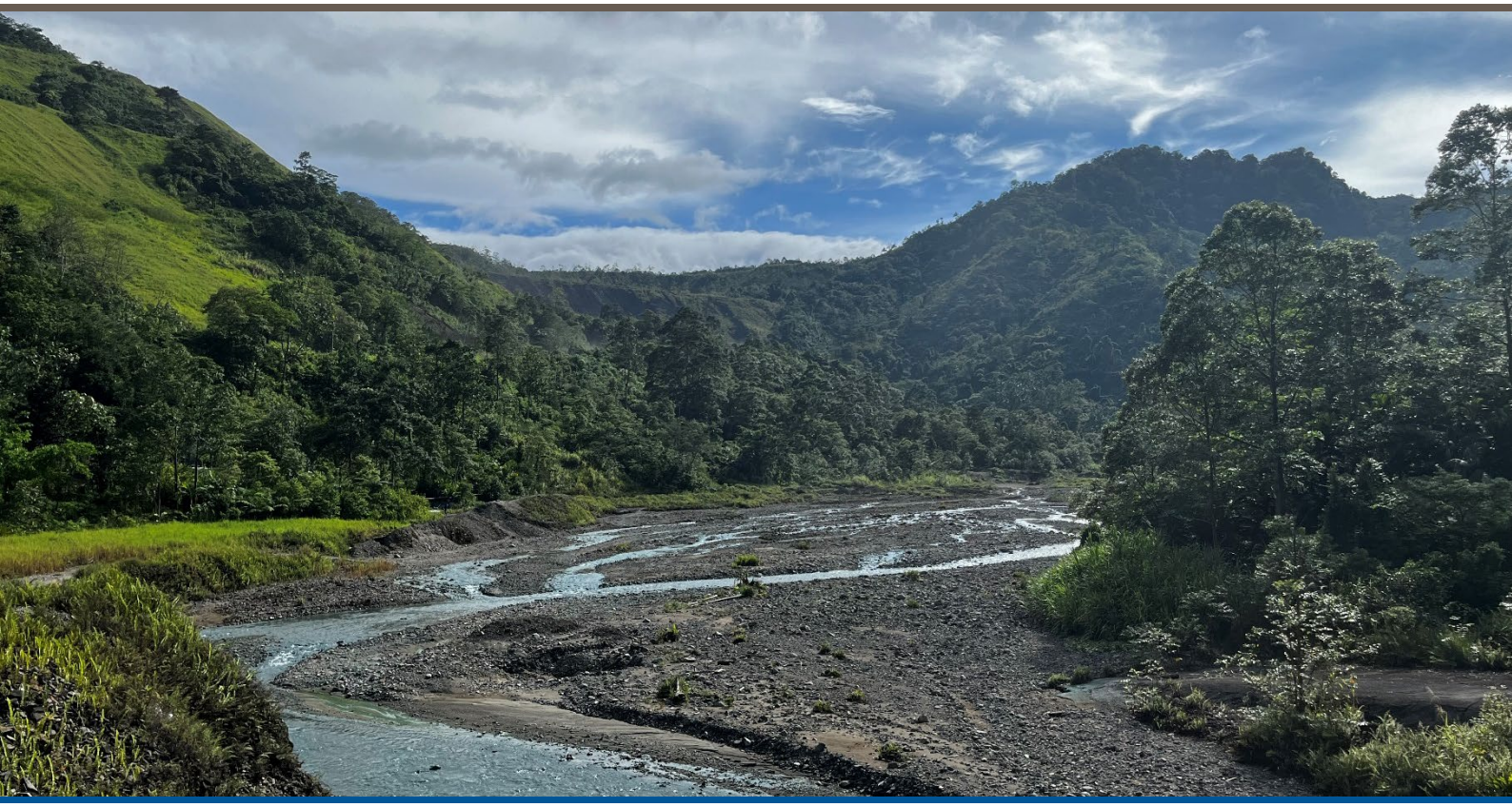
Panguna Mine Legacy Impact Assessment

Phase 1 Assessment Report
Chapter 2 – Setting

Panguna Legacy Assessment Company Limited



Reference: 754-MELEN305719_R03

CONTENTS

LIST OF TABLES

LIST OF FIGURES

2. SETTING

The history of the conflict on Bougainville, the social and environmental setting for the Panguna Mine and the complex history of the mining operation have a significant influence on the scope and execution of the Legacy Impact Assessment. While chapters 5 and 6 provide a detailed contemporary characterisation of the environmental and social setting of the study area respectively, this chapter provides an overview of the social and environmental setting of the Panguna Mine, the history of its development, the 1989 review into the environmental and social impacts of the mine and the conflict to set the scene for the Phase 1 Assessment Report.

2.1 SOCIAL SETTING

Bougainville has a history of human settlement dating back to at least 30,000 years (Macdonald, C and McNee, G 2015). People of diverse origins travelled via New Guinea and the Bismarck Archipelago and settled in Bougainville, with this diversity of origin reflected by the significant differences in languages spoken in Bougainville today. Languages in Bougainville belong to two major families:

- The Austronesian language group, of which there are sixteen languages, who primarily reside in the north of Bougainville.
- The Papuan language group, of which there are eight languages, who primarily reside in the central and southern sections of Bougainville (Tryon 2015).

The dominant languages within the study area are Torau, Nasioi, Nagovisi, and Banoni.

Although belonging to a language group is a component of identity, many Bougainvilleans are polygots, and in addition to speaking multiple Bougainvillean languages and dialects, Tok Pisin is spoken by the much of the population.

Separation by geographic features (e.g., mountains or rivers), and natural resource access and use – that is, the environment that people live in and rely on, has resulted in variations in cultural identity amongst the language groups. These variations present in a range of features, including language (from pronunciation to having separate dialects) cultural practices, diet, and material culture (Ogan 1991; Regan 2015).

Clans are a major source of identity and means of social organisation, and it is common for people to attribute a range of features such as appearance and abilities to clan membership (Regan 2015). Clan membership is inherited matrilineally throughout most of Bougainville, with a few exceptions in Buin and Nissan Island (Regan 2015). Matrilineal descent are defining social features of Bougainville (Ogan 2015); more recently, matrilineality has been emphasised as component of Bougainvillean identity and highlighted through women's participation in the peace-making process (Ogan 2015; Togolo 2023). The importance of matrilineal descent has contributed to a higher status for women in some Bougainvillean societies compared to the general status of women in most Papua New Guinean cultures (Wesley-Smith and Ogan 1992).

Land is of paramount importance in Bougainvillean and Papua New Guinean cultures more broadly. At a high level, the use (such as gardening, hunting, fishing etc) and passing on of land are central to Bougainvillean social custom. Gardening, fishing, and hunting are not only subsistence activities important for food provision and livelihood production, but are also important cultural activities, providing the basis for developing and maintaining social ties and transmitting cultural knowledge. Most people live in small settlements and depend on foraging, clearing areas of land for growing root crops and raising pigs, supplemented by hunting of wildlife or fishing depending on where they live (Macdonald, C and McNee, G 2015). Artisanal mining is also an important source of livelihood or supplementary income for thousands of Bougainvilleans and is at least the second largest industry in the cash economy of Bougainville, behind cocoa production (O'Faircheallaigh, C, Regan, A and Kenema, S 2017).

Across Bougainville, there is traditional leadership structures, including the role of clan and village leaders, which is heredity in some areas (O'Faircheallaigh, C, Regan, A and Kenema, S 2017). The Bougainville Constitution recognises these leaders and other forms of customary authority and seeks to strengthen them through the establishment of Community Government, formerly known as the Council of Elders. The Community Government functions similarly to the local level government areas in other parts of PNG, and blends traditional and modern forms of governance (Macdonald, C and McNee, G 2015). A Community Government area is made up of between three to 15 ward areas. A ward area is the smallest administrative unit within Papua New Guinea's national government structure. People in each ward area elect one woman and one man to serve as their ward representatives for a five-year term (ABG 2022). The election of one woman representative is unique to Bougainville and a legislative requirement.

Church plays an influential role in the daily lives of Bougainvilleans, with regular church attendance and tithing common practices (Jeffery, Kent and Wallis 2017). The influence of the church extends to broader social organising, with faith-based civil society organisations being prominent (Wallis 2019). The church and church-based groups supported Bougainvilleans during the conflict in terms of organising relief supplies. These groups played enduring roles in the reconciliation process (Boege, Brown and Moe 2012). Similarly, women's groups, predominantly faith-based, were formed during the conflict to promote peace and then were heavily involved in the reconciliation process. Consequently, faith based and women's groups continue to dominate 'civil society' in Bougainville (Jeffery, Kent and Wallis 2017; Wallis 2019).

With the exception of Arawa, all of the land developed as part of the Panguna Mine is customarily owned by Bougainvilleans (AGA 1989), including:

- SML: customarily owned by the Nasioi people.
- Loloho port, power station and camp: customarily owned by the Rorovana people.

Within the study area, customary land applies to the Nasioi, Nagovisi, Banoni and Rorovana people.

2.2 ENVIRONMENTAL SETTING

This section provides an overview of the climate, topography and soils, hydrology and biodiversity for context about the environmental setting of Panguna.

Bougainville is a narrow island elongated northwest southeast. It is dominated by a backbone of high mountains from which swift flowing streams descends northeast into the Pacific Ocean and southwest into the Solomon Sea. The main types of soil present in Bougainville are alluvial, colluvial or slope, moderately weathered brown ash, and unweathered sandy volcanic soils with black topsoils.

The mountainous central Bougainville region is drained by numerous small rivers and creeks. Drainage towards the east to the coastal fringe is well defined, while towards the west, rivers meander through extensive swamps prior to discharging into the gently shelving coastline (Minenco 1996).

The island of Bougainville is biogeographically more similar to the Solomon Islands than to the island of New Guinea. Limited information exists on the pre-mining condition of the freshwater and nearshore environments of the study area. There has been some monitoring for riverine and estuarine fishes between 1975 and 1988, though this was primarily aimed at quantifying claims for loss of fish resource, rather than specific monitoring of the ecological health of the rivers and estuaries.

The climate in Bougainville is tropical with high rainfall, temperature and humidity year-round. From the Panguna area down to the east coast of the island at Loloho, the average daily temperature ranged from 23.5ºC to 27.2ºC. Monthly rainfall at Loloho averaged between 153 mm and 328 mm while at the Panguna area the mean monthly rainfall was between 211 mm and 532 mm; total annual rainfall at Loloho was 2,840 mm and for the Panguna area total rainfall was 4,361 mm.

2.3 HISTORY OF THE PANGUNA MINE

This section provides an overview of the history of the Panguna Mine, from exploration and permitting to the cessation of mining in 1989.

2.3.1 Geology and mineralisation

The principal rock types associated with the mineralisation at Panguna comprise intrusions of quartz diorite/granodiorite into andesites (Minenco 1996). The intrusive rock types found at Panguna include microdiorite, diorite, granodiorite, monzonite, syenite, and granophyre (Blake and Miezitis 1967). These rocks contain a range of minerals including plagioclase, augite, pale green hornblende phenocrysts, and abundant andesitic xenoliths. Secondary minerals consist of chlorite, amphibole, epidote, and quartz (Blake and Miezitis 1967).

The Panguna deposit is a porphyry copper type, meaning its copper content is disseminated through rocks which are igneous in origin. The Panguna mineralisation is predominantly in the form of chalcopyrite with some bornite (two copper-iron sulfides) mostly along thin veins. Some of the intrusive rocks have minor amounts of chalcopyrite disseminated within the rock fabric. Gold and silver are contained in the chalcopyrite, but free gold is rare. Pyrite (iron sulfide) and magnetite occur along veins and in disseminated form, and there are also small amounts of molybdenite along veins. The primary ore is covered by layers of secondary and oxidised ore, and in places by boulders, volcanic ash, alluvium and soil.

Initial ore reserve estimates at the Panguna deposit identified approximately 900 million tonnes (Mt) grading at 0.48% copper, 0.55 grams per tonne (g/t) gold, and 3 g/t silver (Minenco 1996).

2.3.2 Exploration and permitting

In 1964, a sizeable porphyry copper and gold deposit was discovered by CRA near the centre of Bougainville (ANU 2021). After extensive exploration and the preparation of a detailed feasibility study, an agreement was negotiated between BCL and the administration and subsequently ratified by the PNG House of Assembly in 1967 and a decision to proceed with developing the mine was made in 1969 (Vernon 2005).

2.3.3 Construction

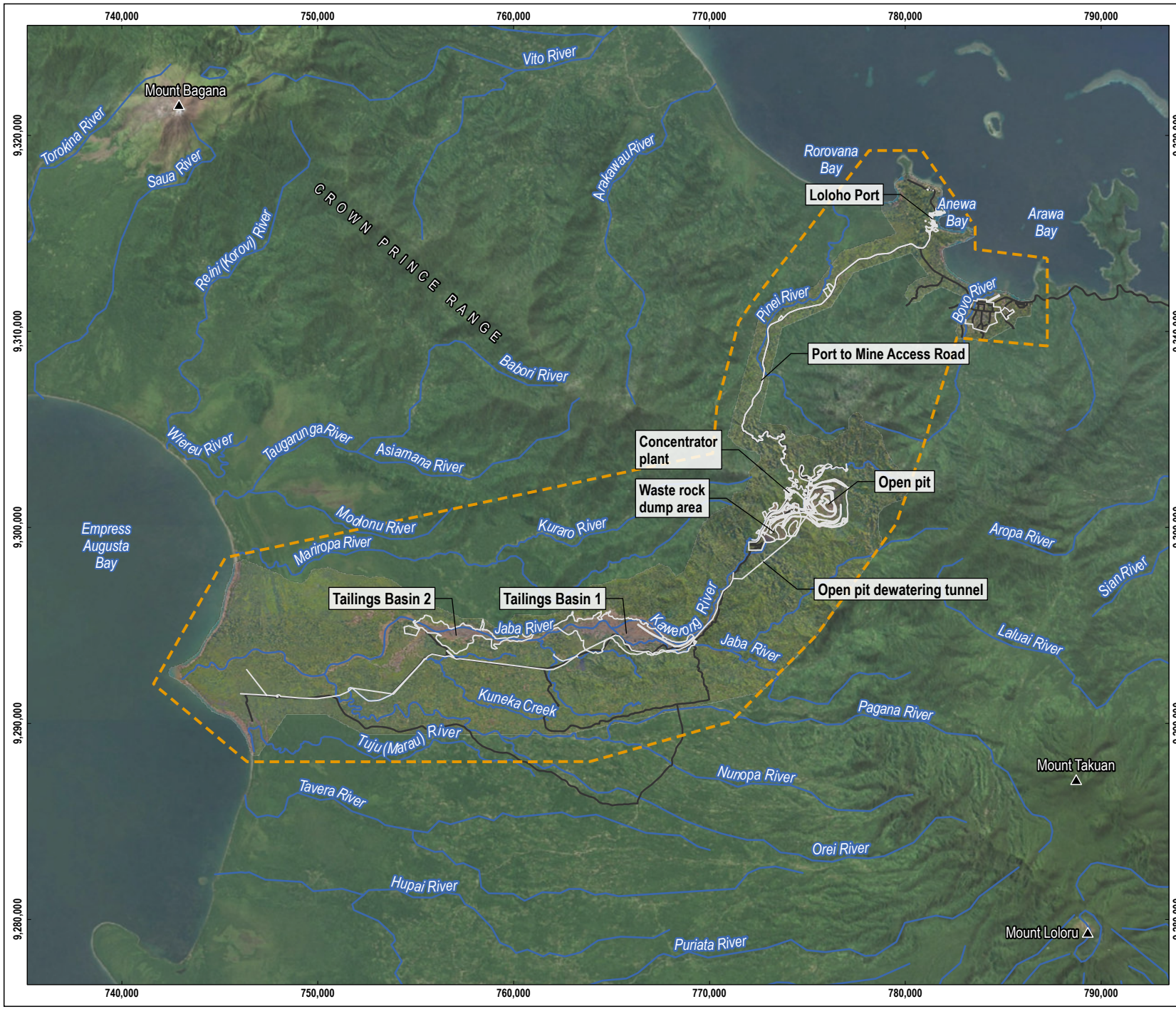
Engineering of facilities for the mine began in 1966. Figure 2.1 shows the key infrastructure elements of the mine.

A temporary access road from the base camp near Kieta was constructed by 1967. Prior to this, provisions for the exploration camp at Panguna were supplied by helicopter. By the end of 1970 the temporary access road was replaced with a two-lane highway, the Port to Mine Access Road. Construction of the Loloho port began in 1969.

The supply of power to the mine was initially provided by an 11 MW power facility at Panguna. This was later replaced by a 135 MW oil burning steam station constructed at the port in Anewa Bay (Construction, Mining, Engineering Publications. Undated).

Residential townships were developed at Panguna and Arawa for the operations phase of the mine to house the Panguna workforce of approximately 2,500 people plus family members in many cases (Construction, Mining, Engineering Publications. Undated). Arawa Town located on the east coast was jointly developed by BCL and the Administration of the Territory of PNG.

Other infrastructure developed as part of the mining operation included the concentrator plant, a dam on the Jaba River for the supply of water to the mine and concentrator, a limestone quarry, office, warehouse and maintenance facilities, as well as potable water and sewage treatment systems.



LEGEND

- Road
- Watercourse
- Infrastructure feature line
- Infrastructure feature area
- Phase 1 study area

SOURCE
Roads, watercourses and infrastructure features from Tetra Tech Coffey.
Imagery from Woolpert (2023) and Google Earth (2020).

0 2.5 5 km

SCALE **1:275,000**
PAGE SIZE: **A4**
PROJECTION: **WGS 1984 UTM Zone 56S**

PANGUNA LEGACY ASSESSMENT COMPANY

PANGUNA MINE LEGACY IMPACT ASSESSMENT PHASE 1

FIGURE 2.1

Key mine features

TETRA TECH COFFEY

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Construction activities also included clearing of 220 hectares of rainforest over the mine pit. This involved the removal of large trees and undergrowth, where methods of clearing involved the use of logging and herbicide (Construction, Mining, Engineering Publications Undated).

Following the removal of vegetation, overburden, comprising volcanic tuff and weathered rock, was removed. This was undertaken by a process known as hydraulicking, a method which involves the use of high-pressure water passed through a nozzle and sprayed over the surface of the overburden, to break it down. Once disturbed and wet, the overburden becomes a mud. This material then flowed down natural drainage lines and into the river system (Construction, Mining, Engineering Publications Undated).

2.3.4 Operations

By the end of 1971, the pre-production, construction and development of the mine had been completed. Production of commercial concentrate began in 1972 (Construction, Mining, Engineering Publications Undated).

Mining and mineral processing

The low-grade copper–gold orebody at Panguna was mined by conventional open cut methods using electric shovels and 100 to 150 tonne (t) trucks (Vernon 2005). The ore material extracted from the pit reported to the concentrator, where ore concentrate, and a tailings waste stream were produced. Of the total mass of ore mined, over 98% became tailings, with less than 2% being ore concentrate (AGA 1989). The concentrate containing 30% copper, 28 g/t gold and 85 g/t silver, was transferred to Loloho port for dewatering and shipping. Further detail on the mineral processing is provided below.

The ore was processed at the concentrator using conventional crushing, grinding and flotation. Ore removed from the open pit was delivered to a gyratory crusher located on the edge of the pit, conveyed to the concentrator facility where it was further crushed through a series of secondary and tertiary crushing and screening equipment and placed in a fine ore stockpile. The concentration process consisted of a series of ball mills, cyclones, regrind mills and flotation cells to liberate and recover copper and gold from the ore.

In the flotation cells, chemical reagents were added to the finely ground ore and air was introduced. In general terms, collector and frother reagents are added to the agitated cells and copper minerals selectively adhere to the froth and float to the surface where the initial copper concentrate is collected. The remaining spent ore, or tailings, sink to the bottom of the tanks. The resulting copper concentrate was sent to a concentrate thickener to remove some of the water resulting in a concentrate slurry of 65 to 70% solids that was pumped to the port facility at Loloho, on the east coast of the island. Port facilities consisted of slurry storage tanks, disc-filters to dewater the concentrate and rotary driers to further dry the material and prepare it for transport by ship. Dewatering water was transferred to a settling pond; however, it is not clear where it was ultimately discharged to.

Initially, tailings from the flotation process were directly discharged into Kawerong River and onward into the Jaba River without thickening or dewatering. Fresh water for use in the grinding and flotation circuits in the concentrator facility was pumped from either the Kawerong River or the Jaba Pump Station, located 6 km from the plant and 600 m lower in elevation.

To increase the availability of water to the concentration plant and to reduce pumping costs, a series of four tailing thickeners were installed in the mid-1980s. These thickeners allowed the tailings material to settle and densify and the recovered water was recycled to the concentrator. In addition to reducing pumping and reagent costs, this improvement project resulted in a reduction of the flotation feed pulp density from as high as 50% solids to 37% solids (Tilyard 2009). This reduced flotation feed density improved the grinding performance of the ball mills and increased copper recovery.

During the last several years of operation, in recognition that discharge of tailings to the river system was not sustainable, a tailings pipeline was designed to transport tailings 32 km to the west coast marine discharge point (BCL undated). Construction of the tailings pipeline was nearly complete in 1989 when the mine operations ceased.

One other process change that occurred in the mid-1980s was the addition of a preconcentration screening plant on the northern end of the waste rock dump to increase head grade, mill throughput, and copper recovery. The plant screened low grade ore and below cut-off grade material (i.e., high grade waste), separating the finer grained material and sending that material to the concentrator for processing. Sulfide grains containing higher grades generally occurred in fracture planes which concentrated in the finer size ranges after blasting and crushing (Tilyard 2009). A conveyor system transported the undersize material (<35 mm) to the coarse ore conveyor joining the primary ore feed to the mill. Oversized material was stacked on the waste rock dump. Based on a review of aerial images it appears that this material was conveyed to the face of the downstream embankment of the waste rock dump and placed with a conveyor spreader.

The initial throughput of the plant was approximately 80,000 tonnes per day (tpd), but through the addition of additional ball mills, in incremental steps, and other process improvements, plant throughput was increased to over 130,000 tpd (BCL 1986; Tilyard 2009; Minenco 1996). During full production of the Panguna Mine, ore was mined at a rate of up to 130,000 tpd (Davies 2005; Minenco 1996).

The Panguna Mine operated profitably until suspension of operations in 1989.

Mine waste production

In total more than 1 billion tonnes of rock were removed from the Panguna pit between 1968 and 1988 (Jeffery, Marshman and Salomons 1988), including ore, waste rock and unconsolidated overburden.

Overburden material, or waste rock (material from the open pit with insufficient metal content to process) was truck hauled to and placed in the waste rock dump area in the valley below the concentrator facility.

Beginning in October 1968, fine unconsolidated overburden was stripped from the deposit to allow access to the underlying orebody (EGI 2014). Fine grained, unconsolidated overburden, initially removed by hydraulic methods, comprised 36 Mt of volcanic ash and 16 Mt of weathered surficial material. This was disposed directly into the Kawerong River (EGI 2014). Hydraulic overburden removal ceased in September 1971 (Pickup and Higgins 1977; Brown Undated) but disposal continued during push back of the pit walls. This overburden continued to be disposed to the Kawerong River, below the toe of the waste rock dumps until 1981, after which it was disposed in the ‘hard rock’ waste dumps.

Average production of waste rock in 1985 was 90,000 tpd (Jeffery, Marshman and Salomons 1988), increasing to 120,000 tpd in 1988 (AGA 1989). The total mass of waste rock produced between the start of production in 1972 and 1988 was initially estimated to be approximately 280 Mt (Jeffery, Marshman and Salomons 1988). However, a higher value of 395 Mt was also calculated for the same time period (EGI 2014). The surface area of the waste rock dumps in 1988 was estimated to be between 2.8 km^2 (Jeffery, Marshman and Salomons 1988) and 2.4 km^2 (EGI 2014). Waste rock was disposed by end dumping methods into steep sided valleys, with the maximum vertical height of the waste rock dumps in the order of 100 to 200 m (AGA 1989).

Waste rock eroded from these dumps ranged from silt to boulder size fractions, with 80% being in the gravel size fraction (2 to 64 millimetres) (Pickup and Higgins 1977). The eroded waste rock largely remained in the Kawerong Valley, with little of the coarse material traveling past the Kawerong-Jaba confluence (AGA 1989).

Ore and tailings production started in 1972, with the generation of approximately 80,000 tpd of tailings, increasing throughout mining to approximately 140,000 tpd of tailings in 1988. The total cumulative mass of tailings that had been disposed by 1988 was estimated to be approximately 500 Mt (Jeffery, Marshman and Salomons 1988). However, based on the mining of 610 Mt of ore with a 2% concentrate proportion, total

tailings tonnages could be as high as approximately 600 Mt. This discrepancy may, at least partially, be due to even higher production rates in 1989 not being considered in the initial figure. Tailings were discharged to the Kawerong River, via a pipeline, as a slurry (60 wt.% solids) (EGI 2014).

It was estimated that approximately 60% of the tailings discharged to the Kawerong River reached the Empress Augusta Bay, with the remaining 40% retained on land within the river valley (Environmental Management and Planning Services 2015). Using the cumulative production figures (500 to 600 Mt) this equates to 300 to 360 Mt of tailings deposited in the Empress Augusta Bay, and 200 to 240 Mt being retained on land. Of the tailings deposited on land, the majority was deposited in the first of two sediment basins downstream of the Kawerong-Jaba confluence, between cross section 11 and cross section 17, and cross section 21 and cross section 25, respectively (see Figure 2.1). It is estimated that 70% of the tailings retained on land were deposited in the Tailings Basin 1 (around 140 Mt to 170 Mt), and a further 10% (20 Mt to 24 Mt) were deposited in Tailings Basin 2. After 12 years of tailings discharge a large delta approximately 700 ha in size had been created at the mouth of the river system, with about 10% of the tailings residing above the high-tide mark (Environmental Management and Planning Services 2015). This delta was estimated to be approximately 945 ha in size in 1989 when operations ceased and approximately 1,015 ha in 2020 (Tetra Tech Coffey 2022a).

Between 1968 and 1988, a total of at least 600 Mt of sediment was determined to have entered the Kawerong-Jaba river system, consisting of a mixture of tailings (at least 500 Mt), overburden, and natural catchment erosion (Jeffery, Marshman and Salomons 1988). However, as natural erosion in the mine catchment area was less than 100,000 tonnes per year, the sediment load was dominated by mine waste materials (Jeffery, Marshman and Salomons 1988). An earlier study also estimated that 226 Mt of sediment had entered the Kawerong River between 1968 and 1976 (Pickup and Higgins 1977). Contributions over that period included 108 Mt of tailings, 70 Mt eroded from waste rock dumps, 46 Mt of fine unconsolidated overburden, and 2 Mt of natural mine catchment sediment erosion.

2.3.5 Cessation of mining

Growing disapproval felt by many Panguna landholders regarding perceived unfair share of financial benefits from the mine, the build-up of distrust of BCL associated with earlier land acquisitions, and the perceived social and environmental effects of the mine, led to a campaign of protests and civil disobedience by landholders in 1988 (see Section 2.5). The mine ceased in 1989 and has since never re-opened. There has been no implementation of formal closure, maintenance of mining or process infrastructure or remediation work on the mine or downstream receiving environment since cessation of mining.

2.4 SUMMARY OF THE AGA REPORT

A review of the environmental, socio-economic and public health impact of the Panguna Mine was ordered by the National Executive Council in 1988 following strong representations from landowners in the mine area (AGA 1989). Prepared by AGA in 1989, the review while contested by some, remains the key document with a detailed description of impacts and community concerns as of 1989, as:

> *"When mining commenced on Bougainville there was no requirement to undertake environmental impact assessment and no environmental report or plan was produced by the mining company or the Government. Prior to the current review reported here the only independent assessment of the Bougainville copper operation had been done for the United Nations Environment Programme in 1977. Environmental reviews have been produced by the Company since 1984" (AGA 1989).*

Impacts that predate cessation of mining in 1989 are not within the Phase 1 Scope of Work, and therefore the impacts discussed in the 1989 AGA report have not been assessed within the Phase 1 Assessment Report. However, a summary of the impacts and community concerns as of 1989 from the review have been included here to provide historical context. As acknowledged by AGA:

> *"Simple statements of the impact of mining on the Panguna area and its landowners are quite inadequate an explanation for the very strong feeling the landowners hold." (AGA 1989).*

2.4.1 Ecological impacts

The AGA (1989) review states that as a result of tailings deposition in the Kawerong and Jaba rivers, "*it will take many years to attain a stable channel and for the remaining areas of tailings to stabilise and revegetate*". Additionally, copper would be likely to continue to leach from the tailings over time. As a result of the unstable flow of water, high sediment load and water chemistry, there were impacts on fish migration to the upper Jaba River system. Though it was noted that the water quality would eventually improve and fish return it is likely that:

> *"… local people may continue to avoid using the water because of lingering suspicion." (AGA 1989).*

The tailings had dammed the tributaries which flowed into the Jaba River. Approximately 120 hectares (ha) of ponds had formed behind the dam, which provided habitat for mosquitoes. The review states that the water table had risen and trees had died in this area:

> *"The forests that once occupied the Jaba Valley are unlikely ever to return. The substrate and physical character of the tailings deposits are foreign to the vegetation of the upper Jaba Valley and the future vegetative community on the tailings is likely to be unique to the area." (AGA 1989).*

The central Empress August Bay was dominated by approximately 900 ha of tailings in 1989. The review determined that the delta would eventually revegetate, depending on sea level changes, but:

> *"…the new tailings disposal scheme will dramatically alter the existing form of the delta and so delay the natural process of revegetation." (AGA 1989).*

The benthic animals had been buried by tailings or killed by copper in "*over about half*" of the Empress Augusta Bay. Evidence collected indicated the deposition of tailings on Empress August Bay beaches could lead to a "*slow decline*" in the population of mussels in the bay. Conversely, evidence collected as of 1989 indicated there was no major impact on the fish resource of the bay, with no copper and no other metals appearing to have accumulated in fish flesh.

2.4.2 Changes to the physical environment

> *"The impact on the physical environment of the mine has been extreme by any measure and most of the adverse impacts are long lasting; in some cases permanent" (AGA 1989).*

As of 1989, the pit covered approximately 400 ha. AGA (1989) state that this land is "*lost forever*" and is "*unlikely ever to regain any significant production value*". The waste rock dumps occupied approximately 300 ha in 1989 and similarly to the pit, this land is unlikely to have any productive value for "*several generations*".

Approximately 3,000 ha of the Jaba Valley inshore from the coastline was occupied by tailings in 1989. The delta was revegetating naturally where it was stable, though the proposed tailing stacks were likely to be: less stable, subject to channelisation and subject to problems associated with low pH (AGA 1989).

The mine resulted in the establishment of two new towns, Arawa and Panguna, and new service facilities such as hospitals, schools and commercial facilities. Additionally, a number of villages were resettled, which involved the "*resettlement of 289 people from eight villages in the Kawerong and Jaba Valleys…between 1969 and 1971*".

2.4.3 Impacts affecting quality of life

AGA (1989) states that there were community concerns over the "*persistent*" and "*unpleasant*" smells of process chemicals nearby the mine:

> *"The smell of process chemicals in the Kawerong Valley is a constant reminder to local people that the mine is discharging chemicals into the environment. Irrespective of the actual hazard associated with these chemicals (it is quite small) their presence signalled in such an obvious and offensive way does nothing to calm the suspicions of the people" (AGA 1989).*

Dust produced by the mining operation was a significant concern for local health and crops:

> *"…we doubt that this is a serious threat we must realise that the landowners have not had the exposure to dust that those in less well vegetated countries have had and this may contribute to their fears." (AGA 1989).*

Noise pollution, primarily from blasting, and the presence of unfamiliar individuals were other stated concerns of communities:

> *"Although none of these problems is as great as in many urban areas, they have not been freely chosen by villages populations." (AGA 1989).*

Furthermore, an increase in traffic resulted in increased accident rates and community concerns, in addition to related issues such as roadside litter. Access to villages had been hindered as a result of hazardous tailings deposits affecting accessibility to the road, for which there was no alternative, as well as safety in areas such as along the northern bank of the Jaba River.

2.4.4 Employment, social services and infrastructure

> *"The landowners have received education and health services, improved communication and infrastructure, and earning opportunities as waged workers and contractors and from produce sales." (AGA 1989).*

The construction of the Port to Mine Access Road had improved access to services and markets for villages affected by mining operations, resulting in improvements in access to education and health services. Additionally, the construction of the power station at Loholo reduced electricity costs. The report states that the introduction of this infrastructure and improvement in services was a "*very considerable improvement*" on the pre-mine conditions. The construction of the mine contributed to a "*significant*" expansion of the labour market (skilled and unskilled) and increased levels of personal income due to wages or compensation payments tied to mine related activities.

However, the "*gains*" from infrastructure and services derived from the mine had resulted in the decline in quality of life in the resettled villages (Dapera, Moroni, Piruari and Kuneka) through the loss of traditional lands and livelihoods:

> *"…cultural concerns…include loss of contact/connection with ancestors through destruction of cemeteries, the land they occupied, and the feelings of having betrayed the trust of both past and future generations as a result of ceding the land. Loss of cultural values associated with the traditional lifestyles is another important consideration." (AGA 1989).*

Many social impacts that resulted from the operation of the mine originated from the resettlement of villages, as described in the review:

> *"A further dimension to the social impact of the operation derives from the landowners' widespread opposition to prospecting and mining at the outset and the fact that their land was made available by the Administration for mining against their wishes and in circumstances where they were powerless to prevent it." (AGA 1989).*

While health services had improved "*considerably*", particularly in Panguna and Arawa, due to increased access to services and income, "*considerable*" concerns were expressed about the effect of dust on communities health. Complaints related to attacks of acute upper respiratory infections, asthma and bronchitis were sited. AGA found:

> *"…no evidence of direct harm to human physical health by the mine's operation. Two possible minor exceptions to this may be the irritant effect of residual lime in the tailings which may delay the healing of sores exposed to them, and the possible irritant effect of excess dust during dry spells which may bring on attacks of asthma in residents of villages in the Special Mining Lease area." (AGA 1989).*

There were also concerns regarding nutrition due to reduced production from crops and the introduction of store and supermarket foods. The review states that while nutrition "*generally improved*" and that it "*follows a pattern typical of…urban and periurban communities in PNG*", the diet in resettled villages (e.g., Dapera), were a concern as:

> *"Loss of land has almost completely destroyed the agricultural base of Dapera and Moroni villages and severely reduced agricultural development opportunities in villages such as Piuruari" (AGA 1989).*

The loss of land had resulted in pressure on food production and the cash-cropping system, resulting in dependence on purchased foods which can be less nutritionally adequate than traditional foods.

2.4.5 Other changes

AGA (1989) discusses changes which took place in Bougainville during the mining era that had no direct relationship to mining activities, such as the independence of Papua New Guinea, population growth and an increase in cash-cropping.

It also discusses other changes around 1989 that were indirectly related to mining activities. For example, that the Panguna Mine and its associated activities contributed to the acceleration of monetisation and modernisation, leading to the adoption of new behaviours and patterns. Although industrial development transforms lifestyles, facilitating faster movement of people and goods, it also contributes to the spread of diseases. These trends were present before the Panguna Mine's inception, however the rapid pace of change

as a result of the mine introduced stress to communities. AGA states that combination of pressure from these trends caused impacts to generational social cohesion, a shift in consumption habits, and a decline in traditional values. The review states:

> *"Despite assurances to the contrary, poor crop performance will continue to be attributed by some people to the mine. To some extent this is correct, not because of chemicals from the mine, but because development may have enhanced the transfer of diseases, and the land lost to the mine has put increased pressure on remaining land for gardening" (AGA 1989).*

2.5 THE CONFLICT

In the decade leading up to independence from Australia, there had been tension within Bougainville to avoid becoming part of the yet to be realised future independent PNG. Many people in Bougainville already saw themselves as separate to the rest of PNG, and much more connected racially, culturally and through historical trading relationships, with the Solomon Islands. During this decade, mining exploration activities at Panguna had begun, and in 1967, the Bougainville Copper Agreement was signed between BCL and the administration. The agreement committed the administration and BCL to terms regarding taxation, royalties, environmental management, employment and infrastructure.

Requiring land for the mine, and with all local landholders refusing to sell, the Government expropriated the land required. The mine and the Bougainville Copper Agreement triggered island-wide separatism and landowner protests. Riot police were brought to manage protesters and allow the mine to progress.

In 1974, in the lead up to PNG claiming independence, the Bougainville Copper Agreement was renegotiated, resulting in the National Government claiming a greater revenue from the mine. This helped reconcile the relationship between the National Government and BCL, but the revenue-sharing arrangement, which largely excluded Bougainvilleans, generated anger in Bougainville. Many Bougainvilleans were also deeply concerned about perceived growing social, cultural and environmental impacts of the mine.

The disapproval felt by many Panguna landholders regarding what was perceived to be an unfair share of financial benefits from the mine, along with the build-up of distrust of BCL associated with earlier land acquisitions (forced and negotiated), and the perceived social (in-migration and population growth, reduced land availability, land use practice changes) and environmental (particularly downriver) effects of the mine, contributed to an organising of people opposing the mine.

When the demands of the North Solomons Provincial Government and the Panguna landholders were not met in 1988, civil disobedience, theft and property damage directed towards the mine began. The campaign included blockades along mine access roads and the use of explosives that targeted powerlines supplying the mine. PNG troops were deployed to Bougainville in 1989 to control the situation unfolding. During this time villages near the mine were looted and burned and residents were moved to 'care centres' operated by the military where human rights abuses have been reported (Havini 1996; Amnesty International 1990).

The civil war on Bougainville lasted for ten years, resulting in up to 15,000 people losing their lives (HRLC 2020), and displacing approximately 70,000 people (Macdonald, C and McNee, G 2015). The main parties involved in the war were the Bougainville Revolutionary Army and the Bougainville Interim Government, fighting against the Government of Papua New Guinea and the Papua New Guinea Defence Force.

Table 2.1 provides a summary of the history of Bougainville since World War 1, with a focus on events leading up to and following the development of the Panguna Mine.

Table 2.1 A short history of Bougainville since World War 1, with a focus on events leading up to and following the development of the Panguna Mine

Year / period	Event
1914 - 1920	Bougainville comes under Australian military rule†
1921	League of Nations mandates Australia control of former German New Guinea, including Bougainville§
1942	Japan invades Bougainville*
1947	United Nations approves Australia establishing the Territory of Papua and New Guinea (TPNG)§
1963	CRA granted authority by the Australian administration to prospect the Panguna area‡
1964	Panguna Valley surveyed by CRA‡
	TPNG House of Assembly first general elections held‡
	Panguna mining exploration begins†
1965	Mining warden rejects objections from local villagers and grants additional prospecting licenses to CRA‡
	Confrontations occur throughout the year between villagers and geologists‡
1966	One-month prison sentences are given to villagers for destroying an exploration camp on their land‡
	The Australian Federal Minister for External Territories visits Bougainville and communicates to villagers that the mine is for the benefit of the entire TPNG as a whole; villagers will receive compensation but no special benefits‡
	Villagers near Panguna cause drilling and exploration operations to be suspended, but exploration later continues under police guard‡
	TPNG House of Assembly passes an amendment to Mining Ordinance that gives 5% royalty share to Panguna landowners‡
	Some landowners resist supporting further exploration activities regardless of the Mining Ordinance amendment‡
1967	Panguna Landowners protest the renewal of CRA's prosecting authorities‡
	Bougainville Copper Agreement signed between BCL and the administration*
1969	BCL granted Special Mining Lease (SML) following presentation of feasibility study to the Administration; unsuccessful objection by Bougainville villagers to the SML in the Australian High Court‡
	Administration compulsorily acquires Arawa plantation for town site for the mine; 1,200 people from 25 villages attend public meeting to protest the compulsory acquisition of Arawa‡
	Rorovana villagers oppose Administration attempts to acquire land at Loloho for port mine facilities; Rorovana villagers forcibly removed from their land at Loloho by riot police‡
	Formation of micro-nationalist Napidakoe Navitu movement in response to widespread unrest relating to land acquisitions for the mine, with approximately 1,500 people attending the first meeting‡
	Terms of the Port Lease at Loloho negotiated between Napidakoe Navitu and BCL‡
1970	People of Arawa Village lease land for town development‡
1971	Panguna Mine and associated construction workforce peaks at over 10,000‡
1972	Panguna mining production begins*
1974	Bougainville Provincial Government established on an interim basis, and the TPNG Government promises Bougainville will receive 95% of the state's mining royalties‡
	Bougainville Copper Agreement renegotiated†
	BCL agrees to a moratorium on exploration within existing prospection authorities‡

Year / period	Event
1975	Bougainville Provincial Assembly declares independence from TPNG, as North Solomons Republic‡
	The Independent State of Papua New Guinea is established*
	Bougainville Provincial Government is suspended by the PNG Parliament‡
1976	Anti-National Government riot on Bougainville‡
	Bougainville Provincial Government reinstated by PNG Government‡
1977	Adoption of the North Solomons Provincial Government (NSPG) Constitution‡
1978	Panguna Landowners Association (PLA) organise to seek increase in compensation payments from BCL‡
1979	BCL rejects requests for increased compensation payments, and in response villagers protest and loot
1980	A new land compensation agreement between the PLA and BCL is signed and the Road Mining Tailings Leases Trust (RMTL) is established‡
1981	The PNG National Government rejects requests by the NSPG for transfer of National Government's equity in the mine, a greater share of tax revenue, royalty rate increases, and an increase in the Non-renewable Resources Fund levy payable to Bougainville‡
1988	Demonstrations by Panguna landowners demanding the National Government cancel the Bougainville Copper Agreement
	Landowners demand K10 billion compensation for alleged land and environment damage, 50% of BCL profits and/or National Government tax revenues transferred to the Provincial Government and BCL ownership transferred to Bougainville within five years‡
	Panguna landowners block three access roads to Panguna, halting BCL mining operations for six hours on 17 May; theft of explosives from Panguna Mine magazine; series of attacks on BCL property‡
	A report on environmental and other impacts of the mine is commissioned by the PNG Government‡
	Panguna mining operations temporarily halted following several periods of explosions‡
	PNG Police riot squads brought to Bougainville from Lae and other areas to assist with managing violence, including Panguna‡
1989	PNG Defence Force troops deployed to Bougainville to help control unrest‡
	Panguna Mine operations are suspended*
1989 - 1998	Bougainville civil war†
2001	Bougainville Peace Agreement signed by the Joint Bougainville Negotiating Team and the Government of PNG*
2004	Autonomous Region of Bougainville (AROB) was established*
2005	The first Autonomous Bougainville Government was established*
2016	Rio Tinto Limited's shareholdings in the mine transferred to the ABG and Government of Papua New Guinea resulting in the ABG and PNG Government holding equal shares in BCL
2019	The non-binding independence referendum held revealing 98% of the Bougainville population wanted full independence as opposed to greater autonomy (BRC 2020)

Source: * *MacDonald, C and McNee, G (2015); † Denoon (2000); § McKenna (2016); ‡ Regan and Griffin (2015)*.

2.6 POST-CONFLICT

In 2001, the Bougainville Peace Agreement was signed by the Joint Bougainville Negotiating Team and the Government of PNG. The agreement included a plan for the disposal of weapons, provision for elections for an autonomous government of Bougainville to be held, and the provision for a referendum on Bougainville's future political status, 10 to 15 years following the election of an Autonomous Bougainville Government (ABG). The first ABG was formed in 2005. In 2019, an independence referendum showed 98% of the Bougainville population wanted full independence as opposed to greater autonomy. In 2021, an agreement was reached between the governments of PNG and Bougainville, in which Bougainville will gain independence by 2027 if it is ratified by Papua New Guinea's parliament.

The trauma of the conflict has had an enduring effect (Regan 2018; McKenna et al. 2021). In addition to those who died in direct fighting, the displacement of approximately 70,000 people to 'care centres', and divisions within Bougainville communities arising from the conflict led to further trauma (Regan 2018). Trauma within the youth population of Bougainville has also been noted (McKenna et al. 2021). Although those born during the Conflict, now aged between 26 and 36 years old, did not participate in fighting, they potentially possess memory of the events that unfolded, and may have been exposed to memories of their relatives. Exposure to problematic parental behaviour, such as drug and alcohol use and violence, as a result of post-conflict trauma has also led to further impacts (McKenna et al. 2021).

Bougainville's educational system was significantly impacted during the conflict, resulting in a large portion of the population experiencing disruptions to their education. It is believed that a cohort exists where no formal education was obtained during the conflict (McKenna et al. 2021). This has had a subsequent effect on the opportunities available to these young people in the formal economy on Bougainville and in other parts of PNG (McKenna et al. 2021). The health system also experiences substantive impacts, which contributed to the death of many during and after the conflict.

2.7 THE FUTURE OF THE PANGUNA MINE

The potential redevelopment of the Panguna Mine has been much discussed over the past decade or so. In February 2024, BCL was granted a five-year extension to Exploration License 01. BCL has publicly stated that it is progressing an active phase of exploration and development planning.

The Legacy Impact Assessment has no relationship with the potential redevelopment of the Panguna Mine.