WAFI–GOLPU PROJECT

MOROBE PROVINCE, PAPUA NEW GUINEA

NI 43-101 Technical Report

Report Prepared For:

Newcrest Mining Limited.

Qualified Persons:

Mr. Kevin Gleeson, FAusIMM

Mr. Pasqualino Manca, FAusIMM

Mr. Daniel Curry, FAusIMM

Mr. Craig Jones, FAusIMM.

Report Effective Date:

30 June, 2020.

NEWCREST MINING LIMITED

CERTIFICATE OF QUALIFIED PERSON

I, Kevin Gleeson, FAusIMM, am employed as the Head of Mineral Resource Management with Newcrest Mining Limited (Newcrest), situated at Level 8, 600 St Kilda Road, Melbourne, Victoria, 3004, Australia.

This certificate applies to the technical report titled "Wafi–Golpu Project, Morobe Province, Papua New Guinea, NI 43-101 Technical Report" that has an effective date of 30 June, 2020 (the technical report).

I am a Fellow of the Australasian Institute of Mining and Metallurgy (FAusIMM). I graduated with a Bachelor of Science (Hons) from the University of Melbourne, Victoria Australia, in 1987.

I have practiced my profession for over 30 years since graduation. I have been directly involved in exploration, interpretation, geological evaluation, development of resource models, ore control, and reconciliation for both open pit and underground mining in Australia, Papua New Guinea, and Indonesia. I have been directly involved in pre-feasibility and feasibility studies for gold and gold–copper deposits, and I currently manage a team of resource modellers and ore deposit knowledge specialists.

As a result of my experience and qualifications, I am a Qualified Person as defined in National Instrument 43–101 *Standards of Disclosure for Mineral Projects* (NI 43–101) for those sections of the technical report that I am responsible for preparing.

I visited the Wafi-Golpu Project for a four-day period, from 14–17 May, 2012.

I am responsible for Sections 1.1 to 1.8, 1.10, 1.11, 1.25; Section 2; Section 3; Section 4; Section 5; Section 6; Section 7; Section 8; Section 9; Section 10; Section 11; Section 12; Section 14; Section 23; Section 24; Sections 25.1 to 25.4, 25.6; Section 26; and Section 27 of the technical report.

I am not independent of Newcrest, as independence is described by Section 1.5 of NI 43–101.

I have been involved with the Wafi–Golpu Project since 2012 in my current role as the Head of Mineral Resource Management.

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

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

Dated: 13 October, 2020

"Signed"

Kevin Gleeson, FAusIMM.

CERTIFICATE OF QUALIFIED PERSON

I, Pasqualino (Lino) Manca, FAusIMM, am employed as the Group Manager – Mining Studies with Newcrest Mining Limited (Newcrest), situated at Level 8, 600 St Kilda Road, Melbourne, Victoria, 3004, Australia.

This certificate applies to the technical report titled "Wafi–Golpu Project, Morobe Province, Papua New Guinea, NI 43-101 Technical Report" that has an effective date of 30 June 2020 (the technical report).

I am a Fellow of the Australasian Institute of Mining and Metallurgy (FAusIMM). I graduated from the Darling Downs Institute of Advanced Education in 1987 with an Associate Diploma in Applied Science (Surveying), from the University of Ballarat in 2002 with a Graduate Diploma in Mining, and from the University of Melbourne in 2010 with a Master of Enterprise (Executive) degree.

I have practiced my profession since 1987 in Australia and Papua New Guinea. I have been directly involved in managing mining and underground engineering and geotechnical studies, mining research and development projects; supervision of cost estimation, cost control and economic analyses for mine planning, and project evaluations; supervision of infrastructure, environmental and social studies and their integration with major mining studies; preparation and delivery of underground short-, medium- and long-term mine designs and schedules; drill and blast designs; and provision of technical support for caving operations.

As a result of my experience and qualifications, I am a Qualified Person as defined in National Instrument 43–101 *Standards of Disclosure for Mineral Projects* (NI 43–101) for those sections of the technical report that I am responsible for preparing.

I have visited the Wafi–Golpu Project on a number of occasions, most recently for a day-long visit on 7 November, 2018.

I am responsible for Sections 1.1, 1.2, 1.12, 1.13, 1.14, 1.16 to 1.25; Section 2; Section 3; Section 15; Section 16; Section 18; Section 19; Section 20; Section 21; Section 22; Sections 25.1, 25.7, 25.8, 25.10 to 25.17; Section 26; and Section 27 of the technical report.

I am not independent of Newcrest, as independence is described by Section 1.5 of NI 43–101.

I have been involved with the Wafi–Golpu Project since 2015 in my role as the study manager for the most recent feasibility and pre-feasibility studies completed on the project.

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

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

Dated: 13 October, 2020

“Signed”

Pasqualino (Lino) Manca, FAusIMM.

NEWCREST MINING LIMITED

CERTIFICATE OF QUALIFIED PERSON

I, Daniel Curry, FAusIMM, am employed as the Head of Mineral Processing with Newcrest Mining Limited (Newcrest), situated at 600 St Kilda Road, Melbourne, Victoria 3004, Australia.

This certificate applies to the technical report titled "Wafi–Golpu Project, Morobe Province, Papua New Guinea, NI 43-101 Technical Report" that has an effective date of 30 June 2020 (the technical report).

I am a Fellow of the Australasian Institute of Mining and Metallurgy (FAusIMM). I graduated from Western Australian School of Mines (Curtin University) with Bachelor of Science degree in Extractive Metallurgy in 1995.

I have practiced my profession for 25 years. I have been directly involved in the design and operation of mineral processing plants for precious and base metals in Australasia, Africa, and South America.

As a result of my experience and qualifications, I am a Qualified Person as defined in National Instrument 43–101 Standards of Disclosure for Mineral Projects (NI 43–101) for those sections of the technical report that I am responsible for preparing.

I have not visited the Wafi–Golpu Project.

I am responsible for Sections 1.1, 1.2, 1.9, 1.15, 1.18, 1.25; Section 2; Section 3; Section 13; Section 17; Section 19; Sections 25.1, 25.5, 25.9, 25.12; Section 26; and Section 27 of the technical report.

I am not independent of Newcrest, as independence is described by Section 1.5 of NI 43–101.

I have been involved with the Wafi–Golpu Project since 2019 when joining Newcrest in my role as the Head of Mineral Processing.

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

NEWCREST
MINING LIMITED

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

Dated: 13 October, 2020

“Signed”

Daniel Curry, FAusIMM.

NEWCREST MINING LIMITED

CERTIFICATE OF QUALIFIED PERSON

I, Craig Jones, FAusIMM, am employed as the Chief Operating Officer, Papua New Guinea, with Newcrest Mining Limited (Newcrest), situated at Level 8, 600 St Kilda Rd, Melbourne, Victoria, Australia.

This certificate applies to the technical report titled "Wafi–Golpu Project, Morobe Province, Papua New Guinea, NI 43-101 Technical Report" that has an effective date of 30 June, 2020 (the technical report).

I am a Fellow of the Australasian Institute of Mining and Metallurgy (FAusIMM, # 337492). I graduated from the University of Newcastle, New South Wales, in 1995 with a Bachelor of Engineering degree.

I have practiced my profession for 25 years. I have been involved in minesite management in Papua New Guinea, and have held executive management roles for mine and business units in Australia, Indonesia, and Papua New Guinea. I have also been involved in development roles in project and asset management, and have managed and led mining, prefeasibility and feasibility studies.

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

I visited the Wafi–Golpu Project most recently from 25 to 26 February, 2019.

I am responsible for Sections 1.1, 1.2, 1.4, 1.17, 1.18, 1.23, 1.24, 1.25; Section 2; Section 3; Sections 4.10, 4.12; Section 19; Section 20; Sections 25.1, 25.2, 25.11, 25.12, 25.16, 25.17; Section 26; and Section 27 of the technical report.

I am not independent of Newcrest, as independence is described by Section 1.5 of NI 43–101.

I have been involved with the Wafi–Golpu Project since 2012 as in my role Executive General Manager Projects and later as later as Chief Operating Officer, Papua New Guinea.

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

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

Dated: 13 October, 2020

“Signed”

Craig Jones FAusIMM

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1.1 Introduction

Mr. Kevin Gleeson, Mr. Pasqualino (Lino) Manca, Mr. Daniel Curry and Mr. Craig Jones prepared this Technical Report (the Report) for Newcrest Mining Limited (Newcrest) on the Wafi–Golpu Project (the Project) in the Independent State of Papua New Guinea (Papua New Guinea, PNG, or the State).

The Project is a 50:50 unincorporated joint venture (JV), termed the Wafi-Golpu Joint Venture or WGJV, between Wafi Mining Limited (Wafi Mining) and Newcrest PNG 2 Limited (Newcrest PNG2), collectively the WGJV Participants. Harmony Gold Mining Company Limited (Harmony) is the ultimate parent company of Wafi Mining. Newcrest Mining Limited is the ultimate parent company of Newcrest PNG2.

The proposed Golpu operation (Golpu Development) is a greenfields development that focuses on the Golpu copper–gold porphyry deposit where Mineral Resources and Mineral Reserves were estimated. Additional Mineral Resources were estimated for the Wafi epithermal gold and Nambonga copper–gold porphyry deposits; however, these deposits are not currently included in the mine plan.

1.2 Terms of Reference

This Report supports disclosure of Mineral Resource and Mineral Reserve estimates in Newcrest's 2020 Annual Information Form.

All measurement units used in this Report are metric unless otherwise noted, and currency is expressed in either United States (US$) dollars or Australian dollars (A$) as identified in the text. The Papua New Guinean currency is the Papua New Guinea kina (PGK). The Report uses Australian English.

Mineral Resources and Mineral Reserves were initially classified using the 2012 edition of the Australasian Joint Ore Reserves Committee (JORC) Code (2012 JORC Code). The confidence categories assigned under the 2012 JORC Code were reconciled to the confidence categories in the Canadian Institute of Mining, Metallurgy and Petroleum (CIM) Definition Standards for Mineral Resources and Mineral Reserves (May 2014; the 2014 CIM Definition Standards). As the confidence category definitions are the same, no modification to the confidence categories was required. Mineral Resources and Mineral Reserves in this Report are reported in accordance with the 2014 CIM Definition Standards. Terminology differences between the reporting standards were addressed in that the term "Ore Reserves" in the 2012 JORC Code is reported as "Mineral Reserves" using the 2014 CIM Definition Standards.

1.3 Project Setting

The Project is situated within the Morobe Province of Papua New Guinea, approximately 65 km southwest of Lae, the nearest commercial centre.

Exploration activities are serviced by an exploration camp that is situated in heavily-forested, mountainous terrain. A combination of roads and access tracks exist between Lae and the Project area. However, the track components are suitable for four-wheel drive vehicles and purpose-built trucks only. During major rainfall events this access route may become closed to vehicular traffic.

Current access to the planned Golpu mine site is via a partly-sealed road from Lae to Timini, and a gravel road from Timini (Demakwa) to Wafi, with the trip taking about three to four hours depending on the weather. This road will be replaced by a new road (including bridges), termed the northern access road, as part of the Golpu Development.

Commercial airlines operate flights between the national capital, Port Moresby, and Nadzab airport, which is approximately a one-hour drive by road from Lae. Helicopter access to the Project site area is available, with suitable areas at the proposed mine site cleared for landing.

The planned mine site area has a high rainfall and two distinct seasons: a dry season from June to September and a rainy season from December to March. The site is characterised by low wind speeds, high humidity and warm temperatures with an average maximum of 28°C and an average minimum of 21°C. Mining activities are planned year-round. Exploration activities can be curtailed by heavy rainfall.

The Golpu Development design envisages three separate areas:

- Mine area: located on the northern side of the Owen Stanley Ranges in the foothills of the Watut River catchment. The elevation ranges from approximately 100–380 masl. Most of the proposed mine area is steep and mountainous, and is covered by dense tropical rainforest;
- Infrastructure corridor: will include the access road connector and pipelines. Located on the floodplains of the Watut and Markham Rivers. Vegetation primarily consists of partially-cleared forest and cultivated gardens. Elevations in the corridor area are about 100 masl;
- Coastal area: includes the proposed port facilities at Lae, near the Markham River estuary on the Huon Gulf and outfall area about 6 km to the east of the port near the Busu River estuary. These areas are at, or very close to, sea level.

Vegetation in the Project area consists of lowland and mid-mountain tropical forests with some areas of tropical grassland in upper elevations. Some areas are partly cleared as part of subsistence agricultural practices.

Two sources of earthquakes were identified in the general Project area: shallow-depth crustal events, and subduction events. Due to the close proximity of large earthquake events in relation to the Golpu Development, low-frequency earthquake sensors were incorporated into the seismic monitoring plan. Data collected from these sensors will be used to validate the earthquake catalogue, the ground motion parameters, and formulate site-specific ground motion relations.

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

The WGJV holds two Exploration Licences covering a total area of approximately 129 km^2, each of which is registered in the names of Wafi Mining and Newcrest PNG2.

The Golpu deposit is located within Exploration Licence 440 (EL440), with a range of major surface facilities to be located on Exploration Licence 1105 (EL1105). The Wafi and Nambonga deposits are also within EL440.

Both tenements were in good standing as at 30 June, 2020. EL440 is in the renewal process. Newcrest expects that the renewal will be granted as all tenement conditions for the previous term were complied with.

Each Exploration Licence is subject to the condition that:

"Subject to any agreement made under Section 17 of the Act, the State reserves the right to elect at any time, prior to the commencement of mining, to make a single purchase of up to 30% equitable interest in any mineral discovery arising from this licence, at a price pro-rata to the accumulated exploration expenditure and then to contribute to further exploration and development in relation to the lease on a pro-rata basis unless otherwise agreed".

If the State chooses to take-up its full 30% interest, the interest of each of Wafi Mining and Newcrest PNG 2 will become 35%.

The WGJV Participants applied for a Special Mining Lease and ancillary tenements (including Leases for Mining Purposes and Mining Easements) in late 2016, covering proposed Golpu Development facilities and infrastructure as they were understood at the time. The Special Mining Lease application included a Proposal for Development, which incorporated the 2016 Feasibility Study report and supporting application documents such as a National Content Plan. Amendments to these tenement applications were made in March 2018, where the location and/or nature of facilities and infrastructure was refined through the 2018 Feasibility Study Update. The Proposal for Development was also updated. Additional applications will also be made where necessary. The grant of the Special Mining Lease and related ancillary tenements remains subject to the completion of *Mining Act 1992* and *Environment Act 2000* processes.

While the WGJV Participants have entered into a compensation agreement for each of EL440 and EL1105, they will need to enter into additional compensation agreement(s) covering land that is the subject of any other tenements that might be required by the Golpu Development. These agreements will need to be registered under the *Mining Act 1992* to become valid and enforceable. Surface rights for facilities and infrastructure (including roads and pipelines) are provided by the relevant mining tenements under the *Mining Act 1992*. Where activities will be undertaken on or under customary land, a compensation agreement with the customary landowners is required.

Extraction of water requires a permit under the *Environment Act 2000*.

The holder of a Special Mining Lease must pay a royalty to the State that is equivalent to 2% of the net proceeds of sale of minerals (calculated as net smelter return (NSR) or free-on-board (FOB) export value, whichever is appropriate). A production levy of 0.5% is also payable to the Mineral Resource Authority (MRA) under the *MRA Act 2018* on the gross value of production (i.e., excluding the offsets of treatment and refining charges, payable terms and freight).

1.5 Geology and Mineralisation

The deposits discovered to date in the Project area are considered by Newcrest to be representative of a number of mineralisation models, including porphyry copper–gold, high-sulphidation, and low-sulphidation epithermal systems.

The basal geology consists of east to east–southeast-dipping metasedimentary rocks of the Owen Stanley Metamorphic Complex, unconformably overlain by sedimentary rocks and volcanic sequences of the Omaura Formation and Langimar Beds. These rocks were intruded by a sequence of diorite stocks with the following paragenesis: emplacement of Nambonga, Western and Golpu diorites; emplacement of Livana diorite in the form of a narrow intrusion with associated dykes intruded along previous intrusive contacts; and explosive emplacement of the Wafi breccia complex. Younger units of the Babwaf Conglomerate and the Wafi Conglomerate unconformably overlie the older units and generally occur in fault-bounded depressions.

The Project-area mineralisation paragenesis includes:

- Metamorphic event producing quartz in bedding-parallel veins;
- Porphyry event recognised as albitisation of feldspars, formation of pervasive biotite throughout the metasediments with potassic feldspar development as selvedges to porphyry-related quartz veins, and sericite/chlorite overprinting of earlier potassic alteration. The phyllic overprint is possibly related to the collapse of the porphyry system and the incursion of meteoric water;
- Diatreme emplacement due to the emplacement of melts into collapsing meteoric system resulting in diatreme breccias and dacite bodies;
- Zoned high/low sulphidation epithermal events with temporal and spatial alteration zonation consisting of initial argillic alteration, followed by intermediate argillic alteration and low-temperature argillic alteration.

The Golpu porphyry deposit extends over about 800 m north–south by 500 m west–east, and was drill tested to more than 2,000 m depth. The Hornblende Porphyry (Livana) is the main mineralised porphyry. The other porphyries act either as weak mineralisers (Golpu Porphyry) or as benign hosts (wall rock) from adjacent mineralising porphyries. The dominant copper–gold-bearing sulphide species vary laterally and vertically within the deposit from an inner bornite (plus chalcopyrite) core, to chalcopyrite as the dominant copper sulphide, and grading out to a pyrite-only shell on the mineralisation margin. The porphyry system is mineralised with gold, copper, silver and molybdenum.

The Wafi diatreme complex is a roughly rectangular-shaped feature, 800 x 400 m at surface with steep, inward-dipping sides. Alteration associated with the high sulphidation gold event overprints the Golpu porphyry-style alteration and mineralisation, with the diatreme carrying fragments of the earlier porphyry alteration. The high sulphidation event remobilised pre-existing porphyry-related copper from the phyllic-argillic altered upper porphyry and deposited this as zoned enargite–tennantite–covellite–chalcopyrite mineralisation. Most of the gold in the high sulphidation overprint was introduced in association with pyrite. A number of mineralised zones, including the A, B, NRG and Link Zones, were defined in the Wafi deposit. Much of the mineralisation is refractory, and is associated with arsenian pyrite.

The Nambonga diorite stock is a low-grade porphyry copper and gold mineralised system, and extends over an area of approximately 200 x 200 m and to a vertical extent of at least 800 m. Much of the mineralisation is associated with silicification, either pervasive or as veins. Mineralisation consists of disseminated and vein-style copper–gold mineralisation and structurally-controlled base metal mineralisation in steeply-dipping lodes.

The understanding of the Golpu deposit settings, lithologies, mineralisation, and geological, structural, and alteration controls on mineralisation is sufficient to support estimation of Mineral Resources and Mineral Reserves. The understanding of the Wafi and Nambonga deposit settings, lithologies, and geological, structural, and alteration controls on mineralisation is sufficient to support estimation of Mineral Resources.

1.6 History

Prior to the establishment of the WGJV, exploration had been conducted by CRA Exploration Pty Ltd (CRAE), Elders Resources Limited (Elders), Australian Gold Fields Limited (Australian Gold Fields), Aurora Gold Limited (Aurora), Abelle Limited (Abelle), and Harmony. Work in the period 1977–2008 included ridge and spur soil sampling, trenching, ground and airborne geophysical surveys, core and reverse circulation (RC) drilling, and technical studies. The Wafi deposit was identified in 1983, the Golpu deposit was discovered in 1990, and the Nambonga deposit was located in 2007.

The WGJV Participants have completed core drilling and numerous technical studies. A feasibility study was completed in 2016 (the 2016 Feasibility Study) and updated in 2018 (2018 Feasibility Study Update). Gold–copper exploration potential remains in the greater Golpu area, including the Western, Northern, Heking Zones and the Miapillit target.

There has been no production from the Project.

1.7 Drilling and Sampling

A total of 791 drill holes (including wedges) were completed in the Project area since 1983, comprising about 267,907 m of core drilling and 17,180 m of RC drilling. Drilling includes holes completed for exploration, resource delineation, geotechnical, and hydrological purposes. A total of 306 drill holes (210,725.45 m), including wedges and re-drills) are used in Mineral Resource estimation for the Golpu deposit. The Mineral Resource estimate for the Wafi deposit is supported by 482 drill holes (205,570.8 m). A total of 34 core holes (18,079.4 m) support the Mineral Resource estimate for the Nambonga deposit. Due to the location of the deposits in close proximity, and the location of the drill collar, a single drill hole can inform more than one estimate.

Core drilling was done by wireline methods using HQ (63.5 mm core diameter), NQ (47.6 mm), and PQ (85 mm) core. There are rare intervals of BQ (36.5 mm) core. Some core was oriented.

Geological logging was both qualitative and quantitative and recorded lithology, mineralisation, alteration mineralogy, weathering, structural characteristics and other physical properties of the core. A consistent geological logging standard and descriptive terminology has been applied since drill hole WR173. Historical logging (CRAE and Elders) was also transformed into this terminology. Detailed geotechnical information, such as rock strength, fracture frequency, rock mass rating (RMR) and discontinuities was collected for some later core drill holes.

Recoveries in core average 98.4% within the Golpu Mineral Resource estimate area. No material relationship was identified between core recovery and grade within the Golpu deposit area. Core recovery at the Wafi deposit is typically good. with >90% recovery in the mineralised units. There is no correlation between the gold grade and higher recovery zones. Core recovery at the Nambonga deposit is typically good with >95% recovery in the mineralised rock types.

Drill hole collars were initially located using a hand-held global positioning system (GPS) instrument, and later surveyed in the Wafi Grid by a qualified and competent surveyor using theodolite or differential GPS (DGPS) instruments. The Elders and CRAE drill holes were surveyed using an Eastman single-shot camera. Downhole surveys were completed on CRAE core holes at the Golpu deposit, typically at 25 m and then every 20–50 m downhole. Harmony/WGJV drill holes were surveyed at the Golpu deposit using a Reflex downhole survey tool, typically with the first reading at 18 m and then every 30 m thereafter downhole.

In the opinion of the QP, the quantity and quality of the logged geological data, collar, and downhole survey data collected in the exploration and infill drill programs are sufficient to support Mineral Resource and Mineral Reserve estimation and mine planning for the Golpu deposit, and Mineral Resource estimates for the Wafi and Nambonga deposits.

All drill core is sampled and assayed over the entire hole length. Most sample lengths at the Golpu deposit are either 1 m (about 80%) or 2 m (about 20%). Sample lengths were mainly 2 m for the earlier drill holes at the Wafi deposit, and then 1 m for all later drill holes. Most core drill hole samples at the Nambonga deposit average 1 m in length, with lengths varying at contacts of mineralised lithological units.

The methods used to derive bulk density values include air/water (approximately 95%) and wax/water (approximately 5%). There is a total of 19,942 determinations available for the Golpu deposit, with means by lithology ranging from 2.43 t/m^3 in oxidised material to 2.77 t/m^3 in hornblende porphyry. The density values used for the Wafi deposit are derived from the Golpu deposit measurements. There is no apparent relationship between bulk density and grade at the Wafi deposit, but there is a weak to moderate correlation between bulk density and RL at the higher oxidised levels. Bulk density domains for the Nambonga deposit were derived from a combination of oxidation, alteration and lithology with mean values assigned to domains ranging from 2.68–2.88.

Third-party, independent analytical and sample preparation laboratories have included Pilbara Laboratories in Lae, SGS Lae and SGS Townsville, Genalysis Lae and Jakarta and Intertek Lae and Jakarta. SGS Townsville obtained ISO9001 accreditations in 2001; there is no accreditation information for SGS Lae in the database. Intertek Lae is the successor laboratory to Pilbara Lae and Genalysis Lae, and is not accredited. Intertek Jakarta, the successor to Genalysis Jakarta obtained ISO17025 accreditation in 2014; accreditations prior to that date are not recorded in the Project database. Check laboratories have included locations and laboratories in Madang (PNG Analytical), Lae (SGS, Analabs, Intertek), Wau (SGS), Townsville (Analabs, SGS, ALS Chemex), and Perth (Genalysis, UltraTrace [now part of the Bureau Veritas group]). Laboratories were all independent; however, accreditations for the time of use are not recorded in the Project database.

Early sample preparation consisted of crushing to either 2 mm or 5 mm, then pulverising to nominal 75 µm. Protocols from the Harmony/WGJV campaigns saw samples crushed to minimum 90% passing 2 mm, and pulverising to minimum 95% passing 106 µm.

Analytical methodologies for the majority of the legacy data are not recorded in the Project database. Information recorded typically consists of the element and detection limit. Legacy analyses were primarily for gold and copper, but a multi-element suite could also be completed. Samples sent to Genalysis/Intertek were assayed for gold, a multi-element suite including copper, silver, molybdenum, arsenic and iron, and sulphur.

All assays are checked and verified in accordance with the Newcrest Resource Development Quality Assurance Quality Control (QA/QC) and database management procedures. QA/QC procedures were in place for all of the Harmony and WGJV programs. The process generally involves submission and analysis of standard reference materials (SRMs), blanks, and duplicates.

Drill hole data are currently stored within an SQL database located at the Lae office. The SQL database uses DataShed software as the user interface. The WGJV provides copies of the database to each of the individual WGJV Participants. Database checks are undertaken by Newcrest employees seconded to the WGJV; these Newcrest personnel include staff who have oversight of database management and resource estimation. The database is regularly backed up, and copies are stored both offsite and in Newcrest facilities.

Sample security has not historically been monitored. Sample collection from drill point to laboratory relied upon the fact that samples were either always attended to, or stored in the locked on-site preparation facility, or stored in a secure area prior to laboratory shipment. Chain-of-custody procedures consisted of sample submittal forms sent to the laboratory with sample shipments to ensure that all samples were received by the laboratory.

During the WGJV drill programs, drill core was delivered directly from the drill rig at the end of each shift by the drill crew to the logging shed within the Wafi Camp security compound. All sample transport for WGJV programs was always under the direct supervision of WGJV employees, with samples placed within tamper-evident packaging from site until delivery to the Intertek Laboratory in Lae.

In the opinion of the QP, the sample preparation, analysis, and security practices, data collection, and quality are acceptable, meet industry-standard practices, and are adequate to support Mineral Resource and Mineral Reserve estimation and mine planning purposes at the Golpu deposit, and Mineral Resource estimates for the Wafi and Nambonga deposits.

1.8 Data Verification

Newcrest includes both internal and third-parties in the data verification steps:

- Internal verification: laboratory inspections; review of geological procedures, resource models and drill plans; sampling protocols, flow sheets and data storage; specific gravity data; logging consistency, down hole survey, collar coordinate and assay QA/QC data; geology and mineralisation interpretation;
- External verification: review of the Golpu deposit drilling, sampling and analytical processes and associated QA/QC procedures by AMC Consultants Pty Ltd. (AMC) in 2012; review of Golpu deposit drill hole collar locations by Quickclose Pty Ltd in 2017; review of the Nambonga deposit database by Maxwell Geoservices in 2008.

The QP, who relies upon this work, reviewed the reports and is of the opinion that the data verification programs indicate that the data stored in the Project database accurately reflect original sources and are adequate to support geological interpretations and Mineral Resource and Mineral Reserve estimation, and in mine planning.

Observations made during the QP's site visit, in conjunction with discussions with site-based technical staff also support the QP's conclusion that Newcrest's processes for geological interpretations, and analytical and database quality are being followed.

Newcrest has implemented a steering committee, the Resources & Reserves Steering Committee to ensure appropriate governance of development and management of resource and reserve estimates, and the public release of those estimates. This is achieved by ensuring regular Resources & Reserves Steering Committee review meetings, internal competent reviews, and independent external competent reviews. The QP's role as the chair of the Resources & Reserves Steering Committee includes review of the estimation processes in place for Mineral Resource and Mineral Reserve estimation, mine planning, and the control procedures in place to ensure the process is being executed as intended.

1.9 Metallurgical Testwork

Laboratories and testwork facilities used during metallurgical evaluation include: Tunra Bulk Material Handling Research Association; JKTech; ALS laboratories in Brisbane and Adelaide; Metso; Outotec; Paterson & Cooke; SGS Environmental Services; Orway Mineral Consultants (OMC); Glossop Consultancy, Ammtec, SGS Lakefield Oretest, Amdel, IML, Fox Anamet, and Optimet. Internal laboratories operated by Newmont, CRAE, and Rio Tinto were also used during Wafi evaluations.

Metallurgical testwork completed on the deposits has included:

- Golpu deposit: modal mineralogy, copper mineralogy, sulphide grain size information, sulphide association, comminution (SMC test, drop weight index (DWi), Bond ball mill work index (BWi), ore hardness), batch flotation, locked-cycle flotation, cleaner/scavenger tests, effect of primary grind size on gold recovery, tailings and concentrate thickening/pumping, concentrate filtration and characterisation; flocculant screening and dynamic settling testwork; rheological characterisation;
- Wafi deposit: Mineralogy, flotation, roasting, pressure oxidation (POX), bacterial leaching, and comminution work;
- Nambonga deposit: No metallurgical testwork was completed to date.

Overall, samples selected for metallurgical testing during completed technical studies on the Golpu and Wafi deposits were representative of the various styles of mineralisation within the different mineralised zones. Samples were selected from a range of locations within the deposit zones. Sufficient samples were taken, and tests were performed, using sufficient sample mass for the respective tests undertaken.

The outcome of the flowsheet development program for the Golpu deposit was the development and optimisation of two process flowsheets. This facilitated the stage-wise upgrading and modification of the process plant to accommodate the changing composition of the plant feed over the life-of-mine (LOM). The first flowsheet was designed to provide an optimal processing solution for treating high-grade ores with a porphyry content of 75% or more, and was termed the LEAN flowsheet. The second flowsheet (the Golpu flowsheet) was designed to treat mineralisation with a porphyry content of less than 75%, and incorporated a pyrite circuit for improved gold recovery from the metasediment-rich material.

Recovery forecasting for the Golpu Development used the metallurgical model derived for year-on-year estimation of metallurgical design parameters. The variability testwork (LEAN flowsheet) indicates metal recoveries for the porphyry-hosted mineralisation (Domain 30 and 33) of 94% for copper and 70% for gold to a 90% confidence level. The metal recoveries are forecast for metasedimentary-hosted mineralisation at 90% for copper and 35% for gold, to a 90% confidence level. Over the LOM, copper recoveries are anticipated to average 94% and gold recoveries are expected to average 68%. Concentrate grade average over the LOM is projected to be 29% Cu and 15 g/t Au. The recoveries predicted for the Golpu Development were benchmarked against a number of operating mines. Forecast copper recoveries are considered to be comparable with other operations that have higher than average copper head grades. Gold recoveries predicted for the Golpu deposit are within the range of recoveries achieved in the operations reviewed, and gold recovery shows no clear relationship to gold head grade.

There is variability between the mineralised zones in the Wafi deposit with the A Zone generally more amenable to direct cyanidation than either the B Zone or Link Zone. A positive correlation exists between arsenic and gold concentration, with the Link Zone having a higher arsenic content than mineralisation in the A and B Zones. Metallurgical recoveries for use in Mineral Resource estimation are assumed to be 91% gold recovery for non-refractory gold mineralisation and minimum of 47% recovery for refractory gold mineralisation.

Metallurgical recoveries for use in Mineral Resource estimation for the Nambonga deposit are assumed at 85% for gold, based on the adjacent Golpu deposit as an analogue.

There are no known deleterious elements that would affect Golpu Development concentrate marketability. There are no known deleterious elements in the Wafi deposit that would affect doré concentrate marketability. There is no information as to whether any deleterious elements are present in the Nambonga deposit, because no deposit-specific metallurgical tests were conducted.

1.10 Mineral Resource Estimation

1.10.1 Golpu Deposit

Wireframes were constructed for lithology, alteration, oxidation, sulphide distribution and structures. All combinations of lithology, alteration, sulphide distribution and faulting were assessed for use as estimation domains. Geostatistical analysis was conducted to review individual elements and correlations between elements.

A composite database was compiled for each element from the assay table database on 10 m composite lengths. Metal per composite assessments were completed on all gold and copper domains. Top-cuts were applied to copper, gold, silver, molybdenum, sulphur, and iron assays in selected domains. No top-cuts were applied to arsenic.

Density was directly assigned to the block model by density domains. Variograms were modelled for all domains, for all estimated elements. Some domains contain limited samples, and in these cases variograms were generated that were similar in structure and range to the closest matching domain.

Quantitative kriging neighbourhood analysis (QKNA) assessments were focused on the maximum number of samples and search distances to be used in the block estimate. The grade model was estimated with ordinary kriging (OK) using pairwise variograms for seven elements: gold, copper, silver, molybdenum, sulphur, arsenic, and iron. The estimation uses the domain composites as informing samples, pairwise variogram models for composite weighting and ellipsoidal search neighbourhoods for composite selection. The elements are estimated into a block model with 40 m x 40 m x 40 m parent cells with 10 m resolution on domain margins; all sub-cells are assigned the parent grade.

The model was validated by comparison with informing composite de-clustered statistics, alternative modelling methods (NN), inverse distance weighting to the second power (ID2), raw variogram OK, discrete Gaussian models and conditional simulation models, and graphical comparisons (swath plots and grade–tonnage curves).

The Mineral Resource is classified as either Indicated or Inferred based on an evaluation of factors including data spacing and distribution, geological confidence as a function of continuity and complexity of geological features, and estimation quality parameters (for example, average distance to informing samples for block estimation). No Measured Mineral Resources were classified.

The Mineral Resource estimate assumes a bulk mining underground extraction method such as block caving and metallurgical recovery for copper and gold by sulphide flotation. Reporting is within an NSR cut-off, which assumes a gold price of US$1,300/oz Au, a copper price of US$3.40/lb Cu, mining cost of US$8.37/t mined, processing cost of US$9.75/t processed, general and administrative (G&A) costs of US$4.17/t/processed, copper concentrate treatment charge of US$100/dry tonne (dmt) of concentrate, transport cost of US$33.50/wet tonne (wmt) of concentrate, and copper refining charges of US$0.10/lb of recovered copper. Silver and molybdenum were not valued in the NSR cut-off; however, these elements were reported within the Mineral Resource as they are expected to be recovered with minor circuit modifications and/or concentrate contract negotiations. Over the LOM, it is anticipated that copper recoveries will average 94% and gold recoveries will average 68%.

1.10.2 Wafi Deposit

Wireframes were constructed for lithology, alteration, oxidation, and structures. Geostatistical analysis was conducted to review individual elements and correlations between elements.

A composite database was compiled based on gold as the primary element from the raw assay database on 4 m composite lengths. Top-cuts were determined by review of statistical parameters for gold, followed by silver and copper. Top-cuts were applied to copper, gold, silver, molybdenum, sulphur, arsenic and iron assays in selected domains.

Density was directly assigned to the block model by rock type and oxidation domains based on Golpu deposit analogue averages. Variograms were modelled for all domains for all estimated elements. The minor domains contain limited samples and could not form coherent variograms. In these cases, the estimate used the variograms generated for the major surrounding domains.

The grade model was estimated using OK on 4 m composites for seven elements: gold, copper, silver, molybdenum, sulphur, arsenic, and iron. The estimation used the domain composites as informing samples, back-transformed Gaussian variogram models for composite weighting, and ellipsoidal search neighbourhoods for composite selection. The elements were estimated into a block model with 20 x 20 x 10 m parent cells with 10 m resolution on domain margins. All sub-cells were assigned the parent grade. The parent block size reflects the estimation precision available from the drill hole spacing and the assumed bulk open pit mining methodology.

The model was validated using visual inspection, comparison with informing composite declustered statistics, alternative modelling methods (ID2), and graphical comparisons (swath plots and grade–tonnage curves).

The Mineral Resource was classified as Indicated and Inferred based on factors including data spacing and distribution, geological confidence as a function of continuity, and complexity of geological features, and estimation quality parameters. No Measured Mineral Resources were classified.

An internal mining concept study was undertaken by the WGJV in 2013. Information from this study was used in assessing reasonable prospects of eventual economic extraction, factored and updated where applicable. Mineral Resources at Wafi are reported assuming open pit mining methods with limited internal selectivity, and a process method that is anticipated to be a combination of a carbon-in-pulp (CIP) and carbon-in-leach (CIL) operation, with a flotation sulphide recovery mill process. The estimates are reported at cut-offs of 0.4 g/t Au for non-refractory gold mineralisation (NRG) and 0.9 g/t Au for refractory gold mineralisation (RG). Mineral Resources are constrained within a conceptual open pit shell that uses the following input assumptions: gold price of US$1,400/oz; mining costs of US$5.40/t mining, and process and general and administrative (G&A) costs of US$17.30/t processed. Metallurgical recovery is estimated at 91% gold recovery NRG and minimum of 47% recovery for RG. Pit slope approximate overall angles range from 33º in oxidised material to 65º in fresh rock.

1.10.3 Nambonga Deposit

The geology model for the Nambonga deposit includes lithology, alteration, oxidation, and structures wireframes. Geostatistical analysis was conducted to review individual elements and correlations between elements.

Assays were composited to 4 m intervals, based on gold as the primary element. Top-cuts were determined by review of statistical parameters, graphed data, decomposition analysis and percentage of metal contributed from the highest-grade samples. Top-cuts were applied to copper, gold, silver, molybdenum, sulphur, arsenic and iron assays in selected domains.

Average bulk densities were assigned to the model based on 277 determinations from Nambonga drill core. Variograms were modelled for the combined major domains for all estimated elements. The minor domains contain limited samples and could not support a variogram. In these cases, the variograms generated on major domain data were used for estimation of minor domains.

Grades were estimated using OK on 4 m composites for seven elements, gold, copper, silver, molybdenum, sulphur, arsenic, and iron. Initial results indicated a lack of variability in the estimate, and the estimate was re-run using 2 m composites. The estimation used the domain composites as informing samples, back-transformed Gaussian variogram models for composite weighting and ellipsoidal search neighbourhoods for composite selection. The elements are estimated into a block model with 40 x 40 x 40 m parent cells and 10 m resolution on domain margins. All subcells were assigned the parent grade. The parent block size reflects the estimation precision available from the drill hole spacing and an assumed bulk underground sub-level caving/block caving mining methodology.

The model was validated using visual inspection, comparison with declustered composites, use of an alternative ID2 interpolation method, and graphical comparisons (swath plots and grade–tonnage curves).

The Mineral Resource is classified as Inferred based on evaluation factors including data spacing and distribution, geological confidence as a function of continuity and complexity of geological features, and estimation quality parameters. No Measured or Indicated Mineral Resources were classified.

The estimate assumes a mass mining by block cave or sub-level caving mining method with no internal selectivity would be used. The Mineral Resource is reported using an assumed 0.5 g/t Au cut-off grade. This cut-off grade is based on the adjacent Golpu deposit as an analogue, assumes an overall mining, processing, and G&A operating cost estimate of about US$15.50/t, a gold price of US$1,300/oz, and a metallurgical recovery of 85% for gold. This equates to a cut-off grade of approximately 0.46 g/t Au, based on gold only. Conceptual costs associated with copper and silver recovery were approximated as equivalent to 0.04 g/t Au. The total cut-off grade for reporting purposes was therefore 0.5 g/t Au.

1.11 Mineral Resource Statement

All Mineral Resources are reported on a 100% basis with an effective date of 30 June, 2020. Newcrest has a 50% interest in the WGJV. Mineral Resources are reported inclusive of those Mineral Resources converted to Mineral Reserves. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.

The Qualified Person for the Mineral Resource estimates is Mr. Kevin Gleeson, FAusIMM, whose job title with Newcrest is Head of Mineral Resource Management. Mr. Gleeson is a Newcrest employee. Mineral Resource estimates are provided by deposit in Table 1-1 to Table 1-5.

Areas of uncertainty that may materially impact the Mineral Resource estimates include: changes to long-term gold and copper price assumptions; changes in local interpretations of mineralisation geometry and continuity of mineralised zones; changes to geological shape and continuity assumptions; changes to metallurgical recovery assumptions; changes to the operating cut-off assumptions for assumed block caving operations (Golpu and Nambonga); changes to the input assumptions used to derive the conceptual underground outlines used to constrain the Golpu and Nambonga estimates; changes to the input assumptions used to derive the conceptual pit shell used to constrain the Wafi estimate; changes to the NSR values used to constrain the Golpu estimate; changes to the cut-off grades used to constrain the Wafi and Nambonga estimates; variations in geotechnical, hydrogeological and mining assumptions; and changes to environmental, permitting and social license assumptions.

Table 1-1: Golpu Deposit Measured and Indicated Mineral Resource Statement

Confidence Category	Tonnage (Mt)	Grade			Contained Metal		
		Au (g/t)	Cu (%)	Ag (g/t)	Au (Moz)	Cu (Mt)	Ag (Moz)
Measured	—	—	—	—	—	—	—
Indicated	690	0.71	1.1	1.3	16	7.5	28
Measured + Indicated	***690***	***0.71***	***1.1***	***1.3***	***16***	***7.5***	***28***

Table 1-2: Golpu Deposit Inferred Mineral Resource Statement

Confidence Category	Tonnage (Mt)	Grade			Contained Metal		
		Au (g/t)	Cu (%)	Ag (g/t)	Au (Moz)	Cu (Mt)	Ag (Moz)
Inferred	140	0.63	0.85	1.1	2.8	1.2	4.6

Notes to Accompany Golpu Deposit Mineral Resource Tables:

1. Mineral Resources are reported with an effective date of 30 June, 2020 using the 2014 CIM Definition Standards. The Qualified Person responsible for the estimate is Mr. Kevin Gleeson, FAusIMM, whose job title with Newcrest is Head of Mineral Resource Management, and who is a Newcrest employee.
2. Mineral Resources are reported on a 100% basis. Newcrest holds a 50% interest in the WGJV.
3. Mineral Resources are reported inclusive of Mineral Reserves. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.
4. Mineral Resources at Golpu are reported assuming a bulk mining underground extraction method and metallurgical recovery for copper and gold by sulphide flotation. Mineral Resources are reported above a net smelter return (NSR) cut-off, which assumes a gold price of US$1,300/oz Au, a copper price of US$3.40/lb Cu, mining cost of US$8.37/t mined, processing cost of US$9.75/t processed, general and administrative (G&A) costs of US$4.17/t processed, copper concentrate treatment charge of US$100/dmt of concentrate, transport cost of US$33.50/wet tonne of concentrate, and copper refining charges of US$0.10/lb of recovered copper. Silver and molybdenum were not valued in the NSR cut-off; however, these elements were reported within the Mineral Resource as they were expected to be recovered with minor circuit modifications or concentrate contract negotiations. Over the life-of-mine, it is anticipated that copper recoveries will average 94% and gold recoveries will average 68%.
5. Tonnages are metric tonnes. Gold and silver ounces are estimates of metal contained in tonnages and do not include allowances for processing losses. Copper tonnes are estimates of metal contained in tonnages and do not include allowances for processing losses.
6. Rounding as required by reporting guidelines may result in apparent differences between tonnes, grade and contained metal content. Rounding is to two significant figures.

Table 1-3: Wafi Deposit Measured and Indicated Mineral Resource Statement

Confidence Category	Tonnage (Mt)	Grade		Contained Metal	
		Au (g/t)	Ag (g/t)	Au (Moz)	Ag (Moz)
Measured	—	—	—	—	—
Indicated	110	1.7	4.4	5.7	15
Measured + Indicated	***110***	***1.7***	***4.4***	***5.7***	***15***

Table 1-4: Wafi Deposit Inferred Mineral Resource Statement

Confidence Category	Tonnage (Mt)	Grade		Contained Metal	
		Au (g/t)	Ag (g/t)	Au (Moz)	Ag (Moz)
Inferred	37	1.4	4.2	1.6	5.0

Notes to Accompany Wafi Deposit Mineral Resource Tables:

1. Mineral Resources are reported with an effective date of 30 June, 2020, using the 2014 CIM Definition Standards. The Qualified Person responsible for the estimate is Mr. Kevin Gleeson, FAusIMM, whose job title with Newcrest is Head of Mineral Resource Management, and who is a Newcrest employee.
2. Mineral Resources are reported on a 100% basis. Newcrest holds a 50% interest in the WGJV.
3. Mineral Resources at Wafi are reported assuming open pit mining methods with limited internal selectivity, and a process method that is anticipated to be a combination of a carbon-in-pulp (CIP) and carbon-in-leach (CIL) operation, with a flotation sulphide recovery mill process. The estimates are reported at cut-offs of 0.4 g/t Au for non-refractory gold mineralisation (NRG) and 0.9 g/t Au for refractory gold mineralisation (RG). Mineral Resources are constrained within a conceptual open pit shell that uses the following input assumptions: gold price of US$1,400/oz; mining costs of US$5.40/t mined, and process and general and administrative (G&A) costs of US$17.30/t processed. Metallurgical recovery is estimated at 91% gold recovery NRG and minimum of 47% recovery for RG. Pit slope approximate overall angles range from 33º in oxidised material to 65º in fresh rock
4. Tonnages are metric tonnes. Gold and silver ounces are estimates of metal contained in tonnages and do not include allowances for processing losses.
5. Rounding as required by reporting guidelines may result in apparent differences between tonnes, grade and contained metal content. Rounding is to two significant figures.

Table 1-5: Nambonga Deposit Inferred Mineral Resource Statement

Confidence Category	Tonnage (Mt)	Grade		Contained Metal	
		Au (g/t)	Cu (%)	Au (Moz)	Cu (Mt)
Inferred	48	0.69	0.20	1.1	0.094

Notes to Accompany Nambonga Deposit Mineral Resource Table:

1. Mineral Resources are reported with an effective date of 30 June, 2020, using the 2014 CIM Definition Standards. The Qualified Person responsible for the estimate is Mr. Kevin Gleeson, FAusIMM, whose job title with Newcrest is Head of Mineral Resource Management, and who is a Newcrest employee.
2. Mineral Resources are reported on a 100% basis. Newcrest holds a 50% interest in the WGJV.
3. Mineral Resources at Nambonga are reported assuming a bulk mining underground extraction method. The Mineral Resource is reported using an assumed 0.5 g/t Au cut-off grade. This cut-off grade is based on the adjacent Golpu deposit as an analogue, assumes an overall mining, processing, and G&A operating cost estimate of about US$15.50/t, a gold price of US$1,300/oz, and a metallurgical recovery of 85% for gold. This equates to a cut-off grade of approximately 0.46 g/t Au, based on gold only. Conceptual costs associated with copper and silver recovery were approximated as equivalent to 0.04 g/t Au. The total cut-off grade for reporting purposes was 0.5 g/t Au.
4. Tonnages are metric tonnes. Gold ounces are estimates of metal contained in tonnages and do not include allowances for processing losses. Copper tonnes are estimates of metal contained in tonnages and do not include allowances for processing losses.
5. Rounding as required by reporting guidelines may result in apparent differences between tonnes, grade and contained metal content. Rounding is to two significant figures.

1.12 Mineral Reserve Estimation

Mineral Reserves are reported for the Golpu deposit only. Indicated Mineral Resources were converted to Probable Mineral Reserves.

The proposed mining method is block caving on three levels:

- The BC44 extraction level is planned at 4400 mRL, and will extract a total of approximately 67 Mt of material over a seven-year period at a peak annualised 16.84 Mt/a production rate. During caving operations, ore from the block cave drawpoints will be delivered by diesel load–haul–dump vehicles (LHDs) to either of two underground gyratory crushers then conveyed to the Watut process plant on surface by an inclined conveyor system;
- The BC42 extraction level is planned at 4200 mRL, and will extract a total of approximately 93 Mt of material over a nine-year period at a peak annualised 16.84 Mt/a production rate. Materials handling from drawpoint to the Watut process plant is identical to that proposed for BC44;
- The BC40 extraction level is planned at 4000 mRL, and will extract a total of approximately 240 Mt of material over a 16-year period at a peak annualised 16.84 Mt/a production rate. Materials handling from drawpoint to the Watut process plant will be identical to that proposed for BC44.

The mine to port area, surface services and infrastructure, BC44 and BC42, underground services, and infrastructure areas are designed to a feasibility level of confidence. The BC40 cave footprint and thus extraction level layout, are designed at a pre-feasibility confidence level. The infrastructure for BC40 is identical to that of BC44 and BC42, and is at a feasibility level of confidence. There will be no additional surface infrastructure for BC40.

The mine design consisted of an iterative process that included creation of mining outlines, and design of extraction and undercut layouts, access, and infrastructure including ventilation and materials handling development. The differentiation of ore and waste was based on an NSR cut-off.

Material generated from BC44 cave establishment activities will be categorised as ore when it has an NSR of >US$10/t. This classification will apply until the first crusher is commissioned at BC44. Such ore will be stockpiled on surface and then used in plant commissioning. Gold produced will be a credit to the capital cost of the Golpu Development up until commercial production is declared. Commercial production will be when the cave has reached its hydraulic radius and is self-sustaining for forward production. Following the commissioning of the first crusher at BC44, the assumption for ore and waste cut-offs is that all material, regardless of grade will be processed to reduce the potentially acid-forming (PAF) storage requirements due to limited space and difficulty of construction of large PAF storage facilities.

Ore determination for the block caves is based on net value calculated for all mining blocks, after deduction of operating costs from the NSR for each block. The software package PCBC was used to select the economic block heights and to schedule the optimum extraction sequence for the mixed/diluted draw columns. Cave ore recovery was assumed to be 100% of the planned height of draw. All columns were taken to the maximum economic height on the BC40 level at the shut-off imposed.

The shut-offs for BC44 and BC42 were nominal in nature as the transition timing between the caves is based on timing and achieving the highest tonnes and grade into a set timeframe. The nominal shut-off decreased with each cave to maintain head grade. As BC40 is the final level, the shut-off was applied as a true shut-off.

The total mining dilution was estimated to be about 17% with toppling contributing approximately 1.5%. All development, except where there was a risk of adding grade, had mining factors for dilution and recovery applied to accurately represent the expected mined tonnes. All mining volumes (shapes) outside the block model had tonnes contributing but not grade. Such tonnage was allocated to unclassified material (waste).

1.13 Mineral Reserve Statement

The Qualified Person for the Mineral Reserve estimate is Mr. Pasqualino Manca, FAusIMM, whose job title with Newcrest is Group Manager – Mining Studies. Mr. Manca is a Newcrest employee.

Mineral Reserves are reported in Table 1-6 on a 100% basis. Newcrest has a 50% interest in the WGJV. The Mineral Reserve estimates have an effective date of 30 June, 2020.

Table 1-6: Mineral Reserves Statement

Confidence Classification	Tonnes (Mt)	Gold Grade (g/t Au)	Copper Grade (%)	Contained Gold (Moz)	Contained Copper (Mt)
Probable	400	0.86	1.2	11	4.9

Notes to Accompany Mineral Reserve Table:

1. Mineral Reserves are reported with an effective date of 30 June, 2020 using the 2014 CIM Definition Standards. The Qualified Person responsible for the estimate is Mr. Pasqualino Manca, FAusIMM, whose job title at Newcrest is Group Manager – Mining Studies, and who is a Newcrest employee.
2. Mineral Reserves are reported on a 100% basis. Newcrest holds a 50% interest in the WGJV.
3. Mineral Reserves are reported using the following assumptions: block cave mining method, gold price of $US1,200/oz Au, copper price of US$3.00/lb Cu, above a net smelter return cut-off of US$10/t (development), US$60/t (BC44), US$40/t (BC42), US$19.15/t (BC40), variable metallurgical recoveries by metallurgical domain. The total dilution is estimated to be about 17% with toppling contributing approximately 1.5%.
4. Tonnages are metric tonnes. Gold ounces are estimates of metal contained in tonnages and do not include allowances for processing losses. Copper tonnes are estimates of metal contained in tonnages and do not include allowances for processing losses.
5. Rounding as required by reporting guidelines may result in apparent differences between tonnes, grade and contained metal content. Rounding is to two significant figures.

Areas of uncertainty that may materially impact the Mineral Reserves estimate include: changes to long-term gold and copper price assumptions; changes to exchange rate assumptions; changes to metallurgical recovery assumptions; changes to the input assumptions used to derive the cave outlines and the mine plan that is based on those cave designs; changes to operating, and capital assumptions used, including changes to input cost assumptions such as consumables, labour costs, royalty and taxation rates; variations in geotechnical, mining, dilution and processing recovery assumptions; including changes to designs as a result of changes to geotechnical, hydrogeological, and engineering data used; changes to the shut-off criteria used to constrain the estimates; changes to the assumed permitting and regulatory environment under which the mine plan was developed; ability to obtain mining permits, including timing for finalisation of the Special Mining Lease; ability to obtain agreements to land under customary ownership; ability to permit deep sea tailings placement; ability to obtain operations certificates in support of mine plans; and ability to obtain and maintain social and environmental license to operate.

Factors that are risk-specific to block cave operations, and which may affect the Mineral Reserves include: inrush of water into the underground workings including decline, cave levels and infrastructure areas; poorer rock mass quality and quantity than interpreted; inability to achieve planned decline development rates having impact on schedule and cost; incorrect estimation of cave propagation potentially leading to air blast; and damage to mine workings due to a seismic event.

1.14 Mining Methods

An evaluation of potential mining methods included consideration of block caving, sub-level caving, sub-level open stoping, and open pit methods. Block caving was selected for the following reasons: orebody geometry and geotechnical conditions; high productivity, low operating cost mining method; and higher-value material located at depth can be accessed earlier.

The proposed mine plan uses technology conventional to block cave operations, including mine design and equipment. The planned mining equipment is conventional to block cave operations.

The project is located in an area of moderate to high temperatures and high humidity. As such, suitable ventilation and refrigeration systems were designed to support safe production.

Access to the mine workings will be via the Watut and Nambonga declines, with each generating waste rock that will either be used in construction activities, processed or deposited within the waste rock storage facilities (WRSFs). Block cave mining will not result in the production of waste rock because all material extracted from the block cave will be fed to the Watut process plant. Block cave mining will cause rock fracturing that will propagate ultimately resulting in a subsidence zone.

During the development of the block cave infrastructure (BC44), ore grade material will be temporarily stockpiled on the process plant terrace for later use during commissioning and initial production from the process plant. During caving operations, ore from the block cave drawpoints will be delivered by load-haul-dump (LHD) vehicles to an underground crusher. The crushed ore will then be conveyed to the surface. The ore conveyor emerging at the Watut declines portal terrace will continue overland for approximately 600 m to deliver crushed ore to a coarse ore stockpile adjacent to the Watut process plant for processing.

The mine is planned to operate 24 hours per day, every day of the year, apart from scheduled and unscheduled shutdowns.

A domained geotechnical model was constructed incorporating interpolated data, with the interpolation controlled by the proximity to interpreted structures and boundaries within the domain. The final geotechnical block model consisted of a total of 18 domains (inclusive of a host domain) and 69 sub-domains. A number of those sub-domains were then subsequently filtered by depth sub-categories. Geotechnical modelling indicated that the caves grew freely in response to draw in all rock types in the column and no stalling or hang-ups were observed on the cave sidewalls at the end of production. No significant variations in the size or growth rate of the caves, and therefore mine production, were observed using a range of design material properties in the Livana Porphyry and surrounding rock masses. However, the potential exists for differential or chimney caving in the weak rock especially near contacts or in fault zones. Pre-conditioning of the ore zone was included to reduce this risk.

Extraction level drawpoints were placed in the Livana Porphyry at both the BC44 and BC42 elevations to ensure robustness and stability. The actinolite material gradually gains strength with depth. At the 4,000 mRL the estimated strength of the actinolite material (based on samples) is such that geotechnical modelling indicates a stable footprint can be established and maintained within the actinolite.

Crushers were placed in the barren western (diorite) porphyry and located >150 m from the cave footprint to reduce the risk of damage from caving-induced abutment stress. Preliminary modelling results indicated that the extraction levels and crusher infrastructure would be stable. Measures such as de-stress slots, extension of the undercut to the east of the footprint and development of the east perimeter drive post completion of the eastern undercut extension will be required to ensure development stability.

Groundwater inflows to the mine will commence at the start of the Nambonga decline development. When mine development reaches BC44, the combined total inflows are predicted to be about 240 L/s. After BC44 and BC42 commence production, the inflows will decrease to approximately 150 L/s in Year 16 of the operation. After that time, the inflows are expected to rapidly increase to about 240 L/s as BC40 commences operation, before decreasing to a steady-state rate of approximately 155 L/s. This is due to propagation of the BC40 cave as it reaches major water-bearing oxide aquifers. Once groundwater is removed from oxide aquifer storage, the inflows are projected to be primarily associated with recharge. Dewatering of the mine will be conducted from underground as well as using surface dewatering bores and horizontal drains. A series of sumps and pump stations will be progressively established during decline development. At the surface a network of horizontal drains and dewatering bores will be established around the cave perimeter. During the period from decline development period and Watut process plant start-up, prior to disposal of the mine water from this dewatering system, mine water will be treated at the surface to conform to PNG environmental guidelines. Following start up all water will be consumed by the processing requirements, or disposed of via deep sea tailings placement (DSTP). Inflows to the mine and discharge to the environment will be monitored for quality and quantity throughout the LOM.

Experience from similar mining operations indicates that once the block cave breaks through to the surface, during heavy rainfall events there will be a high risk of water flows rapidly reporting to the mine workings underground. There is no practical method to seal the subsidence zone. The mine plan will have the following features to deal with high water inflows: emergency water pumping capacity, underground emergency water storage, or allowing for temporary flooding of the lowest mine openings (below major infrastructure).

The ventilation system was designed for a 16.84 Mt/a production capacity. During the capital development period, ventilation needs will be dominated by diesel exhaust dilution requirements, whereas for the steady-state mine the design constraint will be heat rather than diesel dilution. Ventilation will be progressively developed and at peak will consist of the two declines, fan system, and refrigeration plant. The peak installed airflow will be 675 m^3/s, which will be more than the projected 595 m^3/s maximum requirements. The peak installed refrigeration capacity underground and at surface is planned at 37.0 megawatts air cooling (MW_{AC}) as compared to the anticipated peak requirements of 35.0 MW_{AC}.

Each of the block cave footprints are planned to use an El Teniente extraction level layout. The average draw column heights will be 320 m (BC44), 490 m (BC42) and 590 m (BC40) with maximum draw column heights of 530 m (BC44), 805 m (BC42) and 1,120 m (BC40). Initial underground access will be via the Nambonga decline to provide earlier and quicker access to underground drill platforms, and a second means of egress and ventilation. Primary underground access will be via the Watut portal and the twin Watut declines to the underground block cave mine. The Watut declines will also form part of the primary ventilation circuit and materials handling system conveying ore to the Watut process plant. A cave engineering level will be established above the Reid Fault at 4,870 mRL for data gathering, further refinement of the rock mass understanding, monitoring of the cave, and potentially for dewatering.

Ore will be extracted from the block cave drawpoints by LHDs and trammed to the tipple. The ore will be tipped into a run-of-mine (ROM) bin of approximately 200 t live capacity, and will discharge into the gyratory crusher where an estimated 5% (based on a draw height of 150 m) of the ore will be broken by a rock breaker before being crushed to a P_{80} size of approximately 115 mm. The percentage of ore to be broken by the rock breaker decreases as the cave propagates as the fragmentation becomes finer through increased comminution in the cave. The crushed ore will discharge into a 500 t crushed ore bin, where it will be transferred to a collection conveyor via an apron feeder. The collection conveyor will discharge onto the decline conveyor system, transferring onto the main decline conveyor to surface and onto the stockpile feed conveyor, discharging on the coarse ore stockpile adjacent the Watut process plant. Two identical crusher stations will be located on each of the block caves, each of which will be able to process 50% of the ROM feed. Six collection conveyors will be installed underground, two per block cave, and one for each of the crushers.

Underground workshops, complete with spares store and wash bay, will be located at BC44 and at BC40. Underground office, meal room, and ablutions facilities will be located at BC44 and at BC40, close to the workshops. Three refuelling stations will be provided, one for each cave. A radio and leaky feeder system is intended to be used as the primary means of voice communication.

Short-term infrastructure will be required for the Nambonga decline construction. It was assumed that the Logistics Laydown 1 facility near the current Wafi Exploration Camp will be concreted and used as a workshop for maintenance and repairs on the Nambonga decline development fleet. Existing sea containers will be used for offices, a first aid room, a crib room, storage and to house the pressure cleaner and compressor. Fuel storage will be required for the generators located near the Nambonga decline portal and for dispensing of fuel for the mining contractor's diesel equipment fleet. An explosives magazine will also be required.

The selection of 33 kV for underground operations is based on the underground requirement of approximately 37 MVA in the final stages, with a ring topology spanning approximately 16 km.

The peak annual cave production is 16.84 Mt/a with development entering the ore stream being additive to the cave production resulting in a peak production of 17.8 Mt in Year 17. It is proposed that the first block cave, BC44, will be situated at 4,400 mRL. The second block cave, BC42, will be situated at 4,200 mRL. The third block cave, BC40, is planned to be situated at 4,000 mRL. The mine will have a total life of 28 years from first production of the processing plant (excluding construction and closure phases).

1.15 Recovery Methods

The proposed Watut process plant will be a compact copper concentrator that will be progressively built, in line with the mine ramp-up profile.

The plant is designed to treat 8.42 Mt/a of ore for the first three years of operation. In the fourth year of operation, an additional ball mill and flotation cells will be installed, to support throughput ramp up to 16.84 Mt/a. Installation of a pyrite flotation and regrind circuit will facilitate the processing of ore containing a higher metasediment content from year five onwards.

The plant will run intermittently (campaign treatment) and in 50% turndown mode for the first three years. During the mine ramp-up period, the total volume of the coarse ore stockpile and start-up stockpile will be used to maintain plant utilisation as high as practicable, minimising the number of plant stops. The plant is designed to cater for the ore composition changes over the LOM, and blending is not expected to be required.

The process plant will include the following:

- Crushed ore stockpile and reclaim;
- Single semi-autogenous grind (SAG) and SAG/ball (SAB) milling circuit, with the ball mill operating in closed circuit with cyclones at the lower design throughput of 8.42 Mt/a. This will be expanded to include a second ball mill, operating in parallel with the original ball mill circuit when the plant is expanded to a design capacity of 16.84 Mt/a. The target grind size is 80% passing 106 µm;
- A pebble crusher circuit. Pebbles will be recirculated to the SAG mill during the 8.42 Mt/a LEAN flowsheet and early years of the 16.84 Mt/a Golpu flowsheet, with the pebble crusher included due to the expected increased ore hardness in the later years of mine life;
- Copper flotation, comprising rougher flotation, copper rougher cleaner (single Jameson cell), which processes the first rougher concentrate, copper concentrate regrind followed by a three-stage copper cleaner, and cleaner–scavenger stage;
- Additional copper flotation cells forming part of the LEAN circuit that will be commissioned approximately nine years post the Special Mining Lease grant to accommodate the ramping of the process plant to design capacity of 16.84 Mt/a. A pyrite rougher flotation circuit, which further processes the copper rougher tailings, will be introduced 10 years post the Special Mining Lease grant to meet the requirements of the increased metasediment content of the ore, corresponding to a porphyry content of <75%;
- A pyrite concentrate regrind circuit followed by cleaner and cleaner–scavenger stages;
- Concentrate dewatering and handling;
- Tailings thickening, pumping and water recovery;
- Reagent mixing and distribution (including lime slaking, flotation reagents, and flocculants);
- Grinding media storage and addition;
- Water services (including raw water, fire water, potable water, and process water);
- Air services (including high-pressure air and low-pressure process air).

The weighted average ore composition for the first four years of production is projected to be 84.3% porphyry, while from approximately the fifth year this reduces to 43.1% porphyry content. The weighted average porphyry content over the LOM is projected to be 46.2%, while the remainder of the mill feed is metasediment. In order to achieve <1,000 ppm As in the copper concentrate, the limit of arsenic in the feed ore must be <67 ppm As for the LEAN flowsheet and <39 ppm As for the Golpu flowsheet, assuming all arsenic reports to the concentrate.

The port facilities will be sited within a fenced compound within the Port of Lae precinct. Concentrate slurry transported via pipeline from the Watut process plant will be stored in one of three storage tanks before being dewatered using a pressure filter. Filtered concentrate (around 10% moisture) will be gravity fed into the storage shed and stored under cover. Concentrate will be loaded for export via covered conveyors.

The SAG and ball mill high voltage motors will account for approximately 70% of the process plant load, which amounts to nearly 60% of the overall maximum site power demand.

Water will be required for process water make-up and reagent mixing. The two thickener overflow streams will be recycled to the process water tank and the balance of the make-up water requirements will be supplied from the water treatment facility or alternatively from a raw water dam. Watut process plant tailings will be discharged through the DSTP, and as a result no water will be recovered to the Watut process plant from the tailings downstream of the tailings thickener.

Reagents will include grinding media, frothers, collectors, flocculant, sodium metabisulphite, lime, and compressed air.

1.16 Project Infrastructure

The Golpu Development is a greenfield site and currently does not have infrastructure to support mining operations. The infrastructure requirements to support Golpu Development are summarised as follows:

- Mine area: proposed block cave mine, underground access declines, portal terrace and waste rock storage facilities supporting each of the Watut and Nambonga declines, the Watut process plant, power generation facilities, laydown areas, water treatment facilities, quarries, wastewater discharge and raw water make-up pipelines, raw water dam, sediment control structures, roads and accommodation facilities for the construction and operations workforces;
- Infrastructure corridor: concentrate pipeline, terrestrial tailings pipeline and fuel pipeline; mine and northern access roads to connect with the Highlands Highway, laydown areas. New single-lane bridges are proposed over the Markham, Watut and Bavaga Rivers. Laydown areas will be located at key staging areas;
- Coastal area: port facility, including the concentrate filtration plant and materials handling, storage, ship loading facilities and filtrate discharge pipeline; tailings outfall, including a mix/de-aeration tank and associated facilities, seawater intake pipelines and DSTP outfall pipelines, pipeline laydown area, choke station, access track and parking turnaround area.

The existing Demakwa access, Link, and Watut Valley roads will provide initial access to the mine area during construction, while the planned northern access and mine access roads are developed. To facilitate initial access to the mine area, minor upgrades to the existing Demakwa access, Wafi access, Watut Valley, and Nambonga decline access roads will be needed to improve road safety and drainage control. Thereafter, the main construction and operations access to the mine area will be via the northern access and mine access roads. These two roads will be wholly located in the infrastructure corridor. The mine access road will start at the process plant terrace and follow the existing Watut Valley road to its intersection with the existing Link road. The northern access road will commence at the point of intersection and continue north to the point where it crosses the Watut River, then northeast across the Markham River.

Due to the steep terrain a number of terraces will need to be built to allow the required infrastructure to be constructed.

Concentrate and terrestrial tailings pipelines will transport the concentrate and tailings slurries from the process plant terrace located within the mine area to the coastal area. The concentrate pipeline will terminate at the concentrate filtration plant in the port facilities area at the Port of Lae, while the terrestrial tailings pipeline will continue through Lae to the outfall area, located between the Wagang village and the mouth of the Busu River. A fuel pipeline will transport fuel from the Lae bulk fuel storage facility at or near the Port of Lae to a storage facility at the power generation facility in the mine area.

Each major construction centre will have its own dedicated laydown area for the temporary storage of materials to be used during the initial construction and ongoing maintenance of Golpu Development-related facilities.

Use of intermediate fuel oil was assessed to be the most economic and reliable way to meet mine power demand over the LOM. Other power supply options may be assessed during the permitting phase. During the construction phase, power will be provided by on-site diesel generators. Approximately 20 generators (depending on the units selected) are expected to be needed for surface and underground works during construction. For the operations phase, the WGJV proposes to construct and operate a power generation facility using reciprocating engines to supply power for the mine, process plant and accommodation facilities. The first stage will consist of nine 10 MW generator sets to meet the initial power demand of 56 MW. The second stage will accommodate the peak power demand of approximately 100 MW through the addition of five 10 MW units taking the total to 14 generator sets. The ultimate configuration will comprise 12 operating generators and two standby generators.

The existing Wafi and Finchif construction accommodation facilities will be operational during the construction phase. The Wafi accommodation facility has a current capacity of 250 persons and the Finchif construction accommodation facility will be expanded to accommodate up to 1,000 people. Finchif will be retained post-construction. A third accommodation facility, Fere, will be constructed, and used for both the construction and operations phases. It will have a 1,400-person capacity. During construction of the infrastructure corridor between the village of Zifasing and coastal area, outfall system and port facilities area, Golpu Development personnel and contractors will be accommodated at existing accommodation facilities, at Eleven Mile, outside Lae.

The construction workforce required across the Golpu Development areas is estimated to be approximately 2,500 full time equivalent workers, of which approximately two-thirds will be in the mine area. The WGJV expects the Golpu Development to employ around 850 full-time equivalent workers, including both employees and contractors, during the operations phase. A key focus for the WGJV will be the employment of appropriately-qualified PNG citizens, with priority given, where possible, to local landowners in the area.

1.17 Environmental, Permitting and Social Considerations

1.17.1 Overview

The WGJV has completed a number of baseline and supporting studies including physical and biological environment, freshwater environment, nearshore marine environment, offshore marine environment, socio-economic environment, and cultural heritage characterisation, as well as impact assessments.

An Environmental Inception Report (EIR) was submitted on 16 May 2017 and approved by the Conservation and Environment Protection Authority (CEPA) on 8 June, 2017.

An Environmental Impact Statement (EIS) was prepared as the statutory basis for the environmental, social and cultural heritage assessment of the Golpu Development under the *Environment Act 2000*. The EIS objective was to identify potential environmental, social and cultural heritage impacts associated with the Golpu Development and set out the management measures WGJV proposes to address potential adverse impacts. The EIS was submitted to CEPA in June 2018.

1.17.2 Stockpiles

A temporary start-up ore stockpile is planned to store ore extracted during the development of the BC44 undercut and extraction levels. It will be built on a purpose-built, low- permeability base, adjacent to the Watut declines WRSF, to stockpile material for processing until the Watut process plant commences operation. This ore will then be used in the commissioning process.

A coarse ore stockpile will be required to maintain a steady supply of ore for the Watut process plant and to minimise fluctuations in the availability of feed material.

1.17.3 Waste Rock Disposal Facilities

Once the underground crusher is installed, all rock will be transferred to the underground crusher and delivered to the surface as part of the ore stream for processing. Unlike typical open-cut mines, this means there is effectively no waste rock generated during operations. Competent non-acid forming (NAF) material will be used during Golpu Development construction (e.g., for portal terraces) and as lining and capping for the PAF waste rock cells in the WRSFs. The PAF material will be stored in engineered WRSFs adjacent or nearby to the Watut and Nambonga declines.

The Watut declines WRSF design is constrained by the Boganchong Creek valley in which it is proposed to be located. The facility will cover approximately 12 ha of the Boganchong Creek valley. The downstream end of the facility will not have a conventional WRSF toe, but will abut the process plant terrace, forming one continuous footprint that will house the Golpu Development infrastructure. The WRSF has a design capacity of 1.2 Mt of PAF material. The NAF waste rock generated during decline development is proposed to initially be placed next to, and downstream of, the Watut decline portal terrace, to create a NAF fill area. PAF waste will then be placed within the NAF-lined cell and intermediate layers of low-permeability clay placed over the surface of the PAF waste at intervals during operation to limit the duration of exposure to air and water. Routine monitoring of the WRSF cells during operations will allow early detection of seepage and AMD. Potentially-contaminated runoff and seepage from the WRSF will be collected for testing, and will be treated if required.

Waste rock from the Nambonga decline will be stored within a WRSF located near the decline. This WRSF, which will have an approximate 5 ha area, will store approximately 0.86M t of PAF and NAF waste rock from the Nambonga and Watut declines. The seepage and runoff will be captured, and treated, if necessary, to comply with permit conditions using a water treatment plant.

1.17.4 Tailings Storage Facility

The WGJV, through the course of its concept, pre-feasibility and feasibility study programs, has assessed a number of options for tailings management. These included pre-feasibility and feasibility-level investigations into the following options for tailings management for the Golpu Development: on-land storage in a tailings storage facility, dry-stacking, and deep sea tailings placement. Based on a desire to minimise impacts on the biophysical and social environment and cultural heritage and adopt the option with the lowest construction, operational and post closure risks, the WGJV adopted DSTP as the preferred tailings management option for the Golpu Development.

DSTP will involve the discharge of tailings slurry from an outfall pipeline terminus located approximately 200 m below the ocean surface. On exiting the outfall pipe, the tailings will flow down the sloping seafloor as a density current, with the ultimate deposition of the tailings solids on the deep-ocean floor.

A tailings pump station will be located at the process plant terrace. Tailings will be thickened to recover water and process reagents. A 103 km-long terrestrial tailings pipeline will transport tailings slurry from the tailings pump station in the mine area to the outfall system. The outfall system will include a mix/de-aeration tank, two seawater intake pipelines, and two outfall pipelines.

1.17.5 Water Management

The mine water management system was designed to capture potentially-contaminated water within the mine area during construction and operations, and manage, including treatment where necessary, this captured water for re-use or disposal. As a general principle, clean (non-contact) water will be diverted around surface works and, where practicable, water will be intercepted (by dewatering) before it can enter the block cave zone or, prevented from entry into the declines, by shotcreting or grouting. This is intended to minimise the volume of water requiring management during construction and operations. During construction, potentially-contaminated mine wastewater will be treated if necessary, prior to discharge.

During operations, treated mine wastewater (from declines, block caves, runoff and seepage and sewage effluent) will be used as the primary water source for the process plant, and as the transport media for concentrate and tailings. Given that the process water demand exceeds the volume of waste for the majority of the time during operations, it is predicted that there will be limited periods during operations in which mine wastewater will require discharge to the Watut River. Water originating from the Watut declines portal and plant terraces, including the coarse ore stockpile area, will require sediment removal, attenuation, testing, and treatment before being released to the environment, or before it may be harvested for use in the process plant. A raw water dam will allow for the local storage of raw water and for the harvesting of runoff water from the site.

1.17.6 Closure and Reclamation Planning

Construction activities will take place over an approximate five-year period and operations (commissioning, ramp-up and production) will continue for an estimated 28 years. The post-closure period will commence following the cessation of operations.

A Closure and Rehabilitation Plan was prepared for the Golpu Development. The primary objectives will be to leave the site safe and stable in the long-term and to assist Project-affected communities to access long-term, sustainable opportunities post-closure.

A detailed closure schedule for implementation will be developed during the operational stage of the mine as the closure planning progresses. The WGJV proposes undertaking progressive rehabilitation where possible.

A post-production closure cost estimate, at the Golpu Development level, of approximately US$75 M was prepared for the cash flow analysis in support of Mineral Reserves for this Report. The cost estimate is based on the construction and operations plan assumptions made in the 2018 Feasibility Study update and current PNG guidelines for closure planning.

1.17.7 Environmental Considerations

There may be potential impacts on terrestrial biodiversity arising from vegetation clearance and infrastructure development. There is also a risk of acid and metalliferous drainage (AMD) arising during different phases of the Golpu Development, including in and around Golpu following mine closure. There may be potential impacts arising from damage to or failure of the proposed concentrate, terrestrial tailings and fuel pipelines between the mine and coastal areas.

An environmental monitoring program will be implemented to monitor and measure, on a regular basis, the environmental performance of Project activities. The program will be based on a conventional three-phase surveillance system. Environmental monitoring results will be maintained in a dedicated database.

The WGJV extensively investigated options for tailings management for the life of the Project both on land and by DSTP. These investigations confirmed DSTP as the WGJV's preferred method of tailings management based on consideration of long-term safety, engineering, environmental, social, cultural heritage and economic factors.

1.17.8 Permitting Considerations

For the planned Golpu Development operations, the tenements required as at 30 June, 2020, include:

- One Special Mining Lease;
- Six Mining Easements;
- Three Leases for Mining Purposes.

Following consideration of the advice of the Mining Advisory Council, the Minister of Mining may grant any requested Mining Lease, Mining Easement and Lease for Mining Purposes. The Head of State also considers the advice of the Mining Advisory Council in the grant of a Special Mining Lease.

Environmental approval for the Golpu Development is being sought under the *Environment Act 2000* and Environment (Prescribed Activities) Regulation 2002. The required approval for the Golpu Development is a Level 3 environment permit. The Golpu Development EIS was submitted to CEPA.

Apart from the *Mining Act 1992* and *Environment Act 2000* requirements, the Golpu Development will have to comply with aspects from other forms of legislation. The Golpu Development review process may identify other legislation that must be complied with.

1.17.9 Social Considerations

The WGJV stakeholder engagement program commenced in 2008 and, since then, the WGJV has worked closely with its many stakeholders to build relationships. In implementing the program and building these relationships, the WGJV placed an emphasis on local communities within the Project area while also considering the interests of the broader Project stakeholder group.

The WGJV's approach to consultation was informed by International Finance Corporation Performance Standards and the International Council of Mining and Minerals Sustainable Development Framework.

Across the Project area, the majority of stakeholder engagement activities with the local communities are overseen, coordinated and carried out by the WGJV Community Affairs and Lands team. The primary functions of this team are facilitating local community liaison and engagement. The majority of team members are Papua New Guinean, and fluent in the languages spoken by the communities within the Golpu Development area. This enables the team to connect culturally with the communities, resulting in more effective engagement.

At a corporate level, senior managers and executives maintain focused and formal engagement with representatives of the State, Provincial, and local governments, and third-parties in relation to matters such as port access, power supply, transport, and permitting and compliance.

Specialist studies undertaken by the WGJV (e.g., socioeconomic studies involving household surveys, key informant interviews and focus groups) have also provided opportunities for stakeholder engagement.

Feedback and issues raised by stakeholders are recorded during engagements for further action as required by the WGJV. This includes an established grievance mechanism.

Stakeholder engagement will continue throughout the Project (including the Golpu Development) life, although the frequency and nature of engagement will vary according to the specific stakeholder, and the actions contemplated. The WGJV will endeavour to support and implement continuous, meaningful and gender-appropriate engagement directly with Project-affected communities and will also endeavour to provide communication materials in a format suited to each stakeholder group.

1.17.10 Comment on Proposed Development

There is potential for the Project to result in both beneficial and adverse impacts from a socio-economic perspective.

Positive impacts include, and are not limited to: tax and royalty payments; special support grants that can be allocated by the State of PNG to Morobe Province as budget support for infrastructure development; sourcing, where practicable, of equipment and materials from within the province and PNG; establishment of local businesses, employment and training opportunities; and provincial and local community development projects across the health, education, sustainable livelihoods, environment and other program areas.

Potential adverse impacts resulting from the Project have also been assessed including: in-migration; road safety; community health and safety; physical and economic displacement; and, law and order.

Management measures are proposed to manage adverse impacts and to enhance positive impacts where possible including: develop, negotiate and implement in-migration management measures in collaboration with local communities and government; implement measures to prevent injuries to road users and damage to public assets in relation to project activities; and, resettlement management procedures.

1.18 Markets and Contracts

An evaluation of the copper market was undertaken as part of the 2018 Feasibility Study Update. It is expected that Asian smelters will contract the Golpu concentrate as long-term feed source. The concentrate will be attractive to these smelters due to the proximity of the mine and consequently shorter transit times, increasing certainty of supply.

The Golpu concentrate is expected to be relatively high in copper and low in impurities. Levels of gold-in-concentrate are not expected to be elevated to such levels that would limit marketability in markets such as China and India where high concentrate values may be restricted by working capital constraints. The concentrate is not expected to contain deleterious elements at levels prohibitive to sale to Asian smelters.

Metal price assumptions were provided by Newcrest management. Newcrest considers analyst and broker price predictions, and price projections used by peers as inputs when preparing the management pricing forecasts. The commodity price and exchange rate projections were agreed to by the WGJV Participants.

No contracts are currently in place in support of the Golpu Development. Major contracts in support of development are likely to include shaft sinking, decline development, pipelines, conveyors, camp construction, port and roads. Major contracts in support of operations are likely to include: accommodations camp management, building maintenance, underground mine infrastructure development, cave establishment, road maintenance, explosives supply, ground support and consumables supply, material transport and logistics to the Port of Lae, infrastructure engineering procurement and construction management, labour training, and infrastructure construction. Contracts will be negotiated and renewed as needed. Contract terms are expected to be within industry norms, and typical of similar contracts in PNG that Newcrest is familiar with.

1.19 Capital Cost Estimates

Capital and operating cost estimates are based on the 2018 Feasibility Study Update and are presented on a 100% basis. Cost estimates were reviewed as at 30 June, 2020, and remain current.

Newcrest's internal study guidelines require project scope definition for a feasibility study to have an accuracy level of ±15%. Pre-feasibility studies must have a project scope definition accuracy level of ±25%. The overall capital cost estimate for the Golpu Development is at a minimum at a PFS-level (±25%) of accuracy.

The WGJV engaged a number of specialist consultants and estimators to identify the scope and produce corresponding capital cost estimates for their areas of particular expertise. Costs were separated into:

- Direct costs: permanent facilities and services required for their installation and include plant and equipment, bulk material, contractor/sub-contractor costs, freight and vendor representatives;
- Indirect costs: costs to support the purchase and installation of the direct costs. This includes the materials and services required for field construction but are not incorporated into or accounted for as part of the permanent facilities. A standard set of indirect costs with detailed descriptions were calculated in the estimate.

Contingency allowances were applied, as appropriate, and were based on evaluations of all major cost categories.

The LOM capital cost is estimated at US$5,382 M (real December 2017 US$ terms; 100% basis), and includes US$200 M of capitalised net revenue, which is a Newcrest accounting standard for production revenue delivered before commercial production is declared. Table 1-7 summarises the capital cost estimates by area.

1.20 Operating Cost Estimates

The operating cost estimate is derived on a 100% share basis and is expressed in real December 2017 US$ terms. Where applicable, prices/rates obtained in other currencies were converted to US$ using the rates of exchange applicable to the base date of the estimate. The exchange rates used in the development of the operating cost estimate are consistent with the exchange rates applied in development of the capital cost estimate. The estimate accuracy is ±10% to 15%. Cost estimates were reviewed as at 30 June 2020, and remain current.

Other than escalating costs to the specified base date, no allowance was made for real escalation (i.e., above inflation) within the operating cost estimate to forecast future increases or decreases in rates or prices.

The operating cost estimate was developed in monthly increments and is based on first principles, being unit consumption rates and unit prices. Prices were quantified as far as possible and where practicable by quotations, with some other values escalated from the 2016 Feasibility Study.

The overall operating cost estimate is provided in Table 1-8 by area. Forecast operating costs include, over the LOM, US$4.16/t milled for mining costs, US$7.40/t milled for treatment costs, US$1.78/t milled infrastructure costs, and US$3.99/t milled site services costs. This results in an anticipated overall LOM operating cost of US$17.33/t milled.

Table 1-7: Summary Capital Cost Estimate by Area

Description	Execution Capital (US$ M)	Expansionary Capital (US$ M)	LOM Total (US$ M real)	% of Total
Underground mining	819	1,321	2,140	44
Treatment	695	79	773	16
Shared services and infrastructure	210	73	284	6
Regional infrastructure	219	-	219	4
Site support services	117	31	148	3
Project delivery management	462	144	607	12
Other capitalised costs	187	38	225	5
Provisions	315	178	493	10
Capitalised revenue	(200)	—	(200)	NA
Total LOM capital cost (excluding sustaining capital)	2,825	1,864	4,689	100
Sustaining capital	—	693	693	NA
Total LOM capital cost	2,825	2,557	5,382	NA

Note: Expansionary capital includes all major development capital expenditure post commercial production. Sustaining capital is defined as routine stay-in-business capital expenditure estimated as 2.5% of the asset replacement value (ARV). NA = not applicable.

Table 1-8: Operating Cost Estimate by Area (US$/t milled)

Area	Value
Underground mining	
Ventilation & refrigeration	1.27
Production	0.99
Conveying	0.69
Engineering maintenance & services	0.56
Dewatering	0.34
Crushing	0.15
Technical services	0.12
Administration	0.04
Subtotal underground mining	*4.16*
Treatment	
Process plant operations	5.04
Process plant maintenance	0.91
Port filtration plant	0.72
DSTP	0.47
Water treatment plant	0.25
Concentrate pipeline	0.01
Subtotal treatment	*7.40*
Infrastructure	
Power generation plant	1.34
Infrastructure (roads and buildings)	0.28
Services (power and waste)	0.16

Area	Value
Subtotal infrastructure	*1.78*
Site support services	
Environmental, community affairs and land	0.89
Commercial	0.92
Occupational health and safety (OH&S)	0.47
Camp Services	0.40
Information technology (IT)	0.33
Travel	0.18
Supply and logistics	0.19
Human resources (HR)	0.09
Subtotal site support services	*3.99*
Total	***17.33***

Note: Total is inclusive of cost allocations for closure.

1.21 Economic Analysis

This economic analysis includes forward-looking statements. Forward-looking statements can generally be identified by the use of words such as “may”, “will”, “expect”, “intend”, “plan”, “estimate”, “anticipate”, “continue”, “outlook” and “guidance”, or other similar words and may include, without limitation, Mineral Resource and Mineral Reserve estimates, statements regarding plans, strategies and objectives of management relating to the Project including the proposed mine plan, projected mining and process recovery rates and assumptions as to mining dilution, anticipated production or construction commencement dates, expected costs or production outputs and assumptions as to closure costs and requirements; assumptions as to environmental, permitting and social risks. Forward-looking statements inherently involve known and unknown risks, uncertainties and other factors that may cause the actual results, performance and achievements of the Project to differ materially from statements in this analysis. Relevant factors may include, but are not limited to, changes in external economic factors such as commodity prices, foreign exchange fluctuations, interest rates and tax rates, unanticipated changes in sustaining and operating costs, unexpected variations in the quantity of mineralised material, grade or recovery rates, unexpected changes in the environmental or in geotechnical or hydrological conditions, a failure of mining methods to operate as anticipated, a failure of plant, equipment or processes to operate as anticipated, and the risks relating to permitting, licensing and maintaining a social license to operate.

Forward-looking statements are based on Newcrest’s good faith assumptions as to the geological, technical, engineering, market, financial and regulatory factors that will exist and affect the Project’s development and operations in the future. Newcrest does not give any assurance that the assumptions will prove to be correct. There may be other factors that could cause actual results or events not to be as anticipated, and many events are beyond the reasonable control of Newcrest. Readers are cautioned not to place undue reliance on forward looking statements. Forward-looking statements in this economic analysis speak only at the date of issue. Except as required by applicable laws or regulations, Newcrest does not undertake any obligation to publicly update or revise any of the forward-looking statements or to advise of any change in assumptions on which any such statement is based.

The production schedules and financial analysis annualised cash flow table are presented with conceptual years shown. Years shown in these tables are for illustrative purposes only. Additional mining, technical, and engineering studies requested as part of the permitting process may result in changes to the project timelines presented.

The Golpu Development was valued using a discounted cash flow (DCF) approach. Estimates were prepared for all the individual elements of cash revenue and cash expenditures. Capital cost estimates were prepared for initial development and construction of the Golpu Development, in addition to ongoing operations (sustaining capital). The year of the Special Mining Lease grant was defined as the first year of initial capital expenditure, and cash flows are assumed to occur in the middle of each period. The resulting net annual cash flows are discounted back to the date of valuation of start-of-year 1 July, 2019, because the actual starting calendar year has not been determined. A discount rate of 8.50% was used. Input assumptions were reviewed as at 30 June, 2020, are considered acceptable for public disclosure, and remain current.

Metal prices used were $1,200/oz Au and $3.00/lb Cu. The base case economic analysis assumes constant prices with no inflationary adjustments. Royalty provisions in the financial model include:

- Royalty: 2% of the net proceeds of sale of minerals (calculated as NSR or FOB export value, whichever is appropriate);
- Production levy: 0.5% of gross revenue from all mining sales.

The economic analysis reflects the following significant changes to the Mining Taxation Regime announced by the PNG Government in November 2016:

- Introduction of a resources rent tax termed the Additional Profits Tax (APT). The APT is levied at the 30% corporate income rate on profits above an allowed capital return threshold of 15% per annum (nominal terms), and is thus triggered once a 15% rate of return per annum (nominal) was achieved on prior invested capital. Changes in parameters that result in higher profits have the effect of consuming accumulated capital balance (and 15% per annum uplift rate) much faster, triggering the APT;
- An increase to the Foreign Contractor Withholding Tax (FCWT) rate from 12% to 15%;
- Suspension of the double deduction for exploration expenditure provided under section 155N of the Income Tax Act, with no additions to this balance post 1 January 2017.

The economic analysis was performed on a 100% in-country basis without consideration of funding or structuring at the WGJV Participant entity level, and does not take into account differences in the corporate tax treatment by each WGJV Participant. As such, the model is designed to be a standalone discrete project model and assumes (for valuation purposes only) that all cash flows are held in-country by the WGJV (i.e., not repatriated to shareholders). For the purpose of calculating the tax payable, all of the extractive activities and associated infrastructure were assumed to be undertaken under a single Special Mining Lease.

All expenditure, including execution capital expenditure up until first production, was capitalised as allowable capital expenditure (ACE) and depreciated at a rate of 25% using the diminishing value method, as per PNG tax law. Total historical expenditure (actual and forecast) through to the anticipated Special Mining Lease grant is estimated to be US$779 M on a 100% basis.

No salvage value was allocated. Mine closure costs are based on an estimated total closure cost for the operation consisting of an annual spend during operations and a final closure cost incurred over a period of 10 years, starting in the final year of production. This cost is included in operating costs. The conceptual provision for post-production closure costs is estimated at US$75 M.

As shown in Table 1-9, the internal rate of return (IRR) is forecast to be 18.2%, and the projected net present value (NPV) is US$2,604 M. The payback period is estimated at nine and a half years.

1.22 Sensitivity Analysis

Figure 1-1 shows the sensitivity of the IRR to variations in key parameters, whereas Figure 1-2 shows NPV sensitivity. The NPV of the Golpu Development is most sensitive to changes in the copper price, less sensitive to changes in the copper grade, capital costs, gold price, and gold grade, and least sensitive to changes in operating costs.

1.23 Risks and Opportunities

1.23.1 Golpu Development

A risk and opportunity analysis was performed as part of the 2018 Feasibility Study Update. Risk reviews and risk register updates were conducted with a cross section of project managers and discipline leads across all project areas participating. Risks were rated using a risk matrix approach, and mitigation approaches established.

Key risks to the Golpu Development as identified in the 2018 Feasibility Study Update were: vehicle incidents on public roads; inability to use DSTP as the tailings disposal method; law reform processes leading to substantially changed legislative and fiscal regimes impacting the Project; and water or mud inrush to underground workings during construction and operations that would particularly affect the decline, cave levels and infrastructure areas.

Other risks are primarily related to construction and operations, such as: large-scale seismic events, fall of rock, either on surface or underground; failure of cave propagation; delays in cave establishment; underground and surface facilities fires; failures of equipment, surface or underground fixed assets; unplanned explosive initiation; and ground or surface water contamination.

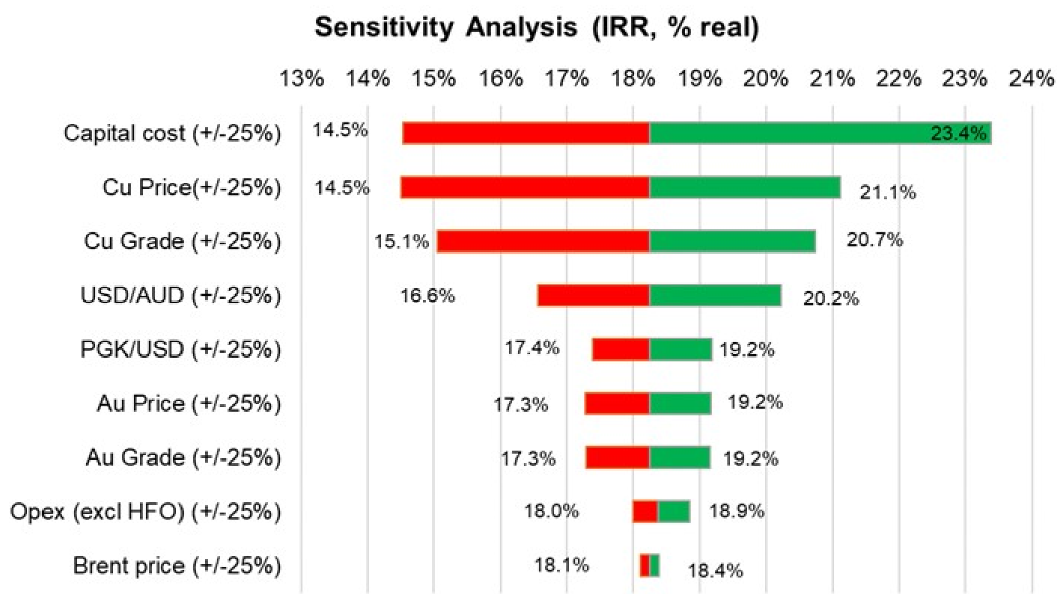
Risks that will require ongoing monitoring during construction and operations include social unrest, disruptions to access road useability (for example, seasonal heavy rainfall events, geotechnical events such as rock falls and slides, and vehicular accidents), and theft and vandalism.

Table 1-9: After-Tax Golpu Development Financial Metrics

Parameters	Units	Value
Maximum negative cash flow (MNCF)	US$ M	2,823
Concentrator start from Special Mining Lease grant	Years	4.75
Payback period from Special Mining Lease grant	Years	9.54
IRR	%	18.2
NPV	US$ M	2,604
Operating cost	US$/t ore milled real LOM avg.	17.33
Project execution capital *	US$ M	2,825
Cash cost (including gold credit) **	US$//lb avg.	0.26
Total production cost #	US$//lb avg.	0.81

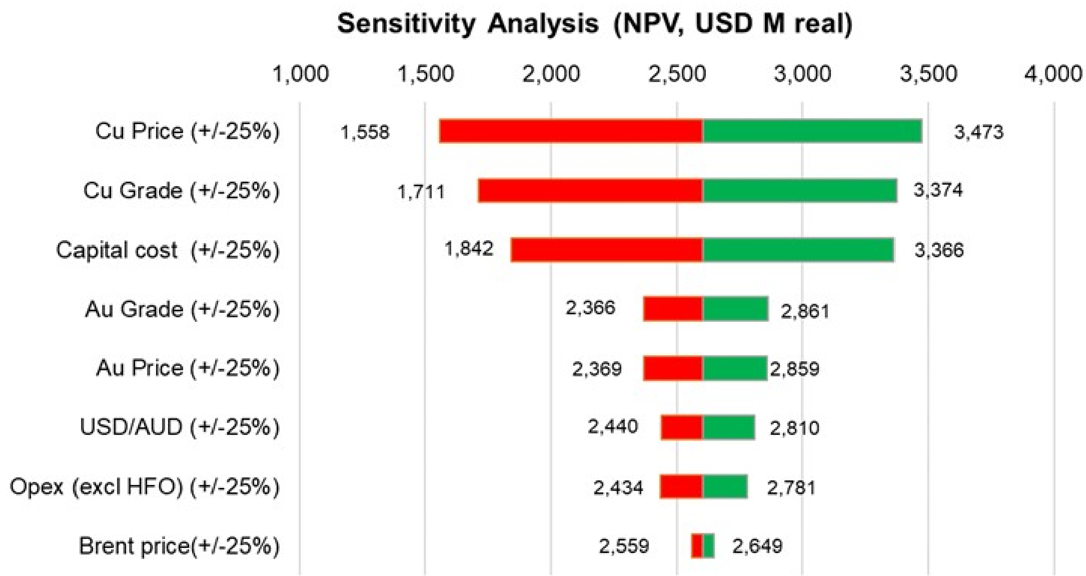
Note: * = includes net capitalised revenue of US$200 M; ** = operating costs + treatment charges/refining charges (TC/RC) + realisation expenses less gross gold revenue/copper pounds; # = operating costs + TC/RC + realisation expenses + total LOM capital (including capitalised revenue) less gross gold revenue/copper pounds.

Figure 1-1: Sensitivity Analysis, IRR



Note: Figure prepared by WGJV, 2019.

Figure 1-2: Sensitivity Analysis, NPV



Note: Figure prepared by WGJV, 2019. USD = US$.

1.23.2 In-Country

Mining and exploration tenure are subject to renewal. There can be no certainty that renewals will be granted, or that they will be granted in a timely manner. Similarly, there can be no assurance that Newcrest will be able to successfully convert exploration tenure into mining tenure to support future mining operations, or successfully maintain its exploration and mining interests and deliver development projects.

Although Newcrest to date has been able to negotiate commercially reasonable and acceptable arrangements with native title claimants or land owners where it operates, there can be no assurance that claims will not be lodged in the future, which may impact Newcrest's ability to effectively operate in relevant geographic areas.

Disagreements between national and regional governments in Papua New Guinea have historically created an uncertain business environment for Newcrest and may increase its costs of business. Such disagreements may resurface in the future and could adversely affect Newcrest's operations in Papua New Guinea.

The State is undertaking a broad review of mining laws, with potential reforms including extending the level of local equity participation in projects; more stringent requirements for local participation in mining-related businesses, local mineral smelting and processing; and implementing broader changes to the regulatory regime for mining and related activities. There can be no certainty as to what changes, if any, will be made to the *Papua New Guinea Mining Act* under the current or future governments. Material changes to the *Papua New Guinea Mining Act* may have a material adverse impact on Newcrest's ability to own or operate its respective properties and to conduct its business in PNG.

The State is also working on a set of new policies concerning geothermal energy, mine closure, sustainability, biodiversity offsets, carbon offsets, offshore mining and resettlement. Policies under consideration that, if adopted and to the extent applicable, may adversely affect the Golpu Development include, increasing the State's entitlement to acquire equity in new mines, restriction on fly-in/fly-out operations, local smelting and processing requirements, mine closure planning and funding obligations, and other changes to the regulatory regime for mining and related activities.

1.24 Interpretation and Conclusions

Under the assumptions in this Report, the Golpu Development shows a positive cash flow over the life-of-mine and supports the Mineral Reserve estimate. The mine plan is achievable under the set of assumptions and parameters used.

1.25 Recommendations

As material engineering studies and exploration programs have largely concluded on the Golpu Development, the QPs are not able to provide meaningful recommendations.

2 INTRODUCTION

2.1 Introduction

Mr. Kevin Gleeson, Mr. Pasqualino (Lino) Manca, Mr. Daniel Curry, and Mr. Craig Jones prepared this Technical Report (the Report) for Newcrest Mining Limited (Newcrest) on the Wafi–Golpu Project (the Project) in the Independent State of Papua New Guinea (Papua New Guinea, PNG or the State).

The Project location is shown in Figure 2-1.

The Project is a 50:50 unincorporated joint venture (JV), termed the Wafi-Golpu Joint Venture or WGJV, between Wafi Mining Limited (Wafi Mining) and Newcrest PNG 2 Limited (Newcrest PNG2), collectively the WGJV Participants. Harmony Gold Mining Company Limited (Harmony) is the ultimate parent company of Wafi Mining. Newcrest Mining Limited is the ultimate parent company of Newcrest PNG2.

The proposed Golpu operation (Golpu Development) is a greenfields development that focuses on the Golpu copper–gold porphyry deposit where Mineral Resources and Mineral Reserves were estimated. Additional Mineral Resources were estimated for the Wafi epithermal gold and Nambonga copper–gold porphyry deposits; however, these deposits are not currently included in the mine plan.

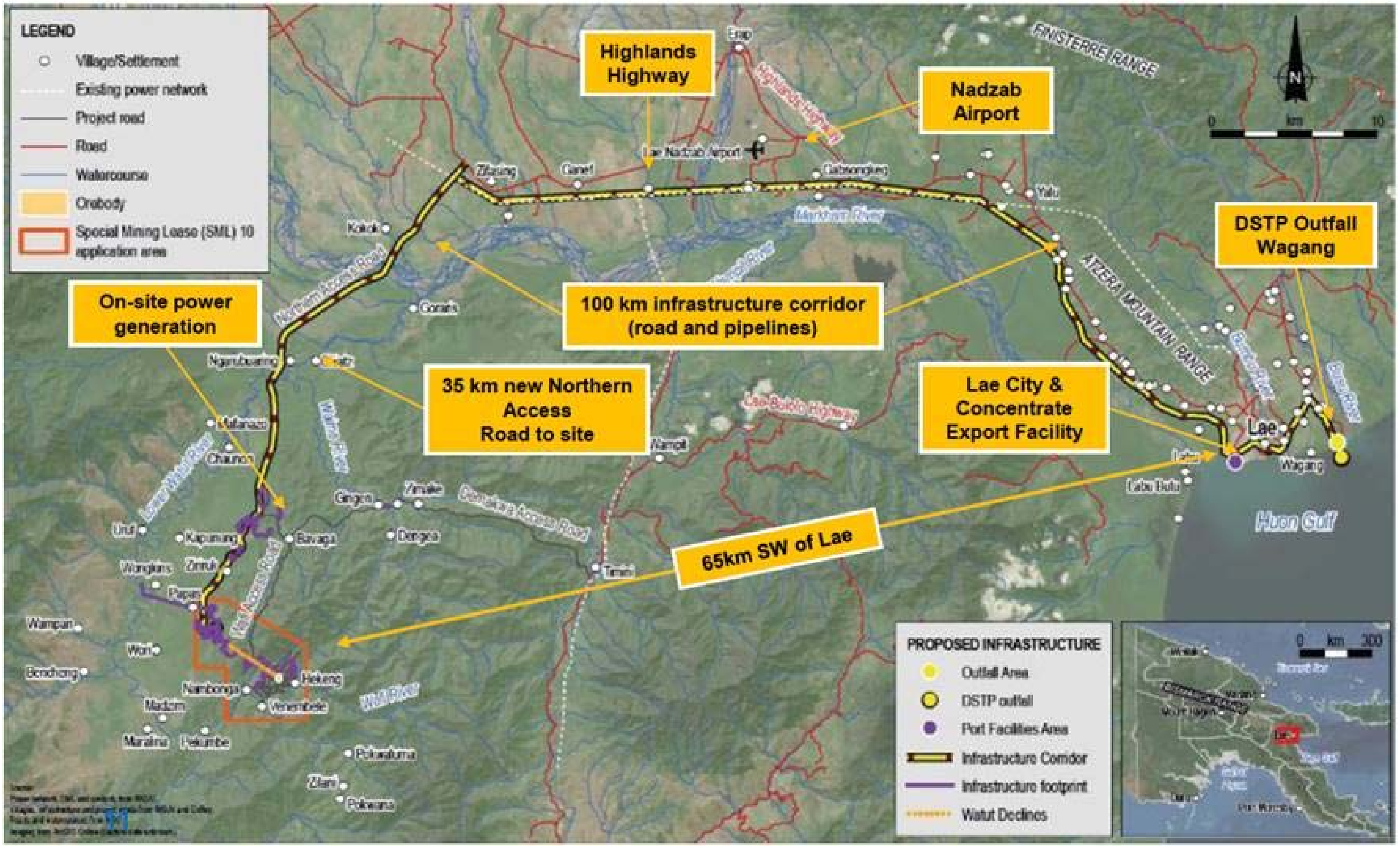
2.2 Terms of Reference

This Report supports disclosure of Mineral Resource and Mineral Reserve estimates in Newcrest's 2020 Annual Information Form.

All measurement units used in this Report are metric unless otherwise noted, and currency is expressed in either United States (US$) dollars or Australian dollars (A$) as identified in the text. The Papua New Guinean currency is the Papua New Guinea kina (PGK). The Report uses Australian English.

Mineral Resources and Mineral Reserves were initially classified using the 2012 edition of the Australasian Joint Ore Reserves Committee (JORC) Code (2012 JORC Code). The confidence categories assigned under the 2012 JORC Code were reconciled to the confidence categories in the Canadian Institute of Mining, Metallurgy and Petroleum (CIM) Definition Standards for Mineral Resources and Mineral Reserves (May 2014; the 2014 CIM Definition Standards). As the confidence category definitions are the same, no modifications to the confidence categories was required. Mineral Resources and Mineral Reserves in this Report are reported in accordance with the 2014 CIM Definition Standards. Terminology differences were addressed in that the term "Ore Reserves" in the 2012 JORC Code is reported as "Mineral Reserves" using the 2014 CIM Definition Standards.

Figure 2-1: Location Plan



Note: Figure prepared by Newcrest, 2018.

2.3 Qualified Persons

This Report was prepared by the following Newcrest Qualified Persons (QPs):

- Mr. Kevin Gleeson, FAusIMM, Head of Mineral Resource Management;
- Mr. Pasqualino Manca, FAusIMM, Group Manager – Mining Studies;
- Mr. Daniel Curry, FAusIMM, Head of Mineral Processing;
- Mr. Craig Jones, FAusIMM, Chief Operating Officer, Papua New Guinea.

2.4 Site Visits and Scope of Personal Inspection

Mr. Kevin Gleeson visited the Project area on 14–17 May, 2012. During that site visit, resource drilling was underway. Mr. Gleeson inspected drilling operations and drill core, reviewed drill collar locations in the field, inspected the on-site sample and core processing operations, and observed the sampling methodology and security measures from drill collar to despatch to laboratory. The site visit included discussions of geology and mineralisation interpretations with Project geological staff.

Mr. Lino Manca has visited the Project area on a number of occasions, including in April 2015, June 2016, June 2017, September 2018 and most recently on 7 November, 2018. The initial site visit was conducted as a site familiarisation to confirm suitability of selected areas for infrastructure and inspect core. The June 2016 visit was conducted to inspect progress on the geotechnical drilling program that was underway. During June 2017, potential sites for the proposed Nambonga decline portal were inspected and a preferred site selected. In September 2018, the geotechnical drilling program that was underway was inspected, and an inspection of the proposed sites for the Nambonga decline infrastructure was completed. The most recent site visit was in support of tendering for the construction of the Nambonga decline.

Mr. Craig Jones visited the Project area from 25 to 26 February, 2019. Mr. Jones has been visiting the Project since 2012; however, since 2017, he has visited the Project four times. During these site visits to the Project, Mr. Jones has inspected selected proposed major infrastructure locations, has discussed mine development plans and risk mitigation measures with Project staff, and has participated in reviews of aspects of environmental and social performance, including environmental compliance, permitting status, and stakeholder, community, and government relations. He has visited local communities and has met with representatives of the Provincial and National governments. Mr. Jones has been involved in permitting discussions relating to grant of the Special Mining Licence required for the Golpu Development.

2.5 Effective Dates

There are a number of effective dates pertinent to the Report, as follows:

- Date of the latest information on environmental, permitting, and social considerations: 30 June, 2020;
- Date of the latest drilling information included in the Report: 30 June, 2020;
- Database close-out date for the Golpu Mineral Resource estimate: 25 March, 2014;

- Database close-out date for the Wafi Mineral Resource estimate: 23 October, 2018;
- Database close-out date for the Nambonga Mineral Resource estimate: 23 October, 2018;
- Effective date of the Mineral Resource estimates: 30 June, 2020;
- Effective date of the Mineral Reserve estimate: 30 June, 2020.

The overall Report effective date is taken to be 30 June, 2020; and is based on the effective date of the Mineral Reserve and economic analysis that supports the Mineral Reserve estimate.

Capital and operating cost estimates, and the inputs to the economic model were reviewed as of 30 June, 2020, and are considered to remain current.

2.6 Information Sources and References

This Report is based in part on internal company and WGJV reports, maps, published government reports, and public information, as listed in Section 27 of this Report.

The primary data sources are:

- WGJV, 2018a: Wafi-Golpu Project Feasibility Study Update: internal WGJV report, March 2018;
- WGJV, 2018b: Environmental Impact Statement: internal WGJV report, June 2018;
- WGJV, 2016: Wafi-Golpu Project Feasibility Study; internal WGJV report, August 2016

The following Newcrest or WGJV employees, or consultants retained by Newcrest, contributed to various aspects of the Report under the supervision of the QPs:

- Ms. Lisa Bowyer, Manager Land Tenure, 12 years of experience with the Project;
- Mr. Rory Carson, Lead Business Analyst, FP&A, two years of experience with the Project;
- Mr. Andrew Chalmers, General Manager – Regulatory Wafi Golpu; six years of experience with the Project;
- Mr. Leigh Cox, General Manager Projects, five years of experience with the Project, including direct project secondment from early 2015 to July 2019;
- Mr. David Finn, Senior Geologist – Targeting, 11 years of experience with the Project;
- Dr. Graeme Hancock, Consultant, 25 years of experience with the Project;
- Mr. Fraser MacCorquodale, General Manager, Exploration, 12 years of experience with the Project;
- Mr. John O'Callaghan, Head of Metallurgy, four years of experience with the Project;
- Mr. Blair Sands, Head of Environment, seven years of experience with the Project;

- Ms. Kyoko Sasahara, Manager Marketing and Logistics, three years of experience with the Project;
- Mr. Michael Sykes, Principal Mine Design and Planning Engineer, 4.5 years of experience with the Project;
- Mr. Duncan Tyler, Principal – Geotechnical Engineer, 3.5 years of experience with the Project.

All figures were prepared by Newcrest or WGJV personnel for the Report unless otherwise noted.

2.7 Previous Technical Reports

Newcrest initially listed with the Toronto Stock Exchange (TSX) in March 2012, and voluntarily delisted from the TSX effective 4 September 2013. During its 2012–2013 listing period, Newcrest filed the following technical reports on the Project:

- Moorhead, C., and Cantrell, R., 2011: Technical Report on the Wafi–Golpu Property in Morobe Province, Papua New Guinea: report prepared by AMC Consultants (Canada) Ltd., for Newcrest, effective date 31 December, 2011, 112 p;
- Moorhead, C., 2012: Technical Report on the Wafi–Golpu Property in Morobe Province, Papua New Guinea: report prepared for Newcrest, effective date 29 August, 2012, 157 p.

3 RELIANCE ON OTHER EXPERTS

This section is not relevant to this Report.

4 PROPERTY DESCRIPTION AND LOCATION

4.1 Introduction

The Project is within the Morobe Province of PNG, approximately 65 km southwest of Lae, the nearest commercial centre.

Deposit locations include, using the AMG66, zone 55 grid:

- Golpu: 440370 east, 9241330 north;
- Wafi: 439620 east, 9240980 north;
- Nambonga: 439690 east, 9242265 north.

4.2 Property and Title in Papua New Guinea

Key laws that regulate mining activity in Papua New Guinea include the *Mining Act 1992* and Regulations, the *Environment Act 2000* and Regulations, the *Mineral Resource Authority Act 2018*, and the *Mining (Safety) Act 1977* and Regulations.

4.2.1 Mineral Title

Mineral rights are held by the State, and mining is regulated at the national level. A Special Mining Lease is issued by the Head of State acting on advice from the National Executive Council (Cabinet). Otherwise, mineral titles are issued by the Minister for Mining on recommendation from the Mining Advisory Council (MAC) subject to the *Mining Act 1992*. The types of licences are summarised in Table 4-1. The Minerals Resources Authority (MRA) has overall responsibility for the promotion, management and regulation of the mining sector under the *Mining Act 1992*.

4.2.2 Surface Rights

The Project area is on land held variously under customary, State, and private ownership, including under State lease. The bulk of the land that will be affected by the Golpu Development is customary owned.

The holder of a tenement under the *Mining Act 1992* is liable to pay compensation to the landholders for all loss or damage suffered or foreseen to be suffered by the landholders from the exploration or mining or ancillary operations (but not for grant of access, nor in respect of the value of any mineral, nor by reference to any rent, royalty or other amount in respect of mining).

4.2.3 Environmental Regulations

The *Environment Act 2000* sets out the requirement for proponents to obtain an environment permit for activities prescribed in the Environment (Prescribed Activities) Regulations 2002 that have the potential to cause environmental harm. The *Environment Act 2000* is administered by the Conservation and Environment Protection Authority (CEPA), previously the Department of Environment and Conservation (DEC).

Under the *Environment Act 2000*, activities are classified as Level 1, Level 2 or Level 3 based on their risk of causing environmental harm and each requires a different level of environmental and social assessment.

Table 4-1: Mineral Titles

Title Type	Comment
Exploration Licence (EL)	Can be granted for a term not exceeding two years, and may be extended for periods not exceeding two years. Cannot exceed 750 sub-blocks in size; requirements as to contiguousness of sub-blocks at application.
Alluvial Mining Lease (AML)	An Alluvial Mining Lease may only be granted over land that is a riverbed and land that extends no further than 20 m from any riverbed. An Alluvial Mining Lease may be granted for a term not exceeding five years which may be extended for periods not exceeding five years. Licence cannot be more than 5 ha in area, and must have a rectangular or polygonal shape.
Mining Lease (ML)	Generally issued for small to medium-scale alluvial and hard rock mining operations. Can be granted for a term not exceeding 20 years, and may be extended for periods not exceeding 10 years. Licence cannot be more than 60 km^2 in area, and must have a rectangular or polygonal shape.
Special Mining Lease (SML)	Generally issued to an Exploration Licence holder for large-scale mining operations. The Minister for Mining may also require the Exploration Licence holder to be a party to a Mining Development Contract with the government. A Special Mining Lease can be granted for a term not exceeding 40 years, which may be extended for periods not exceeding 20 years. Before grant of a Special Mining Lease, the Minister for Mining is required to convene a development forum to consider the views of the persons and authorities whom the Minister believes will be affected by the grant of the Special Mining Lease. Those represented at this forum will include the applicant for the Special Mining Lease; the landholders of the land that is the subject of the application for the Special Mining Lease and other tenements to which the applicant's proposals relate, the National Government, and the Provincial Government, if any, in whose province the land the subject of application for the Special Mining Lease is situated. The Head of State, acting on advice from the National Executive Council is the authority responsible for issuing a Special Mining Lease. Grant of the Special Mining Lease allows the holder to (a) enter and occupy the land over which the mining lease was granted for the purpose of mining the minerals on that land and carry on such operations and undertake such works as may be necessary or expedient for that purpose; and (b) construct a treatment plant on that land and treat any mineral derived from mining operations, whether on that land or elsewhere, and construct any other facilities required for treatment including waste dumps and tailings dams; and (c) take and remove rock, earth, soil and minerals from the land, with or without treatment; and (d) take and divert water situated on or flowing through such land and use it for any purpose necessary for his mining or treatment operations subject to and in accordance with the *Environment Act 2000*; and (e) do all other things necessary or expedient for the undertaking of mining or treatment operations on that land.
Lease for Mining Purpose (LMP)	May be granted in connection with mining operations. Covers aspects such as the construction of buildings and other improvements, and operating plant, machinery and equipment; installation of a treatment plant and the treatment of minerals therein; deposition of tailings or waste; housing and other infrastructure required in connection with mining or treatment operations; transport facilities including roads, airstrips and ports; and any other purpose ancillary to mining or treatment operations or to any of the preceding purposes which may be approved by the Minister. The term of a Lease for Mining Purposes is identical to the term of the Special Mining Lease or Mining Lease in relation to which the Lease for Mining Purpose is granted; where there is no associated lease, a term not exceeding 20 years. The term of a Lease for Mining Purpose can be extended. A Lease for Mining Purpose cannot be more than 60 km^2 in area, and must have a rectangular or polygonal shape.
Mining Easement (ME)	Can be granted in connection with mining, treatment or ancillary operations conducted by the applicant for the mining easement or some other person for the purpose of constructing and operating one or more of the following facilities: a road; an aerial ropeway; a power transmission line; a pipeline; a conveyor system; a bridge or tunnel; a waterway; any other facility ancillary to mining or treatment or ancillary operations in connection with any of the preceding purposes which may be approved by the Minister. The term of a Mining Easement is identical to the term of the tenement in relation to which the Mining Easement was granted. The area of land over which a Mining Easement may be granted is sufficient for the purpose or purposes for which it was granted and shall be in a rectangular or polygonal shape.

Note: one sub-block = approximately 3.41 km^2

Level 3 activities are considered to have the highest risk of causing environmental harm. The grant of a Level 3 environment permit is subject to a comprehensive environmental impact assessment, presented in an Environmental Impact Statement (EIS) and reviewed by the CEPA in consultation with the public.

Prior to submitting an environmental impact statement, a proponent must submit an Environmental Inception Report (EIR). The EIR identifies potential environmental and social issues and studies to be undertaken to support the EIS. As an outcome of their assessment, CEPA will advise on any additional requirements or changes to the EIR and then approve it as the basis for EIS studies to proceed.

The content of an EIS is described in the Guideline for Conduct of Environmental Impact Assessment and Preparation of Environmental Impact Statement prepared by CEPA (DEC, 2004). This includes documenting environmental and social issues associated with the planned project, together with the proponent's proposed management measures, monitoring and reporting.

After completion of the assessment of the EIS and subsequent Ministerial approval in principle for the proposed activity, the Director of CEPA will consider whether to grant an environmental permit that will set out the conditions under which a mine can be constructed, operated, and closed/rehabilitated in accordance with the *Environment Act 2000*.

4.2.4 Closure

Section 99 of the *Environment Act 2000* gives the Director of the CEPA the power to require an environmental bond. Mine closure financial assurance is not a specific requirement under the *Mining Act 1992*. However, the (then) Department of Mining issued a Mine Closure Policy and Guideline in 2005. The policy requires the developer to "put in place security for mine closure costs and establish a Mine Closure Trust Fund" or alternate mechanism that can be in the form of "*bank guarantees, parent company guarantees, insurance policies and cash deposits*" with this to be "*in accordance with the Initial Mine Closure Plan (being the conceptual plan)*". This policy could be implemented by the MRA via conditions on Mining Leases and Special Mining Leases. MRA has been working with the Intergovernmental Forum on new rehabilitation and closure guidelines, entitled "Mining Project Rehabilitation and Closure Guidelines – Papua New Guinea", which were released in September, 2019 and formally endorsed by MRA in December 2019.

4.2.5 Royalties

The holder of a Special Mining Lease must pay a royalty to the State that is equivalent to 2% of the net proceeds of sale of minerals (calculated as net smelter return (NSR) or free-on-board (FOB) export value, whichever is appropriate). The State may elect to retain its right to royalty or to distribute it between the Provincial government of a mine's host province and the landholders of the land upon which the Mineral Resource is mined.

Where the State agrees to distribute any royalties, the landholders are entitled to at least 20% of the total amount of royalties paid to the State.

A production levy of 0.5% is also payable to the MRA under the *MRA Act 2018* on the gross value of production (i.e., excluding the offsets of treatment and refining charges, payable terms and freight).

4.2.6 Fraser Institute Survey

The QP used the 2019 Fraser Institute Annual Survey of Mining Companies report (the 2019 Fraser Institute Survey) as a reasonable source for the assessment by peers in the mining industry of the overall political risk facing an exploration or mining project in Papua New Guinea. Each year, the Fraser Institute sends a questionnaire to selected mining and exploration companies globally. The Fraser Institute Survey is an attempt to assess how mineral endowments and public policy factors such as taxation and regulatory uncertainty affect exploration investment.

The QP relied on the 2019 Fraser Institute survey because it is globally regarded as an independent report-card style assessment to governments on how attractive their policies are from the point of view of an exploration manager or mining company and forms a proxy for the assessment by industry of political risk in specific political jurisdictions from the mining industry's perspective.

Of the 76 jurisdictions surveyed in the 2019 Fraser Institute survey, Papua New Guinea ranks 54th for investment attractiveness, 63rd for policy perception and 38th for best practices mineral potential.

4.3 Project Ownership

The owner of the Project is the Wafi–Golpu joint venture, an unincorporated joint venture in the Morobe Province of Papua New Guinea between Wafi Mining and Newcrest PNG2 as 50:50 participants.

Harmony is the ultimate parent company of Wafi Mining, and Newcrest is the ultimate parent company of Newcrest PNG2.

4.4 Mineral Tenure

4.4.1 Current Tenure

The WGJV holds two Exploration Licences covering a total area of approximately 129 km^2, registered in the names of Wafi Mining and Newcrest PNG2 (Table 4-2; Figure 4-1).

The Golpu deposit is located within EL440, with a range of major surface facilities to be located on EL1105. The Wafi and Nambonga deposits are also within EL440.

Both licences were in good standing as at 30 June, 2020. EL 440 is in the renewal process. Newcrest expects that the renewal will be granted as all tenement conditions for the previous term were complied with.

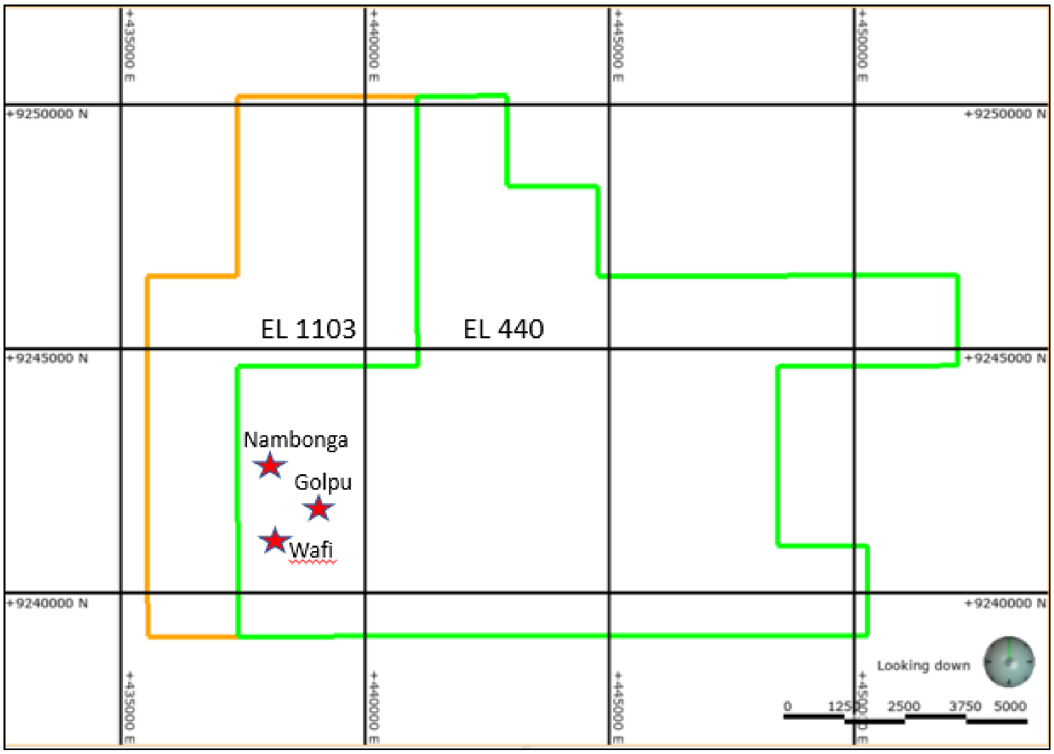
Licence status is reported on a monthly basis and independently monitored by each of Newcrest and Harmony.

The minimum statutory annual expenditure commitment for the Project is PGK74,000.

Table 4-2: Mineral Tenure Table

Lease	Lease Type	Lease Status	Grant Date	Expiry Date	Area km²
EL1105	Exploration License	Granted	26 January 1995	25 January 2021	33
EL440	Exploration License	Renewal pending	11 March 1980	10 March 2020	95.2

Figure 4-1: Tenure Plan



Note: Figure prepared by Newcrest, 2019.

Each Exploration Licence is subject to the condition that:

"Subject to any agreement made under Section 17 of the Act, the State reserves the right to elect at any time, prior to the commencement of mining, to make a single purchase of up to 30% equitable interest in any mineral discovery arising from this licence, at a price pro-rata to the accumulated exploration expenditure and then to contribute to further exploration and development in relation to the lease on a pro-rata basis unless otherwise agreed".

If the State of PNG chooses to take-up its full 30% interest in the Golpu Development, the interest of each of Wafi Mining and Newcrest PNG 2 will become 35%.

4.4.2 Tenure Requirements in Support of Construction and Operations

The WGJV Participants applied for a Special Mining Lease and ancillary tenements (including Leases for Mining Purposes and Mining Easements) in late 2016, covering proposed Golpu Development facilities and infrastructure as they were understood at the time. The Special Mining Lease application included a Proposal for Development, which incorporated the 2016 Feasibility Study report and supporting application documents such as a National Content Plan. Amendments to these tenement applications were made in March 2018, where the location and/or nature of facilities and infrastructure was refined through the 2018 Feasibility Study Update. The Proposal for Development was also updated. Additional applications or application amendments will also be made where necessary.

Table 4-3 summarises the leases required, and the infrastructure that will be covered by each lease type.

The grant of the Special Mining Lease and related ancillary tenements remains subject to the completion of *Mining Act 1992* and *Environment Act 2000* processes.

Additional information on permitting is provided in Section 20.

4.5 Surface Rights

While the WGJV Participants have already entered into a compensation agreement for each of EL440 and EL1105, they will need to enter into additional compensation agreement(s) covering land that is the subject of any other tenements that might be required by the Golpu Development. These agreements will need to be registered under the *Mining Act 1992* to become valid and enforceable.

Surface rights for facilities and infrastructure (including roads and pipelines) are provided by:

- Relevant mining tenements under the *Mining Act 1992*;
- Where activities will be undertaken on or under customary land, a compensation agreement with the customary landowners.

4.6 Water Rights

Extraction of water requires a permit under the *Environment Act 2000*.

4.7 Royalties and Encumbrances

Royalties payable to the State are discussed in Section 4.2.5. There are no other known royalty or similar payments.

4.8 Property Agreements

4.8.1 WGJV

The WGJV is a 50:50 unincorporated joint venture established between Wafi Mining (whose ultimate holding company is Harmony Gold Mining Company Limited) and Newcrest PNG 2 (whose ultimate holding company is Newcrest Mining Limited), collectively the WGJV Participants, under the provisions of a joint venture agreement entered into between the parties in 2008. The Project is 100% owned by the WGJV Participants.

The WGJV Participants have appointed Wafi–Golpu Services Limited (WGSL) as the Operator of the Project, and their agent for undertaking WGJV activities. WGSL is owned equally by the WGJV Participants.

Table 4-3: Lease Requirements in Support of Construction and Operations

Lease Application Type	Note
Special Mining Lease 10	Block cave mines, Watut declines portal terrace, process plant terrace, Watut process plant, Nambonga decline portal terrace, WRSFs, Miapilli clay borrow pit, water treatment facilities, sedimentation dams, raw water dam, explosives magazine facilities, waste management facility, concrete batch plants, electrical substations, workshops and administration buildings, Fere accommodation facility
Lease for Mining Purposes 100	Finchif construction accommodation facility and power generation facilities
Lease for Mining Purposes 104	Port facilities area (including concentrate filtration plant)
Lease for Mining Purposes 105	Outfall area
Mining Easement 91	Infrastructure corridor pipelines from the northern boundary of the Special Mining Lease application to Lae and includes: - Concentrate pipeline from the northern boundary of the Special Mining Lease application to the port facilities area - Terrestrial tailings pipeline from the northern boundary of the Special Mining Lease application to Lae - Fuel pipeline from port facilities area (or from within port area, if third party supplier) to power generation facilities Power transmission lines from the power generation facilities to the northern boundary of the Special Mining Lease application
Mining Easement 92	Mine access road
Mining Easement 93	Northern access road
Mining Easement 94	Wastewater discharge pipeline (for mine dewatering) to the Watut River and co-located raw water make-up pipeline
Mining Easement 96	Terrestrial tailings pipeline – Lae to Wagang
Mining Easement 97	Component of outfall system, specifically the seawater intake and deep sea tailings placement outfall pipelines

The joint venture agreement includes terms establishing a Joint Venture Committee, setting out the duties of the WGJV operator, providing for programs and budgets, establishing processes for funding of expenditure by the WGJV Participants, default provisions, and assignment provisions including pre-emptive rights.

4.8.2 Government of Papua New Guinea

The PNG Government is entitled to make a single purchase of up to 30% equitable interest; this option is outlined in Section 4.4.1.

4.9 Permitting Considerations

Permitting considerations are discussed in Section 20.

4.10 Environmental Considerations

Environmental considerations for the Golpu Development are discussed in Section 20.

Existing environmental liabilities include rehabilitation requirements under applicable environment permits and PNG environmental laws in respect of access roads, earthworks relating to exploration activities such as drill pads and berms, settling ponds, the site exploration camp and associated supporting infrastructure. A portion of these disturbances can be remediated as part of progressive rehabilitation; however, a portion of the already-disturbed areas are required for any future Golpu Development.

As of 30 June, 2020, the MRA held a total of PGK12,000 that had been provided by the WGJV participants in the form of security deposits.

4.11 Social License Considerations

Social license considerations are discussed in Section 20.

4.12 QP Comments on "Item 4; Property Description and Location"

In the opinion of the QP:

- Information provided by Newcrest's legal and tenure experts on the mining tenure held by the WGJV Participants in the Project area supports that the company has valid title that is sufficient to support declaration of Mineral Resources and Mineral Reserves;
- EL 440 is in the renewal process. Newcrest expects that the renewal will be granted as all tenement conditions for the previous term were complied with;
- The WGJV Participants do not currently hold sufficient surface rights to permit construction and operations. Surface rights will be obtained if the current tenement applications are granted. Disturbances on customary land would commence once a compensation agreement is in place for the relevant area;
- Additional negotiations and permits are required for construction and operations (see discussion in Section 20);
- The WGJV currently has some Level 2B environmental permits that include water extraction permissions. However, these permits are for exploration and previously-proposed early activities. Water rights in support of the Golpu Development are still to be obtained;
- Royalties are payable to the Government of Papua New Guinea, consisting of 2% of the net proceeds of sale of minerals (calculated as NSR or FOB export value, whichever is appropriate), and a 0.5% production levy;
- Environmental liabilities for the Project are typical of those that would be expected to be associated with an active exploration project in a high rainfall tropical area, and include rehabilitation and closure of areas that were affected by exploration and drilling activities, earthworks, roads, exploration camps, and associated support infrastructure.

To the extent known to the QP, there are no other significant factors and risks that may affect access, title, or the right or ability to perform work on the Project that are not discussed in this Report.

5 ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE AND PHYSIOGRAPHY

5.1 Accessibility

The Project is located in a greenfields location in a mountainous area of PNG.

Exploration activities are serviced by an exploration camp in heavily-forested, mountainous terrain. A combination of roads and access tracks exist between Lae and the Project site. However, the track components are suitable for four-wheel drive vehicles and purpose-built trucks only. During major rainfall events this access route may become closed to vehicular traffic.

Current access to the planned mine site is via a partly-sealed road from Lae to Timini, and a gravel road from Timini (Demakwa) to Wafi, with the trip taking about three to four hours depending on the weather. This road will be replaced by a new road (including bridges), the northern access road, as part of project construction. A mine access road will also be constructed from the intersection of the northern access road and the current exploration access road.

Commercial airlines operate flights between the national capital, Port Moresby, and Nadzab airport, which is approximately a one-hour drive by road from Lae. The Nadzab airstrip is sealed. Helicopter access to the mine site area is available, with a suitable area at the proposed mine site cleared for landing.

Additional information on accessibility is provided in Section 18.

5.2 Climate

Papua New Guinea has a hot, tropical climate at sea level, cooling towards the highlands. In most parts of PNG rain falls mainly between December and March due to the northwest monsoon, although Port Moresby is dry at that time of year.

The planned mine site area has a high rainfall and two distinct seasons: a dry season from June to September and a rainy season from December to March. The average annual rainfall is 2,836 mm. The site is characterised by low wind speeds, high humidity and warm temperatures with an average maximum of 28°C and an average minimum of 21°C.

The coastal area, where the port and tailings outfall will be located, also experiences two distinct seasons: a southeast monsoon from mid-May to October and a northwest monsoon from mid-November to the end of March, with intervening periods of light, variable winds. Trade winds during the southeast monsoon are moderate. Annual rainfall is between 3,900–4,500 mm with rainfall peaking between May and August. Maximum temperatures average 30ºC and minimum temperatures average 20ºC with little variability across the year.

The infrastructure corridor that will link the coast to the mine has climate aspects that reflect the elevation; with climate settings similar to the planned mine site in the upper elevations, and similar to the coastal area along the river flats and coast.

Mining activities are planned year-round. Exploration activities may be curtailed by heavy rainfall.

5.3 Local Resources and Infrastructure

The closest major community is Lae. Lae is an urban area, a major transport hub, and a commercial, administrative, industrial, residential and educational centre for both the Morobe Province and PNG, with a population in 2011 (the most recent year for which PNG census data are available) of approximately 149,000.

The Golpu Development is a greenfield site that currently does not have the infrastructure to support mining operations. There is no effective local infrastructure with respect to power, water, and roads that are trafficable by vehicles other than all-wheel drive vehicles. Water supply for drilling is sourced from rivers, and power at the exploration camp is locally generated.

Additional information on the infrastructure supporting the Golpu Development and the availability of local resources is provided in Section 18.

5.4 Physiography

The Project exploration camp is situated at an approximate altitude of 400 m. The highest peak in the Project vicinity is Mt Watut, at an elevation of 1,089 m. Mt Golpu reaches 770 m.

The Golpu Development design as contemplated in Sections 15–22 of this Report covers three separate infrastructure areas:

- Mine area: located on the northern side of the Owen Stanley Ranges in the foothills of the Watut River catchment. The elevation ranges from approximately 100–380 masl. Most of the proposed mine area is steep and mountainous, and is covered by dense tropical rainforest;
- Infrastructure corridor: will include the access road connector and pipelines. Located on the floodplains of the Watut and Markham Rivers. Vegetation primarily consists of partially-cleared forest and cultivated gardens. Elevations in the corridor area are about 100 masl;
- Coastal area: includes the proposed port facilities at Lae, near the Markham River estuary on the Huon Gulf, and outfall area about 6 km to the east of the port near the Busu river estuary. These areas are at, or very close to, sea level.

The area is mountainous and rugged, and divided by large upland valleys containing fast-flowing rivers which descend to the plains. The Wafi River and Hekeng, Nambonga, and Buvu Creeks are the main drainages within the Project area, with variable flow rates depending on rainfall.

Vegetation in the Project area consists of lowland and mid-mountain tropical forests with some areas of tropical grassland in upper elevations. Some areas are partly cleared as part of subsistence agricultural practices.

5.5 Seismicity

Two sources of earthquakes were identified by the Seismology Research Centre in the general Project area: shallow-depth crustal events, and subduction events. Crustal events can produce events with a 7.7 magnitude, and subduction events may cause earthquakes with a magnitude of as much as 8.4. The earthquake design for the proposed block cave operations at Golpu is based on a subduction event.

An earthquake catalogue was developed for the Golpu Development, based on works undertaken by the Seismology Research Centre in the period from 2015–2017. This allows for both probabilistic and deterministic analysis for the seismic risk and associated ground loading. From this work it was possible to define the peak ground acceleration (PGA) for earthquake events with a 475-year return period (defined as an OBE), and 10,000-year return period event (defined as a maximum considered earthquake or MCE). The forecast PGA in the 475-year return period was 0.34 *g*, and the 10,000-year forecast was 0.43 *g*.

Due to the close proximity of large earthquake events in relation to the Golpu Development, low-frequency earthquake sensors were incorporated into the seismic monitoring plan. A three-station surface seismic array consisting of both low- and high-frequency sensors was set up in 2016. This array is currently collecting pre-mining seismic (earthquake) data, and is planned to be expanded and integrated with a proposed underground seismic array. Data collected from these sensors will be used to validate the earthquake catalogue, the ground motion parameters, and formulate site-specific ground motion relations.

5.6 QP Comments on “Item 5; Accessibility, Climate, Local Resources, Infrastructure, And Physiography”

In the opinion of the QP:

- The existing local infrastructure, availability of staff, methods whereby goods could be transported to the Project area are well-established and well understood by Newcrest, and can support the declaration of Mineral Resources and Mineral Reserves (see discussion in Section 18);
- There is sufficient suitable land available within the mineral tenure held for mine-area installations such as the process plant and related mine infrastructure, despite rugged topography;
- The WGJV Participants have applied for the necessary mineral tenures to support construction and operations, and infrastructure corridors;
- Surface rights for infrastructure and mining are discussed in Section 4.5.

Operations are expected to be conducted year-round.

6 HISTORY

6.1 Exploration History

A summary of the exploration in the Project area is provided in Table 6-1. The table includes ownership changes where known, and a summary of known Project exploration and study activities completed to date.

6.2 Production

There has been no production from the Project.

Table 6-1: Exploration History

Year	Company/Operator	Work Program
1977–1987	CRA Exploration Pty Ltd (CRAE)	Identified mineralised float in a regional geochemical sampling program. Discovered outcropping mineralisation of the Wafi A Zone near Mount Golpu in 1979 The Mt Wanion Exploration License (EL440) was granted in 1980 Ridge and spur sampling completed 1980–1982 In 1983, core drilling commenced targeting the Wafi prospect, followed by geophysical surveys including a dipole-dipole induced polarisation (IP)/resistivity survey which were completed in 1985 An initial mineral resource was estimated for Wafi in 1986 In 1987, metallurgical testwork identified that the primary mineralisation was highly refractory with low cyanide leach recoveries
1988–1990	CRAE/Elders Resources Limited (Elders) joint venture	Core and reverse circulation (RC) drilling Discovered the Golpu copper–gold porphyry deposit in 1990 Moving loop time domain electromagnetic geophysical survey Resource estimate for Wafi in 1990
1991–1997	CRAE	CRAE re-acquired EL440 from Elders. Conducted aeromagnetic, ground magnetic, self-potential (SP), IP, and controlled source audio-frequency magneto- telluric (CSAMT) geophysical surveys, shallow bedrock geochemical sampling, surface lithochemical sampling, soil geochemical sampling and geological mapping Completed a pre-feasibility study in 1993 Completed a resource estimate for the A Zone at Wafi Resource estimate updated, in 1996 Discovered the high-grade Link Zone at Wafi in 1997 Updated resource estimate for A Zone, B Zone, Link Zone and C Zone
1997–2001	Australian Gold Fields Limited (Australian Gold Fields)	Global Mining Services completed due diligence re-estimate of Wafi resource estimate on behalf of Australian Gold Fields in 1997 Acquired Project from CRAE in 1998 Project placed on care and maintenance from 1999–2001, due to a commodity price downturn
2001–2002	Aurora Gold Limited (Aurora)	Acquired Project ownership Updated Wafi resource estimate on A Zone, B Zone and Link Zone in 2002 Completed check resource estimate at Wafi in 2002
2003	Aurora/Abelle Limited (Abelle)	Aurora merged with Abelle Updated Wafi resource estimate
2004–2008	Harmony	Acquired Abelle Wafi–Golpu Concept Study; completed 2004 Resource estimates for selected deposits updated in 2005, 2006 and 2007 Golpu Standalone Pre-Feasibility Study, completed 2007 Wafi–Golpu Integrated Pre-Feasibility Study, completed 2007 Discovered Nambonga porphyry in 2007
2008 to date	Harmony–Newcrest WGJV	Forms the WGJV Resource estimates updated for selected deposits in 2010, 2011, 2012, 2014 and 2018 Wafi Area Concept Study, completed 2008 Highly mineralised porphyry identified to the northwest of known Golpu mineralisation in October 2009 Golpu Development Project Desktop Study, completed 2009 Wafi Concept Study, completed 2010 Wafi–Golpu Pre-Feasibility Study, completed 2012 Wafi–Golpu Pre-Feasibility Optimisation Study, completed 2014

Year	Company/Operator	Work Program
		Regional geological mapping and geological synthesis in 2015 Re-evaluation of development approach Golpu Stage 2 Pre-Feasibility Study, completed 2015 Golpu Feasibility Study, completed 2016 On 25 August 2016 the Wafi–Golpu Joint Venture submitted a Special Mining Lease application to the Papua New Guinea Mineral Resources Authority. The Special Mining Lease application included a Proposal for Development, which incorporated the 2016 Feasibility Study report and supporting application documents such as a National Content Plan. Environmental approval for the Golpu Development was sought under the PNG Environment Protection (Prescribed Activities) Regulation 2002. The required approval for the Golpu Development was a Level 3 Environment permit Further data collection and technical assessment undertaken in 2016–2017 Feasibility Study Update completed in December 2017 and submitted to the Mineral Resources Authority in March 2018 Submitted an EIS to CEPA on 25 June 2018

7 GEOLOGICAL SETTING AND MINERALIZATION

7.1 Regional Setting

Papua New Guinea is divided into a number of litho-tectonic domains (Figure 7-1). The New Guinea orogen includes the Papuan Fold Belt, New Guinea Thrust Belt, Aure Deformation Zone, Eastern Thrust Belt, and the Owen Stanley Thrust Belt. It consists of sedimentary and volcanic rocks that have undergone fold-and-thrust belt deformation and metamorphism, intrusion of granitic and gabbroic rocks, and obducted oceanic crust. Belts are separated by major structural boundaries, typically thrust faults.

The Project is hosted within the dotted rectangular area shown in Figure 7-1. In this area, the basement consists of a Mesozoic basement assemblage of metasedimentary units (Owen Stanley Metamorphic Complex) that was overthrust by an ophiolite suite at about 60 Ma. All of these rock types were subsequently folded and metamorphosed during the 40 Ma Sepik Arc subduction/accretion event. Sedimentary, volcanic, and volcaniclastic units of the Omaura Formation and Langimar Beds infilled low-lying areas in the period 30–10 Ma. Granitic magmas of the Maramuni Arc subsequently intruded the area, with a peak of activity from about 17–10 Ma. All lithologies were folded and faulted during the formation of the Aure Deformation Zone, between 12–4 Ma. A second intrusive suite, informally termed the Post-Maramuni belt, was emplaced from about 8–1 Ma. Late-stage lithologies include shallow-water sediments and volcaniclastic units (e.g. Babwaf Conglomerate).

7.2 Project Geology

7.2.1 Lithologies

The deposit setting is controlled by the rotation and deformation of the Papuan peninsula. Table 7-1 outlines the complex geological history of the region.

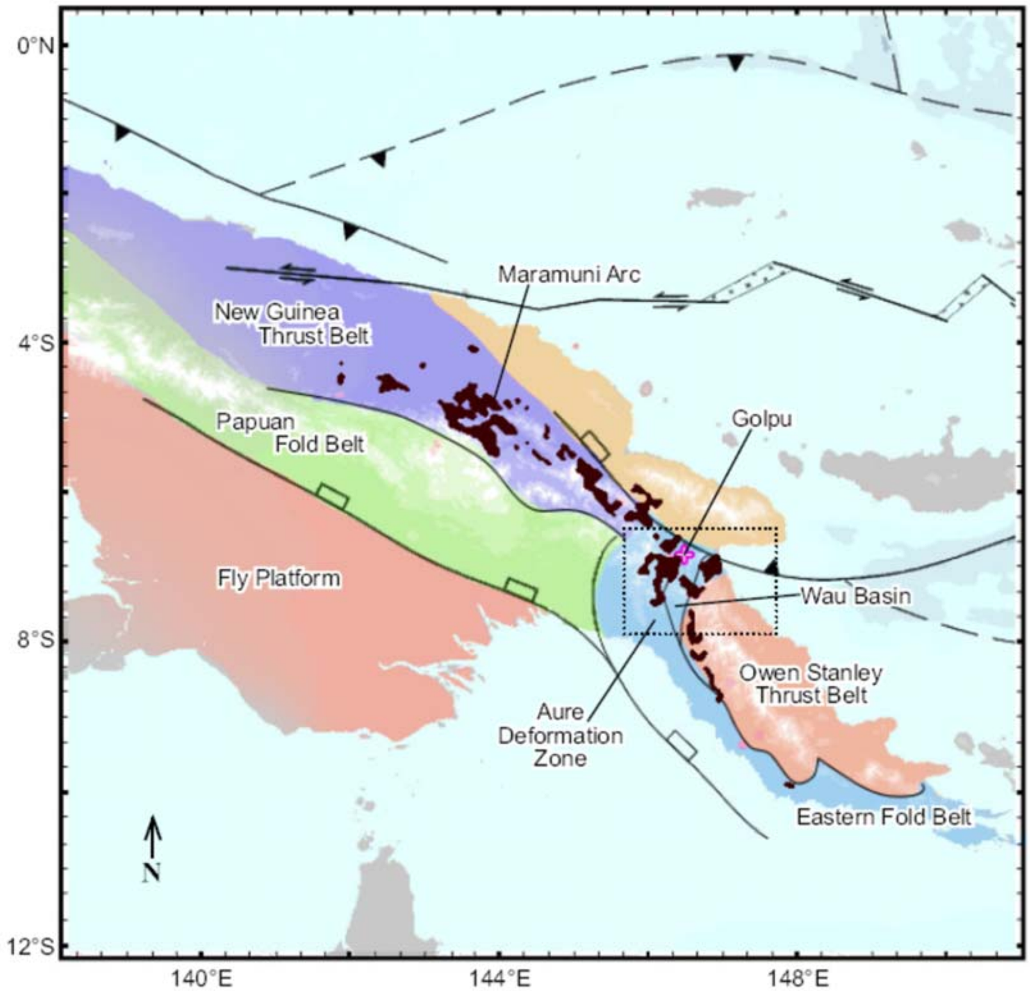
The major lithological units are summarised in Table 7-2. A geology plan for the area is provided in Figure 7-2, an alteration plan is provided in Figure 7-3, the major deposits and prospects are shown on Figure 7-4 in relation to the Wafi diatreme. Figure 7-5 shows the major zones and areas that are referred to in the context of the major deposits.

The basal geology consists of east to east–southeast-dipping metasedimentary rocks of the Owen Stanley Metamorphic Complex, unconformably overlain by sediments and volcanic sequences of the Omaura Formation and Langimar Beds. These rocks were intruded by a sequence of diorite stocks with the following paragenesis:

- Emplacement of Nambonga, Western and Golpu diorites;
- Emplacement of Livana diorite in the form of a narrow intrusion with associated dykes intruded along previous intrusive contacts;
- Explosive emplacement of the Wafi breccia complex.

Younger units of the Babwaf Conglomerate and the Wafi Conglomerate unconformably overlie the older units and generally occur in fault-bounded depressions.

Figure 7-1: Lithotectonic Domains



Note: Figure from Rinne, 2015.

Table 7-1: Geological History

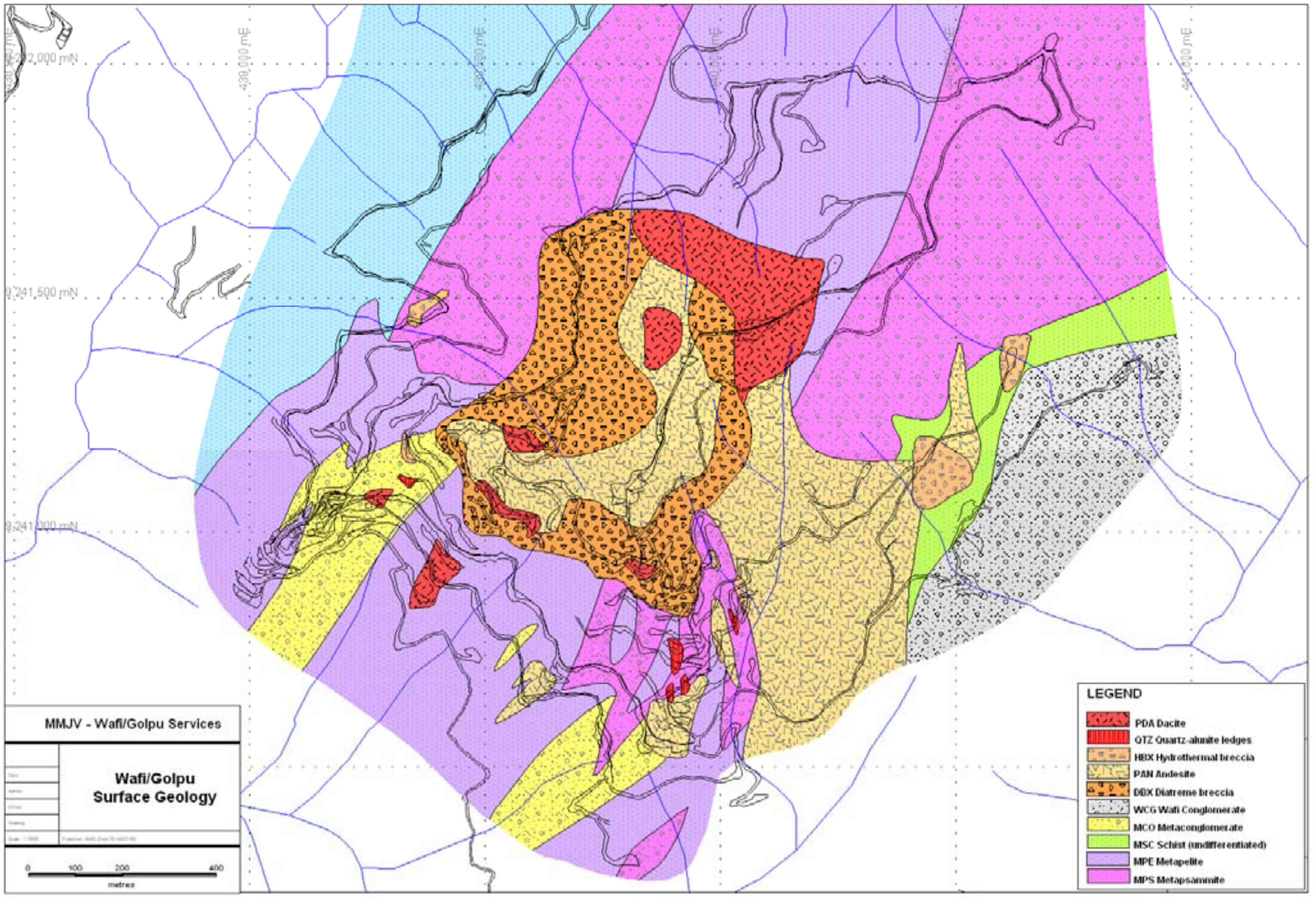
Dates	Episode	Structure
Permian–Jurassic (145–280 Ma) Lower Cretaceous (90–120 Ma) Palaeogene (66–23 Ma) Early Miocene (<23 Ma). Papuan Orogeny dated to 59–20 Ma Golpu host rocks dated to 90–120 Ma	Owen Stanley Metamorphic Complex deposition Deposition of the Wafi–Golpu host rocks Late Cretaceous establishment of Coral Sea Basin (tectonic spreading) Inactivity between 30–23 Ma, deposition of offshore shelf facies in Morobe area Period ends with compression and uplift possibly associated with Finisterre Arc collision, uplift and cooling of the nearby Bena Bena terranes Development of Aure–Moresby Trough due to post-rift thermal sagging during the Eocene	Early thrusting as part of the Papuan Orogeny, multiple overprinting foliations, folding Mylonitic shears, ductile thrusts and tectonites within the Owen Stanley Metamorphic Complex Large nappe folds and recumbent folding as part of the Papuan Orogeny Lower to upper greenschist facies metamorphism in the Morobe area
Mid- to late-Miocene (7–18 Ma) Morobe Granodiorite dated to 15 Ma Wafi–Golpu dated to 9 Ma	Commencement of the Melanesian arc collision along Northern Papua New Guinea Deposition of clastic sediments into the Langimar/Aure basins Significant period of extension and volcanism Deposition of volcanic Langimar Beds Intrusion of Golpu Porphyry suite and related mineralisation Morobe granodiorite intrusion during middle Miocene extension event, Golpu Porphyry late Miocene- marks the end of volcanic activity and extension	Northwest, northeast trends Dextral shear on Sunshine/Kemerenga Faults Morobe granodiorite orientation controlled by deep-seated Sunshine and Kemerenga structures? Langimar Graben development and associated volcanism Reactivation of the Buvu Thrust Faults Stress field re-orients to left lateral shear
Pliocene (2.5–4.5 Ma) Volcanism dated to 3.2–4.0 Ma	Late Miocene to early Pliocene transition marked by period of short-lived compression with uplift and erosion of Langimar Beds Renewed extension, subsidence and basin formation (Babwaf Conglomerate); sedimentation Volcanic flows and intrusions occur during this extension	Reactivation on earlier structures Development of syn-mineral structures Northwest graben bounding structures, northeast structures enabling extension and subsidiary structures Minor low-grade metamorphism during early compression Wedge of Langimar volcanic rocks thrust into the Babwaf Conglomerates
Post Pliocene (<2.5 Ma) Currently active, Niugini Orogeny	Renewed compression due to northward migration of Australian continent. Pivot point, reversal of normal faulting and commencement of regional north–northwest-directed thrusting	Development of post mineral structures Structure shows reverse movement placing fresh rock over oxidised Thrust faulting affects Golpu (Reid/Buvu), reactivation of deep-seated structures

Table 7-2: Lithologies

Unit	Comment	Age
Owen Stanley Metamorphics	Jurassic to late Cretaceous basement unit consisting of inter-bedded conglomerate, sandstone and siltstone horizons. Divided into a western section consisting of argillite, shale, lithic and feldspathic sandstone, greywacke with minor limestone, conglomerate and spilitic volcanic rocks, and an eastern section comprising phyllite, slate, pelitic and psammitic schist, and lesser metavolcanic rock, with blueschist and granulite close to the Owen Stanley Fault System. The pelites are usually laminated and foliated and can be carbonaceous. Psammites are typically well sorted, fine to medium grained, quartz arenites with minor interbedded conglomerates. The conglomerates are generally moderately sorted, matrix to clast supported with rounded to sub-rounded polymict clasts of sediments, volcanic and intrusive lithologies (typically gabbro and granite). They are commonly deformed and lack the abundant quartz clasts seen in the younger Babwaf Conglomerates. The sediments have an overall northerly strike and dip 30–60º to the east.	Jurassic to late Cretaceous
Omaura Formation	Shale and greywacke, with some reef facies limestones.	25 Ma
Langimar Beds	Volcaniclastic pebble to cobble conglomerates interbedded with sandstones and reef facies limestones.	Middle Miocene
	Unconformity	
Babwaf Conglomerate	Poorly-consolidated but well-sorted conglomerate with minor siltstone and sandstone intercalations. Coal and carbonaceous siltstones to mudstones occur throughout this succession, as do significant horizons of crystalline volcaniclastic tuff. Sedimentary beds (10–100 m thick) are reverse-graded from a dark grey to black lithic sandstone to polymict clast-supported conglomerate and represent graben-fill type alluvial fan material. Subdivided into - Plant Sandstones: sandstone unit comprising upward fining gently folded immature, medium to coarse grained sandstones with minor pebbly conglomerates and tuff. Beds commonly have a thickness of 1–5 m. Bedding dips generally shallowly east at an angle of approximately 10–20º with some shallow non-plunging folding present. - Portal Conglomerates: reverse graded pebbly conglomerates with pebbles up to 2–5 cm in size, these fine down into medium to coarse grained immature sandstones with occasional pebbly clasts. The conglomerates generally grade down into coarse immature sandstones. The Portal Conglomerates contain numerous intercalated volcanic tuffs. Initially expressed as thin 5–10 cm thick horizons, the tuffs gradually increase until they are massive units up to 15–20 m thick. - Babwaf Conglomerate: chaotic and poorly sorted pebble to cobble sized conglomerates with horizons of coarse-grained immature sandstones and evidence of braided streams. Occasional horizons of tuff and volcanic rock persist throughout the Babwaf Conglomerates.	Pliocene
Nambonga Intrusion	Initial hornblende- and plagioclase-phyric porphyritic diorite. Mineralised. Late-stage, barren, biotite-phyric diorite	10.33–9.95 Ma
Golpu Intrusive Complex	Mottled grey, plagioclase and quartz-phyric diorite. Western or diorite porphyry. Hornblende and plagioclase-phyric diorite; quartz phenocrysts are absent. Golpu porphyry.	9.01–8.59 Ma

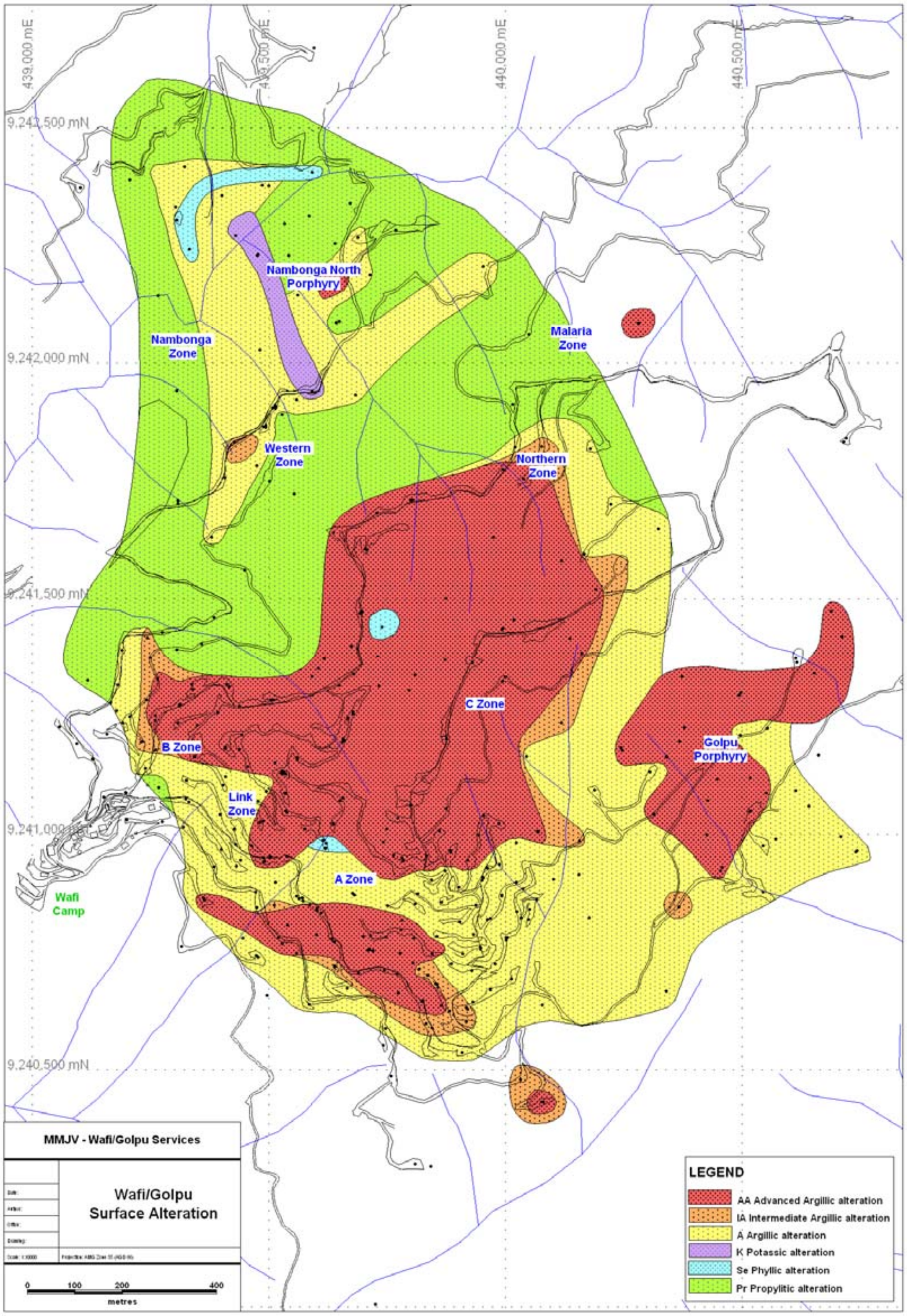
Unit	Comment	Age
	Mottled grey or grey–green crowded hornblende and plagioclase-phyric diorite. Livana porphyry.	
Wafi breccia complex	Large multiphase polymictic breccia. Approximate dimensions of 1,050 x 480 m at surface, tapering to 500 m at depth. Consists of fine-grained volcaniclastic material, occurring as infill to fragments and lapilli. The metasiltstone and metasandstone fragment breccias comprise about 90% of the unit, with fragments occurring in intervals that may be 60–200 m thick. The intervals are typically upward-fining, and more fragment rich at the base.	9.05 Ma
Hekeng Andesite	Unmineralised, massive, 70 m wide dyke, consisting of plagioclase crystals in a chlorite groundmass.	No date, but thought to be later than the Golpu intrusion and Wafi breccia
	Unconformity	
Wafi Conglomerate	Poorly-consolidated conglomerate consisting of Owen Stanley metamorphic rocks and minor carbonaceous material in a poorly-sorted sandy matrix.	Holocene

Figure 7-2: Geology Plan, Wafi–Golpu Area



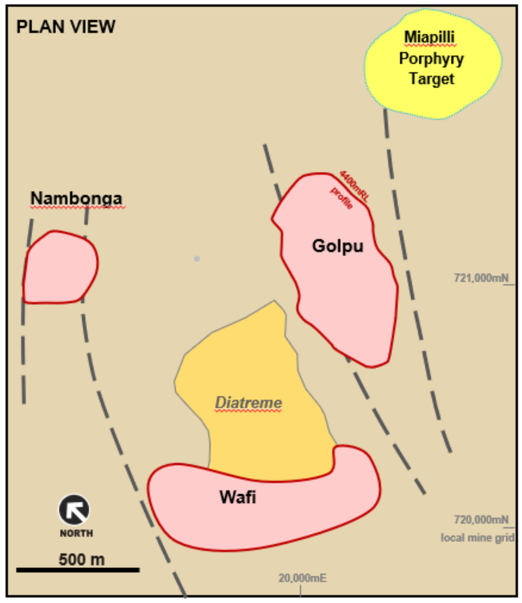
Note: Figure prepared by WGJV, 2012. Map north is to the top of the image.

Figure 7-3: Alteration Plan, Wafi–Golpu Area



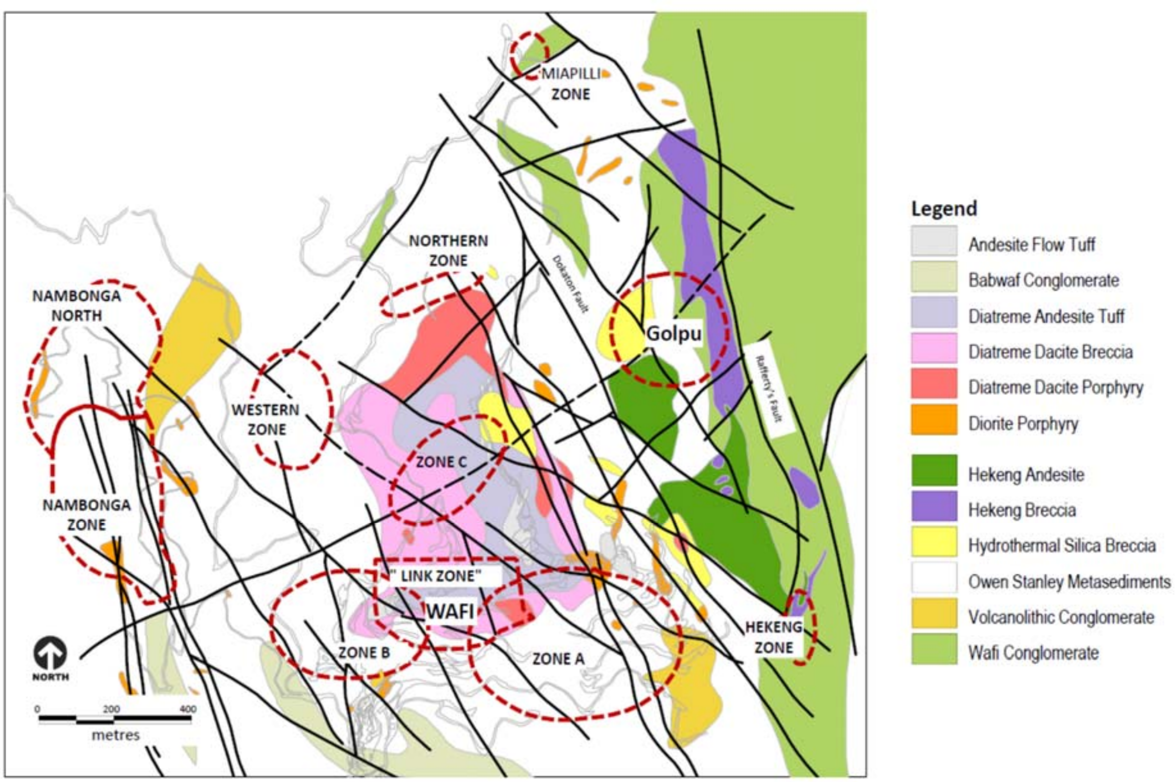
Note: Figure prepared by WGJV, 2012. Map north is to the top of the image.

Figure 7-4: Deposit Location Plan



Note: Figure prepared by Newcrest, 2018.

Figure 7-5: Deposit Zone Locations



Note: Figure prepared by Newcrest, 2019

7.2.2 Metamorphism

The Owen Stanley Metamorphic Complex is metamorphosed to greenschist facies in the Project area.

7.2.3 Structure

The Aura Deformation Zone consists of a series of east to north–northeast-dipping thrust faults and folds. The easterly-dipping thrust faults are interpreted to be part of a lateral ramp system, are about 12–4 Ma in age, and post-date the Maramuni Arc intrusive activity.

North–northeast-trending thrusts may represent transfer faults, and were a localisation factor for the Maramuni Arc intrusive activity.

North–northwest-trending faults are considered to be extensional in nature.

An overview of the interpreted structural setting of the deposits is provided in Figure 7-6.

Bedding is tight to isoclinally folded and overturned, and in the vicinity of Golpu tends to dip south to southeast. There are several overprinting ductile fabrics in the area, the most significant is a bedding-parallel S_1. The second most significant is an S_2 regional foliation which trends north to northeast, and reflects the dominant trend of folding across the district.

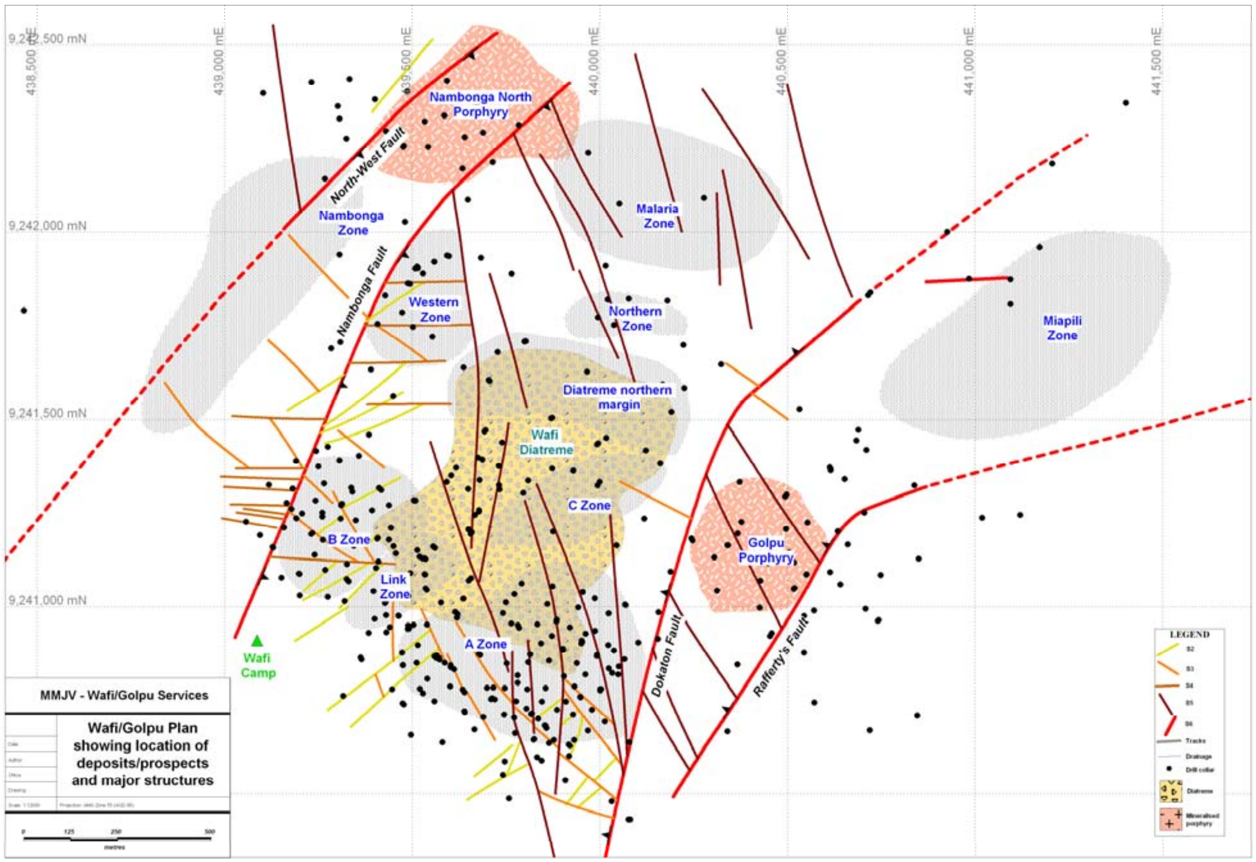
Overlying these deformed metasedimentary rocks are multiple Miocene unconformity surfaces covered by volcanogenic sedimentary detritus.

7.2.4 Mineralisation

The Project-area mineralisation paragenesis includes:

- Metamorphic event producing quartz in bedding-parallel veins;
- Porphyry event recognised as albitisation of feldspars, formation of pervasive biotite throughout the metasediments with potassic feldspar development as selvedges to porphyry-related quartz veins, and sericite/chlorite overprinting of earlier potassic alteration. The phyllic overprint is possibly related to the collapse of the porphyry system and the incursion of meteoric water;
- Diatreme emplacement due to the emplacement of melts into collapsing meteoric system resulting in diatreme breccias and dacite bodies;
- Zoned high/low sulphidation epithermal events with temporal and spatial alteration zonation from earliest to latest:
  - Argillic alteration: alunite ± pyrophyllite overgrowing quartz;
  - Intermediate argillic alteration: dickite/kaolinite ± sericite/illite;
  - Low-temperature argillic alteration, consisting of carbonate–smectite–chlorite–chalcedony.

Figure 7-6: Structural Interpretation Plan



Note: Figure prepared by WGJV, 2012. Map north is to the top of the image.

7.2.5 Weathering

A weathering horizon, 20–130 m thick, has resulted in a zone of selective to locally pervasive oxidation, characterised by development of hematite, with lesser goethite and jarosite.

Fracture-hosted oxidation extends to about 320 m depth, with the most intensive weathering noted along the Hekeng fault.

7.3 Local and Deposit Geology

Wafi–Golpu is a complex, multiphase mineralised system (Figure 7-7), comprising:

- Golpu porphyry copper–gold deposit;
- Wafi epithermal gold deposit;
- Nambonga porphyry gold–copper deposit.

The upper portions of the porphyry systems were overprinted by the high-sulphidation epithermal mineralisation at Wafi.

7.3.1 Golpu

7.3.1.1 Lithologies

The Golpu Intrusive Complex consists of multiple, hornblende-bearing diorite porphyries intruded into the host sedimentary lithologies (Table 7-3; Figure 7-8). The porphyries are separated based on their spatial position and where not texturally destroyed, into coarse hornblende-rich variants, feldspathic-rich units and porphyries containing quartz-eye inclusions. Cross-cutting intrusive contacts are rare. Enclave inclusions of early intrusions in interpreted later intrusions are also rare.

Intrusions range from small dykes to small stocks/bosses and apotheoses. Single intrusions pinch and swell vertically over tens of metres and form dykes, pipes and stocks.

7.3.1.2 Structure

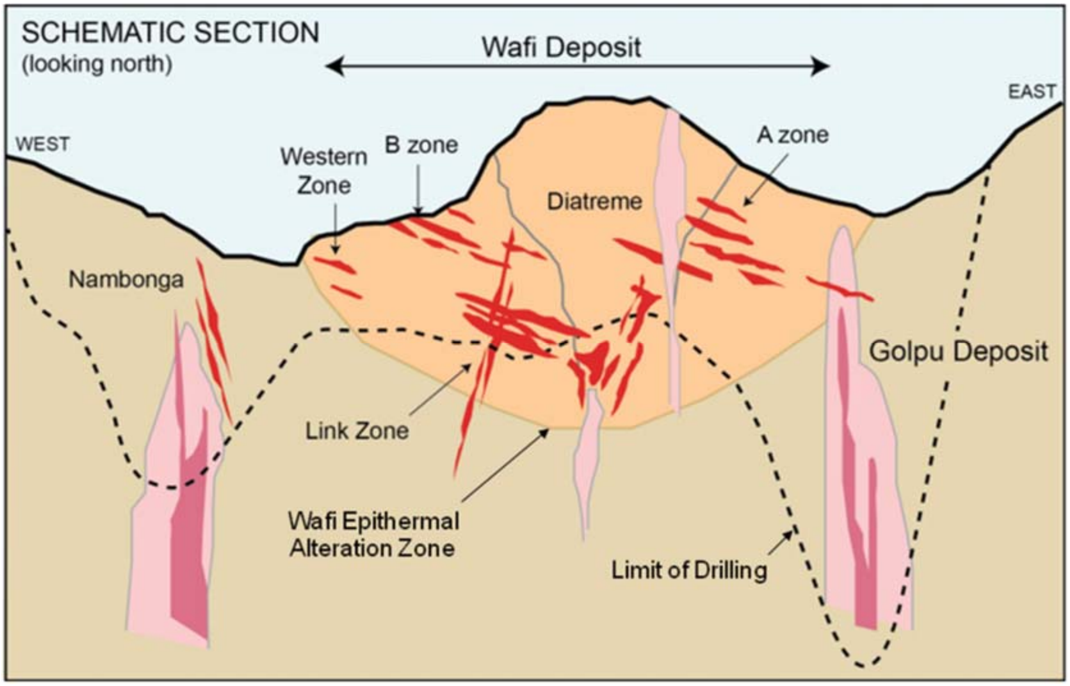
The major interpreted faults affecting the Golpu and Nambonga porphyries are shown in Figure 7-9 and summarised in Table 7-4.

Interpretations from drill data indicate that the Golpu porphyry system is tilted to the east as a result of movement up the Buvu thrust complex and is modelled with a 70° dip to the west. It is assumed that all porphyries were intruded sub-vertically and thrust faulting has rotated and dismembered the porphyry columns with reverse fault displacements.

7.3.1.3 Alteration

Porphyry-derived hydrothermal alteration at Golpu forms upright to steep west-dipping domains that enclose the Golpu Intrusive Complex (Figure 7-10) with alteration shells superimposed by the shallow east-dipping high sulphidation epithermal system.

Figure 7-7: Schematic Section, Wafi–Golpu

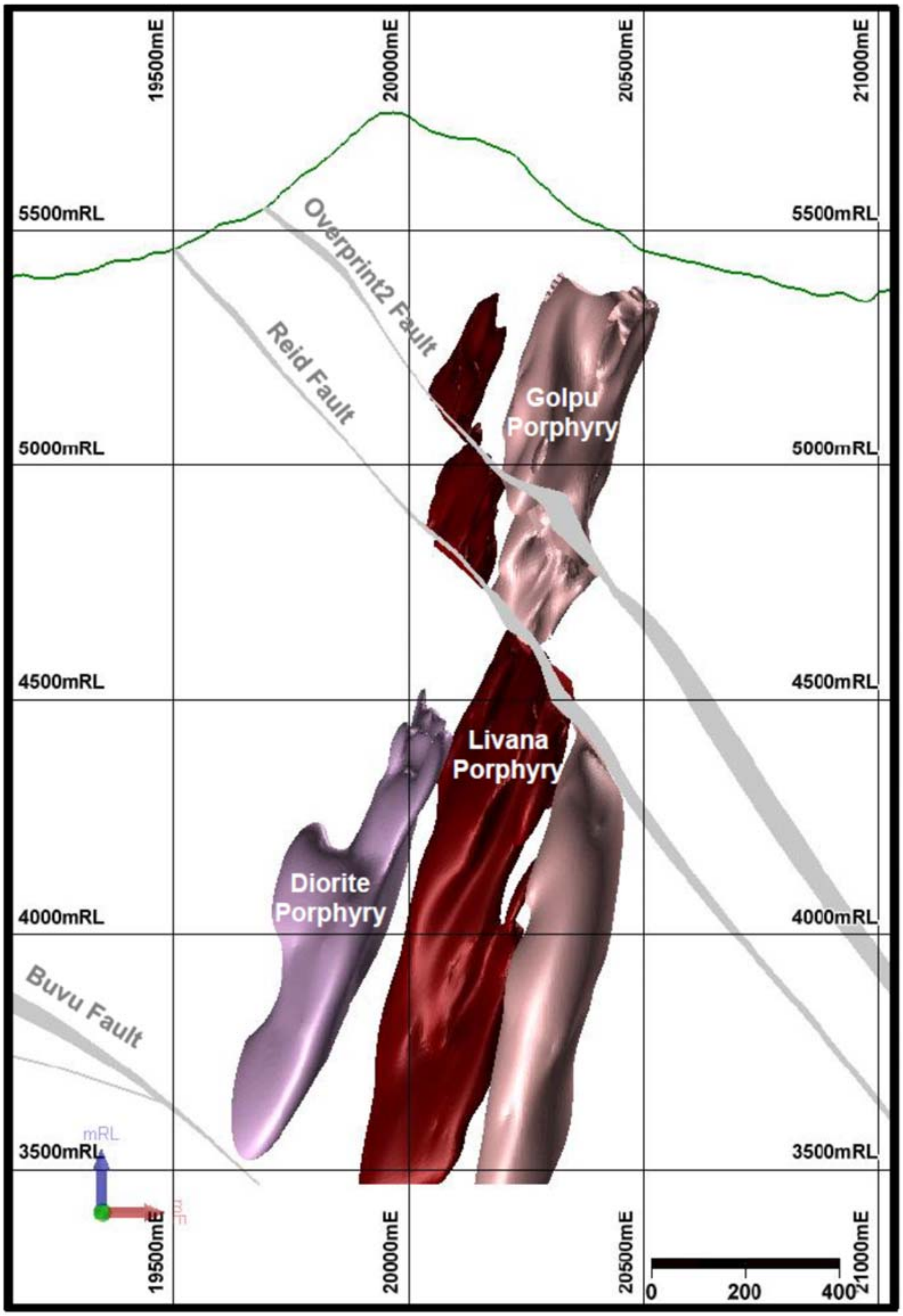


Note: Figure prepared by WGJV, 2013.

Table 7-3: Golpu Lithologies

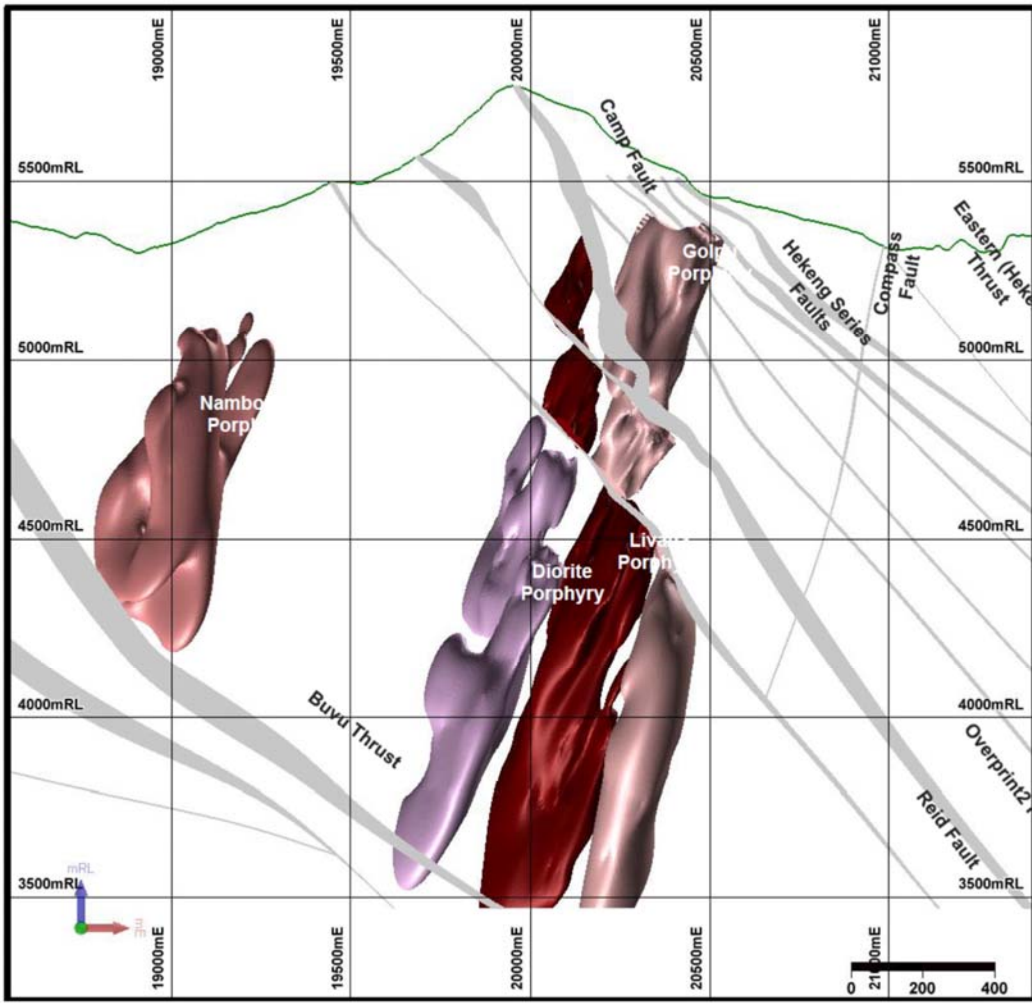
Unit	Description
Owen Stanley Metamorphic Complex	Siltstones and sandstones with minor volumes of conglomerates and shales. Most units are felsic to quartzose felsic with a significant volcanic source rock component. The metasedimentary sequence includes minor dacite porphyry, fragmental volcanic and possible tuffs.
Golpu Porphyry	Dominantly sparsely porphyritic feldspar-phyric diorite. Primary igneous texture comprises coarsely crystalline interlocked phenocrysts (0.5–2 mm; 30–40%). K-feldspar (1–2 mm, 30%) and plagioclase (0.5–2 mm, 20%) occur with interstitial relict hornblende (0.5 mm; 1%). More crowded variants also occur. These intrusions occur as narrow pencil-like intrusive stocks.
Hornblende (Livana) Porphyry	Porphyritic with large tabular hornblende phenocrysts set in a finer grained groundmass (30–40%). Plagioclase (up to 3 mm, 15%) occurs with smaller tabular K-feldspar (up to 2 mm, 5–10%). Plagioclase occurs as twinned crystal clusters. Isolated tabular (up to 2 mm; 1–2%) hornblende is distinctive; relict hornblende is implied from their replaced crystal form when altered (with the pseudomorphs largely replaced by biotite ± K-feldspar).
Diorite Porphyry	The Diorite Porphyry is the only quartz-eye porphyry currently interpreted as a large intrusive body. Most quartz-eye porphyries are narrow, thin dyke-like bodies within larger intrusive units or isolated dykes hosted by sediments. Primary igneous porphyritic texture (groundmass up to >60%); tabular and zoned plagioclase (1–3 mm, 30%) and zoned 'square' feldspar are distinct. Rare quartz-eyes (<0.5 mm; <2%) and isolated biotite phenocrysts (1 mm, 1%) occur throughout.

Figure 7-8: Section Showing Golpu Intrusive Complex



Note: Figure prepared by WGJV, 2018.

Figure 7-9: Structural Features, Golpu–Nambonga

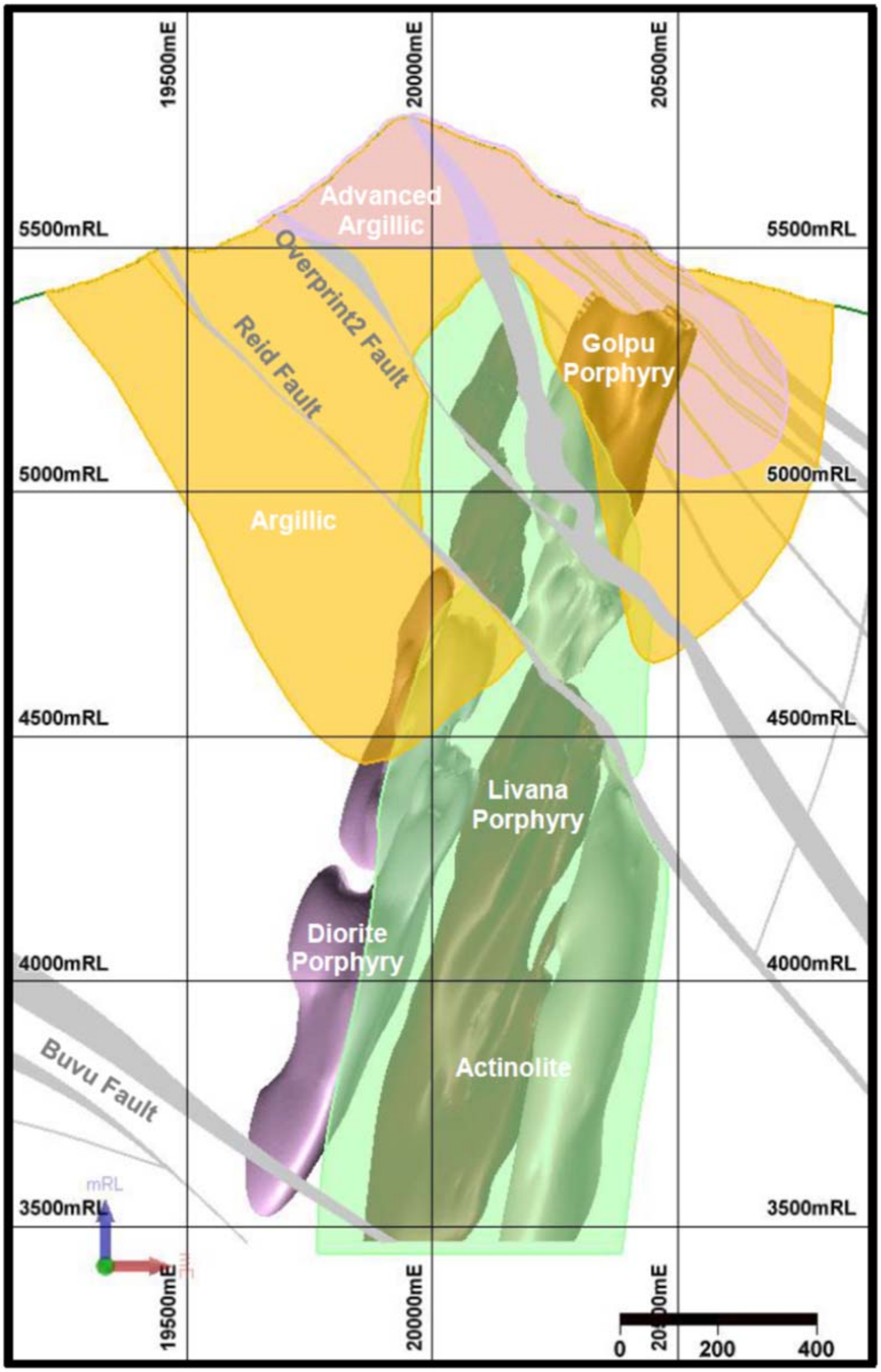


Note: Figure prepared by WGJV, 2018.

Table 7-4: Faults and Structures

Structure/Fault	Note
Camp Fault	Sub-vertical structure; up to 50 m wide and situated above the Overprint 2 thrust fault on the eastern margin of the Hornblende (Livana) Porphyry. The Camp Fault may also be a linking structure between the Overprint Thrust fault and a higher structure.
Compass Fault	Largest known northwest-striking cross fault. Aligned near the southern margin of the Golpu Porphyry and may be a projection of a similar fault in the Wafi deposit. Cross faults generally comprise zones of small to micro faults and rarely form a single significant structure on the ground; more typically appearing as increased joint density or small faults. They are readily apparent on regional geophysical datasets, have various dips to the north and to the south, and almost always have a 110º strike.
Reid Fault	Largest fault recognised to date within the Golpu deposit. Truncates the Golpu mineralisation system, resulting in an apparent 200–250 m up (east over west) and 50 m north displacement of the entire porphyry complex.
Overprint and Overprint 2 Faults.	The Overprint Fault does not appear to significantly disrupt the lithology. It is interpreted to separate the boundary between the advanced argillic, high sulphur, arsenic zone and argillic, high sulphur, low arsenic domain. The Overprint 2 Fault, which occurs between the Overprint and Reid Faults, truncates the Golpu mineralisation system and has an apparent 100 m (east over west) and 20–30 m north displacement of the porphyries.
Hekeng Thrust Complex	Four thrust faults, Hekeng 4, Hekeng 3, Hekeng 2 and Hekeng Faults, are interpreted to form part of the regional Hekeng Thrust complex.
Buvu Fault	Crops out to the west of Golpu. Fault truncates the Nambonga Porphyry at depth and is further extrapolated below the Golpu Intrusive Complex. Interpreted as the basal surface of the entire thrust system. Consists of a wide zone of broken crushed rock, rubble, puggy clays and wide zones of intense brittle–ductile shearing. Divided into three separate thrusts, the Buvu Upper, Middle and Lower Thrusts. These shear zones define multiple anastomosing fault planes that commonly dip between 80–40º to the east. The strike of the Buvu Fault is more northwest (grid) than the north-striking Reid Fault and implies an intersection to the south of Golpu.
Babwaf Thrust	Invoked to explain the intrusion of a wedge of volcanic Langimar Beds into the Babwaf Conglomerate.
DLT Thrust	Interpreted to explain a narrowing of the Golpu Porphyry at depth.

Figure 7-10:Golpu Alteration Domains



Note: Figure prepared by WGJV, 2018.

The zoned alteration includes:

- K-feldspar inner core;
- Magnetite–biotite zone;
- Actinolite–biotite (magnetite–K-feldspar–albite–epidote) zone;
- Biotite (± minor magnetite) zone;
- Chlorite (propylitic) outer margin alteration.

Higher gold and copper grades accompany potassic alteration of moderate to strong pervasive biotite + magnetite alteration with K-feldspar. The best developed K-feldspar + magnetite alteration is centred in and adjacent to the Hornblende (Livana) and Golpu Porphyries. Pervasive biotite–magnetite replacement of the metasedimentary rocks immediately adjacent to the porphyries gives way to actinolite and biotite then microfracture controlled biotite-only alteration on the periphery of the deposit. Actinolite is a key indicator mineral for definition of the mineralised limits. The outermost alteration is chlorite with pyrite ± albite ± anhydrite.

7.3.1.4 Mineralisation

The Golpu deposit extends over about 800 m north–south by 500 m west–east, and was drill tested to more than 2,000 m depth.

Porphyry-style veins are preserved within the clay alteration at the top of the Golpu deposit. These veins have had the copper–iron sulphides removed, leaving only a skeleton of quartz. Irregular molybdenite veins are preserved stable remnants of the porphyry mineralising event.

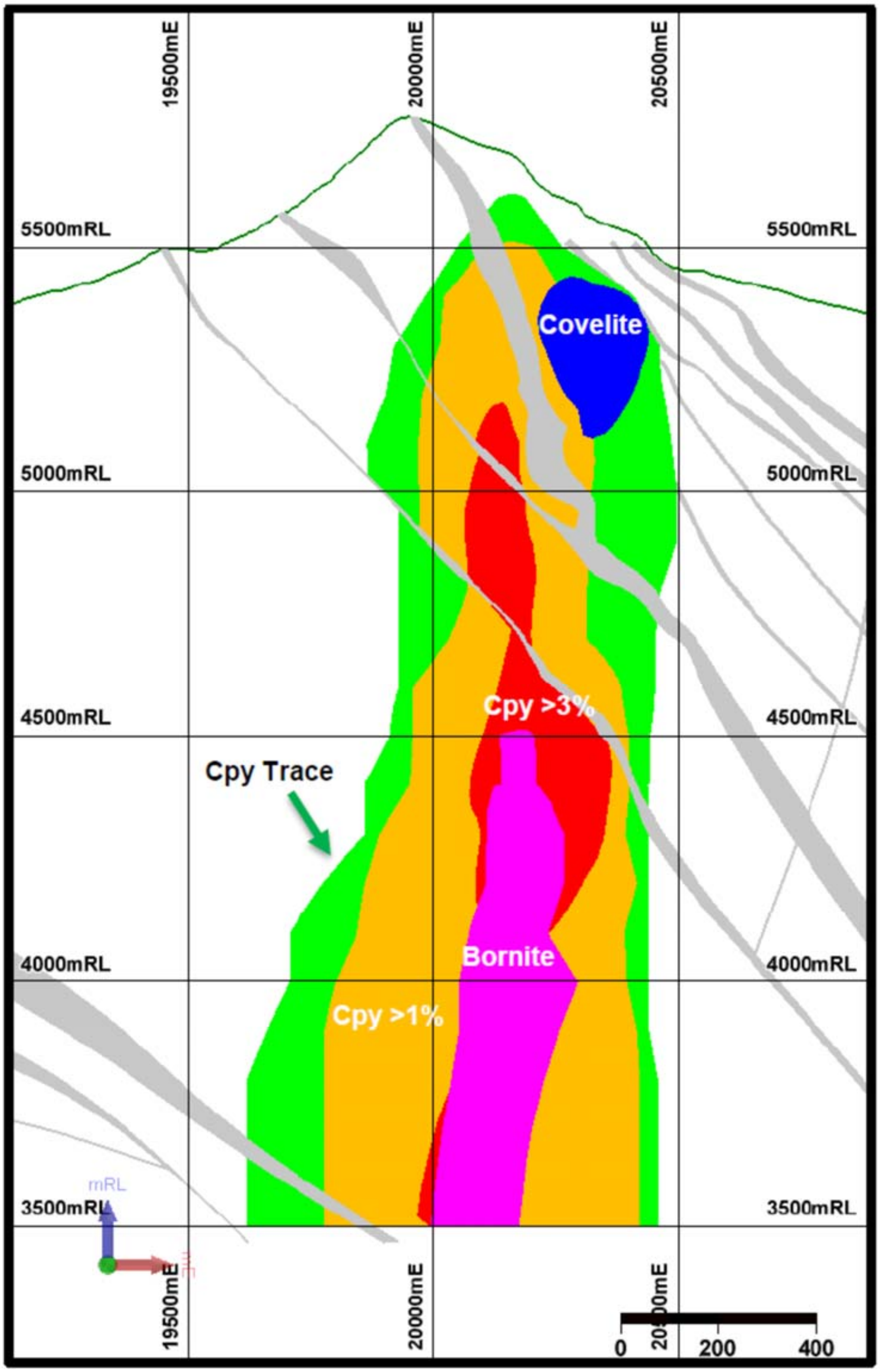
The dominant copper–gold-bearing sulphide species vary laterally and vertically within the deposit from an inner bornite (plus chalcopyrite) core, to chalcopyrite as the dominant copper sulphide, and grading out to a pyrite-only shell on the mineralisation margin (Figure 7-11).

The proportion, by volume, of disseminated copper–iron sulphides varies from trace to as much as 10%. Pyrite increases from near absent in the core to 10% on the margin in a reverse relationship to chalcopyrite. Disseminated sulphides are typically located at the site of relict iron-bearing phases including primary phenocrystic hornblende and hydrothermal alteration-derived biotite–magnetite.

The Hornblende Porphyry (Livana Porphyry) is the main mineralised porphyry. Other porphyries act either as weak mineralisers (e.g., Golpu Porphyry) or as benign hosts (wall rock) from adjacent mineralising porphyries. The mineralisation style in benign (wall rock) porphyries can change due to rheological contrast and chemical variations. Quartz vein stockworks occur on the intrusive margin in sedimentary rocks. Significant zones of quartz flooding may be present. The porphyry system is mineralised with gold, copper, silver and molybdenum:

- Gold, copper and silver trend from highest grade in the Hornblende Porphyry (Livana) core to background levels at the mineralised edge;
- Molybdenum content is low in the gold and copper maxima, but increases outwards to a maximum at the copper margin and declines to background beyond the copper mineralisation limits.

Figure 7-11:Golpu Sulphide Zonation



Note: Figure prepared by WGJV, 2018.

7.3.2 Wafi

The Wafi Diatreme complex is a roughly rectangular shaped feature, 800 m by 400 m at surface with steep, inward-dipping sides. The diatreme comprises intrusive and sedimentary breccias, volcaniclastic rocks and tuffs, and was intruded by several phases of unmineralised dacitic porphyries.

7.3.2.1 Lithologies

The epithermal mineralisation is a late-stage overprint on the Golpu intrusive complex, and is primarily hosted in metasedimentary lithologies of the Owen Stanley Metamorphic Complex. The preferred host units are coarse-grained sedimentary units.

Mineralisation is distributed around a core dacitic vent. The dacite, which is not viewed as part of the Golpu intrusive complex, is assumed to be post-mineral and barren. The dacite was the source for the diatreme breccia which contains fragments of Wafi epithermal mineralisation, and is the last magmatic-related event at Wafi–Golpu.

Two breccias are the centre of interest for the gold mineralisation. The first is limited in extent, is found in the east and southeast of the complex, and is fragment rich. The second, in the west is a diatreme complex with surface dimensions of around 500 x 1,000 m, narrowing with depth to a wine-glass shape. It is matrix supported, containing milled shale, siltstone and feldspar porphyritic diorite clasts, and a matrix of rock flour, lithic fragments, feldspar, and rare quartz crystals. Intense alteration makes the recognition of primary textures difficult, although accretionary lapilli were recognised.

The centre of the epithermal system appears to be located to the south of the vertical projection of the porphyry system. The sheet-like distribution of the epithermal system may be related to permeability, due to both porosity of the sedimentary host and structural controls present during fluid migration. Epithermal alteration is laterally extensive, with the most intense alteration and highest-grade mineralisation located at the Wafi deposit to the southeast of Golpu. Although the Wafi epithermal system is spatially focused around the diatreme breccia, the possibility remains that the dacite intrusive/diatreme breccia used the fluid pathway of the epithermal source, and any evidence was destroyed by explosive events.

An alternate theory has Wafi being related to Golpu, based on:

- The deepest zones of acid alteration and high sulphidation mineralisation are centred on the uppermost Golpu diorites;
- There is only 0.3 Ma between age dates for the intrusions and age dates for the youngest alunite veins in the epithermal system;
- The intermediate sulphidation (outer portions of the high sulphidation epithermal system) is concentrically zoned around Golpu.

However, this interpretation is complicated by the presence of post-mineral faulting that has dissected the original intrusive and epithermal flow configurations.

7.3.2.2 Structure

The Wafi deposit structural setting was summarised in Table 7-4.

7.3.2.3 Alteration

The high sulphidation epithermal system is telescoped over the upper portion of the porphyry system. The high sulphidation alteration is characterised by alunite–pyrophyllite–dickite–sericite and has overprinted the diatreme complex. The diatreme and alteration envelope overprints an earlier zoned system of quartz -> quartz-alunite -> alunite–dickite -> dickite–sericite -> kaolinite–illite-rich clay -> smectite–chlorite–sericite alteration with chalcopyrite–pyrite ± magnetite mineralisation related to the porphyries. The zoned high/low sulphidation event exhibits temporal and spatial zonation from the earlier argillic (alunite ± pyrophyllite overgrowing quartz) to intermediate argillic (dickite–kaolinite ± sericite–illite) to low-temperature argillic (carbonates–smectite–chlorite–chalcedony). The zonation is also represented by the sulphide mineralogy with enargite–luzonite → tennantite → base metal sulphide zoning.

Gold is believed to be associated with the early zoned alteration system but also as a second population related to a late pyrite event related to the later high sulphidation pyrite–clay event.

7.3.2.4 Weathering

Weathering has affected the upper portion of the deposit but below the base of oxidation.

7.3.2.5 Mineralisation

The Wafi deposit has a surface area of approximately 1,100 m x 800 m and was drill tested to about 600 m below surface. A number of zones, including the A, B, NRG and Link Zones, were defined (refer to Figure 7-7). The NRG Zone is the non-refractory portion of the A Zone, and the Link Zone is a more discrete, higher-grade zone characterised by both high sulphidation and low sulphidation mineralisation. It is unclear if the high sulphidation and intermediate sulphidation events at Wafi are independent, or are a continuum of a single event.

The high sulphidation gold event alteration overprints the Golpu porphyry-style alteration and mineralisation, with the diatreme carrying fragments of the earlier porphyry alteration. The high sulphidation event was interpreted to have remobilised pre-existing porphyry-related copper from the phyllic–argillic-altered upper porphyry and deposited this as zoned enargite–tennantite–covellite–chalcopyrite mineralisation. Most of the gold in the high sulphidation overprint was introduced in association with pyrite.

The low sulphidation Link Zone, which occurs on the diatreme margin, between and below the Zones A and B high sulphidation gold mineralisation, is characterised by pyrite with lesser quartz (quartz–sulphide–gold style) veins, which are overprinted by more than one generation of pyrite–sphalerite–galena–carbonate veins (carbonate–base metal–gold style). Selective sampling shows the gold in this zone is related to the arsenian pyrite of the quartz–sulphide-style veins, while the multi-stage low-arsenic carbonate–base metal veins are not well gold-mineralised.

Advanced argillic alteration contains primary copper mineralisation as chalcocite, but gold occurs within pyrite or as electrum associated with pyrite–enargite–tetrahedrite. Mineralisation appears to broadly follow the metasedimentary and volcanic host rocks stratigraphy (i.e., 40–50° to the east, and northeast), and is often sub-parallel to bedding. The copper–gold-bearing lenses occur in kaolinite–chalcocite–pyrite and vuggy quartz ± covellite ± enargite bands that may reach 20 m in thickness.

A cross-section showing the distribution of the gold mineralisation is included as Figure 7-12.

7.3.3 Nambonga

7.3.3.1 Lithologies

Mineralisation is hosted within the Nambonga diorite porphyry stock. Typically, the diorite is medium-grained, containing plagioclase and hornblende phenocrysts set in a feldspathic matrix. The diorite is cut by a late barren diorite phase at depth.

The diorite has intruded lithologies of the Owen Stanley Metamorphic Complex, consisting of metasandstone and minor metaconglomerate.

7.3.3.2 Structure

The deposit appears to be localised along major northwest arc-parallel and northeast-trending transfer faults (refer to setting outlined in Table 7-4).

7.3.3.3 Alteration

Within the porphyry system, a typical porphyry alteration zonation is recognised, grading outwards from inner potassic alteration dominated by potassic feldspar into peripheral propylitic alteration, and upwards into a sericite-dominant phyllic zone.

In the upper levels, within the carapace of the porphyry and metasediment contact, strong silicification/brecciation is evident and quartz stockwork veining is pronounced.

Phyllic alteration, characterised by sericite-K-feldspar-chlorite-pyrite is associated with the brecciation in the upper level, particularly on the hanging wall of the porphyry. This alteration envelope is mushroom-shaped, and tends to decrease in width with increasing depth. The phyllic alteration overprints an early potassic event, may have remobilised the primary copper mineralisation, and enhanced the overall copper/gold grades.

Potassic alteration commonly occurs as selvedges to veins as well as pervasive zones with increased vein density. Potassic alteration partially overprints and grades into a peripheral propylitic zone, which is characterised by a chlorite–carbonate–epidote–pyrite assemblage.

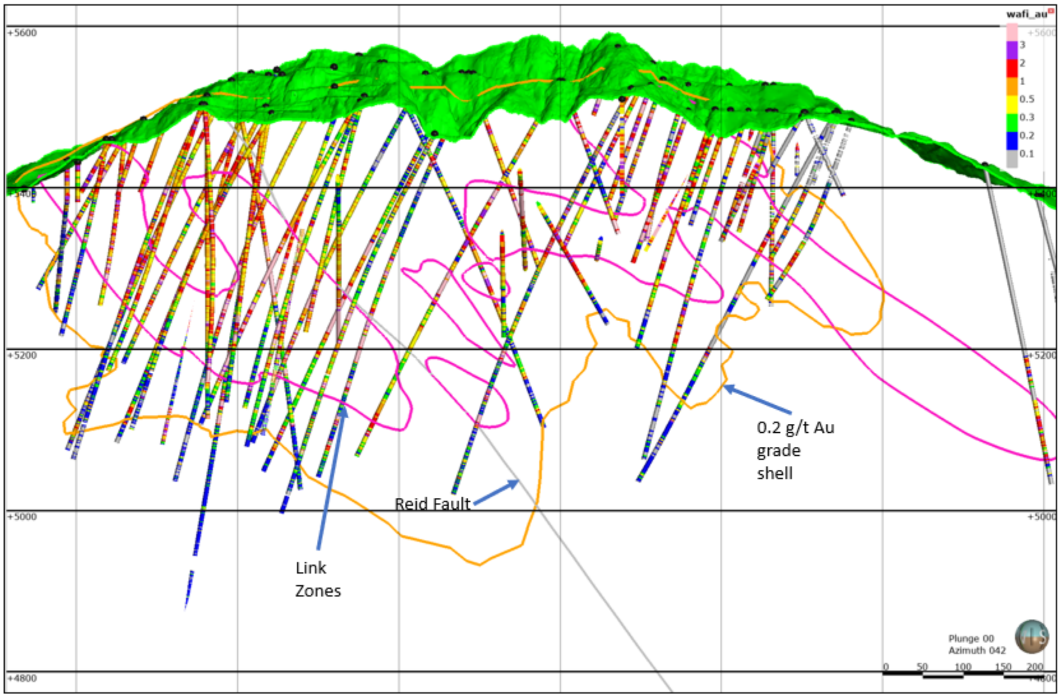
7.3.3.4 Mineralisation

The stock is a low-grade copper and gold mineralised system, and extends over an area of approximately 200 m x 200 m and to a vertical extent of at least 800 m.

Much of the mineralisation is associated with silicification, either pervasive or as veins. Quartz stockwork veins that may be as wide as 10 mm and stockworks overprint the porphyry, especially in the upper levels (Figure 7-13).

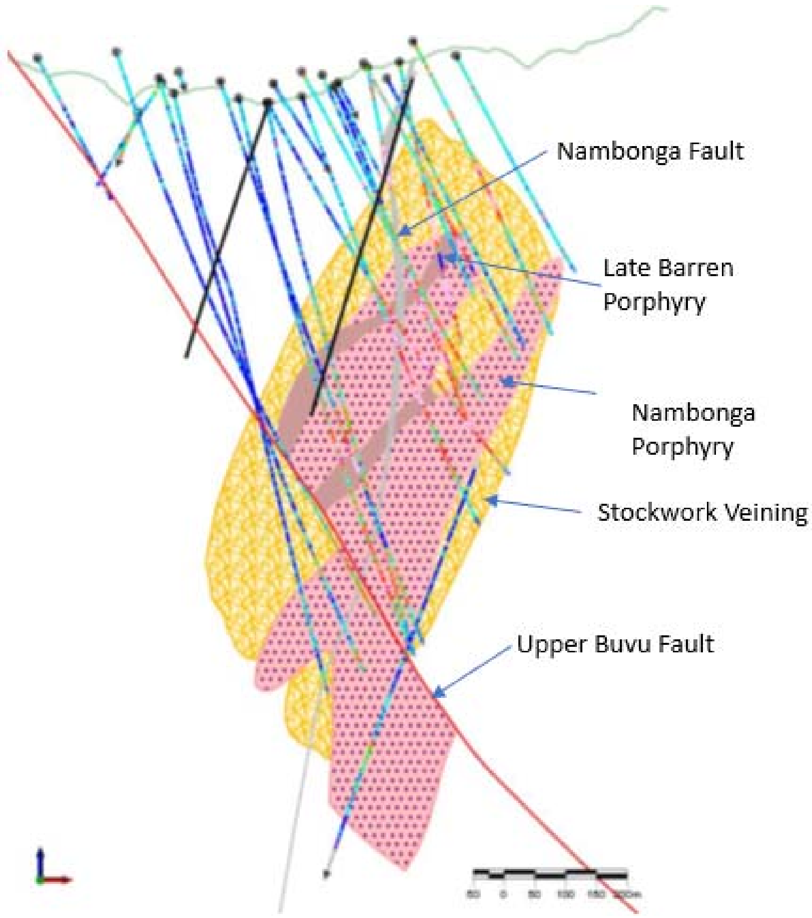
Mineralisation consists of disseminated and vein-style copper–gold mineralisation and structurally-controlled base metal mineralisation in steeply-dipping lodes. Chalcopyrite is the dominant copper sulphide mineral. Chalcopyrite and pyrite form anhedral grains ranging that can reach 0.2 mm in width, and tend to occur as centrelines to quartz veins. Magnetite forms anhedral grains that can be 0.4 mm wide, and is generally present in the margins of the quartz veins or in the wall rock adjacent to quartz veins. Minor magnetite, pyrite and chalcopyrite are disseminated through the host rock.

Figure 7-12:Wafi Cross Section



Note: Figure prepared by Newcrest, 2019. The section is oblique looking northeast (45º; orientation to the Wafi local grid). Gold outline is the 0.2 g/t Au grade shell. Magenta outline is the high-grade Link Zone.

Figure 7-13:Nambonga Schematic Cross-Section



Note: Figure prepared by WGJV, 2019.

Gold was not observed in thin section, and it is likely to be intergrown in a lattice with chalcopyrite or pyrite. Arsenic is negligible to low throughout the porphyry and surrounding metasediment carapace, with the exception of the massive sulphide shoots.

Structurally-controlled base metal mineralisation forms steeply-dipping lodes of variable thickness. The lodes are usually at the margins of the diorite porphyry, where a competency contrast may have acted as a dilational zone between the porphyry and wall-rock metasediments. Paragenetically, the massive sulphide bodies have formed much later than the porphyry intrusion and associated mineralisation.

7.4 Prospects

Prospects and exploration potential are discussed in Section 9.

7.5 QP Comments on "Item 7: Geological Setting and Mineralisation"

In the opinion of the QP:

- Understanding of the Golpu deposit settings, lithologies, mineralisation, and geological, structural, and alteration controls on mineralisation is sufficient to support estimation of Mineral Resources and Mineral Reserves;
- Understanding of the Wafi and Nambonga deposit settings, lithologies, mineralisation, and geological, structural, and alteration controls on mineralisation is sufficient to support estimation of Mineral Resources.

8 DEPOSIT TYPES

8.1 Overview

The deposits discovered to date in the Project area are considered by Newcrest to be representative of a number of mineralisation models, including porphyry copper–gold (Golpu, Nambonga), and high-sulphidation, and low-sulphidation epithermal systems (Wafi).

8.2 Porphyry Deposits

The following discussion of the typical nature of porphyry-copper deposits is sourced from Sillitoe, (2010), Singer et al., (2008), and Sinclair (2006).

8.2.1 Geological Setting

Porphyry copper systems commonly define linear belts, some many hundreds of kilometres long, as well as occurring less commonly in apparent isolation. The systems are closely related to underlying composite plutons, at paleo-depths of 5 km to 15 km, which represent the supply chambers for the magmas and fluids that formed the vertically elongate (>3 km) stocks or dyke swarms and associated mineralisation.

Commonly, several discrete stocks are emplaced in and above the pluton roof zones, resulting in either clusters or structurally-controlled alignments of porphyry copper systems. The rheology and composition of the host rocks may strongly influence the size, grade, and type of mineralisation generated in porphyry copper systems. Individual systems have life spans of circa 100,000 years to several million years, whereas deposit clusters or alignments, as well as entire belts, may remain active for 10 million years or longer.

Deposits are typically semicircular to elliptical in plan view. In cross-section, ore-grade material in a deposit typically has the shape of an inverted cone with the altered, but low-grade, interior of the cone referred to as the “barren” core. In some systems, the barren core may be a late-stage intrusion.

Alteration and mineralisation in porphyry copper systems are zoned outward from the stocks or dyke swarms, which typically comprise several generations of intermediate to felsic porphyry intrusions. Porphyry copper–gold–molybdenum deposits are centred on the intrusions, whereas carbonate wall rocks commonly host proximal copper–gold skarns and less commonly, distal base metal and gold skarn deposits. Beyond the skarn front, carbonate-replacement copper and/or base metal–gold deposits, and/or sediment-hosted (distal-disseminated) gold deposits can form. Peripheral mineralisation is less conspicuous in non-carbonate wall rocks, but may include base metal- or gold-bearing veins and mantos. Data compiled by Singer et al. (2008) indicate that the median size of the longest axis of alteration surrounding a porphyry copper deposit is 4–5 km, while the median size area of alteration is 7–8 km^2.

High-sulphidation epithermal deposits may occur in lithocaps above porphyry-copper deposits, where massive sulphide lodes tend to develop in their deeper feeder structures, and precious metal-rich, disseminated deposits form within the uppermost 500 m.

Figure 8-1 shows a schematic section of a porphyry copper deposit illustrating the relationships of the lithocap to the porphyry body, and associated mineralisation styles.

8.2.2 Mineralisation

Porphyry copper mineralisation occurs in a distinctive sequence of quartz-bearing veinlets as well as in disseminated forms in the altered rock between them. Magmatic–hydrothermal breccias may form during porphyry intrusion, with some breccias containing high-grade mineralisation because of their intrinsic permeability. In contrast, most phreatomagmatic breccias, constituting maar–diatreme systems, are poorly mineralised at both the porphyry copper and lithocap levels, mainly because many such phreatomagmatic breccias formed late in the evolution of systems, and the explosive nature of their emplacement fails to trap mineralising solutions.

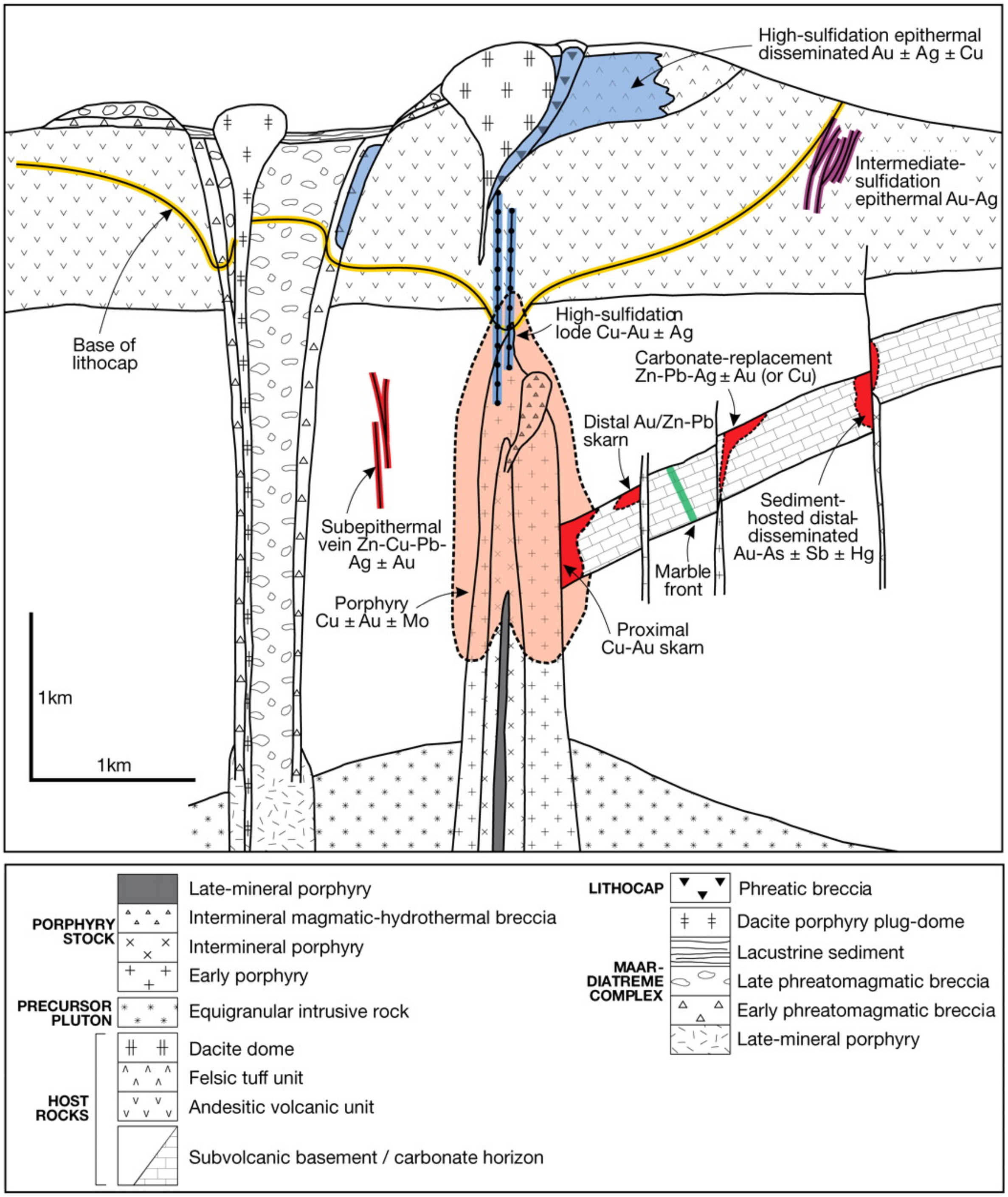
Copper–ore-mineral assemblages are a function of the chemical composition of the fluid phase and the pressure and temperature conditions affecting the fluid. In primary, unoxidised or non-supergene-enriched ores, the most common ore–sulphide assemblage is chalcopyrite ± bornite, with pyrite and minor amounts of molybdenite. In supergene-enriched ores, a typical assemblage can comprise chalcocite + covellite ± bornite, whereas, in oxide ores, a typical assemblage could include malachite + azurite + cuprite + chrysocolla, with minor amounts of minerals such as carbonates, sulphates, phosphates, and silicates. Typically, the principal copper sulphides consist of millimetre-scale grains, but may be as large as 1–2 cm in diameter and, rarely, pegmatitic (larger than 2 cm).

8.2.3 Alteration

Alteration zones in porphyry copper deposits are typically classified on the basis of mineral assemblages. In silicate-rich rocks, the most common alteration minerals are K-feldspar, biotite, muscovite (sericite), albite, anhydrite, chlorite, calcite, epidote, and kaolinite. In silicate-rich rocks that were altered to advanced argillic assemblages, the most common minerals are quartz, alunite, pyrophyllite, dickite, diaspore, and zunyite.

In carbonate rocks, the most common minerals are garnet, pyroxene, epidote, quartz, actinolite, chlorite, biotite, calcite, dolomite, K-feldspar, and wollastonite. Other alteration minerals commonly found in porphyry-copper deposits are tourmaline, andalusite, and actinolite. Porphyry copper systems are initiated by injection of oxidised magma saturated with sulphur- and metal-rich, aqueous fluids from cupolas on the tops of the subjacent parental plutons. The sequence of alteration–mineralisation events is principally a consequence of progressive rock and fluid cooling, from >700° to <250°C, caused by solidification of the underlying parental plutons and downward propagation of the lithostatic–hydrostatic transition. Once the plutonic magmas stagnate, the high-temperature, generally two-phase hyper-saline liquid and vapour responsible for the potassic alteration and contained mineralisation at depth and early overlying advanced argillic alteration, respectively, gives way, at <350°C, to a single-phase, low-to-moderate-salinity liquid that causes the sericite–chlorite and sericitic alteration and associated mineralisation. This same liquid also is a source for mineralisation of the peripheral parts of systems, including the overlying lithocaps.

Figure 8-1: Schematic Section, Porphyry Copper Deposit



Note: Figure from Sillitoe, 2010.

The progressive thermal decline of the systems combined with syn-mineral paleo-surface degradation results in the characteristic overprinting (telescoping) and partial to total reconstitution of older by younger alteration–mineralisation types. Meteoric water is not required for formation of this alteration–mineralisation sequence although its late ingress is common.

8.3 High-Sulphidation Epithermal Deposits

The description for the high-sulphidation epithermal model is summarised from Corbett (2002).

8.3.1 Geological Setting

High-sulphidation epithermal deposits are strongly associated with volcanic complexes that show mixed andesitic and dacitic compositions. Pyroclastic volcanic and porphyry flows are typically intruded by later subvolcanic and volcanic flow domes. The deposits are often localised by similar major structural corridors to those which host porphyry copper–gold deposits.

The deposits are commonly characterised by hydrothermal and phreatomagmatic brecciation that form large funnel shaped breccia bodies that can range from 100–>1,000 m.

Diatreme flow-dome complexes are generally the most important breccia control, particularly at the contact between the diatreme and brecciated host rocks, although phreatic breccias are locally recognised. Many deposits are associated with dome margins. The rapid fluid depressurisation associated with violent diatreme eruptions facilitates dissociation of acid-bearing fluids resulting in initiation of high sulphidation alteration, and also provides important ground preparation.

Most ore systems display elements of structural, breccia, or lithological control. In many instances structural controls predominate in the deeper portions and pass upwards to a lithological control. The intersection of dilatant structures and diatreme margins or permeable horizons represent ideal ore settings. Structural control commonly extends from major structural corridors which localise the ore to dilatant ore-hosting fractures at outcrop scale.

8.3.2 Mineralisation

Sulphide mineralisation is characterised by sulphide assemblages that are dominated by pyrite and enargite–luzonite, with lesser covellite and tennantite–tetrahedrite. Barite and alunite commonly accompany the sulphides.

Vertical metal zonations are apparent as higher copper contents at deeper levels and greater abundances of gold or gold–silver together with local mercury, tellurium and antimony, in the upper portions of poorly-eroded systems, or at the system margins.

Textures can include filling of open space in the existing vuggy silica, fissure veins within subsidiary dilatant structures or matrix to breccias.

8.3.3 Alteration

High-sulphidation epithermal deposits typically display large laterally and vertically zoned advanced argillic to argillic alteration systems. At the core of high sulphidation systems is a zone of residual or vuggy silica, produced by hot acidic fluids leaching many components from the host rocks. Zonation is characterised progressively outwards by mineral assemblages dominated by alunite, pyrophyllite, kaolin, illitic, and chloritic clays.

8.4 Low-Sulphidation Epithermal Deposits

The description for the low-sulphidation epithermal model is taken from Pantaleyev (1996).

8.4.1 Geological Setting

Low-sulphidation epithermal deposits are formed by high-level hydrothermal systems from depths of ~1 km to surficial hot-spring settings. Deposition is related to regional-scale fracture systems related to grabens, (resurgent) calderas, flow-dome complexes and rarely, maar diatremes. Extensional structures in volcanic fields (normal faults, fault splays, ladder veins and cymoid loops, etc.) are common; locally graben or caldera-fill clastic rocks are present. High-level (subvolcanic) stocks and/or dikes and pebble breccia diatremes occur in some areas. Locally resurgent or domal structures are related to underlying intrusive bodies.

Most types of volcanic rocks can host the deposit type; however, calc-alkaline andesitic compositions predominate. Some deposits occur in areas with bimodal volcanism and extensive subaerial ash-flow deposits. A less common association is with alkalic intrusive and shoshonitic volcanic rocks. Clastic and epiclastic sediments can be associated with mineralisation that develops in intra-volcanic basins and structural depressions.

8.4.2 Mineralisation

Ore zones are typically localised in structures, but may occur in permeable lithologies. Upward-flaring ore zones centred on structurally controlled hydrothermal conduits are typical. Large (> 1 m wide and hundreds of metres in strike length) to small veins and stockworks are common with lesser disseminations and replacements. Vein systems can be laterally extensive, but ore shoots have relatively restricted vertical extent. High-grade ores are commonly found in dilational zones in faults at flexures, splays and in cymoid loops.

Textures typical of low-sulphidation deposits include open-space filling, symmetrical and other layering, crustification, comb structure, colloform banding and multiple brecciation.

Deposits can be strongly zoned along strike and vertically. Deposits are commonly vertically zoned over 250–350 m from a base metal poor, gold–silver-rich top to a relatively silver-rich base metal zone and an underlying base metal-rich zone grading at depth into a sparse base metal, pyritic zone. From surface to depth, metal zones can contain gold–silver–arsenic–antimony–mercury, gold–silver–lead–zinc–copper, or silver–lead–zinc. In alkalic host rocks, tellurides, vanadium-mica (roscoelite), and fluorite may be abundant, with lesser molybdenite.

Pyrite, electrum, gold, silver, argentite; chalcopyrite, sphalerite, galena, tetrahedrite, silver sulphosalt and/or selenide minerals are the main mineral species. Quartz, amethyst, chalcedony, quartz pseudomorphs after calcite, calcite; adularia, sericite, barite, fluorite, calcium–magnesium–manganese–iron carbonate minerals such as rhodochrosite, hematite, and chlorite are the most common gangue minerals.

8.4.3 Alteration

Silicification is extensive in ores as multiple generations of quartz and chalcedony are typically accompanied by adularia and calcite. Pervasive silicification in vein envelopes can be flanked by sericite–illite–kaolinite assemblages. Intermediate argillic alteration (kaolinite–illite–montmorillonite (smectite)) forms adjacent to some veins; advanced argillic alteration (kaolinite–alunite) frequently forms along the tops of mineralised zones. Propylitic alteration dominates peripherally and at depth.

8.5 QP Comments on "Item 8: Deposit Types"

Features of the Golpu and Nambonga deposits that classify them as gold–copper porphyries include:

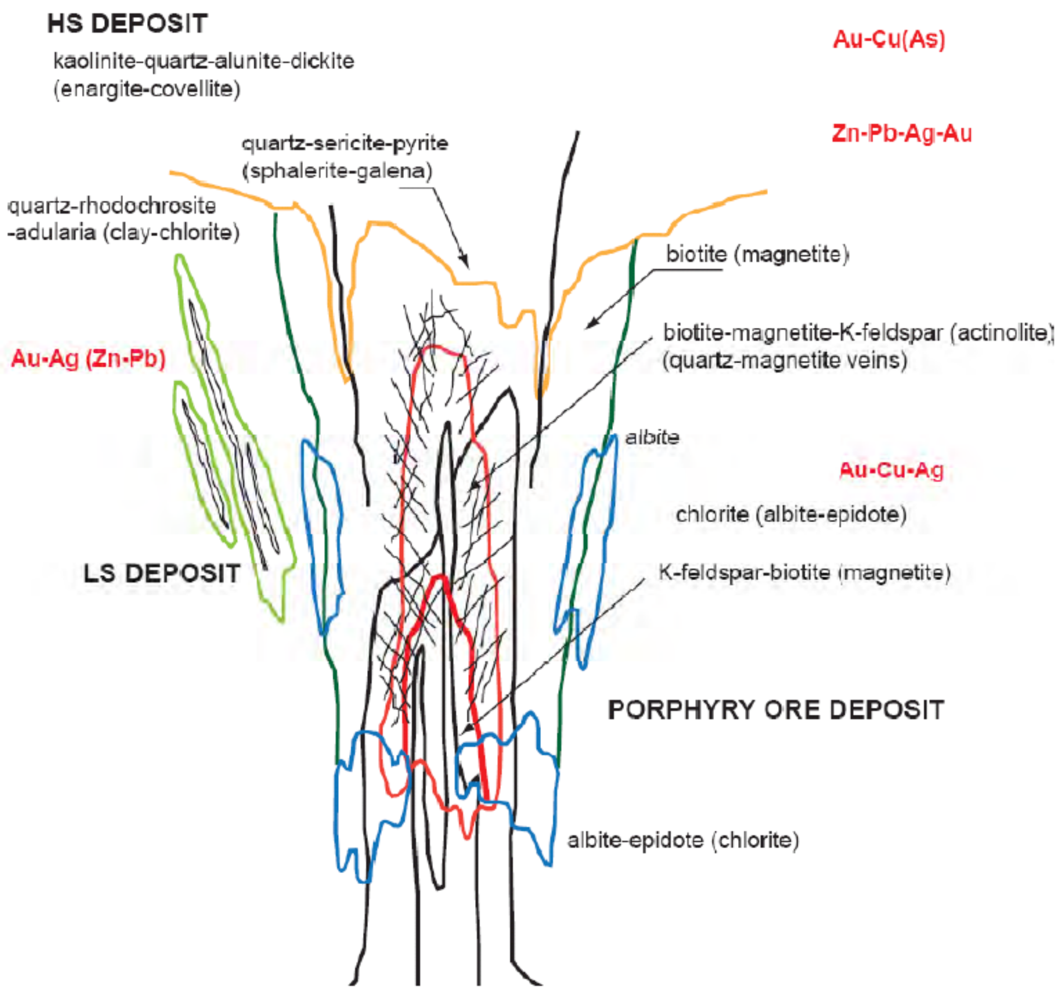
- Multiple, hornblende-bearing diorite porphyries intruded into host sedimentary lithologies. Intrusions range from small dykes to small stocks and apophyses. Individual intrusions pinch and swell vertically over tens of metres and form stocks, pipes and dykes;
- Mineralisation occurs in, or adjoining, porphyritic intrusions;
- Mineralisation is spatially, temporally, and genetically associated with hydrothermal alteration of the intrusive bodies and host rocks;
- Large zones of veining and stockwork mineralisation, together with minor disseminated and replacement mineralisation occur throughout large areas of hydrothermally-altered rock, commonly coincident wholly or in part with hydrothermal or intrusion breccias;
- Hydrothermal alteration is extensive and zoned;
- The dominant copper–gold sulphide species varies laterally and vertically within the deposit from an inner bornite (plus chalcopyrite) core, chalcopyrite as the dominant copper sulphide grading to a pyrite-only shell. The porphyry system is also mineralised with gold, copper, silver and molybdenum;
- Copper grades that are typical of the range of porphyry copper grades (0.2% to >1% Cu).

Features of the Wafi deposit, including the Link area, that classifies the deposit as an example of an epithermal system displaying high- and low-sulphidation elements include:

- Presence of hydrothermal and phreatomagmatic brecciation;
- Alteration assemblage;
- Mineralisation broadly follows the metasedimentary and volcanic host rocks stratigraphy;
- Gold occurs within pyrite or as electrum associated with pyrite–enargite–tetrahedrite. Abundant arsenian pyrite results in high sulphur and elevated arsenic levels in the epithermal-altered volume;
- Copper occurs as zoned enargite–tennantite–covellite–chalcopyrite mineralisation.

The QP considers that exploration programs that use porphyry or epithermal models are a reasonable basis for exploration targeting for copper–gold mineralisation in the Project area. A deposit model specific to the Project area is provided in Figure 8-2.

Figure 8-2: Wafi–Golpu Model Schematic



Note: Figure from Hayward et al., 2011. LS = low sulphidation; HS = high sulphidation.

9 EXPLORATION

9.1 Grids and Surveys

9.1.1 Geodetic Datum

Papua New Guinea Geodetic Datum 1994 (PNG94) is the primary datum, and is the datum officially gazetted by the State for projects commenced after 2000. It is closely aligned with international dynamic datums such as WGS84 and ITRF.

PNG94 was coincident with ITRF92 and WGS84 at the beginning of 1994 but is now different by approximately 1.5 m, due to tectonic movement between 1994 and the present day.

PNG94 is directly compatible with global navigation satellite system (GNSS) and global positioning system (GPS) instruments, and modern geographic information systems (GIS) with no transformation required for interoperability.

For regional mapping and studies where dimensional tolerances are low, the PNGMG94 Zone 55 grid is used. PNGMG94 is a UTM projection with large scale factors which preclude its use for engineering and mining surveys.

A grid projection of PNG94 called WGOLPU94 was designed for use anywhere within the Project area. Latitudes and Longitudes in PNG94 are identical for PNGMG94 and WGOLPU94 grid projections.

9.1.2 Local Grid

The Wafi Local Grid is a planar grid orientated approximately 45º from north, and was used until July 2011 for block modelling and geology database purposes.

In 2011, grid projections were reviewed and optimised to ensure reliable location control for use in mining studies. The optimised grid, WAFL2011, was adjusted to allow adequate coverage of the area, while retaining ease of identification of easting and northing, and relative levels. This optimisation included adding 700,000 m to the local northing.

In 2016, the Wafi Local Grid was converted to GOLPU2016 which is the same as the PNGMG94 grid. The current geology model was built using the GOLPU2016 Local Grid.

9.1.3 Topographic Surface

Topographic control is determined by digital terrain models derived from a high-resolution light detection and ranging (LiDAR) survey covering the area, conducted in 2009 by Fugro Spatial Services, and converted from PNG94 to WAFL2011 local grid. The survey has a spatial accuracy of 0.2 m.

9.1.4 Height Datum

The main height datum is mean sea level (MSL). Because much of the resource at Golpu is significantly below sea level, 5,000 m was added to MSL (WAFL2011/GOLPU2016), for mining and engineering operational purposes, to avoid negative values. This datum is called the WAFL height datum.

9.1.5 Magnetic Declination

The magnetic declination has varied from -6.2º at the start of the Project (1983) to the current position of -5.6º from true north, moving approximately 0.02º west per year.

The Wafi Local Grid was set up assuming a magnetic declination of -5.3º, with the local grid rotated -40º from magnetic grid (i.e. Wafi Local Grid is 40º east of Magnetic North).

The magnetic declination was corrected to a more appropriate midpoint of -5.8º ensuring that all surveys are within 0.3º of magnetic declination at any time. This has resulted in the change in the conversion from magnetic to local grid from -40º to -39.5º (+0.5º).

9.2 Geological Mapping

A number of mapping programs were conducted over the Project area. These included 1:10,000 fact mapping of available outcrop.

Mapping data and subsequent interpretations were used together with drill hole data to model the deposit geology and structure.

A structural model for the Wafi–Golpu area was compiled in 2011.

9.3 Geochemical Sampling

CRAE completed ridge and spur sampling programs from 1980–1982; CRAE also conducted an initial trenching program, comprising 102 trenches, varying in length from 1–1,840 m, for a total 34,129 m of trenching.

Information from these programs was superseded by drill data.

9.4 Geophysics

Geophysical surveys were conducted as part of the early-stage exploration activities. The following surveys were conducted:

- CRAE,1985: Dipole-dipole induced polarisation (IP)/resistivity survey;
- CRAE/Elders, 1990: Moving loop time domain electromagnetic (EM) geophysical survey;
- CRAE, 1991–1997: Aeromagnetic, ground magnetic, self-potential (SP), IP, and controlled source audio-frequency magneto- telluric (CSAMT) geophysical surveys (Tau-Loi and Andrew, 1998).

WGJV staff re-examined some of the geophysical data in 2018, as follows:

- The 1985 survey, conducted using 100 m and 200 m dipole spacing, was compiled and inverted in three-dimensions (3D). Generally high chargeability values were noted, and clearly defined the lithocap as a strong resistor above a relatively conductive zone of clay alteration.
- The 1990 EM survey data were inverted in 3D, and show a clear conductor that coincides with the top of the Golpu deposit. This conductor is probably due to sulphide veining which, unlike magnetite, has not been affected by late advanced argillic alteration.

9.5 Petrology, Mineralogy, and Research Studies

A number of petrological and mineralogical studies were conducted in support of exploration vectoring, deposit understanding, and metallurgical designs.

A total of 49 samples were taken in the area for age-dating. The majority of dates were returned from granodiorite, diorite, porphyry, diatreme, tuff and agglomerate samples using K–Ar methods; however, Rb–Sr dates were determined on granodiorite and porphyry samples. There are two carbon dates from coal/lignite samples in the Wafi Conglomerate.

Recent research and publications on the Project include:

- Rinne, M., 2015: Geology. Alteration, and Mineralisation of the Golpu Porphyry and Wafi Epithermal Deposit, Morobe Province, Papua New Guinea: PhD thesis, University of Tasmania, 162 p.;
- Rinne, M., Cooke, D., Harris, A., Finn, D., Allen, C., Heizler, M. and Creaser, R., 2018: Geology and Geochronology of the Golpu Porphyry and Wafi Epithermal Deposit, Morobe Province, Papua New Guinea: Economic Geology. Vol 113, pp. 271–294.

9.6 Exploration Potential

9.6.1 Regional Potential

Numerous exploration prospects were identified in the Project area, and are shown in Figure 7-5. These have broadly been divided into the following target styles:

- High-sulphidation epithermal gold;
- Porphyry gold–copper;
- Carbonate base metal–gold.

Exploration programs typically use one or a combination of methods, which can include mineralogical and geochemical porphyry vectors, prioritising areas in proximity to multiphase intrusive/magnetic complexes, magnetic and IP geophysical targets, favourable host lithologies and strong structural controls.

9.6.2 Western and Northern Zone

These two areas are prospective for high sulphidation gold mineralisation on the northern/western margins of the diatreme breccia. The targets were drill tested, with the drilling encountering significant gold values over a number of metres. The Western zone remains open to the north and south along strike. The Northern zone is essentially defined by three drill intercepts and is open in all directions.

9.6.3 Heking Zone

The high sulphidation epithermal system that telescopes the Golpu porphyry copper–gold system remains open to the east in terms of mineralisation and the argillic alteration trend. The prospective horizon is covered in the east by the Wafi Conglomerate and an interpreted over-thrust sequence of Owen Stanley Metamorphic rocks. Targets are likely to have no surface geochemical expression and are potentially too deep for geophysical targeting.

9.6.4 Miapilli

The Miapilli target retains exploration potential. The prospect is a magnetic high about 700 m northeast of the northern extents of the Golpu porphyry system. The magnetic high was drill-tested with three drill holes in 2009, which showed the magnetic high to be related to magnetic clasts within the Langimar bed conglomerates rather than an intrusive body.

However, two of the 2009 drill holes situated on the southern margin on the magnetic anomaly intersected very encouraging porphyry-style alteration and mineralisation. Mineralisation is associated with porphyry-style sulphide centreline A-type veins and sheeted, quartz–magnetite–sulphide M-type veins, and to a lesser extent with disseminated sulphides concentrated in metasedimentary lithologies, on the margins of a 100 m-wide andesite porphyry unit. The two drill holes intersected moderate to strong alteration typical of porphyry environments, including quartz stockwork veins.

Drilling to date indicates increasing magnetic susceptibilities, potassic alteration, and molybdenum grades with depth. However, one drill hole showed a change from potassic to propylitic alteration at depth, suggesting structural complexity or a tilt to the porphyry system. A 3D magnetic model constructed for Miapilli indicates that the modelled body has depth continuity, and that only one drill hole has tested the magnetic model area. As the stratigraphy in the Miapilli area dips to the east, it is possible that a potential porphyry system may plunge to the west–northwest, in an orientation similar to that of Golpu and Nambonga.

9.7 QP Comments on "Item 9: Exploration"

In the QP's opinion, the exploration programs completed to date are appropriate to the style of the deposits and prospects. There is some remaining exploration potential in the Project area, with a number of prospects that may warrant additional investigation.

10 DRILLING

10.1 Introduction

Drilling completed to date includes reverse circulation (RC) and core drilling.

Table 10-1 summarises the drilling to 30 June 2020 on a Project-wide basis. A total of 791 drill holes (including wedges) were completed in the Project area since 1983, comprising about 267,907 m of core drilling and 17,180 m of RC drilling. The drill table includes geotechnical, water bore, exploration, resource delineation, and abandoned drill holes in the totals. No drilling has been conducted since the end of 2018.

A total of 306 drill holes (including wedges and re-drills) for 210,725.45 m of drilling are used in Mineral Resource estimation at Golpu (Table 10-2). The resource estimate for the Wafi deposit is supported by 482 drill holes (205,570.8 m; Table 10-3). A total of 34 core holes supports the Nambonga Mineral Resource estimate for a total of 18,079.4 m drilled (Table 10-4). Due to the location of the deposits in close proximity, and the location of the drill collar, a single drill hole can inform more than one estimate.

Drill hole collars are shown in Figure 10-1 by drill type for the Project as a whole, in Figure 10-2 for the Golpu resource estimate area, in Figure 10-3 for the Wafi resource estimate, and in Figure 10-4 for the Nambonga resource estimate.

10.2 Drill Methods

Diamond drilling was performed by wireline methods using HQ (63.5 mm core diameter), NQ (47.6 mm), and PQ (85 mm) core. There are rare intervals of BQ (36.5 mm) core.

Drill contractors included PNG Drillers, and United Pacific Drilling. The most recent programs were completed by Traverse Drilling International (TDI) of Australia using two heli-support drill rigs (SC11 and Cortech CS1000), and as many as six track-mounted DE740 drill rigs.

Some drill cores were oriented for structural analysis with an automated Ace Tool.

10.3 Logging Procedures

All drill core was geologically and geotechnically logged. Geological logging was both qualitative and quantitative, and recorded lithology, mineralisation, alteration mineralogy, weathering, structural characteristics and other physical core properties.

A consistent geological logging standard and descriptive terminology has been applied since drill hole WR173. Historical logging conducted by CRAE and Elders was transformed into this terminology.

Table 10-1: Drill Summary Table

Year	Company	No of Holes	Hole Numbers	Metres Core	Metres RC
1983	CRA	5	WR001–WR004	628	—
1983–1985	CRAE	21	WR005–WR024	5,199	—
1985–1986	CRAE	7	WR025–WR031	2,492	—
1989	Elders	58	WR032–WR085	5,589	2,100
1990	Elders	10	WR086–WR095	3,265	—
1991	Elders/ CRAE	9	WR096–WR103A	4,011	—
1992	CRAE	4	WR103B–WR106	2,178	—
1993	CRAE	8	WR107–WR114	3,941	—
1994	CRAE	2	WR115–WR116	1,761	—
1995	CRAE	22	WR117–WR136A	10,281	—
1996	CRAE	13	WR137–WR149	5,762	—
1997	CRAE	11	WR150–WR160	4,610	—
1998	CRAE /AGF	15	WR161–WR175	5,859	—
2003	Abelle	18	WR176–WR193	8,219	—
2004	Abelle	70	WRC001–WRC070	—	13,155
2005	Harmony	14	WR194–WR207	6,104	—
2006	Harmony	27	WR208–WR233	11,357	—
2007	Harmony	42	WR234–WR255	5,809	—
			WRC071–WRC087	—	1,925
2008	Harmony	19	WR256–WR274	7,716	—
2008	WGJV	32	WR275–WR304	17.868	—
2009	WGJV	35	WR305–WR332	17,377	—
		3	ZN001–ZN003	1,491	
2010	WGJV	59	WR333–WR383	36,121	—
2011	WGJV	47	WR384–WR418	32,354	—
2012	WGJV	61	WR419–WR458	30,004	—
		5	WG001–WG006	224	
2013	WGJV	57	WR459–WR503	33,592	—
		9	WG007–WG015	541	
2014	WGJV	14	WR504–WR516	7,222	—
		37	WG016–WG051	1,730	
		14	WHMB001–WMB014	2,699	
2015	WGJV	17	WG052–WG068	911	
2016	WGJV	8	WR517–WR522	6,014	—
2018	WGJV	18	WG069–WG086	2,828	
Total		***791***		***267,907***	***17,180***

Note: Hole metreage totals can include wedges.

Table 10-2: Drilling Used in Golpu Resource Estimate

Company	Number of Holes	Metres Drilled
Abelle	17	2,802
CRAE	50	24,176.7
Elders	18	3,501.4
Harmony	32	11,861.35
WGJV	189	168,384
Total	***306***	***210,725.45***

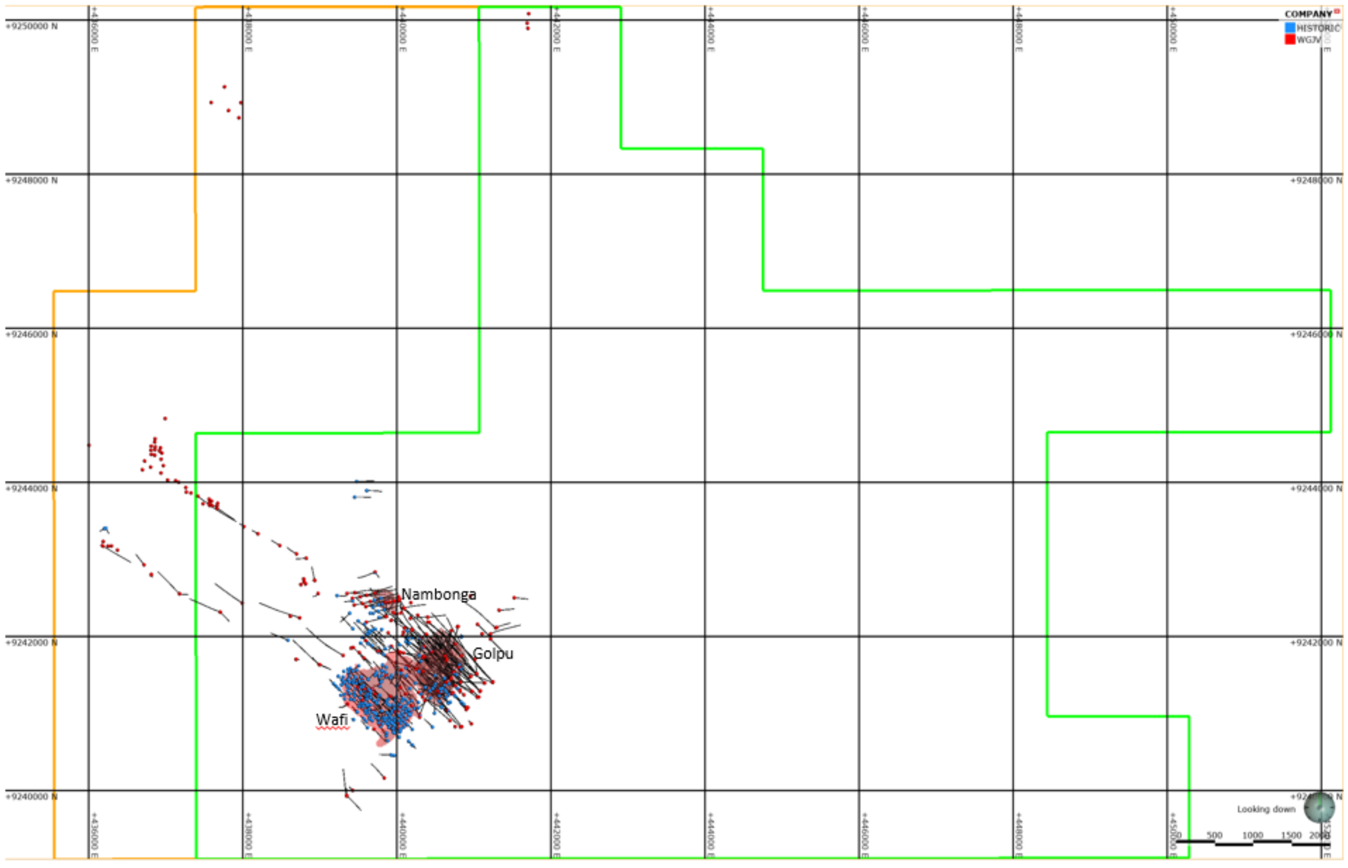
Table 10-3: Drilling Used in Wafi Resource Estimate

Company	Number of Holes	Metres Drilled
Abelle	86	21,143.8
CRAE	93	35,493.6
Elders	68	8,852.9
Harmony	79	23,063.1
WGJV	156	117,017.4
Total	***482***	***205,570.8***

Table 10-4: Drilling Used in Nambonga Resource Estimate

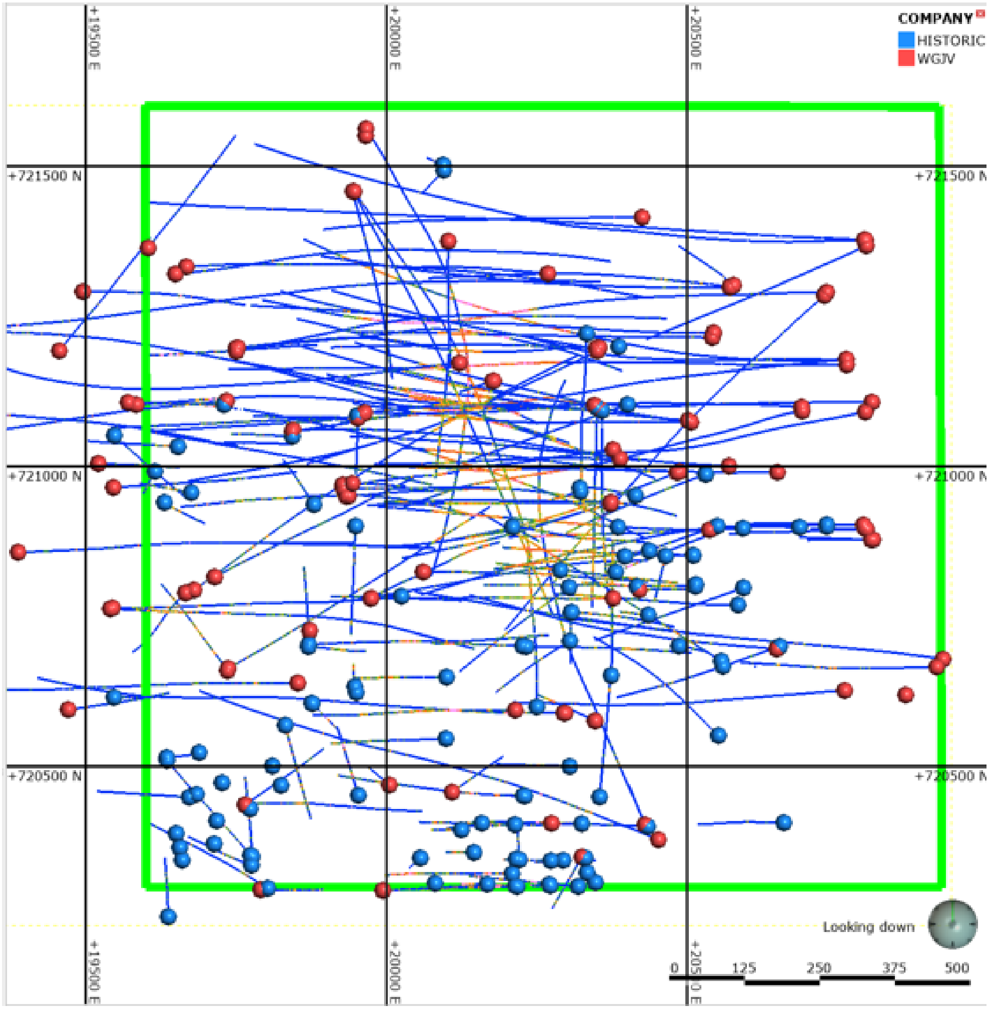
Company	Number of Holes	Metres Drilled
Abelle	—	—
CRAE	—	—
Elders	—	—
Harmony	13	5,097.3
WGJV	21	12,982.1
Total	***34***	***18,079.4***

Figure 10-1:Project Drill Collar Location Plan



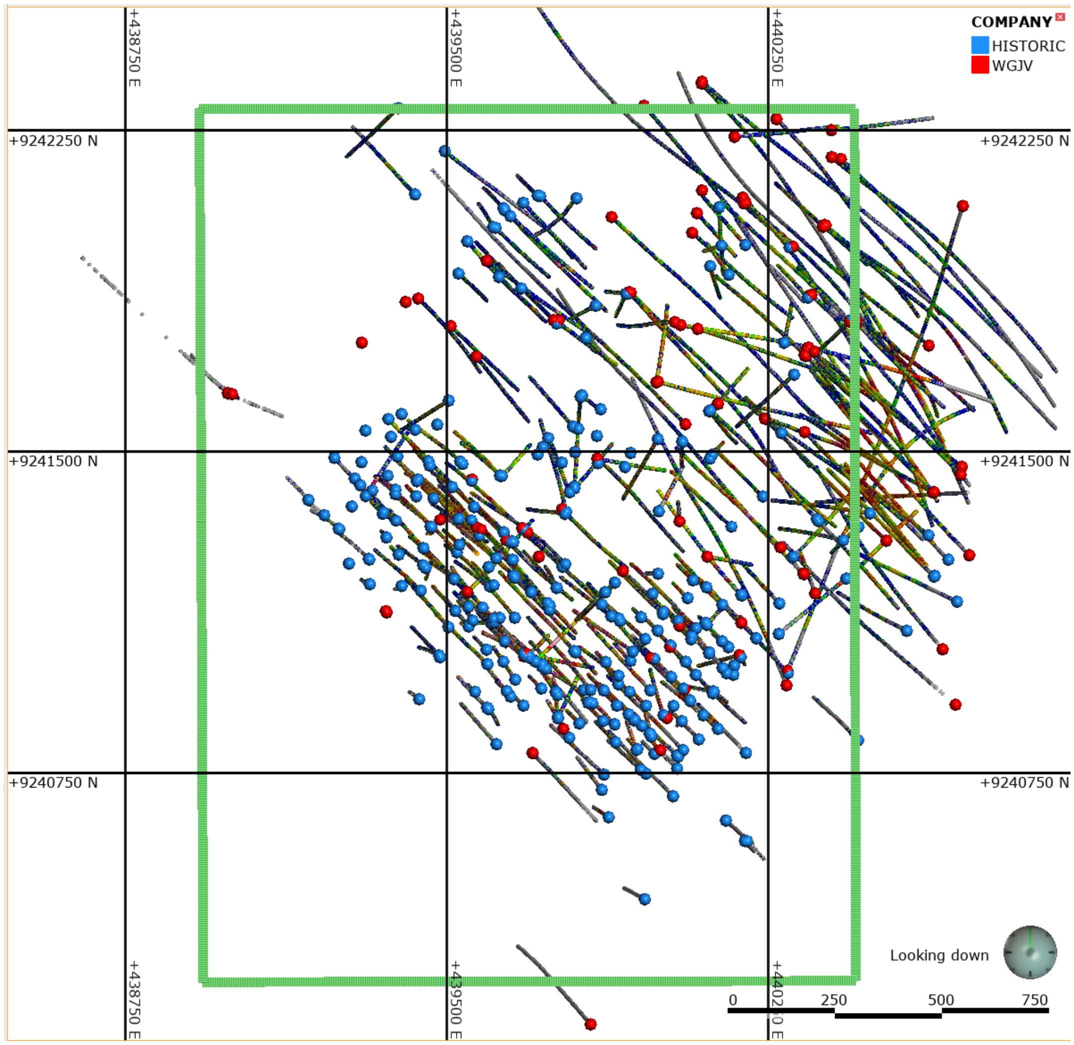
Note: Figure prepared by Newcrest, 2019. Drill holes displayed are separated into those drilled by the WGJV (red hole collar), and those drilled prior to the JV inception (blue hole collar). Pale red shapes are the extent of each of the Mineral Resource estimates projected to surface.

Figure 10-2:Golpu Estimate Drill Collar Location Plan



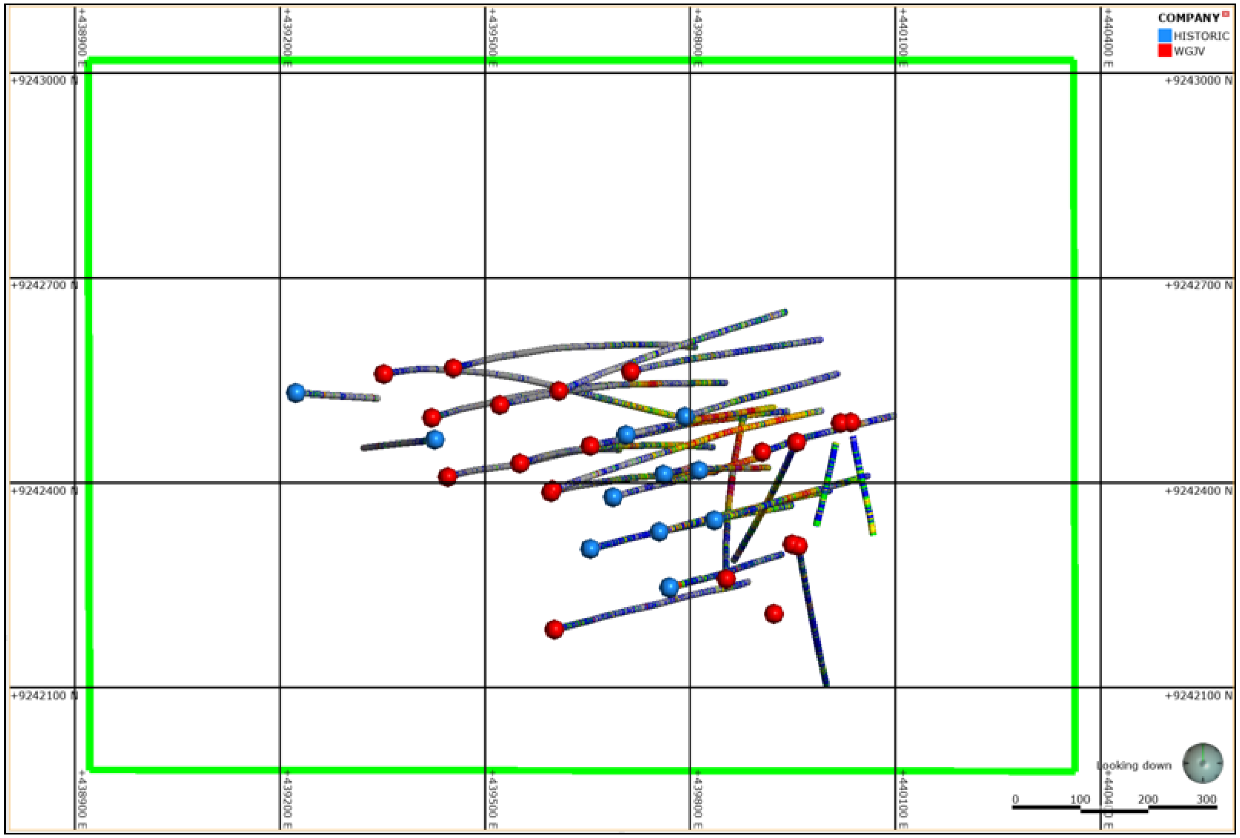
Note: Figure prepared by Newcrest, 2019. Drill holes displayed are separated into those drilled by the WGJV (red hole collar), and those drilled prior to the JV inception (blue hole collar). Green outline is the approximate extent of the Golpu block model.

Figure 10-3:Wafi Estimate Drill Collar Location Plan



Note: Figure prepared by Newcrest, 2019. Drill holes displayed are separated into those drilled by the WGJV (red hole collar), and those drilled prior to the JV inception (blue hole collar). Green outline is the approximate extent of the Wafi block model.

Figure 10-4:Nambonga Estimate Drill Collar Location Plan



Note: Figure prepared by Newcrest, 2019. Drill holes displayed are separated into those drilled by the WGJV (red hole collar), and those drilled prior to the JV inception (blue hole collar). Green outline is the approximate extent of the Nambonga block model.

Geological logging codes evolved over time with increased geological understanding of different rock types and associations. For most drill holes, logging includes details of:

- Core recovery;
- Rock quality designation (RQD);
- Lithology;
- Alteration;
- Weathering;
- Structural features.

Detailed geotechnical information, such as rock strength, fracture frequency, rock mass rating (RMR) and discontinuities was collected for some later core drill holes.

Mineralisation was logged and photographed prior to sampling. All core photos are downloaded and uploaded to a computerised database for future reproduction purposes. Core photographs are available for drill holes completed since 1996.

Magnetic susceptibility readings were measured at 1 m intervals downhole with a hand-held portable magnetic susceptibility device. All the data collected are entered into the database.

Structural measurements were recorded using LogChief software and uploaded into the Project database. All oriented drill core data collected were used for structural interpretation kinematics analysis.

Reflectance spectroscopy mineralogical identification (ASD and Corescan) data were collected to aid in clay and alteration mineral identification.

RC cuttings for each metre drilled were sieved and stored in chip trays for each drill hole. The cuttings were logged for:

- Lithology;
- Alteration;
- Weathering;
- Structural features.

10.4 Recovery

Core recovery was recorded for all core drilling on a metre-by-metre basis as a percentage. All drilling since 2005 was conducted using triple-tube core barrels.

Sample recovery was 96.4% over the entire drilling dataset, including oxide material and Wafi epithermal mineralisation.

Core recoveries average 98.4% within the Golpu Mineral Resource estimate area. No material relationship was identified between core recovery and grade.

Core recovery at the Wafi deposit is typically good, with >90% recovery in the mineralised units. There is no correlation between the gold grade and higher recovery zones.

Core recovery at the Nambonga deposit is typically good, with >95% recovery in the mineralised rock types.

10.5 Collar Surveys

Drill hole collars were located using a hand-held global positioning system (GPS) instrument and later surveyed in the Wafi Grid by a qualified and competent surveyor using theodolite or differential GPS (DGPS) instruments. Drill collars that support resource estimation have co-ordinates provided from these surveys; if no survey was available, the drill hole was excluded from estimation support.

Drill holes WR092 to WR166, drilled by Elders and CRAE from 1990 to 1996, were surveyed by CPS Palanga Surveys Pty Ltd and drill holes WR205 to WR504 drilled by Harmony and WGJV from 2005 to 2014 were surveyed by Asia Pacific Surveyors. The Harmony and WGJV hole-collar positions were marked and labelled with a 1.5 m length of 100 mm diameter PVC pipe cemented into a concrete collar block.

10.6 Downhole Surveys

The Elders and CRAE drill holes were surveyed using an Eastman single-shot camera. Downhole surveys were completed on CRAE core holes at Golpu typically starting at 25 m depth, and then every 20–50 m downhole.

Harmony/WGJV drill holes were surveyed at Golpu using a Reflex downhole survey tool, typically with the first reading at 18 m and then every 30 m thereafter downhole. Ten-metre intervals were used in some deep wedged holes where good survey control was required.

Gyroscope surveys were conducted at Golpu by site geologists from 2011 to 2012. This instrument defined the relative change in orientation from the top to the bottom of the hole but required the starting azimuth to be defined by surface survey. From 2012, downhole surveys were conducted by an independent contractor using a north-seeking gyroscope instrument applying quality control (QC) and calibration procedures. Surveys were completed every 500 m with 100 m overlap down the drill hole.

Downhole surveys were completed on all Wafi and Nambonga core holes typically commencing at 25 m depth, and then every 50 m downhole.

Downhole surveys were not completed for 2007 RC drill holes. The design collar azimuth and dip were used for these drill holes.

Where multiple downhole survey methods were used, all results were recorded in the DataShed database. The highest precision method, and the least susceptible to magnetic interference, is assigned the highest priority and is used for sample locations in the Mineral Resource estimate.

10.7 Drilling Completed Since Database Close-out Date for Mineral Resource Estimates

Eight additional holes were planned to be drilled into the Golpu mineralisation primarily for geotechnical assessments of cave conditions between June 2016 and January 2017. Seven drill holes (7,568.2 m) were completed and one drill hole abandoned.

Geological logging and assays returned from the 2016–2017 program drill holes indicate no material changes to the assumptions in geological and grade continuity in the resource model. The drill results may locally change grade estimates; however, overall, the new drilling should have a minimal effect on the average grade of the model.

Eighteen geotechnical drill holes were completed in 2018. These drill holes were for infrastructure support purposes and are not assayed.

10.8 Sample Length/True Thickness

Drilling density varies in the Golpu area from 50 m x 50 m above 5100 mRL to 200 m x 200 m below 4100 mRL. The Golpu mineralised system is approximately elliptical in plan, elongated towards 345º WLG with a steep westerly to sub-vertical dip. The majority of drilling is oriented across this direction, but the dataset does include holes drilled parallel to the long axis. Most drill holes are complete transects through the porphyry and enclosing mineralised host sediments. The orientation of sampling is considered unbiased toward known structures, and adequate for the disseminated nature of the porphyry gold–copper mineralisation. Drilled thickness in the majority of the drill holes approximates true thickness.

The drill density at the Wafi deposit does not have a uniform spacing, but is typically between 50 x 50 m to 100 x 100 m and increases to 200 x 200 m at depth. Most drilling is clustered in the areas around the high-grade Link Zone and the high-grade portions of the A Zone. Mineralisation at Wafi dips at about 40º east (Wafi Local Grid), subparallel to bedding. The majority of drilling at Wafi is oriented west (Wafi Local Grid) to best drill across the east-dipping mineralisation. Drilling is generally perpendicular to the mineralisation dip, and therefore drill thicknesses approximate true thicknesses.

The drill hole density at collar in the Nambonga area is approximately 100 m along 80 m-spaced lines. Drill hole spacing in the mineralised zones is typically >60 m but may be >100 m in some areas. The majority of the drilling is oriented across the elongation of the main porphyry bodies, and is considered acceptable for the disseminated nature of the porphyry gold–copper mineralisation. Drilled thickness in the majority of the drill holes approximates true thickness.

10.9 Comment on “Item 10: Drilling”

In the opinion of the QP, the quantity and quality of the logged geological data, collar, and downhole survey data collected in the exploration and infill drill programs are sufficient to support Mineral Resource and Mineral Reserve estimation and mine planning for the Golpu deposit, and Mineral Resource estimates for the Wafi and Nambonga deposits as follows:

- Core logging meets industry norms for gold and copper exploration;
- Collar surveys were performed using industry-standard instrumentation at the time the drill program was conducted;
- Downhole surveys were performed using industry-standard instrumentation at the time the drill program was conducted;
- Recovery data from core drill programs are acceptable;
- Geotechnical logging of drill core meets industry standards for planned caving operations;

- Drill orientations are generally appropriate for the mineralisation style and the orientation of mineralisation for the bulk of the deposit areas (refer to drill sections in Section 7);
- Drilling practices, logging, collar surveys and downhole surveys were periodically reviewed by WGJV and Newcrest personnel, and independent auditors (refer to Section 12). These reviews indicate no material issues with the data practices or collection methodologies;
- The drilling patterns provide adequate sampling of the gold and copper mineralisation for the purpose of estimating Mineral Resources (Golpu, Wafi and Nambonga) and Mineral Reserves (Golpu);
- Sampling is representative of the gold and copper grades in the deposit areas, reflecting areas of higher and lower grades.

In the QP's opinion, no material factors were identified with the data collection from the drill programs that could significantly affect Mineral Resource or Mineral Reserve estimation for the Golpu deposit or Mineral Resource estimation for the Wafi and Nambonga deposits.

11 SAMPLE PREPARATION, ANALYSES AND SECURITY

11.1 Sampling Methods

11.1.1 Core

All drill core is sampled and assayed over the entire drill hole length.

Drill core was split using a core saw and half submitted for assay. In the case of PQ core, quarter-core, rather than half-core, could be split and submitted. To maintain core integrity during cutting, some of the core was wrapped in tape to prevent it from breaking.

Core was cut during Harmony and WGJV drilling tenure along the orientation line indicating the bottom side of the drill hole. There is no record for the earlier drill holes as to whether the core was cut along a consistent orientation line. The likelihood of a sampling bias resulting from inconsistent sample selection is not considered to have a material impact on sample quality due to the stockwork nature of mineralisation.

The half core sent for assay was bagged in labelled calico sample bags with the sample number scribed on an aluminium strip included in the bag. The calico bags were placed in larger polyweave bags and transported by road or helicopter to Lae by WGJV employees.

Most sample lengths at Golpu are either 1 m (about 80%) or 2 m (about 20%). Sample lengths were mainly 2 m for drill holes WR001 to WR175 at Wafi, and then 1 m for drill holes from WR176 onwards. Most core drill hole samples at Nambonga average 1 m in length, with lengths varying at contacts of mineralised lithological units.

Historically all core was sawn in half at the Wafi site. During later drill programs, the whole core was directly shipped as plastic-wrapped and secured trays to the dedicated core farm within a security-patrolled compound at Nine Mile, near Lae.

11.1.2 Reverse Circulation

The sampling procedure for the RC drill holes WRC001 to WRC070 was:

- Sample bag is checked, aluminium tag placed in bag with the correct number;
- Bag is attached to the sampler on the rig;
- When the sample bag fills, weigh the sample;
- If the sample is insufficient, the manual riffle splitter is used to split the rejects and obtain the required sample weight;
- Samples are arranged in sequence and blanks and duplicates inserted into the locations specified by the geologist. Duplicates are taken at a frequency of about one in 40 samples;
- Sample dispatch forms are completed, samples are put into poly-weave bags in manageable weights, and despatched to Wau.

The sampling procedure for the RC drill holes WRC071 to WRC087 was:

- Calico sample bags are labelled;
- Standard, blank or duplicate are assigned to every tenth sample;

- Assay pills to monitor sample preparation and analytical accuracy are inserted at random samples throughout sequence;
- 1 m interval of sample is collected from cyclone;
- The sample is put through a riffle splitter;
- Approximately 3 kg of sample is collected in a calico bag;
- Reject is collected in a white polyweave bag;
- The drill hole interval, sample recovery and condition (wet/dry) is recorded in a sample book;
- Samples are transported to site, and then dispatched to the Intertek Laboratory in Lae.

11.2 Density Determinations

The physical determination of bulk density was undertaken on solid pieces of core, 10 cm in length. The measurements were performed on site (as part of the logging process), by geological assistants. Measurements were typically taken at 10 m intervals downhole.

The methods used to derive bulk density values include air/water (approximately 95%) and wax/water (approximately 5%). All bulk density measurements were carried out in accordance with site standard procedures for specific gravity determination ensuring that a consistent methodology was applied for all Harmony and WGJV determinations.

There is a total of 19,942 bulk density measurements for Golpu, with a mean of 2.69 t/m^3. Values range from an average 2.43 t/m^3 in oxidised rock to an average 2.77 t/m^3 in hornblende porphyry.

Golpu bulk density domains were derived from a combination of oxidation, alteration and lithology. Statistical analysis, including histograms, was performed on each domain and anomalous values were excluded from the dataset.

Density values used for Wafi are derived from the Golpu measurements. There is no apparent relationship between bulk density and grade, but there is a weak to moderate correlation between bulk density and RL at the higher oxidised levels (WGJV, 2013).

Evaluation of the available Nambonga data indicated a significant change in the specific gravity (SG) of the host rocks that appears to correspond to a change in core quality from highly broken near surface to solid core at depth. The 291 measurements above the SG anomaly had an average bulk density of 1.85, whereas below the SG anomaly, the mean bulk density value was 2.85. This SG anomaly was coded into the model; however, the rocks were assigned the heavier unbroken SG, given the bias is believed to be related to the inability of the geologists on site to obtain realistic SG samples due to the highly broken nature of the core. Bulk density domains were derived from a combination of oxidation, alteration and lithology, with mean values ranging from 2.68–2.88 assigned to domains. Statistical analysis, including histograms, was performed on each domain and anomalous values based on two standard deviations were excluded from the dataset. Density was directly assigned to the block model by density domain.

11.3 Geotechnical Determinations

From 2011 onwards, approximately 20 cm intervals of whole core were submitted for unconfined compressive strength (UCS) testing. UCS samples were collected at approximately every 30 m in decline holes and 20 m intervals in resource definition drill holes. These 20 cm intervals were not assayed.

11.4 Analytical and Test Laboratories

Pilbara Laboratories, in Lae (Pilbara Lae), was the primary laboratory during the CRAE/Elders drill campaigns (1990–1996). The laboratory was independent. No accreditations are recorded in the Project database. Pilbara Lae underwent a name change to Analabs Lae during the work program. Analabs was subsequently acquired by Genalysis.

Some primary sample preparation was conducted by SGS Lae, with analysis completed in SGS Townsville during the early evaluation drilling. The laboratories were independent. SGS Townsville obtained ISO9001 accreditations in 2001; there is no accreditation information for SGS Lae in the database.

Samples collected from 2005 onwards were prepared at the Genalysis Laboratory in Lae (Genalysis Lae) and forwarded to the Genalysis Jakarta laboratory (Genalysis Jakarta) for analysis. The Intertek Group subsequently acquired Genalysis and the laboratories were renamed. The laboratories were independent. Intertek Lae is not accredited. Intertek Jakarta obtained ISO17025 accreditation in 2014; accreditations prior to that date are not recorded in the Project database.

A number of laboratories were used as check laboratories over the Project history, including locations and laboratories in Madang (PNG Analytical), Lae (SGS, Analabs, Intertek), Wau (SGS), Townsville (Analabs, SGS, ALS Chemex), and Perth (Genalysis, UltraTrace [now part of the Bureau Veritas group]). Laboratories were all independent; however, accreditations at the time of use are not recorded in the Project database.

11.5 Sample Preparation

Sample preparation used at the Pilbara Lae laboratory comprised:

- Drying;
- Crushing to nominal 5 mm;
- Coarse disc pulverising to nominal 180 µm;
- Splitting 500 g;
- Fine pulverising in ring mill to nominal 75 µm;
- 100 g sub-sample sent for analysis.

Sample preparation at the SGS Wau laboratory, with pulps sent to SGS Townsville for assay, consisted of:

- Drying;
- Jaw crushing to nominal 10 mm;
- Crushing in terminator crusher to nominal 2 mm;

- Splitting 1 kg in rotary splitter;
- Pulverising 1 kg in LM2 to nominal 75 µm;
- Splitting 100 g pulp.

Sample preparation completed at the Intertek Lae sample preparation facility in the period 2005–2011, with pulps sent to Intertek Jakarta for assay, consisted of:

- Weighing entire sample;
- Drying in oven (105ºC standard, 65ºC if mercury to be analysed);
- Weighing dry sample;
- Jaw crushing to nominal 2 mm;
- Riffle splitting of 1.5 kg;
- Pulverising 1.5 kg to -200 mesh (75 µm) using LM5 mill;
- 250 g pulp sent for analysis.

Sample preparation at the Intertek Lae sample preparation facility in the period 2012–2014, with pulps sent to Intertek Jakarta for assay, consisted of:

- Drying at 60ºC;
- Crushing using a Boyd crusher to minimum 90% passing 2 mm;
- Subsample of 3.5 kg (±0.5 kg); pulverised using LM5 mill to minimum 95% passing 106 µm;
- 250 g pulp sent for analysis.

11.6 Analytical Methods

A number of different analytical methods were used over the Project history, and are summarised, where known, in Table 11-1.

Intertek Lae and Intertek Jakarta used varying digest and analytical procedures over the Project history.

During the 2005–2008 Harmony drilling, gold was determined by 50 g fire assay with atomic absorption spectroscopy (AAS) finish, multi-element analyses including copper, silver, molybdenum, arsenic and iron were determined by two-acid digest, followed by inductively-coupled plasma (ICP) multi-spectral (MS) or optical emission spectroscopy (OES) finishes. Copper was reassayed by four-acid digest when original samples assayed >10,000 ppm Cu. Sulphur was determined by LECO.

From 2009–2018, gold was determined by 30 g fire assay with AAS finish, multi-element analyses including copper, silver, molybdenum, arsenic and iron were determined by two-acid digest, followed by an ICP MS/OES finish. Copper was reassayed by four-acid digest when original samples assayed >10,000 ppm Cu. From October 2013 onward, multi-element analyses were determined by four-acid digest with an ICP MS/OES finish.

Table 11-1: Analytical Methods

Laboratory	Method	Element and Detection Limit
CEC_Madang	AAS	Ag (0.5, 1 ppm); As (5, 50 ppm); Au (0.005, 0.05 ppm); Bi (5 ppm); Cu (0.005, 5 ppm); Hg (5, 10, 50 ppm); Mn (5 ppm); Mo (1, 2 5 ppm); Pb (0.005, 5 ppm); Sb (1, 2, 5 ppm); Zn (5 ppm)
Unknown CRAE laboratory	AAS	Ag (1 ppm); Au (0.005, 0.1 ppm); Bi (1 ppm); Cu (2, 5 ppm); Fe (1 ppm); Mn (5 ppm); Mo (2, 5 ppm); Pb (3, 5 ppm); Sb (1 ppm); Zn (2, 5 ppm)
	HAAS	As (1 ppm); Sb (0.05, 1 ppm);
Genalysis	4A_ICPMS	Ag (0.01, 1 ppm); As (0.5, 1 ppm); Ba (1 ppm); Be (0.5 ppm); Bi (0.01, 0.05 ppm); Cd (0.05 ppm); Co (0.1 ppm); Cs (0.1 ppm); Ga (0.1 ppm); Ge (0.1 ppm); Hf (0.1 ppm); In (0.05 ppm); Li (0.1 ppm); Mo (0.1 ppm); Nb (0.1 ppm); Pb (0.5, 1 ppm); Rb (0.1 ppm); Re (0.05 ppm); Sb (0.05, 0.1 pm); Se (1 ppm); Sn (0.1 ppm); Sr (0.05, 0.5 ppm); Ta (0.05 ppm); Te (0.05, 0.1 ppm); Th (0.05 ppm); Tl (0.02, 0.1 ppm); U (0.05 ppm); W (0.1 ppm); W (0.1 ppm); Y (0.1 ppm); Zr (0.5 ppm)
	4A_ICPOES	Al (50 ppm); Ca (50 ppm); Cr (2 ppm); Cu (1 ppm); Fe (0.01%); K (20 ppm); Mg (20 ppm); Mn (1 ppm); Na (20 ppm); Ni (1 ppm); P (10 ppm); Pb (5 ppm); S (50 ppm); Sc (1 ppm); Ti (5 ppm); V (1 ppm); Zn (1 ppm)
Intertek	2A_AAS	Ag (0.1 ppm)
	4A_AAS	Ag (1, 5 ppm); Cu (0.01%, 1%); Fe (0.01%); Mn (0.01%); Pb (0.01%); Zn (0.01%)
	4A_ICPMS	Ag (0.1, 0.5 ppm); Al (0.01%); As (1, 5, 10 ppm); Ba (1, 2 ppm); Be (0.5 ppm); Bi (0.05, 5 ppm); Ca 50 ppm, 0.01%); Cd (0.05, 1 ppm); Ce (0.01, 0.1 ppm); Co (0.01, 1, 2 ppm); Cr (2, 5 ppm); Cs (0.1, 2 ppm); Fe (0.01%); Ga (0.1, 10 ppm); Ge (0.1 ppm); Hf (0.1 ppm); In (0.05 ppm); K (0.01%); La (1 ppm); Li (0.1, 1 ppm); Mg (0.01%); Mn (2 ppm); Mo (0.1, 1 ppm); Na (0.01%); Nb (0.1, 5 ppm); Ni (1 ppm); Pb (1, 2 ppm); Rb (0.1 ppm); Re (0.05, 0.1 ppm); S (0.005%); Sb (0.1, 5 ppm); Sc (1, 2 ppm); Se (1, 20 ppm); Sn (0.1, 5, 10 ppm); Sr (0.5, 1 ppm); Ta (0.05, 0.1, 5 ppm); Te (0.1, 5, 10 ppm); Th (0.05, 0.1 ppm); Ti (0.01 ppm, 0.01%); Tl (0.02, 5 ppm); U (0.05, 0.1 ppm); V (0.05, 1 ppm); W (0.1, 5, 10 ppm); Y (0.1, 0.5, 1 ppm); Zn (2 pm, 0.02%); Zr (0.5, 1, 5 ppm)
	4A_ICPOES	Ag (0.1 ppm); Al (50 ppm, 0.01%); As (1 ppm); Bi (2 ppm); Ca (50 ppm); Cd (0.5 ppm); Co (1 ppm); Cr (5 ppm); Cu (1 ppm); Fe (100 ppm, 0.01%); In (0.1 ppm); K (20 ppm); La (20 ppm); Mg (20 ppm); Mn (1, 10 ppm); Mo (1 ppm); Nb (10 ppm); Ni (1 ppm); P (50 ppm); Pb (1, 5 ppm); S (50 ppm; 0.01%); Sb (5 ppm); Sc (1 ppm); Se (20 ppm); Sn (5 ppm); Sr (1 ppm); Te (5 ppm); Tl (5 ppm); U (0.1 ppm); V (1 ppm); Y (0.5 ppm); Zn (0.02, 1, 10 ppm; 0.02%)
	AR_CVAAS	Hg (0.01 ppm)
	AR_ICPOES	Ag (0.05, 0.1, 0.2, 0.5 ppm); Al (0.01, 20 ppm, 0.01%); As 1, 2, 5 ppm); Ba (1 ppm); Bi (0.01, 2 ppm); Ca (0.01%); Cd (0.2 ppm); Ce (0.01, 20 ppm); Co (0.01, 1 ppm); Cr (1, 2 ppm); Cu (1 ppm); Fe (0.01%); Ga (2 ppm); Hg (0.01 ppm); K (0.01, 20 ppm, 0.01%); La (0.01, 1 ppm); Li (1 ppm); Mg (0.01%); Mn (1 ppm, 1%); Mo (0.01, 1 ppm); Na (0.01%); Nb (1 ppm); Ni (1 ppm); P (20 ppm); Pb (1, 2 ppm); S (50 ppm; 0.005%); Sb (0.02, 1, 5 ppm); Sc (1 ppm); Se (10 ppm); (Sn 5 ppm); Sr (0.02, 1 ppm); Ta (5 ppm); Te (0.01, 0.05, 2, 5 ppm); Ti (0.01, 5 ppm); Tl (0.01 pm); (V 1, 2 ppm); W (0.05, 2, 10 ppm); Y (1 ppm); Zn (1 ppm); Zr (1 ppm)
	CL_AAS	Au (0.01 ppm); AuCN (0.01 ppm)
	COMB	S (0.01%)
	FA_AAS	Au (3 ppm)
	FA_GRAV	Au (3 ppm)
	FA20_AAS	Au (0.01 ppm)
	FA25_AAS	Au (0.01, 1 ppm)
	FA30_AAS	Au (0,005, 0.1

Laboratory	Method	Element and Detection Limit
	FA50_AAS	(0.005,1 ppb, 0.005, 0.01 ppm
	FA50_GRAV	Au (3 ppm)
	FA55_GTA	Au (1 ppb)
	LECO	C (0.01%); CO3 (0.05%); S (0.01%)
	OG_ICPOES	Al (0.01%); Ba (2 ppm); Cu (1,10 ppm); Mn (1 ppm); Pb (1 ppm); S (0.01%); Zn (1 ppm)
	XRFFS	Al_2O_3 (0.01%); Cao (0.1%); Cr_2O_3 (0.005, 0,01%); Fe (0.01%); Fe_2O_3 (0.01%); K_2O (0.01%); LOI (0.01%); MgO (0.01%); MnO (0.005, 0.1%); Na_2O (0.1%); P_2O_5 (0.001, 0.1%); SiO_2 (0.01%); Ti (0.01%); TiO_2 (0.1%)
	XRFPP	As (1 ppm, 0.01%); Ba (10 ppm, 0.01%); $CaCO_3$ (0.01%); Sb (1 ppm

11.7 Quality Assurance and Quality Control

Routine QC measures were undertaken to check the precision and accuracy of analytical methods used by the laboratories. The checks involved regular insertion of blanks, duplicates, and gold and base metal standard reference materials (SRMs) into all batches of samples dispatched to the laboratory for analyses.

All assays were checked and verified in accordance with the Newcrest Resource Development Quality Assurance Quality Control (QA/QC) and database management procedures.

The blank samples were sourced from a road base gravel pit near Lae, where no known gold mineralisation exists. SRMs were purchased from Geostats (Australia). Insertion rates were typically 1:40 for SRMs, and 1:100 for blanks.

11.7.1 Golpu

QA/QC protocols for Golpu drilling varied over time, and are summarised in Table 11-2. Repeat samples were obtained from pulverised material at the rate of 1:20. Coarse duplicates, inserted at a rate of one in 20, were also repeat-analysed.

All data from all campaigns support Mineral Resource estimation with no restriction on confidence categories.

No specific drill holes were twinned at Golpu. However, due to the drilling configuration (typically towards grid west or to grid west on the common sections and multiple holes from a single drill pad with small variation in dip), multiple holes cross in close proximity. No major inconsistencies in sampling and assaying were identified between these drill holes.

11.7.2 Wafi

QA/QC protocols for Wafi drilling varied over time, and are summarised in Table 11-3.

Table 11-2: QA/QC, Golpu

Year	Program	Comment
1990–1996	CRAE, Elders	No standards or duplicates were inserted. Regular submission of pulp splits to a second umpire laboratory was conducted. There does not appear to be a systematic bias in the results between the primary and umpire laboratories for this dataset. An evaluation of including/excluding the CRAE/Elders data indicated that the use of these legacy data in the final estimate has no material impact on grade in the classified volumes of the Golpu model. Some domains showed an improved local precision due to the increased data population available with the inclusion of the legacy data.
2005–2008	Harmony	Insertion of SRMs, blanks, specific hole quarter core duplicates and re-assay of selected pulp splits at a second laboratory. Used 19 gold SRMs; no significant bias was observed in any of the gold standards. Used 9 base metal SRMs; Cu analysed using a 2-acid method (Cu <10,000 ppm) showed a consistent negative bias of 5–7%. For Cu >10,000 ppm, analysed using a four-acid method; the results showed no significant bias. Silver and arsenic showed a consistent negative bias of 5–10% across all grade ranges. Blank sample results showed acceptable levels. However, there were a number of outliers, some of which are likely to be SRM swaps. A selection of pulps was sent to a second laboratory for re-assay. Gold results showed a good correlation; however, the copper results showed a 7.5% bias in the Intertek results compared to the umpire laboratory, SGS Townsville. No SRMs were included in the batch, so it is not possible to determine which set of results (or both) are biased. However, the internal copper standards suggest that Intertek did not have any significant copper-positive bias. The program assay results were considered acceptable for use in Mineral Resource estimation.
2009–2014	WGJV	Included submission of SRMs, blanks, campaign quarter core duplicates and re-assay of selected pulp splits at a second laboratory. Insertion rates consisted of SRMs at 1:20; coarse duplicates at 1:20, pulp duplicates at 1:20. 5% of all sample pulps were checked at a nominated second check laboratory with new standards included at a rate of 1:20. Matrix-matched SRMs were created from homogenised coarse reject Golpu mineralised material and implemented into the QA sample stream from April 2013, in addition to the commercially-purchased SRMs already in use. Used 15 gold SRMs; results typically fell within ±2 standard deviations (SDs), with a small number of outliers. No significant bias was observed in any of the gold SRMs. Used 15 base metal SRMs, with four-acid (full digest) certifications for copper, silver, arsenic, molybdenum, sulphur and iron. Copper results, when analysed by two-acid digest for samples containing <10,000 ppm Cu, were negatively biased by 5–10% against the SRM certification. Copper results, when analysed by four-acid (full digest) run on samples containing >10,000 ppm Cu, showed no significant bias compared to the standard certification. Since October 2013, all copper analyses were run with four-acid digest, and no significant bias has been observed. Silver, arsenic, molybdenum and iron showed a consistent negative bias of 5–10% when analysed by two-acid (partial digest) methods. From October 2013, when analysed by the four-acid (full digest) method, no significant bias was observed. Sulphur results analysed by LECO performed within acceptable limits throughout. Blank samples for Au and Cu show that blanks results performed well with only a small number of outliers. Gold and copper results from laboratory repeats also compared well. SGS Townsville and UltraTrace Laboratories Perth used as check laboratories. Gold, copper, silver, sulphur and iron results showed a good correlation between laboratories. The original Intertek laboratory results for silver and arsenic samples are 5–6% lower than the results from the umpire laboratory. Resubmitted a selection of coarse reject samples to Intertek. The coarse duplicate results performed very well and were consistent with the style of mineralisation and the splitting mechanism used. The relative paired difference average for 80% of the samples is well below the generic 25% for gold and 20% for base metals that was used as an internal guide to assess repeatability of coarse duplicates.

Year	Program	Comment
		The analysis methods employed are considered appropriate for the mineralisation style and tenor of grades. No material issues were identified that would invalidate the use of the primary assays held in the Wafi–Golpu DataShed database for Mineral Resource estimations for Golpu.

Table 11-3: QA/QC, Wafi

Program	Comment
Elders	Regular submission of standards and duplicates was not carried out
CRAE	CRAE identified a significant bias in the Elders Resources sample data for drill holes WR032 to WR085 and a program of re-assay and check assay sampling was carried out during 1996 and 1997. The re-assays are reported as being at least partly incorporated into the drill hole database. As the bias had not been resolved, samples from the affected Elders drill holes were not used in grade estimation in the Wafi resource estimate CRAE is reported to have included standards and blanks in sample batches for some drilling but these are not documented. Umpire assays at a second laboratory were completed
Abelle/Harmony	Included regular SRMs, blanks and duplicates. 19 different standards were used between 2003–2007 with almost all results falling within a two standard deviation range with a small number of outliers Pulp repeat assays, and coarse split duplicates were submitted for assay. The pulp repeats illustrate suitable precision and the coarse split duplicates illustrate acceptable repeatability through the sample preparation process Selected pulps from mineralised intervals were sent to SGS Townsville laboratory for check. The umpire assays show that there is no bias present between the Intertek Jakarta and SGS Townsville laboratories

A review of the QA/QC data was completed, with the following findings:

- Results of check assays for the period 1990–1996 indicate no systematic bias in gold results from Analabs Lae;
- Gold results from quarter core duplicate compare fairly well although there are a number of samples outside the ±10% range;
- A selection of pulps was sent to SGS Townsville in 2007. Gold results illustrate a number of samples outside the acceptable limits, however there does not appear to be a consistent bias present. The erroneous results are possibly due to sample mix-ups in the sample preparation and/or assay process, or nugget effect; this bias has not been followed up.

A review of historical documentation on the Wafi database and assay data found that CRAE identified a significant bias in the Elders analytical results. Log probability plots of the gold sample populations grouped by company illustrate that the Elders sample population is biased higher than the CRAE and Harmony/WGJV sample populations for the gold range of 0.1–5 ppm; the bias is significant. The Elders drill holes were relatively shallow and predominantly clustered in the southern area of A Zone and several in the shallower areas of B Zone. As the Elders drill holes have an average depth of <150 m, a further check on the bias was done by comparing the sample populations for all samples with a “depth to” value <150 m. This check compared similar samples from the other drilling data and further confirmed the presence of the bias in the samples. As a result, samples from the affected Elders drill holes (WR032–WR085) were not used in grade estimation.

11.7.3 Nambonga

Sample preparation, security and analytical procedures used at Nambonga were the same as those used for the Wafi and Golpu deposits.

Laboratory pulp checks showed good precision between the splits, repeats and original samples. The low-grade gold SRM being used performed consistently well. Blanks are generally consistent but with some erratic results and bias in some drill holes.

11.8 Databases

Drill hole data are currently stored within an SQL database located at the Lae office. The SQL database uses DataShed software as the user interface.

Drill core was logged directly in the core shed into laptops using LogChief logging software with periodic integration to the WGJV database.

Initial collar surveys were uploaded into LogChief. The final collar pickups were provided by a qualified surveyor in comma-separated value (csv) format, and directly uploaded into DataShed.

Downhole survey data were imported via *.csv files from the survey instruments into LogChief logging software and then uploaded into the DataShed database.

Density data were directly recorded into the LogChief logging software, and then uploaded into DataShed.

Assay data were received from the laboratory in digital format, and were uploaded to the WGJV database using import templates. Significant intersections were reported by the geology team, and verified by the WGJV Geology Manager.

All data uploaded to the database had to pass data integrity checks and reviews. User access to the database was controlled by a hierarchy of permissions and was controlled by WGJV database administrators, with oversight of data integrity by an external DataShed software specialist.

Historical assay data collated by CRAE were imported into the WGJV database from an existing MS Access database. The process used by CRAE to transfer assay data into their database was not recorded; however, checks of the assay data in the database with the original hardcopy results conducted in 2010 (Smith, 2010) indicated that the data were acceptable for use in a Mineral Resource estimate.

The WGJV provides copies of the database to each of the individual WGJV Participants. Database checks are done by Newcrest employees seconded to the WGJV; these Newcrest personnel include staff who have oversight of database management and Mineral Resource estimation.

The database is regularly backed up, and copies are stored in offsite and in Newcrest facilities.

11.9 Sample Security

Sample security has not historically been monitored. During early exploration campaigns, sample collection from drill point to laboratory relied upon the fact that samples were either always attended to, or stored in the locked on-site preparation facility, or stored in a secure area prior to laboratory shipment. Chain-of-custody procedures consisted of sample submittal forms to be sent to the laboratory with sample shipments to ensure that all samples were received by the laboratory.

During the WGJV drill programs, drill core was delivered directly from the drill rig at the end of each shift by the drill crew to the logging shed within the Wafi Camp security compound. This compound is fenced, and 24-hour patrolled.

Whether transported as trayed whole core or sawn core samples, all transport for WGJV programs was always under the direct supervision of WGJV employees within tamper-evident packaging from site until delivery to the Intertek Laboratory in Lae.

Core samples are prepared in Intertek Lae within their secured premises and pulps are air-freighted by international couriers to Intertek Jakarta for assaying. A detailed labelling, documentation and tamper-evident packing protocol is in place for this transfer. Pulps are stored on a long-term basis in Jakarta. Assay results from Intertek Jakarta are returned to the WGJV network, and loaded to the Wafi database by dedicated administrators after correlation against despatch records, and after passing the QA/QC protocol.

11.10 Sample Storage

Drill core is stored in a dedicated and fenced facility at Nine Mile, near Lae. Due to the nature of mineralisation, the sulphidic intercepts are especially prone to oxidation and degradation. Some core, particularly for metallurgical purposes, is stored in a cold-storage facility in Brisbane.

Pulps and crusher residues were returned from the Lae laboratory to the Nine Mile core farm for long-term storage under direct supervision of WGJV staff.

Since 2011, pulps are retained for all samples in a dedicated storage facility at Intertek Jakarta.

11.11 Comments on Item 11: "Sample Preparation, Analyses and Security"

In the opinion of the QP, the sample preparation, analysis, and security practices, data collection, and quality are acceptable, meet industry-standard practices, and are sufficient to support Mineral Resource and Mineral Reserve estimation and mine planning purposes, based on the following:

- Drill sampling was adequately spaced to first define, then infill, gold and copper anomalies to produce prospect-scale and deposit-scale drill data;
- Sample preparation for core samples has followed a similar procedure since Harmony acquired the Project in 2005. The preparation procedure is in line with industry-standard methods;
- Analytical methods for core samples used similar procedures. The analytical procedures are in line with industry-standard methods;
- The WGJV has used a QA/QC program comprising blank, SRM and duplicate samples. QA/QC submission rates were typical for the program at the time the data were collected. Evaluations of the QA/QC data do not indicate any significant problems with the analytical programs, therefore the gold and copper analyses from the core drilling are suitable for inclusion in Mineral Resource estimation;
- Data collected prior to the introduction of digital logging were subject to validation;

- Verification is performed on all digitally-collected data on upload to the main database, and includes checks on surveys, collar co-ordinates, lithology, and assay data. The checks are appropriate, and consistent with industry standards;
- Sample security has relied upon the fact that the samples were always attended or locked in the on-site sample preparation facility. Chain-of-custody procedures consist of filling out sample submittal forms that are sent to the laboratory with sample shipments to make certain that all samples are received by the laboratory;
- Current sample storage procedures and storage areas are consistent with industry norms.

12 DATA VERIFICATION

12.1 Laboratory Visits

Laboratory inspections were regularly conducted over the Project history, although older inspection records are no longer available. Inspection periods have varied between monthly and six-monthly intervals.

Additional measures include laboratory visits performed by the Newcrest Operations Chemist. Visits have included:

- Intertek Lae: 2013;
- Intertek Perth: 2013, 2017.

Laboratory visits have also been undertaken on Newcrest's behalf by consultant sampling specialists such as Agoratek International.

12.2 Internal Data Verification

Drill hole data for the Project were collected over many years by a number of operators. Resource documentation indicates that at various times the legacy data were reviewed and compiled into a drill hole database. Limited numbers of the original laboratory certificates are available for the legacy data. More current drilling activity by Harmony and more recently by WGJV was conducted under standard operating procedures that include data verification before data are accepted into the drill hole database.

12.2.1 CRAE

Legacy assay data collated by CRAE was imported into the Project DataShed database from an existing Access database. The process used by CRAE to transfer assay data into their database is not recorded; however, checks of the assay data in the database with the original hardcopy results indicate they are acceptable for use in a resource estimate (Smith, 2010).

Approximately 20% of composites used in the Golpu Mineral Resource model are derived from CRAE/Elders drilling. These drill holes are located in the upper Golpu Porphyry where there is also significant drill data acquired during Harmony and WGJV drill programs. The later drilling supports the use of the CRAE/Elders data in estimation.

12.2.2 Database

Data review was completed before the estimation of Mineral Resources and Mineral Reserves. Checks included:

- Logging records were reviewed against core photographs as part of the interpretative geology compilation;
- Validation of collar surveys against planned locations. All collars were reviewed specifically to ensure collars are within tolerance of the surface survey. A campaign of collar surveys was completed before the database was closed. Some historical hole collars that were considered to be in error could not be located due to rehabilitation of the drill pad; in these rare cases, the centre of the pad was surveyed and applied to the collar;

- Downhole surveys were reviewed for consistency of hole path and any discrepancies either assigned a low priority in the database so it would not be used in the final extract dataset or corrected if the error was apparent. Checks included plots of depth versus dip and dip versus azimuth to identify unrealistic steps in the reported data. For dips, this may result from the collar set-up value not reflecting first downhole survey, and errors in dip recording due to not allowing time for the instruments to stabilise. For azimuths, errors result from magnetite inference for Reflex tools, incorrect joining of non-north seeking gyro survey runs, and compass azimuth orientation at collar that does not align with gyro surveys;
- Non-assayed drill holes were removed from the database extract used in estimation;
- Assays were reviewed for consistency and errors and compared against observed mineralisation. Spot checks were conducted to ensure QA/QC protocols were followed before data were loaded to the database;
- Where a below detection level assay value is reported, the following values were applied based on half of the lowest valid reported assay result:
  - Gold: 0.002 ppm Au;
  - Copper: 0.5 ppm Cu;
  - Silver: 0.05 ppm Ag;
  - Molybdenum: 0.05 ppm Mo;
  - Arsenic: 0.5 ppm As;
  - Sulphur: 50 ppm S;
  - Iron: 2 ppm Fe.
- All updates or changes to the database were approved by the Mineral Resources Manager.

No material errors were identified after final data extraction for input to the Mineral Resource model estimation.

12.2.3 Data Review in Support of 2014 Golpu Model

A specific data review exercise was completed before the estimation of the Golpu Mineral Resources:

- Drill hole location and downhole path checks included validation of collar surveys plotted against planned locations and topographic surveys and consistency of the hole trace;
- Assays were reviewed for outliers and errors and compared with observed mineralisation;
- Checks were conducted to ensure QA/QC protocols were followed before data were loaded to the database;
- Logging records were reviewed against core photographs as part of the interpretative geology compilation and wire-framing.

Any errors that were identified were corrected before final data extraction for Mineral Resource estimation purposes.

12.2.4 Data Review in Support of 2018 Wafi and Nambonga Models

A specific data review exercise was completed before the estimation of the Nambonga and Wafi Mineral Resources:

- Drill hole location and downhole path checks included validation of collar surveys plotted against planned locations and topographic surveys and consistency of the hole trace;
- Assays were reviewed for outliers and errors and compared with observed mineralisation;
- Checks were conducted to ensure QA/QC protocols were followed before data were loaded to the database;
- Logging records were reviewed against core photographs as part of the interpretative geology compilation and wire-framing.

Any errors that were identified were corrected before final data extraction as input to the Mineral Resource estimation.

12.3 Resources and Reserves Steering Committee

Newcrest has implemented the Resources & Reserves Steering Committee, to ensure appropriate governance of development and management of resource and reserve estimates, and the public release of those estimates. This is achieved by ensuring regular Resources & Reserves Steering Committee review meetings, internal competent person reviews, and independent external competent person reviews.

In particular, the Resources & Reserves Steering Committee is responsible for monitoring performance of Mineral Resource and Mineral Reserve models, ensuring governance over changes to estimation, and reporting of resources and reserves including critical input parameters of costs base assumptions, metallurgical recovery algorithms and mining dilution. The Resources & Reserves Steering Committee also monitors reconciliation of extracted metal to the resource and provides governance to resolving reconciliation variance. The committee ensures that independent external reviews of Mineral Resources and Mineral Reserve estimates for each deposit are conducted at a minimum of every three years or more frequently when a material change has occurred.

The Resources & Reserves Steering Committee comprises permanent members that represent the following areas: operations, resource management, commercial, mining and metallurgy.

The QP is a member of the Resources & Reserves Steering Committee and the current committee chair.

12.4 External Data Verification

12.4.1 Golpu

12.4.1.1 2012

AMC Consultants Pty Ltd (AMC) were commissioned in 2012 to conduct a review of the drilling, sampling and analytical processes and associated QA/QC procedures that were relied upon to support the Golpu estimates.

The Golpu Mineral Resource and Mineral Reserve estimates were the subject of independent external review by AMC in 2012.

No material issues were identified in these reviews and AMC concluded that the 2012 estimates were prepared using accepted industry practice and had been classified and reported in accordance with the 2012 JORC Code.

12.4.1.2 2018

In 2018, SRK performed an independent review of the Mineral Resource estimate, checking input data and the estimation methodology and process. SRK concluded that the estimate was suitable for use in feasibility-level studies assuming a block caving mining method.

SRK reviewed the Mineral Reserves as documented in the 2018 Feasibility Study Update. Key observations included:

- The approach whereby the 4825 mRL cave engineering platform is established early to provide ground condition information was endorsed, in particular for long term cave monitoring purposes;
- Shaft development rates should be expected to be better than the planned 48 m/month;
- The production schedule indicates material production dips between extraction level horizons;
- Project development forecasts will depend on the actual ground conditions and likely groundwater interactions;
- Additional orebody knowledge is required to confirm the rock strength in actinolite;
- The introduction of a vertical destress slot is supported to mitigate stress impacts on key infrastructure;
- Modelling indicates that cave induced stress will be an issue on all proposed levels and will need intensive schedule control to manage stress build ups during construction and production ramp-up;
- A sustainable cave management/draw control strategy will be required during production to avoid the individual caves running away;
- Mud rushes represent a risk given the rainfall setting and predicted fine fragmentation.

12.4.1.3 Drill Collar Survey Check

An external review of all drill hole locations was completed by third-party surveyors Quickclose Pty Ltd., in February 2012, and updated in May and August, 2016, and again in June 2018 (Stanaway, 2012, 2018).

12.4.2 Wafi

12.4.2.1 2015

AMC reviewed the Wafi Mineral Resource estimate in 2015, and concluded that the 2015 estimates were prepared using accepted industry practice and had been classified and reported in accordance with the 2012 JORC Code.

AMC noted that the assumed mining cost input to the non-refractory cut-off grade calculation appeared to be low compared to AMC's analogues, and recommended it be reviewed.

12.4.2.2 2019

SRK performed an independent review of the Mineral Resource estimate, checking input data and the estimation methodology and process. The estimate was considered to be reported in accordance with the 2012 JORC Code. SRK made a number of observations for consideration in future model updates, including:

- Evaluation of the geological controls on the spatially and statistically distinct higher-grade gold mineralisation within the 300 ppm As shell;
- The 40 m average distance shell may be a good differentiator between the denser and more sparsely drilled areas, and could be useful for sub-classification when examining local uncertainty in the estimates in more detail;
- The local estimate may contain uncertainty that is not fully reflected in the current local block, such that Mineral Resource classification blocks of lower estimation quality may contain significant smoothing and result in underestimation of metal;
- An additional domain based on a grade shell at a grade of around 7 ppm Au may produce a less smooth and better local estimate.

12.4.3 Nambonga

12.4.3.1 2008

Maxwell Geoservices reviewed the Nambonga drill database in 2008, and examined gold and copper assays, data entry, sample dispatch and return, sampling, repeats/checks, SRMs, blanks, duplicates, and assay prills.

Review of core wet and dry sample weights to check for poorly-correlated weights that might be indicative of sampling bias or sample mix ups. Maxwell Geoservices observed that "*Correlation of sample weights was not good up to WR277. Correlation of sample weights is very good for holes WR277A to WR280, and then decreases for the recent holes*".

Evaluation of available pulp/check samples indicated "*Up to hole WR277 there is a general negative bias in the repeat sample analysis. This is particularly evident in WR272. Although there is not a correlation between the samples with poor sample weight pairs and poor Au analysis, in general those holes that indicate good sampling practices also tend to show a less biased and narrower band of scatter of the Au* *results in the quarter core splits. Laboratory pulp checks showed good precision between the splits, repeats and original samples"*

Nineteen gold SRMs were used. No significant bias was observed in any of the gold SRMs. Nine base metal standards were used with certifications for copper, silver and arsenic. Copper analysed with two-acid method < 10,000 ppm showed a consistent negative bias of 5–7%, whereas copper >10,000 ppm analysed with four-acid method showed no significant bias. Silver and arsenic showed a consistent negative bias of 5–10% across all grade ranges.

Of the selection of pulps sent to SGS Townsville for re-assay, gold results showed a good correlation; however, copper results showed Intertek results were 7.5% biased compared to SGS Townsville. Maxwell Geoservices noted that "*internal copper standards suggest Intertek did not have any significant copper positive bias*".

Overall, Maxwell Geoservices concluded that the data collected on the Nambonga deposit were suitable to support Mineral Resource estimates.

12.4.3.2 2018

SRK performed an independent review of the Mineral Resource estimate, checking input data and the estimation methodology and process. The estimate was considered to be reported in accordance with the 2012 JORC Code. SRK made a number of observations for consideration in future model updates, including:

- Multiple copper grade populations can be seen in at least one of the geological model domains, but with the wide-spaced drilling it is not currently clear whether these populations can be separated spatially into additional geological domains;
- The identified presence of at least one late mineralised fault containing high grades but minimal volume suggests that additional unidentified small-scale structures may be contributing to the higher-grade sub-population. It is likely that future additional drilling will address this and determine whether further sub-domaining is warranted;
- The tonnage sensitivity of the block model to changes in estimation parameters should be examined further.

12.5 QP Comments on "Item 12: Data Verification"

The process of data verification for the Project was performed by Newcrest and WGJV personnel and external consultancies contracted by Newcrest.

The QP, who relies upon this work, reviewed the reports and is of the opinion that the data verification programs indicate that the data stored in the Project database accurately reflect original sources and are adequate to support geological interpretations and Mineral Resource and Mineral Reserve estimation, and in mine planning.

The QP performed a site visit in 2012 (refer to Section 2.4), which was the year of the most recent Project resource delineation drill program. Observations made during the visit, in conjunction with discussions with site-based technical staff, support the geological interpretations, and analytical and database quality.

The QP's role as the chair of the Resources & Reserves Steering Committee includes review of the estimation processes for Mineral Resource and Mineral Reserve estimation, mine planning, and the control procedures in place to ensure the process is being executed as intended.

13 MINERAL PROCESSING AND METALLURGICAL TESTING

13.1 Metallurgical Testwork

13.2 Introduction

Laboratories and testwork facilities used during metallurgical evaluation of the Golpu deposit include the following independent consultants: Tunra Bulk Material Handling Research Association; JKTech; ALS laboratories in Brisbane and Adelaide; Metso; Outotec; Paterson & Cooke; SGS Environmental Services; Orway Mineral Consultants (OMC); and Glossop Consultancy.

Laboratories and testwork facilities used during metallurgical evaluation of the Wafi deposit include the following independent consultants: Ammtec, SGS Lakefield Oretest, Amdel, IML, Fox Anamet, JKTech, and Optimet. Internal laboratories at Newmont, CRAE, and Rio Tinto were also used.

Metallurgical testwork completed on the Golpu and Wafi deposits included:

- Golpu: modal mineralogy, copper mineralogy, sulphide grain size information, sulphide association, comminution (SMC test, drop weight index (DWi), Bond ball mill work index (BWi), ore hardness, ore competency (Axb)), batch flotation, locked-cycle flotation, cleaner/scavenger tests, effect of primary grind size on gold recovery, tailings and concentrate thickening/pumping, concentrate filtration and characterisation; flocculant screening and dynamic settling testwork; rheological characterisation;
- Wafi: Mineralogy, flotation, roasting, pressure oxidation (POX), bacterial leaching, and comminution work;

No metallurgical testwork was completed on the Nambonga deposit.

13.2.1 Golpu

13.2.1.1 Sample Selection

The selection of domain composite samples was based on data from a variety of sources including geochemical analysis, Corescan and geological logs, and provides acceptable considerations of mineralogical associations.

Thirteen geometallurgical domains were defined for variability testwork, bulk flotation testwork and ore characterisation (Table 13-1, Figure 13-1, and Figure 13-2).

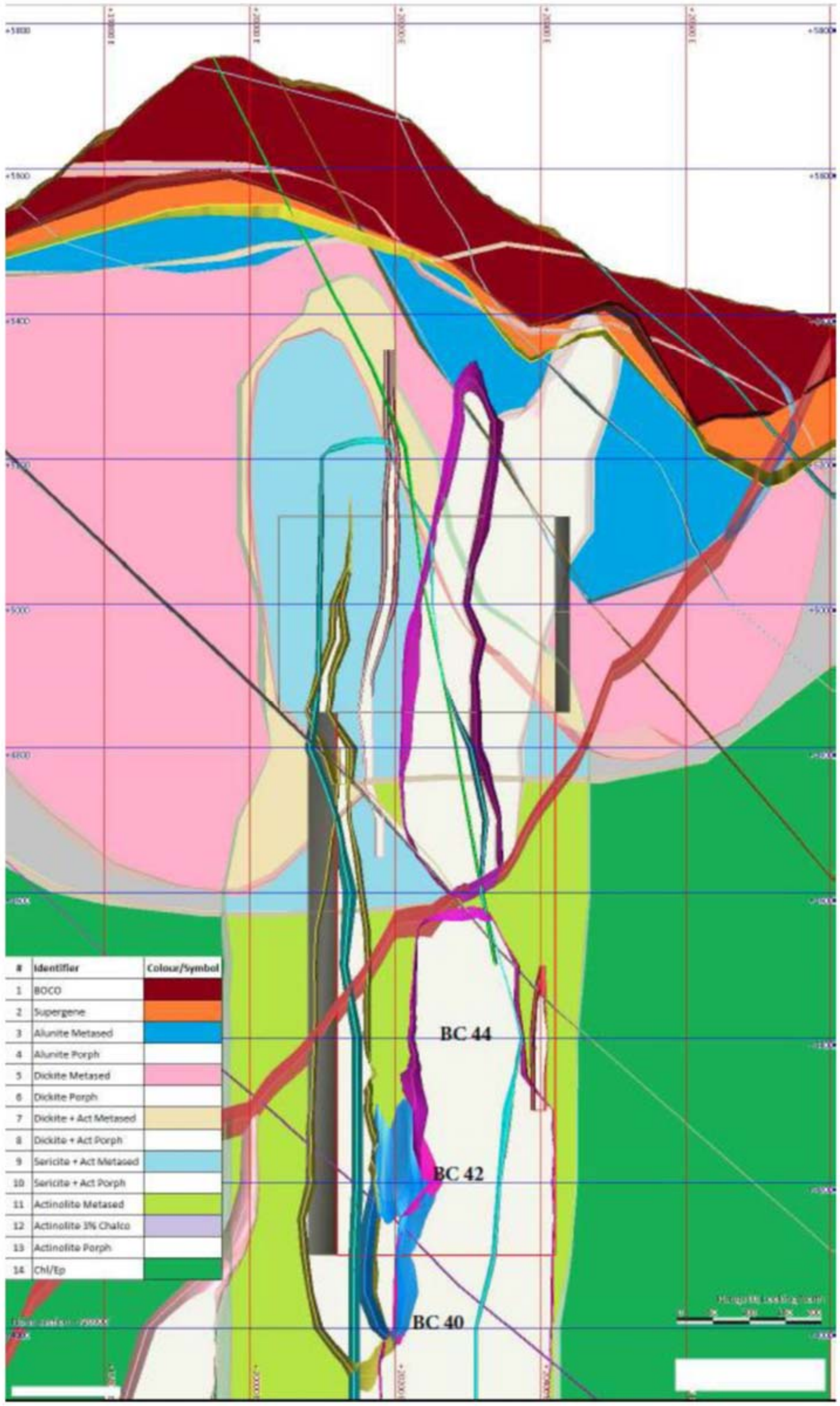
Nine of the domains are of interest in the mining study. Most of the mineralised material is hosted in the Hornblende (Livana) Porphyry (Domain 30/33) and the adjacent metasedimentary rocks (Domain 29). The Hornblende (Livana) Porphyry domains are metallurgically similar, are classified as separate domains based on their position above and below the Reid Fault, and the major alteration types present.

Domain 33 represents a significant proportion of the feed for the first five years of the proposed mine plan. While Domain 30 was the basis of much of the flowsheet development program testwork, substantial legacy work has also been completed on Domain 33.

Table 13-1: Geometallurgical Domains

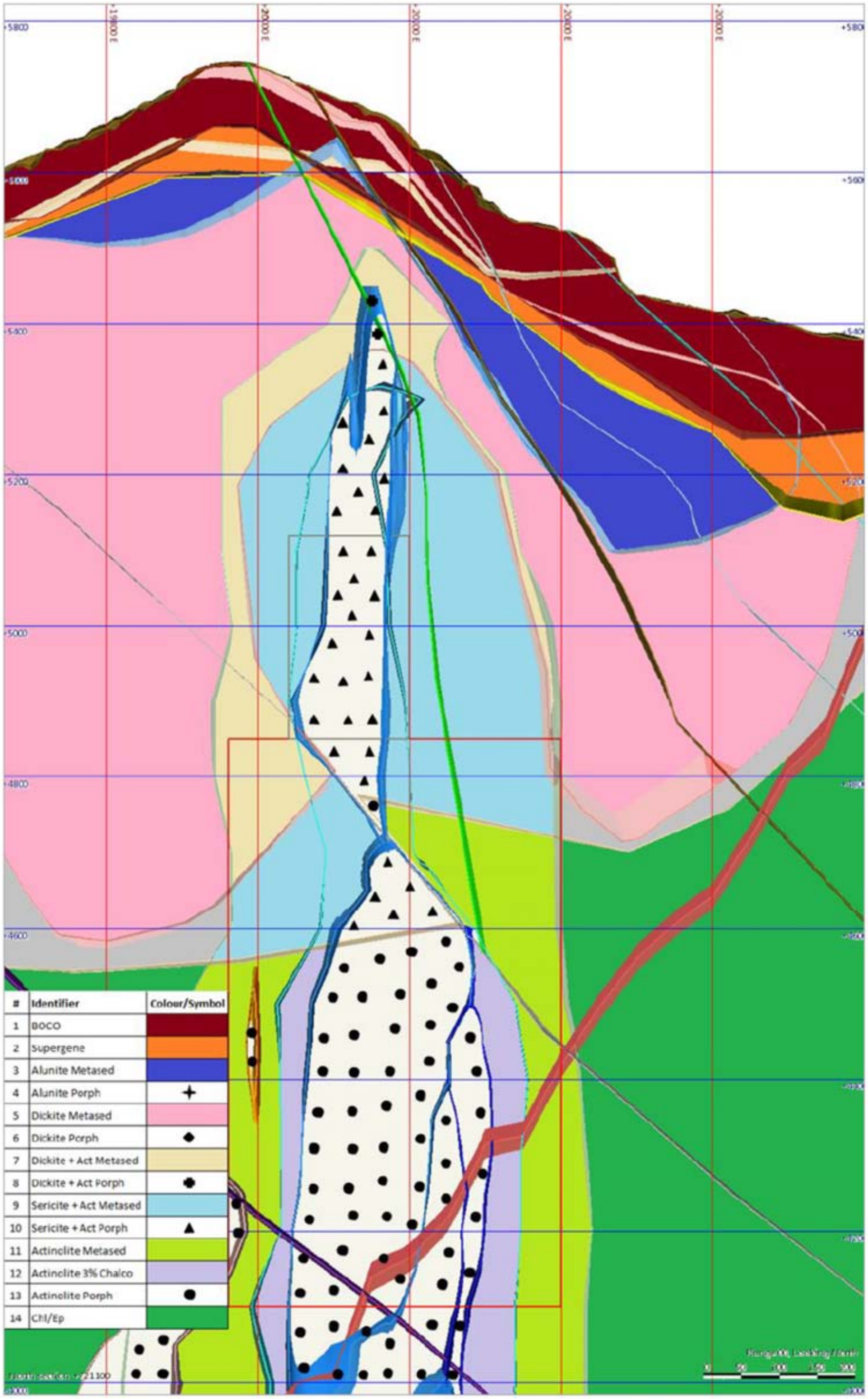
Geometallurgical Domain ID	Description
21	Base of Complete Oxidation
22	Supergene
23	Alunite metasediment
24	Alunite porphyry
25	Dickite metasediment
26	Dickite porphyry
27	Dickite + actinolite metasediment
28	Dickite + actinolite porphyry
29	Sericite + actinolite metasediment
30	Sericite + actinolite porphyry
31	Actinolite metasediment
32	Actinolite 3% chalcopyrite
33	Actinolite porphyry

Figure 13-1:Cross-Section of Geometallurgy Domains at 720,900 mN (Wafi Local Grid)



Note: Figure prepared by WGJV, 2018.

Figure 13-2:Cross-Section of Geometallurgy Domains at 721,100 mN (Wafi Local Grid)



Note: Figure prepared by WGJV, 2018.

Samples required for concentrate and tailings support and vendor testwork were produced via bulk batch flotation, using optimised flotation conditions (2013–2014 testwork campaign).

13.2.1.2 Flowsheet Development

The following testwork and optimisation studies were conducted as part of the flowsheet development program:

- Ore characterisation studies, incorporating multi-element head analysis and quantitative X-ray diffraction (XRD) on geometallurgical variability samples;
- Comminution studies on selected variability samples. The suite of tests conducted included BWi and semi-autogenous grinding (SAG) mill comminution (SMC test) testwork;
- Flowsheet development testwork and flotation optimisation, incorporating:
  - Rougher and cleaner rates to establish flotation kinetics;
  - Primary grind size establishment;
  - Sequential copper and pyrite flotation vs. bulk flotation;
  - Reagent screening and optimisation, including pH modifier, collector and pyrite depressants;
  - Optimisation of the copper and pyrite circuit cleaner regrind sizes;
  - Ore blending testwork;
  - Locked cycle testwork on individual domain samples, as well as on porphyry/metasediment blends;
  - Gold leach characterisation, including leaching of the locked cycle test tailings.

The outcome of the flowsheet development program was the development and optimisation of two process flowsheets. This facilitated the stage-wise upgrading and modification of the process plant to accommodate the changing composition of the plant feed over the life-of-mine (LOM). The first flowsheet, the LEAN flowsheet, was designed to provide an optimal processing solution for treating high-grade ores with a porphyry content of 75% or more. The second flowsheet, the Golpu flowsheet, was designed to treat mineralisation with a porphyry content of less than 75%, and incorporated a pyrite circuit for improved gold recovery from the metasediment-rich material.

Both flowsheets originally incorporated a gold leach circuit for gold recovery from the copper and pyrite scavenger tailings. Economic assessments indicated that the gold leach circuit was not financially viable, and so was removed from future design considerations. This decision should be monitored however, as at high gold prices, the circuit may be warranted.

Table 13-2 summarises the testwork programs conducted by program purpose.

Table 13-2: Golpu Metallurgical Testwork

Ore Characterisation	Flowsheet and Investigative Testwork	Variability Studies	Supporting Testwork	Engineering and Vendor Testwork	Pilot Testing
Chemical characterisation	Confirmation of circuit parameters including comminution	Metallurgical variability by domain	Concentrate quality	Bulk materials handling	For unproven processes, flowsheets, technologies or for complex flowsheets. Note: excluded from this study
Mineralogical characterisation	Ore blending	Variability over LOM	Dangerous goods assessment	Concentrate thickening reagent screening and settling tests	
Metallurgical characterisation	Effect of site water on metallurgical performance		Concentrate solution testing	Concentrate filtration testwork	
	Effect of aging on metallurgical performance		Water treatment testing, mine and port	Bulk concentrate handling	
				Tailings thickening reagent screening and settling tests	
				Bulk tailings characterisation	
				Hydraulic studies (pipeline and pumping	
				Regrind specific energy tests	

Table 13-3 summarises the results from the DWi, BWi and Axb tests. The Axb values ranged from very soft to very hard. BWi values ranged from medium to very hard. Overall, ore competency (Axb) did not correlate strongly with increases in BWi. This indicated that competence and therefore SAG milling performance was not related to grinding energy to achieve product size.

Due to a high co-efficient of variation in the Axb samples, the 75th percentile summaries were used to define the design criteria for the BC44 and BC42 mining zones. Material within BC40 was generally harder than the other two zones, and could potentially necessitate a plant upgrade or installation of a secondary crusher when the material became part of the mill feed stream.

Two sets of benchmarking were undertaken, including benchmarking of the measured comminution data against OMC's database as well as benchmarking of SAG-specific energy estimates for the Golpu Development against similar operations.

Table 13-3: Comminution Parameters

Parameter	Average			75th Percentile		
	2015 Data Only	Full Set (excl. 2015)	Full Set (incl. 2015)	Feasibility Study Data Only	Full Set (excl. 2015)	Full Set (incl. 2015)
BWi (kWh/t)	11.69	13.38	12.94	14.00	14.84	14.50
Axb	46.31	81.55	72.58	82.58	91.30	89.18
DWi (kWh/m^3)	2.25	3.83	3.43	3.94	4.47	4.42

13.2.1.3 Variability Tests

Variability tests were conducted in open circuit, with selected locked-cycle tests conducted to simulate plant conditions and ensure repeatability. The selected variability samples targeted the Golpu Development payback period, and were selected based on the following priority sequence: copper grade, then gold grade, then sulphur grade. The objective of the variability testwork was to generate metallurgical results over a range of head grades and spatial locations (mRLs) within the target domains of the planned block cave. In this manner, trends relating to ore variability could be identified for metallurgical modelling purposes.

The average variability result showed an excellent correlation to the bulk flotation testwork conducted for engineering and support testwork (Table 13-4, Table 13-5). The most obvious trends (recovery as a function of spatial location, head grade and Cu:S ratio) are presented in Figure 13-3 and Figure 13-4. Recovery plots for copper and gold versus respective head grades showed poor correlation. In addition, no relationship between spatial location and recovery was observed. A potential correlation between Cu:S ratio and copper–gold recovery was noted. This correlation was enhanced by splitting the results above and below 4,700 mRL. This, however, is still not a strong correlation, and further work would be required to refine this equation. Attempts were made to look at other parameters (including Fe:S, Au:S, Au:Fe and sulphur) but none of these provided adequate trends. The most promising correlations were between mass pull and recovery, for both concentrate and for rougher concentrate unit operations.

For cyclic variability tests, good copper grades and recoveries were obtained for most samples. The cyclic testwork results correlated well to the batch variability testwork results. It was noted that lower gold recoveries were achieved for some of the batch variability tests, when compared to the cyclic test on the equivalent sample.

13.2.1.4 Flotation Modelling

An Excel-based metallurgical model was developed to predict year-on-year flotation performance based on the proposed life-of-mine plan. Separate recovery models were developed for the LEAN and Golpu flowsheets for porphyry and metasediment. The recovery and mass yields derived from these models were proportionately blended as per the proportions indicated in the LOM to generate a combined recovery model and to appropriately capture the different metallurgical characteristics of the two major lithologies of the ore were captured within the metallurgical model. The models were validated against locked-cycle testwork.

Table 13-4: Statistical Summary of Variability Results – Total Copper Concentrate

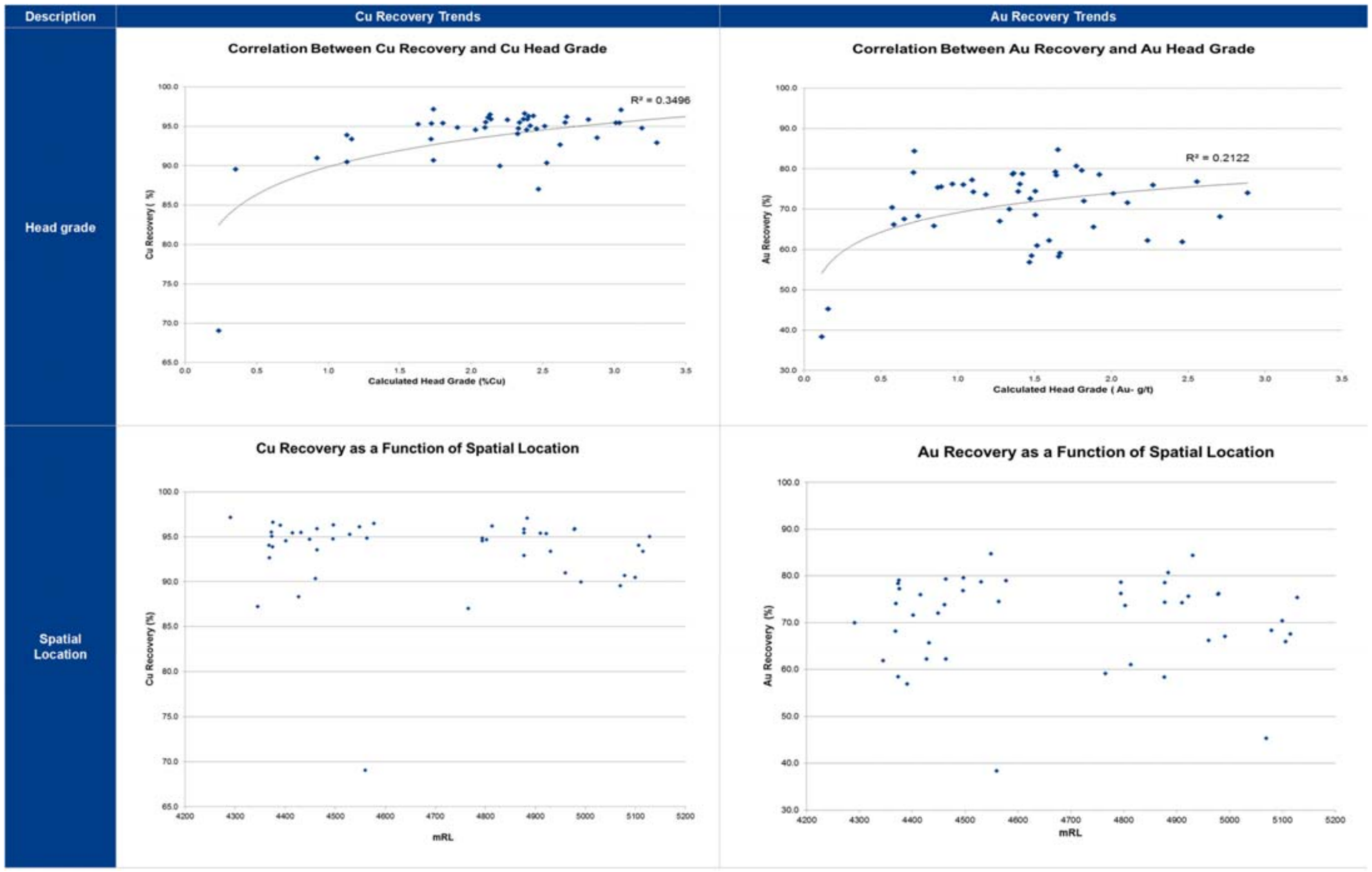
Description	Mass Pull (%)	Concentrate Grade			Recovery		
		Cu (%)	Au (g/t)	S (%)	Cu (%)	Au (g/t)	S (%)
Average	7.30	28.20	13.70	35.50	93.40	70.70	79.60
Maximum	10.80	33.90	24.70	45.80	97.20	84.70	95.30
Minimum	3.20	3.70	1.00	31.70	69.10	38.40	51.40
Standard deviation	1.90	5.40	4.90	2.70	4.50	9.50	10.40

Note: The minimum grade and recovery data were obtained from a very low-grade sample (sample 14), which has a head grade of 0.23% Cu and 0.11 g/t Au. The low grades and recoveries were therefore anticipated.

Table 13-5: Average Variability Results Vs. Bulk Flotation Concentrate

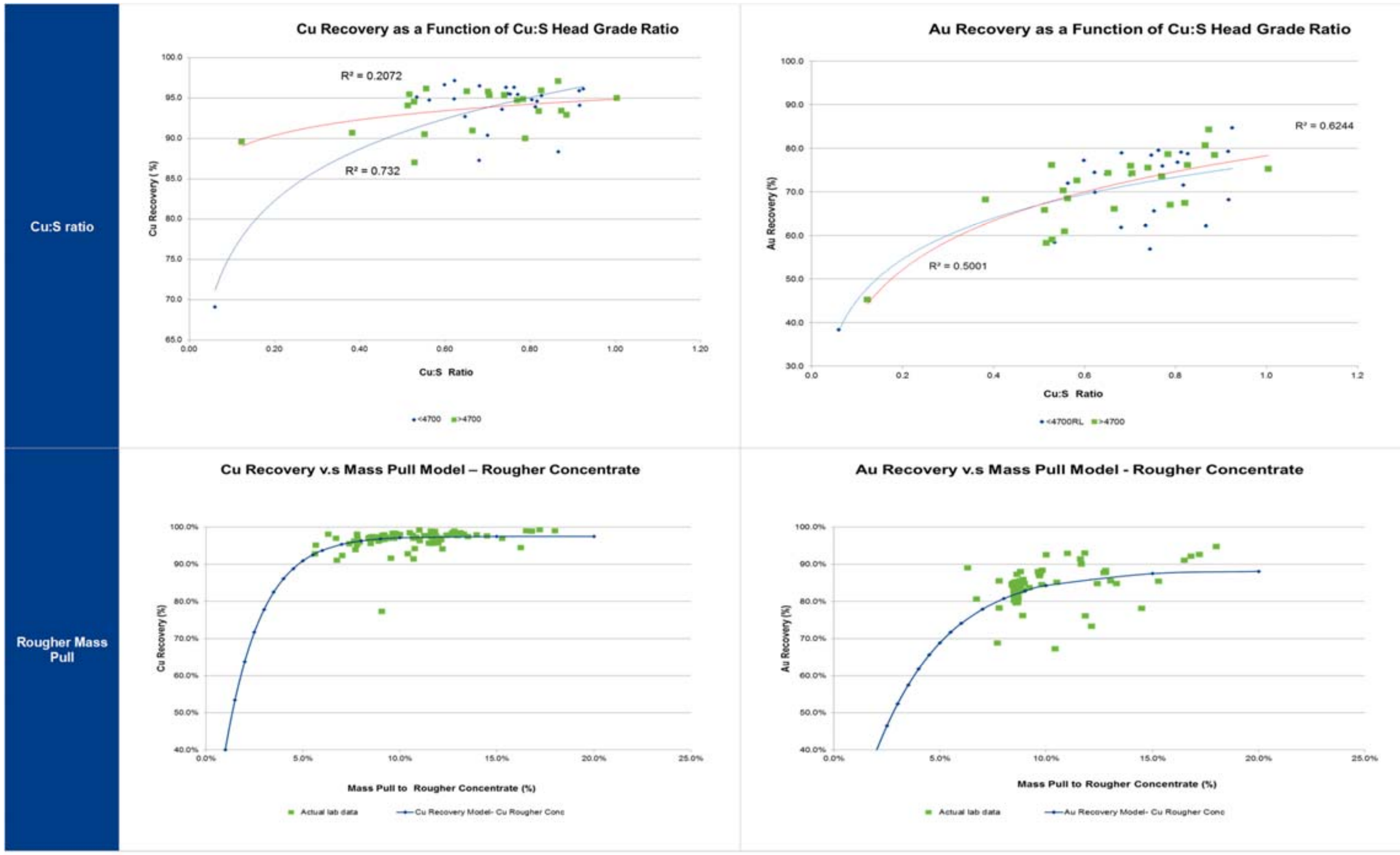
Description	Mass Pull (%)	Concentrate Grade			Recovery		
		Cu (%)	Au (g/t)	S (%)	Cu (%)	Au (g/t)	S (%)
Average	7.3	28.2	13.70	35.50	93.40	70.70	79.60
Bulk concentrate	7.9	28.1	12.98	38.10	95.50	68.60	72.80
Delta	-0.6	-0.1	0.72	-2.60	-2.10	2.10	6.80

Figure 13-3:Recovery Trends



Note: Figure prepared by WGJV, 2018.

Figure 13-4:Variability Trends



Note: Figure prepared by WGJV, 2018.

The foundation of the metallurgical models for all flowsheet variations was a mass pull versus recovery model for copper rougher flotation for the major elements (copper, gold and sulphur), derived from a simple decay model. The maximum recovery for each of the elements of interest was assigned from the maximum recoveries attained from the testwork program.

The remaining unit operations were modelled using standard metal balance techniques. Typically inputs into these unit operations included stage recoveries and concentrate upgrade ratios, expressed in relation to the rougher flotation model, as opposed to fixed recovery and concentrate grade values. This provided the facility for all recovery and grade values within the circuit to vary with head grade.

The metallurgical model was used to track trends relating to the process flowsheet over the anticipated mine life. These trends included mass pull to the various unit operations, copper and gold recoveries, as well as the grades associated with the various streams. The average and maximum values for each phase could be defined, and therefore used as a basis for the process design criteria.

The models derived for both LEAN and Golpu base case circuits were validated against appropriate locked-cycle testwork to ensure that the outputs were consistent with the testwork program. This was conducted by applying the locked cycle test feed grades and ore composition to the developed model and comparing the outputs to the actual testwork results. The models prepared to simulate metallurgical performance compared well with the actual metallurgical performance measured during testwork (Figure 13-5, Figure 13-6).

13.2.1.5 Grind Optimisation

Tests on the optimum grind size for flotation were completed at three sizes, 300 µm, 212 µm, and 150 µm. Results are provided in Figure 13-7 and Figure 13-8.

Recovery decreased significantly when the primary grind size was increased from the proposed grind of 106 µm. On average, a copper recovery drop of approximately 6% was observed when the primary grind was increased from 80% passing 106 µm to 80% passing 300 µm. Similarly, an average gold recovery drop of 9% was observed with the grind size was increased to 300 µm.

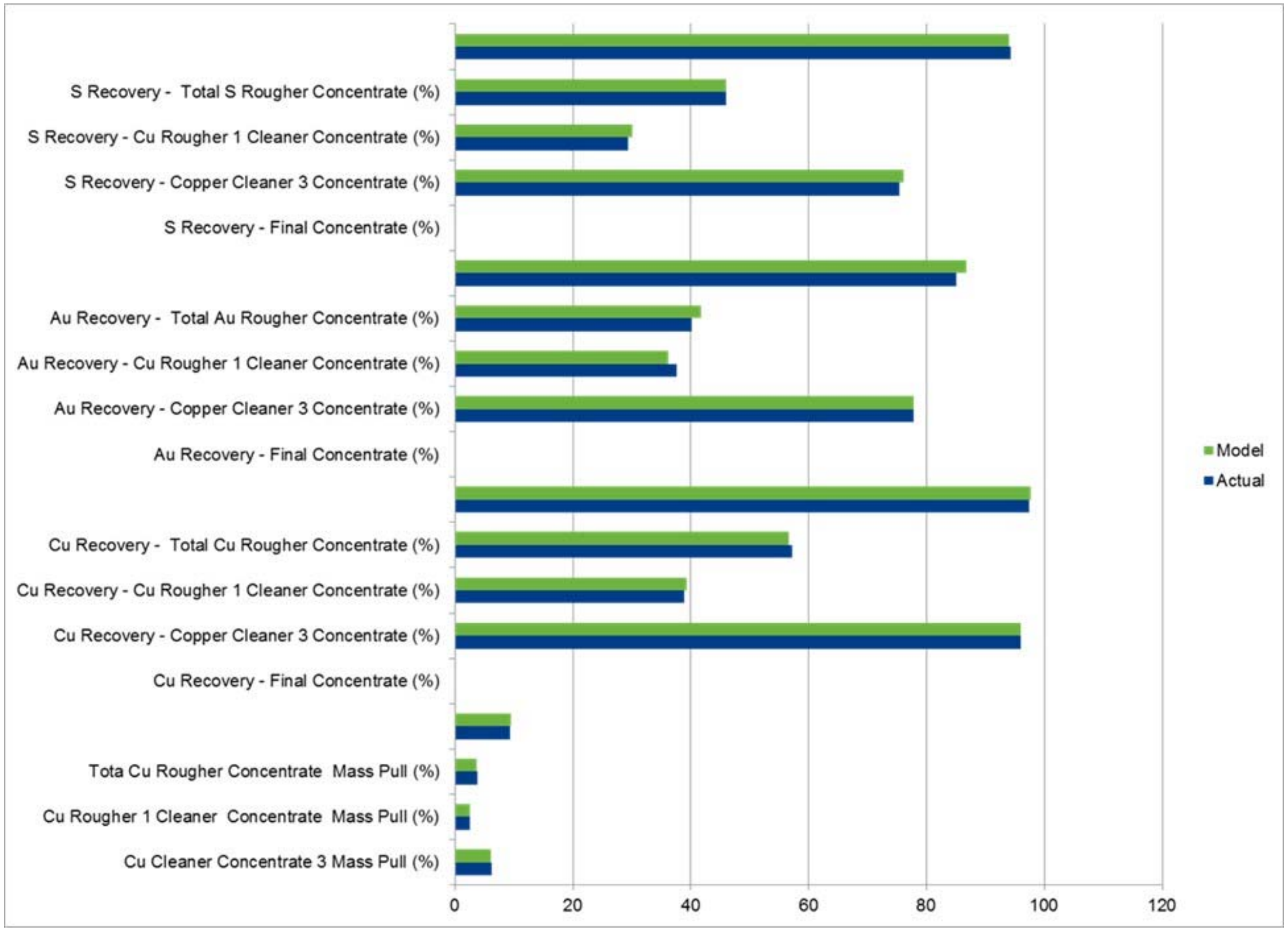
The original recovery model used grinds up to 212 µm, and therefore extrapolates to 300 µm. Based on the testwork data, the model overstates recoveries at the coarser grinds (i.e., that recoveries used at these grinds were higher than will be expected).

It was concluded that the optimal grind size is 80% passing 106 µm.

13.2.1.6 Water

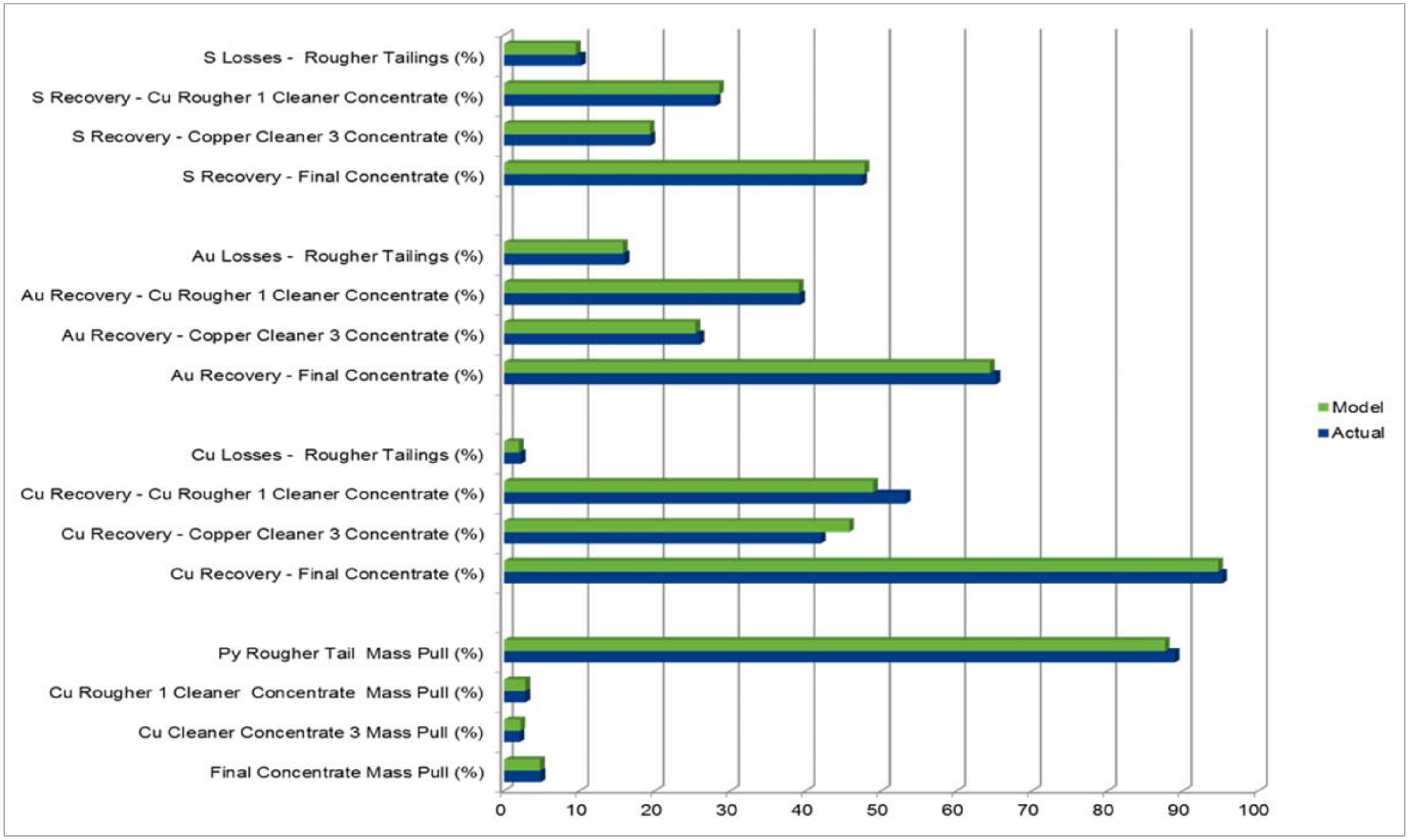
The primary source of make-up water to the proposed Watut process plant will be raw water from the Watut River and treated water from mine dewatering. The treatment process for the water pumped from the mine includes neutralisation, precipitation of heavy metals and removal of suspended solids. As a result, the process plant make-up water will have elevated calcium and SO_4^{2-} levels.

Figure 13-5:LEAN Flowsheet Model



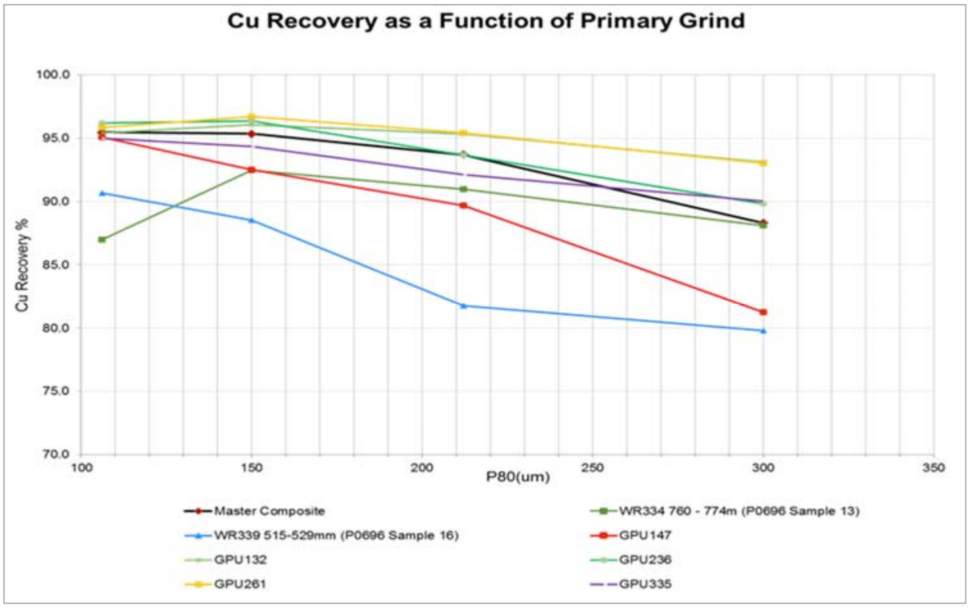
Note: Figure prepared by WGJV, 2018.

Figure 13-6:Golpu Flowsheet Model



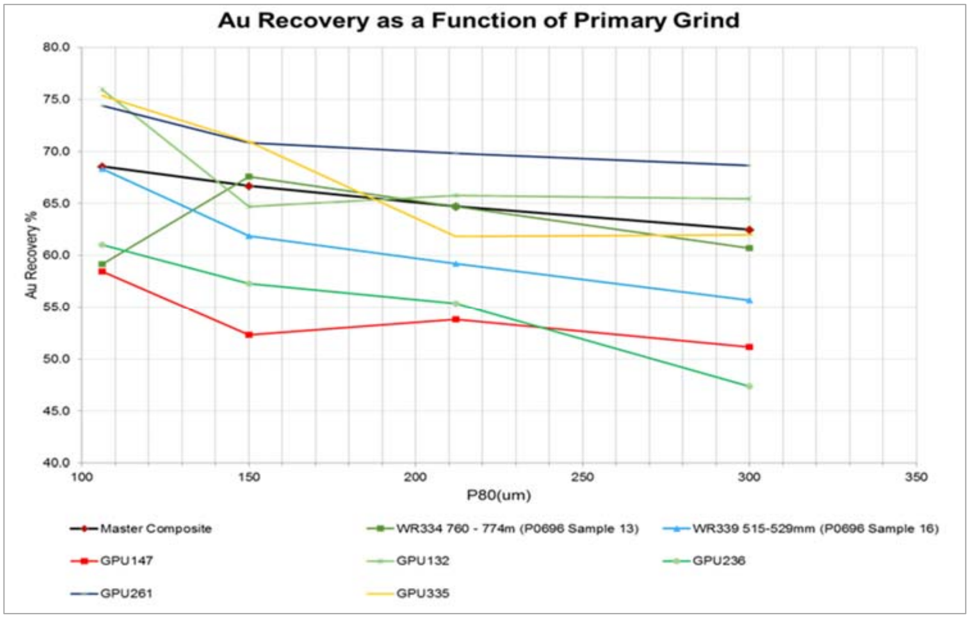
Note: Figure prepared by WGJV, 2018.

Figure 13-7:Copper Recovery vs. Grind Size



Note: Figure prepared by WGJV, 2018.

Figure 13-8:Gold Recovery vs. Grind Size



Note: Figure prepared by WGJV, 2018.

Water used in testwork included site water, derived from boreholes, and a synthetic site water with artificially-elevated calcium and SO_4^{2-} levels. Tests were performed at ALS Adelaide using the various water sources. Copper and gold recoveries using Watut River water and treated mine water showed a marginal improvement over the comparative test with Adelaide water for the LEAN and Golpu flowsheets. It was concluded that the Watut River water and treated mine water quality would not detrimentally affect metallurgical performance.

13.2.1.7 Effect of Ore Composition on Flotation Performance

The LOM plan has increasing proportions of metasediment-hosted mineralisation in the mill feed. Testwork was conducted using the LEAN flowsheet, consisting of batch open circuit and locked-cycle tests on varying composites, ranging from 100% Livana Porphyry to 100% metasediment and selected porphyry:metasediment blend ratios in between these end members.

The results of the locked-cycle testwork indicated that flotation performance is adversely affected by the incorporation of metasediment into the flotation feed. Locked-cycle testwork results correlated well to the batch open circuit testwork conducted on the same samples (Figure 13-9). The locked-cycle test generally produced higher final concentrate recoveries than the batch tests.

13.2.1.8 Effect of Ageing on Metallurgical Performance

Testwork was completed over a two-year period on sub-samples of mineralisation derived from acid rock drainage column test residues to assess the impact of wet ageing and oxidation of ores within the block cave area. The column cells were configured to simulate conditions in a mine surface coarse ore stockpile, where acidic water formation would emanate from a coarse ore stockpile exposed to weathering. The tests were designed as an evaluation of worst-case scenarios.

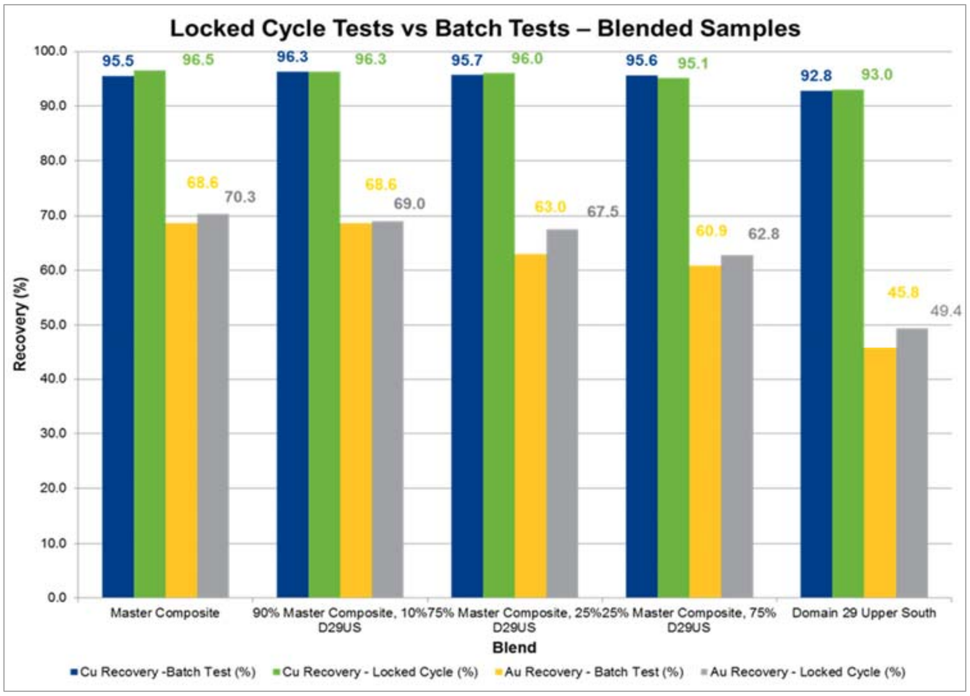
Standard batch cleaner flotation tests were conducted using the LEAN circuit configuration. Both copper and gold recovery were found to be severely impacted as a result of weathering and ageing. This was particularly the case in the cleaner circuit, where significant losses were observed.

Additional tests indicated that losses to rougher tailings could be suitably mitigated through controlled potential sulphurisation, as well as increased collector dosage. It was also observed that controlled potential sulphurisation mitigated the effects of oxidation on copper recovery, and enhanced gold recovery relative to the baseline non-aged sample. The comparative recoveries were, however, at the expense of additional concentrate mass (higher mass pull). Benchmarking to data from Newcrest's Cadia Mine suggests that column ageing may be excessively aggressive, overstating the recovery loss associated with ore oxidation.

13.2.1.9 Alternative Flowsheet

A comparative cyclic flotation test was carried out comparing the LEAN flowsheet to a circuit simulating the use of a Jameson cell. The main intention of the study was to validate the use of the Jameson cell in a copper rougher cleaner cell application, as well as to demonstrate a potential variation in the copper cleaner circuit.

Figure 13-9:Ore Blend Testwork Results



Note: Figure prepared by WGJV, 2018.

The difference between the LEAN circuit and the alternative proposed circuit was negligible in terms of recovery, which indicates that the installation of the Jameson cells could offer an alternative solution to the conventional cells proposed. The benefit is that a single Jameson cell could replace an entire bank of cleaner cells in the copper rougher cleaner application and is also able to attain higher concentrate grades than conventional cells in practice.

13.2.1.10 Concentrate Solution Quality

Tests were completed to establish the degree to which the copper concentrate could leach in transit via the pipeline, and to establish water treatment requirements at the port filtration facility to be able to discharge the filtrate into a natural watercourse. Results indicated that the resulting water meets the discharge specification for most elements, with the potential exception of cobalt.

13.2.1.11 Slurry Pumping and Hydraulic Testwork

Work programs included material properties, settling characteristics, generation of rheograms, and examination of corrosion characteristics. These established the rheological characteristics of a typical concentrate and tailings stream derived from the process plant.

13.2.1.12 Thickener Testwork

Thickener testwork indicated that the tailings sample was readily thickened and was able to achieve the required underflow density target (50% w/w) at peak flux rates of 1.75 $t/m^2/h$ and a flocculant dosage of 20 g/t. The concentrate sample was readily thickened and was able to achieve the required underflow density target (50%) at peak flux rates of 0.25 m^2/h and a flocculant dosage of 5–25 g/t. Overflow clarity was good.

13.2.1.13 Filtration Rates and Equipment

A sample of the final concentrate was supplied to Outotec in order to establish filtration rates for selection and sizing of filtration equipment.

The results indicate that the concentrate produced is readily dewatered, and that final product moisture content <10% is achievable. Standard filtration equipment can be used.

13.2.2 Wafi

13.2.2.1 Mineralogy

Oxide mineralisation in the A Zone and B Zone includes alunite, haematite, goethite, quartz, kaolinite, and micaceous minerals. Some remnant sulphide minerals appear to be present, and are more prevalent in the transitional zone. Gold is associated with silicates, iron oxide and the remnant sulphides.

Within the fresh material, the primary gangue constituents are quartz, illite, kaolinitic minerals, chlorite, clinochore, and minor carbonates. The major sulphide mineral in all zones is pyrite with minor phases of arsenopyrite, marcasite intergrowths and lesser pyrrhotite. Gold was associated with arsenian pyrite, which takes two forms. One is arsenic-enriched rimming around larger, lower-grade pyrites, and the second is very fine particles of enriched arsenian pyrites.

No significant organic carbon or other potential gold preg-robbing material was identified.

13.2.2.2 Metallurgical Tests

Cyanidation Testwork

The early test programs concentrated on the A Zone. A variability program looking at approximately 250 samples was completed, together with more detailed investigations focused on composites classified as oxide (OC1), transitional (TC1) and primary (FC1) zones. Direct cyanidation of oxide samples demonstrated they were non-refractory, yielding high gold recoveries in the mid 90% range with low cyanide and lime consumptions. Slight improvements were found if the oxide samples were ground finer. The transitional zone samples consisted of a combination of highly-oxidised mineralised material with partially weathered sulphide minerals. Direct cyanidation yielded gold recoveries in the 80% range, with reagent consumption similar to or slightly higher than those observed for oxide samples. For both oxide and transitional samples, based on a particle size P80 of 212 µm, a leaching time of 18 hours at a pulp density of 50% was considered sufficient to provide optimum leaching conditions. Cyanidation of the primary sample indicated the mineralisation to be more refractory, yielding poor gold recoveries of 50–60%.

Subsequent testwork largely focused on samples from the Link Zone and adjacent zones, mainly the B Zone. These zones appeared to be significantly more refractory, providing direct gold extractions of <50% from B Zone and 20–30% from Link Zone. Diagnostic leaching suggested that the bulk of the gold in residue was associated with arsenic.

Flotation Testwork

Flotation tests showed a strong similarity between the different zones from a flotation perspective and highlighted the importance of maximising arsenic recovery in order to improve gold recovery. Tests using controlled potential sulphidisation (CPS) were encouraging, potentially due to the tendency for arsenical minerals to be more readily oxidised than pure pyrite.

One significant advantage of flotation was that in obtaining a concentrate for bio-oxidation testwork, manganese was depleted and reported to the tails. This allows for treatment of the concentrate without the added problem of removing manganese from process effluents. Significant potential problems with settling of the flotation tails were encountered, with settling being improved using lower pulp density pulps and a high flocculent dosage.

Detailed liberation characteristics and mineral associations for flotation concentrate and tails showed that the majority of pyrite was liberated in the flotation concentrate, whereas much of the pyrite still present in the tails was locked in binary and ternary particles containing quartz, mica, and feldspar. Gold-bearing arsenian pyrite grains were distributed in binary and ternary minerals in both flotation concentrates and tails. Liberating arsenian pyrite for flotation would require an ultra-fine grind. Arsenopyrite, although a minor phase, also contained "invisible" gold, and followed a similar trend to arsenian pyrite.

Flotation performance was a reflection of grinding conditions, as the mineral surfaces rapidly oxidised. Investigation of methods to mitigate this included CPS and the proprietary Newmont N2TEC technology that uses nitrogen flotation. These programs suggested moderate success from flotation tailings cyanidation and additional work in these areas was recommended.

Fine Grinding of Concentrate

Improvement in gold recoveries was slight when fine grinding was investigated, and confirmed the refractory nature of the primary samples. Whilst conditions were not fully optimised, it was concluded that solid solution gold in sulphides would not be expected to be readily leached from concentrates following ultra-fine milling without some alteration of the gold-bearing sulphide minerals.

Pre-Oxidation Processing

Pressure oxidation, bio-oxidation, and roasting were investigated as potential process options.

Overall program results showed that oxidation of sulphide minerals was very effective in releasing gold for cyanidation. Only partial oxidation of around 50% of the sulphide was necessary to achieve maximum gold recovery, irrespective of the process used, and whether the feed was whole-ore or a flotation concentrate. This relationship applies over the suite of primary samples investigated. Diagnostic leaching confirmed this approach. In addition, nitric acid digests results indicated that to achieve maximum gold recovery, dissolution of around only half the arsenic in the samples was required. Hence, while there was a strong association between gold and arsenic, not all the arsenic had to be oxidised to obtain high gold recoveries.

Pressure oxidation tests were completed as batch tests. Generally high gold recoveries were obtained (low 90% range). Cyanide and lime consumptions were high, largely due to limited washing of POX residues. Flotation of the high-sulphur mineralisation resulted in high weight and sulphur recovery to concentrate at high sulphur but relatively low gold recoveries.

Whole-ore and concentrate roasting studies indicated that lower-temperature roasting was more favourable for gold extraction. Sulphur oxidation of 42.7–59.6% was required to achieve 88.9% gold recovery. Additional oxidation to 94.4% had no significant effect on gold extraction; however, on complete oxidation gold recovery was reduced by around 20%. Lime addition to the roast was found to fix some of the sulphur at the cost of 5–15% gold recovery. There appeared to be no benefit in washing calcine residues when considering both gold recovery and reagent consumptions. Cyanidation following oxidation was very effective with high extractions in short leach times.

Extensive testwork was conducted investigating bio-oxidation on both stirred tank and heap leaching approaches for whole-ore and flotation concentrates.

The oxidation versus extraction profiles for stirred-tank tests showed that moderately high (80–90%) levels of extraction were achieved at 50–70% oxidation, with over 90% at ~70–75%. Initial oxidation kinetics were quite rapid but tended to tail off to become fairly slow to achieve >90% oxidation. Lime and cyanide consumptions were high, though not optimised.

Whole-ore column testwork to simulate heap bio-oxidation was conducted on -9.5 mm and -20 mm crushed Link Zone material that had been agglomerated using sulphuric acid and bacteria inoculum. Sulphide oxidation ranging from 23–29% gave a maximum gold recovery of 74% for the 9.5 mm column after 159 days. The best gold recovery was obtained from a small column using 9.5 mm mineralised material, which achieved 52.8% sulphide oxidation and 85.5% gold recovery. The higher oxidation was attributed to the column being better aerated from a higher surface area to volume ratio compared with the other column leach tests. Better sulphide oxidation and gold recoveries were obtained for the finer crushed size -9.5 mm material than the -20 mm material. Agglomerated ore-column test slump was higher than a target 10%, with most of the slumping taking place within the first 24 hours. This suggested that percolation problems and heap stability could be a problem in full-scale operations. Difficulties with dealing with oxidised product from various technologies also indicated that the effect of acidic oxidation kinetics on clays in the mineralisation could have a deleterious effect.

Tests using the proprietary GEOCOAT process, which involves the use of bio-oxidation in a heap configuration, gave a gold recovery of 91% from the concentrate at 63% sulphur oxidation during column tests. Partial bacteria oxidation of the sulphide concentrate yielded high gold recoveries. Further bacteria oxidation beyond a certain point had no further improvement in gold recovery. Cyanide and lime consumption per tonne of concentrate was very high at 9.2 kg and 11.6 kg respectively, but were not optimised. There was less manganese in the bio-oxidising of the concentrate pregnant leach solution for neutralisation than observed in whole-ore treatment by a factor of 10. This was largely due to the majority of the manganese reporting to the flotation tails, together with the carbonate.

Alkaline Leaching

The concept of oxidative caustic treatment as a method for dissolution of arsenic-rich minerals and enhancement of gold recovery was tested. Gold recovery increased with increased pH and temperature, and with a decrease in particle size.

The best results for whole-ore samples were obtained at P80 of 38 µm, pH of 13, 50°C and 64 kg/t of caustic which yielded 79.4% gold recovery. For flotation concentrate at P80 of 14 µm, pH of 12, and 60°C gave a gold recovery of 91% with an overall recovery of 77.6%.

Comminution Tests

Comminution testing showed samples to have low abrasion characteristics and that grinding media requirements should be low. The abrasion index values ranged from 0.18 in transition material to 0.10 in fresh rock. However, the tests were not conducted on the standard size fractions for this type of testwork, and therefore should be considered as indicative tests only.

Mineralisation was found to become very plastic at high moistures (12%). The primary composite was found to be very compressive and cohesive with steep flow functions.

Bond ball mill work indices were conducted on samples of each material type based on a target grind size of P80 75 µm. Values averaged 12.3 kWh/t for oxide material, 13.3 kWh/t for transition material, and 15 kWh/t for fresh material. All results are considered to be indicative of moderate hardness. Mineralisation hardness decreases with increased weathering.

13.2.3 Nambonga

No metallurgical testwork was performed on any Nambonga samples.

13.3 Recovery Estimates

13.3.1 Golpu

13.3.1.1 Recoveries

Recovery forecasting used the metallurgical model derived for year-on-year estimation of metallurgical design parameters.

The variability testwork (LEAN flowsheet) indicates metal recoveries for the porphyry-hosted mineralisation (Domain 30 and 33) of 94% for copper and 70% for gold to a 90% confidence level. The metal recoveries are forecast for metasedimentary-hosted mineralisation at 90% for copper and 35% for gold, to a 90% confidence level.

Over the LOM, copper recoveries are predicted to average 94% and gold recoveries are forecast to average 68%. Concentrate grade average over the life-of-mine is projected to be 29% Cu and 15 g/t Au.

Recoveries predicted for the Golpu deposit were benchmarked against a number of operating mines. Forecast copper recoveries are comparable with other operations that have higher than average copper head grades. Gold recoveries predicted for the Golpu deposit are within the range of recoveries achieved in the operations reviewed, and gold recovery shows no clear relationship to gold head grade.

13.3.1.2 Concentrate Quality Assessment

Final concentrate derived from the bulk flotation test was used to conduct a product quality assessment, which incorporated:

- Chemical analysis – major elements and potential deleterious elements;

- Mineralogical analysis, including XRD for major gangue phases and QEMSCAN for mineral liberation characteristics;
- Particle size distribution.

The copper concentrate produced had a copper grade of 28%, and gold concentration of approximately 14 g/t Au. As expected, the sulphur grades were high (>35%). The analysis also indicated that the concentrate did not exceed any of the typical concentration restrictions for sale.

The concentrate is predominantly composed of copper sulphides (85%), with chalcopyrite as the major mineral species. Minor and trace copper sulphide minerals present include bornite, covellite and enargite. Pyrite is the main sulphide gangue species, comprising 14.2%, and is therefore also the major gangue species present. The main non-sulphide gangue in the concentrate was silicates, which accounted for approximately 1% of the concentrate composition. The total non-sulphide gangue component accounted for 1.38% of the concentrate, which included traces of iron hydroxides, titanium minerals and apatite.

13.3.2 Wafi

The primary mineralisation types within the A and B, and Link Zones have similar characteristics in that the predominant host of gold (71–74% w/w Au) is arsenian pyrite, and to a minor extent arsenopyrite. Cyanide-recoverable gold is poor, ranging from 12–60%. There is variability between the mineralised zones with the A Zone generally more amenable to direct cyanidation than either the B Zone or Link Zone. A positive correlation exists between arsenic and gold concentration, with the Link Zone having a higher arsenic content than mineralisation in the A and B Zones.

Metallurgical recoveries for use in Mineral Resource estimation are assumed at 91% gold recovery for non-refractory gold mineralisation and minimum of 47% recovery for refractory gold mineralisation.

13.3.3 Nambonga

Metallurgical recoveries for use in Mineral Resource estimation are assumed at 85% for gold, using the adjacent Golpu deposit as an analogue.

13.4 Metallurgical Variability

Samples selected for metallurgical testing during feasibility and development studies were representative of the various styles of mineralisation within the different deposits. Samples were selected from a range of locations within the deposit zones. Sufficient samples were taken, and tests were performed using sufficient sample mass for the respective tests undertaken.

13.5 Deleterious Elements

13.5.1 Golpu

There are no known deleterious elements that would affect concentrate marketability.

13.5.2 Wafi

There are no known deleterious elements that would affect doré marketability.

13.5.3 Nambonga

There is no information as to whether any deleterious elements are present at Nambonga, since no deposit-specific tests were conducted.

13.6 QP Comments on “Item 13: Mineral Processing and Metallurgical Testwork”

The QP notes:

- The testwork completed is adequate to ensure an appropriate representation of metallurgical characterisation and the derivation of corresponding metallurgical recovery factors;
- A total of 13 geometallurgical domains were assigned to represent an improved geological interpretation of the Golpu deposit and increase the understanding of the copper and gold recoveries in the deposit;
- Gold and copper recoveries, on average over the Golpu LOM, are anticipated to be 68% and 95% respectively;
- Concentrate average grade over the Golpu LOM is forecast at 29% Cu and 15 g/t Au;
- Final concentrate derived from the Golpu testwork indicated that the levels of deleterious elements in concentrate did not exceed any of the typical concentration restrictions for sale;
- Testwork on the Wafi deposit indicates that much of the gold mineralisation is refractory, and that there is variability in metallurgical response between the mineralised zones;
- Metallurgical recoveries for use in Mineral Resource estimation for the Wafi deposit are assumed at 91% gold recovery for non-refractory gold mineralisation and minimum of 47% recovery for refractory gold mineralisation;
- No metallurgical testwork was conducted at Nambonga, and Golpu is used as an analogue deposit. Metallurgical recoveries for use in Mineral Resource estimation are assumed at 85% for gold.

14 MINERAL RESOURCE ESTIMATES

14.1 Introduction

Mineral Resources are reported for the Golpu, Wafi and Nambonga deposits. Close-out dates for the databases supporting the estimates are:

- Golpu: database close-out date of 26 March 2014;
- Wafi: database close-out date of 23 October 2018;
- Nambonga: database close-out date of 23 October 2018.

14.2 Golpu

14.2.1 Introduction

All data were extracted from the DataShed database DS_WGJV_EXP_DC on 25 March 2014 as *.csv extractions.

Drill collars were reviewed to ensure collars were within the tolerance of the surface survey. Non-assayed holes were deleted from the estimation-support file. All drill holes were reviewed for downhole surveys, with corrections made to the database as required.

The majority of the raw assay file contains 1 m or 2 m assay intervals. Before constraining by flagging with the Golpu model limits, there were 203,746 assay records in the raw database with an average length of 1.507 m. Within the Golpu block model volume, there are 110,673 assay intervals. Not all intervals are assayed and not all assayed intervals are assayed for all elements.

Wireframe coding was applied to the validated collar, survey and assay files after they were imported into Vulcan software.

14.2.2 Modelling Approach

Wireframes were constructed for lithology, alteration, oxidation, sulphide distribution and structures. All lithological, porphyry-related alteration and fault wireframes were constructed in Leapfrog software using implicit modelling interpolations from primary logging codes extracted from the DataShed database and modified based on interpretative correlations of logged intervals.

Reflectance spectroscopy mineralogical identification data were used in conjunction with the logged alteration dataset. This permitted a higher level of resolution of the minerals in the layered epithermal system enabling the subdivision of clay and other minerals that are typically difficult to visually distinguish.

Alteration associated with the porphyry complex is constrained within an actinolite alteration shell which defines the limit of porphyry mineralisation. Alteration associated with the high sulphidation overprint includes advanced argillic and argillic alteration assemblages.

Oxidation surfaces were modelled at the base of complete oxidation (BOCO) and top of fresh (TOFR). The BOCO surface is located at the first occurrence of fresh or partially weathered material from drill core. The TOFR surface was modelled at the point where there was no partial or fracture-related oxidation recorded in the drill logs.

All interpreted faults were wireframed but were not necessarily used in the estimation model.

Sulphide distribution shells compiled from logging records include trace chalcopyrite, chalcopyrite greater than 1%, chalcopyrite greater than 3%, bornite and the covellite-bearing volume formed within the high-sulphidation epithermal influence volume. Wireframes based on geological interpretations are used to code raw assay files, composite files and the block model.

All combinations of lithology, alteration, sulphide distribution and faulting were assessed for use as estimation domains.

Figure 14-1 to Figure 14-6 show the models constructed.

14.2.3 Exploratory Data Analysis

Geostatistical analysis was conducted to review individual elements and correlations between elements.

Contact analyses were completed on all major lithologies, alterations and fault boundaries. It was concluded that the only porphyry with sharp grade contacts is the high-grade Hornblende (Livana) Porphyry.

Since statistics of fault displaced areas can be similar, lithology and alteration domains were separately modelled above and below major faults where clear displacement can be demonstrated, regardless of the contact analysis results.

Draft domains were compiled for each element to be estimated, based on observed grade distributions, boundary analyses and known geological relationships. After testing, these domains were accepted as the final estimation domains. Drill hole files were flagged in Vulcan software with assigned lithology, alteration, fault interval, sulphide species or molybdenum area, before compositing.

14.2.4 Composites

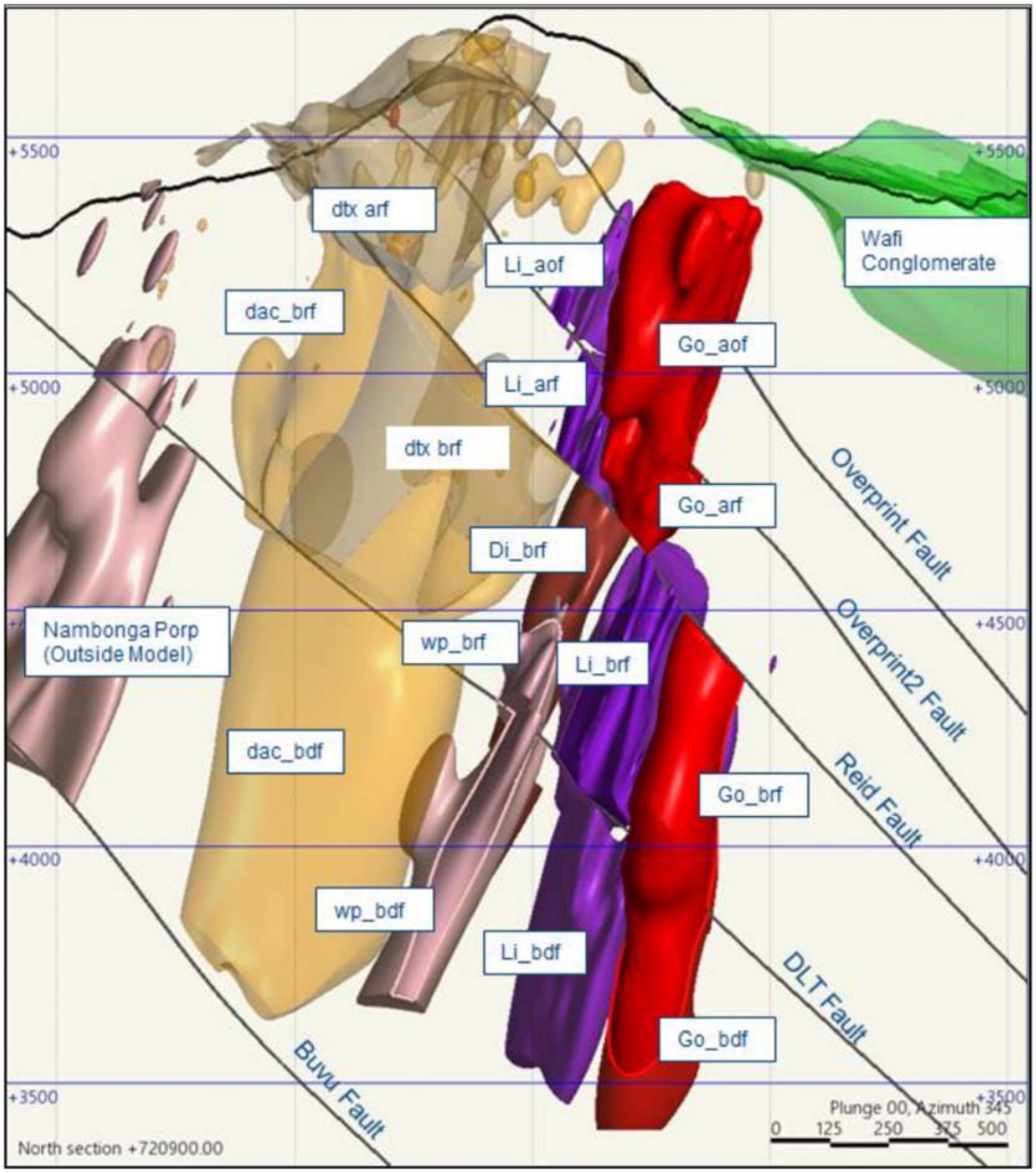
A composite database was compiled for each element from the assay table database on 10 m composite lengths. The resulting composites are split at domain contacts and at absent assay intervals.

14.2.5 Grade Capping/Outlier Restrictions

Top-cuts were determined by reviewing the histograms and the percentage of metal contributed from the highest-grade samples (both raw and de-clustered) in each estimation domain. The applied top-cut block model domain estimates were then compared to each of a discrete Gaussian model and nearest neighbour (NN) model global average grades for validation.

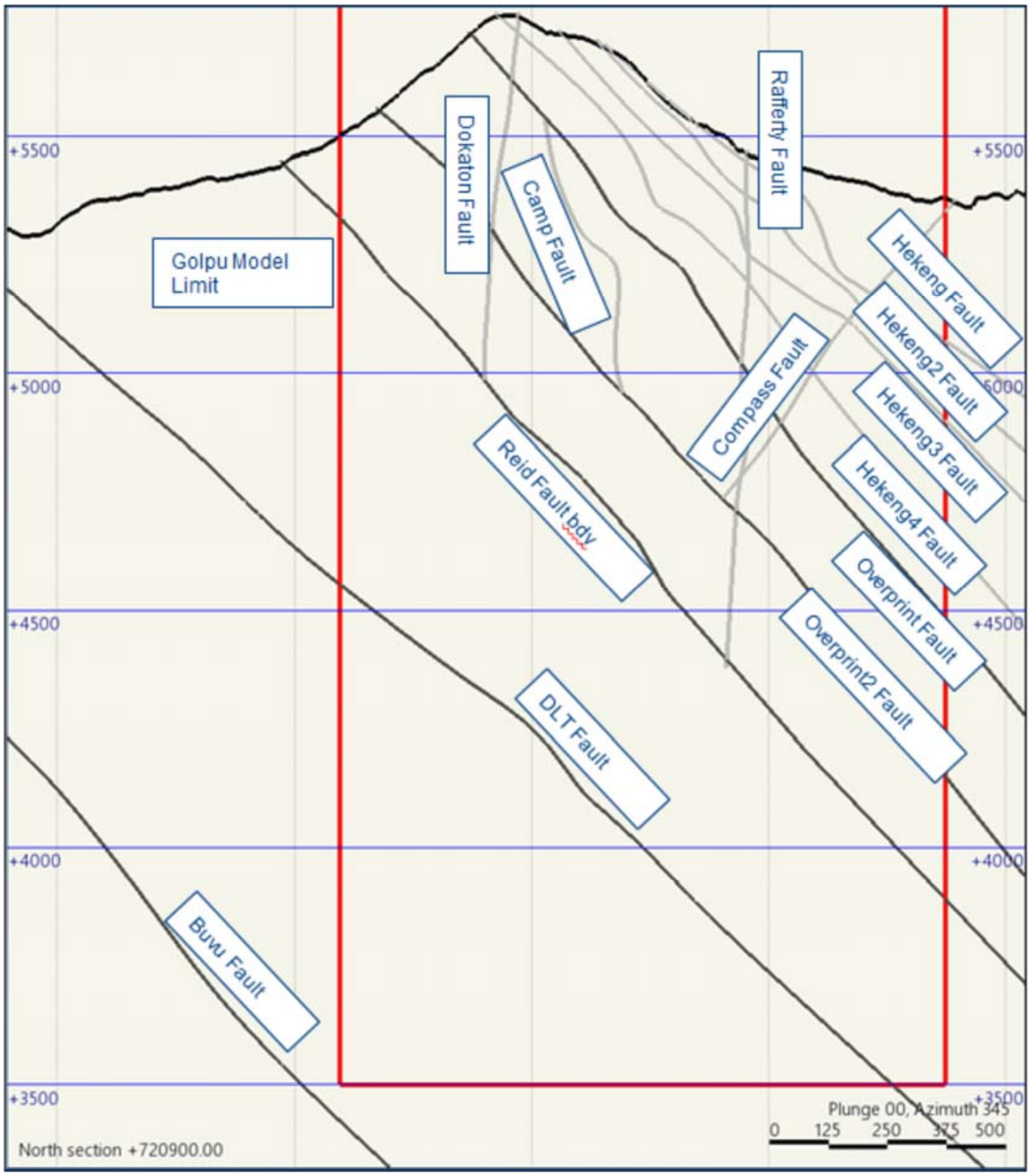
All samples from the Golpu–Wafi region were flagged by estimation domain, including samples outside the Golpu estimation volume (these samples may still assist in the estimation of grade within the model). For those domains that extend beyond the Golpu Model volume, top-cuts were also reviewed relative to the Golpu model volume rather than the entire flagged sample population. For example, the advanced argillic alteration domain includes very high gold grades from the Wafi deposit; in this area, top-cuts representative of the Golpu volume local informing samples were applied.

Figure 14-1:Lithology Wireframes



Note: Figure prepared by WGJV, 2018.

Figure 14-2:Fault Surface Model

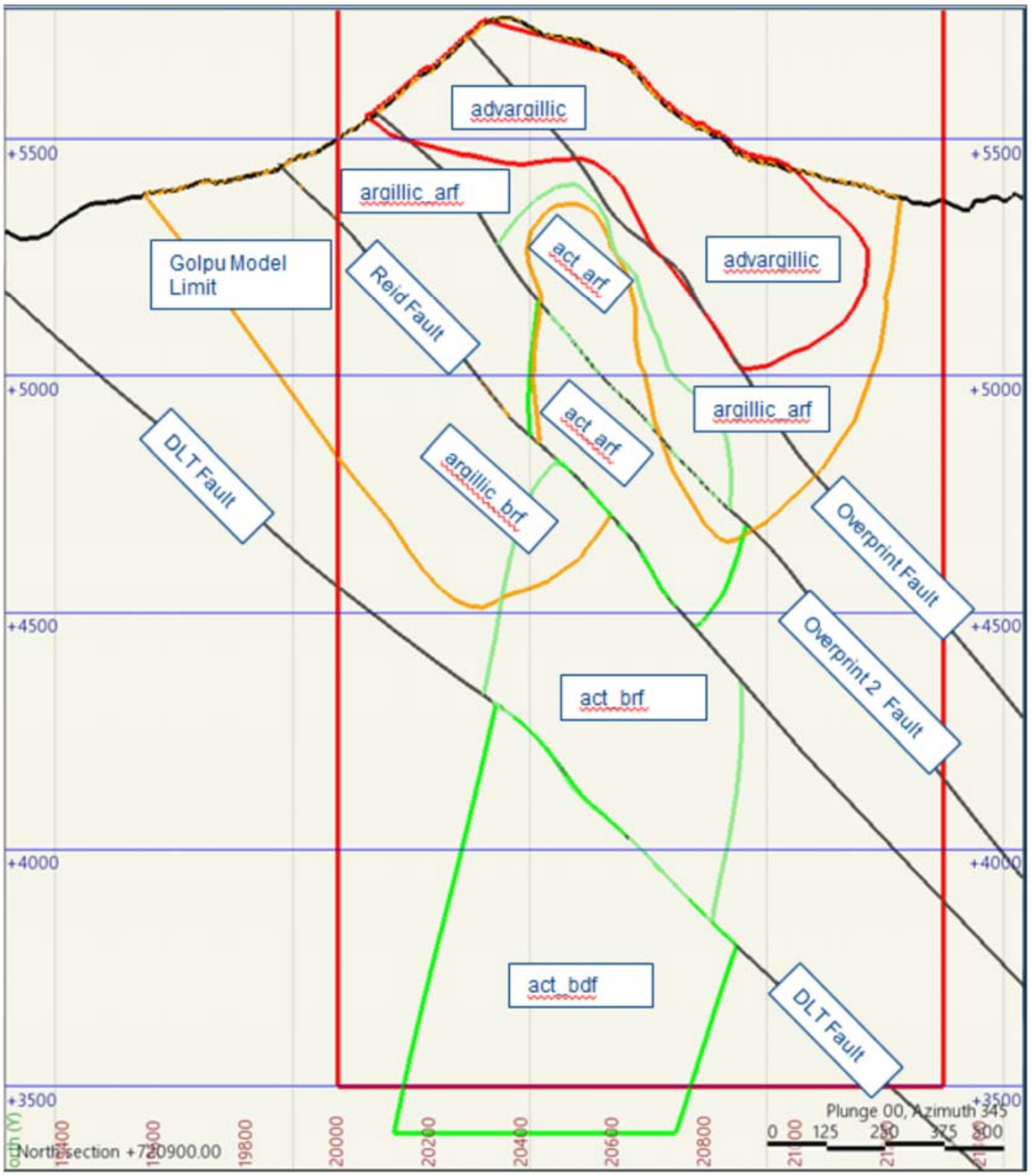


Note: Figure prepared by WGJV, 2018.

Figure 14-3:Oxide Surface Model

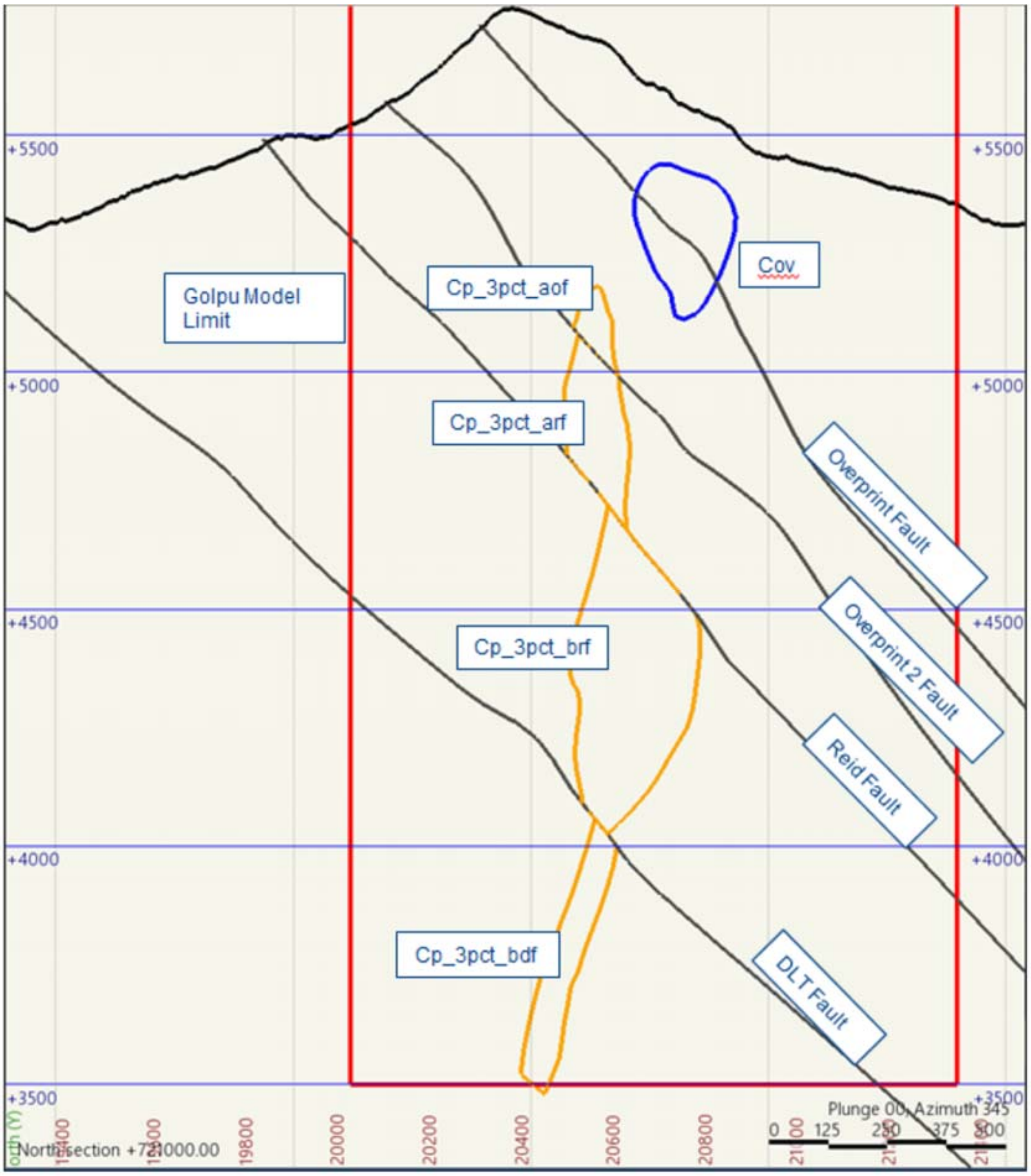
Note: Figure prepared by WGJV, 2018.

Figure 14-4:Alteration Volume Models



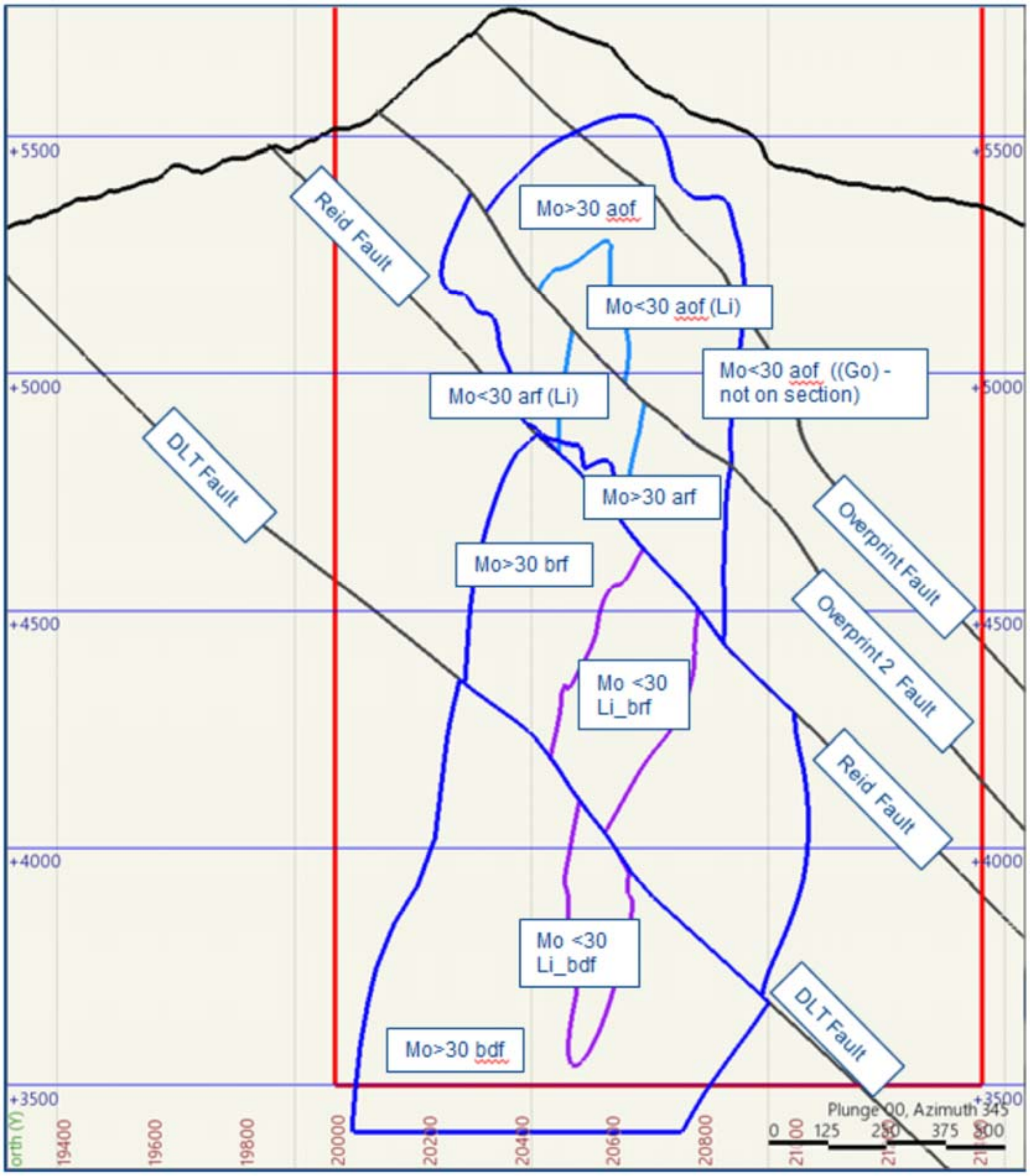
Note: Figure prepared by WGJV, 2018.

Figure 14-5:Sulphide Volume Models



Note: Figure prepared by WGJV, 2018.

Figure 14-6:Molybdenum Shell Models



Note: Figure prepared by WGJV, 2018.

Metal per composite assessments were completed on all gold and copper domains.

Applied top-cut ranges included:

- Copper: 0.5–4.2% Cu;
- Gold: 0.5–16 g/t Au;
- Sulphur: 6.8–15% S;
- Silver: 2.5–30 g/t Ag;
- Molybdenum: 50–800 ppm Mo;
- Iron: 9–25% Fe.

No top-cuts were applied to arsenic.

A restricted high yield search was applied to copper and gold domains to manage maximum metal and ensure compatibility with evaluation models. This applies especially where a domain includes identified bi-modal populations and the high-grade sub-population cannot be domained separately or top-cut out. Rather than imposing a top-cut on the continuous sub-population, high-grade samples were restricted for use at distances typically defined by the short range of the variogram only.

14.2.6 Density (Specific Gravity) Assignment

Density was directly assigned to the block model by density domains (refer to discussion in Section 11.2).

14.2.7 Variography

The majority of the experimental variograms were generated from the domain-flagged, 10 m composites in Supervisor software. Argillic zones were compiled by QG Consultants in Isatis software.

Variograms were modelled for all domains, for all estimated elements. Some domains contain limited samples, and in this case variograms were generated that were similar in structure and range to the closest matching domain. Most well-informed domains generated well structured, low nugget variograms in both pairwise and raw models.

All porphyry-related domains were modelled with an orientation defined by the elongation of the porphyry system (strike/elongation to 345º local grid, 70º west dip and 10º northern plunge). While this orientation is typically clearly defined for well-informed domains, in poorly-informed domains variogram maps can show a strong bias to the predominant east–west drilling direction. However, in all cases, the porphyry direction was imposed on the variogram map and resulting experimental variograms modelled in this orientation only. All argillic alteration, oxidation and cover sequence domains have shallow dips to grid east, and these were used in the variogram maps and models.

14.2.8 Estimation/Interpolation Methods

Quantitative kriging neighbourhood analysis (QKNA) assessments were focused on the maximum number of samples and search distances to be used in the block estimate that optimised the sum of negative weights generated, followed by the quality parameters e.g., average distance of informing samples (either Cartesian or anisotropic), slope of regression and kriging efficiency. As pairwise variograms are used in the grade estimate and hence the domain mean and variance are not used directly, the kriging-derived parameters are relative not absolute.

Based on the review of these QKNA parameters and the visual examination of the resulting grade estimation, the final search parameters used in the model were compiled. All second passes have the same search volume as the primary estimation but due to the generation of negative grades from localised high negative kriging weights, the maximum number of samples is reduced from that used in the first pass. Total number of blocks estimated by the second pass estimates is always very low.

The grade model was estimated with ordinary kriging (OK) using pairwise variograms on 10 m composites for seven elements: gold, copper, silver, molybdenum, sulphur, arsenic, and iron. The estimation uses the domain composites as informing samples, pairwise variogram models for composite weighting and ellipsoidal search neighbourhoods for composite selection. The elements are estimated into a block model with 40 m x 40 m x 40 m parent cells with 10 m resolution on domain margins; all sub-cells are assigned the parent grade. The parent block size reflects the estimation precision available from the drill hole spacing and the planned bulk underground mining methodology (block caving).

Estimation of each element is based on an underlying diffusion model where, in general, grade trends from lower to higher values and return in a relatively continuous relationship. Domainal drift is clearly present for the porphyry system, so pairwise variograms were used for modelling grade estimates.

14.2.9 Block Model Validation

The model was validated by comparison with informing composite de-clustered statistics, alternative modelling methods (NN), inverse distance weighting to the second power (ID2), raw variogram OK, discrete Gaussian models and conditional simulation models and graphical comparisons (swath plots and grade–tonnage curves).

Where the estimated model domain grade is high compared to de-clustered grades and alternative method models, the percentage of metal dependent on the top 1% and 5% of the sample distribution per domain was again reviewed in detail for applied top-cuts and high yield management and if required, re-set.

Swath plots show that the Mineral Resource estimate fairly represents the composite grades. Review of all domains using discrete Gaussian models showed that the Mineral Resource model was within acceptable limits given the composite sample size and drill hole spacing for each of the estimation domains.

Conditional simulations were compiled using two separate methods: sequential Gaussian conditional simulation (SGCS) implemented in Vulcan into points/nodes and direct block simulation (DBSim) using Turning Bands into 10 m blocks in Isatis. Both methods estimate similar mean grades for the gold and copper domains; however, there are substantial variations in the estimated range of simulation cases. The DBSim results are considered more reliable because of both the inherent methodology and the change of support into blocks rather than node estimation. Both methods are similar to the mean grade by domain estimated in the Mineral Resource model.

14.2.10 Classification of Mineral Resources

The Mineral Resource is classified based on an evaluation of factors including data spacing and distribution, geological confidence as a function of continuity and complexity of geological features and estimation quality parameters (for example, average distance to informing samples for block estimation).

No Measured Mineral Resources were estimated.

An Indicated Mineral Resource, where the geological framework can be modelled with confidence and mineralisation continuity can be demonstrated, is classified from below the copper-enrichment zone to either the 4100 mRL WGL or above an interpreted fault (DLT) approximately 1,400 m below surface.

Below this fault and above 3780 mRL WGL, drill hole spacing increased and geological and grade continuity is less reliable; this area is classified as an Inferred Mineral Resource.

Figure 14-7 shows the location of the assigned confidence categories.

14.2.11 Reasonable Prospects of Eventual Economic Extraction

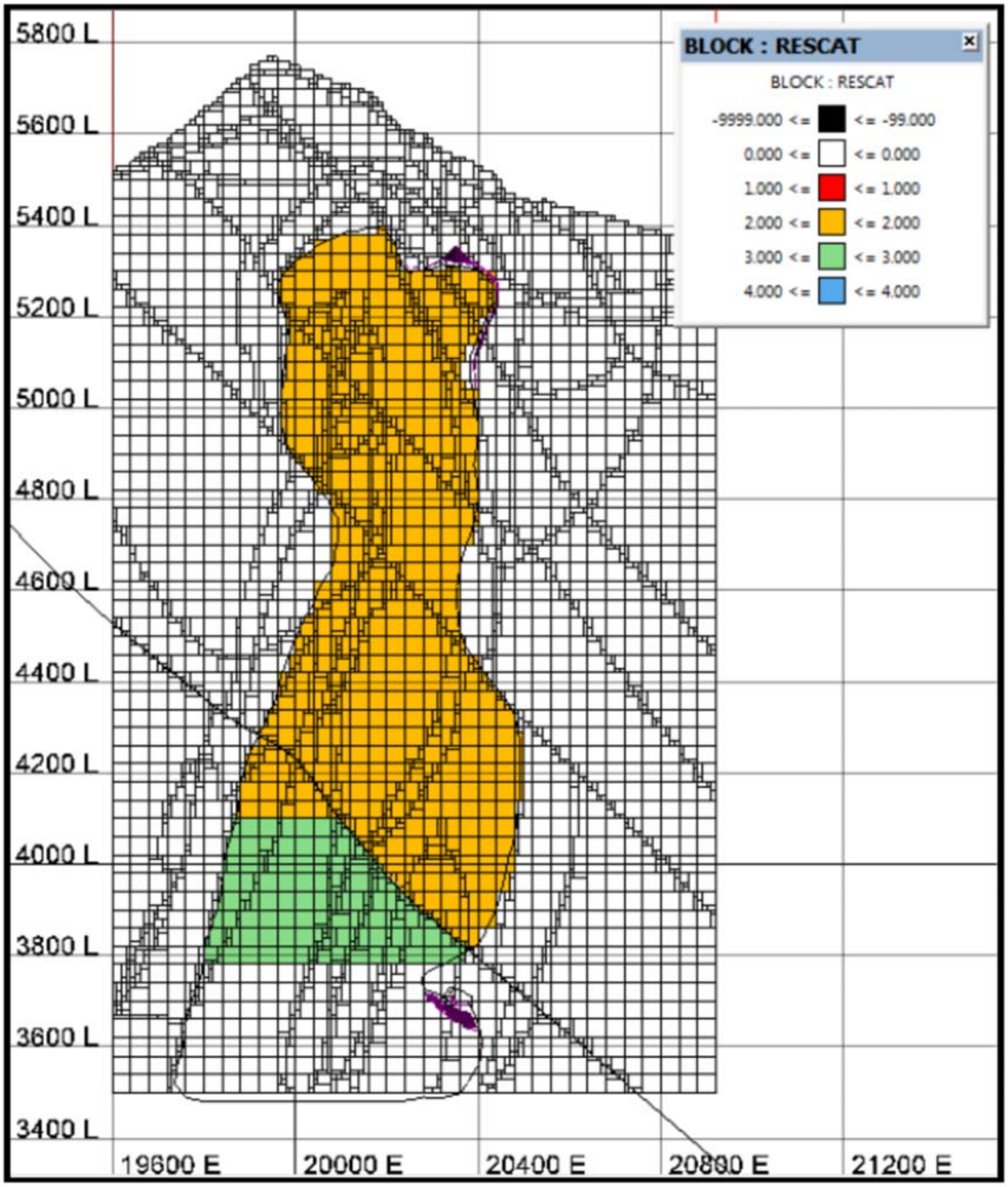
The Mineral Resource estimate assumes a bulk mining underground extraction method such as block caving and metallurgical recovery for copper and gold by sulphide flotation.

The Mineral Resource estimate is reported based on mass mining by block cave with no internal selectivity. The 40 m x 40 m x 40 m parent block size is an appropriate cell size for the planned bulk mining method. The shell does not represent a conceptual block cave footprint and associated draw column height of draw. However, it does represent the economic material potentially recoverable from a major block cave. The primary model was passed through a net smelter return (NSR) calculation sheet and a breakeven value shell was generated at margin 0 to remove isolated projections and incorporate a small volume of internal waste.

The metallurgical recovery model is based on copper flotation with copper and gold recovered to concentrate. Extensive testwork was completed to establish algorithms developed from variability modelling. Metallurgical domains are based on both the host rock type and alteration style. Each metallurgical domain was assigned a recovery algorithm, typically subdivided based on Cu:S and Au:S ratios.

The NSR estimation was required only to establish the Mineral Resource reporting breakeven value shell. Mining and milling costs were based on a block caving mining method and milling through a copper concentrator. The breakeven value shell spatially constraining the grade model includes internal waste, and excludes isolated above-cut-off blocks, which reflects the potential bulk mining scenario. There is no revenue assumed from silver or molybdenum in the NSR estimate; however, these elements were estimated as part of the Mineral Resource estimation process as there may be potential for these metals to be recovered with minor circuit modifications or concentrate contract negotiations, and therefore included in future resource estimate statements.

Figure 14-7:Confidence Categories Assigned



Note: Figure prepared by WGJV, 2018. Orange = Indicated; green = inferred; purple = artefact representing an underlying wireframe to code the resource blocks.

Key value inputs included:

- Gold price: US$1,300/oz;
- Copper price: US$3.40/lb;
- Molybdenum and silver: Not valued;
- Mining cost: US$8.37/t mined;
- Processing cost: US$9.75/t processed;
- General and administrative (G&A) costs: US$4.17/t/processed;
- Copper concentrate treatment charge: US$100/dmt of concentrate;
- Transport cost: US$33.50/wet tonne of concentrate;
- Copper refining charges: US$0.10/lb of recovered copper.

14.3 Wafi

14.3.1 Introduction

All data were extracted from the DataShed database on 23 October, 2018 as *.csv extractions.

All collars were reviewed specifically to ensure collars are within tolerance of the surface survey. A campaign of collar surveys was completed before the database was closed. Some historical hole collars that were deemed in error could not be located due to rehabilitation of the drill pad. In these rare cases, the centre of the pad was surveyed and applied to the collar.

All holes were reviewed for downhole surveys. These include plots of depth versus dip and dip versus azimuth to identify unrealistic steps in the reported data. For dips, this may result from at collar set-up value not reflecting first downhole survey and errors in dip recording due to not allowing time for the instruments to stabilise. For azimuths, errors result from magnetite inference for Reflex tools, incorrect joining of non-north seeking gyro survey runs, and compass azimuth orientation at collar that does not align with gyro surveys.

Where a below detection level assay value was reported, the following values were applied, based on half of the lowest valid reported assay result:

- Gold: 0.005 ppm Au;
- Copper: 0.005% Cu;
- Silver: 0.05 ppm Ag;
- Molybdenum: 0.1 ppm Mo;
- Arsenic: 0.1 ppm As;
- Sulphur: 0.1% S;
- Iron: 0.1% Fe.

14.3.2 Modelling Approach

The May 2019 geology model for the Wafi deposit includes wireframes for lithology, alteration, oxidation, and structures.

All lithological, porphyry-related alteration and fault wireframes were constructed in Leapfrog Geo 4.3 software using implicit modelling from primary logging codes extracted from the DataShed database and modified based on interpretative correlations of logged intervals.

There are a number of porphyries modelled, although these do not have a significant influence on the model. Lithologies including dacite, diatreme, the Wafi Conglomerate, Babwaf Conglomerate, Owen Stanley Metamorphics sedimentary host rock, and recent cover were constructed and flagged into the volume model where intersected to create a lithology model.

Mineralisation wireframes are shown in Figure 14-8.

The wireframes used the following criteria:

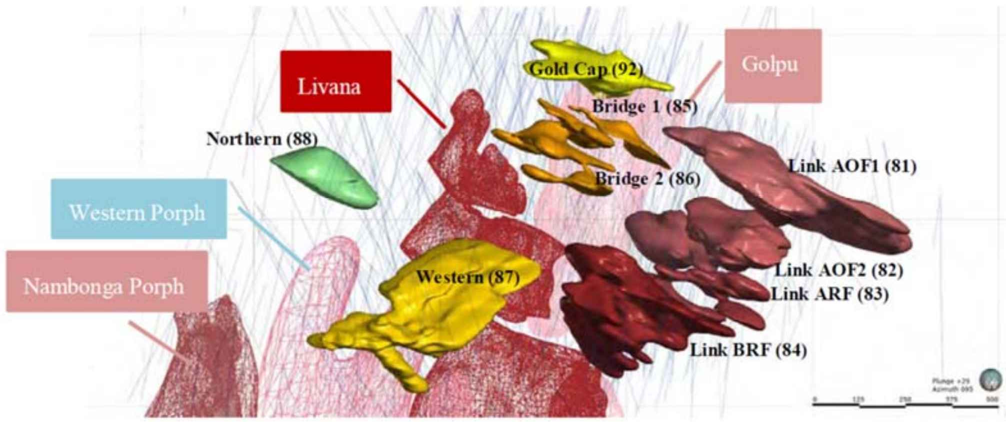
- Link Zone domains: implicitly modelled shells based on sectional interpretations of an implicitly modelled 300 ppm As shell, modified to capture >1 g/t Au intercepts that sit outside the arsenic shell;
- Western Zone: a sectional interpretation of a implicitly-modelled 300 ppm As shell modified to encompass high-grade gold values within the area;
- Bridge zone: implicitly modelled and based on the 1.0 g/t Au grade shell;
- The Gold cap: implicitly modelled and based on the 1.0 g/t Au grade shell in the oxide and transitional zones only;
- Northern zone: a simple 1.0 g.t Au grade shell around the drilling in the northern, area based on four drill holes.

A 300 ppm As shell was selected as it closely correlates to the argillic alteration domain and contains a significant proportion of the >1 g/t Au intercepts across the deposit. The 300 ppm As shell is considered to be less deterministic than selecting an arbitrary gold grade cut-off. The domains were expanded where required to ensure the capture of high-grade gold material outside of the 300 ppm As shell.

Alteration associated with the Golpu porphyry system comprises a high sulphidation overprint and includes argillic and advanced argillic alteration assemblages (Figure 14-9). Fault wireframes include the major thrust faults which are interpreted to displace mineralisation (Figure 14-10). The most significant thrust fault in the area is the Buvu Fault which creates the floor to the Wafi–Golpu system. All interpreted faults were wireframed but may not necessarily be used in the estimation model.

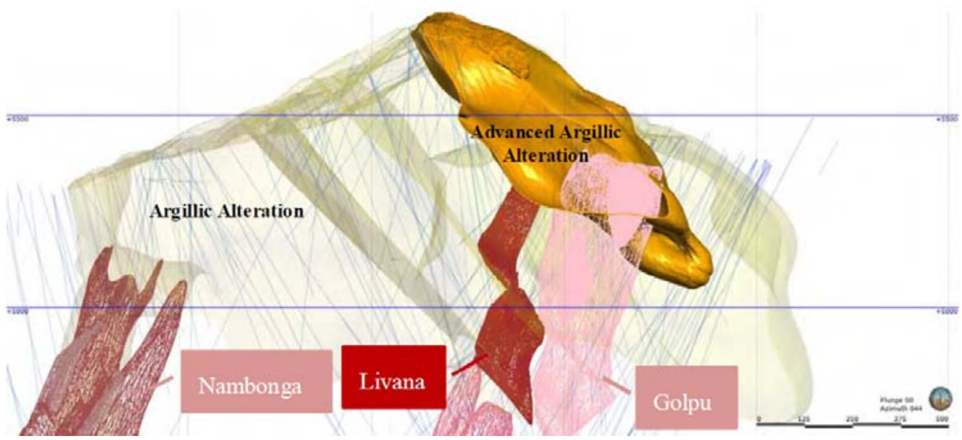
Weathering characteristics were defined by two surfaces: the top of fresh rock (TOFR) and the base of total oxidation (BOCO). Material between these two surfaces included partly oxidised material and was classed as transitional. The base of complete oxidation was modelled by extracting a point at the first occurrence of fresh or partly weathered material in each drill hole log. The top of fresh rock was modelled at the point where there was no partial or fracture oxidation logged. These oxidation surfaces are shown in Figure 14-11.

Figure 14-8:Wafi Resource Domain Wireframes



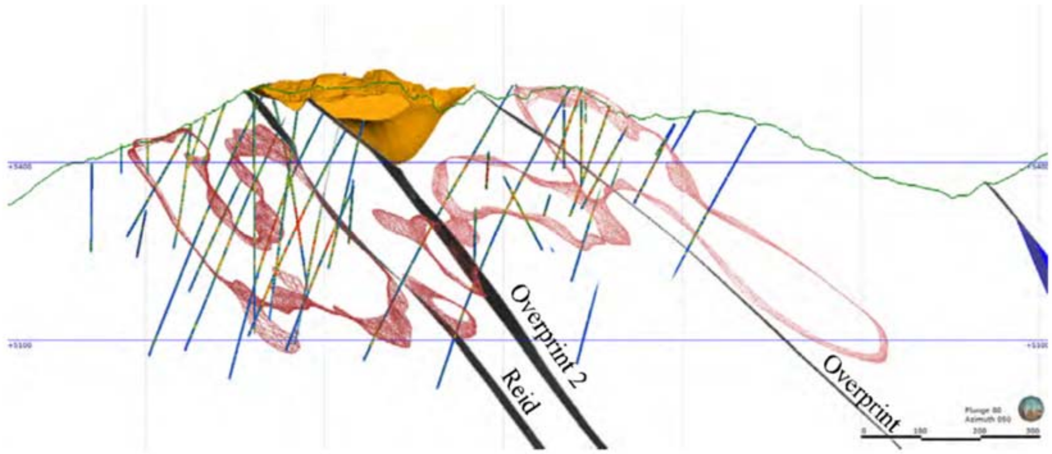
Note: Figure prepared by WGJV, 2019.

Figure 14-9:Wafi Alteration Zones



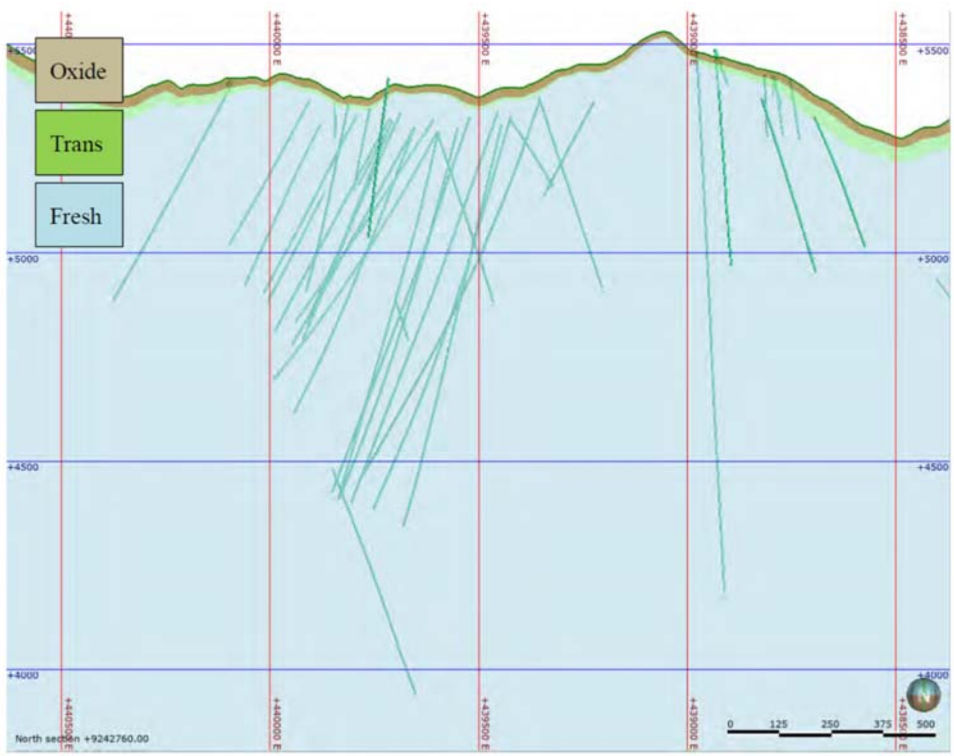
Note: Figure prepared by WGJV, 2019.

Figure 14-10: Wafi Fault Interpretations



Note: Figure prepared by WGJV, 2019.

Figure 14-11: Wafi Oxidation Surfaces



Note: Figure prepared by WGJV, 2019.

The mineralised halo domain comprises generally lower-grade high sulphidation vein mineralisation hosted in metasediments and diatreme defined by a low grade 0.2 g/t Au wireframe. For modelling purposes, the deposit was originally defined using 13 mineralised domains based on mineralisation, alteration and lithological characteristics within nominal 0.5 g/t Au and 0.2 g/t Au wireframes (refer to Figure 14-8).

14.3.3 Exploratory Data Analysis

Geostatistical analysis was conducted to review individual elements and correlations between elements. This analysis was conducted using Isatis 2018.2.

Contact analysis was completed using Micromine software, with the following results:

- The contact between most of the internal higher-grade lodes and the low-grade halo is gradational. A soft boundary was used;
- The contact between the low-grade halo and the host is generally hard. A hard boundary was imposed;
- The contact between the advanced argillic and the argillic domains has little to no impact on grade. The contact was not used in the estimation domains;
- The contact between the oxide–transition and the fresh–transition materials has no impact on grade. The contacts were not used in the estimation domains.

Draft domains were compiled based on observed geology, boundary analyses, and known geological relationships. After testing, these domains were accepted as the final estimation domains for gold, silver and copper. Domains for arsenic, molybdenum, iron and sulphur were based on the alteration domains of argillic (hard boundary on faults) and advanced argillic (soft boundaries).

Figure 14-12 is an example cross-section showing the estimation domains.

14.3.4 Composites

The majority of the raw assay file contains 1 m or 2 m assay intervals. Within the Wafi block model volume, there are 213,684 assay records in the raw database with an average length of 1.5 m. Not all intervals are assayed, and not all assayed intervals are assayed for all elements.

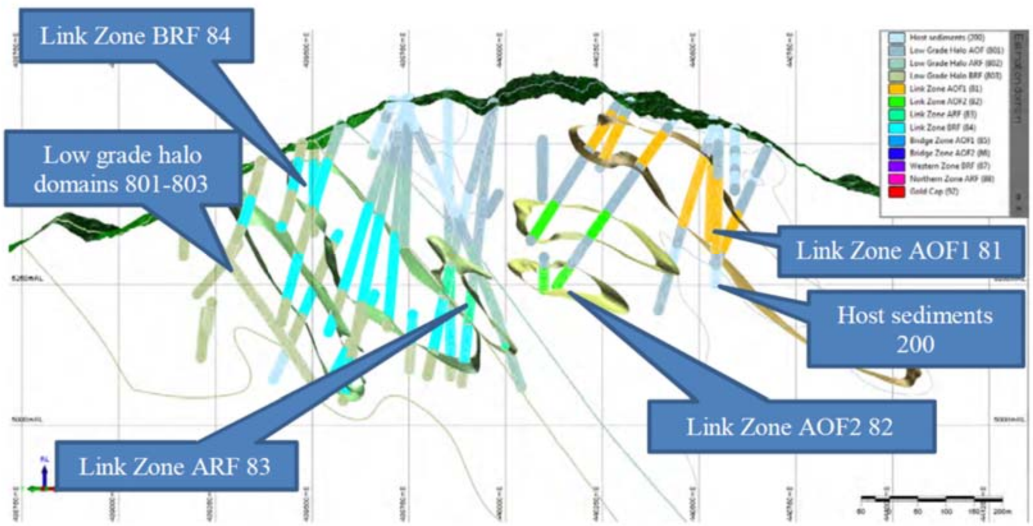
A composite database was compiled based on gold as the primary element from the raw assay database on 4 m composite lengths. The composites were split at the domain contacts and at absent assay intervals for each element.

Drill hole files were flagged with assigned lithology, alteration, fault interval, sulphide species or domain in Vulcan software as part of the compositing process.

14.3.5 Grade Capping/Outlier Restrictions

Top-cuts were determined by review of statistical parameters for gold, followed by silver and copper. Decomposition analysis and percentage of metal contributed from the highest-grade samples (both raw and declustered) in all estimation domains were assessed. The top-cut for the high sulphidation metals (arsenic, sulphur, molybdenum and iron) were then restricted to the 99th percentile after the first runs indicated the estimate was returning too much metal.

Figure 14-12: Wafi Cross Section Showing Estimation Domains



Note: Figure prepared by WGJV, 2019.

Applied top-cut ranges included:

- Copper: 0.11–7% Cu;
- Gold: 3.2–20 g/t Au;
- Sulphur: 11–20% S;
- Silver: 5–120 g/t Ag;
- Molybdenum: 150–450 ppm Mo;
- Iron: 10–20% Fe;
- Arsenic: 900–3600 ppm.

14.3.6 Density (Specific Gravity) Assignment

Density is directly assigned to the block model by rock type and oxidation domains based on averages based on the Golpu deposit. Although significant high-quality density data exist for Golpu, Wafi does not have the same coverage, and thus no estimation of density into the model was conducted.

14.3.7 Variography

The clustering of the gold domains was assessed in Isatis 218.2 software and the analysis indicated the data were moderately clustered, specifically in and around the Link zones and Gold Cap. Declustering was done based on individual domains and a cell size of 100 x 100 x 40 for the entire dataset. Gaussian Transform was completed on the data on a domain by domain basis to enable the development of Gaussian Variograms for estimation purposes. The Gaussian Transform was completed in Isatis using point anamorphosis based on 100 polynomials and on the declustering.

Declustering was conducted based on arsenic in fault domains within the high sulphidation alteration. Arsenic was selected as the main element as it has the strongest correlation with the high sulphidation overprint.

All experimental variograms are generated from the domains flagged into the 4 m composite file in Isatis 2018 software. In all cases Gaussian Variograms were generated and then back transformed based on the Isatis Gaussian anamorphosis and Hermitian polynomial transformations.

All domains are assessed with a geological orientation defined as determined using maximum intensity projection of the grade data in Leapfrog Geo and the average dip and plunge of the stratigraphy (dipping ~51º towards 133º and 97º southeasterly plunge). While this orientation is defined for well-informed domains, this is not so well defined in poorly-informed domains. However, in all cases, the overall trend was impacted by the folded stratigraphy which complicated the interpretation process. A fixed overall trend was selected for all variography.

Given the similar orientations of the data in all the domains (with 15º of azimuth and 10º of dip), the search criteria were maintained across the domains. Variograms were modelled for all domains for all estimated elements. The minor domains contain limited samples and could not form coherent variograms. In these cases, the estimate used the variograms generated for the major surrounding domains.

14.3.8 Estimation/Interpolation Methods

Estimation parameters were based on sample support and not on variogram ranges. The first pass required a search designed to inform the model with the maximum number of samples. The second pass expanded the search (doubled the distance) and reduced the minimum number of samples required to form an estimate. The final third pass maintained the second pass search distance but reduced the number of samples required. Unestimated blocks were left empty, assuming the distance was too great for a valid estimation.

The oxide horizon for arsenic was estimated separately as the oxidation process removes arsenic from the system and the high arsenic grades seen in the fresher units were not replicated in drilling within the oxidised horizon.

The grade model was estimated using OK on 4 m composites for seven elements, gold, copper, silver, molybdenum, sulphur, arsenic, and iron. The estimation used the domain composites as informing samples, back-transformed Gaussian variogram models for composite weighting and ellipsoidal search neighbourhoods for composite selection. The elements were estimated into a block model with 20 x 20 x 10 m parent cells with 10 m resolution on domain margins. All sub-cells were assigned the parent grade. The parent block size reflects the estimation precision available from the drill hole spacing and the assumed bulk open pit mining methodology.

14.3.9 Block Model Validation

The model was validated using visual inspection, comparison with informing composite declustered statistics, alternative modelling methods (ID2), and graphical comparisons (swath plots and grade–tonnage curves).

Visual inspection indicated that there were some areas filled during the third pass where the grade shows a level of smearing. This material does not form part of the current resource estimate, and remains unclassified.

An ID2 model was estimated using the top-cut composites and the same search parameters used in the final OK model estimate. Two estimates were run, one with the exact same parameters as the OK estimate and a second where changes were implemented, such that the minimum and maximum sample numbers were reduced from the 16–24 samples in the OK estimate to 8–16 samples. This comparison was run on all domains. The results show the ID estimate contains more localised grade in the middle grade bins (0.6–1.2 g/t Au) compared to the kriged estimate; however, the overall metal balance was similar.

Scatter plots of the OK estimate were compared against the ID2 estimate, (same sample count) to check the distribution of estimated grades. The ID2 estimate generally returns a slightly higher grade than the OK estimate which is expected given the assumption of linear grade relationships inherent in ID2 estimation. This generally results in fewer tonnes at a higher grade than returned from an OK estimate. However, the ID2 estimates generally return an estimate very similar to the OK estimate. The scatter plot for domain 803 shows a significant data anomaly that consists of a spread of high blocks up against the Reid Fault. These blocks are all informed by an end-of-drill-hole high-grade intersection that happens to be the closest drill hole to these blocks; however, the blocks are not currently classified and therefore are not included in the resource estimate.

Swath plots were compiled by domain in Access to compare the declustered composite assays with the final model estimate sliced by easting, northing and elevation. In the more poorly-informed domains the estimated grades tend to be strongly smoothed; increased sample density generates a much better estimate.

14.3.10 Classification of Mineral Resources

The Mineral Resource was classified based on factors including data spacing and distribution, geological confidence as a function of continuity and complexity of geological features, and estimation quality parameters—for example average distance to informing samples for block estimation. Other estimation quality parameters were also reviewed including slope of regression and kriging efficiency. However, due to the often noisy variograms and high nuggets, these parameters were often far from optimal.

No Measured Mineral Resources were classified. The Indicated and Inferred classification basis is provided in Table 14-1 , and an example cross-section showing the resulting model classification is included as Figure 14-13.

14.3.11 Reasonable Prospects of Eventual Economic Extraction

An internal mining concept study was undertaken by the WGJV in 2013. Information from this study was used to support the assumptions used in assessing reasonable prospects of eventual economic extraction, factored and updated where applicable.

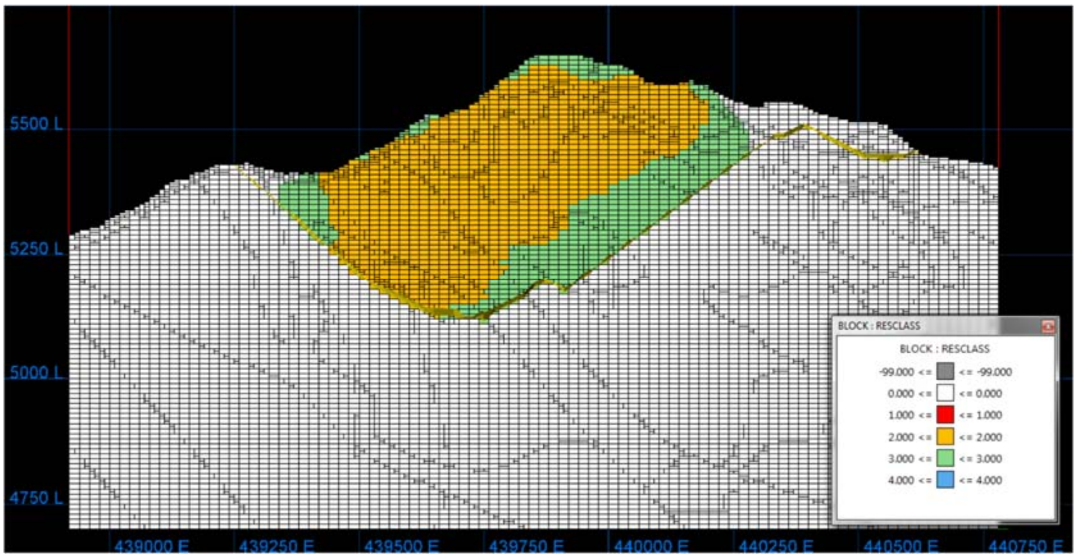
The Mineral Resource estimate is reported assuming an open pit mining method with little internal selectivity. The 20 x 20 x 10 m parent block size is an applicable cell size for the planned mining method.

The process method is assumed to be a combination of a carbon-in-pulp (CIP) and carbon-in-leach (CIL) operation, with a flotation sulphide recovery mill process.

Table 14-1: Wafi Confidence Category Classification Input Considerations

Confidence Category	Minimum Number of Samples	Max Ave Distance	Pass	Variogram Max Range	Slope of Regression
Indicated	24	60	1	60	0.5
Inferred	24	80	1	100	0.15

Figure 14-13: Wafi Example Section, Mineral Resource Classification



Note: Figure prepared by WGJV, 2019. Orange = Indicated, green = Inferred.

Mineral Resources were constrained within a conceptual pit shell that used the following input parameters:

- Commodity price: US$1,400/oz Au;
- Mining cost: US$5.40/t mined;
- Process cost: US$17.30/t processed (includes G&A costs);
- Metallurgical recovery: 91% gold recovery for non-refractory gold mineralisation (NRG) and minimum of 47% recovery for refractory gold mineralisation (RG). The QP notes that RG recoveries could potentially be improved via some form of oxidation process;
- Pit slope angles: overall approximate slope angles ranging from 33º in oxidised material to 65º in fresh rock.

Two cut-off grades were used to report the Wafi Mineral Resource, which are dependent on the metallurgical recovery estimated from testwork and anticipated processing cost differences between non-refractory gold recovered by typical CIP/CIL processing and refractory gold that will have lower overall recoveries or will require pre-oxidation treatment. Cyanide solubility of gold, oxidation state and geochemistry were modelled to estimate the non-refractory–refractory gold distribution within the Wafi model.

Non-refractory gold is reported at a cut-off grade of 0.4 g/t Au and refractory gold is reported at a cut-off grade of 0.9 g/t Au. These cut-off grades are based on US$1,400/oz Au price with modelled recovery and processing, plus realisation costs factored from the 2011–2013 concept studies.

The Wafi Mineral Resource also includes oxide material from the Golpu deposit accessible within the Wafi pit shell and which is excluded from the Golpu Mineral Resource estimate.

14.4 Nambonga

14.4.1 Introduction

All data were extracted from the DataShed database on 23 October 2018 as *.csv extractions.

All collars were reviewed specifically to ensure collars are within tolerance of the surface survey. A campaign of collar surveys was completed before the database was closed. Some historical hole collars that were deemed in error could not be located due to rehabilitation of the drill pad; in these rare cases, the centre of the pad was surveyed and applied to the collar.

All drill holes were reviewed for downhole surveys. These included plots of depth versus dip and dip versus azimuth to identify unrealistic steps in the reported data. For dips, this may result from at collar set-up value not reflecting first downhole survey and errors in dip recording due to not allowing time for the instruments to stabilise. For azimuths, errors result from magnetite inference for Reflex tools, incorrect joining of non-north seeking gyro survey runs, and compass azimuth orientation at collar that did not align with the gyro surveys.

Where below detection level assay values were reported, the following values were applied based on half of the lowest valid reported assay result:

- Gold: 0.005 ppm Au;
- Copper: 0.005% Cu;
- Silver: 0.05 ppm Ag;
- Molybdenum: 0.1 ppm Mo;
- Arsenic: 0.1 ppm As;
- Sulphur: 0.1% S;
- Iron: 0.1% Fe.

14.4.2 Modelling Approach

The geology model for the Nambonga deposit includes lithology, alteration, oxidation, and structures wireframes.

All lithological, porphyry-related alteration and fault wireframes were constructed in Leapfrog using implicit modelling from primary logging codes extracted from the DataShed database and modified based on interpretative correlations of logged intervals.

Two porphyries were modelled, the Nambonga Porphyry (the main mineralised diorite porphyry) and the Late Porphyry (the late-stage, barren inter-mineral porphyry that cuts across the main mineralised porphyry stock). Other lithologies including dacite, diatreme, Wafi Conglomerate, Babwaf Conglomerate, Owen Stanley Metamorphics sedimentary host and recent cover were constructed and flagged into the volume model where intersected.

Alteration associated with the Nambonga porphyry comprises minor high sulphidation overprint and includes argillic alteration assemblages.

A BOCO surface was modelled at the first occurrence of fresh or partially weathered material from drill core. A TOFR surface was modelled at the point where there was no further partial or fracture oxidation recorded from drill hole logs. Figure 14-14 is a section showing the modelled oxide surfaces.

Fault wireframes include the major thrust faults which are interpreted to displace mineralisation. The most significant thrust fault is the Buvu Fault which creates the floor to the Nambonga system. The Upper Buvu Fault is interpreted to cut through the Nambonga porphyry system where minor reactivation of the paleo-Ductile Upper Buvu has caused a top to the northwest offset in the Nambonga Porphyry.

A third significant structure is the Nambonga Fault, a subvertical north-striking breccia zone that contains significant mineralisation within it. All interpreted faults were wireframed but were not necessarily used in the estimation model. A section through the fault wireframe model is provided in Figure 14-15.

Wireframes based on geological interpretations were used to code raw assay files, composite files and the block model. All combinations of lithology, alteration, sulphide distribution and faulting were assessed for use as estimation domains.

Six estimation domains were established, as outlined in Table 14-2. A cross-section example of locations of the estimation domains is provided in Figure 14-16.

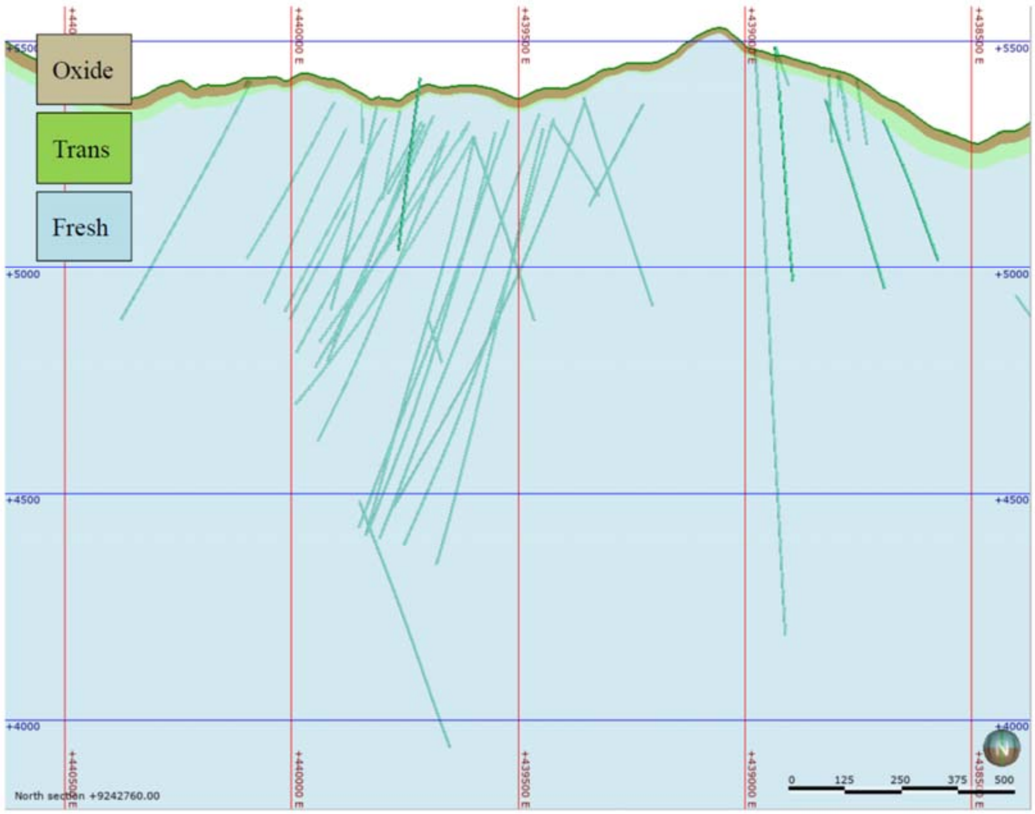
14.4.3 Exploratory Data Analysis

Geostatistical analysis was conducted to review individual elements and correlations between elements.

Contact analyses were completed on all major lithologies; however, fault boundaries were considered hard. Review indicated:

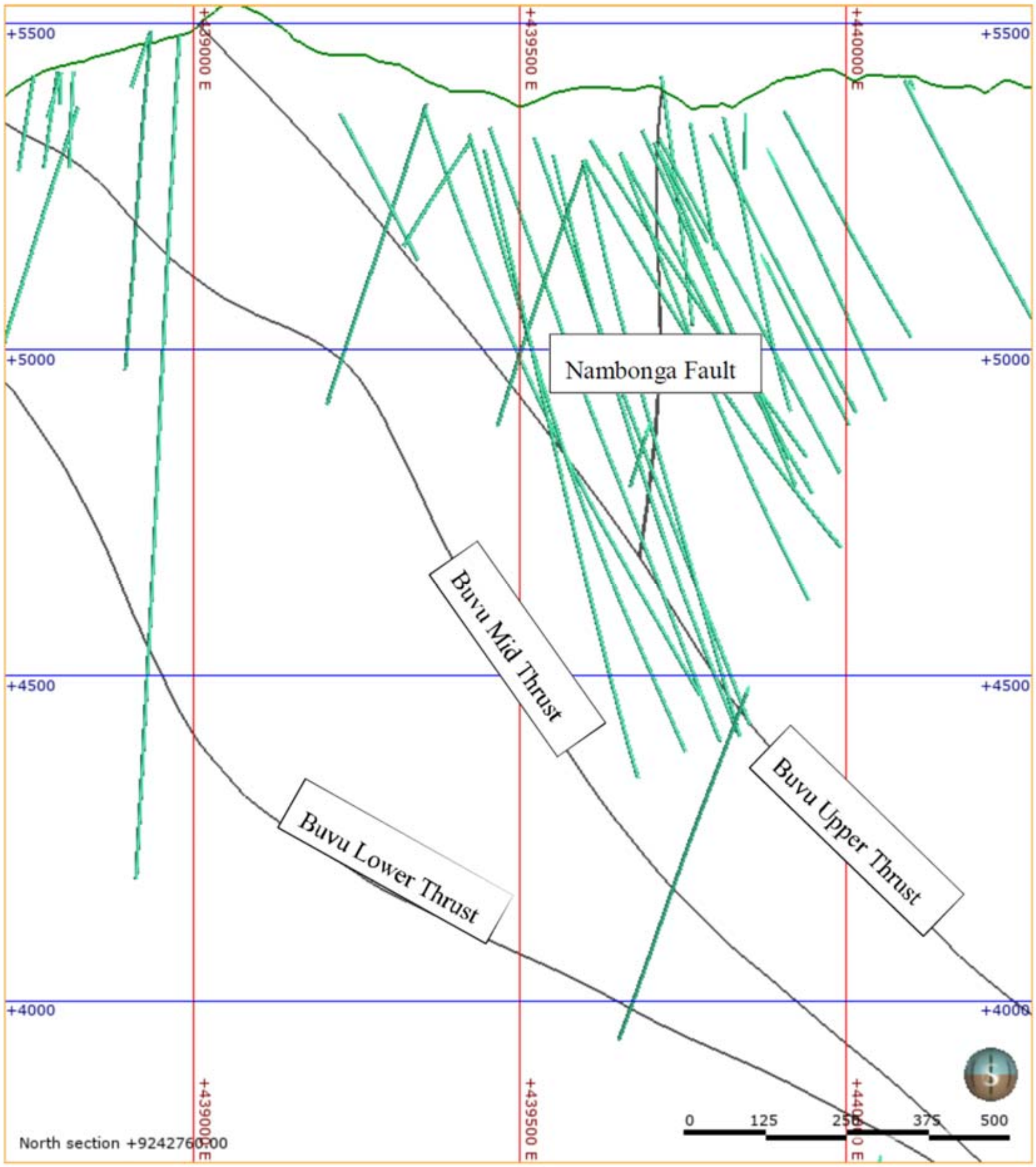
- The contact between the stockwork and the host is soft; however, the grades in the stockwork progressively decrease to background values prior to the edge of the domain. The boundary was treated as hard;
- The contact between the mineralised porphyry and the outer stockwork is gradational. A soft boundary was applied;
- The contact between the mineralised porphyry and the barren post-mineral porphyry is abrupt. The boundary was treated as hard.

Figure 14-14: Nambonga Cross Section Oxide Surfaces



Note: Figure prepared by WGJV, 2018.

Figure 14-15: Nambonga Cross Section Showing Interpreted Faults

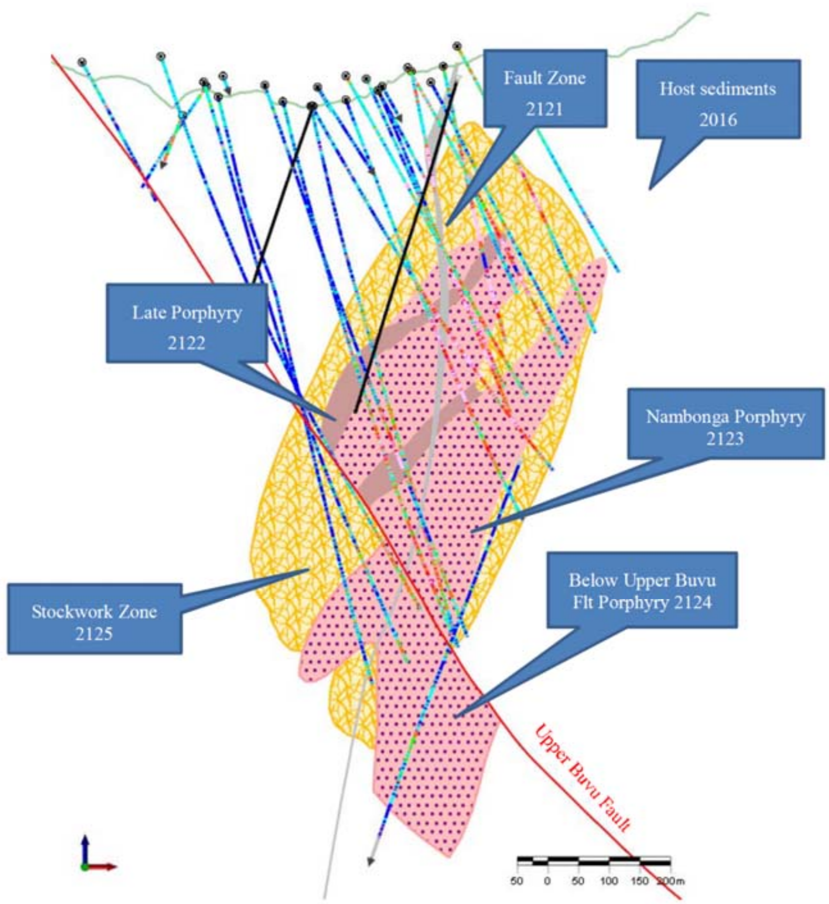


Note: Figure prepared by WGJV, 2018.

Table 14-2: Nambonga Estimation Domains

Domain	Domain Number	Comment
All	2016	Set metasediment background - areas then overwritten in sequence with domains below
Late base metal fault	2121	Late base metal fault that cross cuts the deposit with elevated Au, Cu, Pb and Zn grades. Was not estimated and all composites flagged were excluded from the estimation process
Late Porphyry	2122	Late intermineral porphyry, estimated separately with a hard boundary
Nambonga Porphyry	2123	Main Nambonga porphyry, estimated with soft boundary between it and the stockwork
Nambonga Porphyry BUBF	2124	Main Nambonga porphyry below the Upper Buvu Thrust, estimated with a soft boundary to stockwork and Nambonga Porphyry as too few samples to otherwise inform
Stockwork	2125	Stockwork zone around the porphyry, estimated separately but with a soft boundary to the porphyries

Figure 14-16: Nambonga Cross Section Showing Estimation Domains



Note: Figure prepared by WGJV, 2018.

14.4.4 Composites

The majority of the raw assay file contains 1 m or 2 m assay intervals. Within the Nambonga block model volume, there are 17,313 assay records in the raw database with average length of 1.08 m length. Not all intervals are assayed and not all assayed intervals are assayed for all elements.

Assays were composited to 4 m intervals, based on gold as the primary element. The composites were split at the domain contacts and at absent assay intervals for each element.

14.4.5 Grade Capping/Outlier Restrictions

Top-cuts were determined by review of statistical parameters, graphed data, decomposition analysis and percentage of metal contributed from the highest-grade samples (both raw and declustered) in a combined estimation domain comprising domains 2123 and 2125. The applied top-cut domained top-cut statistics were then compared to the average un-cut grades for validation.

Top-cuts were not individually determined for the minor domains as these are outside the classified area, and in most cases, either the CV variables indicated the domain did not require top-cuts or the lack of data meant any top-cut was not going to be significant. Some spot checks of the minor domains were assessed independently, especially for copper and gold, but no material issues were identified from the checks.

Applied top-cuts included:

- Copper: 0.7% Cu;
- Gold: 2 g/t Au;
- Sulphur: 10% S;
- Silver: 18 g/t Ag;
- Molybdenum: 50 ppm Mo;
- Iron: 12% Fe;
- Arsenic: 500 ppm.

14.4.6 Density (Specific Gravity) Assignment

Average bulk densities were assigned to the Nambonga model based on 277 determinations from Nambonga drill core, of which 132 were in porphyry and massive sulphide domains (refer to Section 11.2). The hanging wall porphyry was assigned the same density as the footwall porphyry.

14.4.7 Variography

All experimental variograms are generated from the domains flagged into the 4 m composite file in Isatis 2017 software. In all cases Gaussian Variograms were generated and then back-transformed based on the Isatis Gaussian anamorphosis and Hermite polynomial transformations.

Variograms were modelled for the combined 2123/2125 domain for all estimated elements. The minor domains contain limited samples and could not form a variogram, in this case the estimate used the variograms generated on the major domains data.

All domains were modelled with a geological orientation defined by the elongation of the porphyry system as determined using maximum intensity projection of the grade data and the average dip and plunge of the system (strike/elongation to 210º local grid, 55º degrees west dip and 93º northern plunge). While this orientation is typically clearly defined for well-informed domains, in poorly-informed domains variogram maps can show a strong bias to the predominant east–west drilling direction. However, in all cases, the porphyry direction was imposed on the variogram map and resulting experimental variograms modelled in this orientation only.

14.4.8 Estimation/Interpolation Methods

Grades were estimated using OK. After the first runs were done at a 4 m composite, the initial results indicated a lack of variability in the estimate. The estimate was re-run using 2 m composites.

All of the second passes were a simple doubling of search volume as the primary estimation, but all other parameters were maintained. The total number of blocks estimated by the second pass estimates was very low.

The grade model is estimated using back-transformed gaussian variograms on 4 m composites for seven elements, gold, copper, silver, molybdenum, sulphur, arsenic, and iron. The estimation uses the domain composites as informing samples, back-transformed Gaussian variogram models for composite weighting, and ellipsoidal search neighbourhoods for composite selection.

The elements are estimated into a block model with 40 x 40 x 40 m parent cells and 10 m resolution on domain margins. All subcells were assigned the parent grade. The parent block size reflects the estimation precision available from the drill hole spacing and an assumed bulk underground sub-level caving/block caving mining methodology.

The estimation of each element is based on an underlying diffusion model, where, in general, grade trends from lower to higher values and return in a relatively continuous relationship. Domainal drift is clearly present for the porphyry system.

14.4.9 Block Model Validation

The model was validated using visual inspection, comparison with informing composite declustered, use of an alternative ID2 interpolation method, and graphical comparisons (swath plots and grade–tonnage curves).

An ID2 model was estimated using the top-cut composites and the same search parameters used in the final OK model estimate. Two changes were implemented, the minimum and maximum numbers of samples were reduced from the 16–28 used in the OK estimate to 8–16, and the declustered weight used in the statistical analysis was used to weight the sample grades prior to estimation.

Swath plots were compiled by domain using Micromine software to compare the declustered composite assays with the final model and the block model estimate by slice by easting, northing and elevation.

No material concerns were noted with the block model and estimate as a result of the validation steps.

14.4.10 Classification of Mineral Resources

The Mineral Resource for the Nambonga deposit is classified based on evaluation factors including data spacing and distribution, geological confidence as a function of continuity and complexity of geological features, and estimation quality parameters (e.g. average distance to informing samples for block estimation). Other estimation quality parameters were reviewed including slope of regression and kriging efficiency. All of the estimated blocks were classified as Inferred. Figure 14-17 is a section through the block model showing the resource classification.

14.4.11 Reasonable Prospects of Eventual Economic Extraction

The estimate assumes that a mass mining method (block cave or sub-level cave) with no internal selectivity would be used. The 40 x 40 x 40 m parent block size is considered to be an applicable cell size for the presumed bulk mining method.

The Mineral Resource for the Nambonga deposit is reported using an assumed 0.5 g/t Au cut-off grade. This cut-off grade is based on a Golpu deposit analogue, assumes an overall mining, processing, and G&A operating cost estimate of about US$15.50/t, a gold price of US$1,300/oz, and a metallurgical recovery of 85% for gold. This equates to a cut-off grade of approximately 0.46 g/t Au, based on gold only. Conceptual costs associated with copper and silver recovery were approximated as equivalent to 0.04 g/t Au. The total cut-off grade for reporting purposes was therefore 0.5 g/t Au.

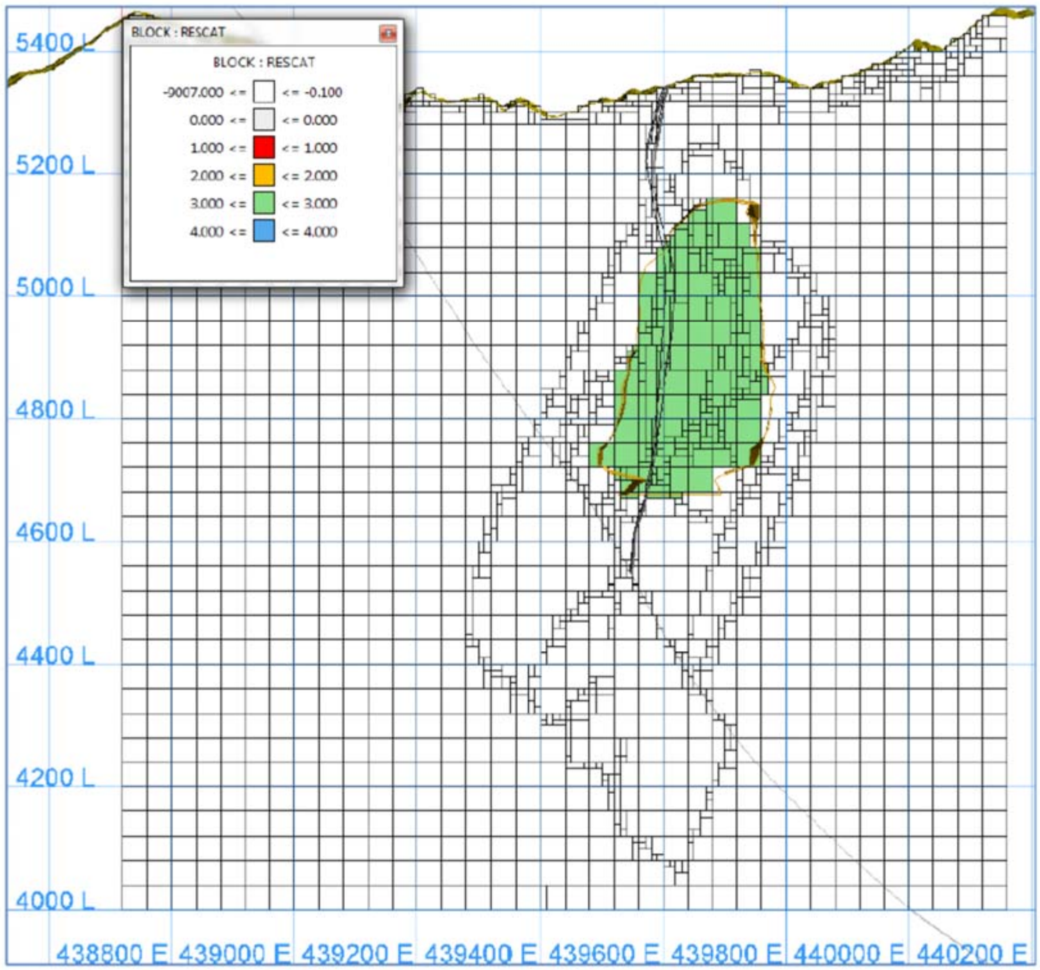
14.5 Mineral Resource Statement

Mineral Resources are reported on a 100% basis with an effective date of 30 June, 2020. Newcrest has a 50% interest in the WGJV. Mineral Resources are reported inclusive of those Mineral Resources converted to Mineral Reserves. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.

The Qualified Person for the estimate is Mr. Kevin Gleeson, FAusIMM, whose job title with Newcrest is Head of Mineral Resource Management. Mr. Gleeson is a Newcrest employee.

Mineral Resource estimates for Golpu are tabulated in Table 14-3 and Table 14-4, for Wafi in Table 14-5 and Table 14-6, and for Nambonga in Table 14-7.

Figure 14-17: Nambonga Example Section, Mineral Resource Classification



Note: Figure prepared by WGJV, 2018. Green = Inferred.

Table 14-3: Golpu Measured and Indicated Mineral Resource Statement

Confidence Category	Tonnage (Mt)	Grade			Contained Metal		
		Au (g/t)	Cu (%)	Ag (g/t)	Au (Moz)	Cu (Mt)	Ag (Moz)
Measured	—	—	—	—	—	—	—
Indicated	690	0.71	1.1	1.3	16	7.5	28
Measured + Indicated	***690***	***0.71***	***1.1***	***1.3***	***16***	***7.5***	***28***

Table 14-4: Golpu Inferred Mineral Resource Statement

Confidence Category	Tonnage (Mt)	Grade			Contained Metal		
		Au (g/t)	Cu (%)	Ag (g/t)	Au (Moz)	Cu (Mt)	Ag (Moz)
Inferred	140	0.63	0.85	1.1	2.8	1.2	4.6

Notes to Accompany Golpu Mineral Resource Tables:

1. Mineral Resources are reported with an effective date of 30 June, 2020 using the 2014 CIM Definition Standards. The Qualified Person responsible for the estimate is Mr. Kevin Gleeson, FAusIMM, whose job title with Newcrest is Head of Mineral Resource Management, and who is a Newcrest employee.
2. Mineral Resources are reported on a 100% basis. Newcrest holds a 50% interest in the WGJV.
3. Mineral Resources are reported inclusive of Mineral Reserves. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.
4. Mineral Resources at Golpu are reported assuming a bulk mining underground extraction method and metallurgical recovery for copper and gold by sulphide flotation. Mineral Resources are reported above a net smelter return (NSR) cut-off, which assumes a gold price of US$1,300/oz Au, a copper price of US$3.40/lb Cu, mining cost of US$8.37/t mined, processing cost of US$9.75/t processed, general and administrative (G&A) costs of US$4.17/t processed, copper concentrate treatment charge of US$100/dmt of concentrate, transport cost of US$33.50/wet tonne of concentrate, and copper refining charges of US$0.10/lb of recovered copper. Silver and molybdenum were not valued in the NSR cut-off; however, these elements were reported within the Mineral Resource as they were expected to be recovered with minor circuit modifications or concentrate contract negotiations. Over the life-of-mine, it is anticipated that copper recoveries will average 94% and gold recoveries will average 68%.
5. Tonnages are metric tonnes. Gold and silver ounces are estimates of metal contained in tonnages and do not include allowances for processing losses. Copper tonnes are estimates of metal contained in tonnages and do not include allowances for processing losses.
6. Rounding as required by reporting guidelines may result in apparent differences between tonnes, grade and contained metal content. Rounding is to two significant figures.

Table 14-5: Wafi Measured and Indicated Mineral Resource Statement

Confidence Category	Tonnage (Mt)	Grade		Contained Metal	
		Au (g/t)	Ag (g/t)	Au (Moz)	Ag (Moz)
Measured	—	—	—	—	—
Indicated	110	1.7	4.4	5.7	15
Measured + Indicated	***110***	***1.7***	***4.4***	***5.7***	***15***

Table 14-6: Wafi Inferred Mineral Resource Statement

Confidence Category	Tonnage (Mt)	Grade		Contained Metal	
		Au (g/t)	Ag (g/t)	Au (Moz)	Ag (Moz)
Inferred	37	1.4	4.2	1.6	5.0

Notes to Accompany Wafi Mineral Resource Tables:

1. Mineral Resources are reported with an effective date of 30 June, 2020, using the 2014 CIM Definition Standards. The Qualified Person responsible for the estimate is Mr. Kevin Gleeson, FAusIMM, whose job title with Newcrest is Head of Mineral Resource Management, and who is a Newcrest employee.
2. Mineral Resources are reported on a 100% basis. Newcrest holds a 50% interest in the WGJV.
3. Mineral Resources at Wafi are reported assuming open pit mining methods with limited internal selectivity, and a process method that is anticipated to be a combination of a carbon-in-pulp (CIP) and carbon-in-leach (CIL) operation, with a flotation sulphide recovery mill process. The estimates are reported at cut-offs of 0.4 g/t Au for non-refractory gold mineralisation (NRG) and 0.9 g/t Au for refractory gold mineralisation (RG). Mineral Resources are constrained within a conceptual open pit shell that uses the following input assumptions: gold price of US$1,400/oz; mining costs of US$5.40/t mined, and process and general and administrative (G&A) costs of US$17.30/t processed. Metallurgical recovery is estimated at 91% gold recovery NRG and minimum of 47% recovery for RG. Pit slope approximate overall angles range from 33º in oxidised material to 65º in fresh rock
4. Tonnages are metric tonnes. Gold and silver ounces are estimates of metal contained in tonnages and do not include allowances for processing losses.
5. Rounding as required by reporting guidelines may result in apparent differences between tonnes, grade and contained metal content. Rounding is to two significant figures.

Table 14-7: Nambonga Inferred Mineral Resource Statement

Confidence Category	Tonnage (Mt)	Grade		Contained Metal	
		Au (g/t)	Cu (%)	Au (Moz)	Cu (Mt)
Inferred	48	0.69	0.20	1.1	0.094

Notes to Accompany Nambonga Mineral Resource Table:

1. Mineral Resources are reported with an effective date of 30 June, 2020, using the 2014 CIM Definition Standards. The Qualified Person responsible for the estimate is Mr. Kevin Gleeson, FAusIMM, whose job title with Newcrest is Head of Mineral Resource Management, and who is a Newcrest employee.
2. Mineral Resources are reported on a 100% basis. Newcrest holds a 50% interest in the WGJV.
3. Mineral Resources at Golpu are reported assuming a bulk mining underground extraction method. The Mineral Resource is reported using an assumed 0.5 g/t Au cut-off grade. This cut-off grade is based on the adjacent Golpu deposit as an analogue, assumes an overall mining, processing, and G&A operating cost estimate of about US$15.50/t, a gold price of US$1,300/oz, and a metallurgical recovery of 85% for gold. This equates to approximately an 0.46 g/t Au cut-off grade, based on gold only. Conceptual costs associated with copper and silver recovery were approximated as equivalent to 0.04 g/t Au. The total cut-off grade for reporting purposes was 0.5 g/t Au.
4. Tonnages are metric tonnes. Gold ounces are estimates of metal contained in tonnages and do not include allowances for processing losses. Copper tonnes are estimates of metal contained in tonnages and do not include allowances for processing losses.
5. Rounding as required by reporting guidelines may result in apparent differences between tonnes, grade and contained metal content. Rounding is to two significant figures.

14.6 Factors That May Affect the Mineral Resource Estimate

Areas of uncertainty that may materially impact the Mineral Resource estimates include:

- Changes to long-term gold and copper price assumptions;
- Changes in local interpretations of mineralisation geometry and continuity of mineralised zones;
- Changes to geological shape and continuity assumptions;
- Changes to metallurgical recovery assumptions;
- Changes to the operating cut-off assumptions for assumed block caving operations (Golpu and Nambonga);
- Changes to the input assumptions used to derive the conceptual underground outlines used to constrain the Golpu and Nambonga estimates;
- Changes to the input assumptions used to derive the conceptual pit shell used to constrain the Wafi estimate;
- Changes to the NSR values used to constrain the Golpu estimate;
- Changes to the cut-off grades used to constrain the Wafi and Nambonga estimates;
- Variations in geotechnical, hydrogeological, and mining assumptions;
- Changes to environmental, permitting and social license assumptions.

The following are also noted in relation to the Golpu estimate:

- A direct consequence of using the Livana Porphyry as an estimation domain with hard boundaries is that any change in the Livana Porphyry interpreted contact results in a direct change in the tonnage of the estimated highest-grade material. Above the Reid Fault, the Livana Porphyry is currently modelled as multiple dykes with elongation to the northwest, but which coalesce in some locations into vertical finger porphyries. Recognition of the multiple thrust slices above the Reid Fault further restricted the vertical extrapolation of the porphyry. However, the realisation that the porphyry shape immediately above a thrust surface should be similar to the shape below, albeit offset, enabled the creation of a single configuration even when there is limited drilling within the thrust-bounded block itself. There are also some remnant areas where the Livana Porphyry contact position remains poorly constrained, for example the eastern contact of Livana Porphyry above Reid Fault;
- Above the Reid Fault, the apparent complexity of the Livana Porphyry shapes requires closer-spaced drilling to resolve than is required for the large, apparently coherent, Livana Porphyry below the Reid Fault. While drill spacing increases with depth, the apparent simplicity of the Livana Porphyry below the Reid Fault may permit wider drill coverage to define the high-grade domain contact compared to the complex configuration above the Reid Fault. However, below the DLT Fault, the Livana Porphyry appears narrower and more elongated than below the Reid Fault. Drill spacing is variable and includes up to 200 x 200 m gaps with limited contacts defined. The limited information below the DLT Fault is reflected in the Inferred Mineral Resource classification and additional drilling is required to refine the geological interpretation;
- While there is confidence in the position of the primary structures, particularly the major thrust faults with abrupt changes in grade, additional structures were recorded in the logging that have not been modelled. Some apparently significant geotechnical structures (e.g., Camp Fault) were modelled; however, these faults have not been applied as grade boundaries. To date, all faults were identified based on empirical data; the faults were recorded in logging and were modelled to offset grade. No fault sequencing, absolute timing or mechanical validity was applied during fault modelling, and additional fault modelling may be required for an integrated and viable structural framework.

The following are also noted in relation to the Wafi estimate:

- There are a number of mineralised intersections encountered across the Wafi–Golpu system that have not been drilled out or in many cases followed up due to a concentration on the porphyry systems. Areas around the Wafi mineralisation itself have not been completely closed out at depth, nor along strike where high-grade intersections commonly sit orphaned at the end of drill holes;
- The main mineralisation domains at Wafi were built using a 300 ppm As contour. This contour was chosen due to it correlating with the higher-grade zones at Wafi; however, the contour corresponds to the high sulphidation overprint, and not to the earlier underlying gold-mineralising event. There are a number of high-grade areas that have not been captured by these domains, even though the outlines were modified to capture some of the nearer high-grade material. Additional work needs to be completed to ensure the correct domain boundaries were selected;

- The interplay between the subvertical faults, the Compass Fault-related structures and the thrust faults and their impact on the deposit is not fully understood. Additional drilling may result in a change to the underlying geological interpretation.

The following are also noted in relation to the Nambonga estimate:

- Incomplete drill hole coverage where the complete grade trend is not fully sampled remains in two areas: the northern and the southern strike extents of the porphyry remain open. In both cases the risk may be expansion or reduction of the mineralised volume. The grade trend may also change with additional drilling as the diffusive model implies the mineralised margin is not an abrupt grade transition;
- The nature of the Upper Buvu Fault where it intersects the porphyries is not well defined. The interaction of the Upper Buvu and the porphyry itself needs further investigation and may result in a change to the underlying geological interpretation;
- The interplay between the subvertical base-metal-filled Nambonga Fault, the Compass structures and the Upper Buvu Thrust and their impact on the deposit is not fully understood. Additional drilling may result in a change to the underlying geological interpretation.

14.7 QP Comments on "Item 14: Mineral Resource Estimates"

The QP is of the opinion that Mineral Resources were estimated using industry-accepted practices, and conform to the 2014 CIM Definition Standards.

There are no other environmental, legal, title, taxation, socioeconomic, marketing, political or other relevant factors known to the QP that would materially affect the estimation of Mineral Resources that are not discussed in this Report.

15 MINERAL RESERVE ESTIMATES

15.1 Introduction

Mineral Reserves are reported for the Golpu deposit only. Indicated Mineral Resources were converted to Probable Mineral Reserves.

The proposed mining method is block caving at three distinct elevations:

- The BC44 extraction level is planned at 4400 mRL, to extract a total of approximately 67 Mt of material over a seven-year period at a peak annualised 16.84 Mt/a production rate. During caving operations, ore from the block cave drawpoints will be delivered by diesel load–haul–dump vehicles (LHDs) to either of two underground gyratory crushers then conveyed to the Watut process plant on surface by an inclined conveyor system;
- The BC42 extraction level is planned at 4200 mRL, to extract a total of approximately 93 Mt of material over a nine-year period at a peak annualised 16.84 Mt/a production rate. Materials handling from drawpoint to the Watut process plant is identical to that proposed for BC44;
- The BC40 extraction level is planned at 4000 mRL, to extract a total of approximately 240 Mt of material over a 16-year period at a peak annualised 16.84 Mt/a production rate. Materials handling from drawpoint to the Watut process plant will be identical to that proposed for BC44.

A layout schematic of the proposed mining operations is provided in Figure 15-1. The proposed mine life will be 28 years from first production of the processing plant (excluding construction and closure phases).

Cost estimates used in the preparation of the Mineral Reserves are based on the most recent mining studies completed in 2018. The Mineral Reserves consist of material when delivered to the mine portal that has a recovered value greater than the cost of all downstream processes, including fixed costs and associated dilution.

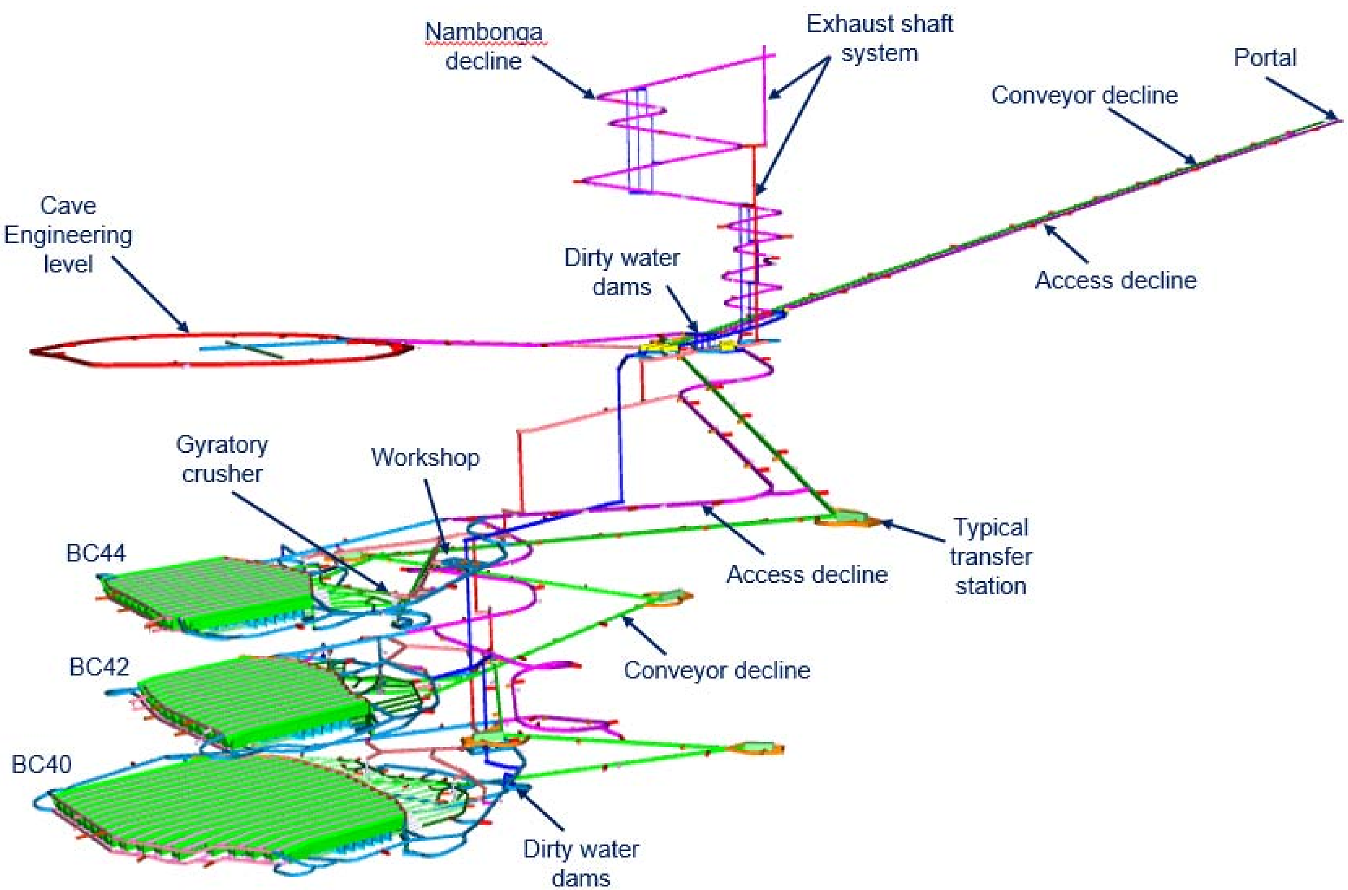
The mine to port area, surface services and infrastructure, BC44 and BC42, underground services, and infrastructure areas are designed to a feasibility level of confidence. The BC40 cave footprint and thus extraction level layout, are designed at a pre-feasibility confidence level. The infrastructure for BC40 is identical to that of BC44 and BC42, and is at a feasibility level of confidence. There will be no additional surface infrastructure for BC40.

Metal price and exchange rate assumptions used in Mineral Reserve estimation are provided in Table 15-1.

15.2 Development of Mining Case

A total of 13 geometallurgical domains were assigned. There is a distinct change in the profile of the metallurgical domains over the LOM. Initially a high proportion of the mineralisation that is milled will consist of metallurgical Domain 33 (porphyry) which is characterised by high recoveries of both copper and gold. After approximately Year 9, the proportion of other rock types will increase, with significant amounts of metallurgical Domain 29, 31 and 32. The high-grade section of the mines corresponds to the highest proportion of metallurgical Domain 33 material, which represents the highest recoveries of all the metallurgical domains.

Figure 15-1:Mine Layout Schematic



Note: Figure prepared by Newcrest, 2018.

Table 15-1: Metal Price and Exchange Rate Assumptions

Item	Value
Gold price	US$1,200/oz
Copper price	US$3.00/lb
Exchange rate (long-term)	A$:US$: 0.75
	PGK/US$ 3.10

The base case was developed by assessing the revenue profile using commercially-available PCBC software, to develop block cave schedules at a high level such that the starting point (or base case) provides approximately the correct strategy that was subsequently used for optimisation. When assessing the transition between three block caves there are many permutations that exist, as the tonnes and grade mined from the upper cave affects the available tonnes and grade of the successive caves.

To simplify the evaluation, it was conducted in two phases:

- Phase 1: Transition timing BC44/BC42. This consists of varying the length of BC44, keeping BC42 consistent in tonnage, and running BC40 to shut-off;
- Phase 2: Transition between BC42/BC40. Adopts the timing of BC44/BC42 from Phase 1 and adjusts the length of BC42.

Due to potentially excessive squeezing of excavations located in actinolite, all drawpoints are to be located in porphyry for the design of extraction levels at a feasibility level of confidence. The extraction level footprints for BC44 and BC42 were located in porphyry material (with some minor overlap across the contact with actinolite due to the geometry of the extraction level layout). On BC40, where the actinolite was shown to be substantially stronger, the footprint extent was based on economic outlines.

As the mine design consists of three levels, to ensure there was not a double-count of tonnes and metal though Deswik software and PCBC, the areas within the caves were depleted to represent the removal of the extraction and undercut levels. This depletion was completed by reducing the density of the block model within the affected area to effectively remove the tonnes and metal available to the cave below.

Draw cones were flat bottomed, starting the elevation at the top of the drawbell. The tonnes reported from Deswik from both the drawbell and undercut were modified such that double-counting of material does not occur.

The mine design process consisted of an iterative process that included:

- Creation of mining outlines;
- Design of extraction and undercut layouts, access, and infrastructure including ventilation and materials handling development.

15.3 Ore Versus Waste Determinations

15.3.1 Net Smelter Return

The NSR is the return from sales of concentrate or metal product, expressed in US$/t, excluding site costs (mining, processing and general and administration) and sustaining and non-sustaining capital costs. The NSR is determined taking into account the treatment, transport and royalty costs “outside the mine gate”. Input parameters for the NSR are summarised in Table 15-2. Gold and copper recoveries used in NSR development are as outlined in Table 15-3.

15.3.2 Development Ore Selection

Material generated from BC44 cave establishment activities will be categorised as ore when it has an NSR >US$10/t. This classification will apply until the first crusher is commissioned at BC44. Such ore will be stockpiled on surface and then used in plant commissioning. Gold produced will be a credit to the capital cost of the Golpu Development up until commercial production is declared. Commercial production will occur when the first block cave has reached its hydraulic radius, and is "self-sustaining" for forward production.

Following the commissioning of the first crusher at BC44, the assumption for ore and waste cut-offs, is that all mineralised material, regardless of NSR cut-off, will be processed to reduce the potentially acid-forming (PAF) storage requirements due to limited space and difficulty of construction of large PAF storage facilities.

Development ore recovery is assumed to be 100% of the in-situ resource block model.

15.3.3 Block Cave Ore Selection

Ore determination for the block caves is based on net value calculated for all mining blocks, after deduction of operating costs from the NSR for each block. The software package PCBC was used to select the economic block heights and to schedule the optimum extraction sequence for the draw columns.

Cave ore recovery is assumed to be 100% of the mixed/diluted block model. All columns are taken to the maximum economic height on the BC40 level at the shut-off shown in Table 15-4. The shut-off for each drawpoint and the shut-off strategy for the footprint defines the economic height of draw (HOD) of a column.

15.3.4 Shut-off Determination

The shut-offs applied for the estimation of Mineral Reserves are provided in Table 15-5.

The shut-offs stated are nominal for BC44 and BC42. As BC40 is the final level, the shut-off is applied as a true shut-off. The shut-offs are nominal in nature as the transition timing between the caves is based on timing and achieving the highest tonnes and grade in a set timeframe. The nominal shut-off decreases with each cave to maintain head grade.

15.3.5 Dilution

Three different dilution types were attributed as part of the block model:

- Mixing dilution which is material above the unmixed economic surface;
- Outside (or toppling) dilution which is material coming from outside the projection of the footprint;
- Planned dilution, sub-economic material that is within an un-mixed economic surface.

Table 15-2: NSR Input Parameters

	Unit	Assumption
	Royalties	2% of gross revenue from all mining sales
	Ongoing regional support	1% of gross revenue from all mining sales
	Production levy	0.25% of gross revenue from all mining sales
Variable	**Unit**	**Assumption**
Concentrate treatment charge	US$/dMt	100
Copper refining charge	US$/lb	0.10
Copper payable scale	%	Variable
Copper minimum deduction	%	1
Gold refining charge	US$/oz	6
Gold payable scale	%	Variable
Ocean freight charge	US$/wMt	40
Franchise deduction (Bill of Loading)	%	0.25
Contracts subject to weight deductions	%	50
Concentrate moisture	%	9
Arsenic trigger level	ppm	1,000
Arsenic penalty in excess of 1,000 ppm	US$/1,000 ppm	2.50
	Gold grade in concentrate (g/t)	**Payment (%)**
	<1	0
	1–3	90
	3–5	95
	5–10	96
	10–20	97
	20–30	97.25
	30–40	97.5
	40–50	98
	50–75	98.25
	75+	98.5

Table 15-3: Metallurgical Recovery Assumptions

Identifier	Cu Conc Grade (%)	Copper Circuit					Pyrite Circuit		Leach Circuit	Mo Circuit
		Copper Recovery (%)		Gold Recovery (%)		Arsenic Deportment	Au Recovery (%)		Au Stage Recovery (%)	Mo Recovery (%)
BOCO	—	—		—		—	—		—	—
Supergene	—	—		—		—	—		—	—
Alunite metasediment	18	80.73 x (1- exp(-1.99 x Cu head %))		37.481 x exp (-0.667 x Au feed (g/t))		As >33,000	77 - Au Rec to Cu Conc		26	
Alunite porphyry	28	91.21 x (1- exp(-1.99 x Cu head %))		66.61 x exp (-0.667 x Au feed (g/t))		As >33,000	87 - Au Rec to Cu Conc		32	
Dickite metasediment	10	73.1 • (1- exp(-3.6 x Cu head %1))		37.481 x exp (-0.667 x Au feed (g/t))			52 - Au Rec to Cu Conc		26	
Dickite porphyry	28	If Cu >0.05%	100 - 25 567/Cu head % - 55.0 516/S head %	If Cu Rec > 0%	44.577 x exp(1.8967 Au:S in feed)		If Au to Cu Conc > 0%	172.81 x exp (-0 .036 x Au Rec to Cu Cone)	32	
		If Cu <0.05%	0%	If Cu Rec = 0%	0%		If Au to Cu Conc = 0%	0%	0	
Dickite + actinolite metasediment	24	84.8 x (1-exp(3.6 Cu head %))		41.37 x exp (-0.65 x Au feed (g.t))			70 - Au Rec to Cu Conc		26	85.228 - 4061.128 /Mo head ppm (@ 50% Mo grade)
Dickite + actinolite porphyry	28	94.55 x 11 - exp(-1 .99 x Cu head %)		49.8 x exp(1.8967 x Au:S in feed)		As in feed (As in feed x 0.0634 + 16.329)	90 - Au Rec: to Cu Conc:		32	
Sericite + actinolite metasediment	24	If Cu:S >0.15, If Cu >0.05%	100 - 3.2963/Cu head % - 25.467/S head %	If Au:S <0.38	44.577 x exp (1.8967 x Au:S in feed)		58.824 x exp (-0 .015 x Au Rec to Cu Conc)		38	
		If Cu:S <0.15, If Cu >0.05%	100 - 2-.5567/Cu head % -65.0516/S head %	If Au:S >0:38	82%		172.81 x exp (-0 .036 x Au Rec to Cu Conc)			
Sericite + actinolite porphyry	28	100 - 3.2963/Cu head % - 25.467/S head %		If Au:S <0.7 If Au:Cu >0.65	85 x (1 - exp(-1 .SO x Au (g/t)))		58. 824 x exp (-0 .015 x Au Rec to Cu Conc)		45	
				Else	6.2944 x exp (3.8436 x Au:Cu in feed)					
Actinolite metasediment	28	If Cu:S > 0.10	100 - 5.93374 / Cu head %	If Au:Cu <1.0	72.743, exp (-0.527 x Au:Cu in feed)		132 x exp (-0.037 x Au Rec to Cu Conc)		84	
		If Cu:S < 0.10	50%	If Au:Cu >1.0	62%		25%		32	

Identifier	Cu Conc Grade (%)	Copper Circuit					Pyrite Circuit	Leach Circuit	Mo Circuit
		Copper Recovery (%)		Gold Recovery (%)		Arsenic Deportment	Au Recovery (%)	Au Stage Recovery (%)	Mo Recovery (%)
Actinolite 3% chalcopyrite	28	If Cu:S > 0.20	100 - 7.3515 / Cu head %	If Au:Cu <0.4	72.743, exp (-0.527 x Au:Cu in feed)		55.531 x exp (-0.022 x Au Rec to Cu Conc)	84	
		If Cu:S < 0.20	Domain 31	If Au:Cu >0.4	144 x exp (-1.627 x Au:Cu in feed)				
Actinolite porphyry	28	If > 0.60 Cu:S	100 - 0.4517/Cu head % - 7.0588/S head %	85 x (1-exp(-1.80 x Au (g/ t)))			55.531 x exp (-0 .022 x Au Rec to Cu Conc)	84	
		If < 0.60 Cu:S	100 - 0.1296/Cu head % - 0.8974/S in feed %						
Chlorite/ epidote	—	—		—		—	—	—	—

Table 15-4: Parameters for Column Heights

Block Cave	Average HOD (m)	90th Percentile HOD (m)	Nominal Shut-Off Value (US$/t)	Drawpoints Closed Due to Shut-Off Value (%)
BC44	320	530	60	4
BC42	490	805	40	5
BC40	590	1,120	25	99

Note: HOD = height of draw

Table 15-5: Shut-off Grades

Activity	Units	Value
Development prior to first BC44 crusher commissioning	US$/t ore milled	10
BC44 (nominal)	US$/t ore milled	60
BC42 (nominal)	US$/t ore milled	40
BC40	US$/t ore milled	19.15

Two forms of dilution will be reported:

- Material with a value less than US$20/t regardless of location;
- Material from outside the vertical walls of the cave that migrates (toppling) into the cave via crater generation.

The total dilution is estimated to be about 17% with toppling contributing approximately 1.5%. BC44, BC42 and BC40 peak at ~17%, ~25% and ~63% dilution respectively for a given year. Around 62% of the total dilution occurs on BC40 due to the nominal shut-off value strategy on BC44 and BC42, which is designed to maintain head grade.

All development has mining factors for dilution and recovery applied to accurately represent the expected mined tonnes. All mining volumes (shapes) outside the block model have tonnes contributing but not metal, the tonnes are allocated to unclassified material.

15.4 Mineral Reserves Statement

Mineral Reserves are reported in Table 15-6 with an effective date of 30 June, 2020, on a 100% basis. Newcrest has a 50% interest in the WGJV.

The Qualified Person for the estimate is Mr. Pasqualino Manca, FAusIMM, whose job title with Newcrest is Group Manager – Mining Studies. Mr. Manca is a Newcrest employee.

Table 15-6: Mineral Reserves Statement

Confidence Classification	Tonnes (Mt)	Gold Grade (g/t Au)	Copper Grade (%)	Contained Gold (Moz)	Contained Copper (Mt)
Probable	400	0.86	1.2	11	4.9

Notes to Accompany Mineral Reserve Table:

1. Mineral Reserves are reported with an effective date of 30 June, 2020 using the 2014 CIM Definition Standards. The Qualified Person responsible for the estimate is Mr. Pasqualino Manca, FAusIMM, whose job title with Newcrest is Group Manager – Mining Studies, and who is a Newcrest employee.
2. Mineral Reserves are reported on a 100% basis. Newcrest holds a 50% interest in the WGJV.
3. Mineral Reserves are reported using the following assumptions: block cave mining method, gold price of $US1,200/oz Au, copper price of US$3.00/lb Cu, above a net smelter return cut-off of US$10/t (development), US$60/t (BC44), US$40/t (BC42), US$19.15/t (BC40), variable metallurgical recoveries by metallurgical domain. The total dilution is estimated to be about 17% with toppling contributing approximately 1.5%.
4. Tonnages are metric tonnes. Gold ounces are estimates of metal contained in tonnages and do not include allowances for processing losses. Copper tonnes are estimates of metal contained in tonnages and do not include allowances for processing losses.
5. Rounding as required by reporting guidelines may result in apparent differences between tonnes, grade and contained metal content. Rounding is to two significant figures.

15.5 Factors that May Affect the Mineral Reserve Estimate

Areas of uncertainty that may materially impact the Mineral Reserve estimates include:

- Changes to long-term gold and copper price assumptions;
- Changes to exchange rate assumptions;
- Changes to metallurgical recovery assumptions;
- Changes to the input assumptions used to derive the cave outlines and the mine plan that is based on those cave designs;
- Changes to operating, and capital assumptions used, including changes to input cost assumptions such as consumables, labour costs, royalty and taxation rates;
- Variations in geotechnical, mining, dilution and processing recovery assumptions; including changes to designs as a result of changes to geotechnical, hydrogeological, and engineering data used;
- Changes to the shut-off criteria used to constrain the estimates;
- Changes to the assumed permitting and regulatory environment under which the mine plan was developed;
- Ability to obtain mining permits, including timing for finalisation of the Special Mining Lease;
- Ability to obtain agreements to land under customary ownership;
- Ability to permit deep sea tailings placement;
- Ability to obtain operations certificates in support of mine plans;
- Ability to obtain and maintain social and environmental license to operate.

Factors that are risk-specific to block cave operations, and which may affect the Mineral Reserves include:

- Inrush of water or mud into the underground workings including declines, cave levels and infrastructure areas;
- Poorer rock mass quality and quantity than interpreted;
- Inability to achieve planned decline development rates having impact on schedule and cost;
- Incorrect estimation of cave propagation potentially leading to air blast, caused by the sudden collapse of the cave when a significant air gap is present due to the cave stalling;
- Damage to mine workings due to a seismic event.

The major control for the block cave-related risks is additional data collection to provide the data necessary to better understand the rock mass and the fragmentation in the cave and also to the provide the opportunity to dewater and understand the potential for further risk mitigation.

15.6 QP Comments on "Item 15: Mineral Reserve Estimates"

The QP is of the opinion that Mineral Reserves were estimated using industry-accepted practices, and conform to the 2014 CIM Definition Standards. Mineral Reserves are based on underground mass mining assumptions.

The Mineral Reserves are acceptable to support mine planning.

There are no other environmental, legal, title, taxation, socioeconomic, marketing, political or other relevant factors known to the QP that would materially affect the estimation of Mineral Reserves that are not discussed in this Report.

16 MINING METHODS

16.1 Introduction

An evaluation of potential mining methods included consideration of block caving, sub-level caving (SLC), sub-level open stoping (SLOS), and open pit methods. Block caving was selected for the following reasons:

- Orebody geometry and geotechnical conditions;
- High productivity, low operating cost mining method;
- Higher-value material located at depth can be accessed earlier in the mine plan.

The proposed mine plan uses technology conventional to block cave operations, including mine design and equipment. Due to high surface ambient temperatures and humidity, and the depth of the mine, considerable ventilation and cooling capacity will be required to be installed to ensure the health and safety of mine workers.

Access to the mine workings will be via the Watut and Nambonga declines, with each generating waste rock that will either be used in construction activities, processed or deposited within the waste rock storage facilities (WRSFs). Block cave mining will not result in the production of waste rock because all material extracted from the block cave will be fed to the Watut process plant. Block cave mining will cause a subsidence zone of fractured rock to develop that will propagate to surface.

During the development of the block caving infrastructure, ore grade material will be temporarily stockpiled on the process plant terrace for later use during commissioning and initial production from the process plant. During caving operations, ore from the block cave drawpoints will be delivered by LHD vehicles to an underground crusher. The crushed ore will then be conveyed to the surface. The ore conveyor emerging at the Watut declines portal terrace will continue overland for approximately 600 m to deliver crushed ore to a coarse ore stockpile adjacent to the Watut process plant for processing.

The mine is planned to operate 24 hours per day, every day of the year, apart from scheduled and unscheduled shutdowns.

16.2 Geotechnical Considerations

Geotechnical interpretations are supported by point load testing, uniaxial compressive strength testing, modified punch testing (block punch index), triaxial (multi-stage) tests, acoustic televiewer (ATV) and manual logging of drill core, and RQD, RMR, intact rock strength (IRS) and tunnelling quality index (Q’) measurements and calculations. In-situ stress testing was undertaken with ANZI cells in addition to acoustic emission testing and borehole breakout (from ATV surveys).

A domained geotechnical model was constructed incorporating interpolated data, with the interpolation controlled by the proximity to interpreted structures and boundaries within the domain. The final geotechnical block model consists of a total of 18 domains (inclusive of a host domain) and 69 sub-domains. A number of those sub-domains are then subsequently filtered by depth sub-categories.

The final compiled interpolated block model of RMR, RQD, and IRS, together with the summary statistics of rock quality and strength for each domain and sub-domain, was supplied to Itasca Australia Pty Ltd (Itasca) as design input for the numerical assessment of stability and cave propagation.

Figure 16-1 is an example cross-section through the geotechnical model, illustrating the types of domains defined in the model.

Itasca completed 3D numerical analyses, including FLAC3D and CAVESIM in order to assess caveability and subsidence over the LOM. The models encompassed the BC44, BC42 and BC40 block cave designs, 10 regional faults and the pre-mining surface topography. All the model permutations resulted in successful propagation of the BC44, BC42 and BC40 caves (Table 16-1).

The caves grew freely in response to draw in all rock types in the column and no stalling or hang-ups were observed on the cave sidewalls at the end of production. No significant variations in the size or growth rate of the caves were observed using upper design material properties in the Livana Porphyry. However, the potential exists for differential or chimney caving in the weak rock especially near contacts or in fault zones. Itasca recommended that future studies explore the potential for cave engineering (e.g., hydraulic fracturing, horizontal slots, etc.) to increase the caveability of the Livana Porphyry.

The location of the footprint with respect to the surface topography (west area of the footprint under a mountain) leads to increased subsidence towards the west. A stability angle of 45º was selected for all the near surface materials, which means that the crater develops with a 45º angle unless failure occurs within the crater slopes due to rock mass yielding or slipping along the faults. Given the relatively conservative stability angle adopted for the analysis, the crater slopes remain stable at the end of production, with very limited surface cracking around the edges of the crater.

Design considerations are summarised in Figure 16-2 to Figure 16-5, and Table 16-2.

Extraction level footprints were placed in the Livana porphyry at both the BC44 and BC42 elevations to ensure robustness and stability as the actinolite host rock mass has a lower strength at these elevations. Below 4,200 mRL, the actinolite rock mass gains strength and geotechnical advice is that the extraction level footprint could extend beyond the Livana Porphyry and into the actinolite to recover the remnant mineralised material above BC40.

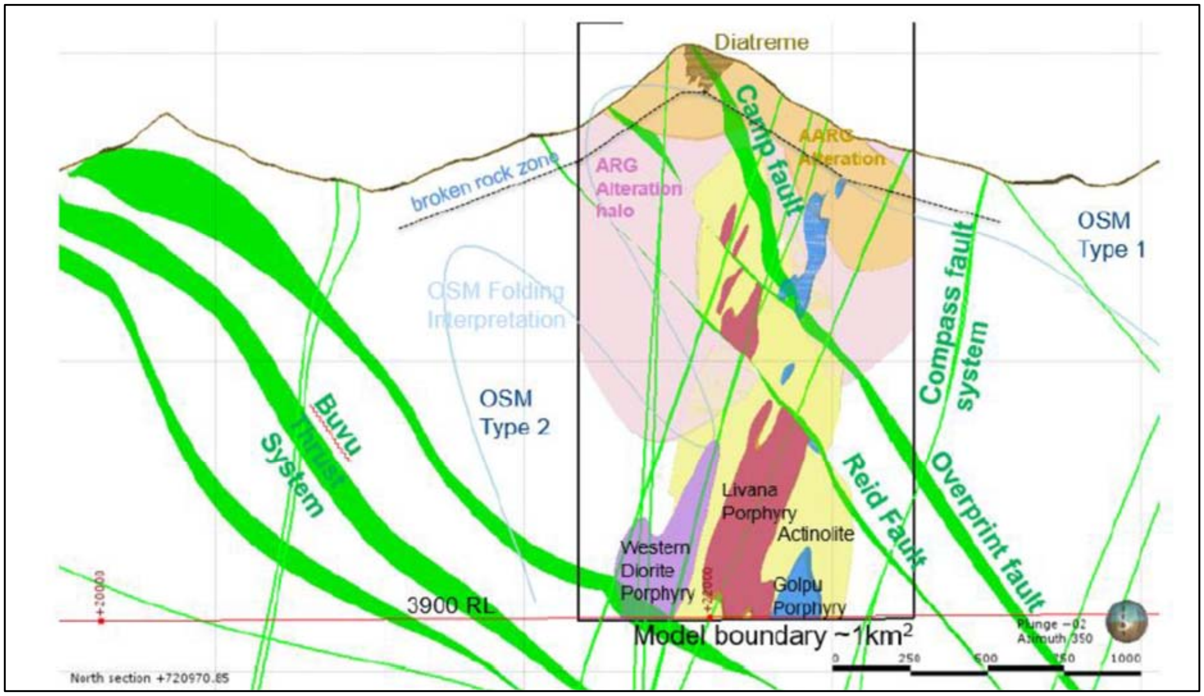
Crushers were placed in the barren western (diorite) porphyry and located >150 m from the cave footprint to reduce the risk of damage from caving induced abutment stress. Preliminary modelling results indicate that the extraction levels and crusher infrastructure will be stable. Measures such as de-stress slots, extension of the undercut to the east of the footprint and development of the east perimeter drive post completion of the eastern undercut extension will be required to ensure the stability of this development.

16.3 Hydrogeological Considerations

16.3.1 Inflows

Groundwater inflows to the mine will commence at the start of the Nambonga decline development. By the time development reaches BC44 the combined total inflows are predicted to increase to about 240 L/s. After BC44 and BC42 commences production the inflows will decrease to about 150 L/s in Year 16 of the operation. After that time, the inflows are expected to rapidly increase to about 240 L/s as BC40 commences operation before decreasing to a steady-state rate of 155 L/s. This is due to propagation of the BC40 cave as it reaches major water-bearing oxide aquifers.

Figure 16-1:Example Cross-Section, Geotechnical Model

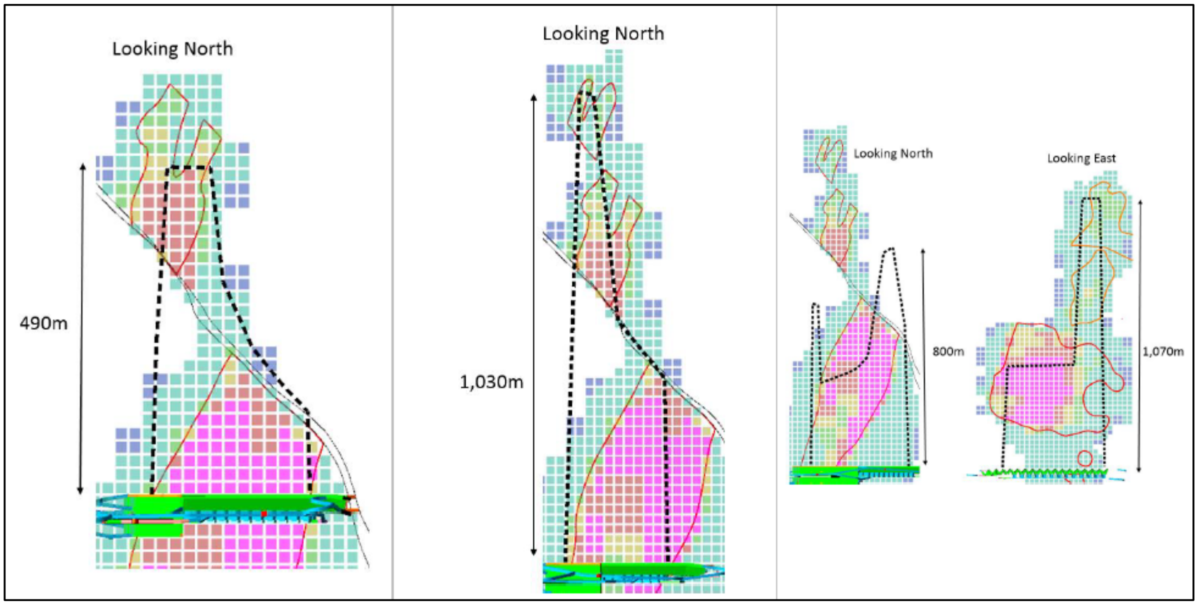


Note: Figure prepared by WGJV, 2018. OSM = Owen Stanley Metamorphic Complex, ARG = argillic zone; AARG = advanced argillic zone.

Table 16-1: Cave Modelling Results

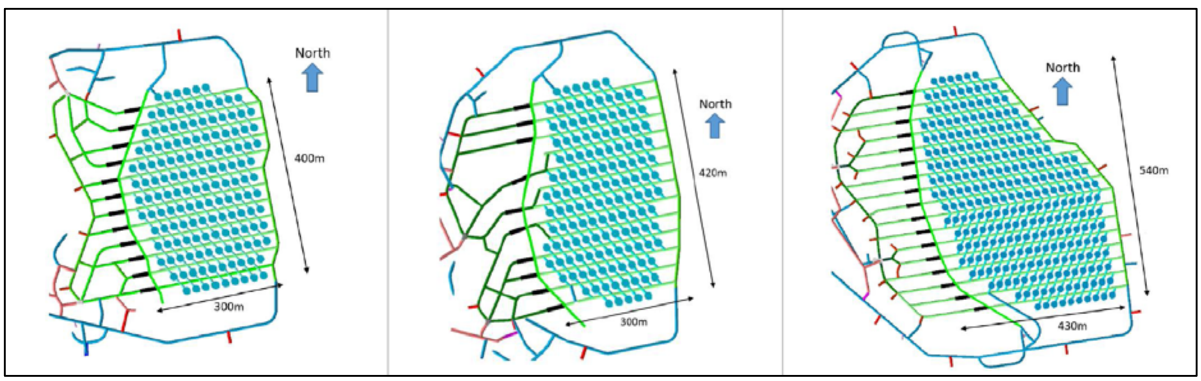
Cave	Notes
BC44	The models indicate that almost all reserves located vertically above the footprint are successfully caved. The caving mechanism involves first chimney caving in the weaker rock units to surface. At breakthrough the cave is near vertical below Reid Fault, but much of the reserves above the Reid Fault are not mobilised. Following breakthrough, the cave gradually broadens towards the north and along Camp Faults near surface. The predicted cave shape at the end of BC44 production is bound by Compass 5 Fault in the north and Compass 6 Fault in the south near surface, and the yielded zone extends between 50–100 m around the cave.
BC42	Cave propagation during the early stages is driven by shear failure of the material in a high stress environment, with major principal stresses exceeding 90 MPa. The proposed schedule results in physical breakthrough into BC44 production level after 10 months of production (two months before production ends in the upper lift), and seismogenic connection with BC44 up to three months earlier. At the end of BC42 production, the cave is predicted to be vertical up to 5100 mRL. Above this level, the span of the cave reduces slightly, mostly due to interaction with the faults in a lower-stress environment.
BC40	Cave propagation during the early stages is driven by shear failure of the material in a high stress environment, with major principal stresses exceeding 100 MPa. The proposed schedule results in physical breakthrough into BC42 after seven months, and seismogenic connection up to four months earlier. At the end of BC40 production, the cave is predicted to be near vertical, and significant yielding (>50% cohesion loss) can be observed up to 200 m from the cave in the weak sediments. The models indicate that almost all reserves located vertically above the BC40 footprint are successfully caved.

Figure 16-2:Block Height Mining Schematic



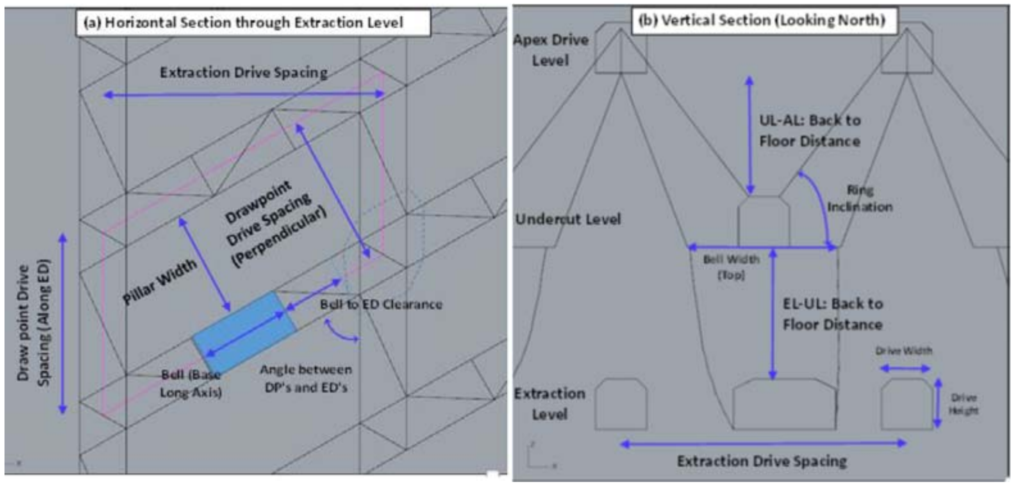
Note: Figure prepared by WGJV, 2018. Left = BC44; centre = BC42; right = BC40.

Figure 16-3:Footprint Dimensions Schematic



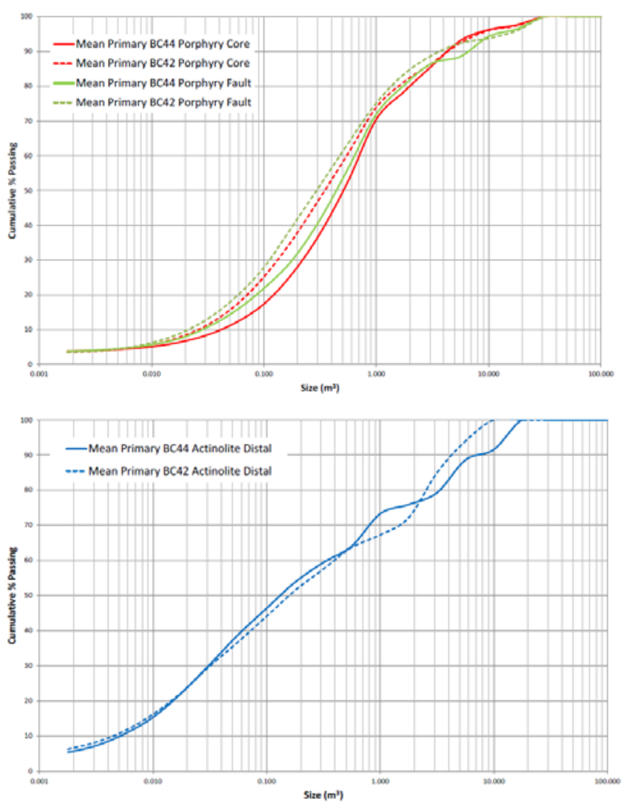
Note: Figure prepared by WGJV, 2018. Left = BC44; centre = BC42; right = BC40.

Figure 16-4:Layout Design Schematic



Note: Figure prepared by WGJV, 2018. Left = BC44; centre = BC42. ED = exploration drive; DP = drawpoint; EL = extraction level; AL = apex drive level; UL = undercut level.

Figure 16-5:Example Fragmentation Curves



Note: Figure prepared by WGJV, 2018. Top = BC44; base = BC42.

Table 16-2: Geotechnical Design Considerations

Item	BC44		BC42		BC40	
Livana Porphyry Q'	Core: 7.5	Fault dist.: 5.6	Core: 7.5	Fault dist : 5.6	Core: 7.5	Fault dist.: 5.6
Actinolite Q'	Proximal strength: 6.3	Distal: 5.1	Proximal strength: 6.3	Distal: 5.1	Proximal strength: 4.7	Distal: 6.2
Livana Porphyry RMR	Core: 66	Fault dist.: 59	Core: 66	Fault dist.: 59	Core: 66	Fault dist.: 59
Actinolite RMR	Proximal strength: 63	Distal: 58	Proximal strength: 63	Distal: 58	Proximal strength: 63	Distal: 61
Livana Porphyry UCS	Core: 80 MPa	Fault dist.: 59 MPa	Core: 80 MPa	Fault dist.: 59 MPa	Core: 80 MPa	Fault dist.: 59 MPa
Actinolite UCS	Proximal strength: 28 MPa	Distal: 34 MPa	Proximal strength: 28 MPa	Distal: 34 MPa	Proximal strength: 50 MPa	Distal: 50 MPa
In situ stress field	S1 = 61 MPa (1,230 m)	S3 = 34 MPa (1,230 m)	S1 = 71 MPa (1,450 m)	S3 = 40 MPa (1,450 m)	S1 = 78 MPa (1,615m)	S3 = 45 MPa (1,615m)
In situ stress orientations	East–west horizontal	East–west horizontal	East–west horizontal	East–west horizontal	East–west horizontal	East–west horizontal
Main access	Twin decline		Spiral decline		Spiral decline	
Block height (height of draw)	40–490 m		80–1,030 m		157–1,070 m	
Depth (min and max measured from surface to footprint)	Min: 1,150 m	Max: 1,300 m	Min: 1,390 m	Max: 1,530 m	Min: 1,530 m	Max: 1,730 m
Footprint area	72,360 m^2		71,550 m^2		137,160 m^2	
Caving initiation area (undercut)	108,285 m^2		121,360 m^2		201,160 m^2	
Caving initiation shape	Rectangle		Rectangle		Rectangle	
Caving initiation hydraulic radius	20–33	(Livana Porphyry)	20–33	(Livana Porphyry)	20–33	(Livana Porphyry)
Caving initiation undercut strategy	Advanced		Advanced		Advanced	
Caving initiation undercut shape	W-cut with apex drive		W-cut with apex drive		W-cut with apex drive	
Caving initiation undercut rate	4,000 m^2/month		4,000 m^2/month		4,000 m^2/month	
Extraction level layout	El Teniente		El Teniente		El Teniente	
Extraction level extraction drive orientation	259º		259º		261º	
Extraction level extraction drive spacing	30 m		30 m		30 m	
Extraction level draw point drive spacing	18 m	(along ED)	18 m	(along ED)	18 m	(along ED)

Item	BC44		BC42		BC40	
Extraction level draw point drive spacing	15.5 m	(Perpendicular)	15.5 m	(Perpendicular)	15.5 m	(Perpendicular)
Extraction level draw point angle to extraction drive	59º		59º		59º	
Extraction level extraction to undercut level clearance	12 m		12 m		12 m	
Extraction level drive dimension	5 m x 5 m		5 m x 5 m		5 m x 5 m	
Undercut level drive spacing	30 m		30 m		30 m	
Undercut level drive dimension	5 m x 5 m		5 m x 5 m		5 m x 5 m	
Undercut level undercut to apex level clearance	15 m		15 m		15 m	
Undercut level undercut direction	47°	Single front advance direction	47°	Single front advance direction	Chevron 47°/111°	Chevron front advance direction
Apex level drive dimension	5 m		5 m		5 m	
Apex level drive spacing	30 m		30 m		30 m	

Once groundwater is removed from oxide aquifer storage, the inflows are projected to be primarily associated with recharge.

16.3.2 Dewatering

Dewatering of the mine will be conducted from underground as well as using surface dewatering bores and horizontal drains. A series of sumps and pump stations will be progressively established during decline development. This system will be maintained for the LOM. The system is outlined in Figure 16-6.

At the surface a network of horizontal drains and dewatering bores will be established around the cave perimeter. The purpose of the horizontal drains will be to lower the piezometric levels within the weathered aquifer, whereas the purpose of the dewatering bores will be to intercept a significant percentage of groundwater before it enters the decline and/or cave zone, thereby reducing both safety risks and pump duty in underground.

Since the water extracted by these dewatering bores is currently discharging to the streams (as streams base flow) around the future cave zone, no treatment of this water is envisaged, and the water will be discharged directly to these streams. This will not only reduce mine water treatment requirements, but will also contribute to maintaining environmental flows in the streams affected by mine dewatering.

During the period from decline development period and Watut process plant start-up, prior to disposal of the mine water from this dewatering system, mine water will be treated at the surface in order to adjust its chemistry to conform with PNG environmental guidelines. After adjustment, the mine water will be discharged to Boganchong Creek.

Following start up all water will be consumed by the processing requirements, or disposed of via deep sea tailings placement (DSTP); only in an emergency will the treated water be discharged to the creek. Inflows to the mine and discharge to the environment will be monitored for quality and quantity throughout the LOM.

16.3.3 Stormwater

Experience from similar mining operations indicates that once the block cave breaks through to the surface, during heavy rainfall events there will be a high risk of water flows rapidly reporting to the mine workings underground. The reporting time varies at different mines, from 24 hours to two to three weeks.

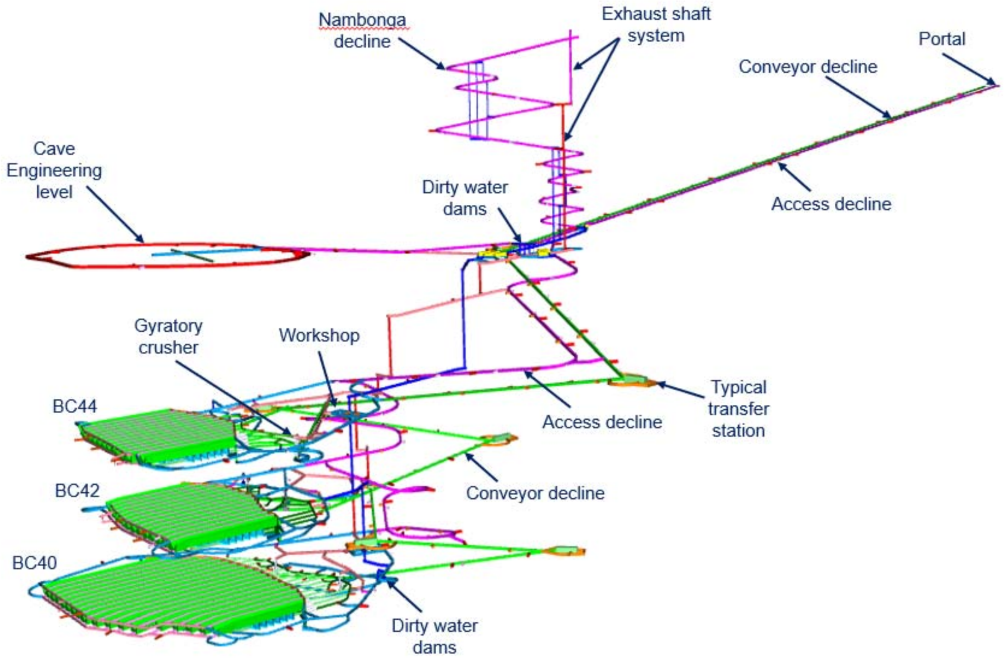
There is no practical method to seal the subsidence zone and the mine will be prepared for dealing with such rapid increase in mine water inflows by a combination of providing emergency water pumping capacity, underground emergency water storage, and allowing for temporary flooding of the lowest mine openings.

All pump stations and electrical equipment associated with dewatering will be installed above the expected flood line, to ensure mine dewatering can still be achieved during and after a flood event.

16.4 Design Considerations

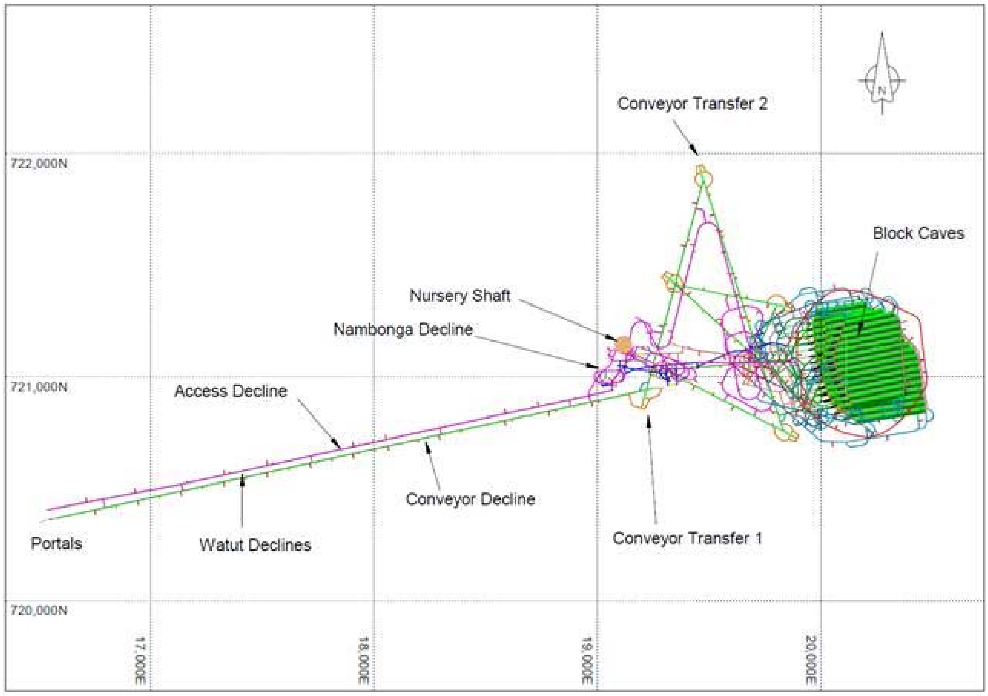
Figure 16-7 and Figure 16-8 are simplified figures showing the planned mine layout.

Figure 16-6:Water Handling System Schematic



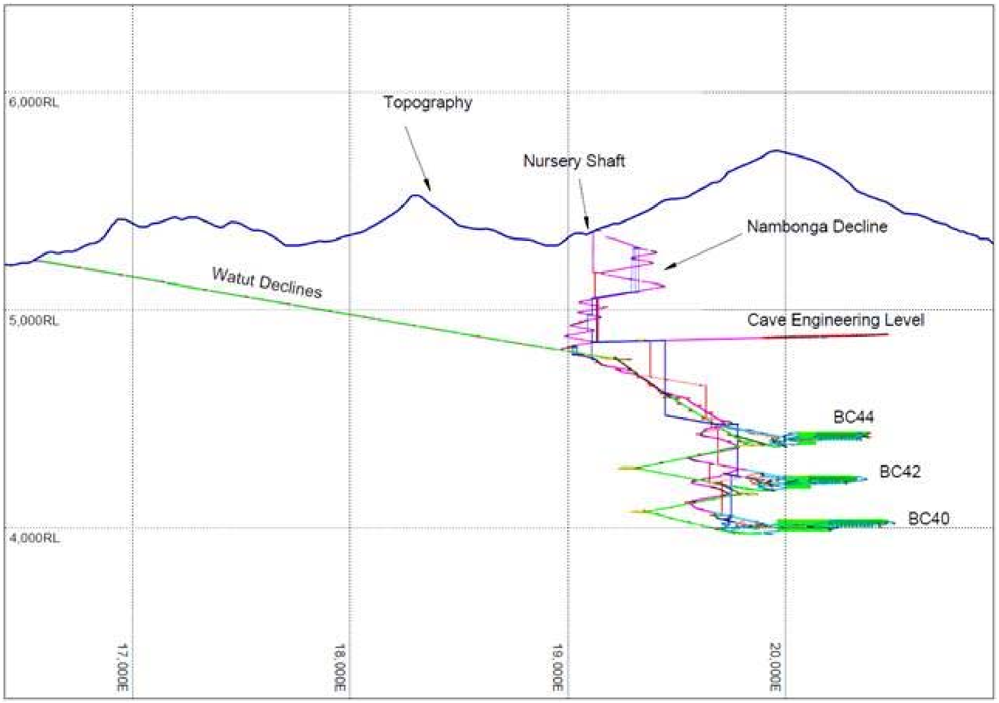
Note: Figure prepared by WGJV, 2018.

Figure 16-7:Mine Design Schematic, Plan View



Note: Figure prepared by WGJV, 2018.

Figure 16-8:Mine Design Schematic, Section View (looking north)



Note: Figure prepared by WGJV, 2018.

16.4.1 Access

The decline access system will consist of five parts:

- Watut decline system (twin parallel declines);
- Nambonga decline system;
- BC44 decline system;
- BC42 decline system;
- BC40 decline system.

The minimum required cross-sectional area for the declines is a finished profile of 6.35 mH x 5.4 mW.

The Watut decline system will be the primary production, people, equipment, and maintenance access point. The decline will consist of two parallel declines with lateral connections between them extending from the Watut portals to conveyor transfer station 1 (TF1). The twin declines are required for ventilation and egress during both construction and production phases. During production the declines will be used as access and as a material handling system.

The primary role of the Nambonga decline is a high-velocity ventilation system. It will provide early access to the mineralisation prior to completion of the Watut declines, and will provide the operation with a second front for decline access to the orebody that does not intersect the higher-risk Buvu Thrust zone which transects the Watut declines. Once the mine is operational, the decline will be used only for inspections and emergency egress.

Below TF1, the decline system will be extended as required in three sections, Watut to BC44, BC44 to BC42, and BC42 to BC40 (Figure 16-9 to Figure 16-11).

Each system will consist of:

- Conveyor decline;
- Access decline;
- Return air system;
- Intake air system.

The conveyor decline will be located outside the cave zone for BC40 as it is part of the LOM infrastructure.

The mine design consists of eight conveyor legs and seven transfer stations. Each of the conveyor transfer stations will have a bypass development loop. In conjunction with the bypass loops, additional development is allocated to electrical equipment such as substations and ring main units, as well as miscellaneous storage.

The cave engineering level will be located at 4,870 mRL, approximately 780 m from the Nambonga decline. This level will be used for data gathering, further refinement of the rock mass understanding, monitoring of the cave and potentially for dewatering.

16.4.2 Cave Design

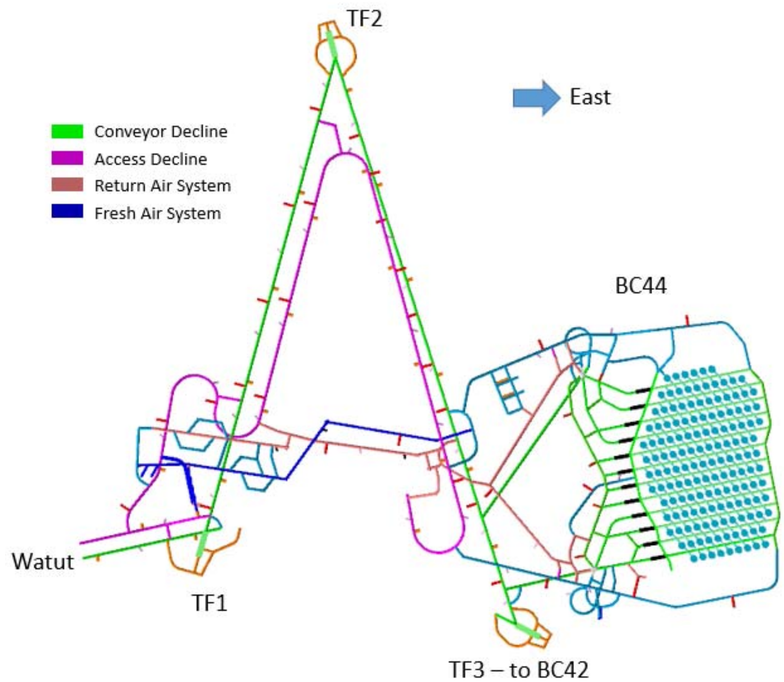
Figure 16-12 to Figure 16-14 show the extraction levels and associated access development for BC44, BC42 and BC40 respectively. Both a north and south access to the eastern and western side of the footprint are included in the design. The inclusion of the additional access also manages the intake air velocities.

Table 16-3 summarises the cave layout assumptions.

The extraction level designs for the three levels are based on the El Teniente drawpoint layout style with drives with an excavation size of 5 m high by 5 m wide, suitable to accommodate an automated 21 t loader after ground support is installed. The orientation of the drawpoint drives is parallel to the undercut front, and perpendicular (for BC44 and BC42) to the Compass Fault system. It is considered to be standard practice to orientate the drawpoint drives perpendicular to the undercut front for abutment stress management during undercut progression. The orientation was selected to provide greater access flexibility during the construction of the footprint. Due to the final perimeter drive being mined post-undercut, the drawpoint drives provide a temporary perimeter drive for equipment and ventilation.

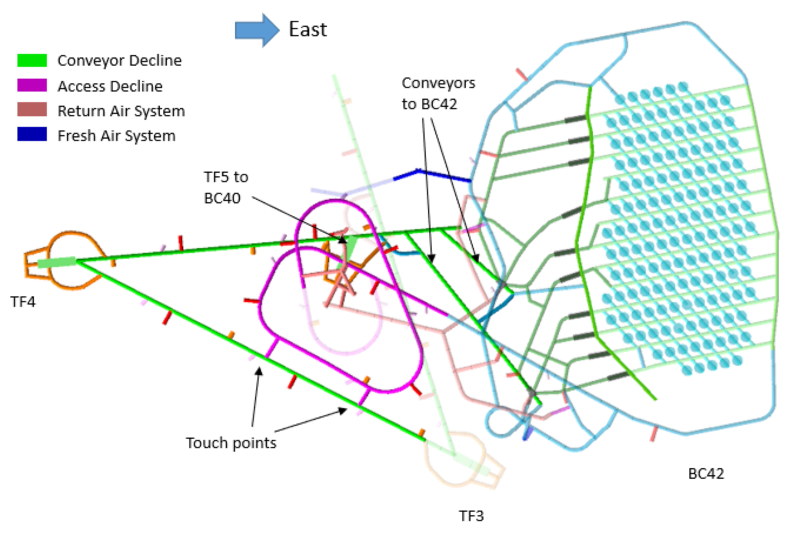
All levels have a layout spacing of 30 m x 18 m for draw interactivity and to provide a stable footprint. Each level will have two gyratory crushers located on the western side of the footprint, and each crusher will have a three-way tipple. The crusher tipple will be the highest location on the extraction levels to ensure that the materials handling system is never flooded. To enable this, extraction levels will grade from the west to the east with sumps located in the eastern perimeter drive.

Figure 16-9:BC44 Decline System Schematic Plan View



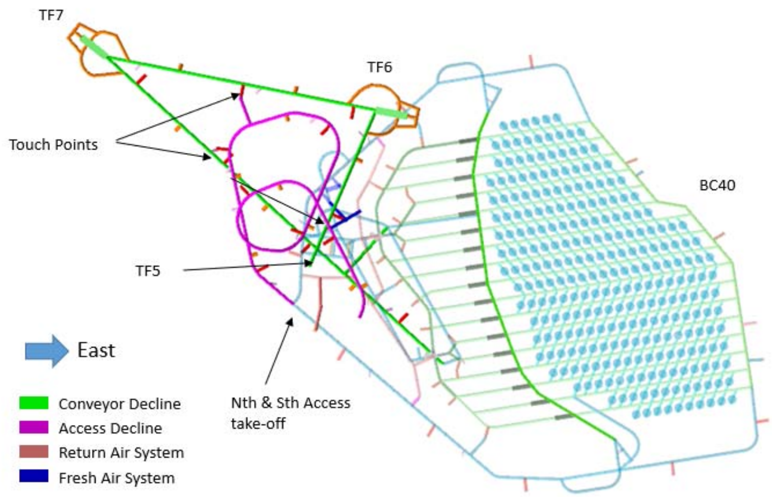
Note: Figure prepared by WGJV, 2018.

Figure 16-10: BC42 Decline System Schematic Plan View



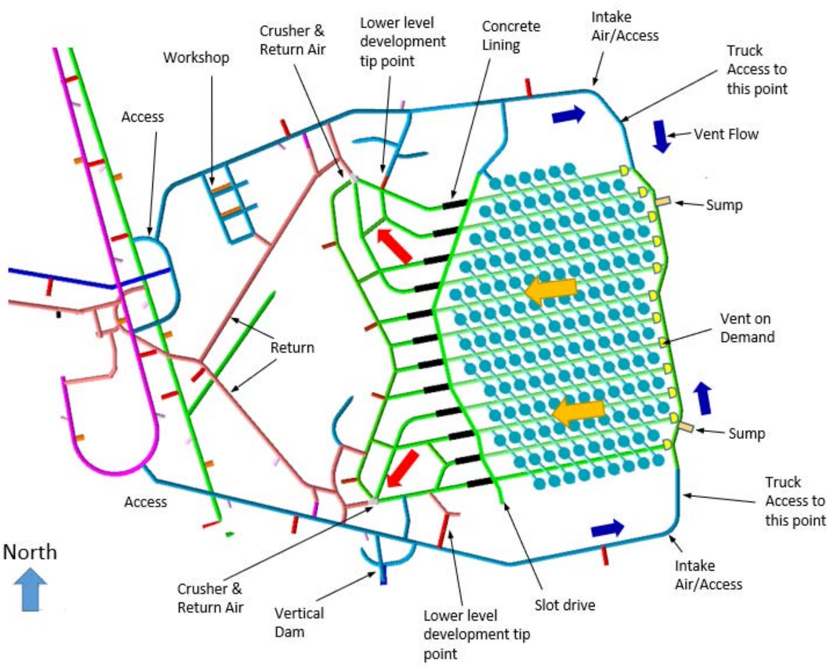
Note: Figure prepared by WGJV, 2018.

Figure 16-11: BC40 Decline System Schematic Plan View



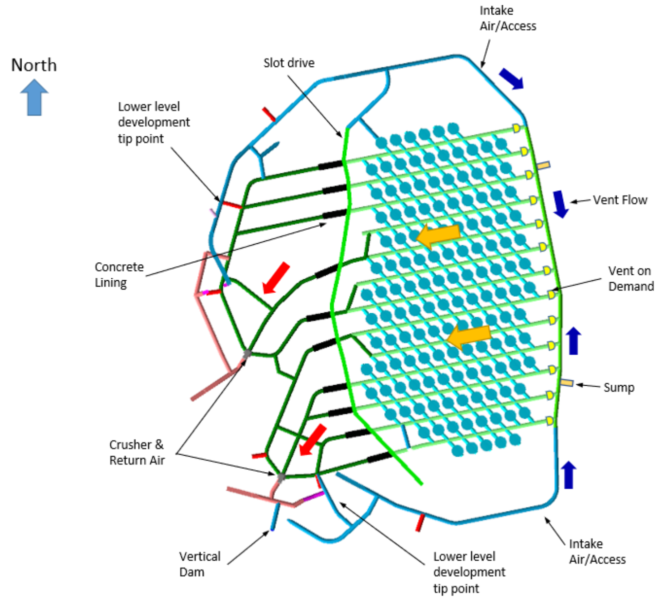
Note: Figure prepared by WGJV, 2018.

Figure 16-12: BC44 Extraction Design Schematic



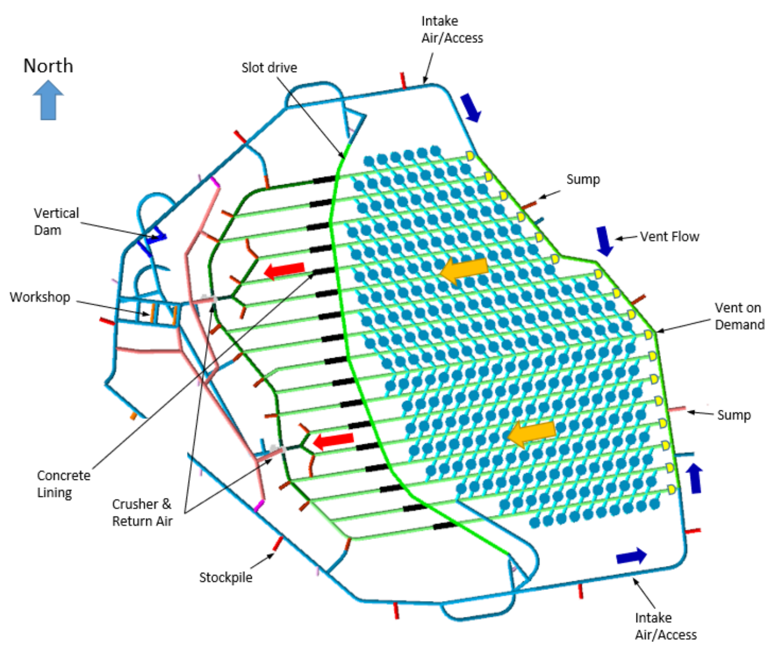
Note: Figure prepared by WGJV, 2018.

Figure 16-13: BC42 Extraction Design Schematic



Note: Figure prepared by WGJV, 2018.

Figure 16-14: BC40 Extraction Design Schematic



Note: Figure prepared by WGJV, 2018.

Table 16-3: Cave Layout Assumptions

Block Cave	Number of Extraction Drives	Number of Drawpoints	Production Area (m^2)	Approx. Dimensions Undercut Length x Width (m)
BC44	12	268	72,360	400 x 300
BC42	13	265	71,550	420 x 300
BC40	17	508	137,160	540 x 430

Each of the block caves has the same ventilation strategy, which consists of intake air being delivered to the north and south of the eastern perimeter drive via the accesses. Airflow will move from east to west and be exhausted via a 3 m diameter rise located above each of the crushers. The airflows within the extraction drives will be governed by a ventilation-on-demand (VOD) system successfully implemented at Newcrest's Cadia East mine. Using the VOD system and having two exhaust points on the footprint that are located at the tipple keeps the system simple, easily managed, and ensures velocities required to manage dust are achieved where required.

An advanced undercut strategy was adopted for all caves. Geotechnical modelling has also shown a requirement to extend and lower the undercut 40 m over the extraction level eastern perimeter drive to provide stress shielding. To ensure undercut connectivity the W-cut design consists of two levels (Figure 16-15): the undercut level (at the top of the drawbells); and the apex level (top of the apex pillar).

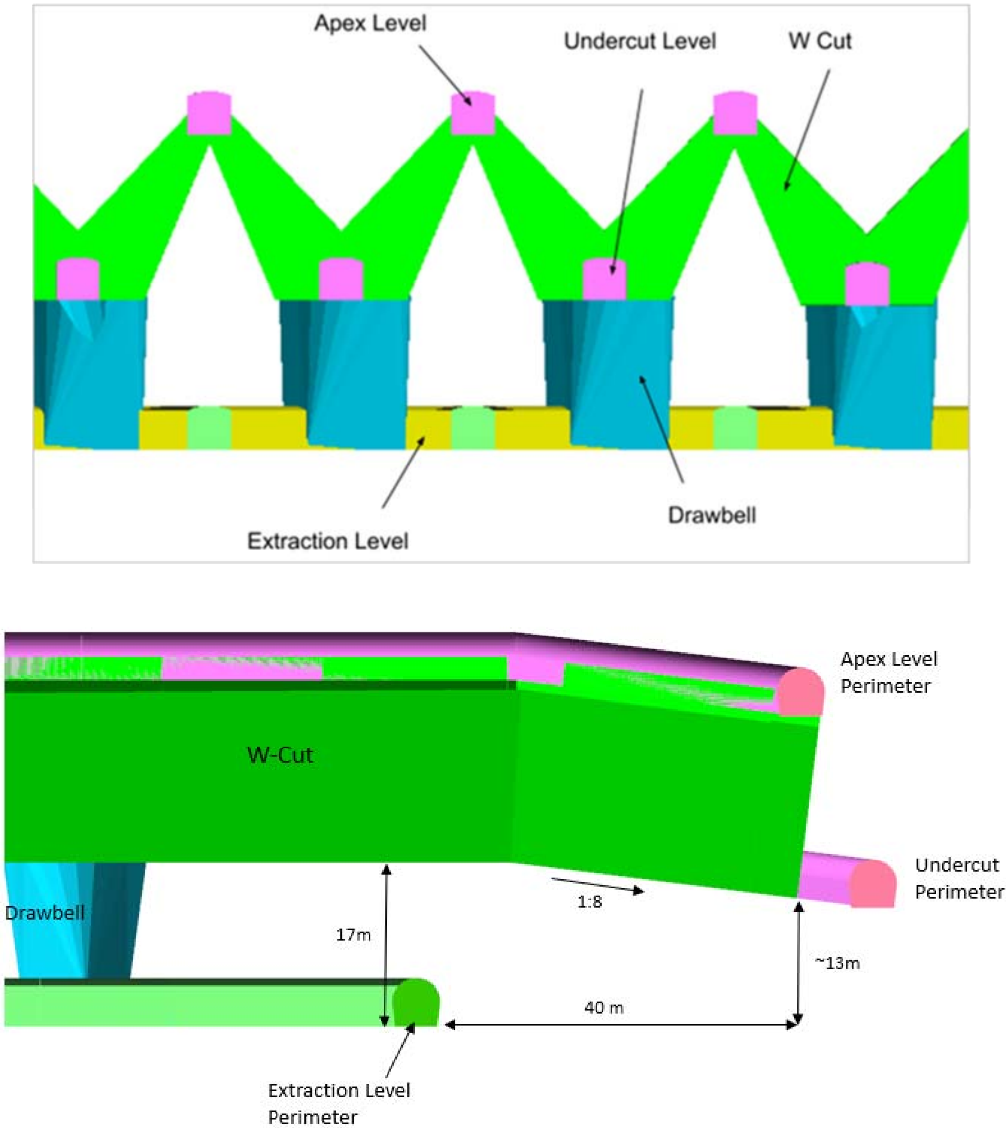
The undercut drill-and-blast design incorporates conditioning with blasting every third ring. The W-cut will be established with a slot to create initial void then rings will be fired progressively with the swell removed after each firing. A typical firing will consist of two rings. The burden varies based on the rock type; however, the average burden is approximately 3 m. About 30% of the undercut tonnes will be removed during undercutting, and the remainder will be mined as part of the cave.

The planned double-ended drawbells will be mined to a shape similar to that used at Newcrest's Cadia East operations in Australia. The drawbells will be 12 m long at the base and about 16 m high to create a functional drawbell. The drawbell drill-and-blast design will be a central slot with dumped rings radiating outwards from this slot. The dumped rings will act like a wedge firing and assist the blasting. Drawbells will be fired in a single shot with approximately 30% of the tonnes planned to be removed at firing. The remaining tonnes would be excavated as part of the cave.

A de-stress slot will be located on the western side of each of the footprints and is designed to create a barrier to protect the footprint infrastructure (drawpoints and drawbells) from the abutment stresses. The slot will be integrated with the undercut to provide an unbroken shield. The slot will be established using standard long hole rise blasting, and extended using three-hole patterns on a 2.9 m burden.

All firing will be up-holes progressing in front, and in the direction of the undercut. The slot will be progressed in 14.5 m (along strike, five rings) shots with the upper level leading by a minimum of one shot for safety and interaction purposes. The slot will remain full throughout the process with sufficient material removed to demonstrate material is flowing and the targeted porosity within the slot is obtained.

Figure 16-15: W-Cut Schematic



Note: Figure prepared by WGJV, 2018.

16.4.3 Design Parameters

Design parameters were summarised in Section 15.2.

16.5 Ventilation

The ventilation system was designed for a 16.84 Mt/a production capacity. During the capital development period, ventilation needs will be dominated by diesel exhaust dilution requirements, whereas for the steady-state mine the design constraint will be heat rather than diesel dilution.

Ventilation assumptions are included in Table 16-4 and Table 16-5 and the planned flow layout in Figure 16-16.

Table 16-4: Ventilation Assumptions

<table>
<tr><th>Stage</th><th>Purpose</th><th>Ventilation</th></tr>
<tr><td>1</td><td>Nambonga and Watut Declines development</td><td>Two dedicated ventilation districts, the Nambonga decline development and the Watut declines development. Each district will be ventilated independently and will require separate temporary cooling systems installed at the respective portals to supply fresh refrigerated air to the development activities. For the Nambonga decline development, cooled air will flow down the decline from where air is exhausted via a set of vertical raises into a bulkhead wall with ducting and exhaust fans. For the Watut declines development, cooled air from the bulk air cooler (BAC) will be force ventilated via fans located after the BAC down the service decline and will be exhausted via the conveyor decline. The Nambonga system will be decommissioned at the end of Stage 1 while the Watut system will be upgraded to a permanent system for Stage 2 onwards</td></tr>
<tr><td>2</td><td>Decline to BC44</td><td>Ventilated with fresh refrigerated air from the service decline and the now permanent cooling system at the Watut portal. This air will be returned to surface via the conveyor decline as well as the Nambonga decline system</td></tr>
<tr><td>3</td><td>BC44 cave establishment</td><td>Ventilated with fresh refrigerated air from both the service and conveyor declines and will be exhausted via the Nambonga decline system. The refrigeration plant at the Watut portal will be expanded and will supply cold water to two BAC cells at Watut. At this stage, the main fan station will be installed underground near the breakaway to exhaust air to the Nambonga decline system</td></tr>
<tr><td>4</td><td>BC44 full production and exhaust shaft development</td><td rowspan="4">Ventilated with fresh refrigerated air from the service decline and the Nambonga decline. The air will be returned via the exhaust shaft and the conveyor decline. The refrigeration plant at Watut will be expanded further and will supply cold water to two BAC cells at Watut and four underground closed-circuit cooling coil banks located at the bottom of the Nambonga decline. Air cooler fans will be located after the Watut BAC and before each underground air cooler to control the airflow distribution. The main fan station will be installed underground near the breakaway and will continue to operate throughout these stages. A second fan station will be installed at the conveyor decline portal</td></tr>
<tr><td>5</td><td>BC42 production ramp-up</td></tr>
<tr><td>6</td><td>BC42 full production and BC40 cave establishment</td></tr>
<tr><td>7</td><td>BC40 full production</td></tr>
</table>

Table 16-5: Ventilation and Refrigeration Requirements

Stage	Production (Mt/a)	Installed Airflow (m^3/s)	Required Airflow (m^3/s)	Installed Surface Cooling (MW_{AC})	Installed UG Cooling (MW_{AC})	Installed Total Cooling (MW_{AC})	Required Total Cooling (MW_{AC})	Intakes	Returns
Stage 1 Watut		160	160	4.0	—	4.0	4.0	SD	NAM
Stage 1 Nambonga		170	170	4.7	—	4.7	4.7	NAM	Exh Duct
Stage 2	—	330	225	12.0	—	12.0	12.0	SD	CD+NAM
Stage 3	7.0	370	370	24.0	—	24.0	24.0	SD+NAM	CD
Stage 4	16.8	675	675	17.0	18.0	35.0	35.0	SD+NAM	CD+Exh#
Stage 5	16.8	675	595	17.0	18.0	35.0	35.0	SD+NAM	CD+Exh#
Stage 6	16.8	675	675	17.0	20.0	37.0	37.0	SD+NAM	CD+Exh#
Stage 7	16.8	675	595	17.0	20.0	37.0	35.0	SD+NAM	CD+Exh#

Note: SD = service decline; NAM = Nambonga decline; CD = conveyor decline; Exh# = exhaust shaft, MW_{AC} = megawatts air cooling.

Figure 16-16: Ventilation Layout Schematic

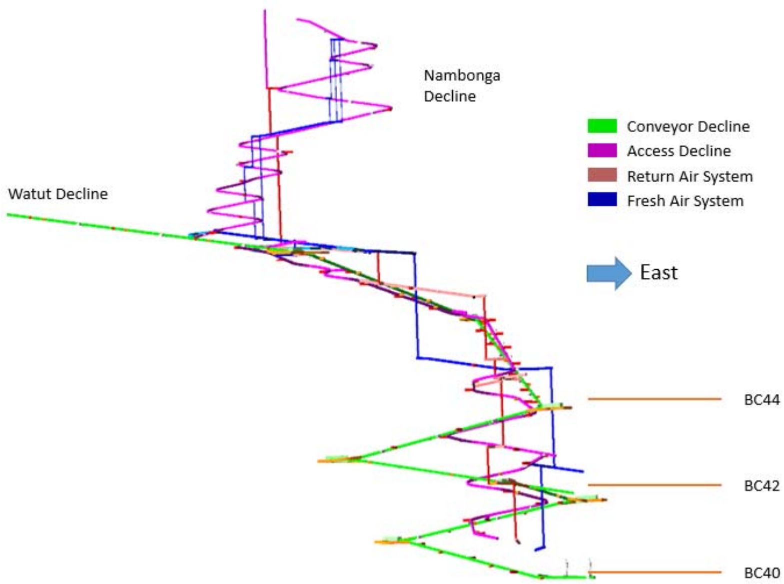


Figure prepared by WGJV, 2018

16.6 Materials Handling System

Ore will be extracted from the block cave drawpoints by LHDs and trammed to the tipple. The ore will be tipped into a ROM bin of approximately 200 t live capacity, and discharge into the gyratory crusher where an estimated 5% (based on a draw height of 150 m) of the ore will be broken by a rock breaker before being crushed to a P80 size of approximately 115 mm. The percentage of ore to be broken by the rock breaker decreases as the cave propagates as the fragmentation becomes finer through increased comminution in the cave.

The crushed ore will discharge into a 500 t crushed ore bin. The crushed ore will then discharge from the crushed ore bin onto an apron feeder and transfer onto a collection conveyor. A static magnet will be located at the discharge chute of the apron feeder, and provide the first location at which tramp metal can be removed. A cross-belt magnet will be located on the collection conveyor to remove any tramp metal missed by the static magnet. A weightometer and metal detector will also be located on the collection conveyor. The metal detector will trip the collection conveyor should any metal be detected that was missed by the two magnets.

The collection conveyor will discharge onto the decline conveyor system, transferring onto the main decline conveyor to surface and onto the stockpile feed conveyor, and discharging onto the coarse ore stockpile adjacent the Watut process plant.

Two identical crusher stations will be located on each of the block caves, crusher station A and crusher station B. Each crusher will be able to process 50% of the ROM feed. The crusher stations will be located on 4,400 mRL (BC44), 4,200 mRL (BC42) and 4,000 mRL (BC40). The materials handling strategy for the three block caves is identical, with the same mechanical equipment being installed in the crusher chambers. The only difference is the length of the conveyor belts.

Six collection conveyors will be installed underground, two per block cave, and one for each of the crushers. The conveyors are designed for 1,500 t/hr (including 6% moisture) to cater for block cave production.

The incline and overland conveying systems include nine conveyors, conveyor legs 1–8 underground, and the overland conveyor from the portal to the coarse ore stockpile.

The function and objectives of the incline and overland conveying system are:

- Transport crushed ore from BC44, BC42 and BC40 to a transfer point on surface at the portal;
- Transport crushed ore from the transfer point on surface at the portal to the coarse ore stockpile;
- The incline and overland conveying systems allow concurrent transport of ore from both BC44 and BC42 for a short period, as well as from BC42 and BC40 for a short period.

16.7 Equipment

Estimated peak equipment requirements are summarised in Table 16-6.

16.8 Facilities

16.8.1 Workshops

Underground workshops, complete with spares store and wash bay, will be located at BC44 and at BC40. These facilities are required to conduct minor maintenance services for the mining fleet. No underground workshop is provided for BC42.

Underground office, meal room and ablutions facilities will be located at BC44 and at BC40, close to the workshops. These facilities will be installed in redundant development excavations that will be available at the completion of cave establishment activities.

Three refuelling bays will be provided, one at each block cave. The refuelling bay at BC44 will become redundant, and will need to be salvaged before the BC42 cave propagates to this level. Similarly, the refuelling bay at BC42 will become redundant, and will need to be salvaged before the BC40 cave propagates to this level.

A radio and leaky feeder system is intended to be used as the primary means of voice communications at the mine. The radio coverage will include the portal areas and underground areas except for the development ends.

For the short-term construction requirements for the Nambonga decline, it was assumed that the Logistics Laydown 1 facility near the Wafi Exploration Camp will be concreted and used as a workshop to undertake maintenance and repairs on the Nambonga decline development fleet.

Table 16-6: Equipment Requirements

Function	Equipment	Number
Mine Development and Cave Establishment Equipment		
Free Dig Development	Tunnel excavator	1
Drilling	Face drilling jumbo	3
Drilling	Long-hole production drill	4
Ground support	Rock bolting jumbo	6
Ground support	Spray/agitator unit	12
Ground support	High volume agitator	3
Ground support	Cable bolting jumbo	4
Loading	LHD – development	4
Hauling	Truck 60 t	7
Charging	Charge up unit – development	2
Charging	Charge up unit – production	2
Services	Integrated tool carrier	5
Primary Production Equipment		
Loading	LHD - production	BC44 = 8 BC42 = 8 BC40 = 9
Secondary breakage	Rock breaker	2
Secondary breakage	Secondary breaking jumbo	2
Hang-up removal	Vehicle mounted water cannon	1
Hang-up removal	High hang-up removal unit	1
Supporting and Secondary Equipment Fleet		
	Integrated tool carrier	6
	Telehandler	2
	Water truck	1
	Grader	3
	Vibratory compactor	1
	Skid steer loader	2
	Light vehicle	21
	Underground bus	2
	Services truck	2
	Flatbed delivery truck	1

Note: LHD = load–haul–dump vehicle.

Existing sea containers will be used for offices, a first aid room, a crib room, storage and to house the pressure cleaner and compressor. Fuel storage will be required for the generators located near the Nambonga decline portal and for dispensing of fuel for the mining contractor's diesel equipment fleet. An explosives magazine will also be required.

16.8.2 Power

The selection of 33 kV for underground is based on the underground requirement of approximately 37 MVA in the final stages, with a ring topology spanning approximately 16 km. The current design does not allow for full redundancy underground; however, one supply cable is sufficient to keep underground dewatering systems in operation. A 33kV backbone will be established at the main load areas (Cave Engineering Level, BC44, BC42, and BC40 and distant conveyor head ends). The 33kV supply cable will be installed in the conveyor declines from the portal to the respective load centres and will return to the portal via the service decline.

33/11 kV transformers at each load centre main substation will distribute 11 kV to the respective level substations. The 11 kV radials will supply to main ventilation fans, high lift pump stations, crusher stations, nearby conveyor head ends, and block cave operations.

Isolated conveyor transfer stations will be supplied via 33 kV ring main units and three winding transformers, minimising high-voltage (HV) feeders/terminations and reducing footprint requirements.

Two HV yard 30 MVA 132/33 kV transformers will supply 33 kV to the Watut declines via buried cable to the portal area. Mining contractor 11 kV supply will be transferred to the permanent supply before the underground material handling system and the Watut process plant are commissioned.

Four of the currently-available 550 kVA generators on site will be used for the Nambonga decline, until refrigeration is required. A separate generator will be required to provide power for the mining contractor workshop facility that will be located at the Logistics Laydown 1 facility. This will be provided by the mining contractor.

Large HV transformers will be required for all the pump stations. Two 20 MVA 22/11 kV transformers will supply the substation with a bus coupler arrangement. Each transformer will be capable of supplying the entire pump station power requirement.

16.9 Planned Production Schedule

The cave opening strategy for each of the caves was determined based on creating optimal geotechnical conditions for undercut and footprint development. Cave progression was limited by the production rate curves adopted and implemented in PCBC. Given the vertical separation between the caves is 200 m, a reduction in production during the cave transition periods can be expected. However, this was minimised to maximise project value by increasing the concurrent production from the two caves and allowing the second (lower) cave to develop to a point where it can be productive when the first (upper) cave is closed. This is primarily achieved by adopting a minimum draw of 32 t/day/drawpoint. The second strategy adopted to maximise production during the transition period is to progressively close the footprint above as the cave encroaches from below.

16.9.1 Lateral Development

Lateral development will peak during the development of BC44 and the Cave Engineering Level, and is anticipated to be about 1,400 m/month. The Cave Engineering Level was scheduled to be completed in two stages: the first stage will be completed early to establish drilling and monitoring, and the second phase will complete the "ring" of development around the cave prior to the cave extending to this elevation. Development between BC44 and BC42 will be almost continuous with ventilation infrastructure required to be mined prior to the extension of the BC42 declines.

Each level is scheduled with a maximum allowable development rate of 1,100 m/month. During the peak periods BC44 is expected to average ~1,000 m/month, BC42 to average 885 m/month, and BC40 to average 1,000 m/month.

16.9.2 Raw Water

The underground requirements for raw water will be provided from surface using one decline pipeline for both mine service water and fire water. The supply will be fed down the conveyor decline in a high-pressure steel pipe, without pressure reduction until BC44, and strategically placed for fire water feed to the fire deluge stations. The maximum flowrate requirement for mine service water is approximately 20 L/s.

16.9.3 Truck Haulage

The truck haulage for each level will cease with the completion of the crusher. Peak periods of haulage will correlate with the peak development loads. Haulage requirements are expected to be low for BC42 and BC40 due to the low haulage distance. Both BC44 and BC42 will have facilities for truck tipping onto the tipple drives so the production loaders can add the material to the crusher feed, with minimal disruption.

16.9.4 Cave Establishment Drilling Schedule

Cave establishment drilling will be constrained in the schedule to one drill on the undercut level and two drills on the extraction level. While three drills are needed, the flexibility required will see one of the drawbell drills also undertaking drilling on the undercut. The maximum drill metres per month are less than 8,500 drill metres per month per drill. The drilling requirement is erratic, based on the drawbell schedule. The production schedule within PCBC is based on a smoothed drawbell opening. The average expected monthly drilling requirement for BC44 is ~17,600 m/month, BC42 is ~18,400 m/month and BC40 is ~17,350 m/month.

16.9.5 Undercut and Drawbell Schedule

The maximum assumptions in the undercut and drawbell schedules are designed to mitigate the risk of seismic events and problems with the undercut advance which typically occur in caving operations. The drawbell schedule is limited mainly by the undercut advance and adhering to the lead lag rules between the undercut firings and the start of the drawpoint development. The rate of the drawpoint opening is limited to nine drawbells per month.

16.9.6 Proposed Ore and Waste Schedule

To minimise storage and handling costs once the material handling system is operational on BC44, all material generated will enter the ore stream and will be processed.

Development ore will include undercut swell tonnes and will make up a small proportion of the total tonnes within the schedule. The peak annual cave production rate is 16.84 Mt/a with development entering the ore stream being additive to the cave production resulting in a peak production of 17.8 Mt in Year 17.

It is proposed that the first block cave, BC44, will be situated at 4,400 mRL. The second block cave, BC42, will be situated at 4,200 mRL. The third block cave, BC40, is proposed to be situated at 4,000 mRL. The mine has a total forecast life of 28 years from first production of the processing plant (excluding construction and closure phases).

Figure 16-17 shows the annual tonnage and grade production projections.

Figure 16-18 shows the projected production of ore, tailings, and concentrate.

16.9.7 BC44 Schedule

Figure 16-19 is a production profile for BC44. The production rate of 16.84 Mt/a will not be achieved for a full year on BC44. The production from the cave will diminish as higher-grade cave material from BC42 displaces cave production from BC44. The grade will peak as the cave is focused on the below Reid Fault porphyry and will decrease as mixing impacts dilution. The grade will stabilise and marginally increase as the above Reid Fault porphyry reports to the drawpoints.

Cave production will occur simultaneously between BC44 and BC42 for 22 months with the final year of BC44 production reducing as interaction from BC42 limits the available production area on BC44.

16.9.8 BC42 Schedule

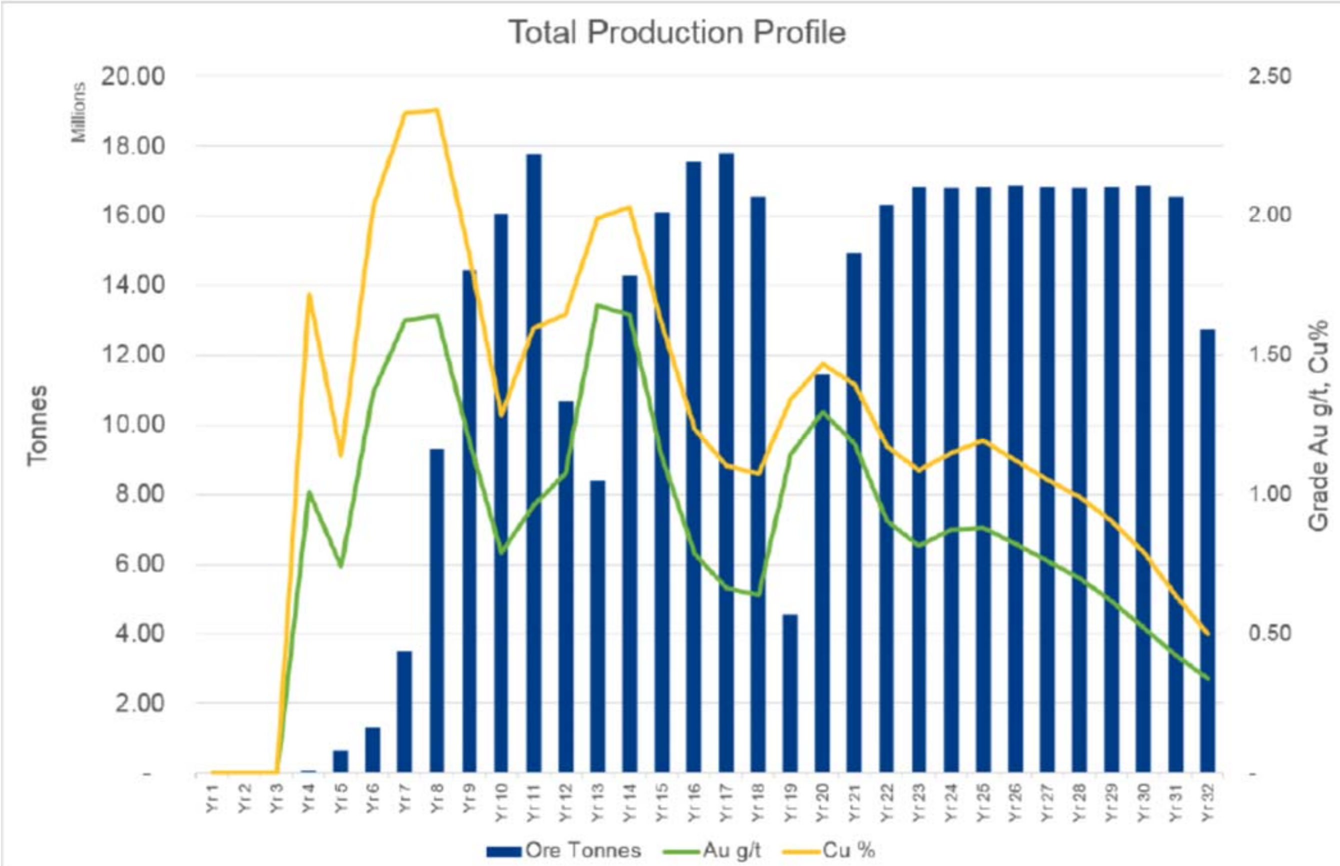
Figure 16-20 shows the production profile for BC42. The initial grades are extremely low representing the decline/access waste development entering the ore stream. The reduction and stabilisation of grade is due to the remnant BC44 grades entering the drawpoints.

BC42 and BC40 cave production will occur simultaneously for 16 months with interaction between BC42 and BC40 occurring over a five-month period and during this time production will be reduced on BC42. This is expected to be less than the interaction between BC44 and BC42 due to the additional depth and stress.

16.9.9 BC40 Schedule

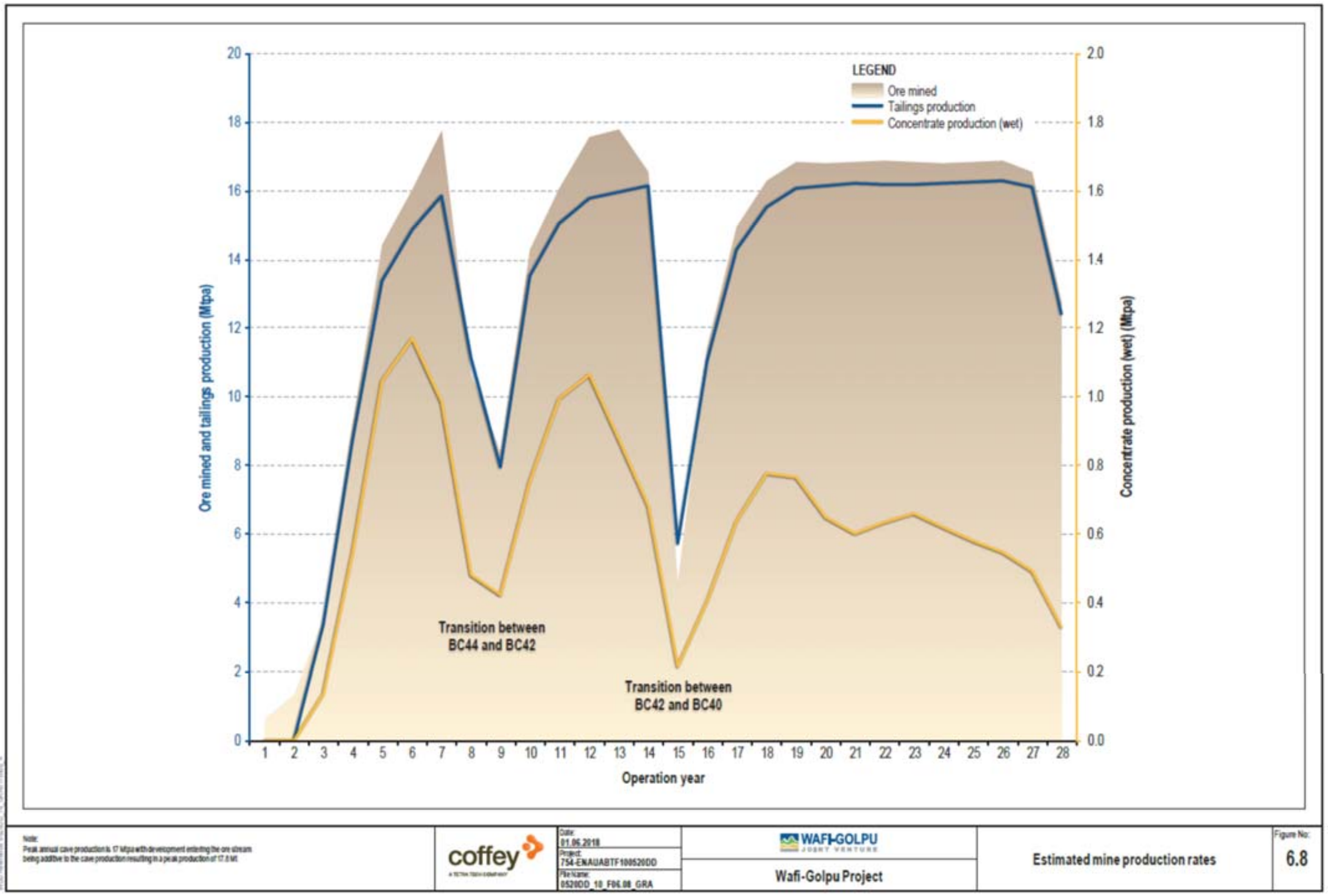
Due to the size and the central chevron front of BC40, cave production will not occur until 39 months after the BC40 decline commences. Block cave 40 will contribute to the production over a 19-year period; of this period, cave production is forecast to be about 16 years. Figure 16-21 shows the production profile for BC40.

Figure 16-17: Forecast Annual Production Tonnes and Grade



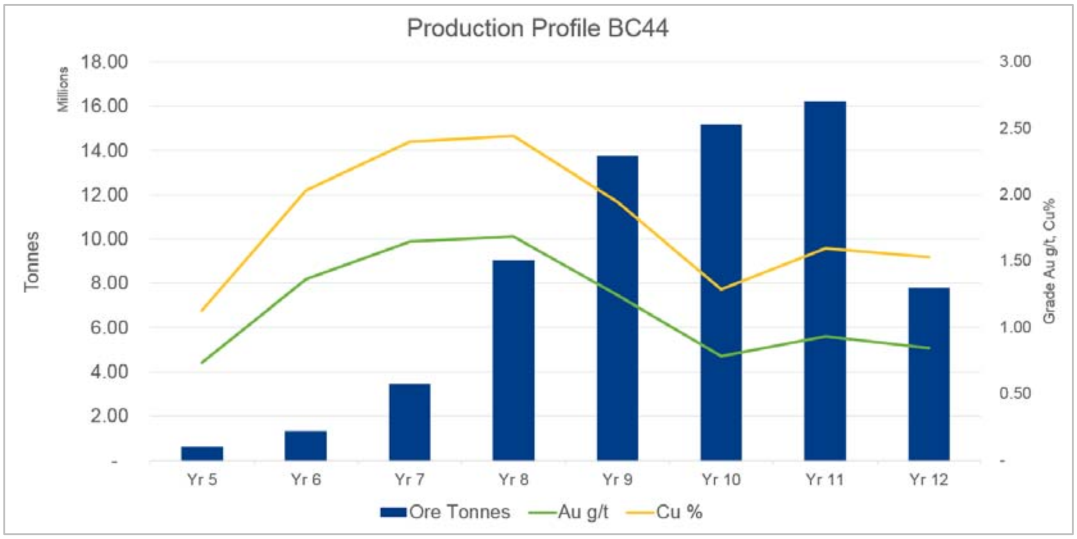
Note: Figure prepared by WGJV, 2018.

Figure 16-18: Projected Life-of-Mine Production Rates, Ore, Tailings, and Concentrate



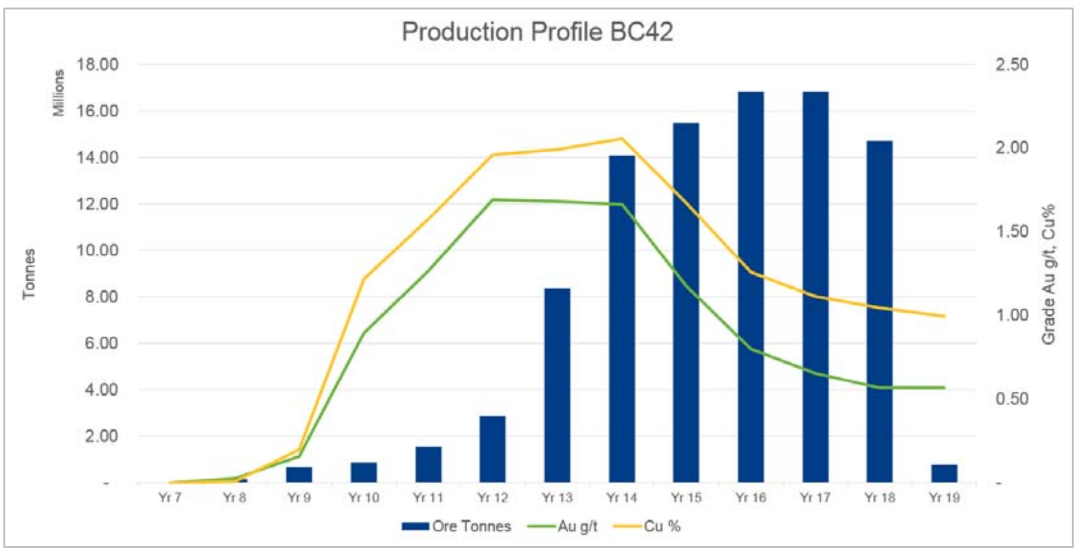
Note: Operation Year in the context of this chart refers to from first ore production, approximately five years post Special Mining Lease grant.

Figure 16-19: Proposed BC44 Production Profile



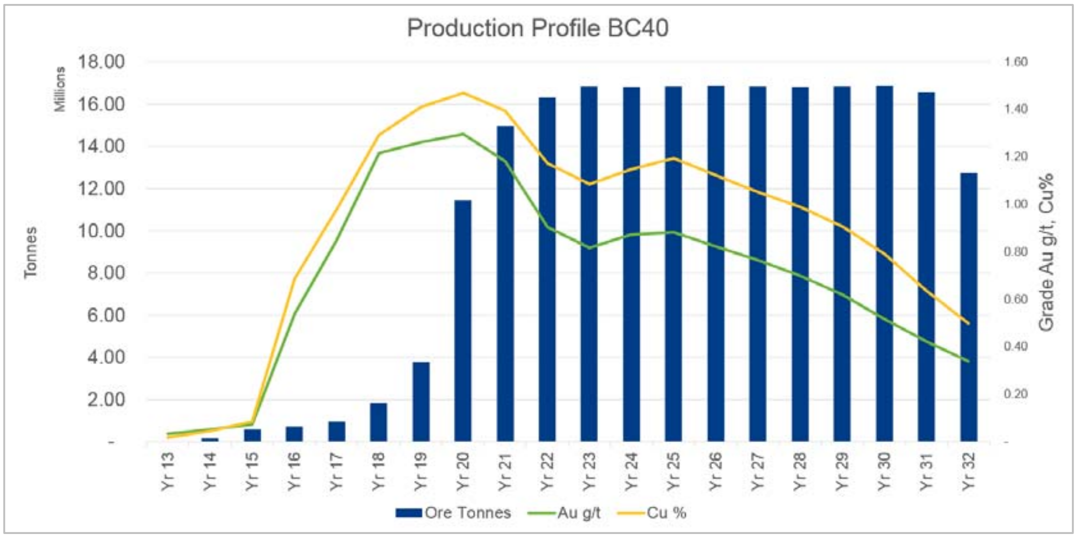
Note: Figure prepared by WGJV, 2018.

Figure 16-20: Proposed BC42 Production Profile



Note: Figure prepared by WGJV, 2018.

Figure 16-21: Proposed BC40 Production Profile



Note: Figure prepared by WGJV, 2018.

16.10 QP Comments on "Item 16: Mining Methods"

The QP notes:

- The proposed mine plan uses block cave methods; three cave panels are planned;
- The projected mine life is approximately 28 years;
- The planned equipment fleet is conventional to block cave operations.

17 RECOVERY METHODS

17.1 Introduction

The proposed Watut process plant will be a compact copper concentrator that is progressively built (in line with the profile of the mine ramp-up) to be capable of processing approximately 17 Mt/a of crushed ore at peak capacity to produce a high-grade copper concentrate.

Plant design was based on the following:

- Testwork and modelling completed to validate the preferred or other alternative flowsheets, plant operating strategies and major equipment type and sizing;
- Details of trade-off studies conducted to select the preferred flowsheet, major equipment items, and determine the final plant layout;
- Evidence that supports forecast plant key performance indicators and product specifications over the anticipated Golpu Development payback period based on testwork undertaken;
- Evidence that scale-up rates required to reach commercial plant production rates are achievable and realistic.

A two-stage ramp-up philosophy will be used. The plant will run intermittently (campaign treatment) and in 50% turndown mode for the first three years. During the mine ramp-up period, the total volume of the coarse ore stockpile and start-up stockpile will be used to maintain plant utilisation as high as practicable, minimising the number of plant stops.

The plant is designed to cater for the ore composition changes over the LOM, and blending is not expected to be required.

17.2 Process Design Criteria Inputs

17.2.1 Input Sources

Process design criteria inputs were derived from the following sources:

- Mill feed inputs were based on a standard feed size distribution with P80 size of 86 mm in the product from the primary gyratory crusher with a nominal closed side setting of 150 mm;
- Comminution design parameters were developed using power modelling of the appropriate metasediment and porphyry comminution samples. The 75th percentile of all available data was used as the basis for mill sizing. Regrind mill design inputs were based on vendor-conducted testwork for the copper regrind circuit, and were assumed for the pyrite regrind circuit;
- Flotation design parameters were derived from year-on-year metallurgical modelling, using the proposed mine plan, current and historical testwork as basis. The maximum scenario per phase, as identified by the year on year modelling was used for design purposes;
- Flotation residence times were defined from testwork. The laboratory times were scaled up by a factor of 2.1, which is an industry-standard practice;
- Bulk ore handling design parameters were based on testwork conducted;

- Concentrate settling, filtration and slurry pumping characteristics were based on testwork conducted;
- Tailings settling, filtration and slurry characteristics were based on testwork conducted.

17.2.2 Mineralisation Physical Characteristics

Physical characteristics of the mill feed material include:

- Ore specific gravity is 2.8 t/m^3; bulk density of crushed ore is 1.9 t/m^3 and concentrate is 2.2 t/m^3;
- Coarse ore moisture content is taken as 6% by mass for the design but can vary between 2–10% by mass;
- Coarse ore angle of repose and angle drawdown of 38º and 55º respectively;
- Axb characteristics of 62.3 for the porphyry ore and 60.0 for the metasediment throughout the LOM;
- BWi characteristics of 15.3 kWh/t for the porphyry ore and 14.7 kWh/t for the metasediment throughout the LOM;
- The abrasion index for the mill design is 0.296 g for the porphyry ore and 0.072 g for the metasediment;
- The abrasion index for consumables estimation is 0.218 g for the porphyry ore and 0.063 g for the metasediments.

17.2.3 Mineralisation Chemical Characteristics

The weighted average ore composition for the first four years of production is 84.3% porphyry, while from approximately the fifth year this reduces to 43.1% porphyry. The weighted average porphyry content over the LOM will be 46.2% while the remainder is metasediment.

In order to achieve <1,000 ppm arsenic in the copper concentrate, the limit of arsenic in the feed ore must be <67 ppm for the LEAN flowsheet and <39 ppm for the Golpu flowsheet, assuming all arsenic reports to the concentrate.

17.2.4 Operating Assumptions

The number of operating days per year is assumed to be 365 days. There will be two shifts per day, at 12 hours per shift.

The overall availability and utilisation of the grinding and flotation circuits is projected to be 91.3% at nominal throughput of 16.84 Mt/a, based on other similar concentrators. This equates to 8,000 operating hours per year.

An overall availability and utilisation figure was assumed to be 93.0%, equivalent to an instantaneous new mill feed of 2,068 t/hr.

The availability of the filtration circuit is anticipated to be 91.3%, based on typical pressure filter installations, equating to 8,000 operating hours per year. This allows for regular maintenance of the concentrate filters and the changing out of blinded and holed filter cloths.

The weighted average feed composition for the first three years of process plant operation is 84.3% porphyry with the balance metasediment. This will be treated using the LEAN flowsheet.

When the porphyry content drops to below 75% with a commensurate increase in metasediment content, the ore requires a different treatment regime, i.e., a pyrite flotation circuit is required, in order to maintain the required gold and copper recovery levels. The Golpu flowsheet is required to treat this material.

The throughput ramp-up while the porphyry content remains above the 75% LEAN flowsheet cut-off, necessitates the inclusion of the second ball mill and additional copper flotation cells with the Golpu flowsheet's pyrite flotation circuit is commissioned later in response to the reduced porphyry content.

The annual average copper concentrate production rate for the first four years of operation, representing the ramp-up period, is 256,003 t and 518,656 t for the balance of the LOM. The mass pull to concentrate was simulated over time in line with the copper head grade to target a specified concentrate copper grade.

The calculated mass pulls from various testwork reports are in the range of 6.43–7.89% of mill feed for the LEAN flowsheet and much reduced to 2.07–6.01% of mill feed for the Golpu flowsheet. Weighted average mass pull for the LEAN and Golpu flowsheets were predicted to be 6.69% and 3.92% respectively.

The concentrate flotation circuit is designed for maximum mass pulls and the tailings thickener is designed for the minimum mass pulls. The overall mass pull to concentrate over the LOM is 4.12%.

17.2.5 Implementation Assumptions

The plant will be implemented progressively as follows:

- 8.42 Mt/a LEAN flowsheet including single SAG and ball mill (SAB) circuit;
- Staged implementation of the 16.84 Mt/a Golpu flowsheet expansion, incorporating:
  - Additional ball mill and copper flotation cells to accommodate the increase in throughput;
  - Pyrite flotation and regrind circuit, coinciding with a change in ore composition to <75% porphyry;
  - Pebble crusher to be installed at a future date to meet demand of increased ore hardness corresponding to certain portions of the BC40 orebody.

17.2.6 Product Quality Requirements

The design assumptions for production of copper concentrate include:

- Minimum copper grade: 25%;
- Sulphur: <38%;
- Arsenic: <1,000 ppm;
- Fluorine: <300 ppm;
- Transportable moisture limit: 10.8%.

17.3 Process Flow Sheet

Models for the two process flowsheet variations were derived from the validated base case flowsheets, using standard metal balance techniques per unit operation. A simplified flow diagram for the LEAN flowsheet is provided in Figure 17-1 and in Figure 17-2 for the Golpu flowsheet.

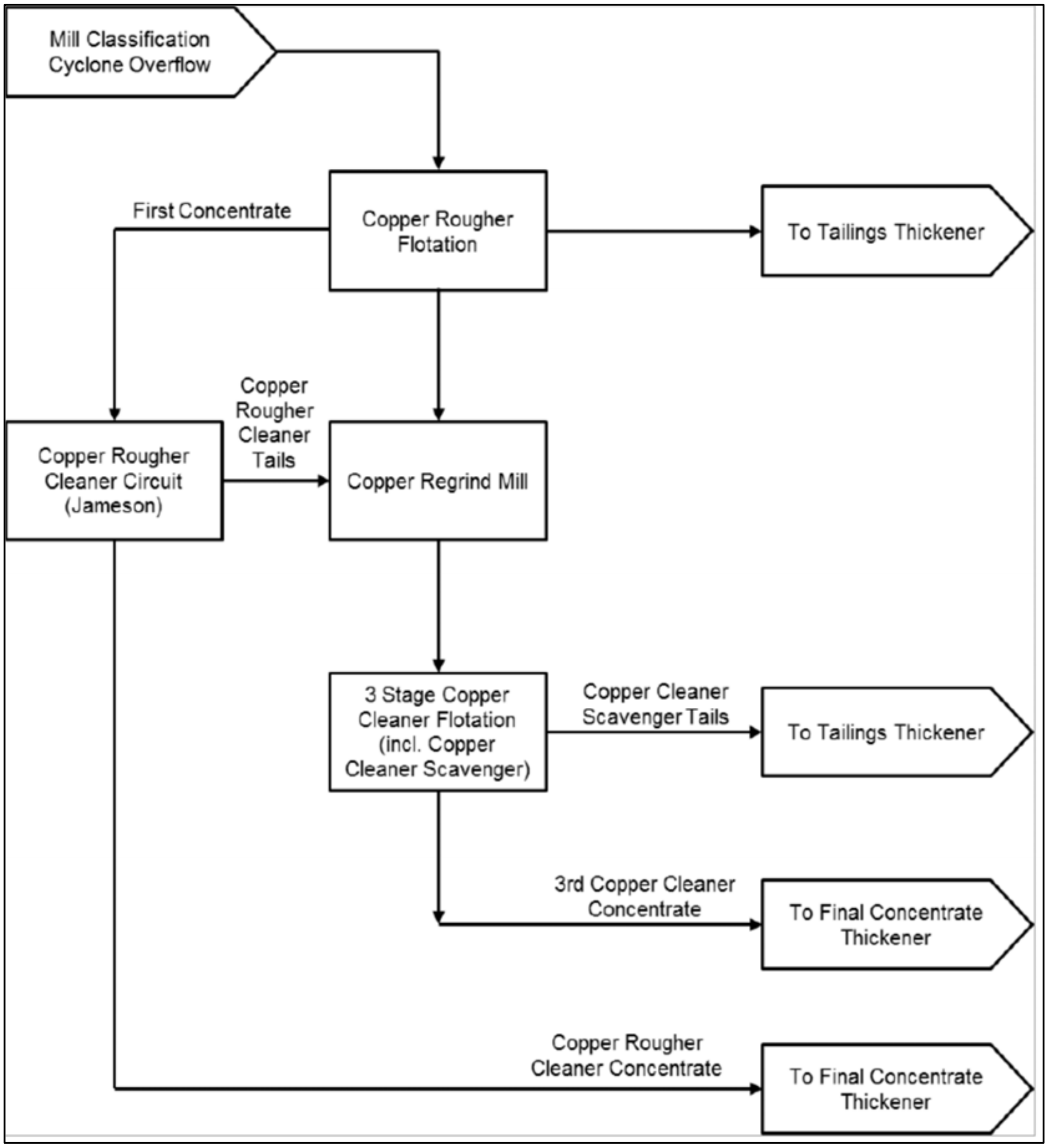
17.4 Plant Design

17.4.1 Plant Overview

The process plant will include the following:

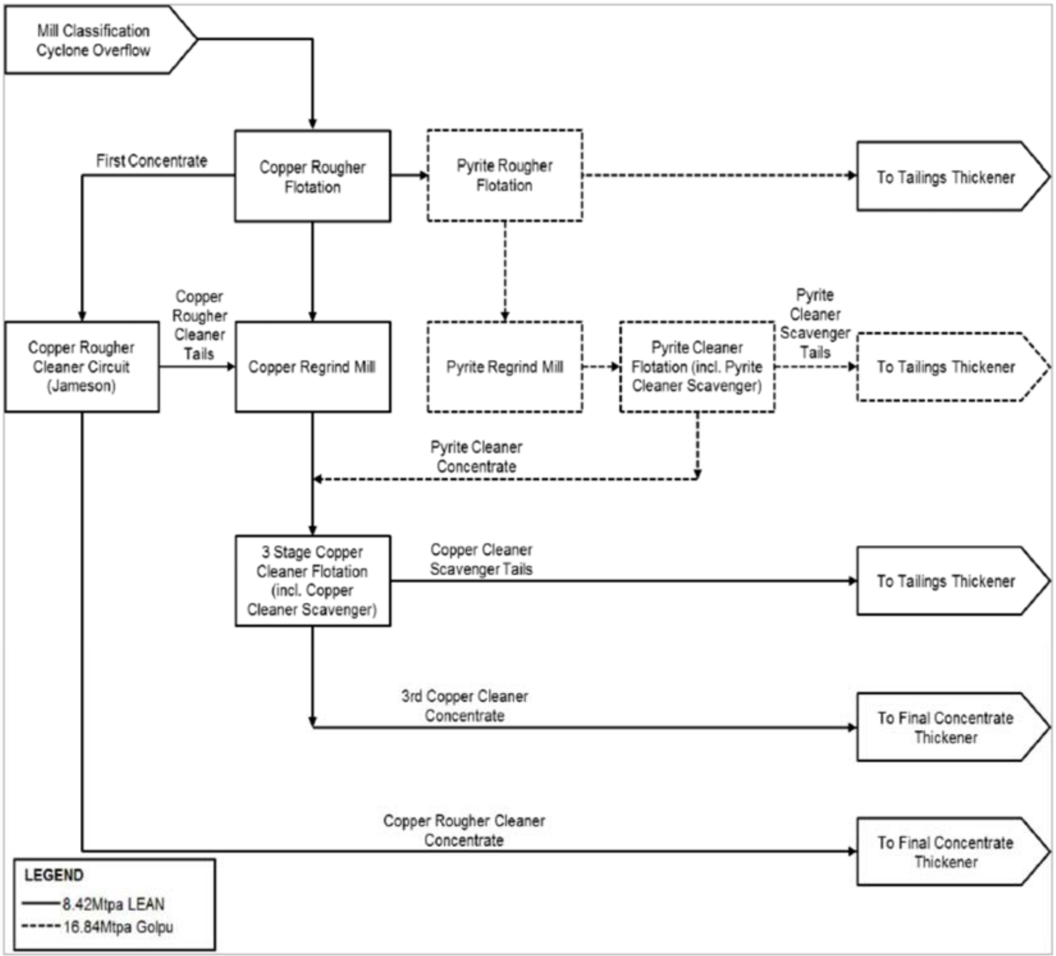
- Crushed ore stockpile and reclaim;
- Single SAB milling circuit, with the ball mill operated in closed circuit with cyclones for operation at the lower design throughput of 8.42 Mt/a. This will be expanded to include a second ball mill, operating in parallel with the original ball mill circuit when the plant is expanded to a design capacity of 16.84 Mt/a. The target grind size is a P80 of 106 µm;
- A pebble crusher circuit is included. Pebbles are recirculated to the SAG mill during the 8.42 Mt/a LEAN and early years of the 16.84 Mt/a Golpu flowsheet with the pebble crusher included when necessitated by increased ore hardness in the later years of mine life;
- Copper flotation comprising rougher flotation, copper rougher cleaner (single Jameson cell) which processes the first rougher concentrate, copper concentrate regrind, followed by a three-stage copper cleaner, and cleaner–scavenger stage;
- Additional copper flotation cells forming part of the LEAN circuit are commissioned nine years post Special Mining Lease grant to accommodate the ramping of the process plant to design capacity of 16.84 Mt/a. A pyrite rougher flotation circuit, which further processes the copper rougher tailings, is introduced 10 years post Special Mining Lease grant to meet the requirements of the increased metasediment content of the ore, corresponding to the porphyry content of less than 75%;
- A pyrite concentrate regrind circuit followed by cleaner and cleaner–scavenger stages;
- Concentrate dewatering and handling;
- Tailings thickening, pumping and water recovery;
- Reagent mixing and distribution (including lime slaking, flotation reagents, and flocculants);
- Grinding media storage and addition;
- Water services (including raw water, fire water, potable water, and process water);
- Air services (including high-pressure air and low-pressure process air).

Figure 17-1:LEAN Flowsheet



Note: Figure prepared by WGJV, 2018.

Figure 17-2:Golpu Flowsheet



Note: Figure prepared by WGJV, 2018.

17.4.2 Ramp-up Considerations

Commissioning will culminate in the introduction of ore and reagents into the plant, start-up and steady, controlled ramp-up to first time operation. This will be followed by performance testing, which will involve operation of the facilities and carrying out defined tests and activities to demonstrate the facilities meet the contract and design parameters. Performance tests are typically 72 hours in duration.

An optimisation period will follow, covering the initial few weeks of operation, when reagent-dosing systems are being optimised, and operators are becoming familiar with measurement and control protocols. Concentrator start-up/ramp up and optimisation is anticipated to take a maximum of two months.

Mining production will ramp up to 16.84 Mt/a over a period of five years. The operating strategy during this time is for the plant to run intermittently (campaign treatment), and in 50% turndown mode during the first three years of start-up, commencing approximately five years post Special Mining Lease grant. During the mine ramp-up period, the total volume of the coarse ore stockpile and the start-up stockpile is to be used to enable the Watut process plant to operate for approximately six days at a time whenever possible in order to minimise the number of plant stops and associated recovery losses.

The plant is designed to operate at nominal throughputs of 8.42 Mt/a and 16.84 Mt/a with corresponding design values of 8.42 Mt/a and 16.84 Mt/a respectively. Considerations for the turndown regime include:

- The initial installation of a SAG mill and single ball mill together with a copper flotation circuit containing a minimum number of cells per bank enables the plant to operate in turndown mode during the first three years of operation. Intermittent operation will, however, still be required to align with the mine production in the first two years and at times thereafter;
- The single tailings pipeline and pumps are sized for the final nameplate throughput. It is proposed that the tailings pipeline is operated at slurry concentrations of approximately 35% during the first two years to maintain the requisite pipeline velocity during 50% turndown operation. Alignment with the mine production rate during these early years will necessitate batch operation of the overland pipeline at times and a dedicated raw water flushing system was included;
- A single concentrate pipeline and pumps are sized for the final nameplate throughput. Overland concentrate pumping will operate on a batch basis under turndown conditions and a dedicated process water flushing system was included.

The plant operating strategy for the mine ramp up period will consist of:

- The plant will start up and be commissioned and optimised at 8.42 Mt/a (50% turndown); after this commissioning, testing and tuning period it will be operating for approximately six days at a time;
- The plant will then run intermittently at 8.42 Mt/a for the balance of the first 12 months, operating approximately six consecutive days per month, gradually depleting the start-up stockpile as well as using the coarse ore stockpile volume of 40 kt.
- Hired/contracted front end loaders, or push dozers, (on remote control once the underground conveyor system starts up) working full time during this period, reclaim the start-up stockpile, discharging ore into the coarse ore stockpile feeders;
- After 12 months, the start-up stockpile is completely depleted, and the plant will continue to run intermittently at 8.42 Mt/a until early Year 8, using the coarse ore stockpile only;
- In early Year 8, the process plant production will ramp up to 16.84 Mt/a, in line with the mine ramp-up. Plant nameplate production cannot be sustained initially, and the plant will intermittently operate using the coarse ore stockpile as buffer capacity;
- From approximately Year 9, mine production can sustain full process plant operation, and the process plant will operate continuously from that point onwards.

17.4.3 Coarse Ore Stockpile

Crushed ore will be conveyed to a single, conical, open stockpile which will have a live capacity of approximately 41.4 kt dry solids. The design basis average live residence time will be 20 hours, based on the Golpu flowsheet.

Coarse ore will be reclaimed from the stockpile by four belt feeders. Each feeder will be designed to provide 33% of the full feed rate to the SAG mill to enable three feeders to achieve nameplate capacity. Each belt feeder will discharge onto the mill feed conveyor that will transport crushed ore to the SAG mill feed chute.

17.4.4 Comminution Circuit

The comminution circuit will consist of a single SAG mill in open circuit, followed by two ball mills, configured in parallel, operating in closed circuit with dedicated classification cyclones. However, the comminution circuit is configured as a single SAB combination for the LEAN flowsheet for the first three years.

All three mills will share a common discharge sump. Scats/pebble return conveyors were incorporated into the circuit with a pebble crusher included, but deferred to the latter years of operation to accommodate harder ores at that time. Scats and pebbles will be recirculated via external conveyors to the SAG mill feed.

The Golpu flowsheet will be commissioned in two stages with the additional ball mill circuit brought on later to match the increased tonnage profile, resulting in a SAG/ball mill configuration with the two ball mills operated in parallel. The Golpu pyrite circuit will be commissioned the following year.

A pebble crusher is included in the scats/pebble circuit later in mine life when necessitated by the increased ore hardness of portions of BC40. The design caters for a possible future inclusion of a bifurcated chute and additional conveyors to return crushed pebbles to the ball mills in equal proportions should increase ore hardness towards the end of the LOM necessitate it.

The SAG mill will be operated in open circuit while each ball mill will be configured in closed circuit with a dedicated classification cyclone cluster. Each ball mill will have a circulating load of 240%. The SAG and ball mill are designed for operating at 75% of critical speed. The specific energy values used were obtained from testwork and are 6. kWh/t for the SAG mill and 9.2 kWh/t for the ball mills. The total charge volume ranges between 20–25% by volume in the SAG mill and 25–34% by volume in the ball mill. The ball charge volume is adjusted according to the demand and operation of the mill. The in-mill density designed for is 67% by mass for the SAG mill and 70% by mass in the ball mills. The discharge of both SAG and ball mills will be via a trommel screen.

Each ball mill will be operated in closed circuit with a classification cyclone cluster, the underflow will return to the mill while the cyclone overflow product will be routed across a 3 mm square aperture vibrating trash screen to protect downstream processes from ingress of oversize material in the event of the cyclones roping. Two standby cyclones are included in each classification cyclone cluster. The cyclone overflow product specification is a P_{80} of 106 µm and a density of 36% solids by mass to allow for a nominal dilution from the downstream trash screen spray water while maintaining a flotation feed density of 35% solids by mass.

Individual cyclone feed pumps will feed the separate cyclone clusters with cyclone underflow returning to the respective ball mill feed chutes. The mill feed conveyor will transfer ore (together with pebble/crushed pebble recycle) to the SAG mill feed chute. Steel grinding media will also be added to the mill feed hopper via an automated ball loading system.

Equipment specifications are outlined in Table 17-1.

17.4.5 Flotation Circuit

With the exception of the copper rougher cleaner, all flotation cells selected for the design were forced air flotation cells.

The copper rougher cleaner circuit will consist of a Jameson flotation cell equipped with froth-washing facilities and an external recycle mechanism. Jameson Cells are best used for recovery of fast-floating liberated material, as is the case with the Golpu ore. It has been demonstrated at several similar operations that, in this application, Jameson Cells are capable of producing final product grades in a single stage of flotation. A single Jameson cell was selected that was capable of treating a feed stream of 105 t/hr solids with a concentrate of 67.4 t/hr solids. These cells can operate successfully in turndown mode through manipulation of the recycle stream.

The flotation circuit will be fed from a surge tank with a residence time of 10 minutes to ensure a stable feed. The copper flotation circuit includes a rougher flotation bank and three-stage cleaning as well as a single cleaner scalper cell (Jameson Cell) and a scavenger bank. The initial 50% LEAN configuration will consist of a reduced number of cells per bank. Additional flotation cells will be added to each bank to accommodate the production ramp-up.

The pyrite flotation circuit is only applicable during the Golpu flowsheet and will consist of a rougher, a cleaner and a scavenger bank.

Required residence times were determined at laboratory scale and are provided in Table 17-2. The scale up factor applied to the laboratory determined residence time is 2.1 for all the flotation cells.

The optimum pH of the feed material into each bank was determined by laboratory testwork and will be adjusted to the required value using lime. Copper and pyrite rougher flotation requires a pH of 7 while all-cleaner and scavenger cells, including the rougher cleaner cell, require operation at a pH of 10.

The flotation cells will be arranged in a cascading bank with two cells on one level which allows for one level control per level. Froth wash water is allowed for on every cell but only stipulated in the copper rougher cleaner cell as a ratio of 1:1 relative to the water content of the concentrate. The concentrate density was designed throughout the flotation circuit to always be at 25% by mass.

Mass pull assumptions are provided in Table 17-3. Flotation cell sizing and the number of cells required are provided in Table 17-4.

The flotation circuit will consist of two circuits: copper flotation and pyrite flotation, each with dedicated regrind circuits. The copper flotation circuit will comprise a single train of rougher flotation cells, rougher 1 concentrate cleaning via a Jameson Cell, concentrate regrind, three stages of cleaning in separate banks and a bank of scavenger cells. The flotation cells will be forced draught cells where the level in each cascade step will be controlled by an internal dart valve arrangement. The final cell in each bank will be fitted with external, up flow dart valves to facilitate level control in the final cell.

Table 17-1: Mill Equipment Specifications

Criteria	Units	SAG Mill	Ball Mill
Units installed		1	2
Diameter (inside shell)	mø	11.0	7.0
Effective grinding length	m	5.5	11.7
Diameter and length (Imperial)	ft x ft	36 x 18	23 x 38.5
Length:diameter ratio		0.5	1.66
Discharge arrangement		Grate	Overflow
Speed (design)	% Nc	75	75
Liner type		Steel	Steel
Liner thickness (new)	mm	100	100
Media type		Steel balls	Steel balls
Media (top size)	mm	125	50
Ball charge (design)	% vol	14	34
Total load (design)	% vol	25	34
Pinion power (design)	kW	11,970	9,525
Installed	kW	2 x 8,000	2 x 6,250

Table 17-2: Residence Times

Area	Residence Time (minutes)
Copper roughers	12
Copper cleaners	12
Copper scavengers	6
Second cleaners	12
Third cleaners	11
Pyrite roughers	13
Pyrite cleaners	6
Pyrite scavengers	6

Table 17-3: Mass Pull Assumptions

Area	Design Mass Pulls LEAN (%)	Design Mass Pulls Golpu (%)
Copper rougher 1st concentrate	6.22	5.08
Copper rougher 2nd concentrate	4.54	5.78
Copper rougher total concentrate	9.97	9.75
Copper rougher cleaner	4.57	3.26
Copper cleaners	5.19	4.08
Copper scavengers	0.5 throughout LOM	

Area	Design Mass Pulls LEAN (%)	Design Mass Pulls Golpu (%)
Second cleaners	4.39	3.45
Third cleaners	3.41	3.14
Pyrite roughers	2.73	
Pyrite cleaners	1.10	
Pyrite scavengers	1.60	
Final concentrate	7.98	6.40

Table 17-4: Flotation Cell Requirements

Area	LEAN		Golpu	
	Number	Sizing (m^3)	Number	Sizing (m^3)
Copper rougher flotation	4	300	8	300
Copper rougher cleaner	single Jameson cell, B6500/24			
Copper cleaner flotation	3	100	6	100
Copper scavenger flotation	3	40	5	40
Second cleaner flotation	5	40	7	40
Third cleaner flotation	3	40	5	40
Pyrite rougher flotation	—	—	7	300
Pyrite cleaner flotation	—	—	5	30
Pyrite scavenger flotation	—	—	4	30

Concentrate from the first one or two copper rougher cells will flow by gravity to the rougher cleaner (Jameson) flotation cell. The concentrate produced in this cell will be pumped directly to the final concentrate thickener. The Jameson cell tailings will join the concentrate from the balance of the rougher cells which together will be pumped to a densification cyclone cluster ahead of the regrind mill. The overflow of the copper densification cyclone cluster will bypass the regrind mill while its underflow will be passed through the vertical mill once after which the streams will join to feed the copper cleaner flotation cells. The concentrate from the cleaners will be pumped to the second cleaner cells while the tailings will gravitate to the scavenger cells. The concentrate from the second cleaner bank will be pumped to the third cleaner bank while its tailings will be pumped to feed the copper cleaner bank.

The third cleaner concentrate will join the concentrate from the Jameson cell to make up the final concentrate of the copper flotation circuit. The tailings from the third cleaners will gravitate into the second cleaner cells.

The copper rougher and scavenger tailings will be final tailings when operating the Watut process plant in the LEAN configuration, and will be routed to the tailings thickener. The copper rougher tailings will be routed to the pyrite roughers when configured for the Golpu flowsheet.

Collectors (AERO 3894A and AP3894) and a frother will be added at various points in the flotation circuit to maximise copper recovery.

When the ore composition drops below 75% porphyry, a pyrite flotation circuit will be required. The pyrite feed tank ahead of the pyrite rougher flotation circuit will have a residence time of three minutes and pumps copper rougher tailings to the pyrite rougher flotation bank. The pyrite flotation circuit will consist of a single train of rougher flotation cells, rougher concentrate regrind, followed by a bank of cleaner and a bank of scavenger cells.

Concentrate from the copper rougher cells will be pumped to a densification cyclone cluster ahead of the regrind mill. Overflow from the copper densification cyclone cluster will bypass the regrind mill while its underflow will pass through the vertical mill once, after which the streams will join to feed the pyrite cleaner flotation cells. Concentrate from the pyrite cleaner bank will be pumped to the copper cleaner cells while the tailings will gravitate to the scavenger cells. Concentrate from the scavenger bank will be pumped to the pyrite cleaner bank. Pyrite rougher and scavenger tailings will be final tailings as these gravitate to the tailings thickener.

Collectors (AERO 3894A and PAX) and SMBS will be added at various points in the flotation circuit to maximise remaining copper and pyrite recovery.

17.4.6 Copper Regrind Milling Circuit

Concentrate from the second to the eighth rougher flotation cells will be combined with the tailings stream from the copper rougher cleaner flotation cell and then directed to the regrind circuit. The overflow from the copper regrind densification cyclone cluster will bypass the regrind mill while the underflow will feed the regrind mill; this is approximately 80% of the circuit feed.

One standby cyclone is allowed for in the regrind mill. The regrind mill will be in open circuit with the cyclone cluster and will allow material to pass through once only; no provision is made for recycle.

The target grind size for copper concentrate regrind is 80% passing 20 µm.

One vertical mill was selected as the regrind mill with an overflow discharge arrangement. The dimensions of the selected Vertimill VTM4500-C are 6.6 m diameter with a height of 19.4 m to top of motor. The mill operating density design is for 70% solids by mass, and one mill media charge is anticipated at 325 t.

The specific energy obtained by ISAmill testwork is 26.7 kWh/t and the specific energy obtained by Jaw testwork is 19.24 kWh/t. These were conducted at 20 µm. The installed power requirement for the mill is 3,356 kW (4,500 HP).

Grinding media will be 12–19 mm steel balls, with a consumption rate of 40 g/kWh.

17.4.7 Pyrite Regrind Milling Circuit

Concentrate from the pyrite rougher flotation cells will be directed to the pyrite regrind circuit. The overflow from the pyrite regrind densification cyclone cluster will bypass the regrind mill while the underflow will feed the regrind mill; this is approximately 80% of the circuit feed. One standby cyclone is allowed for in the regrind mill

The pyrite regrind mill will operate in the same manner as the copper regrind mill in that it will be in open circuit with the cyclone cluster and will allow material to pass through once only. No provision was made for recycle.

The target grind size for pyrite concentrate regrind is 80% passing 30 µm.

One vertical mill was selected as the regrind mill with an overflow discharge arrangement; the dimensions of the Vertimill VTM1000-WB are 3.23 m diameter and length of 13.34 m to the top of the motor. The mill operating density is a planned 70% solids by mass, and one mill charge is estimated at 82 t.

The specific energy used for the mill design is 12.9kWh/t. The installed power requirement for the mill is 746 kW (1,000 HP).

Grinding media will be 12–19 mm steel balls, with a consumption rate of 40 g/kWh.

17.4.8 Concentrate Thickener Design

Concentrate will be pumped from the copper flotation circuit to a 26 m diameter high-rate copper concentrate thickener, sized for the highest mass pull within the Golpu flowsheet. The settling rate, used as design flux, is projected at 0.25 t/m^2/hr. The rise rate assumption is 1.22 m/hr. The design underflow solids content is 60% by mass.

Flocculant will be added to the thickener feed stream to enhance settling. Flocculant consumption is anticipated to be 10 g/t of thickener feed, equivalent to 0.64 g/t mill feed.

The concentrate thickener overflow will report to the process water tank. Copper concentrate solids will settle and will be collected at the underflow at a density of 60% solids. The thickener underflow stream will be pumped to three mechanically-agitated concentrate storage tanks, which will provide eight hours surge capacity per tank ahead of the concentrate pumping system at the nominal 16.84 Mt/a throughput. This is equivalent to 6.8 hours per tank at the 16.84 Mt/a design throughput.

17.4.9 Concentrate Filtration Design

Concentrate will be dewatered using pressure filtration technology. The target moisture content in the filter cake is 9.5% by mass. A vertical plate-and-frame-type filter was selected for concentrate filtration duty. Two filters will be installed with a combined filtration rate of 140 t/hr at a design filtration flux of 409 kg/(m^2/hr).

Two sets of three surge tanks each will be installed ahead of the filter, each with eight hours residence time at 16.84 Mt/a throughput. One set of tanks will be located at the process plant site and the second set of tanks will be located at the port facilities area.

The concentrate filtration facility at the port facilities area will include a water treatment plant prior to the discharge of filtrate into the ocean.

Concentrate filter cake will be discharged directly onto the ground for stockpiling by front-end loader.

17.4.10 Concentrate Transport Design

The concentrate pumping system will consist of two positive displacement pumps operated in a duty/standby arrangement. A charge pump will be necessary to feed the positive displacement pumps as well as a slurry loop to ensure correct density and rheology of the slurry for the long-distance pumping. A buried concentrate, steel and HDPE-lined, pipeline will transport concentrate the 93 km from the Watut process plant to the port facilities area on the coast.

The pipeline is designed for 122.7 t/hr, with a maximum of 130.3 t/hr, and a design solids content of 58% w/w (±2%) in order to maintain the velocity within the 1.40–1.62 m/s design envelope.

Twenty-four hours of concentrate slurry storage capacity will be provided ahead of the filtration plant in three concentrate storage tanks that will be located at the port facility. These tanks will be identical in size to those at the Watut process plant.

For periods during campaign treatment, and once the Golpu flowsheet is implemented where concentrate production is intermittent or low, the system is intended to pump batches of slurry and water successively through the pipeline to prevent the settling of solids in the pipeline during prolonged stops. The concentrate pipeline may be stopped for extended periods, when full of water, during periods of low concentrate production. During periods of high concentrate production, the frequency of water batching will be reduced.

Filtrate water treatment requirements at the port facilities area will be highest in the early years of mine development, when concentrate production will be low due to frequent flushing of the concentrate overland pipeline. As concentrate production increases over the first five years of production, filter utilisation will increase, and water treatment requirements will reduce.

Dewatered concentrate (filter cake) will be stored in a covered stockpile for shipment to be further refined.

17.4.11 Tailings Thickener Design

Flotation tailings gravitate from the copper and pyrite flotation circuits to a dedicated 42 m diameter high-rate thickener, sized for the lowest concentrate mass pull with the Golpu flowsheet. The settling rate assumption, used as design flux, is 1.5 $t/m^2/hr$. The rise rate is projected to be 7.50 m/hr. Design underflow solids content is expected to be 55% by mass.

Flocculant will be added to the thickener feed to enhance settling. Flocculant consumption is anticipated to be 20 g/t of thickener feed, which is equivalent to 18.78 g/t mill feed.

Tailings will be thickened to 55% w/w solids prior to discharge to the tailings transfer tank. Thickener overflow will gravitate to the process water tank. Tailings will be pumped via overland pipeline to a mixing tank at the coast (about 6 km to the east of Lae) from where a marine outfall pipeline will transfer tailings to the deep water of the Huon Gulf.

The tailings pumping system will consist of three positive-displacement pumps operated in a two duty/one standby arrangement. A charge pump will be necessary to feed the positive-displacement pumps as well as a slurry test loop to ensure correct density and rheology of the slurry for the long-distance pumping.

The steel, HDPE-lined pipeline will transport tailings for a distance of about 103 km from the Watut process plant to the coast.

No water will be returned to the process plant downstream of the tailings thickener.

17.5 Port

Receipt of sea freight during the construction phase is expected to be accommodated within the current Port of Lae facilities. During the operations phase, concentrate export and bulk fuel import requirements will require vessel movements at the port.

The port facilities will be sited within a fenced compound within the Port of Lae precinct. Access to the facilities will be via existing roads to the security-control point.

17.5.1 Concentrate Filtration Plant

The concentrate filtration plant will operate 24 hours per day, 365 days per year apart from scheduled and unscheduled maintenance shutdowns. Concentrate slurry transported via pipeline from the Watut process plant will be initially stored in one of three storage tanks before being dewatered using a pressure filter. Filtered concentrate (around 10% moisture) will be gravity fed into the storage shed and stored under cover. The stockpile shed is designed to hold additional concentrate of 70,000 wmt. Two operating filters will be installed. A filter cake discharge bunker, situated beneath each filter, will have a capacity of 24 hours of residence time. The capacity of the covered filtered concentrate stockpile beneath each filter will be 1,856 t.

From the concentrate storage shed, concentrate will be loaded for export via covered conveyors equipped with rain covers and drip/spillage trays. Each conveyor will be sized for 600 t/h wet solids. The conveyor loading area will also be within an enclosed building to contain dust, noise and light to allow 24-hour operation, but will be naturally ventilated to avoid build-up of exhaust fumes from mobile equipment.

Cargoes to a maximum of 40,000 t of concentrate will be loaded onto each ship. Ship loading will be conducted with duplicate ship loading equipment at a combined rate of approximately 1,200 wet tonnes per hour.

Once ship loading is complete, the mobile conveyors will be moved to the wash bay and cleaned prior to storage outside the concentrate storage shed. Export of the concentrate overseas will be by ship, with an estimated 18 shipments per year (i.e., about one shipment every three weeks).

The concentrate storage tanks are designed to hold the equivalent of 24 hours production of concentrate to cater for maintenance and unplanned outages.

17.5.2 Wastewater Treatment Plant and Filtrate Discharge

A wastewater treatment plant will treat filtrate from the concentrate slurry and stormwater captured on site. The plant will consist of pH adjustment and solids removal.

The water treatment plant will be part of the vendor package for the port facilities area. It will be designed to treat an average of 1,695 m^3/day at an instantaneous throughput of 111 m^3/h by nano-filtration. The brine produced will be subjected to precipitation with hydrated lime to remove metal hydroxides and gypsum salts. This will be followed by sulphide precipitation. The water treatment plant will recover 88% of the feed water.

The filtrate will be continuously discharged to the marine environment at a rate of around 30 L/sec during operations. The filtrate will be treated where necessary to comply with the PNG Environment (Water Quality Criteria) Regulation 2002 criteria for the marine environment.

17.5.3 Potable Water

The potable water consumption requirements for concentrate filtration will be low and are assumed to be provided by connection to the Lae mains supply. The system will provide water to relevant areas of the port facilities area (e.g., site buildings, safety showers and emergency eyewash stations.

17.5.4 Emergency Storage and Pollution Control Design Parameters

A concrete-lined pond was sized, together with the concentrate tanks and bunded area, to contain the volume in the concentrate pipeline should this require emergency draining.

Under storm conditions, the containment pond will collect site run-off. Bunds around reagent tanks will be sized for a one-in-200-year storm events and are therefore unlikely to overflow. Reagent spills will be assessed and handled in accordance with the relevant material safety data sheets or processed through the water treatment plant.

The pond volume is projected to be 1,450 m^3, and will be sufficient to hold the contents of an entire concentrate tank (800 m^3) in the unlikely event of leakage or tank rupture.

17.5.5 Diesel Fuel Storage and Distribution

Two diesel fuel storage areas are proposed: one for refuelling of equipment, and another supplying diesel-driven generators that will supply emergency power to the concentrate filtration plant. Both the refuelling storage vessel and the emergency generator fuel storage tank will be self-bunded, double-skinned storage tanks.

17.5.6 Power Supply

Electrical power will be sourced from an independent power provider such as PNG Power Limited or some other third-party provider. A container-mounted electrical substation will be installed at the port facilities area. Diesel generators will be onsite for back up.

17.5.7 Ancillary Buildings

The port facilities will include the following containerised buildings:

- Office, which also houses the control room;
- Crib room;
- Ablutions, change room and laboratory for preparation of concentrate samples for analysis;
- Reagent storage warehouse;
- Motor control centre.

17.6 Energy, Water, and Process Materials Requirements

17.6.1 Energy

The SAG mill will require two 8,000 MW drives, and each ball mill will require two 6,250 MW drives. The SAG and ball mill HV motors will account for approximately 70% of the process plant load, which amounts to nearly 60% of the overall maximum site power demand.

Additional information on the power demand is included in Section 18.13.

17.6.2 Water

Water is required for process water make-up and reagent mixing. The two thickener overflow streams will be recycled to the process water tank and the balance of the make-up water requirements will be supplied from the water treatment facility or alternatively from a raw water dam.

The process water tank will be fitted with two sets of pumps. The process water pumps will supply dilution water to the milling circuit as well as providing process water to every tank in the plant. The dedicated flushing and hosing water pumps will supply hosing-down water throughout the entire Watut process plant.

The raw water tank will be fed with clean raw water from the water treatment facility or alternatively from the raw water dam. The raw water tank will also be fitted with two sets of pumps: it will supply the reagent pumps for reagent dilution and the spray water pumps for all of the spray systems in the process plant (e.g., at the concentrate thickener feed screen).

The potable water supply will supply the plant safety showers and provides sampler spray/dilution water.

Water will be supplied from the water treatment plant located at the mine infrastructure area or alternatively directly from a raw water dam.

Process plant run-off will be collected in the site-wide stormwater management system and directed to the raw water dam via silt traps.

Watut process plant tailings will be discharged down the DSTP and as a result no water will be recovered to the Watut process plant from the tailings downstream of the tailings thickener.

Thickened flotation concentrate will be pumped from the Watut process plant to the concentrate filtration facilities located at the port facilities area. Concentrate filtrate will be treated and discharged to the relevant regulations/guidelines for seawater quality. Discharge will be directly into the tidal basin, adjacent to the plant site.

17.6.3 Process Materials

Materials required for the process plant include:

- Steel grinding media;
- Frother IF6500;
- Collector AP3894;
- Collector A3418A;
- Collector A3418A;
- Collector PAX;
- Flocculant Magnafloc M155;
- Sodium metabisulphite (SMBS);
- Lime;
- Compressed air.

17.7 QP Comments on "Item 17: Recovery Methods"

The QP notes:

- The proposed plant uses conventional designs and equipment;

- The technology associated with the ore processing is an industry standard for this style of deposit;
- The plant will be scaled, and progressively built in line with the profile of the mine ramp up;
- Two flowsheets are proposed.

18 PROJECT INFRASTRUCTURE

18.1 Overview

The Golpu Development as envisaged will occupy three geographical areas consisting of the mine area, an infrastructure corridor, and a coastal area. The infrastructure corridor will link the mine and coastal facilities. The infrastructure requirements to support the Golpu Development are summarised as follows:

- Mine area: proposed block cave mine, underground access declines, portal terrace and waste rock storage facilities supporting each of the Watut and Nambonga declines, the Watut process plant, power generation facilities, laydown areas, water treatment facilities, quarries, wastewater discharge and raw water make-up pipelines, raw water dam, sediment control structures, roads and accommodation facilities for the construction and operations workforces;
- Infrastructure corridor: concentrate pipeline, terrestrial tailings pipeline and fuel pipeline; mine and northern access roads to connect with the Highlands Highway, laydown areas. New single-lane bridges are proposed over the Markham, Watut and Bavaga Rivers. Laydown areas will be located at key staging areas.
- Coastal area: port facilities, including the concentrate filtration plant and materials handling, storage, ship loading facilities and filtrate discharge pipeline; tailings outfall, including a mix/de-aeration tank and associated facilities, seawater intake pipelines and DSTP outfall pipelines, pipeline laydown area, choke station, access track and parking turnaround area.

Table 18-1 provides a list of the infrastructure that will be required; Figure 18-1 shows the planned layout for the mine and infrastructure corridor areas, and Figure 18-2 is a layout plan for the proposed coastal area. Figure 18-3 shows the infrastructure layout plan for the Watut process plant and declines area. Figure 18-4 shows the infrastructure planned for the Nambonga decline area.

18.2 Access

The existing Demakwa access, Link and Watut Valley roads will provide initial access to the mine area during construction, while the northern access and mine access roads are developed. To facilitate initial access to the mine area, minor upgrades to the existing Demakwa access, Wafi access, Watut Valley and Nambonga decline access roads are needed to improve road safety and drainage control.

Thereafter, the main construction and operations access to the mine area will be via the northern access and mine access roads. These two roads will be wholly located in the infrastructure corridor. The mine access road will commence at the process plant terrace and follow the existing Watut Valley road to its intersection with the existing Link road. The northern access road will commence at the point of intersection and continue north to the point where it crosses the Watut River, then northeast across the Markham River, approximately 3.5 km to the west of its confluence with the Watut River.

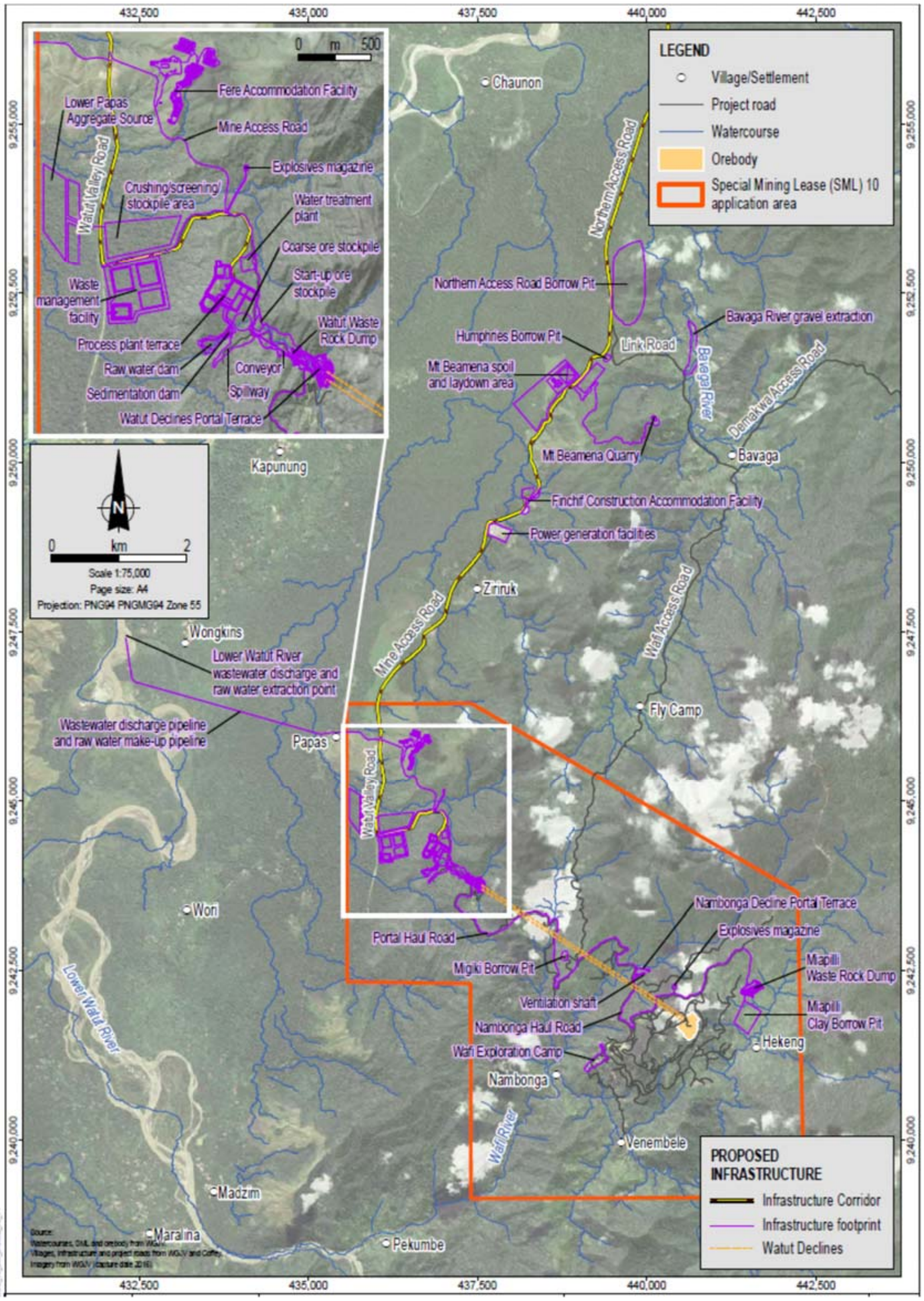
Table 18-1: Planned Infrastructure

Area	Facility	Item	Components
Mine (block cave mine, declines and subsidence zone)	Watut declines portal terrace	Decline entrances (portals)	
		Watut WRSF	
		Water treatment facilities	
		Ventilation fans	
		Refrigeration plant including cooling towers	
		Conveyors and transfer points	
		Electrical substations and switch rooms	
		Drainage and stormwater infrastructure	
		Diesel generators and associated infrastructure	
		Workshops, buildings, fuel facilities, washdown bay	
		First aid and emergency response	
	Process plant terrace	Watut process plant	Coarse ore stockpile
			Grinding units
			Flotation units
			Reagent storage
			Concentrate storage tanks and pump station
			Tailings thickeners, tanks and pump station
		Helicopter pad	
		Offices	
		Access control (security)	
		Change house	
		Mine power supply yard	
		Laboratory	
		Sewage treatment facility	
		Workshop, fuel facilities and washdown bay	
		Raw water dam	
		Sedimentation dams	
		Ore stockpiles	
	Nambonga decline portal terrace	Decline entrance (portal)	
		Ventilation fans	
		Air cooling system including refrigeration machines	
		Transfer points for waste rock	

Area	Facility	Item	Components
		Drainage and stormwater infrastructure	
		Diesel generators and associated infrastructure	
	Associated Nambonga decline infrastructure and facilities	WRSFs	
		Miapilli clay borrow pit	
		Nambonga haul road	
		Lower Papas area aggregate source and crushing/screening area	
		Process water tank	
		Water treatment plant	
		Workshops, buildings, fuel facilities, first aid, washdown bay	
		Explosives magazine	
	Ventilation shaft		
	Wastewater discharge pipeline to the Watut River		
	Raw water make-up pipeline from the Watut River to the Watut process plant (co-located with the wastewater discharge pipeline)		
	Accommodation facilities	Fere accommodation facility	
		Finchif construction accommodation facility	
	Power generation facilities		
	Explosives magazines		
	Waste management facility	Topsoil stockpiles/laydown areas	
	Borrow pits and gravel extraction sources	Migiki borrow pit	
		Humphries borrow pit	
		Northern access road borrow pit	
		Bavaga River gravel extraction	
		Waime River gravel extraction	
	Mt Beamena quarry, spoil and laydown and crushing/screening area		
	Mt Beamena quarry access road		
Infrastructure corridor	Mine access road		
	Northern access road		
	Concentrate pipeline to transport the copper-gold concentrate from the Watut process plant to the concentrate filtration plant at the Port of Lae		
	Fuel pipeline from the Port of Lae to the power generation facilities (as required) at the mine area		
	Terrestrial tailings pipeline from the mine area to the outfall area		
	Construction pads and laydown areas		

Area	Facility	Item	Components
Coastal area	Port facilities area including concentrate filtration plant and materials handling, water treatment plant and filtrate discharge pipeline, concentrate storage and ship loading facilities		
	Outfall system including mix/de-aeration tank, seawater intake pipelines, DSTP outfall pipelines, laydown area, diesel storage, parking and associated access road		
	Bulk intermediate fuel oil storage facility and fuel pump station at the Port of Lae		
	Laydown area for outfall system construction (Lae tidal basin preferred)		
	Bulk intermediate fuel oil (IFO) storage facility and fuel pump station		
Community roads	Resettlement road		
	Watut services road		

Figure 18-1:Proposed Layout Plan, Mine and Infrastructure Corridor



Note: Figure prepared by WGJV, 2018.

Figure 18-2:Layout Plan, Coastal Area

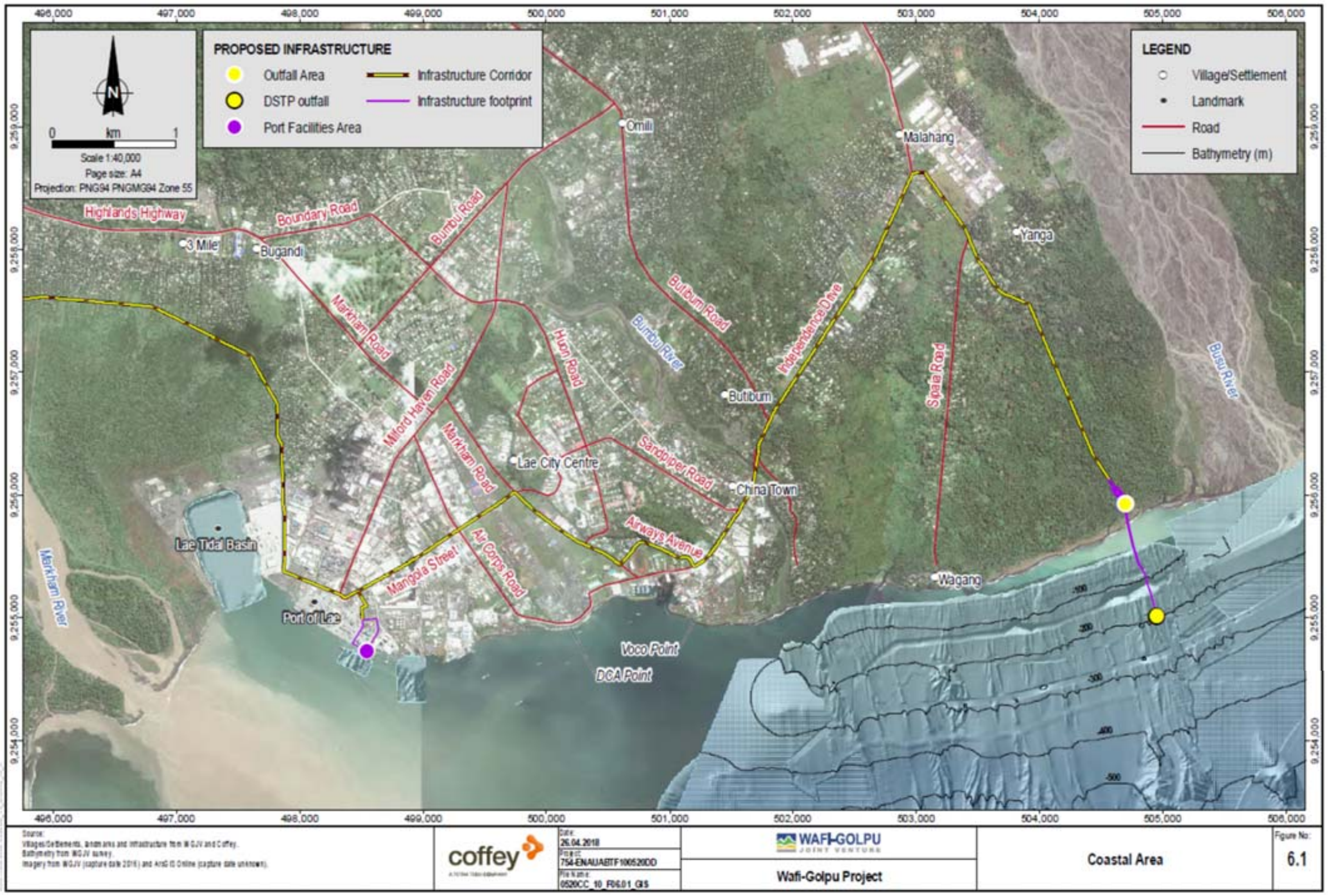
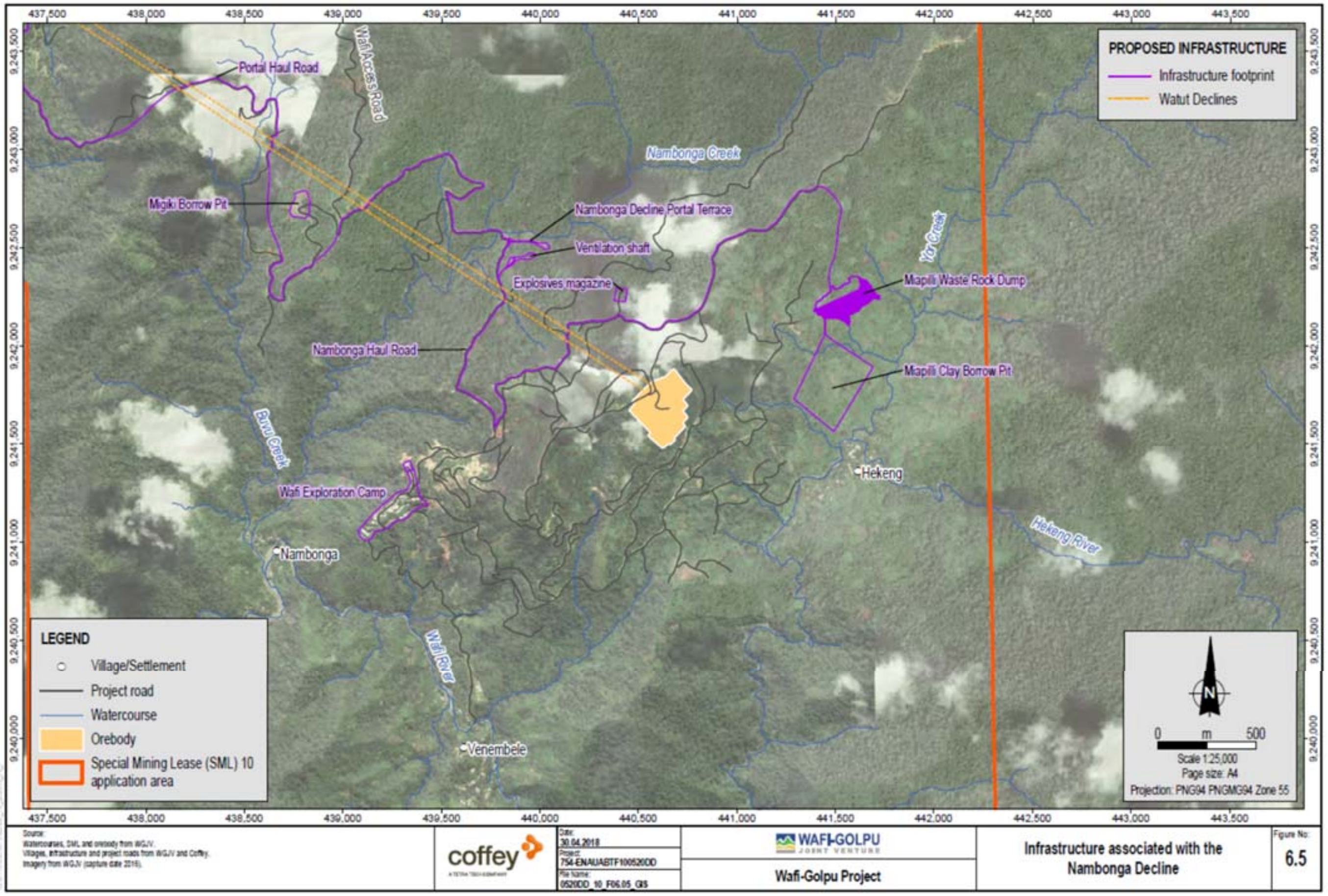


Figure 18-3:Infrastructure Layout, Watut Declines and Watut Process Plant

Note: Figure is an oblique schematic, and no overall scale is applicable. Figure looks approximately north.

Figure 18-4:Infrastructure Layout Plan, Nambonga Decline



The roads will be nominally 10 m wide, unsealed and designed to a one-in-20-year annual exceedance probability flood event and will consider the requirements of the PNG Department of Works Road Design Manual. Permanent bridges will be constructed at the Bavaga, Watut, Markham and Leron Rivers. Bridges will be designed to a one-in-100-year annual exceedance probability flood event. In addition to roads and bridges, laydown and turning areas may be required. Where possible, these will be located within the construction corridor or within existing disturbed areas, and the size of an individual area will be determined on a case-by-case basis.

It is intended that the northern access road will be a public road, but the mine access road will be a private road, controlled via a security access point to the north of the Finchif construction accommodation facility. The mine access road will provide access to the Fere accommodation facility. A short road from the mine access road will also provide access to the explosives magazine.

Within the area of the proposed Special Mining Lease the mine access road will intersect with the Watut Valley road. The Watut Valley road will provide access to the laydown area, the WRSFs and the Watut process plant. The Nambonga decline access road will provide access to the Nambonga decline portal terrace.

As at 30 June, 2020, it was envisaged that two public community access roads may be constructed:

- Watut services road providing a transport link between Kapunung and Madzim villages (approximately 20 km);
- Resettlement road from Madzim to Old Hengambu villages (approximately 18 km). This road may be used to link Pekumbe, Pokwaluma and old Hengambu with the two currently-proposed locations for resettlement villages, Nongokwa and Kwepkwep. The route and construction of this road depends on the outcome of the resettlement process, as it is intended to provide persons physically displaced by the proposed mine with equivalent or improved road access. The road alignment will ultimately be determined by the location to which displaced persons are relocated.

A vehicle fleet will deliver fuel, food, materials and supplies during the construction and operations phases.

In most cases, personnel travelling to and from the mine area at the start and end of construction and operations shifts will be transported in buses provided by the WGJV.

18.3 Infrastructure Terraces

A number of terraces will need to be built to support construction of infrastructure.

18.3.1 Watut Declines Portal Terrace

Due to the steep terrain in the area of the planned Watut declines portal, a portal terrace is proposed to be built within the Boganchong Creek valley to form a marshalling area for the underground activities. The high wall will be constructed to form a geotechnically-stable, steeply-angled face from which to commence construction of the entrances to the Watut declines. The high wall will necessitate the excavation of approximately 300,000 m^3 of material, which will be used for construction of the portal terrace and the portal haul road. This road will provide access between the process plant terrace and the portal terrace.

18.3.2 Nambonga Decline Portal Terrace

A number of terraces will be built in the Nambonga decline portal area. The concept design of the Nambonga decline portal is based on a reinforced tunnel abutting the high wall and retaining walls along a known landslip zone. The reinforced tunnel will protect the portal entrance from possible future landslides. The extent and application of these measures will be determined once the geotechnical design is complete.

18.3.3 Watut Process Plant Terrace

The process plant terrace will be constructed as a precursor to the mining operations phase. The terrace will be constructed on a ridgeline and will be made up of three platforms, with a 7–12 m step between each platform.

18.4 Subsidence Zone

As a result of mining, a subsidence crater is expected to start to form on the ground surface above the orebody approximately 38 months after the start of block caving (as estimated from numerical modelling). The zone is projected to be approximately 975m in diameter with a depth of approximately 400 m from the natural ground surface at the conclusion of mining (Itasca, 2018). Following mine closure and cessation of dewatering, it is predicted that the subsidence zone will eventually become partially filled with rainwater and groundwater, creating a subsidence zone lake.

18.5 Waste Storage Facilities

The WRSFs are discussed in Section 20.4.

18.6 Tailings Storage Facilities

Tailings management is discussed in Section 20.6.

18.7 Water Management

The water management strategy and supporting infrastructure requirements are discussed in Section 20.7.

18.8 Pipelines

The conceptual design parameters for the pipelines are provided in Table 18-2. The concentrate and terrestrial tailings pipelines will transport the concentrate and tailings slurries from the process plant terrace located within the mine area to the coastal area.

The concentrate pipeline will terminate at the concentrate filtration plant in the port facilities area at the Port of Lae, while the terrestrial tailings pipeline will continue through Lae to the outfall area, located between the Wagang village and the mouth of the Busu River.

The fuel pipeline will transport fuel from the Lae bulk fuel storage facility at or near the Port of Lae to a storage facility at the power generation facility in the mine area. In the absence of suitable State of PNG guidelines, the fuel pipeline will be designed in accordance with Australian Standard 2885.

Table 18-2: Pipeline Conceptual Design Parameters

Pipeline	Nominal Pipeline Diameter	Pipeline Length (km)	Design Capacity	Design Flow Rate	Design Pressure	Material	Lined
Concentrate	200 mm	103	130 t/h (dry)	134 m^3/hr	27.0 MPa	Steel	6 mm HDPE
Fuel	200 mm	86.5	15.5 kL/h	0.0043 m^3/s	200 bar	Steel	No
Terrestrial tailings	700 mm	103	1,934 t/h (dry)	2,273 m^3/hr	8,750 kPa	Steel	17.4 mm HDPE

All pipelines will have cathodic protection for corrosion control, leak detection systems and pigging systems to enable cleaning and internal inspection of the pipelines. Pipelines will be buried to minimise ongoing land disturbance and to protect the pipelines from surface interference, except at valve or pump stations. The pipelines will cross numerous watercourses, and the methods used to traverse watercourses (e.g. bridge, underbore, direct bury) will be determined on a case-by-case basis, and will largely depend on the width, depth and flow rate of a watercourse as well as bank stability.

18.9 Laydown Areas

Each major construction centre will have its own dedicated laydown area for the temporary storage of materials to be used during the initial construction and ongoing maintenance of Golpu Development-related facilities. This will include the existing Bavaga laydown yard and Finchif 2 construction area, as well as new laydown areas at:

- Watut process plant;
- Portal terraces;
- Power generation facilities;
- Watut River crossing;
- Markham River crossing;
- Outfall area;
- Port of Lae.

18.10 Quarries and Borrow Pits

Hard rock will be required for various Golpu Development activities and structures, e.g., concrete aggregates, retaining walls and road construction. Gravel will be required for use in the concrete batch plants, the preparation of gabion baskets, and for the gravel wearing course on roads. This rock is expected to be sourced from borrow pits and gravel extraction sites from rivers.

Initially, hard rock is proposed to be extracted from the South Papas, Madzim and Northern Access Road borrow pit sites, and river gravel from the Waime River.

Aggregate required to establish the Nambonga decline will be sourced from the Lower Papas area, and trucked to a nearby crushing and screening plant for processing and stockpiling.

Clay required to encapsulate PAF material may be sourced from the Miapilli clay borrow pit, to be located in proximity to the facility, but may also come from other borrow pits and quarries. These proposed borrow pits will be located as close as possible to the construction sites.

Raw materials will be hauled along the upgraded portal haul road to a concrete batching plant near the Nambonga decline. Until the northern access route is complete, cement will be trucked to site in containerised loads via the existing Demakwa access road.

Additional sites that may be developed include a quarry at Lense Sibal Beamena and river gravel extraction from the Bavaga River. Rock extracted from the quarry at Lense Sibal Beamena will most likely require crushing and screening.

Gravel extraction from the Waime River will require an excavator operating from a levy adjacent to the river. The material will be washed, crushed and screened in an area adjacent to the extraction site. Similar borrow pits are likely to be established adjacent to the Busu, Erap and Markham Rivers. Specific locations are yet to be determined. Gravel and aggregate may also be procured in Lae from established suppliers and trucked to the point of use.

18.11 Power

Power generation using intermediate fuel oil was assessed to be the most economic and reliable way to meet mine power demand over the life of the operation. Other power supply options may be assessed during the permitting phase.

During the construction phase, power will be provided by on-site diesel generators. Approximately 20 generators (depending on the units selected) are expected to be used for surface and underground works.

For the operations phase, the WGJV proposes to construct and operate a power generation facility using reciprocating engines to supply power for the mine, process plant and accommodation facilities.

Three separate points of supply are necessary for Golpu Development-wide permanent power requirements. These are:

- Mine area: The largest point of supply will be the power generation facilities, with 132 kV distributed to the mine area electrical switchyard located on the process plant terrace. To ensure reliability of supply, two 132 kV circuits, one overhead and one buried, will be used. The annual power supply reliability target at the maximum demand level is 99.9%;
- Port facilities area: The second point of supply is for the concentrate filtration plant. Electrical power will be sourced from an independent power provider such as PNG Power Limited or some other third-party provider;
- Outfall area: The third point of supply will be from generator facilities. The loads required for the outfall system operation are small and the implementation of small- scale alternative supplies is appropriate for such requirements.

Power usage assumptions are included in Table 18-3.

Table 18-3: Power Consumption Forecast

Area	Consumption (MW)
Underground water pumping	4.5
Ventilation and refrigeration	16.4
Process plant	59.0
Materials handling	15.1
Ancillary functions	16
Total	111

The power generation facilities for the mine area are proposed to be located approximately 6.5 km north of the Watut process plant on an existing cleared pad (Finchif 2), and will be constructed in two stages. The first stage will consist of nine 10 MW generator sets to meet the initial power demand of 56 MW. The second stage will accommodate the peak power demand of approximately 100 MW through the addition of five 10 MW units taking the total to 14 generator sets.

The use of multiple medium-speed, mid-range reciprocating compression ignition engines of ~10 MW size was selected as the most feasible option. The ultimate configuration will comprise 12 operating generators and two standby generators.

18.12 Fuel

Bulk fuel will be delivered to the mine area via truck (diesel) and a fuel pipeline (IFO). Vehicular delivery will provide fuels to meet the needs of vehicles, diesel generators during construction and mobile equipment. The IFO will be transported from the Port of Lae via the fuel pipeline to support the on-site power generation facilities.

Bulk fuels (diesel and oils) will be delivered to the mine area by fuel tankers and stored in above-ground tanks. Diesel will also be reticulated to a dedicated vehicle re-fuelling bay near the workshop to service the surface mobile equipment fleet. An expected 25 tanker deliveries per week will be required during the construction phase when fuel demand is greatest, associated with diesel generator consumption. Diesel will be stored in a series of 60,000 L, self-bunded storage tanks.

Drums of aviation fuel will also be kept on site to support helicopter operations.

18.13 Accommodation

The existing Wafi and Finchif construction accommodation facilities will be operational during the construction phase. The Wafi accommodation facility has a current capacity of 250 persons and the Finchif construction accommodation facility will be expanded to accommodate up to 1,000 people. Finchif will be retained post-construction. The facilities will upgrade existing services to source water, generate power and manage sewage.

The Fere accommodation facility will be used for both the construction and operations phases and have capacity to house 1,400 people. Facilities will include accommodation units, ablution facilities, kitchen and mess facilities, recreation facilities, laundry facilities and a medical centre. Sewage will be treated by a sewage treatment plant located at the camp.

Each accommodation facility will be equipped with onsite generators for initial and emergency power, and will be connected to the mine area grid once bulk power is available.

During construction of the infrastructure corridor between the village of Zifasing and coastal area, outfall system and port facilities area, personnel and contractors will be accommodated at existing accommodation facilities, at Eleven Mile, outside Lae.

18.14 Water Supply

The planned water supply is discussed in Section 20.8.

18.15 Workforce

Due to the geographic spread of the proposed infrastructure, separate construction teams will be required at a number of sites. The construction workforce across these areas is estimated to be approximately 2,500 full time equivalent workers, of which approximately two-thirds will be in the mine area.

A key focus for the WGJV will be the employment of appropriately-qualified PNG citizens, with priority given, where possible, to landowners of local districts in the area.

The WGJV expects the Golpu Development to employ around 850 full-time equivalent workers, including both employees and contractors, during the operations phase and further indirect jobs created in the region. The operations workforce will work a variety of rosters dependent on their role and home location.

The progressive localisation of jobs, both in terms of the proportion of PNG workers and, more specifically, the proportion of PNG workers from Morobe Province, will contribute to rising employment and wages levels within the Province throughout the LOM. Employment and training opportunities will be directed to maximising the proportion of PNG workers over time.

18.16 Operating Hours

The operating hours are anticipated to be:

- Mine: 24 hours per day, 365 days per year, apart from scheduled and unscheduled shutdowns;
- Watut process plant: short campaigns (e.g., seven days on, seven days off) during ramp-up in Years 1 and 2 and expected 365 days per year at full production, with the exception of scheduled and unscheduled shutdowns;
- Fuel pipeline: 24 hours per day with regular pigging operations on an as required basis;
- Concentrate filtration plant: 24 hours per day, 365 days per year, subject to scheduled and unscheduled maintenance shutdowns;
- Mix/de-aeration tank: intended 365 days per year, excluding scheduled and unscheduled shutdowns.

18.17 QP Comments on "Item 18: Project Infrastructure"

The QP notes:

- The Golpu Development is a greenfield site and currently does not have infrastructure to support mining operations;
- The Golpu Development as envisaged will occupy three geographical areas consisting of the mine area, an infrastructure corridor, and a coastal area. The infrastructure corridor will link the mine and coastal facilities;
- Two major access roads are required to be constructed to support planned operations; prior to the completion of these roads, access will continue to use the existing Demakwa access, Link and Watut Valley roads;
- Power supply will be via a power generation facility using reciprocating engines;
- Three accommodations villages will be used. The existing Wafi and Finchif construction accommodation facilities will be operational during the construction phase. Finchif will continue to be used during operations. A third facility, Fere, will be constructed, and used for both the construction and operations phases.

19 MARKET STUDIES AND CONTRACTS

19.1 Market Studies

An evaluation of the copper market was undertaken as part of the 2018 Feasibility Study Update.

19.1.1 Introduction

The majority of the world's copper concentrate (concentrate) production is processed through pyrometallurgical processes in copper smelters and refineries. Primary smelting technologies may be further broken down to Outokumpu, Mitsubishi, Teniente, Noranda, Isasmelt and Vanyukov processes. Recent technological advances have seen the introduction of double-flash and bottom-blown furnaces, with both technologies being advanced significantly in China. The bottom-blown furnaces are reputedly able to treat lower concentrate grades with higher impurities whilst maintaining high metal recoveries.

Mines producing concentrate and smelters smelting and refining concentrate can be categorised as either integrated or custom. Integrated mines/smelters produce concentrate from their own mines for feed to their own smelters. Some integrated producers cross the arbitrary definition by buying or selling concentrate on the market from time to time to supplement smelter feed, or to off-load excess mine production. Custom producers buy or sell concentrate on the open market. The custom market is the larger of the markets, and due to the increase in blending operations performed by traders, it can be reasonably expected that their share of global custom concentrate has increased.

The demand for copper concentrate is driven by China, which has emerged as the largest buyer of copper concentrate on a global basis. Consequently, whereas Japanese and European smelters once led the market in establishing commercial terms which were often followed by others in the market, the Chinese smelters now share that role. About 80% of custom concentrate purchasers are located in the Asian region.

19.1.2 Smelter Terms

Mines typically enter into one or more of the following types of contracts:

- Tier 1 Long-term (or frame) contracts between mines and smelters;
- Tier 2 Long-term (or frame) contracts between mines and traders;
- Tier 3 The spot market (via traders).

The structure of direct contracts between mines and smelters (Tier 1) can be either block contracts or brick contracts:

- In a block contract, 100% of the quantity for each contractual period is priced at one time (usually one-year periods);
- Brick contracts typically price 50% of each year's quantity over a two-year period.

Consequently, the volatility of commercial terms is decreased, as commercial terms applied in any one-year period will be the average of agreed terms over two years.

The duration of a direct mine to smelter contract is often at least three years and may be as long as 10 years. Contracts may be rolled automatically for an agreed period of time if neither party objects.

Mine to trader contracts typically will not exceed 3–5 years.

Spot contracts may cover direct business between mines and smelters however it almost always involves contracts between mines and merchants.

Most long-term contracts specify a fixed annual sales tonnage or tonnage range over multiple years. Most mines place the majority of their production with smelters under long-term contracts but reserve a proportion for merchant spot and merchant long-term sales.

19.1.3 Copper Payment Terms

The current typical copper payable by a smelter is 96.5% subject to a 1.0% unit deduction for a copper content of 20–30%. At levels exceeding 30%, smelters may agree to a higher copper payable rate. However, some smelters have also sought a higher unit deduction for concentrate where the copper grade is below 24%.

For standard grade for copper concentrates (25–35% Cu), direct mine–smelter treatment charges over the past 10 years have varied from US$42–US$110 per dry metric tonne of concentrate, and refining charges from US¢4.2–US¢11.0 per pound of payable copper. These terms are for long-term frame contracts between major producers and Asian smelters agreed on an annual calendar year basis.

For higher-grade copper concentrates, smelters may also seek higher treatment charges from producers when the market is in the favour of the smelters to partially compensate the smelters for lower revenue received from the higher-grade producers in terms of ¢/lb Cu. Lower grade concentrate (<22–24%) may pay a series of penalties; especially for new entrants in a surplus market.

19.1.4 Copper Concentrate Precious Metal Terms and Refining Charges

The gold payable scale in a sales contract may vary from smelter to smelter. A typical payability scale for an Asian smelter is shown in Table 19-1. European smelters demand a minimum deduction forgold in the application of the scale.

In Asian markets, silver is paid at 90% of the analytical silver content subject to such content being higher than 30 g/t and no payment is made below 30 g/t. European smelters typically exact a deduction on the silver content.

19.1.5 Deleterious Elements

Schedules for most deleterious elements are already established in the market. Typical penalties for deleterious elements are shown in Table 19-2 (Wood Mackenzie, 2013).

As some smelters will be more sensitive to certain elements, those smelters may demand more punitive charges or will set a firm ceiling for those elements in their contracts. From a commercial perspective, smelters will sometimes seek an income stream from penalties, even when those elements may not contribute to an overall deleterious impact on their processes.

Table 19-1: Metal Payable Scale

Item	Unit	Assumption
Copper Payable Scale		
20% < Cu in concentrate ≤ 21%	% Cu payable	95.00
21% < Cu in concentrate ≤ 22%	% Cu payable	95.24
22% < Cu in concentrate ≤ 23%	% Cu payable	95.45
23% < Cu in concentrate ≤ 24%	% Cu payable	95.65
24% < Cu in concentrate ≤ 25%	% Cu payable	95.83
25% < Cu in concentrate ≤ 26%	% Cu payable	96.00
26% < Cu in concentrate ≤ 27%	% Cu payable	96.15
27% < Cu in concentrate ≤ 28%	% Cu payable	96.30
28% < Cu in concentrate ≤ 29%	% Cu payable	96.43
29% < Cu in concentrate ≤ 30%	% Cu payable	96.50
30% < Cu in concentrate ≤ 32%	% Cu payable	96.60
> 32% Cu in concentrate	% Cu payable	96.65
Gold Payable Scale		
≤1 g/t Au in concentrate	% Au payable	0.00
1 g/t < Au in concentrate ≤3 g/t	% Au payable	90.00
3 g/t < Au in concentrate ≤5 g/t	% Au payable	92.00
5 g/t < Au in concentrate ≤7 g/t	% Au payable	94.00
7 g/t < Au in concentrate ≤10 g/t	% Au payable	95.00
10 g/t < Au in concentrate ≤15 g/t	% Au payable	96.00
15 g/t < Au in concentrate ≤20 g/t	% Au payable	97.00
20 g/t < Au in concentrate ≤40 g/t	% Au payable	97.50
40 g/t < Au in concentrate ≤45 g/t	% Au payable	97.75
45 g/t < Au in concentrate ≤50 g/t	% Au payable	98.00
50 g/t < Au in concentrate ≤60 g/t	% Au payable	98.125
>60 g/t Au in concentrate	% Au payable	98.25

Table 19-2: Deleterious Elements Penalty Schedule

Element	Limit	Penalty per DMT Over Free Limit (typical ~US$/t concentrate)	Range
Arsenic	>0.2%, <0.5%	2	US$2–3 per 0.1% up to 0.5%
	>0.5%, <1%	7	US$5–8 per 0.1% between 0.5–1%
	>1%	10	US$8–12 per 0.1% above 1%
Alumina	3%	1.25	US$1–2 per 0.1%
Antimony	0.05%	1.5	US$1–2 per 0.01%
Bismuth	0.02%	2	US$1.5–3 per 0.01%
Cadmium	0.03%	2	US$1–5 per 0.01%
Chlorine	300 ppm	1	US$1–3 per 100 ppm
Fluorine	300 ppm	1	US$1–2 per 100 ppm
Lead	1%	2	US$1–5 per 1%
Mercury	5 ppm	0.2	US$0.1–5 per 100 ppm
Nickel and cobalt	0.5%	1	US$1 per 0.1%
Selenium	300 ppm	1.50	US$1.50 per 100 ppm
Silica	10%	1	US$1 per 1%
Zinc	3%	4	US$1–5 per 1%

Note: Figures sourced from Wood Mackenzie, 2013.

From time to time, smelters may attempt to introduce a new penalty element or seek a favourable variation to the penalty structure for a specific element, without a sound technical basis. Some penalty elements, such as arsenic, do not present any technical challenge to smelters, but do contribute to emission and waste disposal costs. Smelters will typically seek to source up to a specific annual limit of arsenic, to ensure penalty revenue is maximised, without incurring fines or additional disposal costs. Smelters are currently claiming heightened sensitivity to arsenic, fluorine, mercury and molybdenum.

Analysis of final concentrate derived from the bulk flotation testing indicated that the concentrate did not exceed any of the typical concentration restrictions for sale.

19.1.6 Payment Terms

Payment terms with Asian smelters generally allow for 90% payment against a provisional invoice after a period of time (following the carrying vessel's arrival at the port of discharge) ranging from three business days to 15 calendar days.

Sales to traders usually entail 100% pre-payment at the time of shipment by the trader to the mine and would typically be associated with a discount compared to typical smelter arrival terms (e.g. payment after arrival + three business days) at a reference interest rate.

19.1.7 WGJV Concentrate Specification

The Golpu concentrate is expected to be relatively high in copper and low in impurities (Table 19-3 and Table 19-4).

Table 19-3: Copper Concentrate Analysis, Major Elements

Element	Value	
Cu	29.2	%
Au	17.0	ppm
S	30.4	%
Fe	39.4	%
Ag	30.0	ppm
Mo	32.0	ppm
Si	150	ppm

Table 19-4: Copper Concentrate Analysis, Other Elements

Element	Value		Comments
Pb	130	ppm	Typically, 120–140 ppm
Zn	685	ppm	
As	<10	ppm	Typically, 100–700 ppm, well below the smelter penalty threshold of 2,000 ppm
Sb	1.9	ppm	
Bi	<0.002	%	
Ni	37	ppm	
Al	440	ppm	Typically, 1,200–1,600 ppm
F	20	ppm	Well below the smelter penalty threshold of 300 ppm
Cl	<0.01	%	
Mg	200	ppm	Typically, 350–400 ppm
Hg	<10	ppm	

Levels of gold-in-concentrate are not expected to be elevated to such levels which may limit marketability in markets such as China and India where high concentrate values may be restricted by working capital constraints.

Payability ranges for gold and copper used in the financial model were included in Table 19-1.

19.1.8 WGJV Marketing Strategy

It is expected that Asian smelters will contract the Golpu concentrate as long-term feed source. The concentrate will be attractive to these smelters due to the proximity of the mine and consequently shorter transit times to give certainty of supply. The concentrate is not expected to contain deleterious elements at levels prohibitive to sale to Asian smelters.

In determining product allocation, the WGJV will need to consider market reliability, diversity and economic returns. Marketing activities would be commenced at an early stage to ensure that target smelters will incorporate the concentrate into long-term feed plans.

Marketing assumptions used in the financial analysis are summarised in Table 19-5.

Table 19-5: Marketing Assumptions Used in 2018 Feasibility Study Update

Parameter	Units	Value
Arsenic penalty trigger	ppm	2,000
Arsenic penalty trigger	US$/t real	2.50
Concentrate moisture	% shipped	9.7
Ocean export freight	US$/t /wmt real	24.05
Shore-side loading cost	US$/t /wmt real	6.51
Bill of loading weight franchise deduction	%	0.25
Contracts subject to weight franchise deduction	%	50
Gold payable scale (10–15 g/t concentrate, Au grade)	%	96.00
Gold payable scale (15–20 g/t concentrate, Au grade)	%	97.00
Gold refinement charge	US$/oz real	6.00
Copper payable scale (20–32% concentrate Cu grade)	%	96.50
Copper minimum deduction	%	1.00
Copper treatment cost (TC)	US$/t real	90.0
Copper refinement cost (RC)	US$/lb real	0.09
Contracts subject to price participation	%	—

19.2 Commodity Price Projections

Metal price assumptions were provided by Newcrest management. Newcrest considers analyst and broker price predictions, and price projections used by peers as inputs when preparing the management pricing forecasts.

Metal price and exchange rate assumptions used are included in Table 19-6.

The commodity price and exchange rate projections were agreed to by the WGJV Participants.

19.3 Contracts

No contracts are currently in place in support of the Golpu Development.

Major contracts in support of development are likely to include shaft sinking, decline development, pipelines, conveyors, camp construction, port and roads. Major contracts in support of operations are likely to include: accommodations camp management, building maintenance, underground mine infrastructure development, cave establishment, road maintenance, explosives supply, ground support and consumables supply, material transport and logistics to the Port of Lae, infrastructure engineering procurement and construction management, labour training, and infrastructure construction.

Contracts will be negotiated and renewed as needed. Contract terms are expected to be within industry norms, and typical of similar contracts in PNG that Newcrest is familiar with.

Table 19-6: Metal Price and Exchange Rate Assumptions

	Item	Value
Metal price	Copper	US$3.00/lb
	Gold	US$1,200/oz
Exchange rates	US$ to PNG kina	1 US$ = PGK 3.10
	US$ to A$	1 US$ = A$ 1.33
	US$ to Euro	1 US$ = EUR 0.90
	US$ to British Pound	1 US$ = GBP 0.64
	US$ to South African Rand	1 US$ = ZAR 13.0
	US$ to NZ$	1 US$ = NZ$ 1.43

Note: EUR = euro (€); GBP = British pound (£); ZAR = South African rand.

19.4 QP Comments on "Item 19: Market Studies and Contracts"

The QP notes:

- Market studies were conducted. The Golpu concentrate is expected to be relatively high in copper and low in impurities, and be saleable;
- Asian smelters are most likely to contract the Golpu concentrate as long-term feed source;
- Forecast payability and deduction assumptions appear reasonable;
- The terms contained within any future refining agreement and sales contracts would be expected to be typical of and consistent with Australian standard industry practice, and be similar to contracts for the supply of copper concentrate elsewhere in Australia;
- No contracts are currently in place in support of the Golpu Development. Contracts will be negotiated and renewed as needed. Contract terms are expected to be within industry norms, and typical of similar contracts in PNG that Newcrest is familiar with;
- Commodity price and exchange rate projections were agreed to by the WGJV Participants. The WGJV participants consider analyst and broker price predictions, and price projections used by peers as inputs when preparing the management pricing forecasts.

The QP is of the opinion that the marketing and commodity price information is suitable to be used in the cash flow evaluations supporting Mineral Reserve estimates.

20 ENVIRONMENTAL STUDIES, PERMITTING AND SOCIAL OR COMMUNITY IMPACT

20.1 Baseline and Supporting Studies

The WGJV has completed a number of baseline and supporting studies, as summarised in Table 20-1. These studies culminated in the preparation of an EIS in 2018. Additional studies are ongoing, with further studies planned to be completed prior to the commencement of construction and/or commissioning.

20.2 Environmental Considerations

An EIR was submitted on 16 May 2017 and approved by CEPA on 8 June 2017.

The EIS was prepared as the statutory basis for the environmental, social and cultural heritage assessment of the Golpu Development under the *Environment Act 2000*. The EIS was developed to address the Department of Environment and Conservation publication GL-Env/02/2004, Guideline for Conduct of Environmental Impact Assessment & Preparation of Environmental Impact Statement. The objective of the EIS was to identify potential environmental, social and cultural heritage impacts associated with the Golpu Development and set out the management measures WGJV proposes to address potential adverse impacts. The EIS was lodged with CEPA in June 2018.

The EIS provides CEPA with a thorough appraisal of the Golpu Development to inform Ministerial decision-making as to whether to grant approval in principle for the Golpu Development under the *Environment Act 2000*, and subsequent to that, grant a Level 3 environment permit for the Golpu Development.

20.3 Stockpiles

20.3.1 Temporary Ore Stockpile

A temporary start-up ore stockpile is planned to store ore extracted during the development of the BC44 undercut and extraction levels. It will be built on a purpose-built, low- permeability base, adjacent to the Watut declines WRSF, to stockpile material for processing until the Watut process plant commences operation. This ore will then be used in the commissioning process.

20.3.2 Coarse Ore Stockpile

A coarse ore stockpile will be required to maintain a steady supply of ore for the Watut process plant and to minimise fluctuations in the availability of feed material. Crushed ore from underground will be conveyed to a single, conical, open stockpile with a live capacity of approximately 40,000 t.

The stockpile will be located on a purpose-built compacted earth base constructed between the Watut declines portal terrace and the process plant terrace. The majority of ore in the coarse ore stockpile will be stored there for an average of 18 hours. However, a proportion of the ore will remain within the stockpile for a longer period of time. The coarse ore stockpile is expected to be completely removed every eight months to allow access to the feeder tubs for inspection and maintenance.

Table 20-1: Baseline and Supporting Studies

Major Area	Study Type	Components
Physical and biological environment characterisation	Location	
	Climate	
	Geology	
	Topography	
	Seismicity	
	Soils	Soil geochemistry; acid sulphate soils
	Groundwater	Hydrogeological units; hydraulic properties; groundwater recharge; groundwater levels and flow direction; groundwater discharge and use; groundwater–surface water interaction; groundwater quality; conceptual hydrogeological model
	Terrestrial ecology	Desktop review; field surveys; Protected and Special Purpose Areas; vegetation and flora; fauna; noise; air quality
Freshwater environment characterisation	Hydrology, water quality and sediment quality	Lower Watut River catchment; lower Markham River floodplain
	Aquatic ecology	Lower Watut River catchment; lower Markham River floodplain
	Drainage and hydrology	Lower Watut River catchment; lower Markham river floodplain; flood frequency analysis
	Sediment transport and fluvial geomorphology	Sediment load and sources, fluvial geomorphology
	Water quality	Physico–chemical parameters; TSS, major ions and hardness; dissolved metals and metalloids; metal bioavailability assessments; total metals and metalloids; nutrients
	Sediment quality	Organic carbon in sediment
	Aquatic ecosystems and habitats	Aquatic flora; aquatic fauna
Nearshore marine environment characterisation	Geology and bathymetry	
	Seismicity	
	Tides, currents and waves	
	Fluvial influences	Regional sediment regime; Markham River
	Nearshore marine environment sediment geochemistry	Particle size distribution; metals; nutrients and carbon
	Nearshore marine environment water quality	Physico-chemical parameters; nutrients, faecal coliforms and oil and grease; dissolved metals
	Nearshore marine ecology	Foreshore and shallow pelagic environment; benthic environment; coral reefs and seagrass
	Nearshore marine environment fauna and flora	Cetaceans and marine mammals; sea turtles; coral reef flora and fauna; nearshore infauna assemblage; crocodiles; avifauna; Labu Lakes flora and fauna; invasive and alien species
	Bathymetry	
	Upper ocean profiling	

Major Area	Study Type	Components
Offshore marine environment characterisation	Potential for coastal upwelling	
	Ocean currents	Ocean current data collection; ocean floor mass movement events; outfall A currents; canyon mooring currents
	Terrestrial sediment supply	
	Sediment transport through the Markham Canyon	
	Benthic sediment characteristics	Particle size; metals
	Offshore marine ecology	Deep-slope and pelagic fish; zooplankton and micronekton; deep-sea benthic ecology
Socioeconomic environment characterisation	Socioeconomic baseline studies	Socioeconomic baseline: study area 1 (mine area, surrounds and access corridors) Socioeconomic baseline: study area 2 (infrastructure corridor from Zifasing to Lae) Socioeconomic baseline: study area 3 (Lae) Socioeconomic baseline: study area 4 (Wagang and Yanga villages)
	National and Provincial context	
Cultural heritage characterisation	Settlement history	
	World War II history	
	Recorded cultural heritage	
Physical and biological environment impact assessment	Landform and soils	
	Groundwater	
	Terrestrial ecology	
	Air quality	
	Greenhouse gas assessment	
	Noise and vibration	
Freshwater environment impact assessment	Impact identification	
	Proposed management measures	
	Monitoring	
Nearshore marine environment impact assessment	Impact identification	
	Proposed management measures	
	Monitoring	
Offshore marine environment impact assessment	Impact identification	
	Proposed management measures	
	Monitoring	
Socioeconomic impact assessment	Impact identification	
	Proposed management measures	
	Monitoring	
Health risk assessment	Assessment criteria	Air; soil; drinking water; surface water; food (aquatic and terrestrial)
	Design controls and management measures	
Cultural heritage impact assessment	Impact assessment	Resettlement program; chance finds
	Management measures	

Major Area	Study Type	Components
	Monitoring	
Unplanned events (natural hazards and accidental events)	Regulatory framework review	Corporate framework review
	Hazard assessment	Natural events; pipeline rupture; underground access way collapse; WRSF failure; inundation of port facilities area and outfall area; explosion; fire; major loss of containment
Cumulative impact assessment	Cumulative impact assessment	

20.4 Waste Rock Storage Facilities

20.4.1 Overview

Once the underground crusher is installed, all rock will be transferred to the underground crusher and delivered to the surface as part of the ore stream for processing. Unlike typical open-cut mines, this means there is effectively no waste rock generated during operations.

Geochemical characterisation of mine materials in and around the Golpu deposit was conducted on multiple sets of samples obtained between 1990 and 2017, specifically to identify PAF material. These studies show that almost all of the ore and much of the waste rock is PAF. Competent non-acid forming (NAF) material will be used during construction of the Golpu Development (e.g., for portal terraces) and as lining and capping for the PAF waste rock cells in the WRSFs. The PAF material will be stored in engineered WRSFs adjacent or nearby to the Watut and Nambonga declines.

20.4.2 Watut Declines WRSF

The Watut declines WRSF design is constrained by the Boganchong Creek valley in which it is proposed to be located. The facility will cover approximately 12 ha of the Boganchong Creek valley and will be about 780 m long and 140 m wide, with a varying vertical height. The downstream end of the facility will not have a conventional WRSF toe but will abut the process plant terrace, forming one continuous footprint housing Golpu Development infrastructure. The WRSF has a design capacity of 1.2 Mt of PAF material.

The NAF waste rock generated during decline development is proposed to initially be placed next to, and downstream of, the Watut decline portal terrace, to create a NAF fill area above the portal terrace steel culvert underdrain. This 1–2 m thick layer of compacted NAF waste with very low permeability (approximately $1x10^{-9}$m/s) will cover the valley floor underlying the WRSF. PAF waste will then be placed within the NAF-lined cell and intermediate layers of low-permeability clay placed over the surface of the PAF waste at intervals during operation to limit the duration of exposure to air and water. Only one PAF cell is planned to be operational at any given time and each cell will be operational for a period of approximately eight weeks. Once a PAF cell reaches capacity, a cover of NAF material and compacted clay will be placed on top to cap the cell and the PAF waste disposal will progress to the next cell in the series. Given that the majority of the excavated material is expected to be PAF, encapsulation will involve sourcing of clay material and capping rock from quarries or borrow pits.

To prevent water ponding within the active cell receiving PAF waste, a gravity decant water system will direct water to a series of collection sumps for testing, treatment if necessary, and discharge.

Routine monitoring of the WRSF cells during operations will be undertaken to allow early detection of seepage and acid and metalliferous drainage (AMD). Potentially contaminated runoff and seepage from the WRSF will be collected for testing, and will be treated if required. This water will either be used to fulfil process plant water demands during operations or be discharged to the downstream environment in the lower Watut River.

20.4.3 Nambonga Decline WRSF

Waste rock from the Nambonga decline will be stored within a WRSF that will be located near the decline. The WRSF will store approximately 0.86 Mt of waste rock from the Nambonga and Watut declines, consisting mostly of PAF waste rock (0.83 Mt) and a small amount of NAF waste rock (0.03 Mt).

The WRSF will cover an approximate 5 ha area, and will be about 10 m high. It will be designed and constructed to appropriately manage PAF material in a manner consistent with that described for the Watut WRSF and will include a drainage and leachate recovery system. The NAF material for construction of the base of the WRSF and for encapsulation will be sourced from borrow pits or quarries.

The drainage and sediment control system for the WRSF will be designed to overflow to the environment in a controlled manner during a storm event. The seepage and runoff will be captured, treated if necessary, to comply with permit conditions using a water treatment plant located at the Watut decline portal terrace, and discharged to Watut Creek.

20.5 Waste Management

The WGJV participants intend to implement strategies to avoid or minimise the production of waste. Where generation of waste cannot be avoided, options to reuse or recycle wastes will be implemented where possible and disposal will be used as the last resort. Hazardous and non-hazardous materials will be managed according to a Project Environmental Management Plan.

A dedicated waste management facility for the mine area, including a landfill, will be located near the Watut process plant. Power and water reticulation will be provided to this facility. Wastes will be collected and sorted at the waste management facility and then managed according to waste material type. The area will be hard-paved, and runoff collected for treatment if required.

20.6 Tailings Management

20.6.1 Introduction

The WGJV, through the course of its concept, pre-feasibility and feasibility study programs, has assessed a number of options for tailings management. This has included pre-feasibility and feasibility-level investigations into the following options for tailings management for the Golpu Development:

- On-land storage in a tailings storage facility (TSF);
- Dry-stacking on-land storage;

- DSTP.

Two methods of on-land tailings disposal were not considered for the Golpu Development. These were:

- Riverine disposal of tailings: while mines at Ok Tedi, Porgera and Tolukuma use this method, it was not considered due to the potential environmental and social impacts on downstream communities.
- Underground tailings disposal (e.g., paste backfilling) was not considered, as this approach is not feasible for a total tailings stream storage and in block cave mines there is no safe space for any storage above the extraction levels.

While some disturbance is unavoidable during the management of tailings, WGJV's primary objective is to avoid, minimise or reduce the effects of the preferred tailings management method on the natural, social and cultural heritage environment with a focus on preserving local peoples' use of, access to and enjoyment of the environment. This includes consideration of water quality, land use (terrestrial or offshore), ecological values (e.g., gardens, plants, animals and plant communities, including marine ecology), community impacts and impacts to cultural heritage sites.

Between 1993 and 2017, 45 terrestrial TSF site options were assessed for their viability to support a terrestrial TSF for the Golpu Development.

The WGJV adopted DSTP as the preferred tailing management option for the Golpu Development based on consideration of long-term safety, engineering, environmental, social, cultural heritage and economic factors. Deep sea tailings placement is presently used at six mines in four countries. Mines in PNG that use DSTP to manage tailings are Misima (mined out/closed), Lihir (operated by Newcrest), Ramu, and Simberi. The Woodlark project, also located in PNG, is approved to use DSTP but has not yet commenced full construction.

In 2010, the Conservation and Environment Protection Authority (then Department of Environment and Conservation), in collaboration with the Mineral Resources Authority, commissioned the Scottish Association for Marine Sciences to prepare a set of Draft General Guidelines for DSTP in PNG (SAMS, 2010). The completion of the engineering design for the DSTP system for the Golpu Development that supports the Mineral Reserves and the environmental investigations, which informed design were undertaken in accordance with the Draft General Guidelines for DSTP in PNG, to the maximum practicable extent.

20.6.2 Tailings Placement Assumptions

Deep sea tailings placement involves the discharge of a tailings slurry from a pipeline into the sea at a location where deep oceanic water occurs close to shore and a steep and continuous slope occurs between the outfall terminus and the deep ocean floor. The preferred option of DSTP was considered by WGJV for the Golpu Development due to the availability of deep water in the Huon Gulf, located some 100 km to the east of the mine area that could potentially accommodate the placement on the ocean floor of the current anticipated LOM tailings of approximately 360 Mt.

Deep sea tailings placement was considered as a potentially viable option in the Huon Gulf given that:

- The coastal margins of the Huon Gulf slope steeply to depths of 300 m within 10 km of the coast, and to depths of 2 km within 30 km from shore;

- A submarine canyon runs eastwards through the Huon Gulf commencing near the Markham River mouth. Called the Markham Canyon, it slopes continuously downwards before joining the New Britain Trench, which reaches depths of over 9 km (Figure 20-1 and Figure 20-2).

Deep sea tailings placement will involve the discharge of tailings slurry from an outfall pipeline terminus that will be located approximately 200 m below the ocean surface. On exiting the outfall pipe, the tailings will flow down the sloping seafloor as a density current, with the ultimate deposition of the tailings solids on the deep-ocean floor, nominally at a depth >1 km. Figure 20-3 is a conceptual representation of the tailings density current.

The DSTP studies to date have confirmed that:

- The Outfall area is a highly suitable environment for DSTP;
- The tailings are expected to mix and co-deposit with a significant, naturally occurring loading of riverine sediments from the Markham, Busu and other rivers that are also conveyed via the Markham Canyon into the Huon Gulf;
- The pelagic, deep-slope and sea floor receiving environment has a very low biodiversity as a result of the riverine sediment transport, deposition and regular mass movements (underwater landslides);
- Risks to human health from consuming fish caught in the Huon Gulf beyond baseline conditions are not expected from the use of DSTP;
- The natural riverine sediments are expected to also bury the co-deposited tailings at closure and promote benthic recovery to pre-mine conditions.

20.6.3 Tailings Placement Designs

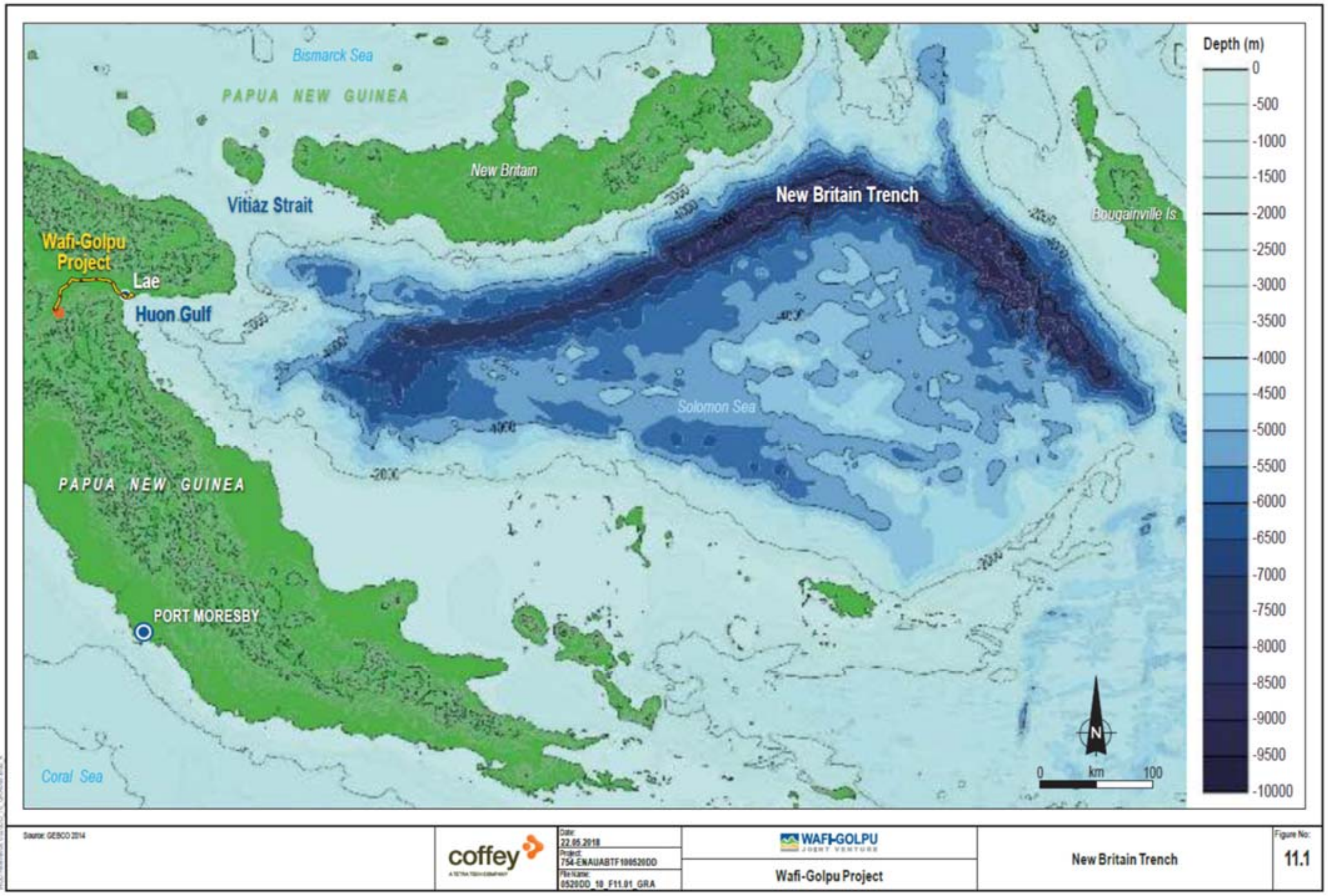
Proposed infrastructure for management of tailings through DSTP comprises:

- Tailings pump station located at the process plant terrace. Tailings will be thickened to recover water and process reagents;
- 103 km long terrestrial tailings pipeline to transport tailings slurry from the tailings pump station in the mine area to the outfall system;
- Tailings outfall system consisting of:
  - A mix/de-aeration tank (14 m diameter, 15 m high) located in a dry moat 120 m inland from the shore;
  - Two HDPE seawater intake pipelines (outside diameter of 1,000 mm), approximately 505 m in length, that draw seawater from a depth of 60 m and deliver it to the mix/de-aeration tank;
  - Two HDPE outfall pipelines (outside diameter of 1,000 mm), approximately 985 m in length, that convey diluted tailings from the mix/de-aeration tank to approximately 200 m depth in the Huon Gulf.

The DN700 HDPE-lined carbon steel pipeline will have a pump discharge pressure of 3,736 kPa(g) and will see a maximum pressure of 5,111 kPa(g) approximately 1.6 km (CH1630) from the pump discharge at maximum design conditions.

The pipeline is designed for a solids SG of 2.82 and a d50 and d90 of 50.6 µm and 123 µm respectively.

Figure 20-1:New Britain Trench



Note: Proposed tailings pipeline and outfall locations shown as dashed yellow–black line.

Figure 20-2: Markham Canyon

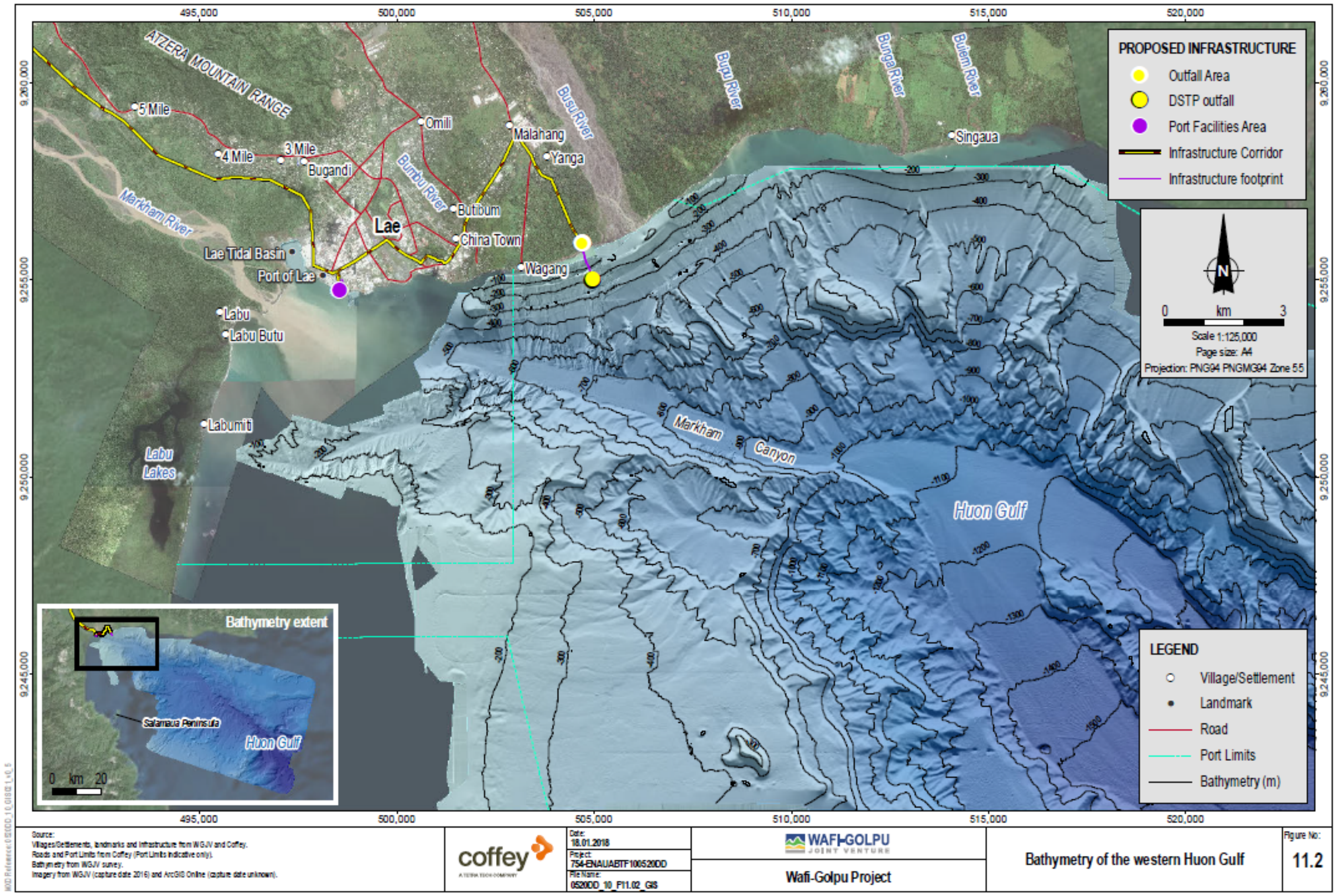
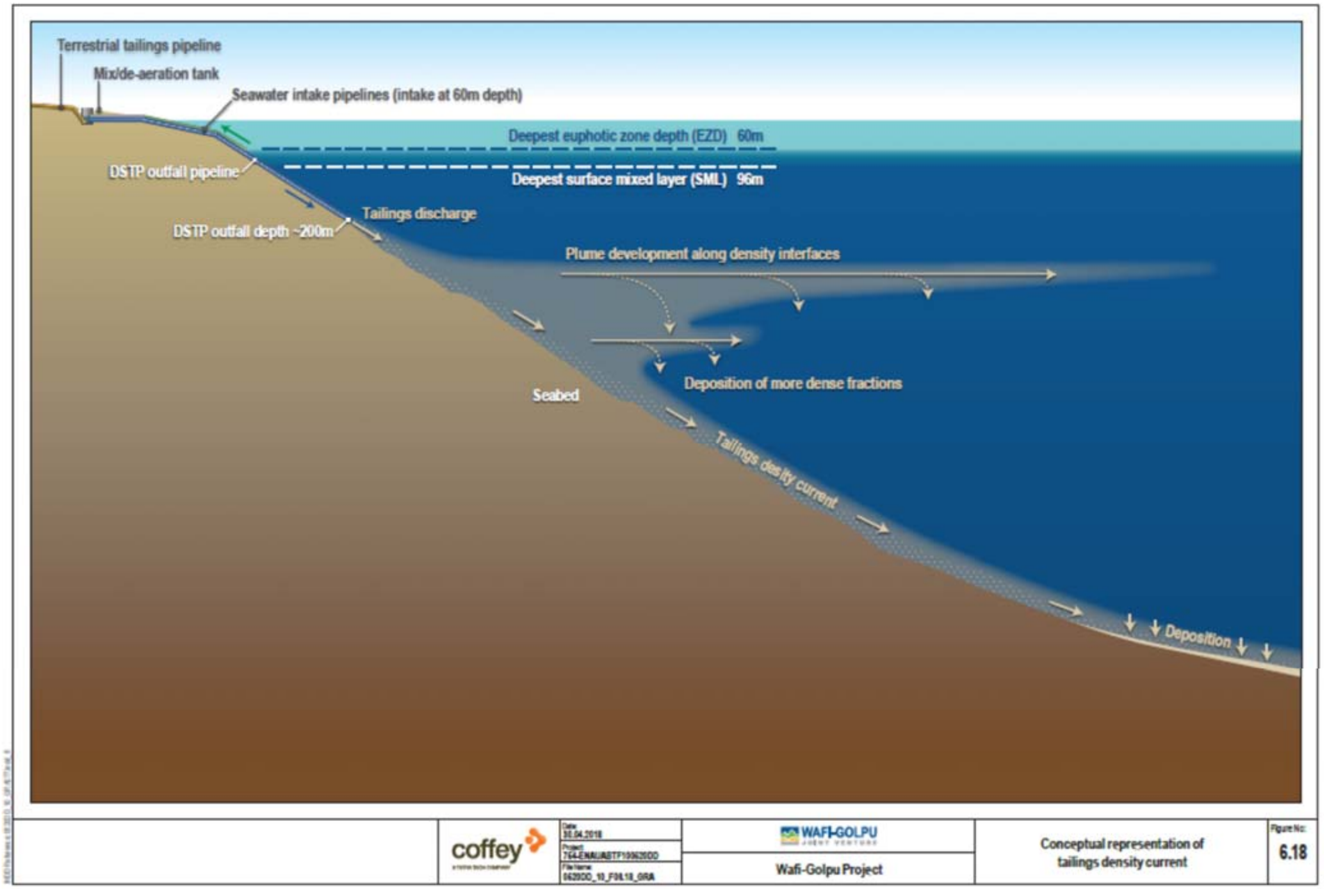


Figure 20-3:Conceptual Representation of Tailings Density Current



Design solids concentration is 55% by weight, although reduced concentrations of 35% solids are required in the first three years of operation, when the Watut process plant will be operating under turndown conditions, to maintain adequate velocity to prevent solids deposition in the terrestrial tailings pipeline.

Minimum allowable operating velocities range from 1.12–1.85 m/s dependent on solids concentration, with the higher velocities required at low solids concentration. Choking will be required to prevent slack flow at the discharge end of the terrestrial tailings pipeline.

The overland terrestrial tailings pipeline will discharge into a mixing/deaeration tank where the tailings will be diluted with sea water in a ratio of four units of water to one unit of tailings.

Two HDPE outfall pipelines (outside diameter of 1,000 mm), approximately 985 m in length, will convey diluted tailings from the mix/de-aeration tank to approximately 200 m depth in the Huon Gulf.

20.7 Water Management

20.7.1 Overview

The mine water management system was designed to capture potentially-contaminated water within the mine area during construction and operations, and manage, including treatment where necessary, this captured water for re-use or disposal. As a general principle, clean water will be diverted around surface works and, where practicable, water will be intercepted (by dewatering) before it can enter the block cave zone or, prevented from entry into the declines, by shotcreting or grouting. This is intended to minimise the volume of water requiring management during construction and operations.

20.7.2 Construction

The water treatment plant is based on a system developed by Clean TeQ (2017) and will be installed on the process plant terrace prior to development of the Watut declines. During construction, potentially contaminated mine wastewater will be treated if necessary and discharged to the Watut River via the wastewater discharge pipeline.

Sewage will be treated at a sewage treatment plant on the process plant terrace with the treated effluent reporting to the Watut River via the wastewater discharge pipeline. Residue generated through the sewage treatment process will be sent to the waste management facility.

Runoff from the surface construction activities (i.e., from the process plant terrace and the accommodation camp) will flow to sedimentation or storm water ponds before discharging to the environment. During construction, sedimentation ponds will be designed to accommodate flows up to a 24-hour two-year average recurrence interval, and be structurally sound in events up to 100-year average recurrence interval. Other sediment controls (e.g., channels and check dams) will have capacity for a 10-year average recurrence interval flow.

20.7.3 Operations

During operations, treated mine wastewater (from declines, block caves, runoff and seepage and sewage effluent) will be used as the primary water source for ore processing and as the transport media for concentrate and tailings. Given that the process water demand exceeds the volume of waste water for the majority of the time during operations, it is predicted that there will be limited periods during operations in which mine waste water will require discharge to the Watut River.

Sludge generated from water treatment will report directly to the process plant during operations. Runoff and seepage from the coarse ore stockpile will be used directly in the process plant without treatment.

During operations, surface water management structures, such as sedimentation ponds, are designed for one-in-25-year rainfall events. Major storm water structures, such as the terrace storm water bypass system and the underdrain installed to divert water originating from the headwaters of Boganchong Creek, will be designed for a one-in-50-year storm event. Water originating from the Watut declines portal and plant terraces, including the coarse ore stockpile area, will require sediment removal and attenuation and testing and treatment before being released to the environment, or before it may be harvested for use in the process plant. A raw water dam will allow for the local storage of raw water and for the harvesting of runoff water from the site.

Bunded areas around hazardous materials storage facilities will be designed to contain spills and storm water during a one-in-200-year storm event.

20.7.4 Groundwater Inflow

The groundwater inflows predicted to enter the underground mine were modelled and the predicted changes in inflows over time reflect the various stages of mine construction and operation.

Numerical groundwater modelling predicts groundwater inflows to the mine will commence at the start of the Nambonga decline development, peaking at 144 m^3/hr in the early years of construction. Groundwater inflows from the Watut declines are predicted to peak approximately two years later at 360 m^3/hr. Inflows from the Nambonga and Watut declines are predicted to reach a steady state in early operations at approximately 70 m^3/hr and 180 m^3/hr, respectively. The block caves are predicted to produce the greatest proportion of groundwater inflow, peaking at close to 600 m^3/hr around Year 8 of operations. Surface water inflows through the subsidence zone are predicted to become a more predominant contributor around the middle of operations.

Groundwater inflows to the ventilation shaft are predicted to be negligible (estimated to be <0.002 m^3/s) as the ventilation shaft is planned to be lined with concrete.

To remove water inflows from the underground workings, a series of sumps and pump stations will be established progressively during decline development, forming a cascade pumping system that will operate for the life of the mine. Dewatering of the underground operations will also involve the establishment of surface dewatering bores and horizontal drains. Dewatering infrastructure is referred to as the main decline's cascade dewatering system and block cave's high lift dewatering system. The other dewatering systems including the interconnecting declines and sumps are referred to as ancillary dewatering systems. The main declines system has dewatering capacity of 360 m^3/hr and the block cave systems individually have a dewatering capacity of 648 m^3/hr. This excludes emergency dewatering capacity.

Groundwater modelling predicts that by the end of mine life the groundwater drawdown will reach a maximum depth of 800 m and extend 1,400 m southwest, 1,250 m southeast and 1,300 m northeast of the mine.

20.7.5 Sediment Control Infrastructure

Sedimentation ponds will be installed downstream of key infrastructure, prior to construction, to capture sediment-laden water. Construction of sedimentation ponds in Boganchong Creek downstream of the Watut declines portal terrace and facilities on the process plant terrace will limit sediment reporting to downstream reaches of this creek.

Sedimentation ponds will generally comprise an embankment wall of rock, earth and concrete against which the sediment will accumulate. Sediment will be removed on a periodic basis using an extended boom excavator from adjoining roads and will be placed in the landfill area within the waste management facility or the Watut WRSF. Water will drain into downstream watercourses via an overflow spillway. Sediment control infrastructure, such as ponds will be excavated regularly, so as to maintain their efficiency, with removed sediments deposited within the waste management facility or the Watut WRSF.

A raw water dam (with a nominal holding capacity of 40,000 m^3) will act as a holding facility for storage of raw water and for the harvesting of runoff water. The dam will be located in a steep-sided valley downstream of the process plant. The wall will be 30 m high from the lowest toe point to the crest, with an average height of 20 m.

Access roads, facility sites and supporting infrastructure will be designed to maintain adequate surface water flows and avoid redirection of stream flows, where practicable. Stormwater drainage and bunding systems will be designed and constructed capable of withstanding a one-in 200-year storm event.

The main water treatment plant will be a modular design, allowing equipment modules to be added/removed as the mine water profile changes. It will be located north of the process plant terrace and adjacent to the southern end of the infrastructure corridor. Treatment will be completed (as required) by a high-density sludge treatment process using lime precipitation to reduce metals concentrations. The high-density sludge containing gypsum and metal hydroxides will be stored in geotubes on the Watut declines portal terrace until such time as the Watut process plant becomes operational, at which stage the sludge will be directed to the plant for metal recovery and disposal. An estimated 50% of the overflow from the high-density sludge clarifier is proposed to be sent to the DeSALx unit where calcium and sulphate are both reduced. The DeSALx system uses strong acid cation and weak based anion resins, regenerated with sulphuric acid and hydrated lime respectively. When mixed back in with the remaining 50% of overflow a treated water sulphate target of <800 mg/L is achieved. Spent regeneration solutions will be recycled to the high-density sludge unit to provide a zero liquid discharge process. High-recovery reverse osmosis will be installed on a portion of the DeSALx treated water stream to supplement on-site potable water requirements, with water sourced from either the lower Watut River or mine dewatering.

An additional water treatment plant at the Nambonga decline area will be available prior to the commencement of significant decline development to treat water from the Nambonga decline and from the Nambonga decline WRSF, as required.

20.8 Water Supply

Water produced during construction will be reused where possible (e.g., in dust suppression activities or for shaft drilling water supply). Of the treated water produced during construction (peak of around 890 m^3/hr), between 10–50% will be reused. The balance will be discharged to the Watut River via the wastewater discharge pipeline.

The total demand for water will be typically around 1,600 m³/hr during operations. Reductions in demand occur from Year 6–Year 7 of operations and Year 13–Year 15 as mining transitions from BC44 to 42 and BC42 to 40, respectively. Treated water and runoff water from the process plant and stockpile areas will be used to supply the water demands, where possible. For the majority of operations, 100% of the treated water is likely to contribute to water supply.

Additional site water demands, i.e., those not fulfilled through treated water, will be supplemented using lower Watut River water. Water from the lower Watut River will conservatively provide around 50% of the total demand during operations. This volume of water would represent less than 1% of the flow rate of the lower Watut River, even during the dry season.

20.9 Closure

20.9.1 Closure Considerations

Construction activities will take place over an approximate five-year period and operations (commissioning, ramp-up and production) will continue for an estimated 28 years. The post-closure period will commence following the cessation of operations.

20.9.2 Closure-Related Legislation and Guidelines

While not explicitly addressing mine rehabilitation or closure, the *Environment Act 2000* has an important influence on mine closure through the environment permit application, EIS, and environmental management plans submitted in support of permit applications. The content of these documents informs Governmental decisions to approve the Project, and will be supplemented by conditions in approvals and permits issued under the *Environment Act 2000* and associated subordinate legislation.

Environmental quality standards and guidelines developed pursuant to the *Environment Act 2000* (e.g., the PNG Environment (Water Quality Criteria) Regulation 2002) must also be taken into account when developing mine rehabilitation and closure plans.

The PNG Mine Closure Policy and Guidelines (2005) primarily focus on the administrative and financial requirements to achieve key closure objectives. In addition, six new mining policies are under consideration (The National, 2017) by the PNG National Executive Council, including a policy on rehabilitation and mine closure.

In late 2019 the PNG government released new Mining Project Rehabilitation and Closure Guidelines to provide guidance for the administration, regulation and monitoring of the rehabilitation and mine closure obligations in PNG, with the understanding that mine sites exist in various stages of operation and evolution (through proposal variations and permitted amendments) and will consequently require different content within their Rehabilitation and Mine Closure Plans. Current, applicable, legislative requirements, policies and guidelines will be taken into account in the permitting process for the Golpu Development leading ultimately to the grant of a Special Mining Lease and Environment Permit that will set out applicable closure-related requirements.

Any additional closure laws and policies that may become applicable to the Project during the mine life will be reviewed and incorporated into the WGJV's closure planning processes.

20.9.3 Proposed Closure Process

At the completion of mining and processing, the mine and associated infrastructure will be closed. The closure phase includes progressive rehabilitation, decommissioning, rehabilitation post-closure monitoring and maintenance, and relinquishment.

A Conceptual Closure and Rehabilitation Plan was developed with the following key post-closure environmental objectives:

- Mitigate generation and release of acidic and suspended solids discharges to the downstream receiving environment;
- Rehabilitate the project area to self-sustaining, stable landforms;
- Develop and meet post-closure land use objectives to be agreed with the regulator in consultation with stakeholders.

Key social objectives of the Conceptual Closure and Rehabilitation Plan include minimising the reliance on the mine by the local communities to enable the transition to sustainable alternative industries and economic activities and to promote alternate employment opportunities.

A detailed closure schedule for implementation will be developed during the operational stage of the mine as the closure planning progresses.

The WGJV intends to adopt a consultative and risk-based approach to defining post-closure land uses and arrangements for the disposal of assets. The closure approach will have regard to regulatory requirements, community preferences and WGJV perspectives. The default position will be that all assets and infrastructure associated with the Golpu Development will be decommissioned and/or removed at closure; however, this will be subject to negotiation with landowners, government and other stakeholders.

The WGJV proposes to conduct progressive rehabilitation where possible. As many of the Golpu Development domains (notably the underground mine) are not readily available for substantial progressive rehabilitation during the operations phase of the mine, most rehabilitation will occur once production ceases and decommissioning begins. There will be some areas (worked out borrow pits, former drilling pads, temporary laydown areas and the WRSFs) that can be progressively rehabilitated.

In the lead up to closure, re-use and recycling opportunities for fixed and mobile plant and infrastructure will be considered. This could include the removal of selected equipment for use by a third party, or leaving some infrastructure in situ for alternative uses or community purposes. Where no feasible or practicable alternatives are identified, it is proposed that the Golpu Development components will be decommissioned.

Decommissioning will commence upon the cessation of mining activities and final processing of ore which will include the processing of all remaining stockpiled ore so that all remaining PAF material is encapsulated within the WRSFs. The declines and ventilation shaft will be appropriately sealed, and infrastructure, facilities, equipment and services (unless otherwise agreed with stakeholders) removed. At the end of its useful life, the Watut process plant will be decommissioned, dismantled and sold, buried or removed, as appropriate.

Post-closure monitoring is proposed to include:

- Engineering inspections to monitor operating to design specifications of the:
  - Structural integrity of portals and ventilation shaft;
  - Surface water control and collection infrastructure;
  - Landfill cap and gas management system;
  - Water treatment infrastructure;
- Surface water monitoring at:
  - Discharge locations from subsidence zone lake and WRSFs to monitor consequences of predicted AMD generation;
  - Upstream and downstream points downstream of operational areas;
- Groundwater monitoring:
  - Water quality at monitoring bores;
  - Groundwater levels in nominated monitoring bores near subsidence zone;
- Assessment of erosion and rate of accumulation of sediments in designated ponds;
- Chemistry and benthic biology of ocean floor sediments in the predicted tailings deposition zone to compare with pre-mining (baseline) and reference site conditions to determine the trajectory of change over time;
- Biological monitoring of:
  - Species diversity and vegetation cover of rehabilitated areas;
  - Abundance of invasive species;
- Socio-economic survey to assess the effectiveness and outcomes of social programs.

Construction of final closure landforms will be followed by a period of monitoring prior to relinquishment of the site. During this time the WGJV will remain responsible for ongoing management of the site including maintenance of roads, maintenance of equipment and potentially repairs to failed landforms. A detailed maintenance plan will be developed in the year prior to closure of the site; however, it is expected to include the elements outlined in the section above. It is envisaged that a small workforce will be employed to conduct maintenance and monitoring activities. The WGJV will develop an appropriate funding and governance structure for post-closure maintenance and monitoring.

20.9.4 Closure Provision

An overall, post-production closure cost estimate, at the Golpu Development level, of approximately US$75 M was prepared for the cash flow analysis in support of Mineral Reserves for this Report. The cost estimate is based on the construction and operations plan assumptions made in the 2018 Feasibility Study update, current PNG guidelines for closure planning, and the closure and rehabilitation steps outlined in this sub-section.

Until the EIS is approved, the Special Mining Lease is granted, and the associated permit and operating conditions imposed by the various regulatory authorities are itemised, the WGJV Participants will be unable to arrive at a more detailed LOM closure estimate.

20.10 Permitting

20.10.1 Mining Lease Application

The right to explore for, mine and sell minerals is conferred upon an applicant by the State of PNG through the grant of a tenement under the *Mining Act 1992*. Tenements are granted for a fixed term over a fixed area to persons or companies undertaking a specific activity or program (of exploration or mining) approved by the State. The WGJV currently holds exploration licences issued under the Act. For the planned operations, as at 30 June, 2020, the tenements required (refer to Table 4-3) will include:

- One Special Mining Lease;
- Six Mining Easements;
- Three Leases for Mining Purposes.

Following consideration of the advice of the Mining Advisory Council, the Minister of Mining may grant the Mining Lease, Mining Easement and Lease for Mining Purposes. The Head of State also considers the advice of the Mining Advisory Council in the grant of the Special Mining Lease.

Additional discussion on lease applications was provided in Section 4.4.

20.10.2 Memorandum of Understanding

On December 11, 2018, the WGJV Participants signed a memorandum of understanding (MOU) with the State of PNG, affirming a mutual intention to proceed with the development of the Wafi–Golpu mining project. The MOU provided a framework of key terms to be included in the Mining Development Contract, including a provision for stability to underpin the significant long-term investment required to develop and operate the project.

The validity of the MOU was subsequently challenged by the Governor of Morobe Province in the National Court in Lae, Papua New Guinea, and a stay order was granted. The stay order prevented the WGJV Participants from engaging in discussions with the State of PNG. Most activities in furtherance of project permitting ceased as a result, although discussions continued with the independent review consultants engaged by the State of PNG to review the Golpu Development EIS.

On February 11, 2020, the National Court dismissed the proceeding and the stay order. This followed the PNG Minister for Mining advising the WGJV Participants that the State of PNG had withdrawn its support for the MOU. The dismissal allows the WGJV Participants to re-engage with the State over Golpu Development permitting and progressing discussions on the grant of the Special Mining Lease.

The Governor of the Morobe Province has appealed to the Supreme Court of PNG against the dismissal of the proceeding. Timing of hearing of the appeal was unknown to the QP as at 30 June, 2020. If the Governor's appeal is ultimately successful, the permitting process may be adversely impacted.

20.10.3 EIS

Environmental approval for the Golpu Development is being sought under the *PNG Environment Act 2000* and Environment Protection (Prescribed Activities) Regulation 2002. The required approval for the Golpu Development is a Level 3 Environment permit.

The key requirements of the EIS process under the *Environment Act 2000* include:

- Preparation and submission of an environmental inception report (EIR) (Section 52 of the *Environment Act 2000*). The *Environment Act 2000* is presently the subject of amendment under the *Environment (Amendment) Act 2014*, with certain aspects of the latter statute not yet having come into force (at the Report effective date);
- Preparation and submission of an EIS (Section 53 of the *Environment Act 2000*);
- A public review and referral phase (Sections 54 to 58 of the *Environment Act 2000*);
- In-principle approval of the proposed activities by the Minister for Environment, Conservation and Climate Change (Section 59 of the *Environment Act 2000*).

On 25 June 2018, the Golpu Development EIS was submitted to CEPA and is currently being assessed.

20.10.4 Other Relevant Legislation

Apart from the *Mining Act 1992* and *Environment Act 2000*, the Golpu Development will have to comply with aspects of the legislations set out in Table 20-2. Other legislation may also be requested to be complied with during the Golpu Development review process.

20.11 Social Considerations

20.11.1 Project Setting

Villages in and around the mine area are inhabited by the Babuaf, Hengambu and Yanta cultural groups. The combined population of these villages is approximately 3,900.

Approximately 6,000 people live in the villages on the lower Watut and lower Markham Rivers (including those along the existing Demakwa access road and the section of the proposed infrastructure corridor between the mine area and Zifasing). These villages are generally inhabited by people of the Wampar cultural group. The Wampar, Babuaf, Hengambu and Yanta villages are located in a remote rural area. Residents are generally dependent on the natural environment for food, housing materials, firewood and medicine, which they either grow in gardens or gather from surrounding forests. Houses are predominately made from local materials with wooden posts and frames, timber or bamboo walls, and sago leaves or grass used for roofs.

Table 20-2: Other Legislation

Title	Title
Fauna (Protection and Control) Act 1996	*Central Banking Act* and Central Bank (Foreign Exchange and Gold) Regulation
National Water Supply and Sanitation Act 2016	*Coroners Act 1953* and Coroners Regulation 1955
Natural Cultural Property (Preservation) Act 1965 and National Cultural Property (Preservation) Regulations 1965	*Criminal Code Act 1974*
National Museum and Art Gallery Act 1992	*Customs Act 1951*
National Cultural Commission Act 1994	*Explosives Act 1953* and Explosives Regulation 1956
War Surplus Materials Act 1952	*Fire Service Act 1962* and Fire Service Regulation 1966
Cemeteries Act 1955	*Goods and Services Tax Act 2003*
Marine Pollution (Ships & Installations) Act 2013	*Employment Act 1978*
Environment (Permits) Regulation 2002	*Employment of Non-Citizens Act 2007*
Environment (Prescribed Activities) Regulation 2002	*Income Tax Act 1959*
Environment (Water Quality Criteria) Regulation 2002	*Industrial Safety, Health and Welfare Act 1961* and Industrial Safety, Health and Welfare Regulation 1965
Public Health (Drinking Water) Regulation 1984	*Inflammable Liquid Act 1953* and Inflammable Liquid Regulation 1968
Investment Promotion Act 1992	*Land Act 1996*
Land Registration Act 1981	*Land Disputes Settlement Act 1975* and Land Disputes Settlement Regulation 1975
Maritime Zones Act 2015	*1978 Migration Act*
Plant Disease and Control Act 1953 and Plant Disease and Control Regulation 1956	

A widespread system of bush tracks provides access between villages. Villagers also use the lower Watut River, travelling by raft or canoe, to access markets downstream. The existing Wafi and Demakwa access roads are used by public motor vehicles to provide vehicular access to Lae and beyond.

From Zifasing, the infrastructure corridor will turn east towards Yalu village, and southeast from Yalu village to Lae. This section of the planned infrastructure corridor traverses villages and settlements including the villages of Ganef, Gabsongkeg, Nasuapum and Munum. The area is predominantly rural, and includes a number of agricultural enterprises (such as chicken farms and palm oil plantations). Between Yalu and Lae, the area is peri-urban, with mixed rural, industrial, commercial and residential areas.

Lae is an urban area, a major transport hub, and a commercial, administrative, industrial, residential and educational centre for both the Morobe Province and PNG, with a population in 2011 (the most recent year for which PNG census data is available) of approximately 149,000. The port facilities area is proposed to be located within the gazetted area of the Port of Lae.

The terrestrial tailings pipeline will traverse parts of the city of Lae north and east to Wagang and Yanga villages, two peri-urban villages to the east of Lae. In Wagang and Yanga villages, the majority of households rely on subsistence agriculture, hunting and fishing, but many are also employed by or own businesses in Lae.

Residents of these villages typically have access to electricity from the grid, and water is supplied from springs, creeks, rainwater tanks and wells.

20.11.2 Stakeholder Consultation

The stakeholder engagement program commenced in 2008 and the WGJV has worked closely with its many stakeholders to build relationships. In implementing the program and building these relationships, the WGJV has placed an emphasis on local communities within the Project area, while also considering the interests of the broader Project stakeholder set. Stakeholder engagement is integral to advancing the Golpu Development. The WGJV believes that understanding and responding to local community concerns and grievances and respecting local customs is particularly important to Project success. Stakeholder engagement is planned to continue for the life of the Project.

Stakeholders identified include:

- Villages, communities and landholders;
- Landowner associations;
- National Government;
- Morobe Provincial Government;
- Morobe Provincial Administration;
- Local-level government;
- Training and education institutions;
- Industry;
- Project and operations;
- Coastal recreational and sporting clubs;
- Fisheries sector participants;
- Media;
- Local churches;
- Non-government organisations (NGOs);
- Australian High Commission.

The WGJV's approach to consultation was informed by International Finance Corporation (IFC) Performance Standards (IFC, 2012) and the International Council of Mining and Minerals (ICMM) Sustainable Development Framework (ICMM, 2015).

Across the Project area, the majority of stakeholder engagement activities with the local communities are overseen, coordinated and performed by the WGJV Community Affairs and Lands team. Facilitating local community liaison and engagement is the primary function of this team, the majority of members of which are Papua New Guinean, and fluent in the languages spoken by the communities within the Project area. This enables the team to connect culturally with the communities, resulting in more effective engagement.

At a corporate level, senior managers and executives maintain focused and formal engagement with representatives of the State of PNG, local and provincial-level governments and third-parties in relation to matters such as port access, power supply, transport, and permitting and compliance.

Specialist studies conducted by the WGJV (e.g., socioeconomic studies involving household surveys, key informant interviews and focus groups) have also provided opportunities for engagement.

Communication aids and support materials selected are based on the specific needs of different stakeholders. Communication aids that are regularly used to support an understanding of the Golpu Development include digital (PowerPoint) presentations, videos, posters, maps, recognition guides (e.g., unexploded ordnance, flora and fauna), vernacular language (*tok ples*) interpreters and scale models of the Golpu Development area. To improve understanding of Golpu Development activities, site visits have also been arranged for stakeholders.

Engagement is often undertaken as face-to-face meetings. Technical briefings, workshops, information sessions, training sessions, teleconferences, field surveys, site visits and informal discussions are also conducted.

Feedback and issues raised by stakeholders are recorded during engagements for further action as required by the WGJV. This includes an established grievance mechanism. The WGJV uses a data management system to record feedback and issues, including WGJV responses to feedback, and actions taken or proposed to address the identified issues.

The WGJV undertakes regular stakeholder engagement activities involving as many as 1,000 people per month.

In March 2018, the WGJV conducted a series of information sessions across the Golpu Development area (commonly referred to in PNG as a roadshow). Information sessions were held at Lae, Wagang, the Wampar LLG office (in Nadzab), Zifasing, and at the respective community halls of the Yanta, Babuaf and Hengambu. Roadshow sessions were attended by WGJV staff, EIS specialists and PNG government representatives and overseen by an independent Free, Prior and Informed Consent advisor. The latest project design, proposed project schedule, approvals process and the consultation program were presented. Attendees were given opportunities to ask questions and make comments. Questions and comments sought to understand the project description, project benefits, DSTP impacts and socioeconomic impacts.

The WGJV recognises that timely, transparent engagement and WGJV responsiveness to issues raised by stakeholders will be critical to maintaining and enhancing ongoing stakeholder support.

Stakeholder engagement will continue throughout the life of the Golpu Development, although the frequency and nature of engagement will vary according to the specific stakeholder and the actions contemplated. The WGJV will endeavour to support and implement continuous, meaningful and gender-appropriate engagement directly with project-affected communities and will also endeavour to provide communication materials in a format suited to each stakeholder group.

20.12 Monitoring Plans

20.12.1 Environmental

An environmental monitoring program is proposed to be implemented to monitor and measure, on a regular basis, the environmental performance of Golpu Development activities. Monitoring is proposed to cover each environmental aspect detailed in the Project Environmental Management Plan, including:

- Air quality and greenhouse gas;
- Noise and vibration;
- Native vegetation clearance and rehabilitation;
- Prevalence and control of weeds, pests and pathogens (terrestrial and aquatic);
- Aquatic and terrestrial flora and fauna;
- Seepage from WRSFs (for early identification of AMD);
- Groundwater;
- Discharges into watercourses;
- Surface water and sediment quality in impacted and control catchments;
- Discharges into the marine environment, particularly associated with DSTP;
- Solid waste management;
- Any further monitoring required by environment permit conditions.

In addition to monitoring, an inspection and audit regime will be conducted during the construction and operation of the Golpu Development. During construction activities, inspections and audits will focus on:

- The performance of construction sites and installed management devices such as erosion and sediment control devices;
- Compliance of activities with the Project Environmental Management Plan;
- Responses required to address incidents or complaints.

An audit will be performed upon completion of construction, which will include a review of environmental requirements, records and incidents to determine any outstanding environmental protection measures yet to be finalised.

During the operations phase, a structured risk-based inspection and audit schedule will be developed for key operational infrastructure.

Both external and internal environmental audits will be performed periodically to identify opportunities for improvement to both the Environmental and Social Management Framework and operational performance.

The WGJV will prepare an environmental performance report at a frequency to be agreed with CEPA that provides information that may be required in the conditions to the environment permit that may be granted for the Golpu Development.

20.12.2 Socioeconomic

A monitoring program is planned to be implemented to monitor the effectiveness of the Project Social Management Plan against socioeconomic performance indicators, and is proposed to include monitoring of:

- Key social indicators including, but not limited to, those which inform the understanding of maternal and child health, general population health and nutrition, and school attendance;

- Key economic indicators such as employment, agricultural business turnover, local business turnover and household income.

Monitoring will be conducted on a participatory basis with communities and in collaboration with government agencies. Performance indicators will be used to measure and track performance against the effectiveness of management and control measures that will be described in the Project Social Management Plan.

The WGJV will prepare a social performance report that:

- Reviews the performance of the WGJV against the Project Social Management Plan;
- Provides a summary of key socioeconomic issues experienced in the Golpu Development area during the reporting period;
- Provides a summary of the activities and outputs of social programs.

20.12.3 Cultural Heritage

Regular archaeological and cultural heritage monitoring will be performed, which will include:

- Confirming that the Project Cultural Heritage Management Plan, including the site-specific management measures agreed with local communities and the PNG National Museum and Art Gallery, are implemented. This is to address both sites affected by Golpu Development infrastructure and resettlement activities;
- Routinely inspecting recorded archaeological and other cultural heritage sites in the Golpu Development area to confirm they are managed as agreed;
- Ongoing liaison with local communities regarding cultural heritage issues, including receipt of complaints through the Concerns, Complaints and Grievance Procedure related to disturbance of oral tradition, historical and archaeological cultural heritage sites;
- Conducting performance audits to evaluate the effectiveness of management measures.

Monitoring activities will be at their most intensive at any time when new ground disturbance occurs, irrespective of whether this is during Golpu Development construction, operation or closure. This includes, for example, the establishment of roads and infrastructure, when the risk of physical disturbance of sites is highest.

The WGJV will report to the Director of the PNG National Museum and Art Gallery and the Managing Director of CEPA in accordance with relevant permit conditions and as per legislative requirements. Reporting to landowner communities will be as per the requirements of agreements with those communities and guided by International Finance Corporation Performance Standard 8.

20.13 Sustainable Business Management System

The WGJV proposes to implement a Sustainable Business Management System to manage the predicted environmental, socioeconomic and cultural heritage impacts, and other risks, of the Golpu Development. The Environmental and Social Management Framework was developed to guide the environmental and social aspects of the Sustainable Business Management System.

Potential environmental, socioeconomic and cultural heritage impacts will be addressed by implementing the proposed management measures presented in one or more of the plans shown in the Environmental and Social Management Framework; principally:

- Environmental Management Plan: Addresses construction and operations activities that directly affect an environmental aspect;
- Social Management Plan: Addresses matters that pertain to community health, safety and security, in-migration and resettlement;
- Cultural Heritage Management Plan: Addresses matters that relate to an archaeological or historic site, or an oral tradition site that holds importance to a community.

In addition, measures to promote in-country opportunity will be pursued primarily through the National Content Plan which will set out WGJV's approach to local employment and training (workforce development), local procurement (supplier development), and community development projects across the health, education, sustainable livelihoods, environment and other program areas (strategic community investment).

The Stakeholder Engagement and Management Plan will also play a fundamental role in the successful implementation of the preceding management plans through the maintenance of a constructive dialogue with potentially affected persons and communities throughout the life of the Golpu Development. This dialogue includes investigating and addressing complaints raised by stakeholders through the Concerns, Complaints and Grievance Procedure.

The Land Access Management Plan will address land access and land use compliance and monitoring. This plan will be developed prior to construction activities commencing.

The Conceptual Closure and Rehabilitation Plan sets out proposed closure strategies after cessation of mining operations aimed at leaving, to the extent reasonably possible, a sustainable socioeconomic and physical environment. A Rehabilitation and Mine Closure Plan will be developed in the future to govern closure activities.

20.14 Comment on Proposed Development

There is potential for the Project to result in both beneficial and adverse impacts from the socio-economic perspective.

Positive impacts include, and are not limited to: tax and royalty payments; special support grants that can be allocated by the State of PNG to Morobe Province as budget support for infrastructure development; sourcing, where practicable, of equipment and materials from within the province and PNG; establishment of local businesses, employment and training opportunities; and provincial and local community development projects across the health, education, sustainable livelihoods, environment and other program areas.

Potential adverse impacts resulting from the Project have also been assessed including: in-migration; road safety; community health and safety; physical and economic displacement; and, law and order.

Management measures are proposed to manage adverse impacts and to enhance positive impacts where possible including: develop, negotiate and implement in-migration management measures in collaboration with local communities and government; implement measures to prevent injuries to road users and damage to public assets in relation to project activities; and, resettlement management procedures.

20.15 QP Comments on "Item 20: Environmental Studies, Permitting, and Social or Community Impact"

The QP notes:

- Baseline and supporting studies were completed for the three planned infrastructure areas. Additional studies are ongoing, and/or planned to be completed prior to the commencement of construction and/or commissioning;
- Temporary and coarse ore stockpiles will be required;
- Waste from decline construction will be stored in two WRSFs. Once the underground crusher is installed, all rock will be transferred to the underground crusher and delivered to the surface as part of the ore stream for processing. There will effectively be no waste generated during operations;
- The WGJV adopted DSTP as the preferred tailing management option for the Golpu Development;
- During operations, treated mine wastewater will be used as the primary water source for ore processing and as the transport media for concentrate and tailings;
- Permits that need to be obtained include the following lease types: Special Mining Lease, Mining Lease, Mining Easements and Leases for Mining Purposes;
- The National Court dismissed the proceeding and the stay order against the MOU; however, the Governor of the Morobe Province appealed to the Supreme Court against the dismissal of the proceeding. Timing of hearing of the appeal was not known to the QP as at 30 June, 2020. If the Governor's appeal is ultimately successful, the permitting process may be adversely impacted;
- Apart from the *Mining Act 1992* and *Environment Act 2000*, the Golpu Development must comply with aspects of other forms of legislation. Additional legislation may also be requested to be complied with during the Golpu Development review process;
- Stakeholder engagement will continue throughout the project life, although the frequency and nature of engagement will vary according to the specific stakeholder and the actions contemplated.

21 CAPITAL AND OPERATING COSTS

21.1 Introduction

Capital and operating cost estimates are based on the 2018 Feasibility Study Update, and are presented on a 100% basis. Cost estimates were reviewed as at 30 June 2020, and remain current.

Newcrest's internal study guidelines require project scope definition for a feasibility study to have an accuracy level of ±15%. Pre-feasibility studies must have a project scope definition accuracy level of ±25%. The overall capital cost estimate meets pre-feasibility accuracy levels. The mine to port area, surface services and infrastructure, BC44 and BC42, underground services, and infrastructure areas are designed to a feasibility level of confidence. The BC40 cave footprint and thus extraction level layout, are designed at a pre-feasibility confidence level. The infrastructure for BC40 is identical to that of BC44 and BC42, and is at a feasibility level of confidence.

21.2 Capital Cost Estimate

21.2.1 Basis of Estimate

The capital cost of the Golpu Development is defined as the expenditure required for engineering, designing, procuring, fabricating, delivering, constructing and commissioning the scope as defined by the 2018 Feasibility Study Update. This includes all direct (equipment and materials purchases, installation costs, contractors fixed and time related disbursements, transportation costs, capital spares and commissioning assistance), and indirect costs (WGJV Participants team, site support, construction management fees and contingency) to deliver a fully operational mine.

The estimate is expressed in United States Dollars (US$); however, capital costs were sourced in local (currency incurred) to the extent possible. Where applicable, prices/rates obtained in other currencies were converted to US$ using the conversion factors in Table 21-1.

The WGJV engaged a number of specialist consultants and estimators to identify the scope and produce corresponding capital cost estimates for their areas of particular expertise.

Costs were separated into direct and indirect costs, as outlined in Table 21-2.

All designs were developed and completed in SmartPlant 3D in an intelligent environment. All two-dimensional drawings were generated from the 3D model in an AutoDesk AutoCAD format. Various specialised software packages were used during the Golpu Development, including but not limited to Sidewinder (conveyor design), Newton Professional (chute design), and ETAP (electrical reticulation design).

Take-off factors were used to measure designed components that were not shown on drawings and are applicable across all commodities. Design growth factors were used to complete the scope beyond what was given on the available design data. The amount of design growth applied to the take-off quantity was dependent on the completeness of the design information.

Table 21-1: Exchange Rate Assumptions

Currency	Abbreviation and Symbol	Base Currency	Rate of Exchange (real) per Financial Year						
			FY19	FY20	FY21	FY22	FY23	FY24	FY25
United States Dollar	US$/t	US$	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Australian Dollar	A$	US$	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Euro	EUR - €	US$	1.11	1.11	1.11	1.11	1.11	1.11	1.11
PNG Kina	PGK - K	US$	0.32	0.32	0.32	0.32	0.32	0.32	0.32
New Zealand Dollar	NZD - $	US$	0.70	0.70	0.70	0.70	0.70	0.70	0.70
South African Rand	ZAR - R	US$	0.077	0.077	0.077	0.077	0.077	0.077	0.077

Table 21-2: Direct Versus Indirect Costs

Cost	Area	Component
Direct cost	Permanent facilities and services required for their installation and include plant and equipment, bulk material, contractor/sub-contractor costs, freight and vendor representatives	Plant and equipment include the mechanical, electrical and instrumentation components of a plant, which are either, shop assembled, modularised or pre- assembled on site Bulk materials are those material such as rebar, piping, cables, and structural steel which as purchased based on quantity Installation refers to the manual labour and contractor/sub-contractor costs to install or erect the plant, equipment and bulk material Contractor/sub-contractor costs are those costs which cover construction equipment and other costs required to support the installation. Cost components covered by these rates include: - Temporary facilities including mobilisation and demobilisation - Maintenance of temporary facilities and equipment - Ownership and operation of construction equipment - Tools and consumables - Site office operation - Staff and supervision - Home office and corporate overheads - Profit Freight costs are associated with the transport of plant, equipment, and material from the point of manufacture to site. These costs include storage costs, air freight, ocean fright, land freight, shipping agents' expenses and fees as well as demurrage costs Vendor representation is a cost associated with equipment supplier representation on site during the installation and pre-operational testing of equipment, including mobilisation and demobilisation of the representative and any special tools
Indirect costs	Costs to support the purchase and installation of the direct costs. This includes the materials and services required for field construction but are not incorporated into or accounted for as part of the permanent facilities. A standard set of indirect costs with detailed descriptions were calculated in the estimate	Temporary construction facilities Pre-operational and commissioning assistance Duties and taxes (including foreign contractor withholding tax) Insurance Engineering, procurement and construction management (EPCM) fees and other consultants WGJV Participants cost Contingency

Labour productivity allowance accounted for site productivity factors such as congestion, restrictive work practises. and effective shift work cycles. as well as the availability of suitably skilled and experienced labour in the market. No allowances were made for labour productivity beyond what was allowed for by each of the estimates.

Weather delays due to rain (a rain day means a programmed workday when there has been more than 20 mm of rain on site) were estimated for surface re-measurable packages during the construction phase.

In Papua New Guinea, foreign company suppliers are subject to Foreign Contract Withholding Tax (FCWT) in relation to income sourced in PNG, with PNG domestic tax legislation deeming the PNG entity engaging a contractor for “prescribed purposes” to be the contractor’s agent for income tax purposes. The rate of FCWT is 15% of the gross income derived from the contract, and is often seen by contractors as an additional cost to them, and not seen as income tax, and is therefore assumed to be included in the gross up of their contract price for the estimate. For customs, import and excise duties these costs, while quantified, were excluded from the estimate on the assumption that exceptions would be received during construction.

The estimate starting point was the 2015 Pre-feasibility Study and the 2016 Feasibility Study. A number of areas, with costs >$US1 M, were re-validated by the preferred vendor. These packages comprise 5% of total capital cost estimate, and are predominantly mechanical, electrical and instrumentation equipment supplied and delivered to site. The SAG mill, ball mill and gyratory crushers were the only packages where a minimum of three offers was solicited, given the change in equipment sizing. Prices for new types of equipment not previously evaluated were obtained in a similar manner, where a preferred vendor was determined.

The mine portal terrace and high wall, northern access road and bridges had progressed into an early contractor involvement tender process that had commenced after the 2016 Feasibility Study was completed. This, however, was terminated prior to execution. The rates of each of these tender packages were used for the 2018 Feasibility Study Update and escalated by using the native inflation and exchange rates to appropriately roll forward the costs to December 2017 real terms. This pricing strategy constitutes 2% of the total capital cost estimate.

Packages with a value of <US$1 M were escalated using an escalation formula, as the equipment specifications and sizes had changed since the 2016 Feasibility Study. These packages predominantly consisted of supply and delivery of mechanical, electrical and instrumentation equipment.

WGJV Participant costs were derived from a forecasted manpower plan based on the planned scope of work and effort levels as well as current budget forecasts. No escalation was applied. The WGJV costs represent largely fixed costs involved in maintaining site and project support to a minimum of care and maintenance status. Onsite support represents 70% of the total WGJV costs over the capital estimate period, and off-site support costs comprise the balance of total WGJV Participant costs. Labour costs represent 47% of the total WGJV costs demonstrating the large amount of human capital in delivering support to the construction phase.

Other capitalised costs are primarily one-off community affairs expenditure (mostly resettlement and compensation) together with pre-production expenses and resource definition (underground drilling) in support of the mine design.

The EPCM costs comprise proposed costs for EPCM services during the execution of the total Golpu Development from the first year post the grant of the Special Mining

Lease, to completion 20 years later (completion of BC40). The costs are calculated based on man hours over time, developed in line with the project execution schedule.

The capital estimate was separated by package value (in US$ real terms, 95 packages) and Min (P0) and Max (P100) and mode ranges (percentage changes from the base estimate). Contingency was derived in native currency of the respective package and converted to US$ by using the approved rates of exchange as opposed to a lump sum US$ value. Commercially-available Palisade @Risk software was used to run a Monte Carlo simulation (10,000 iterations). Based on the level of project definition and outcomes of the Monte Carlo simulation, a P80 confidence level was selected by the project team to determine the level of contingency confidence. This resulted in a contingency of 10.1% being applied to the total estimate.

Sustaining capital is defined as expenditure required to sustain ore production and treatment post the end of the major construction activities (last drawbell fired) for BC44, BC42 and BC40. The capital estimate was reviewed to identify individual expenditure items (dominantly mechanical, electrical, piping, instrumentation, etc.) in the treatment, materials handling (crushing and conveying) and site support services (camps, power, water treatment) areas which will require ongoing capital investment to sustain availability. Mine development capital related to accessing and developing BC42 and BC40 is considered to be part of the execution capital estimate and is not part of sustaining capital.

21.2.2 Capital Cost Summary

The LOM capital cost is US$5,382 M (real December 2017 terms; 100% basis), and includes US$200 M of capitalised net revenue, which is a Newcrest accounting standard for production revenue delivered before commercial production is declared. Commercial production will be when the cave has reached its hydraulic radius and is "self-sustaining" for forward production. Table 21-3 summarises the capital cost estimate by area, and Table 21-4 provides the capital cost estimate by cost element.

21.3 Operating Cost Estimate

21.3.1 Basis of Estimate

The operating cost estimate is derived on a 100% share basis and is expressed in real December 2017 US$ terms. Where applicable, prices/rates obtained in other currencies were converted to US$ using the rates of exchange applicable to the base date of the estimate. The exchange rates used in the development of the operating cost estimate are consistent with the exchange rates applied in development of the capital cost estimate. The estimate accuracy is ±10% to 15%.

Other than escalating costs to the specified base date, no allowance was made for real escalation (i.e., above inflation) within the operating cost estimate to forecast future increases or decreases in rates or prices.

The operating cost estimate was developed in monthly increments and was based on first principles, being unit consumption rates and unit prices. Prices were quantified as far as possible and where practicable by quotations, with some values escalated from prior estimates in the 2016 Feasibility Study.

Areas and facilities included in the estimate are provided in Table 21-5, to ensure that each area and facility has an associated operating cost.

Table 21-3: Summary Capital Cost Estimate by Area

Description	Execution Capital (US$ M)	Sustaining Capital (US$ M)	LOM Total (US$ M real)	% of Total
Underground mining	819	1,321	2,140	44
Treatment	695	79	773	16
Shared services and infrastructure	210	73	284	6
Regional infrastructure	219	-	219	4
Site support services	117	31	148	3
Project delivery management	462	144	607	12
Other capitalised costs	187	38	225	5
Provisions	315	178	493	10
Capitalised revenue	(200)	—	(200)	NA
Total LOM capital cost (excluding sustaining capital)	2,825	1,864	4,689	100
Sustaining capital	—	693	693	NA
Total LOM capital cost	2,825	2,557	5,382	NA

Note: Sustaining capital includes all major development capital expenditure post commercial production. Sustaining capital is defined as routine stay-in-business capital expenditure estimated as 2.5% of the asset replacement value (ARV). NA = not applicable.

Table 21-4: Summary Capital Cost Estimate by Cost Element

Cost Element	Execution Capital (US$ M)	Expansionary Capital (US$ M)	LOM Total (US$ M real)	% of Total
Net measured works				
Plant & equipment supply	273	264	537	11
Bulk material supply	129	15	144	3
On-site installation including disbursements	1,365	1,095	2,460	52
Transportation, spares/first fills, commissioning	98	46	144	3
Sub-total net measured works	*1,865*	*1,420*	*3,285*	*70*
Allowances				
Take-off allowances	34	10	44	1
Design growth allowances	71	70	141	3
Specific item/risk factor allowance (weather)	42	—	42	1
Subtotal allowances	*147*	*80*	*227*	*5*
Foreign contractor withholding taxes				
Sub-total foreign contractor withholding taxes	*30*	*19*	*49*	*1*
Indirect capital				
Project management: procurement management consultant and WGJV	480	165	645	14
Pre-production operations	53	-	53	1
Resettlement and community affairs	135	2	137	3
Sub-total indirect capital	*668*	*167*	*835*	*18*
Contingency (on LOM capital)				
Sub-total contingency (on LOM capital)	*315*	*178*	*493*	*10*
Capitalised net revenue				
Sub-total capitalised net revenue	*(200)*	—	*(200)*	*(4)*
Sub-total execution and expansionary capital	***2,825***	***1,864***	***4,689***	***100***
Sustaining capital				
Sub-total sustaining capital	—	*693*	*693*	*NA*
Total capital	***2,825***	***2,557***	***5,382***	***NA***

Note: Expansionary capital includes all major development capital expenditure post commercial production. Sustaining capital is defined as routine stay-in-business capital expenditure estimated as 2.5% of the asset replacement value (ARV). NA = not applicable.

Table 21-5: Areas and Facilities Considered in Operating Costs

Area/Facility Category	Description	Components
Underground mining	Mine development, mine equipment and services/infrastructure. Includes ore handling facilities within the mine used to transport ore to the treatment plant. Includes temporary and permanent facilities, utilities and services located within the mine that service the mine.	Production; engineering maintenance & services; dewatering ventilation & refrigeration; technical services; administration; crushing; conveying
Treatment	Starts at receipt of ore to the coarse ore stockpile and ceases where concentrate is delivered over the rail to the ship at the port facilities area. This entails the reagent systems and process plant common services and utilities, mobile equipment, the slurry and tailings pipelines as well as the port filtration and tailings disposal facilities (deep sea tailings placement).	Process plant operations; process plant maintenance; concentrate pipeline; port filtration plant; water treatment plant; DSTP
Shared services and infrastructure	Shared services and infrastructure include the main supply sources for permanent services and utilities to the underground mining and/or the process plant facilities. These permanent services and utilities include the power generation plant, fuel pumping and pipeline, project site wide water (treatment, distribution and disposal), support buildings, workshops and stores. Essentially the key infrastructure source and supply systems that deliver to the area of demand within the boundary of the operating license.	Water services; power generation plant
Regional infrastructure	Regional infrastructure includes facilities that do not form part of a systemic model and are not situated geographically within the underground mining, treatment and shared services and infrastructure facilities. These include construction and permanent camps, regional access roads, solid waste and recycling, power supply (from off-site/external), aggregate and gravel sourcing facilities as well as regional mobile equipment.	Services; infrastructure; general
Site support services	Site support services are elements of cost that are indirectly associated with the permanent works, these include establishing temporary construction facilities as well as the operation and maintenance of these facilities. It is further expanded to include freight and materials handling and project overhead costs such as insurances, taxes and duties.	Community affairs & land; camp services; commercial; travel; environmental; human resources (HR); training; information technology (IT); occupational health and safety (OH&S); supply and logistics
Project delivery management	Project delivery services such as EPCM fees, project team, and related services.	Includes operational support staff seconded to the project including engineering, finance, contracts and procurement, HR, etc.
Other capitalised costs	Not applicable for operating costs	
Contingency	Not applicable for operating costs	

Each area and facility had five key cost categories:

- Labour: all direct employee costs including all on-costs;
- Fixed overheads: includes personnel related expenses such as recruitment, travel, camp, general business expenses, general freight, and business overheads such as insurance;
- Utilities: power costs;
- External services: provision of goods and services which are contracted to third-party suppliers;
- Materials and supplies: include fuels (i.e., diesel), process chemicals and reagents, operating and maintenance materials, spare parts and other consumables.

The five cost categories were subdivided into activity and process, and further detailed per commodity where materials and supplies are broken down into consumables, intermediate fuel oil (IFO; fuel for power generation), fuel (diesel for mobile fleet), liners, grinding media and reagents.

Global inputs and assumptions included general information pertinent to all areas of the operation such as fuel prices, labour rates/salaries, foreign exchange rates and other material assumptions. The consumption and cost rates contained the physical quantities and unit cost rate inputs such as tyre costs and costs per assay. Appropriate cost drivers (i.e., treated tonnes) ensured that costs were forecast on parameters that were most reflective of future cost behaviour of the particular cost. The labour cost was developed from first principles that translated into a monthly headcount which was detailed per origin (expatriate and local), roster type, etc.

There is no contingency allowance.

Any post commissioning start-up costs likely to be incurred within six years post the grant of the Special Mining Lease (commercial production) are included in the capital cost estimate. These costs include commissioning assistance, first fills, commissioning spares, two-year operating spares and other associated indirect costs required for the commissioning of equipment, plant and infrastructure. Start-up costs also include capitalised revenue.

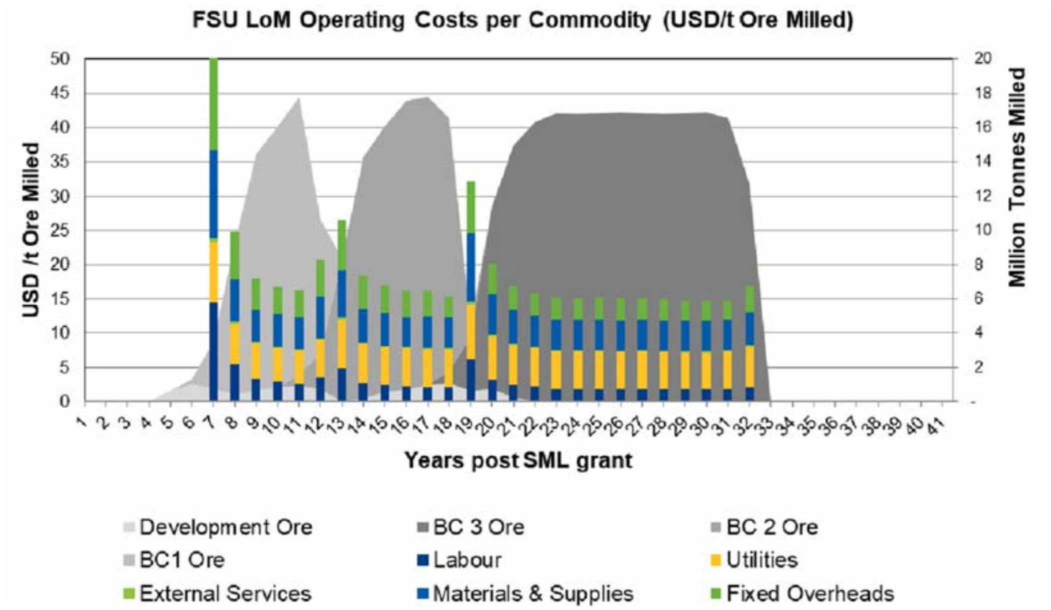
21.3.2 Unit Costs

Figure 21-1 presents the unit cost over the LOM as well as total ore production, given in terms of years post the grant of the Special Mining Lease.

Labour and fixed overhead costs, as anticipated, reflect a higher cost per tonne during the ramp-up and ramp-down periods, with the cost profile mirroring that of the production profile. Materials and supplies together with utilities cost fluctuate with the reduced throughput at each cave interaction point (13 and 19 years post the Special Mining Lease grant), but will still increase as these costs are not 100% variable. Labour, fixed overheads and external services remain mostly fixed.

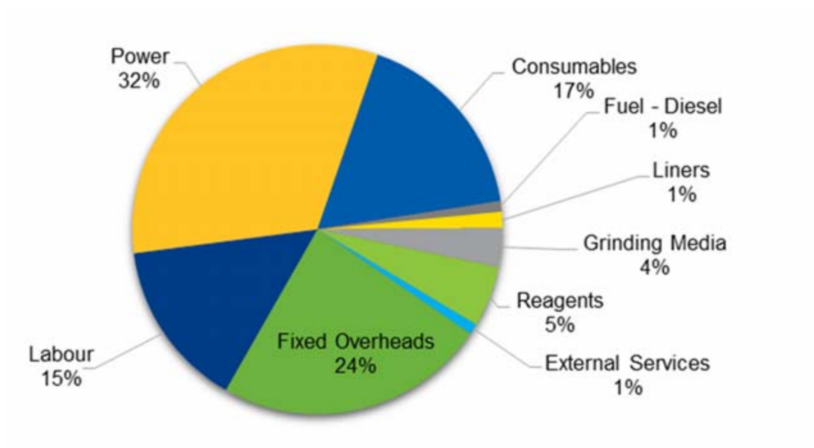
Power (utilities) costs comprise 32% of the LOM costs (Figure 21-2), and the largest proportion of total costs. This high relative proportion is because a block caving operation has very few pieces of mobile equipment (and corresponding low labour cost) with the bulk of ore handling costs being via fixed infrastructure (conveyors), ventilation and dewatering, all of which drive elevated power consumption.

Figure 21-1:LOM Unit Costs (US$/t real)



Note: Figure prepared by WGJV, 2018. FSU = 2018 Feasibility Study Update.

Figure 21-2:LOM Operating Costs by Commodity



Note: Figure prepared by WGJV, 2018.

Materials and supplies consisting of consumables (17%), reagents (5%), grinding media (4%), liners and diesel also account for a large portion of the total operating cost at 28%, followed by fixed overheads at 24%.

21.3.3 Operating Costs by Area

Table 21-6 provides a breakdown of the operating cost by area.

21.4 QP Comments on "Item 21: Capital and Operating Costs"

The QP notes:

- The life of mine capital cost is US$5,382 M (real Dec 2017 terms), and includes US$200 M of capitalised net revenue;
- Operating costs include mining costs of US$4.16/t milled, treatment costs of US$7.40/t milled, infrastructure costs of US$1.78/t milled, and site support services costs of US$3.99/t milled, for an overall average operating cost over the LOM of US$17.33/t milled.

Table 21-6: Operating Cost Estimate by Area

Area	Units	Value
Underground mining		
Ventilation & refrigeration	US$/t ore milled	1.27
Production	US$/t ore milled	0.99
Conveying	US$/t ore milled	0.69
Engineering maintenance & services	US$/t ore milled	0.56
Dewatering	US$/t ore milled	0.34
Crushing	US$/t ore milled	0.15
Technical services	US$/t ore milled	0.12
Administration	US$/t ore milled	0.04
Subtotal underground mining	US$/t ore milled	4.16
Treatment		
Process plant operations	US$/t ore milled	5.04
Process plant maintenance	US$/t ore milled	0.91
Port filtration plant	US$/t ore milled	0.72
DSTP	US$/t ore milled	0.47
Water treatment plant	US$/t ore milled	0.25
Concentrate pipeline	US$/t ore milled	0.01
Subtotal treatment	US$/t ore milled	7.40
Infrastructure		
Power generation plant	US$/t ore milled	1.34
Infrastructure (roads and buildings)	US$/t ore milled	0.28
Services (power and waste)	US$/t ore milled	0.16
Subtotal infrastructure	US$/t ore milled	1.78
Site support services		
Environmental, Community Affairs & Land	US$/t ore milled	0.89
Commercial	US$/t ore milled	0.92
OH&S	US$/t ore milled	0.47
Camp Services	US$/t ore milled	0.40
IT	US$/t ore milled	0.33
Travel	US$/t ore milled	0.18
Supply and Logistics	US$/t ore milled	0.19
HR	US$/t ore milled	0.09
Subtotal site support services	US$/t ore milled	3.99
Total	***US$/t ore milled***	***17.33***

22 ECONOMIC ANALYSIS

22.1 Forward-Looking Statements

This economic analysis includes forward-looking statements. Forward-looking statements can generally be identified by the use of words such as “may”, “will”, “expect”, “intend”, “plan”, “estimate”, “anticipate”, “continue”, “outlook” and “guidance”, or other similar words and may include, without limitation, Mineral Resource and Mineral Reserve estimates, statements regarding plans, strategies and objectives of management relating to the Project including the proposed mine plan, projected mining and process recovery rates and assumptions as to mining dilution, anticipated production or construction commencement dates, expected costs or production outputs and assumptions as to closure costs and requirements; assumptions as to environmental, permitting and social risks. Forward-looking statements inherently involve known and unknown risks, uncertainties and other factors that may cause the actual results, performance and achievements of the Project to differ materially from statements in this analysis. Relevant factors may include, but are not limited to, changes in external economic factors such as commodity prices, foreign exchange fluctuations, interest rates and tax rates, unanticipated changes in sustaining and operating costs, unexpected variations in the quantity of mineralised material, grade or recovery rates, unexpected changes in the environmental or in geotechnical or hydrological conditions, a failure of mining methods to operate as anticipated, a failure of plant, equipment or processes to operate as anticipated, and the risks relating to permitting, licensing and maintaining a social license to operate.

Forward-looking statements are based on Newcrest’s good faith assumptions as to the geological, technical, engineering, market, financial and regulatory factors that will exist and affect the Project’s development and operations in the future. Newcrest does not give any assurance that the assumptions will prove to be correct. There may be other factors that could cause actual results or events not to be as anticipated, and many events are beyond the reasonable control of Newcrest. Readers are cautioned not to place undue reliance on forward looking statements. Forward-looking statements in this economic analysis speak only at the date of issue. Except as required by applicable laws or regulations, Newcrest does not undertake any obligation to publicly update or revise any of the forward-looking statements or to advise of any change in assumptions on which any such statement is based.

The production schedules and financial analysis annualised cash flow table are presented with conceptual years shown. Years shown in these tables are for illustrative purposes only. Additional mining, technical, and engineering studies requested as part of the permitting process may result in changes to the project timelines presented.

22.2 Methodology Used

The Golpu Development was valued using a discounted cash flow (DCF) approach. Estimates were prepared for all the individual elements of cash revenue and cash expenditures.

Capital cost estimates were prepared for initial development and construction of the project, in addition to ongoing operations (sustaining capital). The year of the Special Mining Lease grant was defined as the first year of initial capital expenditure, and cash flows are assumed to occur in the middle of each period.

The resulting net annual cash flows are discounted back to the date of valuation of start-of-year 1 July, 2019, because the actual starting calendar year has not been determined. A discount rate of 8.50% was used. Golpu Development economics are presented on a 100% basis. Newcrest holds a 50% interest in the project.

Input assumptions were reviewed as at 30 June, 2020, are considered acceptable for public disclosure, and remain current.

22.3 Financial Model Parameters

22.3.1 Mineral Reserves and Mine Life

The Mineral Reserve estimate was provided in Table 15-6.

The assumed active mine life is 28 years.

A production profile is included as Figure 22-1.

22.3.2 Metallurgical Recoveries

Over the LOM, copper recoveries will average 95% and gold recoveries will average 68%. Concentrate grade average over the life-of-mine is projected to be 29% Cu and 15 g/t Au.

22.3.3 Smelting and Refining Terms

Smelting and refining cost assumptions were outlined in Table 19-5.

22.3.4 Metal Prices

The 2018 Feasibility Study Update assumes the following metal prices as discussed in Section 19.2:

- Copper: US$3.00/lb;
- Gold: US$1,200/oz.

22.3.5 Capital and Operating Costs

The capital cost estimate was included as Table 21-4 and the operating cost estimate in Table 21-6.

22.3.6 Royalties

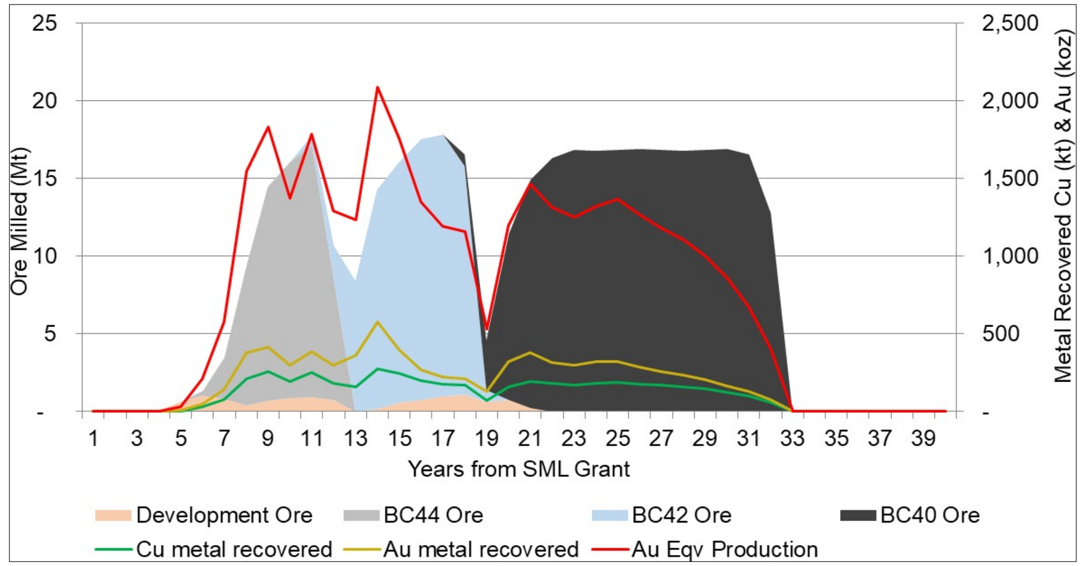
Royalty provisions in the financial model include:

- Royalty: 2% of the net proceeds of sale of minerals (calculated as NSR or FOB export value, whichever is appropriate);
- Production levy: 0.50% of gross revenue from all mining sales.

22.3.7 Working Capital

The cash flow model includes an allowance of 21 days for accounts receivable and 30 days for accounts payable.

Figure 22-1:Production Plan



Note: Figure prepared by WGJV, 2018.

22.3.8 Taxes

The economic analysis reflects the following significant changes to the Mining Taxation Regime announced by the PNG Government in November 2016:

- Introduction of a resources rent tax termed the Additional Profits Tax (APT). The APT is levied at the 30% corporate income rate on profits above an allowed capital return threshold of 15% per annum (nominal terms), and is thus triggered once a 15% rate of return per annum (nominal) was achieved on prior invested capital. Changes in parameters that result in higher profits have the effect of consuming accumulated capital balance (and 15% per annum uplift rate) much faster, triggering the APT;
- An increase to the Foreign Contractor Withholding Tax (FCWT) rate from 12% to 15%;
- Suspension of the double deduction for exploration expenditure provided under section 155N of the Income Tax Act, with no additions to this balance post 1 January 2017.

The economic analysis was performed on a 100% in-country basis without consideration of funding or structuring at the WGJV Participant entity level and does not take into account differences in the corporate tax treatment by each WGJV Participant. As such, the model is designed to be a standalone discrete project model and assumes (for valuation purposes only) that all cash flows are held in-country by the WGJV (i.e., not repatriated to shareholders).

For the purpose of calculating the tax payable, all of the extractive activities and associated infrastructure were assumed to be undertaken under a single Special Mining Lease. This method is considered adequate for the 2018 Feasibility Study Update estimates.

In PNG, tax is paid on a company basis. All expenditure, including execution capital expenditure up until first production, was capitalised as allowable capital expenditure (ACE) and depreciated at a rate of 25% using the diminishing value method, as per PNG tax law.

Total historical expenditure (actual and forecast) through to the anticipated Special Mining Lease grant is estimated to be US$779 M on a 100% basis.

22.3.9 Closure Costs and Salvage Value

No salvage value was allocated.

Conceptual mine closure costs are based on an estimated total closure cost for the operation consisting of an annual spend during operations and a final closure cost incurred over a period of 10 years, starting in the final year of production. This cost is included in operating costs. The conceptual post-production closure costs are estimated at US$75 M.

22.3.10 Financing

The base case economic analysis assumes 100% equity financing and is reported on a 100% project ownership basis. Newcrest holds an 50% interest in the WGJV, and Harmony holds the remaining 50% interest.

22.3.11 Inflation

The base case economic analysis assumes constant prices.

A 2% US$ inflation rate was used for calculation of tax in nominal terms.

Capital and operating costs are based on Q4 2017 US$.

22.4 Financial Analysis

The project development strategy involves a staged construction of the mine starting with ramping-up production as fast as possible to extract the high-grade material from BC44 to maximise free cash flows and help fund ongoing development of BC42 and BC40. Block caves 44 and 42 are also staged to focus initially on the high-grade orebody zones then expand into the lower (relatively) grade areas with BC40 and mining the available Mineral Reserves to economic cut-off, thereby sustaining a high production rate of 16.84 Mt/a, staging mine development capital, optimising Mineral Reserve recovery, managing capital at risk, and improving value. The first phase is the start-up mine in the high-grade BC44 porphyry, between 8–12 years post the Special Mining Lease grant, with free cash flows declining until 14 years post the Special Mining Lease grant when the second phase (BC42) starts and continues with high returns until 18 years post the Special Mining Lease grant. Thereafter free cash flows decline until BC40 starts producing at full capacity at 21 years post the Special Mining Lease grant.

Development of the Golpu deposit is principally a trade-off between the high initial development cost of a greenfield block cave mine and revenue. The high-grade nature of the deposit results in high forecast free cash flows which are offset by the requirement for a significant initial capital investment.

Table 22-1 is a summary of the key parameters that the anticipated project metrics are based on.

Table 22-1: Key Financial Parameters/Assumptions

Area	Metric	Value
First ore (first BC44 drawbell fired)	Years post the Special Mining Lease grant	5.5
Treatment plant start	Years post the Special Mining Lease grant	4.75
BC44 steady state production	Years post the Special Mining Lease grant	9.5
BC42 steady state production	Years post the Special Mining Lease grant	14.8
BC40 steady state production	Years post the Special Mining Lease grant	21.7
Commercial production period	Years post commercial production	26
Ore mined	Mt	376
Cu grade	%	1.27
Au grade	g/t	0.90
Cu metal produced	kt	4,520
Au metal produced	koz	7,445
Cu metal produced	Kt/a average	161
Au metal produced	Koz/a average	266
Project execution capital (to commercial production)	US$ M real	2,825
Project expansionary capital (LOM, excl. sustaining)	US$ M real	1,864
Sustaining capital (post commercial production) *	US$ M real	693
Total project capital (LOM)	US$ M real	5,382
Total operating cost (real)	US$/t ore milled LOM	17.33
Cash cost (including gold credit) **	US$/lb avg.	0.26
Total production cost #	US$/lb avg.	0.81

Note: * = Sustaining capital defined as routine stay in business capital expenditure estimated as 2.5% of the asset value; ** = Operating costs + treatment charges/refining charges (TC/RC) + realisation expenses less gross gold revenue/copper pounds; # = Operating costs + TC/RC + realisation expenses + total LOM capital (including capitalised revenue) less gross gold revenue/copper pounds. Figures were rounded and may not sum due to rounding.

The internal rate of return (IRR) is forecast to be 18.2%, and the projected net present value (NPV) is US$2,604 M. The payback period is estimated at nine and a half years. The project financial metrics are provided in Table 22-2

The after-tax cash flow on an annualised basis is provided in Table 22-3 to Table 22-7. In these tables, all figures were rounded, and may not sum due to rounding.

Figure 22-2 shows the free cash flow (i.e. post-tax cash flow) over the LOM. Free cash flow is calculated as operating cash flow less capital expenditure.

Table 22-2: Project Financial Metrics

Parameters	Units	Value
Maximum negative cash flow (MNCF)	US$ M	2,823
Concentrator start from Years post the Special Mining Lease grant	Years	4.75
Payback period from Years post the Special Mining Lease grant	Years	9.54
IRR	%	18.2
NPV	US$ M	2,604
Operating cost	US$/t ore milled real LOM avg.	17.33
Project execution capital *	US$ M	2,825
Cash cost (including gold credit) **	US$//lb avg.	0.26
Total production cost #	US$//lb avg.	0.81

Note: * = includes net capitalised revenue of US$200 M; ** = operating costs + treatment charges/refining charges (TC/RC) + realisation expenses less gross gold revenue/copper pounds; # = operating costs + TC/RC + realisation expenses + total LOM capital (including capitalised revenue) less gross gold revenue/copper pounds. Figures were rounded and may not sum due to rounding.

Table 22-3: Cash Flow Analysis on an Annualised Basis (Year 1 to Year 10)

	Unit	LOM Sum/Avg	1	2	3	4	5	6	7	8	9	10
Economic Parameters												
Gold price	US$/oz	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Copper price	US$/lb	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
US$/PGK	US$/PGK	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
US$/A$	US$/A$	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
US$/ZAR	US$/ZAR	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Operating Summary												
Total material moved	kt	375,640	—	—	—	41	641	1,317	3,492	9,303	14,435	16,059
Ore processed	kt	375,640	—	—	—	—	384	1,615	3,492	9,303	14,435	16,059
Gold grade - milled	g/t	0.90	—	—	—	—	0.74	1.26	1.62	1.64	1.20	0.79
Copper grade	%	1.27	—	—	—	—	1.14	1.88	2.37	2.38	1.86	1.29
Metal Production												
Gold production	koz	7,445	—	—	—	—	6	49	141	378	415	299
Copper production	kt	4,520	—	—	—	—	4	29	79	212	257	195
Gold eq. production	koz	32,359	—	—	—	—	29	209	577	1,548	1,830	1,373
Cash costs (C1)	US$/lb Cu	0.26	—	—	—	—	0.70	0.21	0.51	0.01	0.07	0.29
Cash Flow Summary												
Gross revenue	US$M	38,545	—	—	—	—	—	—	693	1,858	2,197	1,648
[-] Realisation costs	US$M	4,956	—	—	—	—	—	—	85	228	278	216
[-] Site operating costs	US$M	6,433	—	—	—	—	—	—	172	231	261	269
[-] Cash payments for tax	US$M	8,542	—	—	—	—	—	—	—	133	273	164
[-] ∆ Net working capital	US$M	—	(12)	(21)	(6)	(48)	25	59	6	54	16	(35)
[-] Rehabilitation payments	US$M	75	—	—	—	—	—	—	—	—	—	—
Operating cash flow	US$M	18,540	12	21	6	48	(25)	(59)	430	1,213	1,369	1,035
[-] Project capital	US$M	2,825	145	395	471	1,050	741	23	—	—	—	—
[-] Sustaining capital	US$M	2,557	—	—	—	—	—	—	206	209	185	264
Free Cash Flow	***US$M***	***13,157***	***(133)***	***(374)***	***(465)***	***(1,003)***	***(766)***	***(82)***	***224***	***1,004***	***1,184***	***770***

Table 22-4: Cash Flow Analysis on an Annualised Basis (Year 11 to Year 20)

	Unit	LOM Sum/Avg	11	12	13	14	15	16	17	18	19	20
Economic Parameters												
Gold price	US$/oz	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Copper price	US$/lb	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
US$/PGK	US$/PGK	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
US$/A$	US$/A$	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
US$/ZAR	US$/ZAR	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Operating Summary												
Total material moved	kt	375,640	17,767	10,664	8,386	14,277	16,071	17,558	17,802	16,536	4,555	11,457
Ore processed	kt	375,640	16,840	11,591	8,386	14,277	16,071	16,840	16,840	16,840	5,931	11,457
Gold grade - milled	g/t	0.90	0.96	1.06	1.68	1.64	1.14	0.79	0.67	0.64	1.05	1.29
Copper grade	%	1.27	1.59	1.64	1.99	2.03	1.62	1.24	1.11	1.08	1.30	1.47
Metal Production												
Gold production	koz	7,445	386	298	360	577	400	267	221	211	128	322
Copper production	kt	4,520	254	180	158	274	246	197	176	171	73	159
Gold eq. production	koz	32,359	1,783	1,290	1,231	2,089	1,755	1,352	1,190	1,155	529	1,197
Cash costs (C1)	US$/lb Cu	0.26	0.16	0.20	(0.10)	(0.20)	0.13	0.39	0.51	0.54	0.74	0.07
Cash Flow Summary												
Gross revenue	US$M	38,545	2,140	1,548	1,477	2,507	2,106	1,623	1,428	1,386	635	1,436
[-] Realisation costs	US$M	4,956	279	197	176	306	274	216	192	186	81	179
[-] Site operating costs	US$M	6,433	275	242	223	262	273	273	271	271	192	231
[-] Cash payments for tax	US$M	8,542	329	218	235	511	404	278	230	223	61	279
[-] ∆ Net working capital	US$M	—	34	(23)	2	47	(28)	(29)	(7)	(1)	(24)	36
[-] Rehabilitation payments	US$M	75	—	—	—	—	—	—	—	—	—	—
Operating cash flow	US$M	18,540	1,223	914	841	1,382	1,183	885	742	707	324	710
[-] Project capital	US$M	2,825	—	—	—	—	—	—	—	—	—	—
[-] Sustaining capital	US$M	2,557	140	92	56	79	153	209	180	164	80	92
Free Cash Flow	***US$M***	***13,157***	**1,082**	**821**	**786**	**1,302**	**1,029**	**676**	**562**	**544**	**244**	**619**

Table 22-5: Cash Flow Analysis on an Annualised Basis (Year 21 to Year 30)

	Unit	LOM Sum/Avg	21	22	23	24	25	26	27	28	29	30
Economic Parameters												
Gold price	US$/oz	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Copper price	US$/lb	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
US$/PGK	US$/PGK	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
US$/A$	US$/A$	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
US$/ZAR	US$/ZAR	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Operating Summary												
Total material moved	kt	375,640	14,945	16,312	16,835	16,799	16,840	16,886	16,835	16,799	16,840	16,886
Ore processed	kt	375,640	14,945	16,312	16,835	16,799	16,840	16,840	16,840	16,840	16,840	16,840
Gold grade - milled	g/t	0.90	1.18	0.90	0.82	0.87	0.88	0.82	0.76	0.70	0.62	0.52
Copper grade	%	1.27	1.39	1.17	1.09	1.15	1.19	1.12	1.05	0.99	0.91	0.79
Metal Production												
Gold production	koz	7,445	382	318	300	319	319	284	256	234	203	166
Copper production	kt	4,520	197	181	173	182	190	179	168	158	145	126
Gold eq. production	koz	32,359	1,466	1,315	1,253	1,322	1,365	1,268	1,180	1,104	1,000	861
Cash costs (C1)	US$/lb Cu	0.26	0.04	0.20	0.23	0.19	0.20	0.29	0.36	0.42	0.52	0.68
Cash Flow Summary												
Gross revenue	US$M	38,545	1,759	1,578	1,504	1,587	1,638	1,521	1,416	1,325	1,200	1,033
[-] Realisation costs	US$M	4,956	221	201	192	203	210	200	187	175	159	138
[-] Site operating costs	US$M	6,433	253	258	256	255	257	254	254	251	250	249
[-] Cash payments for tax	US$M	8,542	612	536	509	551	574	523	477	439	384	310
[-] Δ Net working capital	US$M	—	17	(8)	(3)	5	2	(6)	(5)	(4)	(6)	(8)
[-] Rehabilitation payments	US$M	75	—	—	—	—	—	—	—	—	—	—
Operating cash flow	US$M	18,540	656	591	550	574	595	550	504	464	413	343
[-] Project capital	US$M	2,825	—	—	—	—	—	—	—	—	—	—
[-] Sustaining capital	US$M	2,557	62	47	41	35	36	34	35	34	35	30
Free Cash Flow	***US$M***	***13,157***	***594***	***544***	***509***	***539***	***559***	***516***	***469***	***430***	***377***	***314***

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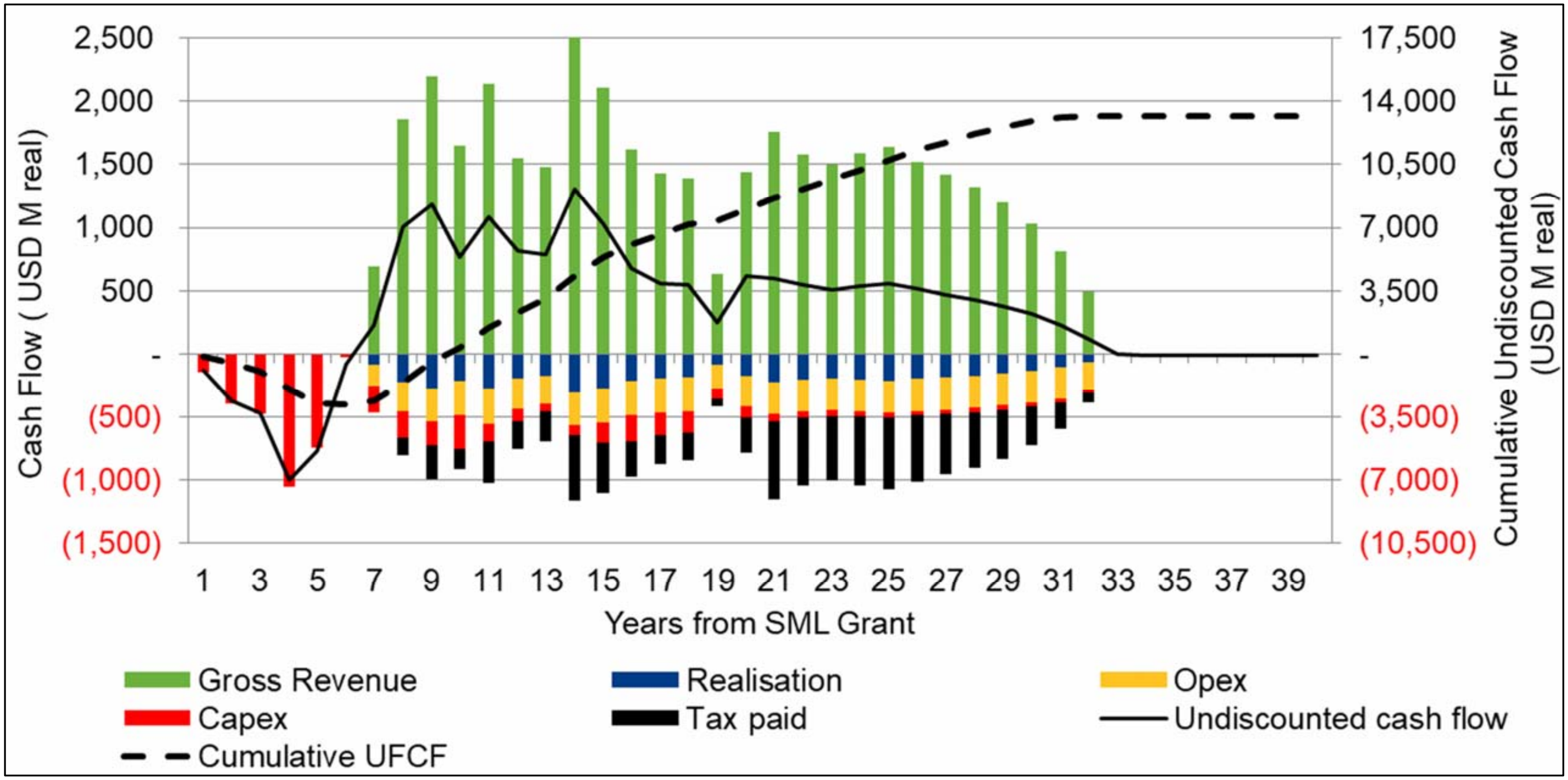
Table 22-6: Cash Flow Analysis on an Annualised Basis (Year 31 to Year 40)

	Unit	LOM Sum/Avg	31	32	33	34	35	36	37	38	39	40
Economic Parameters												
Gold price	US$/oz	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Copper price	US$/lb	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
US$/PGK	US$/PGK	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
US$/A$	US$/A$	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
US$/ZAR	US$/ZAR	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Operating Summary												
Total material moved	kt	375,640	16,556	12,747	—	—	—	—	—	—	—	—
Ore processed	kt	375,640	16,602	12,747	—	—	—	—	—	—	—	—
Gold grade - milled	g/t	0.90	0.42	0.34	—	—	—	—	—	—	—	—
Copper grade	%	1.27	0.64	0.50	—	—	—	—	—	—	—	—
Metal Production												
Gold production	koz	7,445	129	77	—	—	—	—	—	—	—	—
Copper production	kt	4,520	100	60	—	—	—	—	—	—	—	—
Gold eq. production	koz	32,359	678	409	—	—	—	—	—	—	—	—
Cash costs (C1)	US$/lb Cu	0.26	0.91	1.43	—	—	—	—	—	—	—	—
Cash Flow Summary												
Gross revenue	US$M	38,545	814	491	—	—	—	—	—	—	—	—
[-] Realisation costs	US$M	4,956	110	67	—	—	—	—	—	—	—	—
[-] Site operating costs	US$M	6,433	244	208	—	—	—	—	—	—	—	—
[-] Cash payments for tax	US$M	8,542	212	79	—	—	—	—	—	—	—	—
[-] Δ Net working capital	US$M	—	(11)	(13)	(5)	—	—	—	—	—	—	—
[-] Rehabilitation payments	US$M	75	—	8	8	8	8	8	8	8	8	8
Operating cash flow	US$M	18,540	259	142	(2)	(8)	(8)	(8)	(8)	(8)	(8)	(8)
[-] Project capital	US$M	2,825	—	—	—	—	—	—	—	—	—	—
[-] Sustaining capital	US$M	2,557	30	27	—	—	—	—	—	—	—	—
Free Cash Flow	***US$M***	***13,157***	***228***	***116***	***(2)***	***(8)***	***(8)***	***(8)***	***(8)***	***(8)***	***(8)***	***(8)***

Table 22-7: Cash Flow Analysis on an Annualised Basis (Year 41 to Year 42)

	Unit	LOM Sum/Avg	41	42
Economic Parameters				
Gold price	US$/oz	1,200	1,200	1,200
Copper price	US$/lb	3.00	3.00	3.00
US$/PGK	US$/PGK	0.32	0.32	0.32
US$/A$	US$/A$	0.75	0.75	0.75
US$/ZAR	US$/ZAR	0.08	0.08	0.08
Operating Summary				
Total material moved	kt	375,640	—	—
Ore processed	kt	375,640	—	—
Gold grade - milled	g/t	0.90	—	—
Copper grade	%	1.27	—	—
Metal Production				
Gold production	koz	7,445	—	—
Copper production	kt	4,520	—	—
Gold eq. production	koz	32,359	—	—
Cash costs (C1)	US$/lb Cu	0.26	—	—
Cash Flow Summary				
Gross revenue	US$M	38,545	—	—
[-] Realisation costs	US$M	4,956	—	—
[-] Site operating costs	US$M	6,433	—	—
[-] Cash payments for tax	US$M	8,542	—	—
[-] Δ Net working capital	US$M	—	—	1
[-] Rehabilitation payments	US$M	75	8	—
Operating cash flow	US$M	18,540	(8)	(1)
[-] Project capital	US$M	2,825	—	—
[-] Sustaining capital	US$M	2,557	—	—
Free Cash Flow	***US$M***	***13,157***	***(8)***	***(1)***

Figure 22-2:Free Cash flow



Note: Figure prepared by WGJV, 2018. Capex = capital costs; UFCF = unlevered free cash flow. Free cash flow = post-tax cash flow. Free cash flow is calculated as operating cash flow less capital expenditure.

22.5 Sensitivity Analysis

A deterministic point-estimate sensitivity analysis was conducted on each of the key project variables and value drivers. The sensitivity analysis reflects the changes in IRR (%) and NPV (US$ M) for the corresponding individual movement in each factor.

Figure 22-3 and Figure 22-4 present sensitivity analyses using IRR and NPV metrics, respectively.

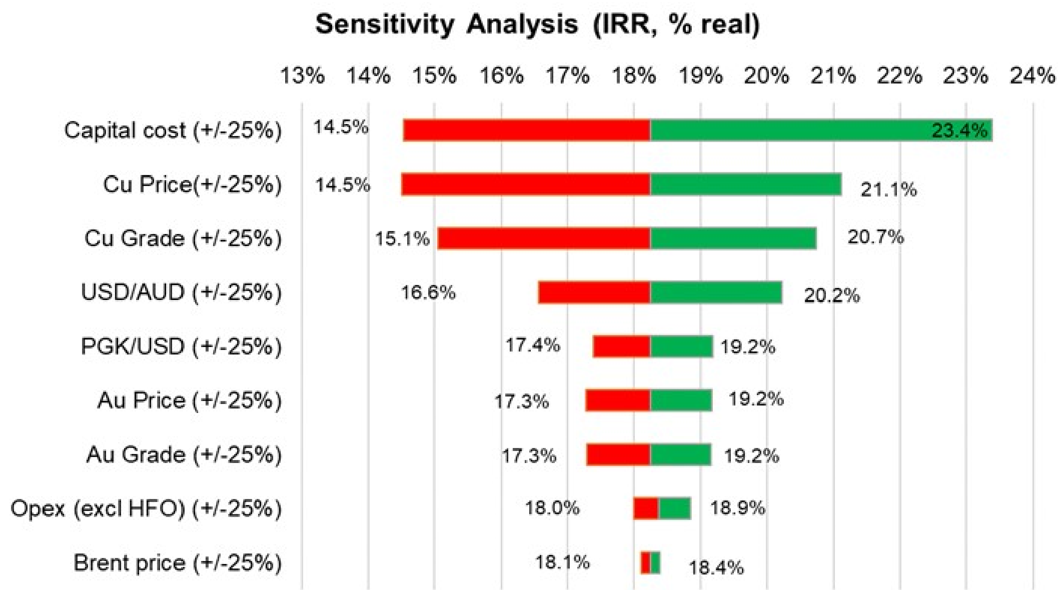
The Golpu Development NPV is most sensitive to changes in the copper price, less sensitive to changes in the copper grade, capital costs, gold price, and gold grade, and least sensitive to changes in operating costs.

22.6 QP Comments on “Item 22: Economic Analysis”

The QP notes:

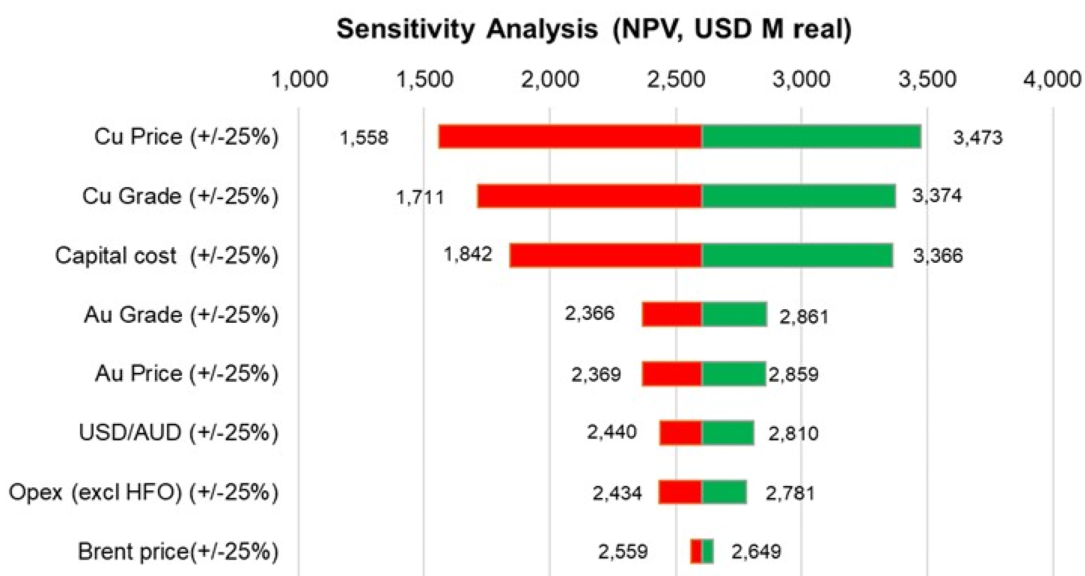
- The economic analysis is presented on a 100% basis. Newcrest holds a 50% interest in the WGJV;
- The IRR is forecast to be 18.2%, and the projected NPV is US$2,604 M. The payback period is estimated at nine and a half years;
- The Golpu Development is most sensitive to changes in the copper price, less sensitive to changes in the copper grade, capital costs, gold price, and gold grade, and least sensitive to changes in operating costs.

Figure 22-3:Sensitivity Analysis, IRR



Note: Figure prepared by Newcrest, 2019.

Figure 22-4:Sensitivity Analysis, NPV



Note: Figure prepared by Newcrest, 2019.

23 ADJACENT PROPERTIES

This section is not relevant to this Report.

24 OTHER RELEVANT DATA AND INFORMATION

This section is not relevant to this Report.

25 INTERPRETATION AND CONCLUSIONS

25.1 Introduction

The QPs note the following interpretations and conclusions in their respective areas of expertise, based on the review of data available for this Report.

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

Information from legal experts and Newcrest's in-house experts support that the tenure held is valid and sufficient to support a declaration of Mineral Resources and Mineral Reserves. EL 440 is in the renewal process. Newcrest expects that the renewal will be granted as all tenement conditions for the previous term were complied with.

The Project is a 50:50 unincorporated joint venture, the WGJV, between Wafi Mining and Newcrest PNG2. Harmony is the ultimate parent company of Wafi Mining. Newcrest is the ultimate parent company of Newcrest PNG2.

If the State of PNG chooses to take-up its full 30% interest, the interest of each of Wafi Mining and Newcrest PNG 2 will become 35%.

The WGJV Participants applied for a Special Mining Lease and ancillary tenements (including Leases for Mining Purposes and Mining Easements) in late 2016, covering proposed Golpu Development facilities and infrastructure as they were understood at the time. Amendments to these tenement applications were made in March 2018, where the location and/or nature of facilities and infrastructure was refined through the 2018 Feasibility Study Update. The grant of the Special Mining Lease and related ancillary tenements remains subject to the completion of *Mining Act 1992* and *Environment Act 2000* processes

While the WGJV Participants have entered into a compensation agreement for EL440 and EL1105, they will need to enter into additional compensation agreement(s) covering land the subject of any other tenements that might be required by the planned Golpu operations.

Where activities will be undertaken on or under customary land, a compensation agreement with the customary landowners is required.

Extraction of water requires a permit under the *Environment Act 2000*.

The Project is subject to a 2% mining royalty and a 0.5% production levy.

Existing environmental liabilities include roads, earthworks relating to exploration activities such as drill pads and berms, settling ponds, the site exploration camp and associated supporting infrastructure. A portion of these disturbances can be remediated as part of progressive rehabilitation; however, a portion of the already-disturbed areas are required for the Golpu Development.

To the extent known to the QP, there are no other significant factors and risks known to Newcrest that may affect access, title, or the right or ability to perform work on the Project that are not discussed in this Report.

25.3 Geology and Mineralisation

The deposits discovered to date in the Project area are considered by Newcrest to be representative of a number of mineralisation models, including porphyry copper–

gold (Golpu and Nambonga) and high-sulphidation, and low-sulphidation epithermal systems (Wafi).

The understanding of the Golpu deposit settings, lithologies, and geological, structural, and alteration controls on mineralisation is sufficient to support estimation of Mineral Resources and Mineral Reserves. The understanding of the Wafi and Nambonga deposit settings, lithologies, and geological, structural, and alteration controls on mineralisation is sufficient to support estimation of Mineral Resources.

The mineralisation style and setting are well understood and can support declaration of Mineral Resources (Golpu, Wafi and Nambonga) and Mineral Reserves (Golpu).

There is some remaining exploration potential in the Project area, with a number of prospects that may warrant additional investigation.

25.4 Exploration, Drilling and Analytical Data Collection in Support of Mineral Resource Estimation

The exploration programs completed to date are appropriate for the style of the deposits in the Project area.

Sampling methods are acceptable for Mineral Resource estimation.

Sample preparation, analysis and security are generally performed in accordance with exploration best practices and industry standards.

The quantity and quality of the lithological, geotechnical, collar and down-hole survey data collected during the CRAE, Harmony, and WGJV exploration and delineation drilling programs are sufficient to support Mineral Resource estimation.

No material factors were identified with the data collection from the drill programs that could significantly affect Mineral Resource estimation.

Sample preparation, analysis, and security practices and results for the CRAE, Harmony, and WGJV programs are acceptable, meet industry-standard practice, and are adequate to support Mineral Resource estimation. The collected sample data adequately reflect deposit dimensions, true widths of mineralisation, and the style of the deposits. Sampling is representative of the gold, copper, silver and molybdenum grades in the Golpu deposit, of the gold and silver grades in the Wafi deposit, and of the gold and copper grades in the Nambonga deposit, reflecting areas of higher and lower grades.

QA/QC programs for the CRAE, Harmony, and WGJV campaigns adequately address issues of precision, accuracy and contamination. Drilling programs typically included blanks, duplicates and SRM samples. QA/QC submission rates meet industry-accepted standards. The QA/QC programs did not detect any material sample biases in the data reviewed that supports Mineral Resource estimation.

The data verification programs concluded that the data collected from the Project adequately support the geological interpretations and constitute a database of sufficient quality to support the use of the data in Mineral Resource estimation.

25.5 Metallurgical Testwork

Metallurgical testwork and associated analytical procedures were appropriate to the mineralisation type, appropriate to establish the optimal processing routes, and were performed using samples that are typical of the mineralisation styles found within the

Golpu and Wafi deposits. No metallurgical testwork was conducted on Nambonga material.

Samples selected for testing were representative of the various types and styles of mineralisation. Samples were selected from a range of depths within the deposits. Sufficient samples were taken so that tests were performed on sufficient sample mass.

Recovery factors estimated are based on appropriate metallurgical testwork, and are appropriate to the mineralisation types and the selected process routes for the Golpu and Wafi deposits. Recoveries are estimated for the Nambonga deposit using Golpu as an analogue.

There are no known deleterious elements that would affect Golpu concentrate marketability. There are no known deleterious elements that would affect marketability of doré produced from the Wafi deposit. There is no information as to whether any deleterious elements are present at Nambonga, since no deposit-specific tests were conducted.

25.6 Mineral Resource Estimates

The Mineral Resource estimation for the Project conforms to industry-accepted practices, and is reported using the 2014 CIM Definition Standards.

Areas of uncertainty that may materially impact the Mineral Resource estimates include: changes to long-term gold and copper price assumptions; assumptions that silver and molybdenum can be recovered with minor circuit modifications or concentrate contract negotiations (Golpu); changes in local interpretations of mineralisation geometry and continuity of mineralised zones; changes to geological shape and continuity assumptions; changes to metallurgical recovery assumptions; changes to the operating cut-off assumptions for assumed block caving operations (Golpu and Nambonga); changes to the input assumptions used to derive the conceptual underground outlines used to constrain the Golpu and Nambonga estimates; changes to the input assumptions used to derive the conceptual pit shell used to constrain the Wafi estimate; changes to the NSR values used to constrain the Golpu estimate; changes to the cut-off grades used to constrain the Wafi and Nambonga estimates; variations in geotechnical, hydrogeological and mining assumptions; and changes to environmental, permitting and social license assumptions.

There is upside potential for the estimates if mineralisation that is currently classified as Inferred can be upgraded to higher-confidence Mineral Resource categories.

25.7 Mineral Reserve Estimates

The Mineral Reserve estimation for the Project incorporates industry-accepted practices and meets the requirements of the 2014 CIM Definition Standards.

Mineral Reserves were estimated assuming conventional block caving methods. Mineral Resources were converted to Mineral Reserves using a detailed mine plan, an engineering analysis, and consideration of appropriate modifying factors. Modifying factors include the consideration of dilution and ore losses, underground mining methods, geotechnical and hydrological considerations, metallurgical recoveries, permitting and infrastructure requirements.

Areas of uncertainty that may materially impact the Mineral Reserve estimates include: changes to long-term gold and copper price assumptions; changes to exchange rate assumptions; changes to metallurgical recovery assumptions; changes to the input assumptions used to derive the cave outlines and the mine plan that is based on those cave designs; changes to operating, and capital assumptions used, including changes to input cost assumptions such as consumables, labour costs, royalty and taxation rates; variations in geotechnical, mining, dilution and processing recovery assumptions; including changes to designs as a result of changes to geotechnical, hydrogeological, and engineering data used; changes to the shut-off criteria used to constrain the estimates; changes to the assumed permitting and regulatory environment under which the mine plan was developed; ability to obtain mining permits, including timing for finalisation of the Special Mining Lease; ability to obtain agreements to land under customary ownership; ability to permit deep sea tailings placement; ability to obtain operations certificates in support of mine plans; and ability to obtain and maintain social and environmental license to operate.

Factors that are risk-specific to block cave operations, and which may affect the Mineral Reserves include: inrush of water into the underground workings including decline, cave levels and infrastructure areas; poorer rock mass quality and quantity than interpreted; inability to achieve planned decline development rates having impact on schedule and cost; incorrect estimation of cave propagation potentially leading to air blast; and damage to mine workings due to a seismic event.

25.8 Mine Plan

Mining operations are assumed to be conducted year-round.

The mine plans are based on the current knowledge of geotechnical, hydrological, mining and processing information. Due to high surface ambient temperatures and humidity, and the depth of the mine, considerable ventilation and cooling capacity will be required to be installed to ensure the health and safety of mine workers.

Underground operations will use conventional block cave underground mining methods and equipment fleets.

The peak annual cave production is 16.84 Mt/a with development entering the ore stream being additive to the cave production resulting in a peak production of 17.8 Mt in Year 17. It is proposed that the first block cave, BC44, will be situated at 4,400 mRL. The second block cave, BC42, will be situated at 4,200 mRL. The third block cave, BC40, is proposed to be situated at 4,000 mRL. The first two block caves are expected to be mined for seven and nine years respectively during the first 14 years of the mine life. The third block cave, BC40, proposed to be situated at 4,000 mRL, is expected to be mined for 16 years.

The mine has a forecast total life of 28 years from first production of the processing plant (excluding construction and closure phases).

25.9 Recovery Plan

The proposed processing methods are conventional to the industry. The comminution and recovery processes are widely used with no significant elements of technological innovation.

The process plant flowsheet designs were based on testwork results, previous study designs and industry-standard practices.

Two process flowsheets will be used. The LEAN flowsheet was designed to provide an optimal processing solution for treating high-grade ores with a porphyry content of 75% or more. The Golpu flowsheet was designed to treat mineralisation with a porphyry content of less than 75%, and incorporated a pyrite circuit for improved gold recovery from the metasediment-rich material.

The proposed Watut process plant will be a compact copper concentrator that is progressively built using a two-stage ramp-up.

The plant will incorporate the following: crushed ore stockpile and reclaim; SABC circuit; rougher flotation, copper rougher cleaner (single Jameson cell), copper concentrate regrind, three-stage copper cleaner, and cleaner–scavenger stage; pyrite rougher flotation circuit; pyrite concentrate regrind circuit; concentrate dewatering and handling; tailings thickening, pumping and water recovery; reagent mixing and distribution; grinding media storage and addition; and water and air services.

The process plant will produce variations in recovery due to the day-to-day changes in ore type or combinations of ore type being processed. These variations are expected to trend to the forecast recovery value for monthly or longer reporting periods.

The plant is designed to cater for the ore composition changes over the LOM, and blending is not expected to be required.

Copper concentrate is assumed to be shipped out of the port of Lae. Concentrate slurry will be transported via pipeline from the process plant site to the port, where it will be filtered prior to ship upload for export.

25.10 Infrastructure

Golpu is a greenfield site and does not have infrastructure to support mining operations. The mine plan requires significant supporting infrastructure.

The Golpu Development as envisaged will occupy three geographical areas consisting of the mine area, an infrastructure corridor, and a coastal area. The infrastructure corridor will link the mine and coastal facilities.

The mine area will include proposed block cave mine, underground access declines, portal terrace and waste rock storage facilities supporting each of the Watut and Nambonga declines, the Watut process plant, power generation facilities, laydown areas, water treatment facilities, quarries, wastewater discharge and raw water make-up pipelines, raw water dam, sediment control structures, roads and accommodation facilities for the construction and operations workforces. Infrastructure will require construction of a number of terraces due to the topography.

Within the infrastructure area will be the concentrate pipeline, terrestrial tailings pipeline and fuel pipeline; mine and northern access roads to connect with the Highlands Highway, and laydown areas.

The port, including the concentrate filtration plant and materials handling, storage, ship loading facilities and filtrate discharge pipeline; tailings outfall, including a mix/de-aeration tank and associated facilities, seawater intake pipelines and DSTP outfall pipelines, pipeline laydown area, choke station, access track and parking turnaround area, are included in the coastal area.

Upgraded existing access roads will provide the initial Golpu Development access, but will be replaced by planned northern access and mine access roads to be used during the main construction and operations phases. These two roads will be wholly located in the infrastructure corridor.

Power generation will be staged. The first stage will consist of nine 10 MW generator sets to meet the initial power demand of 56 MW. The second stage will accommodate the peak power demand of approximately 100 MW through the addition of five 10 MW units, taking the total to 14 generator sets. The ultimate configuration will comprise 12 operating generators and two standby generators.

The existing Wafi and Finchif construction accommodation facilities will be operational during the construction phase, with Finchif used during operations as well. A third accommodation facility, Fere, will be used for both the construction and operations phases.

25.11 Environmental, Permitting and Social Considerations

Baseline and supporting studies were completed in support of current and proposed mine design and permitting.

Two stockpiles in support of operations will be required, a temporary ore stockpile to store ore extracted during the development of the block cave extraction levels, and a coarse ore stockpile to maintain a steady supply of ore for the Watut process plant and to minimise fluctuations in the availability of feed material.

Two WRSFs will be used, the Watut declines WRSF and the Gardens WRSF. Seepage and runoff will be captured, and if necessary, treated to comply with permit conditions.

Based on a desire to minimise impacts on the biophysical and social environment and cultural heritage and adopt the option with the lowest construction, operational and post closure risks, the WGJV adopted DSTP as the preferred tailing management option for the Golpu Development. Deep sea tailings placement will involve the discharge of tailings slurry from an outfall pipeline terminus located approximately 200 m below the ocean surface. On exiting the outfall pipe, the tailings will flow down the sloping seafloor as a density current, with the ultimate deposition of the tailings solids on the deep-ocean floor.

The mine water management system was designed to capture potentially contaminated water within the mine area during construction and operations, and manage, including treatment where necessary, this captured water for re-use or disposal.

A Conceptual Closure and Rehabilitation Plan was prepared for the Golpu Development. A detailed closure schedule for implementation will be developed during the operational stage of the mine as the closure planning progresses. The WGJV proposes undertaking progressive rehabilitation where possible.

Additional mineral tenures will be required in support of construction and operations, including Special Mining Leases, Mining Leases, Mining Easements, and Leases for Mining Purposes. Environmental approval for the Golpu Development is being sought under the PNG *Environment Act 2000* and Environment Protection (Prescribed Activities) Regulation 2002. The required approval for the Golpu Development is a Level 3 Environment permit. The Golpu Development EIS was submitted to CEPA. Apart from the *Mining Act 1992* and *Environment Act 2000*, the Golpu Development will have to comply with aspects of other forms of legislation. Additional legislation may also be requested to be complied with during the Golpu Development review process.

The stakeholder engagement program commenced in 2008 and, since then, the WGJV has worked closely with its many stakeholders to build relationships. Feedback and issues raised by stakeholders are recorded during engagements for further action as required by the WGJV. This includes an established grievance mechanism. Stakeholder engagement will continue throughout the life of the Project, although the frequency and nature of engagement will vary according to the specific stakeholder.

Those issues which have the greatest potential for adverse impacts, and which are likely to be of greatest interest to Golpu Development stakeholders include: the need for some households to physically relocate; terrestrial biodiversity impacts; physical or chemical impacts of DSTP in the Huon Gulf; AMD risks; impacts arising from damage to or failure of the proposed pipelines; and impacts on current social structures, local subsistence agriculture economies and subsistence resource use.

Positive social outcomes may result from direct financial benefits to the State and Morobe Province, workforce employment and training, and procurement of equipment and materials from within Morobe Province and elsewhere in PNG.

25.12 Markets and Contracts

It is expected that Asian smelters will contract the Golpu concentrate as long-term feed source. The Golpu concentrate is expected to be relatively high in copper and low in impurities. Levels of gold-in-concentrate are not expected to be elevated to such levels which may limit marketability in markets such as China and India where high concentrate values may be restricted by working capital constraints. The concentrate is not expected to contain deleterious elements at levels prohibitive to sale to Asian smelters.

The marketing approach is consistent with what is publicly available on industry norms, and the information can be used in mine planning and financial analyses for the Golpu concentrate in the context of this Report.

Metal price assumptions were provided by Newcrest management. Newcrest considers analyst and broker price predictions, and price projections used by peers as inputs when preparing the management pricing forecasts. The commodity price and exchange rate projections were agreed to by the WGJV Participants.

No contracts are currently in place in support of the Golpu Development. Major contracts in support of development are likely to include shaft sinking, decline development, pipelines, conveyors, camp construction, port and roads. Major contracts in support of operations are likely to include: accommodations camp management; building maintenance; underground mine infrastructure development; cave establishment; road maintenance; explosives supply; ground support and consumables supply; material transport and logistics to the Port of Lae; infrastructure engineering procurement and construction management; labour training; and infrastructure construction. Contracts will be negotiated and renewed as needed. Contract terms are expected to be within industry norms, and typical of similar contracts in PNG that Newcrest is familiar with.

25.13 Capital Cost Estimates

Capital and operating cost estimates are based on the 2018 Feasibility Study Update. Newcrest's internal study guidelines require project scope definition for a feasibility study to have an accuracy level of ±15%. Pre-feasibility studies must have a project scope definition accuracy level of ±25%. Cost estimates were reviewed as at 30 June, 2020, and remain current.

The mine to port area, surface services and infrastructure, BC44 and BC42, underground services, and infrastructure areas were designed to a feasibility level of confidence. The access to BC40, and its associated mining layout were designed at a pre-feasibility confidence level. BC40 underground infrastructure, however, is to a feasibility level of confidence, using the same data as BC44 and BC 42.

Contingency allowances were applied, as appropriate, and were based on evaluations of all major cost categories.

The life of mine capital cost is US$5,382 M (real Dec 2017 terms), and includes US$200 M of capitalised net revenue, which is a Newcrest accounting standard for production revenue delivered before commercial production is declared.

25.14 Operating Cost Estimates

The operating cost estimate is derived on a 100% share basis and is expressed in real December 2017 US$ terms. Cost estimates were reviewed as at 30 June, 2020, and remain current.

The operating cost estimate was developed in monthly increments and is based on first principles, being unit consumption rates and unit prices. Prices were quantified as far as possible and where practicable by quotations, with some values escalated from prior estimates in the 2016 Feasibility Study.

Forecast operating costs include, over the LOM, US$4.16/t milled for mining costs, US$7.50/t milled for treatment costs, US$1.78/t milled infrastructure costs, and US$3.99/t milled site services costs. This resulted in an anticipated overall LOM operating cost of US$17.33/t milled.

25.15 Economic Analysis

The financial evaluation is based on a DCF model. The resulting net annual cash flows are discounted back to the date of valuation of start-of-year 1 July 2019 because the actual starting calendar year has not been determined. A discount rate of 8.50% was used. Input assumptions were reviewed as at 30 June, 2020, are considered acceptable for public disclosure, and remain current.

The economic analysis was performed on a 100% in-country basis without consideration of funding or structuring at the WGJV Participant entity level and does not take into account differences in the corporate tax treatment by each WGJV Participant. For the purpose of calculating the tax payable, all of the extractive activities and associated infrastructure were assumed to be undertaken under a single Mining Lease. All expenditure, including execution capital expenditure up until first production, was capitalised as ACE and depreciated at a rate of 25% using the diminishing value method, as per PNG’s tax law.

The internal IRR is forecast to be 18.2%, and the projected NPV is US$2,604 M. The payback period is estimated at nine and a half years.

The Golpu Development is most sensitive to changes in the copper price, less sensitive to changes in the copper grade, capital costs, gold price, and gold grade, and least sensitive to changes in operating costs.

25.16 Risks and Opportunities

25.16.1 Golpu Development

A risk and opportunity analysis was performed as part of the 2018 Feasibility Study Update. Risk reviews and risk register updates were conducted with a cross section of project managers and discipline leads across all project areas participating. Risks were rated using a risk matrix approach, and mitigation approaches established.

Key risks to the Golpu Development as identified in the 2018 Feasibility Study Update were: vehicle incidents on public roads; inability to use DSTP as the tailings disposal method; law reform processes leading to substantially changed legislative and fiscal regimes impacting the Project; and water or mud inrush to underground workings during construction and operations that would particularly affect the decline, cave levels and infrastructure areas.

Other risks are primarily related to construction and operations, such as: large-scale seismic events, fall of rock, either on surface or underground; failure of cave propagation; delays in cave establishment; underground and surface facilities fires; failures of equipment, surface or underground fixed assets; unplanned explosive initiation; and ground or surface water contamination.

Risks that will require ongoing monitoring during construction and operations include social unrest, disruptions to access road useability (for example, seasonal heavy rainfall events, geotechnical events such as rock falls and slides, and vehicular accidents), and theft and vandalism.

25.16.2 In-Country

Mining and exploration tenure are subject to renewal. There can be no certainty that renewals will be granted, including in a timely manner. Similarly, there can be no assurance that Newcrest will be able to successfully convert exploration tenure into mining tenure to support future mining operations, or successfully maintain its exploration and mining interests and deliver development projects.

Although Newcrest to date has been able to negotiate commercially reasonable and acceptable arrangements with native title claimants or land owners where it operates, there can be no assurance that claims will not be lodged in the future, which may impact Newcrest's ability to effectively operate in relevant geographic areas.

Disagreements between national and regional governments in Papua New Guinea have historically created an uncertain business environment for Newcrest and may increase its costs of business. Such disagreements may resurface in the future and could adversely affect Newcrest's operations in Papua New Guinea.

The State is undertaking a broad review of mining laws, with potential reforms extending the level of local equity participation in projects; more stringent requirements for local participation in mining-related businesses, local mineral smelting and processing; and implementing broader changes to the regulatory regime for mining and related activities. There can be no certainty as to what changes, if any, will be made to the *Papua New Guinea Mining Act* under the current or future governments. Material changes to the *Papua New Guinea Mining Act* may have a material adverse impact on Newcrest's ability to own or operate its respective properties and to conduct its business in PNG.

The State is also working on a set of new policies concerning geothermal energy, mine closure, sustainability, biodiversity offsets, carbon offsets, offshore mining and resettlement. Policies under consideration that, if adopted and to the extent applicable, may adversely affect the Golpu Development include, increasing the State's entitlement to acquire equity in new mines, restriction on fly-in/fly-out operations, local smelting and processing requirements, mine closure planning and funding obligations, and other changes to the regulatory regime for mining and related activities.

25.17 Conclusions

Under the assumptions in this Report, the Golpu Development shows a positive cash flow over the life-of-mine and supports the Mineral Reserve estimate. The mine plan is achievable under the set of assumptions and parameters used.

26 RECOMMENDATIONS

As major engineering studies and exploration programs have largely concluded on the Golpu Development, the QPs are not able to provide meaningful recommendations.

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