated Mineral Resources to Indicated and Measured Mineral Resources
- Discovery of the Nuvuyak deposit, followed by extension drilling that resulted in an Inferred Mineral Resource.

Plan maps and cross-sections for all the deposits on the Goose Site are provided in the subsections below.

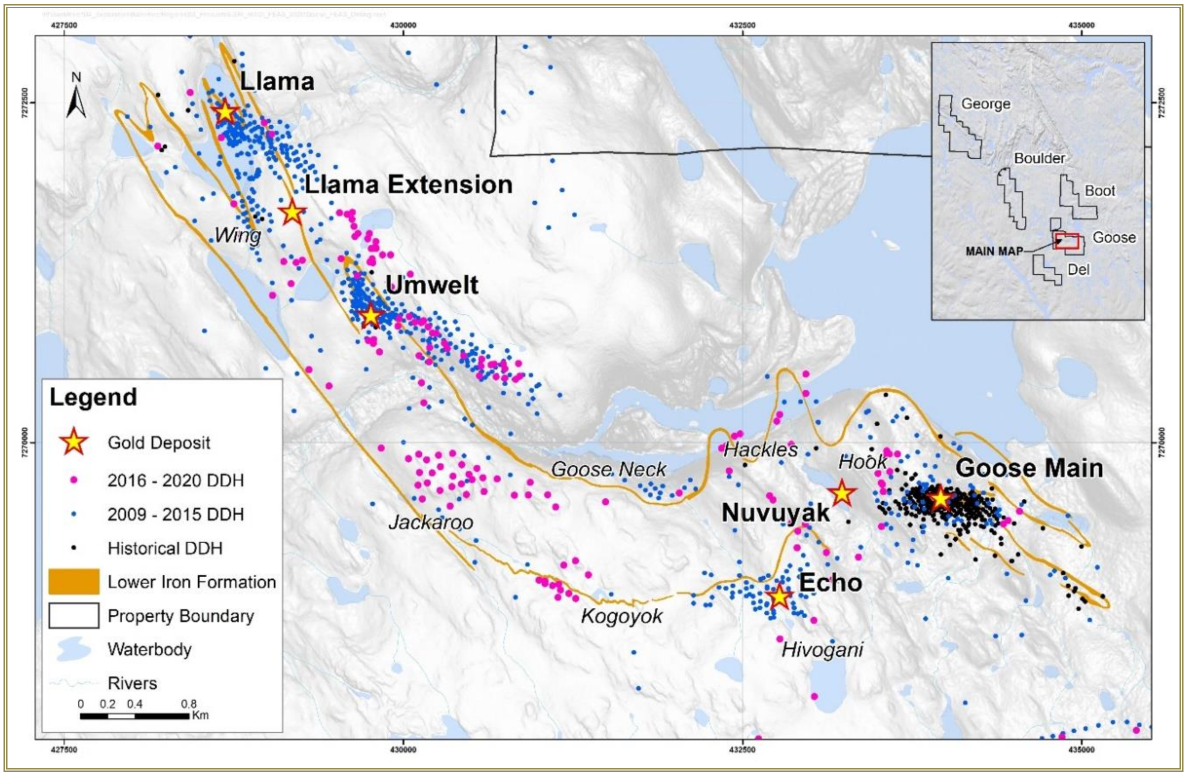
10.3 Goose Site

The Goose Site consists of the Llama, Llama Extension, Umwelt, Echo, Nuvuyak, and Goose Main deposits, as well as the Wing, Kogoyok, Goose Neck, Hackles, Hook, and Camp Zone showings. This Updated Feasibility Study focuses on developing the Llama, Umwelt, Echo, and Goose Main deposits, as well as incorporating the new Mineral Resources at the Llama Extension and Nuvuyak deposits; for this reason, plans and cross-sections for them are presented below. Additionally, a generalized location plan of the Goose Site deposits is also presented. Drilling in these deposits enables a robust interpretation of the geology and mineralized zones. Core recovery for the diamond drilling at the Goose Site is excellent, with the average core recoveries over time being 99.62%.

The drill spacing over the deposits at the Goose Site forms a notional grid, as follows:

- 25 to 50 m grid north by 25 to 50 m grid east over the Llama deposit
- 50 m by 50 m over the Llama Extension deposit
- 25 to 50 m grid north by 25 to 50 m grid east over the Umwelt deposit
- 50 m by 50 m over the Echo deposit
- 80 m by 60 m over the Nuvuyak deposit
- 15 to 30 m grid north by 30 m grid east over the Goose Main deposit.

Figure 10-1 shows all the drilling carried out on the Goose Site to date, with the drill holes completed since 2016 highlighted in pink.

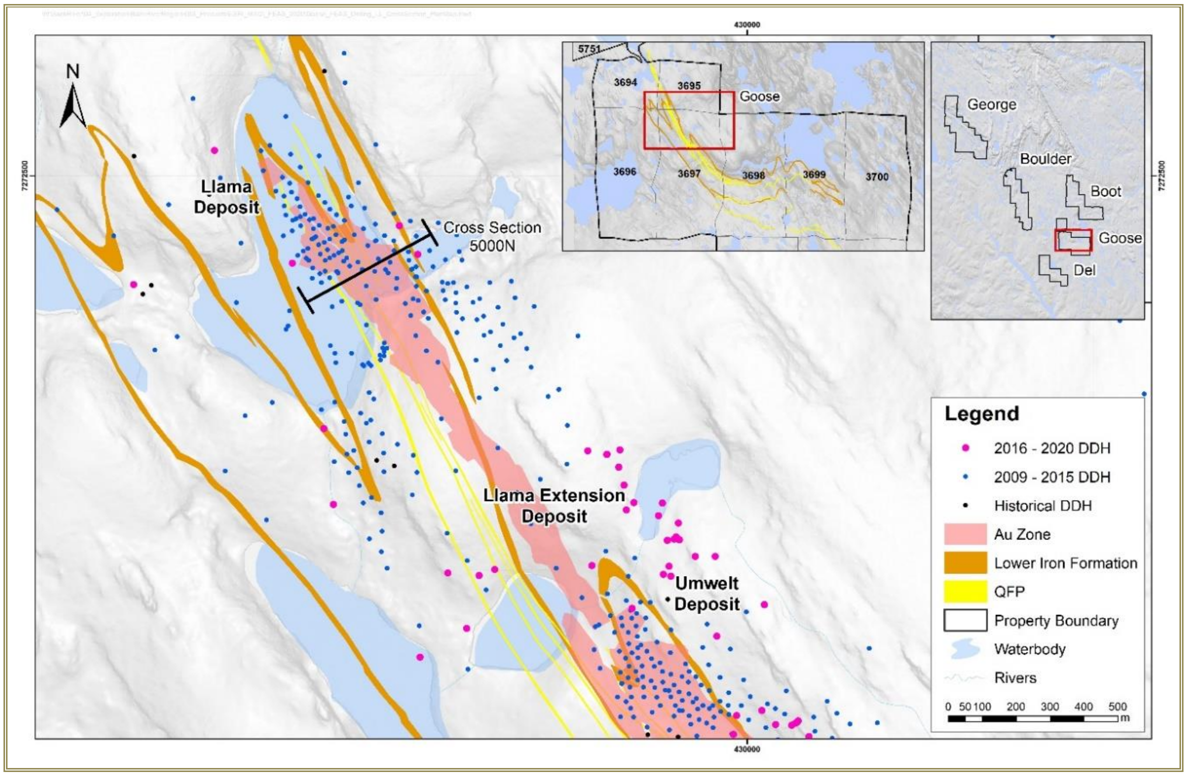


Source: Sabina, 2020.

Figure 10-1: Goose Site Diamond Drill-Hole Plan

10.3.1 Llama Deposit

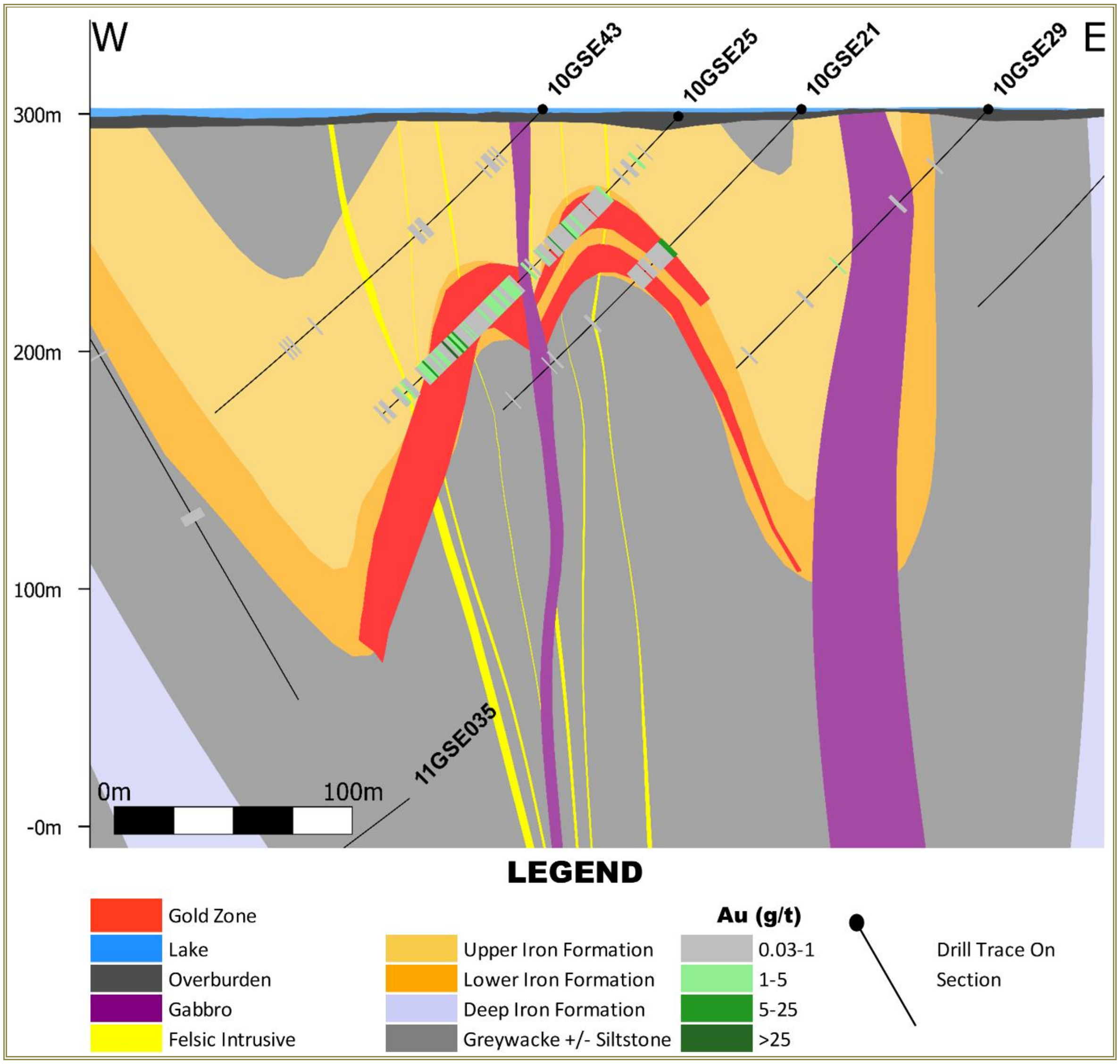
Drilling at the Llama deposit comprises 219 drill holes, totalling 57,464 m; of these, Sabina drilled 219 drill holes for a total of 57,381 m, with one drill hole drilled by the previous operator. Collar locations of all Llama deposit drill holes are shown in Figure 10-2, with drill holes completed since 2016 highlighted in pink. Between 2016 and 2020, one exploration hole and one geomechanical hole were drilled at the Llama deposit.



Source: Sabina, 2020.

Figure 10-2: Llama Deposit Diamond Drill-Hole Collar Plan

A representative Llama cross-section is included as Figure 10-3, showing the folded nature of the stratigraphy and the angle of intersection with the mineralization attained from the surface drilling. The gold grades are shown down hole, and the hole numbers include the year drilled.

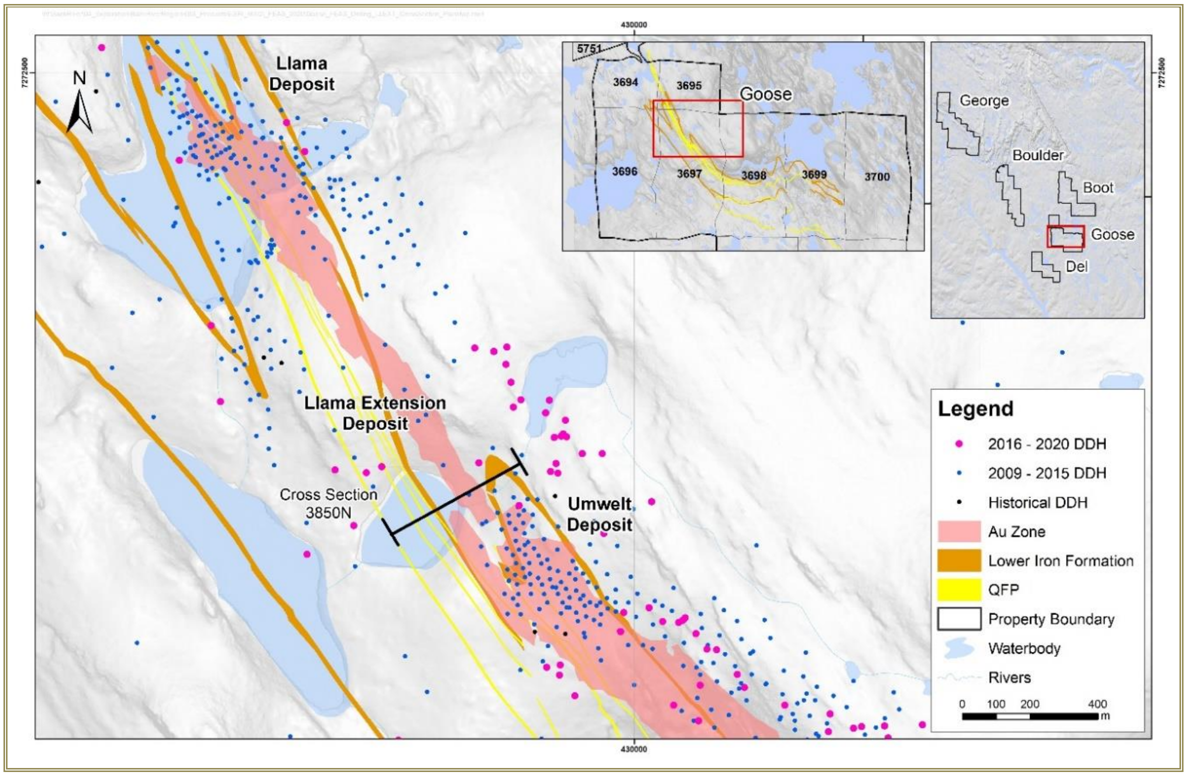


Source: Sabina, 2020.

Figure 10-3: Llama Section at 5,000 m North (Local Grid)

10.3.2 Llama Extension Deposit

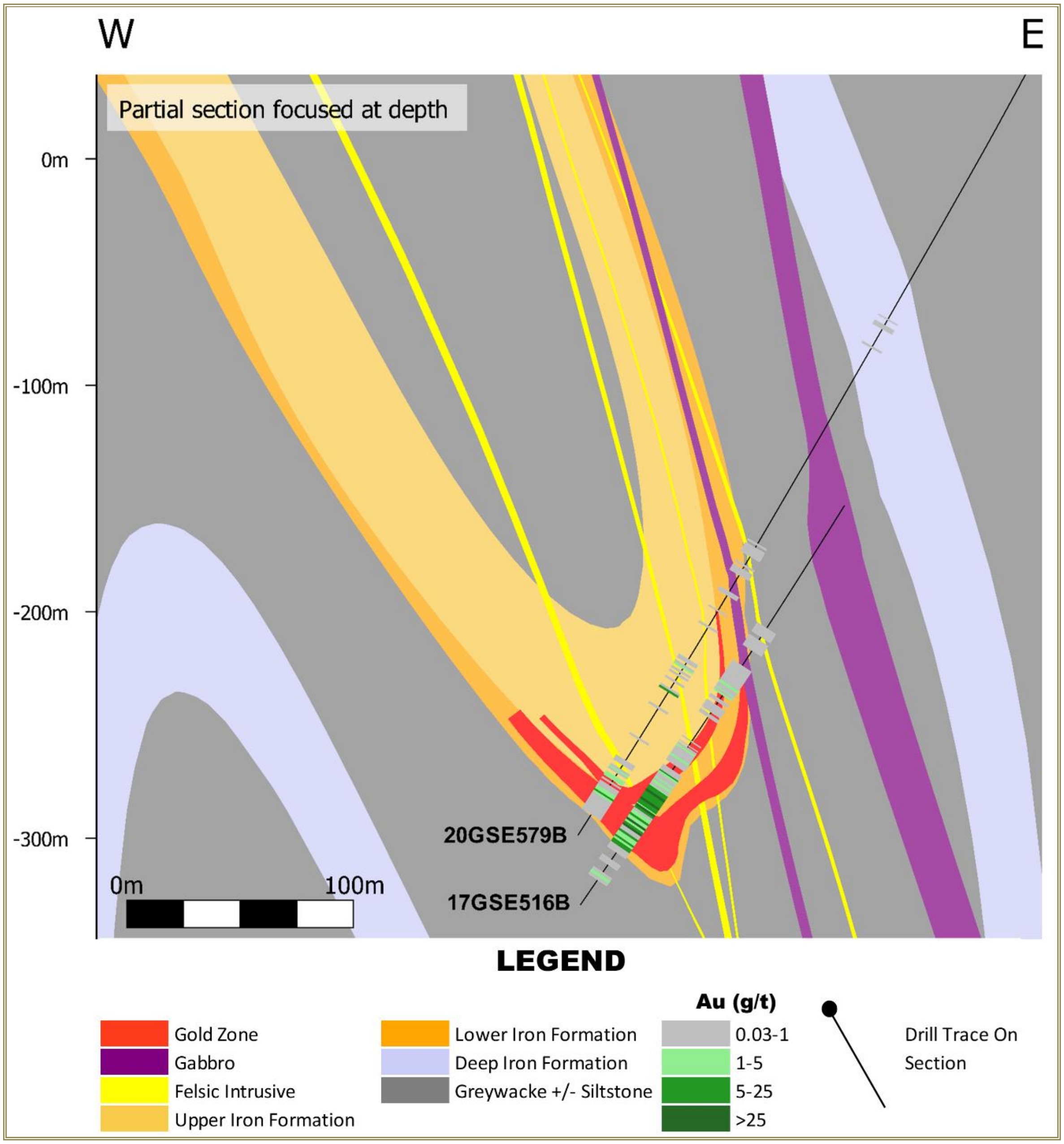
Drilling at the Llama Extension deposit comprises 22 drill holes, totalling 13,639 m, all by Sabina. Collar locations of all drill holes for the Llama Extension deposit are shown Figure 10-4 with drill holes completed since 2016 highlighted in pink.



Source: Sabina, 2020.

Figure 10-4: Llama Extension Deposit Diamond Drill-Hole Collar Plan

A representative Llama Extension cross-section is included as Figure 10-5, showing the folded nature of the stratigraphy and the angle of intersection with the mineralization attained from the surface drilling. The gold grades are shown down hole, and the hole numbers include the year drilled. Unlike other deposits at the Goose Site, the Llama Extension deposit is hosted in the syncline of the south-plunging iron formation stratigraphy.

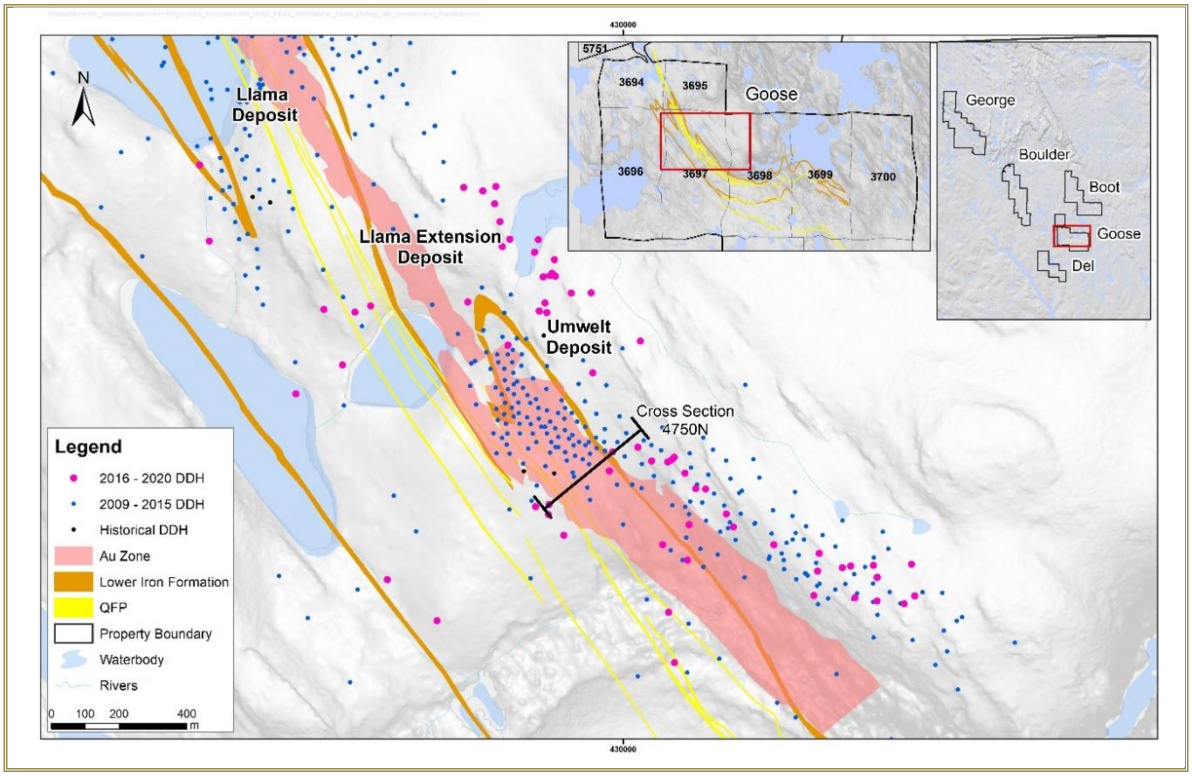


Source: Sabina, 2020.

Figure 10-5: Llama Extension Section at 3,850 m North (Local Grid)

10.3.3 Umwelt Deposit

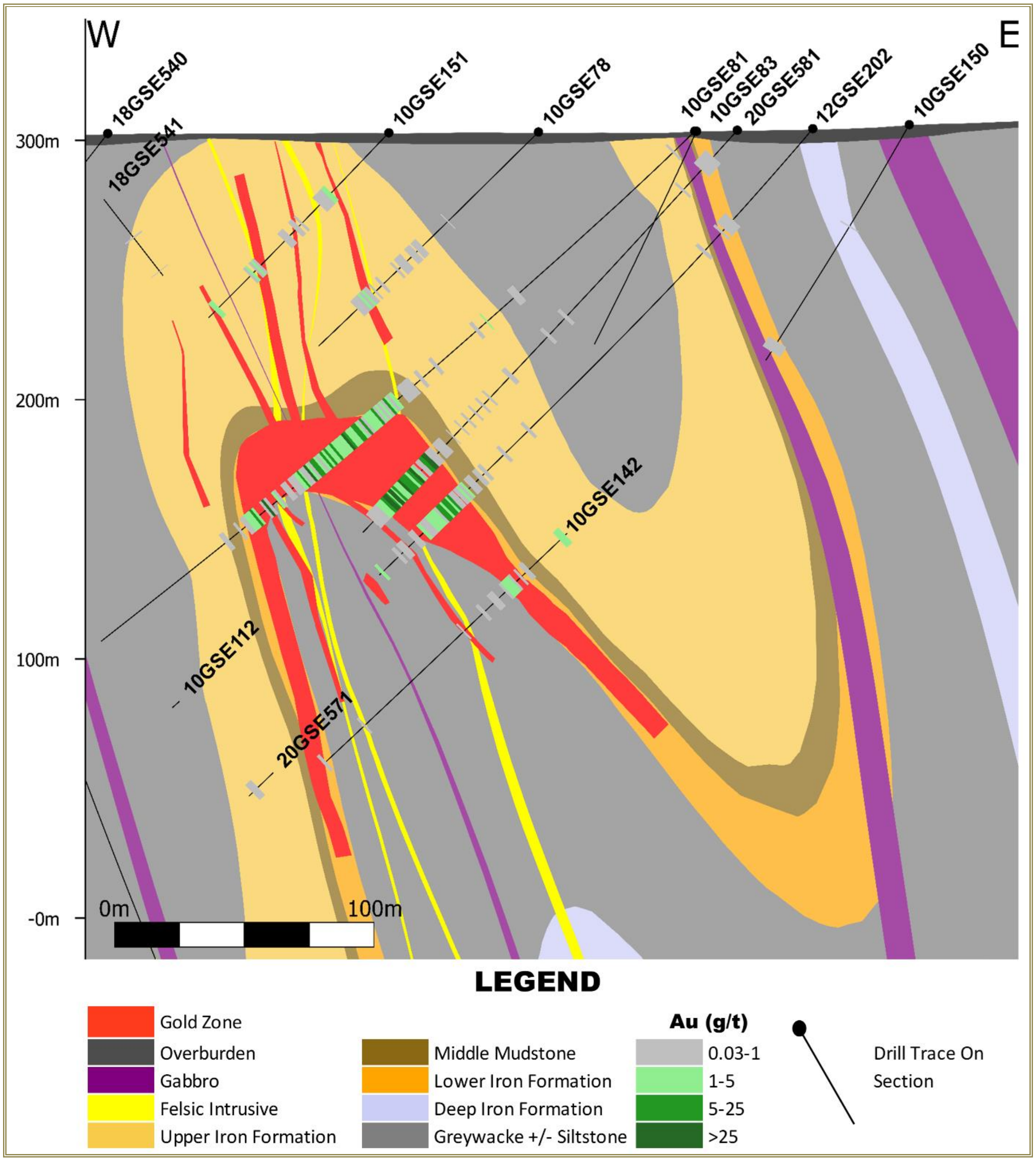
Drilling at the Umwelt deposit comprises 275 drill holes, totalling 103,782 m. Sabina completed all but three, for a total of 103,177 m. Collar locations of all drill holes for the Umwelt deposit are shown in Figure 10-6, with drill holes completed since 2016 highlighted in pink.



Source: Sabina, 2020.

Figure 10-6: Umwelt Deposit Diamond Drill-Hole Collar Plan

A representative Umwelt cross-section is included as Figure 10-7, showing the folded nature of the stratigraphy and the angle of intersection attained from the surface drilling. The gold grades are shown down hole and the hole numbers include the year drilled.

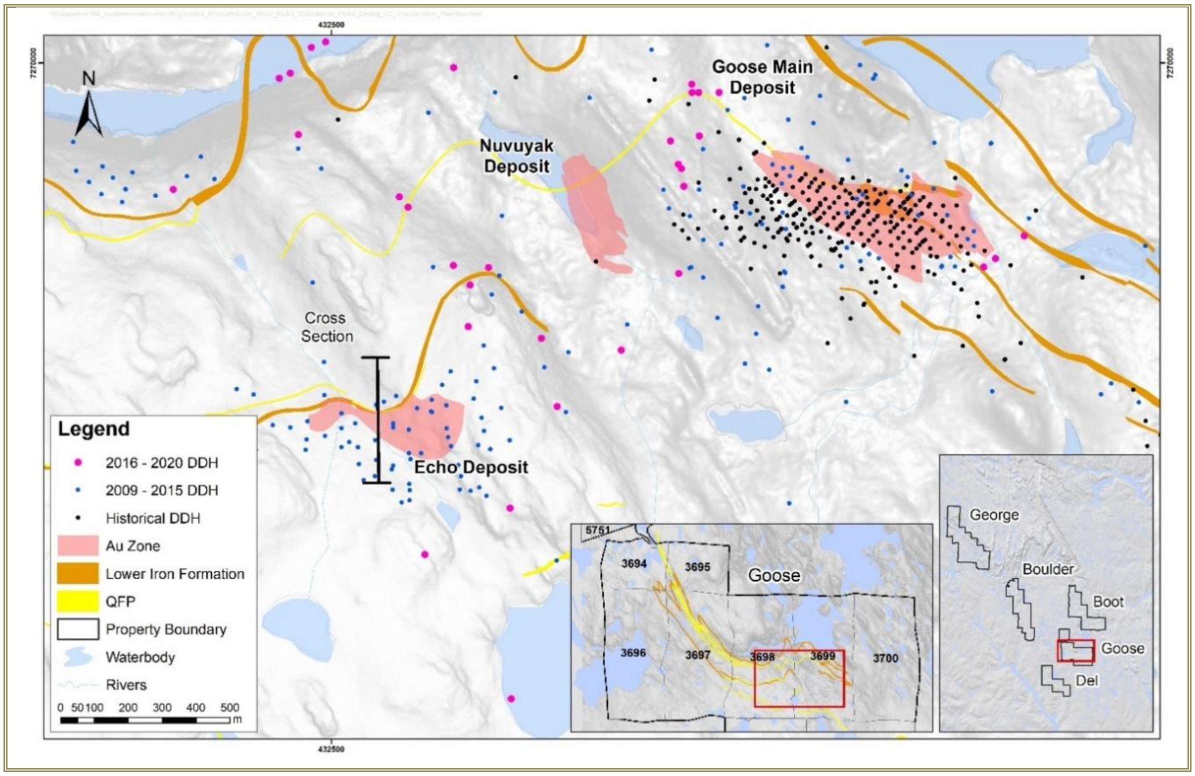


Source: Sabina, 2020.

Figure 10-7: Umwelt Section at 4,775 m North (Local Grid)

10.3.4 Echo Deposit

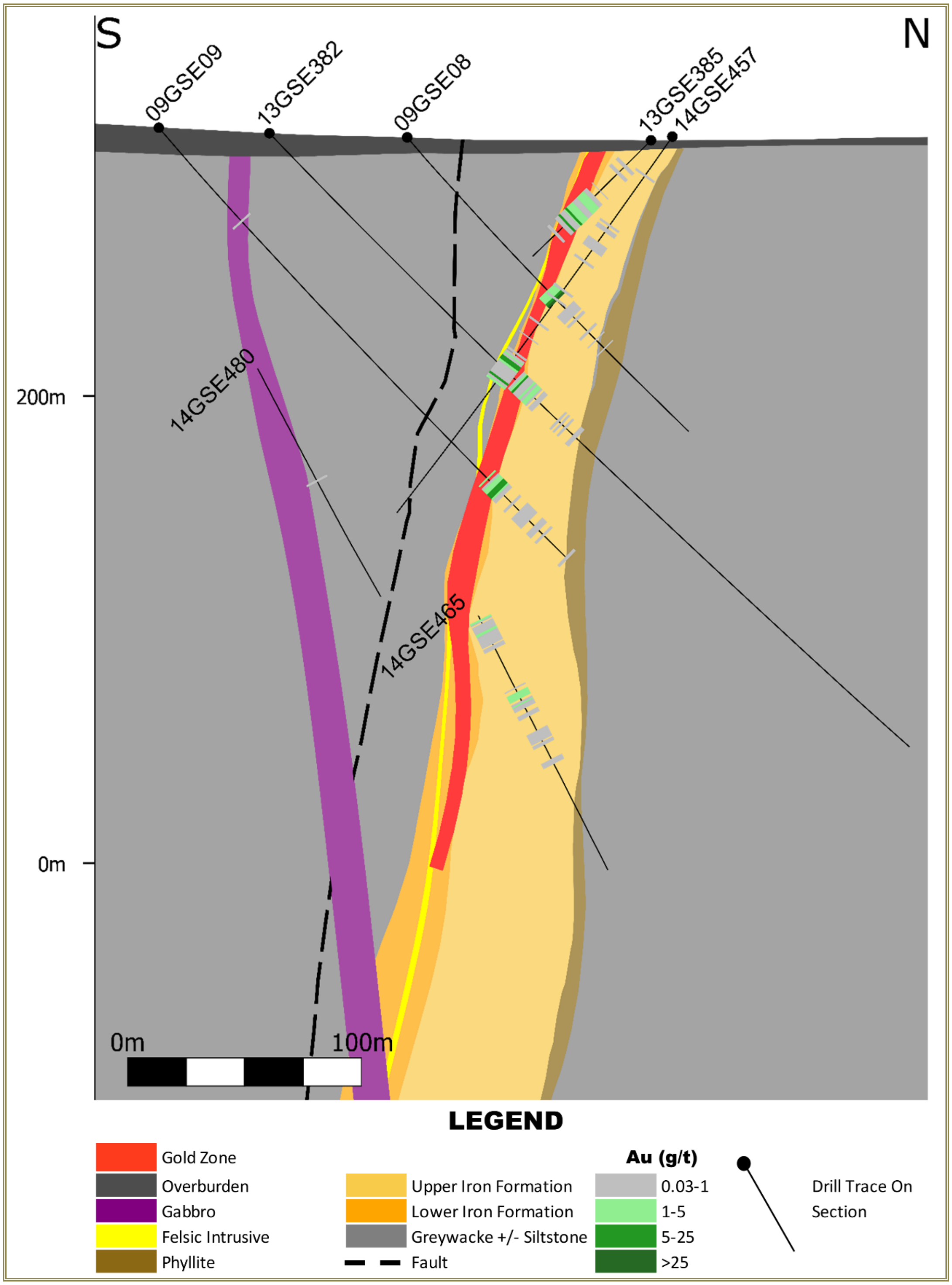
Drilling at the Echo deposit comprises 81 drill holes, for a total of 21,331 m, all drilled by Sabina. Collar locations of all drill holes for the Echo deposit are shown in Figure 10-8 with drill holes completed since 2016 highlighted in pink.



Source: Sabina, 2020.

Figure 10-8: Echo Deposit Diamond Drill-Hole Collar Plan

A representative Echo cross-section is included as Figure 10-9, showing the folded nature of the D2 folded limb stratigraphy and the angle of intersection attained from the surface drilling. The gold grades are shown down hole, and the hole numbers include the year drilled.

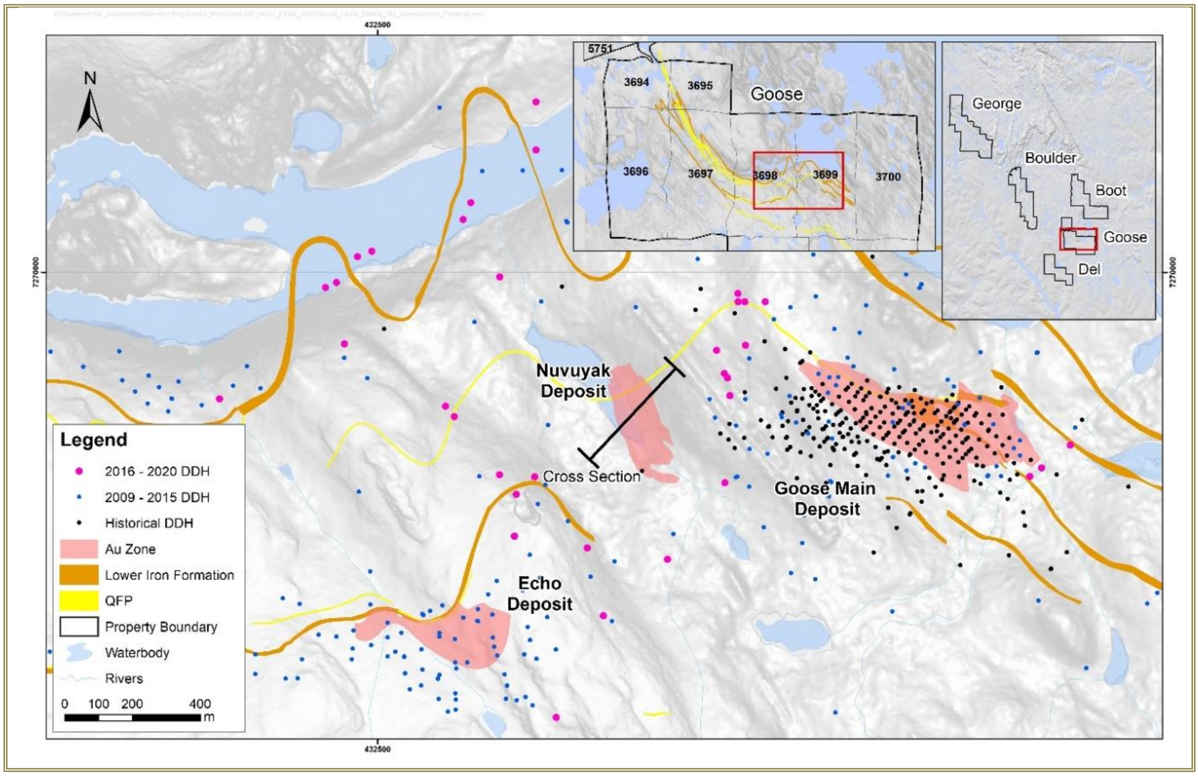


Source: Sabina, 2020.

Figure 10-9: Echo Section at 432,640 m East

10.3.5 Nuvuyak Deposit

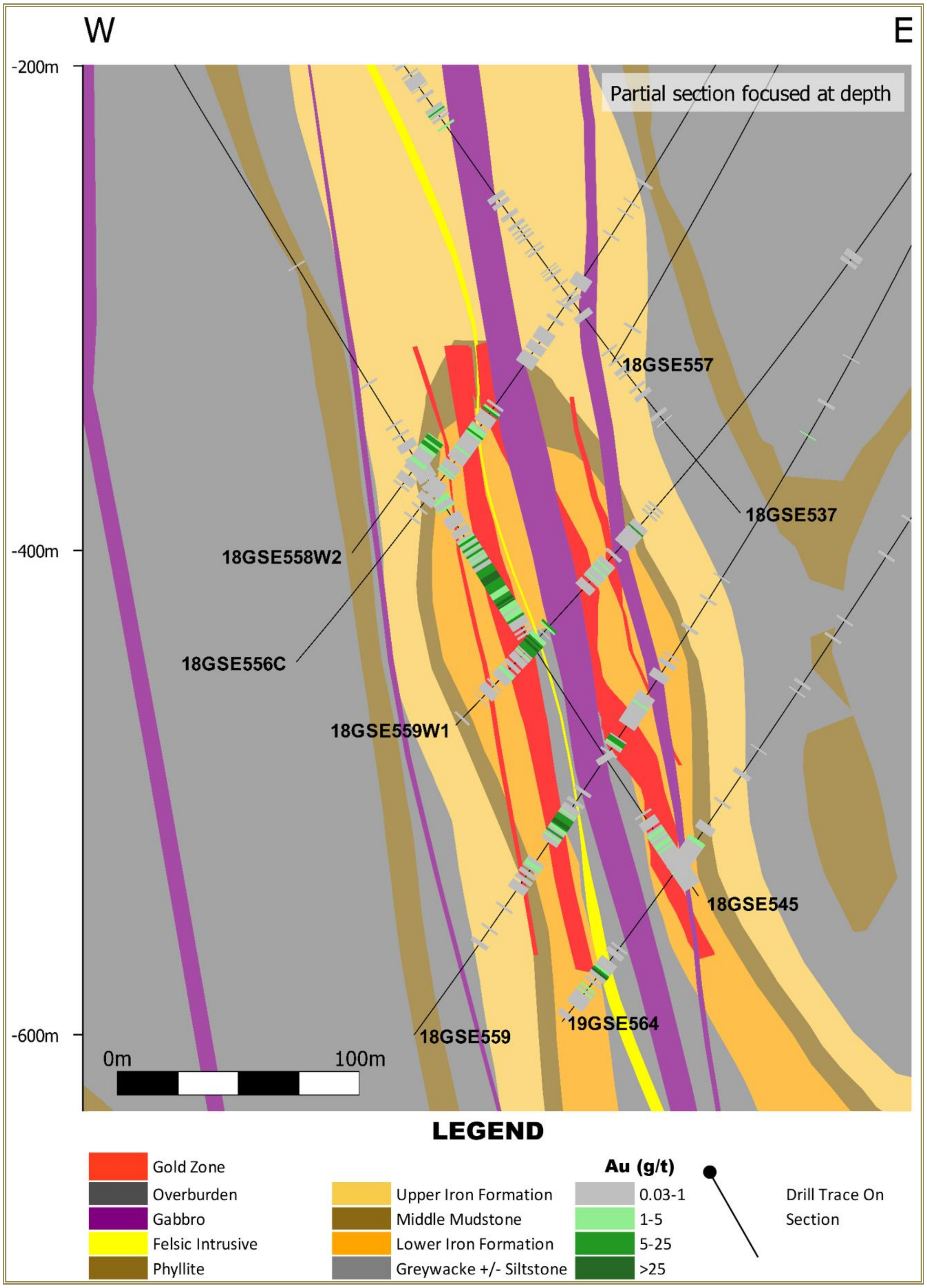
Drilling at the Nuvuyak deposit comprises 18 drill holes, totalling 13,117 m, all drilled by Sabina. The Nuvuyak deposit is approximately 850 m west of the Goose Main deposit and approximately 1,000 m down plunge. Collar locations of all drill holes for the Nuvuyak deposit are shown in Figure 10-10, with drill holes completed since 2016 highlighted in pink.



Source: Sabina, 2020.

Figure 10-10: Nuvuyak Deposit Diamond Drill-Hole Collar Plan

A representative Nuvuyak cross-section is included as Figure 10-11, showing the folded nature of the stratigraphy and the angle of intersection attained from the surface drilling. The gold grades are shown down hole, and the hole numbers include the year drilled.

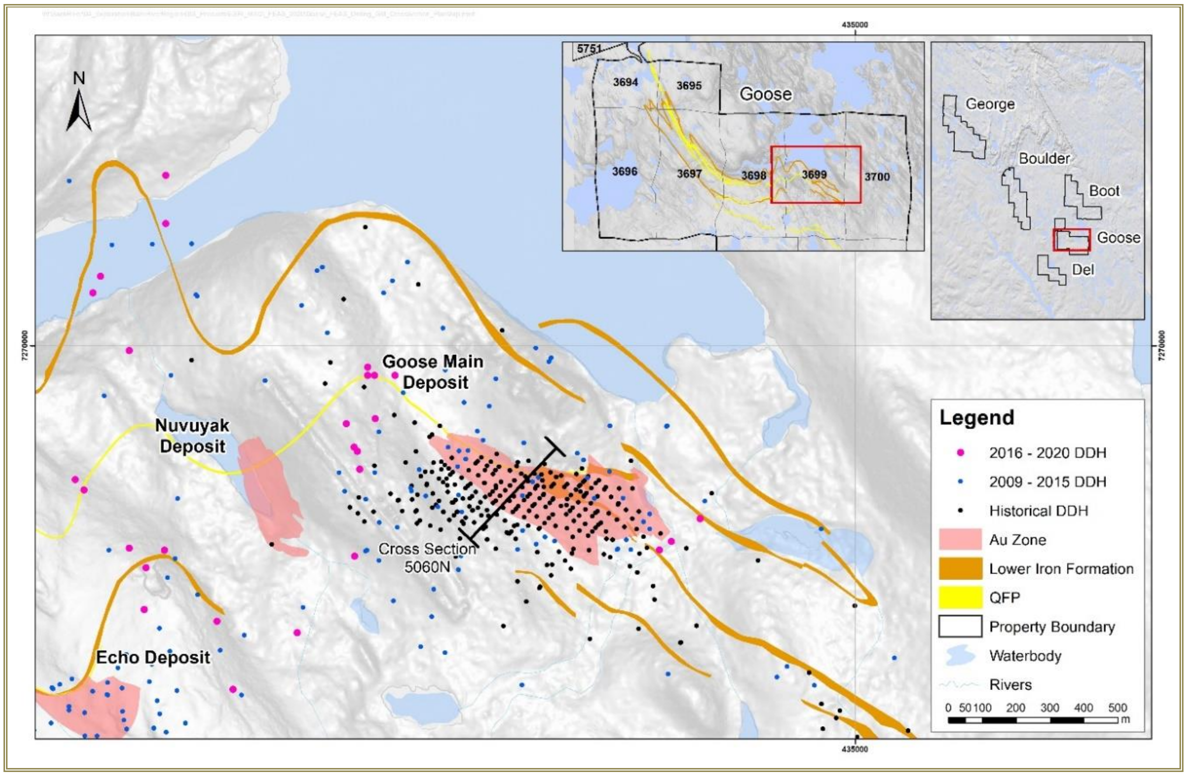


Source: Sabina, 2020.

Figure 10-11: Nuvuyak Section at 7,269,550 m North

10.3.6 Goose Main Deposit

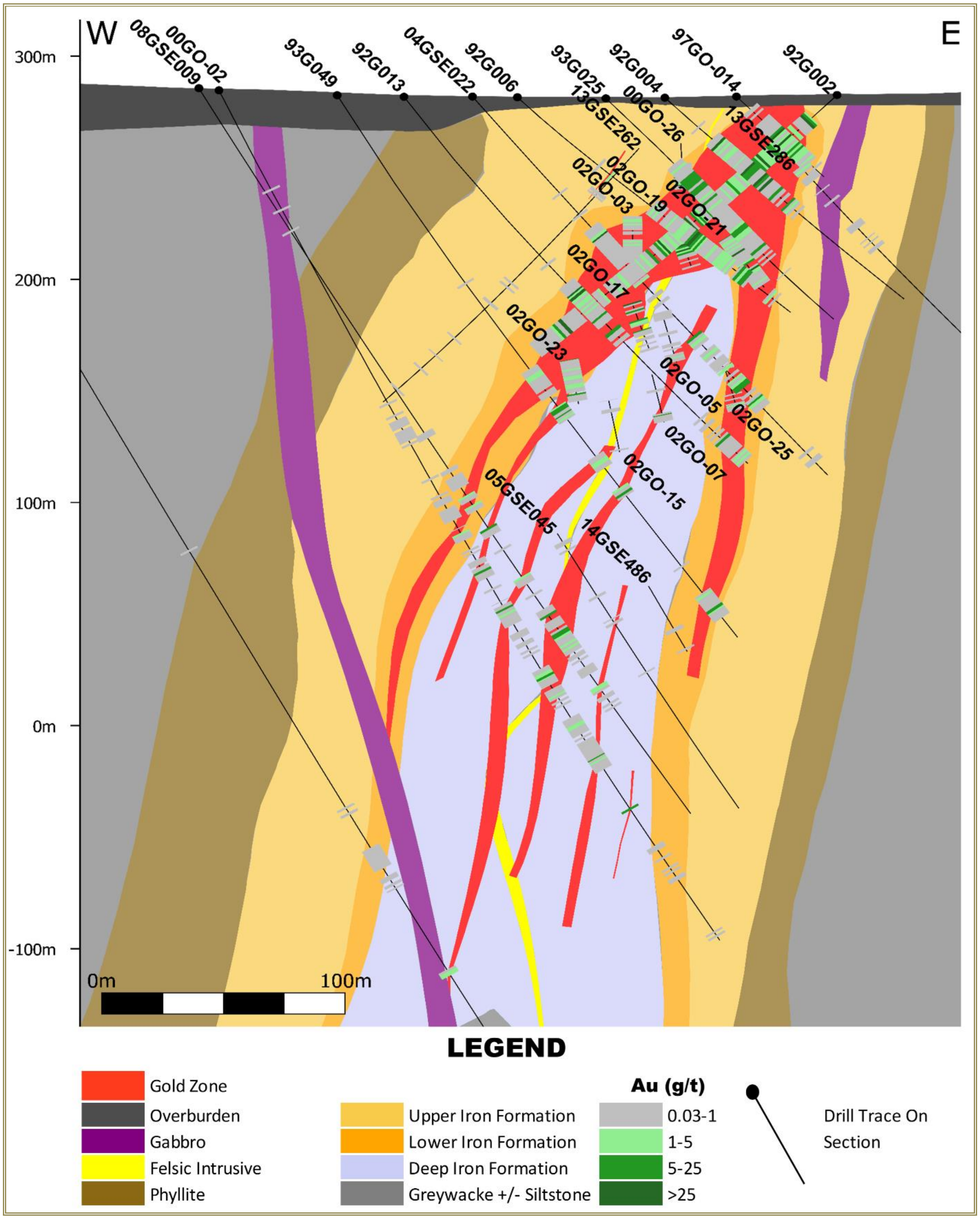
Drilling at the Goose Main deposit comprises 336 drill holes for a total of 83,426 m. Of that total, Sabina completed 42, totalling 10,079 m. Collar locations of all drill holes for the Goose Main deposit are shown in plan in Figure 10-12 with drill holes completed since 2016 highlighted in pink.



Source: Sabina, 2020.

Figure 10-12: Goose Main Diamond Drill-Hole Collar Plan

A representative Goose Main cross-section is included as Figure 10-13, showing the complex geology and the angle of intersection with the mineralization attained from the surface drilling. The gold grades are shown down hole and the hole numbers include the year drilled.



Source: Sabina, 2020.

Figure 10-13: Goose Main Section at 5,060 m North (Local Grid)

10.3.7 Goose Site Other Drilling

Geomechanical

In 2017, detailed geomechanical logging was carried out on approximately the lower 150 m of each of two drill holes at the Vault Zone within the Umwelt deposit. Additionally, specific intervals of existing and historic exploration core associated with the proposed crown pillar at the Umwelt deposit were logged for geomechanical properties. Six drill holes were selected, and a total of approximately 180 m was logged. In addition, 20 to 30 cm-long samples were taken from uncut core and sent for subsequent laboratory strength testing.

Inspection and maintenance of thermistors and vibrating wire piezometers that had been previously installed at the Goose Site were also competed in 2017.

Metallurgical

A metallurgical sampling program was conducted in 2020, in which 14 previously drilled exploration holes from the Umwelt deposit were selected and sent for metallurgical testing at Base Metallurgical Laboratories Ltd. (BML) in Kamloops, BC. Quarter core was sent for most sample intervals but where the core had previously been quartered, a representative 15 cm of quarter core was left in the box, and the rest of the interval was sent for testing.

10.4 George Site

The George Site consists of the Loc1, Loc2, LCPn, LCPs, GH, and SL deposits, as well as numerous showings. This Updated Feasibility Study focuses on developing the Llama, Umwelt, Echo, and Goose Main deposits, as well as incorporating the new Mineral Resources at the Llama Extension and Nuvuyak deposits, so only a location map of the George Site deposits and showings is included here, as the deposits have been described in earlier reports; (JDS, 2015, Tetra Tech, 2013, 2014).

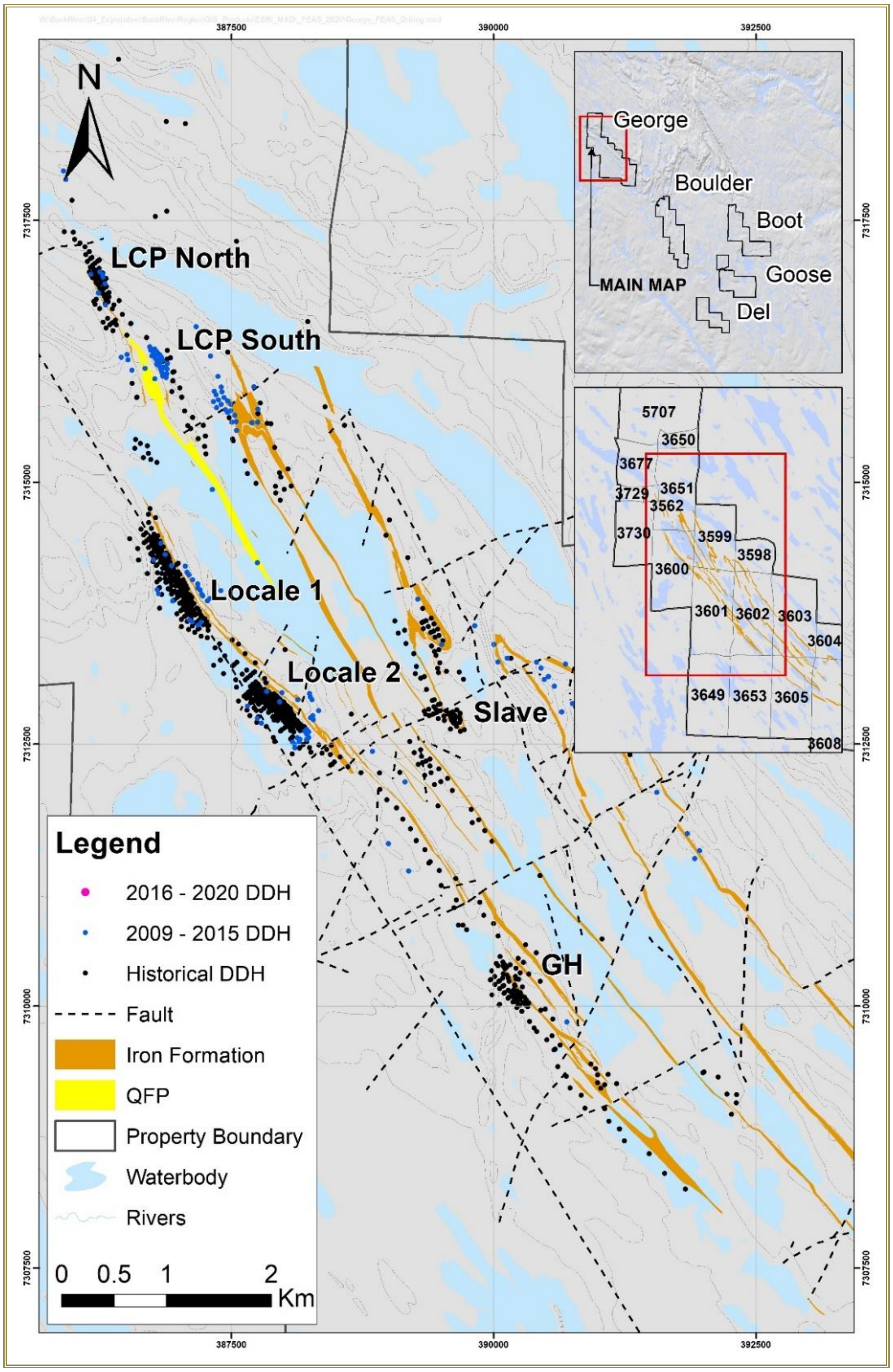
The drilling in these deposits, as well as field mapping and geophysical interpretation, enable a robust interpretation of the geology and mineralized zones.

There has been no new drilling at the George Site since 2013.

The drill spacing over the deposits at the George Site forms a notional grid, as follows:

- 30 to 60 m grid north by 30 m grid east over the LCPn deposit
- 40 to 80 m grid north by 30 m grid east over the LCPs deposit
- 30 to 60 m grid north by 30 to 60 m grid east over the two Locale deposits
- 30 m grid north by 30 m grid east over the GH deposit
- 30 to 60 m north by 30 m east over the SL deposit.

The locations of named prospects and drilling locations for the George Site are shown in Figure 10-14. No diamond drilling was carried out at the George Site from 2014 through 2020.

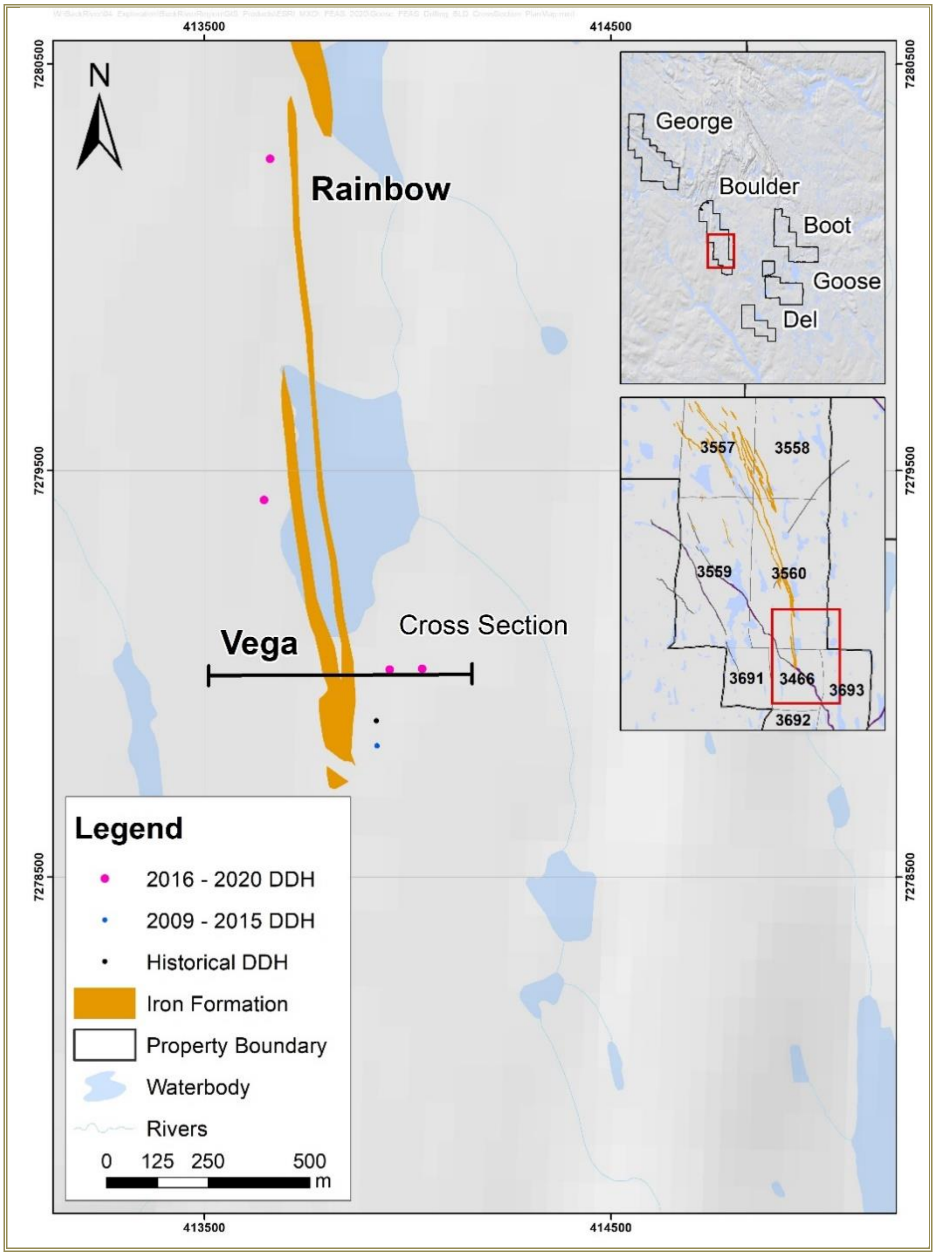


Source: Sabina, 2020.

Figure 10-14: George Site Deposits and Diamond Drill-Hole Collar Plan

10.5 Boulder Prospect

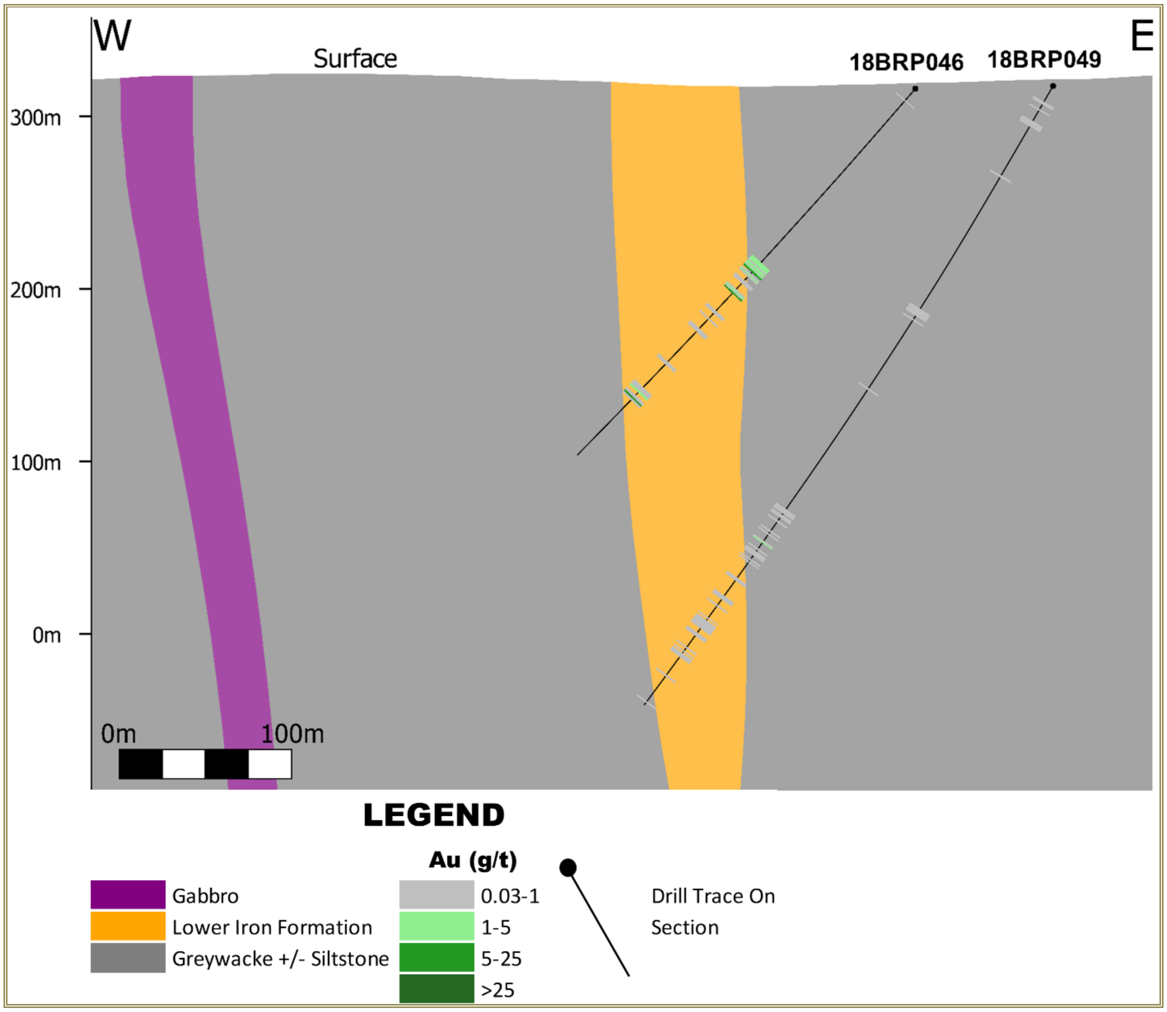
The Boulder prospect consists of the Vega, Humpback, Rainbow, and Jaeger targets, as well as the Galland, East Boulder, and Peace showings. Drilling at the Boulder prospect comprises 89 drill holes, totalling 23,033 m. Of that total, Sabina completed 51 drill holes, for a total of 14,861 m. Collar locations of all drill holes completed since 2016 are highlighted in pink and shown in Figure 10-15.



Source: Sabina, 2020.

Figure 10-15: Boulder Prospects and 2018 Diamond Drill-Hole Collar Plan

A representative Boulder cross-section is included as Figure 10-16, showing the folded nature of the stratigraphy and the angle of intersection attained from the surface drilling. The gold grades are shown down hole, and the hole numbers include the year drilled.



Source: Sabina, 2020.

Figure 10-16: Boulder Section at 7,279,020 m North

10.6 Diamond Core Sampling and Logging

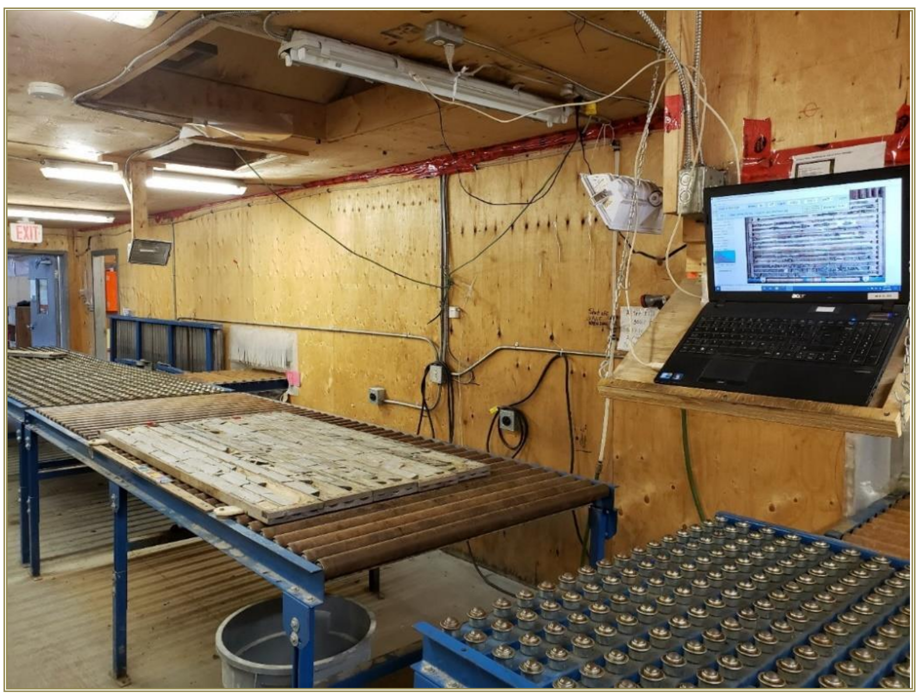
Diamond core was sampled and logged according to the following process:

1. The diamond core was placed in appropriately labelled wooden core trays at the drill rig prior to transport to the closest camp and core facility.
2. All geological information was captured digitally and updated to a Microsoft Access® database.
3. All diamond core was photographed using a digital camera, and the images were stored on the company server.
4. Geological information was captured, including lithology, veining, description of specific structures and alteration styles, along with the width, intensity, and associated mineral assemblage.
5. Rock quality designation (RQD) measurements were undertaken to record the number and nature of natural breaks in the core for subsequent geomechanical assessment. Other data collected included magnetic susceptibility, conductivity, and recovery.
6. The core was sampled, predominantly based on geological logging, with sample intervals ranging from a minimum sample length of 30 cm and a maximum sample length of 150 cm, with an optimal sample length of 100 cm.
7. The orientation of the core in the core box was maintained for sampling consistency.
8. Once all technical data had been derived from the core, selected sections were then halved lengthwise using a diamond saw, to consistently cut along the line drawn by the geologist, before being correctly placed back into the tray.
9. The half core was then sampled, ensuring that the same side was consistently sampled, and placed into bags labelled with the assigned sample number, leaving half of the core in the box.
10. Two-part sample tickets were used during sampling. One half of the sample tag accompanied the sample; the other half was stapled into the box for reference.
11. The residual half core was catalogued and stored for reference purposes.
12. The trays were consecutively stacked and clearly relabelled with the drill hole number, tray number, and interval.

The core processing area is well laid out and equipped with a good reception area to receive core, a well-lit core logging area, and an efficient process through all the data-capture process, from photography to the cutting area (as shown in Photo 10-1 to Photo 10-4).

Source: Sabina, 2020.

Photo 10-1: Core Logging Facility

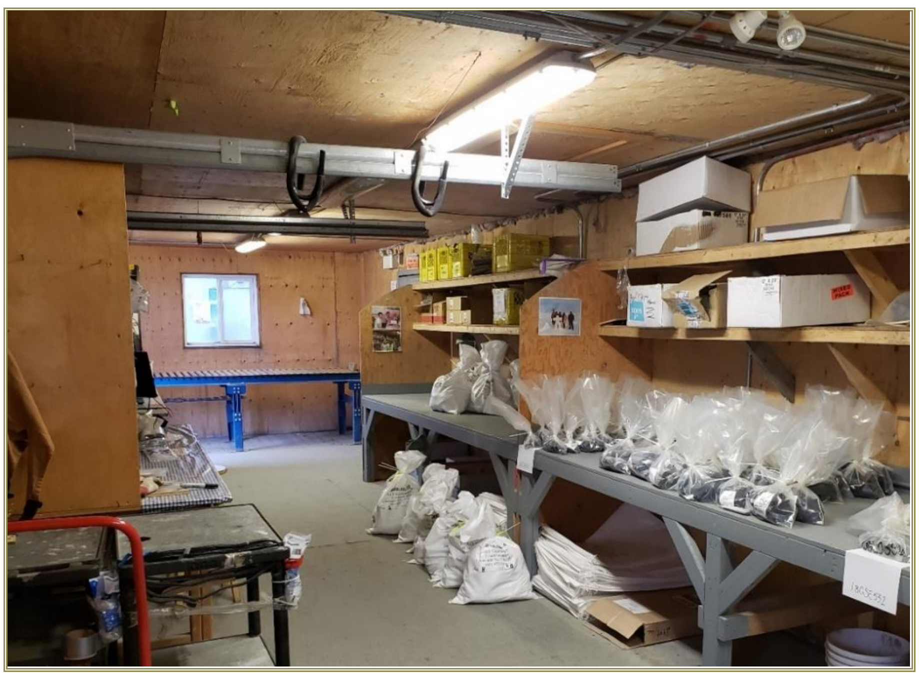


Source: Sabina, 2020.

Photo 10-2: Core Photography Area and Rollers to Core Cutting Facility

Source: Sabina, 2020.

Photo 10-3: Core Cutting Facility and Conveyors, viewed from Core Photography Area to Sample Shipping Area



Source: Sabina, 2020.

Photo 10-4: Sample Shipping Area and Conveyor viewed from Core Cutting Facility

10.7 Bulk Density Measurements

TSL Laboratories (TSL), SGS, and ALS measured specific gravity (SG) by air-weighing the core, then weighing the core in water while suspended beneath scales. Core was not sealed prior to immersion. Previous studies have shown that there is no material difference between the measurements of sealed versus unsealed core (Cater et al., 2009); therefore, the QP considers the SG measurements to be suitable for use as dry bulk-density measurements, which can be used to generate tonnages in the Mineral Resource estimate.

During the 2016–2020 drilling programs, Sabina measured SG on site (Photo 10-5) and sent 341 (14%) of the SG samples to TSL, SGS, and ALS for comparative testing. Measurements from the laboratory testing compared well with those on site, with the yearly correlation coefficients ranging from 0.97 to 1.00. From 2016 to 2020, 2,488 SG measurements were collected from deposits around the Goose Site. The total number of SG measurements for the Goose Site is 15,387. A total of 4,746 SG measurements has been collected from the George Site.

SG was assigned based on local values for deposits with restated Mineral Resource estimates, provided that the number of samples was greater than 100. For deposits with updated or new mineral resource estimates, SG was assigned from within grouped domains for mineralized zones, and from site-wide values for non-mineralized rock. The assignment methodologies are described in Section 14.2.1 for the Goose deposit, and in Section 14.3.1 for the George deposits.

Source: Sabina, 2020.

Photo 10-5: SG Measurement Station

10.8 Database Review

10.8.1 Recompilation of Historical Logged Data

In 2013, all 1985 to 2009 drill hole logged data for the Goose Site was recompiled from various historical digital sources to populate the GEOVIA GEMS™ databases with supporting data for ongoing exploration. The data compilation is complete for the Goose Site. Sabina is considering recompiling historical logged data for the George Site as well.

10.8.2 Historical Collar and Down-Hole Survey Review

In 2013 Sabina checked all survey data for the Goose and George sites, from the period 1985 to 2012. Drill-hole survey data were checked against original drill logs, reports, and survey files where available. Select collars were re-surveyed in the field as a cross-check. Where material errors were found, corrections were applied to the GEOVIA GEMS™ database. Various Sabina team members proofed and validated final GEOVIA GEMS™ database correction files for each area.

11 SAMPLE PREPARATION, ANALYSES, AND SECURITY

11.1 Introduction

The 2015 Technical Report (JDS, 2015b) discusses data up to 2015. In 2016, the only drilling and sampling conducted was not in the Mineral Resource areas, therefore is not included in this section. In the period from 2017–2020 the following work was carried out:

- 2017—4,755 samples were submitted for analysis
- 2018—13,470 samples were submitted for analysis
- 2019—3,942 samples were submitted for analysis
- 2020—5,031 samples were submitted for analysis.

Sample handling, preparation, analyses, and QA/QC results for samples analyzed from 2017–2020 are discussed in this section.

11.2 Historical and Previous Sabina Work

For the historical datasets, independent reviews were completed by RPA (2011), Coffey Mining (2009), and WGM (2003, 2005). Based on these reviews, the QP is satisfied that the exploration approach and sample data are of sufficient quality for inclusion in resource evaluation studies. A summary of the historical sample preparation, analyses, and security is presented in the 2012 Technical Report (SRK, 2012).

A summary of the 2012 sample preparation, analyses, and security is presented in the 2013 Technical Report (Tetra Tech, 2013). A summary of the 2013 sample preparation, analyses, and security is presented in the 2014 Mineral Resource update (Tetra Tech, 2014). A summary of the 2014–2015 data is presented in the 2015 Technical Report (JDS, 2015b).

11.3 Sample Shipment and Security

Sabina's sample shipment and security procedure involved direct drill and sample management; secure transportation methods; sampling and logging areas; and sample storage facilities.

Instructions were provided to the primary laboratory, using detailed requisition forms outlining procedures for sample preparation and assay.

Samples were transported by charter aircraft from the Property to Yellowknife. The samples were then transported by either air freight or transport truck from Yellowknife to the laboratory. An established chain of custody was employed to ensure the safe and secure transport and delivery of core samples to the laboratory.

SGS and ALS, the two primary laboratories used from 2017 to 2020, in turn sent notifications of receipt to confirm the arrival of samples at the laboratory.

Sabina's shipment procedures are considered to provide adequate security for the samples used in the Mineral Resource estimate.

11.4 Sample Preparation and Analysis

Table 11-1 summarizes the laboratories used for the 2017–2020 sample preparation and analysis. All are independent of the issuer.

Table 11-1: Laboratories (2017–2020)

Year	Laboratory		Location	Accreditation
2017–2019	Primary	SGS	Burnaby	ISO/IEC 17025:2017
	Umpire	ALS	Vancouver	ISO/IEC 17025:2017
		BV	Vancouver	ISO/IEC 17025:2017
2020	Primary	ALS–prep	Yellowknife	ISO/IEC 17025:2017
		ALS–analysis	Vancouver	ISO/IEC 17025:2017
	Umpire	Actlabs	Kamloops	ISO/IEC 17025:2017

Source: AMC, 2020.

Samples are received by the laboratory, then sorted and dried prior to preparation. In 2020, samples were crushed and pulverized in Yellowknife before shipping to the laboratory for analysis.

Rock samples and core samples are primary-crushed in a jaw crusher to a minimum of 95% passing (P_{95}) 10 mesh. Equipment is cleaned between each sample with compressed air and brushes, and, where necessary, with barren rock. To verify compliance with QC specifications, the laboratory performs a screen test at the start of each group; every 50th sample; after a change of machine or environmental conditions; or when the nature of the sample appears different. All screen data are recorded in the laboratory database, and are available at the client's request.

A representative split sample is obtained by passing the entire reject sample through a riffler, and by alternating catch pans before taking the final split. Rock and core pulp sizes are 1,000 g. The remaining reject material is returned to a bag labelled "Reject," and stored. The subsample (referred to as the master pulp) is then pulverized to a minimum 95% passing 140 mesh in a pulverizing bowl of chrome-steel. Checks on screens are performed at the start of each group; every 50th sample; after a change of machine or environmental conditions; or when the nature of the sample appears different. All screen data are available for examination upon request. Pulverizers are cleaned with a sand wash at the start of each group, or whenever it is deemed necessary. A subsample of roughly 200 g (referred to as the coin pulp) is obtained by random sampling of the homogenized master pulp.

For each sample submitted, there is a:

- Reject sample
- Master pulp of about 800 g
- Coin pulp of about 200 g is split from the master pulp, then from the coin pulp, about 50 g is selected for FA; for select samples, 0.2 g is selected for ICP analysis.

11.5 Sample Analysis

Gold is analyzed by an FA/AA spectrometry (AAS) finish using a 50 g subsample of the coin pulp. FAs were finished with AAS, and samples with higher grades that exceeded the maximum detection limit of AAS received a supplemental gravimetric (GRAV) finish. All samples over 3,000 ppb are analyzed by FA/GRAV using a 50 g subsample of the coin pulp. The furnace size allows for 84 samples, 76 of which are client samples and eight of which are laboratory QC samples.

Metallics are performed on a new 1,000 g split from the reject material if enough is remaining, or on the remaining pulp from the master pulp, which is typically 800 g. Metallics are screened at 140 mesh; the entire plus fraction (+140 mesh) is assayed by FA/GRAV, and the minus fraction (−140 mesh) is assayed by FA/AA (2 assay ton charge) in duplicate. Results are reported for the plus and minus fractions, and the weighted average for the sample.

For the four acid-digest multi-element determination, a 0.2 g subsample of the coin pulp is digested with HNO_3, HCl, HF, and $HClO_4$. The resulting solution is split into two—one part is analyzed by ICP and the other by ICP-mass spectrometry, for a total determination of 49 elements.

For whole-rock determination, a 0.1 g subsample of the coin pulp is fused with $LiBO_2$. The resulting solution is analyzed by ICP to determine major oxides and some minor elements.

Table 11-2 lists the lower and upper detection limits (LDL and UDL), by laboratory, for each analytical method used for assaying gold.

Table 11-2: Detection Limits of Analytical Methods for Gold

Laboratory	Analytical Method	Description	LDL (Au g/t)	UDL (Au g/t)
SGS	GE FAA515	50 g FA/AAS	0.005	10
	GO FAG505	50 g FA/GRAV	0.5	10,000
ALS	Au-AA24	50 g FA/AAS	0.005	10
	Au-GRA22	50 g FA/GRAV	0.05	10,000
BV	FA450	50 g FA/AAS	0.005	10
	FA550-Au	50 g FA/GRAV	0.9	none

Source: AMC, 2020.

11.6 Quality Assurance and Quality Control

For the 2017–2020 campaigns QA/QC sample insertion was carried out according to the following protocols:

- A gold certified reference material (CRM) sample, every 20th sample, and at the beginning of every shipment
- A multi-element CRM at the start of every shipment
- A blank sample every 20th sample.

Subsequently, on return of the results the process consisted of the following:

- Every 4th sample with a value ≥0.2 g/t Au has a repeat pulp and reject duplicate analysis with the initial laboratory.
- Every 8th sample with a value ≥0.2 g/t Au has a pulp repeat analysis at a different laboratory carried out. Between 2017 and 2019, the pulp was submitted to ALS for analysis for a check assay, and in 2020 to Actlabs.
- Where there was insufficient sample for a duplicate, another ≥0.2 g/t Au sample nearby was selected.

Table 11-3 summarizes the number of QA/QC samples submitted from 2017–2020. No check assays for 2020 have been completed at the effective date of this Technical Report.

Table 11-3: Summary of QA/QC Samples Submitted from 2017–2020

Year	2017	2018	2019	2020	Total
Total Assays	4,575	12,772	3,942	5,031	26,320
CRM (Au)	267	708	259[1]	302	1,536
Blanks	251	667	218	282	1,418
Pulp Duplicates	106	308	102	148[2]	664
Coarse Duplicates	105	298	102	147[2]	652
Check Assays	57	154	102		313

Source: AMC, 2020.
Note: [1] Total includes re-run CRMs.
[2] Only 88 duplicate sample analyses were completed at the effective date of this Technical Report.

Industry norm is that CRMs, blanks, and duplicates should represent approximately 5% of the total samples submitted. A summary of submission rates is presented in Table 11-4. The sample submission rates for the 2017–2020 campaigns are sufficient. It is noted that no field duplicates have been submitted.

Table 11-4: QA/QC Sample Submission Rates from 2017–2020

Year	2017	2018	2019	2020
Total Assays	4,575	12,772	3,942	5,031
CRM (Au) (%)	6	6	7	6
Blanks (%)	5	5	6	6
Duplicates (%)	5	5	5	6
Check Assays (%)	1	1	3	N/A

Source: AMC, 2020.
Note: Check assays for 2020 have not been submitted.

11.6.1 Assay Results of Certified Reference Materials

CRMs should be obtained for all economic minerals. For each economic mineral, there should be three corresponding standards:

- At around the expected cut-off grade (COG) of the deposit
- At the expected average grade of the deposit
- At a higher grade.

The CRMs were sourced predominantly from Geostats Pty Ltd., with a few CRMs from CDN Laboratories. The source, CRM name, and expected value of each CRM are documented in Table 11-5, along with the number of samples submitted.

Table 11-5: Summary of CRMs Submitted (2017–2020)

Year	Source	CRM	Expected Au Value (g/t)	Standard Deviation	No. of Assays
2017	CDN	S1	0.328	0.027	14
	CDN	GS-1b	1.020	0.035	69
	CDN	S3	37.080	0.610	67
	CDN	GS-14	7.470	0.155	52
	CDN	S2	13.280	0.405	65
Total					**267**
2018	Geostats	G907-8	6.780	0.270	1
	Geostats	G310-1	4.940	0.220	119
	Geostats	G311-2	4.930	0.180	16
	Geostats	G300-9	1.530	0.060	4
	Geostats	G307-8	1.990	0.080	31
	Geostats	G910-2	0.90	0.0500	45
	CDN	S3	37.080	0.610	141
	CDN	GS-14	7.470	0.155	11
	CDN	S2	13.280	0.405	143
	Geostats	G310-5	1.010	0.050	94
	Geostats	G907-3	2.880	0.110	103
Total					**708**
2019	Geostats	G910-7	0.513	0.030	2
	Geostats	G904-8	5.532	0.180	1
	Geostats	G907-8	6.780	0.270	1
	Geostats	G909-8	33.640	1.520	1
	Geostats	G310-1	4.940	0.220	1
	CDN	GS-1b	1.020	0.035	1
	Geostats	G316-7	5.850	0.190	10
	Geostats	G903-9[1]	11.260	0.410	3
	Geostats	G907-6[1]	7.250	0.290	4

Year	Source	CRM	Expected Au Value (g/t)	Standard Deviation	No. of Assays
	Geostats	G308-3	2.500	0.110	9
	CDN	GS-2a[1]	2.040	0.095	6
	Geostats	G315-2	0.980	0.040	3
	CDN	S3	37.080	0.610	49
	Geostats	G316-8	6.110	0.210	41
	Geostats	G910-4[1]	16.920	0.720	1
	CDN	S2	13.280	0.405	49
	Geostats	G310-5	1.010	0.050	41
	Geostats	G907-3	2.880	0.110	35
Total					**258**
2020	Geostats	G316-7	5.85	0.190	3
	Geostats	G307-8	1.99	2.230	38
	Geostats	G308-3	2.50	0.1100	24
	Geostats	G315-2	0.98	0.0400	61
	CDN	S3	37.080	0.610	61
	Geostats	G318-4	5.930	0.200	51
	CDN	S2	13.280	0.405	63
Total					**301**

Source: AMC, 2020.
Note: [1] Denotes re-run CRM samples included because of insufficient material of previously inserted CRMs.

It is recommended that assay batches with two CRMs outside two standard deviations should be re-run, and that assay batches with one CRM outside three standard deviations should also be re-run. As CRM data accumulate over time, results should be reviewed for biases in the data.

Table 11-6 shows the results of Sabina's CRMs. A warning is defined as being outside two standard deviations from the expected value, if there are two warnings in the same batch, this is considered a fail. If one CRM is three standard deviations outside the expected value, this is also considered a fail.

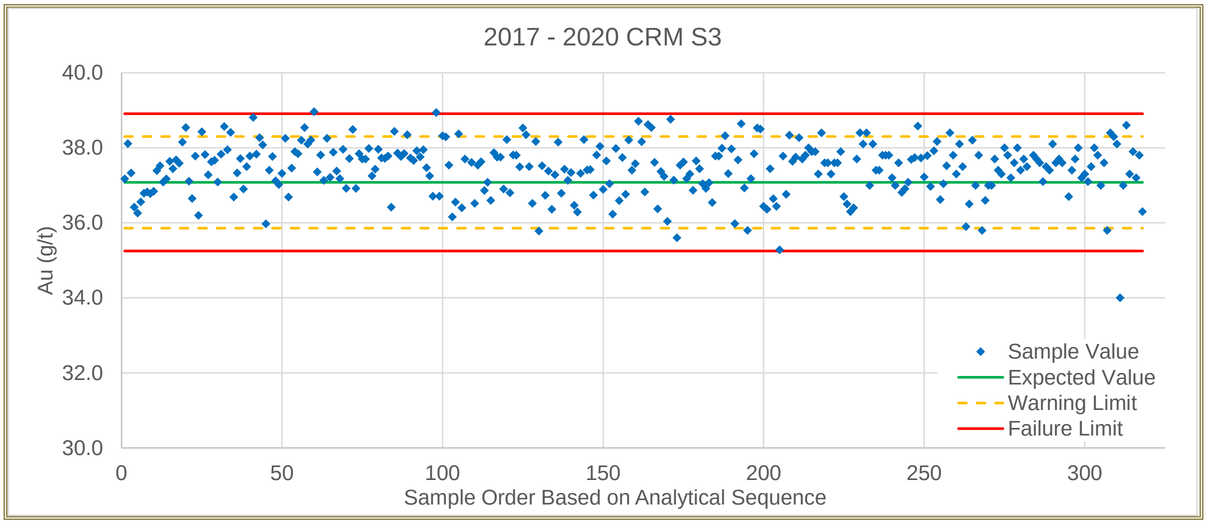
Table 11-6: Assay Results of CRMs for Gold (2017–2020)

Year	CRM	Expected Au Value (g/t)	Standard Deviation	No. of Assays	Warnings	Fail
2017	S1	0.328	0.027	14	1	3
	GS-1b	1.020	0.035	69	-	-
	S3	37.080	0.610	67	6	1
	GS-14	7.470	0.155	52	6	9
	S2	13.280	0.405	65	2	0
Total				**267**	**6%**	**5%**

Year	CRM	Expected Au Value (g/t)	Standard Deviation	No. of Assays	Warnings	Fail
2018	G907-8	6.780	0.270	1	-	-
	G310-1	4.940	0.220	119	2	0
	G311-2	4.930	0.180	16	-	1
	G300-9	1.530	0.060	4	-	-
	G307-8	1.990	0.080	31	2	-
	G910-2	0.90	0.0500	45	2	-
	S3	37.080	0.610	141	19	2
	GS-14	7.470	0.155	11	1	1
	S2	13.280	0.405	143	7	-
	G310-5	1.010	0.050	94	4	1
	G907-3	2.880	0.110	103	3	1
Total				**708**	**6%**	**1%**
2019	G910-7	0.513	0.030	2	2	-
	G904-8	5.532	0.180	1	-	-
	G907-8	6.780	0.270	1	-	-
	G909-8	33.640	1.520	1	-	-
	G310-1	4.940	0.220	1	-	-
	GS-1b	1.020	0.035	1	1	-
	G316-7	5.850	0.190	10	-	2
	G903-9[1]	11.260	0.410	3	-	-
	G907-6[1]	7.250	0.290	4	-	-
	G308-3	2.500	0.110	9	2	-
	GS-2a[1]	2.040	0.095	6	-	-
	G315-2	0.980	0.040	3	1	-
	S3	37.080	0.610	49	6	-
	G316-8	6.110	0.210	41	9	13
	G910-4[1]	16.920	0.720	1	-	-
	S2	13.280	0.405	49	3	-
	G310-5	1.010	0.050	41	6	-
	G907-3	2.880	0.110	35	6	2
Total				**258**	**14%**	**7%**
2020	G316-7	5.85	0.190	3	-	-
	G307-8	1.99	2.230	38	-	-
	G308-3	2.50	0.1100	24	-	-
	G315-2	0.98	0.0400	61	-	-
	S3	37.080	0.610	61	5	3
	G318-4	5.930	0.200	51	0	2
	S2	13.280	0.405	63	0	2
Total				**301**	**2%**	**2%**

Source: AMC, 2020.
Note: [1] Denotes re-run CRM samples included because of insufficient material of previously inserted CRMs.

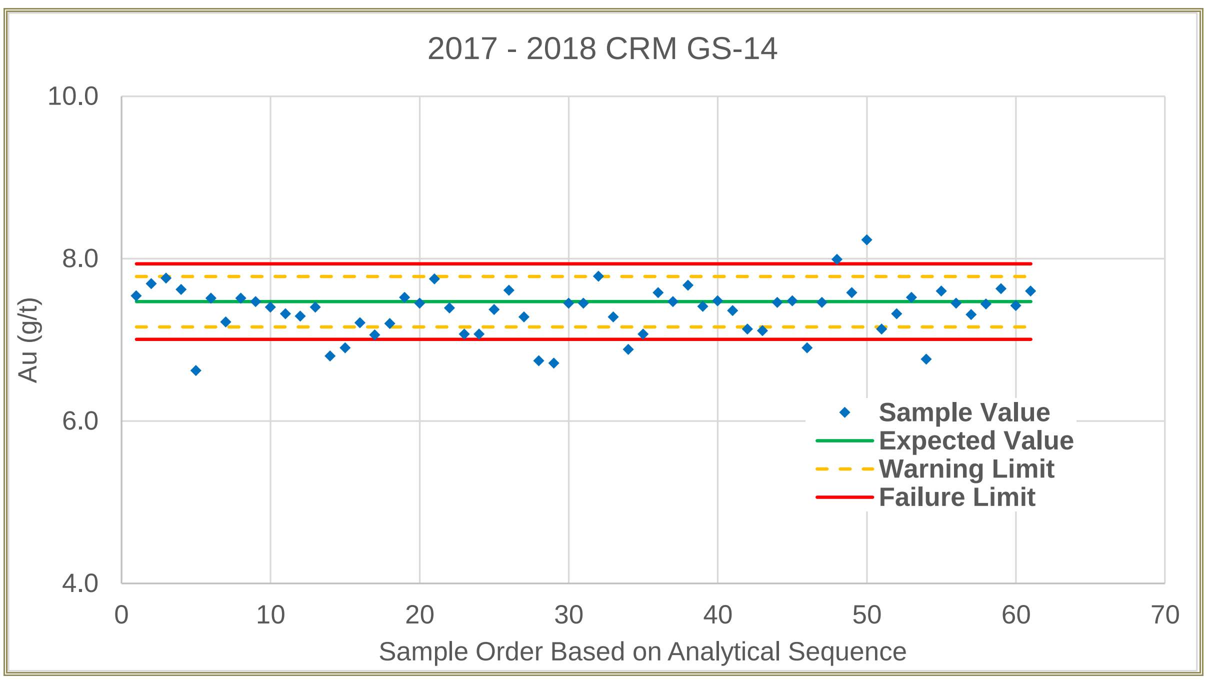
Figure 11-1 to Figure 11-3 show the results for S3, GS-14, and G310-5, which represent high-grade, average-grade, and approximate COG for the deposit, respectively.



Source: AMC, 2020.

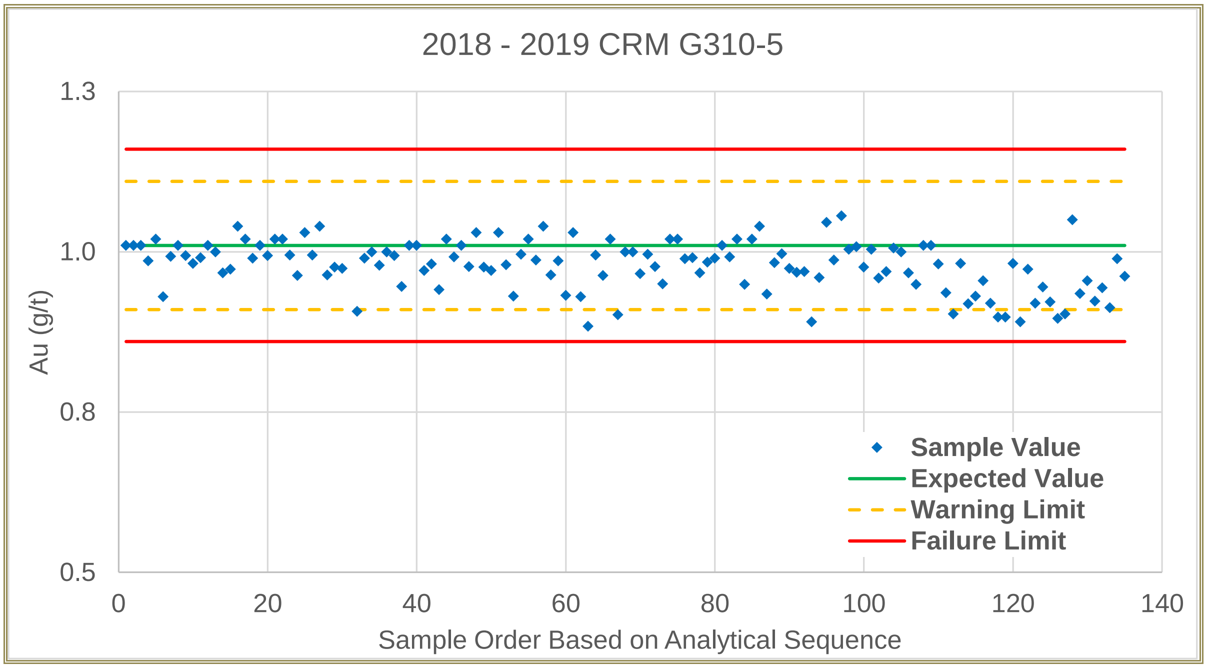
Note: Biased high, but within acceptable limits.

Figure 11-1: Control Chart for 2017–2020 S3



Source: AMC, 2020.

Figure 11-2: Control Chart for 2017–2018 GS-14



Source: AMC, 2020.

Note: Biased low but within acceptable limits

Figure 11-3: Control Chart for 2018–2019 G310-5

Following is a summary of the CRM performance:

- There were no batches where two warnings were recorded in the same batch. All fails recorded are a result of the CRM being outside of three standard deviations.
- All fails in 2017 were attributed to CRMs being outside the limit of three standard deviations.
- For 2018, two fails are attributed to a mix-up of CRMs S3 and G907-3; G310-5 was a processing error; S3 failed when the batch was re-run and the subsequent re-run passed.
- In 2019, there was an increase in warnings and fails. This prompted a CRM re-run program to investigate the causes. A summary of this is presented in Section 11.6.2.
- No fails were recorded in 2020.

Sabina documents all CRM fails. Each fail is treated individually and investigated. Batches are not re-run if the AAS or the GRAV CRM do not fail; if there are no mineralized samples in the batch; or if there is an obvious sample mix-up.

Upon receipt of any re-run batches, the original and re-run samples are checked for consistency using a relative paired difference (RPD) comparison plot, and a decision is made to keep the original assay values or the values from the re-run batch. This method measures the absolute difference between a sample and its duplicate. Typically, for the 2017–2019 failures, the original batch assay values have been kept.

Sabina monitors the results closely and documents the reasons for failures. The results of the CRMs are acceptable.

11.6.2 CRM Re-Run Program

In 2019, there was a higher-than-normal proportion of CRM failures with the CRM G316-8 performing particularly poorly. This prompted Sabina to conduct a CRM re-run program that involved sending eight different CRMs to three different laboratories—SGS, ALS, and BV, all in Greater Vancouver. The results are summarized in Table 11-7.

Table 11-7: 2019 Results of CRM Re-Run Program

Code	No. CRMs/Laboratory	SGS Fail/Warning	ALS Fail/Warning	BV Fail/Warning
G316-7	1	-	-	-
G307-8	2	0/2	-	-
G907-6	1	-	-	-
G308-3	1	0/1	-	-
G315-2	2	-	-	-
S3	2	-	-	-
G316-8	3	1/3	-	-
S2	2	-	-	-

Source: AMC, 2020.

All warnings and failures from SGS were biased low. The CRM G316-8 performed well in the re-run, confirming that there was nothing wrong with the CRM material. A check assay program was also conducted in 2019 with all three laboratories—SGS, ALS, and BV—to confirm the validity of the assay results of 2019. The results of which are discussed in Section 11.6.5.

11.6.3 Assay Results of Blank Samples

The following blank tests may be carried out:

- Coarse blanks test for contamination during both the sample preparation and assay process
- Pulp blanks test for contamination during the assay process.

Blanks should be inserted in each batch sent to the laboratory, with an additional coarse blank inserted immediately after expected high-grade samples. In the QP's opinion, the "pass" requirement for blanks is that 80% of the coarse blank assays should be less than twice the detection limit for that element.

Blanks were taken from unmineralized sections of core (mainly late gabbro dykes) that had been removed from the core boxes and either kept in bins in the sampling room or bagged in individual sample bags. Only coarse blanks were submitted. The results of the coarse blanks are summarized in Table 11-8.

Table 11-8: 2017–2020 Assay Results of Coarse Blanks

Year	Blank Assays	No. Assays >2x LDL	QP's Pass Rate (%)
2017	251	97	61
2018	667	115	83
2019	218	42	81
2020	282	0	100

Source: AMC, 2020.

Notes: AAS detection limit, 0.005 Au g/t; GRAV detection limit, 0.05 Au g/t.

All years met the pass criteria, except 2017. It is noted that the internal pass/fail criteria set by Sabina defines a blank failure if the sample returns a value of greater than 0.1 g/t. Using this criterion there was a 99% pass rate for 2017, and all other years had a 100% pass rate. Given the COG of the deposit and threshold for defining mineralized envelopes, this criterion is adequate.

Although Sabina did not insert pulp blanks into its sample stream, the low failure rate suggests the laboratory has little or no contamination present in either the sample preparation or assay processes.

11.6.4 Assay Results of Duplicates

Unmineralized samples should not be sent as duplicates because assays near the detection limit are commonly inaccurate.

Duplicate data can be viewed on a scatter plot, but they should also be compared using the RPD plot. It is desirable to achieve 80% to 85% of the pairs with less than 15% RPD between the original assay and check assay (Stoker, 2006) for coarse duplicates and 10% RPD for pulp duplicates. Sample pairs should be excluded from the analysis if the combined mean of the pair is less than 15 times the detection limit (Kaufman & Stoker, 2009). Removing the low values ensures that there is no undue influence on the RPD plots due to the higher variance of grades, likely near to the detection limit where precision becomes poorer (Long et al., 1997).

The duplicate data have been reviewed by combining the 2017–2019 data analyzed at SGS, and separately for the 2020 data analyzed at ALS. The results are also presented separately by AAS and GRAV methods to determine the performance of each method. If AAS and GRAV duplicates are reviewed together, this will remove several samples from the comparison, because of the difference in LDL between the two methods. For a reasonable interpretation of RPD plots, greater than 100 sample pairs are required. A summary of the RPD analysis by method and year is given in Table 11-9.

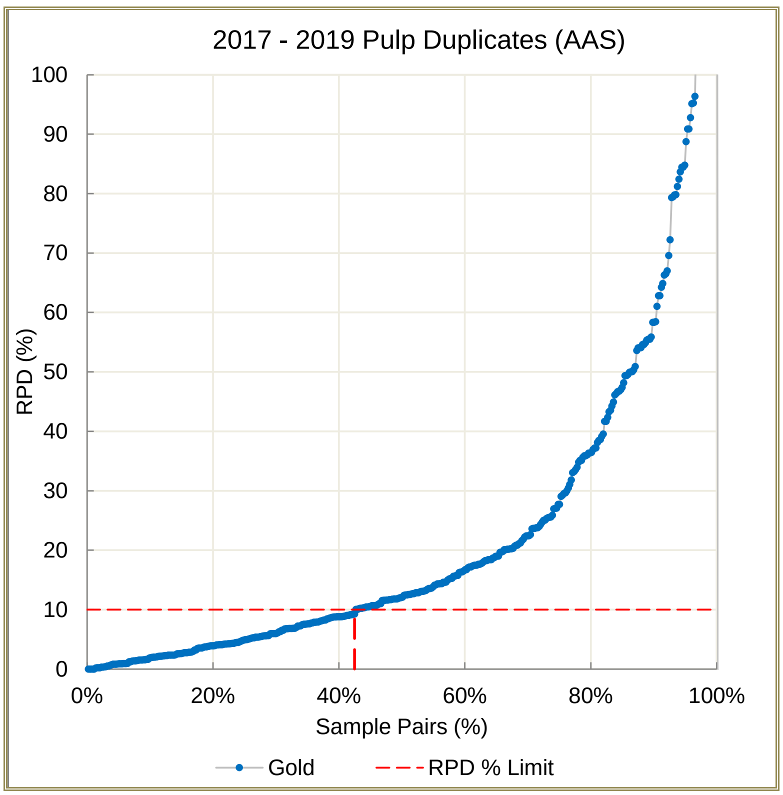
Figure 11-4 and Figure 11-5 show the RPD plot and scatter plot for the 2017–2019 pulp duplicates for the AAS analytical method.

Table 11-9: Summary of Duplicate Assay Results (2017–2020)

Method	Year	2017–2019	2020
AAS	Pulp Sample Pairs (Pairs >15xLDL)	442 (433)	49 (49)
	Pulp Sample Pairs <10% RPD	43%	43%
	Bias (%)	2.02	−4.86
	Coarse Sample Pairs (Pairs >15xLDL)	443 (433)	49 (49)
	Coarse Sample Pairs <15% RPD	50%	56%
	Bias (%)	2.32	3.73
GRAV	Pulp Sample Pairs (Pairs >15xLDL)	<100	<100
	Pulp Sample Pairs <10% RPD	n/a	n/a
	Bias (%)	3.52	−2.06
	Coarse Sample Pairs (Pairs >15xLDL)	164 (164)	26 (26)
	Coarse Sample Pairs <15% RPD	69%	77%
	Bias (%)	1.51	0.91

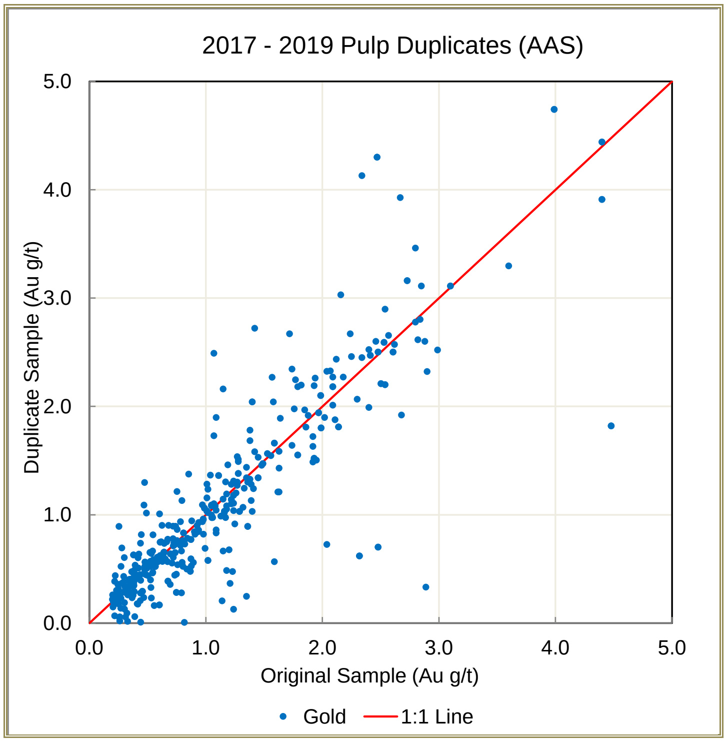
Source: AMC, 2020.

Note: The poorer performance of the AAS results may be due to the stated detection limit being significantly lower than the practical detection limit.



Source: AMC, 2020.

Figure 11-4: 2017–2019 RPD Plot Pulp Duplicates AAS



Source: AMC, 2020.

Figure 11-5: 2017–2019 Scatter Plot Pulp Duplicates AAS

The following observations are made:

- For 2017–2019, the GRAV method performs better than the AAS method for both pulp and coarse duplicates. This is likely due to the stated detection limit being significantly lower than the practical detection limit for the AAS method. Also, the GRAV method is predominantly reporting data above 3 g/t Au, and is therefore, not impacted by detection limit issues.
- For 2017–2019, coarse duplicates performed a little outside the ideal parameters; however, this may be due to the geological variances common in Archean gold deposits.
- For 2017–2019, pulp duplicates performed well-outside the ideal parameters. This may be partly due to the geological variances common in Archean gold deposits, but other components may be involved, and investigation is required, as discussed below.
- Pulp duplicates are sent at the end of the season. The pulp material might be settling and not properly being re-mixed prior to the duplicate assay being analyzed. Requesting real-time pulp and coarse duplicates on sample submittal forms is suggested.
- There is no discernible change in performance due to a change of laboratory. Additional data are required to confirm this.
- Although the low performance of the duplicates is not unusual for Back River, and may be due in part to geological variance, this raises an issue that should be considered for subsequent QA/QC programs.
- Some samples in 2019 did not meet the required grind size of 106 µm.

11.6.5 Results of External Check Assays

The purpose of a check laboratory is to increase confidence in the accuracy of the primary laboratory (Long et al., 1997).

The check assays were reviewed in the same way as described for the duplicates in Section 11.6.4. Table 11-10 summarizes the results of the 2017–2019 check assay program. The results of the 2020 check assay program were not returned by the effective date of this Technical Report, thus were not included in Table 11-10.

Table 11-10: Summary of Check Assay Results (2017–2019)

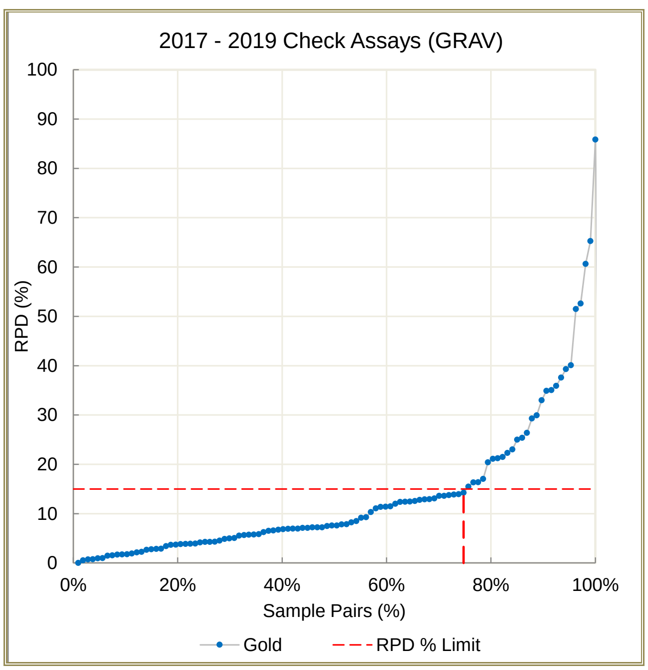
Year	Method	AAS	GRAV
2017–2019	Sample Pairs (Pairs >15xLDL)	200 (198)	107 (107)
	Sample Pairs <15% RPD	50%	75%
	Bias (%)	4.45	0.85

Source: AMC, 2020.

Note: Positive bias values indicate a bias towards the SGS sample value; SGS was the primary laboratory.

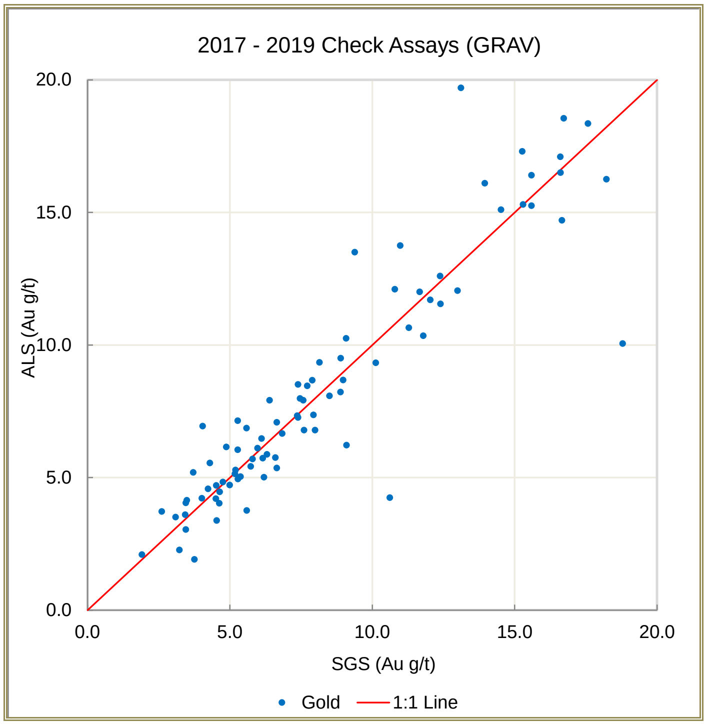
The results show a better performance for the GRAV method compared to the AAS method. There is a positive bias towards the SGS samples for the AAS analysis. There is no evidence of a negative bias for the SGS samples as was evidenced in the CRM re-run sample program of 2019. As mentioned previously, the different performance of the analytical methods should be monitored.

Figure 11-6 and Figure 11-7 show the RPD and scatter plots, respectively, for the 2017–2019 GRAV analytical method check assays.



Source: AMC, 2020.

Figure 11-6: RPD Plot Check Assays GRAV (2017–2019)



Source: AMC, 2020.

Figure 11-7: Scatter Plot Check Assays GRAV (2017–2019)

11.7 Conclusions

The change in laboratory in 2020 has brought about an improvement in performance.

In the QP's opinion, the sampling, sample preparation, security, and analytical procedures adopted by Sabina for its exploration programs are rigorous and meet or exceed accepted industry standards. In addition, the QA/QC results confirm that the assay results may be relied upon for Mineral Resource estimation purposes.

12 DATA VERIFICATION

On 21 and 22 October 2020, the QP Ms. Dinara Nussipakynova, P.Geo. of AMC, visited the Property to undertake the following data verification steps:

- Goose Site tour
- Review of site camp, infrastructure, and core facilities
- An inspection of the core shed and drill core intersections from the Goose and George sites.

The QP reviewed the orientation of stratigraphy and foliation at the Goose deposits and undertook a more detailed review of the upper sediments in the central area of the Goose Site and the lower sediments in the quarry near Echo. The drilling process was completed before the site visit; therefore, no drilling procedures were reviewed live. In addition to examining outcrops, the inspection also consisted of reviewing drill core of selected representative intervals for the Goose Main, LCPs, Umwelt, Nuvuyak, and Llama Extension deposits. The observation of the core handling, core logging, sampling, and core storage facilities confirmed a well-established procedure. Table 12-1 lists the inspected drill holes.

Table 12-1: Inspected Back River Project Drill Holes

Drill Hole	Interval (m)	Deposit
04GSE011	24–56	Goose Main
07GRL031	171–280	LCPs
17GSE516B	660–704	Llama Extension
19GSE566	718–750	Nuvuyak
19GSE569	520–539	Umwelt
20GSE571	227–254	Umwelt

Source: AMC, 2020.

For this Updated Feasibility Study, the QP reviewed the processes used in the data collection and handling in 2017–2020 and undertook random cross-checks of assay results in the database with original assay results on the assay certificates returned from the SGS and ALS. This verification consisted of comparing 1,495 of the 21,832 (6.7%) assays for the 2017–2020 drilling at Goose. No errors were detected. In addition, verification was carried out using the normal routines in Datamine™ Studio RM (Version 1.6) (Datamine) where the database was checked for collar, survey, and assay inconsistencies, overlaps, and gaps.

The QP makes the following observations based on the data verification and site visit:

- Site geologists are appropriately trained and conscious of the specific sampling requirements of heterogeneous gold deposits.
- Procedures for data collection and storage are well-established and adhered to.
- QA/QC procedures are adequate and give confidence in the assay results.
- Cross-checking a sample set of the database with the original assay results uncovered no errors.

The QP considers the database fit for purpose, and in the QP's opinion, the geological data provided by Sabina for the purposes of Mineral Resource estimation were collected in line with industry best practice as defined in the *CIM Exploration Best Practice Guidelines* (CIM, 2018) and the *CIM Estimation of Mineral Resources & Mineral Reserves Best Practice Guidelines* (CIM, 2019). As such, the data are suitable for use in the estimation of Mineral Resources.

13 MINERAL PROCESSING AND METALLURGICAL TESTING

13.1 Introduction

The metallurgical testwork forming the basis of this section was supervised by Canenco's Stacy Freudigmann, P.Eng., working in conjunction with the team from Sabina. The results of the testwork, together with financial evaluation data, were used to develop metallurgical design criteria. The programs completed before 2017 were previously written and reported in the September 2015 NI 43-101 *Technical Report for the Initial Project Feasibility Study on the Back River Gold Property, Nunavut, Canada* (JDS, 2015b). This section summarizes the more recent test programs.

13.2 Testing History

In earlier stages of Project development, testing was undertaken on composites from each of the deposits designated in the mine plan. More recent testwork was carried out to determine the variability of individual samples, selected lithologically and spatially to represent the resource. Earlier testing was designed to optimize the flowsheet, and the resulting flowsheet was then used to determine the metallurgical performance of several variability composites (VC).

Most of the metallurgical testwork evaluated both silver and gold recovery. Silver has not been included in the mine plan as there was insufficient assaying of the borehole samples. No credit for silver has therefore been claimed in the Project revenue. The focus in this section is therefore on gold and the optimization of gold recovery.

A substantial amount of testing was undertaken on the Back River Project, as summarized in Table 13-1. Metallurgical samples were selected from different depths and drill holes to ensure that there was coverage of all the deposits, and that recoveries were representative of the mineralization types in those deposits. Additional testing was carried out on samples that represent plant feed being treated early in the mine plan.

Extensive mineralogical work has been undertaken on the Back River Property deposits and has been previously reported. Since 2010, Giovanni Di Prisco of Terra Mineralogical Services had been contracted to review and provide detailed characterizations and predictive metallurgical assessments of the gold mineralization present in the Goose and George sites. In all, there are 13 reports summarizing the Llama, Echo, Umwelt, and Goose Main deposits at the Goose Site, as well as the Loc1, Loc2, and LCP deposits at the George Site.

Table 13-1: Summary of Testwork Completed

Year	Laboratory	Report No.	Deposit/Site/Sample	Mineralogy	Comminution	Gravity	Flotation	Cyanidation	Cyanide Destruction	Solid–Liquid Separation	Other
2020	BML	BL695	Umwelt			X		X			Variability
2020	BML	BL563	MPC-1, -2, -3, and VCs					X	X		
2019	FLS	P-18104	Goose Main, Llama, Umwelt		X						VXP Fine Grinding
2018	BML	BL303	MPC-1, -2, -3	X	X	X		X	X		
2018	Pocock Industrial		MPC-1, -2, -3							X	Tailings Thickening
2018	Metso	20287984	MPC-1, -2		X						Jar Mill Grindability
2018	FLS		MPC-1, -2, -3			X					Gravity Modelling
2017	SGS	16198-001	Comp. 2 Ro. Con		X						IsaMill Regrinding
2017	BML	BL190			X		X				Tailings Generation for Fine Grinding by SGS
2017	BML	BL178	George, Goose Main, Llama, Umwelt			X	X	X			17 VC Composites
2017	BML	BL186	Goose						X		CN Detox Program on BL014 samples
2016	BML	BL014	Goose Main, Llama, Umwelt	X		X	X	X			Tailings Generation for Program BL186
2015	B.C. Mining Research		Goose								Sorting
2014	Tomra		Goose								Sorting
2014	Gekko	T1152 (BL014)	Goose						X		Supervised by Kemetco
2014	FLS		Goose			X					
2014	SGS		Goose Main, Llama			X		X			
2014	ALS	KM4361	George, Goose		X	X		X			
2014	ALS	KM4030	George, Goose	X	X	X	X	X			Heap Leach, Settling, Viscosity
2013	ALS	KM3589	George, Goose	X	X	X	X	X			Settling, Viscosity
2011	Terra		Echo, Llama, Umwelt	X							
2010	SGS	12521-001	Goose		X			X			
2009	Gekko	T0439	George, Goose		X	X	X	X	X		Settling
2007	SGS	11320-004	George, Goose	X		X	X				
2006	Geoscience		Goose	X							
1998	PRA	97-080	George, Goose		X	X		X			
1992	Hazen		George		X	X		X			

Source: Canenco, 2020.

Notes: ALS = ALS Metallurgy; Gekko = Gekko Systems Ltd.; Geoscience = Geoscience Laboratories; Hazen = Hazen Research Inc.; PRA = Process Research Associates Ltd.; SGS = SGS Mineral Services; Terra = Terra Mineralogical Services, BML = Base Metallurgical Laboratories Ltd.; FLS = FLSmidth A/S.

13.3 Recent Testwork

13.3.1 Sorting

Two studies were conducted to assess the sortability of the Back River deposits. TOMRA Systems ASA (TOMRA) investigated rock specimens for their amenability to detection by four different types of sorting technologies. Bern Klein from B.C. Mining Research Ltd. at the University of British Columbia reviewed that testwork along with mineralogical/geological reports and examined selected drill core samples.

Mineralogical information for the Back River deposits indicated that while there are variations, there are also significant and important similarities related to gold and silver mineralization that are relevant to sorting. It is therefore expected that an effective sorting system for one deposit would be applicable to others. Examination of drill core showed distinct contacts between mineralization and waste, as well as significant extents of mineralization versus gangue lithologies, implying that the deposits will be amenable to sorting.

The TOMRA test program assessed heterogeneity based on gold and sulphur grades of selected rocks, then evaluated sorting using a range of sensor technologies, including: visible spectrum (colour), dual energy X-ray transmission (DEXRT), near-infrared spectroscopy (NIS), EM, and optical sorting with ultra-violet (UV) illumination. DEXRT was found to be the most promising, as it demonstrated good sorting results for sulphide minerals. However, the correlation between gold and sulphur was inconsistent, so DEXRT was not able to achieve the same results for gold. Upon review, it was determined that the initial scoping high-level study conducted by TOMRA was not comprehensive enough with respect to characterizing heterogeneity of mineralization and waste, as well as assessing sensor systems. A follow-up program undertaken by BC Mining Research Ltd. was developed to assess the following sorting options:

- Analysis of sensor response signatures (rather than relying on single threshold levels)
- Combining sensor responses to improve discrimination
- Analysis of proxies for target metals
- Assessing heterogeneity of gangue phases for rock rejection
- Applying regression analysis to sensor signals
- Assessing rock size heterogeneity.

In this program, the pulverized assay pulp samples (120 samples) from each rock that was used in a study to assess sortability in the initial study were subjected to XRF and EM sensor analysis. The assayed gold grades for each sample were fitted to the XRF and EM responses using multivariable linear regression.

For each model, threshold gold grades were set with the objective of achieving greater than 95% gold recovery. Results for each of the eight models, along with predicted sorting product grades, recoveries, and weight percentage rock rejection are shown in Table 13-2. The calculated weighted grade of a composite containing all 120 samples was 0.336 g/t Au.

Table 13-2: Results from Mineral Sorting Testwork by Regression Model

Model	Threshold (Au g/t)	Sorting Concentrate			Rejection Weight %
		Weight %	Au g/t	Au Rec %	
1	0.03	64.9	0.49	95.2	35.1
2	0.01	73.1	0.40	91.8	26.9
3	0.075	75.3	0.43	95.6	24.7
4	0.14	79.5	0.41	97.4	20.5
5	0.20	77.2	0.42	95.8	22.8
6	0.60	78.8	0.41	96.9	21.2
7	0.10	85.5	0.37	94.4	14.5
8	0.05	80.2	0.49	95.3	19.8

Source: Canenco, 2020.

At a target recovery of greater than 95%, up to 35% of the rock can be rejected. It should be noted that the low grade of the composite sample has a negative consequence on the calculated recoveries. If the head grade is increased, the recoveries should increase. The regression models indicate which XRF elements at EM frequency responses are most significant.

Overall, the regression analysis approach to developing a discrimination algorithm shows encouraging results with respect to the sortability of the Back River mineralization. Additional testwork is recommended to verify and develop a sorting system for these deposits.

13.3.2 Base Metallurgical Laboratories Cyanide Detoxification Program BL186 (2017)

Program BL186 included an assessment of different detoxification steps from a flotation concentrate. Approximately 4 kg of rougher concentrate from test program BL014's optimization composite was leached, then the slurry split and detoxified using Caro's acid and the Inco SO_2/Air process. The program was used to investigate the two methods and provide solution for further analysis.

The Inco SO_2/Air process investigated the SO_2 to weak acid dissoluble cyanide (CN_{WAD}) (g/g) ratios of 5 and 7, using 50 ppm Cu_2SO_4 as a catalyst. The feed slurry measured a CN_{WAD} of 627 ppm, and the detoxified product was 200 ppm after three cycles. The Caro's acid method using mol H_2O_2:mol CN_{WAD} ratios of 2 and 4 resulted in final CN_{WAD} measurements of 57 ppm and 3.5 ppm, using a higher Cu_2SO_4 dose of 130 ppm. A second set of tests was completed using the two methods to achieve lower final cyanide concentrations using higher Cu_2SO_4 dosages for the first three tests, D1 to D3, for extended detoxification times. The resulting cyanide concentration was below 10 ppm for all four tests. A summary of the extended results is shown in Table 13-3.

Table 13-3: Summary of Extended Detoxification Test Results

Detox Test	Sample	Test Method	Feed/Detox Solution Assays (ppm)					Retention Time (min)	Final Test Conditions		
			CN_{FREE}	CN_{WAD}	Cu	Fe	Zn		Cu_2SO_4 (ppm)	SO_2:CN	H_2O_2:CN
Feed	BL014 Test 16	-	584.0	627.0	33.0	76.3	3.0	-	-	-	-
D1	Rougher Conc. Leach Slurry	Inco	-	1.5	0.2	24.0	<0.01	1,046	100	10	-
D2		Inco	-	1.4	0.2	<0.10	<0.01	1,045	200	7	-
D3		Caro's	-	1.3	-	-	-	1,080	260	-	2
D4		Caro's	-	3.5	0.6	7.4	<0.01	120	130	-	4

Source: BML testwork, 2017.

13.3.3 Base Metallurgical Laboratories Test Program BL303 (2018)

BL303 testwork completed in 2018 consisted of creating three mine production composites (MPC) mimicking Years 1–2, Years 3–5, and Years 6–9 of the mine plan, named MPC-1, MPC-2, and MPC-3, respectively. Approximately 75 kg of MPC-1 was made from 17 VCs; two from the Llama open pit area and 15 from the Umwelt open pit area. Approximately 150 kg of MPC-2 was made from 35 VCs: 14 from the Goose Main open pit area, 14 from the Llama open pit area, and seven from the Umwelt underground. Approximately 25 kg of MPC-3 was made from 12 VCs: seven from the Goose Main open pit area, and five from Umwelt underground.

Significant work was undertaken on these composites to confirm earlier testwork parameters, including mineralogy, comminution work, gravity testwork, and some flowsheet development refinement. Diagnostic leaching, oxygen uptake rate determinations, and cyanide detoxification work were also performed. In this program, all the samples did detox; however, MPC-1 appeared to struggle with the parameters selected, and these parameters were further refined in test program BL563.

The head assays for each of the MPCs are listed in Table 13-4.

Table 13-4: Summary Assay

Sample	Assay					
	Ag (g/t)	Au (g/t)	As (%)	Fe (g/t)	S (%)	TOC (%)
MPC-1	3.2	6.36	0.44	10.6	3.19	0.41
MPC-2	1.5	7.07	0.46	9.6	2.60	0.39
MPC-3	1.7	4.96	0.29	10.0	2.34	0.50

Source: BML testwork, 2018.

Mineralogy

Mineralogy undertaken on MPC-1 and MPC-2 samples included unsized bulk mineral analysis (BMA) and trace mineral search (TMS) using quantitative evaluation of minerals by scanning electron microscopy (QEMSCAN). The BMA confirms that pyrite is the main sulphur-bearing mineral, followed by pyrrhotite, with smaller amounts of arsenopyrite. The mineral content and sulphide distribution results are listed in Table 13-5 and Table 13-6.

Table 13-5: Mineral Content

Minerals	Mineral Content (%)	
	MPC-1	MPC-2
Chalcopyrite	0.01	0.01
Galena	<0.01	<0.01
Sphalerite	0.01	0.01
Cobaltite	<0.01	<0.01
Pyrite	3.27	3.21
Pyrrhotite	2.94	2.29
Arsenopyrite	1.00	0.79
Iron Oxides	4.21	2.27
Quartz	37.5	41.5
Grunerite	21.6	14.4
Ferro-Actinolite	14.9	13.3
Others	14.6	22.2

Source: BML testwork, 2018.

Table 13-6: Sulphide Distribution

Minerals	Percent S-Bearing Minerals	
	MPC-1	MPC-2
Chalcopyrite	0.09	0.11
Galena	<0.1	<0.1
Sphalerite	0.13	0.08
Cobaltite	<0.1	<0.1
Pyrite	56.1	62.2
Pyrrhotite	37.4	31.9
Arsenopyrite	6.22	5.63
Others	<0.1	<0.1

Source: BML testwork, 2018.

The TMS indicated similar gold occurrences in both composites. Of the 34 to 38 gold particles observed, gold occurrence was approximately equal parts of native gold and electrum, as seen in previous studies. The gold distribution was analyzed with respect to liberated, adhesion, and inclusion. The liberated and adhesion gold particles can be leached, whereas the gold present as tiny inclusions within larger multiphase particles is harder to leach. The inclusion particles require further grinding to expose the gold for leaching. The TMS results are summarized in Table 13-7 and Table 13-8.

Table 13-7: Gold Occurrence Deportment by Mineral Species and Class for MPC-1

Gold Mineral	Mineral Distribution (%)	Au Circular Diameter (µm)	Distribution by Class (%)		
			Liberated	Adhesion	Inclusion
Electrum	53	2	7	14	32
Native Gold	47	3	5	11	32
All	100	2.5	11	25	64

Source: BML testwork, 2018.

Table 13-8: Gold Occurrence Deportment by Mineral Species and Class for MPC-2

Gold Mineral	Mineral Distribution (%)	Au Circular Diameter (µm)	Distribution by Class (%)		
			Liberated	Adhesion	Inclusion
Electrum	44	2.6	3	3	37
Native Gold	56	5.6	6	20	31
All	100	2.5	9	23	69

Source: BML testwork, 2018.

Comminution Testwork

Bond ball mill work index (BWi) and Levin tests were completed on MPC-1 and MPC-2. The results indicate that the two composites are moderately hard, with BWi of 16.0 kWh/t for MPC-1 and 17.0 kWh/t for MPC-2 at a closing screen size of approximately 150 µm. The Levin test was completed on both composites, with an additional test on a higher mass sample of MPC-2. The results give an indication of the grinding energy required for different size-distributions. The results are summarized in Table 13-9 and Table 13-10.

Table 13-9: BWi Summary

Sample	Feed Size (F_{80} µm)	Product Size (P_{80} µm)	Cycle Grams (Gpr)	BWi (kWh/t)
MPC-1	2,475	107	1.28	16.5
MPC-2	2,505	108	1.25	17.0

Source: BML testwork, 2018.
Note: Gpr = grams per revolution; P_{80} = 80% passing.

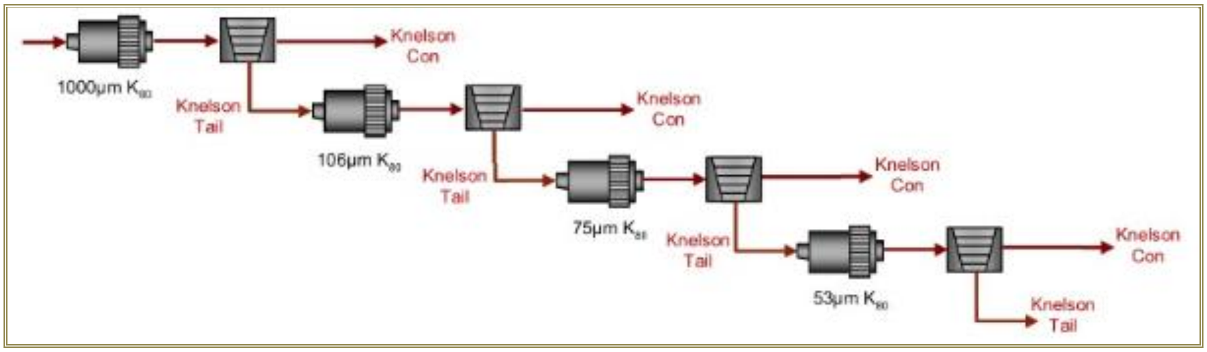
Table 13-10: Levin Test Results

Sample	Feed Size (F_{80} µm)	Product Size			
		5 kWh/t	10 kWh/t	15 kWh/t	30 kWh/t
MPC-1	113	90	70	62	43
MPC-2	111	87	69	59	41
MPC-2 High Mass	111	84	66	56	40

Source: BML testwork, 2018.

Gravity Recoverable Gold Testwork and FLSmidth Gravity Modelling

Gravity recoverable gold (GRG) testwork was completed by BML on the three composites MPC-1, MPC-2, and MPC-3, and the results modelled by FLSmidth (FLS). GRG represents the amount of gold that is potentially available to be recovered in the gravity circuit. The highest percentage and grade of gravity gold recovered to the concentrates for all samples was at a grind size of 80% passing (P_{80}) of approximately 106 µm. The testwork flowsheet and results from the testwork completed by BML for each composite are shown in Figure 13-1, and summarized in Table 13-11 to Table 13-13.



Source: BML testwork, 2018.

Figure 13-1: GRG Test Program Flowsheet

Table 13-11: Overall Gravity Recovery Results for MPC-1

Sample	Product	Weight (%)	Weight (g)	Au Assay (g/t)	Distribution (%)
MPC-1	Knelson Conc. 1	1.0	95.4	66.6	10.4
	Knelson Conc. 2	1.0	93.6	247.0	37.8
	Knelson Conc. 3	1.0	97.8	105.0	16.8
	Knelson Conc. 4	0.9	90.0	52.3	7.9
	Knelson Tailings 4	96.1	9,250	1.8	27.4
	GRG Value	-	-	-	72.6
Recalculated Feed		-	9,627	6.4	-

Source: FLS testwork, 2018.

Table 13-12: Overall Gravity Recovery Results for MPC-2

Sample	Product	Weight		Au Assay	Distribution
		(%)	(g)	(g/t)	(%)
MPC-2	Knelson Conc. 1	0.6	98.4	107.0	9.4
	Knelson Conc. 2	0.6	99.0	531.0	47.0
	Knelson Conc. 3	0.6	100.6	136.0	12.3
	Knelson Conc. 4	0.6	99.5	83.3	7.4
	Knelson Tailings 4	97.4	15,171	1.77	24.0
	GRG Value	-	-	-	76.0
Recalculated Feed		-	15,569	7.2	-

Source: FLS testwork, 2018.

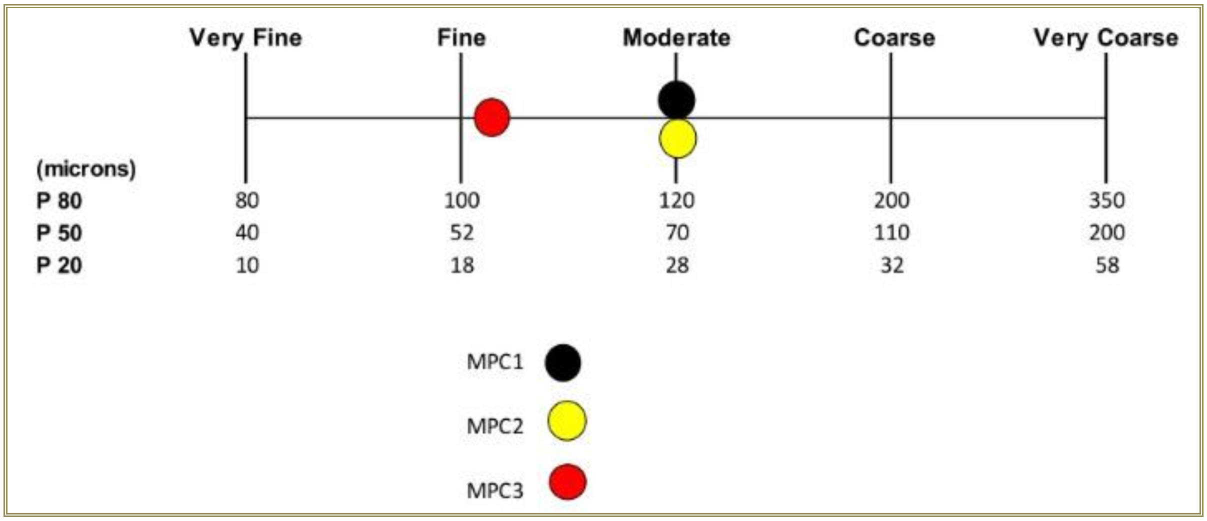
Table 13-13: Overall Gravity Recovery Results for MPC-3

Sample	Product	Weight		Au Assay	Distribution
		(%)	(g)	(g/t)	(%)
MPC-3	Knelson Conc. 1	1.2	90.8	46.9	10.2
	Knelson Conc. 2	1.3	93.9	203.0	45.8
	Knelson Conc. 3	1.2	89.2	65.0	13.9
	Knelson Conc. 4	1.1	80.6	34.7	6.7
	Knelson Tailings 4	95.2	7,019	1.38	23.3
	GRG Value	-	-	-	76.7
Recalculated Feed		-	7,373	5.65	-

Source: FLS testwork, 2018.

The GRG for all three samples was in the high 70% range. The results are depicted using the AMIRA size classification scale for GRG as illustrated in Figure 13-2. The two samples representing the initial years of mining would be classified as moderate and are favourable for gravity recovery.

To model the results and provide circuit options, the GRG was adjusted as a function of particle size to correct for actual plant grind. From the data, three circuit options were provided, which included installing gravity in: the primary grinding circuit only; the secondary grinding circuit only; and both grinding circuits. The sizing options were based on a primary grinding circuit with a typical 300% circulating load and target grind size P_{80} of approximately 106 µm, with the secondary grinding circuit using a circulating load of 150% and final grind size P_{80} of approximately 50 µm. The recommended sizing for each option is listed in Table 13-14.



Source: FLS testwork, 2018.

Figure 13-2: AMIRA Size Classification Scale for GRG

Table 13-14: FLS Gravity Modelling Results

	Primary Gravity				Primary Gravity				Combined Primary/Secondary Results		
Ore Type	Model	Feed Rate (t/h ea.)	Cycle Time (min)	Gravity Rec. (% Au)	Model	Feed Rate (t/h ea.)	Cycle Time (min)	Gravity Rec. (% Au)	Gravity Rec. (% Au)	Gravity Conc. (kg/d)	Gravity Conc. (g/t)
MPC-1	2 x KC-QS30	80	40	32	None	-	-	-	32	2,736	2,486
MPC-2	2 x KC-QS30	80	40	36	None	-	-	-	36	2,736	3,469
MPC-3	2 x KC-QS30	80	40	30	None	-	-	-	30	2,736	2,086
MPC-1	None	-	-	-	1 x KC-QS30	80	30	37	37	1,824	4,318
MPC-2	None	-	-	-	1 x KC-QS30	80	30	40	40	1,824	5,316
MPC-3	None	-	-	-	1 x KC-QS30	80	30	36	36	1,824	3,770
MPC-1	2 x KC-QS30	80	40	32	1 x KC-QS30	80	30	15	47	4,560	2,230
MPC-2	2 x KC-QS30	80	40	36	1 x KC-QS30	80	30	17	53	4,560	2,814
MPC-3	2 x KC-QS30	80	40	29	1 x KC-QS30	80	30	15	44	4,560	1,905

Source: FLS testwork, 2018.

Flowsheet Development

The flowsheet developed in previous test programs was used to test the response of the year composites. The composites were initially ground to a P_{80} of approximately 1,000, 106, and 50 µm with gravity at each stage. The gravity concentrate from each stage was combined and subjected to intensive leach, with the gravity tailings progressing to the leach stage. Both carbon-in-leach (CIL) and carbon-in-pulp (CIP) circuits were tested. The test parameters used the previously developed flowsheet with 16 h pre-oxidation (pre-ox), 48 h leach, 20 g/t lead nitrate, and 500 ppm NaCN. The overall gold extraction was on average in the range of 92% to 93% for the three composites. The leach results are summarized in Table 13-15.

Table 13-15: Leach Test Summary

Sample	Test	Conditions	Gravity-Conc.-Leach Distribution		Au Extraction Gravity Tailings (%)	Cumulative Au Extraction (%)		CN Tailings Grade (g/t)	Consumption (kg/t)	
			Pan Conc. (%)	Combined Tailings (%)	48 h	0 h	48 h	Au	NaCN	Lime
MPC-1	4-7	CIL-7	31.7	68.3	87.8	31.7	91.6	0.51	1.1	4.0
	4-10	CIP-10	31.7	68.3	88.9	31.7	92.4	0.46	0.7	4.2
	4-13	CIL-13	31.7	68.3	90.4	31.7	93.4	0.37	1.5	3.6
	4-16	CIP-16	31.7	68.3	87.8	31.7	91.7	0.48	0.7	3.4
MPC-2	5-8	CIL-8	45.1	54.9	87.6	45.1	93.2	0.39	0.8	2.7
	5-11	CIP-11	45.1	54.9	85.0	45.1	91.8	0.53	0.5	2.9
	5-14	CIL-14	45.1	54.9	89.3	45.1	94.1	0.36	1.3	2.5
	5-17	CIP-17	45.1	54.9	85.5	45.1	92.1	0.49	0.7	2.3
	5-25	CIP-Goose Water	45.1	54.9	92.5	45.1	95.7	0.27	0.3	4.3
	5-26	CIP-West Bay Saline	45.1	54.9	92.2	45.1	95.7	0.28	0.3	4.8
MPC-3	6-9	CIL-9	28.2	71.8	81.0	28.2	86.4	0.69	0.9	3.1
	6-12	CIP-12	28.2	71.8	93.5	28.2	95.3	0.25	1.0	3.1
	6-15	CIL-15	28.2	71.8	92.3	28.2	94.5	0.26	0.9	1.9
	6-18	CIP-18	28.2	71.8	90.9	28.2	93.5	0.32	0.5	1.8

Source: BML testwork, 2018.

Diagnostic Leach Tests

Multistage diagnostic leach tests were conducted on the leach residue from composites MPC-1, MPC-2, and MPC-3 to investigate gold deportment. The test program included five stages: high-intensity cyanide leach; hydrochloric acid digestion; nitric acid digestion followed by cyanidation; aqua regia digestion; and FA. The data from each stage provided information on the association of gold with carbonate, arsenic, silicate/or gangue, and determined the gold amenability to cyanidation and acid solubility. The results confirm previous mineralogical work and indicate the gold appears to be free, associated with pyrite and arsenopyrite. Table 13-16 summarizes the findings of the testwork.

Table 13-16: Multistage Sequential Diagnostic Summary

Stage	MPC-1		MPC-2		MPC-3	
	CIL-07	CIP-10	CIL-08	CIP-11	CIL-09	CIP-12
	Au per Stage (g/t)					
Cyanidable Gold	0.09	0.29	0.08	0.29	0.27	0.18
Carbonate Locked Gold	0.06	0.07	0.02	0.05	0.04	0.03
Arsenical Mineral (AsPy)	0.24	0.25	0.17	0.17	0.33	0.15
Pyritic Sulphide Mineral	0.05	0.03	0.12	0.03	0.19	0.04
Silicate (Gangue) Encapsulated	0.06	0.01	0.05	0.01	0.17	0.04
Total (recalc. Au Grade)	0.49	0.66	0.43	0.55	1.00	0.44
Measured Au Grade	0.51	0.46	0.39	0.53	0.69	0.25
	Au Distribution (%)					
Cyanidable Gold	18.3	44	17.5	52.2	26.9	40.8
Carbonate Locked Gold	11.8	11.3	4.2	9.1	3.8	6.9
Arsenical Mineral (AsPy)	47.9	38.4	39.2	31	33.2	34.6
Pyritic Sulphide Mineral	9.8	4.8	27.3	5.9	19.3	8.7
Silicate (Gangue) Encapsulated	12.2	1.5	11.7	1.8	16.9	9.1
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: BML testwork, 2018.

Oxygen Uptake Rate Testwork

Composites MPC-1 and MPC-2 samples were processed using the optimized flowsheet parameters, with dissolved oxygen (DO) measurements taken every minute for 15 min at Hours 0, 1, 2, 3, 4 ,5, 6, and 24. The results indicate the DO rates slowed and dropped off after 5 h for MPC-1 and 6 h for MPC-2. The measurements at each interval are given in Table 13-17.

Table 13-17: Oxygen Uptake Rate

Sample	Oxygen Consumption—mg/L/min at time-hours							
	Hour 0	Hour 1	Hour 2	Hour 3	Hour 4	Hour 5	Hour 6	Hour 24
MPC-1	0	0.31	0.33	0.24	0.2	0.21	0.03	0.09
MPC-2	0	0.36	0.35	0.3	0.25	0.28	0.38	0.18

Source: BML testwork, 2018.

Cyanide Detoxification Testwork

Cyanide detoxification testwork was conducted on the leach tailings for composites MPC-1, MPC-2, and MPC-3. The samples were leached based on the previously developed flowsheet parameters, then treated with Inco SO_2/Air process using Cu_2SO_4 as a catalyst to reduce the CN_{WAD} to below a 10 ppm target. The results indicate that lower SO_2:CN_{WAD} ratios and Cu_2SO_4 additions struggled to achieve the target 10 ppm CN_{WAD} for MPC-1. Final parameters indicated that a SO_2:CN_{WAD} ratio of 5.5:1 with 40 ppm Cu_2SO_4 as a catalyst for 60 min achieved the target final CN_{WAD} for MPC-1, with potentially lower requirements for MPC-2. The results are summarized in Table 13-18.

Table 13-18: Detoxification Test Results

Comp.	Detox Test	Test Parameters				Test Length		Feed/Detox Solution Assays (ppm)				
		pH	Ret'n Time (min)	SO_2 g/g CN_{MP}	Cu (mg/L)	Min.	No. of Displacements	CN_{MP}	Cu	Fe	Ni	Zn
MPC-2	Feed	-	-	-	-	-	-	195	19.7	9.0	1.01	1.69
	C1	8.5	46	3.5	15	270	3	1.40	0.40	3.9	<0.01	<0.01
	C2	8.5	45	4.5	15	270	3	1.20	0.10	2.4	<0.01	<0.01
	C3	8.4	45	5.5	15	270	3	1.09	0.13	2.8	<0.01	<0.01
MPC-1	Feed	10.5	-	-	-	-	-	176	10.7	1.8	0.30	0.72
	C4	9.3	61	3.5	15	120	2	78.8	25.5	0.8	0.16	<0.01
	C5	8.9	60	3.5	25	120	2	22.2	12.5	<0.01	<0.01	<0.01
	C6	9.0	59	5.5	40	300	5	5.40	0.71	<0.01	<0.01	<0.01
MPC-3	Feed	10.5	-	-	-	-	-	67.0	13.3	3.5	0.20	1.91
	B1	9.2	-	5.5	40	120	-	3.07	0.10	<0.01	<0.01	<0.01

Source: BML testwork, 2018.

13.3.4 Fine Grinding

Three test programs to investigate fine grinding were completed between 2017 and 2019. SGS completed IsaMill testing on a rougher concentrate sample created by BML (BL190) to determine the specific energy requirement. To reduce the sample from an F_{80} of approximately 53 µm to a P_{80} of approximately 22 µm and 11 µm resulted in specific energy requirements of 19.0 kWh/t and 67.7 kWh/t, respectively. In 2018, samples representing MPC-1 and MPC-2 were sent to Metso for particle-size analysis and Jar Mill grindability tests targeting a P_{80} of approximately 50 µm. The results indicated that, to reduce the mill feed to the target grind size of P_{80} of approximately 50 µm from feed size F_{80} of approximately 106 µm, the Vertimill specific energy requirement was 5.91 kWh/t for MPC-1 and 6.37 kWh/t for MPC-2. Similar testwork was completed by FLSmidth to determine the VXP mill specific energy requirement on Goose Main, Llama, and Umwelt samples. The FLSmidth VXP results are shown in Table 13-19.

Table 13-19: FLSmidth VXP Specific Energy Requirement

Sample	Feed Size (F_{80} µm)	Product Size (P_{80} µm)	Specific Energy (kWh/t)
GM-OP_VS LOW	102.849	50	3.7
GM-OP_VS UPP	118.913	50	2.1
LL-OP_VS LOW	109.765	50	5.4
LL-OP_VS UPP	81.893	50	3.1
UM-OP_VS	115.723	50	4.5
UM-OP_VS 15/17	107.093	50	4.4
UM-UG_VS LOW	115.187	50	5.0
UM-UG_VS UPP	119.088	50	5.0

Source: FLS testwork, 2019.
Notes: GM = Goose Main; LL = Llama; UM = Umwelt.

In addition to the fine grinding, BWi tests were completed at a target grind size of P_{80} of approximately 106 µm on the eight samples. The FLS results indicate the Back River deposits range from medium to very hard, with an average of 17.93 kWh/t and a 75th percentile of 18.17 for all samples tested. The BWi for each sample is listed in Table 13-20.

Table 13-20: BWi

Sample	Feed % Closing Size	(F_{80} µm)	(P_{80} µm)	(kWh/t)	Classification
GM-OP_VS LOW	11.58	2,071.1	110.8	18.68	Hard
GM-OP_VS UPP	12.79	2,102.6	111.2	21.74	Hard–Very Hard
LL-OP_VS LOW	12.99	2,076.7	112.6	17.61	Hard
LL-OP_VS UPP	12.88	2,054.9	113.7	18.00	Hard
UM-OP_VS	15.40	2,027.1	116.2	17.72	Hard
UM-OP_VS 15/17	13.06	2,065.8	112.1	17.79	Hard
UM-UG_VS LOW	16.28	2,048.2	117.1	15.43	Medium–Hard
UM-UG_VS UPP	17.78	1,961.9	113.6	16.47	Hard

Source: FLS testwork, 2019.
Notes: GM = Goose Main; LL = Llama; UM = Umwelt.

13.3.5 Solid Liquid Separation Testwork—Pocock (2018)

Tailings samples representing MPC-1, MPC-2, and MPC-3 were sent to Pocock Industrial (Pocock) to conduct solid–liquid separation tests to provide thickener and pumping design criteria. The testwork included flocculant screening, static and dynamic thickening tests, and viscosity tests. The flocculant screening tests indicate that flocculant SNF AN 913 SH at a slurry concentration of 15% showed the best performance. The static thickener tests are summarized in Table 13-21.

Table 13-21: Static Thickener Test Results

Material Tested	Recommended Conventional Thickener Operating Parameter Ranges						
	Flocculant			Min. Unit Area at Specific Feed Solids Conc. and U/F Density (m^2/t/d)			Maximum U/F Solids Conc. (%)
	Type	Dose (g/t)	Conc. (g/L)	15% Feed Solids	20% Feed Solids	25% Feed Solids	
MPC-1	AN 913 SH	20	0.1	0.191	0.215	0.229	67
MPC-2	AN 913 SH	20	0.1	0.202	0.228	0.252	64
MPC-3	AN 913 SH	20	0.1	0.192	0.227	0.261	67

Source: Pocock testwork, 2018.
Notes: Flocculant concentration used for testing was 0.1 g/L. Actual flocculant concentration should be 0.1 to 0.2 g/L prior to contact with the pulp.
Unit area includes a 1.25 scale-up factor. The range of unit areas provided corresponds to the range of feed solids concentration and underflow densities shown. Thickener feed solids concentration ranged by weight for 15%, 20%, and 25%.

The dynamic thickener testwork was completed to determine the design criteria for a high-rate thickener. The results from the tests on each of the composites shows that a slightly higher flocculant dosage—5 to 10 g/t—was required, compared to the static thickener tests, to achieve similar underflow densities. At a solids feed concentration of 20%, the design hydraulic loading rate for MPC-1, MPC-2, and MPC-3 were 4.19 $m^3/m^2/h$, 3.92 $m^3/m^2/h$, and 4.05 $m^3/m^2/h$, respectively. The results are summarized in Table 13-22.

Table 13-22: Dynamic Thickener Test Results

Material Tested	Recommended Conventional Thickener Operating Parameter Ranges						
	Tested Feed Solid (%)	Flocculant			Design Basis Net Feed Loading (m^3/m^2h)	Predicted O/F TSS Conc. Range (mg/L)	Predicted U/F Density
		Type	Dose (g/t)	Conc. (g/L)			
MPC-1	19.72	SNF AN 913 SH	25–30	0.1–0.2	4.19	150–250	67
MPC-2	19.78	SNF AN 913 SH	25–30	0.1–0.2	3.92	150–250	64
MPC-3	19.91	SNF AN 913 SH	25–30	0.1–0.2	4.05	150–250	67

Source: Pocock testwork, 2018.
Note: TSS = total suspended solids.

Table 13-23 shows the rheology data for each of the three composites.

Table 13-23: Rheology Data Results

Material	Solids Conc. (%)	Coefficient of Rigidity (Pa)	Yield Value (Pascals or N/m^2)	Apparent Viscosity, (Pa·sec) at the following Shear Rates:								
				5 Sec^{-1}	25 Sec^{-1}	50 Sec^{-1}	100 Sec^{-1}	200 Sec^{-1}	400 Sec^{-1}	600 Sec^{-1}	800 Sec^{-1}	1,000 Sec^{-1}
Thickened MPC-1	66.7	0.277	44.9	7.194	2.960	2.019	1.377	0.940	0.641	0.512	0.437	0.387
	66.5	0.090	25.6	3.182	1.317	0.900	0.616	0.421	0.288	0.230	0.197	0.174
	65.1	0.047	18.2	2.127	0.839	0.562	0.376	0.252	0.169	0.134	0.113	0.099
	61.6	0.022	7.8	1.080	0.388	0.250	0.161	0.103	0.066	0.051	0.043	0.037
Thickened MPC-2	66.5	0.186	55.7	6.372	2.641	1.807	1.237	0.846	0.579	0.464	0.396	0.351
	65.0	0.097	35.8	4.003	1.641	1.118	0.761	0.518	0.353	0.282	0.240	0.213
	63.5	0.044	27.1	2.637	1.024	0.682	0.454	0.302	0.201	0.158	0.134	0.117
	58.8	0.020	12.8	1.390	0.499	0.321	0.207	0.133	0.086	0.066	0.055	0.048
Thickened MPC-3	68.5	0.222	50.4	6.662	2.808	1.935	1.334	0.919	0.634	0.510	0.437	0.387
	67.4	0.155	30.0	4.281	1.848	1.287	0.897	0.624	0.435	0.352	0.303	0.270
	65.6	0.081	21.9	2.780	1.151	0.787	0.538	0.368	0.252	0.202	0.174	0.152
	62.1	0.035	10.8	1.516	0.554	0.359	0.233	0.151	0.098	0.076	0.063	0.055

Source: Pocock testwork, 2018.

13.3.6 Base Metallurgical Laboratories Detoxification Optimization Testwork (2020)

In early 2020, a gap analysis was undertaken, and it was determined that the metallurgy required additional SO_2/Air detoxification testwork to understand the detox response of the different mineralogies and to confirm the historical optimization work undertaken in previous test programs.

The approach for the detoxification test program was based on historical work, the current process design criteria (PDC), and the current CN_{WAD} target of less than 10 ppm.

Due to MPC-1 appearing historically to have the most issues with detoxification, it was selected for optimization testwork; the optimum conditions would be confirmed on the other two composites, and six separate VCs representing different mining areas from the three deposits: Goose Main, Umwelt, and Llama. All the testwork, leaching, and detoxification would use site water.

The optimization work on MPC-1 would focus on:

- Diluting the leach pulp density of 50% to 45% for detox as per the PDC. One test would be undertaken at the leach density of 50% solids to confirm the 2014 observation that the pulp density had little effect on the reaction, and to provide understanding that the target CN_{WAD} would still be achievable should dilution water be unavailable in the process plant.
- Varying the SO_2:CN_{WAD} ratio from 6.5–4.0:1.
- Maintaining the solution pH from 9.0–9.5.
- Varying the copper dosage from 40 mg/L down to 20 mg/L.
- Retention time would remain at 90 min as per the PDC.

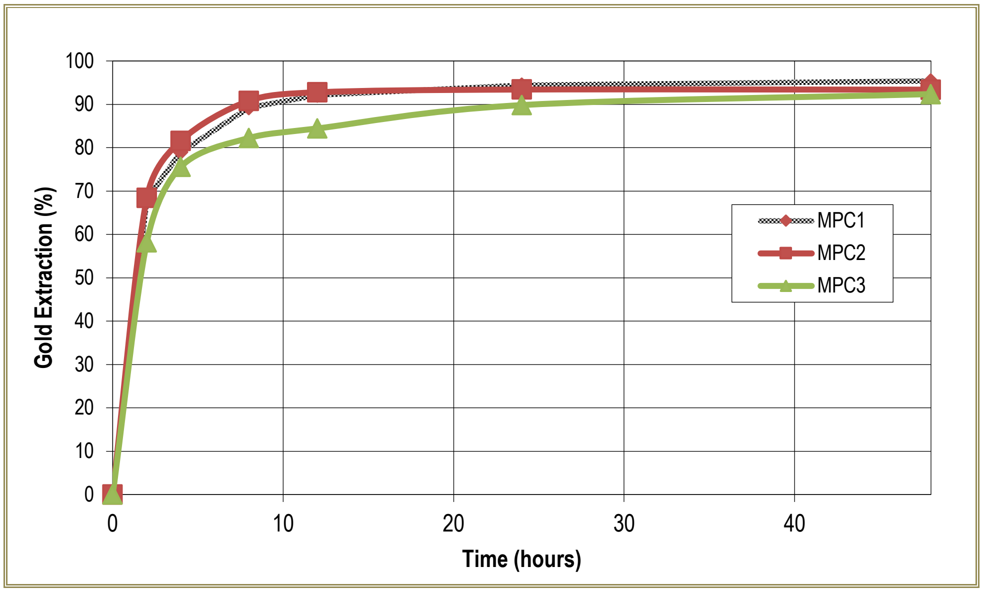
After all the above testing, a LOM composite was created and tested twice; using site water, the composite would be run through the process and detoxified. The resulting solution would be recovered and then diluted using inputs from the tailings storage (TS) and process mass balance available at that time, and then re-run to provide further understanding of both the metallurgical and environmental responses.

There was sufficient mass of MPC-1 and MPC-2 for the test program; however, a number of VCs were completely consumed in the previous test programs, and all of MPC-3 was consumed in the 2018 detox program. To create these mine plan composites, several new VCs had to be created to build a new MPC-3 and also have VCs available for discreet tests.

Detoxification Optimization

The optimization testwork was completed on a 20 kg sample of MPC-1 using the current flowsheet with the following parameters: a primary grind P_{80} of approximately 50 µm; gravity recovery; pre-ox of the gravity tailings for 16 h; leach of the pre-oxidized gravity tailings for 48 h at 50% solids; pH 11; DO above 20 ppm; 20 g/t $PbNO_3$; and a NaCN concentration of 500 ppm. The last NaCN addition was at 24 h, and the level of CN allowed to drift down to the 48-h termination.

The DO levels in these tests were all maintained above 20 ppm, and as a result, the leach kinetics are excellent, with most of the leaching concluded after 24 h. The final gold stage leach extractions for MPC-1, MPC-2, and MPC-3 were 95.4%, 93.4%, and 92.4%, respectively (Figure 13-3 and Table 13-24). Gravity recovery for these tests was 41.2%, 54.7%, and 50.1%, respectively. Overall extractions for the three MPCs were 97.3%, 97.0%, and 96.2% for gold; 63.0%, 72.8%, and 98.3% for silver. Metallurgically, these samples responded similarly to the variability program undertaken in the previous feasibility study.



Source: BML testwork, 2020.

Figure 13-3: 2020 Stage Leach Kinetics on Mine Plan Composites

Table 13-24: 2020 MPC-1 Optimization Detox Test Summary

Detox Test	SO_2:CN_{WAD} (g/g)	Cu Addition (mg/L)	Retention Time (min)	pH	% Solids	CN_{WAD} 90 min (ppm)	CN_{WAD} Test End (ppm)
Feed	-	-	-	-	-	45.8	45.8
C1	5	40	90	9.4	45	5.6	4.6
C2	5	40	90	9.4	45	4.6	3.4
C3	5	40	90	9.3	45	3.6	3.3
C4	5	40	90	9.2	45	3.0	1.8
C5	5	40	90	9.2	45	8.2	8.9
C6	5	40	90	9.1	50	9.1	7.6
C7	4.5	40	90	9.0	45	9.7	9.2
C8	4	40	90	8.9	45	12.7	6.7

Source: BML testwork, 2020.

Tests C1 to C3 were undertaken to assess decreasing the SO_2:CN_{WAD} ratio from 6.0–5.0:1 while maintaining the $CuSO_4$ at the level where the 2018 testwork finished—40 mg/L $CuSO_4$. All results achieved below the target CN_{WAD} level of 10 ppm, even within the 90 min. available.

Based on the results of Test C3, the copper dosage was reduced from 40 to 20 mg/L. It was observed that the CN_{WAD} started to increase slightly to 8.2 ppm for Test C5. Test C6 was a repeat of C5, with a higher pulp density at 50%. The test was successful, with the CN_{WAD} being under the target of 10 ppm at 90 min at 9.1 ppm and 7.6 ppm after the last test displacement, showing the reaction was stable and CN_{WAD} still descending after 90 min. This confirmed previous work showing varying pulp density has minimal effect on the reaction in a laboratory setting.

Based on the results of Test C5, C7 and C8 assessed decreasing the $SO_2:CN_{WAD}$ ratio from 5.0 to 4.0:1 while maintaining the $CuSO_4$ at 20 mg/L $CuSO_4$. It is quite clear that after 90 min, the CN_{WAD} levels increase above the target CN_{WAD} level of 10 ppm, although after the final displacement, the results show the CN_{WAD} levels were stable and descending, indicating there may be room for further optimization in operations. The conditions from Test C5 were selected for confirmation testing on the other MPCs and VCs. These were:

- $SO_2:CN_{WAD}$ ratio at 5.0:1
- $CuSO_4$ addition at 20 mg/L
- Retention time at 90 min
- pH at 9.0
- Pulp density at 45%
- Target DO of 8 ppm.

CN_{WAD} levels for MPC-2 and MPC-3 after 90 min were 2.1 and 7.5 ppm. After the final displacement on MPC-3 the CN_{WAD} level was also 2.1 ppm. Both samples were successfully detoxed using the above conditions.

Detoxification—Variability Composites

The leach results for the VCs are summarized in Table 13-25, and compare well with previous testwork.

Table 13-25: VC Gold Extraction Summary

Sample ID	Head Grade (g/t Au)	Gold Extraction (%)			Consumption (kg/t) NaCN
		Gravity	48 h	Historical 48 h	
MPC-1	6.36	41.2	97.3	92.4	0.47
MPC-2	7.07	54.7	97.0	94.1	0.44
MPC-3	4.96	50.1	96.2	95.3	0.50
GM-OP-VS-10	0.8	57.5	97.6	95.7	0.57
GM-OP-VS-25B	11.8	65.4	97.6	96.1	0.97
LL-OP-VS-2B	16.3	21.8	90.0	93.5	1.80
LL-OP-VS-8	18.8	54.5	97.6	97.7	0.68
UM-OP-VS-18B	4.4	38.9	91.9	-	0.73
UM-UG-VS-11B	10.4	47.0	96.7	92.4	0.94

Source: BML testwork, 2020; Canenco, 2020.
Notes: GM = Goose Main; LL = Llama; UM = Umwelt.

The VCs were all successfully detoxed, with the CN_{WAD} levels all below the target of 10 ppm, as illustrated in Table 13-26. There is some variability observed in the CN_{WAD} feed and tailings, which corresponds well with the changes in cyanide consumers in the mineralization.

Table 13-26: VC Detox Summary

Composite	Detox Test	SO_2:CN_{WAD} (g/g)	Cu Addition (mg/L)	Retention Time (min)	pH	% Solids	CN_{WAD} Feed (ppm)	CN_{WAD} 90 min (ppm)	CN_{WAD} Test End (ppm)
GM-OP-VS-10	C16	5	20	90	9.1	45	30.9	0.5	0.5
GM-OP-VS-25B	C13	5	20	90	9.4	45	8.2	2.8	1.9
LL-OP-VS-2B	C11	5	20	90	9.6	45	10.6	3.5	3.0
LL-OP-VS-8	C12	5	20	90	9.3	45	23.2	2.1	5.4
UM-OP-VS-18B	C15	5	20	90	9.3	45	29.2	6.8	1.3
UM-UG-VS-11B	C14	5	20	90	9.4	45	15	9.8	7.4

Source: BML testwork, 2020.
Notes: GM = Goose Main; LL = Llama; UM = Umwelt.

Life-of-Mine Double Run

The approach to this test for the LOM composite, created from equal proportions of all three MPCs based on the mine plan, was as follows:

- Recover the detoxed solution from the initial test.
- Dilute the solution similarly to what would be observed in an average case in operations from run-off and precipitation in the TS.
- Further dilute the reclaimed solution pumped to the process plant with incoming fresh make-up water to balance the process.
- Re-run the leach-detox process with the diluted process solution to assess the changes in the metallurgical response.

Dilution

Year 4 of the mine life water balance was selected after discussions with the incumbent environmental engineering company managing the site-wide water balance to create the average dilution parameters for the test (Table 13-27). It was hypothesized that Year 4 would represent steady-state operations where the process plant would still be depositing tailings, with average dewatering of pits and precipitation occurring on site.

Table 13-27: Process Water Dilution—Year 4 LOM Average

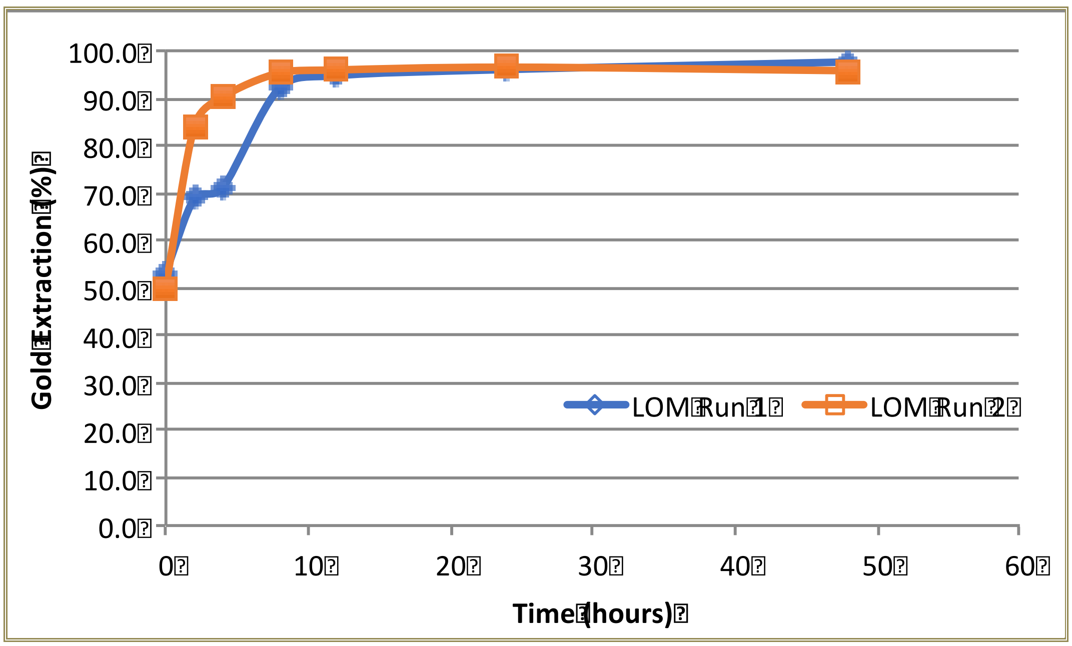
Item	Unit	Amount
Slurry Water In	(m^3/h)	128.6
Other Water In	(m^3/h)	84.9
Other Water Out	(m^3/h)	44.2
Amount of Water Diluting the Slurry Water In	(m^3/h)	40.7
Percentage Dilution in TS	%	32
Reclaim	(m^3/h)	87.3
Fresh Water to Plant	(m^3/h)	41.3
Percentage Dilution of Reclaim	%	47

Source: Knight Piésold, 2020.

The average water leaving with the detoxed slurry from the process plant was approximately 128 m³/h. The "other" water entering the TS on average includes runoff, pit dewatering, and precipitation, and totals approximately 85 m³/h. During the year, the tailings facility (TF) will be subjected to an average evaporation rate of 44 m³/h. This leaves approximately 40 m³/h of water entering on average over Year 4, which will dilute an equivalent of 32% of the detoxed process-water stream. Based on the SRK site water-balance at the time, which was based on a different mine plan (SRK, 2020), this diluted water called "reclaim water," will be pumped back to the process plant at 87.3 m³/h, and to balance the process the fresh water diluting that stream is equivalent to 47%, or 41 m³/h. This would clearly change based on process design, tailings locations and optimizations; however, it was selected at the time as indicative.

Leach

The gravity recovery and leach kinetics for the LOM composite with site water and detoxed diluted water are very comparable, resulting in 24 h gold leach extractions of 96.0% and 96.5% for Run 1 and Run 2, respectively, as illustrated in Figure 13-4.



Source: BML testwork, 2020.

Figure 13-4: LOM Leach Kinetics

The leach tests would appear to indicate that under standard average operating conditions, recycling reclaim water when it is diluted in the TF, and again by fresh water as it enters the process plant, does not adversely impact the leach response.

Detox

The detox tests had excellent results. Initially, the second detox run had an issue with reagent addition, and the first results were above the CN_{WAD} target of 10 ppm, with an average of approximately 16 ppm; however, once the reagents were reset, the next CN_{WAD} measurement was 4.5 ppm. This is in line with the 90 min detox result from Run 1 of 5.0 ppm. These results, as shown in Table 13-28, would also indicate that recycling of the water through the process does not adversely impact detoxification.

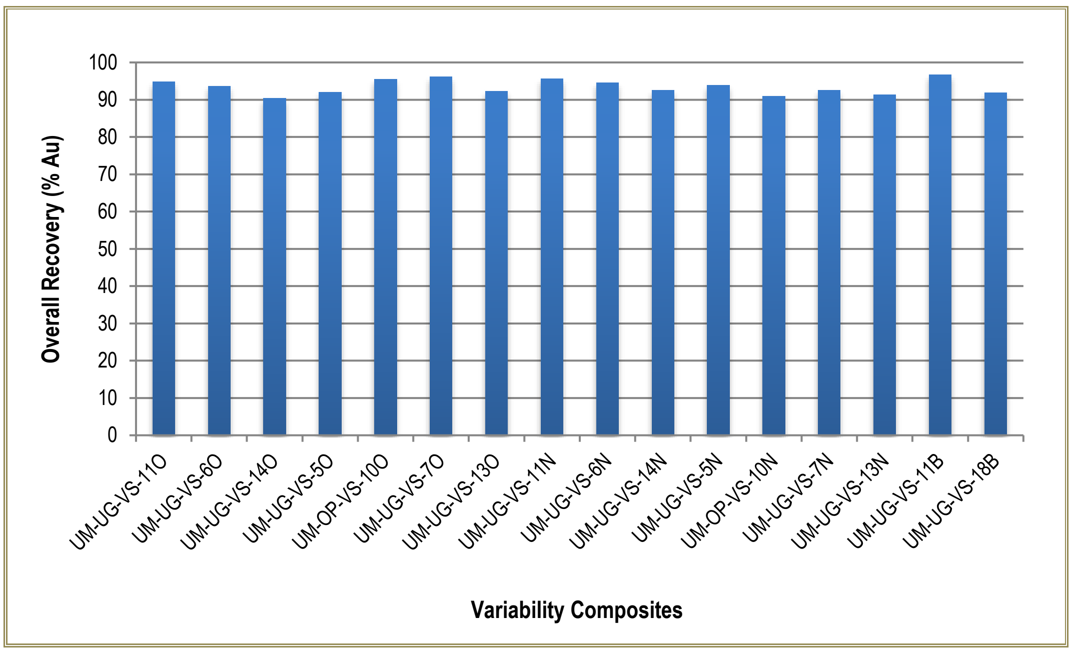
Table 13-28: LOM Detox Results

Composite Test	CN_{WAD} Feed (ppm)	CN_{WAD} 90 min (ppm)	CN_{WAD} Test End (ppm)
LOM Run 1	102.0	5.0	1.3
LOM Run 2	65.2	4.5	4.0

Source: BML testwork, 2020.

13.3.7 Base Metallurgical Laboratories Umwelt Variability Testwork (2020)

Based on the testwork undertaken in program BL563 with the optimized process variables from the current flowsheet, there was indication that the Umwelt VCs had an improved metallurgical response, including a potential recovery increase over the historical testwork. As the flowsheet has been updated and further developed since the historical testwork on the Umwelt mineralization was undertaken in KM4361, a new variability program was developed, and late in 2020, an additional 269 samples were obtained from site, representing 14 drill holes from the Umwelt deposit, used to create 14 VCs, upon which testwork was undertaken. The overall gold extraction is illustrated in Figure 13-5. Testwork used the current flowsheet, consisting of gravity, followed by, in order: pre-ox of the gravity tailings for 16 h at a pulp density of 50%; leaching of the pre-ox discharge for 48 h; pH11; NaCN dose of 500 ppm maintained for the first 24 h, 20 g/t $PbNO_3$; making sure to sparge the oxygen such that the DO level is maintained above 20 ppm for the entire test.



Source: BML testwork, 2020.

Figure 13-5: Umwelt Variability Recovery Results

The average overall gold recovery for the Umwelt VCs tested with the current flowsheet is 93.4%. After solution losses, the PDC gold recovery for the Umwelt mineralization is estimated at 92.9%.

13.3.8 Design Criteria and Flowsheet Development

The summary design criteria are provided in Section 17.

The flowsheet parameters include:

- A primary grind P_{80} of approximately 50 µm
- Gravity recovery
- Pre-ox of the gravity tailings for 16 h at 50% solids
- Leach of the pre-oxygenated gravity tailings for 48 h at 50% solids; pH 11; DO above 20 ppm; 20 g/t $PbNO_3$; and a NaCN concentration of 500 ppm; with the last NaCN addition at 24 h, and the level of CN allowed to drift down to the 48-h termination.

The detoxification of the leach tailings indicates the Back River mineralization is amenable to detoxification. It is recommended that the following conditions be used for design, and the starting point for operations in the detoxification circuit:

- SO_2:CN_{WAD} ratio at 5.0:1
- $CuSO_4$ addition at 20 mg/L
- Retention time at 90 min
- pH at 9.0
- Pulp Density at 45%
- Target DO of 8 ppm.

14 MINERAL RESOURCE ESTIMATES

14.1 Introduction

This section presents the Mineral Resource estimate for the Goose Site, comprising the Llama, Llama Extension, Umwelt, Echo, Nuvuyak, and Goose Main deposits, and the George Site, made up of the LCPn, LCPs, Loc1, Loc2, SL, and GH deposits.

These are re-estimates for the Goose Main and Echo deposits, maiden Mineral Resource estimates of the Llama Extension and Nuvuyak deposits, and an updated estimate for Umwelt incorporating new drilling. Llama has not been re-estimated as there were no new data available. AMC's Ms. D. Nussipakynova, P.Geo., carried out all estimation and reporting; Ms. Nussipakynova takes responsibility for these estimates.

The Mineral Resources for the George deposits were updated by reporting from new optimized pit shells. AMC's Ms. D. Nussipakynova, P.Geo., reviewed and validated LCPn and LCPs, Loc1, Loc2, SL and GH deposits; Ms. Nussipakynova takes responsibility for these estimates.

AMC is not aware of any known environmental, permitting, legal, title, taxation, socioeconomic, marketing, political, or other similar factors that could materially affect the stated Mineral Resource estimates.

These estimates are dated 31 December 2020 and supersede the previous estimates outlined in the JDS (2015b) report.

The data used in the estimates include results of all drilling carried out on the Property to 15 November 2020. The cut-off date of the data varies for each deposit. For Llama and George deposits, the data are based on drilling results up to 31 December 2013. The cut-off date of drilling results for Goose Main and Echo is 31 December 2014. The data used for Umwelt include the drilling results up to 16 October 2020, and for Llama Extension and Nuvuyak the cut-off date is 15 November 2020.

The results of the estimates are summarized in Table 14-1 and expanded in Table 14-2 in the same format as the previous technical report (JDS, 2015b). It is important to note that, in all Mineral Resource tables in this section, the Mineral Resources are inclusive of any Mineral Resources converted to Mineral Reserves. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.

Table 14-1: Summary of Mineral Resources as of 31 December 2020

Resource Classification	Tonnes ('000s)	Grade (g/t Au)	Metal (Au '000s oz)
Measured	9,707	5.75	1,796
Indicated	23,745	5.93	4,525
Measured and Indicated	33,452	5.88	6,321
Inferred	13,794	6.44	2,856

Source: AMC, 2020.

Notes: CIM Definition Standards (CIM, 2014) were used for reporting the Mineral Resources.
The QP is Dinara Nussipakynova, P.Geo. of AMC.
Measured and Indicated Mineral Resources are inclusive of Mineral Reserves.
Metal price: US$1,550/oz for gold
Exchange rate: C$1.31:US$1.00.
Process Recovery: Goose deposits is 93% and for George deposits is 95%.
COGs: Goose and George deposits open pit—1.4 g/t Au; Goose deposits underground—3.0 g/t Au; George deposits underground—3.5 g/t Au.
Goose Mineral Resources deposits are Goose Main, Umwelt, Echo, Llama, Llama Extension, and Nuvuyak.
George Mineral Resources deposits are LCPn, LCPs, Loc1, Loc2, GH, and SL.
Open pit Mineral Resources are constrained by an optimized pit shell using gold price and exchange stated above.
The George underground Mineral Resources were estimated within mineral domains expanded to a minimum horizontal width of 2 m.
Drilling results for Goose Main, Echo, Llama Extension and Nuvuyak are up to 15 November 2020.
Drilling results for Umwelt are up to 16 October 2020.
Drilling results for Llama and all George deposits are up to 31 December 2013.
The numbers may not add due to rounding.

Table 14-2: Mineral Resources as of 31 December 2020 by Deposit

Resource Classification	Deposit	Open Pit/Underground	Tonnes ('000s)	Grade (g/t Au)	Metal (Au '000s oz)
Measured	Goose Main	Open Pit	4,265	4.67	640
		Underground	52	5.08	9
	Llama	Open Pit	1,774	6.29	359
		Underground	85	5.27	14
	Umwelt	Open Pit	3,525	6.82	773
		Underground	6	3.82	1
Measured Total			**9,707**	**5.75**	**1,796**
Indicated	Goose Main	Open Pit	3,758	4.02	486
		Underground	563	5.57	101
	Echo	Open Pit	290	6.73	63
		Underground	694	5.37	120
	Llama	Open Pit	851	6.66	182
		Underground	799	7.80	201
	Umwelt	Open Pit	3,414	5.64	620
		Underground	6,233	7.61	1,525
	George	Open Pit	5,178	4.99	831
		Underground	1,965	6.27	396
Indicated Total			**23,745**	**5.93**	**4,525**
Inferred	Goose Main	Open Pit	224	3.97	29
		Underground	601	5.37	104
	Echo	Open Pit	0.3	5.48	0.05
		Underground	115	4.72	17
	Llama	Open Pit	13	7.40	3
		Underground	325	6.25	65
	Umwelt	Open Pit	65	4.31	9
		Underground	2,922	6.03	566
	Llama Extension	Underground	1,744	7.55	424
	Nuvuyak	Underground	2,417	7.50	583
	George	Open Pit	995	5.28	169
		Underground	4,373	6.31	887
Inferred Total			**13,794**	**6.44**	**2,856**

Source: AMC, 2020.
Notes: CIM Definition Standards (2014) were used for reporting the Mineral Resources.
Refer to the footnotes in Table 14-1 for prices and COGs applied to each deposit.

14.2 Goose Site

The Goose Site consists of Llama, Umwelt, Echo, and Goose Main deposits, and the recently discovered zones of Llama Extension and Nuvuyak. All Mineral Resources for the Goose Site are presented in this section. However, this

Updated Feasibility Study focuses on developing the Goose Main, Llama, Umwelt, and Echo deposits. The lithological domains for these deposits were provided by Sabina. The domains were reviewed and accepted by AMC.

Sabina carried out building of mineralization domains using a gold threshold of 0.3 g/t for most deposits. Gold mineralization domains were updated at Umwelt in 2020, with the mineralization interpretation threshold retained at 0.3 g/t Au in the upper portion of the deposit and increased to between 0.5 g/t and 1 g/t in lower portion. A gold threshold of 1.0 g/t was used to build the mineralization domains at Llama Extension and Nuvuyak. Minor changes were made to one of the Echo gold domains to incorporate results from two drill holes. The QP reviewed and accepted mineralization domains with only minor changes applied to Goose Main to incorporate drilling results from 2014 and gap samples processed in 2018.

All estimations were carried out in Datamine software. To account for the folded nature of the Goose Site deposits, the dynamic anisotropy option in Datamine was used for estimating, which allows the orientation of the ellipsoid to be defined individually for each block in the model. Grade interpolation was carried out using ordinary kriging (OK) for all main domains of the deposits except in domains where data are sparse. In that situation, and for the Llama Extension and Nuvuyak deposits, the interpolation method employed was inverse distance squared (ID^2).

14.2.1 Data Used

Drill Hole Database

The data used in the estimate consisted of surface diamond drill hole data held in a Microsoft Access® database, which was provided to AMC as Microsoft Excel® files. The data type and number of holes used in the estimation are shown in Table 14-3.

Table 14-3: Goose Site Drill Hole Data used in the December 2020 Estimate

Deposit	Company	Years	No. of Drill Holes	Metres Drilled (m)	No. of Assays	Meters Assayed (m)
Goose Main	Pre-Sabina	1992–2008	245	61,803	40,154	24,537
	Sabina	2010–2014	24	5,816	4,309	4,337
Echo	Sabina	2009–2014	49	13,432	6,914	7,355
Llama	Sabina	2010–2013	145	40,389	24,170	25,137
Umwelt	Pre-Sabina	2005	1	217	230	210
	Sabina	2010–2020	224	85,985	37,423	39,540
Nuvuyak	Sabina	2018–2020	14	12,589	6,503	6,729
Llama Extension	Sabina	2012–2020	20	13,938	6,638	6,903
Total		**1992–2020**	**722**	**234,168**	**126,341**	**114,748**

Source: AMC, 2020.

Notes: All drill holes are surface diamond drill holes that intersected the mineralization domains.
Drill data results up to date:

- 31 December 2013 for Llama; 31 December 2014 for Goose Main and Echo, with incorporation of results from a gap sampling program at Goose Main in 2018.
- October 2020 for Umwelt; 15 November 2020 for Llama Extension and Nuvuyak.
- 31 December 2013 for George deposits.

Bulk Density

The collection of bulk density measurements is described in Section 10. Mineralization at the Property is hosted within competent rock that contains minimal voids, pits, and oxidized surfaces. Previous operators undertook a comparative study between SG and bulk density measurements. As the overall difference between the two determinations was negligible (less than 1%), SG measurements are considered a good approximation of bulk density (Cater et al., 2009).

The majority of mineralization at Llama, Llama Extension, Umwelt, Echo and Nuvuyak is hosted within the iron formation. At Goose Main, mineralization also occurs in the greywacke and mudstone.

SG values were applied to the geology for each deposit. At Goose Main, Echo and Llama, the SGs were applied from values derived from local lithology wireframes. For Umwelt, Llama Extension, and Nuvuyak the SGs of each rock type were assigned values from within wireframes of the entire Goose Site. The SG values used for the main rock types are shown in Table 14-4. For overburden an SG value of 1.80 was assigned to all deposits.

Table 14-4: SG Values for Goose Site by Rock Type

Stratigraphy	Goose Main	Echo	Umwelt	Llama	Llama Extension	Nuvuyak
Overburden	1.80	1.80	1.80	1.80	1.80	1.80
Gabbroic Dyke	3.00	3.03	3.03	3.01	3.03	3.03
Felsic Dyke	2.69	2.69	2.69	2.73	2.69	2.69
Upper Iron Formation	2.93	2.97	2.86	2.95	2.86	2.86
Lower Iron Formation	3.03	3.02	3.13	3.14	3.13	3.13
Deep Iron Formation	2.82	N/A	2.79	2.76	2.79	2.79
Phyllite	2.83	2.83	N/A	N/A	N/A	2.80
Lower Greywacke	2.78	2.75	2.75	2.77	2.75	2.76
Upper Greywacke	2.77	2.78	2.78	2.83	2.75	2.78
Middle Greywacke	N/A	N/A	N/A	N/A	N/A	2.80
Basal Greywacke	N/A	N/A	2.75	N/A	2.75	2.74
Middle Mudstone	N/A	N/A	2.90	N/A	2.90	2.90

Source: AMC, 2020 (from Sabina raw data).

For the estimation, the SG values assigned to mineralization at Goose Main and Llama are the same as the host rock. At Llama Extension, Umwelt, Echo, and Nuvuyak, values were the median from SG values inside the mineralization wireframes and applied to the respective block models. This change of procedure was to improve accuracy of SGs used, since mineralized rocks typically have greater sulphidation, veining, and alteration than barren or low-grade rocks. Note that Llama was not updated. Table 14-5 shows the SG values assigned to the mineralization domains by deposit.

Table 14-5: SG Values for Goose Site mineralization

	Goose Main	Echo	Umwelt	Llama	Llama Extension	Nuvuyak
Mineralization Domains	Host Rocks	3.04	2.76, 3.06, 3.15	Host Rocks	3.14	3.11, 3.24

Source: AMC, 2020.

14.2.2 Domain Modelling

The geology model for all the deposits is composed of six main rock types:

- Gabbroic dykes
- Felsic dykes
- Upper greywacke
- Upper Iron Formation
- Lower Iron Formation
- Lower greywacke.

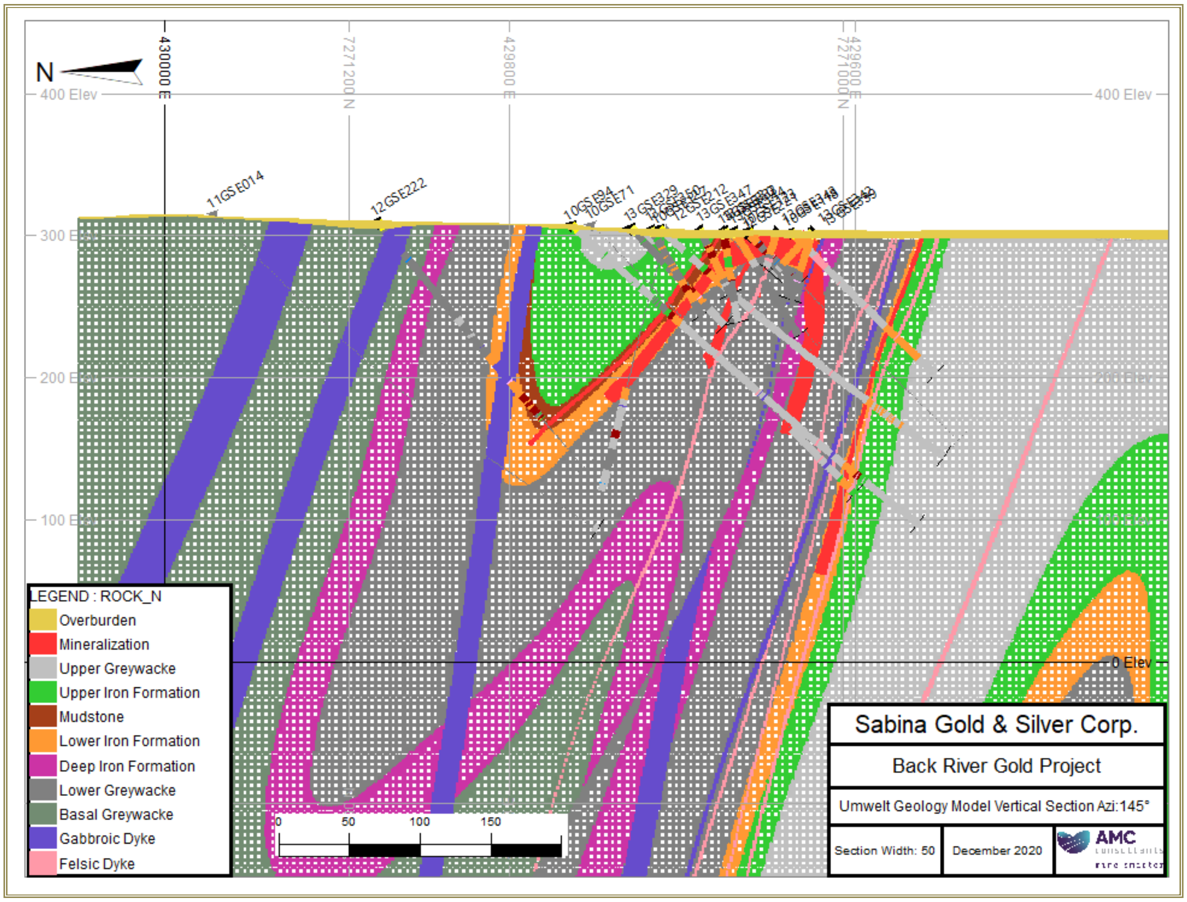
Other stratigraphic units have been recognized at the various deposits, many of which have been modelled. At the Echo, Goose Main, and Nuvuyak deposits, a phyllite unit was modelled. At the Llama, Llama Extension, Umwelt, Nuvuyak, and Goose Main deposits, a DIF was modelled. A middle mudstone was modelled at the Umwelt, Echo, and Nuvuyak deposits. The stratigraphic package is folded at these locations.

Mineralization domains for Llama, Echo, and Goose Main deposits were built in 2014 using a gold threshold of 0.3 g/t Au. Domains at Llama were not updated in 2020, and domains at Goose Main and Echo were slightly modified to incorporate additional assay data. Mineralization domains at Umwelt were fully updated in 2020 to incorporate new drilling, using a gold threshold in the upper portion of the deposit set to 0.3 g/t, and increased to between 0.5 g/t and 1 g/t in the deposit's lower portion to better match underground mining strategies. Gold thresholds at the Llama Extension and Nuvuyak deposits were set to 1.0 g/t to reflect that extraction will likely be via underground methods. The mineralization domains were built on the understanding that mineralization occurs predominantly in the LIF and is cross-cut by gabbroic and felsic dykes.

The blocks inside the block models are coded by different geological units, bulk density values, and estimated gold values. Figure 14-1 shows an example of the folded nature of the stratigraphic units and mineralization at the Umwelt deposit in cross section.

Sabina provided the re-interpreted mineralization domains for Umwelt, Echo, and maiden domains for Llama Extension and Nuvuyak. The number of mineralization domains varied between the deposits. There were four mineralization domains at the Llama deposit, two at the Llama Extension deposit, 16 at the Umwelt deposit, two at the Echo deposit, four at the Nuvuyak deposit, and 24 at the Goose Main deposit. The higher number of mineralization domains at the Goose Main deposit reflects the more complex geometry of the stratigraphic units and mineralizing system at this deposit. The number of domains at Umwelt increased from 13 in 2014 to 16 in 2020 to reflect improvements in the understanding of the mineralizing system.

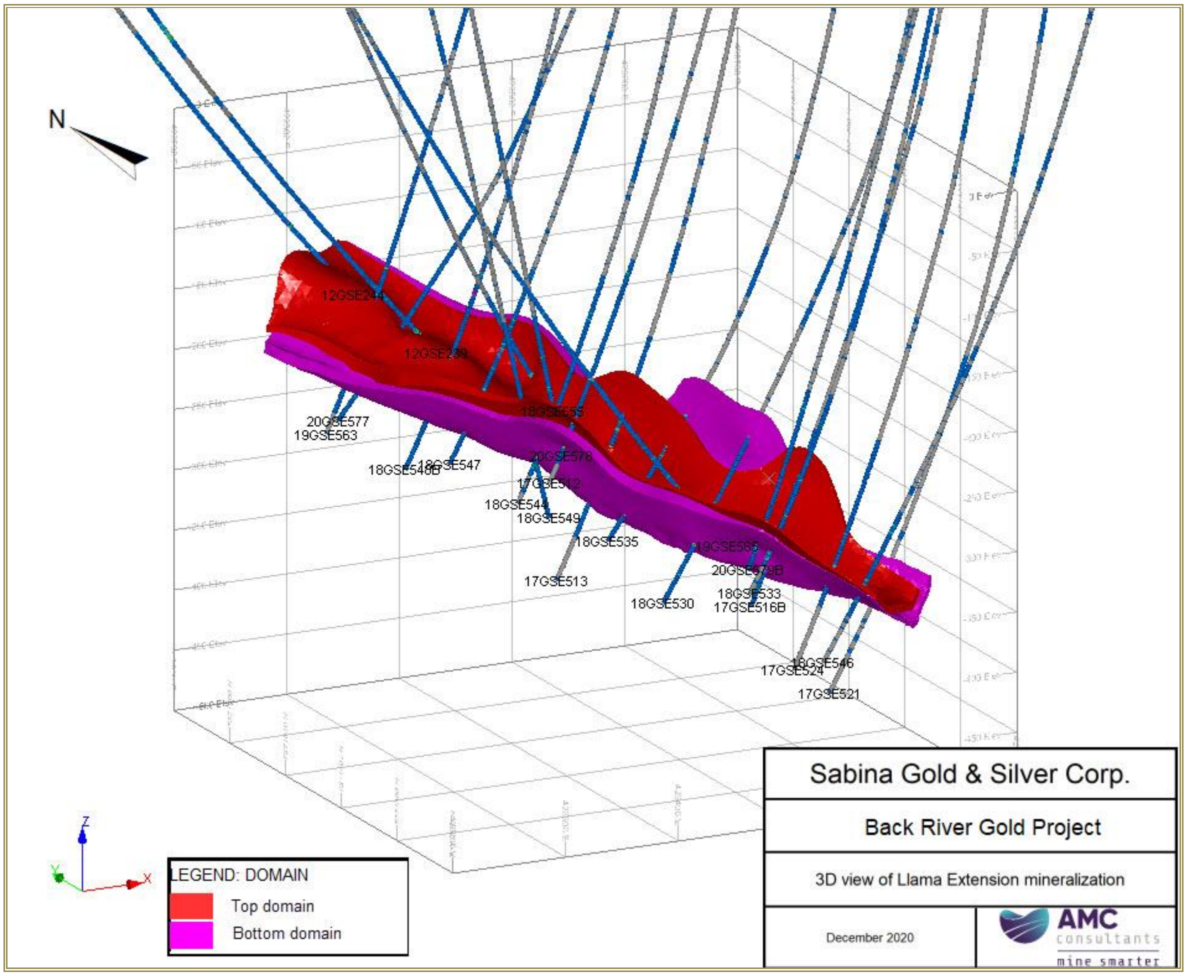
On completion of the domain modelling, the QP carried out visual checks to ensure that the constraining wireframes honoured the raw data. Slight modifications in mineralization domains were made for Goose Main. The modifications were made based on assays of three additional drill holes from 2014, that were not used in previous estimates, since those assays arrived after the data deadline.



Source: AMC, 2020.

Figure 14-1: Cross-Section of Umwelt Geology Model

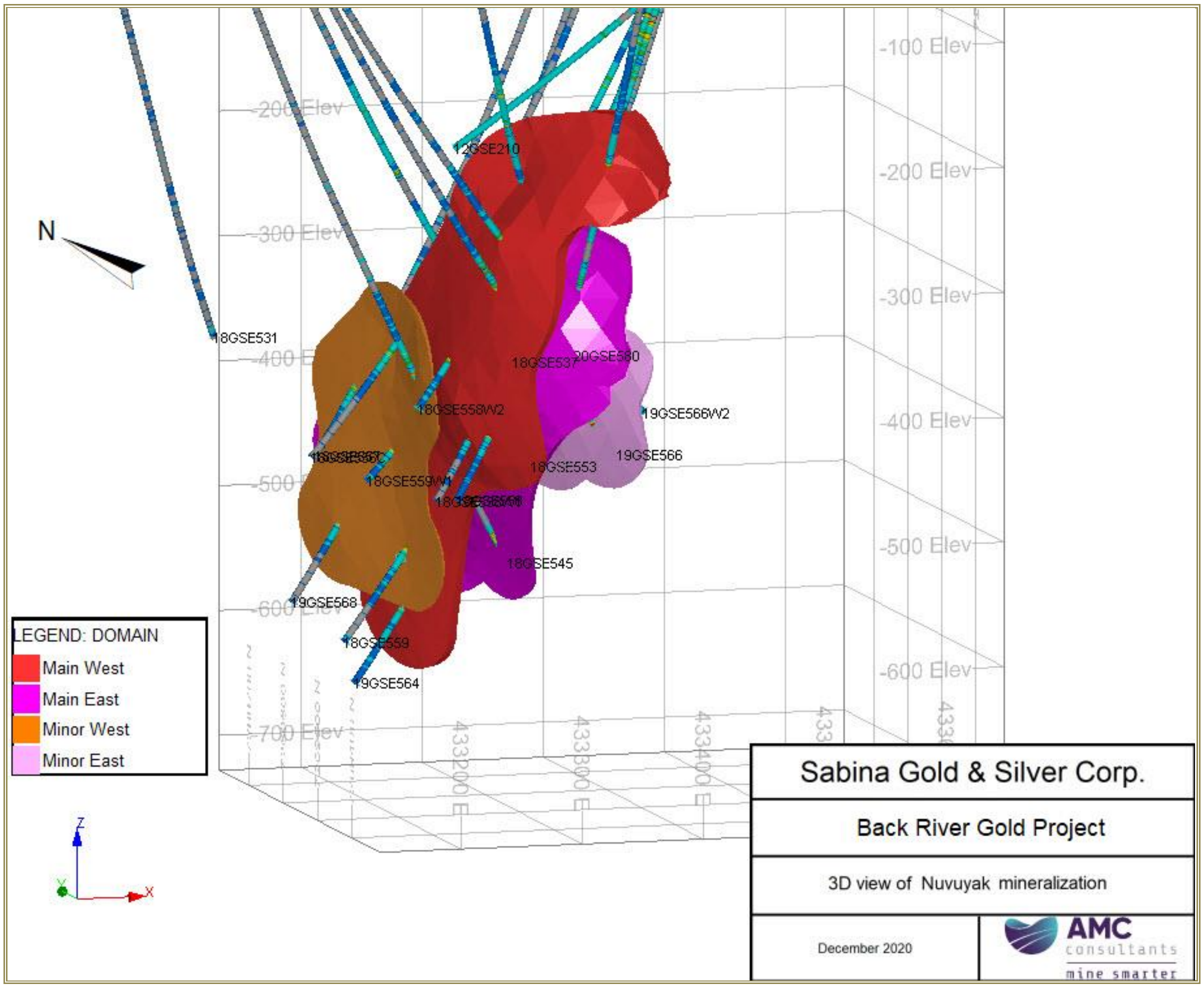
Two mineralization domains were interpreted at the Llama Extension. Figure 14-2 shows the 3-D view of the drill holes and domains looking to the northeast. Nuvuyak mineralization consists of four separate domains: Main East and West, and Minor East and West.



Source: AMC, 2020.

Figure 14-2: 3-D View of the Llama Extension Mineralization Domains

The Figure 14-3 shows the 3-D view of the drill holes and domains at Nuvuyak looking to the northeast.



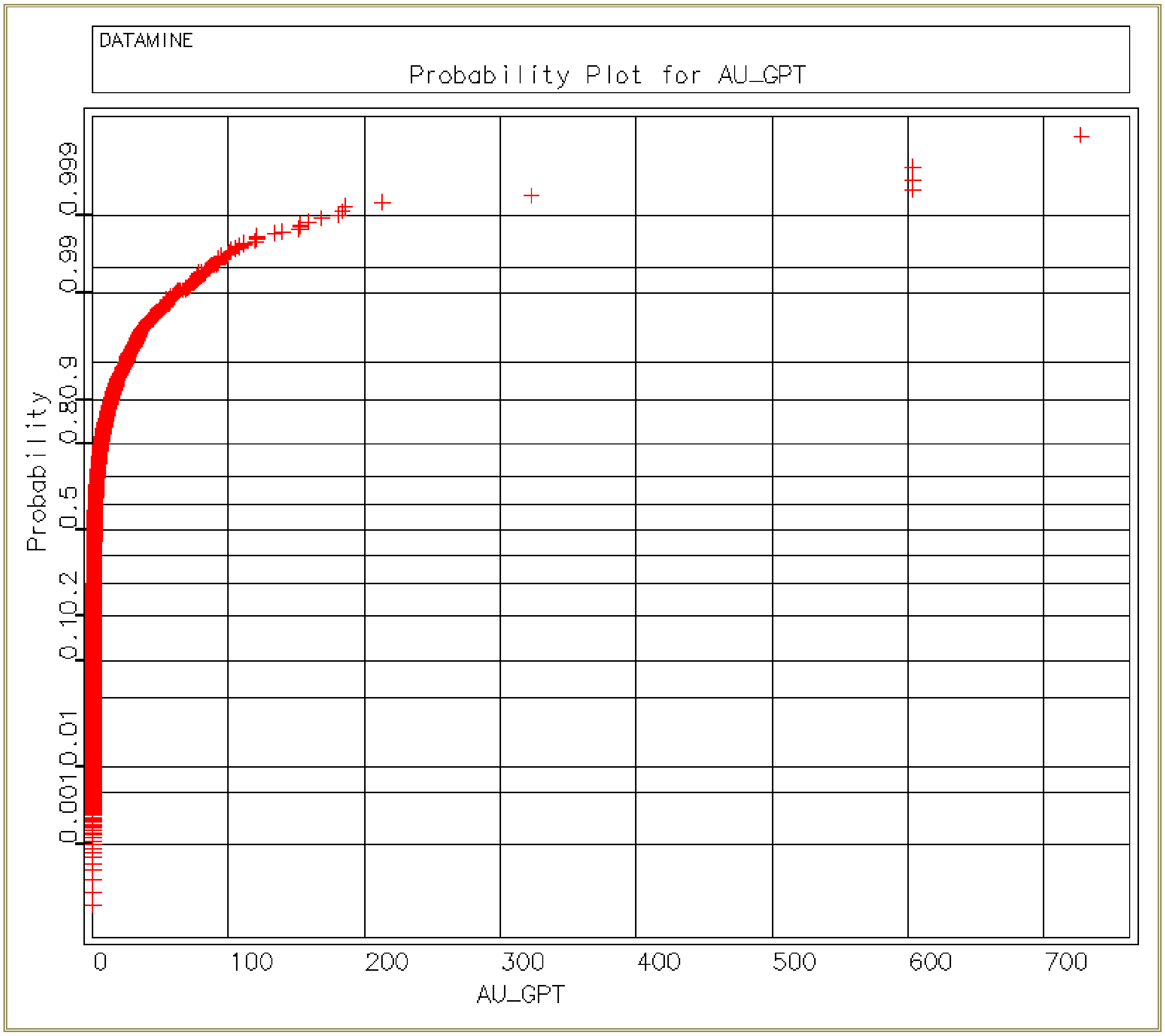
Source: AMC, 2020.

Figure 14-3: 3-D View of the Nuvuyak Mineralization Domains

14.2.3 Statistics and Compositing

Within each mineralized domain, intervals of gabbroic dykes, felsic dykes, overburden rocks, and lost core were removed, marked absent, and not used in the gold grade estimation. Unsampled intervals within mineralization domains were assigned a zero value for gold grades. Within the mineralization domains at the Goose Main deposit, not all the mineralized material was sampled in the older drilling, and locally some unsampled material was included. In Domain 1 of Goose Main there were about 20 intervals assigned a zero grade. This was the largest number of any domain. Unsampled material within mineralization domains was not an issue at the other Goose Site deposits.

The gold grades were viewed on log probability plots for each domain, and outliers were capped prior to compositing. The largest top cut of 200 g/t was applied for Domain 1 in Goose Main. Figure 14-4 shows the log probability plot of the Domain 1 Goose Main deposit. The second largest top cut value of 115 g/t Au was selected for Domain 1, the largest domain in the Umwelt deposit. This increase in capping from 80 g/t in 2014 is attributed to the intersection of many significant high-grade zones along the length of the deposit. Raw gold assay data were capped at 80 g/t for Echo, and 50 g/t for Llama Extension and Nuvuyak.



Source: AMC, 2020.

Figure 14-4: Log Probability Plot of Raw Gold Assay Data for the Goose Main Deposit (Domain 1)

A review of sample lengths for each deposit showed that the majority of samples are 1.0 m long. As such, a composite length of 1.0 m was chosen for all deposits.

Table 14-6 and Table 14-8 show the statistics of selected raw, edited, capped, and composited gold data from all mineralization domains for each deposit. Edited intervals refer to the removal of overburden, lost core and gabbroic and felsic dykes, as well as the addition of zeros for unsampled intervals through mineralization domains.

Table 14-6: Statistics of Gold Assay Data—Llama and Llama Extension

	Llama				Llama Extension			
	Raw	Edited	Capped	Comp.	Raw	Edited	Capped	Comp.
No. of Samples	3,263	3,078	3,078	2,948	423	396	396	343
Minimum (Au g/t)	0.000	0.000	0.000	0.03	0.006	0.006	0.006	0.012
Maximum (Au g/t)	262.1	393.4	100.0	100.0	115.8	115.8	50.0	47.7
Mean (Au g/t)	**4.21**	**4.66**	**4.42**	**4.42**	**5.81**	**6.04**	**5.44**	**5.48**
SD (Au g/t)	12.83	15.06	11.71	10.58	13.33	13.61	10.07	8.56
CoV	3.05	3.23	2.65	2.40	2.30	2.25	1.85	1.56

Source: AMC, 2020.

Notes: SD = Standard Deviation; CoV = Coefficient of Variation.

Table 14-7: Statistics of Gold Assay Data—Umwelt and Echo

	Umwelt				Echo			
	Raw	Edited	Capped	Comp.	Raw	Edited	Capped	Comp.
No. of Samples	6,460	6,481	6,439	5,668	580	538	538	445
Minimum (Au g/t)	0.003	0.000	0.000	0.000	0.015	0.015	0.015	0.015
Maximum (Au g/t)	442.1	442.1	115.0	115.0	119.7	119.7	80.0	66.5
Mean (Au g/t)	5.91	5.86	5.55	5.55	3.72	3.99	3.87	3.87
SD (Au g/t)	15.49	15.44	12.31	11.14	9.52	9.82	8.51	7.14
CoV	2.62	2.63	2.22	2.01	2.56	2.46	2.20	1.84

Source: AMC, 2020.

Notes: SD = Standard Deviation; CoV = Coefficient of Variation.

Table 14-8: Statistics of Gold Assay Data—Nuvuyak and Goose Main

	Nuvuyak				Goose Main			
	Raw	Edited	Capped	Comp.	Raw	Edited	Capped	Comp.
No. of Samples	598	495	500	449	14192	14005	13976	11,038
Minimum (Au g/t)	0.003	0.003	0.003	0.005	0.001	0.000	0.000	0.000
Maximum (Au g/t)	102.0	102.0	50.0	47.9	727.2	727.2	200.0	183.4
Mean (Au g/t)	4.64	5.61	5.35	5.33	3.53	3.55	3.40	3.40
SD (Au g/t)	9.43	10.15	8.81	8.10	13.14	13.19	9.82	8.65
CoV	2.03	1.81	1.65	1.52	3.73	3.71	2.89	2.54

Source: AMC, 2020.

Notes: SD = Standard Deviation; CoV = Coefficient of Variation.

14.2.4 Block Model

Block Model Parameters

Parent blocks of 5 m by 10 m by 5 m were used in the Llama, Llama Extension, Umwelt, and Goose Main models, with sub-blocking using a split of Datamine option number two. The block model origins, parent block size, number of blocks along the axis, and rotation are shown in Table 14-9 to Table 14-11. The models are rotated counter-clockwise around the Z-axis.

Table 14-9: Block Model Parameters—Llama and Llama Extension

Parameter	Llama			Llama Extension		
	X	Y	Z	X	Y	Z
Origin (m)	428,985	7,271,330	-250	429,288.9955	7,270,895.8494	-450
Parent Block Size	5	10	5	5	10	5
Minimum Block Size	0.625	1.250	0.050	0.625	0.250	0.125
Rotation Angle (deg)	0	0	-35	0	0	-35
No. of Blocks	172	130	117	172	80	165

Source: AMC, 2020.

Table 14-10: Block Model Parameters—Umwelt and Echo

Parameter	Umwelt			Echo		
	X	Y	Z	X	Y	Z
Origin (m)	430,120.6813	7,269,708.0790	-600	432,000	7,268,650	-150
Parent Block Size	5	10	5	5	5	5
Minimum Block Size	0.25	0.50	0.25	0.25	1.25	0.25
Rotation Angle (deg)	0	0	-35	0	0	0
No. of Blocks	172	198	185	200	170	110

Source: AMC, 2020.

Parent blocks of 10 m by 5 m by 10 m were used in the Echo block model, with sub-blocking using a split of five in the X direction, and ten in the Y and Z directions. The parent block size for Echo has been changed to 5 m by 5 m by 5 m with same sub-blocking during the combining with geology. The Echo model is not rotated.

Parent blocks of 5 m by 5 m by 5 m were used in the Nuvuyak block model, with sub-blocking using a split of two. The block model dimensions of Nuvuyak are shown along with Goose Main in Table 14-11.

Table 14-11: Block Model Parameters—Nuvuyak and Goose Main

Parameter	Nuvuyak			Goose Main		
	X	Y	Z	X	Y	Z
Origin (m)	433,100	7,269,100	-670	434,320	7,269,040	-230
Parent Block Size	5	5	5	5	10	5
Minimum Block Size	1.250	0.250	0.050	0.625	0.250	0.125
Rotation Angle (deg)	0	0	-20	0	0	-60
No. of Blocks	110	160	210	140	104	112

Source: AMC, 2020.

14.2.5 Variography and Grade Estimation

Variography was carried out on all main domains that had sufficient sample quantity. The purpose of the variograms was to determine the search distances and to produce inputs for the OK estimates. To model the variograms more accurately, the Datamine "unfold" option was used.

The OK interpolation method was used for the estimation of all domains for Umwelt and Echo, most domains for Llama, and five main domains for Goose Main. The ID^2 method was used for the small domains in Goose Main and Llama, and for estimating Llama Extension and Nuvuyak due to the lower data density in these domains. The dimensions of the search radius for each deposit are shown in Table 14-12. To account for the folded nature of the deposits, the "dynamic anisotropy" option in Datamine was used for estimating the Goose deposits, allowing the orientation of the search ellipsoid to be defined individually for each block in the model.

Several passes were employed, each using different search distances and multiples as follows:

- Pass 1 = 1 x search distance
- Pass 2 = 2 x search distance
- Pass 3 = 4 or 3 x search distance, depending on the domain.

The third pass was completed to fill the wireframes to depth. The search distances are shown in Table 14-12, along with the minimum and maximum number of samples used for each pass.

At the Goose Main deposit Domains 1, 3, and 15, the estimate filled about 84% of the total volume. In Umwelt Domains 1, 2, and 9, the estimate filled about 91% of the total volume. The remaining 21 domains in Goose Main and 13 domains in Umwelt were interpreted from fewer drill holes, therefore less-strict parameters were used to estimate these domains, and they were classified accordingly.

Table 14-12: Estimation Search Parameters—Goose Site

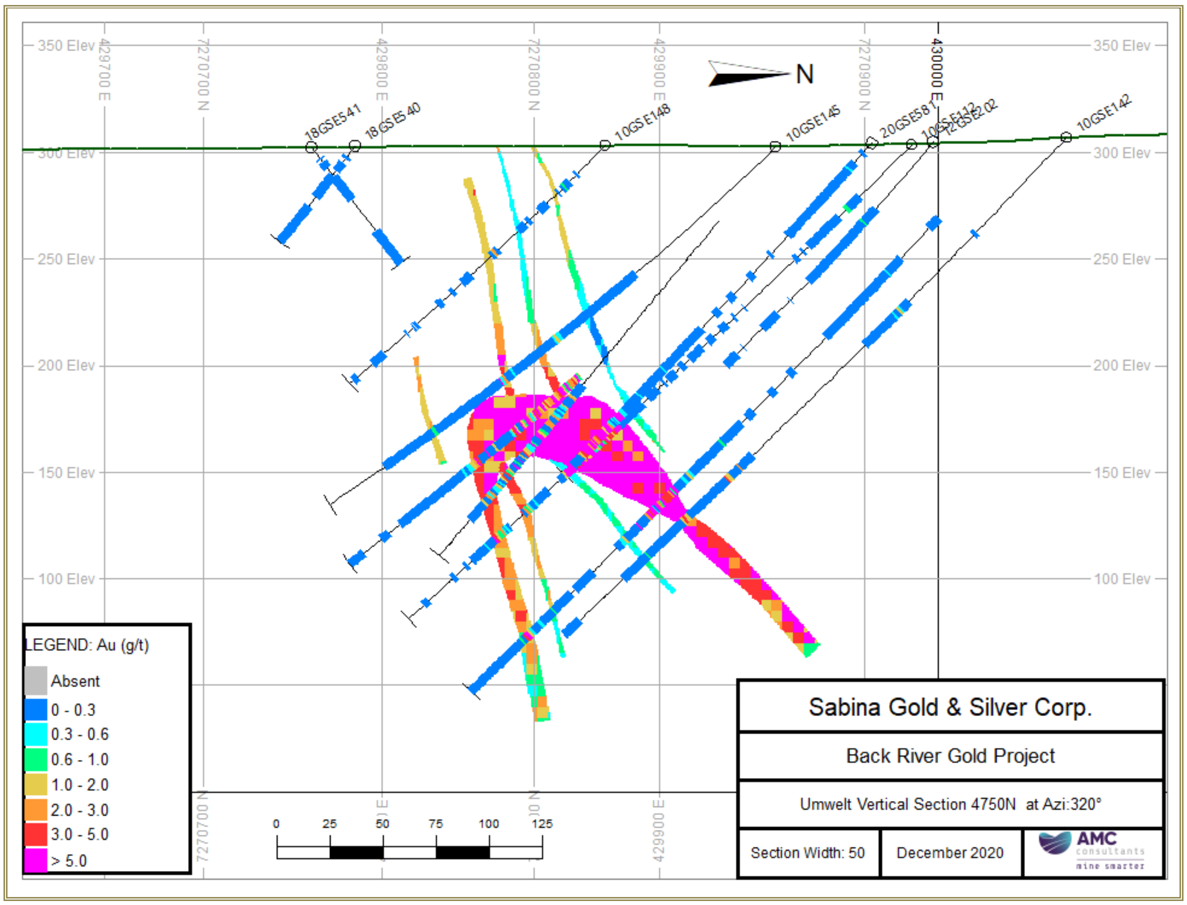
Deposit	Domain	Pass	X (m)	Y (m)	Z (m)	Min No. of Samples	Max No. of Samples	Min No. Of Drill Holes
Goose Main	Domain 1	1	90	60	13	8	16	4
		2	180	120	26	6	16	3
		3	360	240	52	2	16	1
	Domain 3	1	100	100	12	8	16	4
		2	200	200	24	6	16	3
		3	400	400	48	2	16	1
	Domain 15	1	115	130	12	8	16	4
		2	230	260	24	6	16	3
		3	460	520	48	2	16	1
	All other domains	1	35–60	25–70	5–10	6–10	16–20	1–4
		2	70–120	50–140	10–20	4–6	16	1–3
		3	140–240	100–280	20–40	1–2	16	1–2
Echo	Domain 1	1	70	80	8	8	16	1
		2	140	160	16	6	20	1
		3	280	320	32	1	20	1
Umwelt	Domain 1	1	65	65	10	12	20	3
		2	130	130	20	8	16	2
		3	260	260	40	4	16	1
	Domain 2	1	70	70	10	12	20	4
		2	140	140	20	8	16	3
		3	280	280	40	4	16	2
	Domain 9	1	70	70	10	12	18	4
		2	140	140	20	8	18	3
		3	280	280	40	4	12	2
	All other domains	1	25–70	25–70	5–10	1–12	10–20	1–6
		2	50–140	50–140	10–20	4–8	10–20	1–3
		3	100–280	100–280	20–40	1–4	4–16	1–2
Llama	All domains	1	40	40	5	4	16	2
		2	80	80	10	4	16	2
		3	120	120	30	2	16	1
Llama Extension	All domains	2	70	70	10	10	16	5
		2	140	140	20	8	16	4
		3	350	350	50	2	16	1
Nuvuyak	Domains 1 and 2	1	60	60	10	10	16	5
		2	120	120	20	8	16	4
		3	240	240	40	2	16	1
	Domains 3 and 4	1	60	60	10	10	16	1
		2	120	120	20	8	16	1
		3	240	240	40	2	16	1

Source: AMC, 2020.

14.2.6 Block Model Validation

The block models were validated in four ways. First, visual checks were carried out to ensure that the grades respected the raw gold assay data, and also lay within the constraining wireframes. Secondly, the statistics of the model and composites were compared. Thirdly, the swath plots were reviewed. Lastly, in addition to an OK estimate, nearest neighbour (NN), ID^2, and inverse distance cubed (ID^3) were run in Datamine for comparison purposes. These results were statistically compared to the composite gold assay data with satisfactory results.

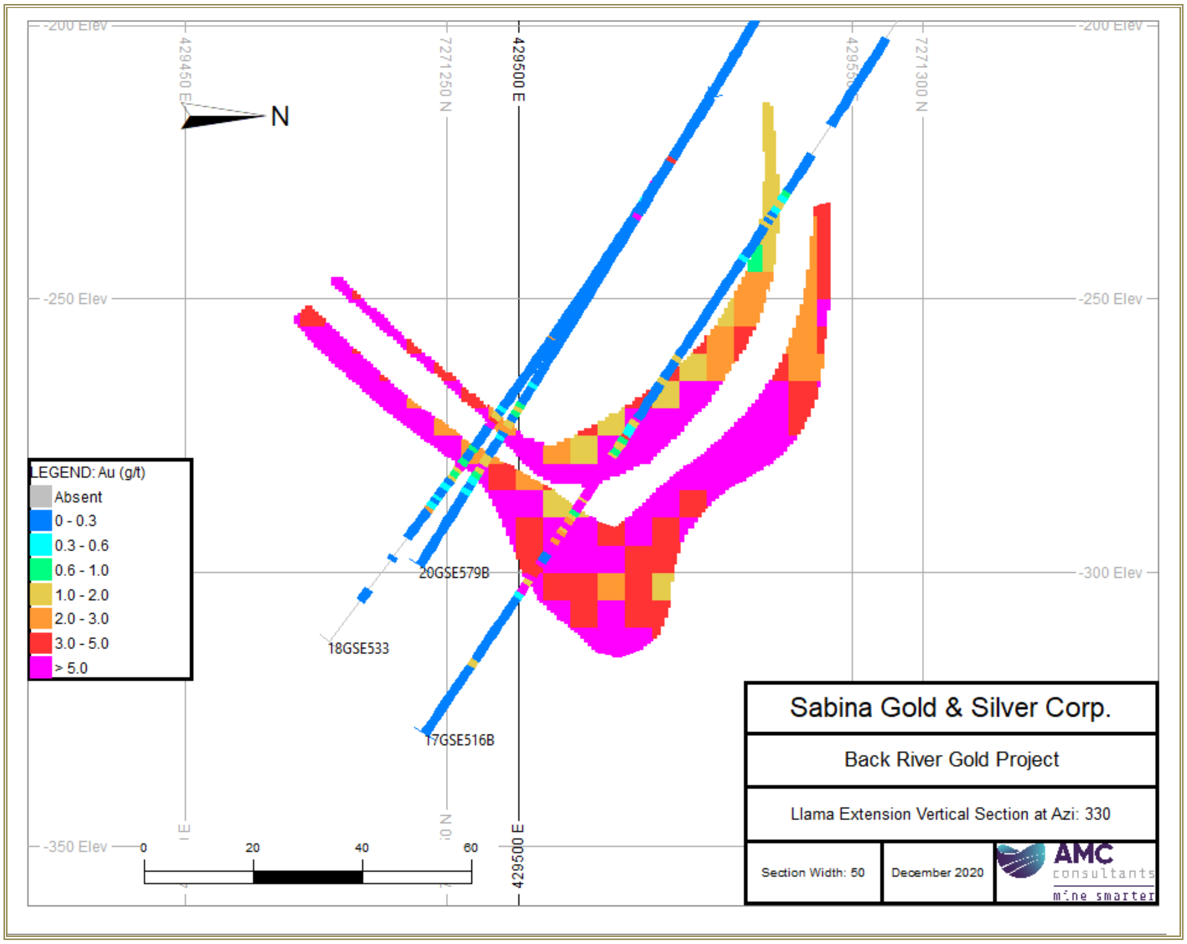
Figure 14-5 shows an example of a vertical section of drill holes and block model for Umwelt. A Llama Extension vertical section is shown in Figure 14-6, and a Nuvuyak vertical section is shown in Figure 14-7.



Source: AMC, 2020.

Note: Cross-section line is shown in Figure 10-6 (Umwelt deposit diamond drill hole collar plan)

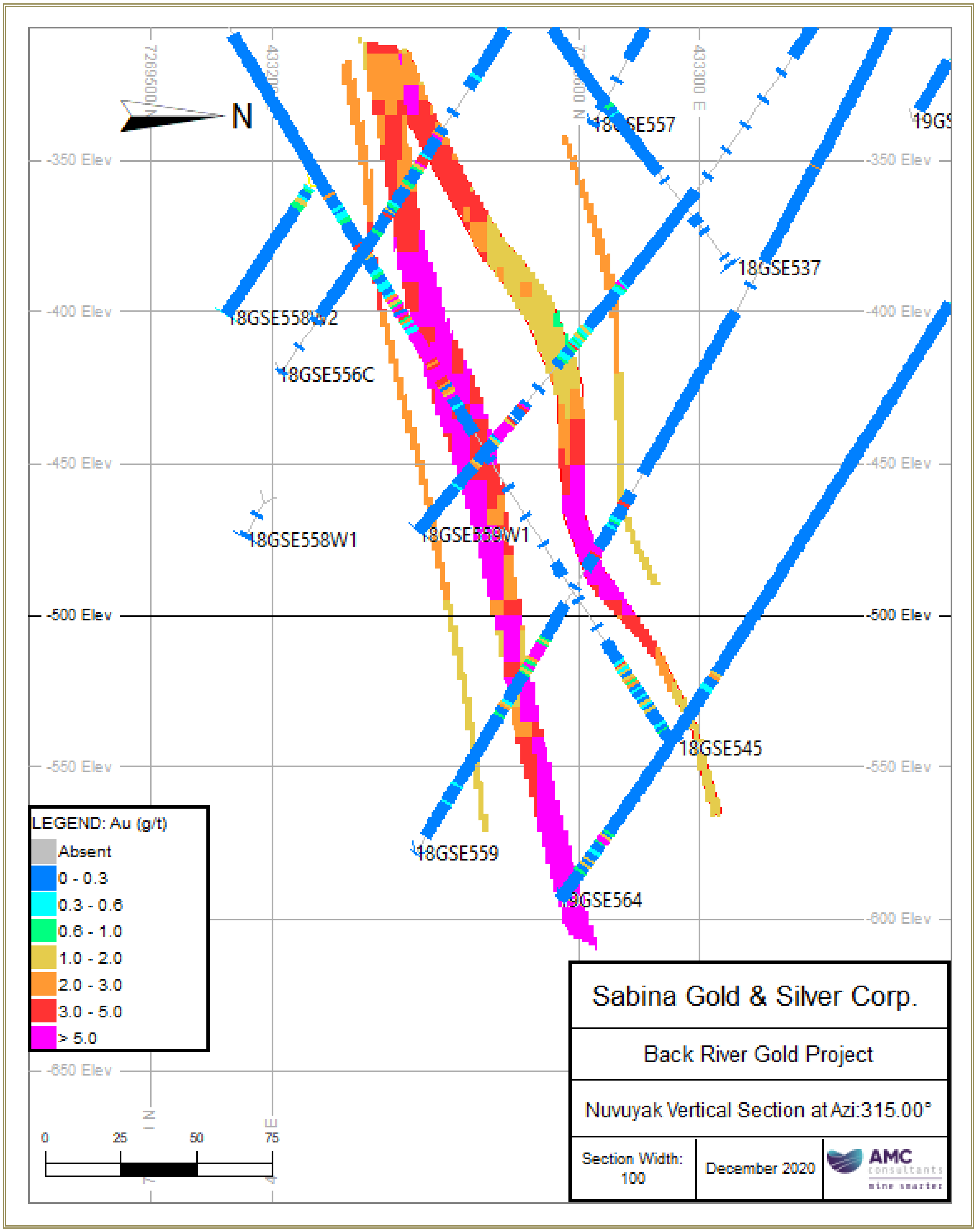
Figure 14-5: Cross-Section of Umwelt Mineralization Model



Source: AMC, 2020.

Note: Cross-section line is shown in Figure 10-4 (Llama Extension deposit diamond drill hole collar plan)

Figure 14-6: Cross-Section of Llama Extension Mineralization Model



Source: AMC, 2020.

Note: Cross-section line is shown in Figure 10-10 (Nuvuyak deposit diamond drill hole collar plan) 100 m section width.

Figure 14-7: Cross-Section of Nuvuyak Mineralization Model

14.2.7 Resource Classification

Resource classification was completed using an assessment of geological and mineralization complexity, data quality, and data density. Classification was carried out using data support as a main criterion, with a manual review creating volumes based on drill hole density and number of samples to inform a block, thus removing outliers.

Parameters were applied as shown in Table 14-13 for Goose Main and Table 14-14 for Llama, Llama Extension, Umwelt, Nuvuyak, and Echo. More stringent rules of support were applied to the Goose Main deposit due to the more complex geometry of the mineralization. A study of the classification of Llama Extension and Nuvuyak resulted in these being classified as Inferred Mineral Resources.

Table 14-13: Main Criteria for Resource Classification—Goose Main

Resource Classification	Search Distance (m)	Minimum No. of Samples	Maximum No. of Samples	Minimum No. of Drill Holes
Measured	25 by 25 by 25	10	32	5
Indicated	50 by 50 by 50	8	32	4
Inferred	100 by 100 by 100	4	16	2

Source: AMC, 2020.

Table 14-14: Main Criteria for Resource Classification Other Deposits—Umwelt, Llama, Llama Extension, Nuvuyak, and Echo

Resource Classification	Search Distance (m)	Minimum No. of Samples	Maximum No. of Samples	Minimum No. of Drill Holes
Measured	30 by 30 by 30	8	16	4
Indicated	60 by 60 by 60	8	16	4
Inferred	120 by 120 by 120	4	16	2

Source: AMC, 2020.

14.2.8 Mineral Resource Estimates

Mineral Resource estimates consist of open pit and underground Mineral Resources for the Llama, Umwelt, Echo, and Goose Main deposits at the Goose Site. The vertical depth of the Llama Extension and Nuvuyak deposits preclude open pit Mineral Resources, and hence are reported as underground Mineral Resources. Open pit Mineral Resources are reported between a base-of-overburden surface and a conceptual pit shell based on a US$1,550/oz Au price. Assumptions considered for the conceptual pit shell included mining costs, processing costs, and gold recoveries obtained from Sabina and validated by the QP. These are summarized in Table 14-15. Based on these costs, a COG of 1.4 g/t Au was applied for reporting the open pit Mineral Resources.

The results of the Goose Site open pit and underground Mineral Resource estimates as of 31 December 2020 are shown in Table 14-16.

Table 14-15: Parameters for Conceptual Open Pit Shell

Item	Unit	Open Pit Optimization Parameters
Gold Price	US$/oz	1,550
Exchange Rate	C$:US$	1.31:1.00
Refining/Transport	$/oz	2
Royalties	%	4.8
Processing Costs	$/t ore	29.92
General and Administrative	$/t ore	49.85
Base Mining Costs	$/t	4
Preliminary Overall Slope Angles	degrees	40–51
Metallurgical Recovery	%	93

Source: AMC, 2020.

Table 14-16: Goose Site Mineral Resource Estimates

Resource Classification	Deposit	Open Pit/Underground	Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)
Measured	Goose Main	Open Pit	4,265	4.67	640
		Underground	52	5.08	9
	Llama	Open Pit	1,774	6.29	359
		Underground	85	5.27	14
	Umwelt	Open Pit	3,525	6.82	773
		Underground	6	3.82	1
Measured Total			**9,707**	**5.75**	**1,796**
Indicated	Goose Main	Open Pit	3,758	4.02	486
		Underground	563	5.57	101
	Echo	Open Pit	290	6.73	63
		Underground	694	5.37	120
	Llama	Open Pit	851	6.66	182
		Underground	799	7.80	201
	Umwelt	Open Pit	3,414	5.64	620
		Underground	6,233	7.61	1,525
Indicated Total			**16,602**	**6.18**	**3,298**
Inferred	Goose Main	Open Pit	224	3.97	29
		Underground	601	5.37	104
	Echo	Open Pit	0.3	5.48	0.05
		Underground	115	4.72	17
	Llama	Open Pit	13	7.40	3
		Underground	325	6.25	65
	Umwelt	Open Pit	65	4.31	9
		Underground	2,922	6.03	566
	Llama Extension	Underground	1,744	7.55	424
	Nuvuyak	Underground	2,417	7.50	583
Inferred Total			**8,426**	**6.64**	**1,800**

Source: AMC, 2020.
Notes: CIM Definition Standards (CIM, 2014) were used for reporting the Mineral Resources.
The QP is Dinara Nussipakynova, P.Geo. of AMC.
Measured and Indicated Mineral Resources are inclusive of Mineral Reserves.
Metal price: US$1,550/oz for gold
Exchange rate: C$1.31:US$1.00.
Process Recovery: Goose deposits is 93%.
COGs: open pit is 1.4 g/t Au. underground is 3.0 g/t Au.
Goose Mineral Resources deposits are Llama, Llama Extension, Umwelt, Echo, Nuvuyak, and Goose Main.
Open pit Mineral Resources are constrained by an optimized pit shell using gold price and exchange stated above.
Drilling results for Goose Main, Echo, Llama Extension and Nuvuyak are up to 15 November 2020.
Drilling results for Umwelt are up to 16 October 2020.
Drilling results for Llama are up to 31 December 2013.
The numbers may not add due to rounding.

The sensitivity to COG for the open pit component of Goose Main and Echo is shown in Table 14-17, and sensitivities for Llama and Umwelt are shown in Table 14-18. Note the selected COG is shown in bold.

Table 14-17: Goose Main and Echo—Open Pit Tonnes and Grade Sensitivities

Resource Classification	COG (g/t Au)	Goose Main			Echo		
		Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)	Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)
Measured	1.0	4,810	4.27	661	N/A	N/A	N/A
	1.2	4,537	4.47	651	N/A	N/A	N/A
	1.4	**4,265**	**4.67**	**640**	**N/A**	**N/A**	**N/A**
	1.6	3,986	4.89	627	N/A	N/A	N/A
	1.8	3,752	5.09	614	N/A	N/A	N/A
	2.0	3,515	5.30	599	N/A	N/A	N/A
Indicated	1.0	4,247	3.70	505	291	6.71	63
	1.2	4,004	3.85	496	291	6.71	63
	1.4	**3,758**	**4.02**	**486**	**290**	**6.73**	**63**
	1.6	3,509	4.20	474	287	6.79	63
	1.8	3,258	4.39	460	281	6.88	62
	2.0	3,013	4.60	445	275	7.00	62
Inferred	1.0	295	3.31	31	0.3	5.48	0.05
	1.2	260	3.60	30	0.3	5.48	0.05
	1.4	**224**	**3.97**	**29**	**0.3**	**5.48**	**0.05**
	1.6	195	4.34	27	0.3	5.48	0.05
	1.8	174	4.67	26	0.3	5.48	0.05
	2.0	151	5.10	25	0.3	5.48	0.05

Source: AMC, 2020.

Table 14-18: Llama and Umwelt—Open Pit Tonnes and Grade Sensitivities

Resource Classification	COG (g/t Au)	Llama			Umwelt		
		Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)	Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)
Measured	1.0	2,062	5.58	370	3,733	6.51	781
	1.2	1,908	5.94	364	3,632	6.66	777
	1.4	**1,774**	**6.29**	**359**	**3,525**	**6.82**	**773**
	1.6	1,672	6.58	354	3,422	6.98	768
	1.8	1,576	6.88	348	3,325	7.13	762
	2.0	1,496	7.14	343	3,222	7.30	756
Indicated	1.0	976	5.96	187	3,693	5.31	630
	1.2	906	6.34	185	3,557	5.47	626
	1.4	**851**	**6.66**	**182**	**3,414**	**5.64**	**620**
	1.6	806	6.95	180	3,280	5.81	613
	1.8	762	7.26	178	3,147	5.99	606
	2.0	721	7.56	175	3,018	6.16	598
Inferred	1.0	15	6.31	3	83	3.66	10
	1.2	14	6.89	3	75	3.91	9
	1.4	**13**	**7.40**	**3**	**65**	**4.31**	**9**
	1.6	10	8.55	3	58	4.64	9
	1.8	9	9.39	3	52	5.02	8
	2.0	9	9.81	3	44	5.55	8

Source: AMC, 2020.

The underground Mineral Resources were reported between the base of the conceptual pit shells and the base of the Inferred Resource at each deposit. No allowances were made for crown pillars.

A study was carried out using mineable shape optimizer (MSO) at the Llama deposit to review the "reasonable prospects for economic extraction." The input parameters for the MSO runs were obtained from JDS (2015a, 2015b) to compare with the previously reported Mineral Resources. It was decided that, as the deposits are so linear and mineralization is largely strata-bound, a review of outliers and inclusion of dilution would represent a fair estimate, respecting reasonable prospects for economic extraction.

Sabina provided assumptions to derive a COG, including mining costs, processing costs, and recoveries, which the QP validated; these are shown in Table 14-19. A 9% dilution factor was added. Based on these assumptions the COG was derived as 2.8 g/t and rounded to 3.0 g/t for the Goose Site deposits.

Table 14-19: Derivation of Underground COG

Item	Unit	Underground Parameters
Gold Price	US$/oz	1,550
Exchange Rate	C$:US$	1.31:1.00
Royalties	%	4.8
Mining Costs	$/t ore	66.00
Process Costs	$/t ore	29.92
General and Administrative	$/t ore	49.85
Mining Dilution	%	9
Metallurgical Recovery	%	93

Source: AMC, 2020.

The sensitivity to COG for the underground component of the Goose Main and Echo deposits is shown in Table 14-20; sensitivities for Llama and Umwelt are shown in Table 14-21; and sensitivities for Llama Extension and Nuvuyak are shown in Table 14-22. Note the selected COG is shown in bold.

Table 14-20: Goose Main and Echo—Underground Tonnes and Grade Sensitivities

Resource Classification	COG (g/t Au)	Goose Main			Echo		
		Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)	Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)
Measured	2.0	78	4.22	11	N/A	N/A	N/A
	2.5	65	4.61	10	N/A	N/A	N/A
	3.0	**52**	**5.08**	**9**	N/A	N/A	N/A
	3.5	39	5.71	7	N/A	N/A	N/A
	4.0	34	6.02	7	N/A	N/A	N/A
	4.5	25	6.62	5	N/A	N/A	N/A
Indicated	2.0	1,075	4.10	142	1,033	4.41	147
	2.5	810	4.71	123	856	4.87	134
	3.0	**563**	**5.57**	**101**	**694**	**5.37**	**120**
	3.5	405	6.49	85	548	5.93	104
	4.0	302	7.44	72	445	6.45	92
	4.5	239	8.28	64	370	6.89	82
Inferred	2.0	1045	4.13	139	181	3.92	23
	2.5	799	4.72	121	149	4.27	20
	3.0	**601**	**5.37**	**104**	**115**	**4.72**	**17**
	3.5	468	5.98	90	75	5.51	13
	4.0	377	6.52	79	52	6.28	11
	4.5	301	7.09	69	35	7.28	8

Source: AMC, 2020.

Table 14-21: Llama and Umwelt—Underground Tonnes and Grade Sensitivities

Resource Classification	COG (g/t Au)	Llama			Umwelt		
		Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)	Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)
Measured	2.0	152	4.02	20	18	2.85	2
	2.5	113	4.65	17	12	3.24	1
	3.0	**85**	**5.27**	**14**	**6**	**3.82**	**1**
	3.5	64	5.96	12	4	4.12	1
	4.0	49	6.63	10	2	4.85	0
	4.5	37	7.45	9	1	5.30	0
Indicated	2.0	1,137	6.22	227	7,401	6.80	1,618
	2.5	950	7.00	214	6,794	7.21	1,575
	3.0	**799**	**7.80**	**201**	**6,233**	**7.61**	**1,525**
	3.5	668	8.71	187	5,680	8.03	1,467
	4.0	574	9.52	176	5,136	8.49	1,402
	4.5	507	10.21	167	4,620	8.96	1,331
Inferred	2.0	440	5.27	75	4,558	4.74	695
	2.5	372	5.81	70	3,650	5.37	630
	3.0	**325**	**6.25**	**65**	**2,922**	**6.03**	**566**
	3.5	289	6.63	62	2,404	6.63	512
	4.0	248	7.10	57	2,043	7.14	469
	4.5	205	7.70	51	1,805	7.53	437

Source: AMC, 2020.

Table 14-22: Llama Extension and Nuvuyak—Underground Tonnes and Grade Sensitivities

Resource Classification	COG (g/t Au)	Llama Extension			Nuvuyak		
		Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)	Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)
Inferred	2.0	2,221	6.46	462	3,258	6.21	650
	2.5	1,966	7.01	443	2,820	6.83	618
	3.0	**1,744**	**7.55**	**424**	**2,417**	**7.50**	**583**
	3.5	1,545	8.11	403	2,144	8.05	555
	4.0	1,370	8.67	382	1,961	8.45	533
	4.5	1,216	9.22	361	1,782	8.87	508

Source: AMC, 2020.

14.3 George Site

The George Site consists of the LCPn, LCPs, Loc1, Loc2, SL, and GH, deposits. AMC's Ms. D. Nussipakynova, P.Geo., reviewed and validated these estimates; Ms. Nussipakynova takes responsibility for the estimates carried out in 2014.

While the George Site block models were not updated from the previous estimation, the statement has changed due to the reporting parameters, such as conceptual pit outlines being updated, and the COGs changed.

All Mineral Resources at the George Site are discussed in this section. However, this Updated Feasibility Study focuses on developing the Llama, Umwelt, Echo, and Goose Main deposits at the Goose Site.

Sabina provided the lithological domains for these deposits. The QP reviewed the domains and generally accepted them with minor additions. Sabina also carried out building of mineralization domains by using a gold threshold of 0.3 g/t Au. The QP reviewed and accepted the mineralization domains with only minor changes.

All estimations at the George Site were carried out in Datamine. Due to the narrow width of mineralization at the Loc1, Loc2, GH, and SL deposits, a two-dimensional (2-D) accumulation method was used to estimate the Mineral Resource. In this method, the gold accumulation (gold grade multiplied by horizontal thickness) and the horizontal thickness are estimated into a 2-D block model, which is required during estimation to correctly assign weights to samples of different lengths. The estimated block grade is then back-calculated by dividing estimated block gold accumulation by estimated horizontal thickness of the block. With this method, one dimension of the parent block is the horizontal thickness of the mineralization. The other parent cell dimensions are determined by the average drill-hole spacing in longitudinal section. The parent-block size varies between deposits, with the smallest block size being 20 by 10 m and the largest 25 by 25 m; most commonly, these are in the Y and Z direction, respectively.

Interpolation was carried out for all deposits using the OK method.

14.3.1 Data Used

Drill Hole Database

The data used in the estimate consisted of surface diamond drill-hole data held in a Microsoft Access® database, which was provided to AMC as Microsoft Excel® files. The data type and number of holes are shown in Table 14-23, and have not changed since 2014.

Table 14-23: George Site Drill Hole Data used in the October 2014 AMC Resource Estimate

Deposit	Year	No. of Drill Holes	No. of Assays	Metres Drilled (m)
Loc1	1986 to 1997	184	6,678	28,595
	2005	2	968	1,036
	2008	9	1,461	1,522
	2012	20	1,791	5,518
	2013	8	478	1,373
	Total	**223**	**11,376**	**38,044**
Loc2	1985 to 1997	226	12,115	39,882
	2005	4	1,697	2,102
	2006	1	413	703
	2008	10	2,123	2,189
	2012	11	2,066	3,328
	2013	20	3,412	6,323
	Total	**272**	**21,826**	**54,527**
LCPn	1985 to 1997	69	1,720	9,693
	2007	2	728	763
	2012	4	173	864
	2013	4	-	311
	Total	**79**	**2,621**	**11,631**
LCPs	1988 to 1997	3	72	270
	2006	6	770	1,323
	2007	30	9,440	9,763
	2012	6	329	1,336
	2013	43	2,613	6,555
	Total	**88**	**13,224**	**19,247**
GH	1986 to 1997	69	3,096	10,915
SL	1986 to 1997	39	2,130	5,331

Source: Sabina, 2015.
Notes: All drill holes are surface diamond drill holes.
Numbers may not directly correlate to those in the 2014 Technical Report (Tetra Tech, 2014), as drill holes were reassigned to deposit areas in August 2014.
Drill-hole data are to 31 December 2013 for all deposits, except for Loc1 and Loc2, for which some existing core was re-sampled up to 21 July 2014.

Bulk Density

The collection of bulk density measurements is described in Section 10. Mineralization at the Property is hosted within competent rock that contains minimal voids, pits, and oxidized surfaces. Previous operators undertook a comparative study between SG and bulk density measurements. As the overall difference between the two determinations was negligible (less than 1%), SG measurements are considered a good approximation of bulk density (Cater et al., 2009).

The SG values used for the main rock types of each deposit are shown in Table 14-24. For each deposit, the local specific gravities were derived using the wireframes of each rock type where possible. In the case of the GH and SL deposits, where the number of samples was less than 100 per rock type, the SGs of rock types from the entire George data set were applied. In the case of the other deposits, if there were fewer than 100 samples per rock type, data from the adjacent deposit was added to the local values. An SG of 1.80 t/m^3 was assigned to overburden material for all deposits.

Table 14-24: Mean SG Values for the George Deposits (t/m^3)

Stratigraphy	LCPn	LCPs	Loc1	Loc2	SL	GH
Upper Greywacke	2.76	2.76	N/A	N/A	N/A	N/A
Lower Greywacke	2.77	2.77	2.76	2.76	2.80	2.76
UIF	N/A	N/A	3.04	3.04	3.07	3.07
LIF	3.00	3.00	3.12	3.12	3.07	3.07
DIF	2.77	2.77	2.77	2.77	N/A	N/A
Phyllite	2.81	2.81	2.81	2.81	N/A	N/A
Pelite	N/A	2.81	N/A	N/A	N/A	2.82
Intermediate Dyke	2.81	N/A	2.76	2.76	N/A	N/A
Felsic Dyke	N/A	2.69	N/A	N/A	N/A	2.67
Mudstone	N/A	N/A	N/A	N/A	N/A	2.82
Gabbro	N/A	N/A	N/A	2.92	N/A	2.89

Source: AMC, 2015, modified 2020.

The majority of mineralization is hosted within the iron formation at the George Site. Occasionally, mineral domains were expanded beyond the iron formation to a minimum width of 2 m. These extensions were considered waste material and assigned the bulk density of the greywacke.

14.3.2 Domain Modelling

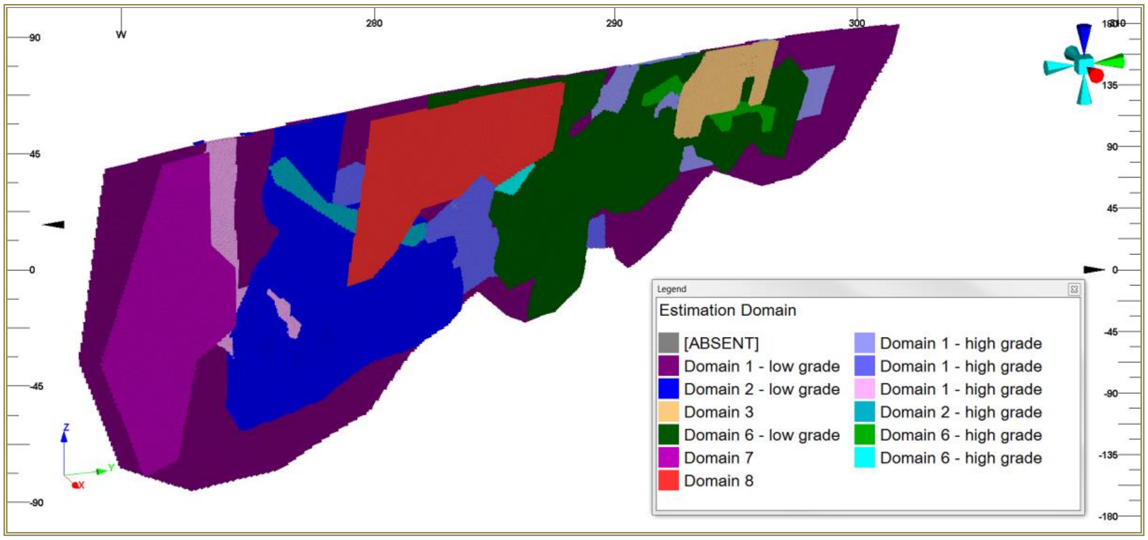
Sabina provided all geology models. The geology models for the George Site all consisted of iron formation and greywacke solids. Faults (Loc1, Loc2, SL), felsic or intermediate dykes (all deposits except SL), and mudstone or pelite and phyllite solids (all deposits except SL) were provided where necessary.

As previously mentioned, Sabina carried out building of mineralization domains using a gold threshold 0.3 g/t Au. AMC reviewed and accepted mineralization domains.

The blocks inside the block models are coded by different geological units, bulk density values, and estimated gold values. Figure 14-8 shows the mineralization domains at the Loc1 deposit.

The number of mineralization domains varied among the deposits. There were two mineralization domains each at the LCPn and LCPs deposits; five each at the GH and SL deposits; six at the Loc1 deposit (three of these zones were subdivided into low and high-grade domains before estimation, as shown in Figure 14-8); and 19 at the Loc2 deposit. The reason for the higher number of mineralization domains at Loc2 was the numerous footwall zones.

On completion of the domain modelling, visual checks were carried out to ensure that the constraining wireframes respected the raw data.



Source: AMC, 2015.

Note: Different colours represent individual mineral domains, including high-grade sub-domains.

Figure 14-8: 3-D View of Loc1 Mineralization Domains Looking Northwest

14.3.3 Statistics and Compositing

The LCPn and LCPs deposits were estimated into a normal block model; as such, AMC selected a compositing interval of 1 m, which is the median sample length. This length also gave the appropriate selectivity for the narrow-vein style of this mineralization. Composited gold assay data were then examined on a probability plot, and gold grades were capped at 40 g/t Au, affecting less than 1.5% of the samples. The raw, composited, and capped gold assay data of the LCPn and LCPs deposits are shown in Table 14-25.

Table 14-25: Statistics of Raw, Composited, and Capped Gold Assay Data—LCPn and LCPs

	LCPn			LCPs		
	Raw	Composite	Capped	Raw	Composite	Capped
No. of Samples	601	425	425	695	707	707
Minimum (Au g/t)	0.02	0.02	0.02	0.00	0.01	0.01
Maximum (Au g/t)	232.84	73.79	40.00	71.33	71.33	40.00
Mean (Au g/t)	4.94	4.81	4.55	5.90	5.80	5.70
Standard Deviation (Au g/t)	13.40	9.03	7.58	8.93	8.22	7.60
Coefficient of Variation	2.71	1.88	1.67	1.51	1.42	1.33

Source: AMC, 2015.
Note: Statistics are shown for the largest domain of each deposit.

The Loc1, Loc2, GH, and SL deposits were estimated by the 2-D accumulation method. As such, the full width of mineralization was composited in preparation for the 2-D accumulation method. True and horizontal thicknesses were calculated using the orientation of each drill hole and the average vein orientation.

The statistics of the raw and composited gold assay data are presented for the main domain of each of the deposits in Table 14-26. True thickness is presented in Table 14-26 as this is a more geologically meaningful value than horizontal thickness. However, it should be noted that all gold accumulation, thickness estimation, and dilution post-processing was completed based on horizontal thickness, to simplify the estimation process and ease of use of the block model.

After analysis, capping of gold values was not employed for the Loc1, Loc2, GH, and SL deposits.

Table 14-26: Statistics of Loc1, Loc2, GH, and SL Deposits

Deposit and Domain	Data Type Variable Weighted by	Drill Holes Au (g/t) Length	Composites		
			Au (g/t) True Thickness	True Thickness (m) Declustered Weights	Au Accumulation Declustered Weights
Loc1 Domain 1	No. of Samples	2,080	202	202	202
	Minimum	0.005	0.13	0.36	0.17
	Maximum	88.3	24.2	18.35	263.44
	Mean	4.95	4.78	5.04	24.94
	SD	8.83	4.31	3.19	33.36
	CoV	1.78	0.90	0.63	1.34
Loc2 Domain 1	No. of Samples	1,878	183	183	183
	Minimum	0	0.04	0.971	0.03
	Maximum	102.14	36.04	15.55	161.23
	Mean	4.39	4.30	4.57	19.91
	SD	8.75	4.20	2.88	26.20
	CoV	1.99	0.98	0.63	1.34
GH Domain 1	No. of Samples	294	53	53	53
	Minimum	0.01	0.0	0.2	0.0
	Maximum	96.7	14.7	12.0	93.1
	Mean	4.3	4.2	2.7	11.4
	SD	6.7	3.1	2.5	18.8
	CoV	1.56	0.7	0.9	1.6
SL Domain 2	No. of Samples	207	21	21	21
	Minimum	0.01	0.1	0.5	0.2
	Maximum	64.2	8.6	26.4	143.5
	Mean	4.5	4.5	5.3	27.8
	SD	7.4	2.7	5.3	41.5
	CoV	1.64	0.6	1.0	1.5

Source: AMC, 2015.
Notes: Statistics are for the largest domain in each deposit based on number of samples/domain.
SD = Standard Deviation; CoV = Coefficient of Variation.

14.3.4 Block Model

Block Model Parameters

The parent block size for the LCPn and LCPs deposits was 5 by 10 by 10 m with sub-blocking employed in both. Sub-blocking resulted in minimum cell dimensions of 0.25 by 1 by 1 m.

The 2-D accumulation method was used for the other George deposits where one dimension of the parent block is the horizontal thickness of the mineralization. However, the other parent cell dimensions were determined by the average drill hole spacing in longitudinal section. This cell dimension was 20 by 20 m for Loc1 and Loc2, and 25 by 25 m for the GH and SL deposits.

All George Site block model dimensions were changed while combining the grade models with geology models. The block model dimensions and rotations after combining with geology are shown in Table 14-27. The models were rotated counter-clockwise around the Z-axis.

Table 14-27: Block Model Parameters—George Site

Axis	X	Y	Z	X	Y	Z
Deposit	**LCPn**			**LCPs**		
Origin (m)	386,300	7,316,290	-30	386,650	7,315,550	-70
Parent Block Size	5	10	5	5	10	5
Rotation Angle (deg)	0	0	-30	0	0	-24
No. of Blocks	88	98	86	120	75	100
Deposit	**Loc1**			**Loc2**		
Origin (m)	387,175	7,313,400	-40	388,000	7,312,330	-340
Parent Block Size	10	10	5	10	10	5
Rotation Angle (deg)	0	0	-30	0	0	-30
No. of Blocks	40	140	84	48	124	144
Deposit	**GH**			**SL**		
Origin (m)	390,390	7,309,460	-130	389,480	7,312,470	-10
Parent Block Size	2	5	5	2	5	5
Rotation Angle (deg)	0	0	-38	0	0	-25
No. of Blocks	220	250	150	250	100	90

Source: AMC, 2015, modified 2020.

14.3.5 Variography and Grade Estimation

Variography was carried out on all domains that had sufficient sample density. If a domain did not have enough sample density for variography, the adjacent domain was used. The exception to this was the SL deposit, which had insufficient sample density for variography in all domains; therefore, the variography from the GH deposit was used instead.

Interpolation was carried out using the OK method. Several passes were employed, which used increasing search ellipsoid distances. The objective of the search strategy was to capture approximately two lines of drilling in the first pass, then expand the search in the second and third passes to allow the estimate to capture the minimum number of samples required.

A fourth pass was employed with a large search distance and relaxed search criteria to fill blocks that were un-estimated after three passes. There is low confidence in the grade of the fourth pass blocks, and the majority of them are excluded from the Mineral Resource.

The search parameters are provided in Table 14-28. For the SL and Loc2 deposits, the parameters for the largest domain are shown.

Table 14-28: Minimum and Maximum Sample Parameters—George Site

Deposit	Pass	Search Distance Major Direction (m)	Search Distance Semi-Major Direction (m)	Search Distance Across Strike (m)	Minimum No. of Samples	Maximum No. of Samples	Minimum No. of Drill Holes
LCPn	1	30	20	5	4	16	2
	2	60	40	10	4	16	2
	3	100	65	15	4	16	2
	4	300	195	45	1	16	2
LCPs	1	30	20	5	4	16	2
	2	60	40	10	4	16	2
	3	100	65	15	4	16	2
	4	300	195	45	1	16	1
Loc1	1	60	60	N/A	6	16	6
	2	90	90	N/A	6	16	6
	3	120	120	N/A	6	16	6
	4	200	200	N/A	1	16	1
Loc2 (Domain 1)	1	120	100	N/A	6	16	6
	2	180	150	N/A	6	16	6
	3	200	200	N/A	2	16	2
	4	200	200	N/A	1	16	1
GH	1	65	40	N/A	2	4	2
	2	130	80	N/A	2	4	2
	3	195	120	N/A	2	4	2
	4	260	160	N/A	2	4	2
SL (Domain 2)	1	60	50	N/A	2	3	2
	2	90	75	N/A	2	3	2
	3	120	150	N/A	1	3	1

Source: AMC, 2015.

14.3.6 Block Model Validation

The block models were validated by visual checks, statistical comparisons, and swath plots. The validation showed that the grades in the block model had a satisfactory match to the composite data.

14.3.7 Resource Classification

AMC classified the Mineral Resource with consideration of the narrow-vein style of mineralization, observed gold grade continuity, and drill hole spacing. The nominal drill hole sample spacing in the Indicated Mineral Resource in longitudinal projection was approximately 30 by 30 m, while the nominal drill hole sample spacing in the Inferred Mineral Resource in longitudinal projection was approximately 50 by 50 m. Currently, there is insufficient knowledge of the structural style and continuity of the mineralization to support a Measured Resource category for the George Site deposits.

14.3.8 Mineral Resource Estimates

Mineral Resource estimates consisted of underground and open pit Mineral Resources for all the George Site deposits.

Open pit Mineral Resources were reported between a base-of-overburden surface and a conceptual pit shell based on a US$1,550/oz Au price with C$1.31:US$1.00 exchange rate. Assumptions considered for the conceptual pit shell included mining costs, processing costs, and gold recoveries obtained from Sabina and validated by the QP; these are shown in Table 14-29. A COG of 1.4 g/t Au was applied for reporting the open pit Mineral Resources. A COG of 3.5 g/t Au was applied for underground Mineral Resources. Underground Mineral Resources were reported within mineral domains which were expanded to a minimum width of 2 m where required.

Table 14-29: Conceptual Mineral Resource Open Pit Shell Parameters

Item	Unit	Open Pit Optimization Parameters
Gold Price	US$/oz	1,550
Exchange Rate	C$:US$	1.31:1.00
Refining/Transport	$/oz	2
Royalties	%	4.8
Processing Costs	$/t ore	29.92
General and Administrative	$/t ore	49.85
Base Mining Costs including Transportation to Goose Mill	$/t	7
Preliminary Overall Slope Angles	degrees	44–47
IPFS Optimization Metallurgical Recovery	%	95

Source: AMC, 2020.

The results of the George Site open pit and underground Mineral Resource estimates as of 31 December 2020 are shown in Table 14-30.

Table 14-30: George Site Mineral Resource Estimates

Resource Classification	Deposit	Open Pit / Underground	Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)
Indicated	LCPn	Open Pit	543	6.19	108
		Underground	183	6.98	41
	LCPs	Open Pit	1,087	6.04	211
		Underground	108	7.96	28
	Loc1	Open Pit	2,105	4.92	333
		Underground	397	5.86	75
	Loc2	Open Pit	1,031	3.85	128
		Underground	1,221	6.19	243
	SL	Open Pit	190	4.68	29
		Underground	49	4.81	8
	GH	Open Pit	222	3.02	22
		Underground	7	4.14	1
Indicated Total			**7,143**	**5.34**	**1,227**
Inferred	LCPn	Open Pit	21	6.07	4
		Underground	111	5.09	18
	LCPs	Open Pit	27	4.55	4
		Underground	115	8.05	30
	Loc1	Open Pit	182	3.46	20
		Underground	1,341	6.96	300
	Loc2	Open Pit	69	2.21	5
		Underground	2,387	6.12	470
	SL	Open Pit	146	4.88	23
		Underground	322	5.09	53
	GH	Open Pit	550	6.4	113
		Underground	97	5.19	16
Inferred Total			**5,368**	**6.12**	**1,056**

Source: AMC, 2020.

Notes: CIM Definition Standards (CIM, 2014) were used for reporting the Mineral Resources.
The QP is Dinara Nussipakynova, P.Geo. of AMC.
Measured and Indicated Mineral Resources are inclusive of Mineral Reserves.
Metal price: US$1,550/oz for gold
Exchange rate C$1.31:US$1.00.
Process Recovery is 95%.
COG: open pit is 1.4 g/t Au, underground is 3.5 g/t Au.
Open pit Mineral Resources are constrained by an optimized pit shell using gold price and exchange stated above.
The underground Mineral Resources were estimated within mineral domains expanded to a minimum horizontal width of 2 m.
Drilling results for all George deposits are up to 31 December 2013.
The numbers may not add due to rounding.

The sensitivity to COG for the open pit component of LCPn and LCPs is shown in Table 14-31, sensitivities for Loc1 and Loc2 are shown in Table 14-32; and sensitivities for GH and SL are shown in Table 14-33. Note the selected COG for reporting is shown in bold.

Table 14-31: LCPn and LCPs—Open Pit Tonnes and Grade Sensitivities

Resource Classification	COG (g/t Au)	LCPn			LCPs		
		Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)	Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)
Indicated	1.0	573	5.93	109	1,128	5.86	213
	1.2	561	6.04	109	1,110	5.94	212
	1.4	**543**	**6.19**	**108**	**1,087**	**6.04**	**211**
	1.6	528	6.32	107	1,063	6.14	210
	1.8	523	6.37	107	1,040	6.24	209
	2.0	514	6.45	107	1,015	6.34	207
Inferred	1.0	23	5.70	4	27	4.55	4
	1.2	22	5.73	4	27	4.55	4
	1.4	**21**	**6.07**	**4**	**27**	**4.55**	**4**
	1.6	20	6.20	4	27	4.55	4
	1.8	18	6.81	4	27	4.55	4
	2.0	18	6.81	4	27	4.57	4

Source: AMC, 2020.

Table 14-32: Loc1 and Loc2—Open Pit Tonnes and Grade Sensitivities

Resource Classification	COG (g/t Au)	Loc1			Loc2		
		Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)	Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)
Indicated	1.0	2,234	4.71	338	1,091	3.71	130
	1.2	2,152	4.85	335	1,057	3.79	129
	1.4	**2,105**	**4.92**	**333**	**1,031**	**3.85**	**128**
	1.6	2,042	5.03	330	1,008	3.91	127
	1.8	1,952	5.18	325	998	3.93	126
	2.0	1,825	5.41	318	980	3.97	125
Inferred	1.0	274	2.69	24	84	2.01	5
	1.2	213	3.15	22	74	2.13	5
	1.4	**182**	**3.46**	**20**	**69**	**2.21**	**5**
	1.6	164	3.69	19	60	2.30	4
	1.8	155	3.80	19	47	2.45	4
	2.0	140	4.00	18	41	2.53	3

Source: AMC, 2020.

Table 14-33: GH and SL—Open Pit Tonnes and Grade Sensitivities

Resource Classification	COG (g/t Au)	GH			SL		
		Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)	Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)
Indicated	1.0	252	2.80	23	199	4.52	29
	1.2	243	2.86	22	195	4.59	29
	1.4	**222**	**3.02**	**22**	**190**	**4.68**	**29**
	1.6	210	3.10	21	190	4.68	29
	1.8	188	3.27	20	190	4.68	29
	2.0	174	3.37	19	190	4.68	29
Inferred	1.0	605	5.93	115	150	4.76	23
	1.2	579	6.14	114	146	4.88	23
	1.4	**550**	**6.40**	**113**	**146**	**4.88**	**23**
	1.6	540	6.49	113	146	4.88	23
	1.8	528	6.60	112	146	4.88	23
	2.0	526	6.62	112	142	4.97	23

Source: AMC, 2020.

The sensitivity to COG for the underground component of LCPn and LCPs is shown in Table 14-34, sensitivities for Loc1 and Loc2 are shown in Table 14-35; and sensitivities for GH and SL are shown in Table 14-36. Note the selected COG for reporting is shown in bold.

Table 14-34: LCPn and LCPs—Underground Tonnes and Grade Sensitivities

Resource Classification	COG (g/t Au)	LCPn			LCPs		
		Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)	Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)
Indicated	2.0	264	5.65	48	127	7.16	29
	2.5	231	6.13	46	119	7.47	29
	3.0	198	6.69	43	113	7.73	28
	3.5	**183**	**6.98**	**41**	**108**	**7.96**	**28**
	4.0	168	7.27	39	102	8.20	27
	4.5	145	7.76	36	95	8.48	26
Inferred	2.0	214	3.85	26	170	6.30	34
	2.5	162	4.38	23	148	6.90	33
	3.0	122	4.92	19	124	7.70	31
	3.5	**111**	**5.09**	**18**	**115**	**8.05**	**30**
	4.0	81	5.60	15	108	8.32	29
	4.5	68	5.85	13	100	8.63	28

Source: AMC, 2020.

Table 14-35: Loc1 and Loc2—Underground Tonnes and Grade Sensitivities

Resource Classification	COG (g/t Au)	Loc1			Loc2		
		Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)	Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)
Indicated	2.0	680	4.56	100	1,905	4.95	303
	2.5	580	4.97	93	1,669	5.33	286
	3.0	505	5.30	86	1,431	5.75	265
	3.5	**397**	**5.86**	**75**	**1,221**	**6.19**	**243**
	4.0	341	6.22	68	1,016	6.68	218
	4.5	312	6.40	64	861	7.13	197
Inferred	2.0	1,762	5.92	335	6,047	4.03	784
	2.5	1,570	6.37	322	4,396	4.69	662
	3.0	1,453	6.66	311	3,350	5.30	571
	3.5	**1,341**	**6.96**	**300**	**2,387**	**6.12**	**470**
	4.0	1,280	7.11	293	1,885	6.75	409
	4.5	1,085	7.62	266	1,579	7.24	368

Source: AMC, 2020.

Table 14-36: GH and SL—Underground Tonnes and Grade Sensitivities

Resource Classification	COG (g/t Au)	GH			SL		
		Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)	Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)
Indicated	2.0	29	2.94	3	106	3.87	13
	2.5	17	3.42	2	103	3.90	13
	3.0	12	3.74	1	87	4.12	12
	3.5	**7**	**4.14**	**1**	**49**	**4.81**	**8**
	4.0	2	5.45	0.3	48	4.83	7
	4.5	1	6.63	0.2	37	5.05	6
Inferred	2.0	197	3.86	24	422	4.57	62
	2.5	140	4.52	20	405	4.66	61
	3.0	116	4.87	18	361	4.89	57
	3.5	**97**	**5.19**	**16**	**322**	**5.09**	**53**
	4.0	77	5.57	14	292	5.22	49
	4.5	64	5.84	12	219	5.56	39

Source: AMC, 2020.

14.4 Comparison with Previous Resource Estimates

The previous Mineral Resource estimates on the Property (JDS, 2015b) had an effective date of 21 October 2014. Changes to the Mineral Resource estimates in this report are due primarily to:

- New drilling at the Umwelt deposit and the updated block model
- Some new data incorporated into the Goose Main and Echo block models
- New drilling at Llama resulting in the Llama Extension and new block model
- Recently discovered Nuvuyak deposit
- Updated conceptual pit shells
- Changed reporting COGs.

A comparison between the 2014 and 2020 Mineral Resource statements is shown in Table 14-37.

Table 14-37: Comparison of 2014 and 2020 Mineral Resource Estimates

Deposit	AMC—21 October 2014			AMC—31 December 2020			Difference		
	Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)	Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)	Tonnes (%)	Grade (%)	Au (%)
Measured									
Goose Main Open Pit	4,478	4.32	621	4,265	4.67	640	-5	8	3
Goose Main Underground	110	6.24	22	52	5.08	9	-53	-19	-59
Llama Open Pit	1,874	5.86	353	1,774	6.29	359	-5	7	2
Llama Underground	110	5.72	20	85	5.27	14	-23	-8	-30
Umwelt Open Pit	3,699	6.07	722	3,525	6.82	773	-5	12	7
Umwelt Underground	1	9.21	0.3	6	3.82	1	567	-59	233
Total Measured	**10,273**	**5.27**	**1,740**	**9,707**	**5.75**	**1,796**	**-6**	**9**	**3**
Indicated									
Goose Main Open Pit	2,877	4.19	388	3,758	4.02	486	31	-4	25
Goose Main Underground	853	7.32	201	563	5.57	101	-34	-24	-50
Echo Open pit	321	6.07	63	290	6.73	63	-10	11	0
Echo Underground	596	6.17	118	694	5.37	120	16	-13	2
Llama Open Pit	821	6.01	159	851	6.66	182	4	11	14
Llama Underground	752	8.72	211	799	7.80	201	6	-10	-5
Umwelt Open Pit	1,963	5.38	340	3,414	5.64	620	74	5	82
Umwelt Underground	3,387	8.92	972	6,233	7.61	1,525	84	-15	57
George Open Pit	4,321	5.04	700	5,178	4.99	831	20	-1	19
George Underground	2,079	6.62	443	1,965	6.27	396	-5	-5	-11
Total Indicated	**17,969**	**6.22**	**3,593**	**23,745**	**5.93**	**4,525**	**32**	**-5**	**26**
Total Measured & Indicated	**28,242**	**5.87**	**5,333**	**33,452**	**5.88**	**6,321**	**18**	**0.1**	**19**

Deposit	AMC—21 October 2014			AMC—31 December 2020			Difference		
	Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)	Tonnes ('000s)	Grade (g/t Au)	Au (oz '000s)	Tonnes (%)	Grade (%)	Au (%)
Inferred									
Goose Main Open Pit	215	3.20	22	224	3.97	29	4	24	32
Goose Main Underground	429	6.83	94	601	5.37	104	40	-21	11
Echo Open pit	-	-	-	0.3	5.48	0.05	100	100	100
Echo Underground	71	5.91	14	115	4.72	17	62	-20.1	21
Llama Open Pit	0	0	0	13	7.40	3	100	100	100
Llama Underground	295	6.77	64	325	6.25	65	10	-7.7	2
Umwelt Open Pit	121	2.29	9	65	4.31	9	-46	88.4	0
Umwelt Underground	1,788	11.59	667	2,922	6.03	566	63	-48.0	-15
Llama Extension Underground	-	-	-	1,744	7.55	424	100	100	100
Nuvuyak Underground	-	-	-	2,417	7.50	583	100	100	100
George Open Pit	929	4.75	142	995	5.28	169	7	11.2	19
George Underground	3,902	6.69	840	4,373	6.31	887	12	-5.7	6
Total Inferred	**7,750**	**7.43**	**1,851**	**13,794**	**6.44**	**2,856**	**78**	**-13.3**	**54**

Source: AMC, 2020.

Notes: CIM Definition Standards (CIM, 2014) were used for reporting the Mineral Resources.

2014:

- Open pit Mineral Resources were constrained by optimized pit shells at a gold price of US$1,500/oz Au with a C$1.00:US$1.00 exchange rate.
- Open pit COG was 1.0 g/t Au.
- Underground COG was 4.0 g/t Au for George deposits and 3.5 g/t Au for all the Goose deposits except Umwelt, which was 4.5 g/t Au.
- Drilling results up to 31 December 2013, were included except for the October Echo estimate (4 July 2014) and the October Loc1 and Loc2 estimates (31 July 2014).

2020:

- Metal price: US$1,550/oz for gold with an exchange rate: C$1.31:US$1.00.
- In 2020 the COG applied to the open pit resources was 1.4 g/t Au.
- In 2020 the underground COG is 3.5 g/t Au for George deposits and 3.0 g/t Au for all the Goose deposits.
- Drilling results for Goose Main, Echo, Llama Extension and Nuvuyak are up to 15 November 2020.
- Drilling results for Umwelt are up to 16 October 2020.
- Drilling results for Llama and all George deposits are up to 31 December 2013.

For both estimates the George underground Mineral Resources (LCPn, LCPs, Loc1, Loc2, GH, and SL) were estimated within mineral domains expanded to a minimum width of 2 m.

The numbers may not add due to rounding.

The comparison of the 2020 Mineral Resource estimate with the 2014 estimate shows:

- Measured tonnes have decreased by 6%, while grade increased by 9% and gold ounces increased by 3%. The difference in Measured Resource reflects the increase of reporting COG from 1.0 g/t in to 1.4 g/t Au.
- Indicated tonnes increased by 32%, while grade decreased by 5% and ounces increased by 26%. The increase in Indicated tonnes reflects the update of Umwelt deposit, where new drilling results led to an increase in Indicated category of the mineralization with depth.
- Inferred tonnes increased by 78%, while grade decreased by 13% and ounces increased by 54%. The significant increase is due to discoveries of the Llama Extension and Nuvuyak.

15 MINERAL RESERVE ESTIMATES

15.1 Introduction

The Mineral Reserves documented in this section are estimated based on CIM guidelines that define Mineral Reserves as "**the economically mineable part of a Measured or Indicated Mineral Resource**" (CIM, 2014, p. 6)... "demonstrated ... by at least a Pre-Feasibility Study" (CIM, 2014, p. 7). This must include adequate information on mining, processing, metallurgical, economic, and other relevant factors that demonstrate, at the time of reporting, that economic extraction can be justified. A Mineral Reserve "**includes diluting materials and allowances for losses which may occur when the material is mined**" (CIM, 2014, p. 6).

"*Mineral Reserves are those parts of Mineral Resources which, after the application of all mining factors, result in an estimated tonnage and grade which, in the opinion of the Qualified Person(s) making the estimates, is the basis of an economically viable project after taking account of all relevant*" (CIM, 2014, p6)… "**processing, metallurgical... economic, marketing, legal, environmental, social and governmental factors**" (CIM, 2014, p. 6).

> *Mineral Reserves are inclusive of diluting material that will be mined in conjunction with the Mineral Reserves and delivered to the treatment plant or equivalent facility. The term 'Mineral Reserve' need not necessarily signify that extraction facilities are in place or operative or that all governmental approvals have been received. It does signify that there are reasonable expectations of obtaining such approvals.* (CIM, 2014, p. 6)

To convert Mineral Resources to Mineral Reserves, estimates of the gold price, mining dilution, process recovery, refining/transport costs, royalties, mining costs (both open pit and underground), processing costs, selling costs, and overhead costs were used to estimate COG for each deposit. Along with geotechnical parameters, COGs formed the basis for the selection of economic mining blocks.

The delineation of Mineral Reserves is based on the review of the previous study (JDS, 2015b), modification and addition of underground deposits, and reworking of mine plans based on revisions and updates to Mineral Resources as disclosed in Section 14.

The QPs have not identified any known legal, political, environmental, or other risks that would materially affect the potential development of the Mineral Reserves.

A summary of the Mineral Reserves for the Project is shown in Table 15-1. The effective date for all the Mineral Reserves contained in this report is 15 January 2021.

The Mineral Reserve estimations take into consideration on-site operating costs (e.g., mining, processing, site services, freight, power generation, logistics, and general and administrative [G&A]), geotechnical analysis for both open pit wall angles and underground stope size, metallurgical recoveries, and selling costs., The Mineral Reserves also incorporate allowances for mining recovery, dilution, and overall economic viability.

Table 15-1: Summary of Mineral Reserves (effective date 15 January 2021)

Site/Reserve Category	Mining Method	Diluted Ore (t '000s)	Diluted Gold Grade (Au g/t)	Contained Gold (oz '000s)
Proven	Open Pit	7,471	5.42	1,302
Probable	Open Pit	2,412	4.80	372
Proven	Underground	537	7.21	124
Probable	Underground	8,272	6.73	1,790
Proven	Open Pit & Underground	8,008	5.54	1,426
Probable	Open Pit & Underground	10,684	6.29	2,162
Total Proven and Probable	**Open Pit & Underground**	**18,692**	**5.97**	**3,588**

Source: MP, 2021.
Notes: A gold price of US$1,500/oz is assumed.
An exchange rate of C$1.31:US$1.00 is assumed.
Mineral Reserves are based only on Measured and Indicated Mineral Resources.
Marginal COG based on optimization design criteria.

15.2 Open Pit Mineral Reserves

15.2.1 Umwelt, Llama, and Goose Open Pit Mineral Reserve Basis of Estimate

For the Umwelt, Llama, and Goose Main deposits, no additional pit optimization has been completed. The pit optimizations completed for the 2015 study are relevant for the Umwelt, Llama, and Goose Main areas of the deposits based on the review completed by MP, as JDS (2015b) used conservative metal prices versus current prices. JDS (2015b) included the use of Datamine NPV Scheduler (NPVS)™ software, application of COGs, and selection of pit shells based on economic optimization. The selected shells were the basis for the subsequent design of open pits, including, ramps, berms, and battered bench faces.

The open pit designs provided in JDS (2015b) were then reviewed by MP, with updated metal pricing, operating costs, and operating framework to confirm their economic viability. The pit wall slopes were reviewed against geotechnical stability criteria.

15.2.2 Echo Open Pit Mineral Reserves Basis of Estimate

Sabina completed studies on the use of a larger Echo open pit for mill tailings disposal. The study showed improved economic results for the Project based on the following:

- The use of the Echo pit for backfilled tailings allows the removal of the tailings storage facility (TSF) construction from the capital costs.
- The excavation of the Echo pit is shown to have lower construction risk than that of a dedicated TSF, for numerous reasons, including:
  - The requirement for construction in winter
  - The quantity of detailed construction work required to complete the TSF.
- Echo open pit is closer to the mill facility than the TSF, which reduces operability risks for the tailings pipeline.
- The TSF, as planned, required a higher reclamation bond to be placed than the Echo facility.

With the TSF no longer in the plan, MP conducted pit optimization work on the Echo deposit, and in correspondence with Sabina selected a pit shell with sufficient volume to allow for two years of mill tailings capacity.

15.2.3 Mining Method and Mining Costs

MP reviewed the limits of the open pit shell versus underground method of extraction determined by JDS for Umwelt, Llama, and Goose Main. The limit of open pit versus underground at Echo was determined by the required tailings capacity, to ensure the pit is completed before the start of production. The MP optimization of Echo, and the JDS analysis and subsequent MP review of Umwelt, Llama, and Goose Main, results in four open pits.

15.2.4 Loss and Dilution

MP reviewed the dilution completed by JDS and found that an external mining dilution calculation was applied to various deposits as detailed below.

This external mining dilution was based on a calculation of the number of waste blocks adjacent to an ore block in the mineral inventory block model using Hexagon Mining's MineSight™ (MineSight) "four side contact routine." Ore blocks were those above a given gold COG that were within a given zone—in this case a resource classified as Measured or Indicated.

The waste block edges for each block were calculated on each horizontal plane in the model. This is shown in Figure 15-1 for a typical bench in Umwelt, where the number of waste edges can vary from zero (i.e., the block is surrounded by all ore blocks) to four (i.e., the block is surrounded by all waste blocks). Dilution was estimated using the number of waste edges for each block, a gold grade of zero was assumed for all waste, and a dilution width of 0.30 m for each waste block's edge, which was deemed appropriate based on MP's review of similar deposits.

The results of the above analyses are summarized, by deposit, in Table 15-2. As a result of the analyses, external dilutions of 4%, 9%, 7%, and 10% were applied to the Echo, Llama, Umwelt, and Goose Main deposits, respectively.

MP reviewed the recovery factor used by JDS and found that no factor was present in the block model. A global mineral loss factor of 4% was therefore added based on benchmark analysis of similar deposit types. The loss of ore is due to operational blasting movement of ore and waste, misdirected ore sent to waste, or carry-back material (buildup of frozen material in truck boxes).

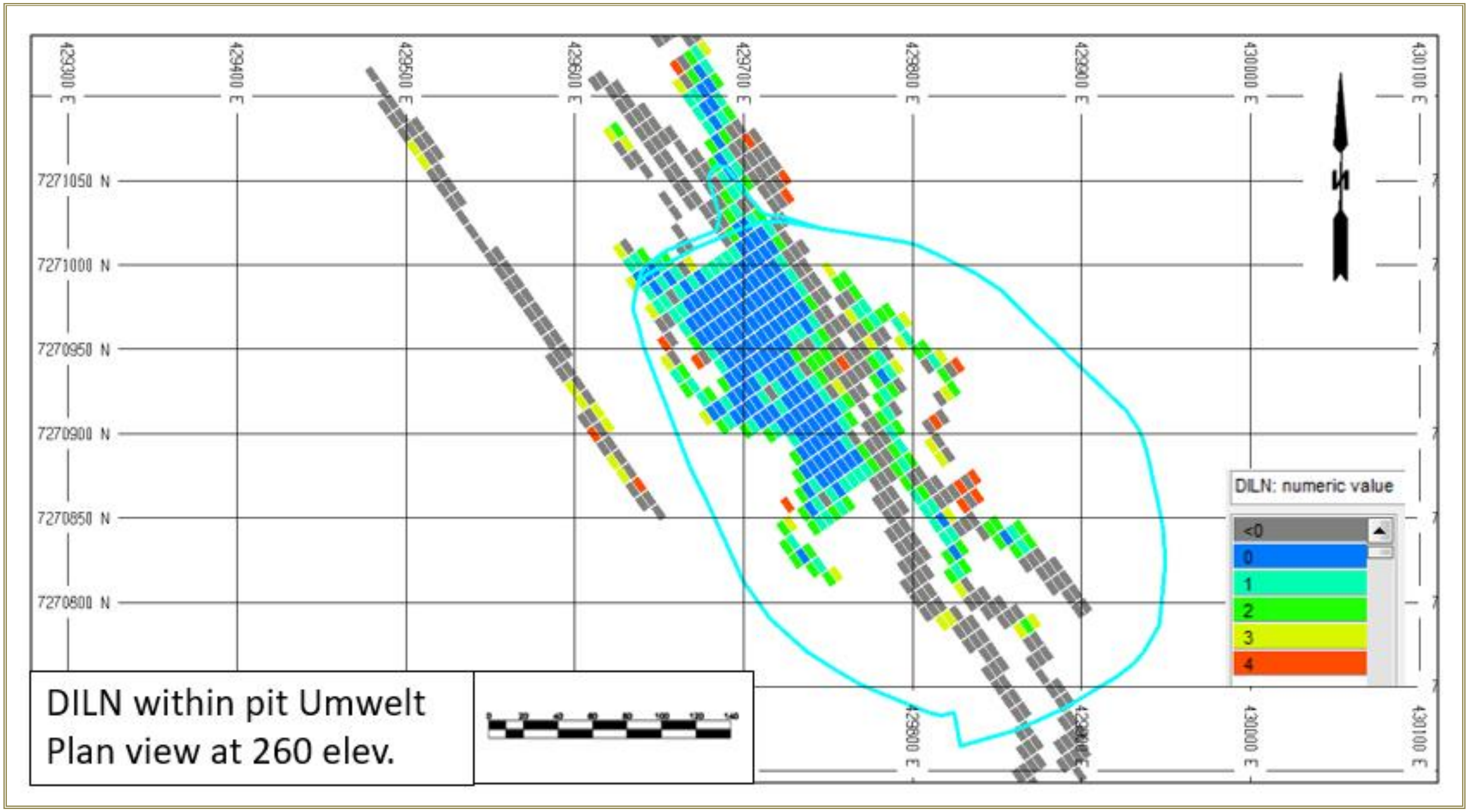


Figure 15-1: Umwelt Main Bench Plan View at Elevation 260 masl

Table 15-2: Open Pit Dilution Estimates by Deposit

No. of Waste Edges	Llama				Umwelt				Goose Main				Echo			
	No. of Blocks	Distribution (%)	Dilution Applied (%)	Contribution to Total External Dilution (%)	No. of Blocks	Distribution (%)	Dilution Applied (%)	Contribution to Total External Dilution (%)	No. of Blocks	Distribution (%)	Dilution Applied (%)	Contribution to Total External Dilution (%)	No. of Blocks	Distribution (%)	Dilution Applied (%)	Contribution to Total External Dilution (%)
0	1,600	18	0	0	8,588	32	0	0	3,164	16	0	0	1,111	23	0	0
1	2,818	31	6	1.8	7,892	29	6	1.7	5,319	27	6	1.6	1,495	30	3	0.9
2	2,715	30	12	3.6	6,780	25	12	3.0	6,612	33	12	4.0	1,818	37	6	2.2
3	1,526	17	18	2.7	2,834	11	18	1.7	3,643	18	18	2.9	373	8	9	0.7
4	504	6	24	1.3	1,001	4	24	0.9	1,301	6	24	1.6	130	3	12	0.3
Total	**9,163**	**100**		**9.4**	**27,095**	**100**		**7.3**	**20,039**	**100**		**10.0**	**4,927**			**4.1**

15.2.5 Geotechnical Considerations

Knight Piésold carried out field investigations and analyses designed to characterize geotechnical and hydrogeological conditions required for feasibility-level open pit designs. The various pit slope design parameters, including geotechnical considerations, are discussed in detail in Section 16.

Based on the location and characteristics of the geomechanical domains and pit shells, design sectors were identified for each of the proposed pits. Slope stability analyses were undertaken in each sector to define achievable slope configurations. These analyses included kinematic and limit-equilibrium analyses. The results provided guidance regarding achievable bench faces, and inter-ramp and overall slope angles for each design sector, as presented in Section 15.2.7.

The results of the Knight Piésold analyses and a review confirm that the recommended geometries are reasonable and appropriate. To achieve these angles, the design assumes that controlled blasting and proactive geotechnical monitoring would be undertaken, along with an ongoing commitment to geomechanical data collection and analyses during future stages of design. Maintaining flexibility in the mine plan would be important to accommodate any slope-stability issues.

15.2.6 Echo Lerchs–Grossman Optimization

The sizes and shape of the ultimate Echo open pit were obtained using the optimizing Lerchs–Grossman (LG) algorithm, as implemented in GEOVIA Whittle software. Key inputs used for the LG runs are shown in Table 15-3.

It must be noted that the key open pit optimization input parameters may differ from the final parameters used in the Project economic model. MP has reviewed the differences and concluded that the variances are immaterial to the pit designs.

Table 15-3: Echo Optimization Parameters

Item	Unit	Optimization Assumption
Revenue, Smelting, and Refining		
Gold Price	US$/oz	1,500
Payable Metal	% Au	99.8
Refining/Transport	US$/oz	2
Royalties % of NSR	US$/oz	4.25
Exchange Rate	C$:US$	1.31:1.00
Net Return	$/oz	1,872
	$/g	60
Open Pit OPEX Estimates		
OP Mining Cost	$/t mined	4.13
Goose Deposits Processing Cost	t:t	41.00
Sealift/WIR Costs	$/t milled	15.00
Site Services	$/t milled	12.19
Stockpile Re-Handling Costs	$/t milled	1.00
G&A	$/t milled	10.00
Freight	$/t milled	5.00
Total OPEX Estimate (Excluding Mining)	**$/t milled**	**84.19**
Process and Mining Losses		
Process Recovery	%	95.5
External Mining Dilution—OP	%	4
Geotechnical Parameters		
Slope Angles (Overall)	degrees	40 to 50

Source: MP, 2021.

15.2.7 Cut-Off Grade and Mineral Reserves Criteria

Once pit shapes were established, marginal COG were used to determine the total amount and grade of ore in each pit. The marginal, or incremental, COG is specific to the mining method, and is defined as the minimum grade at which mineralized material already located at the pit rim (i.e., contained within the pit and already mined) pays for all additional costs incurred if it is sent for processing. According to this definition, the marginal COG corresponds to a break-even grade that excludes mining costs. The open pit Mineral Reserves comprise all mineralized material with grades equal to or above this marginal COG. Incremental COGs are shown in Table 15-4.

Table 15-4: Incremental COGs—OP

Item	COG (g/t Au)
Umwelt Pit	1.52
Goose Main Pit	1.47
Llama Pit	1.52
Echo Pit	1.46

Source: MP, 2021.
Note: Diluted gold grades.

Detailed pit design involves converting the optimized pit shells into an operational open pit mine design, which is discussed further in Section 16. Table 15-5 shows the main geometrical parameters used in the pit design.

***Table 15-5: Ultimate Pit Design Parameters*—All Pits**

Description	Umwelt	Llama	Goose	Echo
Bench Height	5 m (single, working)	5 m (single, working)	5 m (single, working)	5 m (single, working)
	20 m (quadruple; final pit)	20 m (quadruple; final pit)	20 m (quadruple; final pit)	20 m (quadruple; final pit)
Face Angle	65° to 75°	75°	75°	55° to 75°
Berm Width	8.6 m to 10 m	8.6 m to 10 m	8.6 m to 10 m	8.6 m to 10 m
Inter-Ramp Angle (IRA)	48° to 55°	52° to 55°	52° to 55°	42° to 55°
Ramp Width—Double Lane	20 m	20 m	20 m	20 m
Ramp Width (Single-Lane–Lower Benches)	15 m	15 m	15 m	15 m
Ramp Gradient	10% 12% (for pit bottom access)	10% 12% (for pit bottom access)	10% 12% (for pit bottom access)	10% 12% (for pit bottom access)
Overall Slope Angle (OSA)	39.6° to 45.5°	41.2° to 47.7°	47.2° to 50.2°	40° to 53°

Source: JDS, 2015a; Knight Piésold, 2015a.

15.2.8 Open Pit Mineral Reserves Estimate

The open pit Mineral Reserves are shown in Table 15-6.

Table 15-6: Back River Open Pit Mineral Reserves Estimate

Deposit	Category	Total Ore (t '000s)	Au COG (g/t)	Au Grade (g/t)	Contained Au (oz '000s)
Umwelt	Proven	2,385	1.52	6.05	464
	Probable	314		4.00	40
Llama	Proven	1,443	1.52	6.66	309
	Probable	403		7.01	91
Goose Main	Proven	3,643	1.47	4.51	529
	Probable	1,433		4.07	187
Echo	Proven		1.46	-	-
	Probable	261		6.36	53
Total Open Pit Mineral Reserves	**Proven**	**7,471**	**-**	**5.42**	**1,302**
	Probable	**2,412**		**4.80**	**372**
	Total	**9,883**		**5.27**	**1,674**

Notes: A gold price of US$1,500/oz is assumed.
An exchange rate of C$1.31 to US$1.00 is assumed.
Mineral Reserves are based only on Measured and Indicated Mineral Resources.
Marginal cut-off grade based on pit optimization design criteria.
Diluted Au grades.
Diluted recovered tonnes.

15.3 Underground Mineral Reserves

MP re-evaluated the underground Mineral Reserves, including the following adjustments:

- Llama underground mine plans were revised for the revised COG.
- Umwelt underground mine plans were revised based on the updated Mineral Resource. Umwelt now includes deeper high-grade zones, as well as the inclusion of crown pillar resources. The underground mine design also includes a revision to the underground access to benefit from a planned exploration decline, for which Sabina has commenced construction.
- Echo underground mine plans were revised to account for the larger open pit, the updated Mineral Resources, and revision to underground access.
- Goose Main underground mine plans were revised based on updated Mineral Resources and revision to underground access.

Underground mining at Umwelt, Llama, and Goose Main includes excavation of areas of the crown pillar. Mining of the crown pillars occurs where comparatively high grades justify the use of cemented rockfill (CRF) to create a "plug."

The mining of the crown pillar at Umwelt is subject to the following principles:

- The selective mining of high-grade areas in the crown pillar
- Advance mining of the open pit prior to mining of the crown pillar
- Application of a 15 m permanent pillar between the completed pit and the final underground excavation
- Tight filling of the crown pillar with CRF prior to the storage of tailings in the open pit
- Controlled retreat mining with tight filling for selected zones where any undercutting of CRF is warranted by continuous high grade
- Installation of ground stability monitoring equipment in the crown pillar for advance warning of ground movement.

The mining of the crown pillar at Goose Main and Llama is subject to the following principles:

- The selective mining of high-grade areas in the crown pillar
- Advance mining of the crown pillar ahead of open pit mining
- Tight filling of the crown pillar with CRF
- Controlled retreat mining with tight filling for selected zones where any undercutting of CRF is warranted by continuous high grade
- Installation of ground stability monitoring equipment in the crown pillar for advance warning of ground movement.

Three mining methods have been selected and applied for the feasibility assessment. These are selected based on favouring lower risk, selective mining, lower dilution, higher mining recovery, and flexibility to adapt to unexpected changes in mineralization and/or ground conditions. Post-pillar-cut-and-fill (PPCF) was also considered but not selected. The three mining methods selected are listed below:

1. Drift-and-fill (DF)/cut-and-fill (CF) using CRF throughout
2. CF/CF with partial use of CRF
3. Sub-level stoping.

15.3.1 Cut-Off Grade and Stope Optimization Parameters

The COG for the underground deposits is included below:

- Umwelt 3.9 g/t
- Umwelt crown pillar 4.8 g/t
- Llama 4.1 g/t
- Llama crown pillar 5.0 g/t
- Goose Main 4.1 g/t
- Goose Main crown pillar 5.0 g/t
- Echo 3.5 g/t.

The Mineral Reserve Estimate contains some mineralized material in development drifts that is below COG. This material must be excavated to access stopes above COG. Where this material is greater than 3 g/t—sufficient to return a positive cash flow after processing—it is included in the Mineral Reserves and may be processed immediately or stockpiled for processing later.

The COG and subsequent stope optimization analysis were estimated based on the assumptions shown in Table 15-7 and Table 15-8. The assumptions used in the COG estimation may vary from the final figure in the Project economic model, but this is not material to the Mineral Reserve estimate.

Table 15-7: External Economic Inputs—Revenue, Smelting, and Refining

Item	Unit	Economic Inputs
Gold Price	US$/oz	1,500
Payable Metal	%Au	99.8
Refining/Transport	US$/oz	2
Royalties % of NSR	%	4.25
Exchange Rate	C$:US$	1.31:1.00
Net Return	$/oz	1,872
	$/g	60

Cost Estimates

Non-mining cost estimates for processing, G&A, ore haulage, site services, and freight were based on a process plant feed rate of 3,000 t/d, with a subsequent expansion to 4,000 t/d.

Underground mining costs were established from first principles and compared to relevant comparable Canadian underground operations in northern locations for the sake of benchmarking. The cost of sustaining access development for the underground operation was based on first-principle calculations, taking account of the deposit geometry and the selected mining method.

Estimated costs for calculating COGs are summarized in Table 15-8.

Table 15-8: Cost Estimates Applied to Underground COG Estimation

Item	Unit	Costs
Umwelt, Llama, and Goose—CF/DF Mining Cost	$/t mined	125.00
Echo—LHS Mining Cost	$/t mined	100.00
Goose Deposits Processing Cost	$/t milled	41.00
Sealift/WIR Costs	$/t milled	15.00
Site Services	$/t milled	12.19
Stockpile Rehandling Costs	$/t milled	1.00
G&A	$/t milled	10.00
Freight	$/t milled	5.00
Umwelt, Llama, and Goose Total	**$/t milled**	**209.00**
Echo Total	**$/t milled**	**184.00**

Dilution Estimate

External mine dilution was calculated by using estimated overbreak values. Estimated overbreak for DF and CF stopes was based on 0.25 m for each exposed wall and 0.20 m for the floor. Knight Piésold estimated overbreak for hanging wall and footwall sloughing ranged from <0.5 to 1.5 m in Echo stopes.

In each case, the dilution material was assigned a gold grade of zero. The average dilution factors for input into the COG calculations are shown in Table 15-9.

Table 15-9: Estimated Dilution for COG Calculation

Item	Dilution (%)
Umwelt	14
Llama	11
Goose Main	11
Echo	15

Source: MP, 2021.

Metallurgical Recovery Estimate

Metallurgical bench-scale test results for each deposit were used for gold recovery estimation. The metallurgical recoveries used in the COG calculation are shown in Table 15-10.

Table 15-10: Metallurgical Gold Recovery

Item	Gold Recovery (%)
Umwelt	92.9
Llama	92.0
Goose Main	95.0
Echo	95.5

Source: Canenco, 2020.

15.3.2 Stope Optimization

MSO was used to produce economic stope shells, by applying COGs and deposit-specific stope dimensions to Measured and Indicated Resource blocks.

Umwelt

Stope optimization at Umwelt included options for longhole stoping, CF, DF, and PPCF. The CF 5 m wide by 5 m high shapes provide the highest recovery. CF is also a selective mining method that provides operational flexibility. Therefore, CF, with a primary-secondary sequence, was selected as the mining method for the Umwelt underground. Other semi-bulk mining methods, like longhole stoping, would create unstable hanging wall exposures of the weak middle mudstone due to the shallow dip of the deposit and the thickness of the fold. CF mining limits the hanging wall exposure and allows the installation of ground support. MSO analyses where the dip of the stope angle is limited to 40°, resulted in a reduction of tonnage from that of CF, with a commensurate increase in dilution, thereby further reducing the grade.

The dip of the orebody lends itself to potential longhole stoping in isolated areas in the deep zone of the mine, but at higher dilution rates. The dilution estimate at the time of this study indicated that a CF mining method was more favourable. Further geotechnical analysis would be required for a stoping method to determine the additional ground support requirements and further refinement of dilution estimate.

Sill pillar placements were determined based on the grade profile and contained metal in each 5 m level of CF shapes. Based on geotechnical analysis, Knight Piésold recommended 15 m-thick sill pillars. Two permanent sill pillars were included at a similar location to those included in the 2015 study. Four temporary sill pillars were also included. Three of these required a 50% reduced recovery of secondary CF shapes to allow for unrecovered pillars due to the width of the orebody at these locations.

The Umwelt crown pillar will be mined with a CF mining method where both primary and secondary shapes are backfilled with CRF. A 15 m permanent pillar was included between open pit and underground extents. A higher COG was applied to account for the increased cost associated with this mining method.

Llama

The mine design for Llama remains primarily as it was for the 2015 study, with stope shapes between 4 and 10 m wide by 5 m high. MSO was used to verify the mine design and chosen mining method of DF with unconsolidated rockfill (URF). The design was trimmed to account for a larger open pit and the higher COG.

Temporary sill pillars were included in the mine sequence strategy and will be fully recovered with the use of CRF.

The crown pillar will be mined with DF with CRF. A higher COG was applied to account for the increased cost.

Goose Main

Stope optimization at Goose Main included options for longhole stoping and DF. The DF shapes provided a more selective mining method and a higher recovery of the resource. DF shapes between 4 and 10 m wide by 5 m high were the basis of the ore shapes that were further refined to produce operational shapes.

Temporary sill pillars were included in the mine sequence strategy and will be fully recovered with the use of CRF.

The crown pillar will be mined with DF with CRF. A higher COG was applied to account for the increased cost.

Echo

Stope optimization at Echo included options for longhole stoping and DF. Longhole stoping was chosen due to the lower cost of the method and comparable recovery of the resource. The stope shapes vary in width from 3 to 15 m, with a height of 25 m. The stope strike length varies from 15 to 20 m depending on zone. The pillar width in the upper zone is 7.5 m due to the presence of stopes greater than 10 m thick. The pillar width in the lower zone is 5 m due to relatively thinner stopes. The dip of the stopes ranged from 50° to vertical.

As recommended by Knight Piésold, a permanent crown pillar of 35 m was applied between the open pit and underground. The MSO results produced a naturally barren zone 25 m thick that fulfills the requirement of a sill pillar. No additional sill pillars were included.

15.3.3 Underground Mineral Reserves Estimate

The underground Mineral Reserve estimate is based on the assumptions, optimization results, and detailed planning explained in the preceding subsections. The Mineral Reserve estimate is shown in Table 15-11.

Table 15-11: Underground Mineral Reserves Estimate—Goose Deposits

Deposit	Category	Total Ore (t '000s)	Au COG (g/t)	Au Grade (g/t)	Contained Au (oz '000s)
Umwelt	Proven	431	3.9 g/t 4.8 g/t—Crown	7.0	97
	Probable	6,796		6.7	1,461
Llama	Proven	46	4.1 g/t 5.0 g/t—Crown	5.3	8
	Probable	722		7.4	171
Goose	Proven	60	4.1 g/t 5.0 g/t—Crown	10.0	19
	Probable	467		7.7	114
Echo	Proven	-	3.5 g/t	-	-
	Probable	287		4.7	43
Total Underground Mineral Reserves	**Proven**	**537**		**7.2**	**124**
	Probable	**8,272**		**6.7**	**1,790**
	Total	**8,809**		**6.8**	**1,914**

Source: MP, 2021.
Notes: A gold price of US$1,500/oz is assumed.
An exchange rate of C$1.31:US$1.00 is assumed.
Diluted Au grades shown.
Diluted recovered tonnes.
Mineral Reserves are based on Measured and Indicated Mineral Resources only.

16 MINING METHODS

16.1 Introduction

Sabina's Project includes the Goose and George Project sites, the only sites on the Property with resource estimates. Multiple deposits have been explored at both sites. This Updated Feasibility Study focuses on the Goose Site and on the deposits that have Mineral Resources estimated in the Measured and Indicated categories. Mine planning has been completed for the Umwelt, Llama, Goose Main, and Echo deposits, and excludes Llama Extension, and Nuvuyak.

Both open pit and underground mining are planned for the deposits included in the Mineral Reserves. In 2015, JDS completed an open pit optimization process and an analysis of the optimal open pit to underground transition. MP reviewed the resulting open pit shapes, and has updated the pit shapes for this Updated Feasibility Study with the following revisions:

- Umwelt open pit—no revisions
- Llama open pit—no revisions
- Goose Main open pit—no revisions
- Echo open pit—pit size increased, and open pit advanced to pre-production to create a pit for depositing tailings for the first two years of mine life.

MP reviewed the underground designs completed in 2015 and made the following revisions:

- Umwelt underground—new design
- Llama underground—reduced 2015 design
- Goose Main—new design
- Echo—new design.

Table 16-1 shows the LOM tonnes estimated for the deposits, both open pit and underground.

Industry-standard mining methods, equipment, dilution calculations, and production rates were used throughout the planning process.

Table 16-1: LOM Tonnes and Grade by Mining Method

Mining Method	Deposits	Diluted Ore (Mt)	Diluted Au Grade (Au g/t)	Contained Au (oz '000s)
Open pit	Umwelt	2.7	5.8	504
Open pit	Llama	1.8	6.7	400
Open pit	Goose Main	5.1	4.4	716
Open pit	Echo	0.3	6.4	53
Underground	Umwelt	7.2	6.7	1,559
Underground	Llama	0.8	7.2	179
Underground	Goose Main	0.5	7.9	134
Underground	Echo	0.3	4.6	43
Total		**18.7**	**6.0**	**3,588**

Source: MP, 2021.

16.2 Open Pit Mining

16.2.1 Open Pit Planning

MP reviewed the open pit design and dilution estimates for Umwelt, Llama, and Goose Main.

The following main steps were part of the planning process for Echo:

- Defining optimization parameters, such as gold price, preliminary operating-cost estimates, pit wall angles, preliminary dilution, and metallurgical recovery estimates for the design of Echo pit
- Developing the Echo operational design for the ultimate pit using MineSight
- Determining incremental (or mill) COG based on economic parameters for each deposit
- Determining external mining dilution based on mineral inventory block model using MineSight
- Creating LOM production schedule to maximize economic return while satisfying the plant feed and mine production constraints and considering the underground mine production
- Calculating hauling distances, per bench and phase, according to the LOM plan for the Echo pit and the defined haulage network
- Estimating equipment fleet and personnel requirements from the LOM production schedule.

Topographic and Resource Model Description

Sabina provided digital mine topography and open pit design in UTM WGS 84, Zone 13 W coordinates. Topography was supplied as 1 m level LIDAR contour data and was used for Echo pit design calculations and engineering estimates. Volumetric estimates were calculated using design surfaces that intersected these topographic contours.

AMC prepared the 3-D resource block models for the various deposits used in this study; these models are explained in detail in Section 14. The models contain lithology, in situ density, ore and waste types, resource classification, ore and waste percentage, and gold grades (g/t Au).

16.2.2 Open Pit Optimization and Sensitivity Analysis

Open pit optimization was completed only for the Echo deposit, for this Updated Feasibility Study. The intent of the optimization was to design a pit with a capacity to store two years of mill tailings. Echo pit optimization results are summarized in Section 15.2.6.

Open Pit Optimization Results

Echo pit optimization results are summarized in Table 16-2.

Table 16-2: Pit Optimization Results

Deposit	Mineralized Material (t '000s)	Diluted Au Grade (Au g/t)	Contained Au (oz '000s)	Waste (t '000s)	Total Material (t '000s)	Strip Ratio (t:t)
Echo	293	6.07	57	6,928	7,221	24

Source: MP, 2021.
Note: Pit optimization results are based on shells and ARE NOT RESERVES.

16.2.3 Open Pit Design Criteria

Open pit slope angles vary for each deposit; general criteria for pit design have been prepared by Knight Piésold, as discussed below.

Geotechnical and Hydrogeological Characterization

Knight Piésold's recommendations for slope angles based on its analyses of geomechanical and hydrogeological conditions are described in Section 15.2.7, and were used in the open pit mine planning (Knight Piésold, 2015a).

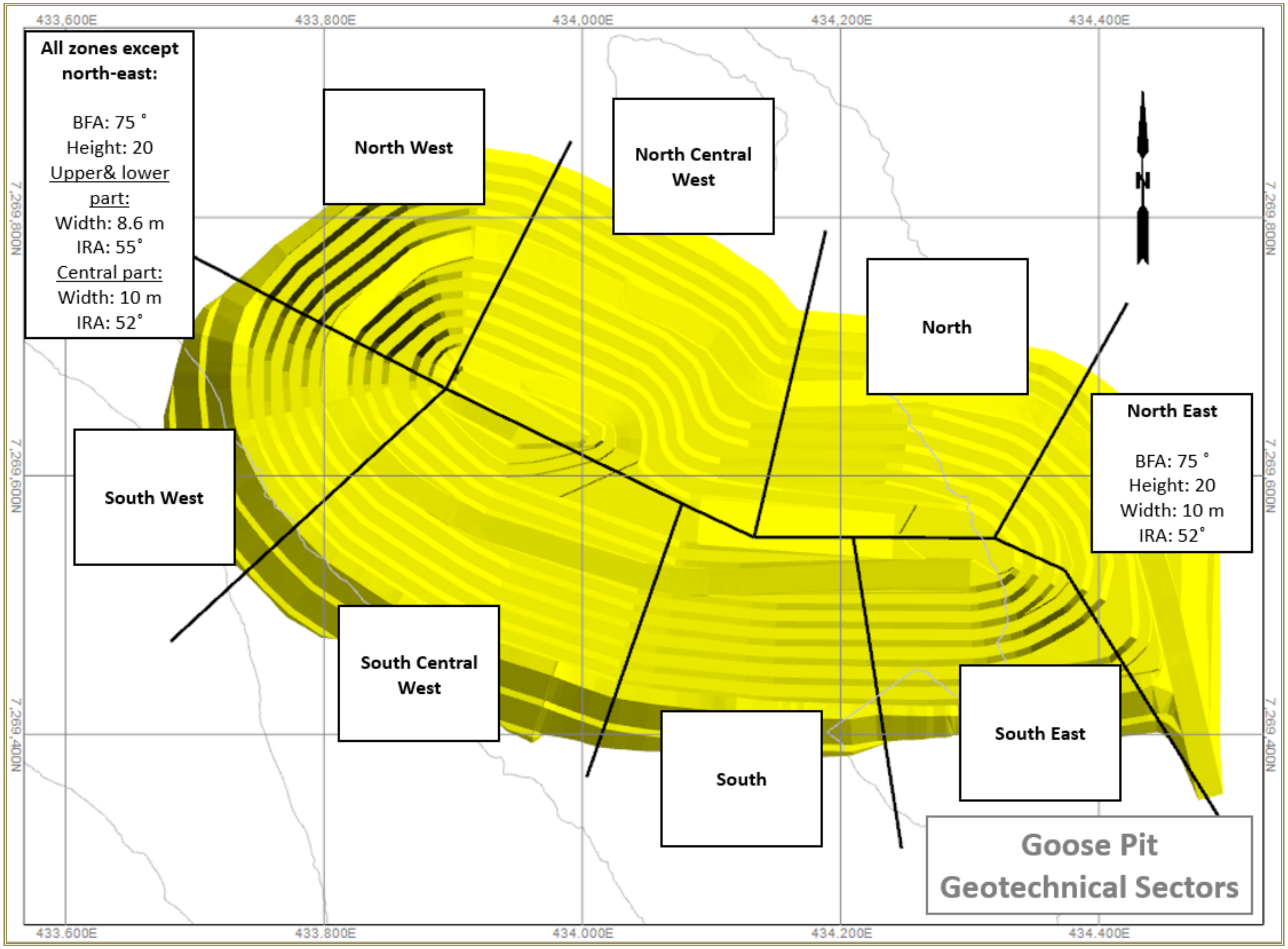
General Design Parameters

The general open pit design parameters used in the Echo detailed design are as follows:

- Pit walls
  - Bench height, single bench mining, 5 m
  - Height between catch benches, 20 m
  - Bench face angle, 55° to 75° (variable as per Knight Piésold geomechanical guidance)
  - Berm width, 8.6 to 10 m (variable).
- Haul roads (in and out of pit)
  - Total road width allowance, 20 m
  - Running surface on final two-way roads, 15 m
  - Berms, 3.8 m wide (40° slope)
  - Ditch, 1.0 m wide
  - Ramp grades, 10% standard and 12% for pit bottom access
  - Single-lane road allowance, 15 m
  - Specific areas for caribou crossing may be established.

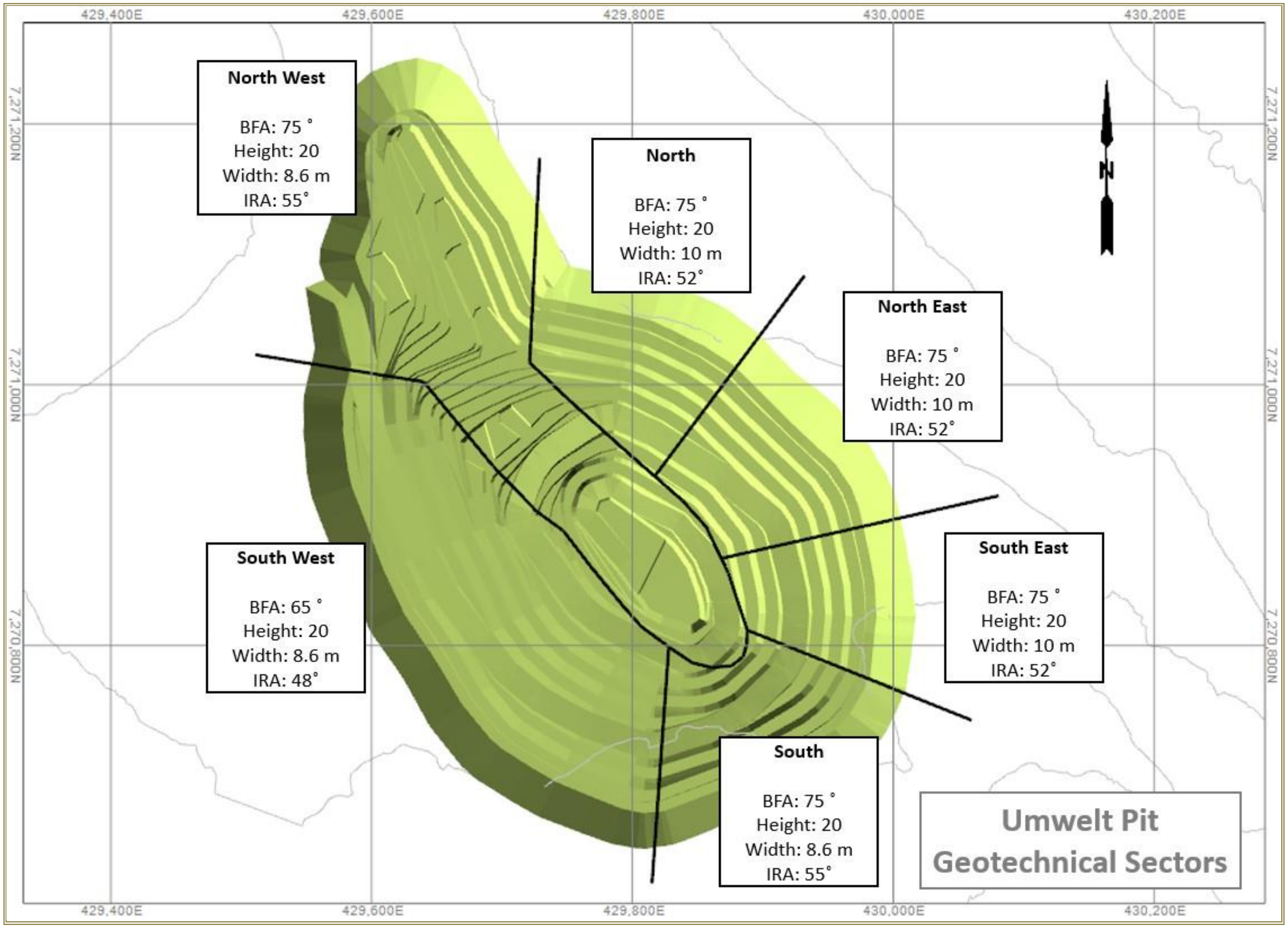
- Operations road (general light vehicle traffic and occasional heavy equipment)
  - Width, 8 m to 10 m
- Mining
  - Minimum pushback operating width, 50 to 60 m
  - Minimum pit bottom width, 25 to 30 m
  - Pit bottom sub-out depth, 5 m.

Primary haulage roads are required between the various open pit deposits and the primary ore crusher, waste rock storage areas (WRSA), construction areas, and maintenance facilities. To date approximately 4 km of roads have been constructed. Roads are constructed using waste rock fill. Roads within the ultimate WRSAs are designed to be all-fill construction. Roads are proposed to be constructed of non-potentially acid generating (NPAG) material generated from the open pits. Dust on the roads is planned to be controlled using water trucks or, possibly, chemical suppressants, as needed. The design sectors for the four open pits are shown Figure 16-1 to Figure 16-4.



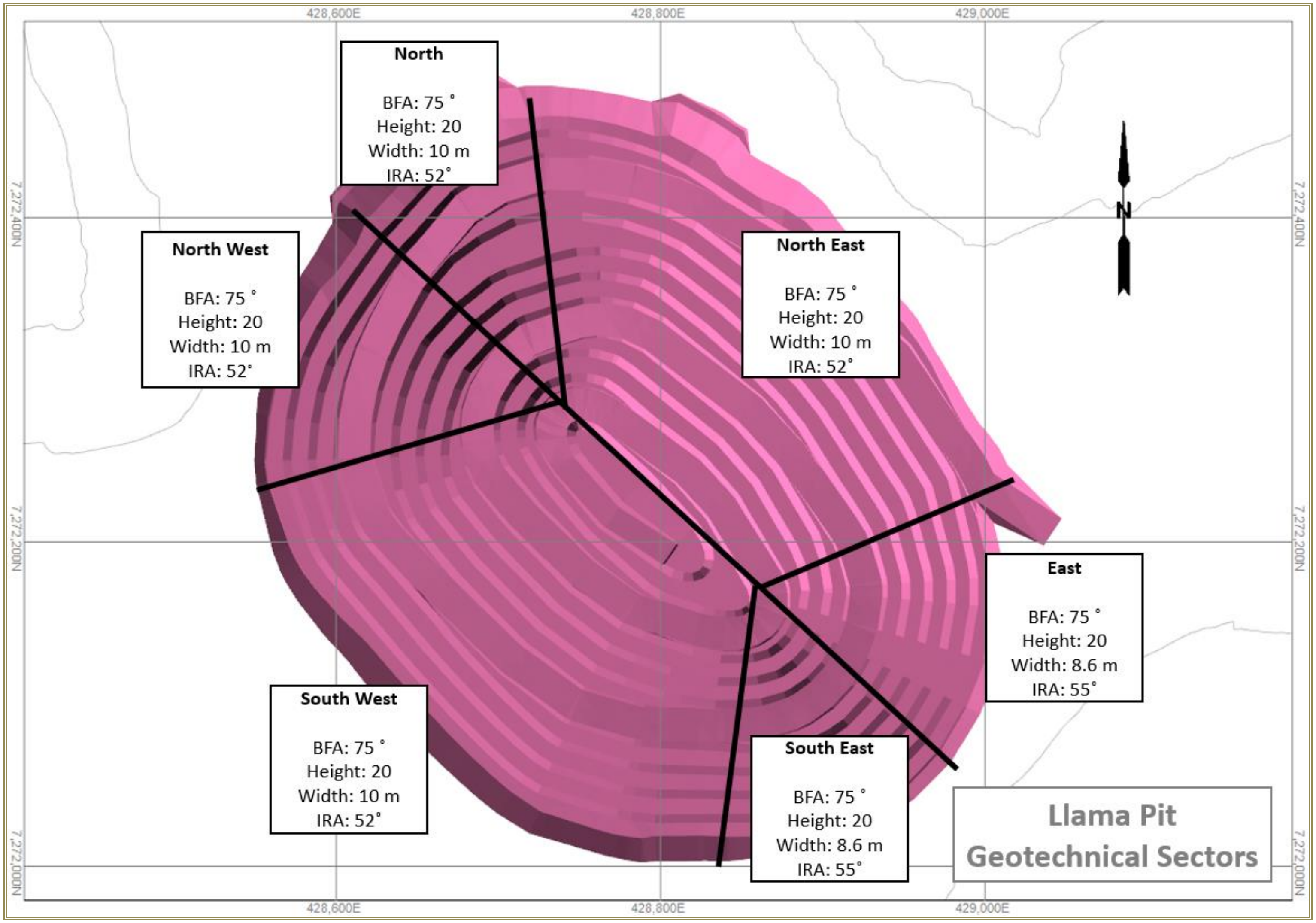
Source: Knight Piésold, 2021.

Figure 16-1: Goose Main Geotechnical Sectors



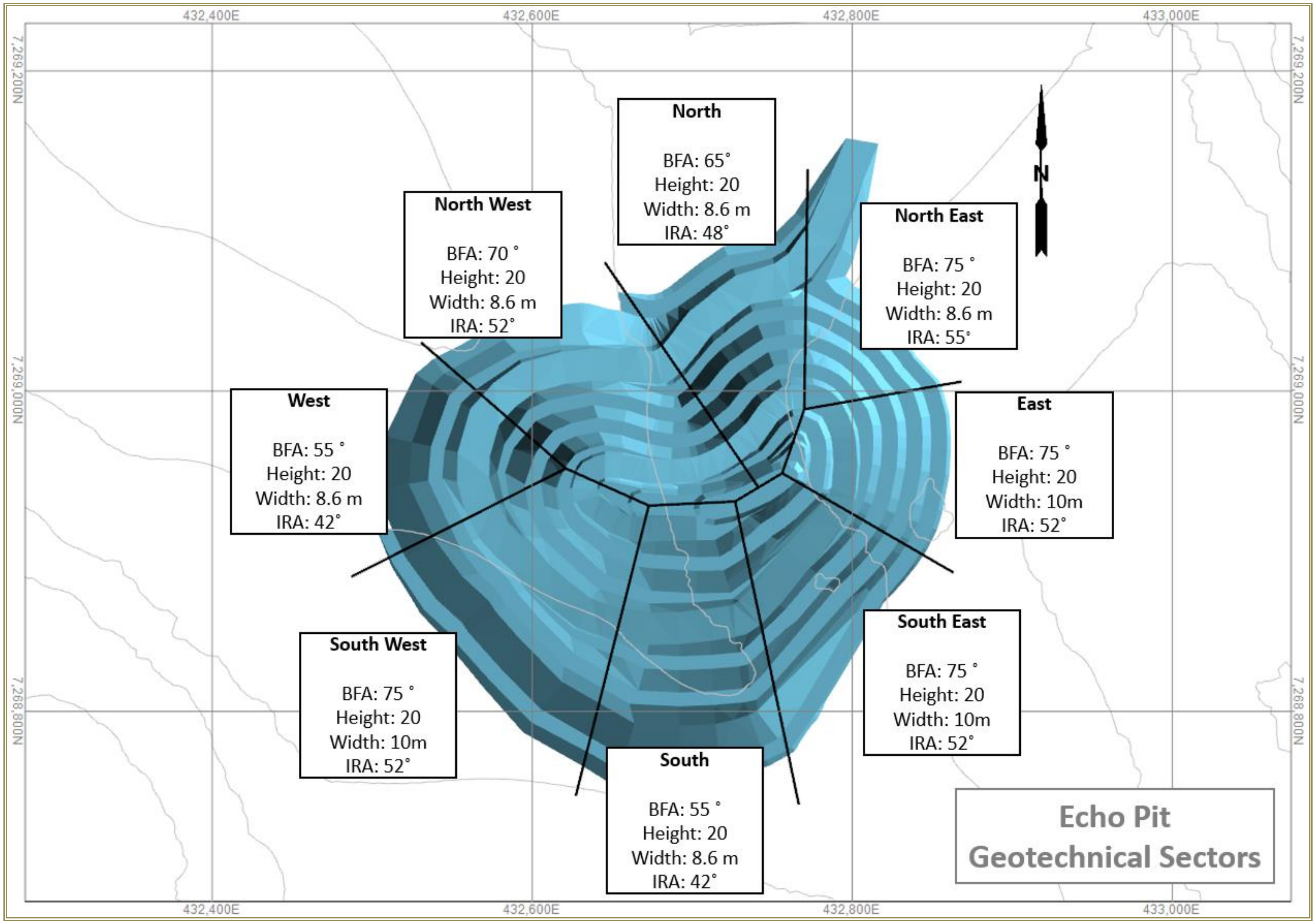
Source: Knight Piésold, 2021.

Figure 16-2: Umwelt Geotechnical Sectors



Source: Knight Piésold, 2021.

Figure 16-3: Llama Geotechnical Sectors



Source: Knight Piésold, 2021.

Figure 16-4: Echo Geotechnical Sectors

Open Pit Designs

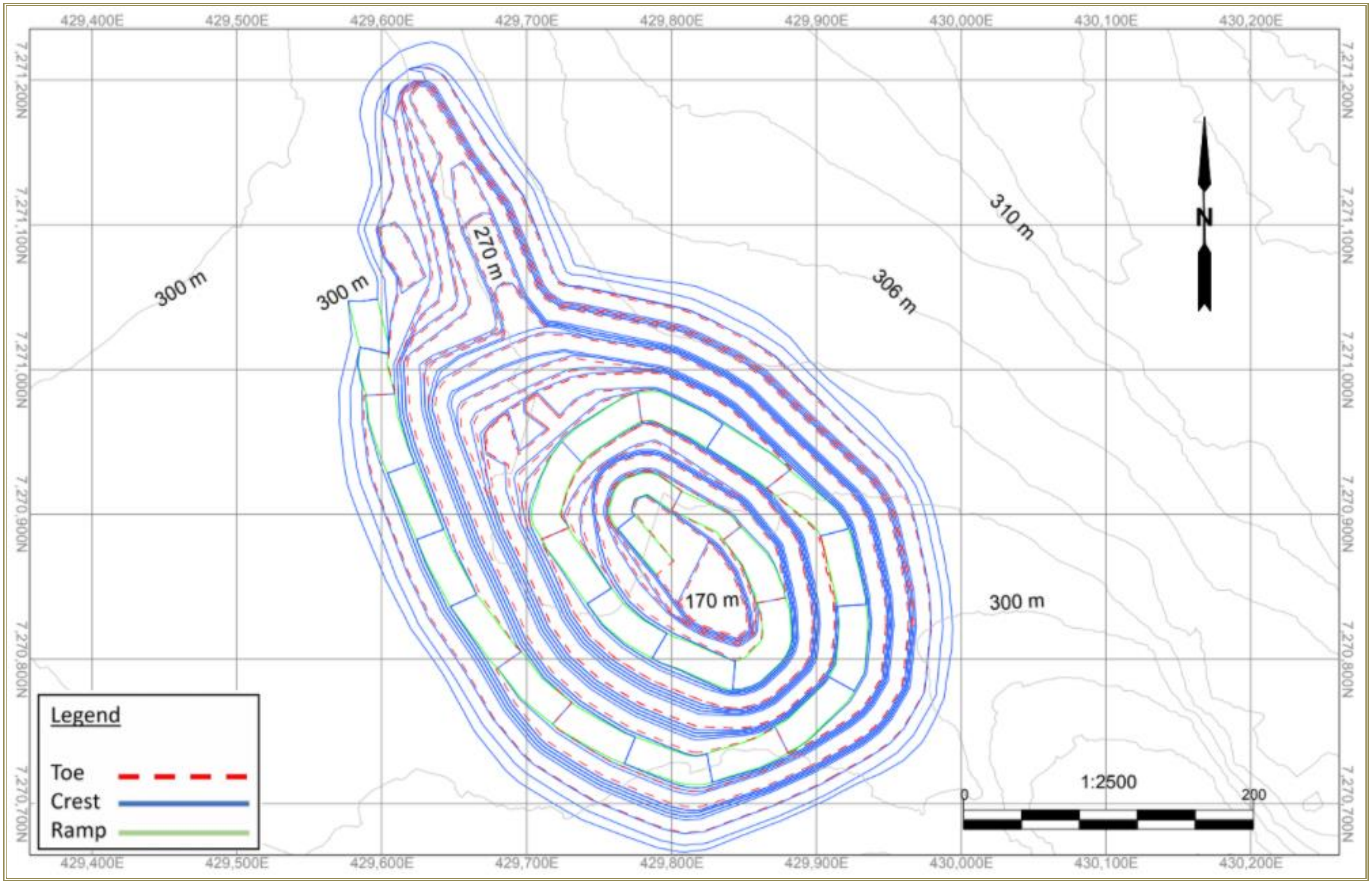
Detailed mine designs were undertaken on the proposed Echo open pit using the Whittle shells as guidance. The pit shape dimensions are summarized in Table 16-3. Plan views of each open pit design are shown in Figure 16-5 to Figure 16-8. No changes were implemented for Umwelt, Llama, or Goose Main designs by JDS.

Table 16-3: Open Pit Dimensions

Open Pit	Length (m)	Width (m)	Depth (m)
Umwelt	600	350	135
Llama	550	420	200
Goose Main	850	400	180
Echo	360	315	100

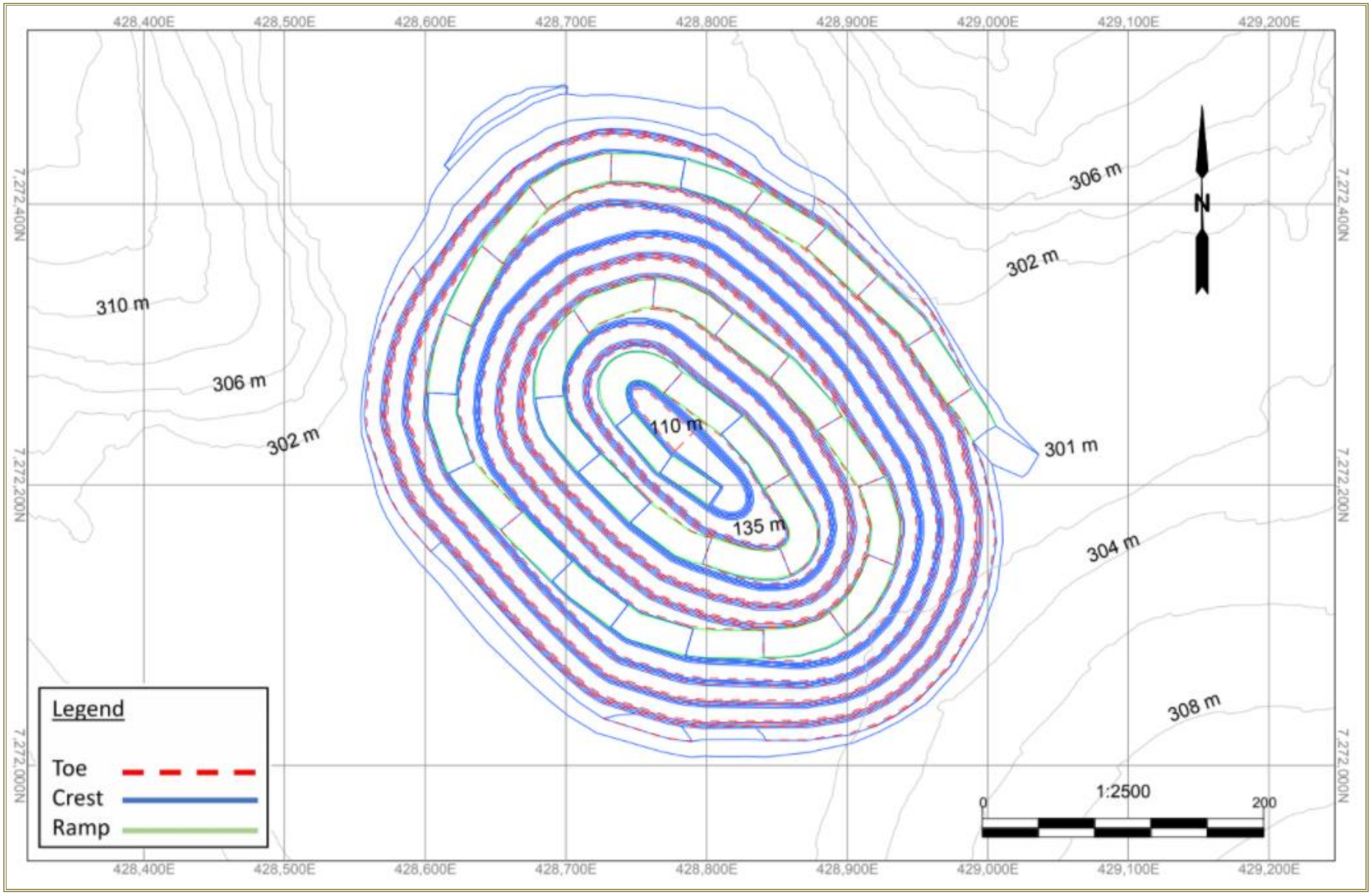
Source: MP, 2021.

The detailed pit designs, combined with calculated COG, determine the Mineral Reserve estimate for each deposit, which are summarize in Section 15. These values were used in the LOM schedule and economic model.



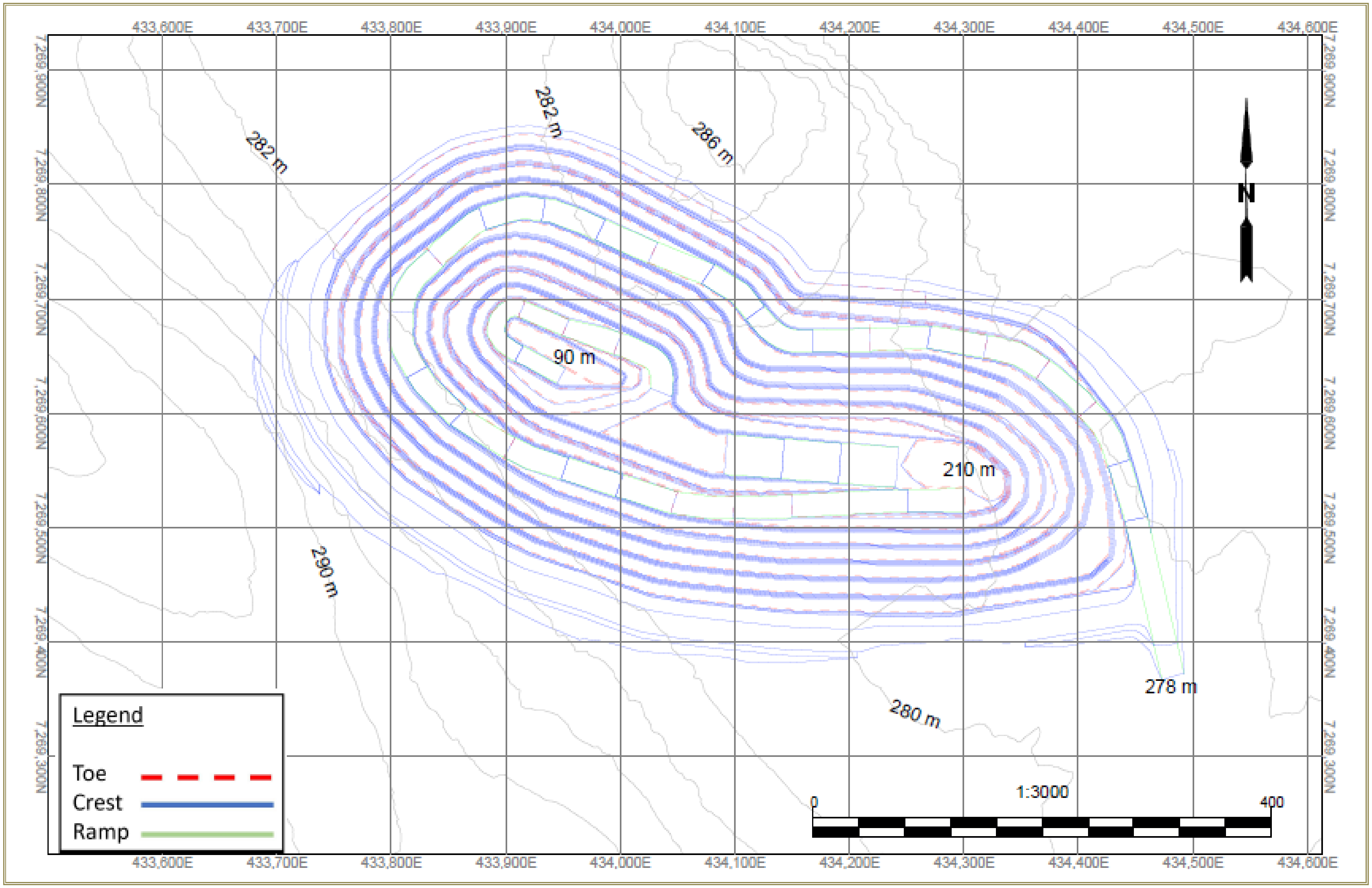
Source: MP, 2021.

Figure 16-5: Umwelt Pit Design



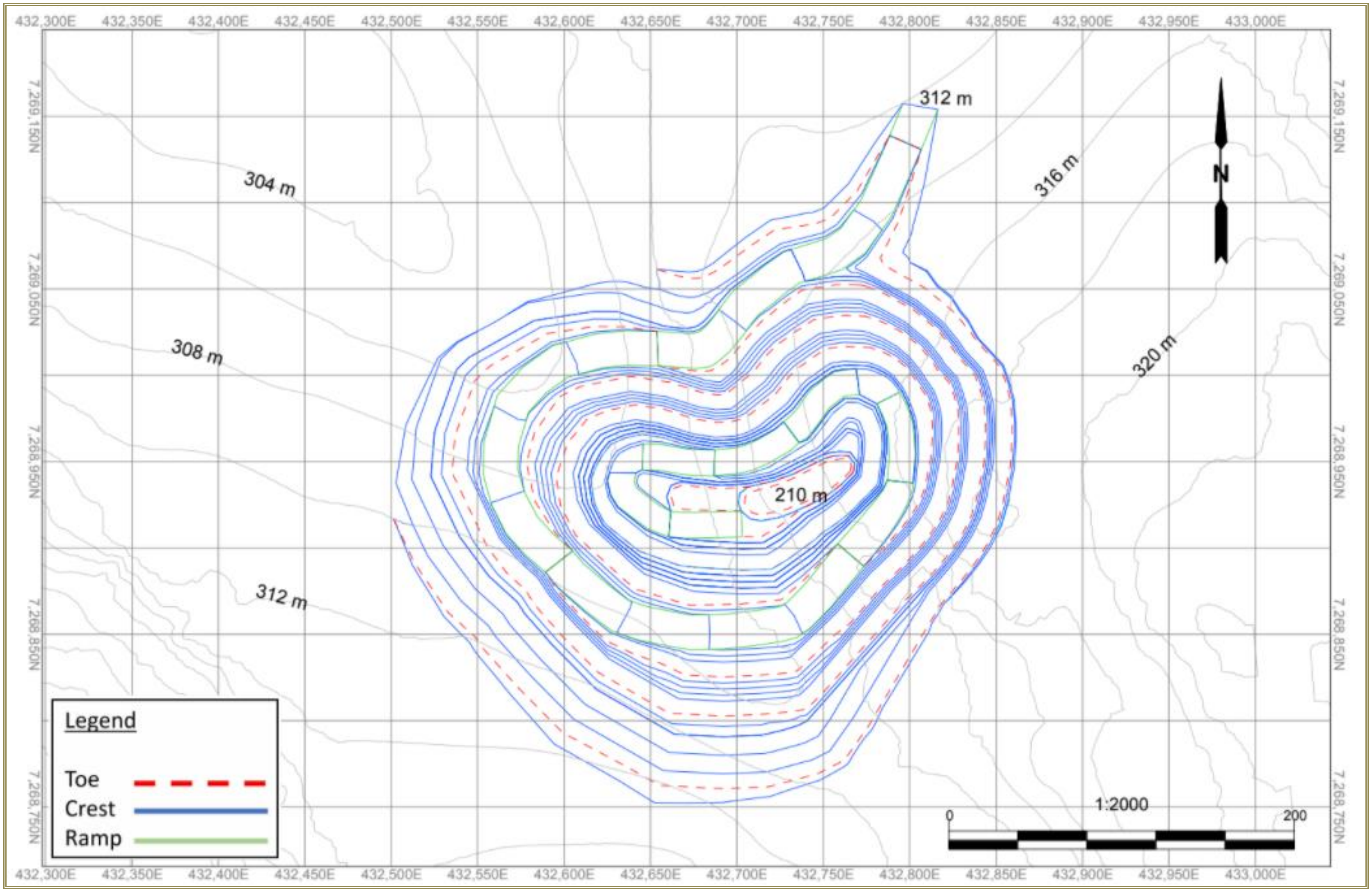
Source: MP, 2021.

Figure 16-6: Llama Pit Design



Source: MP, 2021.

Figure 16-7: Goose Main Pit Design



Source: MP, 2021.

Figure 16-8: Echo Pit Design

16.2.4 Open Pit Mine Production Schedule

The Project open pit mines were designed to produce a total of 9.9 Mt of ore and 99.0 Mt of waste rock over a 14-year period (including two years of pre-production), yielding an overall open pit strip ratio of 10.1:1 (t:t).

The open pit and underground mine production schedule includes only the deposits at the Goose Site (Echo, Umwelt, Llama, and Goose Main). Due to the limited production capacity of the underground mines, specifically their inability to produce the full 3,000 t/d to 4,000 t/d mill feed, the open pit mines will supplement ore feed. The mine schedule was developed using the following basic criteria:

- Maximize Project economics.
- Maintain plant throughput at a net yearly production rate of 1.1 Mt/a (3,000 t/d) of ore through Q3 Year 2, and 1.5 Mt/a (4,000 t/d) thereafter.
- Ensure suitable and adequate quantities of waste material are produced from the open pits, for construction during the pre-production period.
- Use run-of-mine (ROM) stockpiles and accelerated open pit mining methods to maximize the mill head grade during the early years of operation.
- Balance stripping ratio as much as possible by keeping two open pits active at the beginning or end of a pit's life.
- Maximize the pit production rate per period according to the geometry of the phases and the number of shovels and loaders that can work within that geometry.

Open Pit Phase Design

Given the relatively small footprints of the open pits at Echo, Umwelt, and Llama, no additional pushbacks or phases were designed for the mine plan development. For the larger Goose Main open pit, the deposit will be mined in two phases.

Open Pit Mining Sequencing

Pit sequencing focuses on achieving the required plant feed production rate, mining higher-grade ore, and stockpiling lower-grade mill feed (to maximize mill head grades) early in the mine Pit sequencing focuses on achieving the required plant feed production rate, mining higher-grade ore, and stockpiling lower-grade mill feed (to maximize mill head grades) early in the mine life, while balancing grade and strip ratios, and taking account of underground production. The open pit mining sequence begins with the Echo open pit, followed by Umwelt, Llama, and Goose Main. All process plant feed material would be hauled directly to the ore stockpiles near the crusher at the process plant site.

The sequence of open pit development is as listed below:

- Year −2—earthworks/construction begins at the Goose Site. Echo and Umwelt open pit mining begins. Waste rock is planned to be used to construct roads, laydown areas, and for site preparation.
- Year −1—pre-production continues with mining at the Echo and Umwelt open pits, with Echo being completed in the final quarter. Total ore stockpiled in pre-production is 2.2 Mt.

- Year 1—Open pit mining at Umwelt is completed and mining of Llama commences.
- Year 3—Mining in the Llama open pit continues. Goose Main open pit mining commences.
- Years 5—Llama open pit is completed.
- Year 12—Goose open pit is completed.

Pre-Production Development

Pre-production covers the period prior to first commercial gold production. Open pit mining activities during this period are scheduled to provide sufficient ore exposure for plant start-up and commissioning, which takes place in Q1 Year 1. Mining also focuses on providing sufficient waste rock for constructing, for example, site roads and laydown areas. Ore mined during the pre-production period is planned to be stockpiled and re-handled to the mill during operations. Mining in the pre-production period would create substantial high-grade stockpiles to maximize mill head grades in the early part of the production schedule.

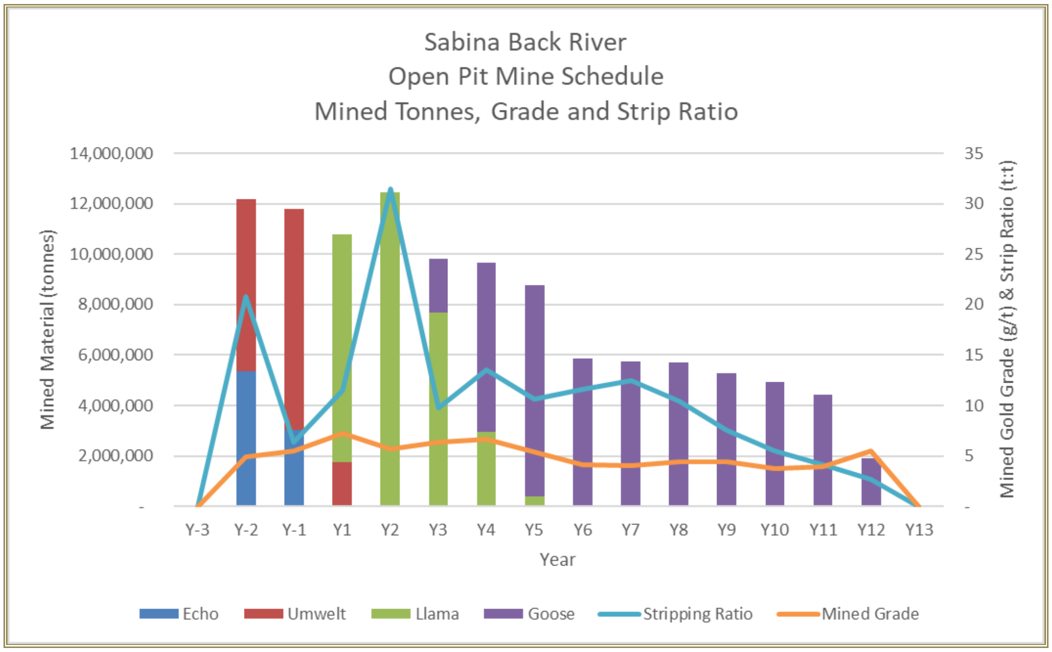
A total of 8.1 Mt of waste and 0.3 Mt of ore are scheduled to be mined from the Echo open pit, and 13.7 Mt of waste and 1.9 Mt of ore from the Umwelt open pit in the pre-production period, using the mine production fleet.

Mine Plan and Open Pit Production Schedule

ROM stockpiles were designed to allow for ore blending at the mill and to maximize mill head grades in the early part of the Project. Three stockpiles are planned:

- Low grade (COG to 5 g/t Au)
- Medium grade (5 g/t to 8 g/t Au)
- High grade (greater than 8 g/t Au).

The Project deposits are most economic when the open pits are mined concurrently. Figure 16-9 summarizes ore tonnage and grade by period.



Source: MP, 2021.

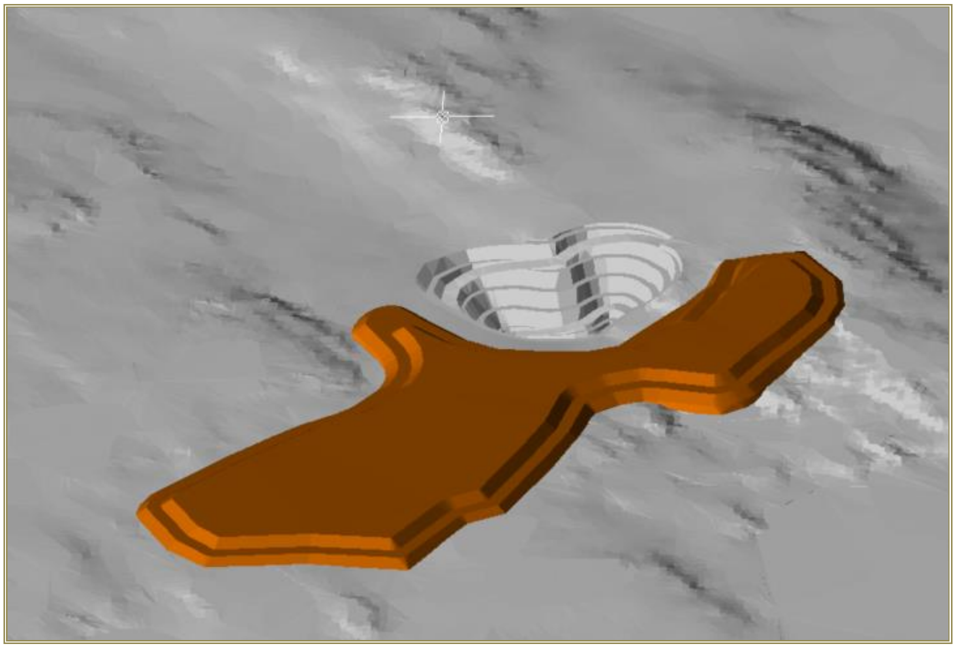
Figure 16-9: Total Ore Tonnages, Gold Grade and Strip Ratio

16.2.5 Waste Rock Management

Umwelt and Llama have been allocated dedicated WRSAs. The waste rock from the Echo and Goose Main open pits will be stored in a shared WRSA. The Echo pit will also be backfilled, and waste rock will continue to be placed to form a dump on top of the backfilled pit. A portion of waste rock from the open pit will be stored underground as backfill. The plan for the encapsulation of potentially acid generating (PAG) rock types and the foundation strategy is discussed in Section 18.1.1 and Section 18.1.6.

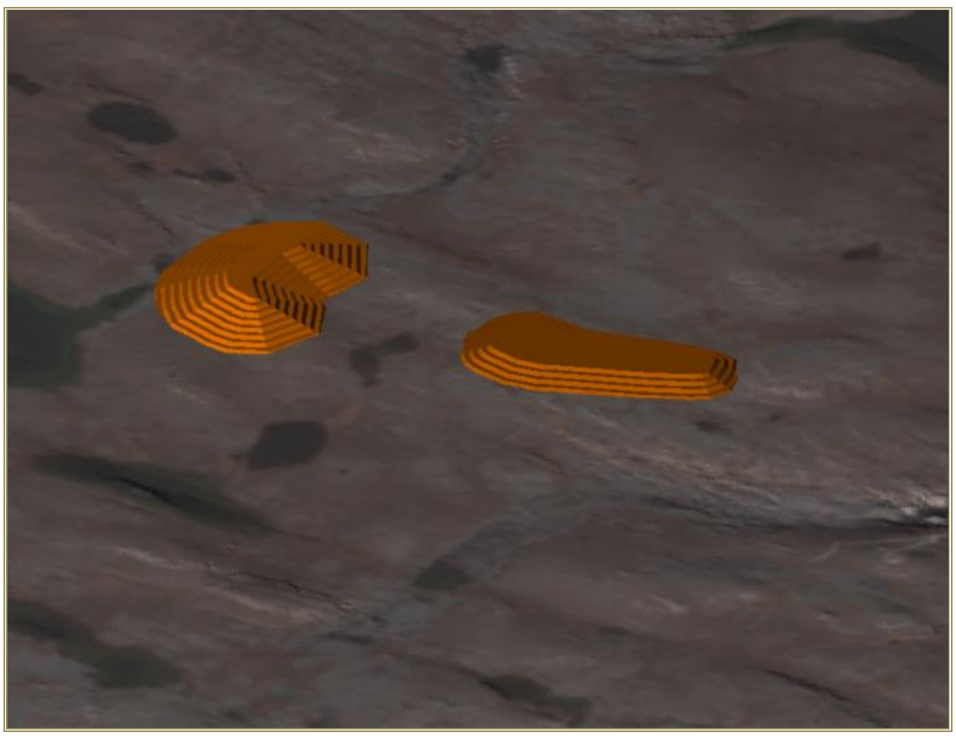
The design criteria for waste dumps includes 10 m high lifts, with minimum of 15 m wide berms. Haul roads on waste dumps will be a minimum of 20 m wide.

Figure 16-10 to Figure 16-12 show the designs for the waste dumps as updated or completed for this Updated Feasibility Study.



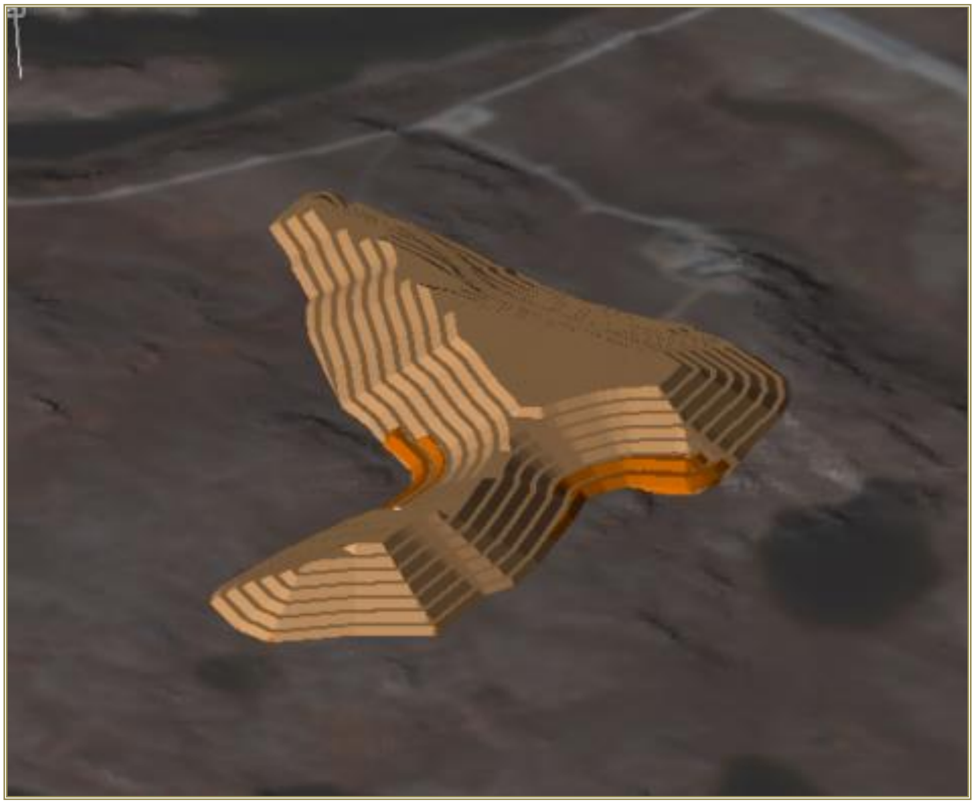
Source: Sabina, 2021.

Figure 16-10: Echo Pit and WRSA



Source: Sabina, 2021.

Figure 16-11: Umwelt and Llama WRSA



Source: Sabina, 2021.

Figure 16-12: Goose Main WRSA in Same Location as Echo Open Pit and WRSA

16.2.6 Mine Equipment Requirements

The Project open pit mining activities were assumed to be undertaken by an Owner-operated fleet. The equipment was selected based on a standard open pit mining operation with conventional drill, blast, load, and haul activities. Selection also considered bulk excavation of waste using hydraulic excavators, and bulk-selective loading of ore using a front-end loader or smaller hydraulic backhoes. Given the overall scale of operations and equipment requirements, a diesel-powered-only fleet was selected.

Any reference to a specific supplier or piece of equipment should not be seen as an endorsement; this information is provided for reference purposes only. Additional analysis regarding equipment selection is planned to be carried out at the engineering and procurement stages of the Project.

The annual open pit mining equipment requirements are shown in Table 16-4.

Table 16-4: Open Pit Primary Equipment Requirements

Type	Total No. of Units	Year																
		-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Sandvik DR410i (152–270 mm)	2	-	2	2	2	2	2	2	2	2	1	1	1	1	1	1	-	-
Leopard DI550 Drill (89–152 mm dia.)	1	-	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Cat 6015 Shovel (7 m^3)	2	-	2	2	2	2	1	1	1	1	1	1	1	1	-	-	-	-
Cat 390 Excavator (4 m^3)	1	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cat 990 Wheel Loader (10 m^3)	1	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
Cat 775 Truck (64 t)	12	-	12	12	10	10	10	10	10	7	7	7	7	7	7	7	1	1
Cat D8 Track Dozer	1	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-	-
Cat D9 Track Dozer	3	-	1	1	3	3	3	3	3	3	3	3	3	3	3	3	1	1
Cat 824 Wheel Dozer (4.2 m blade)	1	-	-	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cat 14M Grader	3	-	2	2	3	3	3	3	3	3	3	3	3	3	3	3	-	-
Water Truck	2	-	-	-	1	1	1	1	1	1	2	2	2	2	2	2	2	2

Source: MP, 2021.

General Operating Parameters

The open pits are designed with 5 m benches in both the waste and ore headings, with adequate phase geometry to achieve a maximum production level of 12.2 Mt/a. Mining is scheduled to advance sequentially through the pits, with up to two pits active at any time. Given the required production rate and pit geometries, vertical advance rates were limited to three to four benches per quarter, resulting in frequent ramp development and new bench construction.

Time definitions, work regime structure, and standard standby and delay parameters were applied to the mine equipment section.

Estimates for effective utilization of major equipment were based on vendor recommendations, cost services, factors, and MP experience. Initially, effective utilizations of 65% for the drilling equipment, 52% for the loading equipment, 59% for the hauling equipment, and 65% for support and auxiliary equipment were assumed. For Year 5 and beyond, a reduction in mechanical availability of 5% has been applied, causing a reduction in effective utilization in the later part of the mine life (Table 16-5).

Table 16-5: Availability, Target Use of Availability, and Effective Utilization of Major Equipment

Open Pit Equipment	Mechanical Availability (Year 5+) (%)	Use of Availability (%)	Operator Efficiency (%)	Effective Utilization (%)
Sandvik DR410i Drill (152–215 mm dia.)	85	90	85	65
Cat 6015 Shovel (7 m^3)	85	96	80	49
Cat 990 Wheel Loader (10 m^3)	85	96	80	52
Cat 775 Truck (64 t)	85	96	80	59

Source: MP, 2021.

Notes: Mechanical availability: measure of maintenance downtime (total available hours less mechanical downtime) divided by total available hours. For Year 5 and beyond a reduction in mechanical availability of 5% has been applied.
Use of availability: operational hours divided by total available hours.
Effective use: product of mechanical availability, use, operator efficiency, and operational losses.

Blasthole Drilling and Blasting

Based on the selected bench height (drilling is planned to occur on 10 m high benches) and the production schedule, a 251 mm diameter production drill was selected. Drill pattern details are shown in Table 16-6.

Table 16-6: Ore and Waste Drilling Parameter Assumptions

Item	Unit	Ore	Waste
Diameter	mm	152	251
Dry Density (In Situ)	t/m³	3.0	2.9
Drill Bench Height	m	10	10
Burden	m	3.8	6.3
Spacing	m	4.8	7.8
Sub-Drill	m	1.2	2
Total Hole Length	**m**	**11.2**	**12**
Stemming	m	1.7	3.1
Tonnes/Hole	t	544	1,420
Drilling Factor	t/m	49	118
Penetration Rate	m/h	14.8	11.2

Source: MP, 2021.

Notes: To achieve the recommended bench face angles (BFA) and inter-ramp angles (IRA) within the stronger rock mass units, it was assumed that 3% of the total drilled material would be pre-split and conducted with a smaller drill. Operating costs were included to cover the additional cost of this small-diameter (152 mm) drill.

Based on these parameters, annual production capacity was estimated for each type of drill for each period of the mine plan. The blast design used ammonium nitrate fuel oil (ANFO) as the main explosive for blastholes. Given the relatively dry climatic conditions at the Property, emulsion was included as being used 20% of the time in the cost estimate. Table 16-7 shows the planned blasting parameters for both ore and waste.

Table 16-7: Estimated Blasting Parameters

Item	Unit	Ore	Waste
Column Charge	m	9.3	8.9
Column Charge	kg	144	372
Powder Factor	kg/t	0.27	0.26

Source: MP, 2021.

Wet rock conditions are assumed to be minimal given the climatic conditions at site. However, if any water is encountered, blastholes would need to be dewatered and/or bag liners used. An explosives supplier is planned to be contracted to mix ANFO and provide blasting accessories. The Owner would supply AN, fuel oil, explosives magazines, and delivery trucks. Owner personnel are assumed to be responsible for loading and pattern tie-ins.

Loading

The main criterion for selecting loading equipment is the ability to mine selectively given the nature of the ore bodies and pit design configurations.

Primary loading is planned to be performed by diesel-hydraulic front shovels with a 7 m^3 bucket. A wheel loader with a 10 m^3 bucket and a 4 m^3 bucket excavator would be used for secondary loading, re-handle, and shovel support.

Operating hours for the loading fleet were estimated by calculating the amount of material required to be moved within a given period with appropriate productivity factors applied. Fleet size was then calculated using total operating hours for the period and the operating hours per unit within the period.

Productivities showing the number of passes and fill factors are summarized in Table 16-8 for both waste and ore. In addition to loading time, the loading unit productivities include estimates for waiting, maneuvering time, and unproductive time. Based on these parameters, the annual production capacity was estimated for each type of loading unit for each period of the mine plan.

Dig rates reflect the selective nature of the mining operation.

Table 16-8: Loading Unit Productivity Assumptions

Item	Unit	Ore		Waste	
		7 m³ Shovel	10 m³ FEL	7 m³ Shovel	10 m³ FEL
In situ Material Density	t/m^3	3.0	3.0	2.9	2.9
Material Swell Factor	loose:bank	1.4	1.4	1.4	1.4
Loose Material Density	t/lcm	2.1	2.1	2.1	2.1
Bucket Size	m^3	7	10	7	10
Bucket Fill Factor	%	90	85	90	85
Tonnes per Bucket	t	13.5	18.2	13.0	17.5
Size of Truck to Load	t	64	64	64	64
Theoretical Buckets to Load	#	4.5	3.4	4.7	3.5
Average Buckets to Load	#	5	4	5	4
Average Loading Cycle Time	s	40	45	40	45
Average Spot Time Between Loads	s	30	30	30	30
First Bucket Time	s	15	15	15	15
Total Time to Load Truck	min	3.4	3.0	3.4	3.0
Theoretical Loading Time per Day	min	1,152	1,152	1,152	1,152
Theoretical Avg. Truck Loads per Day	#	253	304	253	304
Truck Load Factor	%	95	95	95	95
Average Truck Load	t	61	61	61	61
Estimated Loading Productivity	t/d	15,400	18,500	15,400	18,500
Estimated Loading Productivity	t/oph	801	963	801	963

Source: MP, 2021.

Hauling

The Project truck haulage fleet was selected to match the selected loading fleet; this resulted in selecting trucks with a payload of 64 tonnes. Haulage profiles were estimated for the mine plan for every bench of the Project pits in the different years of the mine life and for each material type (waste/ore). Separate values were calculated for haulage within the pits (between the bench and the pit exits) and outside of the pit limits (between the pit exit and the destination—e.g., primary crusher/stockpile or WRSAs). The distances were split between ramp and horizontal haulage.

Table 16-9 summarizes the haul cycle parameters used to calculate truck productivities. Truck performance was calculated for every loading unit and period of the plan, with allowance for the travel time and other fixed times of the cycle, such as loading. This varies according to the loading equipment used, dumping, waiting, and spot times.

Table 16-9: Haulage Cycle Parameters

Description	Unit	Value
Rated Payload	tonnes	64
Fill Factor	%	95
Adjusted Average Payload	tonnes	61
Dump Time at Crusher/Stockpile	min/load	1.5
Dump Time at Crusher/Stockpile	min/load	1.5
Dump Time at WRSA	min/load	1
Stopped Time (Non-Hauling)	% of net operating hours	10
Effective Use	%	59

Source: JDS, 2015b.

Support/Ancillary Equipment

The selection of auxiliary and support equipment was based on the size and type of the primary loading and hauling fleet, the geometries of the various open pits, and the number of roads and WRSAs that would be in operation at any given time.

Selection of the type of equipment was based on vendor recommendations and MP experience in similarly sized operations. The auxiliary equipment fleet is planned to be composed of two types of track dozer (Cat D8 and D9 classes), one type of wheel dozer (Cat 824 class), one type of grader (Cat 14M class), and two sizes of water truck (15 m³ and 23 m³).

The major tasks to be completed by the support equipment include the following:

- Bench and road maintenance
- General maintenance
- Reclamation support
- Shovel support/cleanup.

The primary support equipment unit functions are as follows:

- Cat D9 track dozer—primarily used for shovel support/cleanup, WRSA maintenance, road construction, highwall cleaning, and other projects as needed
- Cat 824 wheel dozer—used to support WRSA maintenance, drill pattern cleanup, and support for shovel floor maintenance
- Cat 14M grader—primarily used for road maintenance, pit and WRSA floor maintenance, road construction, and service-road maintenance.

The following items were also included as support equipment:

- Drill (152 mm) for secondary blasting and pre-split drilling
- Fuel trucks to supply diesel fuel to all the hydraulic diesel excavators, dozers, and drills, as required
- Lube truck to supply lubricants, hydraulic fluids, and cooling water to all open pit equipment
- Mobile mechanical trucks, equipped with tools, welding machine, work table with press, and replacement parts, to provide preventative and corrective maintenance in the field
- Small excavator (3 m^3) for road and pit maintenance
- Low-boy transporter truck (100 tonne) to transport dozers, drills, small backhoe, and major components
- Tire manipulator for tire maintenance
- Mobile lights to illuminate waste dumps and construction areas.

16.2.7 Mine Maintenance

The key elements provided by maintenance to satisfy the requirements of open pit mine production are equipment safety, availability, reliability, and operability.

The strategy for repair and maintenance of the open pit mobile equipment fleets for the Project is planned to be a balance between minimizing risk and costs to Sabina. Sabina personnel would carry out all on-site maintenance using Sabina's own installations. On-site work would consist of mainly preventative maintenance and major-component exchange. Given the estimated mine life, no major rebuilds are anticipated; however, if required, they would be performed on-site by contractors.

16.2.8 Mine Personnel

Basis

The work schedule assumes a 24 h/d, 7 d/week, 355 d/a mining operation (10 days of non-production have been assumed for adverse weather conditions and Caribou migration). Operations and mining personnel would work on two 12 h shifts per day. Production, maintenance, and technical personnel are planned to be primarily on a 2-week-in/2-week-out rotation.

With the exception of the blasting crew, all hourly labour and supervisory personnel would rotate between day and night shifts. Management and technical staff would work the day shift only, with the exception of ore control technicians who would rotate with the crews.

Equipment operator labour requirements are based on equipment hours calculated from engineering estimates of productivities and activities, quantities of the various materials moved, and hourly equipment operating rates. Other support labour requirements within the open pit mining operation are determined by engineering estimates of activities.

Maintenance labour requirements are based on the number of equipment units to be maintained, estimates of mechanical availability, and maintenance labour intensities for each open pit fleet type.

Personnel Levels and Structure

The mining operation is planned to be overseen by the mine manager, who would report to the general manager.

Under the direction of the mine superintendent, the mine operations department would be responsible for operator training and the open pit operation. This includes drilling, blasting, loading, hauling (ore and waste), dump and haul road construction/maintenance, and mine dewatering. Each mine operating crew would be led by a mine shift supervisor. The estimated number of operators is based on the annual equipment requirements and the crew schedule.

The mine maintenance department would report to the mine maintenance superintendent. Maintenance crews are planned to work the same shift schedule as the mine operations crews. Each maintenance crew would be led by a maintenance shift supervisor. A mine and maintenance general supervisor is also planned for the operation. The estimated number of maintenance personnel is based on the annual equipment requirements.

Staff and labour requirements over the LOM for operations are summarized in Table 16-10. Staff requirements were determined by assessing the LOM plan and scale of open pit operations. Cutbacks were made at the end of mine life, once ore production ceases.

Table 16-10: Yearly Personnel Requirements for Open Pit Mine Operations

Description	Year																
	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mine Shift Supervisor	-	2	4	4	4	4	4	4	4	4	4	4	4	4	4	-	2
Driller, Blasthole	-	12	12	12	12	8	8	8	8	4	4	4	4	4	4	-	-
Blaster	-	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-	-
Blasting Helper	-	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-	-
Shovel/Loader Operator	-	18	15	16	14	10	10	11	8	7	7	7	7	6	6	3	3
Truck Driver	-	40	40	34	33	32	32	31	22	22	22	22	22	21	22	2	2
Track Dozer Operator	-	6	6	10	10	10	10	10	10	10	10	10	10	10	10	3	3
R.T. Dozer Operator	-	-	-	3	3	3	3	3	3	3	3	3	3	3	3	-	-
Grader Operator	-	5	5	7	7	7	7	7	7	7	7	7	7	7	7	-	-
Laborer/Trainee	-	-	2	4	8	8	8	8	8	8	4	-	-	-	-	-	-

Source: MP, 2021.
Note: Only production personnel, excluding maintenance, management, and technical services.

Labour Build-Up and Initial Training Schedule

Key operations personnel are planned to be recruited before the completion of the construction phase of the Project. The management team, including managers, human resources, and environment, health and safety, would be in place before construction begins. Staffing levels would then progressively increase during the construction phase of the Project.

16.3 Underground Mining

The Goose Site has four deposits with the necessary grade, continuity, and tonnage to be considered for underground mining—namely Umwelt, Llama, Goose Main, and Echo. All four deposits have sufficient economic underground resources to support an underground mining operation. Each of the underground mines would be located below open pits.

16.3.1 Underground Mining Context

The geometry, geotechnical parameters, and hydrogeological parameters were considered in determining the mining method for each deposit.

Deposit Geometry

Umwelt

Umwelt is a continuous, massive deposit with a shallow dip of 35°, extending to a depth of 800 m below surface. It has an average strike length of 170 m and an approximate thickness of 40 m. Umwelt has a large underground reserve inventory; the highest grades are found in two mining blocks—the deep zone and the crown pillar.

Llama

Llama has similar orebody characteristics to Umwelt and is a steeply dipping deposit varying from 4 to 20 m wide. The folded, nose section of the deposit dips at 30° and is up to 30 m thick. The deposit extends to a depth of 360 m below surface, with an average strike length of 180 m.

Goose Main

Goose Main is also a steeply dipping, relatively irregular deposit comprising multiple parallel zones. The zones are generally narrow (around 4 m), but they sometimes increase to 10 m wide. The deposit extends to a depth of 390 m below surface, with an average strike length of 190 m.

Echo

Echo is a continuous deposit consisting of a single zone varying from 4 to 15 m thick, with an average dip of 60°. The deposit geometry is significantly curved, extends to a depth of 325 m below surface, and has an average strike length of 150 m. Echo is the deposit with the lowest average grade in the underground reserve inventory.

Geotechnical Considerations

Knight Piésold (2015) conducted geotechnical and rock mechanics evaluations for the Goose and George Project sites, based on geotechnical data captured from exploration drill holes. That evaluation forms the basis of ground support and excavation design for the underground deposits included in this Updated Feasibility Study.

The main lithological units at the Project are as follows:

- Greywacke and interbedded sediments: the most common rock type at site. These units overlie and underlie the ore deposits.

- Iron formation: Sabina identified several BIFs. The iron formation is the host rock for the gold mineralization. The LIF (5 to 20 m thick) is separated from the UIF (15 to 30 m thick) by the middle mudstone (described below).
- Mudstone: phyllitic mudstone overlies the iron formation in some areas and is typically 5 to 20 m thick. The middle mudstone layer is less than 10 m thick, which separates the lower and UIFs. This mudstone can be strongly foliated.
- Felsic dykes, porphyry intrusions and gabbro/diorite dykes: these units cross-cut the other lithologies and are the youngest at site.

Faulting was observed at the Goose and George sites. Two main fault orientations were recorded: sub-parallel to the deposits (NW–SE to N–S) and perpendicular to the deposits (NE–SW). Faults typically dip steeply, are a few metres thick, contain gouge, and are slickensided.

Knight Piésold defined the geomechanical domains by lithology. Their characteristics are as follows:

- Greywacke and interbedded sediments: generally GOOD to VERY-GOOD quality (rock mass rating [RMR] values from 60 to 85) with a mean UCS of 95 MPa.
- LIF: generally GOOD to VERY-GOOD quality (RMR values from 65 to 90) with a mean UCS of 195 MPa.
- UIF: generally GOOD to VERY-GOOD quality (RMR values from 65 to 85) with a mean UCS of 125 MPa.
- Phyllitic mudstone: generally GOOD quality (RMR values from 60 to 80) with a mean UCS of 55 MPa.
- Middle mudstone: the rock mass quality of the middle mudstone is highly variable and ranges from FAIR to GOOD quality (RMR values from 45 to 75) with a mean UCS of 60 MPa. The middle mudstone is generally of lower and more variable quality than the other lithologies.
- Gabbro dykes: generally GOOD to VERY-GOOD quality (RMR values from 70 to 85) with a mean uniaxial compressive strength (UCS) of 140 MPa. Knight Piésold grouped the felsic dykes and intermediate dykes with their host domain.

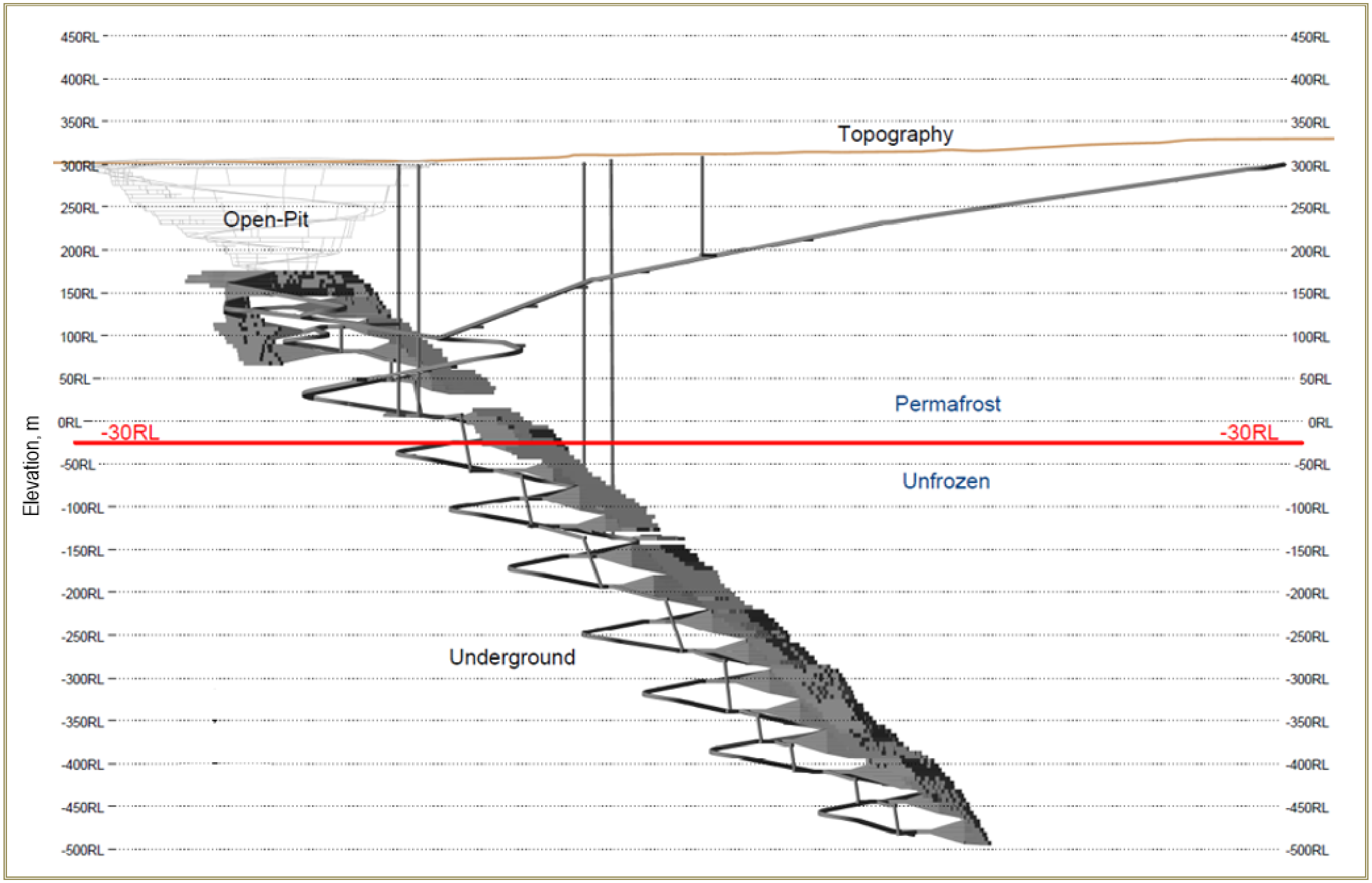
Knight Piésold (2015b) developed geotechnical underground design recommendations for the Goose Main, Llama, Umwelt, and Echo deposit. The recommendations were based on the available data and the selected mining methods, including achievable stope spans; expected mining dilution; sill pillar, rib pillar, and crown pillar dimensions; ground support standards; and access development placement. These recommendations were reviewed by Knight Piésold and adapted on a case-by-case basis as part of the current study to reflect changes to the mine design and mine scheduling.

Knight Piésold reviewed both mine design and mine scheduling and provided recommendations to MP on mine planning and mine scheduling based on expected ground performance.

Hydrogeological and Permafrost Considerations

Groundwater inflows and water management strategies are discussed in detail in Section 20.

Groundwater is expected once mining occurs below permafrost as shown in Figure 16-13.



Source: MP, 2021.

Note: RL refers to Relative Level which also corresponds to elevation.

Figure 16-13: Expected Groundwater Zone at Umwelt

16.3.2 Underground Mining Method Selection

The underground mining method was selected based on orebody characteristics, such as grade, dilution, dip, continuity, and thickness. Estimated productivity and selectivity of the mining methods were also considered.

Four mining methods were considered:

- CF
- DF
- Post-pillar cut-and-gill (PPCF)
- Longhole stoping with URF as backfill.

Most mining methods that require cemented backfill were disregarded, due to the high cement freight costs to site. The exceptions were CF and DF, which were selected for the extraction of the crown pillar in Umwelt, Llama, and Goose Main. CF with CRF, with a primary–secondary sequence, was selected for Umwelt due to the added flexibility and higher recovery of the mining method when compared to PPCF.

The CF method was selected for the Umwelt deposit due to its variability, shallow dip, and thickness. Other semi-bulk mining methods, like longhole stoping, would create unstable hanging wall exposures of the weak middle mudstone due to the shallow dip of the deposit and the thickness of the fold. CF mining limits the hanging wall exposure and allows the installation of ground support. Even limiting the dip to 40° in MSO analyses, resulted in reduced tonnage and increased dilution, further reducing the grade. There is the potential to apply a longhole stoping method at the deep part of the deposit where the orebody has a much steeper dip and reduced thickness in the fold of the deposit. This opportunity should be explored in subsequent optimization efforts.

While the orebody dip of the Goose Main deposit is sufficient for longhole stoping, the resulting increase in internal and external dilution reduced the number of stopes that were produced by MSO, enabling DF to have better economic results. The narrow width of the Goose Main orebody eliminated CF from consideration. Unlike Umwelt, the thick folded nose section at Llama does not contain enough material above COG throughout the fold to warrant a CF method. Like Umwelt, the semi-bulk mining methods would create unstable hanging wall exposures at Llama in the weak middle mudstone due to the shallow dip of the deposit. Therefore, an overhanded DF mining method was selected for the Goose Main and Llama deposits to enable flexibility and selectivity during mining operations.

Longhole stoping with URF was selected for Echo due to the steep dip of the deposit and relatively uncomplicated orebody characteristics. Unlike the other three deposits, effective extraction of the Echo deposit does not require a higher degree of selectivity, and a longhole stoping method provides a cost-effective means of extraction.

Cut-and-Fill Mining Method

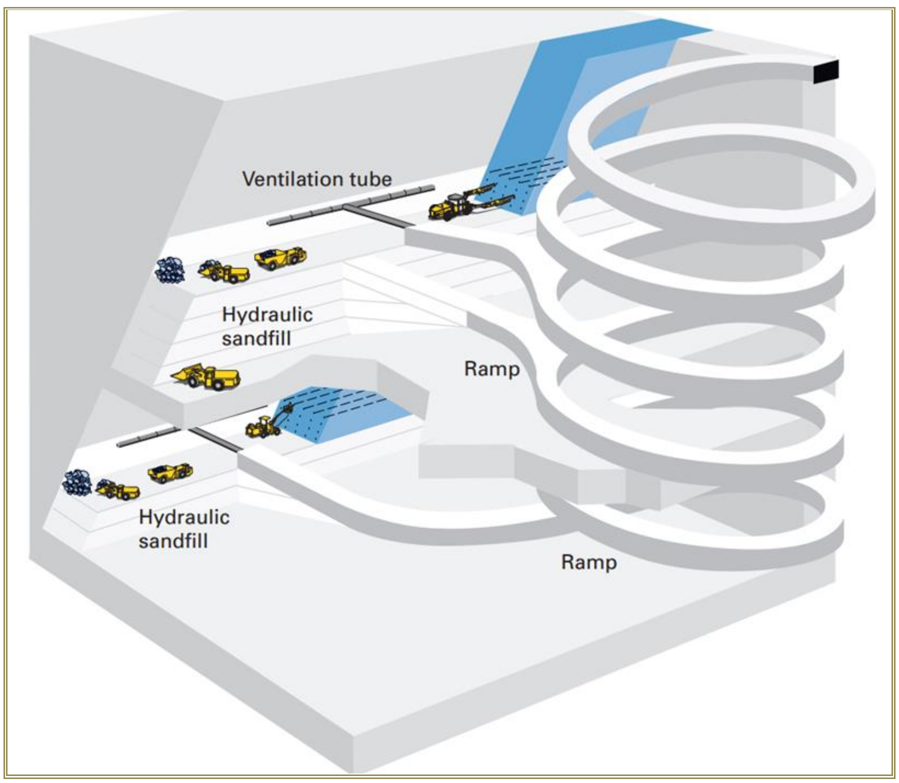
CF is a flexible and selective mining method, well suited to thick, shallow-dipping orebodies. Primary and secondary headings alternate in a grid pattern that spans the width of the orebody. Headings follow the drill, blast, muck, ground support cycle typical of advancing a normal heading. Primary and secondary headings would then be predominately backfilled with CRF and URF, respectively. In the crown pillar at Umwelt, both primary and secondary headings would be backfilled with CRF to create a plug prior to placing tailings in the open pit above the crown pillar. Primary headings must be completed before adjacent secondary headings begin to advance. The heading design for Umwelt is 5 m wide by 5 m high.

An overhanded CF sequence has been selected for Umwelt; as each level is completed, the level above would be mined, resulting in a bottom-to-top sequence. Blocks of mining would be limited to no more than five levels. Where required for scheduling or due to geotechnical constraints, sill pillars would be used to further segment the mine with combined blocks of levels. Each bottom-to-top sequence would begin at a sill pillar and advance until reaching another sill pillar, or the extent of the Mineral Reserve.

The mining blocks would be accessed from the main decline in the footwall via level accesses and attack ramps. Each block would have a level access. Once the first level in the block is completed, the level access would be slashed to an appropriate gradient to create an attack ramp and access to the next level. Once access is established, the CF mining cycle would begin again, working on top of the backfill.

The CF grid results in a productive mining method, as it produces multiple headings available for mining; however, it does require ground support and backfill for every heading. Maintaining high production rates depends on adherence to an efficient mining cycle.

A conceptual view of CF is shown in Figure 16-14.



Source: Knight Piésold, 2013b.

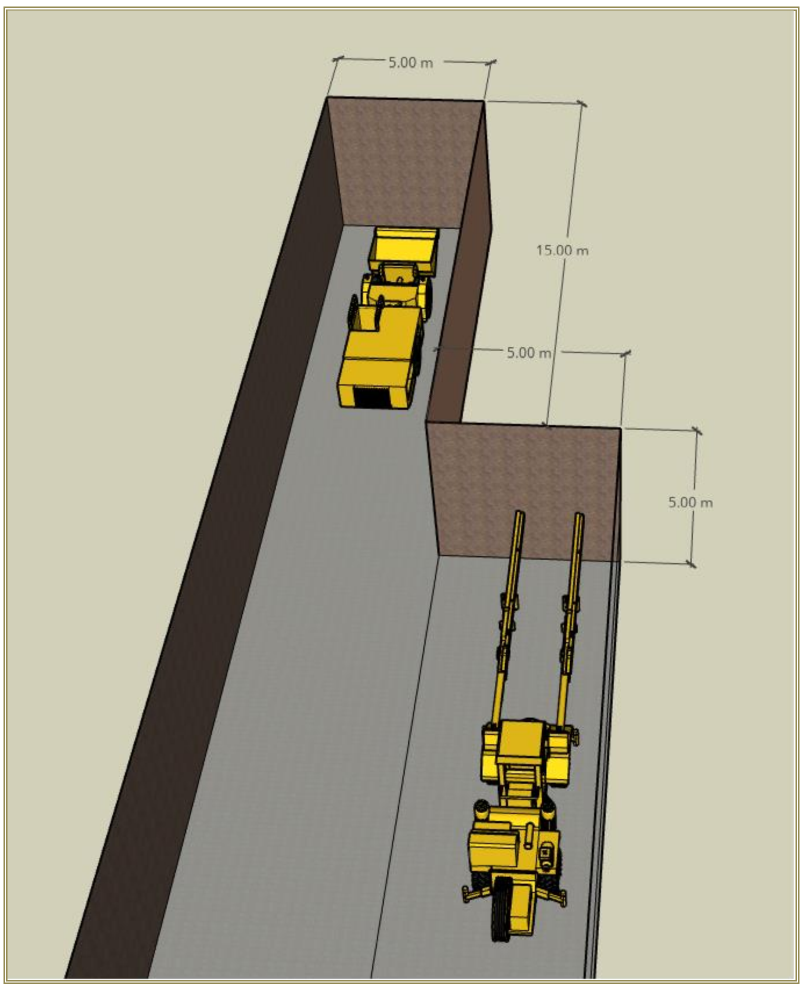
Note: CRF and URF will be used instead of hydraulic sandfill.

Figure 16-14: Perspective View of CF/DF Mining

Drift-and-Fill Mining Method

DF mining is similar to CF, as it follows the typical mining cycle of drill, blast, muck, and ground support with the same type of equipment. DF differs from CF in that it has only a single heading per level; alternatively, if multiple headings do occur, there is a permanent pillar between the headings. DF does not have a primary to secondary sequence or grid. CF headings sizes also remain the same to allow for a grid pattern, whereas DF consists of headings that vary in width. DF is a flexible and selective mining method, well suited to thin and relatively high-grade ore bodies.

DF headings would consist of 5 m high by 4 to 10 m wide excavations that would be excavated and then supported. For excavations greater than 5 m wide, the stope will be developed in two passes as shown in Figure 16-15. Where parallel ore zones exist, a rib pillar with a minimum width of 4 m would be left between the stope drifts. Parallel stope drifts would be connected by cross-cuts.

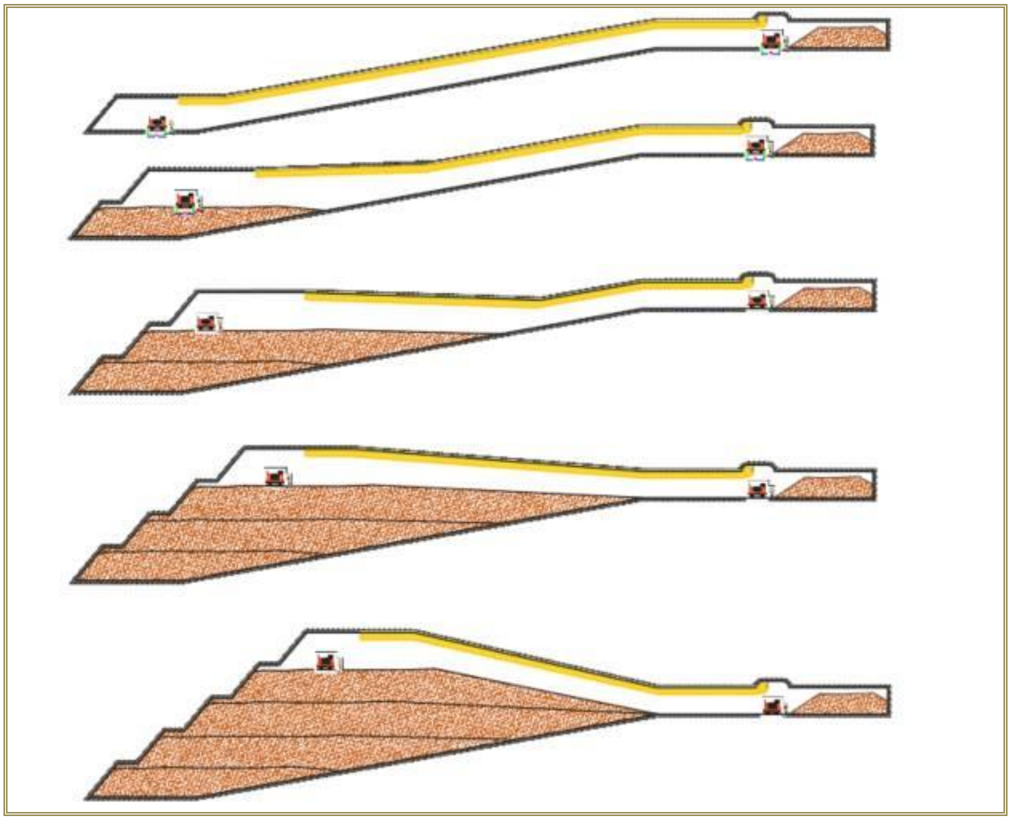


Source: MP, 2021.

Figure 16-15: DF Two Pass Sequence

An overhanded DF sequence has been selected for the Goose Main and Llama deposits. Backfill consists of CRF in the crown pillar and URF in the remaining parts of the Goose Main and Llama underground mines.

A conceptual view of the DF mining method is shown Figure 16-16.



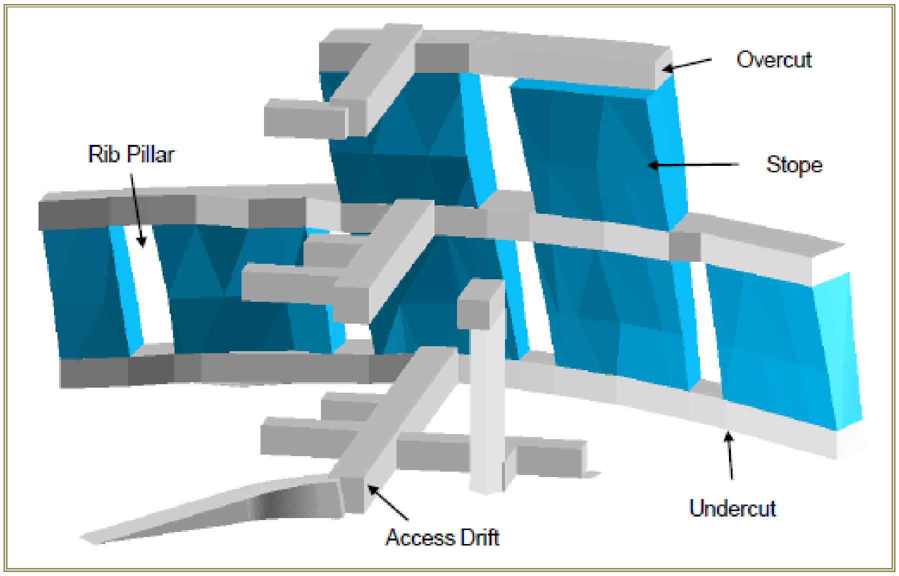
Source: Sabina, 2020.

Figure 16-16: DF Section View

Longhole Stoping Mining Method

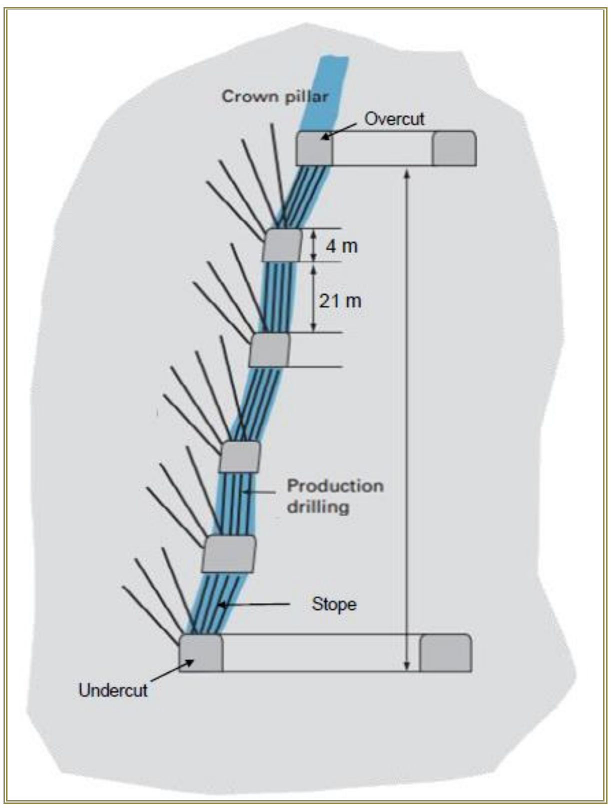
Longitudinal longhole stoping is a cost-effective mining method that is well suited to steep tabular deposits with a hanging wall to footwall thickness greater than a few metres. Overcuts and undercuts are typically advanced along strike to the end of the orebody on each sub-level. On retreat, the stope is drilled and blasted from the overcut, and ore is removed from the undercut. Once the ore is removed, the stope is backfilled with, in this case, URF. URF use requires that permanent rib pillars be left between adjacent stopes.

As with the previous methods, multiple mining blocks have been proposed, with permanent sill pillars between them. Longitudinal longhole stoping can be reasonably productive and is typically more cost effective than highly selective mining methods such as DF or PPCF. Figure 16-17 and Figure 16-18 show generalized schematics of the longitudinal longhole stoping mining method.



Source: Knight Piésold, 2015b.

Figure 16-17: Perspective View of Longitudinal Stoping



Source: Knight Piésold, 2015b.

Figure 16-18: Longhole Stoping Cross-Section View

Post Pillar Cut-and-Fill

Post-pillar cut-and-fill mining was not selected for the feasibility study, based on finding that the gold grade in potential pillars justifies the use of cemented fill for increased extraction. While not selected, the mining method and equipment can be applied to post-pillar cut-and-fill at any time to reduce mining costs if required. This method will not be applied to the mining in proximity to open pits, as these areas will use high cement content CRF. The method could be applied to increase productivity and reduce costs mining areas where cemented fill is not needed for global stability.

16.3.3 Underground Production Capacity and Scheduling

Deswik design and scheduling software was used to produce a detailed mine plan for the underground mines, including a merged schedule that incorporated all the deposits. Deswik targeted high-grade mining areas first for the sake of improved net present value (NPV), given constraints such as rates for development, drilling, stoping, and backfilling. The cost of access was also considered.

A production rate of 1,500 t/d was applied in the Umwelt underground mine plan and a production rate of 500 t/d was applied in the Llama, Goose Main, and Echo underground mine plans. Underground mining occurs at Umwelt for the LOM. The remaining deposits would be mined in a Llama, Goose, Echo sequence. During the years when both Umwelt and Llama or Goose Main are mined, the underground production rate would reach 2,000 t/d. As Echo would be mined near the end of mine life, the underground production rate would not increase significantly beyond 1,500 t/d during the Echo years.

The production rate is summarized in Table 16-11.

Table 16-11: Mine Production Rate

Deposit	Production Rate (t/d)
Umwelt	1,500
Llama	500
Goose	500
Echo	500
Total Underground	**1,500 to 2,000**

Source: MP, 2021.

The underground mine plan sequence is influenced by the strategy implemented to extract the Umwelt, Llama, and Goose Main crown pillars.

During active mining of open pit and underground, open pit and underground mining activities must be offset by 40 m vertically. Once open pit mining is completed, underground mining will encroach within an offset of 15 m from the open pit. The crown pillar extraction is planned to be completed prior to tailings or water being stored in the relevant pits.

The Umwelt decline is scheduled to begin in Year −1 with production beginning in Year 1 to ensure the crown pillar is planned to be extracted mid-Year 3.

Underground mining of the crown pillar at Llama is planned the same way. The Llama decline was scheduled to begin in Year 1 to ensure the crown pillar has been extracted prior to the pit reaching the offset distance in Year 4.

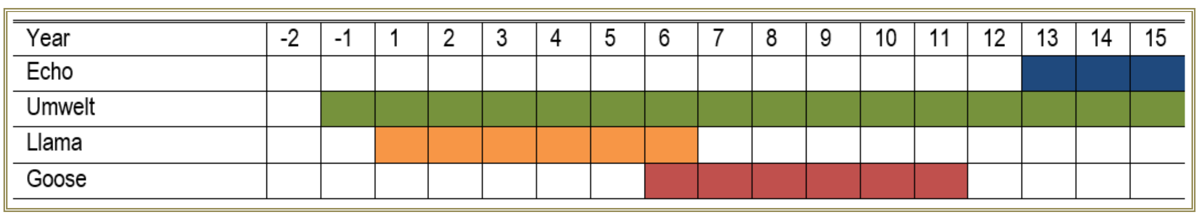
The Goose Main decline was scheduled to begin Year 6 and the crown pillar must be extracted prior to the pit reaching the offset distance in Year 12.

Echo underground would be mined last due to the lower gold grade.

Temporary sill pillars were included in the sequence for Umwelt, Llama, and Goose Main. Two 5 m levels above the temporary sill would be backfilled with CRF. For Llama and Goose Main, mining progresses up, towards the CRF, and a final 10 m level would be extracted with uphole drilling and extraction directly under the CRF. Active mining must be at least five levels above the sill and the span is limited to 6 m if active mining is occurring in the levels above. For Umwelt, the traditional CF cycle would be maintained but a reduced recovery, 50%, was applied to secondary headings.

The Umwelt schedule targeted a high-grade zone near elevation 190 m and the crown pillar for extraction during the first few years of mine life. In general, three mining zones were advanced in Umwelt during the LOM. The schedules for the remaining deposits were primarily dictated by mining method sequence and crown pillar constraints.

The resulting sequence of underground operations is shown Figure 16-19.



Source: MP, 2021.

Figure 16-19: Sequence of Underground Operations

16.3.4 Mine Access Design

The Umwelt, Llama, Goose Main, and Echo deposits are planned to be accessed via declines, based mainly on the depth of the mineralized zones. A decline is scheduled to provide early access to the ore zones, reduce initial capital, allow access to follow the deposit down plunge, and allow the opportunity to carry out infill exploration drilling.

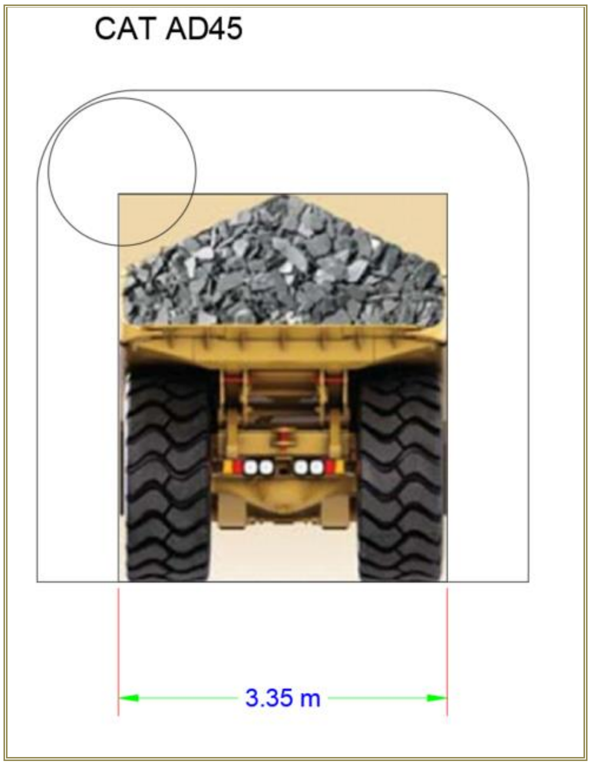
Decline

The decline at all four deposits would be used to haul ore and waste, as well as to provide access for personnel, equipment, materials, and services. It is also planned to be used as an exhaust airway.

The location of the Umwelt decline portal was chosen due to proximity to the pit access road, and to reduce the length to the crown pillar area of the underground mine. Local site conditions were also considered, such as flat topography, to minimize CF work for laydown pad construction. Environmental offset limits from streams were maintained. A box cut has been excavated through overburden to solid bedrock, and been prepared for collar of the decline.

A single, shared portal is planned for Goose Main and Echo. The location of this decline portal was chosen to align with an existing quarry on site to reduce excavation cost. The location of the Llama portal was chosen due to the proximity of the pit access road.

The size of the decline was selected according to required clearances for the chosen mobile equipment and required ventilation during development and production. It was determined that a 4.5 m wide by 5.0 m high profile would be suitable for up to a 45-tonne haul truck. In general, the decline is planned to be driven at a 15% gradient. Figure 16-20 shows the clearance for the size of truck planned for the Project operations.



Source: MP, 2021.

Figure 16-20: Haul Truck Clearance for Truck Size Selected

The decline is designed to minimize intersections with major faults or the middle mudstone rock unit. In addition, the offset of the decline from the open pit was maximized, maintaining a 25 to 30 m offset between decline and stopes.

Remuck bays are proposed every 150 m along the decline. They are designed to be 15 m long, to store two rounds of development muck. Later, the remuck bays would be used for equipment and material storage, or could be converted to sumps, refuge stations, or explosives magazines.

Level Access and Attack Ramps

Access development is planned to consist of a decline from surface to the depth of the deposits. Level accesses are designed to be located every 40 to 50 m vertically at Umwelt, Llama, and Goose Main. Level accesses are designed to be located every 25 m vertically at Echo. At least one remuck and sump are included on each level.

For Umwelt, Llama, and Goose Main, attack ramps would provide the access to the orebody and have a maximum gradient of 20%. Once a cut has been mined and backfilled, the back of the attack ramp is planned to be slashed down (i.e., take-down back), and a ramp would be constructed with the slashed rock to access the next cut above. Echo does not require attack ramps due to the longhole stoping mining method.

Level accesses and attack ramps are planned to be developed off the decline at a 4.5 by 5.0 m profile. All infrastructure development, that would not be used for access was designed at a 4 by 4 m profile (i.e., remucks, ventilation drifts and sumps).

16.3.5 Ventilation Raises, Rock Passes, and Drifts

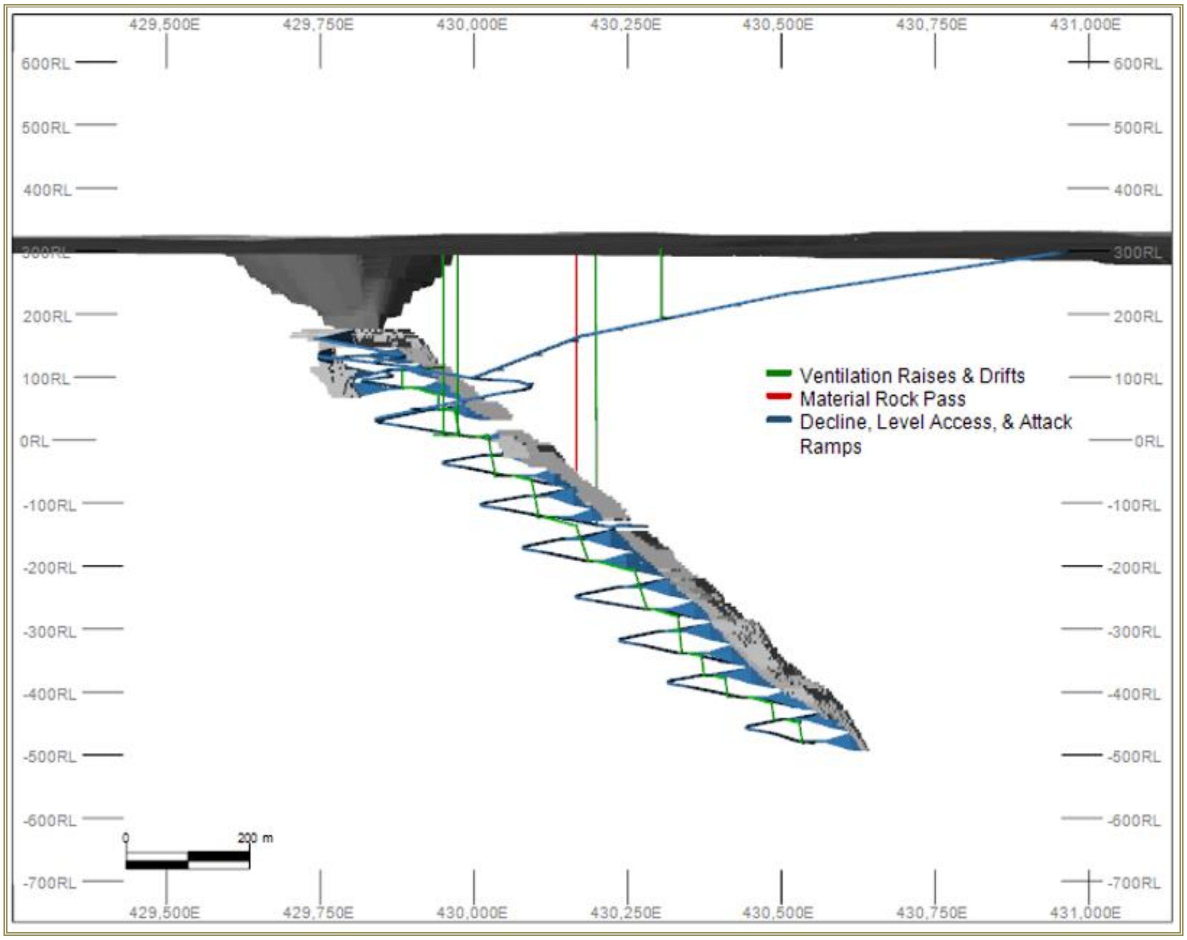
Ventilation raises are planned to be developed from surface. Some of the raises would also be equipped with ladderways to serve as secondary egress in emergencies. The top and longest portion of the ventilation raises are designed to be developed by raiseboring at 4 m diameter. The lower portions would be relatively short and would be developed by drop raising on a 4 by 4 m profile. Lateral ventilation drifts at 4 by 4 m profile are planned to connect the ventilation circuits to the level access.

Based on ventilation modelling results, a twinned fresh-air raise (FAR) system would be required at Umwelt (see Section 16.3.8). One of the two FAR systems would be equipped with an egress ladderway. A single FAR would be required at each of Llama, Goose Main, and Echo.

A return-air raise (RAR) system midway down the Umwelt deposit would be required to keep the airspeed at an acceptable level in the decline. The 4-m diameter RAR would be developed by raiseboring from surface. Llama, Goose Main, and Echo would not require RARs.

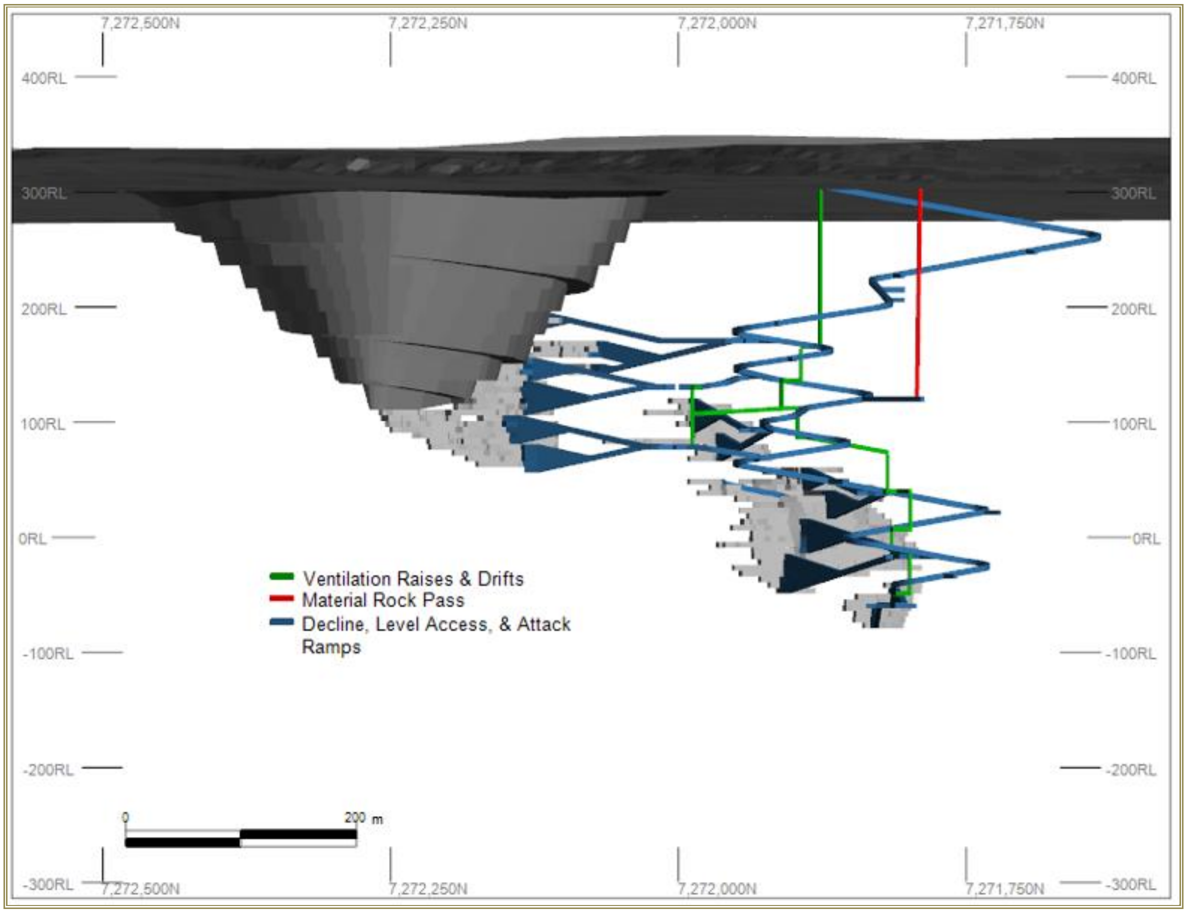
Material rock passes have been included for Umwelt, Llama, and Goose Main. Due to the relatively small size of the mine, a material pass was excluded for Echo. Material passes would be developed by raiseboring at 4.0 m diameter.

Figure 16-21 to Figure 16-23 display the access design and ventilation for Umwelt, Llama, Goose Main, and Echo, respectively.



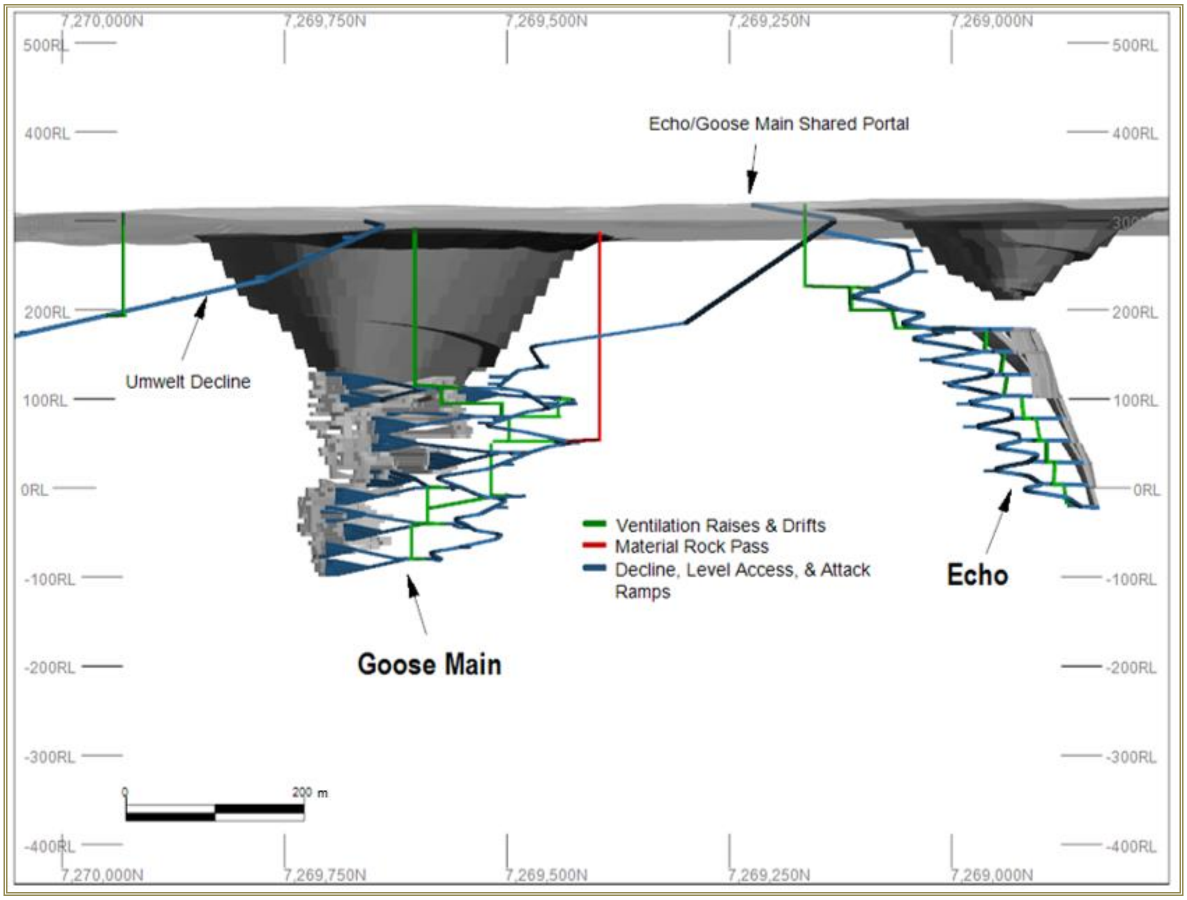
Source: MP, 2021.

Figure 16-21: Umwelt Underground Operation Access Design (Section)



Source: MP, 2021.

Figure 16-22: Llama Underground Operation Access Design (Section)



Source: MP, 2021.

Figure 16-23: Goose and Echo Underground Operation Access Design (Section)

16.3.6 Production Design

Ore at Umwelt is planned to be mined by excavating rooms in 5 m high cuts in a bottom-up mining sequence. Sill pillars with a vertical height of 15 m would separate the mining blocks. Permanent sill pillars were located between 30 and 15 masl, and between −130 and −145 masl.

Ore at Goose Main and Llama is planned to be mined via the DF sequence outlined in Section 16.1.2. Sill pillars with a vertical height of 10 m would separate the mining blocks. One 10 m permanent sill pillar in the SE zone between −30 and −40 masl was included in the Llama design. The grade of the deposit allowed for some natural pillars in the Goose Main design.

Ore at Echo is planned to be mined via longhole stoping with a standard sublevel spacing of 25 m. Ore drives would be developed on each sublevel at a 4 m height and a 4 m minimum width along the strike of the ore zone. Undercuts are planned to be slashed on retreat to a maximum span of 10 m before stoping starts. Depending on the width of the mineralization, stopes would be between 5 m and 13 m wide and have a strike length of 15 m. Permanent rib pillars, with a width of 5 to 7.5 m, would be left between adjacent stopes to contain URF. No permanent sill pillars were included in the Echo design, but a barren zone does occur between mining blocks at elevation 100 masl.

16.3.7 Unit Operations

General mine planning criteria are summarized in Table 16-12.

Table 16-12: Mine Planning Criteria

Parameter	Unit	Value
Operating Days per Year	d	365
Shifts per Day	shifts	2
Hours per Shift	h	12
Work Rotation	weeks in/weeks out	2 x 2
Ore Density	t/m³	Variable and sourced from resource model
Waste Density	t/m³	2.89
Swell Factor	%	34
Placed Backfill Density	t/m³	2.16

Source: MP, 2021.

Mining equipment types referenced in the following subsections are for reference purposes only. The equipment referred to was used for estimation purposes and was not based on a competitive selection process.

Development

The development headings are planned to be driven with electro-hydraulic, two-boom jumbos similar to the Sandvik DD421-60. Blastholes with 45 mm diameter would be drilled to a depth of 4.2 m. The advance per round is assumed to be approximately 4.0 m.

After the round is drilled, the blastholes would be charged with explosives by a Kovatera ANFO loader. The holes would be loaded with a blend of ANFO. Lifter holes would be loaded with packaged emulsion. The round would be tied-in by the blaster, and the blast would either occur during a shift, when all personnel are accounted for in a designated safe location, or at a shift change. Blasting is planned to be initiated by non-electric caps.

Following the blast, ventilation would be re-established, and the blast smoke would clear. Upon re-entry to the heading, the miners would scale and check the workplace for any safety concerns. The muck pile would be washed down to suppress any dust.

In the next stage, the blasted rock would be mucked from the face by a load-haul-dump (LHD) vehicle, either directly into a truck or into a remuck bay. A Sandvik LH514 was selected as an example unit for the mucking operation. The muck is planned to be hauled from underground to surface by haul trucks like the Caterpillar AD45. Additional information on the haulage cycle is provided in the following subsections.

Once the face is clear of muck, and the back, walls, and face of the heading are scaled, ground support would be installed according to geotechnical recommendations. A MacLean Omnia 975 Scissor Bolter was selected for ground support installation.

Typical ground support installation in access development is planned to consist of 2.4 m long bolts on the back and 1.8 m long bolts on the walls at a 1.5 by 1.5 m pattern with 6-gauge welded wire-mesh installed within 1.5 m of the floor. For corrosion protection, plastic-coated bolts and galvanized mesh would be installed in long-term development headings. In areas with poor ground conditions and in intersections, 3.7 or 4.6 m Super Swellex bolts would be used as secondary ground support. Swellex bolts have been selected, as the ground temperature is expected to generally be below 0°C, limiting the use of fully encapsulated resin-rebar bolts.

A Kovatera scissor truck is planned to be used to install services, which would be advanced roughly every 20 m. Service water and dewatering lines are designed to be steel pipes connected by Victaulic-type couplings. Electrical power and leaky feeder communication lines are planned to be advanced at the same time. The scissor truck would also be used to install and maintain auxiliary ventilation fans and ducting.

Long term lateral development advance rates are scheduled for an advance of 5.8 m/d.

Ventilation drop raises are planned to be drilled using a Sandvik DL321 Drill. Drop raises would be developed on a 4 by 4 m profile and a maximum length of 35 m. This drill would also be used for production drilling at Echo.

The drill holes would be loaded with ANFO and blasted in 2.8 m lifts. A sufficient amount of muck is planned to be removed at the bottom of the raise between blasts so that the next blast is not obstructed.

Upon completion of blasting, the raise would be scaled, and ground support installed in the raise by working on top of the muck pile or on top of temporary staging installed in the raise. Galvanized welded wire mesh and 1.8 m plastic-coated Swellex bolts would be installed on a 0.9 m square pattern. Egress ladderways would also be installed. The ground support and ladders would be installed starting at the top of the raise, and muck would be drawn down as the installation process proceeds.

A raisebore machine would be purchased and remain onsite. A contractor would operate the machine to excavate raisebored shafts.

Loading and Hauling

Blasted material from development headings and stopes would be mucked by LHD directly to a haul truck or to a remuck bay, located up to 150 m from the face. During the pre-production period, development waste rock would be hauled to surface and stored close to the portal at a temporary waste stockpile. When underground ore production commences, development waste would be transported to mined-out stopes for direct backfilling. Surplus waste material would be hauled to surface; waste rock would not be stored underground.

Trucks loaded with ore are planned to drive up the decline to surface and dump the ore in different ore stockpile areas depending on the grade of the material.

The same trucks would transport backfill material on backhaul from surface or the base of a material rock pass to mined-out stopes when required. A Caterpillar 966H front-end loader would load the underground haul truck with backfill from a waste stockpile at the portal laydown area on surface.

The Sandvik LH514 14 tonne LHD was selected to be paired to a Caterpillar AD45 45 tonne haul truck. To ensure the haul trucks and LHDs would not be overloaded, reduced fill factors were applied.

Haulage profiles for all production levels and material types were generated for the underground operation. A waste balance was performed to further identify the destination for the waste material and the source for the backfill material. These calculations were used to determine equipment hours for both haul trucks and LHDs.

Backfilling

All the mining methods require backfill to maintain ground stability and to provide a base for mining to transition to the level above. Development waste from the underground mine would be used for backfill as it is available. The deficit of available material will be resolved by crushing open pit waste material and transporting the crushed rock underground. Umwelt, Llama, and Goose Main designs include a material rock pass to be used instead of backhauling to reduce congestion and risk to delays in ore transportation. During the initial years of these three deposits, backhauling will be used, as the material rock pass will not be complete. Due to the lower volume and general orientation of Echo, a material rock pass was not included for this deposit. Backfill material for Echo will be transported via the backhaul of trucks delivering ore to surface.

CRF would be used at Umwelt, Llama, and Goose Main for crown pillar and temporary sill pillar extraction. CRF would also be used for Umwelt primary headings. CRF would consist of development waste or crushed material from the surface less than 100 mm in diameter. An underground screen would ensure oversized development waste is not used. A CRF mixing bay will consist of a cement mixing system and spray bar. Rock is mixed with the cement via LHD and hauled to the destination. Multiple mixing bays would be constructed at Umwelt due to the quantity required. The cement content of CRF varies from 5% to 9% (w/w) depending on application of the backfill. This results in a weighted average cement content of 6.1% for Umwelt and 9% for Llama and Goose Main underground.

A Caterpillar 966H front-end loader would load underground haul trucks or the material rock passes from the temporary waste stockpile with backfill.

Table 16-13 summarizes the backfill requirements for the Umwelt underground operation.

Table 16-13: Backfill Summary

Deposit	URF Required (m³ '000s)	CRF Required (m³ '000s)	Total Backfill (m³ '000s)
Umwelt	1,280	1,280	2,560
Llama	340	20	360
Goose Main	170	140	310
Echo	90	-	90
Total	**1,880**	**1,440**	**3,320**

Source: MP, 2021.

16.3.8 Mine Services

Ventilation

The underground operation ventilation system is designed to dilute and remove dust, diesel emissions, and blasting fumes, and to maintain compliance with Nunavut mine regulations. A ventilation network was modelled in Ventsim™ software for all four deposits, based on the detailed mine design. The mine design was imported from Deswik with the proper drift profiles. Industry-standard friction factors and shock losses were included in the model to accurately simulate the ventilation system. Additional resistance for escape ladderways was included in the modelling. The required pressures and flow rates were calculated and used to select primary ventilation fans and estimate electrical power consumption.

Airflow Requirements

Airflow requirements for the underground operation were based on expected diesel emissions of the underground mining fleet. According to the Nunavut mining legislation, "the ventilation quantity shall be at least 0.06 m^3/s for each kW of the diesel-powered equipment operating at the work site" (*Mine Health and Safety Act*, Section 10.62 [2]). This minimum applies to engines that have not been approved by CANMET or MSHA. Ventilation for the underground operations was based on CANMET guidelines where applicable.

Mobile equipment lists were compiled to determine baseline airflow requirements. The power rating of each piece of equipment was determined and ventilation utilization factors applied. Ventilation losses of 20% were applied to determine total ventilation requirements. The airflow requirements for each of the mines are summarized in Table 16-14.

Table 16-14: Airflow Requirements

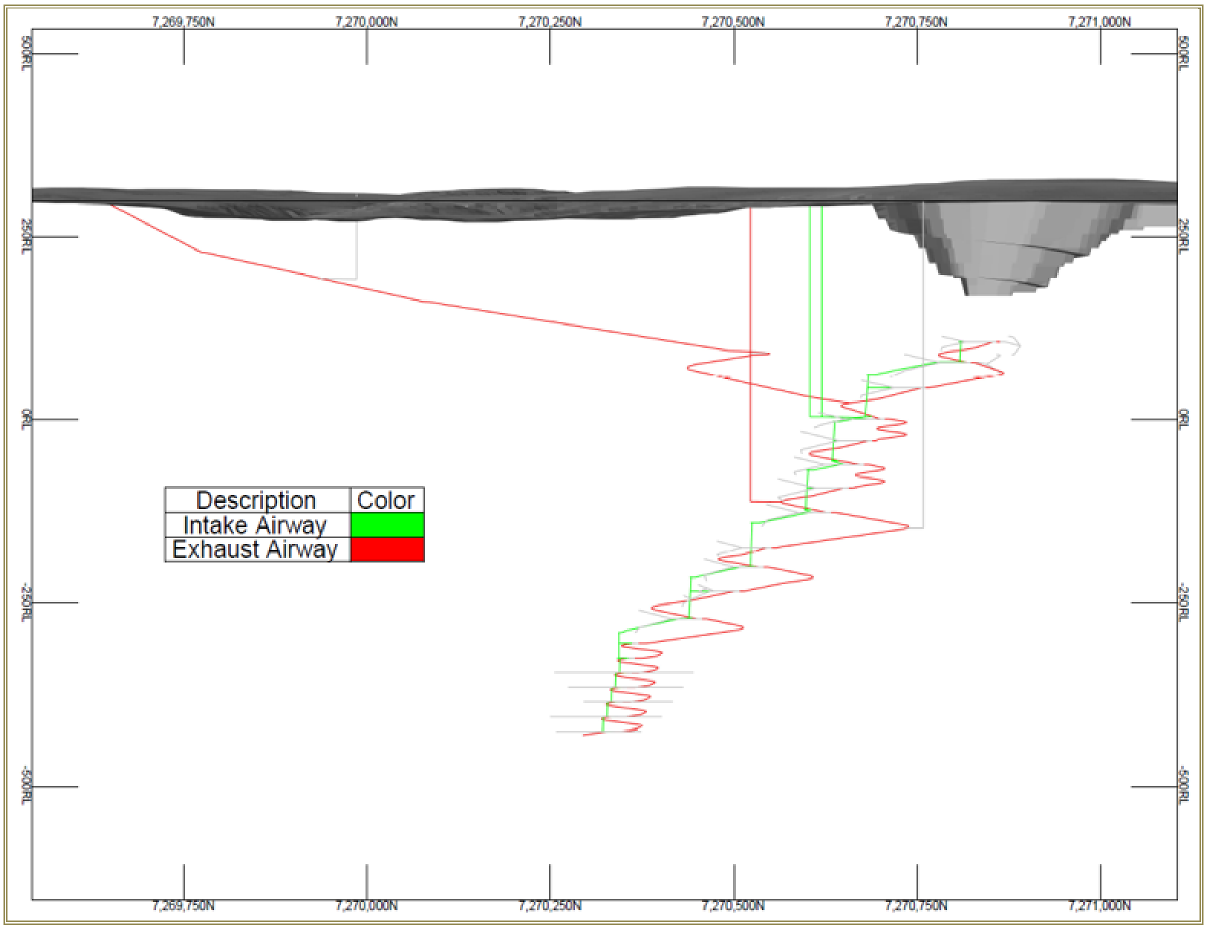
Deposit	Airflow Requirement based on CANMET (m^3/s)
Umwelt	185
Llama	75
Goose	75
Echo	70

Source: MP, 2021.

Primary Ventilation Design

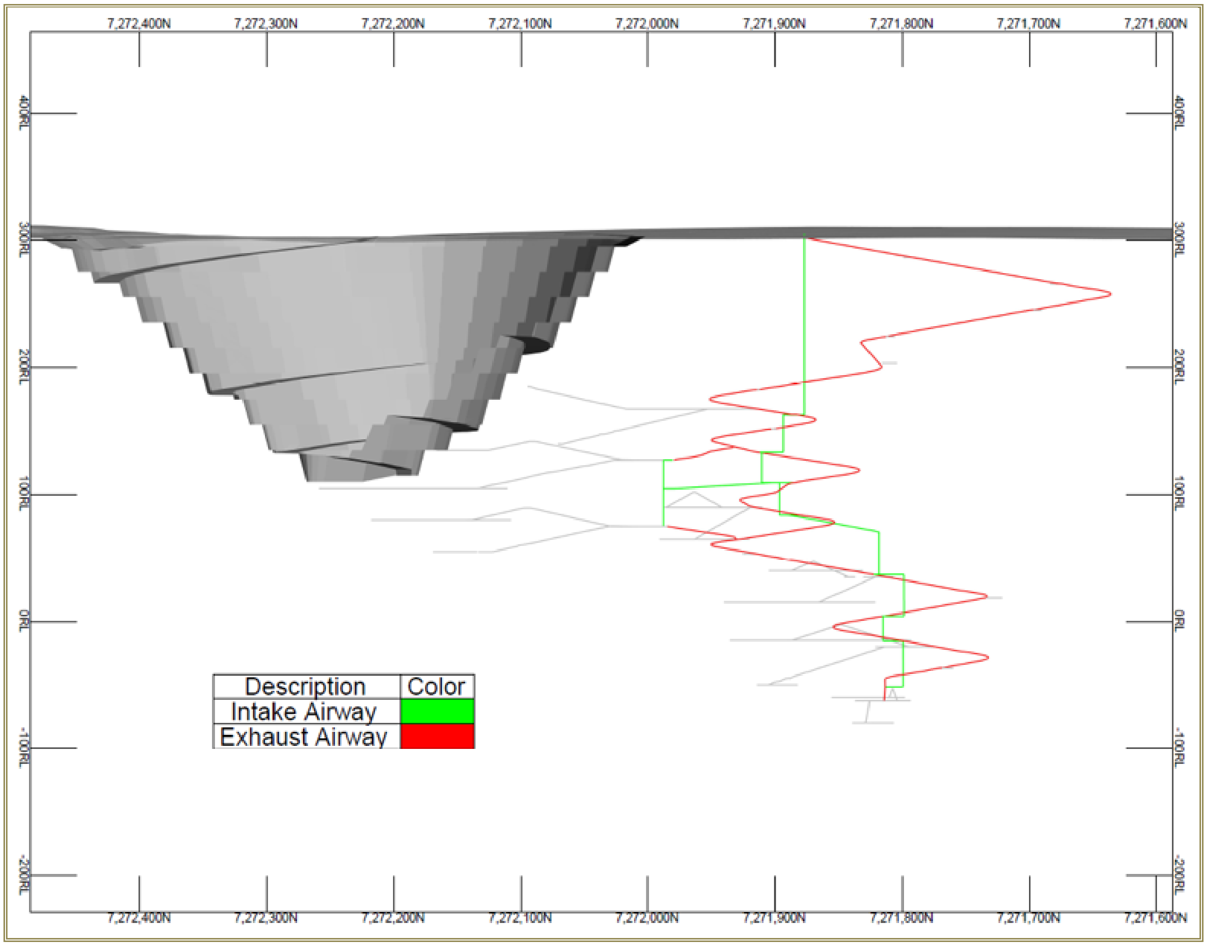
The mine is designed to be ventilated by a positive-pressure ventilation system with primary fans on the surface at intake raises. Fresh air would be directed down through a system of FAR adjacent to the decline. The FARs would be connected by lateral development drifts to create a ventilation circuit. At each of the levels, a regulator would be installed at the ventilation drift to control the air directed into the level or decline. The used return air from working areas would be exhausted up the decline to surface in each of the four mines. Umwelt would also exhaust return air through a RAR near the midpoint of the deposit. A maximum air velocity of 6 m/s in the decline was used in the design criteria to maintain appropriate environmental conditions. The maximum airflow in the decline is therefore approximately 130 m^3/s. Operations above and below the RAR in Umwelt would need to be balanced during some years to ensure the velocity constraint in the decline is not exceeded.

The intake and return ventilation circuits are shown in Figure 16-24 to Figure 16-27.



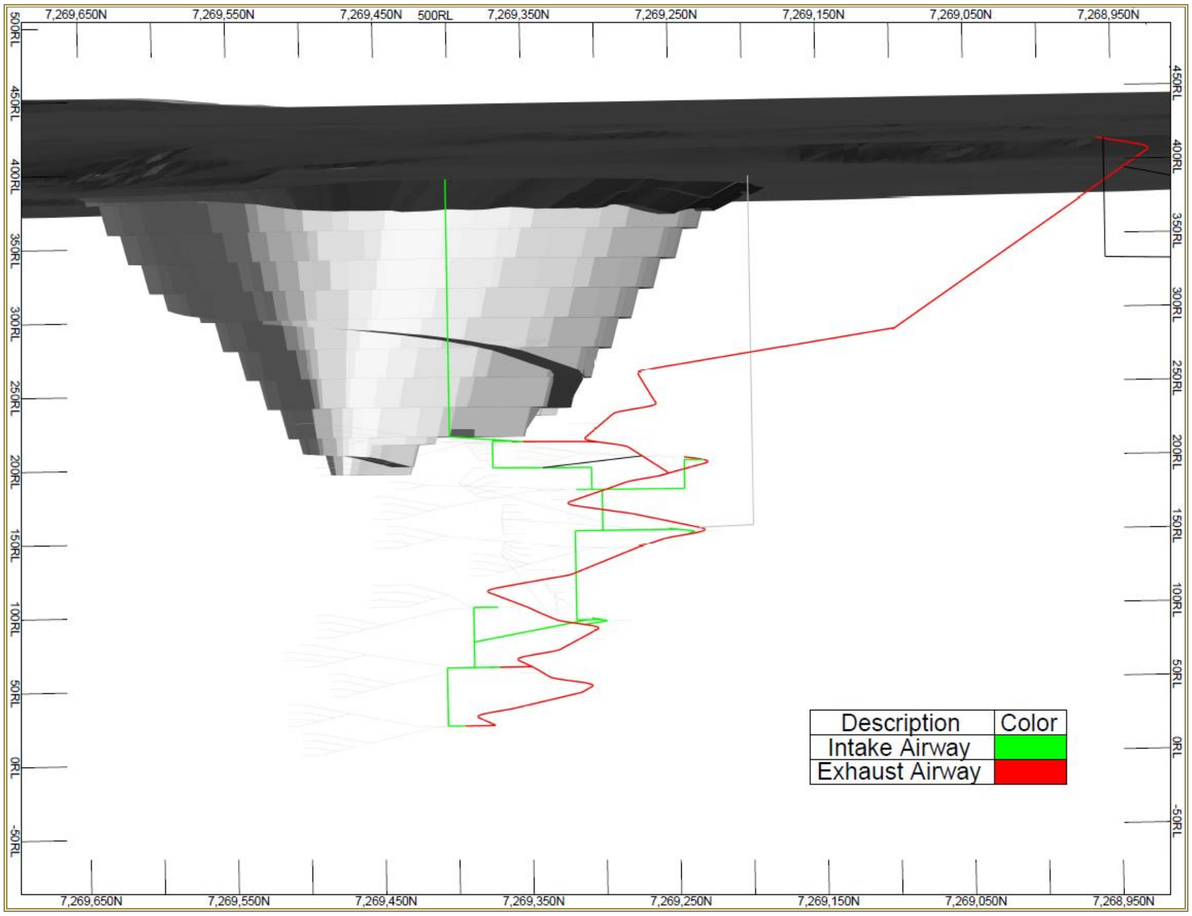
Source: MP, 2021.

Figure 16-24: Umwelt Ventilation Circuit



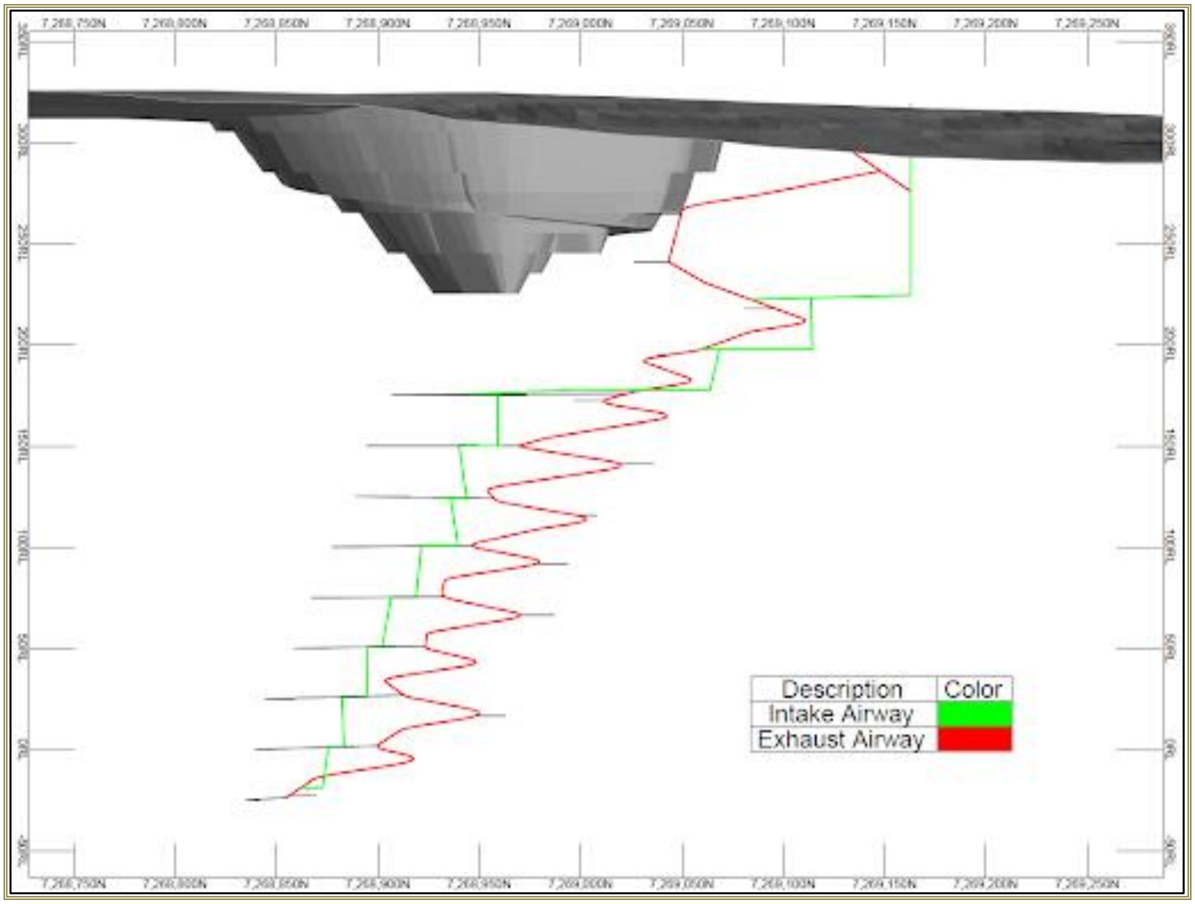
Source: MP, 2021.

Figure 16-25: Llama Ventilation Circuit



Source: MP, 2021.

Figure 16-26: Goose Main Ventilation Circuit



Source: MP, 2021.

Figure 16-27: Echo Ventilation Circuit

Main Fans

The main fans were designed to be installed on surface at the collars of raisebored intake raises. Main fans were specified to be able to meet the maximum capacity of the system (i.e., the decline maximum airflow). As the required airflow would fluctuate throughout the LOM, airflow would be controlled with variable-frequency drives.

Due to similar operating parameters of the mines, the main fans and motors would be standardized and interchangeable for the four mines. This would reduce costs for critical spares.

The main fan(s) power, total pressure, and airflow for each of the deposits are shown in Table 16-15.

Table 16-15: Primary Ventilation

Deposit	No. of Intake Raises/Main Fans	Main Fan Pressure (Pa)	Main Fan Motor (kW)	Main Fan Airflow (m^3/s)
Umwelt	2	2,020	375	185
		2,040	375	
Llama	1	1,560	375	75
Goose Main	1	1,600	375	75
Echo	1	1,180	375	70

Source: MP, 2021.

Ventilation During Development

Prior to establishing the primary ventilation system, required airflow for the advance of the decline is planned to be supplied by auxiliary ventilation. Ducting would provide intake air to the end of the decline via a positive pressure system. Return air will be exhausted to surface via the decline.

Dual 1.22 m diameter ducting with 75 kW fans would be installed to provide at least 26 m^3/s of air to the decline face. Low-friction-factor plastic ducting will be required to reduce the resistance of the system. Once the primary ventilation system is established, the ducting and fans would be stripped out of the decline.

The required number of development fans for the underground mine is shown in Table 16-16.

Table 16-16: Development Phase Ventilation Requirements

Deposit	Development Distance to First Raise (m)	Number of 75 kW Fans
Umwelt	750	2
Llama	1,000	2
Goose	1,600	2
Echo	520[1]	1

Source: MP, 2021.
Note: [1] Distance stated is the development distance from the Goose decline to the first Echo raise.

Auxiliary Fans

Auxiliary fans are planned to be used to ventilate the advancing development and active production levels. Fresh air would be sourced from the ventilation raises and forced using smaller auxiliary fans through ventilation ducting to the active headings. Ducting would be removed on retreat and used again on the next cut or advancing face.

The expected number of auxiliary fans required during production is shown in Table 16-17.

Table 16-17: Auxiliary Fan Requirements

Deposit	Number of 150 kW Fans	Number of 75 kW Fans	Number of 50 kW Fans
Umwelt	1	9	3
Llama	4	6	1
Goose Main	4	6	2
Echo	1	3	1

Source: MP, 2021.

Ventilation Bulkheads

Ventilation bulkheads with regulators would be required at the ventilation cross-cuts on each level to control airflow to active levels and the decline. Airlock access doors would be required at each regulator to facilitate access to the escape ladderway in cases of emergency.

Mine Air Heating

Intake air would be heated during the winter months to prevent ice build-up on roadways and in ventilation raises.

The intake air is planned to be heated to a temperature of +2°C. The mine air heating systems would consist of indirect-fired diesel heaters.

Heating calculations were based on average site temperatures and modelled intake airflows. Heat generated from underground diesel equipment was not considered in the estimation of mine air heating requirements.

Electrical Power Distribution

Power will be run to each underground mine via 4.16 kV cables from the main distribution switchgear adjacent to the power plant. Primary power cables will be run down vent raises or via decline portals, as appropriate for each mine layout. Movable mine power centres will be located in the vicinity of each electrical load and 4.16 kV cabling will be daisy-chained and spliced as required to reach each area. Mine power centres will consist of a primary fused disconnect switch, step-down transformer to 600 V, secondary distribution and ground-fault/ground-check protective relays as required by CSA M421—*Use of Electricity in Mines*.

The major electrical power consumption in the mine arises from the following:

- Main and auxiliary ventilation
- Mine dewatering pumps
- Underground mobile equipment
- Air compressors
- Refuge stations.

The estimated annual electrical power consumption for the underground operation averages 32000 MWh.

Compressed Air

The underground mobile drilling equipment, such as jumbos, rockbolters, and longhole rigs, are equipped with self-contained air compressors. Additional compressed air will be provided to underground machinery via surface and underground compressor. This will reduce service-water consumption, which would be substantial due to the use of brine for drilling blastholes. Multiple 93 kW compressors capable of delivering sufficient air volume and pressure will be used for underground mining. These will be positioned underground once space is available, to minimize piping and allow operation in heated conditions.

Service Water Supply

Service water for underground is planned to be used mainly for drilling, dust suppression, and washing of development faces. The service water will be provided as brine water to prevent freezing. Initially, surface brine mixing tanks will supply underground where sumps and settling ponds are located. The brine preparation, recycling, and distribution will be completed underground for the rest of the LOM, minimizing the discharge of water from underground.

Water would be supplied from a service-water tank close to the portal and would be gravity fed to the underground work areas via 100 mm diameter pipelines. Pressure reduction valves would be installed along the decline as needed. The service water tank would be refilled with underground mine water or by a site services water truck in the case that sufficient water is not generated via mining activities and groundwater leakage.

Face pumps are planned to collect the service water and return it to the nearest sump, where it would be decanted and pumped to surface for reuse. Water recycling would reduce the overall water consumption at site.

Mine Dewatering

Sources of mine water include meltwater runoff down the decline, groundwater leakage, drilling activities and the combustion of diesel fuel. To the extent possible, water will be settled and reused within the mine for drilling activities. As the decline develops, small movable pumps will be employed along the length to transport excess water to the surface. Larger, stationary pump stations will be installed at pre-determined depth intervals to serve as dewatering facilities for the life of each underground mine. From the portal, or top of vent raise, as appropriate for each mine layout, excess water will be pumped to contact water ponds for settling and treatment.

Communications

A leaky feeder communication system would be used for underground operations. Key personnel, such as mobile mechanics, crew leaders, shift supervisors, and mobile equipment operators, would be supplied with an underground radio to contact the leaky feeder network.

Femco mine telephones would be located at key infrastructure locations in the mine, such as refuge stations. The mine telephones would be independently powered and would also operate in the absence of mine power.

Explosives Storage and Handling

The primary explosives storage facility would be located on surface. Secondary underground facilities would fulfill explosives need for up to seven days. Day boxes would be used as temporary storage for daily consumption.

Underground magazines would separately store bulk explosives and detonators for each of the deposits. Each magazine would be in a bay off the decline. Access would be controlled with lockable gates. The magazines would be equipped with fire extinguishers, wooden shelves, and concrete flooring.

ANFO would be used as the main explosive for mine development and stoping. Packaged emulsion would be used as a primer and for loading lifter holes in development headings. Smooth blasting techniques could be used, as required, in main access development headings; trim powder could be used to load the perimeter holes.

Blasting in the development headings would be done at any time during the shift when the face is ready for the blast. All underground personnel would be required to relocate to a designated safe work area during blasting.

Explosives handling, loading, and detonation would be carried out by trained and authorized personnel only.

Fuel Storage and Distribution

A fuel station for underground mobile equipment would be located near the mine portal. Haul trucks, LHDs, and smaller mobile equipment would be refuelled at surface at the beginning of each shift. The fuel tank would be refilled by site services regularly.

No permanent underground fuel and lube stations were planned. A Kovatera UT99 fuel and lube truck is planned, with a capacity of 170 L of fuel and 500 L of oil and lube. Mobile equipment such as bolters and jumbos would be refilled by the fuel and lube truck.

Day tanks for diesel fuel are planned to be installed for the mine air heaters. The tanks would be refuelled by site services.

Fuel consumption for mobile and stationary underground equipment was estimated based on equipment operating hours, engine fuel consumption, load factors, and utilization. Annual fuel consumption, including fuel for mine air heating, is shown in Table 16-18.

Table 16-18: Annual Fuel Consumption

Deposit	Average[1] (L/a)	Maximum (L/a)
Umwelt	6,400,000	6,700,000
Llama	2,600,000	2,800,000
Goose Main	2,800,000	3,200,000
Echo	2,400,000	4,100,000

Source: MP, 2021.
Note: [1] Average listed is for the years with steady-state production.

Underground Transportation

All mine supplies and personnel would access the underground work areas via the decline.

Mobile equipment, such as LHDs, haul trucks, and supervisor vehicles, would primarily be parked on surface between shifts. Workers who are not operating this equipment would be transported to the underground work areas via a personnel carrier.

Materials and supplies would be delivered to the active underground workings or storage bays by auxiliary equipment.

Surface Infrastructure

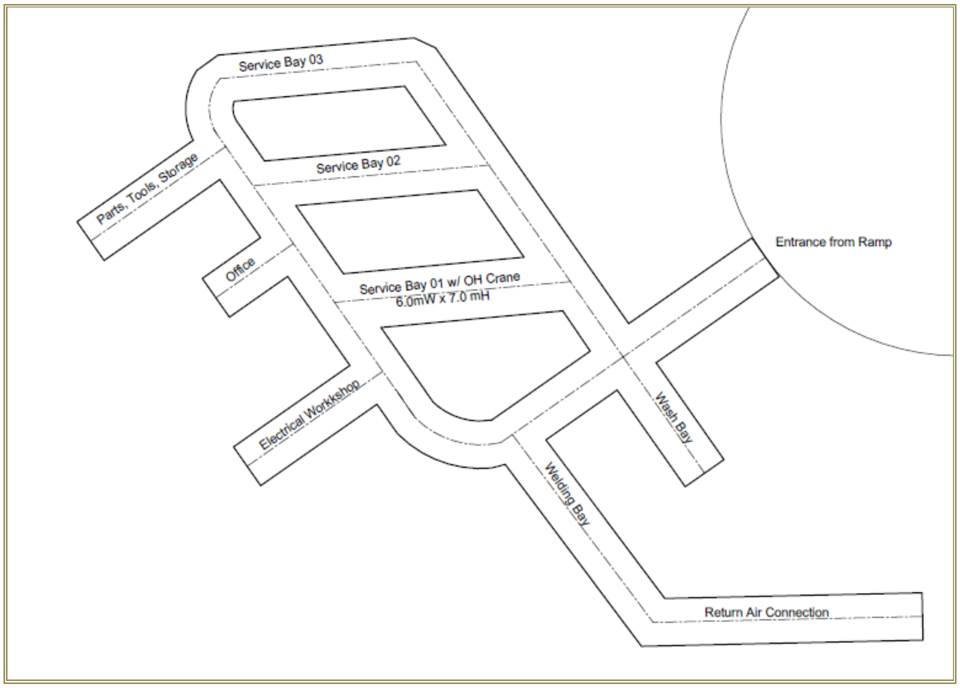
Next to the portal, a laydown pad would be used for short-term storage of underground consumables, mobile equipment parking, and permanent surface infrastructure, such as a fuel station, E-House, or an emergency shelter. Temporary ore and backfill waste stockpiles would also be in this area.

All other major infrastructure is planned to be located at the central truck shop, which includes the mine dry, mine offices, warehouse, and mechanical shops.

Underground Workshop

A small workshop/service area would be located at Llama, Goose Main, and Echo. A larger two-bay workshop would be located at Umwelt due to the depth of the deposit.

The Umwelt workshop is displayed in Figure 16-28.



Source: MP, 2021.

Figure 16-28: Umwelt Workshop

16.3.9 Mine Safety

Fire Prevention

Fire extinguishers would be provided at the underground refuge stations, electrical substations, pump stations, fueling stations, explosives magazines, and other strategic areas, and maintained in accordance with regulations and best practices. Every vehicle would carry at least one fire extinguisher; the correct size and type would depend on the type of vehicle. Underground heavy equipment would be equipped with automatic fire-suppression systems.

Mine Rescue

A fully trained and equipped mine rescue team is essential to the safe operation of any mine. The mine rescue team would be trained for surface and underground emergencies.

Refuge Stations

Self-contained portable refuge stations would be provided in the main underground work areas. The stations are designed to be equipped with compressed air, potable water, and first aid equipment. They would also be supplied with a fixed telephone line and emergency lighting. The refuge chambers would be sealable to prevent the entry of gases. The portable refuge stations are planned to be moved to new locations as the work areas advance; this eliminates the need to construct permanent refuge stations.

Emergency Egress

The main decline is planned to provide primary egress from the underground workings. The FAR system would provide the secondary egress in case of emergency. The escapeway would be equipped with steel ladders and platforms.

Emergency Stench System

A stench gas system would be installed on each fresh-air intake and could be triggered to alert underground personnel in the event of an emergency.

16.3.10 Mobile Equipment

The selection of underground mining equipment is based on the mining method; drift and stope dimensions; production rate; and operating and capital costs. Equipment would be rebuilt and/or replaced over the LOM. Some auxiliary equipment would be shared between the active underground mines, and equipment would be transferred from mine to mine as mining ends at one deposit and begins at another.

A summary of selected mobile equipment for the underground operation is shown in Table 16-19.

Mining equipment makes and models are for reference purposes only and were not part of a comprehensive competitive selection process.

Equipment requirements were developed based on the scheduled production and development, and unit rates estimated from first principles. Operational efficiencies and mechanical equipment availability factors were included in the calculations.

A summary of the LOM equipment requirements is shown in Table 16-20.

Table 16-19: Mobile Equipment Summary

Description	Make	Model	Overhaul Frequency (h)	Replacement Frequency (h)	Estimated Mechanical Availability (%)
Haulage Truck (45 t)	Cat	AD45	14,000	28,000	85
LHD 6 m³ (15 t)	Sandvik	LH514	14,000	28,000	85
LHD 4.5 m³ (10 t)	Sandvik	LH410	14,000	28,000	85
Jumbo (2 boom)	Sandvik	DD422i	12,500	25,000	75
Production Drill	Sandvik	DL321	12,500	25,000	75
Diamond Drill	Boart Longyear	LM55	15,000	30,000	75
Rockbolter	MacLean	Omnia 975	12,500	25,000	75
ANFO Loader	Kovatera	MC100	15,000	30,000	90
Boom Truck	Kovatera	MC100	15,000	30,000	90
Fuel-Lube Truck	Kovatera	UT99	15,000	30,000	90
Scissor Truck	Kovatera	UT99	14,000	28,000	90
Supervisor Vehicle	Toyota	Landcruiser	15,000	30,000	90
Electrician Vehicle	Toyota	Landcruiser	15,000	30,000	90
Personnel Carrier	Kovatera	UT99	14,000	28,000	90
Utility Truck	Toyota	Landcruiser	15,000	30,000	90
Mechanics Truck	Toyota	Landcruiser	15,000	30,000	90
Portable Welder	-	-	14,000	28,000	90
Grader	CAT	14M	14,000	28,000	90
Forklift/Telehandler	CAT	TH514C	14,000	28,000	90
FEL (Surface)	CAT	966H	14,000	28,000	90

Source: MP, 2021.

Table 16-20: Annual Mobile Fleet Requirements

Description	Year (No. of Units)																	
	−3	−2	−1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Haulage Truck (45 t)	-	-	1	3	5	6	7	7	7	6	7	7	8	7	5	6	5	3
LHD 6 m^3 (14 t)	-	-	1	2	4	4	4	3	4	4	3	4	4	4	3	3	3	2
Jumbo (2 boom)	-	-	1	2	4	4	4	3	4	3	4	4	4	3	2	3	3	2
Production Drill	-	-	-	1	2	1	1	-	-	1	1	-	-	-	-	1	1	1
Diamond Drill	-	-	1	1	1	1	1	-	1	-	-	-	-	-	-	1	-	-
Rockbolter	-	-	1	3	5	5	5	4	4	4	5	5	5	4	3	3	3	2
ANFO Loader	-	-	1	2	2	3	2	2	3	2	2	2	2	2	1	2	2	2
Boom Truck	-	-	1	2	2	2	2	2	3	2	2	2	2	2	1	2	2	1
Fuel-Lube Truck	-	-	1	2	2	2	2	2	3	2	2	2	2	2	1	2	2	1
Scissor Truck	-	-	1	2	2	2	2	2	3	2	2	2	2	2	1	2	2	1
Supervisor Vehicle	-	-	1	2	2	2	2	2	3	2	2	2	2	2	1	2	2	1
Electrician Vehicle	-	-	1	2	2	2	2	2	3	2	2	2	2	2	1	2	2	1
Personnel Carrier	-	-	1	2	2	2	2	2	3	2	2	2	2	2	1	2	2	1
Utility Vehicle	-	-	1	2	2	2	2	2	3	2	2	2	2	2	1	2	2	1
Mechanics Truck	-	-	1	2	2	2	2	2	3	2	2	2	2	2	1	2	2	1
Grader	-	-	1	2	2	2	2	2	3	2	2	2	2	2	1	2	2	1
Forklift/Telehandler	-	-	1	2	2	2	2	2	3	2	2	2	2	2	1	2	2	1
FEL (Surface)	-	-	1	2	2	2	2	2	3	2	2	2	2	2	1	1	1	1

Source: MP, 2021.

16.3.11 Mine Personnel

The underground mine is planned to operate on two shifts per day (day shift/night shift), 365 d/a, with four crews on rotation. Two crews would be on site at any one time, one on day shift and one on night shift, with the other crews off-site on break. Hourly mining and maintenance personnel would work a two-week-on, two-week-off (2 x 2) rotation. Salaried supervisors and technical staff would work on the same 2 x 2 rotation.

Hourly personnel were estimated based on development and production rates, operational efficiencies, and maintenance requirements.

Peak underground mining personnel requirements are summarized in Table 16-21.

Table 16-21: Underground Mine Operations Personnel—Peak Quarter and Average

Position	Peak Quantity	Avg. Quantity	Hourly/Salary
Mine Supervisor/Shift Boss	9	7	Salary
Coverage Miner	6	4	Hourly
Longhole Drill Operator	2	1	Hourly
Jumbo Operator	13	8	Hourly
Ground Support/Bolter/Shotcrete	29	20	Hourly
Development Service	14	8	Hourly
Blaster	5	3	Hourly
LHD Operator	13	10	Hourly
Truckdriver	30	21	Hourly
Backfill/Construction	2	2	Hourly
Utility Vehicle Operator	11	7	Hourly
Backfill FEL Operator	8	5	Hourly
Total Operations Personnel	120	88	

Source: MP, 2021.
Note: Only production personnel, excluding maintenance, management, and technical services.

16.3.12 Underground Development Schedule

Mine development was scheduled to provide access to production areas and to support the following:

- Establishing primary ventilation circuits and emergency egress
- Installing mining services (power distribution, dewatering, explosives magazines, etc.)
- Providing sufficient access to production areas to achieve and maintain the targeted mine production rate.

Development schedules were based on estimated cycle times for jumbo development and best practices for North American mining operations.

All development during pre-production was considered capital development. During the production phase, the decline, ventilation drifts, infrastructure drifts, and raises would be considered capital development, but cross-cuts, CF, and DF headings were included in the operating costs.

All development during pre-production is shown as capital development. During the production phase, the decline, ventilation drifts, infrastructure drifts, and raises would be considered capital development, but cross-cuts, CF and DF headings, and stopes would be included in the operating costs.

Annual development for the underground operation is summarized in Table 16-22.

Table 16-22: Development Schedule

Description	Total	Year																	
		−3	−2	−1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Umwelt																			
Capital Lateral (m)	18,300	-	-	700	3,100	4,000	4,200	2,200	600	500	600	300	400	200	300	400	400	300	200
Capital Vertical (m)	2,000	-	-	-	300	1,000	600	100	-	-	-	-	-	-	-	-	-	-	-
Operating Lateral (m)	105,100	-	-	-	100	6,300	7,500	8,000	7,800	7,800	8,100	7,700	7,900	8,100	8,100	7,500	7,500	7,500	4,400
Llama																			
Capital Lateral (m)	8,500	-	-	-	2,800	3,300	1,100	900	400	-	-	-	-	-	-	-	-	-	-
Capital Vertical (m)	500	-	-	-	300	200	-	-	-	-	-	-	-	-	-	-	-	-	-
Operating Lateral (m)	17,300	-	-	-	400	3,500	4,300	4,100	4,400	500	-	-	-	-	-	-	-	-	-
Goose																			
Capital Lateral (m)	7,800	-	-	-	-	-	-	-	-	1,900	2,800	1,700	600	600	200	-	-	-	-
Capital Vertical (m)	600	-	-	-	-	-	-	-	-	-	500	100	-	-	-	-	-	-	-
Operating Lateral (m)	15,100	-	-	-	-	-	-	-	-	-	300	2,800	5,100	4,300	2,600	-	-	-	-
Echo																			
Capital Lateral (m)	3,300	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,500	1,900	-
Capital Vertical (m)	300	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	200	200	-
Operating Lateral (m)	700	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	600	-
Total																			
Capital Lateral (m)	37,900	-	-	700	5,900	7,300	5,300	3,100	1,000	2,400	3,400	2,000	1,000	800	500	400	1,900	2,200	200
Capital Vertical (m)	3,400	-	-	-	600	1,200	600	100	-	-	500	100	-	-	-	-	200	200	-
Operating Lateral (m)	138,200	-	-	-	500	9,800	11,800	12,100	12,200	8,300	8,400	10,500	13,000	12,400	10,700	7,500	7,600	8,100	4,400

Source: MP, 2021.
Note: Numbers may not add due to rounding.

16.3.13 Underground Production Schedule

Underground production is considered to have started as soon as the first ore is mined. As Umwelt is the first underground operation, production would begin when the first CF heading is mined, which is scheduled to occur in Year 1.

The following strategies were used for production scheduling:

- In the early stages of mine life, improve Project economics by targeting mining blocks with higher-grade mineralization.
- Extract the Umwelt, Llama, and Goose Main crown pillars according to the deposits geotechnical constraints including timing of mining of open pit and underground mining in the vicinity of open pits.
- Ensure that open pit and underground completion allow for use of open pits for tailings and saline water storage.

16.4 Project Production Schedule

16.4.1 Combined Open Pit and Underground Production Schedule

The mill-feed tonnage would simultaneously be provided by a series of open pit and underground mines as well as three stockpiles, namely: high-grade, mid-grade, and low-grade.

Table 16-23 summarizes the combined LOM production and mill feed schedule as well as stockpile balances for the Project.

Figure 16-29 and Figure 16-30 illustrate the combined LOM processing schedule for the Project, including mill-feed grades and tonnages by grade bin, along with stockpile balances. The benefits of a grade-bin stockpiling strategy and processing high-grade ore early in the mine life results in economic benefits. However, this strategy needs the extraction of ore and waste at a rate beyond what the mill can handle at start-up; the strategy pays for itself by advancing considerable revenue in the early years, enhancing the rate at which capital is paid back.

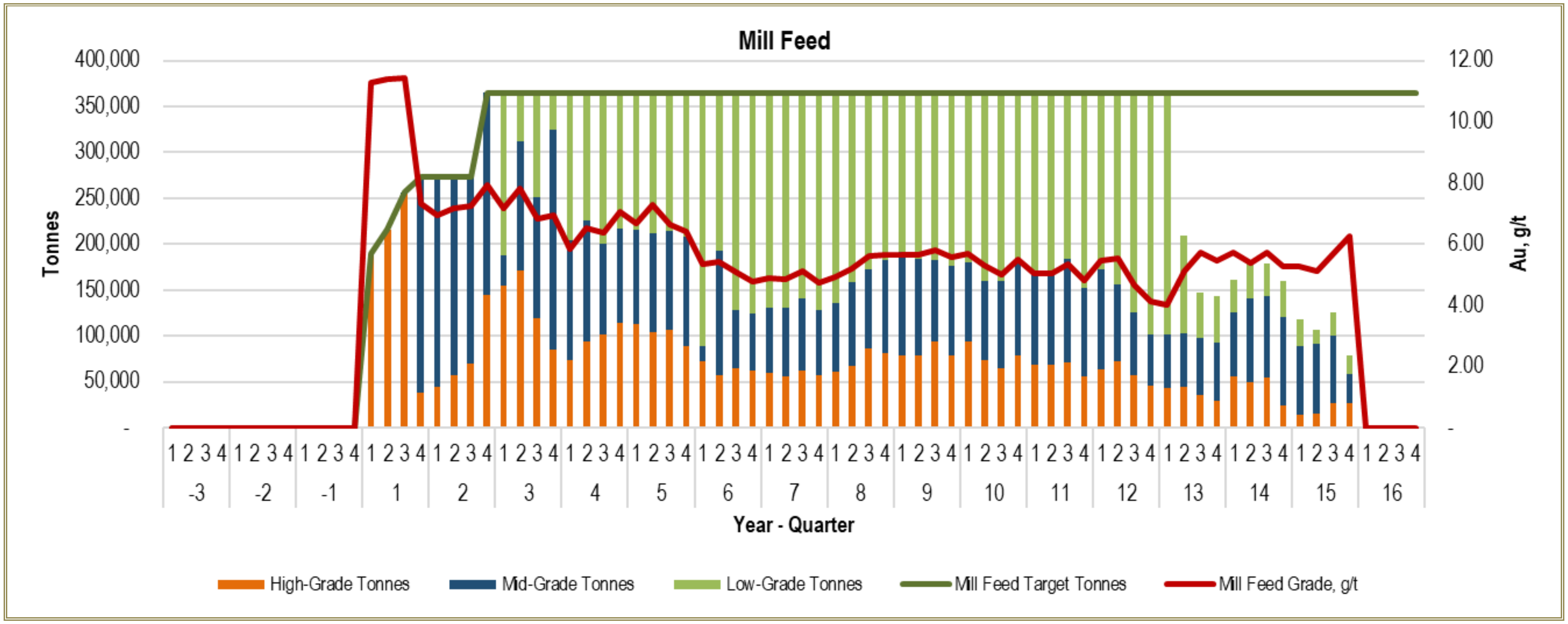
Table 16-23: Combined LOM Production Schedule

Description	Unit	Year Summary																	
		Total	−3	−2	−1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Open Pit																				
Umwelt																				
Waste	t ('000s)	14,630	-	6,330	7,350	950	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ore	t ('000s)	2,700	-	480	1,420	800	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avg. Grade	g/t	5.81	-	4.98	5.30	7.24	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stripping Ratio	t/t	5	-	13	5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Material	**t ('000s)**	**17,330**	**-**	**6,810**	**8,770**	**1,740**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
LLama																				
Waste	t ('000s)	30,680	-	-	-	8,990	12,070	6,810	2,550	260	-	-	-	-	-	-	-	-	-	-
Ore	t ('000s)	1,850	-	-	-	70	380	880	400	110	-	-	-	-	-	-	-	-	-	-
Avg. Grade	g/t	6.73	-	-	-	7.12	5.71	6.41	7.84	8.49	-	-	-	-	-	-	-	-	-	-
Stripping Ratio	t/t	17	-	-	-	138	31	8	6	2	-	-	-	-	-	-	-	-	-	-
Total Material	**t ('000s)**	**32,530**	**-**	**-**	**-**	**9,050**	**12,450**	**7,690**	**2,960**	**370**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Goose Main																				
Waste	t ('000s)	45,990	-	-	-	-	-	2,110	6,450	7,740	5,400	5,300	5,190	4,680	4,170	3,560	1,390	-	-	-
Ore	t ('000s)	5,080	-	-	-	-	-	40	260	640	470	430	500	620	760	860	510	-	-	-
Avg. Grade	g/t	4.39	-	-	-	-	-	6.05	4.81	4.85	4.12	4.01	4.41	4.44	3.79	3.99	5.49	-	-	-
Stripping Ratio	t/t	9	-	-	-	-	-	56	25	12	12	12	10	8	5	4	3	-	-	-
Total Material	**t ('000s)**	**51,070**	**-**	**-**	**-**	**-**	**-**	**2,150**	**6,710**	**8,380**	**5,870**	**5,730**	**5,690**	**5,300**	**4,920**	**4,420**	**1,900**	**-**	**-**	**-**
Echo																				
Waste	t ('000s)	8,120	-	5,290	2,840	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ore	t ('000s)	260	-	80	180	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avg. Grade	g/t	6.36	-	4.54	7.13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stripping Ratio	t/t	31	-	68	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Material	**t ('000s)**	**8,390**	-	**5,360**	**3,020**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Description	Unit	Year Summary																		
		Total	−3	−2	−1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Open Pit Summary																				
Total Waste	**t ('000s)**	**99,430**	-	**11,620**	**10,190**	**9,940**	**12,070**	**8,920**	**9,000**	**8,000**	**5,400**	**5,300**	**5,190**	**4,680**	**4,170**	**3,560**	**1,390**	-	-	-
Stripping Ratio	t/t	10	-	21	6	12	31	10	14	11	12	12	10	8	5	4	3	-	-	-
OP Ore	t ('000s)	9,880	-	560	1,610	860	380	920	660	750	470	430	500	620	760	860	510	-	-	-
OP Grade	g/t	5.27	-	4.92	5.51	7.23	5.71	6.40	6.65	5.41	4.12	4.01	4.41	4.44	3.79	3.99	5.49	-	-	-
OP Au	oz ('000s)	1,670	-	90	280	200	70	190	140	130	60	50	70	90	90	110	90	-	-	-
Underground																				
Umwelt UG																				
Ore	t ('000s)	7,230	-	-	-	-	450	540	560	560	540	540	540	530	530	540	520	530	520	310
Avg. Grade	g/t	6.71	-	-	-	4.38	6.89	6.64	6.10	8.12	7.64	7.08	7.11	6.93	6.76	6.34	6.14	6.03	5.81	5.92
Llama UG																				
Ore	t ('000s)	770		-	-	20	160	190	190	190	20	-	-	-	-	-	-	-	-	-
Avg. Grade	g/t	7.24	-	-	-	5.34	7.35	7.76	7.35	6.96	4.78	-	-	-	-	-	-	-	-	-
Goose UG																				
Ore	t ('000s)	530	-	-	-	-	-	-	-	-	-	10	90	170	150	110	-	-	-	-
Avg. Grade	g/t	7.90	-	-	-	-	-	-	-	-	-	9.52	8.75	7.84	8.24	6.58	-	-	-	-
Echo UG																				
Ore	t ('000s)	290	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	160	120
Avg. Grade	g/t	4.61	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.67	4.68	4.58
Underground Summary																				
UG Ore	t ('000s)	8,810	-	-	-	20	610	730	760	760	560	550	630	700	680	640	520	540	680	430
UG Grade	g/t	6.75	-	-	-	5.17	7.01	6.93	6.42	7.82	7.54	7.14	7.35	7.14	7.08	6.38	6.14	5.99	5.54	5.54
UG Au	oz ('000s)	1,910	-	-	-		140	160	160	190	140	130	150	160	150	130	100	100	120	80
Total Mining																				
Ore	t ('000s)	18,690	-	560	1,610	880	1,000	1,650	1,420	1,510	1,030	980	1,130	1,330	1,440	1,500	1,040	540	680	430
Grade	g/t	5.97	-	4.92	5.51	7.18	6.51	6.63	6.53	6.62	5.99	5.78	6.05	5.88	5.35	5.01	5.82	5.99	5.54	5.54
Au	oz ('000s)	3,588	-	90	280	200	210	350	300	320	200	180	220	250	250	240	190	100	120	80

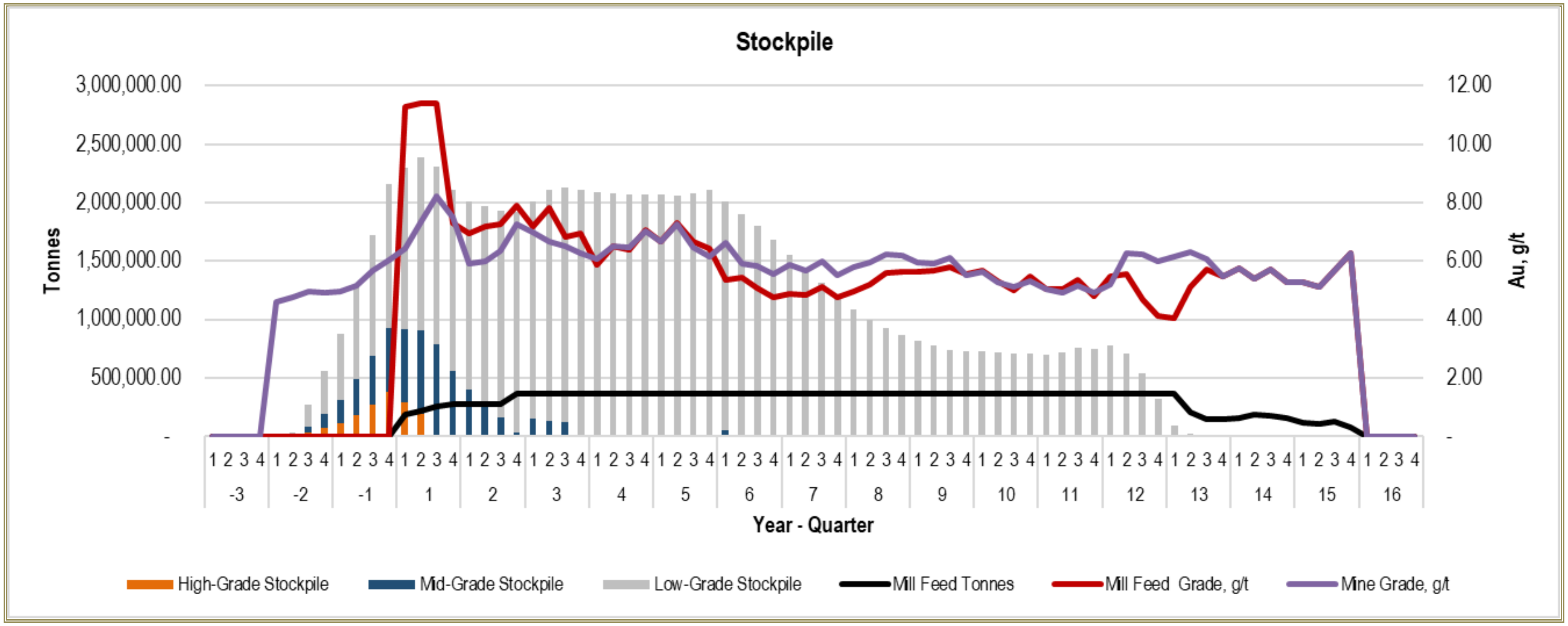
Description	Unit	Year Summary																		
		Total	−3	−2	−1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Processing																				
Mill Feed—Direct from Mine																				
Ore	t ('000s)	11,130	-	-	-	320	510	810	1,050	940	620	600	810	840	780	1,250	960	540	680	430
Grade	g/t	7.29	-	-	-	11.72	8.86	8.89	7.71	8.75	7.77	7.55	7.24	7.59	7.54	5.45	6.04	5.99	5.54	5.54
Au	oz ('000s)	2,610	-	-	-	120	150	230	260	270	150	140	190	210	190	220	190	100	120	80
Mill Feed—from Stockpile																				
Ore	t ('000s)	7,570	-	-	-	620	670	650	410	520	840	860	650	620	680	210	500	320	-	-
Grade	g/t	4.02	-	-	-	9.40	6.23	5.07	3.27	3.13	3.24	3.07	3.01	3.03	2.90	2.77	2.86	2.87	-	-
Au	oz ('000s)	980	-	-	-	190	130	110	40	50	90	90	60	60	60	20	50	30	-	-
Total Mill Feed																				
Ore	t ('000s)	18,690	-	-	-	940	1,190	1,460	1,460	1,460	1,460	1,460	1,460	1,460	1,460	1,460	1,460	870	680	430
Grade	g/t	5.97	-	-	-	10.18	7.37	7.20	6.45	6.76	5.16	4.90	5.35	5.67	5.37	5.06	4.95	4.82	5.54	5.54
Au	oz ('000s)	3,588	-	-	-	306	281	338	303	317	242	230	251	266	252	237	232	134	122	76
Metallurgical Recovery	%	93	-	-	-	93	93	92	93	93	93	93	94	94	94	94	94	94	94	94
Stockpile Balance		Max	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
High-Grade Stockpile	t ('000s)	380	-	70	380	290	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mid-Grade Stockpile	t ('000s)	770	-	120	540	770	400	150	-	-	50	-	-	-	-	-	-	-	-	-
Low-Grade Stockpile	t ('000s)	2,110	-	370	1,240	1,550	1,890	2,110	2,090	2,110	1,960	1,550	1,080	820	730	750	780	90	-	-

Source: MP, 2021.
Note: Numbers may not add due to rounding.



Source: MP, 2021.

Figure 16-29: Process Plant Schedule and Head Grade



Source: MP, 2021.

Figure 16-30: Stockpile vs. Mill Feed

17 RECOVERY METHODS

17.1 Introduction

The results of the metallurgical testwork described in Section 13, together with financial evaluation data, were used to develop metallurgical design criteria, which in turn were used to design the process facility described in this section. Elements of this section completed before 2015 were extracted from the JDS Feasibility Study (JDS, 2015b). Canenco updated that version for this Updated Feasibility Study based on the design changes undertaken.

17.2 Summary

The process selected for the Back River Project is based on testwork described in Section 13 and consists of a leach and carbon adsorption process comprising: crushing; grinding; gravity concentration; leaching; carbon adsorption; detoxification; carbon elution and regeneration; gold refining; and tailings thickening and disposal.

The mill is designed with a nominal capacity of 3,000 t/d at a planned average feed grade of 6 g/t Au. The crushing circuit will operate at an availability of 70%. Milling and leaching circuits will operate 24 h/d, 365 d/a, at an availability of 92%.

An expansion of plant nominal capacity to 4,000 t/d is planned for Year 2 of operation under the same operating schedule of 24 h/d, 365 d/a, at an availability of 92%.

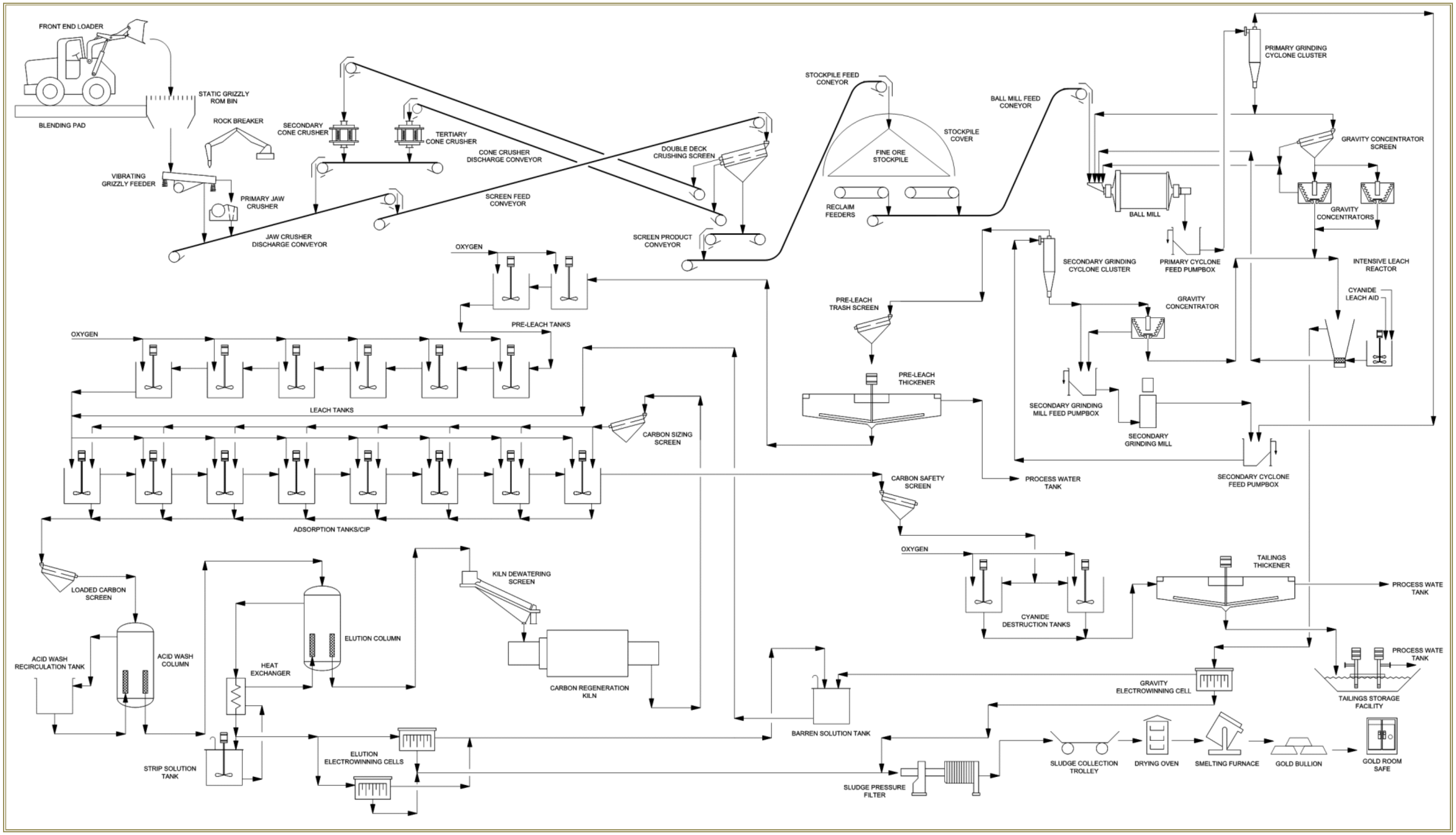
The 3,000 t/d plant will consist of the following unit operations:

- Primary crushing—a vibrating grizzly and jaw crusher in open circuit producing a final product P_{80} of approximately 100 mm.
- Classification—a vibrating double-deck banana screen operating in closed circuit with both the secondary and tertiary crushers. Apertures will be 30 mm and 10 mm on the first and second decks respectively.
- Secondary crushing—a standard cone crusher fed from the double-deck screen oversize, crushing to a P_{80} of approximately 22 mm.
- Tertiary crushing—a short-head cone crusher fed from the second deck of the double-deck screen, crushing to a P_{80} of approximately 13 mm.
- Fine mineralized material stockpile and reclaim—a covered stockpile with a 15 h live storage, will have two reclaim belt feeders feeding the ball mill feed conveyor.
- Primary grinding—a ball mill in closed circuit with hydrocyclones producing a final product P_{80} of approximately 106 µm.
- Secondary grinding—a fine-grind stirred mill in closed circuit with hydrocyclones producing a final product P_{80} of approximately 50 µm.
- Gravity concentration—gravity concentration of cyclone underflows from both the primary and secondary grinding circuits to produce a gold-rich concentrate for intensive leach.

- Intensive leaching—gravity gold dissolution within the intensive leach reactor for gold recovery in electrowinning.
- Leaching and carbon adsorption—gold leaching by cyanidation, facilitated by oxygen, followed by adsorption of solution gold onto carbon particles.
- Detoxification—detoxification of cyanide in slurry via sodium metabisulphite (SMBS) for SO_2, oxygen and copper sulphate, to produce a slurry discharge to the tailings thickener at a target CN_{WAD} <10 ppm.
- Tailings thickening—producing an underflow solids density of 60%–65% solids for discharge to the TS.
- Carbon elution and regeneration—acid wash of carbon to remove inorganic foulants, elution of carbon to produce a gold-rich solution, and thermal regeneration of carbon to remove organic foulants.
- Gold refining—gold electrowinning (sludge production), filtration, drying, and smelting to produce gold doré.

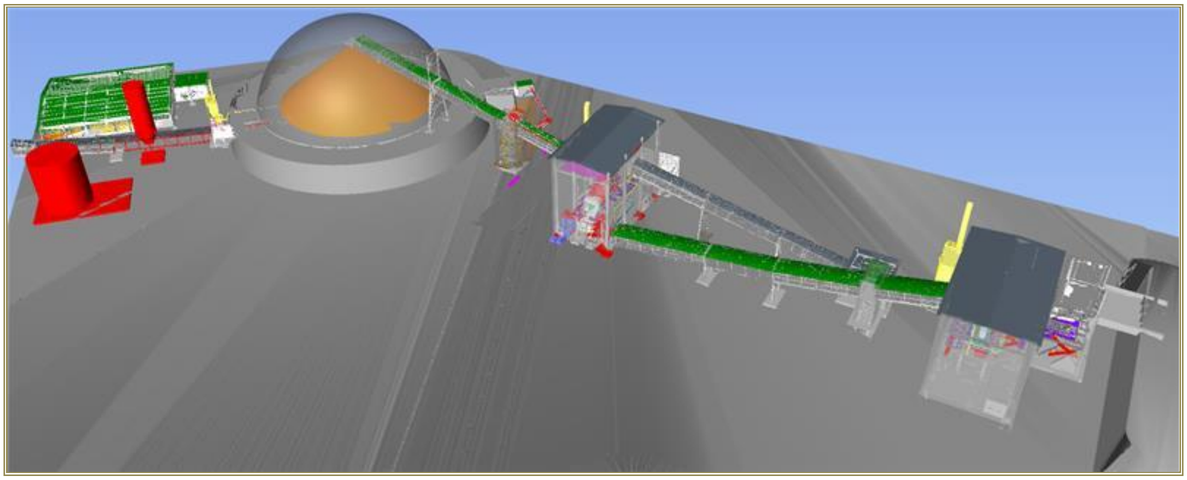
The expansion to 4,000 t/d will be achieved by adding a second tertiary crusher and second stirred mill, along with necessary ancillary equipment. The primary grind P_{80} will be increased from approximately 106 µm to approximately 212 µm to facilitate the increased throughput through the current ball mill with minor modifications to the classification system. Major downstream unit operations have been sized to achieve 4,000 t/d without significant capital modifications.

A summary of the process flowsheet appears as Figure 17-1. Models of the crushing and process facilities are provided in Figure 17-2 and Figure 17-3, respectively.



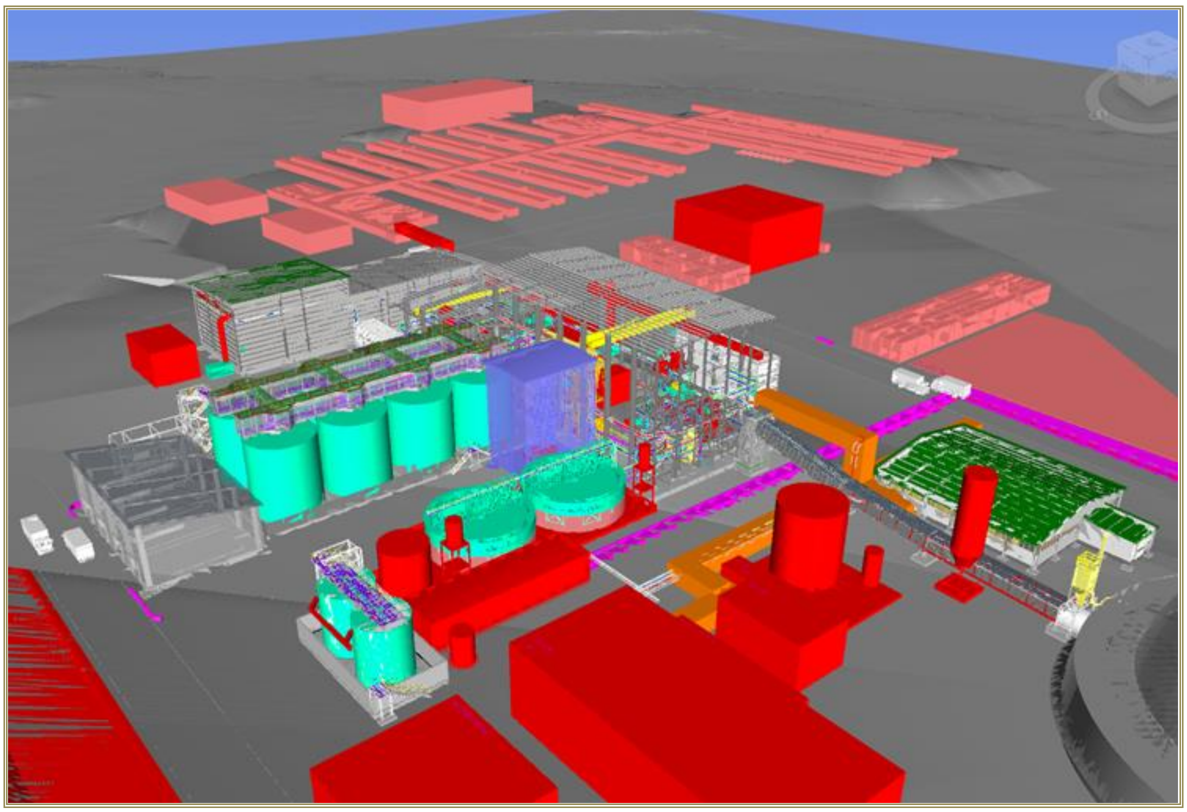
Source: SDE, 2021.

Figure 17-1: Plant Summary Flow Diagram



Source: SDE, 2021.

Figure 17-2: Crushing and Storage 3-D Model, Mineralized Material Fed from Right to Left



Source: SDE, 2021.

Figure 17-3: Process Plant 3-D Model, Mineralized Material Feed from Lower Right

17.3 Process Design

17.3.1 Process Design Criteria

The PDC and mass balance detail the annual mineralized material and product capabilities, major mass flows and capacities, and plant availability. Consumption rates for major operating and maintenance consumables can be found in the operating cost estimate described in Section 22. Key PDC are given in Table 17-1.

Table 17-1: Major PDC

Area	Criteria	Unit	3,000 t/d Design Value	4,000 t/d Design Value
General	Gold	g/t	10	7.5
	Silver[1]	g/t	5	3.75
	Daily throughput	t/d	3,000	4,000
	Process plant availability	%	92	92
	Overall gold recovery	%	93.4	93.3
Crusher System	Availability/Utilities	%	70	70
	Crusher work index (CWi)	kWh/t	14.6	14.6
	Number of crushing stages	-	3	3
	Crushing system product size (P_{80})	mm	9.5	9.5
Fine Mineralized Material Storage	Capacity (live)	t	2,000	2,000
	Capacity (total)	t	10,000	10,000
	Capacity (live)	h	15	12
Grinding	BWi (106 µm), 75th percentile	kWh/t	17.2	17.2
	BWi (53 µm), 75th percentile	kWh/t	18.3	18.3
	JKTech A×b, SMC 25th percentile		27.8	27.8
	Ball mill product size (P_{80})	µm	106	212
	Fine-grind mill product size (P_{80})	µm	50	50
Gravity Recovery	Gold recovery	%	40	40
	Feed to primary gravity circuit	t/h	160	160
	Feed to secondary gravity circuit	t/h	80	80
Screening and Thickening	Feed density	% w/w	30	30
	Thickener underflow density	% w/w	55	55
Leaching and CIP	Leach retention	h	48	36
	CIP Carousel residence time	min	19	14.25
	Leach slurry feed rate	m^3/h	168	219
	CIP slurry feed rate	m^3/h	168	219
	CIP carbon retention time	d	24	24
	CIP carbon concentration	g/L	50	50
	Loaded carbon grade	g/t	6,250	6,250
Tailings Thickening	Thickener feed density	% w/w	45	45
	Thickener underflow density	% w/w	65	65

Area	Criteria	Unit	3,000 t/d Design Value	4,000 t/d Design Value
Cyanide Destruction	Feed solution CN_{WAD}	ppm	500	500
	Target discharge solution CN_{WAD}	ppm	<10.0	<10.0
	Total residence time	h	3	2.25
Carbon Treatment	Acid used	-	HCl	HCl
	No. of acid wash vessels	-	1	1
	Acid wash batch size	t	4	4
	Number of elution vessels	-	1	1
	Elution batch size	t	4	4
Electrowinning and Refining	EW recovery	%	99	99

Source: SDE, 2021.

Note: [1] Silver is not included in the precious metal economics.

17.4 Process Plant Description

17.4.1 Primary Crushing

Mineralization from open pit and underground mining operations will feed a vibrating grizzly–primary jaw crusher system, which produces a product size P_{80} of approximately 100 mm.

Feed material to the crusher system will be hauled by 64-tonne haul trucks from the ROM stockpile or from the mines. Material will be stockpiled near the jaw crusher or direct-dumped through a static grizzly into a dump pocket. Stockpiled material will be re-handled using a loader. Extreme oversize material from the static grizzly will be removed for later size reduction using mobile machinery.

A vibrating grizzly feeder will draw material from the dump pocket. The spacing between the rails on the grizzly feeder will be 100 mm. The vibrating grizzly oversized material will discharge directly into the primary jaw crusher. A rock breaker is also provided for any long-aspect-ratio oversize not removed by the static grizzly. The undersized material will bypass the crusher and feed directly onto the primary crusher discharge conveyor.

17.4.2 Screening

The screen-feed conveyor will collect product from all three crushers and feed onto a double-deck vibrating banana screen. An electromagnet and metal detector are provided to protect downstream equipment from tramp metal ingress.

The top deck aperture will be 30 mm and a bottom deck aperture will be 10 mm, generating an undersize product stream P_{80} of approximately 9.5 mm. The oversize from the top screen deck will convey to the secondary crusher, while middlings from the second screen deck will convey to the tertiary crusher.

Screen undersize is transferred using two conveyors to the fine mineralized material stockpile dome.

17.4.3 Secondary and Tertiary Crushing

The secondary crusher will reduce the screen oversize (+30 mm) to a nominal product size P_{80} of approximately 22 mm using a standard mantle configuration with a closed side setting (CSS) of 22 mm.

The tertiary crusher will reduce the middling screen fraction (+10 mm to 30 mm) to a nominal product size P_{80} of approximately 13 mm using a short-head mantle configuration with a CSS of 13 mm. After the expansion to 4,000 t/d, a splitter box will be added above the existing tertiary crusher to divert half of the middling screen fraction to a newly installed tertiary crusher of identical configuration.

Both crushers discharge to a common conveyor system for recirculation back to the double-deck banana screen. A common bypass chute from the crusher feed bins is also designed to allow for each crusher to be shut down individually to allow for maintenance at a reduced overall throughput rate.

17.4.4 Fine Ore Stockpile and Reclaim

The fine-mineralized material storage facility will consist of a dome-covered stockpile with two in-line belt feeders located within a corrugated pipe reclaim tunnel. The belt feeders will transfer material to the conveyor feeding the ball mill.

The mineralized material storage facility will have a 2,000-tonne live capacity that can support process plant operations for 16 h when the crushing plant is not operating. The total capacity of the stockpile is 10,000 tonnes, which corresponds to approximately three days storage. Each belt feeder can provide the total throughput to the plant when required. The stockpile will be managed using a dozer to ensure the total capacity can be used effectively when needed. The live capacity of the stockpile will be reduced to 12 hours after the expansion of the plant to 4,000 t/d.

For pH management of downstream processes, quicklime will be added to the reclaim conveyor from a lime silo via a screw feeder.

17.4.5 Grinding

The grinding circuit will consist of a ball mill operating in closed circuit with a hydrocyclone cluster and a fine-grind mill operating in closed circuit with a hydrocyclone cluster. Material from the fine ore stockpile will be fed to the ball mill via the ball mill feed conveyor. The grinding circuit will operate at a nominal throughput of 136 t/h (fresh feed) and produce a target final particle size P_{80} of approximately 50 µm. The ball mill will be 4.6 m in diameter by 8.8 m effective grinding length, driven by a 3.3 MW motor.

Water will be added to the ball mill to maintain the charge in the mill at a constant slurry density. Slurry will overflow from the ball mill to a trommel screen, attached to the ball mill discharge end. The ball mill trommel screen oversize will overflow into a trash bin for removal from the system. The trommel is also removable to allow for simple access to the mill interior for maintenance.

The ball mill hydrocyclone cluster will classify the feed slurry into coarse and fine fractions. The coarse underflow will feed the ball mill for additional grinding. The fine overflow with a nominal P_{80} of approximately 106 µm will flow by gravity to the fine-grind mill cyclone feed pump box for classification prior to additional grinding. The ball mill hydrocyclones have been designed to facilitate a 400% recirculating load, although under normal operations this will perform at 300%. Additional grinding will be performed by a 1.5 MW fine-grinding stirred mill to achieve the final grind P_{80} of approximately 50 µm. On expansion of the plant to 4,000 t/d, a secondary stirred mill will be installed in parallel to provide extra-fine grinding capacity. The ball mill product size will be coarsened to a P_{80} of approximately 212 µm to facilitate the higher throughput rate without changing the ball mill.

A portion of the primary hydrocyclone underflow will be pumped to a trash screen, which in turn feeds a gravity concentrator circuit. A portion of the secondary hydrocylone underflow will also be handled similarly with a dedicated gravity concentrator.

17.4.6 Gravity Concentration

The gravity recovery and intensive leach circuits will consist of gravity concentrators with a feed trash screen; gravity tailings pump box, and tailings pump feeding a concentrate hopper; and a skid-mounted intensive leach reactor. The overall design target gravity gold recovery is 40% or 1.7 t/d of concentrate.

The scalping screen prior to the gravity concentrator removes coarse particles and/or metal pieces that would otherwise fill the concentrator with lower-grade material, reducing the capacity and/or damaging the concentrator. Scalping screen oversize will be directed by a launder to the gravity tailings box. Periodically, the centrifugal concentrator will be bypassed and switched to flushing mode to recover the collected concentrate.

Gravity concentrate material will contact the leach solution in an intensive leach system. At the completion of the batch leach cycle, the resulting gold-rich pregnant solution will be pumped to the gold refinery for gold recovery using electrowinning cells.

The intensive leach reactor tailings, along with decanted pre-wash fines, will be pumped to the ball mill cyclone feed-pump boxes for return to the grinding circuit.

17.4.7 Thickening

The fine-grind mill product and secondary cyclone overflow will flow by gravity to a vibrating trash screen to remove trash material. The vibrating screen will have an area of 3.7 m^2 and an opening of 600 µm.

The undersize from the screens will flow by gravity to the pre-leach thickener. Flocculant solution (anionic polyacrylamide) will be added to the thickener feed to promote the settling of solids. The pre-leach thickener will have a diameter of 18 m and produce a thickened product of 55% solids for the leach circuit. The CIP circuit will add process water to allow carbon adsorption to occur at 50% solids density.

The thickened slurry from the pre-leach thickener will be pumped to the leach circuit. Thickener overflow solution will flow by gravity to the process water tank.

17.4.8 Leaching and Carbon Adsorption

The pre-leach thickener underflow will be pumped to two 12.5 m-diameter by 14 m-high pre-ox tanks in series, prior to being leached in four similar-sized leach tanks. The pre-oxidation tanks will oxidize some sulphide material to reduce cyanide consumption and improve gold recoveries. The leach circuit will increase gold concentration in the solution prior to contact with activated carbon in the CIP circuit. The leach circuit is designed to provide 48.0 h retention time, with an additional 19.5 min in the CIP tanks. All leach tanks will be located outside and adjacent to the main process building.

The circuit will be operated as a single train. The first two tanks will be used as a pre-ox system, dissolved oxidation level will be above 20 ppm and lead nitrate will be dosed to assist with oxidizing sulphides to reduce cyanide consumption and improve recovery.

Leached slurry from the final leach tank will flow by gravity to the CIP carousel circuit for carbon adsorption. Dissolved gold and silver will be adsorbed onto activated carbon in the CIP tanks.

The CIP carousel circuit is designed to provide a total slurry retention time of 19 min. The CIP carousel circuit is a modification of the traditional CIP circuit. Leached slurry feeds a distribution launder. The distribution launder, using valving and piping, can feed any of the CIP tanks. There will be a carbon inventory in each of the CIP tanks, but they will not be pumped counter-current to the slurry flow. Instead, when CIP Tank 1 carbon is loaded, the distribution launder will send fresh leach slurry to CIP Tank 2. CIP Tank 1 loaded carbon is then pumped to the carbon handling plant for gold refining, and newly regenerated carbon will fill CIP Tank 1. CIP Tank 1 will become the tailings tank, and CIP Tank 2 will be the head tank. This practice is continued through the tanks with CIP Tank 1 eventually becoming the head tank once again. There will be an option to pump carbon slurry from a CIP tank to the first leach tank if preg-robbing is encountered.

Each CIP tank will have a single inter-stage screen/agitator to retain carbon particles in the tank and allow discharge of slurry to the next tank. All CIP tanks will be at the same elevation.

The average carbon concentration in the CIP carousel circuit is expected to be 50 g/L. As the slurry proceeds through the circuit, metal values in the solids and solution will progressively decrease. Carbon will leave the first CIP tank once metal loading reaches about 6,249 g/t Au and 2,815 g/t Ag. In the CIP tank in the carousel that is acting as the head tank, a loaded carbon pump will pump slurry containing carbon to the loaded carbon screen. Loaded carbon will be collected and transferred to the acid wash tank daily. The tailings stream from the CIP carousel circuit will flow onto a carbon safety screen to capture any carbon particles that may have escaped from the final CIP tank. Safety screen undersize will then be pumped to detoxification prior to the tailings thickener for dewatering.

17.4.9 Carbon Acid Wash, Elution, and Regeneration

Carbon Acid Wash

Loaded carbon will be treated with hydrochloric acid solution in the acid wash tank to remove calcium deposits, magnesium, sodium salts, silica, and fine iron particles. Organic foulants such as oils and fats are unaffected by the acid and will be removed after the elution step by thermal reactivation using a kiln.

The carbon will first be rinsed with fresh water. Acid will then be pumped from the acid wash circulation tank to the acid wash vessel. Acid will be pumped upward through the acid wash vessel and overflow back to the acid wash circulation tank. The carbon will then be rinsed with fresh water to remove the acid and any mineral impurities.

A recessed impeller pump will transfer acid washed carbon from the acid wash vessel into the elution vessel. Carbon slurry will discharge directly into the top of the elution vessel. Under normal operation at 3,000 t/d, only one elution will take place each day.

Carbon Stripping (Elution)

The carbon stripping (elution) process will use barren solution to strip the carbon, creating a pregnant solution that will be pumped through electrowinning and back to the strip column.

The strip column will be a carbon steel tank that will hold approximately 4 tonnes of carbon. During the strip cycle, solution containing approximately 1% sodium hydroxide and 0.1% sodium cyanide at a temperature of 140°C (284°F) and 450 kPa (65 psi) will be circulated through the strip vessel. Solution exiting the top of the elution vessel will be cooled below its boiling point by the heat recovery heat exchanger. Heat from the outgoing solution will be transferred to the incoming cold solution, prior to the cold solution passing through the solution heater.

Carbon Regeneration

A recessed impeller pump will transfer the stripped carbon from the elution vessel to the kiln feed dewatering screen. The kiln feed screen doubles as a dewatering screen and a carbon sizing screen, where fine carbon particles will be removed. Oversize carbon from the screen will discharge by gravity to the carbon-regeneration kiln feed hopper. Screen undersize carbon, containing carbon fines and water, will drain by gravity into the carbon fines tank. Subsequently, the carbon fines will be collected into bags for disposal. A horizontal kiln with residual heat dryer will be used to treat 4 to 8 t/d of carbon, equivalent to 200% regeneration of carbon if required. The regeneration kiln discharge will be transferred to the carbon quench tank by gravity, cooled by fresh water and/or carbon fines water prior to being pumped back into the processing circuit. The carbon regeneration will use residual heat from the kiln to heat the pre-dryer.

To compensate for carbon losses by attrition, virgin carbon is added to the carbon attrition tank along with fresh water to mix and activate the carbon. The fresh carbon will then drain into the quench tank.

17.4.10 Gold Electrowinning and Refining

Pregnant solution from the strip vessel will be pumped to the refinery for electrowinning to produce a gold sludge. Resulting barren solution will be pumped back into the barren solution tank for reuse, with periodic bleeding to the CIP circuit.

Intensive leach reactor pregnant solution will be pumped from the intensive leach unit into a solution tank within the gold electrowinning room. The solution will then be pumped into an electrowinning cell with solution overflowing back into the recirculating tank. Once the gold has been extracted from the intensive leach reactor pregnant solution, the resulting barren solution will be pumped to the CIP circuit.

Gold-rich sludge will then be washed off the cathodes in the electrowinning cells into the sludge holding tank. Periodically, the sludge will be drained, filtered, dried, mixed with fluxes and smelted in a furnace to produce gold doré. This process will take place within a secure and supervised area. The gold doré will be stored in a vault awaiting shipment.

17.4.11 Detoxification and Thickening

The detoxification circuit will consist of two mechanically agitated tanks, each with a capacity of 163 m^3 and a residence time of 90 min per tank. Cyanide will be destroyed using the SO_2/Air process with a ratio of 5:1 SO_2:CN_{WAD}. Treated slurry from the detoxification circuit will flow to a tailings thickener where the thickened tailings will be pumped to the TS.

In the detoxification tanks, oxygen will be sparged from near the bottom of the tanks, under the agitator impeller, to target a DO level of 8 ppm. Lime slurry will be added to maintain the optimum pH of 9.0, and $CuSO_4$ will be added as a catalyst, maintaining 20 ppm concentration in solution. SMBS will be dosed into the system as a solution as the source of SO_2. This system has been designed to reduce the solution concentration to a target of less than 10 mg/L CN_{WAD} prior to transfer to the TS via the tailings thickener.

17.4.12 Process Plant Water Supply and Consumption

The following types of water will be used in the process plant:

- Process water—overflow water from the pre-leach thickener and tailings thickener will be used as process water. Process water will be used predominantly in the grinding circuit to dilute slurry to the required densities.
- Reclaim water—water reclaimed from the TS will be used as process water. The estimated reclaim water recovered from the tailings thickener is 225.8 m^3/h. After its commissioning, the TS reclaim barge will provide an estimated 54 m^3/h of reclaim water to the process water tank.
- Fresh water—fresh water for the process plant will be pumped from Goose Lake and used as reagent make-up water and for cooling water services in the oxygen plant. The estimated fresh-water consumption in the process plant fresh and potable water is about 12 m^3/h. This excludes camp and mine water.
- Make-up process water—the required total make-up water, including fresh water, for the process is 23 m^3/h.

17.4.13 Air Supply

The air distribution system to supply instrument, plant, and process air will be centralized, except for the crushing area air system. The following compressed-air supply centres are planned:

- An air compressor system with a standby unit in the crushing area will provide air for that area at a rate of 6 m^3/min at 1,034 kPag. Both compressors are equally sized for 100% redundancy.
- An air compressor system with a standby unit in the process plant will provide process and instrument air for that area at a rate of 46 m^3/min at 1,034 kPag. Both compressors are equally sized for 100% redundancy.
- A dedicated compressor will supply low-pressure oxygen to the pre-ox tanks.

18 PROJECT INFRASTRUCTURE

18.1 Overview and Design Criteria

The Project consists of two main sites, the Goose and MLA (Figure 4-1). The MLA is on Bathurst Inlet, approximately 130 km north-northwest of the Goose Site.

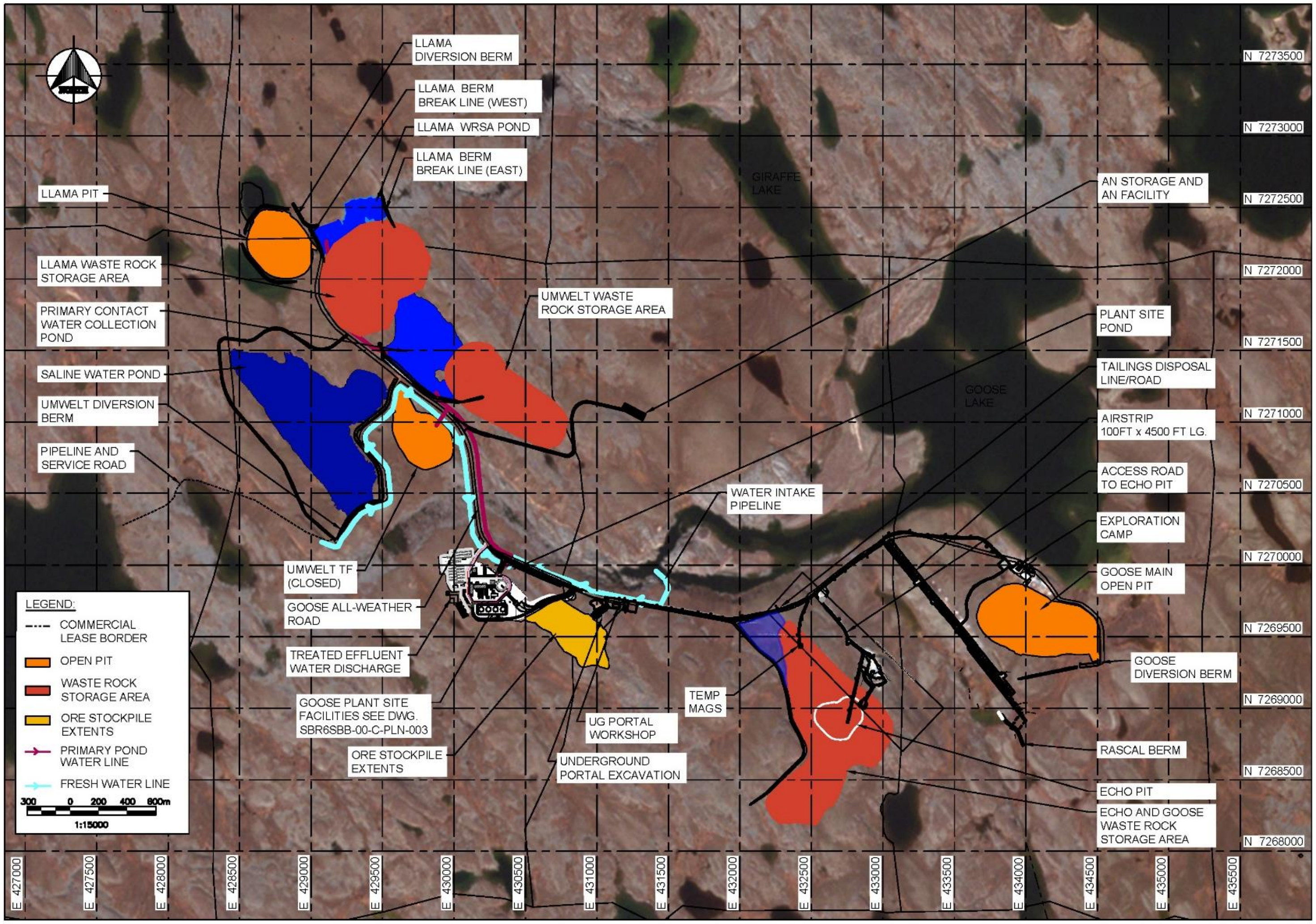
Both sites are accessible year-round by air. The MLA is also accessible by sea during the summer months. In winter a WIR connects the two sites. Due to their remote nature, significant infrastructure is required for access, power generation, consumable storage, and accommodations.

The site layouts for Goose and the MLA are shown in Figure 18-1 to Figure 18-3.

18.1.1 General Infrastructure Design Criteria

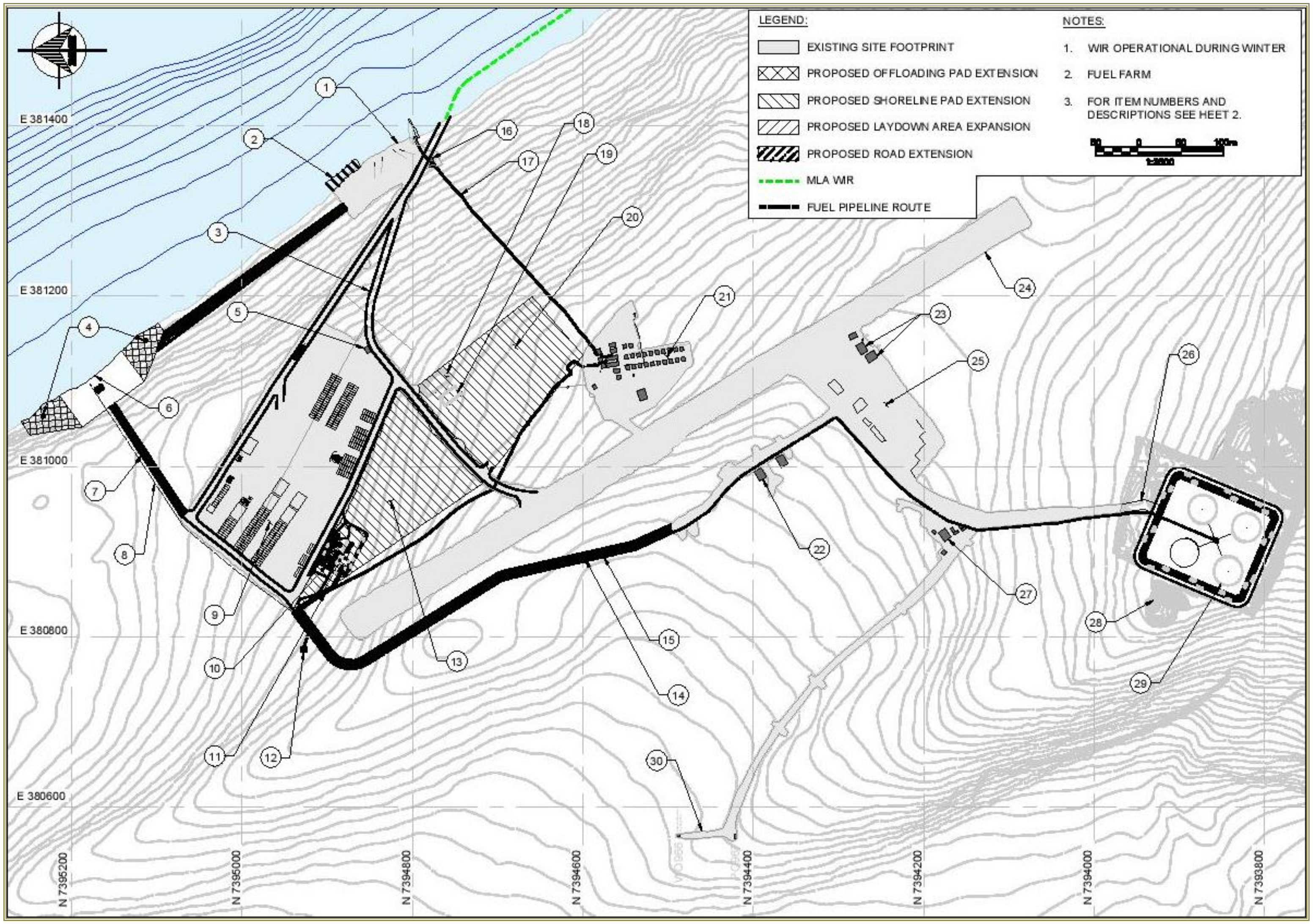
Two broad design criteria were applied when designing infrastructure: facilities would be fit-for-purpose to minimize cost, and of appropriate quality to ensure safe and reliable operations. Some design elements developed using this philosophy include:

- Paint structures only for protective or safety purposes (e.g., fuel tanks not painted).
- Use fabric buildings where practical.
- Use compacted-fill floors where appropriate.
- Use compact building footprints to optimize heating and heat recovery.
- Minimize the difference in elevation and the horizontal distances between the open pits, underground portal, mill site, crushing plant, airstrip, and in-pit TS, to minimize the capital and operating costs for truck haulage, roads, earthworks, and pipelines.
- Minimize the Project footprint to keep ground disturbance and cost to a minimum.
- Locate key infrastructure in areas of shallow bedrock.
- Respect environmental design requirements, such as discharge points, set-back from water, and snow loading.
- Consider site water management requirements.
- Consider traffic management and safety.
- Consider climatic conditions.
- Consider local wind patterns with respect to noise, dust, drifting snow and other atmospheric emissions.



Source: SDE, 2021.

Figure 18-1: Overall Site Layout



Source: SDE, 2021.

Figure 18-2: MLA Site Layout

ITEM	DESCRIPTION
1	EXISTING SHORELINE PAD
5	PROPOSED SHORELINE PAD EXTENSION
3	PROPOSED ROAD EXTENSION (NOM. GRADE 7.5%)
4	DEADMAN ANCHOR
5	DISTRIBUTION AND LOGISTICS DISPATCH
6	FUEL OFFLOADING SHORELINE PAD
7	PROPOSED SERVICE ROAD EXTENSION TO SHORELINE PAD
8	SHORELINE TRANSFER PIPELINE
9	FREIGHT STORAGE AREA
10	FUEL OFFLOADING AND TRANSFER AREA
11	GREY WATER PIPE
12	GREY WATER DISCHARGE
13	EXTENTS OF FREIGHT STORAGE PAD EXPANSION (APPROX. AREA = 18375 sq. m)
14	ROAD EXTENSION TO FREIGHT PAD
15	PIPELINE ROUTE (APPROX. LENGTH = 1.3 Km)
16	DESALINATION PLANT
17	DISALINATION WATER PIPE
18	EQUIPMENT SHOP
19	WAREHOUSE AND COLD STORAGE
20	EXTENTS OF CONTAINER STORAGE PAD (APPROX. AREA = 19740 sq. m)
21	CAMP AREA
22	TEMPORARY FUEL
23	DRUMMED FUEL STORAGE
24	EXISTING ALL WEATHER AIRSTRIP
25	LAYDOWN AREA
26	ROAD CONTINUED FOR TANK FARM ACCESS
27	SECONDARY MECHANICAL SHOP
28	WASTE PILE
29	MLA FUEL TANK FARM SEE DWG. XXX-XXX
30	ABANDONED ROAD

Source: SDE, 2021.

Figure 18-3: MLA Site Layout-Description

18.1.2 Project Geotechnical Conditions Overview

Over the past decade, multiple geotechnical characterization studies have been performed on Goose, involving drilling, sampling, and materials testing of rock, soils, and water. The results of the testwork and subsequent analyses were used to characterize the geotechnical conditions for the Project and provide design recommendations for mining and infrastructure. A summary of the various site conditions is provided in the subsections below.

18.1.3 Soil Conditions

During the Quaternary Period, the region was subjected to multiple glaciations that have resulted in the striated landscape and overburden materials characteristic of a post-glacial environment, with moraine sediments predominating. Other soils include glaciofluvial and organic sediments, with marine sediments only in proximity to Bathurst Inlet, as well as exposed weathered bedrock. Overburden thickness varies from 1 m, associated with outcropping weathered bedrock in the highlands, to greater than 37 m in topographic lows (Rescan, 2014).

The two Project sites are in a region of continuous permafrost. Permafrost temperatures below the point of zero amplitude range between −6°C and −8°C (Rescan, 2014). Basal permafrost depths range from 490 to 570 m below ground surface. The active layer depth ranges from approximately 1.3 to 4.2 m below ground surface, with the greatest active layer depths occurring in areas with thin soil veneers. Due to the salinity in some surficial groundwater, the active layer takes up to 60 days to refreeze in some areas (Rescan, 2014).

Overburden soils at the Goose and onshore MLA sites generally consist of silty sands with some clay and gravel. Pockets of sandy, silty gravel till underlie these deposits at the Goose Site (Knight Piésold, 2013b).

In general, ice content within the soils at the Goose and onshore MLA sites ranges from 10% to 30%.

18.1.4 Borrow Quarry Sources

Goose Site

Construction rock for infrastructure development at the Goose Site will be sourced from the existing quarry near the Goose airstrip (airstrip quarry) and from within the footprint of the various open pits (Umwelt, Goose Main, or Echo pits/quarries). The Goose airstrip quarry comprises mainly greywacke and mudstone, with minor amounts of BIF, large intrusive gabbro dykes, and smaller felsic to intermediate dykes. Acid rock drainage (ARD) results indicate that some of this quarry rock is PAG and may have to be segregated and used appropriately or mixed to obtain acceptable geochemical conditions. Additional geochemical characterization testing (as outlined in the Quarry Management Plan) is being completed in advance of quarry blasting to ensure that the materials are geochemically stable prior to deposition.

The quarry areas in each pit will be selected entirely within the greywacke unit. Samples of rock from quarry areas will be sampled to ensure they are classified as NPAG.

Samples from both the airstrip and the Umwelt quarries both contained slightly elevated solid phase arsenic concentrations, based on static testing. This indicates that there is a minor potential for slightly elevated arsenic from the contact water. Though these data were from a total metals content test and not from a leaching test. It should be noted that contact water can be managed by Sabina's authorized and approved Water Management Plan, should elevated arsenic from quarry contact water be encountered. During detailed design, short-term leach testing (such as Shake Flask Extraction testing) should be conducted to assess the leaching potential of the materials under neutral conditions.

MLA Site

Prior to construction, preliminary geochemical characterization was completed on a small number of surface outcrop samples representing quarry rock that was to be excavated during development of the MLA fuel storage farm. During construction additional samples were collected. The MLA samples were described as weathered quartzite conglomerate and quartz arenite/quartzite (sandstone), and test results showed that these materials have a negligible potential for metal-leaching/acid rock drainage (ML/ARD).

18.1.5 Overburden Stripping

It is assumed that the 1 to 4 m-deep overburden active layer can be mined using conventional truck and shovel techniques. Some temporary access roads comprising competent quarried or ROM rock may need to be constructed during the summer months, when permafrost degradation is in full effect due to excavation. Alternatively, low-bearing-pressure equipment may be used. Winter excavation of the overburden active layer or underlying permafrost in any season will require drilling and blasting. These soils will absorb a significant amount of the blast load and, as a result, closer drill-hole spacing and higher blast load factors than those used for regular rock blasting will be required.

18.1.6 Geotechnical Design Principles

Overburden Stockpile Design

Overburden stockpiles are designed to be constructed at the quarry or mine areas, or directly deposited in WRSAs. Two overburden products will be produced in each area: frozen overburden from permafrost areas, and unfrozen overburden from summer stripping or talik zones. Geotechnical considerations have been heeded in the design of overburden stockpiles.

Waste Rock Storage Area Foundations

WRSAs constructed on permafrost soils (i.e., directly on the tundra) will be designed to promote freeze-back. This will minimize long-term environmental effects from possible ML/ARD, provided the waste rock is proven to be geochemically compatible, meaning that it does not generate excessive heat and thereby degrade permafrost. Testing has indicated that excessive heat generation is not expected.

Permafrost soils are expected to provide suitable foundation conditions for WRSAs, provided that the foundation remains frozen. To ensure that the foundation remains frozen, it is recommended that the first lift of all new WRSAs be constructed during the winter season. If the first lift of waste rock is constructed during the summer months, the WRSA will be subject to differential settlement due to consolidation settlement of the active layer. The amount of settlement will vary, but will likely be between 10% and 30% of the active layer thickness, which ranges from 1 to 4 m. This settlement will occur only during the first summer, assuming that appropriate freeze-back is achieved during the following winter.

The overall maximum height (i.e., total vertical thickness) of the WRSA should be limited to 100 m, unless appropriate analysis is carried out to confirm otherwise.

In areas where the WRSAs are constructed over tailings (over Echo Pit), notable settlements should be expected. Operational plans will be required to be put in place to ensure site safety requirements and overall dump stability is upheld. When WRSA foundations are on exposed bedrock, no significant issues are expected. Therefore, placement on exposed bedrock is preferred and can proceed during any season, provided adequate snow and ice clearing has been completed.

Permafrost Foundations

On the Goose Site, frozen overburden materials are expected to have sufficient bearing capacity, while thawed overburden soils are expected to have only a medium strength—when drained, a large proportion of the surficial glacial tills and outwash have a very high sand content. Thawing is typically a slow process in these soils unless massive ice is present, or thermal erosion of buried ice results. However, the site does have some areas of more silt-rich soils. For example, silt-rich soils were observed at a few of the water-management infrastructure locations (e.g., the primary pond) and under some of the diversion locations. Overall, some deformation can be expected during permafrost thaw, and it is recommended that surface infrastructure be founded on frozen soils as often as practical. Care will be taken when designing infrastructure and pads to ensure that building-generated heat does not promote permafrost thaw.

Structures that are particularly sensitive to differential settlement, such as the Goose process plant and fuel storage tanks, will be founded on exposed bedrock or on a compacted, engineered-fill layer on top of bedrock.

Talik Foundations

A description of the presence and extent of taliks on the Property is presented in SRK (2015). If facilities are constructed in or near lakes, there may be foundation interactions with talik zones. Soils within talik zones may have lower bearing capacities, and design and construction on these overburden soils will take this into account.

Surface-Water Management Facilities

Surface-water management facilities are planned for the Project, such as water conveyance channels, stormwater ditches, and sediment control ponds. Excavation of channels and/or ditches into overburden soils will be avoided wherever possible. Ponded water on permafrost soils will also be avoided.

18.1.7 Tailings Facilities

In contrast to the plans outlined in JDS (2015b), which included the construction of a purpose-built TSF and associated dams, all the Goose Site tailings will be deposited into the various pits: first Echo, then Umwelt, and finally Llama. Therefore, no above ground tailings dams are planned for the Back River Project.

Specific details pertaining to tailings management are discussed in Section 20.5.

18.1.8 Infrastructure Foundation Preparation Recommendations

Considering all the conditions listed in the preceding sections, the specific Project foundation preparation recommendations are summarized in Table 18-1.

Table 18-1: Infrastructure Foundation Preparation Recommendations

Area	Recommendations
Goose Site	Bedrock foundation required for critical structures such as fuel storage tanks, heated buildings, and process equipment foundations. For bedrock foundation the following will be required.
	• Strip (doze) the upper 0.5 m of overburden and discard in overburden stockpile, or place in non-critical pads. If winter construction is planned, drilling and blasting will be required.
	• Drill and blast upper 3.5 m of fractured rock: usable rock will be used for construction fill, and the unusable remainder will be discarded in the WRAs.
	• Rock shatter not required. The exposed surface needs to be cleaned and roughly leveled.
	• 2.5 m compacted ROQ rockfill pad (on top of undisturbed grade) required for unheated essential structures such as the airstrip.
	• 1.0 m compacted ROQ rockfill pad (on top of undisturbed grade) required for unheated non-essential structures such as secondary roads.
	• Rockfill pads will ideally be done in lifts no greater than 1.5 m, with the maximum rock size limited to 0.9 m.
	• A 150 mm thick layer of 50 mm (minus surfacing material) is recommended as a topping layer for ROQ pads. No transition layer required, provided the ROQ is well graded. There may be some holes that develop due to consolidation, but minimal repair should be required. An allowance of 20% extra 50 mm minus material should be provisioned for.
	• Mine haul roads should be 1.5 to 2.0 m thick to minimize deformation.
	• Rock shatter required where roads cross over rock highs that impact road grade.
MLA	Bedrock foundation required for critical structures, such as fuel storage tanks and buildings. For bedrock foundation the following will be required:
	• Strip (doze) the upper 0.5 m of overburden and use in non-critical pads. If winter construction is planned, drilling and blasting will be required.
	• Drill and blast upper 1.5 m of bedrock. 100% can be assumed to be useable as ROQ construction fill.
	• 2.0 m compacted ROQ rockfill pad (on top of undisturbed grade) required for unheated essential structures.
	• 1.0 m compacted ROQ rockfill pad (on top of undisturbed grade) required for unheated non-essential structures such as secondary roads.

Source: JDS, 2015b; SRK, 2015.

18.2 On-Site Infrastructure

This section describes the Goose on-site infrastructure.

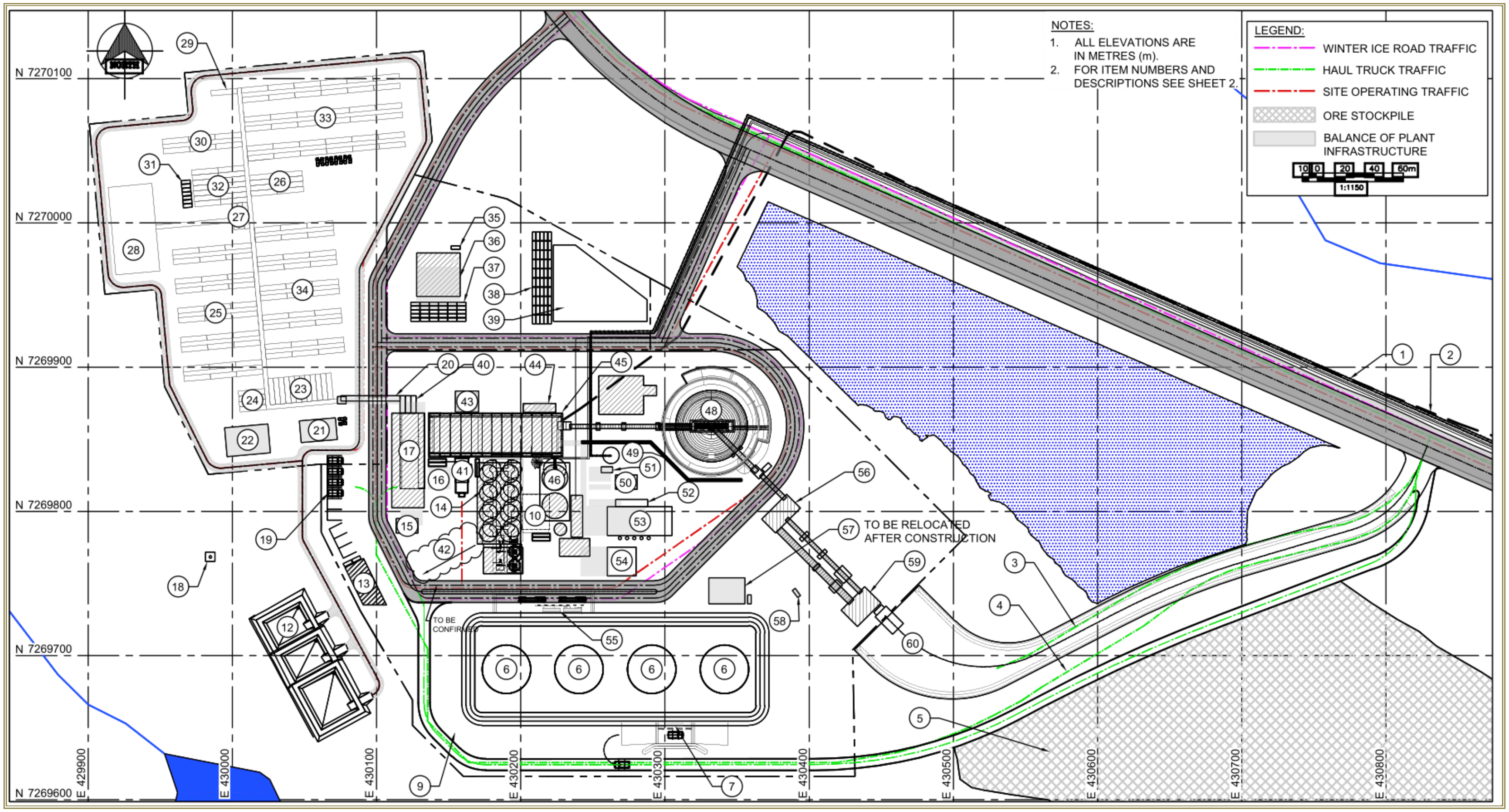
18.2.1 Goose Site

Site Infrastructure

Major infrastructure at the Goose Site includes the following:

- Process-related facilities
- Assay lab
- Oxygen plant
- Truck shop
- Power plant
- Fuel storage farm
- Utilities
- Permanent camp, administration office, and mine dry facility
- Storage areas
- Airstrip
- TS (which will be in mined-out pits)
- WRSAs
- Industrial waste management facilities, such as the incinerator
- Plant site water management facilities/infrastructure (camp/plant site pond).

Figure 18-4 shows major infrastructure at Goose Site, and Figure 18-5 provides the descriptions of the infrastructure shown.



Source: SDE, 2021.

Figure 18-4: Goose Plant Site

ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	WATER INTAKE LINE	31	STORAGE SEA CANS
5	TAILINGS DISPOSAL LINE	32	KITCHEN / DINING / FOOD STORAGE
3	ACCESS ROAD TO DUMP POCKET (NOM. GRADE 8%)	33	180 EXEC BEDS
4	ACCESS ROAD TO FUELINGAND TRUCK SHOP (NOM. GRADE ±5%)	34	CAMP PAD EL 313,500
5	ORE STOCKPILE FOOTPRINT EXTENTS	35	MODULAR WASHROOM
6	GOOSE SITE FUEL FARM (STORAGE CAPACITY = 40M LITRES)	36	WAREHOUSE
7	FUEL MODULE	37	REAGENTS STORAGE AREA
8	_	38	CONTAINER STORAGE AREA
9	PLANT SITE PAD EL. 313.000 m	39	HAZARDOUS MATERIALS AREA
10	O5 PLANT	40	TRUCK SHOP LUNCH AND WASHROOM FACILITIES
11	TO BE CONFIRMED	41	GOLD ROOM
12	LAND FARM	42	LEACH TANK DRAINAGE
13	TIRE REPAIR AREA	43	REAGENT OFFLOADING AREA
14	CIP CIRCUIT	44	FRESH / FIRE WATER TANK
15	BULK LUBE STORAGE	45	STOCKPILE COVER
16	ASSAY / LAB	46	THICKENER
17	TRUCK SHOP	47	-
18	TREATED EFFLUENT WATER DISCHARGE	48	STOCKPILE COVER
19	READY LINE	49	UTILIDOR
20	ARTIC CORRIDOR	50	POTABLE WATER PLANT
21	ERT	51	FIRE PROTECTION MODULE
22	SEWAGE TREATMENT PLANT	52	ELECTRICAL DISTRIBUTION
23	OFFICES	53	POWER PLANT
24	DRIES	54	INCINERATOR
25	400 J&J BEDS	55	FUEL OFFLOADING MODULE
26	ENTRY, BOOTS ROOM, SECURITY, LUGGAGE	56	SCREEN BUILDING
27	LOUNGE	57	CONSTRUCTION / EMERGENCY POWER
28	GYM	58	MODULAR WASHROOM
29	MEDIC	59	CRUSHER BUILDING
30	SUPER EXEC BEDS	60	DUMP POCKET PAD EL. 328.000 m

Source: SDE, 2021.

Figure 18-5: Goose Plant Site—Description

Plant–Site Integration

The process plant and fuel tanks are positioned where the bedrock is very close to the surface. As much infrastructure as possible is located close to the process plant to make the site energy- and operationally efficient—especially during the long, harsh Arctic winter—as well as to take advantage of the beneficial subsurface conditions.

Assay Lab

An assay lab will be installed on site in Year –2 of construction. This lab will serve multiple purposes over the mine life including use as a field assay lab for the mining, environmental, and geology departments. During mine operations it will be used for daily metallurgical accounting and reconciliation. It includes facilities for sample preparation, FA, carbon sulphur assay, wet chemistry, and analytical methods for the quantification of various metal assays. This assay lab was previously over the fence in the JDS (2015b) feasibility study.

Oxygen Plant

The process building will be serviced by an 18 t/d oxygen plant to provide oxygen to the pre-leach/leach section, as well as to the cyanide destruction section. The 4,000 t/d operating scenario is expected to consume approximately 17 t/d of oxygen. Previously, the oxygen plant was executed as an over the fence (JDS, 2015b).

Truck Shop

The truck shop will consist of a 66 by 23 m structural steel, pre-engineered building consisting of six bays. Four bays will have approximately 9 m high ceiling, and two will have approximately 13 m ceilings. The shop is designed to accommodate various facilities to repair and maintain mining equipment. Light surface vehicle maintenance will be conducted in an adjacent facility. These facilities also provide storage space for spare parts and consumables.

Truck shop components are shown in Table 18-2.

Table 18-2: Truck Shop Components

Description	Area (m^2)	Comments
Service Bays	1,265	Four truck bays and one wash bay, each 12 m wide x 18 m deep
Wash Bay	253	12 m wide x 18 m deep

Source: Sabina, 2020.

The service bays are designated to service and repair major mining equipment. The facilities will include automatic hose reels in two bays to dispense engine oil, transmission fluid, hydraulic oil, solvent, diluted coolant, and grease. The truck shop will be equipped with a 10-tonne overhead crane and compressed-air system that will provide service to all bays. Wash and tracked equipment bays are planned. Building heating will be supplemented with in-slab heating, sourced from the low-temperature cooling loop from the power plant.

Tire repair will be done outside, weather permitting. In poor weather, tire repair will be done in the shop with the appropriate safety measures, such as adequate personnel access-control and clearances.

Warehouse and Laydown Area

A container storage area is located to the north of the truck shop and plant area. Spare parts that do not require protection from the elements will be stored in the laydown area adjacent to the container storage yard. Break bulk freight can also be stored there.

A separate construction laydown area has been designated to the southeast of the process area. Should additional storage for construction materials be required, it can be added to the south of the freight storage and fuel storage areas.

Crushing Building and Process Building

The three-stage crushing plant will be in a pre-engineered structural steel building heated to −10°C (tempered) in the winter by diesel-fired air handlers and electric unit heaters. The process plant will also be in a pre-engineered building with overhead cranes for equipment maintenance and heated to 5°C by glycol air handlers and unit heaters.

Fuel Storage

Diesel fuel storage capacity at the Goose Site is designed for year-round operation at maximum fuel usage. Table 18-3 provides the Goose Site's annual fuel use. The peak year of operational will require 55 ML of diesel fuel storage, comprising five 10 ML and two 2.5 ML field-erected fuel tanks. Four 10 ML fuel tank will be erected in Year −2 to support construction, and the remaining tanks will be constructed in Year 2. For further information on fuel requirements during the production phase, refer to Section 24.1.1.

Maximum annual fuel consumption requires 55 ML of diesel fuel storage on site. The Updated Feasibility Study includes storage capacity for 40 ML prior to commissioning of the Goose Site, with a further 15 ML to be installed in operation, for a total of 55 ML.

The fuel tank farm containment area will be lined with high-density polyethylene (HDPE) for spill containment. Fuel dispensing equipment for mining, plant services, and freight vehicles will be adjacent to the fuel tanks, and the fuelling area will drain into the containment area. A fuel transfer module will provide fuel directly to the power plant.

Table 18-3: Goose Site Fuel Usage (Litres)

Pre-production Fuel	Year -3	Year -2	Year -1	Total
Sum of Fuel Consumption—Goose—Camp	495,000	2,958,433	4,081,031	**7,534,464**
Sum of Fuel Consumption—Goose—EPC, Process, Site Services	-	1,326,159	1,696,064	**3,022,223**
Sum of Fuel Consumption—Goose—Earthworks	964,499	179,073	205,695	**1,349,267**
Sum of Fuel Consumption—Goose—Mining UG	-	1,232	1,052,172	**1,053,404**
Sum of Fuel Consumption—Goose—Mobile Open Pit	-	5,647,850	6,543,809	**12,191,659**
Sum of Fuel Consumption—WIR Construction—Camp	-	1,139,093	1,098,142	**2,237,235**
Total	**1,459,499**	**11,251,840**	**14,676,913**	**27,388,252**

Source: JDS, 2015b.

18.2.2 Explosives Storage and Preparation

Sabina has held discussions with explosives suppliers about necessary site infrastructure and related costs for explosives storage and management. For this Updated Feasibility Study Sabina has included costs associated with outsourcing explosives management to the explosives' supplier. The explosives supplier provides the explosives and site facilities for preparing the explosives prior to use. Sabina will provide an area prepared specifically for this purpose, and power to the site.

Explosives storage at the Goose Site consists of the following three main components:

- Bulk AN storage
- ANFO manufacturing
- Explosive storage magazines.

Bulk AN will be shipped to site in 1-tonne tote bags in 20 ft ISO containers. The AN storage area is sized to allow for a maximum of 4,000 tonnes of AN, or 200 ISO containers.

ANFO required for underground mining will be manufactured and bagged in 1-tonne totes using bagging equipment in the AN facility. The bagged ANFO will then be transported to the underground mine for use in blasting operations.

ANFO required for open pit blasting will be mixed on a bulk ANFO truck at the blasthole. The bulk ANFO truck will take on AN and fuel oil at the Goose AN facility. Bulk AN will be augered from the 1-tonne tote bags into a 30-tonne silo, and the bulk ANFO truck will drive underneath to load AN. Fuel oil will be loaded into the bulk ANFO truck from a 20,000 L double-walled fuel tank, also located on the AN facility pad.

Packaged explosives and explosive detonators will be stored in approved explosive magazines on separate pads. The powder magazine will be a 40 ft container magazine capable of holding 32 tonnes of explosives, and the cap magazine will be a 20 ft container magazine capable of holding approximately 600 cases of detonators.

The design of all storage facilities will meet government regulations and be located according to required separation distances as regulated by the Explosives Regulatory Division (ERD) of Natural Resources Canada (NRC).

18.2.3 Camp, Administration Offices, and Mine Dry Facilities

A camp with a combination of “executive” (with private bathroom) and “Jack & Jill” rooms (in adjacent rooms share a bathroom) will be used during the construction phase at the Goose Site to accommodate approximately 500 workers. The proportion of executive to Jack & Jill rooms will be approximately 25% to 75%. During operations, all rooms will be converted to single occupancy, with 201 rooms available at the start of operations. An additional 23 rooms will be added in Year 1, and 38 rooms in each of Years 2 and 3, for a maximum of 300 rooms.

The camp will include kitchen and dining facilities, and a recreation area suitable for 300 workers.

The camp complex will include an office area for an integrated operations team and G&A staff. Additionally, a suitable mine dry/change facility will be included in this complex.

The camp complex will be constructed of modular units manufactured off-site, in compliance with highway transportation size restrictions. Camp modules will be limited to single story and sit on wood cribbing. The camp will comply with all building and fire code requirements and be provided with firehose stations throughout. Arctic corridors will be provided to connect the camp core facilities and dormitories with the process plant and truck shop, and all facilities, including the kitchen, will be sized and built for 300.

18.2.4 Domestic Waste Management

Food waste from the kitchen facilities will be segregated and burned daily in the incinerator to avoid attracting wildlife by disposing of food waste in the open air.

All hazardous waste (such as batteries and biomedical waste) will be transported to approved facilities in the south either via backhaul flights or sealift.

Recyclable waste could be backhauled to suitable off-site recycling facilities for proper disposal.

Non-hazardous, non-leaching, inorganic garbage will be collected and disposed of within an on-site landfill in a WRSA.

A land farm for storing and treating hydrocarbon-contaminated soil will be adjacent to the main plant pad.

18.2.5 Ancillary Structures

A construction power plant will be installed when the camp is built, to provide power during the construction period. The generators and switchgear will be housed inside modified shipping container modules. When the process plant is operational, the construction power plant will function as a source of emergency power in case the main power plant malfunctions.

A batch plant will be installed to provide concrete for constructing the Goose Site process plant and infrastructure. The batch plant will be inside a large, fabric building to allow year-round operation.

18.2.6 Utilities and Services

Sewage Treatment Plant

Sewage will be treated by a biological reactor sewage treatment plant (STP) housed in modified shipping containers, which are fully shop-assembled prior to shipment to site. A sludge-drying system is also provided in a separate 40 ft container. The dewatered sludge is disposed of in the incinerator.

The treatment plant includes influent screening, an equalization/bioreactor tank to handle the daily peaks in flow, a membrane system, treated effluent storage, and UV disinfection. The treated effluent is discharged to the tundra during construction and operations.

Fresh/Fire Water

Fresh water is drawn from Goose Lake by a pump station on the shore at a point of sufficiently deep water, then pumped via a recirculating pipeline to the fresh/fire-water tank. Fire water will be stored at the bottom of the tank, and the fresh water will be drawn from the upper portion of the tank.

Potable Water

Water will be pumped from the fresh/fire-water tank to the potable water treatment plant. Treated water from the plant will be stored in an insulated and heated storage tank, which accommodates the potable water demand variances; the water will then be distributed to the process plant, camp, and mine dry facilities.

The plant is contained in one 20 ft shipping container, which is fully shop-assembled prior to shipment to site. It contains the complete treatment system, including filtration, and UV and chlorine disinfection.

Process Water

Process water is collected in the process water tank and pumped to various points in the process plant. The tank is fed by tailings reclaim water via a reclaim pump barge, as well as water from pre-leach and tailings thickener overflows. The tank is outside the process building and is a bolted construction design.

Heating, Ventilation, Dust Control, and Fume Extraction

Continuous ventilation will be provided for all personnel-occupied spaces, as well as select unoccupied spaces. Ventilation rates will vary in accordance with applicable codes and standards depending on the level of occupancy and the intended use of the space. Ventilation systems will include make-up air units for continuous supply of tempered air, exhaust fans to provide the required number of air changes per hour, and localized exhaust fans to remove fumes, where required. The process plant includes dust control and fume extraction systems.

Site Communications

Site data connectivity will be provided via satellite connection. Site-wide communications design will incorporate reliable communications systems to ensure that personnel at the mine site have adequate voice, data, and other communication channels available. Data bandwidth will be prioritized for operational and business activities. A number of integrated systems will be provided for on- and off-site communication at the Goose Site, including inside the process plant. On-site communications will be facilitated by satellite phones, very-high frequency (VHF) radio, and an optical-fibre cable network. A pit dispatch mesh will operate on the surface, with a leaky feeder VHF for the underground mine.

A trunked radio system consisting of hand-held, mobile, and base digital radios will provide operations with wide-area coverage for on-site communication. The trunked radio system will be interfaced to the on-site Voice-over-Internet-Protocol telephone system.

Fire Protection System

At a minimum, the Goose Site facilities will be protected from fire in accordance with applicable codes and standards. The fire alarm system will consist of manual pull stations at building exits, and audible and visual notification devices throughout the work areas. A digital fire-alarm system has been included for all required buildings at the plant site.

Surface and underground mobile equipment will be fitted with fire extinguishers. The fleet of open pit mining equipment will also have fitted fire-suppression systems.

The fire-water main, hydrant, and standpipe system will service the Goose Site facilities by a fire-water tank and modularized pump unit. A fire-water truck will provide supplemental protection. All buildings and conveyors have fire extinguishers, and some will have standpipe systems and fire-truck connectivity. The galleried conveyors represent safety risks for occupants because the enclosure will act as a conduit for smoke and heat; for that reason, automatic sprinkler protection will be installed on these conveyors to mitigate the associated risks.

Fire suppression for the power generators will be provided. The accommodations camp, truck shop, and administration offices will be fitted with sprinklers and/or firehose stations.

Security

Security needs will be served by a card access system and video cameras. Security ensures access is restricted to qualified personnel for safety reasons and theft mitigation.

Power Generation

A single, captive power plant will be used to meet the electrical power demands of the complete Goose Site operation, including the underground mine. The power plant will consist of diesel-fired reciprocating engine generator sets (genset). To maximize overall efficiency, this power plant will operate as a combined heat and power (CHP) plant whereby the waste heat is recovered.

The estimated electrical loads are shown in Table 18-4. Note that the values below represent the maximum power requirements throughout the life of the Project.

The power plant design is based on eight 3 MW diesel generator sets in an N+2 arrangement, with the generators' 100% short-time rating capable of supplying short-duration peaks. All generators are rated for 4160 V.

Table 18-4: Project Electrical Load List

Description	Peak Demand Load (MW)	Average Running Load (MW)
Goose Processing and Infrastructure	13.5	11.7
Goose Underground Loads	5.2	4.0
Goose—Total	**18.7**	**15.7**
MLA—Total	0.5	0.3
Grand Total	**19.2**	**16.0**

Source: JDS, 2015b.

Power Distribution

The power plant includes all switchgear and control equipment to accommodate the generators. This equipment includes 4160 V switchgear for the generators and process plant feeders, load-sharing systems, neutral grounding equipment, surge suppression, local and master control systems, and all necessary low-voltage distribution equipment for power plant ancillaries.

Power will be distributed throughout the plant site at 4160 V, and each electrical room will be fed radially from dedicated breakers. Two installed spare breakers will be provided for future expansion.

The electrical loads at the Umwelt underground mine will be fed with 5 kV power cables that are laid alongside the roads and overland piping. Tailings reclaim pumps will be powered by a dedicated, local power plant consisting of an N+1 genset configuration. Seasonal open pit dewatering will be handled by diesel pumps to eliminate the need for long distance, high-voltage transmission lines to the Llama, Umwelt, and Goose Main open pits.

Waste Heat Recycling

Heating for buildings and facilities at the Goose Site will be provided primarily by heat recovery from the power plant. Waste heat from the power plant will be transferred with a glycol circulation system that extends throughout the plant site. In addition, a full-sized diesel-fired boiler system at the power plant will supplement the recovered heat as required and serve as a backup heat source.

18.2.7 Site Roads

The road network for the Goose Site will consist of all-season haul roads and service roads. Site access will be by the WIR between the MLA and Goose site.

Due to geotechnical conditions, all-season roads will be constructed with embankment fills only. The embankment material will be sourced from the airstrip quarry or from waste material from the open pits. Underlying geotechnical conditions will dictate the appropriate thicknesses of roadbed material.

Figure 18-1 shows site road locations. Service roads are used for smaller vehicles (e.g., light trucks) to access mining areas and ancillary infrastructure, such as water supply sources, the airstrip, and the AN storage facility.

18.2.8 Airstrip

The Goose airstrip is a vital component of the site infrastructure because air transportation is the primary means of access for mine personnel and incidental freight to and from the Goose Site.

The existing Goose airstrip is designed to handle turboprop passenger aircraft similar in size to a de Havilland Dash 8, ATR-72, and Electra. The airstrip is also sufficient to handle cargo aircraft up to a C-130 Hercules. The airstrip was designated as a “registered aerodrome,” and the design will be in accordance with TC’s standards, as set out in TP312E *Aerodrome Standards and Recommended Practices*.

The existing Goose airstrip is currently approximately 4,500 ft long and approximately 100 ft wide, this is deemed sufficient to accommodate the required aircraft. Sabina plans to lengthen the airstrip by another 500 ft to allow larger aircraft.

To ensure year-round efficient operations, the Goose airstrip will be equipped with a GPS instrument approach system; this allows instrument flight rules (IFR) approaches and departures under suitable weather conditions. The airstrip lighting package will include runway edge lighting and taxiway edge lighting.

At the Goose Site, the site’s crew buses will transport passengers between the aircraft and camp facilities.

18.2.9 Waste Rock Storage

Three main areas have been identified for WRSAs. These are shown in Figure 18-1. Waste will be stored adjacent to the Umwelt and Llama pits, and directly over the top of the location of Echo pit after completion of backfilling with tailings once the tailings have consolidated. The Echo WRSA location will be used for both the Echo and Goose Main open pit mine waste, whereas Umwelt and Llama waste will be deposited in the Umwelt and Llama WRSA, respectively

Underground mine waste will be temporarily stored on surface, used for construction (if NPAG), and permanently stored underground as backfill. Underground mining will have a waste rock deficit for backfilling, and waste rock from open pits will make up the deficit and be transported underground as backfill.

Slopes of WRSAs are designed with 10 m benches, 10 m berm widths, with 34° slopes. As far as possible, the dumps are designed to be as flat as possible, with the intent of keeping WRSA facilities in confined catchment basins.

The encapsulation of PAG waste rock, has been approved in the current permit. This involves waste dumps built such that the outer shells will be formed from NPAG (at least 5 m NPAG cover), and the PAG material encapsulated within this material.

Drainage from WRSAs is considered contact water, and will be contained by various contact water ponds, as discussed in Section 18.1.1.

18.2.10 Plant and Site Control System and Communications

The process plant facilities, power plant, fuel station, pumping stations and all other process or support facilities will be controlled and monitored by a site-wide plant control system (PCS). All process control and monitoring operations will be conducted from the main control room adjacent to the process plant building, via human-machine interface) screens displaying all process variables and alarm conditions. To the extent practical, all site controllers will be based on a single platform for maximum functionality and ease of integration. Where required, third-party controllers will be integrated into the main control system.

Communications external to the site will be provided by a dual satellite link to ensure high reliability. Bandwidth will be sufficient for site business operations; remote operation and troubleshooting of the PCS and all drives/controllers; as well as reasonable leisure activities for staff during off hours. To minimize costs and production delays associated with technician site visits, the site network will be planned to allow maximum remote support capabilities by allowing technicians to log in to specific equipment controllers to troubleshoot and assist site staff with repairs and modifications.

Cyber security will be a priority during the selection of communication technologies and providers. Current solutions appropriate to the Arctic will be implemented.

In addition to the infrastructure at the plant site there is various water management infrastructure that has been updated as part of the Updated Feasibility Study. This infrastructure was updated to better match the latest mine plans and based on the available site information. The primary water management infrastructure is:

- Llama pit diversion
- Llama WRSA pond
- Saline water pond (or sometimes referred to as the Umwelt Dam)
- Saline water pond diversions
- Primary pond (also acts as the contact water pond for the Umwelt WRSA)
- Umwelt WRSA diversion (portion of the explosives access road)
- Plant/camp site pond
- Diversion upstream/upslope of Echo pit
- Echo WRSA pond
- Goose pit diversion.

Water management infrastructure was sized by also considering climate change and impacts, linked to freeboard requirements for ponds, and peak flows requirements for the diversions. Thermosyphons have also been included in some of the ponds designs (saline water pond, primary pond, and considered for the Umwelt WRSA pond) due to some of the uncertainty in the foundation conditions. The thermosyphons have been included to ensure additional operational flexibly is maintained to keep the dam permafrost foundations frozen for their design lives (typically a maximum of 17 years, mine life plus two predevelopment years, and breached at closure). Additional drilling at the detailed design stage of design will provide further clarity if these thermosyphons are actually required. An overview of the water management infrastructure is shown in plan view on Figure 18-1.

To help store (ponds) or convey (diversions) water these water management ponds and diversions typically are designed with minimum fill thicknesses to help ensure that the foundation permafrost is maintained. For the ponds, spillways have been incorporated into the designs. Typically, spillways are planned to typically be slight swales in the dam crests that trucks will be able to easily pass over (10% grades or less on the side slopes through the crest). These spillways are not intended to be used, and operation of the ponds is planned done with the assistance of pipelines and pumps to keep the pond elevations as low as practical, and below the point of passive discharge. These spillways are therefore for emergency purposes only and to ensure the hydrotechnical and geotechnical aspects of the dams are upheld, even during extreme upset conditions.

18.2.11 Site Water Management

In addition to the infrastructure at the plant site there is various water management infrastructure that has been updated as part of the Updated Feasibility Study. This infrastructure was updated to better match the latest mine plans and based on the available site information. The primary water management infrastructure is:

- Llama pit diversion
- Llama WRSA pond
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- Saline water pond diversions
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- Umwelt WRSA diversion (portion of the explosives access road)
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- Echo WRSA pond
- Goose pit diversion.

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18.3 Off-Site Infrastructure

18.3.1 Winter Ice Road

The WIR forms a critical component of the off-site infrastructure used to link the Goose Site with the MLA. The WIR will be constructed annually from the MLA at Bathurst Inlet to the Goose Site, beginning in Year−2. The WIR will be the primary method of delivering equipment and materials to the Goose Site during construction, and throughout operations.

Once the road is constructed and deemed suitable for hauling, it will be monitored and maintained to ensure safe and continuous operation until all freight has been transferred from the MLA to the Goose Site. During the annual winter road season, a fleet of transport trucks will ensure the delivery of freight and fuel from the MLA to the Goose Site.

Each year a total of 172 km of WIR will be constructed between the MLA and the Goose Site. The breakdown of WIR distances constructed on ice and land is summarized in Table 18-5.

Table 18-5: Winter Ice Road Segment Length

Description	Distance on Land (km)	Distance on Ice (km)	Total Distance (km)	No. of Water Bodies
MLA to George Junction	40	65	105	22
George Junction to Goose	33	34	67	29
Total MLA to Goose Site	**73**	**99**	**172**	**51**

Source: SDE, 2021.

Distances on ice and land are used to estimate both construction durations and haul cycle times. Construction progress rates vary significantly between ice and land; ice construction progresses faster. The number of water bodies along each road is also an important factor in determining haul cycle times, as speeds are significantly reduced for loaded trucks travelling over land between the bodies of water (also known as portages).

WIR construction is planned to begin in early December of each year, starting in Year −3. At this time, it is expected that the tundra subgrade and water bodies will be frozen and able to support light, tracked equipment. To construct the WIR to commence hauling in January, the construction will be advanced from two headings: one crew working north from the Goose Site, and a second working south from the MLA. Due to the seasonal nature of the WIR construction, it has been assumed that it will be performed by an experienced contractor that will provide all labour and operate the Owner's equipment.

The WIR will be constructed over frozen bodies of water and portages. Ice construction consists of using ground-penetrating radar to first determine if there is adequate ice thickness to support construction equipment. Areas with thinner sections of ice might require manual flooding to increase ice thickness to accommodate legal loads. Once suitable ice thickness is achieved, snow is cleared from the right-of-way. Portage construction typically consists of layers of compacted snow and water placed on the frozen tundra to create a level driving surface suitable for highway-legal loads.

Based on the first WIR completed successfully in 2018–2019, the estimated construction rate-of-advance using two headings is as follows: on ice, it is 9 km/d total; on land it is 2 km/d total. Rates of advance are based on Sabina's experience and consultations with contractors who are experienced in ice road construction in the NWT and Nunavut. Table 18-6 provides construction duration estimates.

Table 18-6: WIR Construction Days

Description	Construction on Land			Construction on Ice			Total Construction (d)
	Distance (km)	Rate (km/d)	Duration (d)	Distance (km)	Rate (km/d)	Duration (d)	
MLA to Goose Site	73.0	2.0	36.5	99.0	9.0	11.0	47.5[1]

Source: SDE, 2021.
Note: [1] Total construction time excludes contingency. The total construction with contingency time is estimated to be 56 days.

WIR construction will adhere to Fisheries and Oceans Canada (DFO) requirements for ice bridges and snow fills, as well as DFO under-ice water withdrawal protocols.

Temporary emergency shelters will be placed along the WIR every 60 km. These will be equipped with survival and communications equipment.

Freight quantities have been estimated for the LOM to be 470,000 tonnes of freight averaging 31,000 t/a. Fuel quantities to be shipped are shown in Table 18-7.

Table 18-7: WIR Fuel Quantities

Year	Fuel (ML)
Year 1	32.5
Year 2	48.4
Year 3	52.4
Year 4	52.1
Year 5	51.7
Year 6	45.5
Year 7	48.2
Year 8	50.3
Year 9	50.4
Year 10	50.2
Year 11	43.6
Year 12	40.8
Year 13	40.8
Year 14	**44.0**
Year 15	**27.1**
Total	**678.0**

Source: JDS, 2015b.

Freight hauling is expected to average 25 tonnes per load. Fuel hauling will use tridem-axle tankers with a 59,000 L load capacity (an average of 55,000 L per tanker was used for cost estimating).

The duration of a complete cycle between the MLA and the Goose Site exceeds the 12 h maximum allowable shift. Therefore, it is anticipated that haul truck operators would work an 8 h shift, and each truck would take 16 h to make a complete cycle. Table 18-8 provides cycle-time details calculated for freight and fuel from the MLA to the Goose Site. The cycle times were used to determine the number of trucks and trailers required for each year.

Table 18-8: WIR Cycle Times

Description	Cycle Time (h) MLA to Goose Site	
	Freight	Fuel
Unload/Reload Time at MLA	1.5	1.0
Travel Time Loaded	7.3	7.3
Unload/Reload Time at Goose	1.5	1.0
Travel Time Empty	5.4	5.4
Subtotal Cycle Time Before Delays	15.7	14.7
Shift Change Delays	0.3	1.3
Total Cycle Time	**16.0**	**16.0**

Source: Sabina, 2021.

Once the WIR is in full operation, the labour crews will be scaled back to perform road maintenance. WIR maintenance will take place 24 h/d, with two labour crews working 12 h shifts: one crew based at the MLA and one at the Goose Site.

Maintenance crews will focus on the following tasks:

- Maintaining road widths and repairing damaged ice sheets, as required.
- Conducting focused flooding along the road in areas where icing is lagging.
- Profiling ice every second day until the road reaches 100% capacity, then weekly after that.
- Snow removal when required.
- Providing rescue and recovery work, as required.

Once hauling on the WIR is complete, perform the following tasks to decommission the road and prepare for demobilization:

- Gather all road signs and properly store them for future use.
- Remove any garbage found along the route.

- Conduct final maintenance of all ice road construction equipment.
- Demobilize from site.

18.3.2 Marine Laydown Area

The Project includes the MLA, a marine receiving and staging facility on Bathurst Inlet, approximately 130 km north-northwest of the Goose Site. During the construction phase, and throughout the LOM, equipment, supplies, and fuel will be transported to the MLA by ocean-going, ice-class barges and ships from western and eastern ports in Canada. The MLA will be connected via WIRs to the Goose Site during construction and operations.

The MLA will be used to receive fuel, cargo, and consumables during Project construction and operation. Products will not be exported via the MLA, as gold doré will be transported by air directly from the Goose Site.

Fuel and cargo will be received and staged at the MLA during the summer months when there is no sea ice, typically from August to September, and will be transported to the Goose Site by truck via the WIR from January to April. Outside of these periods, MLA activities will be limited to on-site storage and periodic monitoring for loss prevention. The MLA will generally be unstaffed in the times between the summer receiving period and the winter transportation period.

During periods of marine receiving and staging activities, crew transport between the MLA and Yellowknife, will be facilitated by the all-weather airstrip.

Sabina successfully operated three season of logistics operations from consolidation points at Hay River and Bécancour to the MLA port.

Marine Laydown Area Functional and Design Criteria

During operations, the MLA has been designed to handle off-loading and storage of 55 ML of diesel and 15,000 ta of consumables. An approximately 39,000 m^2 laydown area is constructed, along with a 10 ML fuel tank. Additional fuel storage of 45 ML will be constructed. Additional laydown area is provided to accommodate construction storage requirements.

The fuel tankers will use shore-mounted anchorages to secure the ship offshore during off-loading. As defined in the TP 12402—*Oil Handling Facilities Standards*, the MLA will have a Level 2 OHF classification, which will permit transfer rates to a maximum of 750 m^3/h. The fuel supplier will supply and connect floating 200 mm discharge hoses to a shore-installed connection that will allow the fuel to be pumped to the fuel storage facility. The fuel supplier will provide all spill response equipment required for the classification facility as detailed in TP-10783—*Arctic Waters Oil Transfer Guidelines*.

Cargo will be transported to the MLA by either ocean-going barges or ships.

The ships and barges will be self-sufficient for off-loading cargo. Lightering barges will be used to transfer cargo from the vessel to the lighter barge landing at the MLA. Freight will then be hauled to a laydown area where it will be stored until the annual WIR is open.

Navigation to Bathurst Inlet

Dry freight throughout the Project pre-production and production phases will be consolidated annually at either of the two marshalling facility locations: Edmonton, Alberta, in the west, for furtherance to Hay River, NWT, during the summer shipping season, and onward shipment by barge to the MLA; and Bécancour, Québec, in the east, for onward shipment to the MLA. As mentioned earlier, point of origin is the main criterion used to determine whether to use Edmonton or Bécancour as the marshalling point.

Since both routes require the vessels to travel through Canadian Arctic waters, they are required to comply with TC's *Arctic Waters Pollution Prevention Act* (AWPPA). The AWPPA deals with shipping in Canadian waters that lie above 60° north latitude. The controlling regulation made under the AWPPA is called the Arctic Shipping Pollution Prevention Regulations (ASPPR). The ASPPR provides for construction and machinery standards for various classes of ice-strengthened vessels and establishes when and where in the Canadian Arctic such vessels can navigate, based on their class and ice conditions in the area. Table 18-5 shows the vessel routes from Hay River and Bécancour. The normal shipping season from Hay River to the MLA begins in the second or third week of July and extends to the end of September, a 10-to-12-week shipping season. Transit time from Hay River to the MLA is approximately 17 or 18 days under normal conditions. From Bécancour, the shipping season is shorter due to the traditional Arctic ice-up season, which means that ships traverse the waters from mid-August to the third week of September, approximately five weeks. Under normal conditions, transit time from Bécancour to the MLA is 11 to 12 days. Both shipping windows could be shorter or longer, depending on ice conditions.

The ASPPR governs navigation through what is commonly known as the "Zone/Date System," in which Arctic waters are divided into sixteen Shipping Safety Control Zones, with a schedule of earliest and latest entry dates for each zone corresponding to specific categories of vessels. Zone 1 has the most severe ice conditions; Zone 16 the least. Figure 18-7 illustrates the Zone Map.

The MLA comprises the marine infrastructure, laydown area, and upland infrastructure. Upland infrastructure includes the following (Figure 18-7):

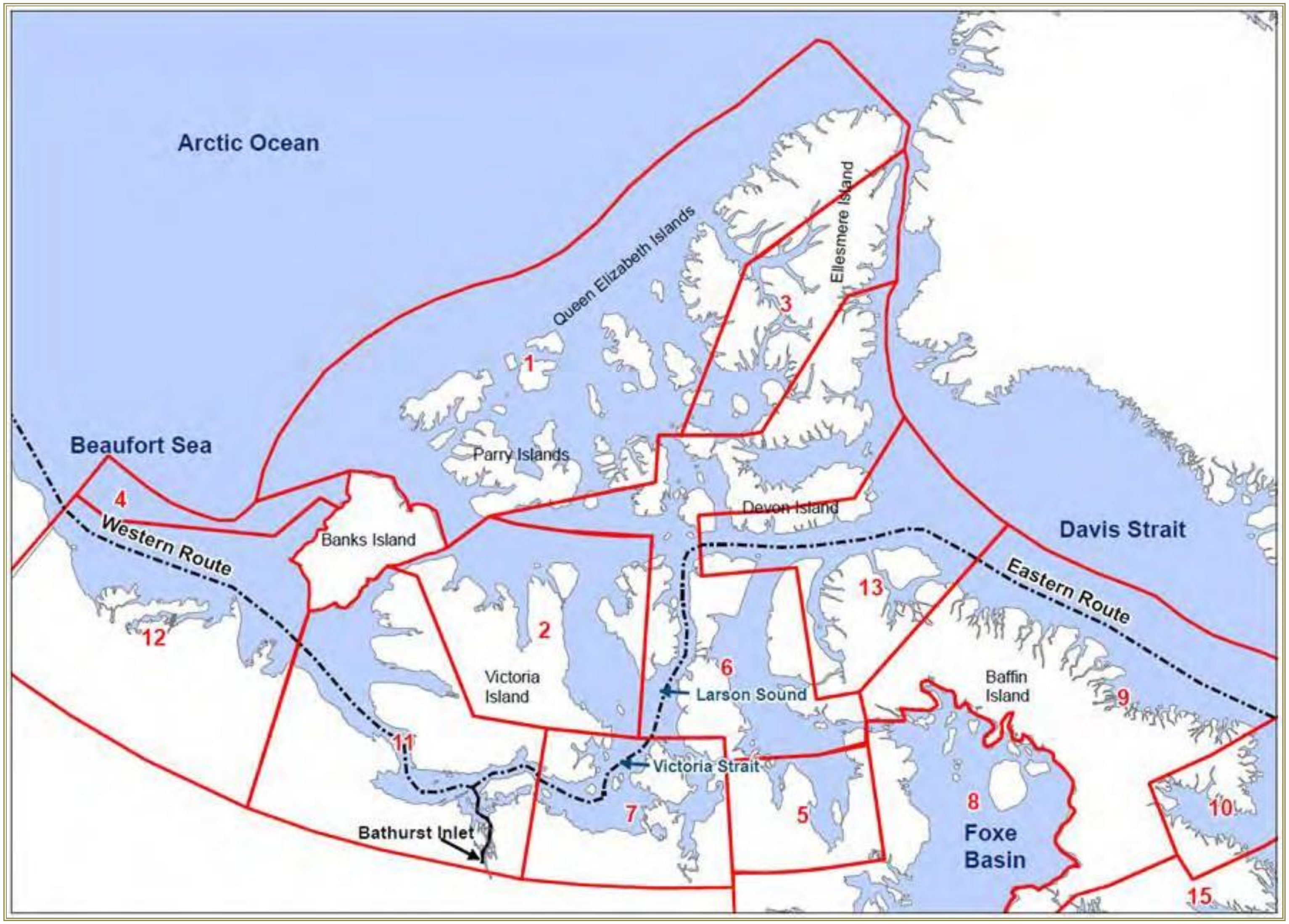
- Diesel fuel storage tank farm
- Container storage area of approximately 39,000 m^2
- Construction laydown area
- Warehouse
- Power plant
- Maintenance shop
- Desalination plant
- Fresh/fire-water storage and distribution
- Approximately 40-person camp with offices
- Ancillary equipment for site operation.

The marine infrastructure comprises a single, grounded terminal barge that will accept lighter barges. Lightering barges will shuttle freight from the ocean-going vessels that are moored at a water depth of approximately 12 m to the shore.

Other components of the MLA include an onshore fuel manifold for off-loading fuel from tankers.

Source: Sabina, 2020.

Figure 18-6: Shipping Routes



Source: Sabina, 2020.

Figure 18-7: ASPPR Zone System Map with Shipping Routes

18.3.3 Site Infrastructure

Maintenance Shop

A maintenance shop (fabric building with compacted-fill floor) will be provided to service vehicles and other equipment at the MLA. The building will be heated with waste-oil/diesel-fired heaters and equipped with the necessary tools and equipment.

Warehouse and Laydown Area

A warehouse (fabric building with compacted-fill floor) will be provided to store antiscalant until it can be shipped from the MLA to the Goose Site. Material or equipment that requires protection from the elements at the MLA will be cold stored in sea containers. Materials that can be exposed to the elements will be stored in the laydown areas.

Camp and Administration Offices

A camp with a single-occupancy room configuration will be used during the construction and operation phases at the MLA to accommodate up to approximately 40 workers. There will be two dorms with a "gang" bathroom arrangement.

A fabric emergency response team (ERT) building with a compacted-fill floor is provided to house an F250 pickup with an emergency response "camper." No fire engine is provided.

Site Communications, Fire Protection, and Security

Communications systems, security, and fire protection will be similar to those described for Goose.

Fuel Storage

The fuel tanks are filled directly from the fuel supply ships through the shore manifold and a booster pump module at the shore. The fuel storage area is equipped with a tanker/light-vehicle fueling module for filling the tanker trucks that transport the fuel to Goose on the WIR, and for fueling local vehicles.

Blasting Agents Storage

AN will be shipped in sea containers and stored at the MLA. Blasting agents are not mixed at the MLA Site.

Waste Management

Bermed and HDPE-lined areas will be constructed at the construction laydown area: one to function as a land farm; a second to function as a hazardous materials storage area. An incinerator will be provided to burn kitchen waste and other acceptable combustible materials.

Power Supply, Generation, and Distribution

A small power plant will be installed at the MLA to meet demand. The sizing philosophy is N+1 for site power requirements.

Utilities and Services—Potable Water

Ocean water will be pumped from Bathurst Inlet to a reverse osmosis (RO) treatment plant near the camp via a pump station located next to the inlet. The plant will desalinate and treat the water for use as potable water, and to feed the fresh/fire-water tank. The plant is sized for approximately 40 people based on a consumption of 275 L/d per person.

18.4 Mobile Equipment

Mobile site support equipment provides operations support at MLA and Goose. A list of site support equipment by location is available upon request.

18.5 Labour Force

Each of the two sites will have a site-support work crew, responsible for the following:

- Maintaining and repairing infrastructure facilities
- Transferring freight from storage areas to the warehouse and operation centres
- Transporting personnel between camp and aircraft
- Loading and unloading aircraft
- Conducting airstrip operations and maintenance
- Performing waste management duties (i.e., incineration, water treatment, hazardous waste handling)
- Providing plant-site snow removal
- Managing site water
- Overseeing mobile crusher operations (Goose only)
- Overseeing TS operations (Goose only).

19 MARKET STUDIES AND CONTRACTS

The Project will produce doré containing gold and silver. At this point, assaying and modelling of silver grades has not been completed; as such, the revenue projected for the Project is based solely on the sale of gold.

Gold pricing is readily available, and fluctuates with economic and geopolitical factors, as is well documented. The World Bank publishes gold price forecasts in nominal United States dollars. Sabina has reviewed historical average pricing sourced from IndexMundi©, as well as forecast pricing as published by the World Bank (World Bank, October 2020).

Further detailed market studies were not completed on the potential sale of gold for the Goose operations.

There are no contractual arrangements for shipping or refining. Table 19-1 shows the terms used in the economic analysis.

Table 19-1: Gold Sales Terms used in the Financial Model

Item	Unit	Value
Gold Payable	%	99.8
Gold Refining Charge	US$/oz	1.00
Dore Insurance	% of gold payable	0.15
Gold Transport Cost	US$/oz	1.00

Source: SDE, 2021.

19.1 Metal Prices

Metal pricing used in the Updated Feasibility Study varies depending on application. Mine Resources were stablished at US$1,550/oz, Mineral Reserves at US$1,500/oz, and economics evaluated at US$1,600/oz. These values are within a range which can be supported by empirical or expert data. The exchange rate of C$1.31:US$1.00 is based on the three-year average, sourced from Indexmundi.com.

Gold pricing data are shown below:

- Three-year trailing average gold price (World Bank, 2021) US$1,510/oz
- World bank forecast gold price to 2030 US$1,533/oz
- Consensus price (CIBC Global Mining Group, 2021) US$1,608/oz.

These metal prices provide a conservative estimate of long-term Mineral Reserves while still reflecting current market conditions for the economic model.

20 ENVIRONMENTAL STUDIES, PERMITTING, AND SOCIAL OR COMMUNITY IMPACT

20.1 Environmental and Social Governance

Sabina has an established Sustainable Development Policy that includes the following commitments:

- Meet or strive to exceed all relevant legislated sustainable development requirements in the regions where Sabina works.
- Ensure appropriate personnel, resources, and training are made available to implement Sabina's sustainable development objectives.
- Establish clear lines of responsibility and accountability throughout Sabina to meet these objectives.
- Implement proven management systems and procedures to facilitate Sabina's sustainable development objectives. A priority will be placed on developing and implementing management structures related to the environment, health and safety, emergency response, and stakeholder engagement.
- Act as responsible stewards of the environment for both current and future generations. Sabina will make use of appropriate assessment methodologies, technologies, and controls to minimize environmental risks throughout all stages of mineral development.
- Work closely with local communities and project stakeholders to understand their needs, address their concerns, and provide project-related benefits to create win-win relationships. Sabina's goal is to earn and maintain a social licence to operate at all company operations while building partnerships.
- Pursue economically feasible projects to generate shareholder profitability and support long-term positive socioeconomic development in the regions where Sabina works.
- Use a precautionary approach as it applies to potential effects from Sabina's activities. Work with employees, contractors, and stakeholders to promote a culture of open and meaningful dialogue to ensure that any known or suspected departures from established protocols are reported to management in a timely manner.
- Regularly review this policy to ensure it is consistent with Sabina's current activities and the most recent legislation.
- Continually improve Sabina's performance and contributions to sustainable development including pollution prevention, waste minimization, and resource consumption.
- Implement programs at each of Sabina's operations to monitor and report compliance and proactively address potential deficiencies in our policies and procedures.

Sabina has staff dedicated to the environmental and social performance of the Project, including at the executive level. The environmental team conducts environmental monitoring at the Project sites, and actively maintains permits and approvals covering the existing and proposed facilities required for mine development.

In Nunavut, and within the Kitikmeot Region in which the Project is situated, Sabina has also maintained long-standing relationships with the communities potentially affected by the Project: the regional Inuit association (Kitikmeot Inuit Association), Nunavut's Institutes of Public Government, the Government of Nunavut, and federal regulatory agencies. Consultation records are maintained in a database.

20.2 Environmental Studies

Baseline data collection was initiated at the Property on a limited scale in 2008. Hydrology and meteorology baseline data were collected in 2008, as well as fish habitat and community information. No baseline studies were conducted in 2009, except for the continued operation of the meteorology station near the Goose exploration camp. Extensive baseline studies were carried out in 2010, 2011, 2012, 2013, and 2014. Baseline work during this period included archaeology, metal leaching/acid-rock drainage (ML/ARD) evaluation, hydrology, meteorology, air quality (including dust-fall monitoring), noise, freshwater and marine water quality, sediment quality, aquatic biology, bathymetry (lake, marine, and pond), freshwater and marine fish and fish habitat, ecosystem mapping, vegetation/wetlands, soil and terrestrial landforms, rare plants, country foods, wildlife (terrestrial and marine), socioeconomics, Traditional Knowledge (TK), and land use. The description of the existing environment in this Technical Report is based on results of these studies. Further detail, including copies of the various baseline reports, is provided in the Final Environmental Impact Statement (FEIS), which was submitted to the NIRB in November 2015 (Sabina, 2015).

Additional baseline and monitoring programs have been underway since the FEIS was published, to establish a robust pre-development dataset by which future environmental monitoring during mine development can be compared. Regional environmental baseline programs have also been conducted in the area over the past couple of decades as part of other mineral development and infrastructure projects and government monitoring programs. Data from these regional studies are also relevant to the Property.

20.2.1 Atmospheric Environment

Climate and Meteorology

The Project area experiences relatively low precipitation, but due to sub-zero temperatures for much of the year, also experiences snow accumulation. Summer is a season of nearly perpetual daylight, while winter is dominated by night, twilight, and extreme cold. Due to the relative absence of obstructions to impede the wind (e.g., trees, buildings, mountains), wind speeds are generally high.

Air Quality, Noise, and Vibration

The air quality in the atmospheric Regional Study Area (RSA) is predominantly pristine, reflecting the Project's remoteness and the lack of, and localized nature of, sources of anthropogenic air and noise emissions sources.

Physical Environment

Geology

The Goose Property is in the central-eastern portion of the Slave Geologic Province, near its boundary with the Churchill Province. The Goose Property consists of a package of variably folded and faulted sedimentary rocks. Greywacke and subordinate mudstone surround and variably interbed with silicate banded-iron formation and oxide banded-iron formation. The sedimentary package is cross-cut by mafic dikes, lesser volumes of felsic dikes, and volumetrically insignificant quartz veins.

The MLA is underlain by lower to middle Proterozoic sedimentary rocks of the Kilohigok Basin, part of the Bear Province. Glacial material deposited after the Quaternary Wisconsin glaciation covers much of the Archean geological provinces. Glacial deposits predominantly comprise moraine deposits (glacial till), which consist of mostly sand and variable amounts of silt.

Permafrost

The Project is located within the continuous permafrost region of western Nunavut. A seasonally thawed active layer is present immediately beneath ground surface, with a mean maximum depth of approximately 2 m and a mean annual temperature that averages −6.5°C. Subsurface temperatures are perennially below 0°C at depths up to approximately 500 m below ground surface, except beneath some surface water bodies. At the Goose Property, open (through) taliks that connect to the deep groundwater are inferred to be present beneath waterbodies with widths greater than 200 m and water depths exceeding 1.3 m. Cryopegs are inferred to be present at the base of the permafrost and adjacent to deep taliks, as the groundwater beneath the permafrost has been shown to be hypersaline.

Landforms and Soils

The Project is in an area dominated by gently undulating or rolling landscapes with numerous kettle lakes connected by streams. Terrain elevation ranges between 300 and 700 metres above sea level (masl) and slope gradients rarely exceed 7%. Uplands are typically covered by morainal materials (51% of the Goose Property) deposited on Precambrian sedimentary, metamorphic, or intrusive rocks. Glaciofluvial (14%), organic (6.4%), marine (8.5%), and lacustrine (1.1%) deposits are less common. Exposed bedrock occurs over 2.6% of the Goose Property. The thickness of mineral soils overlaying bedrock (overburden) is the highest in plains and very gently sloping areas (average of 10.6 m) and decreases in rolling and undulating landscapes (average of 4.8 m).

Several distinct landform types, including eskers, morainal rocky ridges, and boulder fields exist throughout the terrestrial RSA. Cold climate is also associated with several soil phenomena. Thermokarst typically occurs in wetlands as a system of very irregular hummocks and hollows, which form due to frost heaving and ice accumulation on the bottom of organic horizons. The presence of permafrost and annual freeze-thaw cycles results in poor development of soils. About two-thirds of the inspected soils have been classified as Static Cryosols and one-third as Turbic Cryosols.

Baseline soil samples were collected in 2012 at 51 sites within the Local Study Area (LSA), and 20 sites outside of the LSA but within the RSA. Most soils have a low proportion of coarse fragments (below 30%) and low surficial stoniness (below 15%). Most soils are moderately coarse (loam, sandy loam, fine sandy loam). Mineral soils in the terrestrial RSA are predominantly acidic (median pH is 5.9, range from 4.7 to 6.8). In general, soil metal concentrations in the LSA do not exceed Canadian Council of Ministers for the Environment (CCME) guidelines.

20.2.2 Terrestrial Environment

Vegetation

Vegetated ecosystems in the mine area are dominated by mesic tundra, dry-sparse tundra, and moist shrub-dominated tundra. Sparsely vegetated ecosystems constitute nearly 9% of the mine's LSA. Non-vegetated ecosystems, constituting approximately 18% of the LSA, are dominated by freshwater lakes and ponds. Special landscape features include esker complexes; cliffs; bedrock outcrop and lichen-dominated ecosystems; riparian ecosystems; wetland ecosystems; and marine beaches and old beach heads.

Key Terrestrial Wildlife

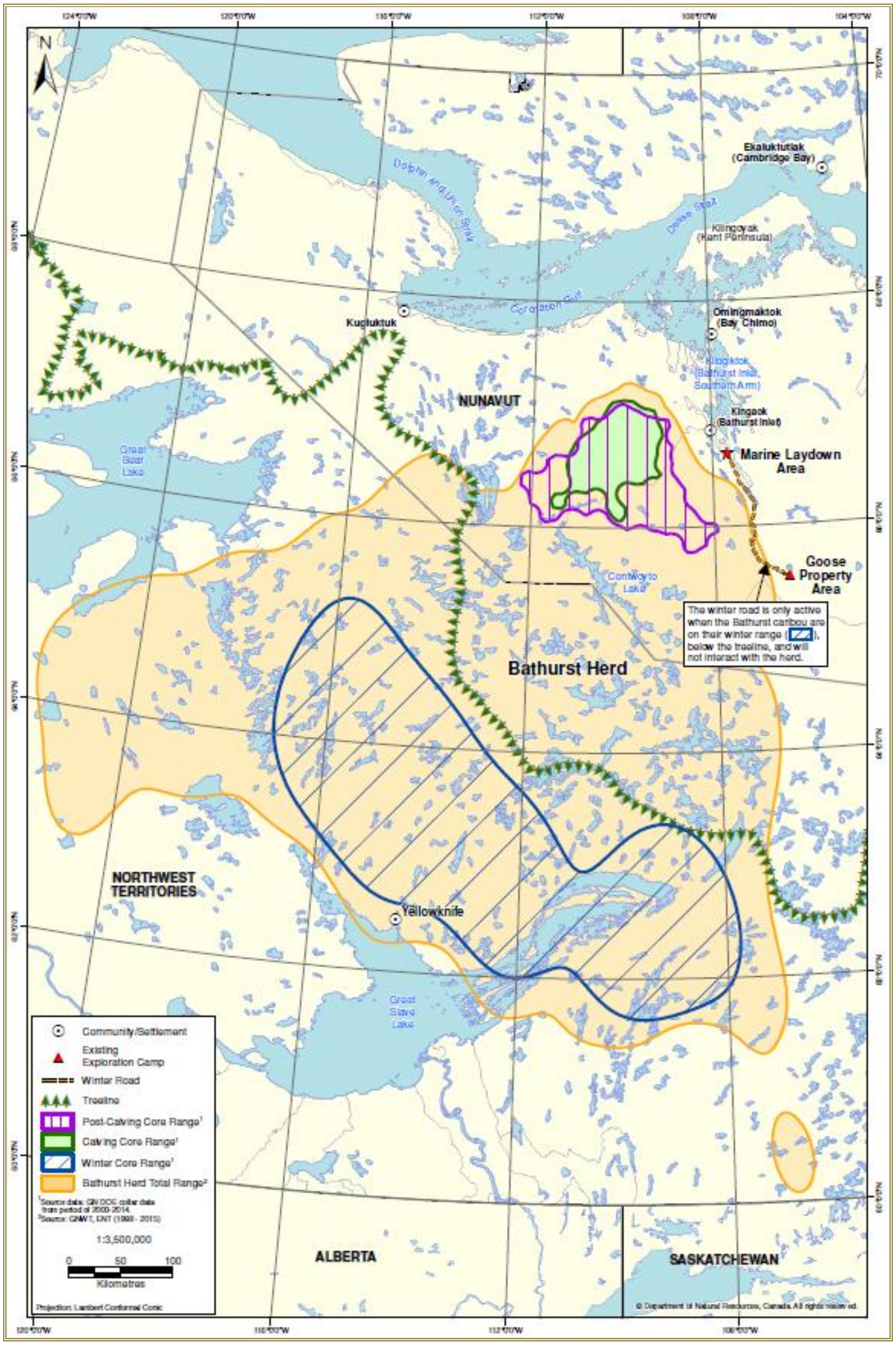
Key terrestrial wildlife species present in the regional study area include barren-ground caribou, muskox, grizzly bear, wolverine, grey wolf, arctic red fox, and various migratory birds, including raptors. Terrestrial wildlife species identified as valued ecosystem components (VEC) in the Project's FEIS are described briefly below.

Caribou

The ranges of three barren-ground caribou herds overlap the Project's wildlife RSA, as shown on Figure 20-1 to Figure 20-3:

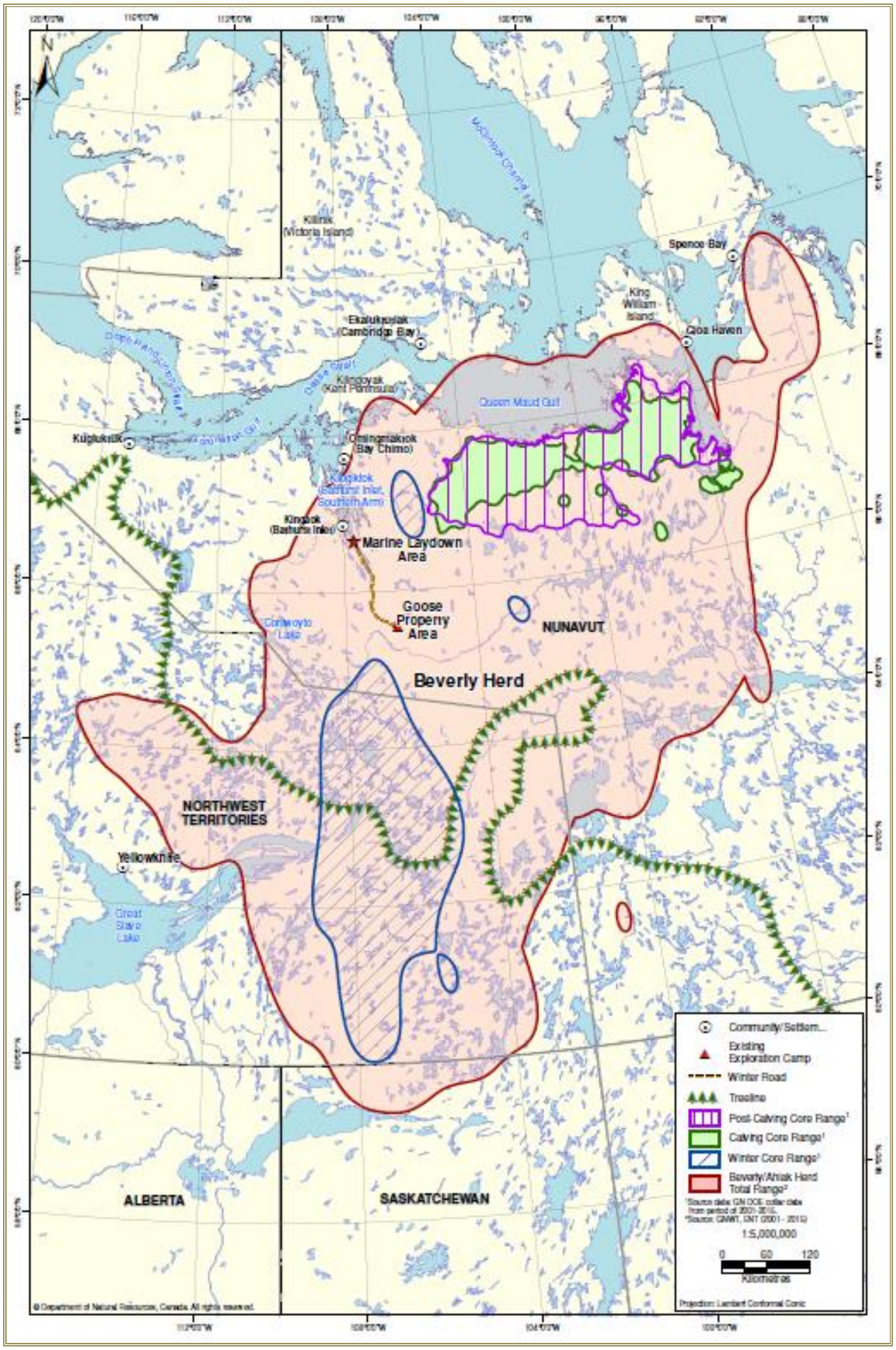
- Bathurst herd
- Beverly and Ahiak herd
- Dolphin and Union herd.

The Bathurst herd is found in the RSA, primarily during post-calving period. The herd calves between the Hood and Burnside Rivers, approximately 240 km northwest of the Project site. Following calving, the Bathurst caribou travel southeast in large groups, passing 30 to 60 km to the west of the Project site (their closest approach) on their way to their summer range surrounding Contwoyto and Nose Lakes, 60 to 100 km southwest of the Project site. This herd winters south of the treeline. The Bathurst herd has suffered a dramatic decline in numbers, from a high of roughly 470,000 in the mid-1980s to a low of about 8,200 in 2018 (Government of the Northwest Territories [GNWT], 2018).



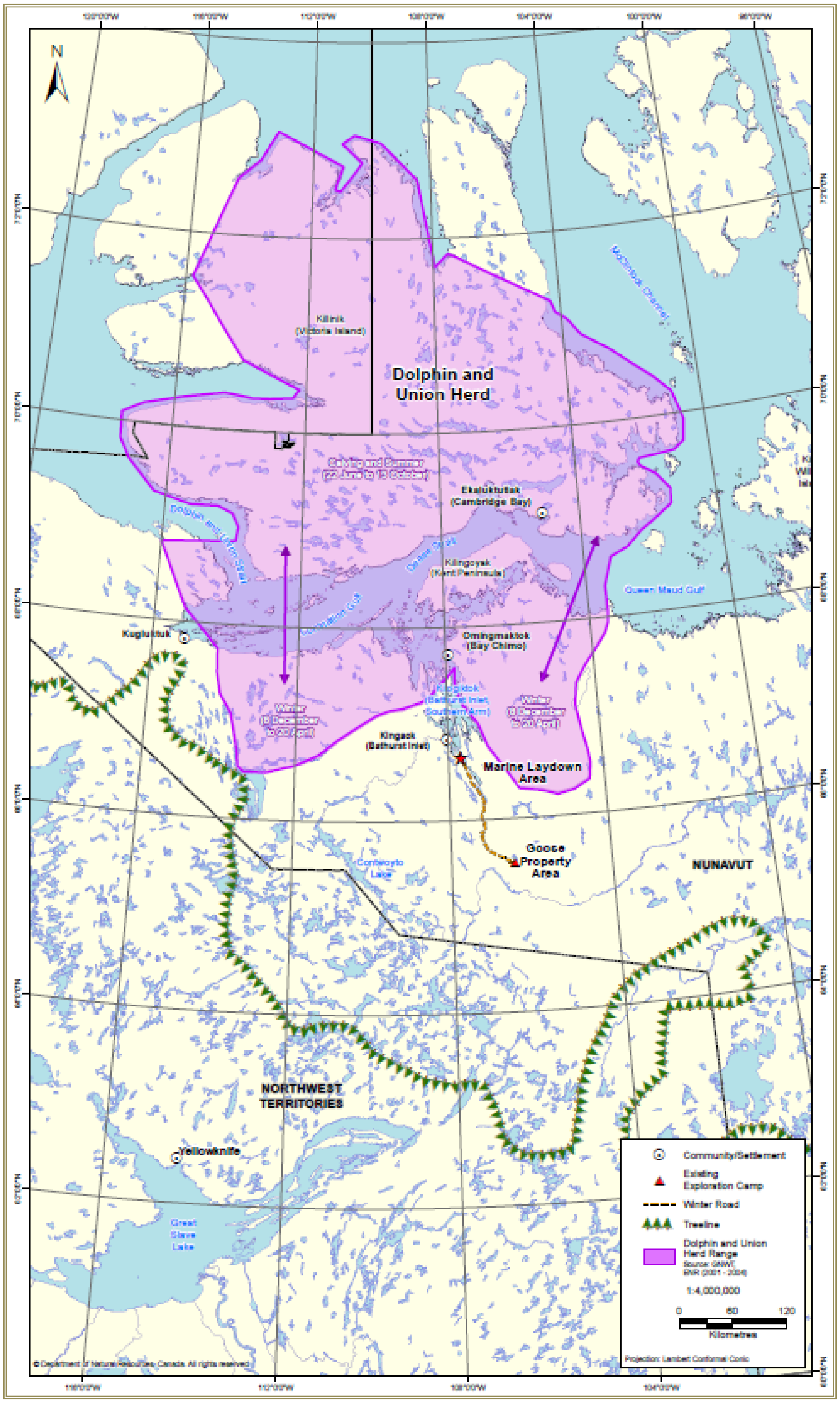
Source: Sabina, 2015.

Figure 20-1: Annual Ranges of the Bathurst Caribou Herd



Source: Sabina, 2015.

Figure 20-2: Annual Ranges of the Beverly/Ahiak Caribou Herd



Source: Sabina, 2015.

Figure 20-3: Annual Ranges of the Dolphin and Union Caribou

In 2019, the GNWT published the *Bathurst Caribou Range Plan*, which was developed in collaboration with 21 organizations, including Indigenous governments, wildlife management boards, and industry from the NWT, Nunavut, and Saskatchewan (GNWT, 2019). The plan will help guide decision-makers, companies, and communities within the established co-management and regulatory systems to manage activities on the land in a way that supports the Bathurst caribou's recovery. The range plan provides non-binding recommendations to governments and industry. Sabina has been implementing its own caribou protection measures since 2017 (Sabina, 2016); these measures were approved following review by federal, Nunavut, and NWT wildlife agencies during the NIRB environmental review of the Project. The approved protection measures are based on herd vulnerability, group size, time of year, and the potential disturbance of onsite activities including blasting, heavy mobile equipment, helicopters, and all season and WIR operations. Over the past three years Sabina has trigger these protection measures a few times annually with activities decreased or stopped for an average of less than 30 minutes. There is also a requirement for the shutdown of outdoor activities during the calving and post calving period if groups of caribou are in close proximity of the Project site. Sabina has not triggered this requirement in any of the past three years, and based on caribou collar data, Sabina would not have triggered this requirement over the past 10 years as caribou calve hundreds of kilometres from the Project site. Monitoring of these protections' measures, including their observational effectiveness, is collected and reported annually as part of the Wildlife Mitigation and Monitoring Report.

The Beverly herd, and a separate Ahiak herd, have traditionally been two separate herds that appear to have merged in the mid-1990s (Adamczewski et al., 2015). The Ahiak herd calved in the western Queen Maude Gulf area by the coast, and the Beverly herd calved on the tundra near Garry Lake, southeast of the Ahiak calving grounds. Since 2002, the Beverly herd has shifted its calving range to join the Ahiak herd in the western Queen Maude Gulf area. The two herds have been referred to singularly as the Beverly herd in recent Government of Nunavut reports (Campbell et al., 2012; Nagy et al., 2011; Nagy, Campbell, & Kelly, 2012).

Historically, the Ahiak herd spent the summers in the Queen Maud Gulf Migratory Bird Sanctuary and wintered predominantly on the tundra, south of the Thelon Game Sanctuary, which extends their winter range into the NWT. The Government of Nunavut's most recent population survey (2011) estimates the Ahiak herd at 71,000 animals (GNWT, 2020a).

The range used by the Beverly herd extends from the boreal forests of Saskatchewan, across the subarctic taiga of the Northwest Territories, to the Arctic tundra of west-central Nunavut (GNWT, 2020a). The herd calves in both the Western Queen Maud Gulf area and the traditional calving grounds near Beverly Lake in Nunavut. A 2018 population survey undertaken by the Government of Nunavut preliminarily estimated the size of the Beverly herd at 103,000 animals (GNWT, 2020a).

Committee on the Status of Endangered Wildlife in Canada (COSEWIC) suggested that it would be appropriate to include the Beverly and Ahiak subpopulations together when considering population estimates, as there are two interpretations about recent trends in their distributions and abundances (COSEWIC, 2016).

In November 2016, COSEWIC for the first time assessed the eight barren-ground caribou herds—including the Bathurst and the Beverly and Ahiak herds—as Threatened (COSEWIC, 2016). None of these herds are currently scheduled under the *Species at Risk Act* (SARA).

The Dolphin and Union herds, also known as island caribou, calve and spend the summer on Victoria Island, and winter on the mainland, generally to the east and west of the marine RSA during the winter, and seldom detected by trail cameras in the RSA. Dolphin and Union caribou are listed as a species of Special Concern under both the federal SARA and the territorial *Species at Risk (NWT) Act*. In 2017, COSEWIC re-assessed the status of Dolphin and Union caribou as Endangered in Canada (Conference of Management Authorities, 2020), and in the same year, Environment and Climate Change Canada (ECCC) proposed a management plan for the Dolphin and Union population of barren-ground caribou (ECCC, 2017). In 2018, the GNWT, the GN and their respective wildlife management boards produced a management plan for the Dolphin and Union Caribou (GNWT, Government of Nunavut, Wildlife Management Advisory Council (NWT), and the Nunavut Wildlife Management Board, 2018), which highlighted the potential impacts of ice-breaking on this herd. The Back River Project ships only during the open water season.

Grizzly Bears

TK indicates that grizzly bears are found throughout the RSA, especially in association with major river systems such as the Western River, and coastal areas, including Bathurst Inlet. Using a DNA mark-recapture analysis, the regional population of bears was calculated in 2012 to be 72 females and 54 males, and in 2013, 64 females and 54 males (Sabina, 2015).

Muskox

Muskox occur at moderate to low densities across the Canadian Arctic, and are valued by the Inuit as a source of food, hides, horns, and wool, as well as for the commercial export of meat. TK indicated that muskox populations have been undergoing a long-term recovery from previously low numbers and occur throughout and surrounding the RSA at low densities. Aerial baseline surveys agreed with TK information (Sabina, 2015).

Wolverine and Furbearers

Wolverines are members of the mustelid family, which includes weasels, badgers, and martens. Like other mustelids, wolverines are carnivorous, and are both scavengers and predators on a wide range of prey (COSEWIC, 2003). Very large home ranges and low population densities are characteristic of this solitary species. Inuit have generally regarded wolverines as pests, as they cause damage to caches, destroy property, and steal food (Kitikmeot Inuit Association [KIA], 2012). Their status as pests changed because of the fur trade, as their pelts were highly valued and sought after (KIA, 2012). This resource dramatically increased Inuit trapping and hunting of wolverines. The use of wolverine fur as trim on parkas is a relatively recent custom; however, this local use by Inuit became very important (KIA, 2012).

The wolverine is ranked as Secure in Nunavut (Canadian Endangered Species Conservation Council [CESCC], 2010), and of Special Concern by COSEWIC (2003, 2014). The population size is estimated to be greater than 10,000, so it is above the threshold for designation as Threatened under COSEWIC's ranking system (Slough, 2007).

Wolverines and grey wolves are present in the wildlife RSA. Baseline studies estimated the local population of wolverine to be very low. However, habitat suitability modelling for wolverines indicates that there is approximately 44.7% high-quality habitat within the wildlife RSA. TK identified eskers as the primary denning habitat for wolves. Habitat suitability modelling calculated the habitat covers approximately 1% of the RSA. Denning surveys conducted for grey wolf supported TK information, with eight dens identified in the RSA on eskers, of which five produced pups (Sabina, 2015).

Migratory Birds and Raptors

Migratory birds and their nests are protected by the federal *Migratory Birds Convention Act* (1994) and the Nunavut *Wildlife Act* (2003), which prohibit destruction of bird nests when these are being used by birds and prohibits disturbance to flocks of migratory birds. No species of migratory bird occurring in the RSA is listed as a species of conservation concern under the federal SARA. However, three water bird and ten upland bird species occurring in the RSA are listed as Sensitive under the CESCC designations for Nunavut (CESCC, 2010). Aerial surveys for water birds conducted between 2007 and 2013 indicate that Canada geese accounted for 80% to 90% of all detections of water bird species. Several large wetlands, particularly in the southeast portion of the RSA, are used by geese as a migration corridor and as moulting areas. Additionally, a key staging site was identified on the west side of the RSA where large flocks of geese and ducks were consistently observed during both spring and fall staging surveys. Ground-based surveys for upland birds indicated that counts (species and individuals) were highest in survey plots along the shoreline of Bathurst Inlet, relative to elsewhere in the RSA.

Eight raptor species occur in the RSA, and five of these are species of conservation concern. The cliff-nesting peregrine falcon and the ground-nesting short-eared owl are listed as species of Special Concern on Schedule 1 of the federal SARA. Three additional cliff-nesting species—the golden eagle, gyrfalcon, and rough-legged hawk—are listed as Sensitive in Nunavut by CESCC (CESCC, 2010). Ground-based surveys for upland birds confirmed that ground-nesting raptors occur relatively rarely within the wildlife RSA. Thus, baseline studies for raptors were focused on mapping the location of cliff-nesting raptor nests and measuring the productivity of breeding pairs. Aerial surveys of cliffs were conducted between 2002 and 2013 over approximately 80% of the wildlife RSA. A total of 147 raptor nest sites were mapped; nests of the peregrine falcon were the most abundant of all raptor species. Two nest sites occur within the Project development areas, and an additional seven raptor nest sites occur within a 12 km radius of the Project sites (Sabina, 2015).

20.2.3 Freshwater Environment

Hydrology, Water, and Sediment Quality

Baseline hydrology data are available for the Goose Property LSA from 2010 to 2015. Baseline water-quality data have been collected in the Goose LSA from 1994 to date, with extensive baseline water-sampling programs being carried out from 2010 to 2015. Baseline freshwater sediment quality data have been collected in the Goose LSA from 2007 to date, with the most continuous sampling conducted from 2010 to 2015.

Freshwater Fish and Aquatic Habitat

Comprehensive baseline studies on freshwater fish and aquatic habitat have been conducted in the Goose Property LSA from 2010 to 2020 with more than 30 streams having been characterized. Within the Goose LSA, there are permanent barriers to fish migration along the stream between Pond A and Giraffe Lake, and along the stream between Umwelt Lake and Goose Lake. Unavoidable losses of fish habitat will result from the Project (e.g., loss of Llama Lake due to Llama open pit) will be compensated through the implementation of a fish offsetting plan.

The freshwater fish communities in the Goose Property LSA are characteristic of Arctic freshwater ecosystems and include freshwater as well as anadromous species at the MLA. Baseline studies have been conducted from 2010 to 2020 within the LSA. The freshwater fish communities are typical of inland, headwater regions of the Canadian Arctic. Lake trout was the dominant species, followed by round whitefish, Arctic grayling, slimy sculpin, and ninespine stickleback. Other species found within the LSA include burbot and lake whitefish. No Arctic char have been captured within the Goose LSA, although they are likely present within the freshwater RSA.

20.2.4 Marine Environment

The FEIS also contains additional information on the commercial shipping route and key migratory bird nesting areas, and marine mammals, such as seabirds, sea ducks, and ringed seals. A marine diesel fuel spill model was also developed for the Project.

Marine Water and Sediment Quality

Baseline studies show that water in southern Bathurst Inlet is typical of pristine Arctic marine waters, with low concentrations of nutrients, suspended solids, and metals. The sediment environment in Bathurst Inlet is generally a function of water depth and physical processes. Shallower, nearshore areas are subjected to increased erosion and re-suspension due to the interaction of the wind-driven water currents and the seabed. Metal concentrations in marine sediments were strongly correlated to the relative abundance of silt and clay particles, and therefore were generally greater in the deeper waters. Naturally elevated concentrations of arsenic, chromium, and copper were observed in the deeper sediment samples, and were often greater than the CCME sediment-quality guidelines for the protection of aquatic life. Sediment metal concentrations near the MLA were observed to be naturally low, as expected, because of the relative dominance of sand-size particles.

Marine Fish and Aquatic Habitat

Based on nearshore surveys and TK, potentially important habitat areas for marine and anadromous fish were identified in the LSA and RSA. The outlets of some rivers are important habitat for Arctic char. The marine fish community of Bathurst Inlet is characteristic of Arctic marine ecosystems, and includes marine, anadromous, and freshwater/estuarine species. Nineteen fish species typically found in the Arctic have been captured during baseline studies in the marine LSA. Although no Arctic char were captured, they are presumed to occur due to favourable habitat and appropriate spawning streams that flow into the Inlet.

Seabirds and Sea Ducks

Aerial and ground surveys documented a total of 23 species of seabirds in the marine RSA. No evidence of breeding was recorded during breeding surveys in any years. In spring, staging areas appeared to occur in open-water areas and near major river drainages. In late summer and fall, large numbers (>50 birds) of Canada geese and ducks were observed in the shallow bay southwest of the MLA footprint. The greatest abundances of seabirds and sea ducks were observed in late summer and fall.

Ringed Seals

Aerial surveys were conducted during the spring moulting period (mid-May through mid-July) between 2007 and 2013 to assess the abundance and distribution of ringed seals. Results indicated that ringed seal abundance was spatially variable in Bathurst Inlet, with moderate densities present in most parts of the inlet, except in the southern

RSA south of Kingaok, where very low densities of adult and 8- to 10-week-old pups were found. Ringed seal lairs were found only in the northern RSA during surveys; no lairs were observed in the southern RSA or the LSA. During the summer, ringed seal density is anticipated to be very low in Bathurst Inlet.

20.2.5 Human Environment

The closest communities to the Project are Kingaok, approximately 160 km north of the Goose Property, and Omingmaktok, approximately 250 km northeast (Figure 20-4). These are deemed outpost camps by the Government of Nunavut, as they are used only for short periods of the year by a few Inuit. The communities of Kugluktuk and Cambridge Bay are the closest major regional settlements. Kugluktuk and Cambridge Bay are likely sources of workers and contractors. Communities of the Eastern Kitikmeot region are also likely sources of workers and contractors, including Gjoa Haven, Kugaaruk, and Taloyoak. Yellowknife, NWT, and Edmonton, Alberta, are transport hubs and sources for workers, goods, and services.

Source: Sabina, 2020.

Figure 20-4: Location of Nearby Communities Relative to the Project

Non-Traditional Land and Resource Use

Commercial land use consists primarily of sport hunting, tourism, mineral exploration, and transportation and shipping. Seasonal lodges and adventure tourism companies operate throughout the Kitikmeot Region. One is near the community of Bathurst Inlet (the Bathurst Inlet Lodge). Ecotourism activities include boating in Bathurst Inlet, hiking, sightseeing, and culture and nature interpretation.

The only interaction between the Project and non-traditional land and resource use is predicted for ecotourism activities potentially affected by changes in access to land and resources; changes to the experience of the natural environment; and changes to the abundance and distribution of resources.

Subsistence Economy and Land Use

The Inuit culture and way of life are intrinsically connected with the land. The Inuit people of the Kitikmeot have always depended on Inuit Qaujimajatuqangit, or knowledge of the land and environment. Subsistence land use, such as hunting, fishing, trapping, and gathering, take place throughout the land use RSA. Approximately 10 to 20 Inuit continue to hunt in the Bathurst Inlet area.

Archaeological Sites

There are 269 known archaeological sites within the archaeology RSA. Sixty-four are within 1,000 m of the Project sites and the road rights-of-way; they may be affected directly or indirectly by the Project.

20.3 Project Permitting Requirements

Sabina has successfully completed the various permitting steps to proceed to mine development and has obtained all necessary major permits required for initial construction and operation of the Back River Project. A description of the permitting requirements is provided below.

20.3.1 Land Use Planning and Environmental Assessment

The Back River Project falls within the Kitikmeot Region of Nunavut. Within the Nunavut Agreement, management boards were created as Institutes of Public Government responsible for resource management in Nunavut. The Nunavut Planning Commission (NPC) is responsible for developing, implementing, and monitoring land use plans that guide and direct resource use and development in the Nunavut settlement area. Regional land use plans exist for two other regions, but not for the Kitikmeot Region. The NPC is developing a Draft Nunavut Land Use Plan that, once approved, will apply to all of Nunavut.

New and modified mining projects in Nunavut are subject to an Environmental Assessment (EA) and review prior to certification and issuance of permits to authorize construction and operations. The primary environmental review and approval process that applies to the Project is the territorial EA administered by the NIRB. Some federal regulatory requirements and processes that were applicable prior to the NA continue to apply in Nunavut.

Sabina commenced the EA of the Project in June 2012, with submission of the Back River Project Proposal to the NIRB (NIRB File No. 12MN036). Following the completion of a Project Certificate workshop held in December 2017, the NIRB issued the final Project Certificate (PC No. 007) pursuant to Section 12.5.12 of Article 12 of the Nunavut Agreement.

20.3.2 Authorizations, Licences, and Permits

Following completion of the EA Process, and receipt of the Project Certificate from the NIRB, Sabina sought and obtained the major requisite permits and approvals required for mine construction.

Sabina applied for a Type A Water Licence to the Nunavut Water Board (NWB) in October 2017, in accordance with the regulatory framework provided in the Nunavut Agreement, the Nunavut Waters and Nunavut Surface *Rights Tribunal Act*, and Nunavut Water Regulations. A Type A Water Licence 2AM-BRP1831 was issued to Sabina in November 2018 (NWB, 2018).

Sabina anticipates some regulatory engagement to ensure management plans and associated requirements align with changed activities planned within the UFS.

Sabina and the Kitikmeot Inuit Association announced in April 2018 that the parties had finalized terms under a framework agreement setting out rights and obligations with respect to surface land access on Inuit-owned land on the Project; it is a comprehensive milestone agreement that provides long-term certainty of tenure, and benefits, to the Inuit people.

Sabina has also received key additional permits and regulations from other federal parties, namely, CIRNAC, DFO, ECCC, and TC.

On November 25, 2019, Sabina received *Fisheries Act*'s authorization from the DFO to carry out the work at the Back River Project that may result in serious harm to fish. In addition, on 26 June 2020, Sabina received notice of completion of the Schedule 2 process under the Metal and Diamond Mining Effluent Regulations (MDMER) (Government of Canada, 2020).

Sabina has successfully completed the various permitting steps to proceed to mine development and has obtained all necessary major permits required for construction and operation of the Back River Project. A complete list of existing permits and authorizations for the Back River Project is included in Table 20-1.

Table 20-1: Sabina Existing Permit and Authorization Registry

Authorization No.	Expiry (Year-Month-Day)	Agency	Description
PC No. 007	N/A	NIRB	Back River Project NIRB Project Certificate
2AM-BRP1831	2031-12-31	NWB	Back River Type A Water License
N/A	2038-06-31	KIA	Inuit Impact and Benefit Agreement
KTCL-18D001	2038-04-20	KIA	Commercial Lease—Goose
KTCL-18D002	2038-04-20	KIA	Commercial Lease—MLA
KTCL-18D003	2038-04-20	KIA	Commercial Lease—Winter Road
KTAEL-18C001	2023-04-20	KIA	Advanced Exploration Lease—George
LUL-XX	5 years from Effective Date	KIA	Land Use Licence as per KIA Framework Agreement
KTL312C004	2020-04-25	KIA	Wishbone-Malley Exploration Activities (renewal submitted)
N2018F0021	2023-10-29	CIRNAC	CAT Train Beechey Lake Area
N2017F0016	2022-07-20	CIRNAC	CAT Train connecting Bathurst Inlet—Back River Project
N2016C0011	2021-10-26	CIRNAC	Back River Exploration Activities
N2018F0017	2023-10-11	CIRNAC	WIR Back River Project
Lease No. 76J/12-7-2	2048-08-14	CIRNAC	Marine environment land lease—adjacent to MLA
Lease No. 76J/9-1-2	2048-04-26	CIRNAC	Goose Lake Tailings Storage Facility
2BE-GOO2028	2028-02-18	NWB	Goose Water Licence (Type B)
2BE-GEO2025	2025-05-29	NWB	George Water Licence (Type B)
2BE-MLL1722	2022-06-29	NWB	Wishbone-Malley Water Licence (Type B)
2BC-BRP1819	2019-04-30	NWB	Type B Development Works Water Licence (Replaced by Type A)
12-HCAA-CA7-00007	2031-12-31	DFO	*Fisheries Act* Authorization—Back River Project
18-HCAA-00185	N/A	DFO	Letter of Authorization—Gander Culvert
18-HCAA-00971	N/A	DFO	Letter of Authorization—MLA
18-HCAA-01626	N/A	DFO	Letter of Authorization—WIR
12-HCAA-CA7-00007	N/A	DFO	Letter of Authorization—Rascal Stream Diversion
04 009 19R-M	2021-12-31	NRI	Back River Project Scientific Research License
2012-600767-002	N/A	TC	*Navigation Protection Act*—MLA Discharge Pipeline Authorization
2012-600767-003	N/A	TC	*Navigation Protection Act*—MLA Intake Pipeline Authorization
2012-600767-006	N/A	TC	*Navigation Protection Act*—MLA Lightering Barge Authorization
2012-600767-004	N/A	TC	*Navigation Protection Act*—Umwelt Lake Dewatering Authorization
2012-600767-005	N/A	TC	*Navigation Protection Act*—Llama Lake Dewatering Authorization

Source: Sabina, 2020.

20.3.3 Estimated Permitting Costs

The cumulative costs associated with the permitting process (including consulting fees) are estimated to be over $30 million for baseline studies, EIS preparation, consultation, and other permit applications for the development of the Project; virtually all these costs have already been incurred by Sabina.

Ongoing costs associated with maintaining compliance with Back River Project permits and management plans have been included within the Updated Feasibility Study financials; activities include annual atmospheric, terrestrial, freshwater, marine, fisheries, and socioeconomic monitoring and associated analysis and reporting. Costs for permit any modifications or amendments are not included in the Updated Feasibility Study but are anticipated to be low.

20.4 Community-Related Requirements and Agreements

20.4.1 Community Engagement

Sabina used industry and northern best practices to develop its public consultation and engagement program for the Project. Sabina undertook extensive community consultation, as well as ensuring the inclusion of Traditional Knowledge and Inuit Qaujimajatuqangit (holistically called TK) throughout the permitting process and post-permitting. Sabina continues to receive positive feedback on its approach from community and government representatives, regulators, and other Project stakeholders.

Consultation allows for information on a vast range of topics to be provided and discussed with communities. The process creates an open forum for people to ask questions, make comments, or raise concerns on topics of their choosing. During community meetings, Sabina updates and consults with communities on many aspects of the Project including, but not limited to, plans for construction and design, permitting, and Inuit employment and contracting opportunities. Throughout these engagement activities, communities have provided comments and expressed specific interest on several topics.

Questions, comments, and concerns are subsequently addressed and logged under topic headings in a community engagement database. To date, Sabina has generated two such databases. The first is historical, which spans 2012 through 2017 and contains approximately 165 topic headings/directories. Sabina continues to collect and record community consultation information in a second database begun in 2018. These databases are used company-wide during Project planning and execution.

As of November 2020, Sabina had engaged in 218 community meetings on the Project in the Kitikmeot Region. Numbers shown in Figure 20-5 identify the total number of meetings held for each individual community.

Source: Sabina, 2020.

Figure 20-5: Back River Project Community Meetings or Engagements in the Kitikmeot—Up to November 2020

20.4.2 Traditional Knowledge

Sabina recognizes the inherent value of TK and the importance of its use in the assessment of proposed developments. Sabina has made notable efforts to engage local communities through incorporation of their TK and land use information into the Project's planning, design, operation, and closure.

Sabina partnered with the Kitikmeot Inuit Association in two major elements of its TK study: preparation of a Naonaiyaotit Traditional Knowledge Project (NTKP) database report, and execution of theme-based TK workshops. The basis of this partnership was a TK Agreement signed between Sabina and the Kitikmeot Inuit Association. The foundation of this agreement is that regional TK should be collected, owned, and managed by Inuit directly, and not by a specific proponent.

Sabina and the Kitikmeot Inuit Association additionally cooperated in collecting and reporting of new, or otherwise unrecorded, TK in the Project area. Two TK reports were subsequently prepared by the Kitikmeot Inuit Association for Sabina, which Sabina continues to use, and which provide the majority of TK considered in the Project's planning, design, operation, and closure.

Sabina also commissioned a review of publicly available TK from NWT Indigenous groups, as well as a current land use study for the Project area using a series of Kitikmeot Inuit focus groups and interviews. In addition, Sabina and the Kugluktuk Hunters and Trappers Organization (HTO) collected TK information related to the Bernard Harbour Fisheries Offset (see Section 20.3.2). This information was subsequently provided to the Kitikmeot Inuit Association for their future use and entry into the NTKP database.

As a result of these efforts, the following five reports were produced for use:

1. *Inuit Traditional Knowledge of Sabina Gold & Silver Corp.,* Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (Banci & Spicker, 2012).
2. Naonaiyaotit Traditional Knowledge Project—Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project). Results from Data Gaps Workshops, Final Report (Banci & Spicker, 2014).
3. Back River Project: Existing and Publicly Available Traditional Knowledge from Selected Aboriginal Groups in the Northwest Territories (Rescan, 2013).
4. Traditional Knowledge Study Report on the Arctic Char Fishery in the Nulahugyuk Creek–Hingittok Lake Area (Bernard Harbour), Nunavut (Kugluktuk Hunters and Trappers Organization and Sabina Gold & Silver Corporation, 2015).
5. Back River Project: 2012 Socioeconomic and Land Use Baseline Report (Rescan Environmental Services Ltd. 2012).

TK and land use reports are readily available and used by Sabina in all stages of Project planning and development.

20.4.3 Inuit Impact and Benefit Agreement

Sabina and the Kitikmeot Inuit Association finalized an IIBA and long-term land tenure agreements in April 2018. The parties entered into 20-year benefit and land tenure agreements under a framework agreement setting out rights and obligations with respect to surface land access on Inuit-owned land on the Back River Project. Additionally, these agreements provide Inuit of the Kitikmeot Region with financial and socioeconomic benefits, including training, jobs, initiatives to create additional opportunities outside of the mining industry, share ownership in Sabina, and a 1% net smelter royalty on future production from the proposed mine on the Goose property.

These are comprehensive milestone agreements that provide the long-term certainty of tenure required to de-risk, finance, develop and ultimately mine at Back River. The IIBA also commits Sabina to providing various socioeconomic opportunities throughout the Kitikmeot Region, including preferential employment; contracting; the formation and terms of an Inuit Environmental Advisory Committee; training for local Inuit; continued implementation of a Kitikmeot-focused donation policy; and the payment of all applicable taxes and royalties to governing bodies. The IIBA is managed by a joint committee of appointed members from both Sabina and the Kitikmeot Inuit Association, dedicated to ensuring the implementation of the terms contained within.

20.5 Tailings Management (Mined-Out Pits)

20.5.1 General

An estimated 18.7 Mt of tailings of tailings will be generated over the LOM. The tailings will be deposited into three mined-out open pits that have been defined as the Echo TF, Umwelt TF, and Llama TF.

20.5.2 Tailings Management System Design Requirements

Tailings volumes, characteristics, and disposal assumptions are presented in Table 20-2.

Table 20-2: Tailings Characteristics and Pit Tailings Disposal Design Criteria

Component	Criteria	Source
Tailings Production and Storage Requirements		
Tailings Production Rate (Provided by Sabina)	3,000 t/d in Year 1 (with initial ramp-up) 4,000 t/d starting in Year 2 Ramp down starting in Year 14	Provided by Sabina
By Mass By Volume	18.68 Mt 15.57 Mm^3 based on initial density of 1.2 t/m^3)	Calculated
Pit water cover requirements at closure	5 m freshwater	Sabina, 2017
Pit storage capacities, allowing for 5 m closure water cover	Echo: 2.24 Mm^3 Umwelt: 5.18 Mm^3 Llama: 10.48 Mm^3 Goose Main: 16.13 Mm^3	Depth-Area-Capacity Curves developed by Knight Piésold based on Sabina's pit shells
Active Use Period of: Echo TF Umwelt TF Llama TF	 2.25 years 4.5 years (tailings) 8.25 years	Calculated
Tailings Characteristics		
Tailing Slurry Content	Thickened tailings: 65% solids by weight	Provided by Sabina
Tailings Plasticity	Non-plastic	JDS, 2015b, Pocock, 2018
Tailings Grind Size	P_{80}: 50 µm	SDE, 2021
Tailings Solids Specific Gravity	3.06	SDE, 2021
Tailings Settled Density	1.6 to 1.7 t/m^3 (1.65 t/m^3)	SRK, 2015c; Pocock, 2018
Tailings Deposition		
Deposition Method	Sub-aqueous; an initial operating pond will be established to facilitate sub-aqueous disposal	Knight Piésold
Assumed Ice Entrainment Allowance as a Percentage of Tailings Capacity	0%	Knight Piésold
Tailings Beach Slope	3% subaqueous, 1% subaerial	Estimate by SRK
Tailings Deposition Method	Single-point spigot subaerial discharge (up to 9 spigot locations per TF over the LOM)	Provided by SRK

Source: Knight Piésold, 2021.

20.5.3 In-pit Tailings Disposal

The Echo TF will receive tailings for the first 2.25 years (Years 1 to 3.25), followed by 4.5 years of deposition to the Umwelt TF (Years 3.25 to 7.75), and 8.25 years of deposition in Llama TF (Years 7.75 to 15).

Overlapping with tailings disposal in the Llama TF, brine will be deposited in the Llama TF from about Year 5.5 through 12. In Year 13, the accumulated brine and tailings supernatant mixture will be removed from the Llama TF to the mined-out Goose Main pit. Removal of the saline water from the Llama TF will provide TS capacity for the final two years of operations.

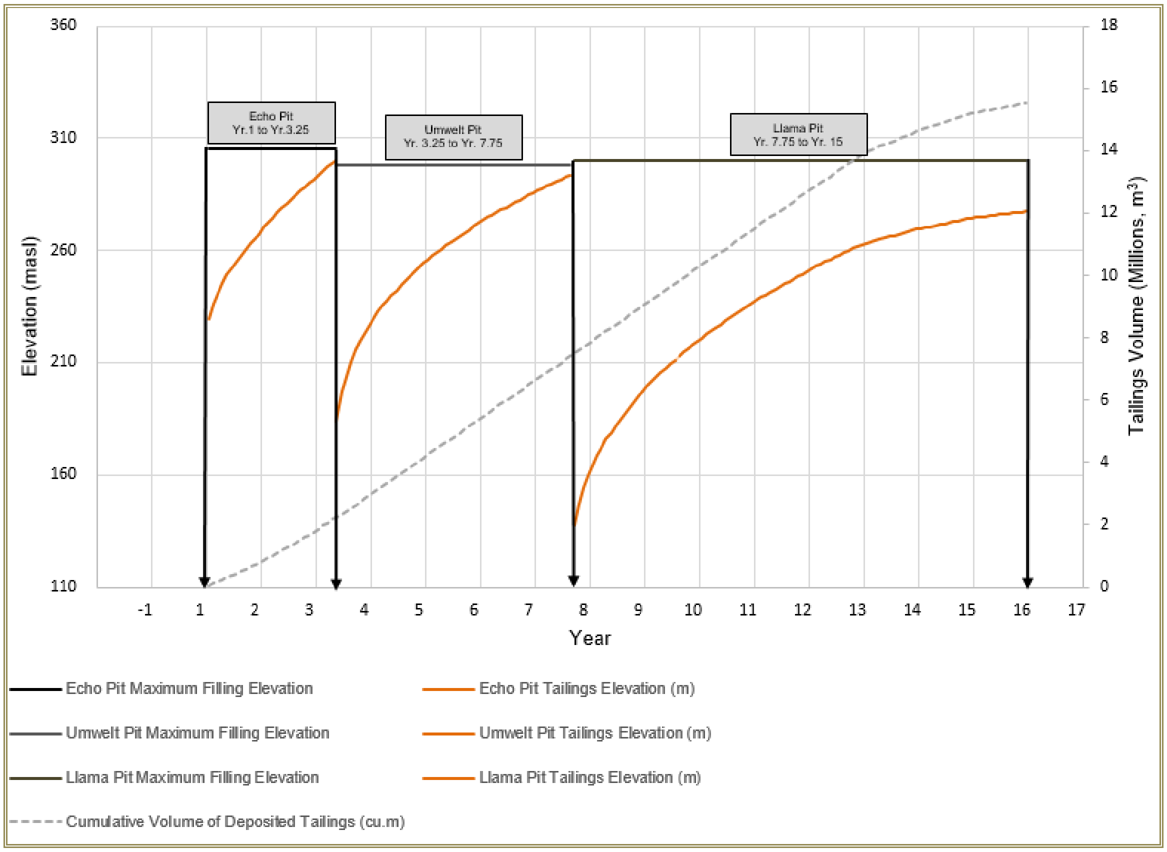
The tailings deposition schedule is summarized in Table 20-3 and on Figure 20-6. The filling of the TFs is based on the initial tailings density of 1.2 t/m^3, and does not reflect consolidation, a conservative assumption in terms of ensuring sufficient room is available for TS.

The current mine plan does not require that Goose Main pit be used for tailings disposal. Mining of this pit is completed by the end of Q3 of Year 12 and will have a capacity of 16.13 Mm^3, excluding the volume associated with a 5 m closure water cover. About a third of the volume of the Goose Main pit will be used as the repository for about 5 Mm^3 of saline water and brine, as discussed further in Section 20.6.9. Goose Main pit could provide for storage of additional tailings and/or saline water if needed.

Table 20-3: Tailings Deposition Schedule

Location	Period (Quarter and Year)	Tailings (Mt)	Tailings (Mm^3)
Echo TF	Q1 Year 1 to Q1 Year 3	2.67	2.22
Umwelt TF	Q2 Year 3 to Q3 Year 7	6.27	5.23
Llama TF	Q4 Year 7 to Q4 Year 15	9.77	8.14
Total Project	Q1 Year 1 to Q4 Year 15	**18.71**	**15.59**

Source: Knight Piésold, 2021.



Source: Knight Piésold, 2021.

Figure 20-6: Tailings Pit Filling Schedule

20.5.4 Tailings Geochemical Considerations

Based on two phases of geochemical testing, all tailings are considered PAG. Humidity cell testing was completed at both room temperature and under refrigerated conditions. It should be noted that the sample under room temperature became acidic in a short time, whereas the refrigerated sample remained neutral for nearly 400 weeks. The refrigerated sample does not consider the effects of freeze/thaw cycles that may take place at site. It is possible that the on-site conditions may further delay the onset of ARD because of the colder ambient temperatures. Regardless of pH, the tailings samples that underwent humidity cell testing demonstrated elevated concentrations of sulphate and arsenic in the leachate. Concentrations of cadmium, cobalt, nickel, and zinc in the leachate increased in response to decreasing pH conditions that occurred in the master composite sample. These findings suggest that the tailings will need to be managed to prevent metal-leaching and acid-rock drainage. As such, open pits used as TFs will be flooded with water (Llama and Umwelt TFs) or covered with waste rock at closure (Echo TF), which will limit acidic conditions from developing (Section 20.7.6). The closure of Echo and Umwelt TFs will occur during operations, as part of ongoing reclamation during the mine life (i.e., progressive reclamation).

The onset to ARD and aggressiveness of the acidification was variable, dependent on the deposit. Based on the test data to date, the most aggressive tailings are likely to be generated from the Umwelt deposit, which will be initially deposited in the Echo TF. As such, these tailings will remain saturated following deposition to minimize the potential for acidification and metal leaching from the materials into the receiving environment.

20.5.5 Tailings Management Systems Operations

A key aspect of the tailings deposition strategy is to deposit tailings sub-aqueously to minimize ice entrainment and thereby maximize the available storage. To accomplish this, an initial operating pond will be established in each TF with sufficient fresh water to ensure that a 5 m water cover (approximately a 3 m water column under 2 m of ice) is maintained during pit filling. Tailings will be deposited in the open pits (tailings facilities) by running the tailings delivery pipeline down the pit access road/ramp.

Tailings will be discharged initially from one point, increasing to four discharge points by the end of the first year of tailings deposition. As tailings start to fill the pit, up to nine discharge points may be required (or constant move of four points) within each of the TFs to maximize use of the available in-pit storage capacity. Discharge locations will be rotated during operations to develop a relatively flat (i.e., horizontal) tailings surface within each of the TFs.

The Echo TF will be filled to within 5 m of its spillover elevation by about Year 3.25. A sufficient water cover will be in place during and following tailings deposition. Starting in Year 4, the water cover in the Echo TF will be pumped to the Echo WSRA Pond and then waste rock from the Goose Main Pit (will be carefully placed within the pit and over the surrounding Echo WRSA. A detailed waste rock placement procedure that outlines safe deposition of waste rock in the flooded Echo Pit will be developed and followed. This is discussed further in Section 18.2.9. Then NPAG waste rock will be placed to encapsulate the Echo TF and WRSA.

The Umwelt TF will be filled to within 5 m of its spillover elevation by about Year 7.75. The Umwelt TF will continue to receive contact water from other mining areas and WRSAs and will operate as a source of reclaim water until the end of Year 15.

Tailings will be deposited in the Llama TF from Year 7.75 until the end of Year 15 (when gold production ends), with tailings ultimately reaching a maximum filling level of El. 277 m, compared to the spillover elevation of El. 300 m. Starting in Year 5.5 and prior to beginning tailings deposition, the Llama TF will be used to store brine (Section 20.6.9). Tailings will therefore be deposited sub-aqueously in the brine until early in Year 13, when the accumulated mixture of brine and tailings supernatant will be transferred to the Goose Main pit, along with saline water that continues to be generated in the Umwelt underground. Due to the presence of brine, it is unlikely that the Llama TF will not be used as a source of reclaim, at least not until the brine/supernatant mixture has been transferred to the Goose Main pit. Tailings will continue to be deposited into the Llama pit during the last three years of mining (Years 13 to 15). If the supernatant in the Llama TF contains unacceptable levels of chloride following transfer of the brine to Goose Main pit, it can be directed to the RO plant for treatment prior to release to the environment.

Additional detail regarding closure of the TFs/pits is provided in Section 20.7.6.

20.6 Water Management

20.6.1 Water Management Overview and Strategy

Three types of water will be managed at the Goose Property as follows:

- Contact water—surface water runoff that contacts disturbed areas. This includes runoff from WRSAs, ore stockpiles, open pits, and infrastructure rock-fill pads; contact water will be reclaimed for use in the mill.
- Saline water—groundwater inflows from underground developments that extend below the basement permafrost and open pit mining where a talik zone is present.
- Non-contact water—all other surface runoff that does not contact disturbed areas.

Contact water will be used to meet process water requirements to the extent possible, so that make-up water withdrawals from Goose Lake are minimized. The handling of contact water is also influenced by tailings disposal plans and the suitability of the water for discharge to the environment.

Non-contact water diversions will be constructed to minimize the volume of contact water on site.

The volume of saline water requiring temporary storage on surface will be reduced using RO so that it is less than the available storage, until the final repository (Goose Main pit) becomes available.

Previous mine plans and corresponding water and load balances completed for the Project (SRK, 2015a, 2020) did not require contact water to be discharged during the construction or operation phases. Under the current mine plan, mining of two open pits during the construction phase without concurrent processing (which consumes reclaim water) or a surface tailings impoundment (that can provide temporary storage). Hence, excess contact water from the open pits and WRSAs will require discharge to the environment during the construction phase.

During operations, RO treatment of the saline water will generate a significant surplus of freshwater. As a result, the discharge of contact water will be required in most years during the operation phase.

20.6.2 Project Water Requirements

The Project's process water requirements for the 3,000 t/d and 4,000 t/d production rates are outlined in Table 20-4.

Table 20-4: Process Water Requirements

Production Rate (t/d)	Reclaim Water (m^3/d)	Make-up Water (m^3/d)	Total (m^3/d)
3,000	1,296	562	1,858
4,000	1,560	826	2,386

Source: SDE, 2020a, 2020b.

Table 20-5 presents the maximum daily and annual water withdrawal rates and volumes to be withdrawn from Goose Lake in accordance with an October 2020 application Sabina submitted to the NWB.

Table 20-5: Proposed Freshwater Supply from Goose Lake

Season	Domestic Use m^3/d)	Process Make-up Water m^3/d)	Maximum Water Volumes m^3/d)
Winter	250	1,250	1,500
Summer	250	1,650	1,900
Annual	-	-	608,700

Source: SDE, 2020a, 2020b.

20.6.3 Water Balance Approach

An Excel-based annual water balance was developed for the Goose Property to establish water management plans for construction, operation, and closure phases of the mine.

The annual operational water balance model is based on mass balance principles, available hydrology inputs, mining and production schedules, and developed water management plans, with consideration of geochemistry data and a previous water quality model. The water balance tracks all inputs, outflows, and available storage at the site. The water balance can be represented in a simplistic form as follows:

$$Water\ Storage = Water\ Input - Water\ Output \quad \text{(eq. 1)}$$

Water inputs to the site include:

- Saline groundwater from the Llama pit, which is in a through talik
- Groundwater from underground mines that extend beneath the basement permafrost and intersect saline groundwater (Llama, Umwelt and Goose)
- Precipitation (direct precipitation on ponds/lakes, and runoff).

The primary water storage locations available at the Goose Property include:

- Open pits
- Underground mine workings (following mining)
- Tailings void space.

Water outputs from the Goose Property include:

- Discharge, such as treated effluent and contact water ponds
- Pit overflow to downstream receptors
- Evaporation
- Seepage.

In general terms, runoff and direct precipitation on ponded areas can be represented as follows:

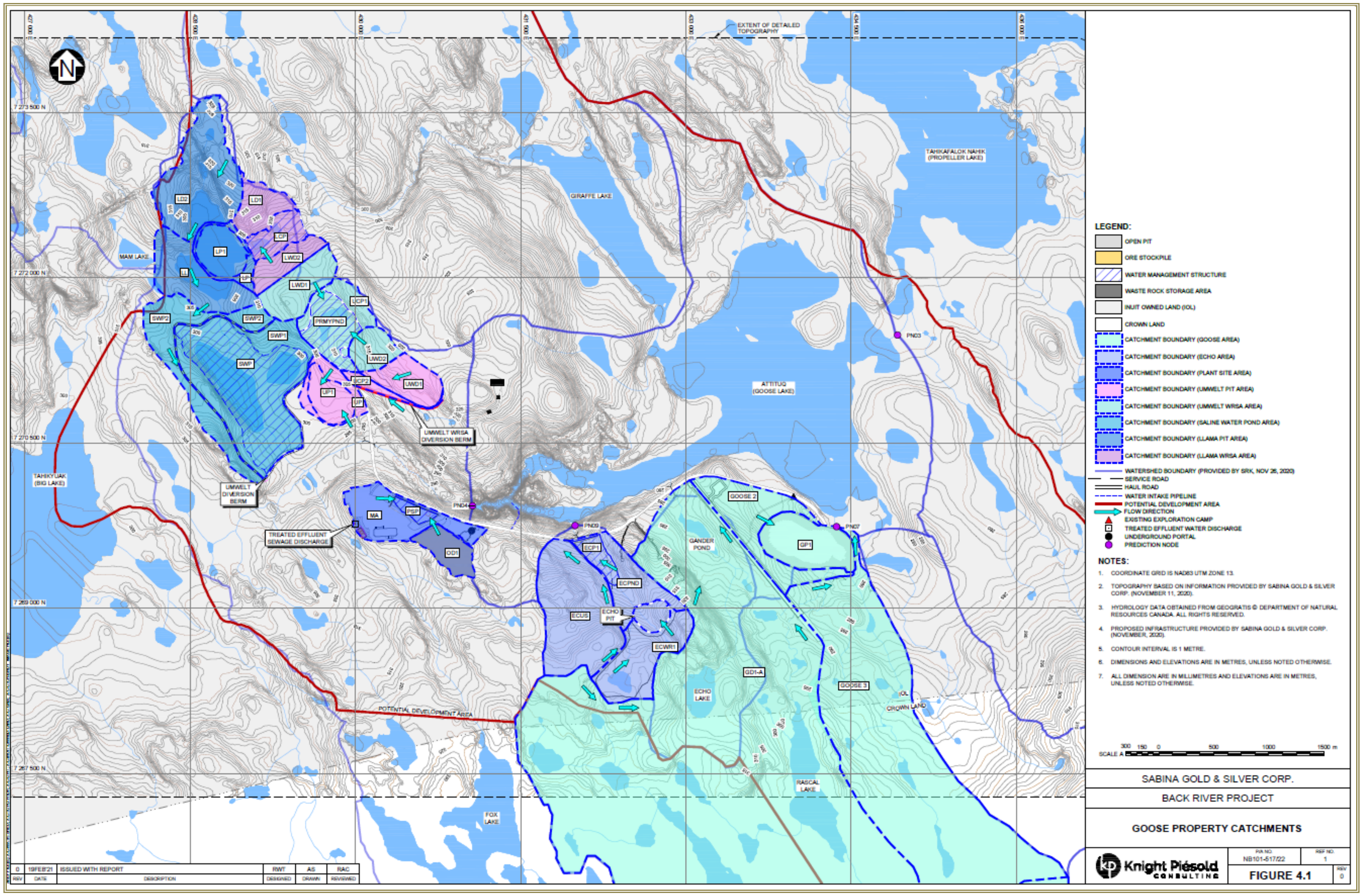
$$Surface\ Runoff = Area \times Precipitation \times Runoff\ Coefficient \quad \text{(eq. 2)}$$

$$Direct\ Precipitation\ Rate = Pond\ Area \times Precipitation\ Release\ Rate \quad \text{(eq. 3)}$$

The runoff coefficient accounts for losses such as evaporation and infiltration.

The modelling of the WRSAs was simplified in the water balance. A runoff coefficient was applied to estimate the net total runoff at the toe of a WRSA. This runoff coefficient accounts for all losses such as evaporation, seepage to the groundwater table, and loss of storage in the waste rock voids. As such, runoff from a waste rock surface area was evaluated using Equation 2.

Project catchment areas and effluent discharge locations (to be used only during active closure) are shown on Figure 20-7.



Source: Knight Piésold, 2021.

Figure 20-7: Goose Property Catchments and Effluent Discharge Locations

20.6.4 Water Quality Considerations

Based on geochemical evaluations undertaken for the Goose Property (Rescan, 2014; SRK, 2015a; 2015d), source term predictions were undertaken for contact water from the following Project components (SRK, 2015a; 2020):

- Ore stockpile
- Tailings beach
- WRSAs
- Pit walls
- Pit high walls (applicable post-closure).

Source terms are derived based on hydrologic inputs and waste tonnages, which include catchment areas, runoff coefficients and infiltration rates, as well as total mass of material in each facility. Source terms developed by SRK (2015a, 2020) were for dissolved metal concentrations and do not account for additional loadings that may result from total suspended sediments, or for nutrient loadings. Additionally, they do not account for subsequent changes to the waste rock mass that have occurred with the latest mine plan. For this reason, they are considered indicative only.

The source terms developed for both these other mine plans showed that the source terms for the tailings beach will exceed MDMER Schedule 4 discharge limits for arsenic (both 2015 and 2020 mine plans) and copper (2020 mine plan). This was a factor in deciding to permanently submerge the tailings with a 5 m water cover or waste rock cover.

The source terms developed for contact water from the ore stockpile, waste rock, pit walls and pit high walls were below the applicable MDMER Schedule 4 discharge limits.

Water quality models were developed for the same previous Project configurations (SRK, 2015d, 2020). Water quality was predicted in all open pits, tailings, WRSAs, and receiving water downstream of the Goose Property. Parameters of concern included: ammonia, chloride, sulphate, arsenic, and copper. There are two main sources of ammonia at the Project: AN used for blasting, and the sodium cyanide used in the leach circuit.

These previous mine plans did not involve contact water discharges during the construction and operation phases. The contact water arising from the ore stockpile, WRSAs, and pit walls is expected to meet applicable discharge limits (SRK, 2015d), time-series water-quality modelling (SRK, 2020) indicated that reclaiming this water for use in process will result in the build-up of parameters of concern within the open pits and pit TFs during operations.

SRK (2020) provided long-term steady-state water-quality predictions for open pit and TF overflows at several prediction nodes, the following being most applicable to the current mine plan (Figure 20-7):

- Prediction Node PN04—Located at the neck of Goose Lake, downstream of the Llama TF and Umwelt TF
- Prediction Node PN07—Located at the outlet of the flooded Goose Main pit.

Prediction Node PN04 is where runoff from the Llama TF and Umwelt TF would report to at closure under the previous mine plan. Modelling at PN04 predicted that ammonia would concentrate in contact water in the Llama reservoir over time, exceeding the discharge limit. Arsenic and copper would become elevated at PN04 over time but would not exceed MDMER discharge limits. However, discharge of this effluent at PN04 at closure would result in arsenic approaching, and copper exceeding site-specific water-quality objectives (SSWQOs) at the outflow of Goose Lake into Propellor Lake (Prediction Node PN03). SRK (2020) recommended that water in the Llama reservoir be treated for ammonia, arsenic, and copper starting in Year 6. This conclusion is expected to remain valid for reclaim water in the Umwelt TF under the current mine plan. With treatment of reclaim water during operations, water treatment during the closure phase is unlikely to be required. The Project's water treatment requirements are described further in Section 20.6.10.

Water quality modelling was also completed at the Goose Main pit/reservoir through the LOM. Modelling indicates that arsenic will approach but not exceed the MDMER discharge limit at PN07 (Goose Main pit outflow) while the pit is being mined (i.e., contact water pumped from the active pit will approach the MDMER limit for arsenic). In the current mine plan, water reporting to the Goose Main pit during mining (in Years 3.5 to 12) is likely to also be similarly elevated in arsenic. This contact water will be pumped to the Umwelt TF while mining of Goose Main pit is underway. This water will therefore be treated as part of reclaim water treatment.

The previously modelled mine plan involved the passive filling of the Goose Main pit following mining in Year 8. The predicted resultant water quality in the pit included low concentrations of ammonia, arsenic, and copper such that the water that would eventually discharge from the Goose Main reservoir would meet discharge limits without treatment. The current mine plan involves the transfer of about 5 Mm3 of brine/tailings supernatant from the Llama TF in Year 12, followed by passive flooding of the remainder of the Goose Main pit during the active closure phase (TS volume of 16.13 Mm3, total volume to be flooded of 17.2 Mm3). Because the saline water is denser and is deposited into the mined-out pit first, it is expected to remain at the bottom and not meaningfully impact the quality of the freshwater portion of the reservoir located above. As such, the water that will eventually discharge from the Goose Main reservoir under the current mine plan is also expected to meet discharge limits without treatment.

These previous mine plans did not involve contact water discharges during the construction and operation phases. While contact water arising from the ore stockpile, WRSAs, and pit walls is expected to meet applicable discharge limits (SRK, 2015d), time-series water-quality modelling (SRK, 2020) indicated that reclaiming this water for use in process will result in the build-up of parameters of concern within the open pits and pit TFs during operations.

SRK (2020) provided long-term steady-state water-quality predictions based on previous and different mine plans, for open pit and TF overflows at several prediction nodes, the following being most applicable to the current mine plan (Figure 20-7):

- Prediction Node PN04—Located at the neck of Goose Lake, downstream of the Llama TF and Umwelt TF
- Prediction Node PN07—Located at the outlet of the flooded Goose Main pit.

Prediction Node PN04 is where runoff from the Llama TF and Umwelt TF would report to at closure under the previous mine plan. Modelling at PN04 predicted that ammonia would concentrate in contact water in the Llama reservoir over time, exceeding the discharge limit. Arsenic and copper would become elevated at PN04 over time but would not exceed MDMER discharge limits. However, discharge of this effluent at PN04 at closure would result in arsenic approaching, and copper exceeding site-specific water-quality objectives (SSWQOs) at the outflow of

Goose Lake into Propellor Lake (Prediction Node PN03). SRK (2020) recommended that water in the Llama reservoir be treated for ammonia, arsenic, and copper starting in Year 6. This conclusion is expected to remain valid for reclaim water in the Umwelt TF under the current mine plan. With treatment of reclaim water during operations, water treatment during the closure phase is unlikely to be required. The Project's water treatment requirements are described further in Section 20.6.10.

Water quality modelling was also completed at the Goose Main pit/reservoir through the LOM. Modelling indicates that arsenic will approach but not exceed the MDMER discharge limit at PN07 (Goose Main pit outflow) while the pit is being mined (i.e., contact water pumped from the active pit will approach the MDMER limit for arsenic). In the current mine plan, water reporting to the Goose Main pit during mining (in Years 3.5 to 12) is likely to also be similarly elevated in arsenic. This contact water will be pumped to the Umwelt TF while mining of Goose Main pit is underway. This water will therefore be treated as part of reclaim water treatment.

The previously modelled mine plan involved the passive filling of the Goose Main pit following mining in Year 8. The predicted resultant water quality in the pit included low concentrations of ammonia, arsenic, and copper such that the water that would eventually discharge from the Goose Main reservoir would meet discharge limits without treatment. The current mine plan involves the transfer of about 5 Mm^3 of brine/tailings supernatant from the Llama TF in Year 12, followed by passive flooding of the remainder of the Goose Main pit during the active closure phase (TS volume of 16.13 Mm^3, total volume to be flooded of 17.2 Mm^3). Because the saline water is denser and is deposited into the mined-out pit first, it is expected to remain at the bottom and not meaningfully impact the quality of the freshwater portion of the reservoir located above. As such, the water that will eventually discharge from the Goose Main reservoir under the current mine plan is also expected to meet discharge limits without treatment.

20.6.5 Water Management Facilities

Water management facilities associated with the Goose Property will include the following:

- A freshwater intake in Goose Lake, related pipelines and the water treatment plant
- A primary pond for the storage of water for process and collection of runoff from WRSAs
- A saline water pond (SWP) for the temporary storage of saline water and brine from the RO plant
- An ultra-high recovery RO plant including pre-treatment and subsequent polishing to reduce the volume of saline water to be managed temporarily at surface
- Event ponds at the WRSAs and plant site
- Freshwater diversions intended to minimize the volume of contact water requiring management
- Stream diversions to temporarily redirect flows around mining areas
- Sumps within the pits and in low areas outside of the Llama pit diversion berms
- Barges, temporary intakes, and pipelines associated with lake dewatering (Llama and Umwelt Lakes) and reclaiming water from the primary pond and TFs
- A water treatment system in the process plant to treat elevated concentrations of ammonia, arsenic, and copper in reclaim water in Years 3 through 15 (Section 20.6.10)
- Local management of site runoff from development areas during active construction.

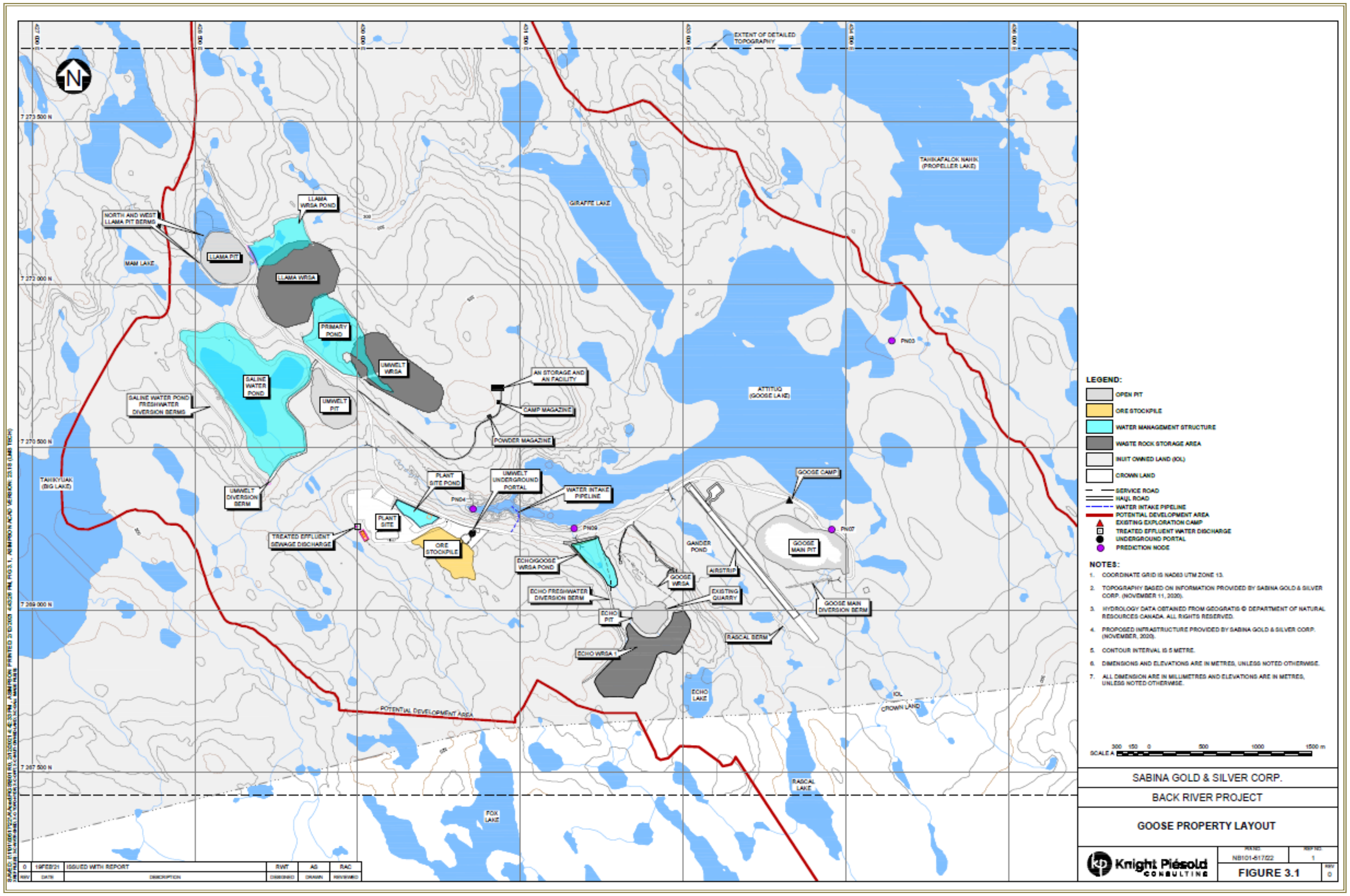
The key water management structures are listed in Table 20-6 and are shown on Figure 20-8. Design details are provided in Section 18.

Table 20-6: Goose Site Water Management Facilities

Facility/ Structure(s)	Catchment ID	Catchment Area (hectares)	Capacity (m^3)	Description
Contact Water Ponds				
Plant Site Pond	PSP OD1 MA	3.95 14.82 35.23	49,800	Constructed in Year −3 and operated for LOM. Receives runoff from the process plant area and ore stockpile. Provides emergency containment for the process plant. Operated as an event pond (kept empty), with the contents discharged to the environment during construction, and pumped to either the primary pond or the Umwelt TF during operations.
Primary Pond	PRMYPND LWD1 UCP1 UWD2	23.49 24.59 11.59 13.67	316,650	Constructed in Year −2 and operated for LOM. Receives runoff from the south portion of the Llama WRSA pond and from the Umwelt WRSA through the LOM. Water will be used in processing when available. Will operate at low capacity throughout the LOM.
Llama WRSA Pond	LCP LWD2 LD1	17.83 14.67 17.37	26,000	Constructed in Year −1 ahead of pre-stripping at Llama Pit in Year 1 and operated for LOM. Receives runoff from the north portion of the Llama WRSA; pumped to the primary pond for subsequent use as reclaim.
Echo/Goose WRSA Pond	ECP1 ECPND ECUS	8.08 23.91 70.85	65,100	Constructed in Year -3 ahead of mining of Echo Pit in Year -2. Receives runoff from the Echo WRSA and pit starting in Year -2 and then the Goose WRSA starting in Year 4. Operated as an event pond (kept empty). Closed out once Goose WRSA has been capped with NPAG and contact water consistently meets discharge limits.
Saline Water Storage				
SWP	SWP SWP1 SWP2 LD2 LL	83.32 28.98 43.77 62.22 35.99	1.79 M	Umwelt Diversion Berm constructed in Year −1 along with lined freshwater diversion berms. Operated for LOM. Receives saline groundwater from Llama UG and pit in Year 1 and brine in Years 2 to 5. By the end of Year 5 it will be necessary to transfer some of the pond's contents to the Umwelt TF. The pond will be emptied in Year 14 to the Goose Main pit and will be decommissioned in Year 15.
Llama TF	LP LP1 LD2	6.89 17.15 62.22	10.5 M (excluding tailings)	Receives brine from Years 6 to 12. Also receives tailings from Years 7.75 to 15. Brine will be transferred to Goose Main pit in Year 13.
Goose Pit	GP GP1 Goose2 Goose3 GD1-A	6.21 27.88 44.60 279.79 3415.69	16.13 M	Final repository for saline water and brine. Will receive saline water from Umwelt UG in Years 13–15, brine from the Umwelt TF in Year 13, and brine from the SWP in Year 14. Will be passively filled with freshwater in Years 15–17 by breaching the Goose Main diversion berm and redirecting 70% of the Rascal Lake catchment to the pit.
Freshwater Diversions				
Echo WRSA Diversion Berm	ECUS	70.85	n/a	Diverts (or partially diverts) freshwater away from the Echo/Goose WRSA Pond.
Umwelt WRSA Diversion Berm	UWD1 UCP2	19.62 5.18	n/a	Diverts (or partially diverts) contact water from the south portion of the Umwelt WRSA to the Umwelt pit.
Llama WRSA Diversion Berm	LD1 LD2 LL	17.37 62.22 36.0	n/a	Diverts non-contact runoff away from the Llama WRSA pond and Llama Open Pit/TF.

Facility/ Structure(s)	Catchment ID	Catchment Area (hectares)	Capacity (m^3)	Description
SWP Freshwater Diversion Berms	LD1 LD2 LL SWP1	17.37 62.22 36.0 28.98	n/a	Diverts freshwater around the SWP.
Goose Main Diversion Berm	Goose 2 Goose 3	44.60 279.79	n/a	Diverts non-contact runoff around Goose Main pit.
Stream Diversions				
Goose Inflow East	Goose 3	279.79	n/a	At the downstream limit where the stream enters Goose Lake.
Rascal Lake Diversion Berm	GD1-A	3,415.69	n/a	Redirects flow in the Rascal Lake catchment away from the Goose Main pit and into the Gander Pond catchment.
Pit Sumps				
Echo Pit Sump	Echo Pit ECWR1	7.16 37.84	n/a	Localized sumps in the pits will collect precipitation and runoff (and for Llama pit, saline groundwater). Water that accumulates in the Echo pit sump will be discharged to the Echo WRSA pond; the sump in the Llama pit (saline water) will be sent to the SWP or RO plant; water in the Umwelt pit will be discharged to the primary pond; water in the Goose sump will be pumped to the Umwelt TF.
Umwelt Pit Sump	UP UP1	10.17 14.86	n/a	
Llama Pit Sump	LP1 LL LP LD2	17.15 35.98 6.89 62.22	n/a	
Goose Main Pit Sump	GP1 GP Goose 2 Goose 3 GD1-A	27.88 6.21 44.60 279.79 3228.8	n/a	

Source: Knight Piésold, 2021.



Source: Knight Piésold, 2021.

Figure 20-8: Goose Property Water Management Facilities

20.6.6 Water Management in Relation to the Mine Development Plan

Table 20-7 presents the water management activities that will occur over the LOM in relation to the mine development plan.

Table 20-7: Water Management Relative to the Mine Development Plan

Mine Year(s)	Mining Activities	Key Water Management Activities
Construction		
−3	Main Construction activities begin, including: • Goose plant site and camp area	Construction of water management facilities: • Water intake infrastructure at Goose Lake • Plant site pond • Echo WRSA pond Active water management features: • Plant site pond
−2	Construction activities continue, including: • Process plant • All-weather roads including water crossings Mining: • Echo pit (starts in Q1) • Umwelt pit (starts in Q2) • Ore is stockpiled at plant site	Construction of water management facilities: • Water discharge infrastructure at Umwelt and Llama Lake to prepare for lake dewatering activities • Primary pond • Plant Site Pond – discharges to the local environment • Echo Pit and WRSA Pond – discharges to the local environment • Umwelt pit—pit water pumped to primary pond • Primary pond (no discharge)
−1	• Construction of process plant • Echo pit (finishes Q4) • Umwelt pit • Umwelt UG (decline begins in Q3) • Llama UG (declines begins in Q4) • Ore is stockpiled at plant site	• Plant Site Pond – discharges to the local environment • Echo Pit and WRSA Pond – discharges to the local environment • Umwelt Pit – pit water pumped to Primary Pond • Primary Pond (no discharge) • Llama Lake and Umwelt Lake dewatering to Goose Lake
Operations		
1	• Construction of SWP • Umwelt Pit (finishes Q4) • Llama Pit (pre-stripping begins in Q2) • Umwelt UG (decline preparation transitions to ore production in Q4) • Llama UG (ore production begins in Q3) • Milling operations begin (water from Primary Pond) • Tailings deposition in the Echo TF	• Plant site pond—discharges to the local environment • Echo WRSA pond—pumped to Echo TF • Echo TF—source of reclaim water • Primary pond—source of reclaim water • SWP receiving saline water from Llama UG and Llama pit
2	• Llama Pit • Umwelt UG • Llama UG • Mill processes ore from active mining areas	• Plant site pond—discharges to the local environment • Echo WRSA pond—pumped to Echo TF • Echo TF—source of reclaim water • Primary pond—source of reclaim water

Mine Year(s)	Mining Activities	Key Water Management Activities
	Tailings deposition in the Echo TF	• Saline water from mining areas treated by RO plant • Brine reports to SWP and freshwater to Umwelt TF • Umwelt TF accumulates water but is not used as a source of reclaim water until Year 3
3	• Llama pit • Umwelt UG • Llama UG • Goose Main pit (mining begins in Q3) • Mill processes ore from active mining areas • Tailings deposition transitions from the Echo TF to the Umwelt TF at the end of Q1	• Plant site pond – pumped to Umwelt TF • Echo WRSA pond—pumped to Umwelt TF • Echo TF—source of reclaim water • Llama WRSA pond—discharges to the primary pond • Primary pond—source of reclaim water • Saline water from mining areas treated by RO plant • Brine reports to SWP and freshwater to Umwelt TF
4	• Llama pit • Umwelt UG • Llama UG • Goose Main pit • Mill processes ore from active mining areas • Tailings deposition in the Umwelt TF • Waste rock from Goose Main pit is deposited over the Echo pit and WRSA, becoming the Goose WRSA	• Plant site pond – pumped to Umwelt TF • Goose (formerly Echo) WRSA pond—pumped to Umwelt TF • Goose Main pit—pumped to Umwelt TF • Umwelt TF—source of reclaim water • Llama WRSA pond—discharges to the primary pond • Primary pond—source of reclaim water • Saline water from mining areas treated by RO plant • Brine reports to SWP and freshwater to Umwelt TF
5	• Llama Pit (finishes at the end of Q2) • Goose Main Pit • Umwelt UG • Llama UG • Mill processes ore from active mining areas • Tailings deposition in the Umwelt TF	• Plant site pond – pumped to Umwelt TF • Goose WRSA pond—pumped to Umwelt TF • Goose Main pit—pumped to Umwelt TF • Umwelt TF—source of reclaim water • Llama WRSA pond—discharges to the primary pond • Primary pond—source of reclaim water • Saline water from mining areas treated by RO plant • Brine reports to SWP and freshwater to Umwelt TF
6–11	• Goose Main Pit • Umwelt UG • Llama UG (finishes in Q1 Year 6) • Goose UG (pre-stripping through Year 6, mining begins in Q3 Year 7 and finishes Q4 Year 11) • Mill processes ore from active mining areas • Tailings deposition transitions from the Umwelt TF to the Llama TF in Q4 Year 7	• Plant Site pond—pumped to Umwelt TF • Goose WRSA pond—pumped to Umwelt TF • Goose Main pit—pumped to Umwelt TF • Umwelt TF—source of reclaim water • Llama WRSA pond—discharges to the primary pond • Primary pond—source of reclaim water • Saline water from mining areas treated by RO plant • Brine reports to Llama TF and freshwater to Umwelt TF
12	As in Years 6 through 11 except: • Goose Main Pit finishes in Q3 Year 12	Water management unchanged from Years 6 to 11 except: • Pumping of brine in Llama TF to Goose Main pit can begin
13	• Umwelt UG • Echo UG (decline preparation begins in Q2, mining begins in Q4)	• Plant site pond – pumped to Umwelt TF • Goose WRSA pond—pumped to Umwelt TF • Llama WRSA pond—discharges to the primary pond

Mine Year(s)	Mining Activities	Key Water Management Activities
	• Mill processes ore from active mining areas • Tailings deposition in the Llama TF	• Umwelt TF—source of reclaim water • Primary pond—source of reclaim water • Saline water from mining areas treated by RO plant • Brine reports to Goose Main pit and freshwater to Umwelt TF • Saline water in Umwelt UG pumped to Goose Main pit • Pumping of brine in Llama TF to Goose Main pit finishes
14–15	As in Year 13 except: • Mining concludes in Echo UG and Umwelt UG in Q4 Year 15 • Mill production rate declines • Stockpiled ore has been processed by Q4 of Year 15	• Plant site pond – pumped to Umwelt TF • Goose WRSA (previously Echo WRSA) pond—pumped to Umwelt TF • Umwelt TF—receives contact water from other ponds and allowed to fill • Llama WRSA pond—discharges to the primary pond • Primary pond—source of reclaim water • Saline water in Umwelt UG pumped to Goose Main pit • Brine in SWP pumped to Goose Main pit • The Goose Main pit diversion berm is breached late in Year 15, and up to 70% of the Rascal Lake catchment is redirected to the Goose Main pit
Active Closure		
16–17	• Decommission remaining infrastructure • Open pits / TFs equipped with armoured spillways and are allowed to overtop and discharge to the environment once monitoring confirms discharge limits have been achieved • Monitoring to ensure compliance with regulatory requirements	• SWP is decommissioned • Active filling of Llama TF in Years 16 and 17 • Goose Main pit has passively filled by the end of Year 17 • Subject to runoff meeting discharge limits, ponds are removed and WRSAs and pits can passively runoff/spillover
Passive Closure and Post-Closure		
18–22+	Monitoring to ensure compliance with regulatory requirements	• No active water management underway • Llama TF has passively filled in Year 18

Key aspects of water management (lake dewatering, contact water management and saline water management) are described below.

20.6.7 Lake Dewatering During Construction

Llama Lake (natural capacity of 0.96 Mm^3) will be dewatered to Goose Lake in the open water season of Year −1 in advance of open pit mining. It is assumed that 50% of the lake water volume will be suitable for direct discharge to Goose Lake via Umwelt Lake. The remaining 50% is assumed to have total suspended solids (TSS) concentrations above the discharge limit and will be treated in a modular water treatment plant. Effluent will be discharged to Umwelt Lake and ultimately flow into Goose Lake.

Umwelt Lake (natural capacity of 0.24 Mm^3) will also be dewatered in Year −1, following dewatering of Llama Lake. Similar to Llama Lake, it is assumed that only 50% of the lake water volume will be suitable for direct discharge.

The remaining 50% is assumed to have TSS concentrations in excess of the discharge limit and will be treated in the modular water ireatment plant. Effluent will be discharged to Goose Lake; this will allow for the SWP to be constructed around the existing extents of Umwelt Lake.

A portion of the water from lake dewatering (likely Umwelt Lake since it will be dewatered second) will be used to fill or nearly fill the primary pond to provide an initial source of make-up water when the process plant is being commissioned and the Echo TF is being established.

20.6.8 Contact Water Management

Contact water will be generated from open pits, TFs, and WRSAs. The anticipated quality of these contact waters is expected to be suitable for discharge (Section 20.6.4). The water management facilities are identified in Section 20.6.5. A description of water management through the mine life is provided in Section 20.6.6.

The annual water balance shows that during each year in construction, there will be a surplus of contact water requiring discharge to the environment. Contact water will be generated from the plant site pond (starting in Year −3), from the Echo WRSA pond, and from the Echo and Umwelt open pits (all starting in Year −2), at a time when there is no processing to consume reclaim water or a TSF or exhausted open pit to store the water. Discharges will occur from the plant site pond, Echo pit, and WRSA pond. Water reporting to the Umwelt pit during this period will be pumped to the primary pond for storage with no discharge required.

The annual water balance also shows that a surplus of contact water will require discharge to the environment in Years 3 through 13.

In Years 1 and 2, the Echo TF and primary pond are the only sources of reclaim water, both receiving flows from event ponds across the site. Starting in Year 2, the RO plant will generate a significant (160,000 to 275,000 m^3) quantity of freshwater discharge to be used in process, which reduces process water requirements from reclaim and make-up water. This water will be pumped to the Umwelt TF for the LOM. No contact water discharges will be required in Years 1 and 2.

In Year 3, the Echo TF, primary pond and Umwelt TF will be sources of reclaim water, and from Year 4 onward, only the primary pond and Umwelt TF will provide reclaim water. Water in the primary pond is derived from runoff from the Llama and Umwelt WRSAs. The Umwelt TF will receive freshwater from the RO plant as well as flows from the plant site pond, Echo/Goose WRSA pond, and Goose Main pit. Water will not be reclaimed from the Llama TF as it will store brine.

In Years 3 through 13, an annual average of 300,000 m^3 of contact water will be discharged to the environment following water treatment for ammonia, arsenic, and copper, as described in Section 20.6.10.

Starting in Year 13 and continuing through to the end of Year 15, process water requirements are reduced as the milling rate declines. Available contact water is similarly reduced after mining in Goose Main pit ceases in Q3 Year 12. In Years 14 and 15, surplus contact water contained in the Umwelt TF and/or primary pond will be pumped to the Llama TF to assist in flooding.

20.6.9 Saline Water Management

Considerable study has been undertaken at the Goose Property to understand permafrost and groundwater conditions in relation to mining (Rescan, 2010, 2012; Rescan ERM, 2014a, 2014b, 2014c, 2015; RGS, 2005; Knight Piésold, 2013a, 2013b; Sabina, 2015; SRK, 2012).

The Property is situated in the Canadian Shield, composed of Precambrian-aged metamorphic rock of sedimentary, volcanic, and plutonic origin (Sabina, 2015). The rock quality of the rock mass units is classified as fair to good. The hydraulic conductivity (K) of the fractured rock is generally low, with a geometric mean of 3×10^{-9} m/s and an arithmetic mean of 3×10^{-7} m/s, based on the testing conducted to date (SRK, 2015b). The hydraulic conductivity appears to decrease with increasing depth, particularly below about 220 m, with no obvious correlation with lithology or structural features such as faults that could act as a flow conduit.

Continuous permafrost underlies the Goose Property, with a thickness of 490 to 570 mbgs. The permafrost is essentially impermeable to groundwater flows.

Shallow groundwater flows occur in the active layer. The interception of shallow, active-layer flow by the proposed pits is considered insignificant due to the active layer being relatively thin (less than 2 m), it is unfrozen only during the summer months, pore water volumes are small, and the water quality is not saline. Furthermore, such flow could be diverted from the pit during operations using diversion structures, if deemed necessary.

Groundwater inflows to the underground mines are expected due to a portion of the underground workings extending below the permafrost. The open pit and underground mining will also occur underneath or adjacent to large lakes associated with bodies of unfrozen ground known as taliks. Site investigations have confirmed the presence of open or through taliks beneath the larger lakes on the Property, including Goose, Llama, Umwelt, Giraffe, Wasp, and Rascal lakes.

The groundwater is estimated to be hyper-saline (salinity of 51‰ to 73‰) with $CaCl_2$ and NaCl as the dominant salts, and with salinity increasing with depth (Rescan ERM, 2015). Estimated concentrations of arsenic (0.008 to 0.047 mg/L), boron (2.5 to 5.3 mg/L), iron (0.9 to 8 mg/L), and zinc (0.18 to 1.0 mg/L) are noted due to their naturally enriched concentration relative to the CCME (2015) guidelines for the protection of freshwater aquatic life. This chemistry and elevated salinity increases with depth and is commonly observed in permafrost environments.

Based on the high salinity, SRK (2015b) recommends that a −2°C temperature isotherm should be used to delineate the base of the permafrost, below which flowing groundwater can be anticipated. The −2°C isotherm depth is estimated to be about 320 to 350 mbgs (−30 masl to −60 masl).

Saline groundwater will be generated from the following mining areas:

- Llama open pit
- Llama underground
- Umwelt underground
- Goose Main underground.

The Llama Pit and Llama underground partially intersect the open talik supported by Llama Lake; this lake will be dewatered prior to the start of mining operations. The Llama, Umwelt, and Goose Main underground mines partially intersect the sub-permafrost groundwater system. The Echo pit and underground are not deep enough to encounter the sub-permafrost groundwater system.

Knight Piésold extrapolated groundwater inflows from previous work by SRK (2015b) to develop saline groundwater estimates for the current mine plan. The geometry of the Llama underground, Llama pit, and Goose Main underground have not changed materially since the previous feasibility study, but the length of time over which each of these have been mined has increased (Llama underground will be mined over six years instead of five; Llama pit will be mined over five years instead of four, and Goose Main underground will be mined over six years instead of four). The previously predicted daily groundwater inflows presented by SRK (2015b) by year were extended over the additional years of mining, with the higher year inflow values applied to the additional years of mining.

The Umwelt underground is the main source of groundwater inflows at the Project. In the 2015 Initial Project feasibility study (JDS, 2015b) it represented more than 50% of the saline water produced over the LOM. The Umwelt underground has increased in size and depth with the current feasibility study, and thus groundwater inflows can be expected to increase accordingly. Knight Piésold reviewed the mine development plan for the Umwelt underground and assigned groundwater inflow estimates to each year based on the previous groundwater inflows. Saline water inflows are estimated to range from 288 m^3/d in Year 1 of mining, to a sustained peak of about 1,600 m^3/d from Year 7 through Year 9, and subsequently decreasing to 1,200 m^3/d as mining is completed in the lower levels and these areas are permitted to flood (Table 20-8). An updated and detailed groundwater model for the Umwelt underground will be required to support detailed engineering and update inflow estimates.

Table 20-8 Daily Groundwater Inflow Estimates

Year	Flow in m^3/d				
	Umwelt UG	Llama UG	Llama Open Pit	Goose Main UG	Total
1		168	120	-	288
2	200	334	120	-	654
3	400	350	76	-	826
4	400	350	76	-	826
5	800	264	19	-	1,083
6	800	185	-	21	1,006
7	1,500	-	-	85	1,585
8	1,500	-	-	85	1,585
9	1,500	-	-	77	1,577
10	1,200	-	-	77	1,277
11	1,500	-	-	16	1,516
12	1,200	-	-	-	1,200
13	1,200	-	-	-	1,200
14	1,200	-	-	-	1,200
15	1,200	-	-	-	1,200

Source: Knight Piésold, 2021.

Pumped groundwater volumes will be somewhat less than the inflow volumes, due to evaporative and sublimative losses, notably those losses associated with water and ice removed with broken rock. The amount of water that leaves the mining operations via these modes can be significant. This has not been accounted for in the groundwater inflow estimates.

The Goose Main pit is the final repository of saline water at the Project, and it becomes available for the storage of saline water at the end of Year 12. Prior to this, saline water will be stored in the SWP (capacity 1.79 Mm^3) and the Llama TF (4 Mm^3, assuming the storage of 6.5 Mm^3 of tailings and maintaining a 5 m freeboard), with a combined storage capacity of approximately 5.79 Mm^3.

Without any water treatment, approximately 7.1 Mm^3 of saline water would require temporary storage on surface through until the end of Year 12. This value consists of the cumulative saline water volume at the end of Year 12 (5.4 Mm^3) plus the volume of freshwater reporting to the SWP in Years −1 through 12 (1.7 Mm^3) from direct precipitation and limited seepage through the lined freshwater diversion berms the lined freshwater diversion berms around the SWP (Table 20-9).

To reduce the volume of saline water requiring temporary storage, RO water treatment will be used to reduce the volume of saline water requiring temporary storage to 52% of its original volume (2.7 Mm^3 by the end of Year 12). Considering almost 1.7 Mm^3 of freshwater inputs as described above, the total volume requiring temporary storage to the end of Year 12 is 4.4 Mm^3. The SWP (1.79 Mm^3) and the Llama TF (4 Mm^3) will provide the necessary saline water (brine) storage requirements until the Goose Main pit becomes available to receive saline water.

The SWP will start to collect saline water from the Llama underground and Llama pit in Year 1. An initial RO unit will be installed in Year 1 and commissioned in Year 2, with a second RO unit installed in Year 5 to suit the increase in groundwater inflows with mine development over time. The RO plant will treat groundwater coming from the mining areas and will discharge the brine effluent to the SWP. The treated effluent stream produced by the RO will be used as make-up water in process.

Brine from the RO plant will be deposited in the SWP until the end of Year 5, storing an estimated 1.8 Mm^3 of brine (inclusive of freshwater inputs into the SWP). As early as Q3 Year 5, but by Year 6, the Llama TF will become the primary repository of brine. In addition, approximately 1.2 Mm^3 of brine will be transferred from the SWP to the Llama TF in Year 6, as the SWP will have reached its maximum storage capacity (1.79 Mm^3). This will create sufficient room in the SWP to accommodate freshwater inputs until the pond contents can be transferred to the Goose Main pit. As early as Q3 in Year 12, through Year 13, brine and supernatant water mixture in Llama TF (almost 3.3 Mm^3) will be transferred to the Goose Main pit. The contents of the SWP (1.8 Mm^3) will be transferred to the Goose Main pit in Year 14, allowing for the pond to be decommissioned in Year 15. The Goose Main pit will have received approximately 5.9 Mm^3 of brine, saline water, and tailings supernatant by the end of Year 14, compared to its capacity of 16.13 Mm^3. Hence additional storage will be available for saline water and brine, if needed.

Table 20-9: Predicted Saline Water Volumes Requiring Treatment and Disposal

Year	Flow (m^3/a)												Description
	Saline Groundwater from Mining Areas		Reverse Osmosis Effluent Streams			Freshwater Inputs to SWP	Saline Water / Brine to SWP		Brine to Llama TF		Brine and Saline Water to Goose Main Pit		
	Annual Total	Cumulative Total	Near Freshwater Effluent[1]	Brine Effluent	Brine Cumulative Total		Annual Total	Cumulative Total	Annual Total	Cumulative Total	Annual Total	Cumulative Total	
-1	-	-	-	-	-	67,534	67,534	67,534	-	-	-	-	Runoff during construction
1	202,196	202,196	-	-	-	135,069	337,265	404,799	-	-	-	-	Saline water to SWP
2	335,786	537,982	161,177	174,609	174,609	135,069	309,677	714,477	-	-	-	-	RO treatment of saline water, brine to SWP (Years 2-5)
3	398,566	936,549	191,312	207,254	381,863	135,069	342,323	1,056,800	-	-	-	-	
4	398,566	1,335,115	191,312	207,254	589,118	135,069	342,323	1,399,123	-	-	-	-	
5	492,371	1,827,486	236,338	256,033	845,151	135,069	391,102	1,790,224	-	-	-	-	
6	-	-	-	-	-	-	-	-1,200,000	1,200,000	1,200,000	-	-	Transfer SWP to Llama TF
	367,190	2,194,676	176,251	190,939	1,036,090	135,069	135,069	725,293	190,939	1,390,939	-	-	Brine from RO treatment to Llama Pit/TF (Years 6-13)
7	578,525	2,773,201	277,692	300,833	1,336,923	135,069	135,069	860,362	300,833	1,691,772	-	-	
8	578,525	3,351,726	277,692	300,833	1,637,756	135,069	135,069	995,430	300,833	1,992,605	-	-	
9	575,605	3,927,331	276,290	299,315	1,937,070	135,069	135,069	1,130,499	299,315	2,291,919	-	-	
10	466,105	4,393,436	223,730	242,375	2,179,445	135,069	135,069	1,265,567	242,375	2,534,294	-	-	
11	553,340	4,946,776	265,603	287,737	2,467,182	135,069	135,069	1,400,636	287,737	2,822,031	-	-	
12	438,000	5,384,776	210,240	227,760	2,694,942	135,069	135,069	1,535,705	227,760	3,049,791	-	-	
13	438,000	5,822,776	210,240	227,760	2,922,702	135,069	135,069	1,670,773	227,760	3,277,551	-	-	Brine to Goose pit
	-	-	-	-	-	-	-	-	-3,277,551		3,277,551	-	Transfer to Goose pit
14	438,000	6,260,776	-	-	-	135,069	135,069	1,805,842	-	-	438,000	3,715,551	Saline water to Goose pit
	-	-	-	-	-	-	-	-1,805,842	-	-	1,805,842		Transfer SWP to Goose pit
15	438,000	6,698,776	-	-	-	-	-	-	-	-	438,000	5,959,393	Saline water to Goose pit

Source: Knight Piésold, 2021.

Notes: The freshwater effluent produced by RO will be pumped to the Umwelt TF for use as reclaim water.

20.6.10 Water Treatment

Water treatment will be required during the construction and operation phases of the Project as follows:

- Lake dewatering during construction (Year −1)—up to half of the water removed from Llama and Umwelt lakes will require treatment for TSS using a mobile water-treatment unit, as noted in Section 20.6.7.
- Saline water treatment Years 2 to 13—saline groundwater generated from select mining areas (Section 20.6.9) will be treated to reduce the volume of saline water/brine requiring temporary storage.
- Reclaim/tailings supernatant water Years 3 to 15—a water treatment unit will be installed in the process plant to reduce concentrations of TSS, ammonia, arsenic, and copper in reclaim water derived from the Umwelt TF that will be discharged to the environment.

In mid-2021, an un-ionized ammonia discharge limit will be added to Schedule 4 of the MDMER. During the construction phase, Echo and Umwelt pits will be mined, and there is insufficient storage to contain all the water generated from open pit mining. Ammonia treatment during construction is not currently planned but may be required if explosives are poorly managed leading to elevated un-ionized ammonia in the pit water.

The saline water treatment and reclaim water treatment requirements during operations are described further below.

Saline Water Treatment

As described in Section 20.6.9, saline water will be treated to generate a smaller volume of brine that meets the available temporary storage in the SWP and Umwelt TF. This will be accomplished using the following treatment steps, based on a budgetary quotation from Saltworks Technologies Inc. (2021):

- Pre-treatment consisting of oxidation with potassium permanganate along with greensand and polymeric ultrafiltration to produce a RO friendly feed (the influent is scaling in iron and manganese)
- Ultra-high recovery RO plant.
- RO polishing plant.

The RO plant will initially consist of an 800 m^3/d inlet capacity ultra-high recovery RO unit plant installed in Year 1 to treat saline water in Years 2 to 5. Treating saline water with an inflow concentration of 80,000 mg/L total dissolved solids (TDS), the ultra-high recovery RO unit will achieve about a 48% recovery of 1,000 mg/L TDS effluent and a 52% brine reject with a TDS concentration of 152,500 mg/L. The 1,000 mg/L TDS effluent stream will be subsequently subject to a polishing step with a 384 m^3/d inlet polish RO that will achieve up to 98% recovery, resulting in 7 to 8 m^3/d of 40,000 mg/L TDS brine that will be recycled back to the ultra-high recovery plant. A second ultra-high recovery RO unit and RO polishing unit with the same capacities will be installed in Year 5 to treat increased saline water quantities expected starting in Year 6 (Table 20-10).

Once the Goose Main pit becomes available for saline water storage in Year 13, the RO plant will be taken offline and saline water from the Umwelt underground can be pumped directly to the Goose Main pit.

Reclaim Water Treatment

Reclaim water treatment will be implemented starting in Year 3 once use of the Umwelt TF is underway, to achieve concentrations below discharge limits at closure for the parameters of concern (ammonia, arsenic and copper). There will be two main sources of ammonia during the operation phase: ammonium nitrate used for blasting, and the sodium cyanide used in the leach circuit. Water treatment will include a process of oxidizing residual cyanide using hydrogen peroxide. This process will liberate copper and other metals that may be complexed with cyanide and will oxidize available arsenite to arsenate. Ferric chloride will also be added to co-precipitate arsenic, and potentially copper. Biological treatment to remove ammonia will be included in the treatment circuit.

This treatment unit will allow for excess contact water to be released during operations as required by the water balance.

Should water quality in the Llama TF or Umwelt TF not be suitable for discharge by the end of operations, treatment will continue until discharge criteria to the receiving environment are met.

20.6.11 Sewage Disposal

Sewage at the Goose Property will be treated using a package sewage treatment plant (STP) (Section 18.2.6). The STP will be located in the Goose plant site area, and treated sewage effluent will be discharged to the tundra west of the Goose plant site. It will be land discharged to maximize attenuation distance prior to entering an outflow watercourse from Fox Lake and ultimately entering Goose Lake.

Off-specification treated sewage during upset conditions will be discharged to the plant site. Any discharges of sewage effluent from the collection pond will need to meet the applicable discharge criteria in the Type A Water Licence (NWB, 2018). In-pond treatment by coagulation can be applied if required as a contingency.

There will be no sewage discharge at the MLA as the camp will operate on a Pacto system which grey water from the kitchen and wash facilities will be discharged to the tundra north of the camp infrastructure.

20.7 Mine Closure and Reclamation Plan

20.7.1 Closure Objectives

The Project's closure objectives are as follows:

- Design the mine for closure—identify the processes that will act upon the mine components after mine closure so that they can be optimized into the mine design.
- Achieve physical stability—minimize risk to humans, wildlife, and the environment. Mine components that are to remain after mine closure will be constructed or modified at closure such that they are physically stable and do not erode, subside, or move from their final intended locations due to any forces.
- Achieve chemical stability—all mine components and wastes remaining after mine closure will be chemically stable with mitigation. Chemical constituents released from the mine area will not endanger humans, wildlife, or the environment.

- No long-term active care—design reclamation activities such that mine components and wastes remaining after mine closure do not require any active maintenance beyond the post-closure phase.
- Consider future land use and aesthetics—compatibility with the surrounding lands after reclamation activities have been completed.
- Utilize progressive reclamation during the construction and operations phases wherever practicable.
- Consider direction from regulators—meet all Project-specific commitments and Project licencing requirements related to closure of the mine.

20.7.2 Closure Criteria

Closure plans for the Project have been developed in accordance with current best management practices, which include relevant federal and territory closure guideline documents, such as the *Mine Site Reclamation Policy for Nunavut* (INAC, 2002) and the *Guidelines for the Closure and Reclamation of Advanced Mineral Exploration and Mine Sites in the Northwest Territories* (Mackenzie Land and Water Board and Aboriginal Affairs and Northern Development Canada, 2013).

With respect to the final water-quality standards and site-specific thresholds, the MDMER and water-quality guidelines for the protection of freshwater aquatic life by the CCME will be adopted and applied.

20.7.3 Logistical Considerations

The remote setting of the Property presents unique challenges related to implementing a cost-effective closure plan—specifically, costs related to the shipping of equipment, materials, and supplies, as well as the construction and operation of WIRs between the MLA and the Goose Site. The closure strategy, as far as practical, avoids backhauling and off-site shipping of any non-hazardous waste. Furthermore, materials and fuel required for closure implementation will need to be brought to the Project by ship and WIR during the final years of operations, and early during the closure phase.

20.7.4 Temporary Closure Activities

Should mining cease temporarily before the mine plan has been fully executed, a care and maintenance program will be required to ensure the site is secure and safe for other land users and wildlife. Access to the mine areas will be controlled and restricted to authorized personnel. All mine openings will be barricaded or guarded, and warning signs will be placed around all open pits and mine openings. Hazardous materials and explosives will be secured and stored safely. All machinery and mobile equipment will be locked out, and mobile equipment will be stored in safe locations.

All WRSAs and stockpiles will be maintained in a physically stable condition, and annual geotechnical inspections will occur. Should temporary closure occur, water management structures will be monitored and maintained accordingly. Surface water-quality monitoring will continue at regular intervals. All infrastructure, including roads, airstrips, and camp areas, will be maintained. It may be necessary to place NPAG over exposed PAG within the WRSAs to avoid the creation of acid generating conditions and the release of adverse water quality runoff. Otherwise, water treatment may be required if temporary closure was sustained beyond the ARD onset time and/or if the underground mines are dewatered to maintain dry conditions.

Temporary closure activities will continue until mining has resumed or until the decision is made to permanently close the mine. Should the mine close permanently, a final Mine Closure and Reclamation Plan (MCRP) will be filed with the NWB, and final closure activities will begin.

20.7.5 Final Closure Activities

Final closure activities are described in Sections 20.7.6 to 20.7.15. Closure and post-closure monitoring is described in Section 20.7.16, and the closure schedule and reclamation estimate are provided in Sections 20.6.17 and 20.6.18.

20.7.6 Open Pits

A boulder fence and warning signs will be placed around each open pit as it is mined out. Boulders will be approximately 1 m in diameter, set back from the final pit crest, and with nil spacing between boulders. The safe distance that the boulder fence will be set back from the pit edge will be determined during operations. The intention of the boulder fence is not to prevent access but to be a significant visual barrier suggesting a change in landscape that will act as a warning sign to both humans and wildlife.

Pit sumps and associated pumps and pipelines will be removed as each open pit is mined out. If not re-purposed, pumps and pipelines will be drained of fluids and disposed at the bottom of pits or landfilled on-site, and hazardous materials will be removed and disposed of at an off-site licenced facility.

Tailings will be disposed in the Echo, Umwelt, and Llama pits when open pit mining is completed, as described in Section 20.5. This influences the closure planning for each pit. The final closure measures for each pit are as follows:

- Echo TF—will have been filled to within about 5 m of its crest (i.e., to El. 300 m with the crest elevation at El. 305 m) with tailings during Year 3 of mining. Together with the initial Echo WRSA, the Echo TF will be incorporated into the Goose Main WRSA starting in Year 4. Water above the tailings in the pit will be pumped to the Umwelt TF prior to waste rock being placed on the tailings in the pit.
- Umwelt TF—will have been filled to within about 5 m of its crest with tailings by the end of Year 7. The spill-over elevation of this pit is El. 298 m. The 5 m closure water cover will largely be in place when tailings deposition ends.
- Llama TF—will have been filled with tailings to El. 277 m by the end of Year 15 of mining. The spill-over elevation of this pit is at El. 300 m. Following tailings deposition, an estimated 2.5 Mm^3 will be required to flood the pit. Once the brine/supernatant mixture in Llama TF has been pumped to the Goose Main pit in Year 13, all Llama diversion berms will be breached, and runoff from the Llama WRSA will also be routed to Llama TF. The tailings thickener may be turned off in the final two years of mining, and active filling of the pit will occur over the two-year active closure phase.
- Goose Main pit—the brine stored in the Llama TF and the SWP will be pumped to the Goose Main pit in Years 14 and 15, respectively. In addition, saline water will be pumped to this pit from the Umwelt underground during Years 13 to 15. At the end of Year 15, the diversion berm around the Goose Main pit will be breached to allow water from the upstream catchments to flow into the pit. The Rascal Lake diversion berm will be partially breached to contribute up to 70% of the flows to the Goose Main pit to

assist with passive flooding. This may involve installing culverts under the airstrip to pass these flows. Alternatively, if the full length of the airstrip is not required, the airstrip could be breached. Directing up to 70% of the Rascal Lake catchment to the Goose Main pit will allow the pit to fill in about two years under average hydrologic conditions (3.3 Mm^3/a from the Rascal Lake catchment, and another 0.5 Mm^3/a from the other catchment to the east). It will be necessary to construct diversion structures and an armoured spillway out of the pit. The freshwater above the saline water will promote formation of a meromictic lake. Further discussion is provided below.

The geometry of the Goose Main pit, along with the salinity stratification, is expected to permanently establish meromixis, in which the pit successfully resists wind mixing and remains permanently stratified. A stratification assessment was completed for the previous feasibility study that evaluated the placement of saline water followed by a freshwater cover in the Llama pit (Pieters & Lawrence, 2015). The study determined that the energy needed to mix the salinity stratification was very high, and on that basis, meromixis is predicted. The authors noted that the salinity gradient in the Llama pit would be much greater than any of three existing pit lakes in Northern Canada that all tend towards meromixis. The depth of the Goose Main pit (189 m) is close to the depth of Llama pit (186 m).

Pit lake water-quality monitoring will be conducted to ensure water meets discharge criteria prior to pit overtopping and passive discharge. In the unlikely event that the water in any of the pit lakes is not suitable for discharge, the pit lake water will be batch-treated to address remaining water-quality impairments. Once the outflow water-quality requirements have been confirmed, the Umwelt, Llama, and Goose Main pit lakes will be allowed to overflow and discharge to the environment. Appropriate erosion protection measures will be constructed at the overflow location to ensure management of any suspended sediments.

The open pit slopes are designed to be stable under operating conditions. During pit development, a pit wall monitoring program, including geotechnical structural mapping, will be implemented to confirm design assumptions and to rapidly detect any unexpected conditions for follow-up and identify the adaptive measures to be undertaken. The partial backfilling with tailings (of Llama TF and Umwelt TF), covering Echo TF with waste rock, and the resultant flooded Llama, Umwelt, and Goose Main open pits will enhance the pit wall stability.

20.7.7 Undergrounds

The Goose Site mobile equipment not being used elsewhere on the Property will have hazardous materials removed and disposed of at a licenced facility; the equipment will be landfilled on site. Mine dewatering pipelines, electrical transmission wires, substations, and pumping stations not suitable for reuse will be cleaned, disposing of any hazardous waste at a licenced facility, and the remaining equipment either dismantled and landfilled, or left in place upon closure.

All underground void space at the Goose Property will flood at the cessation of mining. The mine portals will subsequently be blocked with NPAG waste rock, extending 10 m into the portal from surface. The portal opening will be flush with the surrounding topography or, if required, at a slope angle of 3H:1V. All underground ventilation raises will be closed using engineered concrete caps, or alternatively, will be filled with waste rock, flush with the surrounding ground surface.

20.7.8 Waste Rock Storage Areas

The WRSAs will be shaped such that the overall slopes are 3H:1V and progressively capped with 5 m of NPAG waste rock. All WRSAs are designed to freeze back within a period of no more than 8 to 10 years. The active layer is expected to remain within the outer 5 m cap of NPAG (SRK, 2015e), thus mitigating the risk of acid-rock drainage (ARD).

20.7.9 Non-Hazardous Landfills

Non-hazardous landfills will be constructed within the confines of the WRSAs. All landfill areas will be capped with a minimum of 5 m of NPAG waste rock.

Non-hazardous waste will also be disposed of within the open pits. Where pits are backfilled, non-hazardous waste will be covered with 5 m of NPAG waste rock. Where pits are used as TFs, or flooded, non-hazardous waste must be covered with at least 3 m of water.

Any available underground void space can also be used for disposal of larger non-hazardous waste prior to flooding.

20.7.10 Water Management Structures

Water management ponds at site will be appropriately dewatered, associated pumps and pipelines will be decommissioned, and the pond containment walls will be breached. Similarly, any diversion structures will be breached, and pre-mining flow channels will be re-established.

Soil sampling will be carried out in all water storage facilities to determine whether the exposed sediments meet industrial standards. If not, the contaminated sediments will be excavated and disposed of in the Goose pit or within a WRSA. This includes the top 1 to 2 m layer of sediments around the original footprint of Llama Lake and the SWP where chloride is expected to have penetrated the soils (Sabina, 2020). Any soils from this area exceeding the long-term CCME guideline will be excavated and placed in the Umwelt TF. Any liners, both in containment structures and diversions, will be removed and will be disposed of as non-hazardous waste in on-site landfills. Pumps and pipelines will be removed, stripped of hazardous waste, and landfilled. Hazardous materials will be disposed of off site at a licenced facility.

20.7.11 Water Treatment Facilities

Once water treatment is completed at the Project, the water treatment plants and all associated pipelines will be dismantled, cleaned, and disposed of in the landfill. All water treatment plants will be decommissioned once runoff water quality at designated control points has met the required closure criteria (i.e., Water Licence and MDMER discharge limits).

20.7.12 Buildings and Equipment

At the end of mining, during the active-closure stage, the Goose Site's processing facilities, crusher, power plant, fuel storage facilities, shops and warehouses, and ancillary facilities will be dismantled. Hazardous materials will be removed, all reservoirs will be flushed out, and the remaining materials that are not deemed to have salvage value will be disposed of in a landfill or in an exhausted open pit. All concrete structures will be demolished to ground level with exposed rebar cut and the slabs perforated, with clean rubble disposed of in an on-site landfill. These perforated slabs will be covered with waste rock or overburden, with any sub-grade areas infilled with NPAG waste rock, if required. At the MLA, surface infrastructure will be similarly handled; however, all elements designated for landfilling will be shipped off-site for disposal at a designated landfill or backhauled to Goose Site for landfilling. At all sites, once all buildings and equipment have been removed, the disturbed areas (whether bedrock or thermal pads) will be re-contoured to allow for sheet-flow drainage to the receiving environment.

A fully functional modular 20-person camp, complete with associated support facilities, will be constructed at the Goose Site during the active-closure stage, to accommodate ongoing closure activities. Once this camp is no longer required, which is expected to occur late in the post-closure phase, the camp will be dismantled and disposed of at an off-site licenced facility.

Any mobile equipment used in the open pits that is past its service life will have all hazardous materials removed and disposed of at a licenced facility, and the equipment will then be landfilled on site or will be disposed of in a flooded open pit.

20.7.13 Roads and Airstrips

Mine haul roads and service roads no longer required will be decommissioned once operations are complete. This will include removing any culverts, to maintain pre-construction surface drainage, and general grading of the road surface to promote runoff shedding. Any airstrips and primary access roads, including any required culverts, will remain functional, with a gravel surface for use during post-closure monitoring. Once these final access-infrastructure elements are no longer required at the end of LOM, they will be reclaimed in a similar fashion to the mining haul roads. The WIR alignment is not expected to require any reclamation, but the route will be inspected prior to completion of closure to identify any areas of potential physical instability (e.g., erosion). These areas will be remediated as required. Areas where discontinuous sub-base upgrades were placed to support WIR use, the area will be scarified, but will otherwise remain intact to ensure preservation of the permafrost.

20.7.14 Contaminated Soils

A site investigation will be carried out to determine the volume of contaminated soil and concrete from hydrocarbon spills over the LOM. The investigation will be focused on all parking bays, fuel storage areas, wash bays, truck shops, maintenance areas, and generator areas, as well as along roads and in areas where spills have been reported or known to occur.

Hydrocarbon-contaminated soils will be excavated and remediated in on-site land farms constructed specifically for this purpose at the MLA or Goose Site. The land farms are expected to operate for two to three years.

As required, water contaminated with hydrocarbons will be treated using portable oil-separator units. After these units are no longer required, they will be removed from site and the oil and sludge in the units will be removed to a licenced off-site hazardous waste facility.

20.7.15 Hazardous Materials

All hazardous waste will be properly packaged and shipped off site to a licenced facility for disposal regularly during the operation phase. This will also be done for any remaining hazardous waste at closure. This will either be via sealift or by backhaul flights once the MLA has been decommissioned.

20.7.16 Monitoring

Monitoring will be carried out during the closure and post-closure phases to verify that closure activities are being undertaken as described in the Closure and Reclamation Plan, and closure objectives are being met. The monitoring programs are set out below.

Geotechnical Monitoring

Ground temperature cables (GTC) will be installed within the WRSAs during development of each facility. The GTCs will be monitored to verify that freeze-back is being achieved, as per design. As far as practical, the GTCs will be equipped with remote access data loggers to allow for continuous data acquisition at a frequency determined by the Design Engineer. Monitoring of the GTCs can cease once the data confirms that freeze-back has been achieved for a period of at least five years.

During operations, and until complete decommissioning, an annual geotechnical inspection will be carried out by a qualified geotechnical engineer licenced to practice in Nunavut. These inspections will most likely occur during the summer months when there is no snow cover. Areas to be included in the inspection are all TFs, all WRSAs, open pit high walls, all contact and non-contact water storage ponds, diversion structures, landfarms, and any other surface infrastructure elements possibly affecting permafrost.

Water-Quality Monitoring

Water-quality monitoring will begin as soon as contact or process water is present at the start of construction. Monitoring at designated control points will be checked in accordance with the licence criteria, both with respect to frequency and the necessary testing parameters. Following the active- and passive-closure phases, water-quality monitoring will be systematically scaled back, with ultimate cessation once there has been at least five years of water-quality monitoring that confirms that the final closure objectives have been met.

Aquatic Effects Monitoring

Aquatic effects monitoring will be carried out in accordance with the requirements of the Type A Water Licence. Cessation of this monitoring will occur when a five-year period has elapsed showing the system has achieved the stated closure objectives. A final biological monitoring study will also be conducted, and a final interpretive report will be submitted to ECCC within three years of ceasing mine production, in accordance with the MDMER.

20.7.17 Proposed Closure Schedule

The most significant progressive reclamation activity for the Project is the continued covering of PAG waste rock with 5 m of NPAG waste rock in the WRSAs; this activity will start as soon as open pit mining begins in the construction phase and will continue through the 15-year operating mine life. Active closure will take approximately two years to complete and entails the bulk of the physical closure activities. A previously proposed 5-year passive closure phase that consisted primarily of passive pit flooding and water treatment, though not expected to be necessary, has been retained followed by final decommissioning of the remaining elements of the Project. Finally, post-closure will commence and last at least five years, during which confirmation monitoring occurs. This closure schedule is summarized in Table 20-10.

Table 20-10: Closure Schedule

Closure Stage	Project Year Start	Project Year End
Progressive Reclamation	1	15
Active Closure	16	17
Passive Closure	18	22
Post-Closure	23	27

Source:

20.7.18 Reclamation Bond Requirements

Financial security is required under Type A Water Licence and is posted to CIRNAC for water-related closure costs, and the Kitikmeot Inuit Association for land-based reclamation activities associated with the Project. The amount of security required was agreed upon during the regulatory phase in 2018 (NWB, 2018). The security will be deposited at agreed upon milestones to ensure that the funds required for future reclamation will be available. Criteria have been established that will need to be met prior to release of any security held by the beneficiary. Funds may be released by the beneficiary back to Sabina only if Sabina has satisfied its reclamation obligations. The total closure cost of the Project's Updated Feasibility Study is approximately $41M, which is captured in the financial model (Section 22). To the extent funds are held in trust to cover unforeseen future reclamation costs, or if certain reclamation activities are not completed, the regulatory authorities will have the right to use the security funds to fulfill any necessary obligations.

21 CAPITAL AND OPERATING COSTS ESTIMATE

21.1 Capital Costs

21.1.1 Introduction and Summary

Preparation of the capital cost (CAPEX) estimate is based on standard SDE methodology for NI 43-101 feasibility studies. The estimates were developed using engineering calculations and applying directly related mining Project experience and generally accepted industry factors. Wherever possible, estimates used in this Project were obtained from engineers, estimators, contractors, and suppliers who have provided similar services to existing operations and have demonstrated success in executing the plans set forth in this study.

The following cost estimates are described in this section:

- Initial CAPEX—includes all costs incurred to develop the Property to a state of name-plate production (3,000 t/d)
- Sustaining CAPEX—includes all costs incurred during production for initial and ongoing underground installations and development; fuel services; site surface-water management; mining pits; a process plant nameplate expansion to 4,000 t/d in Year 2; LOM equipment acquisitions and replacements; and annual construction of the WIR.

The nameplate expansion to 4,000 t/d has been considered in the initial equipment selection and engineering design for the initial 3,000 t/d plant. As such, some process equipment is generously sized at 3,000 t/d to allow for ease of future expansion.

Sunk costs and Owner's reserve are not considered in this section.

All cost estimates are based on the following key parameters:

- Owner-performed pre-production mining
- The specific scope and execution plans described in this study. Deviations from these plans will affect the CAPEX.

Table 21-1 summarizes the CAPEX estimate by area and activity.

Note that some totals within the tables in this section might not add exactly due to rounding.

A work breakdown structure (WBS) was established for the initial CAPEX estimate. Costs have been classified into the various WBS areas to ensure that the entire Project scope has been captured.

The accuracy of the CAPEX estimate is in the range of ±15%.

The Project contingency was built up using factors applied to labour, equipment, materials, and vendor packages for each CAPEX category. However, the contingency factor is applied only to the CAPEX estimate as a rolled-up value, and not to the individual estimate components.

Table 21-1: Summary of CAPEX by WBS Level 1 Category

CAPEX	Initial ($ million)	Sustaining ($ million)	LOM ($ million)
Mining[1]	56	348	404
On-Site Development	6	3	9
Ore Crushing and Handling	28	0	28
Process Plant	91	13	104
On-Site Infrastructure (Goose)	97	5	102
Off-Site Infrastructure	2	-	2
MLA	19	4	23
Tailings	5	-	5
Indirect Costs[2]	177	4	181
EPCM	6	-	6
Owner's Costs	68	-	68
Reclamation	-	42	42
Subtotal	554	419	973
Contingency	56	-	56
Total CAPEX	**610**	**419**	**1,029**

Source: SDE, 2021.

Notes: [1] Includes labour and equipment.
[2] Explosives, fuel, maintenance spares, and consumables.
Numbers may not add due to rounding.

This estimate was prepared with a base date of Q4 2020 and does not include any escalation beyond this date. The quotations used for this study were obtained in Q3 or Q4 2020.

The CAPEX estimate uses Canadian dollars as the base currency. When required, quotations received from vendors were converted to Canadian dollars using a currency exchange rate of C$1.31:US$1.00. Duties and taxes are not included in the estimate.

21.1.2 Responsibility Matrix

This CAPEX estimate was developed by a multidisciplinary team of engineers, procurement specialists, construction contractors, and cost estimators. SDE is responsible for developing and assembling the overall CAPEX estimate, with input from companies shown in Table 21-2.

Table 21-2: CAPEX Estimation Responsibility Matrix

Description	Responsibility	Scope
Open Pit (OP) Mining	MP	• OP mine development and production • OP mining equipment
Underground (UG) Mining	MP	• UG mine development and production • UG mining equipment • UG mine services and equipment for ventilation/heating, communications, explosives, and transportation
	DT Engineers	• Electrical power feed from Goose power plant to Goose underground portals and portal emergency generator sets • Mine services and equipment for electrical, compressed air, service water, brine, and dewatering systems
On-Site Development	DT Engineers	• Bulk earthworks • Site drainage • Water management (pipelines) • Airstrip • Roads
	Knight Piésold	• Water management (water pumping system, primary pond sizing)
	SRK	• Earthwork volumes for water retention structures
Ore Crushing and Handling	SDE	• Buildings • Mechanical equipment • Piping • Electrical bulks • Instrumentation equipment and bulks • Detailed civil works • Concrete • Internal steel • Electrical supply/distribution (motor control centres (MCC) and switchgear) • Fine ore storage (reclaim tunnel, steel piles, stockpile cover, electrical, and instrumentation)
Process Plant	SDE	• Buildings • Mechanical equipment • Mechanical platework (tanks, bins, chutes excluded from vendor packages) • Piping • Electrical bulks • Instrumentation equipment and bulks • Detailed civil works • Concrete • Internal steel • Electrical supply/distribution (MCCs & switchgear) • Process control system (PCS), CCTV, control room

Description	Responsibility	Scope
On-Site Infrastructure	DT Engineers	• Detailed civil works • Buildings and camp • Mechanical equipment • Fuel tanks • Piping • Electrical supply (power plant) • Mobile equipment
	Sabina/Toric	• IT and communications • Fire protection and security
On-Site Infrastructure (Ex WBS 3000, 4000)	DT Engineers	• Concrete • Steel • Mechanical platework (minor tanks, bins, chutes excluded from vendor packages) • Electrical supply/distribution (MCCs and switchgear) • E-houses and plant lighting • Incinerator • First aid/EMT • Fuel pumping and distribution
Off-Site Infrastructure	Sabina	• Winter roads
MLA Infrastructure	Sabina	• Bulk earthworks • Camp • Mechanical equipment • Piping • Mobile equipment
	DT Engineers	• Concrete • Mechanical equipment (fuel loading/unloading, dispensing module) • Mechanical platework (tanks, bins, chutes excluded from vendor packages) • Pipeline (fuel) • Electrical
	Sabina/Toric	• IT and communications • Fire protection and security
In Pit Tailings	SDE	• Mechanical equipment • Piping (tailings and reclaim water)
Indirects	By scope above	• Camp and catering • Field indirects • Freight • Vendor reps • Spares • First fills

Description	Responsibility	Scope
Engineering and Procurement	MP	• Mining
	SDE	• Process plant and infrastructure
	SRK	• Inputs on tailings deposition approach and permafrost considerations
Construction and Construction Management	CGT	• All site construction
Owner's Costs	Sabina	• G&A (labour, offices, freight, misc. items)
Contingency	SDE/CGT/Sabina	• Mining, process, infrastructure, tailings, indirects, EPCM, and Owner's costs (labour, materials, equipment, sub-contract)

Source: SDE, 2021.

21.1.3 Mining

Open Pit Mining

Capital costs included for open pit mining have been prepared by MP and are shown in Table 21-3. Costs estimated as initial and sustaining capital include primary equipment, support equipment, and shop tool purchases, as well as fuel, labour, explosives, and maintenance spares in pre-production years.

Table 21-3: Open Pit Mining CAPEX (WBS 1000)

	Pre-production Years ($ million)
Included in Direct Costs	
Labour[1]	19.2
Mobile Equipment	24.8
Support Equipment	1.1
Tools and Equipment	0.4
Total	**45.6**
Included in Indirects	
Explosives	2.4
Maintenance and General Supplies	14.7
Fuel	11.6
Total	**74.4**

Source: MP, 2021.

Notes: [1] Labour costs exclude maintenance personnel.
Maintenance personnel and costs are estimated to cover maintenance for all equipment on site including mining, earthworks, WIR, and site service equipment.

Equipment purchases for operating years have been included as sustaining capital totalling $32.2 million.

Underground Mining

Underground mining commences in Year −1 in the Updated Feasibility Study. The study does not capture any benefits attained from use of a planned exploration decline as underground access. Underground mining starts through collaring the completed boxcut capturing all future costs of underground development at the time of writing.

Underground mining capital costs include mobile and stationary equipment, labour, and materials for pre-production (Table 21-4). In operating years labour and material costs are allocated to sustaining costs based on waste tonnage versus ore tonnage ratios.

Table 21-4: Underground Mining CAPEX (WBS 1000)

	Pre-production Years ($ million)
Direct Costs	
Labour[1]	2.1
Mobile and Stationary Equipment	7.8
Total	**9.9**
Captured as Indirect Costs	
Explosives	0.2
Maintenance	0.25
Fuel	1
Consumables	1.4
Total	**12.8**

Source: MP, 2021

Notes: [1] Labour costs exclude maintenance personnel.
Maintenance personnel and costs are estimated to cover maintenance for all equipment on site including mining, earthworks, WIR, and site service equipment.

Sustaining capital for underground mining has been included in sustaining capital, including the categories shown in Table 21-5.

Table 21-5: Underground Mining Sustaining Capital (WBS 1000)

	Total Sustaining Cost ($ million)
Mobile Equipment	113
Stationary Equipment	26
Underground Development	161
Sustaining Electrical, Mechanical, and Structural	16.9
Total	**317**

Source: MP, 2021

21.1.4 Basis of Cost Estimate for the Ore Handling, Process Plant, Infrastructure, and Tailings

As shown in Table 21-6, the basis of the cost estimate for ore handling, process plant, infrastructure, and tailings include the methods, organization, assumptions, and exclusions used to develop the Project CAPEX estimate.

Table 21-6: CAPEX Deliverables

Item	CAPEX Estimate Deliverables	Level Provided
	CAPEX Accuracy Range %	***±15%***
1	WBS	WBS Level 3
2	Basis of Estimate	Complete
3	Material Unit Rates	Recent Firm Quotes
4	Labour Crew Costs	Established by General Contractor
5	Labour Productivity Evaluation	Established by General Contractor
6	Major Equipment Pricing	Varies, Firm to Budget
7	Minor Equipment Pricing	Varies, Firm to Budget
8	Material Take-Offs from Engineering Deliverables	
	Mining	Mining Plan
	Civil Works and Site Preparation	Prelim. 3-D Model
	Concrete and Foundation Works	Prelim. 3-D Model
	Structural Steelwork	Prelim. 3-D Model
	Architectural Work and Buildings	Prelim. 3-D Model
	Mechanical Equipment	Equip. List
	Long Lead Mechanical Equipment/Materials	Equip. List
	Mechanical Materials	Equip. List
	Building Services (HVAC, Fire, Lighting, etc.)	Prelim. 3D Model
	Piping	P&IDs, GAs, Prelim. 3-D Model
	Electrical Works	Load List, GAs, Prelim. 3-D Model
	Instrumentation, Automation	P&IDs
	Camp	Preliminary
	Indirects	
9	Owner Costs	By Sabina
10	Spare Parts	Budget Quotes or Factored
11	First Fills	Budget Quotes or Factored
12	Commissioning	Preliminary
13	Land Purchase/Servitude Cost	Excluded
14	EPCM Costs	Budget and Firm Quotes
15	Temporary Buildings and Facilities	Preliminary
16	Construction Camp and Services	Preliminary
17	Project Logistics and Freights	Mass and Containers
	Allowances	
18	Foreign Exchange	Fixed
19	Escalation	Excluded
20	Contingencies	Evaluated
21	Risk	Sensitivity
22	MTO Growth Allowances	Neat Quantities

Source: SDE, 2021

Bulk material costs were estimated on a neat basis and incorporated into the estimate include the following components:

- Site development and bulk earthworks
- Concrete
- Steel work
- Mechanical bulks
- Architectural
- Piping
- Electrical and instrumentation bulks
- Facilities, both prefabricated and stick built.

The methodologies for costing of the major facilities are set out in Table 21-7.

Table 21-7: Facility Cost Basis

Facility	Cost Basis
Utilidors	Utilidors are required on site and were estimated from base engineering practices.
Operation Camps	Budget quotes have been obtained based on the estimated camp sizes.
Ancillary Buildings	Costs for facilities have been estimated based on design requirements, and costs estimated based on similar installations.
Power Plant	Budget quotes have been obtained based on the estimated design electrical load.
Incinerators	Sunk Cost.
Truck Shop and Wash Bay	Building sizes have been determined by Project requirements as a pre-engineered facility with services provided by SDE.
Fresh, Fire, Process, and Potable Water	Major holding tanks and pipelines have been quantified by engineering, and priced based on Project commodity costs. The potable water treatment plant has been estimated from a current budget quote.
Sewage Treatment	A budget quote has been obtained for the STP as being part of the camp.

Source: SDE, 2021; DT, 2021.

21.1.5 On-Site Development

The on-site development is described in Section 18 of this Updated Feasibility Study, and contains detailed descriptions of the site earthworks, drainage, airstrip, and miscellaneous infrastructure required for the Goose Site. A summary of the estimated costs for on-site development is shown in Table 21-8.

Table 21-8: On-Site Development Cost Estimate (WBS 2000)

Description	Initial ($ million)	Sustaining ($ million)	LOM Total ($ million)
Bulk Earthworks	0.3	0.7	1.0
Site Drainage	0.2	2.6	2.8
Sabina-Performed Earthworks	6.0	0	6.0
Total	**6.5**	**3.3**	**9.8**

Source: SDE, 2021.

21.1.6 Ore Crushing and Handling, and Process Plant

The ore crushing and handling facilities, and Goose process plant, are described in Section 17. Section 17 also contains the 3-D model images used to derive quantities. A summary of the estimated costs for ore handling and the process plant are shown in Table 21-9.

Table 21-9: Crushing and Handling, and Process Plant Cost Estimate (WBS 3000 & 4000)

Description	Initial ($ million)	Sustaining ($ million)	LOM Total ($ million)
Primary Crushing	2.0	-	2.0
Secondary Crushing	11.0	-	11.0
Tertiary Crushing	1.7	-	1.7
Screening	1.1	-	1.1
Fine Ore Storage	4.6	-	4.6
General Crushing Area	8.1	-	8.1
General Process Plant	30.0	12.9	30.0
Process Plant Building	5.7	-	18.7
Grinding	7.4	-	7.4
Gravity and Intensive Leaching	3.8	-	3.8
Leaching and Carbon Adsorption	14.3	-	14.3
Carbon Processing and Gold Recovery	1.3	-	1.3
Cyanide Destruction	4.6	-	4.6
Reagents	1.8	-	1.8
Process Utilities	21.9	-	21.9
Total	**119.3**	**12.9**	**132.2**

Source: SDE, 2021.

The ore handling and process plant sections of the estimate include the following scope:

- Detailed earthworks
- Concrete
- Internal steel (equipment supports and access platforms)
- Mechanical equipment

- Platework
- Piping
- Electrical
- Instrumentation and process control
- Buildings.

Sustaining CAPEX for plant expansion does not conform with the basis of estimate provided in Section 21.1.4. This sustaining CAPEX is estimated within a range of ±30%.

21.1.7 Infrastructure

On-Site Infrastructure (Goose)

The on-site infrastructure is described in Section 18. A summary of the on-site infrastructure costs is shown in Table 21-10.

Table 21-10: On-Site Infrastructure CAPEX Estimate (WBS 5000)

Description	Initial ($ million)	Sustaining ($ million)	LOM Total ($ million)
Electrical Supply and Distribution	40.8	0	40.8
Water Supply and Distribution	5.6	0	5.6
Fuel Storage and Distribution	13.4	4.7	18.3
Accommodations Camp	12.7	0	12.7
Domestic Waste Management	2.5	0	2.5
Ancillary Facilities	14.5	0	14.5
IT and Communications	2.8	0	2.8
Plant Mobile Fleet	1.5	0	1.5
Miscellaneous Infrastructure	2.7	0	2.7
Total	**96.8**	**4.7**	**101.5**

Source: DT, 2021.

Off-Site Infrastructure

Off-site infrastructure comprises the WIR, including associated mobile equipment and labour requirements. The off-site infrastructure is described in Section 18. Operating WIR costs are carried as indirects rather than as sustaining CAPEX. A summary of the WIR costs is shown in Table 21-11.

Table 21-11: Off-Site Infrastructure CAPEX Estimate—WIR (WBS 6000)

Description	Initial ($ million)	Sustaining ($ million)	LOM Total ($ million)
WIR	1.5	0	1.5
Total	**1.5**	**0**	**1.5**

Source: SDE, 2021; Sabina, 2021.

Marine Laydown Area

The MLA is described in Section 18. A summary of the bulk earthworks, fuel storage, mobile equipment, and infrastructure costs is shown in Table 21-12.

Table 21-12: MLA CAPEX Estimate (WBS 7000)

Description	Initial ($ million)	Sustaining ($ million)	LOM Total ($ million)
MLA—Electrical Supply and Distribution	0.7	0	0.7
MLA—Fuel Storage and Distribution	10.8	3.9	14.7
MLA—Earthworks	0	0.4	0.4
MLA—Ancillary Facilities	1.4	0	1.4
MLA—Information Technology and Communications	0.0	0.0	0.0
MLA—Mobile Equipment	6.4	0	6.4
Total	**19.3**	**4.2**	**23.5**

Source: DT, 2021.

21.1.8 Tailings Management Facility, Reclaim Water, and Pipelines

Tailings management is described in Section 18. A summary of the estimated costs for tailings management, reclaim water, and pipelines for the Goose Site is shown in Table 21-13.

Table 21-13: Tailings Management Facility and Pipelines Cost Estimate—Goose (WBS 8000)

Description	Initial ($ million)	Sustaining ($ million)	LOM Total ($ million)
Tailings Management	4.5	0.1	4.6
Total	**4.5**	**0.1**	**4.6**

Source: SDE, 2021.

21.1.9 Indirect Costs

Project indirect costs include services, supplies, and temporary facilities required to construct and operate the Project. The indirect costs are shown in Table 21-14.

Table 21-14: Indirect CAPEX Estimate (WBS 9000)

Description	Initial ($ million)	Sustaining ($ million)	LOM Total ($ million)
Camp and Catering	17.5	-	17.5
Heavy Construction Equipment (Prepayment Credits)	−1.0	-	−1.0
Construction Field Indirects	52.6	3.7	56.2
Freight and Logistics	40.5	-	40.5
Vendors Reps, Equipment Certification	16.2	-	16.2
Spares (Capital and First Year)	21.5	-	21.5
Fuel	29.5	-	29.5
Total	**176.9**	**3.7**	**180.6**

Source: SDE, 2021; Sabina, 2021.

Camp and Catering

Camp and catering costs have been estimated based on the Project worker hours and construction schedule. Preliminary quotes have been obtained for the camp and catering services based on the estimated construction camp size.

Construction Field Indirects

Construction field indirect costs are split into the following items:

- Shared services labour (pre-production G&A)
- Scaffolding and temporary support
- Equipment rentals and purchases
- Temporary construction facilities
- First aid and medical
- Waste management
- Incidental consumables
- Mobilization/demobilization
- Supervision
- Miscellaneous Costs.

Freight/Logistics

During construction, the annual material, equipment, and supplies requirements are planned to be shipped from the facilities of various suppliers to the marshalling areas. The supplies will then be shipped by ocean-going vessels to the MLA for later transport via the WIR. Section 24 provides additional details of the Project freight requirements.

Certain supplies that have limited storage onsite will be air freighted to site using fixed-wing aircraft.

The freight cost estimate includes the following items:

- Freight to staging port costs
- Sealift costs (staging port to MLA)
- Air freight costs
- Backhaul costs
- Sea-container rental costs
- Sealift support costs.

Vendor Representatives

Vendor representatives will be required at the Project site during construction to verify that installation of the main equipment has been performed in compliance with technical specifications. Representatives will also be required during the pre-commissioning stage. Vendor representative costs were not quoted but were factored in as a percentage of equipment costs.

Commissioning and Start-Up

Commissioning and start-up costs were based on supervision required for the plant and major equipment. Commissioning costs were factored in as a percentage of the equipment costs or estimated by appropriate suppliers.

Spare Parts

Spare parts have been considered for start-up, one year of operations, and capital. Spare parts for equipment were factored in as a percentage of the equipment costs.

First Fills

First fills are required for start-up, and include the following:

- Mill balls and grinding media
- Lime and reagents
- Lubricants
- Glycol for district heating
- Other fills for initial set-up.

First fills were not quoted but were factored in as a percentage of the equipment costs, other than reagents.

21.1.10 Engineering and Procurement

The engineering and procurement estimate uses a first-principles approach based on worker hours and consultant rates. Construction management costs are carried in indirect costs. The engineering, procurement, and construction management (EPCM) costs are summarized in Table 21-15.

Table 21-15: EPCM CAPEX Estimate (WBS 10000)

Description	Initial ($ million)	Sustaining ($ million)	LOM Total ($ million)
Engineering and Procurement	5.5	0	5.5
Total	**5.5**	**0**	**5.5**

Source: SDE, 2021; Sabina, 2021.

Associated services include the following:

- Detailed engineering
- Procurement
- Contract management
- Administration and document control
- Field engineering
- QA/QC
- Health and safety
- Surveying.

21.1.11 Owner's Costs

Owner's costs included in the cost estimate are based on the following:

- Owner's team and consultants during the implementation phase—includes Owner's labour, offices, Owner's consultants, and head-office overhead and costs, during detailed engineering and construction period
- Third-party costs
- Insurances and fees
- Owner's start-up and commissioning crew
- Recruitment and training of operation and maintenance staff
- Community associated costs
- Operational readiness and training
- Administration.

A summary of the Owner's costs is shown in Table 21-16.

Table 21-16: Owner's Cost Estimate (WBS 11000)

Description	Initial ($ million)	Sustaining ($ million)	LOM Total ($ million)
Project and Construction Management	55.3	0	55.3
Corporate Support and Expenses	1.6	0	1.6
Health, Safety, and Environment	6.5	0	6.5
Insurance and Financing	3.6	0	3.6
Commissioning and Operational Readiness	7.4	0	7.4
Total	**74.5**	**0**	**74.5**

Source: SDE, 2021; Sabina, 2021.

21.1.12 Contingency

Contingency is a provision of funds for unforeseen or inestimable costs that can be reasonably expected to occur based on the professional experience of the CAPEX team. It specifically excludes major design changes or changes to the scope of work.

Contingency does not cover *force majeure*, adverse weather conditions, government policy changes, currency fluctuations, escalation, or other Project risks.

The contingency factors take into account the quality of information available at the time of this report, including bulk pricing, fixed and budgetary quotes, and the level of completion of engineering. Significant portions of the Project pricing are quite advanced, including a large portion of process equipment with known pricing, and detailed involvement of construction contractors in preparing the capital cost estimate.

Contingency was estimated based on historical experience on similar projects, built up from individual contingency estimates for all major Project costs, including labour, schedule, material, and equipment risks. Contingency was calculated as a lump sum cost addition of $55.9 million to pre-production CAPEX in the last year of construction, which is an equivalent rate of 10% of CAPEX.

21.1.13 Sustaining Capital

The main sustaining CAPEX includes underground mine development occurring during the operations phase, and a nameplate expansion of the process facilities to 4,000 t/d. Sustaining CAPEX for underground mining represents the permanent infrastructure, and includes the main access ramps, ventilation raise accesses, level accesses, sumps, ore pass accesses, permanent explosive storage cut-outs, main ventilation raises, and mining equipment. Other sustaining CAPEX costs include earthworks for Umwelt pond, freshwater berms, and surface pipe movements.

The following sustaining capital items will be required for the site:

- Open pit sustaining CAPEX is used for replacing equipment over the LOM.
- Underground mining development and equipment purchases.

- On-site development sustaining CAPEX is used for running/moving additional pipelines for the water management at Umwelt pond, and drainage of the site.
- Process plant infrastructure to expand to 4,000 t/d includes a third crusher and a secondary stirred mill in parallel, along with associated material handling equipment, and pumping capacity upgrades.
- On-site infrastructure sustaining CAPEX is used for a water treatment plant.
- MLA infrastructure sustaining CAPEX is used for an additional fuel farm tank at the MLA Site and Goose in Year 2.
- Earthworks including:
  - SWP
  - Goose and Llama pit berms and diversions
  - Echo, Goose, and Llama surface infrastructure to support underground mining, such as ventilation and heating equipment, and associated civil/structural infrastructure.
- Tailings sustaining CAPEX is used for running/moving additional pipelines for the tailings management system.

21.1.14 Closure Cost Estimate

The closure cost estimate assumes closure activities will commence once mining operations stop. Closure will consist of two phases: active closure and post-closure. During the closure phase’s 2-year active stage, most earthworks and facility decommissioning will take place. Approximately 27,000 worker-days will be required for active closure, with the majority expected to be completed in Year 16. Following this, the closure phase’s passive stage will commence, and reclamation activities will continue, as water is collected and treated, and post-closure monitoring continues through the post-closure phase.

Mine closure and reclamation activities include the following:

- Constructing an on-site demolition landfill
- Managing hazardous waste
- Demolishing and disposing of all structures and equipment
- Landfilling all inert waste, including equipment drained of all oils and hazardous materials
- Transporting all hazardous waste from the Project sites
- Disposing all liners and pipelines
- Re-sloping and crowning all WRSAs and landfills
- Decommissioning the airstrips and all site roads
- Sealing all underground mine portals and vent raises
- Collecting and treating all contaminated soils onsite
- Water management and treatment
- Covering of the Echo TF with the Goose WRSA
- Passive flooding of the Umwelt TF and Goose Main pit

- Active flooding of the Llama TF
- Re-contouring the site areas to be consistent with the surrounding geography
- Scarifying disturbed surfaces.

The following assumptions were used to develop the closure cost estimate summarized in Table 21-17:

- Closure cost estimates used a blended rate of $95/h for contractor labour.
- Unit cost estimates were based on the contractor equipment fleet.
- No salvage costs were included in the closure cost estimate due to the impracticality and cost of transporting equipment to market, including the need to construct a dedicated.

Table 21-17: Basis of Closure and Reclamation Estimate Summary

Category	Estimate Basis
Open Pits	Open pit closure costs were estimated by applying unit costs from first principles and previous projects to estimated quantities based on current designs.
Undergrounds	Underground closure costs were estimated by applying unit costs from first principles and previous projects to estimated quantities based on current designs. Vent plugs were estimated using first principles.
Waste Rock Stockpiles and Landfills	Capping and sloping of waste rock stockpiles and landfills were estimated by applying unit costs to estimated volumes based on proposed footprints and tonnage.
Water Management Structures and TFs	Water management structure and TF closure costs were estimated by applying unit costs to material quantities estimated on current designs.
Buildings and Equipment	Buildings and equipment closure costs were estimated using previous project-closure production data, which were scaled by area and material quantities.
Roads and Airstrips	Roads and airstrip closure costs were estimated using first principles consistent with the designs.
Water Treatment	Decommissioning costs used unit cost data from previous projects. Pumping and treatment costs were based on operating costs for similarly sized equipment.
Contaminated Soil	Soil investigations were based on unit costs per metre drilled at the required intervals over the testing footprint. Contaminated soil treatment costs were estimated using first principles and were consistent with previous project-closure data.
Post-Closure / Closure Monitoring	Cost allowances were based on similar projects.
Indirects	Indirect costs were based on the required worker-days to complete active and post-closure activities and associated accommodation, fuel, tool, transportation and supply costs.

Source: Knight Piésold, 2021.

21.1.15 Capital Cost Exclusions

The following items have been excluded from this CAPEX estimate:

- Working or deferred capital
- Financing costs
- Refundable duties (except excise and other refundable fuel taxes)

- Currency fluctuations
- Time lost to *force majeure*
- Additional costs for accelerated or decelerated deliveries of equipment, materials, or services resulting from a change in Project schedule
- Warehouse inventories, other than those supplied in initial fills, capital spares, or commissioning spares
- Any Project sunk costs (studies, exploration programs, etc.)
- Escalation cost
- Depreciation and depletion allowances
- Environmental permits modifications
- Performance bond
- Builders risk insurance.

21.2 Operating Cost Estimate

21.2.1 Introduction and Summary

The operating cost (OPEX) estimate was developed using recent quotations and recent similar project data wherever possible. The OPEX estimate is based on owner operation of the Project, with limited use of contractors. The OPEX is built up based on key operating departments including mining, processing, power generation, oversight and management, and logistics costs.

The target accuracy of the OPEX is ±15%. This cost estimate was supported by the same responsibility matrix as described in Section 21.1.2.

The OPEX estimate is broken into the following sections:

- Open pit mining
- Underground mining
- Crushing and grinding
- Processing
- Site services, infrastructure, and power
- Freight, sealift, and WIR transportation excluding pre-production CAPEX
- MLA
- Tailings
- G&A, camp, and Owner's Costs.

Underground lateral and vertical waste development after the pre-production period has been included in sustaining CAPEX and will not appear as an OPEX (refer to Section 21.1.13). Capital waste development includes the mine's permanent infrastructure, and includes the main access ramp, ventilation raise accesses, level accesses, sumps, ore pass accesses, and permanent explosive storage cut-outs, as well as main ventilation raises.

The total operating unit cost is $141/t processed. LOM OPEX is summarized in Table 21-18, and Table 21-19 shows the annual OPEX by area.

Table 21-18: Estimated Average Operating Cost by Activity

Total Costs	Average Annual Costs ($ million/a)	LOM Costs ($ million)	Average Unit Costs ($/t)	Average Cost per Ounce Payable (US$/oz)
Open Pit Mining[1]	29	355	4.16	80.8
Underground Mining[1]	48	715	81.05	162.8
Processing Costs	46	693	37.06	157.9
Site and Offsite Services Including Freight	30	450	24.04	102.4
G&A	28	415	22.21	94.6
Total Operating Costs	**175**	**2,627**	**140.51**	**598.6**
Dore Refining, Transport, and Insurance	1	19	1.0	4.4
Royalties	22	335	17.9	76.2
Total Cash Costs	**198**	**2,981**	**159.4**	**679.2**
Sustaining Capital	23	419	22.4	95.5
All in Sustaining Costs	**221**	**3,400**	**181.8**	**774.6**

Source: MP, 2021; SDE, 2021.
Notes: [1] Average mining unit costs are estimated in reference to tonnes of material handled in each category. All other unit costs are estimated on the basis of processed tonnes.

Operating costs by category are shown in Table 21-19.

Table 21-19: Estimated Average Operating Cost by Category

OPEX	Average Cost per Tonne Processed ($/t)	LOM Cost ($/t)	Description
Labour	35.3	660	Labour except contractors
Fuel (excluding power generation)	12.2	229	Fuel for mobile and stationary equipment, excluding main generators at Goose site
Power	25.1	470	Fuel, maintenance and labour for power generation at Goose site
Freight, Contractors, Contract Services, Fees, Training, Miscellaneous	30.5	570	General expenses including contractors, fees, training, environmental costs, health and safety, insurances, consulting engineering
Consumables	25.3	474	Mining, processing, camp supplies
Equipment Maintenance	12.1	225	Maintenance parts and supplies
Total Carried as OPEX	**141**	**2,627**	

Source: SDE, 2021.

21.2.2 Operations Labour

Table 21-20 summarizes the total planned workforce during Project operations. Labour requirements were estimated based on a rotational work force, generally on a 2 x 2, fly in/fly out schedule.

Labour base rates and burdens were determined through reference to other northern Canadian operations, and through Sabina's experience on site. Labour burdens include overtime (scheduled and unscheduled), travel pay, production bonus for underground miners, Canada Pension Plan (CPP), Employment Insurance (EI), and Workers Compensation Board (WCB), statutory holiday, pension, and vacation pay allowances of 6% of scheduled hours, and insurance allowance of 8% of base pay.

Table 21-20: Summary of Average Employment by Activity

Department	Total Persons Employed (Average)[1]
Open Pit Mining	103
Underground Mining	149
Processing	68
Site Services	16
Freight	63
MLA	11
Tailings	5
G&A	88
Total	**488**

Source: MP, 2021; Sabina, 2021; SDE, 2021.
Notes: [1] Average of maximum quarter for each year of operations.
[2] Total will not sum as maximum employees in each area do not coincide in the same year.

Fuel

It is expected that fuel deliveries, using a marine shipping contractor, will originate on either the east or west coast of North America. Fuel costs are based on a quote from a vendor with experience in shipping fuel in the Canadian Arctic and include transportation and off-loading into tanks at MLA. Fuel costs used for mobile and non-mobile equipment used in the estimate are summarized in Table 21-21. Fuel prices were calculated based on delivered to the MLA; costs associated with hauling the fuel from the MLA to the Goose site are included in the freight cost.

A diesel price of $0.95/L inclusive of applicable taxes has been applied to the Project OPEX.

Table 21-21: Fuel Price Estimation

Fuel Assumptions	Unit	Mobile Equipment	Power Generation
Cost per Litre Delivered to the MLA by Ship	US$/L	0.55	0.55
F/X Rate	C$:US$	1.31	1.31
Canadian Cost	$/L	0.72	0.72
Diesel Rack Rate	$	0.72	0.72
Transport to Site		included in price	included in price
FET	$$	0.04	0.04
Nunavut Petroleum Tax	$	0.09	0.09
Carbon Tax	$	0.10	0.10
FET Rebate	$	0	(0.04)
Total Cost per Litre	$/L	**0.95**	**0.91**

Source: Sabina, 2021.

21.2.3 Mining

Open Pit Mine Operating Costs

The Owner is to undertake open pit mining activities, which include pit and waste operations, road maintenance, mine supervision, and technical services. The average open pit OPEX for the LOM plan is presented in Table 21-22 by mining facility and category for operating years.

Table 21-22: Open Pit OPEX Estimate—by Category

Open Pit Mining (WBS 01100)	Operating Period Costs ($ million)	Average Unit Cost Mined Open Pit ($/t)
Labour	177	2.07
Fuel	66	0.77
Consumables	8.5	0.10
Explosive Contract	3.6	0.04
Equipment Maintenance Supplies	100	1.17
Total Open Pit Mining Costs	**355**	**4.16**

Source: MP, 2021.

Underground Mine Operating Costs

Development, production, mine maintenance, mine services, and labour are components of the underground mine OPEX build-up. Equipment operating hours, productivities, labour, and consumables were estimated for the underground operation. Consumable usage was based on vendor quotes and consumption rates, and included rock bolts, explosives, drill bits, wire mesh, piping, and electrical power cables. Power consumption was estimated for every time period of mine life and added to Goose site power-generation costs.

Equipment consumables such as parts, tires, electrical power, diesel fuel, and ground-engaging tools (GET) were included in the equipment OPEX.

Stoping and drifting productivities, and OPEX, were estimated based on calculated cycle times for each operation, assuming standard drift and stope dimensions.

The average underground OPEX over the LOM is $81/t mined, excluding costs allocated to sustaining capital, and freight. The estimated costs are based on the LOM schedule presented in this report, and accounts for the material tonnages mined and their associated costs. Table 21-23 summarizes the total LOM underground mining costs by activity and category.

Mine production-cycle OPEX was developed from the mine plan. Haulage profiles were developed for combined ore and waste rock to determine required haulage hours.

Table 21-23: Average LOM Underground OPEX Estimate—by Category

Underground Mining (WBS 01200)	Operating Period Costs ($ million)	Average Unit Cost Mined Underground ($/t)
Labour	202	22.9
Fuel	113	12.8
Consumables	195	22.2
Equipment Maintenance Supplies	79	9.0
Total Underground Mining Costs	**715**	**81**
Underground sustaining capital costs	300	34.1
Total (including allocation from other areas)	**1,015**	**115**

Source: MP, 2021.

21.2.4 Process Operating Costs

The processing plant OPEX estimate includes:

- Process plant labour and consumables for operations
- Process plant maintenance for crushing, grinding, leaching, carbon handling, and gold refining
- Tailings equipment in the process plant, excluding TS and reclaim operations.

The power plant provides electricity to the entire Goose site and infrastructure facilities; a large component of the power consumed will be for the process plant. Power costs are included below as a separate line item, since power is generated through central power plant. Power costs are reallocated to processing based on consumption of power.

A summary of the process plant OPEX is presented in Table 21-24.

Table 21-24: Processing OPEX—by Category

Processing (WBS 03000 and 04000)	Operating Period Costs ($ million)	Average Unit Cost Processed ($/t)
Labour	121	6.5
Fuel	2	0.1
Power	306	16.4
Consumables	239	12.8
Maintenance	24	1.3
Total	**693**	**37.1**

Source: Canenco, 2020.

21.2.5 Site Services, Infrastructure, and Freight

Site services, Infrastructure and freight OPEX includes onsite and offsite operations including freight, sealift, winter ice road, infrastructure operations, maintenance, and support equipment. The costs that occur during the pre-production period are included in pre-production CAPEX, including indirect supporting costs. Details of this can be found in Section 21.1. Table 21-25 summarizes the infrastructure and site services OPEX.

Table 21-25: Site Services and Infrastructure OPEX

	Operating Period Costs ($ million)	Average Unit Cost Processed ($/t)
Labour	29	1.6
Fuel	47	2.5
Contractors	323	17.3
Consumables	30	1.6
Maintenance	20	1.1
Total	**450**	**24**

Source: SDE, 2021.

21.2.6 General and Administrative Costs and Owner's Operating Costs

G&A costs are grouped into the following categories:

- Labour:
  - Administrative staff
  - General management
  - Human resources
  - IT support
  - Community liaison
  - Site services
  - Camp staffing

  - Nurse and paramedic
  - On-site engineering and technical services
- Human resource expenses
- Camp, catering, and janitorial services
- Support equipment, fuel, and maintenance
- Satellite office
- Off-site engineering
- Contractor travel time, orientations, training
- Insurance
- Assay laboratory costs
- IT and communications
- Health, Safety, and Environmental
- Legal services
- Project rights, Kitikmeot Inuit Association fees, fees, and mineral tenures
- Owner's Costs
- Employee passenger travel (to and from site), including hotel compensation.

The total G&A unit OPEX is estimated at $23.30/t processed, excluding power, as summarized in Table 21-26.

Table 21-26: Summary of G&A and Owner's Costs

	Operating Period Costs ($ million)	Average Unit Cost Processed ($/t)
Labour	131	7.0
Fuel	1	0.1
Power	38	2.0
Fees, consultants, contractors, training, insurance, property costs, human resources costs, health and safety, IT expenses, environmental expenses	243	13.0
Consumables	1	0.0
Maintenance	2	0.1
Total	**415**	**22.2**

Source: SDE, 2021; Sabina 2021.

22 ECONOMIC ANALYSIS

In collaboration with Sabina, SDE carried out the economic evaluation of the Project based on production schedule, and applying operating, capital, and sustaining costs, as discussed earlier in this Technical Report. Economic assumptions were developed for both pre-tax and post-tax scenarios, and include the Project's NPV, internal rate of return (IRR), and payback period (time in years to recover the initial capital investment once operations commence).

Pre-tax and post-tax economic forecasts were prepared to a feasibility study-level guideline. Tax estimates were prepared and reviewed by PricewaterhouseCoopers (PwC) in Vancouver, BC, and include estimates of federal and Nunavut taxes with applicable deductions.

The following key inputs applied to arrive at the base case results, gold price, discount rate, and exchange rate. Table 22-1 and Table 22-2 summarize the base-case results of analyses performed. A discount rate of 5% has been applied to determine the base-case NPV of the Project.

Table 22-1: Base Case Results

Parameter	Unit	Value
Au Price	US$/oz	1,600
F/X Rate	C$:US$	1.31:1.00
Mine Life	years	15
Total Processed Ore	Mt	18.7
Average Processing Rate	t/d	3,670
Average Au Head Grade	g/t	6.0
Au Payable	LOM oz ('000s)	3,351
	oz/a ('000s)	223

Source: SDE, 2021.

Table 22-2: Analyses Base Case Results

Description	Unit	Value (US$)	Value (C$)
Average Milling Rate	t/d	3,670	
Mining (Open Pit)	$ million	271	355
Mining (Underground)	$ million	546	715
Process	$ million	529	693
Onsite and Offsite Services Including Freight	$ million	343	450
G&A	$ million	317	415
Doré Transportation, Refining, and Insurance	$ million	15	19
Royalties	$ million	255	335
Average LOM Gold Recovery	%	93.4	
Pre-Tax $NPV_{5\%}$	$ million	1,308	1,713
Pre-Tax IRR	%	33.3	
Pre-Tax Payback Period	years	2.29	
Post-Tax $NPV_{5\%}$	$ million	860	1,126
Post-Tax IRR	%	27.7	
Post-Tax Payback Period	years	2.35	

Source: SDE, 2021.

22.1 Assumptions

All costs and economic results are reported in Canadian dollars ($), unless otherwise stated. Metal prices are reported in Section 19. Numbers are presented on a 100% equity ownership and financing basis, and do not include corporate costs or financing costs. Costs are based on nominal 2021 Canadian dollar values, with no inflation (constant-dollar basis) applied through the Project life. The CAPEX and OPEX estimates have been developed specifically for this Project and are summarized in Sections 21. Details of the production schedule used for this economic analysis are described in Section 16. All pre-financing or sunk costs such as exploration and resource definition costs, engineering fieldwork, studies costs, environmental baseline studies costs, and others are excluded. Provincial sales tax (PST), Goods and Services Tx (GST), or duties are not applied.

Sensitivity analyses were performed for variations in metal prices, C$:US$ exchange rate, operating costs, capital costs and gold grade and recovery to determine the economic impact of changes in these variables on Project economics.

22.2 Methodology Used

Analysis was carried out using Sabina's discounted cash-flow model, which uses mid-year discounting. The pre-production period is estimated to be three years, with NPV and IRR estimated at the point of financing. Exchange rates are held constant, and cost inflation is not accounted.

Gold revenues were forecast based on each price scenario. Operating costs and off-site charges were deducted from the gross revenue to estimate annual operating cash flow.

Sustaining capital costs, as well as closure and reclamation costs, have been applied on an annual basis over the LOM and deducted from the operating cash flow to determine the net pre-tax cash flow. Initial capital costs have been applied over the pre-production years and include costs accumulated prior to first production of doré and pre-production mining costs.

22.3 Timing of Revenue and Working Capital

22.3.1 Working Capital

Annual working capital has been accounted for in the economic analysis due to the timing difference between cash outflows and cash inflows with respect to the operating costs considering procurement and logistics.

22.3.2 Revenue and Net Smelter Revenue Parameters

Project revenues are derived from the sale of gold doré. As yet there are no contractual arrangements for refining. Gold production and sales are assumed to begin in Year 1 and continue for LOM years. Table 22-3 outlines the market terms used in the economic analysis.

Table 22-3: NSR Assumptions Used in the Economic Analysis

Assumptions	Unit	Value
Au Payable	%	99.98
Au Refining Charge	US$/oz	1.00
Insurance	% of payable value	0.15
Transport Cost	US$/oz	1.00

Source: SDE, 2021.

22.4 Taxes

The Project has been evaluated on a post-tax basis to reflect an indicative, but still approximate, Project value. Nunavut mineral royalties, federal income taxes, and Nunavut income taxes were applied to the Project. PwC completed a detailed tax analysis for the post-tax valuation. Commodity taxes have been excluded from the economic analysis.

The following assumptions and methodologies were used in the analysis:

- Nunavut Mineral Royalties:
  - Nunavut mineral royalties have been evaluated as part of the post-tax analysis. The federal government, under the NMR requires a royalty be paid to the federal government on defined mining profits. The Crown royalty is levied on a mine-by-mine basis and is equal to the lesser of 13% of the net value of mine output during a fiscal year, and an escalating rate from 0% to 14% on incremental levels of net value of the mine output during a fiscal year.
  - Generally, the formula to calculate the output of a mine for a fiscal year is based on the profits from both mining and processing operations, minus a processing allowance that removes from taxable profits a given return on the investment in processing assets. Profits are net of mine site OPEX,

exploration costs, depreciation on depreciable mine assets, and a development allowance on pre-production costs. The royalties payable under the NMR are not subject to the rules in the *Income Tax Act* (Canada); however, any royalties paid are deductible for income tax purposes under the *Income Tax Act* (Canada).

  - Mineral claims or leases established prior to the NLCA are grandfathered properties; these have the option of paying royalties based on NMR or negotiating a royalty agreement with the designated Inuit organization. NTI is the designated Inuit organization that has vested title to IOL.
  - The Project Mineral Resources considered in this study occur on grandfathered properties subject to royalties under the NMR.

- Federal and Territorial Corporate Income Tax:
  - Federal income taxes have been calculated using the current enacted corporate rate of 15% to all estimated pre-tax cash flow generated by the Project. The component of pre-tax cash flow related to the Project will generally be determined by the net operating profits, including deductions for any territorial royalty or mining taxes paid, and discretionary deductions for capital cost allowance (CCA), Canadian exploration expenses (CEE), Canadian development expenses (CDE) and reclamation costs paid up to three years after the cessation of pre-tax income. Opening balances of tax pools were incorporated based on Sabina's existing balances, as provided by Management.
  - Nunavut income taxes have been calculated using the current enacted corporate rate of 12% to all estimated pre-tax cash flow generated by the Project. Nunavut income tax is levied on taxable income as determined for federal purposes.
  - Federal income taxes have been educed by an available investment tax credit (ITC) carry-forward balance. This ITC, based on qualifying pre-production mining expenditures, was discontinued after 2015. Sabina earned these ITCs in taxation years through 2015.
- Mineral Property Tax Pools:
  - CEE consists of Canadian exploration expenses incurred for the purpose of determining the existence, location, extent, or quality of a Mineral Resource in Canada. CEE does not include depreciable property of another prescribed class. CEE accumulates in a cumulative CEE pool, and a deduction up to the lesser of the CEE pool balance or taxable income may be claimed each year. The CEE pool balance does not expire and can be carried forward indefinitely. CEE renounced to flow-through share investors will reduce the CEE pool.
  - CDE consists of resource property acquisition costs, many pre-production expenses of bringing a new mine into production (including constructing shafts and haulage ways, or similar underground work) and any exploration drilling costs incurred after the mine comes into commercial production. CDE does not include depreciable property of another prescribed class. CDE is accumulated in a cumulative CDE pool and is eligible for a deduction of up to 30% of the unclaimed CDE balance each year, calculated on a declining basis. The CDE pool balance does not expire and can be carried forward indefinitely.

- Capital Cost Allowance:
  - Specific capital cost class CCA rates were applied and used to calculate the appropriate CCA that Sabina can claim during the entire life of the Project.
  - Capital assets acquired for the purpose of producing income from a mine have been included in Class 41. A CCA deduction is permitted in computing taxable income of up to a maximum of 25% on a declining basis and is subject to a 50% reduction on assets acquired during the year. An accelerated rate, over the 25%, is permitted in certain circumstances.

22.4.1 Third-Party Royalties

The Project is subject to NSR royalties payable to various third-party royalties which have been considered in the economic analysis. A total of $335 million of third-party royalties are payable over the LOM, based on the Project's mine schedule and base-case assumptions.

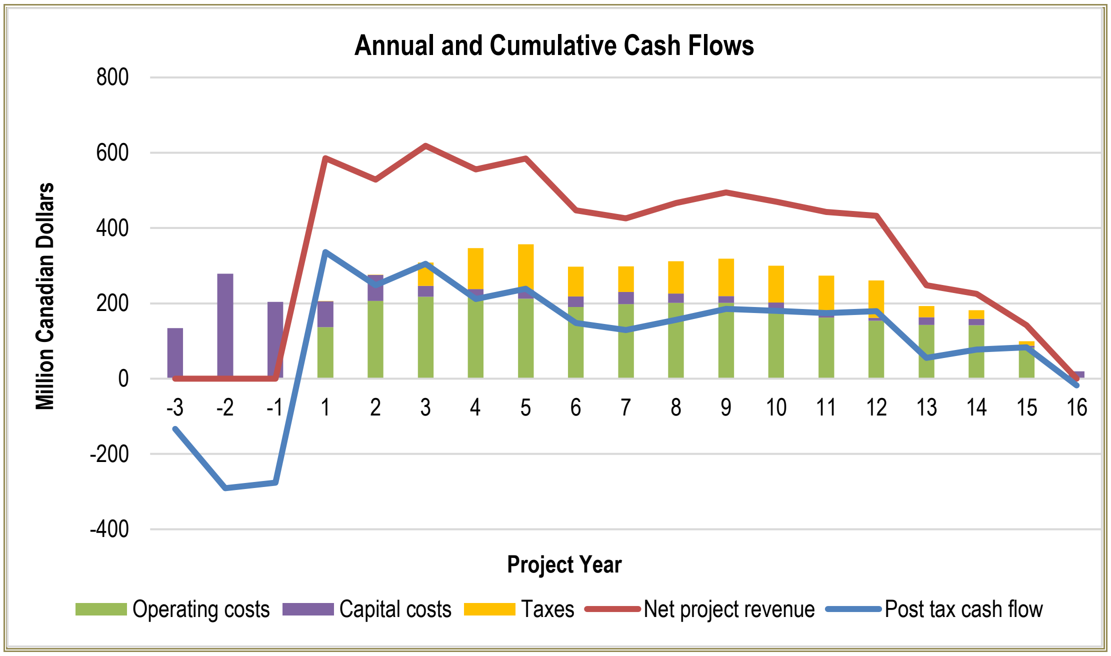
In 2011, Sabina completed the purchase of certain royalties on the Back River and Wishbone Project. The remaining NSR royalties that would apply to the Goose claim area deposit (and other mineral claim areas on the Project, if any) are Goose properties—0.7% NSR payable on the first 400,000 oz of gold production, increasing to 4.25% on gold production over 400,000 oz.

In addition, as described in Section 4, in 2018 Sabina granted a 1% NSR to the Kitikmeot Inuit Association as part of a definitive Framework Agreement. The Framework Agreement, which provides the commercial leases authorizing mine development and operations, is a comprehensive agreement that sets out rights and obligations with respect to surface land access on Inuit owned land at the Back River Project. The Framework Agreement includes an IIBA and other obligations required by the Nunavut land claims agreement.

22.5 Economic Analysis

Based on the findings of this Updated Feasibility Study, it can be concluded that the Project would be economically viable, with a post-tax IRR of 27.7% and a net present value at 5% discount ($NPV_{5\%}$) of $1,126 million. Figure 22-1 shows the projected cash flows used in the economic analysis. Table 22-4 shows the detailed results of the evaluated scenario.

Payback is estimated on annual cash flows without considering discount rates or inflation.



Source: SDE, 2021.

Figure 22-1: Annual and Cumulative Cash Flows

Table 22-4: Summary of Economic Results

Category	Unit	Value (US$)	Value ($)
Operating Costs	$ million	2,006	2,627
Cash Flow from Operations	$ million	3,085	4,042
Initial Capital Costs[1]	$ million	466	610
Sustaining Capital Costs	$ million	320	419
Cash Costs[2]	US$/oz	679	890
All-In Sustaining Cash Costs[3]	US$/oz	775	1,015
Net Pre-Tax Cash Flow	$ million	2,303	3,018
Pre-Tax $NPV_{5\%}$	$ million	1,308	1,713
Pre-Tax IRR	%	33.3	
Pre-Tax Payback	years	2.29	
Total Taxes	$ million	757	992
Net Post-Tax $NPV_{5\%}$	$ million	860	1,126
Post-Tax IRR	%	27.7	
Post-Tax Payback	years	2.35	

Source: SDE, 2021.
Notes: [1] Includes pre-production directs and indirects, and contingency.
[2] (Refining Costs + Insurance + Transport Costs + Third Party Royalties + Operating Costs) / Payable Au oz.
[3] (Refining Costs + Insurance + Transport Costs + Third Party Royalties + Operating Costs + Sustaining Capital Costs)/Payable Au oz.

22.6 Sensitivity

A sensitivity analysis was performed on the base-case financial model to determine the variables with the greatest impact on Project value, as indicated by the post-tax NPV and IRR using a 5% discount rate. The results of this analysis are shown in Table 22-5 to Table 22-7.

Given that most of the Project's costs are in Canadian dollars and its revenues in US dollars, the Project proved to be most sensitive to changes in the foreign exchange rate, followed by metal prices, and head grades; it is least sensitive to CAPEX and OPEX.

A sensitivity analysis of the pre-tax and post-tax results was performed using various discount rates. The results of this analysis are shown in Table 22-7.

Table 22-5: Pre-Tax NPV$_{5\%}$ and IRR Sensitivity Results to Gold Price and Exchange Rate

NPV 5% ($ million)		Au Price (US$/oz)				
IRR (%)		1,000	1,300	1,600	1,900	2,200
C$ to US$	0.95	(379)	178	601	1,005	1,407
		-6.8%	9.3%	18.4%	25.7%	32.2%
	0.90	(263)	283	721	1,146	1,570
		-2.4%	11.7%	20.7%	28.1%	34.6%
	0.85	(132)	397	854	1,304	1,752
		1.6%	14.2%	23.1%	30.6%	37.2%
	0.80	2	523	1,005	1,481	1,958
		5.1%	16.8%	25.7%	33.3%	40.0%
	0.76	93	625	1,126	1,626	2,125
		7.3%	18.8%	27.7%	35.4%	42.2%
	0.70	261	821	1,367	1,912	2,455
		11.2%	22.5%	31.6%	39.4%	46.4%
	0.65	408	1,004	1,590	2,176	2,760
		14.4%	25.7%	34.9%	42.9%	50.0%
	0.60	576	1,215	1,851	2,484	3,117
		17.9%	29.2%	38.6%	46.8%	53.9%

Source: SDE, 2021.

Table 22-6: Post-Tax NPV$_{5\%}$ and IRR Sensitivity Results to CAPEX and OPEX

NPV 5% ($M)		CAPEX						
IRR (%)		-15.0%	-10.0%	-5.0%	0.0%	+5.0%	+10.0%	+15.0%
OPEX	-15.0%	1,371	1,343	1,315	1,286	1,258	1,230	1,201
		35.3%	33.5%	31.9%	30.5%	29.1%	27.8%	26.6%
	-10.0%	1,318	1,290	1,261	1,233	1,205	1,176	1,148
		34.3%	32.6%	31.0%	29.6%	28.2%	27.0%	25.8%
	-5.0%	1,265	1,236	1,208	1,180	1,151	1,123	1,095
		33.3%	31.6%	30.1%	28.7%	27.3%	26.1%	25.0%
	0.0%	1,211	1,183	1,155	1,126	1,098	1,070	1,041
		32.3%	30.7%	29.1%	27.7%	26.5%	25.3%	24.1%
	+5.0%	1,158	1,130	1,101	1,073	1,045	1,017	987
		31.3%	29.7%	28.2%	26.8%	25.6%	24.4%	23.3%
	+10.0%	1,105	1,076	1,048	1,020	992	963	934
		30.3%	28.7%	27.2%	25.9%	24.7%	23.5%	22.4%
	+15.0%	1,051	1,023	995	967	938	909	880
		29.2%	27.7%	26.3%	25.0%	23.8%	22.6%	21.6%

Source: SDE, 2021.

Table 22-7: Post-Tax NPV$_{5\%}$ and IRR Sensitivity Results (Grade and Recovery)

NPV 5% ($M)		Au Grade						
IRR (%)		-15.0%	-10.0%	-5.0%	0.0%	+5.0%	+10.0%	+15.0%
Recovery	-15.0%	381	501	617	730	842	955	1,067
		13.9%	16.4%	18.7%	20.9%	22.9%	24.9%	26.8%
	-10.0%	501	624	743	862	982	1,100	1,219
		16.4%	18.8%	21.1%	23.3%	25.3%	27.3%	29.2%
	-5.0%	617	743	868	995	1,120	1,245	1,370
		18.7%	21.1%	23.4%	25.6%	27.6%	29.7%	31.6%
	0.0%	730	862	995	1,126	1,258	1,390	1,522
		20.9%	23.3%	25.6%	27.7%	29.9%	31.9%	33.9%
	+5.0%	842	982	1,120	1,258	1,397	1,535	1,673
		22.9%	25.3%	27.6%	29.9%	32.0%	34.1%	36.1%
	+10.0%	955	1,100	1,245	1,390	1,535	1,680	1,826
		24.9%	27.3%	29.7%	31.9%	34.1%	36.2%	38.2%
	+15.0%	1,067	1,219	1,370	1,522	1,673	1,826	1,977
		26.8%	29.2%	31.6%	33.9%	36.1%	38.2%	40.2%

Source: SDE, 2021.

22.7 Project Cash Flows

Based on the forecast project production, revenue, capital and operating costs, cash flows, and taxes were modelled in C$. Table 22-8 presents a summary version of the cash flow model, from which forecast economic results.

Table 22-8: Economic Cash Flow Model

	Unit	Total/Average	Year																			
			-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Open pit production tonnes	t '000s	9,883	-	558	1,606	861	383	918	664	751	466	426	496	623	759	860	512	-	-	-	-	-
Underground production tonnes	t '000s	8,816	-	-	-	21	612	728	756	756	560	554	630	704	677	642	523	540	682	429	-	-
Total tonnes mill feed as mined	t '000s	18,698	-	558	1,606	882	995	1,646	1,420	1,507	1,025	980	1,126	1,327	1,436	1,502	1,035	540	682	429	-	-
Total mill feed	**t '000s**	**18,698**	**-**	**-**	**-**	**935**	**1,186**	**1,460**	**1,460**	**1,460**	**1,460**	**1,460**	**1,460**	**1,460**	**1,460**	**1,460**	**1,460**	**865**	**682**	**429**	**-**	**-**
Mill feed grade	g/t	6.0	-	-	-	10.2	7.4	7.2	6.5	6.8	5.2	4.9	5.3	5.7	5.4	5.1	4.9	4.8	5.5	5.5	-	-
Contained ounces	oz '000s	3,588	-	-	-	306	281	338	303	317	242	230	251	266	252	237	232	134	122	76	-	-
Recovered ounces	oz '000s	3,351		-	-	285	261	312	281	295	226	215	236	250	237	224	219	125	114	72	-	
Recovery	%	93.4				93.1%	92.8%	92.5%	92.8%	93.1%	93.3%	93.5%	93.9%	93.9%	94.1%	94.3%	94.2%	93.5%	93.5%	93.6%		
Payable ounces	**oz '000s**	**3,351**		**-**	**-**	**285**	**261**	**312**	**281**	**295**	**226**	**215**	**236**	**250**	**237**	**224**	**219**	**125**	**114**	**72**	**-**	
Gross revenue	$ million	7,023	-	-	-	598	547	655	588	619	473	451	494	524	497	469	458	263	238	150	-	-
Refining, selling and insurance	$ million	(19)	-	-	-	(2)	(2)	(2)	(2)	(2)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(0)	-	-
Royalties	$ million	(335)	-	-	-	(10)	(17)	(34)	(31)	(32)	(25)	(24)	(26)	(27)	(26)	(25)	(24)	(14)	(12)	(8)	-	-
Net revenue		**6,669**	**-**	**-**	**-**	**586**	**529**	**618**	**556**	**585**	**447**	**426**	**467**	**495**	**470**	**443**	**433**	**248**	**225**	**142**	**-**	**-**
Operating Costs																						
Open pit mining costs	$ million	(355)	-	-	-	(34)	(39)	(37)	(37)	(37)	(27)	(33)	(30)	(28)	(21)	(15)	(10)	(4)	(3)	-	-	-
Underground mining costs	$ million	(715)	-	-	-	(11)	(53)	(60)	(60)	(57)	(49)	(51)	(58)	(60)	(53)	(41)	(39)	(44)	(49)	(30)	-	-
Processing costs	$ million	(693)	-	-	-	(38)	(45)	(50)	(50)	(50)	(50)	(50)	(50)	(50)	(50)	(50)	(51)	(43)	(37)	(26)	-	-
Site services, freight	$ million	(450)	-	-	-	(27)	(39)	(39)	(37)	(38)	(34)	(33)	(34)	(33)	(30)	(28)	(27)	(24)	(26)	(1)	-	-
G&A	$ million	(415)	-	-	-	(26)	(29)	(29)	(29)	(29)	(29)	(29)	(29)	(29)	(28)	(26)	(26)	(26)	(26)	(24)	-	-
Total operating costs	**$ million**	**(2,627)**	**-**	**-**	**-**	**(136)**	**(206)**	**(216)**	**(215)**	**(211)**	**(189)**	**(197)**	**(200)**	**(200)**	**(182)**	**(161)**	**(152)**	**(141)**	**(141)**	**(81)**	**-**	**-**
Average units costs																						
Open pit mining costs	$/t	(36)	-	-	-	(39)	(102)	(41)	(56)	(49)	(59)	(78)	(60)	(45)	(27)	(17)	(19)	-	-	-		
Underground mining costs	$/t	(81)	-	-	-	(510)	(87)	(82)	(80)	(75)	(87)	(92)	(92)	(85)	(79)	(64)	(74)	(81)	(72)	(71)		
Processing costs	$/t	(37)	-	-	-	(43)	(45)	(31)	(35)	(33)	(49)	(51)	(45)	(38)	(35)	(34)	(49)	(79)	(55)	(61)	-	
Site services, freight	$/t	(24)	-	-	-	(31)	(39)	(24)	(26)	(25)	(33)	(34)	(30)	(25)	(21)	(19)	(26)	(45)	(38)	(1)	-	
G&A	$/t	(22)	-	-	-	(30)	(29)	(18)	(21)	(19)	(28)	(30)	(26)	(22)	(19)	(17)	(25)	(49)	(38)	(56)	-	
Total	**$/t**	**(140.5)**	**-**	**-**	**-**	**(154)**	**(207)**	**(131)**	**(151)**	**(140)**	**(185)**	**(201)**	**(178)**	**(151)**	**(126)**	**(107)**	**(147)**	**(261)**	**(206)**	**(189)**	**-**	**-**
Operating income	$ million	4,042	-	-	-	450	323	402	341	374	258	229	267	295	288	282	281	107	84	60	-	-
Capital Costs																						
Mining	$ million	(404)	(26)	(17)	(13)	(50)	(54)	(29)	(21)	(21)	(25)	(31)	(24)	(18)	(20)	(12)	(6)	(17)	(17)	(4)	-	-
On-Site Development	$ million	(10)	(3)	(2)	(1)	(1)	(2)	-	(0)	-	-	(0)	-	-	-	-	-	-	-	-	-	-
Ore Crushing and Handling	$ million	(29)	(2)	(22)	(4)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Process Plant	$ million	(104)	(11)	(66)	(14)	(13)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	Unit	Total/Average	Year																			
			-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
On-Site Infrastructure (Goose)	$ million	(101)	(34)	(53)	(9)	-	(5)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Off-Site Infrastructure	$ million	(1)	(0)	(1)	(1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MLA	$ million	(24)	(19)	(0)	(0)	(4)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tailings	$ million	(5)	-	(3)	(1)	-	(0)	-	(0)	-	-	-	(0)	(0)	-	-	-	-	-	-	-	-
Indirects	$ million	(181)	(32)	(79)	(66)	-	(4)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EPCM	$ million	(6)	-	(4)	(2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Owner Costs	$ million	(68)	(6)	(25)	(37)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reclamation	$ million	(42)	-	-	-	-	(4)	-	-	(4)	(3)	(2)	-	-	-	(2)	(2)	(4)	-	(2)	(19)	-
Total capital costs—pre-contingency	$ million	(973)	(134)	(272)	(148)	(69)	(67)	(29)	(21)	(24)	(28)	(33)	(24)	(18)	(20)	(14)	(8)	(21)	(17)	(6)	(19)	-
Contingency	$ million	(56)	-	-	(56)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Capital Costs	**$ million**	**(1,029)**	**(134)**	**(272)**	**(204)**	**(69)**	**(67)**	**(29)**	**(21)**	**(24)**	**(28)**	**(33)**	**(24)**	**(18)**	**(20)**	**(14)**	**(8)**	**(21)**	**(17)**	**(6)**	**(19)**	**-**
Working Capital	$ million	(0)	-	-	(68)	(35)	(5)	1	2	11	(4)	(2)	(0)	9	10	4	6	0	30	41	(0)	-
Bonding	$ million	5	-	(12)	(4)	(8)	-	(5)	-	-	2	3	2	-	-	-	2	0	4	-	2	19
Pre-tax cash flow	$ million	3,018	(134)	(285)	(275)	338	250	370	322	361	228	197	245	286	278	272	280	86	101	95	(18)	19
Taxes	$ million	(992)	-	-	-	(0)	(0)	(66)	(109)	(121)	(79)	(68)	(87)	(100)	(98)	(98)	(100)	(30)	(23)	(12)	-	-
Post-tax cash flow	**$ million**	**2,026**	**(134)**	**(285)**	**(275)**	**338**	**250**	**304**	**213**	**239**	**149**	**129**	**158**	**186**	**181**	**174**	**180**	**56**	**78**	**83**	**(18)**	**19**
Cumulative post-tax cash flow			(134)	(419)	(694)	(356)	(106)	197	410	649	799	928	1,086	1,272	1,452	1,627	1,807	1,863	1,941	2,024	2,007	2,026
Pre-tax NPV	**$ million**	**1,713**																				
Pre-tax IRR	**%**	**33.3**																				
Post-tax NPV	**$ million**	**1,126**																				
Post-tax IRR	**%**	**27.7**																				
Post-tax payback period	**years**	**2.35**																				

Source: SDE, 2021.

23 ADJACENT PROPERTIES

Relevant adjacent properties within the vicinity of the Back River Property are the Qannituq Property held by Silver Range Resources, and the Hackett River Property held by Glencore Canada.

The Qannituq Property consists of two contiguous mineral claims, covering 2,500 hectares adjacent to the northwest boundary of the Goose Site. The claims are underlain by Beechey Lake metasedimentary rocks intruded by granite, which hosts iron formation-style gold mineralization. Most recent exploration at the prospect included reconnaissance prospecting completed in 2017 (Silver Range Resources, 2021).

The Hackett River Property is 50 km west-northwest of the George site, and is a large, undeveloped, volcanogenic massive sulphide deposit that Sabina sold to Xstrata in 2011. Glencore Canada Corp. acquired Xstrata and the Hackett River project in 2013.

The following text is taken from Sabina's news release, dated 2 June 2011:

> *Under the terms of the Agreement, Xstrata has agreed to pay cash consideration of $50 million. Sabina will reserve a silver production royalty equal to 22.5% of the first 190 million ounces of payable silver from the current resource at Hackett River and other properties and 12.5% of all payable silver from the Properties thereafter at no future cost to Sabina.*

24 OTHER RELEVANT DATA AND INFORMATION

24.1 Operational Logistics

The logistics and transportation of construction equipment and materials along with operating supplies, costs, and freight tonnes have been updated. Marshalling areas and port selections have been revisited and revised to better suit the current Project requirements.

This logistics and transportation report update outlines:

- Dry-freight quantities for the pre-production and production phases of the Project (CAPEX/OPEX)
- Methodology for transporting all dry freight from the vendor to the MLA
- Costs associated with transporting dry freight
- Fuel quantities for the Project pre-production and production phases
- Methodology for transporting fuel to the MLA
- Fuel cost
- Transporting personnel.

All items listed have been updated to reflect current 2021 volumes and costs.

All dry freight will be shipped by roll on/roll off for mobile equipment; break bulk for equipment and materials not amenable for container transport; and 20 ft containers for items that can be containerized. Fuel will be transported in combination (combi) freight/fuel barges and in bulk tankers once storage capacity has been established. Prior to establishing infrastructure and the summer shipping season, fuel will continue to be flown into the Goose Site from Yellowknife.

A variety of chartered aircraft will be used for passengers and freight. Passenger flights will originate in Edmonton for North American and other global origins, stopping in Yellowknife to pick up additional passengers and refuel. Passenger and freight flights to the MLA will originate in Yellowknife. Personnel from the Northern Indigenous communities will fly to Yellowknife on regular commercial flights, for transport to the Project site on the Company charter. While the flights from Edmonton will be primarily passenger flights, from time to time there may be small freight loads on these flights. Most air freight will originate in Yellowknife.

24.1.1 Load List

All construction materials and equipment used while constructing the MLA and Goose Site will be transported by aircraft directly to the Goose Site or sealifted to the MLA. Goods destined for the Goose Site during the sealift season will be stored at the MLA pending establishment of the WIR, then trucked via the WIR to the Goose Site. Annual material and equipment quantities required during the production period are listed in Table 24-1.

Table 24-1: Production Freight Requirements (Tonnes)

	Open Pit and Underground Explosives	Open Pit Mining	Underground Mining	Ore Crushing and Handling	Process Plant	Total
Year 1	3,019	718	4,658	1,792	7,291	**17,478**
Year 2	4,162	726	25,793	2,273	9,248	**42,202**
Year 3	3,700	754	25,131	2,797	11,382	**43,764**
Year 4	3,457	774	22,382	2,797	11,382	**40,792**
Year 5	3,220	893	16,186	2,797	11,382	**34,478**
Year 6	1,651	484	15,156	2,797	11,382	**31,470**
Year 7	2,650	546	17,321	2,797	11,382	**34,696**
Year 8	2,488	570	22,414	2,797	11,382	**39,651**
Year 9	2,460	367	22,612	2,797	11,382	**39,618**
Year 10	2,220	363	16,411	2,797	11,382	**33,173**
Year 11	1,757	323	12,767	2,797	11,382	**29,026**
Year 12	1,002	188	10,227	2,797	11,382	**25,596**
Year 13	741	44	11,271	1,658	6,745	**20,459**
Year 14	684	40	16,893	1,307	5,320	**24,244**
Year 15	364	0	8,708	822	3,346	**13,240**
Total	**33,575**	**6,790**	**247,930**	**35,822**	**145,770**	**469,887**

Source: Sabina, 2021.

Note: Quantities are shown in the year they are required at site, and the procurements and staging of equipment, materials, and fuel at the respective east and west coast ports needs to take place at least 10 months before anticipated arrival at site.

In addition to the freight requirements, 719 ML of fuel is required over the 15-year operations period. All fuel required during the production period will be transported by ocean-going vessels during the annual sealift. The inbound fuel breakdown by site is shown in Table 24-2 and Table 24-3.

Table 24-2: Production Fuel Requirements (Litres)

	Winter Ice road	Open Pit Mining	Underground Mining	Crushing and Handling	Process Plant	Site Services Power and Infrastructure	MLA	Tailings and Ponds	General and Administrative	Total
Year 1	1,932,092	6,034,921	3,334,687	118,400	37,000	22,343,049	355,680	532,800	103,320	**34,791,949**
Year 2	2,954,251	7,272,384	8,565,841	118,080	36,900	31,756,855	353,340	531,360	103,320	**51,692,331**
Year 3	3,062,927	7,015,773	9,114,591	118,080	36,900	35,499,294	353,340	531,360	103,320	**55,835,585**
Year 4	2,963,696	6,913,543	9,360,188	118,080	36,900	35,074,106	353,340	531,360	103,320	**55,454,533**
Year 5	2,755,946	6,809,167	9,182,244	118,400	37,000	34,962,585	355,680	532,800	103,320	**54,857,142**
Year 6	2,568,349	3,488,097	8,311,580	118,080	36,900	32,874,346	353,340	531,360	103,320	**48,385,372**
Year 7	2,711,359	5,640,155	7,628,950	118,080	36,900	34,141,221	353,340	531,360	103,320	**51,264,685**
Year 8	2,900,918	5,392,587	8,684,815	118,080	36,900	35,462,596	353,340	531,360	103,320	**53,583,916**
Year 9	2,901,078	5,327,406	8,810,196	118,400	37,000	35,484,111	355,680	532,800	103,320	**53,669,991**
Year 10	2,691,120	5,315,719	8,863,459	118,080	36,900	35,191,701	353,340	531,360	103,320	**53,204,999**
Year 11	2,463,252	4,819,800	6,970,741	118,080	36,900	31,035,119	353,340	531,360	103,320	**46,431,912**
Year 12	2,311,995	2,951,744	6,423,093	118,080	36,900	30,597,251	353,340	531,360	103,320	**43,427,083**
Year 13	2,147,649	1,014,683	6,770,092	118,400	37,000	32,191,907	355,680	532,800	103,320	**43,271,531**
Year 14	2,315,758	915,630	9,998,136	118,080	36,900	32,293,735	353,340	531,360	103,320	**46,666,259**
Year 15	**-**	**-**	6,464,331	118,080	36,900	19,801,173	**-**	531,360	103,320	**27,055,164**
Total	**36,680,390**	**68,911,609**	**118,482,944**	**1,772,480**	**553,900**	**478,709,049**	**4,956,120**	**7,976,160**	**1,549,800**	**719,592,452**

Source: Sabina, 2021.

Note: Quantities are shown in the year they are required at site.

Table 24-3: Goose Pre-Production Fuel Requirements (Litres)

Preproduction Fuel	Year -3	Year -2	Year -1	Total
Sum of Fuel Consumption—Goose Camp	495,000	2,960,748	4,081,804	**7,537,552**
Sum of Fuel Consumption—Goose—EPC, Process, Site Services	539,511	539,511	-	**1,079,022**
Sum of Fuel Consumption—Goose—Earthworks	1,016,056	185,807	216,180	**1,418,043**
Sum of Fuel Consumption—Goose—Mining UG	-	1,232	1,052,172	**1,053,404**
Sum of Fuel Consumption—Goose—Mobile Open Pit	**-**	5,647,850	6,543,809	**12,191,659**
Sum of Fuel Consumption—WIR Construction Camp	**-**	2,044,797	2,044,797	**4,089,594**
Total	**2,050,567**	**11,379,945**	**13,938,762**	**27,369,274**

Source: Sabina, 2021.

24.1.2 Air Freight

Fixed-wing aircraft will be used for catering supplies and passenger transport to the Goose and MLA sites. The Goose Site airstrip will be constructed to handle passenger jet aircraft similar in size to an AVRO RJ 85, or Boeing 737, and can handle cargo aircraft up to the size of a C-130 Hercules.

The MLA has a 3,000 ft long by 75 ft wide all-weather (gravel) airstrip. The MLA is also accessible by ice airstrip in the winter, and ship and barge during the summer months.

Approximate straight-line distances for typical routes are as follows:

- Edmonton to Goose Site................................1,450 km
- Yellowknife to Goose Site..............................520 km
- Yellowknife to George Site ....510 km
- Yellowknife to MLA Site.................................570 km

The primary aircraft type, primary use, capacity, provider, and flight costs are listed in Table 24-4. Personnel will be mobilized to site from Edmonton and Yellowknife. Passenger flights to the Goose Site will use an Avro jet originating in Edmonton.

Table 24-4: Primary Aircraft and Capacities

Site	Aircraft	Primary Use	Capacity	Service Provider	Cost ($/flight)
Goose	C-130 Hercules	Equipment	21,772 kg	Lynden Air	67,392
Goose	Boeing 737	Fuel	15,000 L	Nolinor	16,200
Edmonton–Yellowknife	Avro RJ85	Passengers	90	Summit Air	30,591
Yellowknife–Goose	ATR-72	Passengers/Cargo	Up to 50/7,983 kg	Summit Air	13,325
Goose	De Havilland Dash 7	Passengers/Cargo	Up to 26/4,535 kg	Air Tindi	15,372
Goose	L-188 Electra	Cargo	11,575 kg	Buffalo Airways	19,173
Goose	De Havilland DHC-6 Twin Otter	Supplies	1,090 kg	Air Tindi	10,046
Goose	De Havilland DHC-6 Twin Otter	Passengers	10	Air Tindi	10,046
Yellowknife–Goose	Dornier 228	Passengers / cargo	Up to 11/1587 kg	Summit Air	7,102

Source: Sabina, 2021

24.1.3 Passenger Transportation and Freight Flights

Annual passenger delivery requirements based on the number of personnel rotations during the year are summarized in Table 24-5, and the pre-production passenger requirements are provided in Table 24-6. Aircraft requirements during the pre-production phase comprise a C-130 Hercules program in Year −3 and a series of ATR flights for the explosives detonators in Year −2.

In addition to the passenger transportation flights, Sabina has allowed for three 737 flights and 12 ATR flights per quarter, and one Hercules aircraft program per year. This corresponds to approximately 14 flights per month during the production phase, and approximately 8 flights per month during the pre-production phase.

Table 24-5: Passenger Requirements

	Number of Personnel Rotations	Flights
Year 1	5,152	65
Year 2	6,326	80
Year 3	6,383	80
Year 4	6,349	80
Year 5	6,174	78
Year 6	6,205	78
Year 7	6,275	79
Year 8	6,105	77
Year 9	6,003	76
Year 10	5,355	67
Year 11	4,362	55
Year 12	4,137	52
Year 13	4,366	55
Year 14	4,227	53
Year 15	3,104	39
Total	**80,523**	**1,014**

Source: Sabina, 2021

Table 24-6: Passenger Requirements Pre-production

	Passengers	Approximate Number of Flights (Based on 112 Passenger Capacity)[1]
Year −3	3,825	43
Year −2	1,062	12
Year −1	4,381	49
Total	9,268	**104**

Source: Sabina, 2021.
Note: [1] Loading at 90% capacity.

24.1.4 Sealift Freight

The pre-production logistics plan relies primarily on two sealift seasons and two WIR campaigns for delivering equipment and materials. A fixed-wing aircraft campaign will support construction activities through the duration of construction with delivery of fuel, select bulk materials, and passengers. Rockfill and concrete aggregates will be produced on site using waste from the Echo/Umwelt open pits or existing esker sources There are an estimated 34,000 tonnes of freight required to support construction and pre-production activities for the Project. A load list was prepared to analyze the weights of all equipment and materials required on site. The inbound freight breakdown by area is shown in Table 24-7.

Table 24-7: Pre-Production Annual Material and Equipment Quantities (Tonnes)

Freight Classification	Year −3	Year −2	Year −1
UG and OP Supplies	-	-	17,478
Equipment	400	400	-
Construction Bulks	4,275	4,275	-
Process Plant Equipment	1,557	1,557	-
Accommodation Camp Building	1,778	-	-
Balance of Plant Bulks	1,106	1,106	-
Electrical Equipment	86	86	-
Total	**9,202**	**7,424**	**17,478**

Source: Sabina, 2021.

The freight tonnes and volumes, and the total number of containers required, were determined for each year, and assigned, based on proximity to each port of the outbound cargo, to Edmonton for onward shipment to Hay River and barge transport to the MLA, or Bécancour, for sealift to the MLA. Edmonton/Hay River and Bécancour freight quantities are provided Table 24-8, listed for the year they are transported to the MLA, which is one year before they are needed a site. This is necessary, as freight must be stored at the MLA until January/February of the following year when it can be transported to the sites on the WIR.

Table 24-8: Sealift Freight Quantities (Production Phase)

	Hay River (t)	Hay River (No. of Containers Shipped)	Bécancour (t)	Bécancour (No. of Containers Shipped)
Year 1	4,647	190	12,832	630
Year 2	6,226	319	35,976	1,794
Year 3	6,240	314	37,524	1,882
Year 4	5,998	303	34,794	1,747
Year 5	5,761	289	28,717	1,436
Year 6	4,192	216	27,279	1,367
Year 7	5,190	262	29,505	1,483
Year 8	5,029	254	34,623	1,736
Year 9	5,001	251	34,618	1,748
Year 10	4,760	240	28,412	1,433
Year 11	4,298	217	24,729	1,249
Year 12	3,543	191	22,054	1,119
Year 13	2,246	112	18,212	924
Year 14	1,871	94	22,373	1,127
Year 15	1,111	56	12,130	614
Total	**66,113**	**3,308**	**403,778**	**20,289**

Source: Sabina, 2021
Note: Quantities are shown in the year they are required at site, and the procurements and staging of equipment, materials, and fuel at the respective east and west coast ports needs to take place at least 10 months before anticipated arrival at site.

The dry freight requirements for Years 14 and 15 will be significantly reduced. Therefore, all sea freight required for operations in Years 14 and 15 will be transported to the MLA during the final sealift in Year 13.

Cargo will be transported to the MLA by ice-class ocean-going ships with a deadweight tonnage (DWT) of 12,745 tonnes and draft of 8.515 m.

The barges and ships will be self-sufficient for off-loading cargo. Lightering barges will be used to transfer cargo from the vessel to the lighter barge terminal at the MLA barge landing area.

24.1.5 Fuel Freight

Bulk fuel suppliers have been contacted, and pricing has been obtained for the capacities available at the MLA and Goose site. The peak year of operations will require 55 ML of diesel fuel storage. Fuel pricing is discussed in Section 21.2.3. Taxes indicated are in addition to the quoted fuel pricing. Fuel price includes sufficient hose, pumps, and other necessary equipment and materials required to discharge fuel from ships, directly to the storage tanks at the Bathurst Inlet MLA. Fuel requirements for the Goose Site prior to the Year −2 WIR season will be delivered by fixed-wing aircraft.

24.1.6 Sea Container Costs and Strategy

An evaluation in terms of the costs of renting standard 20 ft containers versus outright purchase was carried out to determine the most cost-effective sea container strategy to pursue. Table 24-9 summarizes the comparison given below.

In the case of rental containers, these would be retained on site for about 26 months, at which time they would be returned to the marshalling facilities for reloading, then returned to site. Total cost to rent is $110/month/twenty-foot equivalent unit (TEU) plus $450 for delivery and return. Thus, renting the needed 24,058 containers at a unit cost of $3,310 would mean a total Project cost of $79.6 million (this may vary due to rental market conditions, and the opportunity to negotiate pricing).

If the containers were to be purchased, a total estimated 6,588 TEUs would be required over the LOM (based on the peak container demand/requirement, multiplied by a factor of 3 (Table 24-9). Container purchase will commence in Year -3 and occur every year until Year 3 according to the total annual container requirements listed in Table 24-10. At the end of Year 3, purchase of the required 6,588 TEUs is expected to be completed. The unit purchase cost would be $3,100, for a total of $20.4 million. Purchase for the Project duration, followed by resale, is clearly far less costly than renting containers.

Table 24-9: Cost Comparison of Rental vs. Purchase and Resale of Sea Containers

Option	Quantity	Rental Unit Cost ($)	Period Required On Site	Purchase Cost ($)	Delivery and Return ($)	Unit Cost ($)	Total ($ million)
Rental	24,058	110	26 Months	N/A	450 each	3,310	**79.6**
Purchase	6,588	N/A	26 Months	2,850	250 each (delivery only)	3,100	**20.4**
Consider 50% residual value on each container purchased at end of life							**10.2**
Purchase versus rental cost difference (excluding 50% residual value of container at the end of life)							**59.2**

Source: Sabina, 2021.

Table 24-10 provides the backhaul quantities for each respective year. As mentioned earlier, containers will be retained at site for 26 months, and therefore containers shipped to site in Year −3 will not be backhauled until Year −1, as illustrated by the quantities given in Table 24-10.

Table 24-10: Annual Container Requirement and Backhaul Quantities

Project Year	Containers Shipped From Bécancour	Containers Shipped From Hay River	Backhaul
Year −3	227	-	-
Year −2	234	-	-
Year −1	630	190	-
Year 1	1,794	319	-
Year 2	1,882	314	1,281
Year 3	1,747	303	2,113
Year 4	1,436	289	2,196
Year 5	1,367	216	2,049
Year 6	1,483	262	1,725
Year 7	1,736	254	1,583
Year 8	1,748	251	1,745
Year 9	1,433	240	1,990
Year 10	1,249	217	2,000
Year 11	1,119	191	1,673
Year 12	924	112	1,466
Year 13	1,127	94	1,310
Year 14	614	56	1,037
Year 15	-	-	1,889
Total	**20,750**	**3,308**	**24,057**

Source: Sabina, 2021.

24.1.7 Labour Force

Sabina's management team will be responsible for Project logistics. The Owner's team will be responsible for the following:

- Coordinating delivery of equipment and material to the appropriate ports
- Ensuring timely delivery
- Tracking movement of equipment and material to the port sites
- Verifying deliveries to the port sites
- Working with the shipping contractor to set shipping priorities
- Validating shipping manifests

- Coordinating off-loading activities at the MLA
- Developing and implementing MLA storage plans
- The primary Sabina staff responsible for Project logistics will be the Procurement/Contracts/Logistics Manager and the Logistics Coordinator.

During the sealift period, additional personnel will be mobilized to the MLA to assist with dry freight off-loading and storage. Due to the brevity of the sealift period, it is anticipated that the sealift support crew will be provided by a contractor.

24.2 Project Execution and Development Plan

24.2.1 Introduction and Philosophy

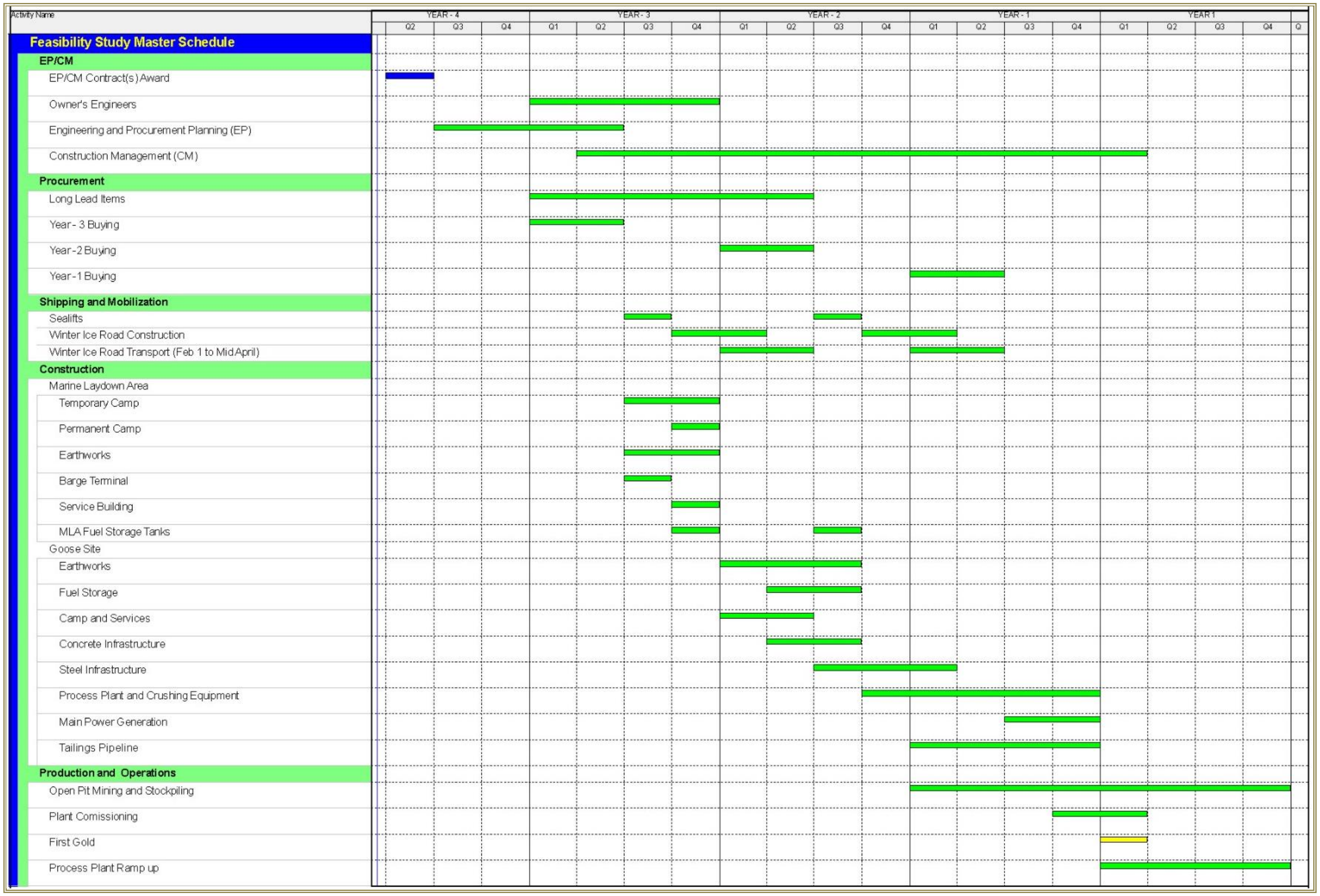
The Project execution plan for this Updated Feasibility Study is based on principles tested and proven in developing remote, logistically challenging projects in northern Canada. These principles include the following:

- Promote safety in design, construction, and operations.
- Minimize disturbance footprint.
- Use fit-for-purpose designs, construction, and operations.
- Consolidate construction and operational needs to the extent practical due to the high cost of transportation to and from site.
- Purchase common equipment fleet at the outset (by Owner) and use for construction needs.
- Minimize on-site labour requirements for an efficient operation.
- Negotiate contracts with suppliers, contractors, and engineers with proven track records in northern Canadian mine developments.
- Complete Project construction components early and turn over to operations.
- Eliminate surplus management organizations.
- Accommodate all site personnel at the same camp (i.e., no management quarters).

Like the operational plan, the majority of construction freight will be delivered using an annual sealift and WIR. Fixed-wing aircraft will deliver select bulk freight and passengers throughout the duration of construction.

24.2.2 Project Scheduling

The Project schedule is driven by the annual sealift and WIR windows in Year −3 and Year −2. A schedule has been developed for the MLA and Goose Site construction activities, using the Updated Feasibility Study cost estimate as the basis for the required work hours. This scheduling exercise indicates that mechanical completion and wet commissioning can be accomplished within the two-year construction period. The key scheduling milestones are shown in Figure 24-1.



Source: SDE, 2021.

Figure 24-1: Key Schedule Milestones

24.3 Temporary Facilities for Construction

24.3.1 Goose Site

The Goose site has been a self-sufficient exploration site for over 20 years, and as such has a great deal of infrastructure already in place (refer to Section 18.1.1); for that reason, mine development through the construction phase requires minimal addition of temporary facilities as the Project transitions to a more permanent site. Examples of the minimal temporary facilities include:

- Construction/contractor field offices
- Site construction power and distribution
- Fuel storage and containment
- Contact water management
- Minor upgrades to the existing exploration camp.

24.3.2 Marine Laydown Area

Having pioneered the MLA in 2018, it is now well established (refer to Section 18.1.1), and like the Goose site it requires only minimal temporary facilities to transform it into its permanent configuration. Those facilities include:

- Construction/contractor field offices
- Site construction power and distribution.

24.4 Site Access and Mobilization

Currently, both sites are accessible by air. The Goose Site has a 4,500 ft long gravel airstrip and the MLA has a 3,000 ft long gravel airstrip. MLA is also accessible by ship and barge during the summer months.

The construction of the Goose Site will occur over a 24-month period. To meet this timeline, the following will be required:

- Air delivery of equipment and supplies necessary to construct the first WIR between Goose Site and the MLA beginning late in Year −3
- Construction of the MLA facilities in Year −3
- Summer sealift campaigns from Hay River and/or Bécancour to the MLA in Years −3 and −2
- Storage of freight at the MLA from the end of the sealift period until the WIR is constructed and freight can be hauled to site
- Construction of the WIR from the MLA to Goose Site starting in December of Years −3 and −2
- Haulage of freight by the WIR from the MLA to Goose Site during Q1 Years −2 and −1.

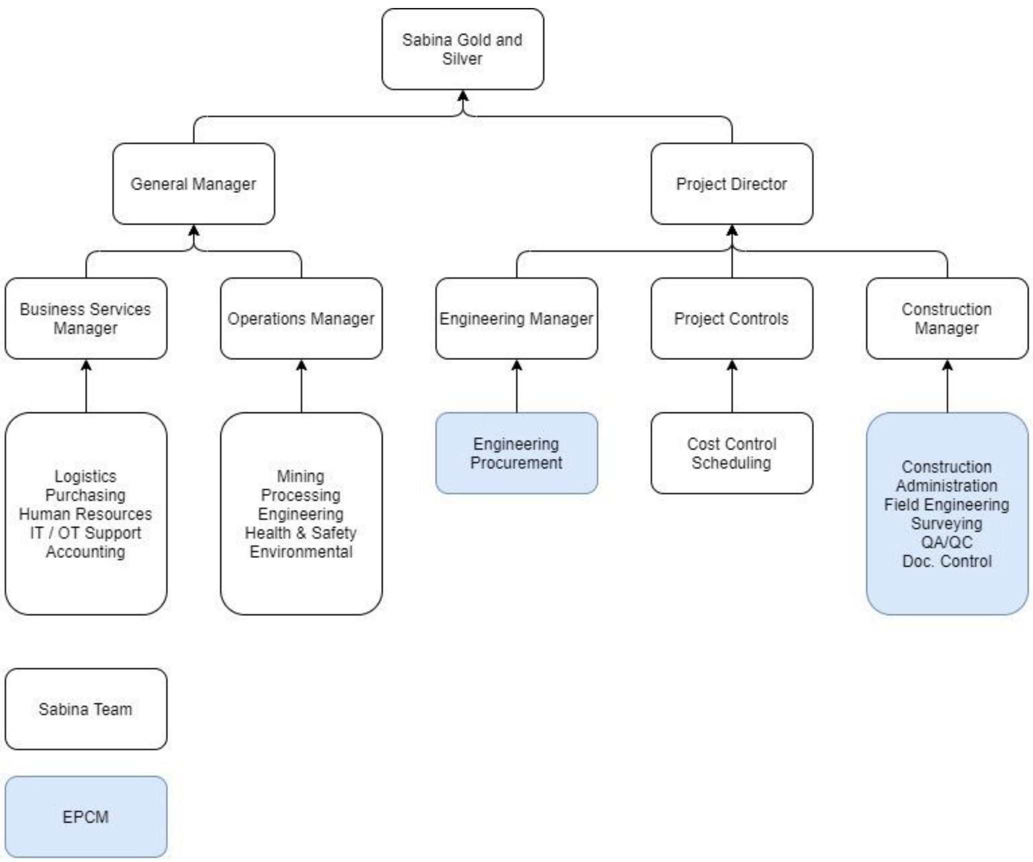
Construction of the Goose Site is dependent on the successful construction and operations at MLA because most of the construction equipment and material will be shipped through this site.

Additional construction to be completed at the MLA will include:

- Remaining fuel tank material (four x 10 ML) and (two x 2.5 ML)
- Fuel off-loading and distribution system
- Truck shop/maintenance shop
- Expanded camp and associated infrastructure
- Diesel generators
- Site laydown areas.

24.5 Engineering, Procurement, and Construction Management

Project management will be an integrated team comprising the Owner's management personnel working in conjunction with engineering, procurement, and construction management (EPCM) resources. The Project leadership organizational chart is shown in Figure 24-2.



Source: Source: Sabina, 2021.

Figure 24-2: Project Management Organization Chart

The Project management team will oversee all EPCM activities for the Project. The Project management team will also coordinate specialized consultants as and if required.

The Project management team will also be responsible for all Project activities from Project formation to final turnover to operations. They will be available to support operations teams with key supervision and management assistance when the operations personnel assume control of Project components as they are completed.

24.5.1 Engineering Team

The engineering team will design each facility and component of the plant and infrastructure using estimated costs, procurement lead time, and installation requirements. Each engineering package will then be turned over to the procurement team following a review by the Sabina team. The engineering team will also monitor construction through to commissioning to ensure design compliance. This may include representation at the vendors' factories, if required. The engineering team's tasks will include the following:

- Create detailed designs for all engineering packages.
- Estimate costs to a high degree of confidence.
- Produce issued for construction drawings, specifications
- Review tenders for technical and design compliance.
- Conduct field engineering during construction.
- Conduct QA/QC.
- Develop a commissioning plan.

24.5.2 Procurement Team

In general, the procurement team will oversee the selection and tendering of all tagged equipment, materials, and commodities as a function of managing the engineering consultant. Tagged equipment is defined as uniquely designed and engineered equipment and assemblies required for the Project as documented in the Project equipment lists. Bulk materials are not specifically engineered items, but rather quantities of materials produced to a given industry standard and are not shown on the Project equipment list. All Project equipment and materials will be purchased, tracked, and referenced to applicable specifications and standards.

The procurement team will use the design packages provided by engineering to obtain competitive tenders. The procurement team's tasks will include the following:

- Prepare tender and contract documents.
- Pre-qualify vendors with input from the Owner's team.
- Review tender submissions for compliance and commercial terms.
- Award and execute contracts.
- Coordinate logistics with Owner's team.
- Resolve any claims and disputes with contractors and vendors.
- Complete and close out contract.

The purchasing schedules for the majority of the procurement packages will be driven by the sealift schedules in Years −3 and −2.

24.5.3 Owner's Team

The Owner's team will be responsible for the following areas:

- Project controls
- Schedule development, review, and tracking
- Logistics
- Warehousing
- Contract administration
- Purchasing
- Cost tracking and forecasting
- Scheduling and cost compliance
- Environmental procedures and compliance.

24.5.4 Construction Management Team

The construction management team's tasks will include the following:

- Review construction designs and contract documents.
- Ensure construction progresses on schedule and on budget.
- Assist with and review schedule development.
- Coordinate and manage site operations.
- Oversee site health and safety.
- Manage and maintain camp.
- Oversee site-wide labour relations.
- Oversee site services.
- Manage document control.
- Review contractor invoices and forward approved invoices to accounts payable.
- Certify contract completion and close out contract.
- Provide input to contractor claims and dispute resolutions.
- Oversee survey control and as-builts.
- Conduct QA/QC.
- Oversee commissioning.

25 INTERPRETATION AND CONCLUSIONS

The economic results of this Technical Report demonstrate that the Project has positive economics and may warrant development, subject to the unique investment criteria requirements of individual investors.

Standard industry practices, equipment, and processes were used in this study. The authors of this Technical Report are not aware of any unusual or significant risks, or uncertainties beyond those discussed herein that could affect the reliability or confidence in the Project based on the data and information made available.

25.1 Risks and Opportunity Management

Most mining projects are exposed to risks that might impact the economics of the Project to varying degrees. Many risks are external and largely beyond the control of the Project proponents, such as market conditions, changes in government legislation, or climate variation. These risks are generally applicable to all capital projects. Mining projects produce an undifferentiated product and are generally market price takers. This makes metal prices a core source of uncertainty for all mining projects. Care should be taken to review this Project periodically to confirm that the assumptions underlying this study are still reasonable and valid; if not, the assumptions used in this Updated Feasibility Study must be updated.

Table 25-1 and Table 25-2 illustrate the criteria and standards used to assign risk profiles in Table 25-3.

Table 25-1: Likelihood of Occurrence Definition

Definition	Criteria
5 – Frequent	91%–100%—It is expected to occur in most circumstances
4 – Probable	76%–90%—Will probably occur some of the time
3 – Occasional	26%–75%—Might occur some of the time
2 – Remote	11%–25%—Could only occur infrequently
1 – Unlikely	0%–10%—May only occur in exceptional circumstances

Source: SDE, 2021.

Table 25-2: Severity Definitions

Severity	Financial Exposure	Schedule
5 – Catastrophic	Greater than 10 million	Greater than 1 month
4 – Critical	Up to 10 million	one month
3 – Problematic	Up to 5 million	one week
2 – Moderate	Up to 1 million	2 days
1 – Minor	Up to 500,000	1 day

Source: SDE, 2021.

Table 25-3 and Table 25-4 summarize the significant Project opportunities and risks and provide a description of their expected impact. A formal review was not conducted of the likelihood and consequence ratings, and pre- and post-mitigation rankings. Such a review should be performed during the detailed engineering phase of development. Some mitigation strategies assume ongoing efforts, and the residual risk assumes these efforts are completed continuously.

The remote location of the Back River Property imposes an additional level of risk to the Project due to the large volume of equipment, fuel, and materials that need to be transported from Hay River and Bécancour to the mine site. Superimposed on methods of transportation are seasonal constraints that require ice-free sea routes for a short window in summer and an ice road in winter. Seasonal weather variations are an inherent risk due to the remote location, and appropriate mitigation strategies will be required in the event of cooler summers or milder winters.

While Sabina has successfully completed a WIR construction campaign, the ice road will be used for the second time in the early months of Year −2. Although the volume of material to be transported on this road during Year −2 will be lower than subsequent years, the uncertainties of a newer ice road will exist.

Extreme winter weather and temperatures between −25°C and −40°C will impact personnel and equipment productivities during construction and operations.

The typical risks associated with open pit and underground mining related to geotechnical conditions, equipment availability and productivity, and personnel productivity are similar to those expected at similar operations. The processing plant risk profile is also similar to other primary gold cyanide leach CIP process plants.

Measures to mitigate many of these issues have been identified and applied in this Technical Report. Additional hazard/risk identification and review of mitigations must continue to be priorities on an ongoing basis during Project development, construction, operations, and closure.

Table 25-3: Significant Project Risks

	Area	Risk Type	Risk Category	Potential Risk/Issue	Consequences	Project Risk			Mitigation Strategy	Residual Risk		
						H&S	Likelihood	Risk Level		Severity	Likelihood	Risk Level
PROJECT/OWNER'S RISK	Project	Health and Safety		Construction and operational health and safety	Damage to infrastructure, personnel, or environment	5 - CATASTROPHIC	1 - UNLIKELY	MEDIUM	Experienced cold-weather labour force. Operating and shut-down procedures. On-site medical and emergency facilities.	4 - CRITICAL	1 - UNLIKELY	MEDIUM
	Project	Project Definition	Technical	Major Project scope changes from suppliers, stakeholders	Project rework, significant schedule impairment	5 - CATASTROPHIC	2 - REMOTE	HIGH	Contracting strategy, engagement of vendors/suppliers, early and ongoing engagement of Owner's engineering team.	4 - CRITICAL	1 - UNLIKELY	MEDIUM
SERVICES AND FACILITIES	Fuel Storage and Distribution (Goose)	Operational	Environmental	Fuel spill—minor	Environmental contamination, possible delay in operations	2 - MODERATE	4 - PROBABLE	MEDIUM	Design of proper passive containment and spill runoff collection system. Appropriate operations procedures and training.	1 - MINOR	4 - PROBABLE	MEDIUM
	Fuel Storage and Distribution (Goose)	Operational	Environmental	Fuel spill—major	Environmental contamination, shutdown of operations	4 - CRITICAL	2 - REMOTE	MEDIUM	Process and safety interlocks. Major-spill containment berm.	3 - PROBLEMATIC	1 - UNLIKELY	LOW
	Fuel Storage and Distribution (Goose)	Operational	Technical	Fuel pump failure	Shutdown of plant power supply	4 - CRITICAL	4 - PROBABLE	VERY HIGH	Redundant pumps in running/standby configuration with automatic switchover.	4 - CRITICAL	1 - UNLIKELY	MEDIUM
	Fuel Storage and Distribution (Goose)	Operational	Human Behaviour	Truck driving away prior to removal of fueling arm, resulting in irreparable damage	Interruption of and potential inability to complete transfer of fuel from MLA to Goose	4 - CRITICAL	3 - OCCASIONAL	HIGH	Strobe lighting and gate installed to prevent accidental drive-away.	4 - CRITICAL	1 - UNLIKELY	MEDIUM
	Fuel Storage and Distribution (Goose)	Operational	Human Behaviour	Contamination of diesel fuel	Gelling and waxing of diesel fuel, engine damage	3 - PROBLEMATIC	3 - OCCASIONAL	MEDIUM	Operational procedures to remove water and other contaminants from tanks prior to refilling.	3 - PROBLEMATIC	2 - REMOTE	MEDIUM
	Fuel Storage and Distribution (MLA)	Operational	Environmental	Fuel spill—minor	Environmental contamination, possible delay in operations	2 - MODERATE	4 - PROBABLE	MEDIUM	Design of proper passive containment and spill runoff collection system. Appropriate operations procedures and training.	1 - MINOR	4 - PROBABLE	MEDIUM
	Fuel Storage and Distribution (MLA)	Operational	Environmental	Fuel spill—major	Environmental contamination, shutdown of operations	4 - CRITICAL	2 - REMOTE	MEDIUM	Process and safety interlocks. Major-spill containment berm.	3 - PROBLEMATIC	1 - UNLIKELY	LOW
	Fuel Storage and Distribution (MLA)	Operational	Technical	Fuel pump failure	Shutdown of plant power supply	4 - CRITICAL	4 - PROBABLE	VERY HIGH	Redundant pumps in running/standby configuration with automatic switchover.	4 - CRITICAL	1 - UNLIKELY	MEDIUM
	Fuel Storage and Distribution (MLA)	Operational	Human Behaviour	Truck driving away prior to removal of fueling arm, resulting in irreparable damage	Interruption of and potential inability to complete transfer of fuel from MLA to Goose	4 - CRITICAL	3 - OCCASIONAL	HIGH	Strobe lighting and gate installed to prevent accidental drive-away.	4 - CRITICAL	1 - UNLIKELY	MEDIUM
	Fuel Storage and Distribution (MLA)	Operational	Human Behaviour	Contamination of diesel fuel	Gelling and waxing of diesel fuel, engine damage	3 - PROBLEMATIC	3 - OCCASIONAL	MEDIUM	Operational procedures to remove water and other contaminants from tanks prior to refilling.	3 - PROBLEMATIC	2 - REMOTE	MEDIUM
	Fuel Storage and Distribution (MLA)	Operational	Technical	Fuel pump failure on diesel offloading barge	Extended transfer process and potential inability to transfer all fuel to MLA storage tanks	3 - PROBLEMATIC	3 - OCCASIONAL	MEDIUM	Fuel transfer pump installed.	3 - PROBLEMATIC	1 - UNLIKELY	LOW
	Fuel Storage and Distribution (MLA)	Operational	Cost/Schedule	Failure to winterize generators	Inability to restart generators and resume fueling operations	3 - PROBLEMATIC	3 - OCCASIONAL	MEDIUM	Operational procedures to winterize generators in place.	3 - PROBLEMATIC	1 - UNLIKELY	LOW

	Area	Risk Type	Risk Category	Potential Risk/Issue	Consequences	Project Risk			Mitigation Strategy	Residual Risk		
						H&S	Likelihood	Risk Level		Severity	Likelihood	Risk Level
	Power Generation (Goose)	Operational	Human Behaviour	Damage to power plant fuel delivery piping	Environmental contamination, system shutdown and extended repairs required to resume operation	4 - CRITICAL	2 - REMOTE	MEDIUM	Signage, bollards, etc. put in place to prevent human error.	4 - CRITICAL	1 - UNLIKELY	MEDIUM
	Power Generation (Goose)	Technical	Technical	Generator failure	Loss of power to plant and facilities	4 - CRITICAL	4 - PROBABLE	VERY HIGH	Installation of n+2 generator configuration	4 - CRITICAL	1 - UNLIKELY	MEDIUM
	Power Generation (Goose)	Health and Safety	H&S	Burn injuries to operators	Personal injury	2 - MODERATE	3 - OCCASIONAL	MEDIUM	Installation of protective pipe insulation	1 - MINOR	3 - OCCASIONAL	LOW
	Power Generation (Goose)	Operational	Cost	Inefficiency in heat recovery due to lack of recovery boiler cleaning	Increased diesel fuel consumption	3 - PROBLEMATIC	5 - FREQUENT	HIGH	Operational procedures to ensure regular cleaning. Bypass valves installed for ease of cleaning.	1 - MINOR	1 - UNLIKELY	LOW
	Power Generation (Goose)	Operational	Cost/Schedule	Increased costs and time associated with maintenance of generators without available overhead crane	Downtime and increased costs	3 - PROBLEMATIC	5 - FREQUENT	HIGH	Installation of overhead crane in power-plant building suitable to assist in generator maintenance.	2 - MODERATE	1 - UNLIKELY	LOW
	Power Generation (Goose)	Technical	Technical	Insufficient heat recovery	Freezing of process facility	4 - CRITICAL	3 - OCCASIONAL	HIGH	Installation of fully sized diesel boilers	2 - MODERATE	1 - UNLIKELY	LOW
	Power Generation (Goose)	Technical	Technical	Complete power plant failure	Freezing of plant, health/safety danger to personnel	5 - CATASTROPHIC	2 - REMOTE	HIGH	Repurposing construction power generators to serve as plant backup generators.	2 - MODERATE	1 - UNLIKELY	LOW
	Accommodation Complex (Goose)	Technical	Construction	Extensive foundation requirements (piling, concrete, etc.)	Increased costs of construction and schedule	3 - PROBLEMATIC	3 - OCCASIONAL	MEDIUM	Source single-story camp units to minimize foundation requirements.	1 - MINOR	2 - REMOTE	LOW
	Accommodation Complex (Goose)	Health and Safety	H&S	Fire occurs in camp complex	Personal injury and/or fatalities	5 - CATASTROPHIC	2 - REMOTE	HIGH	Installing fire hoses and extinguishers, training operations staff in proper usage. Fire alarms installed.	3 - PROBLEMATIC	2 - REMOTE	MEDIUM
	Accommodation Complex (Goose)	Health and Safety	H&S	Wildlife proximity to camp and nearby facilities	Personal injury, environmental disturbance	3 - PROBLEMATIC	4 - PROBABLE	HIGH	Operational procedures for garbage disposal, re-closing doors, signage to remind personnel to adhere to procedures	1 - MINOR	3 - OCCASIONAL	LOW
	Accommodation Complex (Goose)	Health and Safety	H&S	Excessive noise from process plant and power generation	Disrupted sleep, worker dissatisfaction	2 - MODERATE	4 - PROBABLE	MEDIUM	Layout design to consider proximity of camp to noise-generating facilities.	1 - MINOR	3 - OCCASIONAL	LOW
	Accommodation Complex (Goose)	Operational	Human Behaviour	Undesirable living conditions in camp	High employee turnover	3 - PROBLEMATIC	4 - PROBABLE	HIGH	Source camp with adequate comforts, entertainment/communications/internet infrastructure, recreation facilities, comfortable rooms, and nutritious/delicious food.	1 - MINOR	3 - OCCASIONAL	LOW
	Airstrip	Operational	Transportation	Inability to land planes in inclement weather	Employee dissatisfaction, delay of material and personnel delivery	3 - PROBLEMATIC	5 - FREQUENT	HIGH	Installation of supplementary navigation equipment to minimize weather-related delays.	3 - PROBLEMATIC	2 - REMOTE	MEDIUM
	Ancillary Facilities (Goose)	Technical	Technical	Failure of oil-fired heating units	Freezing of equipment, potential personal injury	3 - PROBLEMATIC	3 - OCCASIONAL	MEDIUM	Operational procedures to ensure filling of fuel tanks, regular maintenance, etc.	3 - PROBLEMATIC	1 - UNLIKELY	LOW
	Ancillary Facilities (Goose)	Operational	Technical	Snow accumulation at ingress/egress to facilities.	Additional effort required for snow clearing	2 - MODERATE	5 - FREQUENT	MEDIUM	Layout design to consider likelihood of snow buildup and drift. Operational procedures for regular snow clearing.	1 - MINOR	3 - OCCASIONAL	LOW

	Area	Risk Type	Risk Category	Potential Risk/Issue	Consequences	Project Risk: H&S	Project Risk: Likelihood	Project Risk: Risk Level	Mitigation Strategy	Residual Risk: Severity	Residual Risk: Likelihood	Residual Risk: Risk Level
	Ancillary Facilities (Goose)	Operational	H&S	Difficulty of access to ancillary facilities during winter conditions	Personal injury, frostbite	4 - CRITICAL	4 - PROBABLE	VERY HIGH	Provide workforce with ample supply of vehicles so as to minimize time spent exposed to elements. Ensure layout accommodates driving from camp facility to all other necessary facilities.	1 - MINOR	3 - OCCASIONAL	LOW
	Ancillary Facilities (Goose)	Operational	Environmental	Wildlife presence on sitewide access roads	Wildlife mortality	3 - PROBLEMATIC	4 - PROBABLE	HIGH	Operational procedures outlining yielding to animals on all site roads, reporting wildlife observations, communications between vehicles.	1 - MINOR	4 - PROBABLE	MEDIUM
	Ancillary Facilities (Goose)	Operational	Transportation	Inefficient road layouts for personnel access to various plant facilities	Inefficient work performance	3 - PROBLEMATIC	4 - PROBABLE	HIGH	Layout design to consider efficient vehicle access to and from primary facilities	1 - MINOR	1 - UNLIKELY	LOW
SITE AND CLIMATE	Climate/Hydrology	Technical	Environmental	Additional climate data published by Environment Canada or ongoing monitoring showing increasing precipitation trends linked to climate change predictions	Increase to storm events and associated conveyance rates (peak flows) and storage volumes (at ponds); ponds fill up higher and or more frequently; more management required	3 - PROBLEMATIC	2 - REMOTE	MEDIUM	Spillways incorporated into all dam designs. More diligence to be carried out when collecting data at Goose station to limit data gaps. Potentially install a second Goose weather station. Install a weather station at the MLA to help get better site correlation to the available Bathurst station. Annual checks and updates during operations.	2 - MODERATE	2 - REMOTE	LOW
GEOLOGY	Geology	Technical	Technical	The geology block model under-performs, and gold grade not achieved in the plan	Gold production not achieved	3 - PROBLEMATIC	2 - REMOTE	MEDIUM	Continue gathering information from new drilling; verifying and updating the geology interpretation	1 - MINOR	2 - REMOTE	LOW
	Geology	Technical	Technical	Geological interpretation might change with the consequent reduction in tonnes	Difficulty in achieving plan or mining ahead of plan	1 - MINOR	2 - REMOTE	LOW	Ensure geological model continuously updated. Infill drilling carried out and data used to update model.	1 - MINOR	1 - UNLIKELY	LOW
SHIPPING AND LOGISTICS	Shipping	Technical	Procurement	Critical path procurement	Schedule delays, increased shipping cost	4 - CRITICAL	2 - REMOTE	MEDIUM	Procurement team engaged with engineering firm to directly assist with critical-path items. Targeting delivery at port six weeks prior to marine sealift.	3 - PROBLEMATIC	1 - UNLIKELY	LOW
	Shipping	Technical	Procurement	Transport damage	Material damage, schedule delays	3 - PROBLEMATIC	2 - REMOTE	MEDIUM	Vendor site inspections for containerizing and shipping. Appropriate insurance. Inspection on receipt of equipment at port.	3 - PROBLEMATIC	1 - UNLIKELY	LOW
	Shipping	Technical	Logistics	Port logistics	Freight bumped from full shipments	3 - PROBLEMATIC	2 - REMOTE	MEDIUM	Direct vessel charters to ensure freight cannot be bumped from shipments and arrive in a staggered sequence at MLA. Contracting to share risk with ship operator.	1 - MINOR	1 - UNLIKELY	LOW
	Shipping	Technical	Logistics	MLA logistics	Misplaced material and equipment	2 - MODERATE	1 - UNLIKELY	LOW	Appropriate storage and tagging of containers and break bulk/large loose items.	1 - MINOR	1 - UNLIKELY	LOW
	Shipping	Technical	Logistics	WIR construction	Delay in schedule	3 - PROBLEMATIC	2 - REMOTE	MEDIUM	Excess water permit capacity for ice road construction.	1 - MINOR	1 - UNLIKELY	LOW

	Area	Risk Type	Risk Category	Potential Risk/Issue	Consequences	Project Risk H&S	Project Risk Likelihood	Project Risk Risk Level	Mitigation Strategy	Residual Risk Severity	Residual Risk Likelihood	Residual Risk Risk Level
	Shipping	Technical	Logistics	WIR maintenance and whiteouts	Schedule delays	2 - MODERATE	3 - OCCASIONAL	MEDIUM	Shipping schedule buffer to allow for lost time.	2 - MODERATE	1 - UNLIKELY	LOW
	Shipping	Technical	Logistics	Site inventory management	Schedule risk	1 - MINOR	3 - OCCASIONAL	LOW	Large laydown areas, active quantity/inventory management, specific storage for sensitive equipment and critical items. Contractor-specific laydowns and handover procedures.	2 - MODERATE	1 - UNLIKELY	LOW
CONSTRUCTION	Construction	Technical	Cost/Schedule	Cold-weather construction methods	Reduced labour productivity	5 - CATASTROPHIC	3 - OCCASIONAL	HIGH	Accounted for in labour planning. Engineering design and construction scheduled to allow for early interior work in coldest seasons. Experienced cold-weather construction crews. Contracting strategy to mitigate price risk.	2 - MODERATE	1 - UNLIKELY	LOW
	Construction	Technical	Cost/Schedule	Late changes to estimation of quantities by engineering	Increased construction costs, additional late shipping of materials	4 - CRITICAL	3 - OCCASIONAL	HIGH	Ongoing constructability reviews involving all stakeholders. Detailed reviews of quantities at IFC stages.	3 - PROBLEMATIC	1 - UNLIKELY	LOW
	Construction	Technical	Cost/Schedule	Labour rate risk	Increased construction costs	3 - PROBLEMATIC	5 - FREQUENT	HIGH	Accounted for in pricing/contingency. Contracting strategy to mitigate pricing risk.	3 - PROBLEMATIC	1 - UNLIKELY	LOW
	Construction	Technical	Cost/Schedule	Material escalation risks	Increased construction costs	3 - PROBLEMATIC	5 - FREQUENT	HIGH	Accounted for in pricing/contingency. Early completion of detailed engineering for high-risk items prior to purchasing. Contracting strategy to mitigate pricing risk.	3 - PROBLEMATIC	1 - UNLIKELY	LOW
	Construction	Technical	Cost/Schedule	Labour supply and availability	Construction schedule delays, increased construction costs	4 - CRITICAL	2 - REMOTE	MEDIUM	Availability of labour pool sourced from Alberta. Contract award to contractor to schedule labour early and avoid overcommitment of construction resources.	2 - MODERATE	1 - UNLIKELY	LOW
	Construction	Technical	Cost/Schedule	Poor fabrication	Increased construction costs	3 - PROBLEMATIC	2 - REMOTE	MEDIUM	Significant efforts for off-site fabrication and QA/QC prior to shipment as well as on-site. Contracting strategy for re-work. Proper storage of weather-sensitive components. Preventative maintenance programs for equipment.	2 - MODERATE	2 - REMOTE	LOW
	Construction	Technical	Cost/Schedule	Inadequate engineering efforts	Increased construction costs, schedule delays	3 - PROBLEMATIC	2 - REMOTE	MEDIUM	Ongoing engineering involvement by engineering team with Project team. Design allowances for quantities of material and equipment costs. Involvement of experts and vendor support.	2 - MODERATE	1 - UNLIKELY	LOW
	Construction	Technical	Cost/Schedule	Key construction equipment failure	Schedule risk	3 - PROBLEMATIC	3 - OCCASIONAL	MEDIUM	On-site maintenance capacity, preventative maintenance program, Availability of sufficient spares/wear parts. Standby equipment for critical items.	2 - MODERATE	2 - REMOTE	LOW

	Area	Risk Type	Risk Category	Potential Risk/Issue	Consequences	Project Risk: H&S	Project Risk: Likelihood	Project Risk: Risk Level	Mitigation Strategy	Residual Risk: Severity	Residual Risk: Likelihood	Residual Risk: Risk Level
	Construction	Technical	Cost/Schedule	Extreme weather shutdowns (whiteouts, etc.)	Schedule delays	2 - MODERATE	3 - OCCASIONAL	MEDIUM	Climate-sensitive work scheduled by season and interior work prioritized for cold weather.	2 - MODERATE	1 - UNLIKELY	LOW
	Construction	Environmental	Cost/Schedule	Wildlife	Design impacts for wildlife safety; schedule impairments	3 - PROBLEMATIC	3 - OCCASIONAL	MEDIUM	Internal wildlife management procedures.	2 - MODERATE	2 - REMOTE	LOW
	Construction	Technical	Cost/Schedule	Construction camp living and quality of life.	High labour turnover; schedule delays; reduced productivity	3 - PROBLEMATIC	1 - UNLIKELY	LOW	Fly-in/fly-out rotations of labour. Adequate amenities, food, communications.	2 - MODERATE	1 - UNLIKELY	LOW
	Construction	Contract	Cost/Schedule	Contractor/supplier solvency and corporate performance standards.	Project rework, significant schedule impairment	5 - CATASTROPHIC	2 - REMOTE	HIGH	Contracting strategy, performance securities, use of reputable suppliers, credit checks, transferrable design practices.	3 - PROBLEMATIC	1 - UNLIKELY	LOW
MINING	Mining/Pits	Technical	Cost/Schedule	Overburden depth deeper at pits. Impacts to Echo, Umwelt, Llama, Goose Pit (and later Echo TF, Umwelt TF, Llama TF)	Additional setbacks and reduced slopes needed on top portions of the slope. Impacts to stripping ratio and generation of larger volumes of waste. Potential for larger area of overburden slopes requiring thermal rock cladding (~2+m depending on overburden type). Potential for water in pits to be better managed (less water) to limit thermal loading on overburden portions of pits.	4 - CRITICAL	3 - OCCASIONAL	HIGH	Review of available drilling information. Plan to have 2 m thermal rock cover over all overburden pit slopes. Overburden portions of pit to have shallower slopes for increased stability. Monitoring of overburden pit slope sections during operations (specifically areas where overburden is > 5 m depth).	3 - PROBLEMATIC	3 - OCCASIONAL	MEDIUM
MINING	Environmental & Mining	Technical	Environmental	Overburden with high pore-water salinity encountered (natural salinity)	Impacts to freezing point depression as well as to seepage-water quality.	3 - PROBLEMATIC	3 - OCCASIONAL	MEDIUM	Overburden may be required to be placed back in mined-out pits or in a purpose-built facility. Also, opportunity to change waste rock dump sequencing to better encapsulate this material into the dump. May have impacts on dump stability requirement and overall reduction to the dump slopes.	3 - PROBLEMATIC	2 - REMOTE	MEDIUM
MINING	Mining/Pits	Technical	Environmental	High drilling brine-concentration mixed with underground NPAG waste	Sterilization of usable NPAG rock material for cover. Leaching of Cl in seepage, etc.	3 - PROBLEMATIC	3 - OCCASIONAL	MEDIUM	Change underground development and drilling approaches. Quarry NPAG rock (high costs associated with later and likely impacts to closure ponding also). Sumps and pumps or another pond downstream may be required based on location.	3 - PROBLEMATIC	2 - REMOTE	MEDIUM

	Area	Risk Type	Risk Category	Potential Risk/Issue	Consequences	Project Risk			Mitigation Strategy	Residual Risk		
						H&S	Likelihood	Risk Level		Severity	Likelihood	Risk Level
GEOTECHNICAL	Open Pit	Technical	Technical	Rockfalls and bench scale instabilities	Local production delay Equipment damage	2 - MODERATE	4 - PROBABLE	MEDIUM	Adequately resourced geotechnical department to allow for inspections and monitoring. Procedures for working near benches.	2 - MODERATE	2 - REMOTE	LOW
	Open Pit	Technical	Technical	Inter-ramp slope failure (e.g., due to unexpected fault)	Sterilization of ore Production delay Reduction in open pit TS capacity Loss of Equipment	5 - CATASTROPHIC	2 - REMOTE	HIGH	Adequately resourced geotechnical department to allow for inspections and monitoring. Allowance for ongoing geological interpretation and geomechanical studies.	5 - CATASTROPHIC	1 - UNLIKELY	MEDIUM
	Open Pit	Technical	Technical	Open pit floor failure into underground opening	Production delay Loss of Equipment	4 - CRITICAL	2 - REMOTE	MEDIUM	Adequately resourced geotechnical department to allow for inspections and monitoring. Adequately resourced survey department to allow for documentation of voids and underground workings.	4 - CRITICAL	1 - UNLIKELY	MEDIUM
	Open Pit	Technical	Technical	Ice-falls from open pit benches within Talik during spring (Llama Open Pit)	Production delay Equipment damage	5 - CATASTROPHIC	4 - PROBABLE	VERY HIGH	Allowance for production flexibility in winter and spring so that access to areas of the open pit prone to ice-fall can be restricted.	4 - CRITICAL	2 - REMOTE	MEDIUM
	Open Pit	Technical	Technical	Inability to achieve slope design	Economic loss	5 - CATASTROPHIC	2 - REMOTE	HIGH	Adequately resourced geotechnical department to allow for inspections and monitoring. Allowance for ongoing geological interpretation and geomechanical studies.	5 - CATASTROPHIC	1 - UNLIKELY	MEDIUM
	Open Pit and Underground	Technical	Technical	Unanticipated open pit and underground interactions	Sterilization of ore Production delay Delay in tailings placement in the open pit Equipment damage	5 - CATASTROPHIC	2 - REMOTE	HIGH	Adequately resourced geotechnical department to allow for inspections and monitoring. Allowance for ongoing geological interpretation and geomechanical studies. Crown pillar stability assessments completed as part of feasibility study.	4 - CRITICAL	2 - REMOTE	MEDIUM
	Underground	Technical	Technical	Falls of ground	Production delay Equipment damage	4 - CRITICAL	4 - PROBABLE	VERY HIGH	Adequately resourced geotechnical department to allow for inspections, monitoring and ground support quality control.	4 - CRITICAL	2 - REMOTE	MEDIUM
	Underground	Technical	Technical	Pillar failures (sills, ribs, etc.)	Production delay Loss of Ore Equipment damage	3 - PROBLEMATIC	2 - REMOTE	MEDIUM	Adequately resourced geotechnical department to allow for inspections and monitoring. Pillars could be increased in size if needed to improve stability.	3 - PROBLEMATIC	1 - UNLIKELY	LOW
	Underground	Technical	Technical	Crown Pillar failure	Inrush Production Delay Equipment Loss	5 - CATASTROPHIC	1 - UNLIKELY	MEDIUM	Adequately resourced geotechnical department to allow for inspections and monitoring. Allowance for ongoing geological interpretation and geomechanical studies. Numerical modelling of crown pillar stability .	5 - CATASTROPHIC	1 - UNLIKELY	MEDIUM

	Area	Risk Type	Risk Category	Potential Risk/Issue	Consequences	Project Risk			Mitigation Strategy	Residual Risk		
						H&S	Likelihood	Risk Level		Severity	Likelihood	Risk Level
	Underground	Technical	Technical	Backfill failure (e.g., inadequate strength)	Production delay Equipment damage	2 - MODERATE	2 - REMOTE	LOW	Adequately resourced geotechnical department to allow for inspections and on-site quality-control testing of the backfill	2 - MODERATE	2 - REMOTE	LOW
	Underground	Technical	Technical	Mining induced seismicity	Production delay Equipment damage	3 - PROBLEMATIC	1 - UNLIKELY	LOW	Adequately resourced geotechnical department to allow for inspections and monitoring.	3 - PROBLEMATIC	1 - UNLIKELY	LOW
	Underground	Technical	Technical	Mining block back instability (due to poor backfilling practices)	Production delay Sterilization of ore	4 - CRITICAL	2 - REMOTE	MEDIUM	Adequately resourced geotechnical department to allow for inspections and monitoring. Numerical modelling of mining sequence.	4 - CRITICAL	1 - UNLIKELY	MEDIUM
	Underground	Technical	Technical	Inability to consistently achieve stope design spans	Increased operating cost	3 - PROBLEMATIC	2 - REMOTE	MEDIUM	Adequately resourced geotechnical department to allow for inspections and monitoring.	3 - PROBLEMATIC	2 - REMOTE	MEDIUM
	Underground	Technical	Technical	Increased ground support or reduced ground support service life	Increased operating cost	3 - PROBLEMATIC	2 - REMOTE	MEDIUM	Trial program for using resin-rebar and spin cables instead of inflatable bolts.	3 - PROBLEMATIC	1 - UNLIKELY	LOW
	Underground	Technical	Technical	Increased use of cement for backfill	Increased operating cost	3 - PROBLEMATIC	2 - REMOTE	MEDIUM	Trial backfill program to better define backfill costs.	3 - PROBLEMATIC	2 - REMOTE	MEDIUM
PROCESS	Process	Technical	Environmental	Reduced availability of water in winter months	Lack of process water	3 - PROBLEMATIC	3 - OCCASIONAL	MEDIUM	Tailings thickener added to design, continue to optimize water use and increase water recycle in process to reduce fresh water needs.	3 - PROBLEMATIC	2 - REMOTE	MEDIUM
	Process	Technical	Technical	Metallurgical recoveries are lower than expected	Reduced recovery of gold and reduced revenue	2 - MODERATE	3 - OCCASIONAL	MEDIUM	Additional metallurgical testing of various ore types to optimize the recovery process, add confidence, and apply appropriate process changes.	2 - MODERATE	2 - REMOTE	LOW
	Process	Technical	Technical	Ore bodies are harder to grind than predicted	Final grind of approx. 50 µm cannot be achieved, reduced recovery of gold	2 - MODERATE	2 - REMOTE	LOW	Explore metallurgy at coarse grind sizes, increase grinding intensity to achieve target grind.	2 - MODERATE	2 - REMOTE	LOW
	Process	Technical	Technical	Freezing of process lines/vessels	Production interruptions and potential equipment damage	4 - CRITICAL	3 - OCCASIONAL	HIGH	Heat tracing and insulation of applicable lines. Pumps on emergency power to maintain flow. Dump/purge valves where applicable.	2 - MODERATE	2 - REMOTE	LOW
	Process	Technical	Technical	Freezing of fine-ore stockpile	Production interruption	3 - PROBLEMATIC	3 - OCCASIONAL	MEDIUM	Stockpile designed for dozer access for pile manipulation and clearing. Crushing process maintained at sub-zero temperatures in winter months.	3 - PROBLEMATIC	1 - UNLIKELY	LOW
WATER	Water Mgmt.	Technical	Technical	Foundation conditions different than estimated, due to limited drilling information for all water management infrastructure (specifically, more massive ice, thaw talik apparent, deeper active layer, or more peat or organic-rich soil apparent in the	Additional costs Delays in construction Delays to operation, fines or temporary mine shut down	4 - CRITICAL	4 - PROBABLE	VERY HIGH	SEE SUBSECTION BELOW BY STRUCTURE			-

	Area	Risk Type	Risk Category	Potential Risk/Issue	Consequences	Project Risk H&S	Project Risk Likelihood	Project Risk Risk Level	Mitigation Strategy	Residual Risk Severity	Residual Risk Likelihood	Residual Risk Risk Level
				foundation). Risk by infrastructure element below:								
	Water Mgmt.	Technical	Technical	Llama Pit Diversions—Sediment and foundation conditions	Additional lakebed sediment or weaker foundation conditions may require shallower side slopes to be used for these in lake berms Also, may require some dredging to remove sediment below the berm foundation or over the pits Alternative would be to dewater lake and leave to freeze and the mine frozen material Expect would only be able to free in the range of 2 to 3 m over one winter season So may have impacts on schedule Also potential for additional sediment management required or this material to be put into the pits with the tailings (i.e., into the TFs)	2 - MODERATE	4 - PROBABLE	MEDIUM	Sediment sampling campaign to be carried out after Llama lake is dewatered to help optimize designs.	2 - MODERATE	3 - OCCASIONAL	MEDIUM
	Water Mgmt.	Technical	Technical	Llama WRSA Pond—Drilling information	Limited drilling information around this location Deeper active layer or active talik could mean that additional work on the key trench (deeper), or some freezing system such as thermosyphons to be required.	3 - PROBLEMATIC	3 - OCCASIONAL	MEDIUM	Pond planned generally to be kept dry, except during storm events (i.e., surge pond). Additional drilling to be completed at this location closer to the time of construction to optimize the key trench designs. Monitoring to be carried out to tell if additional remediation is required during operation (such as the installation of thermosyphons).	2 - MODERATE	3 - OCCASIONAL	MEDIUM
	Water Mgmt.	Technical	Technical	Umwelt Dam (SWP)—Saline water balance	Additional saline water encountered as part of the mine plan and/ or facility required to operator for longer than the original design lift Very-limited drilling information around this location, so one of the highest uncertainty on the foundation conditions Massive ice in foundation Thaw talik at location	4 - CRITICAL	4 - PROBABLE	VERY HIGH	A key trench and passive thermosyphons have been incorporated into the design, to build in some robustness for the unknows. Drilling planned to be carried out at this location at least one year in advance of construction. Monitoring instrumentation to be installed into dam.	3 - PROBLEMATIC	3 - OCCASIONAL	MEDIUM

	Area	Risk Type	Risk Category	Potential Risk/Issue	Consequences	Project Risk H&S	Project Risk Likelihood	Project Risk Risk Level	Mitigation Strategy	Residual Risk Severity	Residual Risk Likelihood	Residual Risk Risk Level
	Water Mgmt.	Technical	Technical	Primary pond—Massive ice inclusions	Massive ice has been noted at the foundation of this dam Risk for thermal erosion through foundation Risk if design life extended, then get additional thermal loading to dam and have impacts to foundation on water bypassing structure.	4 - CRITICAL	4 - PROBABLE	VERY HIGH	A key trench and passive thermosyphons have been incorporated into the design, to build in some robustness for the unknowns. Drilling planned to be carried out at this location before construction commences at this location. Monitoring instrumentation to be installed into the dam.	3 - PROBLEMATIC	3 - OCCASIONAL	MEDIUM
	Water Mgmt.	Technical	Technical	Plant/Camp site pond—Bedrock/overburden quality	Overburden on the side tie-ins or heavily fractured bedrock may be encountered as part of this pond construction Potential for seepage flow through bedrock or below key trench if key trench not deep enough.	3 - PROBLEMATIC	3 - OCCASIONAL	MEDIUM	Have included a key trench in the design for the overburden sections. Modifying the pond design at this location so that it is now a fully lined area.	2 - MODERATE	2 - REMOTE	LOW
	Water Mgmt.	Technical	Technical	Diversion upslope of Echo Pit—Massive ice	Massive ice in foundation leading to increase fill thicknesses needed and deformation reducing conveyance capacity.	3 - PROBLEMATIC	3 - OCCASIONAL	MEDIUM	Routine monitoring and maintenance to be completed for this berm throughout the active mine live. Additional fill material to be added to this berm for additional thermal protection (based on monitoring). Adding additional fillet of material in central area where intermediate flow path has been noted in the aerial imagery.	2 - MODERATE	3 - OCCASIONAL	MEDIUM
	Water Mgmt.	Technical	Technical	Echo WRSA Pond—Thaw talik	Large thaw talik below the current creek alignment/center of the ponded area Massive ice	3 - PROBLEMATIC	3 - OCCASIONAL	MEDIUM	Pond to be operated dry except for during storm events (surge pond). Drilling to be completed before construction. Key trench to be deepened based on drilling and thermal monitoring results. Monitoring instrumentation to be installed as part of dam construction. Close monitoring of seepage at this location. Pond set-up to prove seepage flow towards pit.	2 - MODERATE	3 - OCCASIONAL	MEDIUM
	Water Mgmt.	Technical	Technical	Goose Pit Diversion—Massive ice	Massive ice in foundation leading to increase fill thicknesses needed and deformation reducing conveyance capacity.	3 - PROBLEMATIC	3 - OCCASIONAL	MEDIUM	Routine monitoring and maintenance to be completed for this berm throughout the active mine live. Additional fill material to be added to this berm for additional thermal protection (based on monitoring).	2 - MODERATE	2 - REMOTE	LOW
	Hydrology/Water Mgmt.	Technical	Technical	Events larger than 1-in-a-100-year 24 h event experienced by the diversion and ponds (and associated dams)	Diversion and dams overtopped Potential failure of sections of the infrastructure	5 - CATASTROPHIC	3 - OCCASIONAL	HIGH	Spillways incorporated into dam designs. Diversions designed primary of rockfill to be more robust to overtopping. Maintenance planned to be performed on site after all storms larger than 1-in-5-year 24 h events. Ongoing monitoring for all	2 - MODERATE	3 - OCCASIONAL	MEDIUM

	Area	Risk Type	Risk Category	Potential Risk/Issue	Consequences	Project Risk H&S	Project Risk Likelihood	Project Risk Risk Level	Mitigation Strategy	Residual Risk Severity	Residual Risk Likelihood	Residual Risk Risk Level
									ponds and diversions through operations/until breached at closure.			
	Water Management	Technical	Technical	Excessive thaw settlement of foundation consolidation, or long-term undrained creep	Cracking of the dams, loss of freeboard and water-retaining capacity	4 - CRITICAL	3 - OCCASIONAL	HIGH	Consideration in freeboard. Monitoring required at all dams on site (e.g., thermal, deformation). Trade-off on liner types based on known date. Stability and thermal calculations/checks.	2 - MODERATE	3 - OCCASIONAL	MEDIUM
	Water and Load Balance	Technical	Schedule	Lakes unable to be dewatered and fished out in the same seasons	Small window between allowance for fish-out and lake dewatering Also, potential that lake water has higher sediment content and needs treatment before discharge to Goose Lake Delays to construction and potential delay of first gold date.	4 - CRITICAL	3 - OCCASIONAL	HIGH	Carry out all fish-outs in one year. Lake dewatering for Umwelt and Llama lake may be carried out over two open water seasons. Store some of the dewatered lake water temporarily in the primary pond. Have a TSS treatment plant/system set-up at the same time as or before lake dewatering commences.	2 - MODERATE	3 - OCCASIONAL	MEDIUM
	Water Mgmt.	Technical	Technical	Excessive saline water generation from underground workings	Early filling of saline storage pond Potential to release to environment, additional containment measures required	4 - CRITICAL	2 - REMOTE	MEDIUM	Updated groundwater modelling of Umwelt underground. Ongoing monitoring of saline water ingress rates during underground production.	4 - CRITICAL	1 - UNLIKELY	MEDIUM
	Water Mgmt.	Technical	Technical	Inefficient tailings deposition—causes include excess ice entrainment during tailings deposition, reduced feed tailings density, settling rates, or final settle density	Reduced settling efficiency due to pore-water entrainment as ice and reduced return water quantity Risk of early filling of Echo tailings pits due to added volume May require adjusted mine plan	3 - PROBLEMATIC	2 - REMOTE	MEDIUM	Sub-aqueous tailings deposition to reduce risk of freezing of fresh tailings.	2 - MODERATE	1 - UNLIKELY	LOW
	Water Mgmt.	Technical	Technical	Increased seepage through freshwater berm of SWP	Early filling of saline storage ponds Potential to release to environment, additional containment measures required	4 - CRITICAL	2 - REMOTE	MEDIUM	Geomembrane lined diversion berms to limit freshwater ingress	3 - PROBLEMATIC	1 - UNLIKELY	LOW
	Water Mgmt.	Technical	Technical	Adverse open-pit water quality	Non-compliant environmental discharge after closure due to pit filling	3 - PROBLEMATIC	4 - PROBABLE	HIGH	Active treatment of tailings reclaim water	2 - MODERATE	2 - REMOTE	LOW

	Area	Risk Type	Risk Category	Potential Risk/Issue	Consequences	Project Risk			Mitigation Strategy	Residual Risk		
						H&S	Likelihood	Risk Level		Severity	Likelihood	Risk Level
TAILINGS	Tailings	Operations	Management	Large ice entrainment in pit TFs	Reduced design life of TFs Need to move tailings deposition to another pit earlier Most critical for Echo pit when timing and storage space/storage flexibility is the lowest	4 - CRITICAL	3 - OCCASIONAL	HIGH	Remove the water cover for Echo TF. Able to fill tailings up to the pit bring now and at a future stage covered with waste rock. Using thickened tailings. Planning to deposit all tailings subaqueously (deposited 2 m below top water/ice surface at all times).	3 - PROBLEMATIC	2 - REMOTE	MEDIUM

Source: SDE, 2021.

25.2 Opportunities

The Project has several associated opportunities that have been identified as part of the Updated Feasibility Study. These opportunities are described in Table 25-4, but are not considered in this study as further work is required to confirm their impacts on the Project.

Table 25-4: Significant Project Opportunities

Area	Opportunity	Opportunity Category	Description	Benefit	Next Steps
Construction	Human Resources	Human Behaviour	Use of local labour for construction and operations.	Community engagement, availability of ongoing employment.	Ongoing community outreach, involvement of contractor and vendor teams.
Power Generation and Site Services	Technical	Management/Technical	Opportunity for renewable power generation on site. This could include over-the-fence (OTF) contracting of power generation.	Reduced fuel shipping and power generation costs.	Continue to evaluate renewable technologies applicable to site through discussion with vendors/experts. Proceed with most appropriate technology.
Shipping and Logistics	Technical	Technical	Optimization of shipping, load planning, and logistics scheduling.	Reduced shipping costs.	Detailed logistics planning with specific vendor and expert support.
Geology	Technical	Technical	Additional drilling adds to Mineral Resource and/or increases confidence.	Extended mine life and more consistent production of gold.	Continue drilling at depth and flanks, continue infill drilling to upgrade the level of confidence. Continue to explore for additional deposit discoveries.
Mining	Technical	Technical	Optimization of mine plan and earlier development of underground mining.	Extended mine life and more consistent production of gold.	Evaluate mine plan on an ongoing basis as new data becomes available.
Underground	Technical	Technical	Reduce dilution through improved drilling and blasting technology.	Higher grades from less tonnage.	Evaluate overbreak during pre-production mining and bulk sampling.
Underground	Technical	Technical	Reduced backfill cement content.	Reduced operating costs.	Complete backfill trial testing.
Underground	Technical	Technical	Ground support optimization.	Possible decrease in ground-support operating costs.	Characterization of the rock mass during development to assess whether optimization is possible.
Underground	Technical	Technical	Longhole/sub-level stoping.	Increase production rates and reduce mining costs.	Rock mechanic studies of large excavations.
Underground	Technical	Technical	Electrical equipment.	Reduced ventilation and heating costs.	Revision of equipment list.
Process	Technical	Technical	Availability of bulk sampling materials from open pit mining program during construction.	Increase confidence in metallurgical recovery during early years of mill operation. Availability of bulk ore samples for expanded metallurgical testing programs, such as pilot scale ore sorting.	Develop sampling program based on open pit mine schedule.
Process	Technical	Technical	Metallurgical recovery can be improved through optimizing grind size.	Reduced energy costs and improved revenue.	Complete additional metallurgical testing on samples using a statistically relevant design of experiment to estimate best operating parameters for each major ore type.

Area	Opportunity	Opportunity Category	Description	Benefit	Next Steps
Process	Technical	Technical	Additional throughout can be achieved through implementing mineral sorting.	Significant throughput increases with minor penalties to overall metallurgical recovery.	Complete pilot-scale sorting test(s) on various mineralization types.
Process	Technical	Technical	Additional throughput can be achieved by rejecting specific sizes of crushed rock by screening.	Significant throughput increases with minor penalties to overall metallurgical recovery.	Complete pilot-scale screening test(s) on various mineralization types.
Process	Construction	Management	Winter work can accelerate schedule.	Faster start-up.	Procurement planning to focus on tasks which can be accomplished in first winter.
Process	Technical	Technical	Grinding efficiency can be improved through improved classification.	Reduced energy costs and improved revenue.	Optimization of circulating load around the ball mill and stirred mill in operation.

Source: SDE, 2021.

26 RECOMMENDATIONS

Based on the findings of this Updated Feasibility Study, it is recommended that the Project continue to be developed as indicated by its positive economic assessment. As with any significant capital project, additional steps should be taken to mitigate risks identified in Section 25. Many of these risks require ongoing mitigation strategies such as site monitoring or data generation which are not discrete events.

Additional drilling, sampling, modelling, and metallurgical testing should be undertaken to continuously de-risk the Project, explore if any by-product metals can be produced from the deposit economically, and reinforce confidence in the estimated production schedule.

Significant opportunities were also identified in Section 25, which should be explored as part of future work.

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28 QUALIFIED PERSON CERTIFICATES

28.1 Denis Thibodeau, P.Eng.

I, Denis Thibodeau, P.Eng., as an author of this report titled *National Instrument (NI) 43-101 Technical Report 2021 Updated Feasibility Study for the Goose Project at the Back River Gold District, Nunavut, Canada*, with an effective date of 15 January 2021 (the "Technical Report") prepared for Sabina Gold & Silver Corp. and dated 3 March 2021, do hereby certify that:

- I am the Principal and Director at Sacré-Davey Engineering (SDE) with an office at 315 Mountain Highway, North Vancouver, British Columbia, V7J 2K7, Canada, and have worked with SDE during the preparation of this Technical Report.
- I am a Civil Professional Engineer by profession (École Polytechnique de Montréal, registered with the Ordre des Ingénieurs du Québec, Nunavut Association of Professional Engineer and Geoscientist). I have practiced my profession for more than 35 years. I have been directly involved in mining and mineral projects in the Canadian Arctic.
- I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.
- I am independent of the Issuer as defined by Section 1.5 of the Instrument.
- I have not had prior involvement with the property that is subject of this Technical Report.
- I have visited the Back River Property on 20 and 21 October 2020 for two days.
- I am responsible for Sections 1.0–1.2, 1.10, 1.15–1.17, 1.20, 1.21, 2, 3, 18.1, 18.1.1, 18.1.5, 18.1.7, 18.1.8, 18.2, 18.2.1, 18.2.7, 18.2.8; 21 (other than 21.1.3 (underground mining portion), 21.1.3 (open pit), 21.2.3 (open pit), 21.2.3 (underground portion) and 21.1.14), and 24–26 of the Technical Report.
- I have read NI 43-101 and Form 43-101F1 and the parts of the Technical Report for which I am responsible, and they have been prepared in compliance with that instrument.
- I have read the News Release dated February 24, 2021 and confirm this news release is a fair and accurate summary of my sections of this Technical Report.
- As of the effective date of the Technical Report, to the best of my knowledge, information, and belief, the parts of the Technical Report for which I am responsible contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Dated this 3rd day of March 2021, at Montréal, PQ, Canada.

Original Signed and Sealed

Denis Thibodeau, P.Eng.
Sacré-Davey Engineering
Principal and Lead Civil Engineer

28.2 John Morton Shannon, P.Geo.

I, John Morton Shannon, P.Geo., as an author of this report titled *National Instrument (NI) 43-101 Technical Report 2021 Updated Feasibility Study for the Goose Project at the Back River Gold District, Nunavut, Canada*, with an effective date of 15 January 2021 (the "Technical Report") prepared for Sabina Gold & Silver Corp. and dated 3 March 2021, do hereby certify that:

- I am currently employed as a General Manager and Principal Geologist with AMC Mining Consultants (Canada) Ltd. (AMC), with an office at Suite 202, 200 Granville Street, Vancouver, BC, V6C 1S4, Canada, and have worked with AMC during the preparation of this Technical Report.
- I am a graduate of Trinity College in Dublin, Ireland (BA Mod Nat. Sci. in Geology, 1971). I am a member in good standing of the Association of Professional Engineers and Geoscientists of British Columbia (License #32865), the Association of Professional Geoscientists of Ontario (License #0198), and a member of the Canadian Institute of Mining, Metallurgy and Petroleum. I have practiced my profession continuously since 1971 and have been involved in mineral exploration and mine geology for a total of 49 years since my graduation from university. This has involved working in Ireland, Zambia, Canada, and Papua New Guinea. My experience is principally in base metals and gold, and have experience in Archaen gold deposits, having been Chief Geologist of Dome Mine in Ontario for six years.
- I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.
- I have had prior involvement with the property that is the subject of the Technical Report. I co-authored the technical report entitled Technical Report and Prefeasibility Study for the Back River Gold Project, Nunavut, Canada, dated 9 October 2013. I also co-authored the technical report entitled Back River Gold Property Nunavut Territory, Canada. Technical Report for Sabina Gold and Silver Corp. dated 15 February 2013. I also co-authored the technical report entitled Back River Gold Property Nunavut Territory, Canada. Technical Report for Sabina Gold & Silver Corp. dated 4 March 2014. I also co-authored the technical reports entitled Technical Report and Feasibility Study for the Back River Gold Property, Nunavut, Canada, for Sabina Gold & Silver Corp., with an effective date of 20 May 2015, and Technical Report for the Initial Project Feasibility Study for the Back River Gold Property, Nunavut, Canada, for Sabina Gold & Silver Corp., with an effective date of 14 September 2015.
- I am independent of the Issuer as defined by Section 1.5 of the Instrument.
- I have visited the Back River Property from 27 to 28 August 2012 for two days.
- I am responsible for Sections 3, 4 to 11, and 23, and contributed to Section 1 of the Technical Report.
- I have read NI 43-101, and the Technical Report has been prepared in compliance with NI 43-101 and Form 43-101F1.
- I have read the News Release dated 24 February 2021 and confirm this news release is a fair and accurate summary of my sections of this Technical Report.
- As of the effective date of the Technical Report, to the best of my knowledge, information, and belief, the parts of the Technical Report for which I am responsible contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Dated this 3rd day of March 2021, at Vancouver, BC, Canada.

Original Signed and Sealed

John Morton Shannon, P.Geo.
AMC Mining Consultants (Canada) Ltd.
General Manager and Principal Geologist

28.3 Dinara Nussipakynova, P.Geo.

I, Dinara Nussipakynova, P.Geo., as an author of this report titled *National Instrument (NI) 43-101 Technical Report 2021 Updated Feasibility Study for the Goose Project at the Back River Gold District, Nunavut, Canada*, with an effective date of 15 January 2021 (the "Technical Report") prepared for Sabina Gold & Silver Corp. and dated 3 March 2021, do hereby certify that:

- I am employed as a Principal Geologist with AMC Mining Consultants (Canada) Ltd. (AMC) with an office at Suite 202, 200 Granville Street, Vancouver, British Columbia, V6C 1S4, Canada, and have worked with AMC during the preparation of this Technical Report.
- I am a graduate of Kazakh National Polytechnic University (B.Sc. and M.Sc. in Geology, 1987). I am a member in good standing of the Association of Professional Engineers and Geoscientists of British Columbia (License #37412) and the Association of Professional Geoscientists of Ontario (License #1298). I have practiced my profession continuously since 1987 and have been involved in mineral exploration and mine geology for a total of 33 years since my graduation from university. This has involved working in Kazakhstan, Russia, and Canada, in multiple base metal, gold, and silver deposits. My experience is principally in database management, geological interpretation, block modelling, and Mineral Resource estimation.
- I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.
- I have had prior involvement with the property that is the subject of the Technical Report: I co-authored the technical report entitled Technical Report and Prefeasibility Study for the Back River Gold Project, Nunavut, Canada, dated 9 October 2013. I also co-authored the technical report entitled Back River Gold Property Nunavut Territory, Canada: Technical Report for Sabina Gold and Silver Corp., dated 15 February 2013. I also co-authored the technical report entitled Back River Gold Property Nunavut Territory, Canada: Technical Report for Sabina Gold & Silver Corp., dated 4 March 2014. I also co-authored the technical report entitled Technical Report and Feasibility Study for the Back River Gold Property, Nunavut, Canada" for Sabina Gold & Silver Corp., with an effective date of 20 May 2015, and Technical Report for the Initial Project Feasibility Study for the Back River Gold Property, Nunavut, Canada for Sabina Gold & Silver Corp., with an effective date of 14 September 2015.
- I am independent of the Issuer as defined by Section 1.5 of the Instrument.
- I have visited the Back River Property from 21 to 22 October 2020 for two days.
- I am responsible for Sections 12 and 14 and contributed to Section 1 of the Technical Report.
- I have read NI 43-101, and the Technical Report has been prepared in compliance with NI 43-101 and Form 43-101F1.
- I have read the News Release dated 24 February 2021 and confirm this news release is a fair and accurate summary of my sections of this Technical Report.
- As of the effective date of the Technical Report and the date of this certificate, to the best of my knowledge, information and belief, this Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Dated this 3rd day of March 2021, at Vancouver, BC, Canada.

Original Signed and Sealed

Dinara Nussipakynova, P.Geo.
AMC Mining Consultants (Canada) Ltd.
Principal Geologist

28.4 Jacinta Klabenes, P.Eng., PE

I, Jacinta Klabenes, P.Eng., PE, as an author of this report titled *National Instrument (NI) 43-101 Technical Report 2021 Updated Feasibility Study for the Goose Project at the Back River Gold District, Nunavut, Canada*, with an effective date of 15 January 2021 (the "Technical Report") prepared for Sabina Gold & Silver Corp. and dated 3 March 2021, do hereby certify that:

- I am a Senior Engineer with Mining Plus (MP) with an office at Suite 202, 200 Granville Street, Vancouver, British Columbia, V6C 1S4, Canada, and have worked with MP during the preparation of this Technical Report.
- I am a Mining Engineer by profession (South Dakota School of Mines & Technology—B.S. Mining Engineering) and am a registered professional engineer with Engineers and Geoscientists British Columbia, License no. 202970. I have practiced my profession for more than 10 years. I have been directly involved in mining and mineral processing projects in Canada, the United States, and South America.
- I have read the definition of "qualified person" set out in the National Instrument 43-101 (NI 43-101) and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.
- I am independent of the Issuer as defined by Section 1.5 of the Instrument.
- I have not had prior involvement with the property that is subject of this Technical Report.
- I have visited the Project site on 20 and 21 October 2020 for two days.
- I am responsible for Sections 16, 18.2.9, and contributed to Sections 1 of the Technical Report.
- I have read NI 43-101 and Form 43-101F1 and the parts of the Technical Report for which I am responsible, and they have been prepared in compliance with that instrument.
- I have read the News Release dated 24 February 2021 and confirm this news release is a fair and accurate summary of my sections of this Technical Report.
- As of the effective date of the Technical Report, to the best of my knowledge, information, and belief, the parts of the Technical Report for which I am responsible contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Dated this 3rd day of March 2021, at Vancouver, BC, Canada.

Original Signed and Sealed

Jacinta Klabenes, P.Eng., PE
Mining Plus
Senior Engineer

28.5 Maurice Mostert, FSAIMM

I, Maurice Mostert, FSAIMM, as an author of this report titled *National Instrument (NI) 43-101 Technical Report 2021 Updated Feasibility Study for the Goose Project at the Back River Gold District, Nunavut, Canada*, with an effective date of 15 January 2021 (the "Technical Report") prepared for Sabina Gold & Silver Corp. and dated 3 March 2021, do hereby certify that:

- I am the Area Manager for Underground Operations with Mining Plus (MP) with an office at Suite 504, 999 Canada Place, Vancouver, British Columbia, V6C 3T4, Canada, and have worked with MP during the preparation of this Technical Report.
- I am a Mining Engineer by profession (University of the Witwatersrand–M.Sc. Mining Engineering.), registered with the South African Institute of Mining and Metallurgy as a Fellow (FSAIMM) and a graduate of the University of South Africa (UNISA), holding a Bachelor of Technology (B-Tech) Degree. I have practiced my profession for more than 20 years. I have been directly involved in mining and mineral processing projects in Canada, the United States, South America, South Africa, and Europe.
- I have read the definition of "qualified person" set out in the National Instrument 43-101 (NI 43-101) and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.
- I am independent of the Issuer as defined by Section 1.5 of the Instrument.
- I have not had prior involvement with the property that is subject to this Technical Report.
- I have visited the Project site on 20 and 21 October 2020 for two days.
- I am responsible for the Sections 1.7, 15, 21.1.3 (underground mining), and 21.2.3 (underground mining), and contributed to Sections 3, 18, 22, and 25 of the Technical Report.
- I have read NI 43-101 and Form 43-101F1 and the parts of the Technical Report for which I am responsible, and they have been prepared in compliance with that instrument.
- I have read the News Release dated 24 February 2021 and confirm this news release is a fair and accurate summary of my sections of this Technical Report.
- As of the effective date of the Technical Report, to the best of my knowledge, information, and belief, the parts of the Technical Report for which I am responsible contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Dated this 3rd day of March 2021, at Vancouver, BC, Canada.

Original Signed and Sealed

Maurice Mostert, Pr.Tech. Eng., M.Sc., FSAIMM
Mining Plus
Area Manager for Underground Operations

28.6 Neda Farmer, P.Eng.

I, Neda Farmer, P.Eng., as an author of this report titled *National Instrument (NI) 43-101 Technical Report 2021 Updated Feasibility Study for the Goose Project at the Back River Gold District, Nunavut, Canada*, with an effective date of 15 January 2021 (the "Technical Report") prepared for Sabina Gold & Silver Corp. and dated 3 March 2021, do hereby certify that:

- I am the Area Manager—Surface Operation with Mining Plus (MP) with an office at Suite 202, 200 Granville Street, Vancouver, British Columbia, V6C 1S4, Canada, and have worked with MP during the preparation of this Technical Report.
- I graduated with a Bachelor of Applied Science in Mine and Mineral Process Engineering from the University of British Columbia in 1998.
- I have read the definition of "qualified person" set out in the National Instrument 43-101 (NI 43-101) and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.
- I am independent of the Issuer as defined by Section 1.5 of the Instrument.
- I have not been involved with the property that is subject to this Technical Report.
- I have not visited the Project site.
- I am responsible for Section 21.2.3 (Open Pit portion) and 21.2.3 (Open Pit portion) of the Technical Report.
- I have read NI 43-101 and Form 43-101F1 and the parts of the Technical Report for which I am responsible, and they have been prepared in compliance with that instrument.
- I have read the News Release dated 24 February 2021 and confirm this news release is a fair and accurate summary of my sections of this Technical Report.
- As of the effective date of the Technical Report, to the best of my knowledge, information, and belief, the parts of the Technical Report for which I am responsible contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Dated this 3rd day of March 2021, at Vancouver, BC, Canada.

Original Signed and Sealed

Neda Farmer P.Eng.
Mining Plus
Area Manager—Surface Operation

28.7 Stacy Freudigmann, P.Eng., F.Aus.IMM.

I, Stacy Freudigmann, P.Eng., F.Aus.IMM., as an author of this report titled *National Instrument (NI) 43-101 Technical Report 2021 Updated Feasibility Study for the Goose Project at the Back River Gold District, Nunavut, Canada*, with an effective date of 15 January 2021 (the "Technical Report") prepared for Sabina Gold & Silver Corp. and dated 3 March 2021, do hereby certify that:

- I am a Principal with Canenco Consulting Corp. (Canenco) with a business address at 602 East 4th Street, North Vancouver, BC, Canada, and have worked with Canenco during the preparation of this Technical Report.
- I am registered as a Professional Engineer with the Northwest Territories and Nunavut Association of Professional Engineers and Geoscientists (NAPEG #L4673), the Professional Engineers and Geoscientists of Newfoundland & Labrador (PEGNL #N1125) and with Association of Professional Engineers, Geoscientists of British Columbia (PEGBC #33972). I am a Member of the Canadian Institute of Mining and Metallurgy and the Australasian Institute of Mining and Metallurgy as a Fellow, (F.Aus.IMM.). I am a graduate of the James Cook University with a B.Sc. (Hons) in Industrial Chemistry (1996) and Curtin University, Western Australia School of Mines with a Grad.Dip. Metallurgy (1999). I have practiced my profession continuously for more than 20 years. I have been directly involved in mining and mineral processing projects in the Americas, Europe, Asia Pacific, USA and Canada.
- I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.
- I am independent of the Issuer as defined by Section 1.5 of the Instrument.
- I have had prior involvement with the property that is subject to this Technical Report. This includes undertaking the metallurgy and managing the process engineering for the previous feasibility studies.
- I have not visited the Project site.
- I am responsible for the Sections 13 and 17 and contributed to Section 1 of the Technical Report.
- I have read NI 43-101 and Form 43-101F1 and the parts of the Technical Report for which I am responsible, and they have been prepared in compliance with that instrument.
- I have read the News Release dated 24 February 2021 and confirm this news release is a fair and accurate summary of my sections of this Technical Report.
- As of the effective date of the Technical Report, to the best of my knowledge, information, and belief, the parts of the Technical Report for which I am responsible contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Dated this 3rd day of March 2021, at Vancouver, BC, Canada.

Original Signed and Sealed

Stacy Freudigmann P.Eng. F.Aus.IMM.
Canenco Consulting Corp.
Principal

28.8 Ben Peacock, P.Eng.

I, Ben Peacock, P.Eng., as an author of this report titled *National Instrument (NI) 43-101 Technical Report 2021 Updated Feasibility Study for the Goose Project at the Back River Gold District, Nunavut, Canada*, with an effective date of 15 January 2021 (the "Technical Report") prepared for Sabina Gold & Silver Corp. and dated 3 March 2021, do hereby certify that:

- I am a Senior Engineer with Knight Piésold Ltd. (Knight Piésold) with a business address at 1650 Main Street West, North Bay, ON, P1B 8G5, Canada, and have worked with Knight Piésold during the preparation of this Technical Report.
- I am a professional engineer specializing in mining geomechanics and registered with the Northwest Territories and Nunavut Association of Professional Engineers and Geoscientists. I am a graduate of the University of Waterloo holding an Honours Bachelor of Applied Science Degree in Civil Engineering. I have practiced my profession for more than 12 years. I have worked on operating mines and mining projects in North America, including Nunavut, as well as South America, Africa, and Asia.
- I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.
- I am not independent of the Issuer as defined by Section 1.5 of the Instrument.
- I have had prior involvement with the property that is subject to this Technical Report, this includes completing geomechanical site investigation programs and providing geomechanical design input for potential open pit and underground mining at the Project in 2013, 2014, 2015, and 2017.
- I have visited the Project site several times. My most recent visit was between April 23 and 30, 2014.
- I contributed to Sections 1, 15, 16, 25, and 26 of the Technical Report.
- I have read NI 43-101 and Form 43-101F1 and the parts of the Technical Report for which I am responsible, and they have been prepared in compliance with that instrument.
- I have read the News Release dated 24 February 2021 and confirm this news release is a fair and accurate summary of my sections of this Technical Report.
- As of the effective date of the Technical Report, to the best of my knowledge, information, and belief, the parts of the Technical Report for which I am responsible contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Dated this 3rd day of March 2021, at North Bay, ON, Canada.

Original Signed and Sealed

Ben Peacock, P.Eng.
Knight Piésold Ltd.
Senior Engineer

28.9 Richard Cook, P.Geo. (Limited)

I, Richard Cook, P.Geo. (Limited), as an author of this report titled *National Instrument (NI) 43-101 Technical Report 2021 UpdatedFeasibility Study for the Goose Project at the Back River Gold District, Nunavut, Canada*, with an effective date of 15 January 2021 (the "Technical Report") prepared for Sabina Gold & Silver Corp. and dated 3 March 2021, do hereby certify that:

- I am a Specialist Environmental Scientist and Associate with Knight Piésold Ltd. in North Bay, ON, P1B 8G5, Canada, and have worked with Knight Piésold during the preparation of this Technical Report.
- I am a professional geoscientist registered with Professional Geoscientists Ontario (Limited designation) and a graduate of Queen's University holding an Honours Bachelor of Science Degree in Environmental Science. I have practiced my profession for more than 24 years. I have been directly involved in the environmental aspects of mining projects in Canada including Nunavut, as well as South America, Africa, and Europe.
- I have read the definition of "qualified person" set out in the National Instrument 43-101 (NI 43-101) and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.
- I am independent of the Issuer as defined by Section 1.5 of the Instrument.
- I have had prior involvement with the property that is subject to this Technical Report. This includes the preparation of environmental management plans covering ore handling and storage, waste rock and tailings, water management and mine closure during the environmental assessment of the Project.
- I have visited the Project site on 20 and 21 October 2020 for two days.
- I am responsible for Section 20 and 21.1.14 and contributed to Sections 1, 25, 26, and 27 of the Technical Report.
- I have read NI 43-101 and Form 43-101F1 and the parts of the Technical Report for which I am responsible, and they have been prepared in compliance with that instrument.
- I have read the News Release dated 24 February 2021 and confirm this news release is a fair and accurate summary of my sections of this Technical Report.
- As of the effective date of the Technical Report, to the best of my knowledge, information, and belief, the parts of the Technical Report for which I am responsible contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Dated this 3rd day of March 2021, at Vancouver, BC, Canada.

Original Signed and Sealed

Richard Cook, P.Geo. (Limited)
Knight Piésold Ltd.
Specialist Environmental Scientist | Associate

28.10 Amber Blackwell, P.Geo.

I, Amber Blackwell, P.Geo, as an author of this report titled *National Instrument (NI) 43-101 Technical Report 2021 Updated Feasibility Study for the Goose Project at the Back River Gold District, Nunavut, Canada*, with an effective date of 15 January 2021 (the "Technical Report") prepared for Sabina Gold & Silver Corp. and dated 3 March 2021, do hereby certify that:

- I am a Project Geoscientist with Knight Piésold Ltd. in North Bay, ON, Canada and have worked with Knight Piésold during the preparation of this report.
- I am a professional geoscientist registered with Professional Geoscientists Ontario (PGO) and a graduate of The University of Waterloo holding as Honours Bachelor of Science Degree in Earth Science/Environmental Specialization. I have practiced my profession for 10 years. I have been directly involved in the environmental aspects of mining projects in Canada including Nunavut, as well as South America, Africa, and Europe.
- I have read the definition of "qualified person" set out in the National Instrument 43-101 (NI 43-101) and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.
- I am independent of the Issuer as defined by Section 1.5 of the Instrument.
- I have had prior involvement with the property that is subject to this Technical Report. This included the conduction of two geomechanical and hydrogeological site investigation programs for the Goose Property deposits.
- I have visited the Project site on a regular basis.
- I am responsible for Section 18.1.4 and the geochemistry contributions to Sections 1, 18, and 20 of the NI 43-101 report.
- I have read NI 43-101 and Form 43-101F1 and the parts of the Technical Report for which I am responsible, and they have been prepared in compliance with that instrument.
- I have read the News Release dated 24 February 2021 and confirm this news release is a fair and accurate summary of my sections of this Technical Report.
- As of the effective date of the Technical Report, to the best of my knowledge, information, and belief, the parts of the Technical Report for which I am responsible contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Dated this 3rd day of March 2021, at Vancouver, BC, Canada.

Original Signed and Sealed

Amber Blackwell, P.Geo.
Knight Piésold Ltd.
Specialist Geoscientist

28.11 Michael Dawson, P.Eng.

I, Michael Dawson, P.Eng., as an author of this report titled *National Instrument (NI) 43-101 Technical Report 2021 Updated Feasibility Study for the Goose Project at the Back River Gold District, Nunavut, Canada*, with an effective date of 15 January 2021 (the "Technical Report") prepared for Sabina Gold & Silver Corp. and dated 3 March 2021, do hereby certify that:

- I am co-owner of DT Engineers Ltd (DT), with a business address at 7525 Stave Lake St, Mission, BC, V2V 4E9, Canada, and have worked with DT during the preparation of this Technical Report.
- I am an Electrical Engineer by profession (Queens University at Kingston, B.Sc, 2005), registered with Canadian Professional Engineering Associations in Nunavut/Northwest Territories, Yukon Territory, British Columbia, and Ontario. I have practiced my profession for more than 14 years. I have been directly involved in mining and mineral processing projects in Canada.
- I have read the definition of "qualified person" set out in the National Instrument 43-101 (NI 43-101) and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.
- I am independent of the Issuer as defined by Section 1.5 of the Instrument.
- I have had prior involvement with the property that is subject to this Technical Report. I have been contracted to Sabina since February 2019, assisting on several project development (project planning/optimization and peer review) and detailed design (underground mine decline and MLA Fuel Farm) scopes of work.
- I have not visited the Project site.
- I have contributed to Sections 1 and 16 and am responsible for Sections 18.2.2 to 18.2.6 and 18.2.10, 18.3 to 18.4 of the Technical Report.
- I have read NI 43-101 and Form 43-101F1 and the parts of the Technical Report for which I am responsible, and they have been prepared in compliance with that instrument.
- I have read the News Release dated 24 February 2021 and confirm this news release is a fair and accurate summary of my sections of this Technical Report.
- As of the effective date of the Technical Report, to the best of my knowledge, information, and belief, the parts of the Technical Report for which I am responsible contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Dated this 3rd day of March 2021, at Vancouver, BC, Canada.

Original Signed and Sealed

Michael Dawson, P.Eng.
DT Engineers Ltd.
Owner and Principal Electrical Engineer

28.12 Vincy Benjamin, P.Eng., PMP

I, Vincy Benjamin, P.Eng., PMP, as an author of this report titled *National Instrument (NI) 43-101 Technical Report 2021 Updated Feasibility Study for the Goose Project at the Back River Gold District, Nunavut, Canada*, with an effective date of 15 January 2021 (the "Technical Report") prepared for Sabina Gold & Silver Corp. (Sabina) and dated 3 March 2021,do hereby certify that:

- I am a Director of Engineering of Sabina with a business address at 1800 Two Bentall Centre 555 Burrard Street, Vancouver, BC, V7X 1M9, Canada, and have worked with Sabina during the preparation of this Technical Report.
- I am a Mechanical Engineer by profession (Jawaharlal Nehru National College of Engineering, Kuvempu University, Bachelor of Engineering, 1999), registered with Canadian Professional Engineering Associations in Ontario and British Columbia. I have practiced my profession for more than 21 years. I have been directly involved in mining, mineral processing, and oil and gas projects in Canada, USA, Middle East, and India.
- I have read the definition of "qualified person" set out in the National Instrument 43-101 (NI 43-101) and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.
- I am not independent of the Issuer as defined by Section 1.5 of the Instrument.
- I have had prior involvement with the property that is subject to this Technical Report. I have been a full time employee of Sabina Gold & Silver Corp, since April 2019, in my current capacity as Director of Engineering.
- I have visited the Project site on 9 May 2019.
- I have contributed to Sections 18.5 of the Technical Report.
- I have read NI 43-101 and Form 43-101F1 and the parts of the Technical Report for which I am responsible, and they have been prepared in compliance with that instrument.
- I have read the News Release dated 24 February 2021 and confirm this news release is a fair and accurate summary of my sections of this Technical Report.
- As of the effective date of the Technical Report, to the best of my knowledge, information, and belief, the parts of the Technical Report for which I am responsible contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Dated this 3rd day of March 2021, at Vancouver, BC, Canada.

Original Signed and Sealed

Vincy Benjamin, P.Eng.
Sabina Gold & Silver Corp.
Director of Engineering

28.13 John Kurylo, M.Sc, P.Eng.

I, John Kurylo, M.Sc. P.Eng., as an author of this report titled *National Instrument (NI) 43-101 Technical Report 2021 Updated Feasibility Study for the Goose Project at the Back River Gold District, Nunavut, Canada*, with an effective date of 15 January 2021 (the "Technical Report") prepared for Sabina Gold & Silver Corp. and dated 3 March 2021, do hereby certify that:

- I am a Senior Consultant with SRK Consulting (Canada) Inc. (SRK), with a business address at 22nd Floor, 1066 West Hastings Street, Vancouver, BC, V6E 3X2, Canada, and have worked with SRK during the preparation of this Technical Report.
- I am a Geotechnical Engineer by profession (BSc from the University of British Columbia, and MSc from Imperial College London), and am a registered Professional Engineer in Canada (BC, NU/NWT, YK). I have practiced my profession for over ten years and worked on mining and civil infrastructure projects located in the United Kingdom, Europe, Central Asia, South America, Scandinavia, Africa, and North America (primarily Canada).
- I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.
- I am independent of the Issuer as defined by Section 1.5 of the Instrument.
- I have had prior involvement with the property that is subject of this Technical Report, since 2018. For this updated Feasibility Study SRK's primary scope has been the water management infrastructure and inputs into the tailings deposition approach.
- I have visited the Back River Property on 21 and 22 October 2020 over two days.
- I am responsible for Sections 18.1.2, 18.1.3,18.1.6, 18.2.11, and contributed to Section 1.11 and Table 25-3 of the Technical Report.
- I have read NI 43-101 and Form 43-101F1 and the parts of the Technical Report for which I am responsible, and they have been prepared in compliance with that instrument.
- I have read the News Release dated 24 February 2021 and confirm this news release is a fair and accurate summary of my sections of this report.
- As of the effective date of the Technical Report, to the best of my knowledge, information, and belief, the parts of the Technical Report for which I am responsible contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Original Signed and Sealed

John Kurylo, M.Sc, P.Eng.
SRK Consulting (Canada) Inc.
Senior Consultant

28.14 Shervin Teymouri, P.Eng., BASc., M.Eng.

I, Shervin Teymouri, P.Eng., BASc., M.Eng., of Vancouver, BC, as an author of this report titled *National Instrument (NI) 43-101 Technical Report 2021 Updated Feasibility Study for the Goose Project at the Back River Gold District, Nunavut, Canada*, with effective date of 15 January 2021 (the "Technical Report") prepared for Sabina Gold & Silver Corp. and dated 3 March 2021, do hereby certify that:

- I am a Senior Engineer with Sacré-Davey Engineering Inc. (SDE) with a business address at 15 Mountain Hwy., North Vancouver, BC, V7J 2K7, Canada, and have worked with SDE during the preparation of this Technical Report.
- I am a graduate of University of British Columbia, (Geological Engineering 2005).
- I am a member in good standing of the Engineers and Geoscientists of BC (License #35469) and the Northwest Territories and Nunavut Association of Professional Engineers and Geoscientists (# L4694).
- I have practiced my profession continuously since graduation.
- I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) and certify that, by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purpose of NI 43-101.
- My relevant experience with respect to Mine Project Economic Analysis includes 14 years of Economic Analysis.
- I am independent of the Issuer as defined by Section 1.5 of the Instrument.
- I have no prior involvement with the property that is the subject of the Technical Report.
- I have not conducted a site visit to the property.
- I am responsible for Sections 19 and 22 and contributed to Sections 1, 25, and 26 of this Technical Report.
- I have read NI 43-101 and Form 43-101F1 and the parts of the Technical Report for which I am responsible, and they have been prepared in compliance with that instrument.
- I have read the News Release dated 24 February 2021 and confirm this news release is a fair and accurate summary of my sections of this Technical Report.
- As of the effective date of the Technical Report, to the best of my knowledge, information, and belief, the parts of the Technical Report for which I am responsible contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Dated this 3rd day of March 2021, at Vancouver, BC, Canada.

Original Signed and Sealed

Shervin Teymouri, P.Eng., BASc., M.Eng.
Sacré-Davey Engineering
Senior Engineer