PANGUNA MINE LEGACY IMPACT ASSESSMENT
PREPARATORY PHASE

EXECUTIVE SUMMARY

754-MELEN291242_R01

29 MARCH 2022

TETRA TECH
COFFEY

PANGUNA MINE
LEGACY IMPACT ASSESSMENT
OVERSIGHT COMMITTEE

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1. INTRODUCTION

The Panguna mine is on Bougainville Island within the Autonomous Region of Bougainville in Papua New Guinea (PNG) (Figure ES1). Bougainville Copper Limited (BCL) operated the Panguna mine from 1972 to 1989. Companies within the Conzinc Riotinto Australia/Rio Tinto Group (CRA/Rio Tinto) were together the majority owner of BCL or its predecessor companies during the development, operation and suspension phases of the mine up until 2016, when Rio Tinto's shareholdings were transferred to the Autonomous Bougainville Government (ABG) and Government of PNG, resulting in the ABG and Government of PNG holding equal shares in BCL.

The Panguna mine has a complex history. There was opposition from the local community from the time of the granting of leases and approval of the mine. Once the operations were established there was significant anger on Bougainville about the local people not receiving enough of the revenue and benefits of the mine and deep concerns during the 1980s about its perceived growing social, cultural and environmental impacts. This resulted in physical attacks on the mine and because of this it stopped operating in 1989. Since 1989, the mine has never re-opened and there has been no implementation of formal closure, maintenance of mining or process infrastructure or remediation work on the mine or downstream receiving environment.

In September 2020, 156 residents from villages downstream of the Panguna mine, represented by the Human Rights Law Centre (HRLC), filed a Complaint against Rio Tinto Limited (Rio Tinto) with the Australian Government. The Complaint alleges that the Panguna mine is causing ongoing adverse environmental and human rights impacts and seeks commitments from Rio Tinto to:

- Re-engage with affected communities.
- Fund an independent environmental and human rights impact assessment of the mine.
- Contribute to an independent fund to implement solutions.

Figure ES1 Bougainville Island location

2. THE LEGACY IMPACT ASSESSMENT

Rio Tinto and the community members represented by HRLC have agreed to an independent assessment of the mine called the Panguna Mine Legacy Impact Assessment. The assessment will investigate the environmental impacts caused by the mine since the mine stopped in 1989 (including impacts that are happening now or may happen in the future). The Panguna Mine Legacy Impact Assessment will then look at the social and human rights impacts directly connected to these environmental impacts and develop recommendations for what needs to be done to address them.

This work is being overseen by the Panguna Mine Legacy Impact Assessment Oversight Committee, an independent body made up of representatives from the ABG, the Government of PNG, key landowner and community representatives, BCL (as former operator) and the parties to the Complaint, chaired by an Independent Facilitator.

The first step in the Panguna Mine Legacy Impact Assessment is called the Preparatory Phase. Rio Tinto has agreed with the Complainants to commission an independent third-party expert consultant to complete the Preparatory Phase. Tetra Tech Coffey has been appointed to conduct this work.

This Executive Summary has been prepared to summarise the findings of the Preparatory Phase work completed by Tetra Tech Coffey. It comprises a summary of:

- The approach to completing the Preparatory Phase and the limitations of the work.
- The outcomes of each of the main technical areas of investigation for the Preparatory Phase.
- The recommendations for areas of further investigation, prioritised into:
  - Recommendations for an initial screening assessment for investigations related to acute actual and potential risks to local communities that are required to refine or inform the scope and prioritisation of subsequent investigations.
  - Recommendations for detailed investigations for areas of highest risk to local communities.

It is intended that this Executive Summary can be read and understood without needing to read the full Preparatory Phase Report. If readers want more detailed information on the outcomes of the Preparatory Phase then they are encouraged to read the full Preparatory Phase Report.

2.1 SOCIAL SETTING

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. During this decade, mining exploration activities at Panguna had begun, and in 1967, the Bougainville Copper Agreement was signed between BCL and the Australian administration. The agreement committed the administration and the company to terms regarding taxation, royalties, environmental management, employment and infrastructure. 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.

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. In 1988, civil disobedience, theft and property damage directed towards the mine began. Troops were deployed to Bougainville in 1989 to control the situation unfolding.

The subsequent civil war on Bougainville lasted for ten years, resulting in up to 15,000 people losing their lives, and displacing approximately 70,000 people.

In 2001, the Bougainville Peace Agreement was signed by the Joint Bougainville Negotiating Team and the Government of PNG. In 2019, an independence referendum agreed to under the peace agreement showed 98% of the Bougainville population wanted full independence as opposed to greater autonomy.

Today, subsistence-based lifestyles are the predominant way of life for most Bougainvilleans. Most people live in small villages and depend on foraging, clearing areas of land for growing of root crops and raising of pigs, supplemented by hunting of wildlife or fishing, and artisanal mining, depending on where they live.

2.2 ENVIRONMENTAL SETTING

The climate in Bougainville is tropical with high rainfall, temperature and humidity year-round. The northwest cyclone season from December to May has higher rainfall than the southeast trade season from June to November. Lower levels of rainfall are experienced east of the central range, due to the rain shadow effect. Rain occurs primarily as short-duration, high intensity storms, although rainfall of longer duration due to deep tropical depressions is also experienced.

The topography of the Panguna region extends from sea level on the east and west coast up to 1,000 m as it passes through the Crown Prince Range, which runs northwest-southeast through Central Bougainville. This range is the central spine of the island consisting of steep-sided mountains. Copra and cocoa plantations are evident on the eastern lowlands with mainly swamps towards the western end.

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. The total catchment area for rivers draining the Panguna mine lease area is approximately 440 km^2, less than five percent of the area of the island.

2.3 THE PANGUNA MINE

In 1964, a sizeable porphyry copper and gold deposit was discovered by CRA near the centre of Bougainville. Initial ore reserve estimates at the Panguna deposit identified approximately 900 Mt grading at 0.48% copper, 0.55 g/t gold, and 3 g/t silver. After extensive exploration and the preparation of a detailed feasibility study and the negotiation and signing of the Bougainville Copper Agreement, a decision was made in 1969 to proceed with developing the mine.

Figure ES2 shows the key mine features.

By the end of 1971, the pre-production, construction and development of the mine had been completed. Production of commercial concentrates began in 1972, with the generation of approximately 80,000 tonnes per day of tailings, increasing throughout mining to approximately 140,000 tonnes per day of tailings in 1988. Tailings were directly discharged to the Kawerong River in accordance with Agreements with the government and practices at the time. It was estimated that approximately 60% of about 500 Mt tailings discharged to the Kawerong River reached the Empress Augusta Bay, with the remaining 40% retained on land within the river valley. In total more than 1 billion tonnes of rock was removed from the Panguna pit between 1968 and 1988, including ore, waste rock and unconsolidated overburden.

Between 1968 and 1988, a total of 600 Mt of sediment was determined to have entered the Kawerong-Jaba river system, consisting of a mixture of tailings (500 Mt), overburden, and natural catchment erosion. 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.

Mining at Panguna came to an abrupt end in 1989 following attacks on the mine, and there was no implementation of plans for its formal closure and there has been no maintenance or management of the mine since.

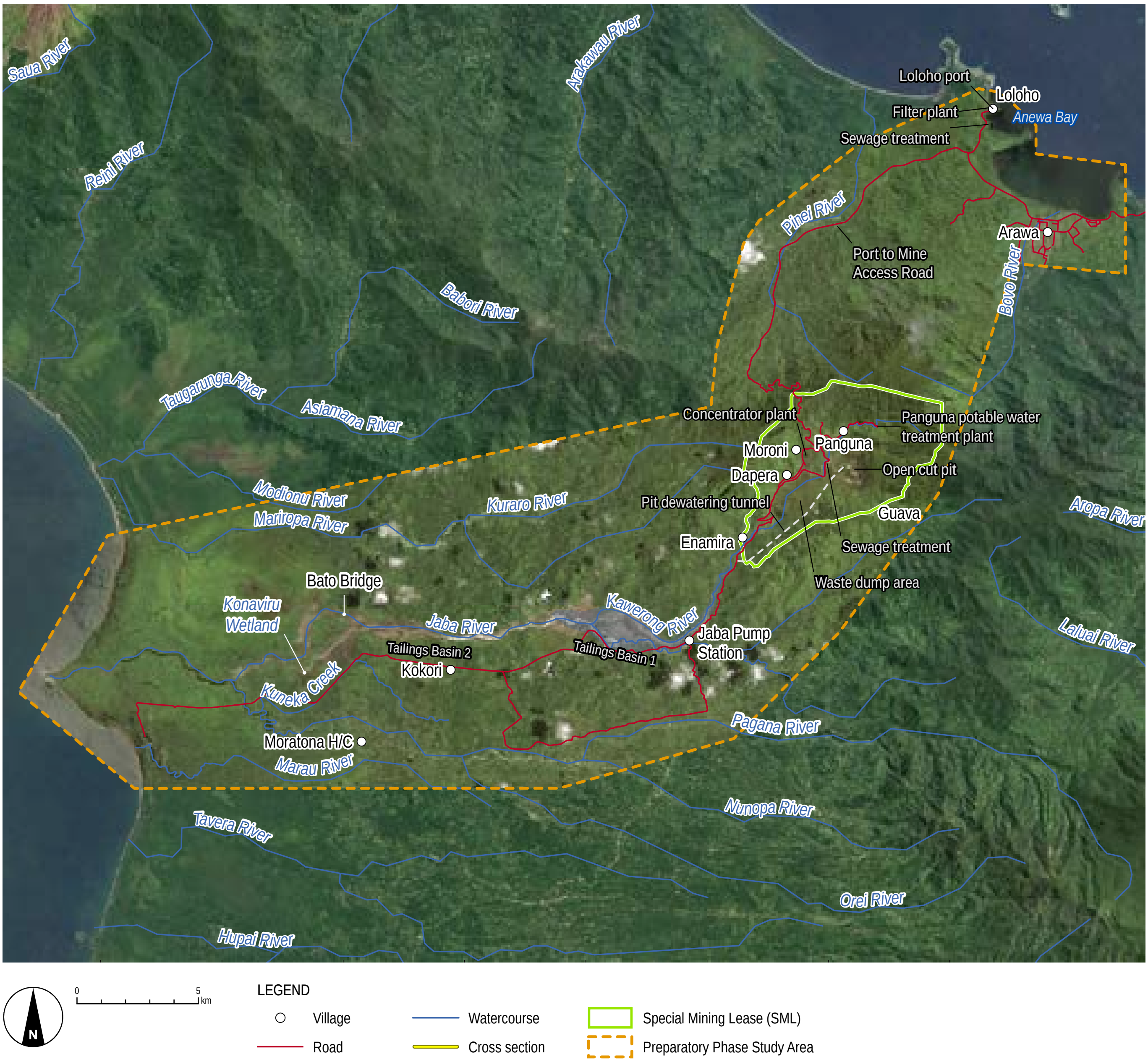

Figure ES2 Key mine features

3. PREPARATORY PHASE SCOPE OF WORK

The objectives of the Preparatory Phase are to:

- Develop a limited fact base of the Panguna mine (based on limited information) in relation to:
  - Environmental issues.
  - State of mine infrastructure.
  - Key population characteristics.
  - Communities at risk of levee failure and flooding.
- Identify data/knowledge gaps and areas of further study, to inform the scoping of the Legacy Impact Assessment.
- Provide baseline information for the Legacy Impact Assessment.

The Preparatory Phase Study Area was established by Tetra Tech Coffey and agreed by Rio Tinto and HRLC to address the Complaint. The Preparatory Phase Study Area (Figure ES3) covers:

- Arawa Bay and Empress Augusta Bay.
- Port area at Loloho.
- Associated mine infrastructure.
- Special mining lease (SML) area.
- Rivers and deltas downstream of the SML.

Because a lot of information about the mine is at least 30 years old, the Preparatory Phase has:

- Collected information about what is known about the environmental impacts of the mine.
- Tried to assess which parts of the Panguna mine present the biggest safety risks to people now.
- Identified gaps where more study is needed.
- Recommended which studies should happen next.

The 10-week Preparatory Phase involved Tetra Tech Coffey reviewing satellite imagery and aerial photos of the mine, historical reports and data held by BCL and some additional reference information such as books provided by Rio Tinto and HRLC. The Preparatory Phase was done as a desktop assessment so there was no visit to Panguna to see the mine and its impacts to the Kawerong and Jaba rivers, talk to people about these impacts and their concerns about how the mine has affected their lives, or to collect environmental samples. The Preparatory Phase was limited to assessing: the state of infrastructure at the mine; potential for levee failure and flooding risks; changes in local populations and landcover; river water quality and ecology impacts; and tailings deposition in Empress Augusta Bay.

It is important to understand that the results of the Preparatory Phase are preliminary and further work is needed to provide better answers about the current environmental and social impacts of the Panguna mine.

The Panguna Mine Legacy Impact Assessment Oversight Committee will use the outcomes of the Preparatory Phase to focus investigations during the next phase of the Legacy Impact Assessment.

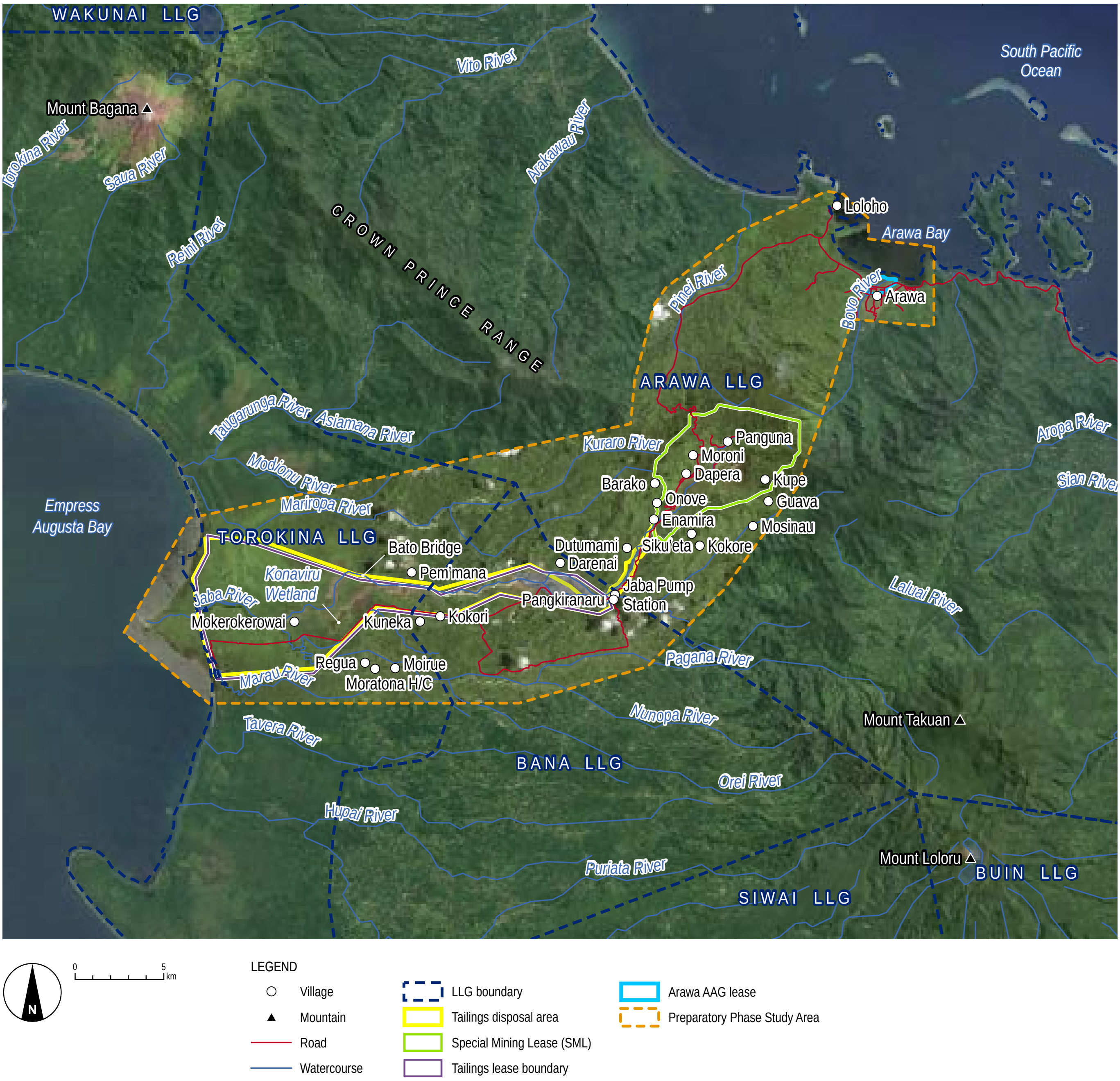

Figure ES3 Preparatory Phase Study Area

4. SUMMARY OF RESULTS FROM THE PREPARATORY PHASE

The sections below summarise the results of the Preparatory Phase for each area of technical investigation. Further detail can be found in the full Preparatory Phase Report.

4.1 STATE OF MINING AND PROCESS INFRASTRUCTURE

Detailed aerial imagery taken during mining in 1979, when operations stopped in 1989 and during 2020 was looked at to see how the mine infrastructure has changed over time. The current state of infrastructure such as buildings, townships, storage tanks, machinery and the port which supported the mine, as well as the process plant, open pit and waste rock dumps, was assessed.

As could be expected, mine and process infrastructure appears in significantly worse condition in 2020 compared to its condition when operations stopped in 1989, as can be seen in the aerial photos from 1989, 2011 and 2020 of the concentrator at the process plant (Plate ES1).

The condition of mine and process infrastructure, post 1989, is in stark contrast to the apparent condition of structures within the relocated village of Dapera, as well as the Arawa townsite, where, while some changes are evident over time, the structures appear to have been maintained in relatively good condition. Evidence of new construction was also observed in some areas of the Preparatory Phase Study Area when comparing images from 2011 to 2020, for the Panguna townsite, waste rock dump (Plate ES2) and Loloho Port.

Infrastructure deterioration is evident in non-structural features such as the North Channel Diversion, which was built between 1976 and 1979 to divert the Upper Kawerong River flows from the waste rock dumps. The North Channel Diversion now appears to be full of sediment in 2020 aerial images (Plate ES3). The level of risk associated with sediment accumulation within the North Channel Diversion cannot be quantified currently because of the lack of topographic data.

Plate ES1 Infrastructure deterioration at the concentrator at the process plant

Plate ES2 Structures constructed at the waste rock dump since 2011

Plate ES3 North Channel Diversion full of sediment from watershed erosion

Within the open pit, there is evidence of significant erosion, slope degradation, and compromised drainage systems.

Potential physical and chemical risks to people and/or the environment were identified for approximately half of the infrastructure. This means that there is a physical risk to people from something falling down, or a chemical risk to people and/or the environment from potential exposure to stored or leaked contaminants.

Detailed assessments are not possible at this stage due to the limitations of available information and will need to be undertaken during the next phase of the Legacy Impact Assessment. Areas of future work will focus on those areas of greatest safety risk to people.

4.2 LEVEE FAILURE

Aerial imagery and historical reports have been used to identify river channels and levees at Panguna.

BCL diverted river channels and constructed tailings retaining walls (also known as levees) to try and keep tailings discharged by the mine within the Tailings Lease boundary around the Jaba River from its junction with the Kawerong River to the mouth of the river at Empress Augusta Bay. Figure ES4 shows the river diversions (blue lines) and levees (black dashed lines) built by BCL which managed, maintained and extended the levees during operation of the mine; the Tailings Lease boundary is shown by the purple line.

Plate ES4 shows the levee constructed at the junction of the Kawerong and Jaba rivers, referred to as the Main/Pump Station Levee.

During operations, disposal of tailings to the Kawerong River meant that there was a constant supply of sediment to the top of the river system. This meant that the river bed built up with sediment. When the mine stopped, there was no more tailings discharged to the river, which stopped the supply of sediment. This means that since the mine stopped in 1989, the top of the river near where tailings used to be discharged has eroded down, washing sediment downstream. No maintenance has been done on the levees for more than 30 years and they have become less stable because the river has eroded down near them. For example, this erosion of the river bed near the Mine Drainage Tunnel Outlet Levee appears to have caused failure of the lower part of the levee but the lowering of the river bed means the levee is no longer needed and mine drainage can freely discharge to the river.

Plate ES4 Levee at Kawerong-Jaba river junction looking upstream, 1981

One of the most important parts of the Preparatory Phase assessment has been to try and assess the potential for levees to fail in the future. Aerial imagery, photographs and videos from 2019/2020 show that the levee at the junction of the Kawerong and Jaba rivers known as the Main/Pump Station Levee (Figure ES5) is almost certain to collapse at some stage in the future but when this will happen is unknown. Plates ES5a and 5b are images of this levee from 2020. In the image on the left hand side of the western end of the levee (Plate ES5a), erosion and seepage is visible in the red circle where the Jaba River is cutting into the south side of the levee and washing away sediment, which makes it less stable; water is flowing through the bottom of the levee.

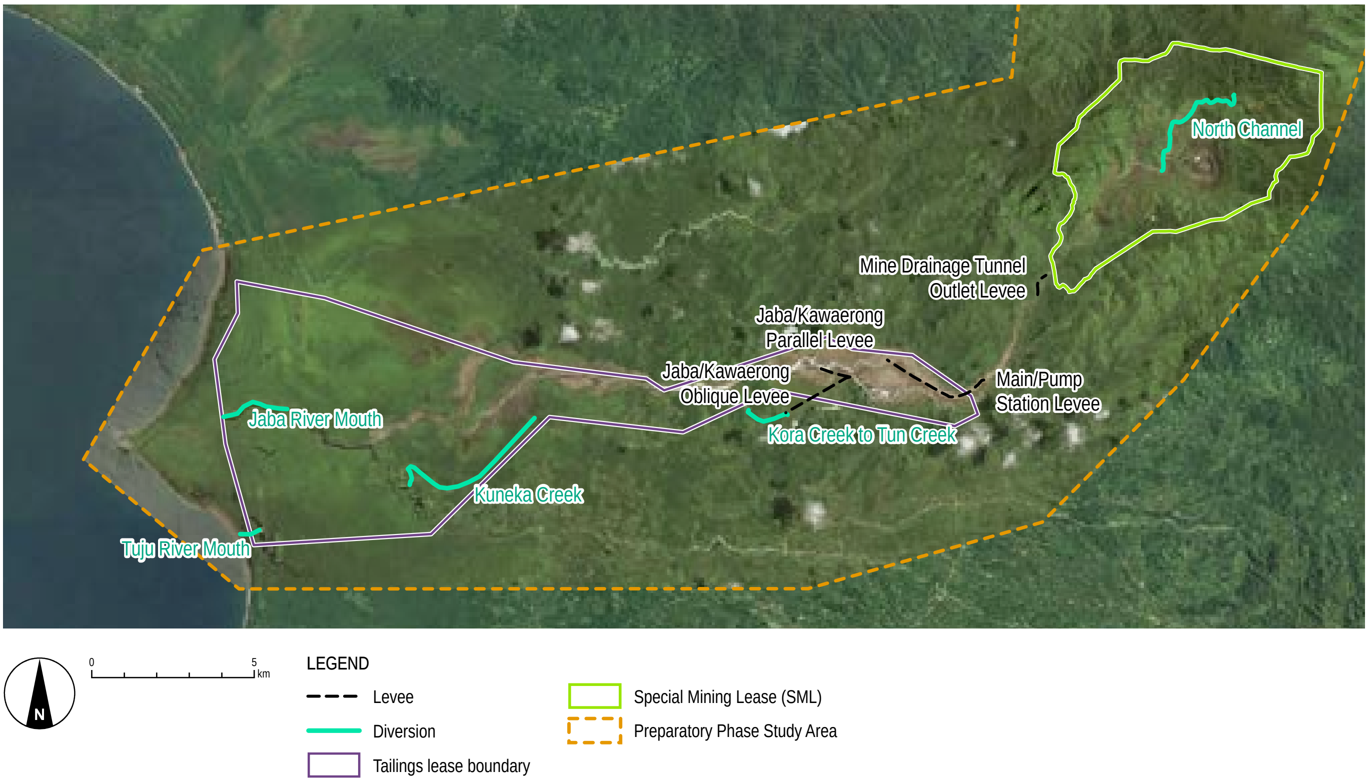

Figure ES4 Location of river diversions (blue), levees (black) and Tailings Lease boundary (purple)

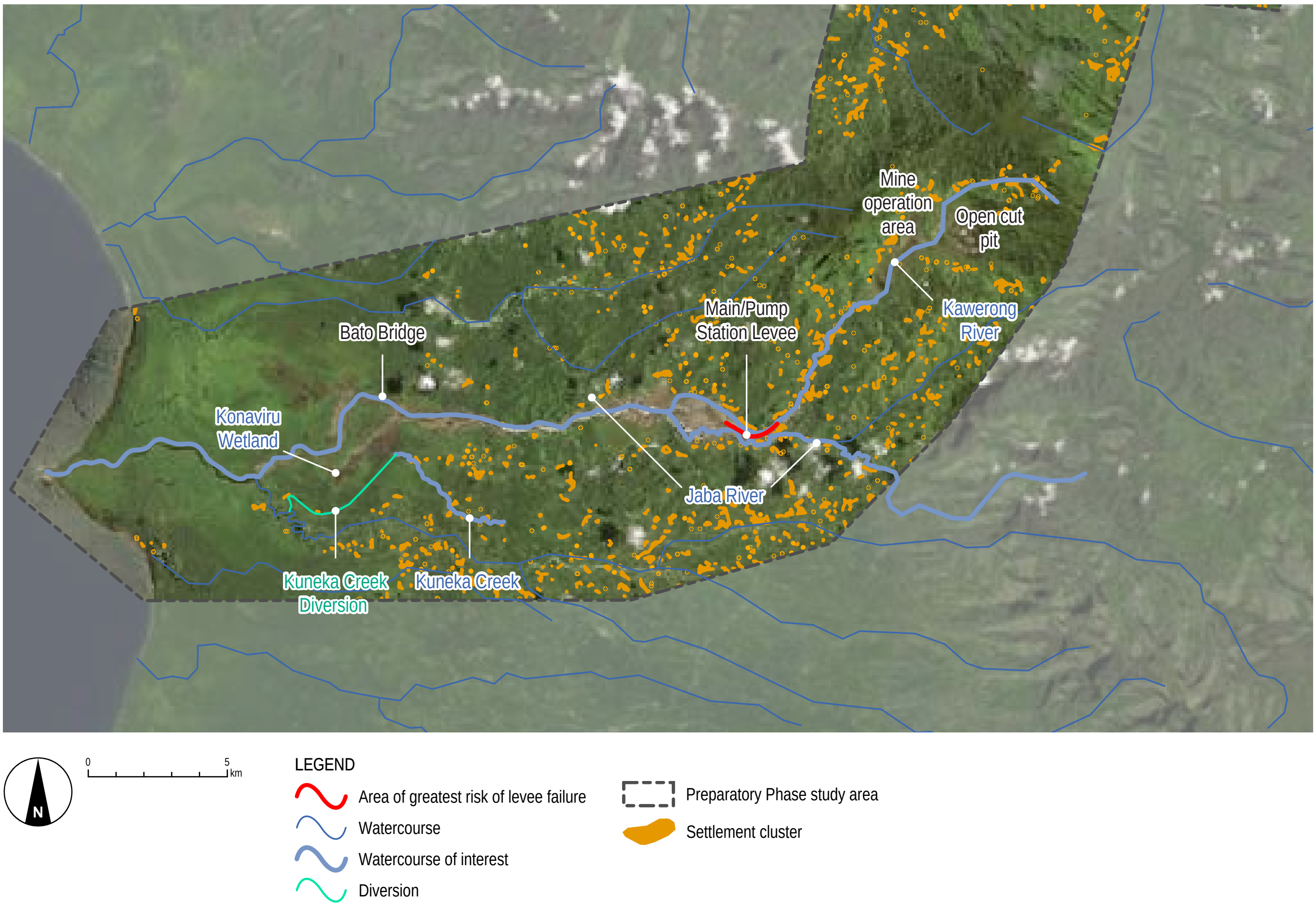

Figure ES5 Location of the levee at the junction of the Kawerong and Jaba rivers

In the image on the right hand side (Plate ES5b), seepage is visible through the levee in the red outline where the Kawerong and Jaba rivers meet further upstream; the bed of the Kawerong River is about 10 m higher than the bed of the Jaba River.

Plate ES5a Seepage and levee erosion zone on western end of levee

Plate ES5b Seepage zone in the levee where the Kawerong and Jaba rivers meet

This levee may collapse due to flooding, earthquake, seepage or water flowing through tunnels which form under the levee wall. If the levee collapsed, structures and people that live on the floodplain downstream of the Jaba River would be directly impacted by flooding or landslide effect. The area inside the yellow line on Figure ES6a (view from the air) and Figure ES6b (view looking up the Kawerong River towards the Panguna mine) shows the area currently expected to be directly impacted if the levee collapses, and the orange colours show the groups of structures where people live. In addition to this, if the levee collapsed there would be an increase in erosion of the Kawerong River and more sediment would be transported into the Jaba River which could result in more flooding downstream.

It is not yet possible to predict when the levee at the junction of the Kawerong and Jaba rivers may fail or how severe its failure may be due to limitations of current information. Further site assessments are required to better understand this risk and these will be a focus of the next phase of the Legacy Impact Assessment.

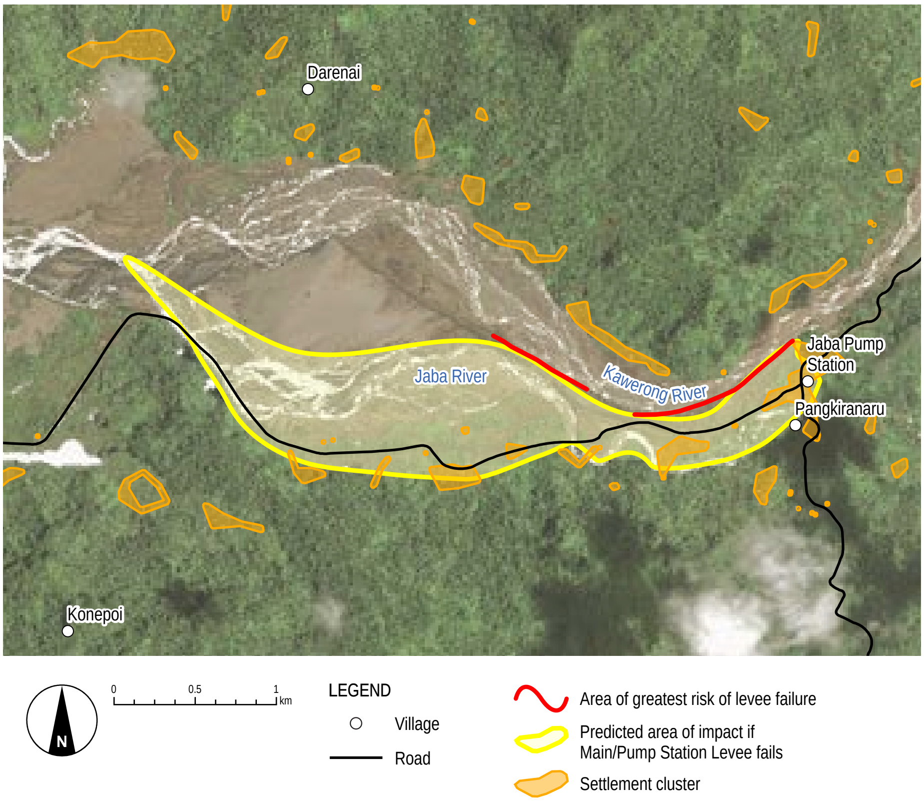

Figure ES6a View from the air of the levee at risk of failure (red line) and predicted area of direct impact (yellow line), showing groups of structures (orange) where people live

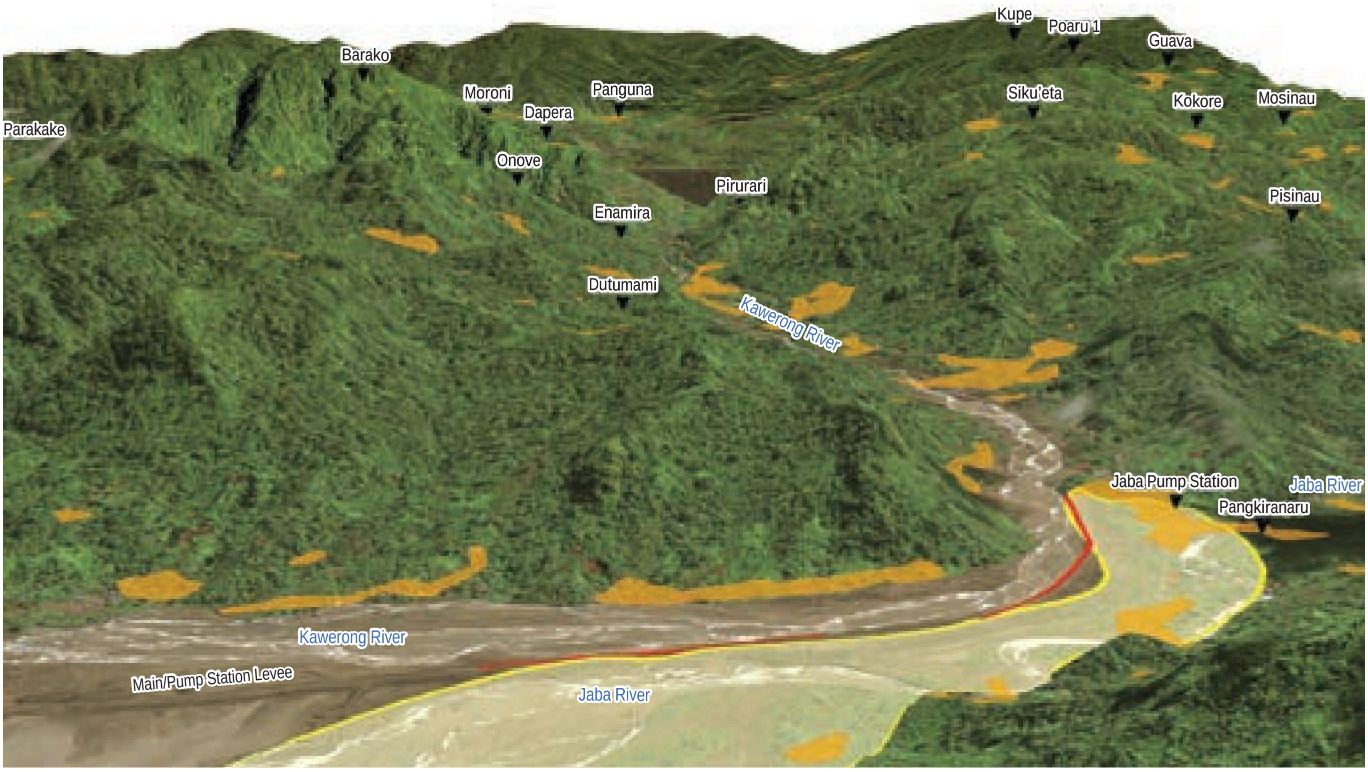

Figure ES6b View looking up the Kawerong River towards the Panguna mine showing the predicted area of direct impact (yellow line) and groups of structures (orange) where people live

4.3 FLOODING

The Preparatory Phase assessment also looked at where flooding may occur in the future, particularly from changes in river flow due to movement of tailings down the river. The bed of the Jaba River has raised over time due to flooding and build-up of previously deposited tailings, such as at the lower Jaba River near Bato Bridge (see Figure ES5).

Raising of the bed of the Jaba River downstream of Bato Bridge before 2011 caused water to flow over the natural levee along the side of the river and a break to form in the natural levee. This led to flooding and deposition of tailings into a low area on the north side of the river, which had affected about 400 ha by 2020 (Plate ES6). The break in the levee is still open, and the low area is likely to continue receiving tailings, unless the change in the direction of the Jaba River described below separates that section of the river.

Build up of the river bed upstream of the Bato Bridge caused the Jaba River to change course in 2017 and start to flow into the Konaviru wetland and lower Kuneka Creek (Figure ES7), changing their flooding patterns and depositing tailings into them.

Based on assessment of 2020 aerial imagery, this change of flow into Konaviru wetland is likely to remain and become the focus of further tailings deposition in future. Figure ES7 shows the risk of flooding from the change in river course to the south of the Jaba River into the Konaviru wetland, with the currently expected area of direct impact from flooding shown in the purple line and groups of structures where people live shown in orange.

It is not yet possible to predict when this will happen and whether the change will be permanent. Further site assessments are required to better understand this risk and these will be a focus of the next phase of the Legacy Impact Assessment.

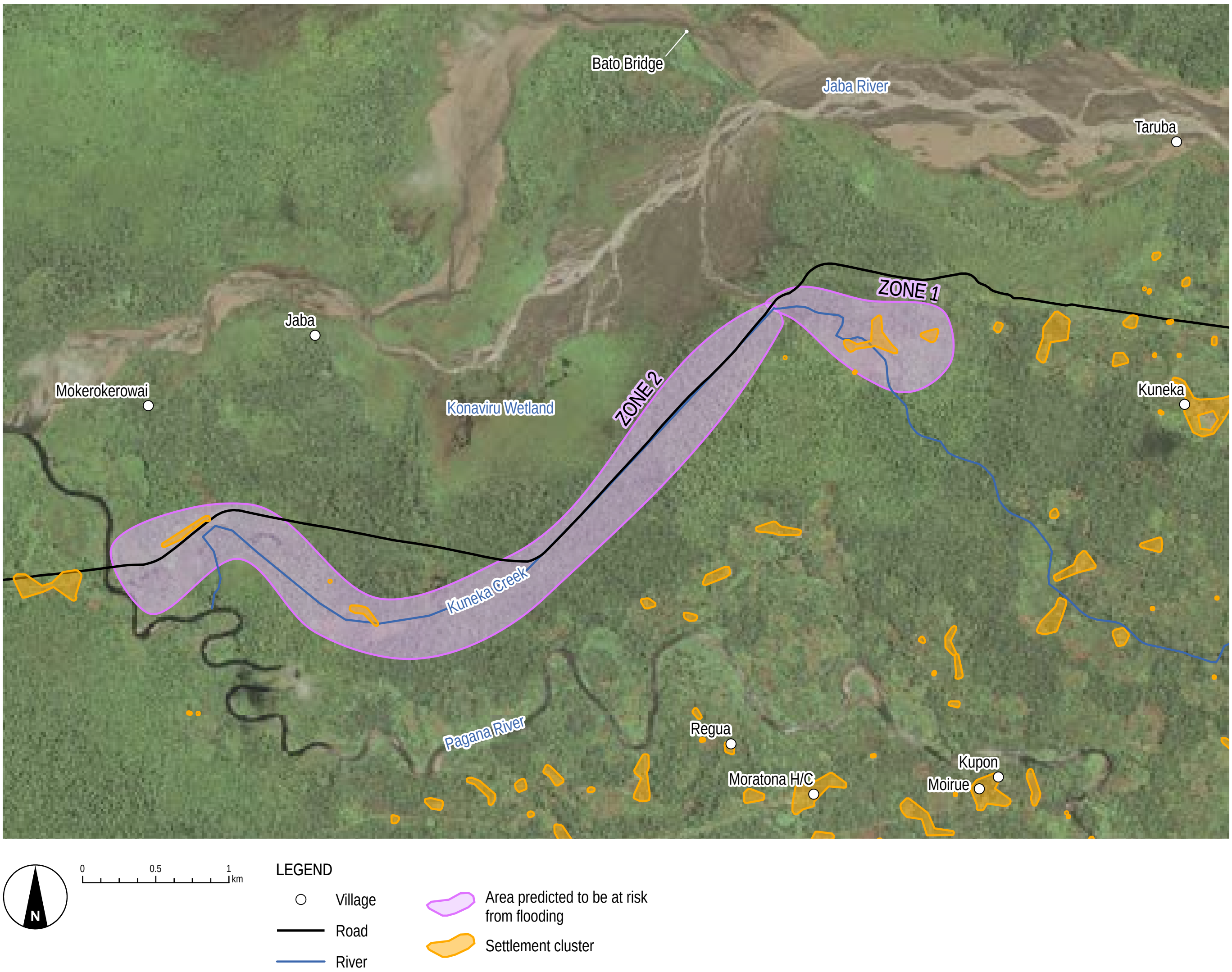

Figure ES7 Area of flooding risk to nearby structures and people with the predicted area of direct impact (purple line), showing groups of structures (orange) where people live

4.4 POPULATION

There is no current information available describing the population within the Preparatory Phase Study Area. Without this information, an estimate of the spatial distribution of the population (where people live) has been made based on identifying residential structures where people are likely to live from aerial imagery. An estimate of the current population for the Preparatory Phase Study Area has been made by extrapolating 2011 census data using previously reported growth rates.

These population growth rates are not likely to account for any recent in-migration associated with artisinal and small-scale mining activities which may involve a population of 2,000 or more people along the tailings basins.

It has been initially estimated that between about 21,600 and 22,800 people are currently residing in about 4,600 to 5,300 residential structures in the Preparatory Phase Study Area. This is about double the number of residential structures that were there at the time mine operations stopped in 1989.

The imagery analysis results, and particularly the extraction of residential structures and the groups of settlements and estimates of population, should be considered preliminary and indicative only.

Further information and ground-truthing, as well as accurate mapping of census units (villages), is required to better define the size and characteristics of the population and this will be done in future phases of the Legacy Impact Assessment.

4.5 IDENTIFICATION OF AT-RISK COMMUNITIES FROM LEVEE FAILURE AND FUTURE FLOODING

Sections 4.2 and 4.3 have identified the areas at greatest risk from levee failure and future flooding based on the limited currently available information. The Preparatory Phase assessment has identified the following at-risk communities using the predicted areas of direct impact shown on figures ES6a and ES7 and population estimates generated from identifying residential structures:

- The community located between the south side of the Main/Pump Station levee and the north bank of the Jaba River and those residents on the floodplain south of the current location of the Jaba River channel (Figure ES6a). There are estimated to be 85 dwelling structures in this predicted area of direct impact, with a potential population of approximately 370 people, conservatively assuming all structures are occupied.
- The communities located in the two flood risk zones associated with the potential flooding resulting from the change in the course of the Jaba River and tailings deposition (Figure ES7). Backwater flooding of Kuneka Creek in Zone 1 could affect an estimated 33 residential structures with a potential population of approximately 130 people. Tailings deposition within the diversion channel could result in flooding in Zone 2 and could affect an estimated 17 structures with a potential population of approximately 70 people. These estimates conservatively assume all structures are occupied.

Better defining the likelihood and consequence of failure of the Main/Pump Station Levee and flooding in Konaviru wetland and Kuneka Creek and the number of people who may be impacted will be a focus of the next phase of the Legacy Impact Assessment.

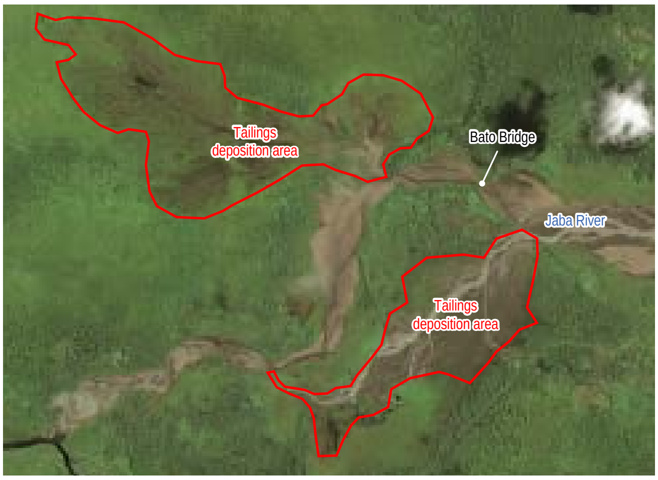

Plate ES6 Indicative existing flooding and tailings deposition areas to the north (downstream of Bato Bridge) and south (upstream of Bato Bridge) of the Jaba River

4.6 LANDCOVER CHANGE

Satellite imagery has been used to determine the change in the type of landcover around the mine and along the Kawerong and Jaba rivers to Empress Augusta Bay from when the mine stopped operations in 1989 to 2021.

Figure ES8 shows the landcover classification for the riverine area in 1989. This shows large areas of sand (i.e., tailings) throughout the highly braided river system, little to no dense vegetation along the Jaba River, no tailings deposition in the area of dense vegetation north of the Jaba River downstream from Bato Bridge, no revegetation of the Jaba River Delta and very few settlements along the margins of the riverine footprint.

In comparison, Figure ES9 shows the landcover classification for the riverine area in 2021. This shows reduced areas of sand along the less braided river system with large areas that were sand in 1989 now being sparse or dense vegetation, conversion of the dense vegetation north of the Jaba River downstream from

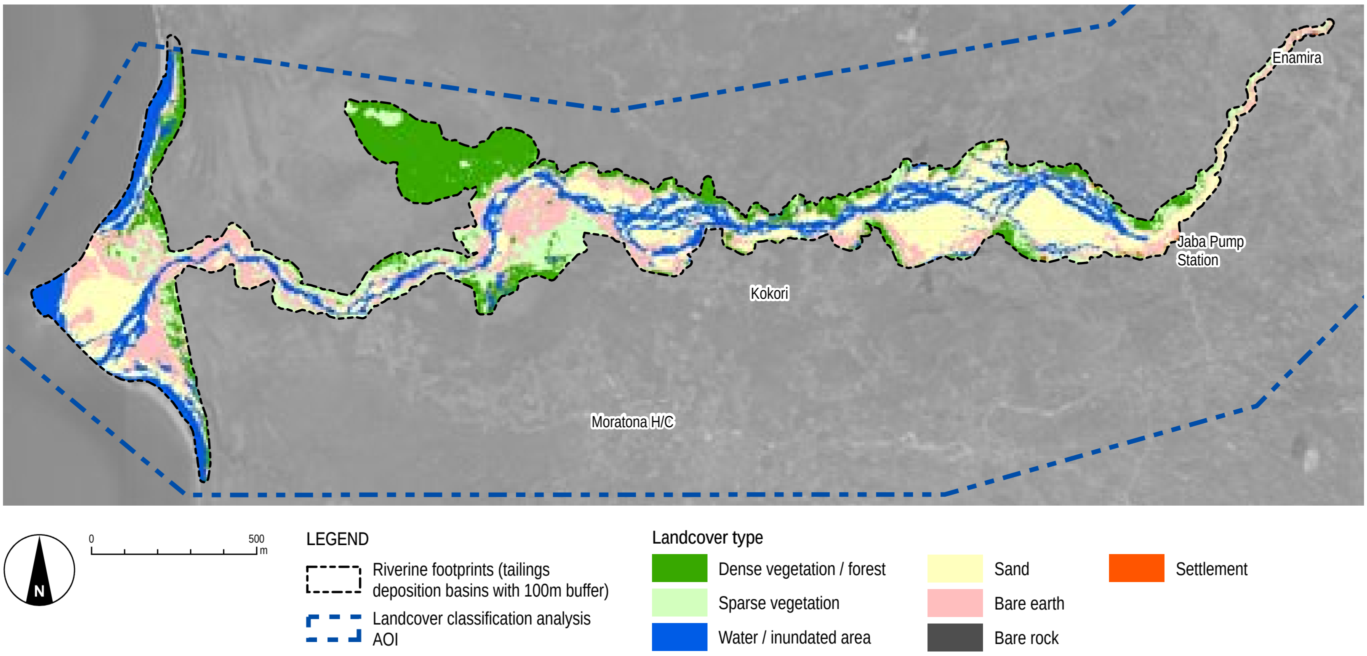

Figure ES8 Landcover classification – Riverine footprint 1989

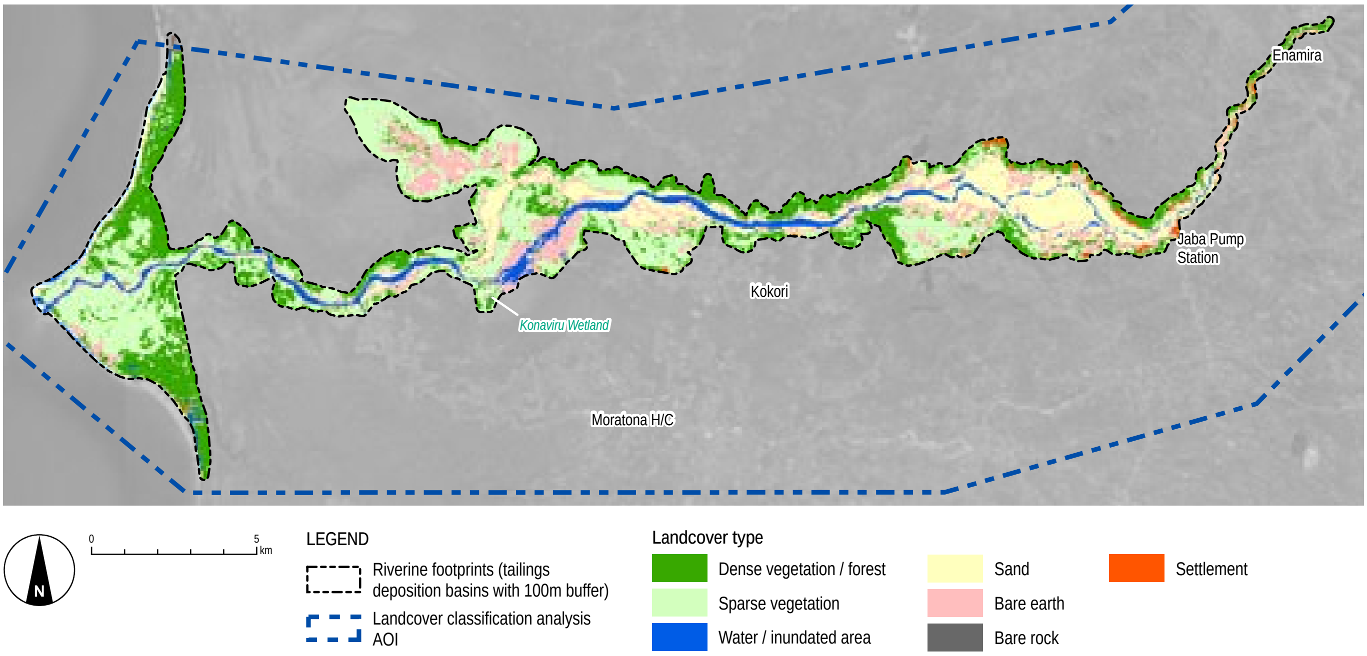

Figure ES9 Landcover classification – Riverine footprint 2021

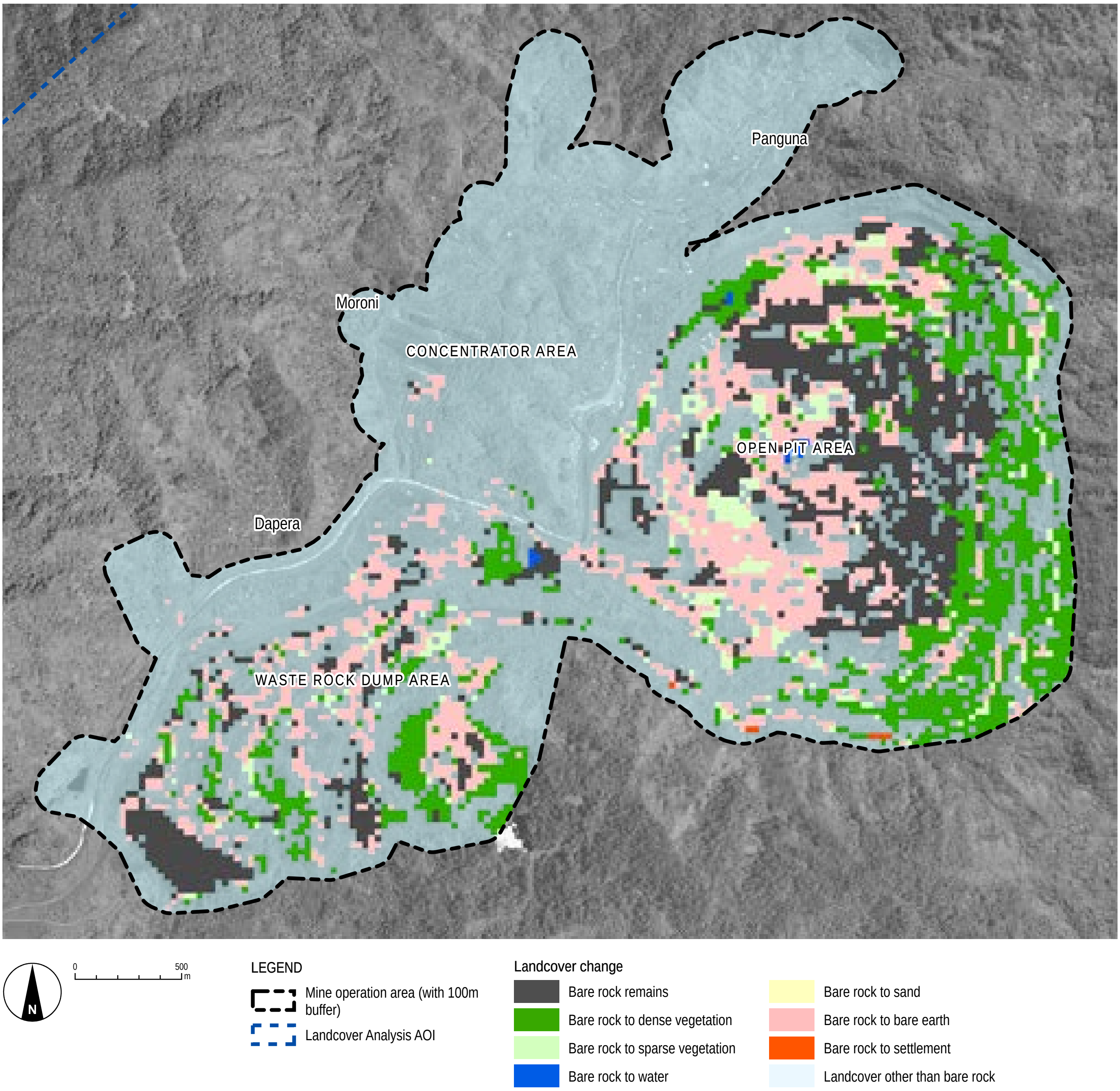

Figure ES10 Change in bare rock from 1989 to 2021 (mine operation area)

Bato Bridge into sparse vegetation and bare earth due to the deposition of tailings in this area, the change in the course of the Jaba River through the Konaviru wetlands, revegetation of most of the Jaba River Delta and more settlements along the margins of the riverine footprint, particularly along the north and south of the edge of the river near the Jaba Pump Station.

Around the mine, Figure ES10 shows that there has been some revegetation of land that was previously bare rock to vegetation, particularly on the eastern side of the open pit and across the waste rock dump. However, large areas remain bare rock or bare earth. Some settlements have been established to the south side of the open pit.

The results of the landcover change assessment will be used during the next phase of the Legacy Impact Assessment to focus areas of investigation for aspects such as resource use and human health risks.

4.7 WATER QUALITY AND ENVIRONMENTAL GEOCHEMISTRY

The assessment of water quality has been largely based on historical data from during mining operations, which was collected intermittently between 1973 and 1989.

Mining had an adverse influence on water quality in the Kawerong and Jaba rivers. In addition to increased suspended sediments, water from the mine commonly had increased concentrations of sulfate, which suggests that the key process in the release of metals to water was the weathering of sulfide minerals in ore and waste rock exposed to air and water. This process is referred to as the formation of acid and metalliferous drainage (AMD) and was the primary process leading to water quality impacts at Panguna. Mine-impacted water due to AMD from the Panguna mine resulted in increased concentrations of copper and less frequently zinc, lead, cadmium, molybdenum, mercury and manganese.

The poorest quality water from the Panguna mine was acidic and metals-rich which seeped through the waste rock dumps. Limited geochemical data from waste rock materials indicates that they were potentially acid forming and did not have much ability to neutralise acid that was formed.

About 500 Mt of tailings were discharged to the Kawerong-Jaba river system during mining. These tailings were potentially acid forming and did not have much ability to neutralise acid that was formed. Highly alkaline water was discharged to the Kawerong River with the tailings, which maintained the pH of the Kawerong-Jaba river system at a value of approximately 8, where pH 7 is neutral. This balanced some of the AMD from the waste rock leachate and reduced the ability of some metals to dissolve in the river. When the process plant was occasionally shut down during operations (such as for maintenance), the pH of the Kawerong-Jaba river system water dropped noticeably, and some metal concentrations went up. The beneficial chemical effects of the alkaline water being discharged with the tailings stopped when the mine stopped operating in 1989.

Water quality monitoring was done in Empress Augusta Bay because approximately 60% of tailings discharged by the mine was washed into the ocean there. An intermittent water quality monitoring program in Empress Augusta Bay showed that the Panguna mine did not have a big impact on the quality of the seawater at the top and middle of the water, but water closest to the bottom of the sea above where the tailings solids settled occasionally had concentrations of copper, cadmium and zinc above Australian water quality guidelines for aquatic ecosystem protection.

The amount of acid and metal discharge from the open pit, waste rock dumps, tailings and groundwater remains poorly understood and the current impacts of this to the water in downstream watercourses are unknown. Further work is needed to understand current water quality and quantify people’s use of water resources downstream of the mine to better understand the human health risks from this.

4.8 RIVERINE ECOLOGY

Limited monitoring for river fishes was conducted between 1975 and 1988, although this was primarily for quantifying claims for loss of fish resource as a result of the mine, rather than specific monitoring of the ecological health of the rivers. Monitoring was not done for other river fauna such as river prawns, mussels, mangrove snails and crabs, which are important components of river food webs, and potentially important to the diet and/or culture of local villagers.

However, the reports and monitoring surveys completed during operation of the mine demonstrate the loss of migratory estuarine-marine fish species from the Kawerong-Jaba and Pagana river systems, due to high sediment loads from disposal of mine waste rock and tailings to the Kawerong River. Fish populations in the Pinei River were also affected by construction of the Port Mine Access Road, but monitoring results suggested fish assemblages had recovered by 1976.

Estimates of fish yield for compensation payments to local villagers estimated a loss of 100% of the total edible fish biomass that would have been caught before the mine from the Kawerong-Jaba river system, and approximately 40% loss of the total edible fish biomass that would have been caught before the mine from the Pagana River system. Compensation was paid to villagers for loss of fish resources from a number of rivers (Kawerong-Jaba, Upper Jaba-Toyo, Pagana, Tum and Kuneka creeks, Pinei and Special Mining Lease systems). While it was widely reported that river fish were not as important to the diet of local villagers as were marine fish to coastal villagers, social aspects such as loss of fishing for recreation and special festivities, and general use and enjoyment of rivers, were also taken into consideration when calculating compensation payments.

Because there is no post-mining data on riverine ecology for the Preparatory Phase Study Area, it is not possible to assess the current state of riverine ecology in mine-affected rivers. Information is needed for water quality and river sediment aspects relevant to aquatic fauna, and aquatic resource use, as well as concentrations of metals in fish tissue and other aquatic fauna that may pose a risk to human health if eaten.

4.9 TAILINGS DEPOSITION – EMPRESS AUGUSTA BAY

Sixty percent of tailings discharged by the mine was washed into Empress Augusta Bay during operations. This had an effect on the size and shape of the Jaba River Delta; Figure ES11 shows this change from 1978 to 2020. Using the Preparatory Phase GIS to calculate the extent of the Jaba River Delta provides:

1. An estimated footprint of 943 ha when the mine stopped operations in 1989.
2. An estimated footprint of 1,015 ha in 2020.

Between 50 and 60% of the Empress Augusta Bay seabed was contaminated with tailings to some extent between 1979 and 1986. Figure ES12 shows the area of the floor of Empress Augusta Bay contaminated by tailings in 1971 (left), 1981 (middle) and 1986 (right). The darker brown colour shows the higher concentration of copper: the area of dark brown (high copper concentration) appears to gradually reduce from 1979 to 1986 but it is not known if this trend has continued.

The current area of contamination and its impact on marine ecology and marine resource use in Empress Augusta Bay is not known and will need to be determined during the Legacy Impact Assessment.

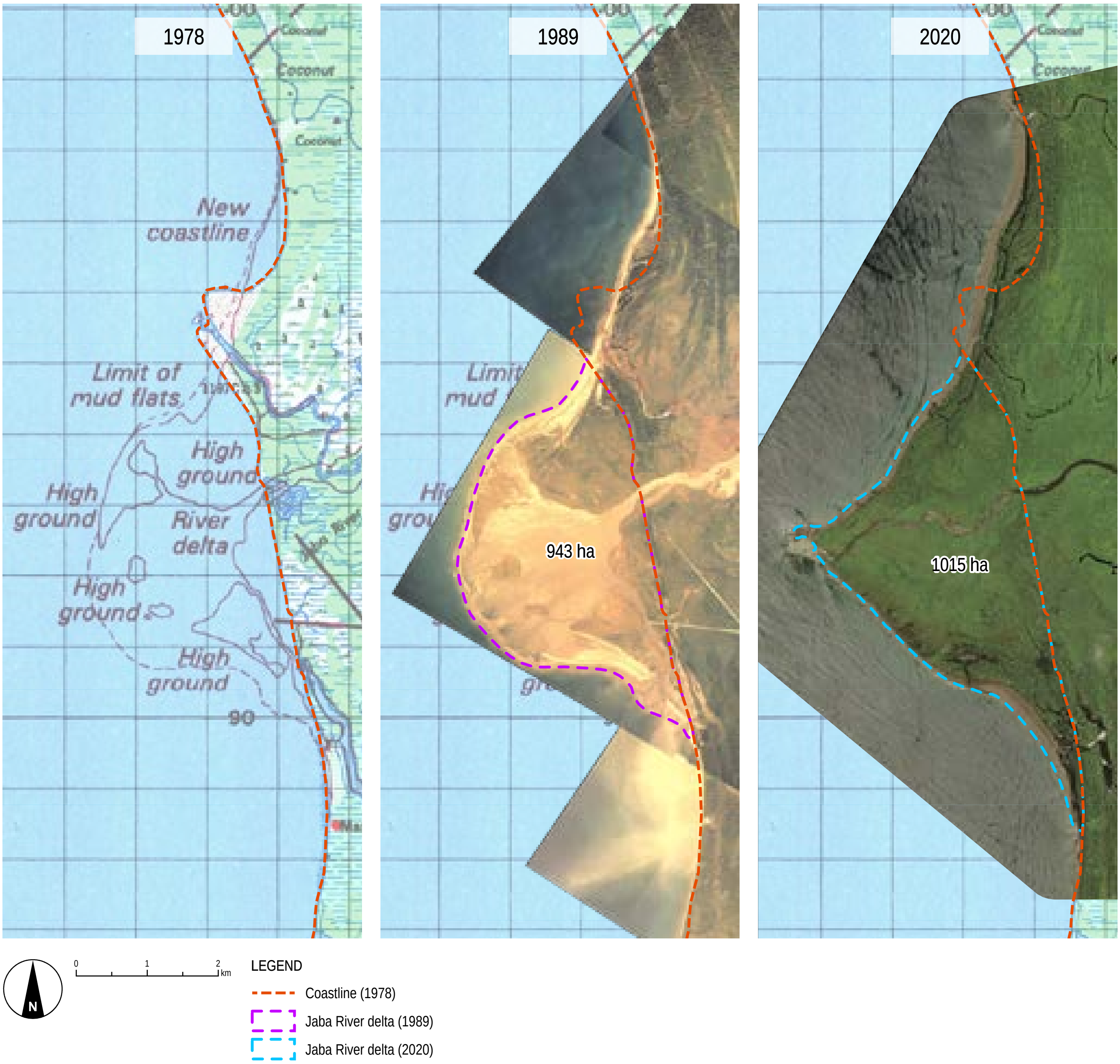

Figure ES11 Jaba River Delta

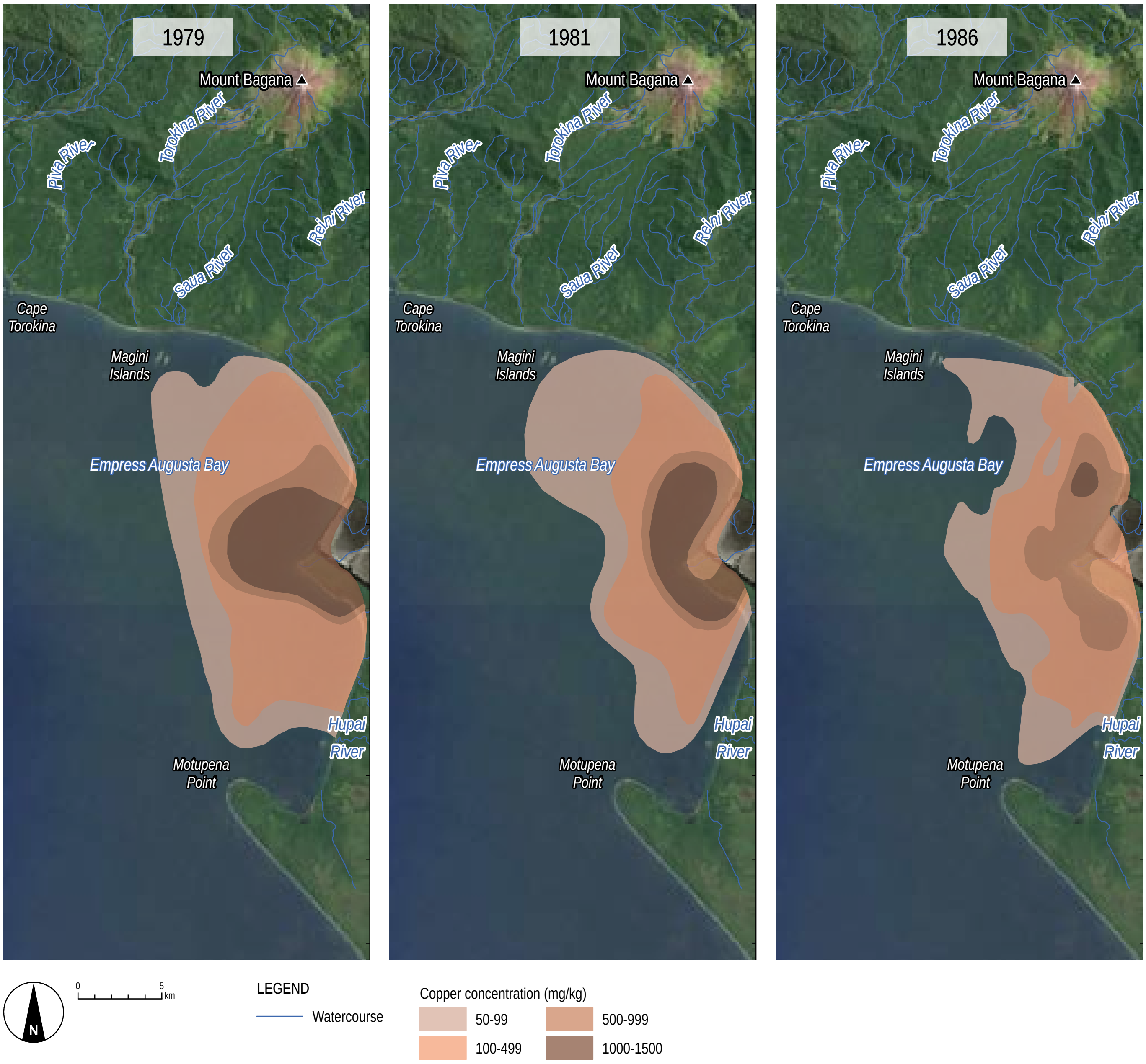

Figure ES12 Contamination of the seabed in Empress Augusta Bay in 1971, 1981 and 1986

5. RECOMMENDATIONS FOR FURTHER ASSESSMENT

The Preparatory Phase work has recommended areas for further investigations, prioritised as follows:

- Recommendations for an initial screening assessment at the commencement of Phase 1 of the Legacy Impact Assessment.
- Recommendations for detailed investigations for areas of highest risk to local communities to be addressed in the rest of Phase 1.

Particular aspects to be assessed in Phase 1 of the Legacy Impact Assessment are the acute actual and potential impacts due to unstable infrastructure and erosion of mineral waste into the rivers and the consequent downstream impacts, water quality, access and supply, and identification and characterisation of potentially affected communities. The following investigations are recommended for the initial screening assessment as they relate to acute actual and potential risks to local communities that are required to refine or inform the scope and prioritisation of subsequent investigations:

- A site inspection and limited data collection to refine the assessment of the risk of failure of the Main/Pump Station Levee, including imminence of failure, the scope of more detailed investigations required and potential mitigation measures for failure.
- Field inspection of levees and diversions and reported locations of flooding and tailings deposition to identify areas of particular risk due to overtopping, scour, piping or slope failure.
- An assessment of mining and process infrastructure condition recording information such as: evidence of current use and inhabitation; types of materials present (including types and quantities of chemicals, condition of storage containers, potential exposure to populations); extent of spills where visible; structural integrity (qualitatively, if not quantitatively); and other information necessary to establish likelihood of exposure, consequence of exposure, and potential exposure routes to better understand relative risks associated with the mining and process infrastructure.
- An initial sampling round of the current freshwater surface water chemistry focusing on representative sampling from:
  - Background rivers, including those monitored during operations, and other major tributaries to the Jaba-Kawerong river system.
  - Kawerong-Jaba river system.
  - Pit dewatering tunnel discharge before mixing with the river.
  - Lakes/standing water within the open cut pit.
  - Waste rock dump leachate streams (subject to accessibility).
  - Representative drinking water sources (e.g., shallow pits/wells) used by villages.

Completing these investigations will help to refine and inform the scope and prioritisation of subsequent Phase 1 investigations so they can be as focussed on the objectives of the Legacy Impact Assessment.

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