FRIEDA RIVER

Frieda River Limited
Sepik Development Project
Environmental Impact Statement
Volume A – Executive Summary

SDP-6-A-00-01-T-084-001

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Prepared for

Frieda River Limited

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IMPORTANT NOTICE

Nature of this document

This Sepik Development Project Environmental Impact Statement (EIS) report (report) was compiled by Coffey Services Australia Pty Ltd for Frieda River Limited in its capacity as Manager of the Frieda River Joint Venture and on behalf of the joint venture participants, Frieda River Limited and Highlands Frieda Limited, in relation to the Sepik Development Project located in Papua New Guinea.

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Responsibility for information

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Date of the report

This EIS report is dated 7 November 2018 and the information was current as at that date.

Disclaimer as to forward-looking statements

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Effect of rounding

A number of figures, amounts, percentages, prices, estimates, calculations of value and fractions in this EIS report are subject to the effect of rounding. Accordingly their actual calculations may differ from the calculations set out in this EIS report and numbers in tables may not add up to total values or 100%.

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Any diagrams, charts, maps, graphs or tables appearing in this EIS report are illustrative only and may not be drawn to scale. Unless stated otherwise, all data contained in diagrams, charts, maps, graphs and tables was based on information available at the date immediately prior to the date of this EIS report.

Mineral Resource and Ore Reserve

The information and terms in this EIS report that relate to the Project's Mineral Resource and Ore Reserve estimates were reported in accordance with the JORC Code, 2012 Edition.

GUIDE TO THE ENVIRONMENTAL IMPACT STATEMENT

The environmental impact statement is presented in three volumes.

Volume A	Executive Summary

Volume B	Main Report
Part 1	Chapter 1 – Introduction Chapter 2 – Viability and Purpose of the Development Chapter 3 – Policy, Legal and Administrative Framework Chapter 4 – Stakeholder Engagement Chapter 5 – Description of the Proposed Development Chapter 6 – Assessment of Alternative Development Options Chapter 7 – Description of Existing Environment
Part 2	Chapter 8 – Physical and Biological Impact Assessment Chapter 9 – Socio-Economic Impact Assessment Chapter 10 – Cumulative Impact Assessment Chapter 11 – Extreme Natural Hazards and Incidental Events Chapter 12 – Environmental and Social Management, Monitoring, Auditing and Reporting Framework Chapter 13 – Conclusion Chapter 14 – References Chapter 15 – Study Team Chapter 16 – Acknowledgements Chapter 17 – Glossary
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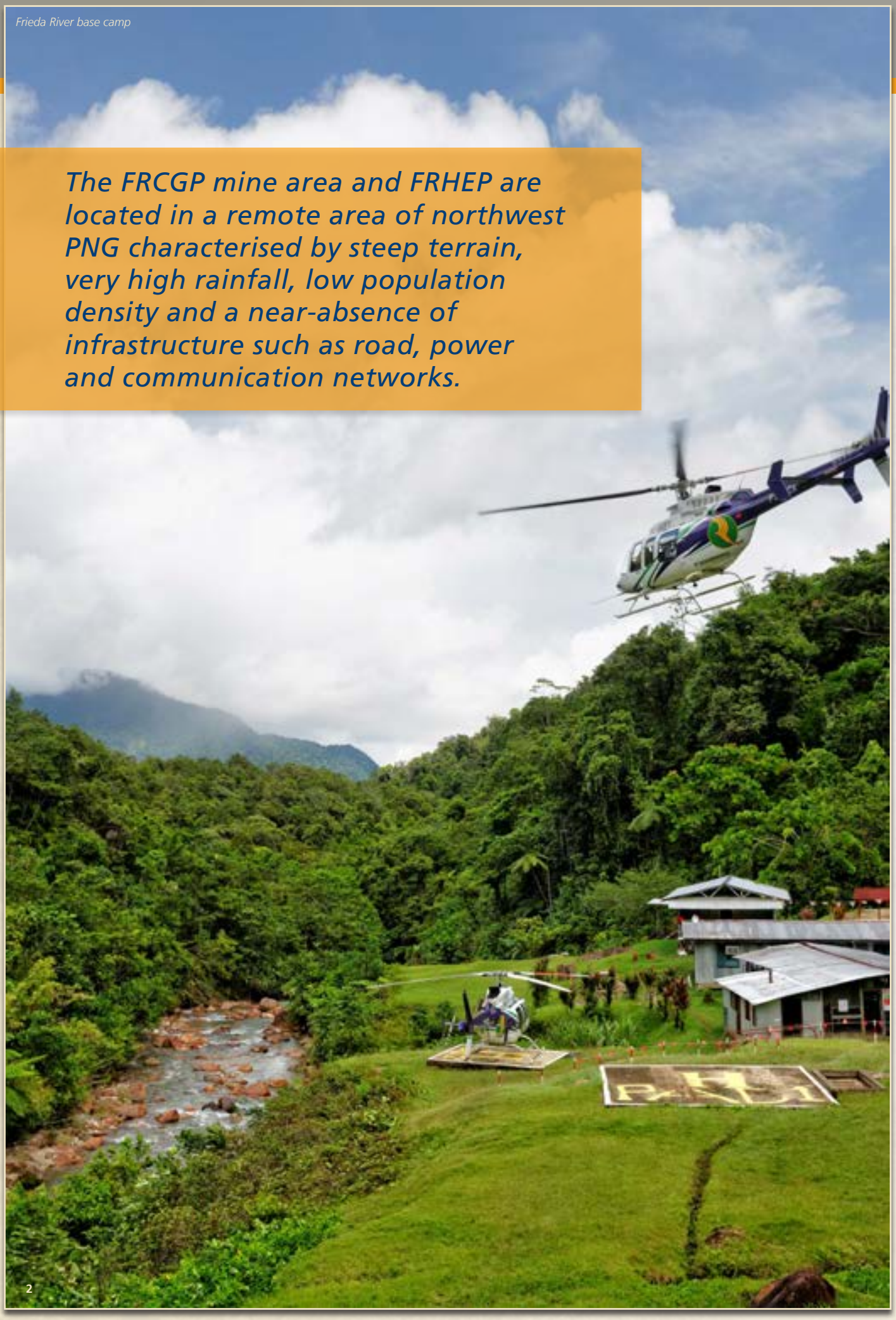
Frieda River

KEY POINTS

- The Sepik Development Project (the Project) presents broad commercial and socio-economic development opportunities for Papua New Guinea (PNG). It is expected to deliver regional benefits to PNG by supporting the implementation of its Development Strategic Plan 2010-2030, providing regional road access in two provinces, improving air and ocean transport infrastructure and establishing access to a reliable supply of renewable power to remote areas of PNG.
- The nation-building Project is underpinned by two commercial projects: the Frieda River Copper-Gold Project (FRCGP) and the Frieda River Hydroelectric Project (FRHEP). These are supported by the Sepik Infrastructure Project (SIP) and the Sepik Power Grid Project (SPGP).
- The total capital investment for the Project will be up to US$6.9 billion (PGK21.7 billion).
- The total Project footprint will cover approximately 16,000 ha. In order of land take, the largest components of the Project are the integrated storage facility (ISF) for the FRHEP (in the order of 75% of the total footprint), open-pit void and haul roads, spoil dumps and the infrastructure corridor.
- The Project will have a seven-year implementation period after which the FRCGP is planned to operate for a minimum of 33 years and the FRHEP for over 100 years.
- The Project is predicted to generate substantial economic benefits including through employment of approximately 5,190 people at the peak of construction and approximately 2,510 people during the expected 33 years of FRCGP operation.
- Total predicted tax, royalty and production levy revenue to PNG governments and landowners of PGK29 billion over the life of the Project.
- Four villages from the Project area will require resettlement. This will affect approximately 194 households comprising approximately 1,316 people. Consultation with the residents of the affected villages has commenced as part of the resettlement planning process.
- Comprehensive environmental, socio-economic and cultural heritage baseline data has been collected over a period of ten years. Extensive stakeholder engagement was undertaken during this time.
- Frieda River Limited (FRL) will work to limit adverse impacts of the Project on the local communities and maximise the potential long-term benefits to these communities. There will be ongoing engagement with communities around the mine area and transport corridors, including the Sepik River.
- FRL will establish an independent advisory committee to assist FRL in addressing the environmental and related social impacts of its mining activities upon the local and downstream communities.
- The key strategy for limiting the impact of the FRCGP on the downstream environment is the subaqueous deposition of waste rock and process tailings within an ISF (part of the FRHEP) and active treatment of open-pit contact water. There will be no riverine disposal of tailings or waste rock for the FRCGP.
- The Frieda River contributes approximately 5% of water inflow to the Sepik River. With the exception of a slight increase in the median suspended sediment concentration during construction, the FRCGP is not predicted to adversely impact the water quality of the Sepik River. There will be minor disruptions to people's use of the Sepik River due to barge traffic during Project construction.
- The slightly increased concentration of suspended sediment during construction will reduce the water quality of the upper Frieda River. This may lead to a change in macroinvertebrate and fish communities towards species more tolerant of increased suspended sediment, such as non-native species already present in the Sepik River basin. Once constructed, the ISF will act as a sediment trap, reducing sediment loads below baseline levels and causing localised changes to aquatic habitats immediately downstream of the embankment.
- Concentrations of dissolved metals such as aluminium and copper are predicted to increase in the Frieda River. This is not expected to result in impacts on aquatic biota.
- The results of the water quality modelling and health impact assessment indicate that discharges from the ISF will not adversely affect human health for people living along the Frieda and Sepik rivers.
- Environmental and socio-economic management strategies will be guided by standards implemented by FRL's parent company, PanAust Limited (PanAust), an internationally recognised leader in environmental management and sustainability in the mining sector. The Environmental Management and Monitoring Plans for each component of the Project document the commitments FRL has made for environmental and socio-economic management.



Frieda River base camp

The FRCGP mine area and FRHEP are located in a remote area of northwest PNG characterised by steep terrain, very high rainfall, low population density and a near-absence of infrastructure such as road, power and communication networks.

1. INTRODUCTION

1.1 Project Description

Frieda River Limited (FRL) is assessing the feasibility of the Sepik Development Project (the Project) in northwest Papua New Guinea (PNG). The Project is underpinned by two commercial projects: the Frieda River Copper-Gold Project (FRCGP) and the Frieda River Hydroelectric Project (FRHEP). These are supported by the Sepik Infrastructure Project (SIP) and the Sepik Power Grid Project (SPGP).

The Project presents a transformative development opportunity for the underdeveloped Sepik region of PNG. The Project aligns with the PNG Development Strategic Plan 2010-2030 (PNGDSP) by leveraging the FRCGP and FRHEP to develop an economic corridor that provides important power, transport and communications infrastructure for shared-use.

The four key elements of the Project are located in the Sandaun and East Sepik provinces and comprise:

- Frieda River Copper-Gold Project.
- Frieda River Hydroelectric Project.
- Sepik Infrastructure Project.
- Sepik Power Grid Project.

An overview of each of these four key elements is provided in Sections 1.1.1 to 1.1.4. Figures ES1 and ES2 show the components of the Sepik Development Project that are assessed in this Environmental Impact Statement (EIS).

FRL will operate the FRCGP on behalf of the Frieda River Joint Venture. It is anticipated that third-party entities will own and operate the remaining Project elements at some stage during the life of the Project.

1.1.1 The Frieda River Copper-Gold Project

The mine area is located in the northern foothills of the Central Range of the New Guinea Highlands in Sandaun Province. It lies in a remote area approximately 200 kilometres (km) from the northern coast and 50 km from the Sepik River.

The FRCGP comprises a large-scale open-pit mine operation feeding ore to a comminution and flotation process plant producing a copper-gold concentrate for export to custom smelters. The copper-gold concentrate will be transported from the process plant to a concentrate storage and export facility located at the Vanimo Ocean Port via a 325-km-long concentrate pipeline located within the infrastructure corridor also containing the road from Vanimo to Hotmin. The concentrate pipeline and export facility are also part of the FRCGP.

The FRCGP is planned to have a minimum mine life of approximately 33 years preceded by a seven-year implementation period.

1.1.2 The Frieda River Hydroelectric Project

The FRHEP reservoir will be located within the Frieda, Nena and Niar river valleys downstream of the mine site. A 600 MW installed power facility will be located on the Frieda River generating 2,800 GWh/year of energy (up to 490 MW). The FRHEP will provide power for the FRCGP via a 22-km-long transmission line.

The reservoir will also provide an integrated storage facility (ISF) for water and sediment retention and the subaqueous storage of both process tailings and mine waste rock produced by the FRCGP.

The FRHEP is planned to have an operating life of over 100 years preceded by a five-year construction period.

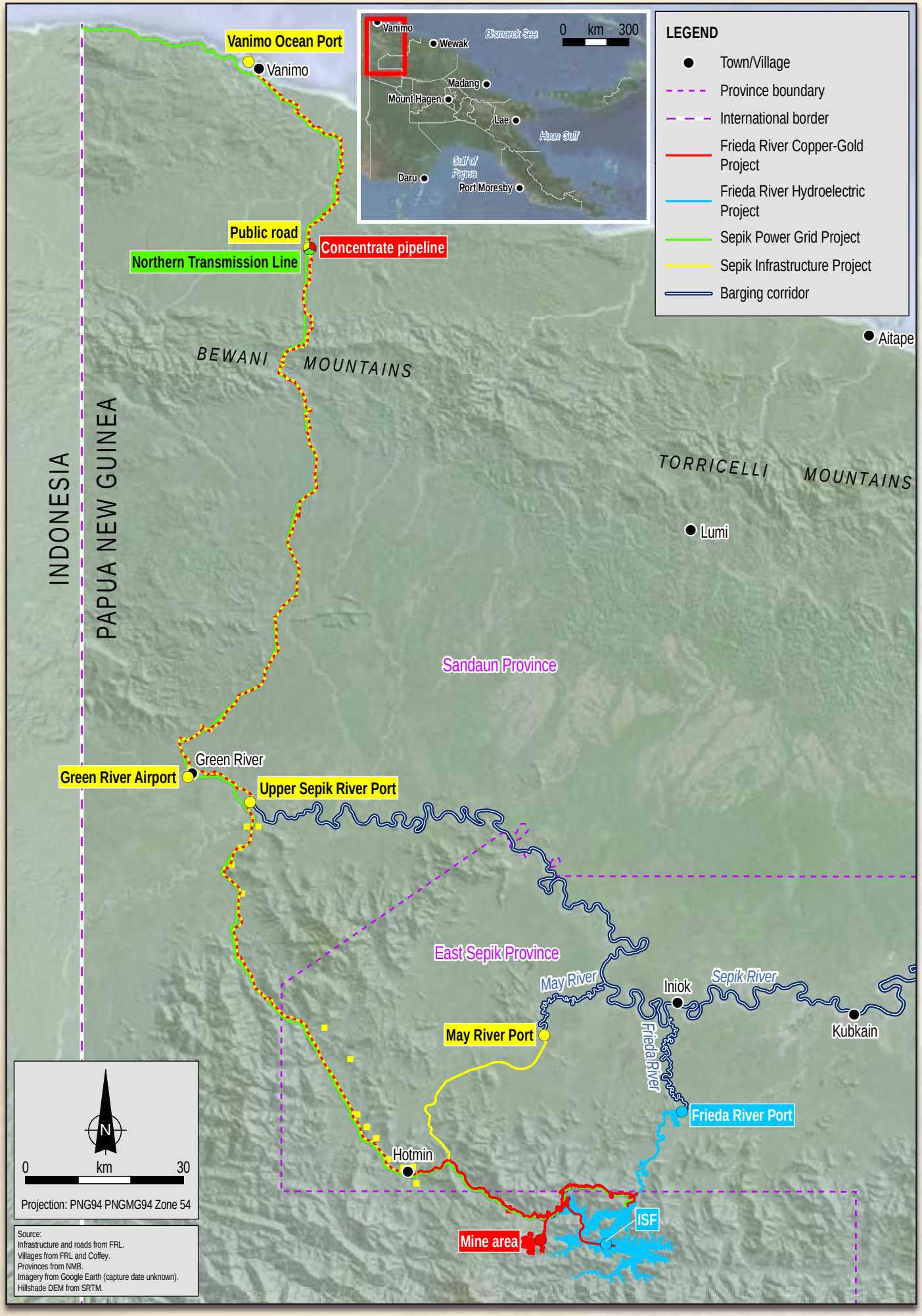


Figure ES1 Project components – regional overview

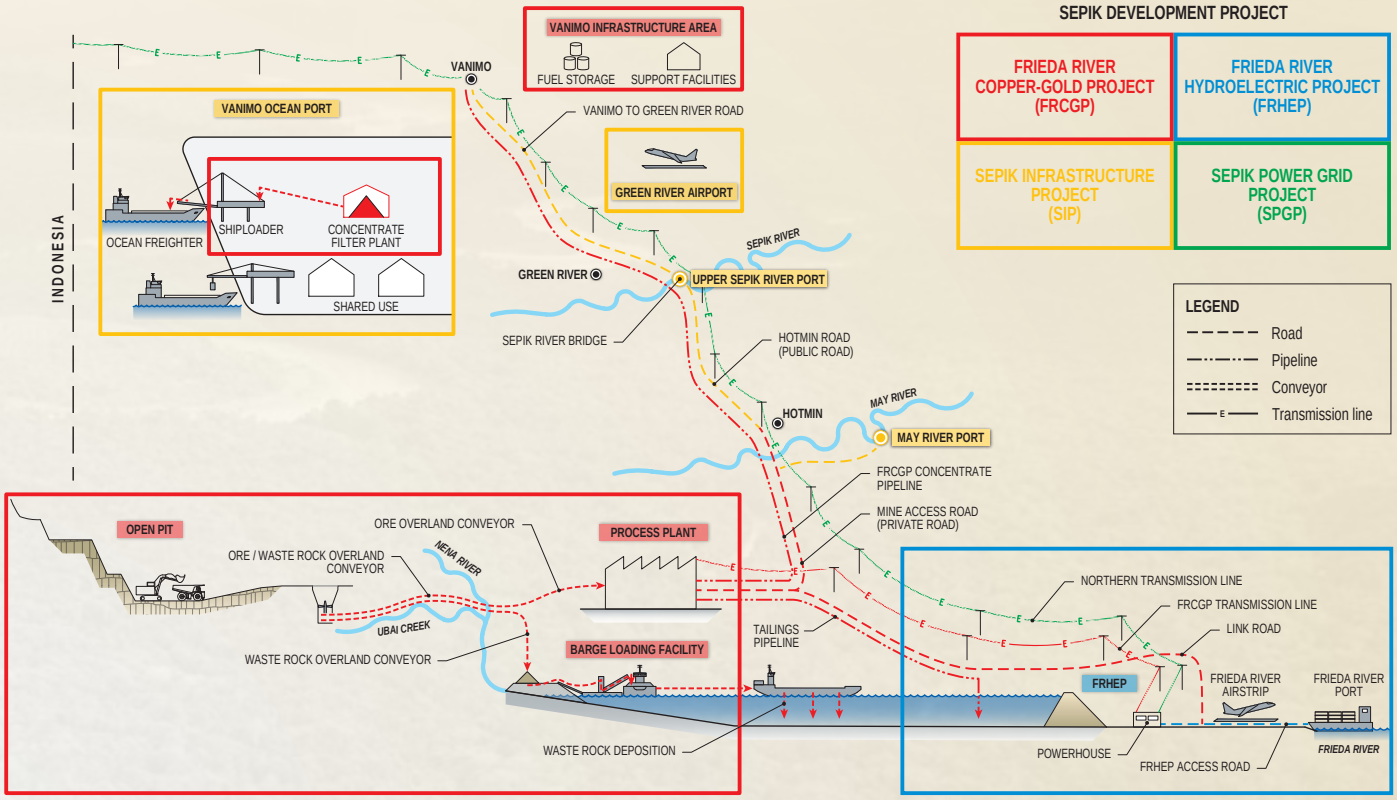


Figure ES2 Components of the Sepik Development Project assessed in EIS

1.1.3 The Sepik Infrastructure Project

The mine and FRHEP sites will be accessed by an upgraded road from Vanimo to Green River and a new road through to Hotmin. The road from Vanimo to Hotmin will be a public road and forms part of the SIP. The SIP also includes an upgraded Green River Airport and Vanimo Ocean Port.

1.1.4 The Sepik Power Grid Project

The SPGP comprises a 370-km-long 275 kV Northern Transmission Line from the FRHEP to the Indonesian border via Vanimo. The transmission line will provide power to FRCGP facilities near Green River and Vanimo. The Northern Transmission Line will export excess power from the FRHEP of 1,450 GWh/year (270 MW) until Year 7 and 760 GWh/year (150 MW) until Year 33. After the FRCGP ceases operations, the full generation capacity of 2,800 GWh/year (490 MW) will be available for export via the Northern Transmission Line to potential customers in PNG and neighbouring Indonesia.

1.2 Context

Copper mineralisation was first discovered in the Frieda River area in 1966/67 with potential commercial mineralisation identified in the early 1970s. Since that time, the area has had a long history of exploration and study activities, undertaken by several companies.

Baseline environmental and social investigations for a possible mine at Frieda River began in 1979 via a joint taskforce consisting of Frieda Copper Pty Ltd and the PNG Government. The scope of work included investigating the Horse-Ivaal porphyry copper-gold deposit as well as the nearby Nena epithermal copper-gold deposit. Various activities and investigations continued intermittently through the 1980s and into the 1990s and, more recently, from 2007 to the present.

The long history of study activities has generated a considerable body of information and a large number of reports that address both the environmental and social aspects of the Project area. Many of the studies undertaken by previous owners remain relevant to the Project and have informed this EIS. Other studies have been updated, where warranted, to include new information and updated baseline data.

The *Environment Act 2000* is the primary legislation for regulating the environmental and socio-economic impacts of new mineral development projects in PNG. The Project involves Level 2 and 3 activities under the Environment (Prescribed Activities) Regulation 2002; sub-categories 14.2, 17.1, 19.1 and 19.2 are Level 3 activities, for which an EIS is required to be submitted to the Conservation and Environment Protection Authority (CEPA).

Coffey has prepared the EIS on behalf of FRL to address the issues set out in the final EIR and form the statutory basis for the environmental assessment of the Project. The EIS is supported by a number of studies and EIS documentation will be made available on the website of FRL's parent company, PanAust.

This Executive Summary has been prepared in English and Tok Pisin to provide an explanation of the Project for non-technical readers. It provides a summary of:

- The description of the proponent, the proposed development activity and its objectives.
- The physical, biological and socio-economic setting of the Project.
- The EIS process and stakeholder engagement to inform people about the Project.
- The main findings of the physical, biological and socio-economic impact assessment.
- The Project's proposed environmental and social management, monitoring, auditing and reporting framework.

A Special Mining Lease (SML) application for the Project was registered by the Mineral Resources Authority (MRA) on 24 June 2016. Subject to approval by the joint venture participants, a proposal for development will be submitted to MRA to support an amendment to the SML9 application.

1.3 Project Proponent

The Project proponent is the Frieda River Joint Venture, an unincorporated joint venture between FRL and Highlands Frieda Limited. FRL (a PNG incorporated company and wholly owned subsidiary of PanAust) will operate the FRCGP on behalf of the Frieda River Joint Venture. It is anticipated that third-party entities will own and operate the remaining Project elements at some stage during the life of the Project.

PanAust is an Australian incorporated company that is owned by Guangdong Rising H.K. (Holding) Limited, a wholly owned subsidiary of Guangdong Rising Assets Management Co. Ltd (GRAM). GRAM is a Chinese state-owned company regulated under the State-owned Assets Supervision and Administration Commission, the People's Government of the Guangdong Province in China.

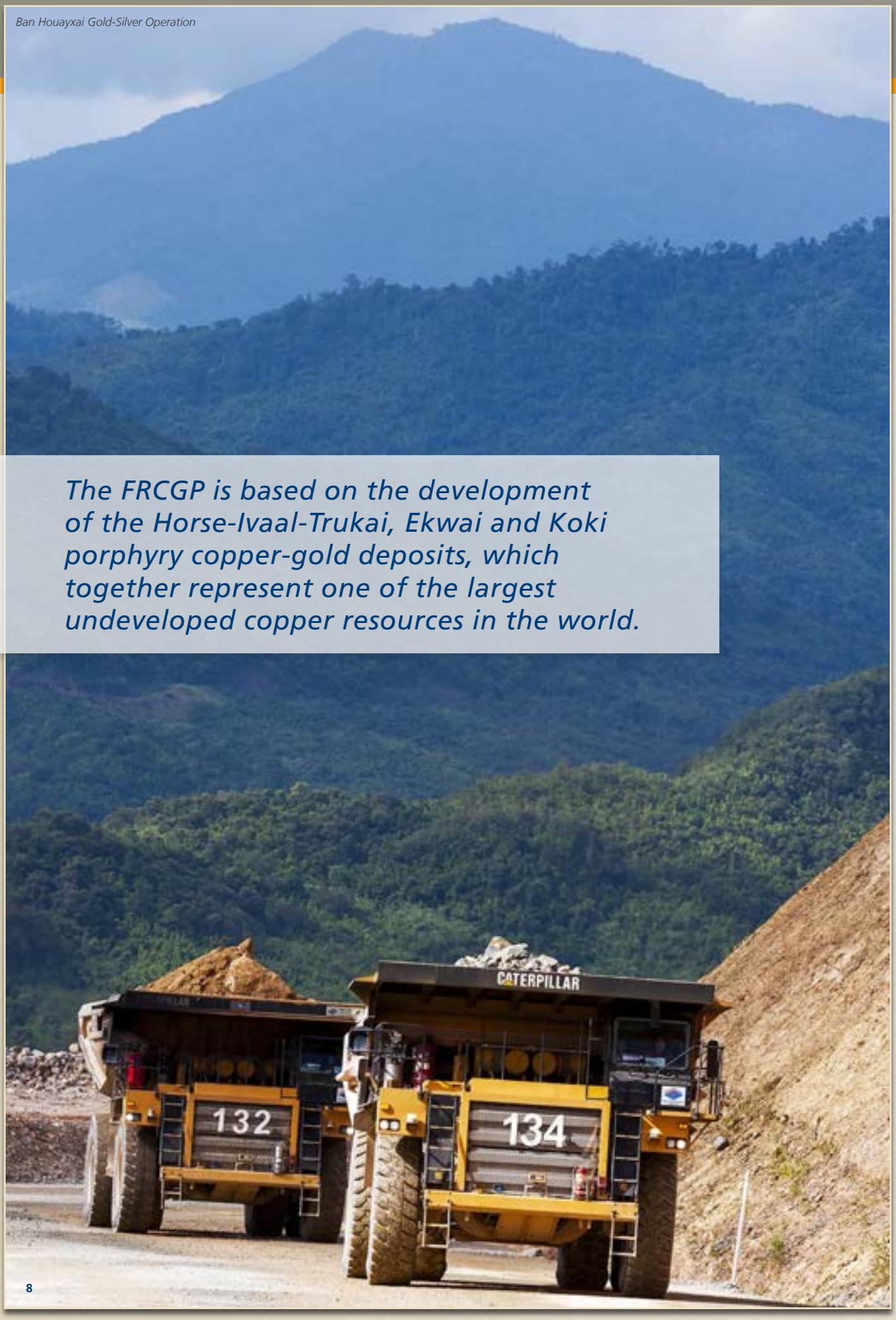
PanAust is a copper and gold producer in Laos and has pre-development opportunities in Laos, PNG, Myanmar and Chile. The Company's producing assets are the Phu Kham Copper-Gold Operation and the Ban Houayxai Gold-Silver Operation; both are located in the Company's 2,600-square-kilometre Phu Bia Contract Area in Laos.

PanAust is an internationally recognised leader in environmental management and sustainability.

Highlands Frieda Limited, a wholly owned subsidiary of Highlands Pacific Limited (Highlands) is a PNG incorporated company listed on the Australian Securities Exchange (ASX) and the Port Moresby Stock Exchange (POMSoX). Highlands has operated in PNG for more than 20 years as a minerals explorer, developer and producer.

Maposi village

The area has had a long history of exploration and study activities undertaken by several companies; various activities and investigations continued intermittently through the 1980s and into the 1990s and, more recently, from 2007 to the present.



Ban Houayxai Gold-Silver Operation

The FRCGP is based on the development of the Horse-Ivaal-Trukai, Ekwai and Koki porphyry copper-gold deposits, which together represent one of the largest undeveloped copper resources in the world.

HITEK open-pit

2. DESCRIPTION OF THE PROPOSED DEVELOPMENT AND ITS OBJECTIVES

2.1 Project Rationale

The viability of the Project depends on a combination of economic, engineering, environmental and social considerations. If developed, the Project will be the second largest capital investment in the resource sector in PNG and will attract significant local employment and foreign investment. The primary economic driver for the Project is the development of the Horse-Ivaal-Trukai, Ekwai and Koki (HITEK) porphyry copper-gold deposits at the FRCGP.

The four components of the Project are interdependent and, as such, each component relies on all other components for the Project to be viable. For example, the initial capital investment for the FRHEP and SIP relies on the commercial viability of the FRCGP, and the FRCGP will not be able to operate without power supplied from the FRHEP along with the use of most SIP infrastructure.

The 2016 FRCGP Feasibility Study report accompanied the application for a SML under the *Mining Act 1992* and formed the basis for the 2016 EIS. This work was updated in 2017 as a Feasibility Study Addendum. An updated Feasibility Study was completed in 2018 to reflect the revised Project scope. It is anticipated that the large Mineral Resource and potential for further exploration success will support the development of the Project beyond the development proposal outlined by the Feasibility Study. The total initial capital investment for the Sepik Development Project will be up to US$6.9 billion.

Due to the remote location and limited existing infrastructure in the region, the development of the Project will require significant investment in support infrastructure to provide the access and services necessary to operate the FRCGP. Establishment of this infrastructure for shared use provides a development opportunity for the Sepik Region of PNG. The scope of the Project has therefore been designed to provide both economically feasible mining and hydroelectric projects and to maximise the lasting development benefits to the region.

The objective of the Project is to develop the large resource projects using enabling shared use infrastructure in an under-developed region of PNG. This will be achieved while operating in a manner that is consistent with PNG regulatory requirements, PanAust Group Sustainability Policy and Sustainability Standards and a range of international standards. FRL is committed to high standards of environmental performance, community cooperation and the principles of sustainable development.

The Project presents broad commercial and socio-economic development opportunities for PNG and aligns with PNG's development plans. In particular, the PNGDSP sets out to provide direction in policy making to achieve the goals of Vision 2050, which describes the country's long-term strategy and reflects the aspirations of Papua New Guineans, with the goal that PNG will be ranked in the top 50 countries in the United Nations Human Development Index by 2050.

While the Project is underpinned by the development of the FRCGP, which is a national priority of the PNG Government, one of the central themes of the PNGDSP is for the PNG economy to advance beyond the mining and petroleum sectors. There is a focus on creating the enabling environment for investment and economic participation through the construction, operation and renovation of physical structures that provide a platform for most other economic activities. This includes telecommunications, electricity, water and waste services, roads and public works programs, ports and airports, shipping and aviation services. The Project provides such an enabling environment for the investment and economic participation envisaged by the PNGDSP.

The Northern Transmission Line aligns with the Border Corridor economic region for the Western, Southern Highlands and Sandaun provinces identified in the PNGDSP. It is envisaged that the FRHEP and SPGP will assist in supplying power to northwest PNG and enable a reliable, renewable supply of power long after the FRCGP has closed. The development of the infrastructure corridor will improve the viability of regional industry including palm oil and agroforestry operations by providing access to markets, lower cost power and communications. Power and roads are proven catalysts for economic growth in developing nations.

Development of the economic corridor will promote the bilateral objectives of PNG and Indonesia to develop the border area and enhance cross-border trade, investment and broader cooperation.

2.2 Mineral Resource and Ore Reserve

Exploration and drilling programs at the HITEK porphyry copper-gold deposits have been undertaken by FRL and its predecessors since the 1960s and have allowed the declaration of a large Mineral Resource as shown in Table ES1, which is reported in accordance with the Joint Ore Reserves Committee Code (JORC Code, 2012). The HITEK deposits contain an estimated combined Measured, Indicated and Inferred Mineral Resource of 2,640 million tonnes (Mt) at a grade of 0.44% copper and 0.23 grams per tonne gold. This represents one of the largest known undeveloped copper deposits in the world.

*Table ES1 HITEK Mineral Resource estimate**

Class	Tonnes (millions)	Copper Grade (%)	Gold Grade (g/t)	Silver Grade (g/t)
Measured	620	0.53	0.30	0.82
Indicated	1,240	0.44	0.22	0.75
Inferred	780	0.35	0.18	0.83
Total*	2,640	0.44	0.23	0.79

*At 0.2% cut-off grade (total copper).

The Measured and Indicated Mineral Resources support the Proved and Probable HITEK Ore Reserve shown in Table ES2.

Table ES2 HITEK 2018 Ore Reserve estimate

Class	Tonnes (millions)	Copper Grade (%)	Gold Grade (g/t)
Proved	604	0.51	0.30
Probable	761	0.42	0.21
Total	1,365	0.46	0.25

2.3 General Overview of Project

A detailed project implementation plan including a construction schedule outlines the intended Project development sequence. During initial construction of the FRCGP and FRHEP, freight will be barged upstream along the Sepik River to the Frieda or May river ports until upgrade of both the Vanimo Ocean Port and the Vanimo to Green River Road are complete. Freight will then be trucked from Vanimo to Green River and barged from the Upper Sepik River Port downstream along the Sepik River. Freight will be trucked to site after the road from Green River to the mine site is complete.

Figure ES3 shows the general layout of the mine and ISF area including the HITEK open-pits, process plant and supporting infrastructure. Figure ES4 shows the supporting infrastructure in the mine and FRHEP area relative to the immediate downstream corridor.

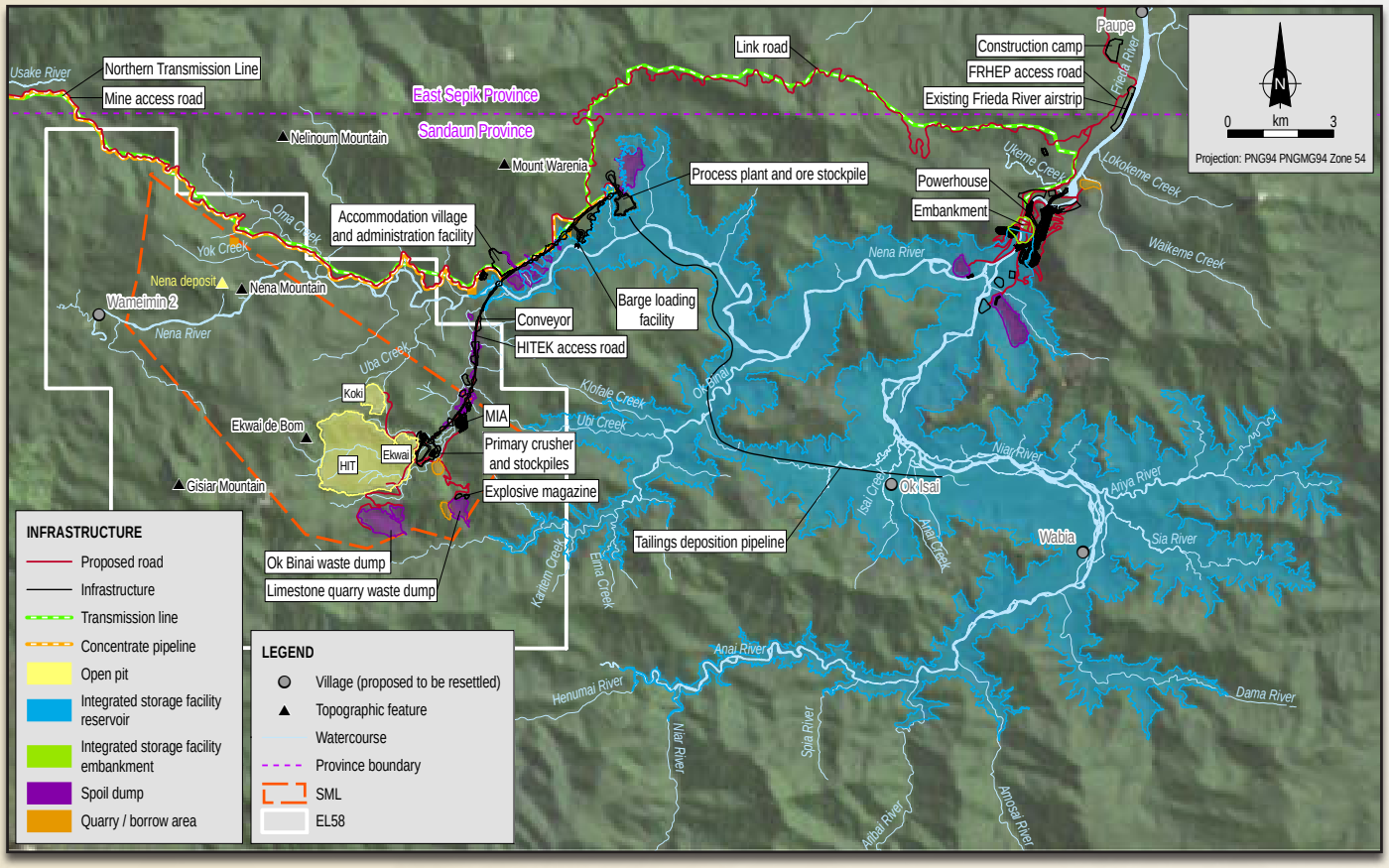


Figure ES3 Mine and ISF area

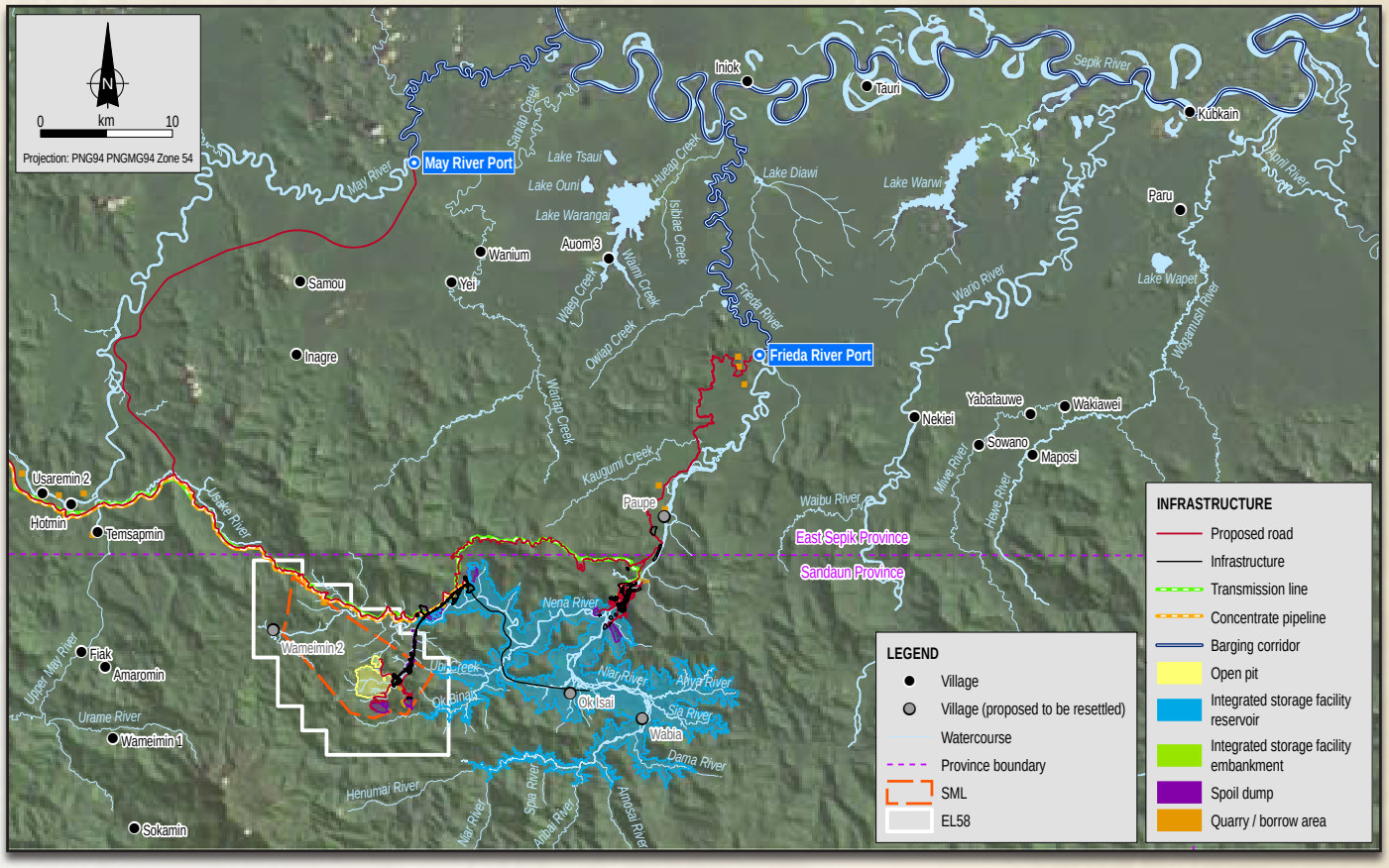


Figure ES4 Mine and FRHEP area and immediate downstream corridor

FRCGP Mining and Processing

The FRCGP comprises a large-scale open-pit mine that will deliver ore to a conventional comminution and flotation process plant to produce a copper-gold concentrate slurry for export.

The mineralisation in the HITEK ore is amenable to sulphide flotation to separate the mineral product from barren tailings. The flotation process lifts the copper grade from an average of approximately 0.5% in the mill feed to approximately 26% in the final concentrate. Figure ES5 shows a schematic of the ore processing circuit.

The mining inventory comprises 1,500 Mt of mill feed. The average annual metal in concentrate production will be 175,000 tonnes (t) of copper and 230,000 ounces (oz) of gold.

In total, the FRCGP footprint will cover approximately 1,145 ha including the open-pit, spoil dumps and haul roads.

The FRCGP will have a mine life of approximately 33 years, preceded by a seven-year implementation period including five years of construction. Ore and waste will be mined from the HITEK open-pits 24 hours per day, 365 days per year. The design stages

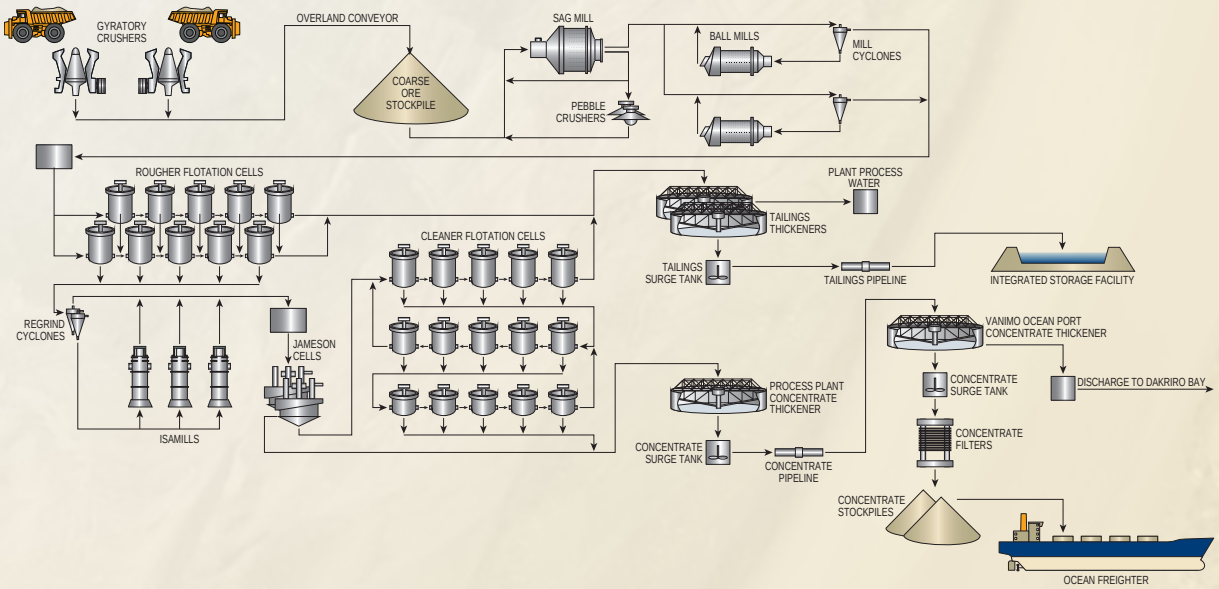


Figure ES5 Ore processing schematic

and open-pit sequencing maximise value while delaying diversion of creeks within the planned mining area to reduce water management requirements.

The open-pit water quality is expected to be poor due to the exposure of potentially acid-forming (PAF) sulphide mineralisation located on the open-pit benches, and subsequent generation of acid and metalliferous drainage (AMD). Water from the open-pit will be treated with quicklime or hydrated lime to neutralise acidity and precipitate metals. Treated water will then be released to Ubai Creek, from where it will flow into the ISF and be subject to further dilution prior to entering the downstream environment. Clean water diversions will be constructed upslope of open-pit areas to divert water around mining areas and reduce water management requirements.

Supporting Infrastructure and SIP

The majority of the workforce will access the site from the upgraded Green River Airport which will be linked to the FRCGP and FRHEP sites by the main access road. The FRCGP accommodation village will be located in the Nena River valley approximately 5 km from the process plant and will house up to 3,500 personnel during construction. A second accommodation village for the FRHEP will house up to 3,300 people during construction. During operations, the FRCGP and FRHEP accommodation villages will house approximately 3,000 personnel with a further 100 personnel to be housed at Vanimo for office, logistics and port operations.

A 325-km-long concentrate pipeline within the infrastructure corridor will transport the copper-gold concentrate slurry to a purpose-built concentrate dewatering, storage and export facility located at Vanimo (Vanimo Ocean Port).

The SIP will provide a range of regional infrastructure that will serve multiple users. It comprises upgrade of the existing port located at Vanimo, upgrade of the Vanimo to Green River Road, construction of a public road from Green River to Hotmin and an upgraded Green River Airport.

The existing port at Vanimo on the eastern shoreline of Dakriro Bay will be developed as a multi-user facility suitable for international vessels, export of copper-gold concentrate, and import of freight and fuel. Other products will be able to be exported by other users.

The existing road from Vanimo to Green River will be upgraded and a new public road constructed from Green River to Hotmin. The road will allow for public transport, commercial ventures and access to new markets. A total of five major bridge river crossings will be required. The extension and upgrade of these roads will contribute to delivering the PNGDSP's 2030 Bewani to Telefomin 'missing link' nation-building road.

The existing airstrip at Green River is located 150 km from the mine site. It is currently a well-formed but basic airstrip with infrequent use. It will be upgraded to an international airport that will cater for larger aircraft and remain available for commercial domestic use. The new facilities will include a terminal with the capacity for 80 passengers, baggage handling facilities, immigration and customs, freight handling and storage facilities. During FRCGP operations, there will be a requirement to operate up to seven flights each week to regional airstrips and fourteen flights each week to commercial airport hubs (e.g., Wewak, Mount Hagen and Port Moresby).

FRHEP and Integrated Storage Facility

The FRHEP will include an engineered ISF for the storage of construction spoil, mine waste rock and tailings, and for sediment control.

To limit the potential for generation of AMD, the ISF will provide a permanent water cover for the waste rock and process tailings material from the FRCGP – termed 'subaqueous deposition'. The ISF will ultimately store 1,450 Mt of waste rock (of which around 1,340 Mt is expected to be PAF) and approximately 1,500 Mt of tailings.

The FRHEP will be constructed in the Frieda River catchment approximately 16 km downstream of the mine and 35 km upstream of its confluence with the Sepik River, and will have an ultimate footprint of approximately 12,700 ha.

The ISF is designed to Australian National Committee on Large Dams Incorporated (ANCOLD) and International Commission on Large Dams (ICOLD) standards.

The international engineering consultancy, SRK Consulting, designed the FRHEP and its design report is provided as Appendix 2 to the EIS. This design has been subject to international expert peer review by

PanAust's Tailings Independent Review Panel (TIRP) which has assessed the adequacy of the FRHEP design and the underlying studies informing this design and provided staged recommendations for additional studies and evaluations.

The FRHEP is designed as a large water retaining dam rather than using conventional tailing storage facility design principles. This design philosophy was adopted by FRL due to recognition of the risks associated with potential seismic activity in the Project area, the high rainfall and the necessity for the structure to remain stable under such conditions. Geotechnical investigations concluded that no large fault structure is present beneath the FRHEP embankment, although several small faults of limited width were encountered.

Two large regional faults are situated near the embankment site: the Frieda Fault is situated approximately 7 km to the south of the site while the Saniap Fault is situated 1 km to the north of the site. Potential movement on these faults has been considered in the seismicity assessment for design of the embankment.

The design of the FRHEP limits potential impacts to downstream water quality while simultaneously allowing for the generation of hydroelectric power. The FRHEP will have a total water-retaining capacity of 9.6 Bm^3, which includes 3.3 Bm^3 of storage capacity for waste rock, tailings and sediment, which is well in excess of the 2.2 Bm^3 of storage required for the life of mine. This ensures that waste rock and tailings deposited into the ISF will remain submerged under all foreseeable conditions. The water capacity of the FRHEP will allow for the 600 MW hydroelectric facility to provide an annual maximum energy generation of 2,800 GWh/year.

Subaqueous deposition of acid forming materials is considered by the International Network for Acid Prevention as one of the most effective methods for limiting AMD generation.

PanAust has extensive experience with the subaqueous deposition method which it successfully uses to manage the potential for AMD from process tailings and mine waste rock at its Phu Kham Operation in Laos.

There will be a need to continuously discharge water from the FRHEP to generate power and maintain a safe operating level because of the significant surplus of rainfall over evaporation; therefore, the ISF has been designed as a 'flow-through' system.

Water will be discharged to the Frieda River downstream of the FRHEP embankment through a set of hydroelectric power intakes during operations and through a spillway during storm events.

Hydroelectric power will be generated using turbines with an installed capacity of approximately 600 MW. At least one turbine at a time will be offline for periods of planned maintenance and one other turbine will be on standby.

From approximately Year 2 of production at the FRCGP, the excess power available for export will be in the order of 1,400 GWh/year. This quantity will reduce to 600 GWh/year from Year 8 due to the increase in power demand for the FRCGP, contributing to meeting the PNGDSP's target of 1,020 MW of hydroelectric power generation capacity by 2030.

FRL commenced a stewardship program and commissioned staged independent expert reviews during design of the FRHEP. The FRHEP stewardship program will continue through the life of the FRHEP and comprises:

- A dam safety program as described by the ICOLD and most of its associated national organisations, including ANCOLD and the Canadian Dams Association.
- A corporate governance and reporting structure.

ISF embankment, spillway and FRHEP powerhouse

Power Supply and SPGP

Power during construction of the FRCGP will be provided by diesel generators located at major infrastructure locations including the open-pit, mine infrastructure area, process plant and site accommodation village until the FRHEP is commissioned.

Power during FRCGP operations will be provided by the FRHEP. The powerhouse will supply power via a dedicated 22-km-long 132 kV transmission line to the process plant. The energy demand for the FRCGP will be approximately 180 MW initially, increasing to 280 MW in Year 8.

The SPGP consists of a new 370-km-long transmission line from the FRHEP to the Indonesian border, via Vanimo. The Northern Transmission Line will be located within the infrastructure corridor and will provide power for the offsite FRCGP facilities at Green River and Vanimo. The transmission line will follow the existing Vanimo-Jayapura Highway from Vanimo to the Indonesian border.

A single wire earth return line will distribute power along sections of the transmission line route. The single wire earth return networks will provide the opportunity for a third-party power provider to distribute and sell electricity to communities along the infrastructure corridor as the Project has made no provision to establish this connection. The current domestic demand along the infrastructure corridor within Hotmin, Green River, Vanimo and other villages is relatively small. However, Jayapura in neighbouring Indonesia has a much higher power demand.

This EIS does not include distribution of power to other users. However, there is potential for a second stage of the SPGP to be developed using further high voltage transmission networks to support industrial and population growth in other areas of PNG.

The full power generation capacity of the FRHEP will be available for third-party use after the FRCGP ceases operations.

Resettlement

The filling of the reservoir will displace the villages of Ok Isai and Wabia, necessitating their resettlement.

The village of Paupe is located north of the Frieda River airstrip adjacent to the Frieda River and 5 km downstream of the proposed ISF embankment. During the seven-year implementation phase of the Project, amenity impacts to Paupe village are anticipated due to its proximity to Project infrastructure.

The proximity of Wameimin 2 to the SML and mine access road could result in high levels of in-migration to the village, before and during development of the mine, and may constrain identified future brownfield expansion areas. In-migration in close proximity to the access road will increase safety risks to people due to potential interactions with heavy vehicles along the mine access road.

As a result, it is proposed that the residents of the Ok Isai, Wabia, Paupe, and Wameimin 2 villages be resettled. Options for resettlement sites have been identified through consultation with residents of these villages, however final locations are yet to be agreed. Options for resettlement locations will be further investigated in consultation with village residents.

Resettled villages will be provided with housing and associated facilities to a standard greater than current facilities.

Additional Infrastructure Not Assessed in this EIS

There is potential for a public road extension from Hotmin to Telefomin; however, this extension has not been included in this EIS as it is not required for the development of the FRCGP and FRHEP. A connecting road to Telefomin establishes an opportunity for public transport and commercial ventures along a route that currently has no transport infrastructure in a remote part of PNG and would complete a 'missing link' nation-building road.

A single wire earth return transmission line will be installed along the Northern Transmission Line to allow a power distributor to sell excess power to communities along the infrastructure corridor. Additional local power distribution infrastructure that is required has not been included in this EIS.

2.4 Development Schedule

Figure ES6 shows the indicative development schedule for the Project. Feasibility Study engineering and Project design have progressed simultaneously with the environmental and social studies and preparation of this EIS. Results from the EIS studies have informed elements of the Project's design and the development proposal will continue to evolve as engineering work proceeds through the detailed design phase.

The schedule is based on obtaining PNG government approval together with a decision by infrastructure providers and commercial developers to proceed with the Project. The Frieda River Joint Venture's approval process will consider several commercial factors including copper and other commodity prices, the PNG regulatory setting and the completion of satisfactory financing arrangements.

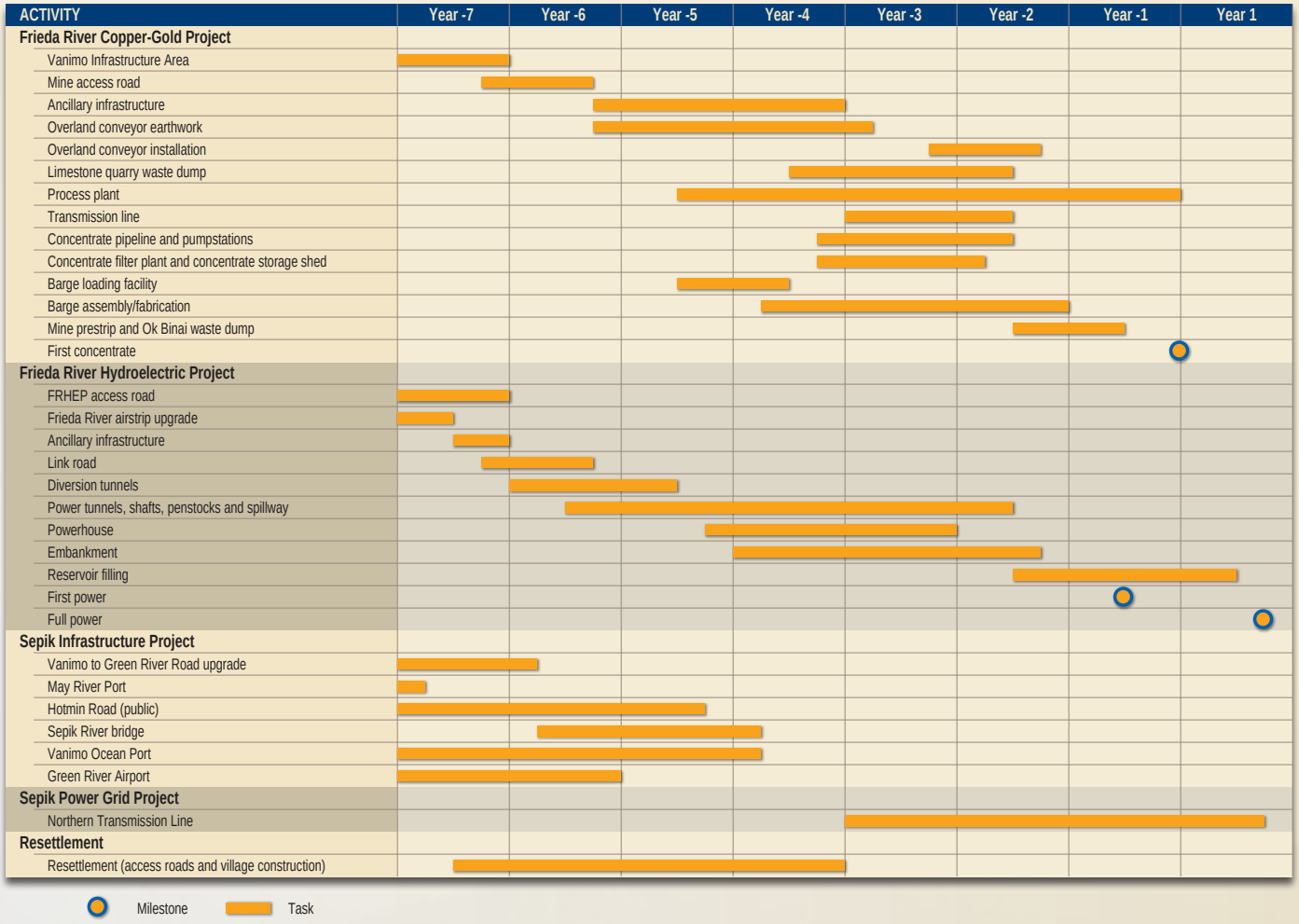


Figure ES6 Sepik Development Project indicative development schedule

2.5 Assessment of Alternative Development Options

Extensive work since 2014 has assessed many development options to determine the feasibility of the Project, limit environmental and social impacts, and enhance potential social and economic benefits. The development options considered prior to 2017 were focussed on the FRCGP as an enclave development – whereby supporting infrastructure was intended for the exclusive use of the FRCGP – but remain relevant to the Project.

Key constraints considered in the assessment of alternative development options were:

- Economic constraints – driven by factors including the characteristics of the mineral deposits, Project development expenditure, fluctuating commodity prices and the need for the FRCGP to be in a position to extract and process ore in a profitable manner throughout the commodity price cycle.
- Physical constraints – including the remote location of the mineral deposits, a lack of enabling infrastructure and the climatic, topographic and geotechnical constraints imposed by the surrounding landscape.
- Environmental constraints – prevailing environmental conditions and sensitivities of the Project's setting.
- Social constraints – the locations, expectations, values and concerns of potentially affected communities.

The description of the Project contained in the EIS represents the current optimisation of the Project design, taking into consideration the economic, physical, environmental and social constraints. The decision-making process that led to the proposed Project development is detailed in Chapter 6 of the EIS.

2.6 Conceptual Closure Planning

Conceptual closure plans have been prepared for the FRCGP and FRHEP that describe decommissioning and rehabilitation concepts consistent with the level of detail available for this phase of the Project. FRL's goal for closure is to rehabilitate disturbed areas in a manner that, where possible, will support self-sustaining vegetation that is consistent with that of surrounding natural areas and to leave a lasting positive legacy in the form of regional infrastructure, enhanced economic activity, transferred skills and self-sustaining community development programs.

Decommissioning of the FRCGP will commence after mining operations have ceased and is expected to take three years. In general, equipment and infrastructure will be removed, dismantled, demolished and salvaged (where economic to do so) with earthworks undertaken to construct final landforms. Some infrastructure such as subsurface pipelines will remain in place. Landforms will be revegetated to meet the agreed final land use, closure objectives, completion criteria and closure indicators, after consultation with stakeholders. Regular post-closure monitoring and maintenance will be undertaken as completion criteria are progressively achieved and sustained.

Following FRCGP decommissioning, FRL may come to an agreement to transfer some FRCGP infrastructure to third parties, if this is mutually beneficial and can be adequately maintained, so that ongoing post-closure activities can be sustained for the life of the structures. This will be determined with relevant stakeholders to ensure that prerequisite approvals have been obtained prior to closure and the point of transfer. The conceptual closure plan conservatively assumes that all FRCGP assets which are not required after relinquishment will be demolished. It is intended that SIP and SPGP infrastructure will be held by other parties.

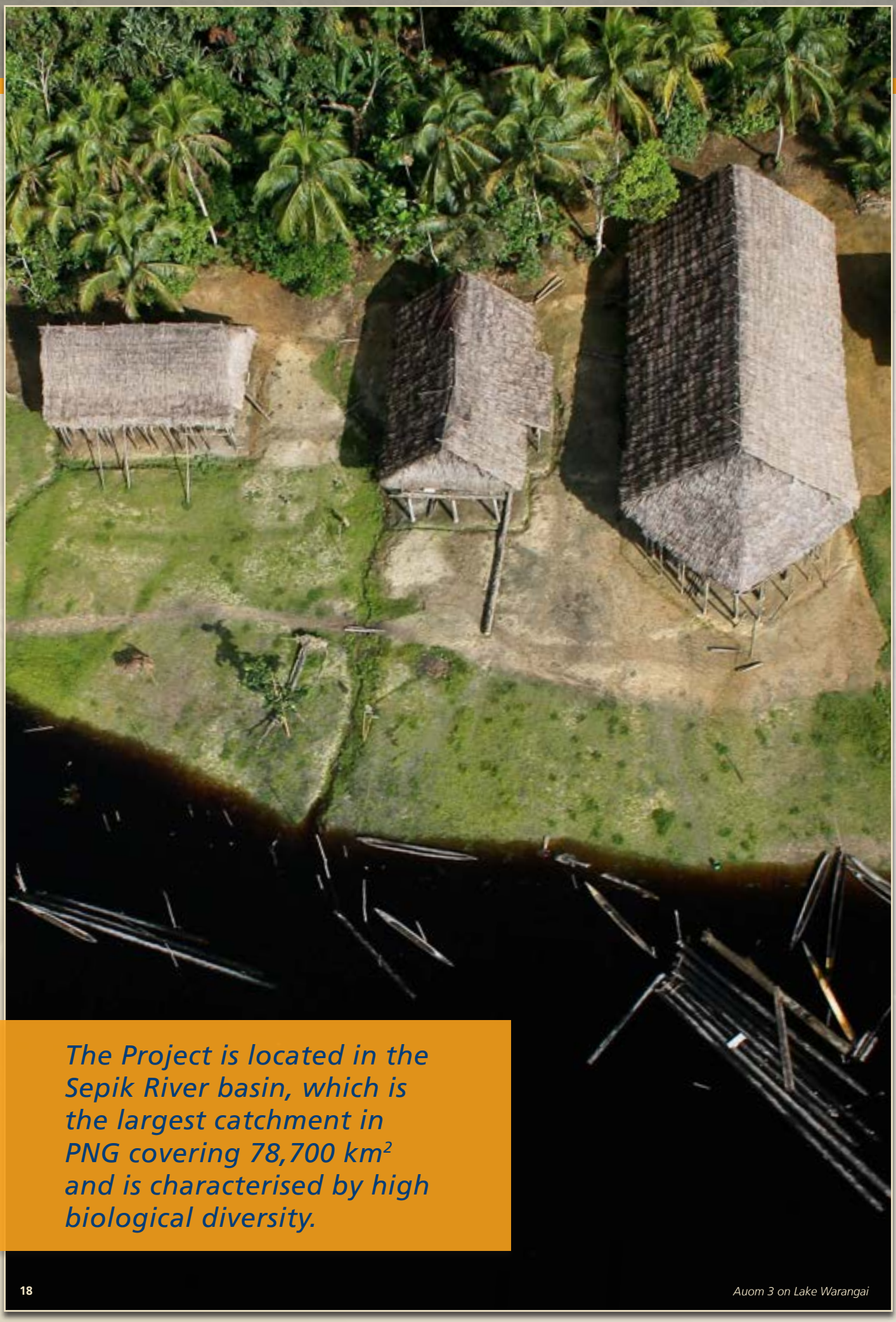
The following infrastructure will remain as part of FRCGP decommissioning:

- The HITEK open-pit void will be actively flooded, which will take approximately three years, and when fully formed, the open-pit lake will cover approximately 40% of the surface area of the final open-pit. There will be a highwall exposed above water level (approximately 600 m high) that is expected to contain PAF material. Active water treatment is expected to be required throughout the life of the mine and continue for approximately 50 years after mine closure until downstream water quality criteria are met. Surface water diversion drains around the open-pit will be maintained while there is active water treatment.
- The mine access road and the link road will be maintained during the closure monitoring period to allow access to the FRHEP, accommodation village and water treatment plant. These roads will be transferred to FRHEP ownership at relinquishment.

The ISF will also remain after mine closure and the FRHEP will continue to generate power. The closure date for the FRHEP could vary, as the potential for continued hydropower demand is yet to be determined, however it is assumed it will operate for more than 100 years. The embankment will be required to be stable in perpetuity and has therefore been designed for closure irrespective of its succession potential. At the time of FRHEP closure, the spillway gates will be removed so that excess water passes over the ungated spillway. This will reduce the depth of the ISF, while not affecting the oxygen barrier function to prevent the oxidation of tailings and waste, and it is expected that the facility will continuously fill with sediment. The long-term stewardship roles and responsibilities for the FRHEP will have been agreed with relevant stakeholders.

Nena River valley

Once the FRCGP has closed the FRHEP will continue to operate. The FRHEP has an operating life of greater than 100 years providing access to a renewable source of power for this region of PNG.



The Project is located in the Sepik River basin, which is the largest catchment in PNG covering 78,700 km^2 and is characterised by high biological diversity.

Auom 3 on Lake Warangai

3. PROJECT SETTING

The Project components cover a range of geographical areas. The FRCGP and FRHEP are predominantly located in Sandaun Province close to the border with East Sepik Province. The infrastructure corridor, including the public road and Green River Airport of the SIP, and the SPGP's Northern Transmission Line route, extends northwest from the mine area primarily through the Usake and Upper May river catchments and then generally north across the Sepik River floodplain and over the Bewani Mountains and the northern coastal plain to Vanimo on the northern coast.

3.1 Terrestrial Environment

The mine and FRHEP area is located in the upper Sepik River basin in the foothills of the Central Highlands of PNG, where elevations generally range up to about 1,500 mASL. Vegetation is dominated by thick tropical rainforest. Figure ES7 shows three-dimensional views of the mine area and May River Port and illustrates the terrain of the hill zone transitioning into the lowland zone.

The climate of the region is dominated by two seasons; the northwest monsoon (wet) season between November and April, and the southeast monsoon (dry) season between May and October. Average annual temperatures vary from about 23°C at the mine site to 27°C in the lowlands. Average annual rainfall in the mine area is between 7,700 and 8,600 mm, while in the lowland zone it is between 3,700 and 6,000 mm. The region is seismically active, with corresponding implications for Project infrastructure and importantly, the design, construction and operation of the FRHEP.

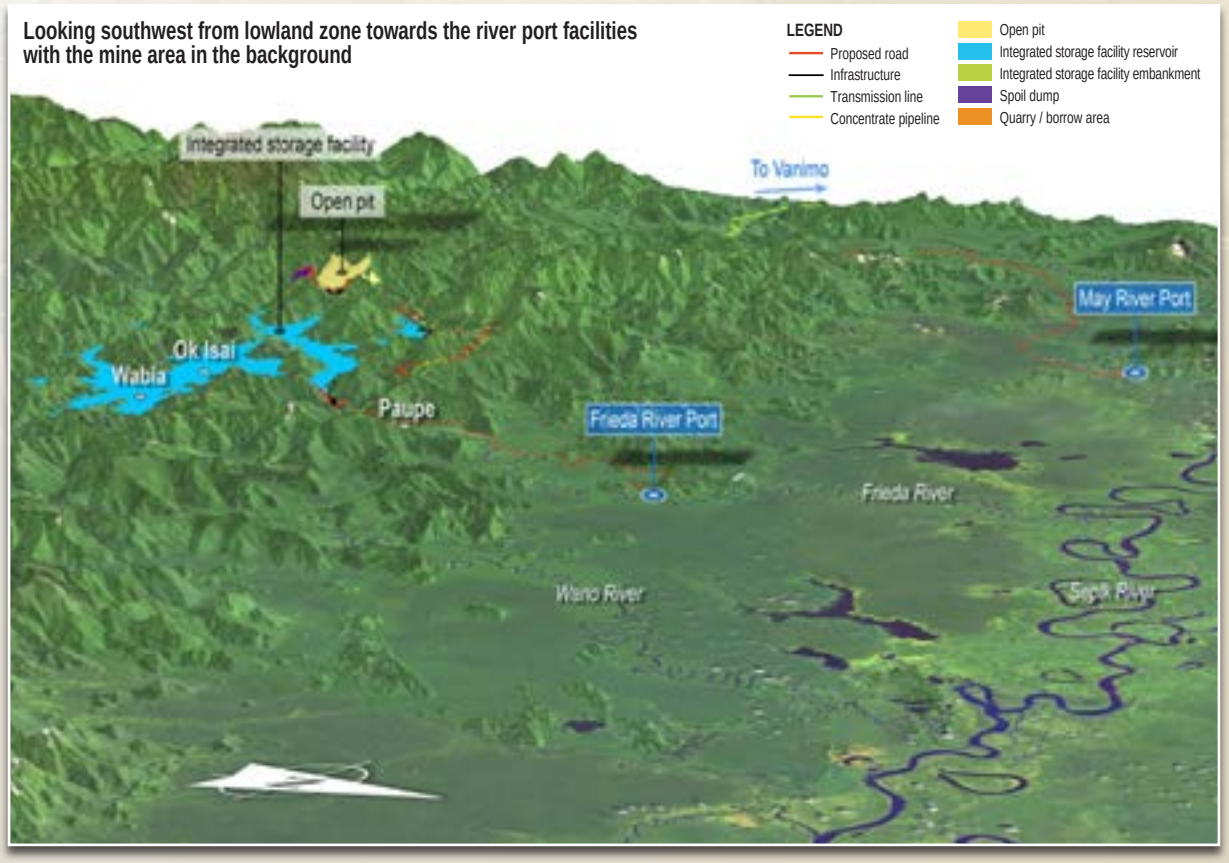


Figure ES7 Three-dimensional view of the mine and FRHEP area and May River Port

Plate ES1

Plate ES2

Plate ES3

Plate ES4

The Sepik River basin is one of Malesia's most biologically diverse environments and is the largest catchment in PNG covering 78,700 km^2. Vegetation in the catchment is varied and includes mangrove forest, herb swamps, tall lowland rainforest, cloud forest and alpine heaths. The region also contains a high diversity of terrestrial fauna, in particular mammals and frogs, in comparison with other remote areas of the PNG highlands. As such, the Sepik River basin rates as a globally significant area of biodiversity.

To this end, the terrestrial biodiversity assessment focussed on an area of 660,571 ha. The surveys were one of the most labour-intensive botanical inventories undertaken in modern New Guinean research, totalling almost 2,000 hours of active surveying. More species were recorded and collected than for any comparable surveys in PNG's post-Independence period, exceeding even the combined results from previously unexplored areas on the Papuan karst. This coverage has contributed to the broader knowledge of PNG terrestrial biodiversity.

A total of 2,229 plants and animal species were recorded during the EIS biodiversity surveys, including 85 species new to science or undescribed, comprising new species of plants, mammals, frogs, reptiles, dragonflies, damselflies and butterflies, as well as range extensions for several species. This is expected given the EIS biodiversity surveys were the first in this area. Pictures of some of the species recorded during the EIS biodiversity surveys are provided in Plates ES1 to ES4.

The area is rich in species endemic to northern New Guinea and mammals, particularly, have high levels of endemism. A number of individual species and ecosystems of conservation significance were also identified.

While the mine and FRHEP area consists of extensive intact habitat, between Green River and Vanimo there are increasing levels of vegetation clearance associated with forestry activities and development of oil palm and sago plantations (Plates ES5 and ES6). Vegetation clearance has extended south along the road corridor over time with the area that had been cleared in each of 2011, 2014 and 2017 in Sandaun Province shown in Figure ES8 , with an estimated total clearance area of 16,700 ha in 2017.

Plate ES1	*An undescribed species of feather-tailed possum,* Distoechurus *sp, photographed at Iniok Village Site*
Plate ES2	*Coroneted fruit-dove (*Gallicolumba rufigula*)*
Plate ES3	*Common paradise kingfisher (*Tanysiptera galatea*)*
Plate ES4	*Family Hylidae (*Nyctimystes fluviatilis*)*
Plate ES5	*Logging in the Bewani Mountains*
Plate ES6	*Oil palm plantation between Vanimo and the Bewani Mountains*

Plate ES5

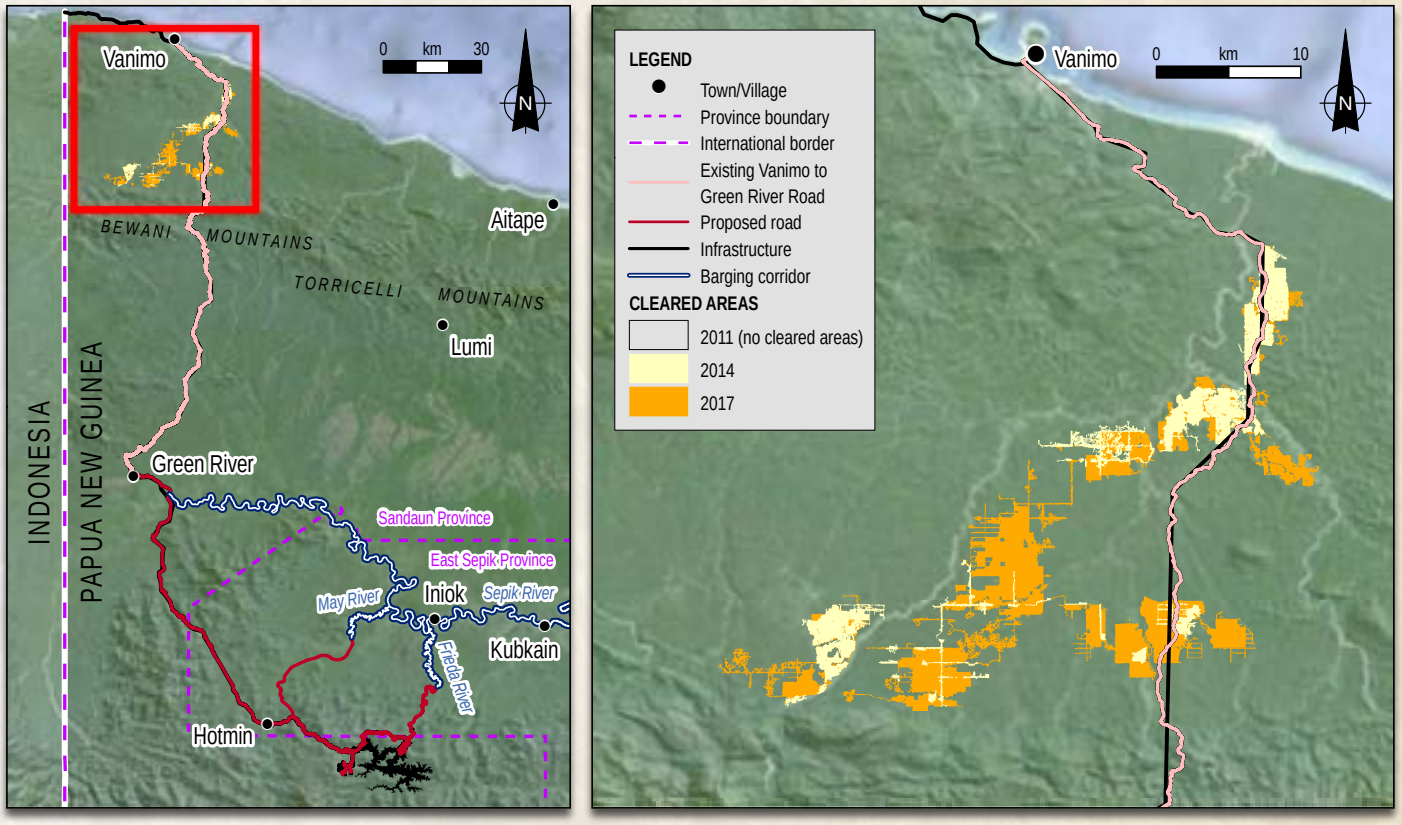


Figure ES8 Area of cleared vegetation in Sandaun Province in 2011, 2014 and 2017

Plate ES6

Plate ES7

Plate ES8

Plate ES9

Plate ES10

3.2 Aquatic and Marine Environment

In the mine and FRHEP area, average stream gradients in the upper reaches of the rivers are very steep with streambeds confined by valley slopes. These upland streams characteristically have rocky streambeds with medium and large boulders and typically fast-flowing clear waters (Plate ES7), although turbidity temporarily increases during high-flow events and downstream of landslips. Levels of suspended solids are otherwise generally low, typical of undisturbed forested catchments.

Streams including the lower Nena and Niar rivers and Ok Binai are mid-catchment rivers with medium gradient profile and partly confined channels (Plate ES8). These streams characteristically have wide, straight to partly meandering channels, moderate sediment loading and cobblestone/gravel streambeds and banks.

Along the lower Frieda River, gradients reduce significantly and the river channel widens and becomes extremely sinuous, showing strong meandering behaviour (Plate ES9). Water quality is generally turbid due to the higher loads of suspended sediment. The overbank flow areas next to the lower Frieda River are also relatively flat, becoming inundated during large flood events, and are characteristically swampy with areas of shallow standing water. The Frieda River within the Sepik River floodplains (and other lowland rivers, including the Sepik River itself) is highly dynamic with constant shifts in the main channel path that result in the formation of oxbow lakes (Plate ES10). The Frieda River contributes approximately 5% of water inflow to the Sepik River.

Watercourses intersecting the infrastructure corridor between the mine area and Vanimo include the Usake/May, Idam and Horden rivers, each of which are tributaries of the Sepik River. These are all mid-catchment rivers with the Idam River transitioning to a lowland river further downstream.

The EIS surface water monitoring program involved 20 sampling events conducted between 2007 and 2017. The study area included the Usake/May, Idam, Horden, Nena/Niar/Frieda, Wario and Sepik rivers, with sampling undertaken at a total of 44 sites that extended to the mouth of the Sepik River. Sampling locations along the infrastructure corridor and in the vicinity of the mine and FRHEP area are shown in Figure ES9. Apart from some local acidity and elevated metal concentrations in the immediate area of the FRCGP mineral deposits, surface water quality characteristics are typical of PNG streams.

Plate ES7 *Upper reach of the Nena River*
Plate ES8 *Niar River at the confluence with Isai Creek*
Plate ES9 *Braided reach of the lower Frieda River*
Plate ES10 *Oxbow lake formation in the lower Frieda River*

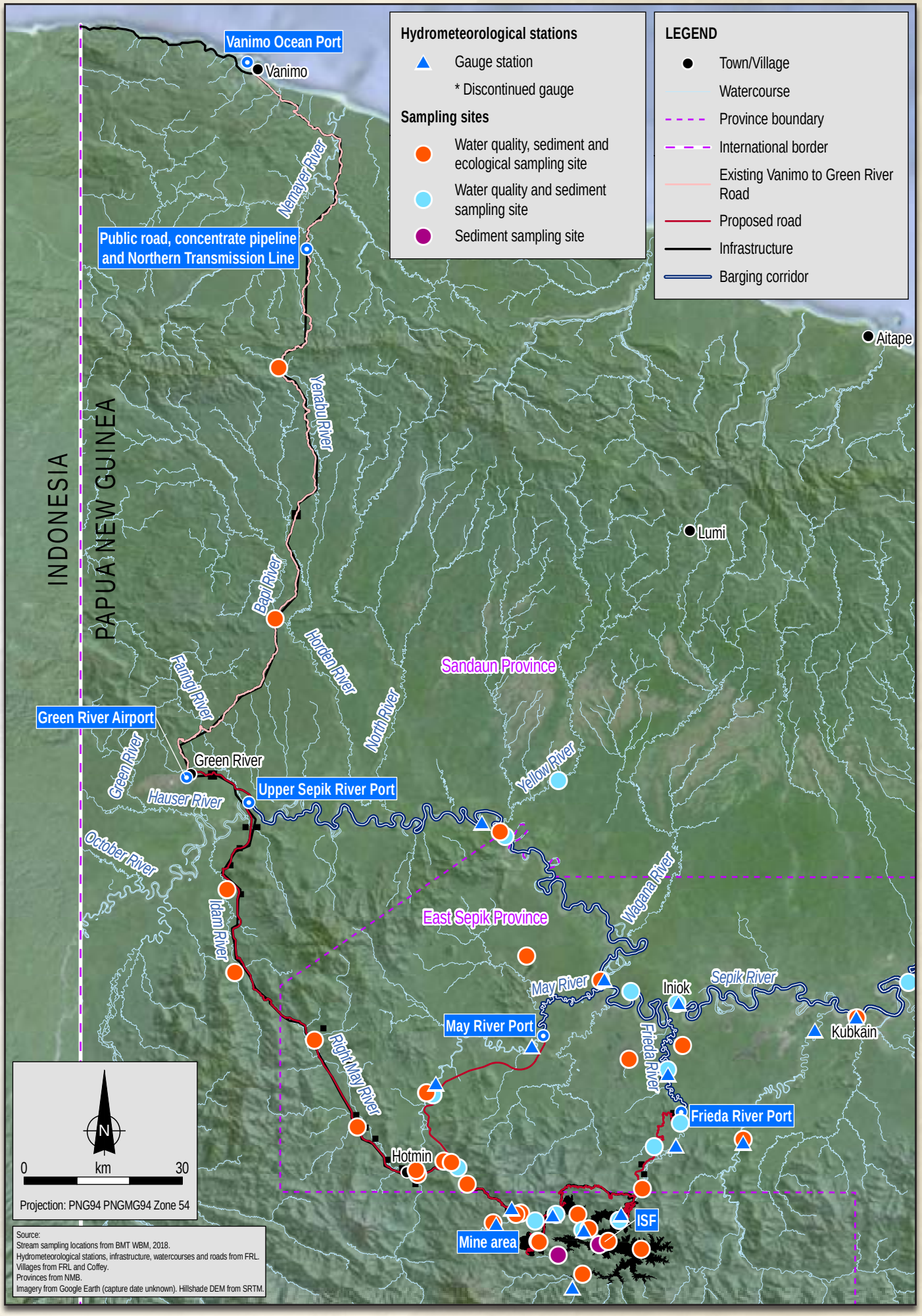


Figure ES9 Stream sampling locations

Plate ES11
Shoreline adjacent to Wesdeco

During characterisation surveys, 33 native and seven non-native fish species were collected from upland creeks and rivers, mid-catchment and lowland rivers and off-river waterbodies in the Sepik River catchment. An important finding of the baseline study was that the upper and middle reaches of the Sepik River catchment had high aquatic habitat integrity and conservation value, most likely because these areas are sparsely populated. However, the composition of the fish community within the Sepik River catchment, particularly in the middle reaches of the Sepik River, has been significantly changed as a result of introduced non-native species. A number of fish species of conservation significance have been reported in the Sepik River system, as have two endemic species of freshwater turtles. Two crocodile species, both of local significance, occur in the Sepik River system.

The nearshore marine environment around the proposed location of the Vanimo Ocean Port contains intertidal, tidal, shallow marine and reef zones (Plates ES11 and ES12). Surface water quality was typical of marine waters and similar across sampling sites, characterised by warm waters (~30°C) with low suspended sediment concentrations. Marine habitats consisted of sandy beaches, subtidal sands, fringing coral reefs and seagrass meadows. Fish communities were seldom observed during the field survey and fish size and abundance was much lower in comparison to fringing reefs in other PNG locations. Reduced fish abundance was attributed to the area being highly overfished due to its proximity to the provincial capital of Vanimo.

3.3 Socio-economic Environment

The Project's social setting has been established in the course of completing a multitude of in-depth studies over more than 20 years. These studies have involved ongoing regular engagement with communities potentially affected by the Project.

The communities associated with the mine and FRHEP area, infrastructure corridor, Vanimo Ocean Port and Sepik River Corridor have been categorised by social catchment areas that have been defined through a consideration of location, the type of Project activity that may occur in proximity to villages in the catchment, and language group or cultural affinity of the villages in the catchment area. Social catchment areas have been defined for the Miyan, Telefol and Paiyamo people (Social Catchment 1A), villages along the new section of road corridor between Hotmin and Green River (Social Catchment 1B), villages along the existing road corridor between Green River and Vanimo (Social Catchment 1C), villages near the Vanimo Ocean Port (Social Catchment 1D), the Sepik River corridor (Social Catchment 2) and Sandaun and East Sepik provinces (Social Catchment 3).

Catchments 1A, 1B, 1C and 1D have been the focus of the characterisation and assessment as these localities are most likely to experience direct Project impacts. These communities live predominantly subsistence lifestyles with

most food sources derived through gardening, hunting and fishing (although to a lesser extent in Catchment 1D given its urban and industrial setting). Opportunities for participation in the cash economy are primarily limited to small scale alluvial gold production and the supply of labour and services to FRL on an intermittent basis for Catchments 1A and 1B. Opportunities are much greater within Social Catchment 1D given its proximity to Vanimo. Some income is also generated through the provision of transport and labour, sale of garden produce and sago harvest and aquatic resource harvest including fish and crocodiles.

Cultural knowledge and practices maintain an important role in society. However, community members also demonstrated a pragmatic approach to cultural change and acknowledged that elements of culture are constantly evolving. Land custodianship in accordance with customary precepts for access and resource use is reasonably strong, partly supported by the isolation and difficulty of access and travel within the area. The current social environment within the social catchments was supportive of health, safety and security, primarily due to remoteness (and consequent minimal contact with outside persons and influences such as alcohol and drugs). Villages have access to good quality gardening land, forests and rivers; however, health and education services are limited at best and non-existent at worst.

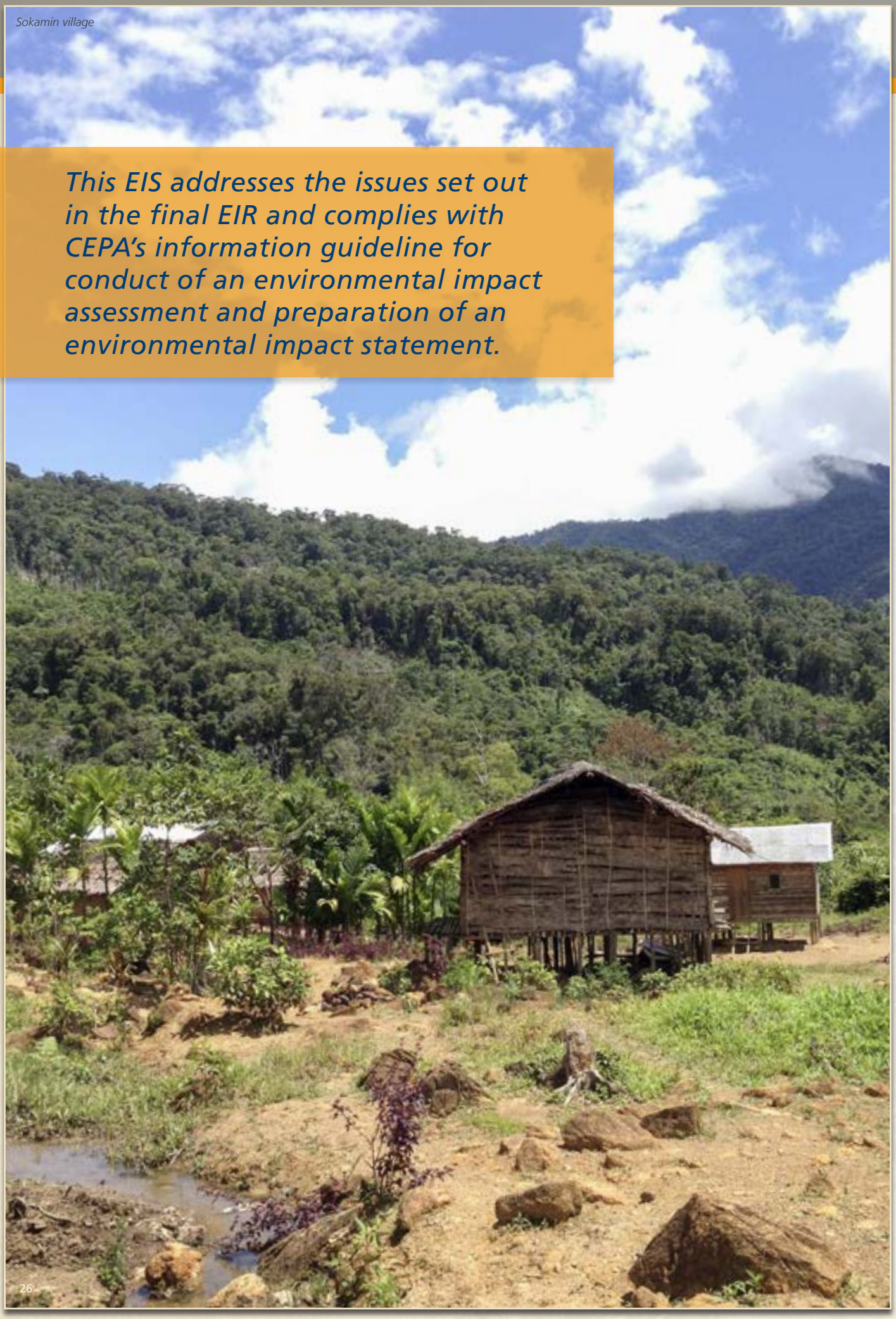
Six social values were identified as being crucial to the qualities of the socio-economic environment that are conducive to individual well-being now and into the future, and for which community stakeholders have a high regard. The six social values are based on discussions with FRL community affairs staff that have a long experience working with Project area villagers, consultation with PNG resource sector community affairs practitioners, and dialogue with mine area social catchment village leaders between 2014 and 2017. Social values can change and may do so rapidly, as key local stakeholders in the Project have themselves initiated quite radical change (and presently continue to experience the consequences of such change) in relatively recent times.

For the communities potentially affected by the Project, the identified social values are:

- Category 1 – Livelihoods
  - Social Value 1: The capacity to support subsistence livelihoods
  - Social Value 2: Opportunities for participation in the cash economy.
- Category 2 – Culture
  - Social Value 3: An enduring ability to sustain individual and group cultural identity and traditions, including connections to ancestors.
  - Social Value 4: An enduring ability to maintain customary rights to land access and resource use.
- Category 3 – Personal and community well-being
  - Social Value 5: An environment amenable to personal and family health, education, safety and security.
  - Social Value 6: The availability of services supportive of personal health, education, safety and security.

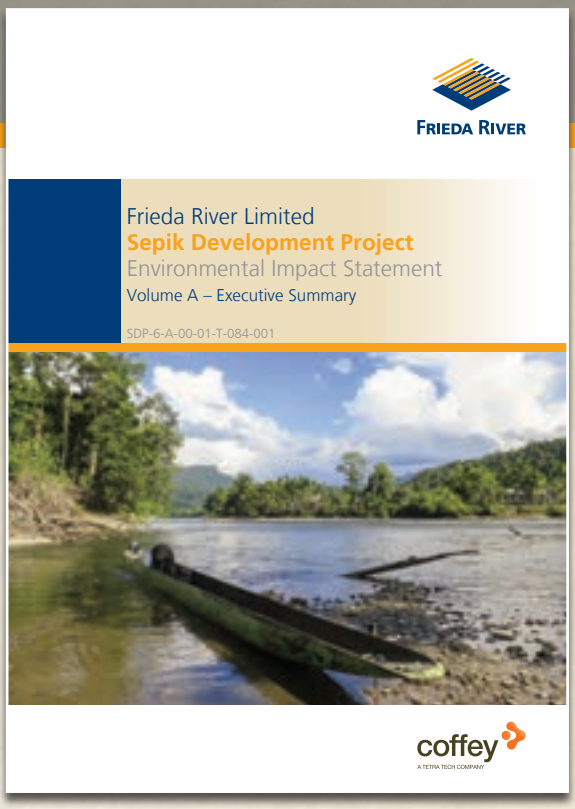
These social values have formed the basis of the socio-economic impact assessment for the Project.

Plate ES12
View of Dakriro Bay from Cis Point



Sokamin village

This EIS addresses the issues set out in the final EIR and complies with CEPA's information guideline for conduct of an environmental impact assessment and preparation of an environmental impact statement.



4. EIS PROCESS

The Independent State of PNG promotes the development of its mineral resources through various policies to manage investment and impacts. This is supported by a legislative and policy framework to ensure that approved developments assess, reduce and manage residual environmental and social impacts such that they are as low as practicable.

4.1 Regulatory Process

The principal legislation for regulating the environmental effects of projects in PNG is the *Environment Act 2000* (the Environment Act), which is administered by CEPA.

FRL submitted a Notification of Preparatory Work, environment permit application and environment inception report (EIR) to CEPA for the Project on 20 December 2017. CEPA approved the EIR on 14 February 2018.

Under Section 53 of the Environment Act, the proponent is required to submit an EIS that addresses the issues set out in the Project's EIR. This EIS addresses the issues set out in the EIR and complies with CEPA's information guideline for conduct of environmental impact assessment and preparation of EIS.

The CEPA Managing Director will make a preliminary assessment (Section 54 of the Environment Act) of the EIS after it is submitted and before making it available for public review (Section 55 of the Environment Act). CEPA's Managing Director will accept the EIS if he or she is satisfied that (Section 56 of the Environment Act):

(a) an environmental impact statement contains an adequate description of the nature and extent of physical and social environmental impacts which are likely to result from the carrying out of a proposed activity; and

(b) all reasonable steps will be taken to minimise environmental harm which may result from the carrying out of the activity; and

(c) the activity will be carried out in a manner which is consistent with all relevant Environment Policies and the Regulation.

The Managing Director's assessment report and any public submissions will also be referred to the Environment Council, a multi-disciplinary panel of experts appointed under Section 57 of the Environment Act. The Environment Council has 90 days to decide whether it is satisfied with the EIS. If the Environment Council is not satisfied, the EIS is returned to the proponent for revision and resubmission. If the Environment Council is satisfied, it will advise the Minister for Environment and Conservation to approve the proposed activity in principle (Section 59 of the Environment Act). After the Minister has issued approval in principle for the Project, CEPA will then finalise the conditions of the Environment Permit and issue the permit under Section 66 and Section 67 of the Act.

4.2 EIS Structure

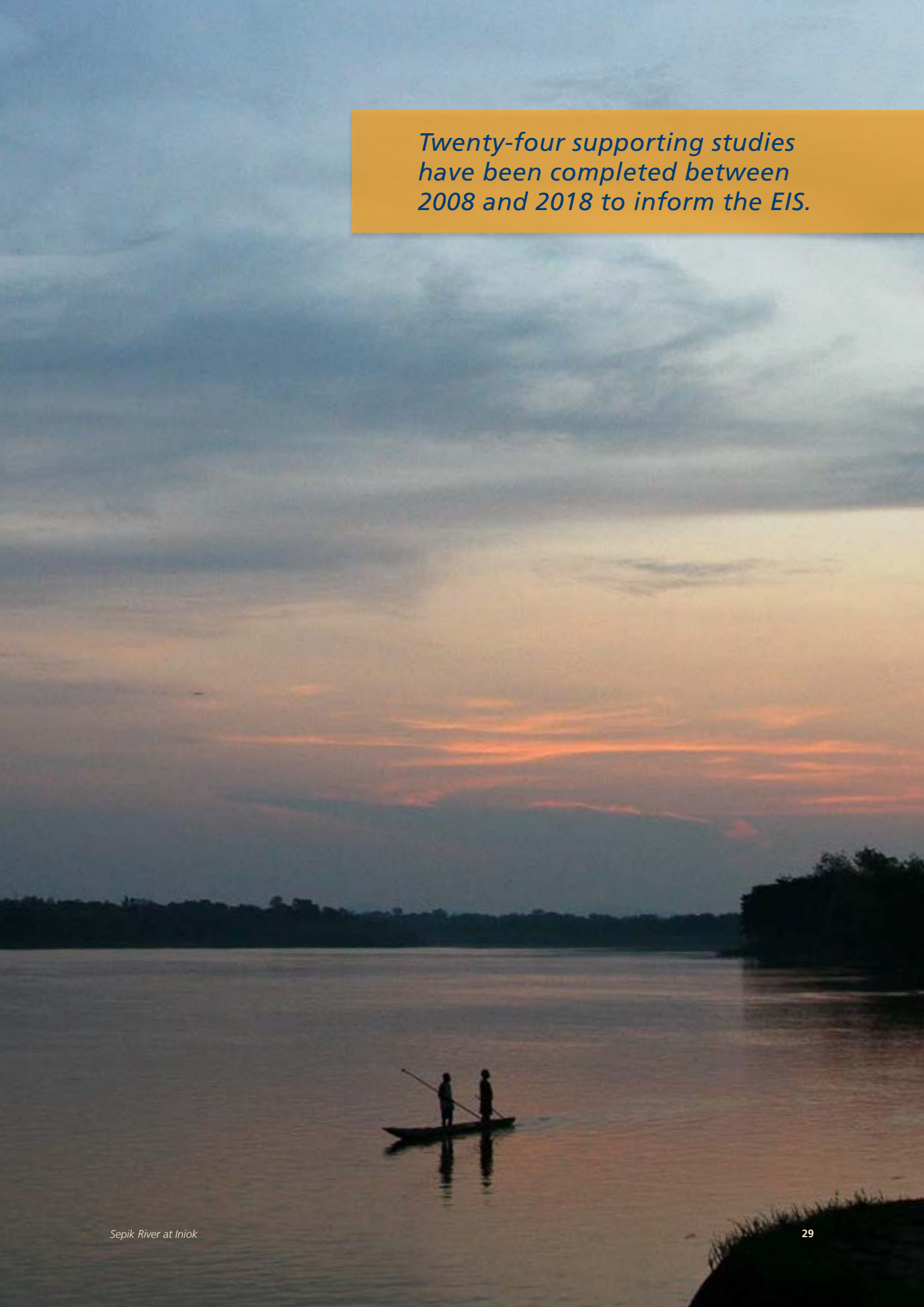
The EIS is presented in three volumes:

- Volume A – Executive Summary (this report).
- Volume B – Main Report. A stand-alone document that can generally be understood without reference to the supporting technical studies upon which it is based. This volume comprises 17 chapters and four attachments, as well as a table of contents that outlines figures, tables and plates in the relevant chapters. The references include bibliographic details for each source cited in the main report.
- Volume C – Appendices. A series of technical reports generated by the various investigations supporting the EIS and appended to the main report. The supporting studies that are appendices to the main EIS report are listed in Table ES3.

Table ES3 Sepik Development Project EIS – supporting studies

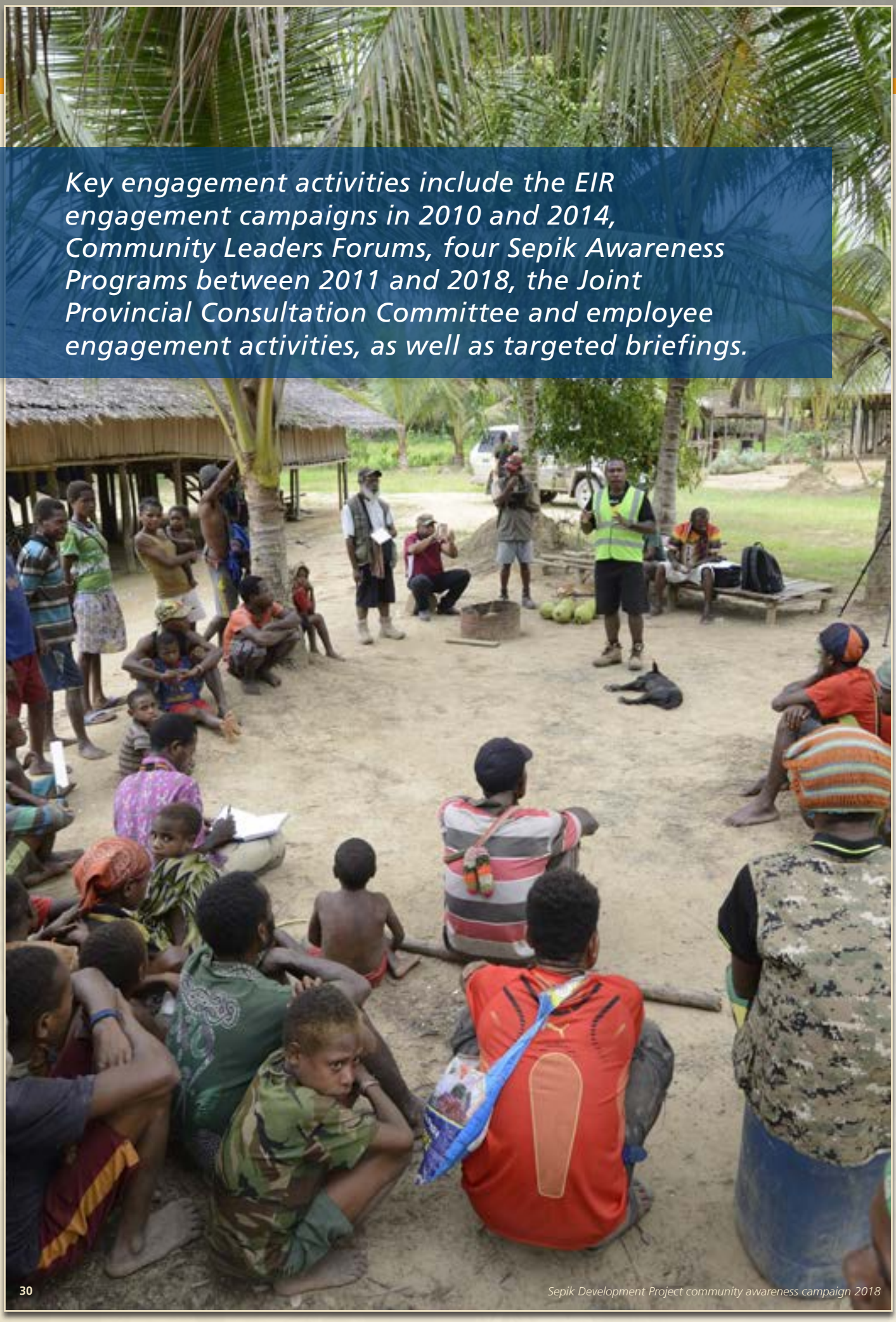
Appendix	Appendix	Lead Author
1	Assessment of the Geochemical Characteristics of Waste Rock and Process Tailings	Environmental Geochemistry International Pty Ltd
2a	Frieda River Hydroelectric Project Selection Phase Study	SRK Consulting (Australasia) Pty Ltd
2b	Frieda River Hydroelectric Project Limnology Study, Phase 2	HydroNumerics Pty Ltd
3a	Frieda River Copper-Gold Project Conceptual Mine Closure Plan	Coffey
3b	Frieda River Hydroelectric Project Conceptual Closure Plan	Coffey
4	Sepik Development Project Regional Groundwater Assessment	Australasian Groundwater and Environmental Consultants Pty Ltd
5	Sediment Transport Assessment	Golder Associates Pty Ltd
6a	Site-wide Water Balance	SRK Consulting (Australasia) Pty Ltd
6b	Site-wide Load Balance	SRK Consulting (Australasia) Pty Ltd
7a	Water Quality, Sediment Quality and Aquatic Ecology Baseline	BMT WBM Pty Ltd
7b	Integrated Storage Facility Bioaccumulation/Biomagnification Analyses - Sepik Development Project	Tetra Tech
8a	Terrestrial Biodiversity Field Assessment for the Frieda River Copper-Gold Project and the Frieda River Hydroelectric Project	Crome, F.; Takeuchi, W.; Aplin, K.; Armstrong, K.; Woxvold, I.; Richards, S.; and Müller, C.
8b	Terrestrial Biodiversity Field Assessment in the May River and Upper Sepik River Catchments	Takeuchi, W.; Armstrong, K.; Woxvold, I.; Richards, S.; Kale, E. and Helgren, K.
8c	Terrestrial Biodiversity Impact Assessment	Francis Crome Pty Ltd
9	Desktop Assessment of Commercial Forestry and Agroforestry within the Sepik Development Project Infrastructure Corridor	University of Nottingham
10	Noise Impact Assessment	SLR Consulting Australia Pty Ltd
11	Air Quality and Greenhouse Gas Assessment	SLR Consulting Australia Pty Ltd
12a	Vanimo Ocean Port Marine Ecology Baseline Study	BMT WBM Pty Ltd
12b	Diffuser Modelling near Vanimo Harbour for the Sepik Development Project	Tetra Tech
13	Social Impact Assessment	Coffey
13.1	Study Area Social Profiles	Coffey
13.2	Cultural Heritage Baseline and Impact Assessment	Andrew Long + Associates Pty Ltd
13.3	Baseline Health, Diet and Nutrition Survey	Centre for Environmental Health Pty Ltd
13.4	Health Impact Assessment	Dempsey Toxicology and Risk Assessment

Twenty-four supporting studies have been completed between 2008 and 2018 to inform the EIS.



Sepik River at Iniok

Key engagement activities include the EIR engagement campaigns in 2010 and 2014, Community Leaders Forums, four Sepik Awareness Programs between 2011 and 2018, the Joint Provincial Consultation Committee and employee engagement activities, as well as targeted briefings.



Sepik Development Project community awareness campaign 2018

5. STAKEHOLDER ENGAGEMENT

5.1 Overview

A key aspect of Project activities to date has been extensive and ongoing engagement with stakeholders over several decades. Stakeholder engagement refers to the activities involving landowners, national and provincial governments, local communities, non-government organisations (NGOs) and other interested parties. Such engagement is critical to obtaining the necessary Project approvals and to establishing broad acceptance of the Project.

Stakeholder engagement has been a major focus following PanAust's acquisition of FRL in 2014. Information about the Project has been presented to stakeholders through forums such as Community Leaders Forums, engagement campaigns and targeted public awareness programs. There has also been ongoing regular consultation with government departments and provincial administrations, along with formal and informal discussions with NGOs and industry related groups on particular issues. While early consultation focussed on the FRCGP, consultation since 2017 has introduced the additional components of the Project.

Local opinions and issues have been sought through: engagement campaigns specifically undertaken for the EIS process; formal and informal meetings with village leaders; and through socio-economic surveys conducted in villages between 2010 and 2018. Socio-economic, cultural heritage, archaeological and community health studies associated with the EIS and socio-economic impact assessment have included further engagement with stakeholders.

5.2 Consultation Requirements

PNG legislation and PanAust Group policies collectively frame the requirements for stakeholder engagement that apply to the process of environmental approvals and preparation and submission of the EIS for the Project. The Project has planned its engagement activities to align to the needs of the Project and of the identified stakeholder groups across the following four themes:

1. Seeking views and input.
2. Awareness and information tools.
3. Partnering for development.
4. Capacity building towards self-empowerment.

Key stakeholders had the opportunity to provide input into the design of the stakeholder engagement program. These opportunities have included participation in social values workshops where local leaders suggested ways to increase dialogue and communication, and input into the development of the grievance mechanism. FRL currently uses a complaints and grievance mechanism which integrates with its incident management system.

5.3 Consultation Activities

Feedback and community input resulting from stakeholder engagement activities have informed decision-making processes for Project design. Key engagement activities include the EIR engagement campaigns, Community Leaders Forum meetings, the Sepik Awareness Program, the Joint Provincial Consultation Committee meetings and employee engagement activities. Figure ES10 shows the communities that have been visited between 2009 and 2018.

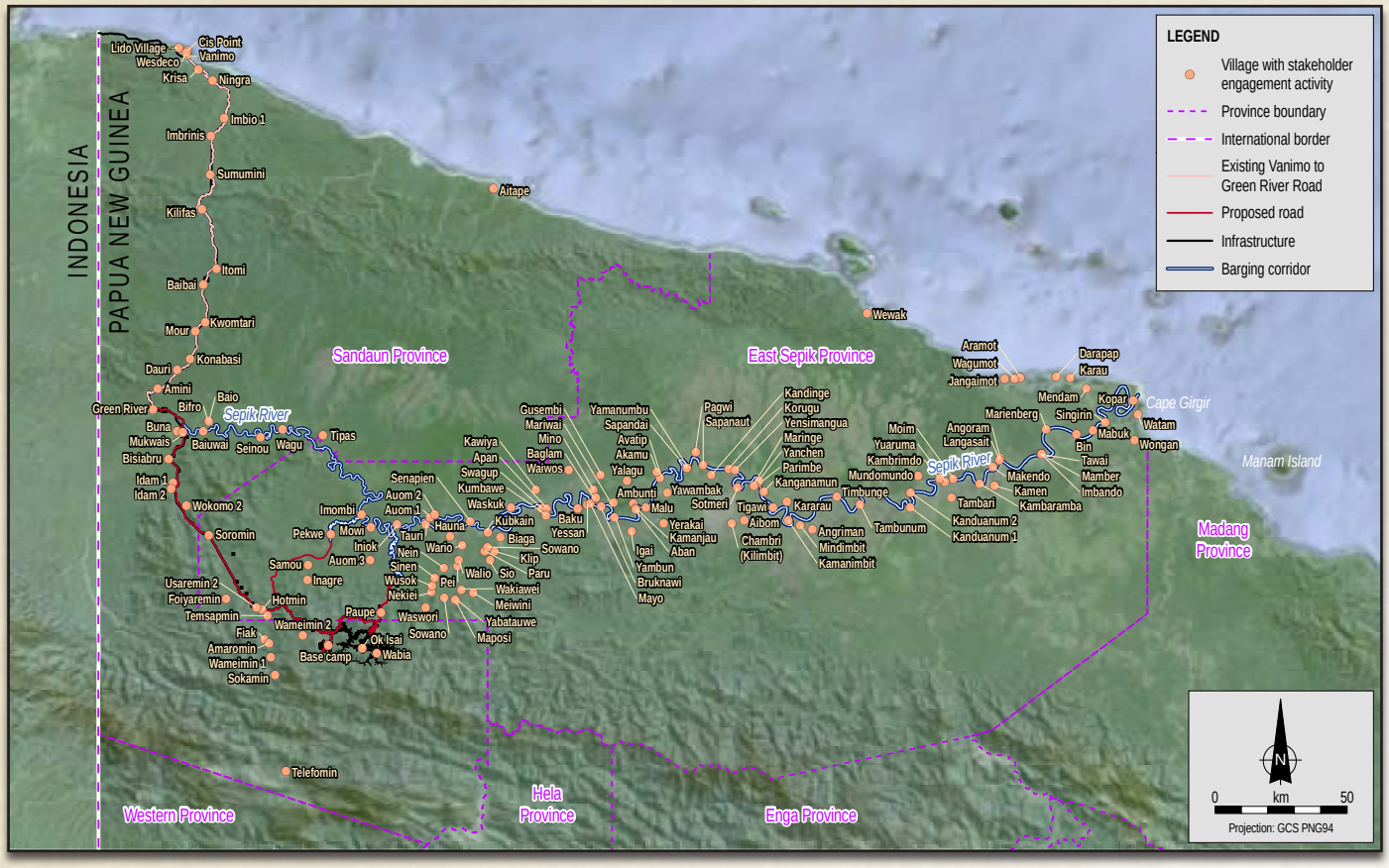


Figure ES10 Villages that have been visited during stakeholder engagement activities for the Project

It is estimated that more than 7,000 people attended the Sepik River engagement sessions across 41 communities during July and August 2015, and more than 4,400 people attended the subsequent sessions in September 2016. A fourth program of engagement sessions was completed in August to October 2018, focusing on the infrastructure corridor and the Sepik River (Plate ES13). The program was delivered to approximately 7,400 people throughout approximately 97 key villages and hamlets.

Consultation with government has included meetings, presentations and workshops at key Project milestones, including following the submission of the SML application in 2016 and submission of the EIR in late 2017. Engagement activities following the 2016 SML application included targeted briefings in Wewak and Vanimo with key state agencies including CEPA, MRA, Department of Treasury, Department of Justice and Attorney General, and Department of Trade, Industry and Commerce.

A State Negotiation Team (SNT) has been formed by the Government of PNG to coordinate permitting for the Project. The SNT, which comprises a range of agencies including the Department of Mineral Policy and Geohazards Management, the MRA and CEPA, has met twice in 2018.

Project proponents meet with the Sandaun and East Sepik Provincial Governments formally through the Joint Provincial Consultative Committee on a scheduled quarterly basis.

FRL hosted a half-day workshop in Port Moresby for CEPA and MRA in August 2018. This introduced CEPA and MRA to senior FRL study team members and the TIRP. It also provided these agencies with detailed information about the design of the ISF including the credentials of the design team and the TIRP, and how the ISF will be constructed, operated and closed.

5.4 Results of Consultation

The types of issues raised and questions asked during the EIS stakeholder engagement activities varied across the different geographic areas, depending on either proximity to proposed activities or infrastructure, local environmental values or access to social services and infrastructure.

Sepik River communities strongly expressed the feeling that they stood little to gain and a lot to lose from the Project, particularly if the river was used for the transport of copper-gold concentrate and supplies, as envisaged in the scope of the 2016 SML application.

All communities raised issues regarding the provision of basic utilities and infrastructure, particularly power and roads. This reflects the near absence of infrastructure in the Project area and surrounds. Roads were desired both between potentially affected communities and for access to the coast.

All communities expressed desire for 'the company' to provide health, education and law and order services, expressing a feeling that the provision of such services had been neglected by responsible entities.

The main points raised relating to employment, training and business development were:

- Preference for people from the Project area to be employed ahead of people from outside the Project area. In several locations, the emphasis was on youth employment and training and, as such, inferred recognition of the lack of existing capacity for skilled workers in the present worker age group. It was also emphasised that the Project presented a window of opportunity for the next generation.
- Desire for business development opportunities for local businesses ahead of businesses from outside the affected provinces and outside PNG.

Many issues were raised during public consultation in relation to benefits and compensation to individual landowners and local communities. These issues are not addressed through the EIS process and will be considered as part of the Development Forum process hosted by the Government of PNG.

The main issues raised and questions asked by members of the community during the Sepik Awareness Programs in 2011, 2015, 2016 and 2018 can be grouped by three main themes:

- Environmental – including the importance of the Sepik River and its ongoing water quality, and a desire for the Project not to adversely impact the Sepik River.
- Sepik River use – including the desire for the Project not to disrupt livelihoods of people living along the Sepik River.
- Benefits – including potential benefits and job opportunities, and compensation arrangements for impacts.

Feedback obtained from national and provincial government representatives during regular Project briefings, workshops, Joint Provincial Consultation Committee meetings and the EIR engagement campaigns focussed largely on the Project description, timing of the Project and EIS, potential for Project disruption by disaffected stakeholders (particularly along the Sepik River), and potential social and environmental impacts on the Sepik River.

Plate ES13
Pre-EIS awareness campaign with Idam 1 and Idam 2 in August 2018

5.5 Ongoing Consultation

A stakeholder engagement plan was developed to guide stakeholder engagement. The plan identifies who needs to be engaged, why and on what issues, and describes the processes, systems and required resources that will enable FRL to effectively undertake leading practice stakeholder engagement.

Public exhibition of the EIS will be conducted in accordance with the requirements of the Environment Act. This will include an EIS engagement campaign conducted by FRL and Coffey and accompanied by CEPA and MRA officers. The EIS engagement campaign will provide a final summary of the findings from the EIS and address issues previously raised by stakeholders. The timing and duration of the EIS engagement campaign will be determined and planned by CEPA in conjunction with FRL but is likely to be between three and six months following the submission of the EIS.

PANORAMA

GRUP NIUSLETA BILONG OL WOKMAN NA WOKMERI LONG PANAUST LIMITED

PANAUST

Isu namba 10 – Q1 2016

Poto: Phu Kham na Ban Houayxai operesenel ekselens; lukim pes 3

TOKTOK BILONG FRED

Mi gat bikpela amamas long tok olsem yia 2015 em i bin wanpela gutpela yia stret bilong PanAust wantaim ol nupela rekot bilong wok i kamap long olgeta ki bisnis indiketa bilong mipela.

Long sait bilong sefti, Grup Totol Rekodabol Injeri Reit (TRIFR) i bin stap long 0.62 wan wan milien wok aua, we em i daunbilo tru long mak bilong 1.35. Mi kisim mak tu i winim taget o mak bilong mipela yet long 0.23 bilong lusim taim bilong wok long injeri o bagarap i kamap (LTIFR) taget na pinisim yia wantaim 0.16 wan wan milien wok aua.

2015 prodaksen, totol 78,449t kopa, 221.616oz gol konsentret na doré na 1,664,242oz silva long konsentret na doré na em stap antap winim taget bilong namel long 74,000t i go 76,000t kopa, 195,000oz i go 205,000oz gol, na 1.4Moz i go 1.5Moz silva.

Sapos yu ritim niusleta long pepa, orait yu ken lukim tu long vidio long PanNet long 'Komyunikesens' 'Panorama' pes.

Ol kos autkam bilong mipela tu i strong tru wantaim Phu Kham long kisim mak bilong C1US$1.30/lb (taget US$1.47/lb) na AISC US$1.69/lb (taget US$1.99/lb); na Ban Houayxai C1US$516/oz (target US$673/oz) na AISC US$687/oz (target US$869/oz).

Mak bilong sefti em mipela i brukim rekot, prodaksen kos we mipela i kamapim em i kamapim gutpela mak long kain taim no gut bilong ikonomi olsem. Mi lukluk i go long 2016 wantaim strongpela tingting olsem mipela inap long mekim nambawan wok yet bihainim hai standet mipela i kamapim long 2015.

Mipela i bin wok gut olsem wanpela praivet kampani inap hap yia nau na wok bilong mipela wantaim mama kampani, GRAM i stap strong yet. Em i gutpela tru long kisim sapot bilong GRAM insait long dispela taim bilong ol prais bilong ol komoditi i go daun. Mipela i kamapim wanpela gutpela kain propit i go long GRAM long pinis bilong 2015; mak bilong mipela em long mekim moa gut na kisim bek bikpela mani moa long yia 2016.

Long Enuel Jeneral Miting bilong GRAM long Guangzhou, mi bin amamas long kisim tupela awot long makim na Phu Bia Maining. Namba wan ples long 'Ekselens long Sefti', na ol narapela long 'Ekselens long Operesens'. Dispela awot i soim strongpela tingting bilong GRAM long bisnis bilong mipela na ol pipel bilong mipela; na long tingting bilong ol long mipela bai wok long kamapim yet hai pefomens autkam long olgeta samting mipela i mekim.

Wok long Frieda River fisibiliti stadi i kam klostu long pinis na ol i tingting long pinisim insait long narapela tupela mun. Stadi i bihainim taim bilong em stret long givim ripot i go long Gavman bilong Papua Niugini long namba wan hap bilong dispela yia long sapotim aplikesen bilong mipela long kisim wanpela Spesel Maining Lis.

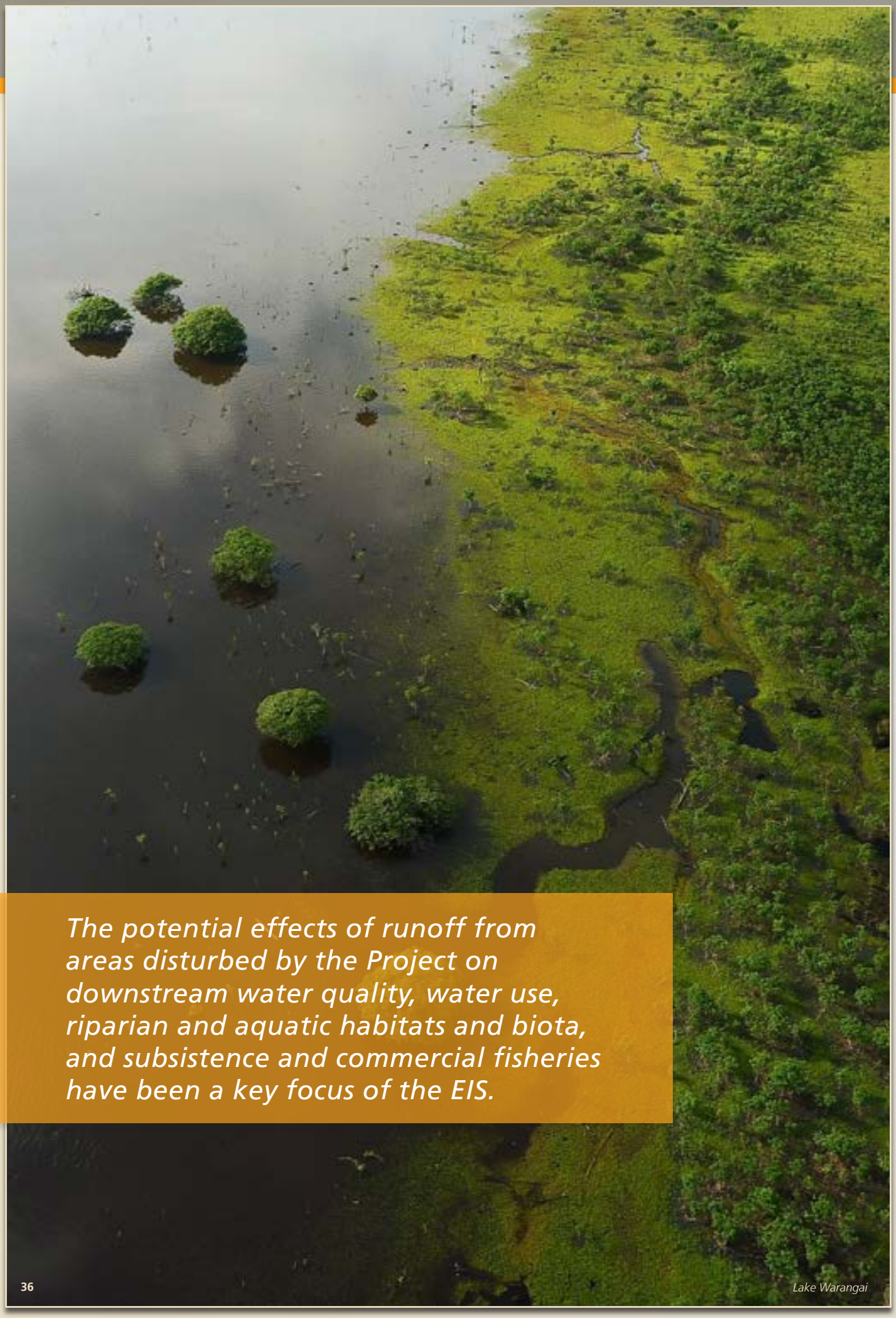
Long projek sait bilong Frieda River, wok i go het yet long Eksploresen Akses Trek (EAT). Taim em i pinis dispela trek bai opim wanpela rot long graun stat long Frieda River i go long main sait na em bai helpim mipela long no ken yusim tumas helikopta transpot. Dispela tu bai kamapim gut sefti na kost autkam bilong Projek.

Long 2016 mipela i ting olsem mipela i ken lukim komoditi prais long salensim mipela yet. Lukluk bilong mipela i stap yet long helt na sefti bilong ol wokman na wokmeri bilong mipela na ol komyuniti na wankain taim tu mipela bai painim rot bilong daunim ol kost na kamapim gut ol pasin bilong wok bilong mipela. Long dispela as, mipela i lukluk long ol Lao-nesenel wokman na wokmeri olsem long singautim ol long kisim planti moa senia wok insait long Kampani olsem ol i bin mekim long 2015.

Tenkyu long olgeta kontribusen bilong yupela long gutpela wok kamap bilong PanAust .

Dr Fred Hess
Menesing Dairekta

Frieda River base camp



The potential effects of runoff from areas disturbed by the Project on downstream water quality, water use, riparian and aquatic habitats and biota, and subsistence and commercial fisheries have been a key focus of the EIS.

Lake Warangai

6. ANTICIPATED PHYSICAL, BIOLOGICAL AND SOCIO-ECONOMIC IMPACTS AND BENEFITS

The Project will represent a large-scale development with the majority of activity in a remote area characterised by steep terrain, very high rainfall, low population density and a near-absence of infrastructure such as road, power and communication networks. The Project will border areas increasingly influenced by human activity (primarily from forestry and agroforestry) along the infrastructure corridor from the mine site towards the northern coast. It is unavoidable that there will be material environmental and socio-economic impacts during its construction, operation and closure. The application of mitigation measures will limit these impacts.

The EIS was scoped to address the physical, biological and socio-economic issues described in the EIR, the findings of which are described in this section.

6.1 Benefits

The Project will generate a broad range of positive social effects and opportunities across communities that currently have minimal access to the cash economy, work and business opportunities, health and education services, and community and regional infrastructure. These include:

- Opportunities for employment (and receipt of associated income) and skills acquisition, both for males and females.
- Opportunities for the development of local economies, including trading businesses and potentially cash cropping, due to improved access to input and product markets.
- Landowner receipt of statutory payments including royalties and compensation that may be applied to consumption or investment.
- Access to improved village-level infrastructure and service delivery in health and education.
- For resettled communities, access to improved village-level infrastructure including new houses and water and sanitation facilities.
- Access to regional infrastructure, such as improved transport links to Sandaun service centres, and the provision of communications facilities.
- Opportunities to establish community programs to improve gender relations and increase support for other vulnerable groups such as youth and the disabled.

The Project will generate several benefit streams that are likely to result in greater provincial and national wealth, particularly from royalties and taxes. The notable aspects of these benefit streams include:

- Direct capital investment in PNG of more than US$6.9 billion (PGK21.7 billion) in real terms.
- Recurrent operating expenditure averaging US$685 million (PGK2.2 billion) per year including significant local expenditure on support services.
- Gold, copper and silver production valued at an average US$1.5 billion (PGK4.8 billion) per year which will generate tax, royalty and production levy revenue to PNG governments and landowners in the order of PGK29 billion in real terms over the life of the Project.
- Project construction workforce will peak at approximately 5,190 full-time equivalent workers per year and an operating workforce of approximately 2,510.

The positive aspects of the Project are also directly linked to PNG development goals and guidelines, in particular, the PNGDSP which provides policy making direction to achieve the goals of Vision 2050. Government and the Project proponents will need to work together with communities to develop practical, affordable and achievable plans for development to ensure that these opportunities present realistic, enduring and intergenerational benefits, particularly for mine and FRHEP area communities.

A significant opportunity associated with the Project, for both local and provincial residents, is participation in employment. FRL has developed a training and development strategy to support workforce development and maximise participation of unskilled local and provincial residents.

Project employment and training will provide long-lasting benefits for communities. People employed and trained by the Project will learn valuable skills that they would likely otherwise not have access to, particularly in Social Catchment 1A, 1B, 1C and 1D. This will provide people with the ability and confidence to seek employment elsewhere in the mining and resources industry in PNG and internationally, should they choose to do so.

Increased access to infrastructure and transport links will present a significant opportunity for communities within and in proximity to the Project area. The proposed public road will provide communities with increased access to markets, enabling opportunities for the sale of surplus goods that could lead to commercial-scale growing and sale of produce and cash crops, thereby providing an ongoing source of income to rural families, particularly women. Such access will also likely promote the establishment of small-scale family enterprises selling garden produce and other products such as food and consumer goods to the workers and other people who travel the public road.

Access to health and educational facilities will be improved because of the development of road and communications infrastructure. This could include medical clinics, hospitals, specialist services and schools, the quality of which will be significantly improved by a long-term, reliable and sustainable source of power. The development of communications infrastructure will likely improve access to medical and educational information and assistance, as well as facilitate more efficient commerce. Development of the Vanimo Ocean Port holds the potential to boost PNG's two-way trade with Asia, while the SPGP will likely stimulate trade between PNG and Indonesia and generate direct and indirect employment opportunities.

Socio-economic management measures implemented through the life of the FRCGP will aim to address the potential for over-reliance on the operation and plan for development programs which are self-financing following mine closure.

6.2 Terrestrial Environment

Soils and Landforms

Construction and operation of the Project will involve the excavation and movement of large volumes of material within the Project's footprint.

Physical disturbance of soils, if unmanaged, may lead to erosion, exposure of potential acid sulphate soils and/or compaction of soils causing reduced capacity to support vegetation. Physical disturbance may also destabilise landforms causing or increasing the potential for landslips and erosion. Soil contamination may reduce the capacity of soils to support soil biota and vegetation.

Physical disturbance will be greatest during construction and decommissioning, due to the concentration of ground-disturbing works. The potential impacts resulting from chemical alterations to soils will be greatest during operations and without appropriate management may extend into closure.

Management measures will aim to minimise disturbance areas, manage erosion of constructed landforms or disturbed areas, minimise soil compaction, ensure appropriate use of soils for rehabilitation, prevent spread of dieback and avoid in situ leaching of acidic water.

Two moderate residual impacts are predicted for the soils and landforms in the mountainous terrain: the reduced physical integrity and stability of landforms and soils; and reduced soil capacity (i.e., physical loss of soil through erosion and changes to the physical and chemical properties of the soil).

Plate ES14
Visualisation of the proposed Sepik River bridge crossing when viewed from Sepik River

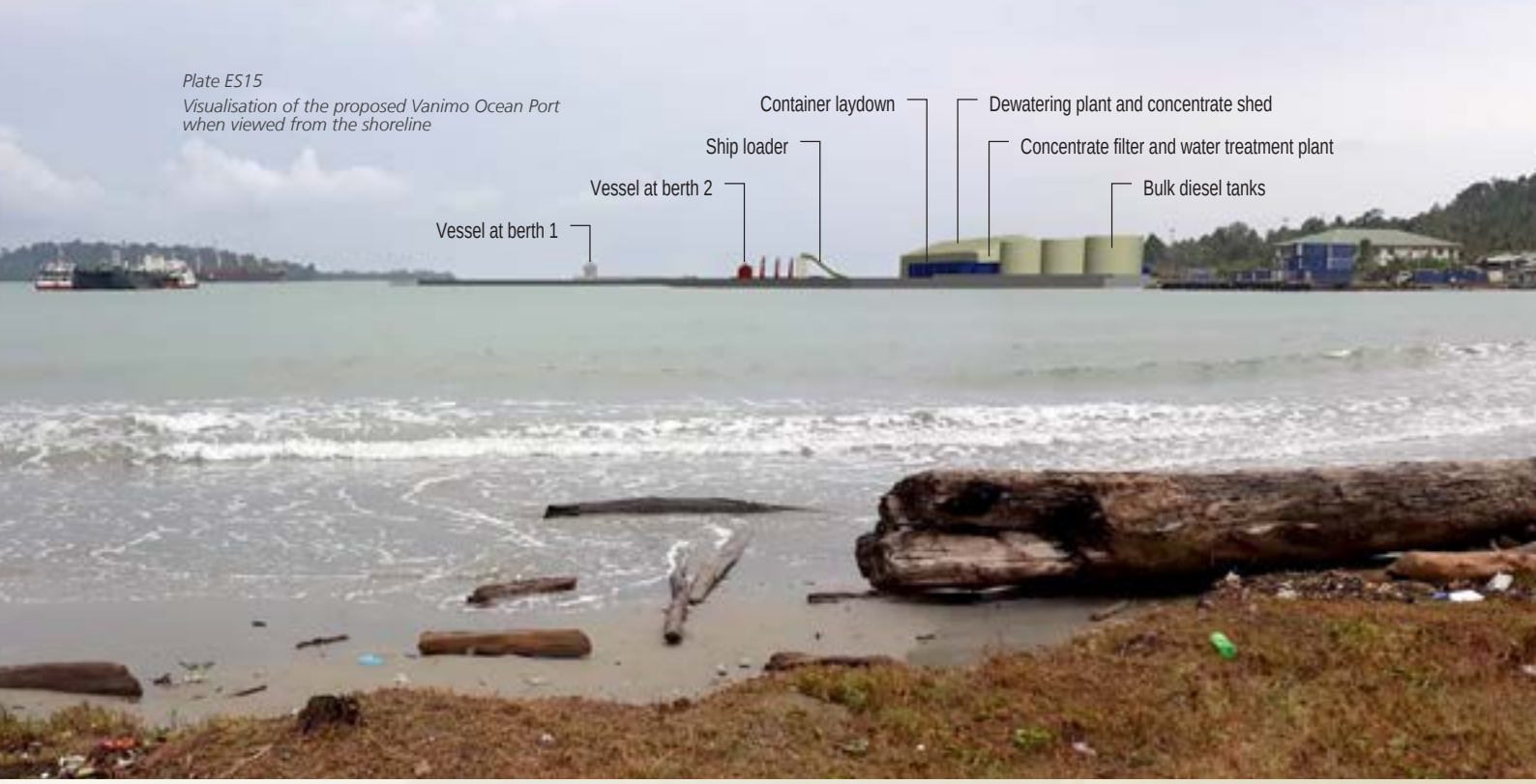


Plate ES15
Visualisation of the proposed Vanimo Ocean Port when viewed from the shoreline

Landscape and Visual Amenity

While the mine and FRHEP infrastructure will permanently change the landscape, it is unlikely to be visible from villages or rivers as they are largely visually enclosed from view.

The Hotmin Road and associated bridge crossings will be visually prominent features for villages in close proximity to the road corridor such as Dioru, Uramesin 2 and Hotmin. The village of Simaiye is approximately 2.5 km south of the Sepik River bridge and may be able to see the bridge, depending on the vantage point (Plate ES14). Excavation and reshaping of the distinctive floodplain hills for the infrastructure corridor or river port facilities will cause a permanent change to substantial elements of the landscape in these areas. This will impact on the long-term scenic amenity of residents living in villages in close proximity to the road corridor and those with direct views of the river port facilities. These changes will have a negligible effect on the overall landscape and the broad panoramic views of the Sepik River, Frieda River and May River floodplains.

The Northern Transmission Line will be a prominent feature in the landscape for public road users and residents of villages located in close proximity to it such as Sumumini, Kilifas, Dioru and Uramesin 2. This infrastructure is also likely to be visible from the upper Sepik River.

Residents of Wesdeco, Lido and parts of Vanimo will experience views of the Vanimo Ocean Port including the concentrate export facility. The facility will be a visually prominent element when viewed from the Vanimo shoreline (Plate ES15).

Progressive rehabilitation will be undertaken where possible, particularly for areas that will be viewed by sensitive receptors. Where progressive rehabilitation is to be undertaken, the choice of revegetation species will be visually in keeping with the surrounding vegetation, so as to maintain a consistent landscape character.

Groundwater

Groundwater extraction over the life of FRCGP is required to depressurise and dewater the open-pits to enable mining to proceed safely. This will result in the lowering of surrounding groundwater levels and an altered hydrogeological regime, with the open-pits acting as a groundwater sink (i.e., a point of groundwater discharge). At the completion of mining, dewatering activities will cease and the open-pit void (i.e., the combined HITEK open-pits) will be actively filled within three years to form the final open-pit lake, to the prescribed spill points. Groundwater will continue to flow through the open-pit lake to the ISF following open-pit lake formation.

The spatial extent of groundwater drawdown extends 5 to 6 km radially from the open-pit centre at the end of mining.

The FRHEP will receive a substantial volume of water from natural and Project sources, which will result in hydraulic loading of the underlying groundwater systems. Groundwater mounding is predicted in the vicinity of the ISF during operation. Modelling indicates mounding in excess of 150 m above the current elevation of the Frieda River and its tributaries with an expected extension of 2 to 4 km from the Nena River and lower sections of the Niar River. Mounding in the upper sections of the Niar River and its major tributary, Anai River, is predicted to be limited to a narrower zone extending 200 to 800 m from the edge of the inundation zone.

During mining, runoff water and groundwater that migrates to the open-pits and contacts sulphide mineral exposures will be collected and treated prior to discharge. At FRCGP closure, the open-pit void will be allowed to fill as soon as possible to reduce the potential for AMD generation. Post-closure, the open-pit lake will become a flow-through surface water feature, gaining groundwater from up-hydraulic gradient and discharging down-gradient via the open-pit lake spill point where contaminated water will be collected for treatment until closure water quality criteria are met.

Groundwater particle tracking indicates that groundwater sourced from the ISF is likely to migrate slowly, with the rate of movement predicted to be 2,500 m after 2,000 years.

The closest mapped swamp woodland and forest complexes, which typically include stands of sago, are located in the Sepik River floodplains well downstream of the ISF area. Therefore, impact to sago as a result of groundwater drawdown around the open-pits or impaired water quality seepage from the ISF is not predicted.

Terrestrial Biodiversity

The mine and FRHEP area south of the upper Sepik River is characterised by extensive intact habitats that show little anthropogenic disturbance or modification. It contains high biodiversity that is rich in species endemic to northern New Guinea. For the purposes of the impact assessment, terrestrial biodiversity values were assessed at four scales: landscape, ecosystem, focal habitat and individual species. A range of direct and indirect impacts to terrestrial biodiversity may occur as a result of the Project development.

Based on the history of resource developments in PNG, in-migration and associated effects can be expected to cause impacts on terrestrial biodiversity values. Indirect impacts may include increased forest conversion to gardens, harvesting of non-timber forest products and possibly small scale logging, increased hunting pressure and increased risk of uncontrolled fire. Furthermore, impacts could be even greater should in-migrants introduce exotic species.

A range of management measures will be adopted by the Project and will include general measures that will apply across the Project area, as well as specific measures for ecologically significant ecosystems, focal habitats and species of conservation significance.

Of the more than 85 species discovered during Project surveys that are potentially new to science, five species (one plant, one mammal, one reptile and two odonates) were found only at survey sites within the Project disturbance area. The rest occurred outside, or both inside and outside, the Project disturbance area. However, experience suggests that continued ecological investigation generally continues to increase the known ranges of species previously thought to be narrowly restricted. This experience is demonstrated by the large number of range extensions resulting from the Project surveys. It is extremely unlikely that any of the new species are entirely restricted to the Project disturbance area. In assessing indirect effects it is noted that none of the species new to science would be of any interest to hunters or subsistence gatherers and so would not be targeted by any in-migrants. Vegetation clearing by in-migrants or the accidental introduction of exotic pests and pathogens is a greater potential impact. Therefore, quarantine measures and pest, weed and disease management during construction and operation are key mitigation measures.

*Amethistine Python (*Morelia amethistina*)*

*De Rooij's bow-fingered gecko (*Cyrtodactylus sermowaiensis*)*

During the design of the Project, a number of options were evaluated to avoid or limit the total area of vegetation to be cleared. The area cleared and inundated during the construction phase of the Project will be up to 16,000 ha of which 91% is likely to be unavailable for rehabilitation, largely due to ongoing operation of the FRHEP.

At the landscape-level, the residual direct impacts to extensive intact habitats is predicted to be major, as forest loss is likely to have a considerable local impact, although the loss will not be large in the regional context. Predicted residual impacts to habitats and biodiversity of cultural significance are moderate. Residual indirect impacts from increased hunting or land use due to in-migration is predicted to be moderate for the high biodiversity level at the landscape scale, species new to science and congregatory flying foxes. All other residual impacts at the landscape-level are predicted to be minor or negligible.

At the ecosystem-level, indirect impacts to montane forests from in-migration (e.g., increased effects relating to wildfires and the introduction of exotic invasive species) are predicted to have a major residual impact. All other residual impacts at the ecosystem-level (i.e., to peat forest, Nena karst, off-river waterbodies and the North Coastal Ranges) are predicted to be minor or negligible as these ecosystems will either be avoided by Project infrastructure or have minimal disturbance.

At the focal habitat level, the Project is predicted to have moderate direct residual impacts on riparian forests (as a result of inundation) and to upland streams (from erosion and sedimentation). It is also predicted to have moderate indirect impacts on caves due to the potential for in-migration and resettlement to increase hunting pressure on cave fauna and to introduce wildlife diseases.

At the species level, residual impacts (i.e., losses of individuals and populations within the Project Area) have been assessed for 85 species. For direct Project impacts there are moderate impacts predicted for five species, minor impacts predicted for six species and negligible impacts predicted for 74 species. Residual indirect impacts are likely to be higher due to the expected difficulty in controlling in-migration related effects. As a consequence, major impacts on eight species, moderate impacts on eight species, minor impacts on 24 species and negligible impacts on 45 species are predicted from indirect causes. The predicted major indirect impacts to eight threatened species of conservation concern result from indirect causes for species targeted by hunters, such as: the Critically Endangered black-spotted cuscus (*Spilocuscus rufoniger*), Telefomin cuscus (*Phalanger matani*m), Sir David's long-beaked echidna (*Zaglossus attenboroughi*), and Bulmer's fruit bat (*Aproteles bulmerae*); the Endangered Western Montane tree kangaroo (*Dendrolagus notatus*) and Goodfellow's tree kangaroo (*Dendrolagus goodfellowi*); and the culturally significant northern cassowary (*Casuarius unappendiculatus*) and dwarf cassowary (*Casuarius bennetti*).

*Black Kite (*Milvus migrans*)*

Noise and Vibration

Modelling shows that the noise scenarios predicted to exceed the adopted Project noise guidelines are:

- During construction of the infrastructure corridor (inclusive of the concentrate pipeline, Vanimo to Hotmin public road, mine access road and Northern Transmission Line) for the villages of Wokomo 2, Dioru, Green River Station, Aminii, Kwomtari, Itomi, Kilifas, Sumumini, Imbrinis and Vanimo.
- During construction and operation of the Green River Airport for the Green River Station.
- During construction and operation of the Vanimo Ocean Port for residents of Vanimo (near the existing wharf) and Wesdeco settlement, noting that the settlement of Wesdeco is located behind the existing Vanimo Forest Products wharf facility.

Blasting may be required during construction of the concentrate pipeline and public road, depending on ground conditions. The villages of Hotmin, Wokomo 2, Dioru, Green River Station, Aminii, Kwomtari, Itomi, Kilifas, Sumumini, Imbrinis, Temsapmin and Vanimo may be affected by ground vibration and/or airblast overpressure, depending on the final road alignment.

The impacts associated with noise and vibration will be relatively short term and community liaison strategies will be implemented to ensure that these communities are made aware of the times and duration that they will be affected. Additional site specific measures will be developed based on community feedback, should they be required.

Air Quality

Construction of Project facilities is likely to result in localised emissions of particulate matter, NO_2, SO_2 and trace metals from fugitive particulates. Modelling indicates that exceedances of Project air quality criteria are not expected for these parameters during construction or operation. The lack of air quality impacts during operations is primarily due to the distance between the mine area and the nearest villages.

There is the potential for 24-hour average PM_{10} concentrations to exceed Project air quality criteria during road and concentrate pipeline construction where sensitive receptors lie within 500 m of the construction activities. In addition, the maximum 24-hour average PM_{10} concentration is predicted to exceed guidelines up to 800 m downwind of the works. This assessment has been based on a number of conservative assumptions and as a result it is expected that actual off-site particulate concentrations will be much lower.

There are a number of existing sensitive receptors (residences) close to the existing Port of Vanimo operations. Provided good management practices are implemented, no significant increase in air quality impacts would be expected as a result of the Vanimo Ocean Port construction or operations activities.

Greenhouse Gases

Annual emissions of greenhouse gases (GHGs) from construction and operation of the Project are estimated to average 639 kt CO_2-e per annum, generating a total of approximately 24,930 kt CO_2-e over the life of the Project. Comparison of the annual Project total Scope 1 GHG emissions over the life of the Project against total national emissions (including land use change and forestry) reported by the Food and Agriculture Organization of the United Nations for 2013, indicate that the Project is expected to result in a relatively minor (1.1%) increase in the national emissions. Long-term operation of the FRHEP has the potential to provide a net-positive impact on PNG's GHG emission inventory based on the amount of electricity offset, GHG efficiency and fuel types used in the displaced generation systems in comparison to existing and future fossil-fuel powered electricity generation.

6.3 Aquatic Environment

Changes to hydrology, sediment transport and water quality have been predicted for a range of assessment points (APs) shown in Figure ES11. The cumulative effects of these changes on aquatic ecology have also been assessed.

Hydrology

A site-wide water balance model for the Project was developed to determine the Project-related changes to flows and volumes of water in watercourses in the Project area and downstream over the life of the FRCGP. The main Project-related effects on hydrology are related to ISF operation and closure including:

- Reduction in downstream flow during filling of the reservoir.
- Alteration in flow patterns from natural conditions.

Construction of the embankment will modify downstream flows in the Frieda River; however, an environmental flow of 50 m^3/s will be maintained during the initial 10-month impoundment filling period.

Average daily flows over the FRCGP operational life for dry, average and wet flow conditions at each of the assessment points are predicted to be lowest in the upland catchments of the mine area and generally increase as the assessment points progress into the lowland areas of the Frieda and Sepik rivers. This is generally consistent with existing conditions with some key differences for the upstream catchments that will occur due to the presence of mine infrastructure, namely the open-pit and the ISF, during operations. Average daily flows in Uba Creek (AP2) are predicted to decrease slightly due to development of the Koki open-pit and the redirection of flows, whereas daily average flows in Ubai Creek (AP1) are predicted to increase during operations as a result of open-pit development and arise from increased capture of groundwater and diversion of runoff water from the surrounding catchment to upstream of this assessment point, including discharge of treated pit water.

Under dry conditions, predicted daily flows at most assessment points will increase by around 65% in the Frieda River (AP6 to AP9), while during wet conditions predicted flows are expected to decrease by around 30 to 40% in the Frieda River. These changes are associated with the regulation of flows resulting from the operation of the hydroelectric power facility.

Ekwai Creek at Frieda River base camp

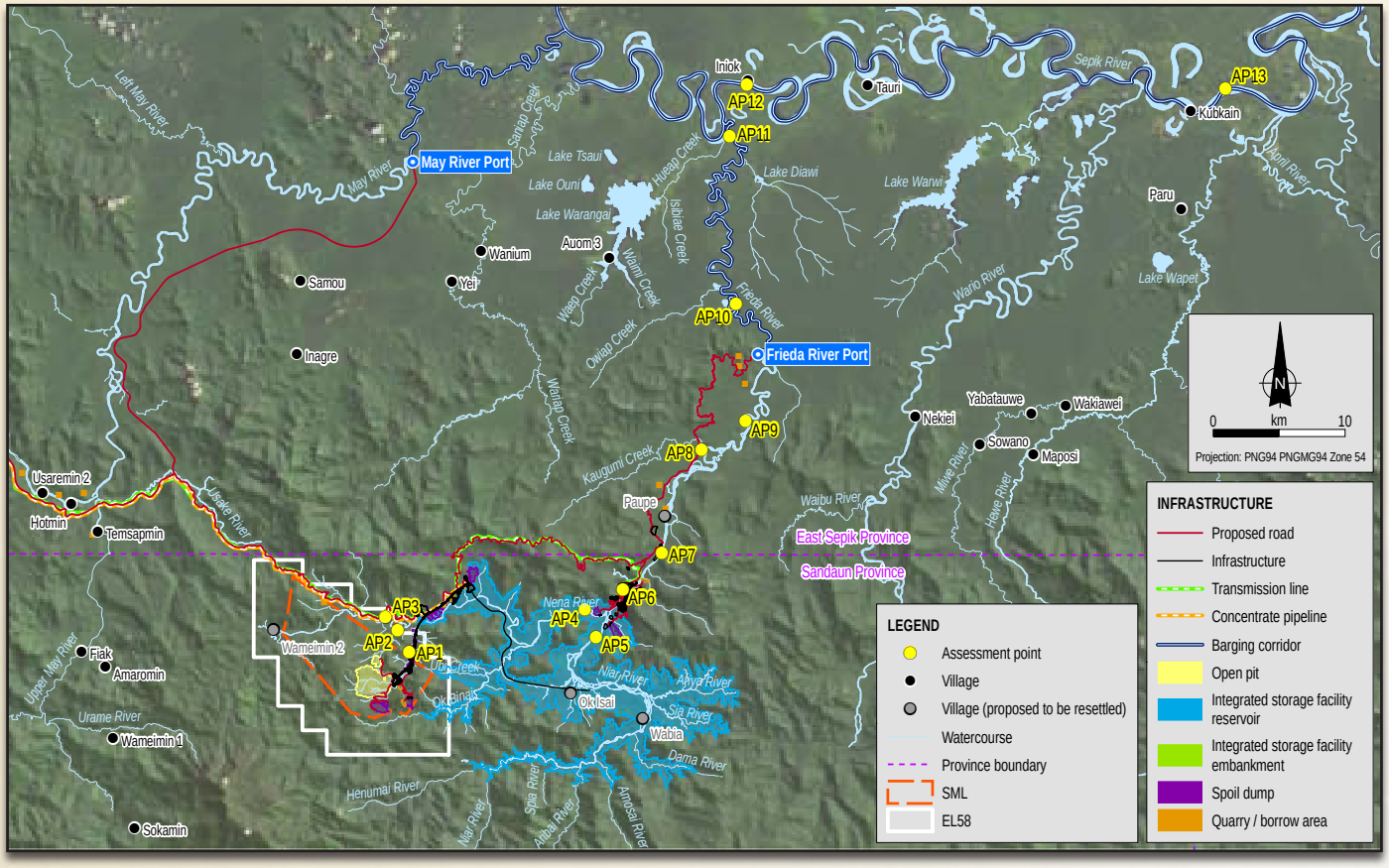


Figure ES11 Assessment points

At the end of the 33-year mining period, the ISF will remain in place and water flows through the ISF may continue to be regulated for power generation. The spillway gates will be removed when the hydroelectric power facility is decommissioned. Water will continue to flow into the facility via direct rainfall and inflow from the upstream catchment and excess water will pass over the ungated spillway which will operate as a flow-through facility. In general, flow trends at the assessment points are predicted to be similar after closure to those during operations. Flows in the Frieda River will be highly modified from the baseline flow conditions arising from the regulation of flows within the reservoir. In addition, flows at Ubai Creek are predicted to increase due to discharge from the open-pit.

Changes to flows in the Sepik River (AP12 and AP13) as a result of the Project are predicted to be undetectable.

Sediment Transport

A sediment transport assessment was completed to quantify the likely impacts of the Project on sediment loads in watercourses draining areas of Project disturbance.

In near-mine watercourses such as Ubai Creek and Uba Creek, annual median suspended sediment concentrations are expected to increase substantially during construction. There will also be increases in stream bed levels downstream of mining and infrastructure areas, with these predicted to perpetuate until the source inputs of coarse sediment decline and/ or sufficiently high flows remobilise deposited material and transport it further downstream to be captured in the reservoir. Following FRCGP closure, suspended sediment concentrations in all watercourses upstream of the reservoir are predicted to reduce progressively as rehabilitation of Project disturbance areas takes place.

Given that some spoil dumps are designed to gradually erode, sediment losses from these dumps into the Ok Binai and then the ISF are predicted to remain high throughout the life of the FRCGP and be captured by the ISF. Stream bed levels in the Ok Binai are predicted to increase by approximately 2 to 3 m over the modelled period and are expected to continue increasing until the spoil and waste dumps are predicted to be fully eroded after 20 years.

The ISF will be the most prominent and effective engineering control limiting sedimentation of the Frieda River. It is estimated around 99% of the sediment inflow, along with process tailings and waste rock placed into the ISF, will be retained within this storage and not transported further downstream. The sediment released over the ISF spillway and/or through the hydroelectric power intake will report to downstream watercourses and will consist predominantly of very fine material.

Downstream of the hydroelectric facility outlet in the Frieda River (AP6), median suspended sediment concentrations are predicted to increase prior to construction of the reservoir. Median suspended

Wabia village in the Upper Frieda River

sediment concentrations are predicted to reduce following closure of the diversion tunnels and subsequent filling of the ISF. During operations, suspended sediment concentrations are predicted to increase over the first 14 years of operations after which concentrations are predicted to decrease. From Year 28, median suspended sediment concentrations are predicted to reduce to approximately 15 to 20% of predicted median concentrations at AP6 under existing conditions.

Annual median sediment concentrations along the middle reaches of the Frieda River are predicted to show a similar pattern to that estimated for AP6. This highlights the limited sediment inflow from the adjacent natural catchment and minimal impact of the limited Project-related infrastructure along this reach. A bed level reduction of up to approximately 3 m is predicted in the Frieda River downstream of the hydroelectric facility outlet compared to a predicted reduction of less than 1 m over the long-term (i.e., 60 years) under existing conditions. This is due to the lower sediment delivery from upstream watercourses due to sediment capture in the ISF.

Annual median suspended sediment concentrations of the Sepik River are not predicted to change as a result of the Project. Similarly, the Project is not predicted to impact the bed level of the Sepik River, which experiences natural changes of up to 2.5 m under existing conditions.

Periodic high flows along the lower Frieda River and Sepik River currently result in overbank flooding and deposition of sediment on adjacent floodplains. Overbank deposition in the lower reaches of the Frieda River is predicted to be reduced due to sediment capture in the ISF. During operations, the predicted flows and sediment deposition that will occur during overbank flooding in the Sepik River are comparable with existing conditions. The Project is not predicted to impact off-river waterbodies and oxbows along the Sepik River.

Water Quality

A load balance model for the FRCGP and FRHEP was developed to determine the concentrations of contaminants within the mine area watercourses, the reservoir and downstream rivers. The most significant Project-related changes to non-sediment related water quality are likely be associated with:

- Open-pit water discharge.
- Placement of waste rock and tailings within the ISF.

An engineered water treatment plant will treat the poor-quality open-pit water (modelled to be low pH and possess elevated dissolved metals concentrations) prior to discharge into Ubai Creek from where it will flow into the ISF and be further diluted prior to entering the downstream environment.

Clean water diversions upstream of the open-pit will be constructed to divert water around the mining area, to avoid contact with exposed wall rock and reduce the volume of water requiring treatment. Sludge generated from treatment of the open-pit contact water will be pumped to the tailings thickener at the process plant for final co-disposal with tailings into the ISF. Open-pit water will be treated prior to discharge throughout operations and for approximately 50 years post-FRCGP closure. This water treatment will cease once downstream water quality criteria and FRCGP closure objectives are met.

Assuming open-pit water treatment and subaqueous placement of waste rock and tailings within the ISF, modelling shows that under dry, average and wet conditions during operations:

- PNG Ambient Water Quality Standards will be met in the Frieda and Sepik rivers.
- PNG Standards for Drinking Water and World Health Organization Guidelines for Drinking Water Quality will be met in the Frieda and Sepik rivers, with the exception of lead (Sepik River) and iron (Frieda and Sepik rivers) that are naturally elevated in these rivers. Predicted concentrations of all total metals are not expected to exceed background concentrations.
- Australian aquatic ecosystem trigger values will be met in the Frieda River with the exception of aluminium, chromium and copper where their respective guideline values are predicted to be exceeded during average and low flows. In the Sepik River, Australian guideline values are predicted to be met with the exception of aluminium and copper. While concentrations of cadmium and zinc are also predicted to marginally exceed their Australian trigger values, the concentrations of these parameters are within the natural variability of the background concentrations within the Frieda and Sepik rivers.
- International Finance Corporation discharge criteria for metals in the ISF discharge are predicted to be met, with the exception of iron which is naturally elevated in the receiving Frieda River at the ISF discharge location.

The predicted bioavailable copper concentrations in the Frieda River approach the Australian 95% ecosystem trigger value. Site-specific copper complexing capacity data was collected to determine the natural capacity of the Nena, Frieda and Sepik rivers to form strongly bound complexes between the dissolved organic matter and dissolved metals, thereby making the metals less bioavailable (i.e., less toxic) to aquatic biota than bioavailable copper. In addition to copper complexing capacity, the adsorption of copper by the substantial concentrations of natural suspended particulate matter will also act to reduce the concentrations of dissolved copper in the Frieda and Sepik rivers. This indicates that site-specific triggers for action in relation to copper concentrations can be justified for the Project and that bioavailable copper is likely to meet the Australia trigger value for copper.

Limnological modelling results indicate that the reservoir is likely to be persistently stratified with no regular periods of complete mixing, and that the addition of waste rock and tailings at the bottom of the reservoir is unlikely to alter the top-down stratification structure (i.e., the warmer upper layers remain above the cooler layers of the reservoir). Therefore, during 'normal'

operations and post-FRCGP and FRHEP closure, it is predicted that there will be no water quality changes (i.e., reduced dissolved oxygen and temperature, increased dissolved and particulate-associated metals and metalloids from the deposited waste rock and tailings) downstream of the embankment as a result of mixing of water layers within the reservoir.

To protect downstream surface water beneficial values, FRL proposes that:

- A single water quality compliance point is established at AP7 in the Frieda River upstream of the existing Paupe village. At this compliance point, water quality shall comply with PNG Ambient Water Quality Standards (Schedule 1) and PNG Drinking Water Guidelines as a regulatory requirement. This compliance point shall be the downstream boundary of the mixing zone; waters upstream of this compliance point shall not be required to meet the PNG water quality standards and guidelines.
- International Finance Corporation effluent discharge standards shall be met for discharges from the ISF into the Frieda River, with the exception of iron which is naturally elevated above the standard.
- Where maximum background concentrations of (dissolved and total) parameters measured in the Frieda River at AP7 exceed the regulatory criteria, the 90th percentile background concentrations be adopted as the site-specific criteria.

Further action by FRL may include:

- Additional site-specific aluminium or copper speciation investigations.
- Biological monitoring in the Frieda and Sepik rivers to confirm predicted impacts to aquatic biota during operations.
- Laboratory toxicity testing of selected macroinvertebrates collected from the Frieda River.

Freshwater Ecology

Potential impacts on freshwater ecological values may be caused by a variety of direct or indirect activities or processes as a result of the Project.

During construction, the residual impacts on aquatic ecology will primarily arise from mobilisation of fugitive coarse and fine sediments to watercourses upstream and downstream of the ISF embankment. Of the three main catchments upstream of the ISF – the Nena River, Ok Binai and the Niar River catchments – construction activities will be most concentrated in the Nena River catchment. The primary stressors resulting in impacts on aquatic ecosystems during the construction period are associated with physical disturbance, altered hydrology and increased coarse- and fine-grained sediment delivery to watercourses. From the late construction period, the ISF will act as a sediment trap to reduce sedimentation and TSS concentrations downstream of the ISF embankment.

In terms of physical habitat loss, reaches of fast-flowing, clear waters in the Ekwai, Ubai and Uba creeks located within the footprint of the open-pits will be diverted around the open-pit perimeters to maintain connectivity and flow between the headwaters and lower reaches of these streams. The aquatic habitats within these sections will be lost and habitats within the recreated diverted creeks are likely to be poor quality with low structural diversity compared to the original pre-disturbance streams.

Residual impacts on freshwater ecology in the Frieda River as a result of construction-related stressors will have moderate significance. The prolonged increase in suspended sediment concentrations during the construction period prior to filling of the reservoir will result in a reduction in the quality of bottom habitat available to microflora and some reduction in photosynthetic activity brought about by increased turbidity in the water column. Direct impacts on benthic macroinvertebrate habitats are expected through burial or suffocation and indirect impacts through reduction of macroinvertebrate food resources (e.g., benthic algae,

diatoms and periphyton, and particulate organic matter). Macroinvertebrates and fish present in these habitats are somewhat tolerant to intermittent high suspended sediment and sedimentation due to the existing low water transparency. Increased sediment concentrations in the Frieda River during construction may favour macroinvertebrates, and to a lesser extent fish, that are tolerant of high suspended sediment concentrations. These changes may be of sufficient duration, intensity or extent to result in a shift in the overall ecosystem structure within reaches of the Frieda River.

The combined impact of these stressors is likely to give rise to major reductions in aquatic biological habitats in terms of structural diversity and aquatic species richness, diversity, density and productivity, resulting in permanent adverse changes to these habitats in the creeks diverted around the open-pits and flooded by filling of the ISF. In the context of the broader region, construction impacted stream reaches represent a small proportion of the overall unaffected aquatic habitats in first and second order streams within the Nena, Niar and Ok Binai river catchments and similar neighbouring catchments.

A reduction in macroinvertebrate distribution and abundance may result in a reduction of food resources for fish, which may in turn affect fish community distribution and abundance. There is likely to be severe reductions in fish abundance and diversity within impacted areas adjacent to, and downstream of, construction areas in the mine and FRHEP area. In the context of the catchments upstream of the ISF embankment, however, these reductions are not considered to be high compared to the overall fish population in the broader catchment.

The lower reach of the Frieda River may provide suitable nesting or foraging areas for crocodiles and turtles, where flow velocities are reduced in river bank vegetation and floodplain habitats. Based on the predicted effects of construction on the lower Frieda River and the Sepik River, impairment of habitat integrity for crocodiles and turtles is not expected.

Floodplain off-river waterbodies, swamps and wetlands of the lower Frieda River are the least likely to be impacted by construction-derived sediments because water flows tend to be confined within the main channels and are too low for overbank inundation of the floodplain to transport suspended sediment loads to these depositional environments. Construction-related impacts on aquatic ecology of the Sepik River are assessed as having a negligible impact significance rating due to the significant separation distance from construction activities, as well as the Sepik River being a turbid river with naturally high suspended sediment concentrations.

After FRCGP operations commence, the main impacts on aquatic ecology will result from the discharge of treated open-pit water to Ubai Creek, as well as the deposition of tailings and waste rock into the reservoir, which are expected to result in increased dissolved metals and metalloid concentrations within the reservoir and downstream of the embankment.

Concentrations of bioavailable copper predicted to occur in the Frieda River during low and average flow conditions may result in some impacts to copper-sensitive species of microalgae and to benthic invertebrates. However, bioavailable copper concentrations in the Frieda River at AP7 will naturally reduce through complexing with organic matter and adsorbing to suspended particulate matter and are likely to meet the Australian guideline value for dissolved copper. Given that the predicted bioavailable concentration of aluminium at AP7 meets US EPA guideline criteria, acute or chronic aluminium-related toxicity is unlikely. As such, impacts on aquatic biota from bioavailable aluminium and copper concentrations are not anticipated in the Frieda River.

Impacts on aquatic habitats in the upper Frieda River during FRCGP operations are predicted, due to the transformation of the habitats below the ISF embankment caused by a reduced sediment load. Operational impacts on aquatic habitats in the mid to lower Frieda River are anticipated to be negligible.

No operational impacts on the aquatic ecology of the Sepik River are expected based on the predictions that hydrological, sediment transport and water quality impacts in the Sepik River are negligible.

Frieda River oxbow

During the post-closure period, Project-related impacts on aquatic habitats and biota within and downstream of the ISF in the Frieda and Sepik rivers are not expected. During post-closure, assuming open-pit water outflows are treated, water quality parameters in the Frieda River at AP7 and in the Sepik River are predicted to meet Australian guideline values for most total dissolved metals, with the exception of total dissolved copper which marginally exceeds the guideline value.

A bioaccumulation study for the ISF during the FRCGP operational and post-closure periods was undertaken to determine if contaminants originating from deteriorated water or sediment quality as a result of the deposited waste rock and tailings within the ISF have the potential to be taken up by aquatic biota and bioaccumulate in the food chain, and subsequently impact on aquatic biota (and ultimately human health). The study considered both the littoral and pelagic zones and the aquatic ecosystems and food webs likely to develop within the ISF. The study focussed on aluminium, cadmium and copper and while there are no standards or criteria for aquatic fish tissue for aquatic biota protection, the study predicts that none of the criteria for human health (i.e., food standards) will be exceeded as a result of the Project.

Nearshore Marine

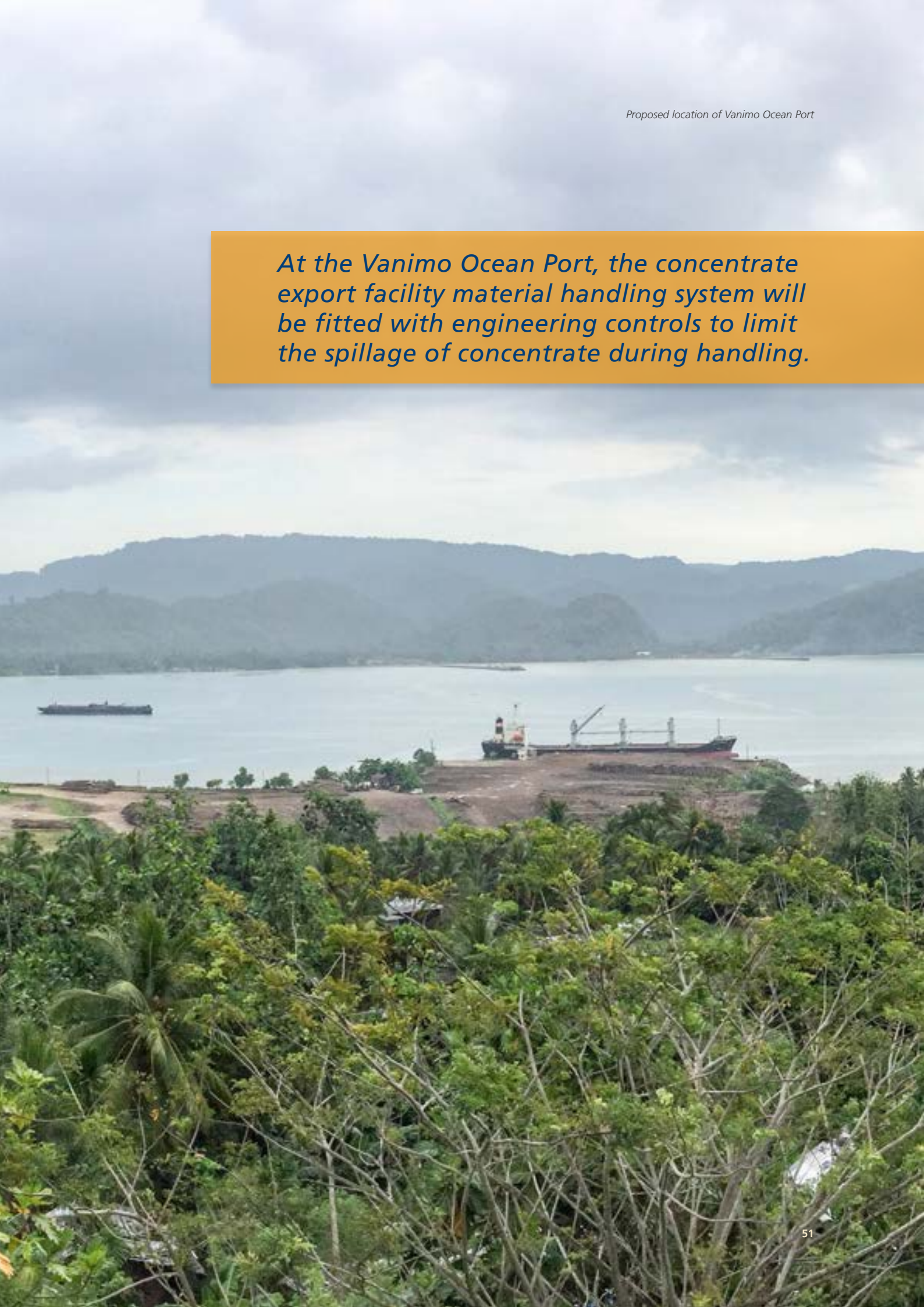
Potential impacts to the nearshore marine environment have been assessed in the context of an existing port with existing levels of environmental impact being upgraded with additional port infrastructure.

Construction of the Vanimo Ocean Port will involve reclamation of coastline adjacent to the settlement of Wesdeco. This will result in direct loss of adjacent reef and seagrass along a 500 m stretch of coastline. Land reclamation for the Vanimo Ocean Port will result in permanent loss of about 3.4 ha of fringing reef and seagrass adjacent to the existing port. This loss will be less than 10% of reef and seagrass habitat within Dakriro Bay. Construction of the new shipping berths will disturb the seabed and cause direct loss of small areas of seabed where pylons are installed. Additionally, the installation of the pylons via pile driving during construction may cause increased suspended sediments and turbidity, resulting in sediment smothering of adjacent benthic habitat.

Disturbance of the seabed could result in elevated concentrations of suspended sediments during construction of the Vanimo Ocean Port and also from propeller wash during vessel movements, which could clog gills of fish or smother benthic infauna. The disturbance of marine fauna due to increased suspended sediment from seabed disturbance is predicted to be minor, as fauna in Dakriro Bay have some resilience to fluctuations in suspended sediments given the delivery of terrigenous sediments from numerous open drains around Vanimo and from four watercourses that drain into the bay from the south.

Potential quarantine-related impacts to the nearshore marine environment in Dakriro Bay need to be considered within the context of the existing and future vessel traffic to the Vanimo Ocean Port, including existing vessel movements unrelated to the Project, which may make attribution to a particular vessel or activity difficult. Project-specific quarantine management measures will be implemented and international vessels arriving at the ocean port will be required to comply with PNG customs and quarantine requirements.

Excess filtrate water from the concentrate thickener will be discharged into nearshore waters for the duration of the FRCGP. It is conservatively predicted that the PNG ambient marine water quality standards will be achieved at 10 m from the discharge point. However, a mixing zone with a (conservative) radius of 100 m from the discharge point is proposed to allow for natural variability and safe access to the monitoring location.



Proposed location of Vanimo Ocean Port

At the Vanimo Ocean Port, the concentrate export facility material handling system will be fitted with engineering controls to limit the spillage of concentrate during handling.

Drilling at the Frieda River site

6.4 Socio-economic Environment

Section 6.1 summarises the benefits that the Project is predicted to have on communities. However, the Project also has the potential to cause indirect positive and negative effects and impacts on communities. The primary indirect causes of social change induced by the Project are likely to be:

- In-migration, which is a phenomenon in PNG that occurs due to personal motivation to access economic opportunity. The infrastructure corridor will provide a new pathway for potential migrants to the FRGCP and FRHEP area. While in-migration may ultimately benefit local trade, employment, infrastructure and services, there can also be negative economic, health and social consequences for host communities, particularly in the short term. These negative consequences include pressure on land and resources, price inflation, restricted business and employment opportunities for local communities, damage to cultural heritage, inability to maintain customary rights and practices, disruption to social relations, impaired community safety and security, higher incidence of infectious diseases, and reduced availability of health and education services.
- Substantial landowner incomes generated by the Project are expected to be spent and contribute to the incomes of a variety of entities throughout PNG. This will provide financial benefits at a local, provincial and national level through the procurement of goods and services, payment of wages and the distribution of Project benefits but can also result in strains on social relations within and between communities, changes to traditional lifestyles and systems of governance, and the consumption of alcohol and drugs that has the potential to lead to increased public and domestic violence.

Social Catchment 1A: Mine Area

Of the three social sub-catchments which constitute Social Catchment 1A: Mine Area, the assessment has identified that the Telefol social sub-catchment will experience the highest level of impact (due to inundation of the Ok Isai and Wabia villages by the FRHEP and their necessary relocation), followed by the Paiyamo social sub-catchment due to the proximity of construction activity and the need for relocation. Across all three social sub-catchments in Catchment 1A, the primary causes of social change attributable to the Project relate to the disturbance of resources used to support subsistence livelihoods, the social effects associated with access to cash incomes and the transition to a cash-based economy, the re-establishment of livelihoods following resettlement, and impacts caused by induced in-migration. Across Social Catchment 1A, the greatest loss of resources used for subsistence purposes will occur in the Telefol social sub-catchment, due to land inundation, and the Paiyamo social sub-catchment, particularly with respect to potential effects on water quality throughout construction due to its location downstream from the mine area, noting that the findings of the health impact assessment predict that there will be no impacts to human health.

The Paiyamo social sub-catchment is also predicted to encounter substantial in-migratory pressure due to Paupe's location close to Project infrastructure and physical accessibility. In addition to these factors, Paupe residents may also experience impacts associated with Project traffic and transport activity should they engage in activity in proximity to the mine access road and Frieda River Port. The combination of impacts predicted to occur across all Social Catchment 1A communities, and particularly in the Telefol and Paiyamo social sub-catchments due to village relocation, will place significant pressures on social values which will require the effective implementation of proposed mitigation measures, along with external support and partnerships, to ensure effective management.

Social Catchment 1B: New infrastructure and road corridor, Hotmin to Green River

There will be a continuing dependence on subsistence livelihoods in the social catchment until cash incomes improve significantly. In general, full access to subsistence resources will be maintained along the road corridor as the alienated land will be a very small percentage of that available. Improved access to the catchment via the public road may stimulate further logging or industrial-scale agriculture, such as oil palm plantations, which will remove land from subsistence production while generating cash income from employment.

While there will be potential for in-migration along the road corridor, effects are more likely to be felt in areas closer to population centres, such as at Green River or Hotmin. This may create opportunities for the sale of surplus subsistence crops in these locations. Public road access to larger population centres may also provide an opportunity for the planting of cash crops or the commercial exploitation of fish or other aquatic products. In-migration along the road corridor may result in some land appropriation in selected areas, principally near population centres or known alluvial gold areas, which may act to erode customary rights in those areas.

FRL employees handling drill core

Development enabled by improved road access and the opportunity to connect to reticulated power (such as employment, production for sale, cash crop production) is expected to lead to improved household income levels, a portion of which may be allocated to the improvement of housing (such as corrugated iron roofing and water tanks). Improved access and power may also facilitate the establishment of commercial trade stores and more reliable access to government services because of lower service delivery costs. Development of the public road will also provide improved connection to population centres that may stimulate population movement and interactions with different cultural groups. Eventually this may lead to longer-term relationships (including marriage) that will act to alter cultural identity.

The presence of a construction workforce may lead to potential health and security risks which, in the absence of effective management, may develop and impair community well-being. There are a range of management measures which will be included in a construction social management plan including careful camp location (sufficiently distant from a village to minimise impact but not exclude village employment) and camp and employment codes of practice to manage employee behaviour.

Safety risks resulting from the interaction of residents and traffic are almost certain (as villagers will use the road as a pedestrian walkway) with the potential for loss of life. The risk is capable of being managed through implementation of traffic management and safety plans, drawing on the experience of other major infrastructure and resource projects in PNG. However, even with effective plan implementation, the risk remains high due to the potential for fatalities.

Social Catchment 1C: Existing infrastructure corridor, Green River to Vanimo

The viability of subsistence livelihoods in the catchment has already been adversely affected by the impacts of logging and oil palm plantation establishment. It is possible that the improved access provided by the road upgrade may enhance the viability of existing broad scale land use (oil palm) and former land uses (such as rubber plantations near Green River) leading to the conversion of more land to cash cropping.

The population within the catchment has been subject to significant lifestyle change over the past decades including change due to the presence of large-scale logging operations with follow-up planting of oil palm plantations. This has exposed the population to outside cultural influences to a significantly greater extent than what has occurred in Social Catchment 1B.

Improved access will stimulate in-migration, particularly to the Green River area. This in-migration is envisaged

Local villagers selling garden produce to FRL

Social baseline surveys in 2015

and supported by the government as Green River is designated a Level 2 Growth Centre under the Sandaun Province Growth Centre Strategy (Vanimo being Level 1). This could lead to additional land requirements at the station which would be subject to negotiation with customary owners who are generally supportive of development in the area to restore and upgrade infrastructure and to provide commercial business opportunities. While it is possible that this development could impair customary rights to land, the consequences are likely to be minor.

In general, upgraded road access should support improved levels of service delivery for government-provided services in health, education and policing, though in-migration to Green River may require the expansion of these services and their enabling infrastructure to cope with a higher level of demand. While improved access should enable more economic activity in the catchment, access to investment funds by locals may still inhibit local-led development thereby creating opportunities for external investment, particularly in trading ventures that repatriate profits out of the local area.

As with Catchment 1B, the presence of a construction workforce may lead to potential health and security risks. Similar management measures to Catchment 1B can mitigate the consequences to minor. There will also be similar elevated safety risks to pedestrians using the road as a walkway, which will be managed through appropriate traffic management measures.

Social Catchment 1D: Vanimo Ocean Port

Impacts from the construction and operation of the Vanimo Ocean Port will largely be confined to the area immediately surrounding the port development site which is contained within the existing port boundary. The construction and operation of the port infrastructure has the potential to impair the amenity of adjacent settlements (Wesdeco and Cis Point) through the imposition of noise, light and vehicular traffic at nuisance levels, and altering the character of the existing surrounding environment and visual outlook from one of peri-urban village to one of industrial precinct. This will be managed through an environmental management and monitoring plan which will include a traffic management plan.

Construction of the port facilities will present opportunities for employment and skill development for Vanimo residents and landowners of the port area. There will also be a limited number of employment opportunities during port operations.

Social Catchment 2: Sepik River Corridor

Some villages in Catchment 2 may experience highly localised and short term disruption to fishing associated with barge movements during construction. Fishing activity in the Frieda and May rivers has the potential to be disturbed during construction (in advance of the public road being constructed) by barge movements as fish nets may not be able to be set when barges are passing through, or they could be damaged or destroyed by passing barges if not removed beforehand. Barge movements along the Sepik River are unlikely to impact fishing as fishing is predominantly undertaken in off-river water bodies and not in the Sepik River main channel. There is a risk that the wash effect of barges travelling along the Sepik River could lead to minor flooding in houses built in proximity to the banks, as during periods of flooding the water level along the river rises close to the underside of the flooring of houses.

The numbers of wild crocodiles are not expected to be impacted by the Project and crocodile farming is also not expected to be impacted as breeding activities and harvesting of crocodile eggs, juveniles and adults typically occurs in off-river waterbodies which modelling predicts will not be impacted by the Project.

Sepik River corridor villages have a close affinity with the health of the river which is vital to their well-being. Communities have expressed concern over the potential for river pollution should the

Dugout canoes

Dried fish ready for eating

Plant nursery for mine site rehabilitation

structural integrity of the ISF embankment be compromised, or should there be uncontained spillage of chemicals or fuels that subsequently enter the river systems during construction and operations. The Project will implement barge vessel operation management measures to ensure safe handling and transport of equipment and materials during construction. Impaired water quality affecting the subsistence livelihood of the Sepik River corridor is unlikely. It is still possible that community anxiety about water quality and personal safety will be heightened, thereby affecting personal mental health and well-being, of which the consequence is moderate.

Social Catchment 3: Sandaun and East Sepik Provinces

FRL will seek to recruit the majority of its workforce from PNG with a preference to employ from Sandaun and East Sepik provinces. A preferential employment system will be implemented, but candidates must possess the relevant skills and experience to fulfil the requirements of each role. Improved national human capital from training and work opportunities in the Sandaun and East Sepik provinces as a direct and indirect result of the Project has the potential to result in reduced dependence on foreign workers and provide improved quality of life and life choices for those trained and experienced individuals. This will also increase the resource pool of trained, experienced potential employees with skills able to be applied to other resource Projects and transferable to other industries.

Social Considerations for Project Closure

Once a decision to close the FRCGP is taken and the decommissioning and closure process is put in place, income streams for the social catchments will sharply decrease as levels of employment will reduce significantly. This will particularly be the case for Social Catchments 1A and 1B which are located closest to the mine area and which will have the greatest percentage of villagers employed by the FRCGP, as well as receiving other financial benefits.

During decommissioning and closure, the number of personnel employed for the FRCGP will decrease until there is a small maintenance team remaining on site until relinquishment. This labour decrease is a significant social risk during the closure process. To address this risk in advance of closure, FRL will prepare a supplement to the Human Resources Plan that outlines retention strategies for necessary personnel and investigate alternative employment options for locally employed staff.

Training is one aspect that FRL can directly influence during the life of the Project to provide sustainable long-term benefits. The proposed 30-plus year operating life of the FRCGP, with credible potential for this to significantly extend, allows sufficient time for FRL to establish comprehensive training programs for the local workforce that will provide employees with skills that equip them for employment during the Project, and allow them the option to transfer those skills to work on mining (or other) projects elsewhere after the FRCGP closes, should they choose to do so.

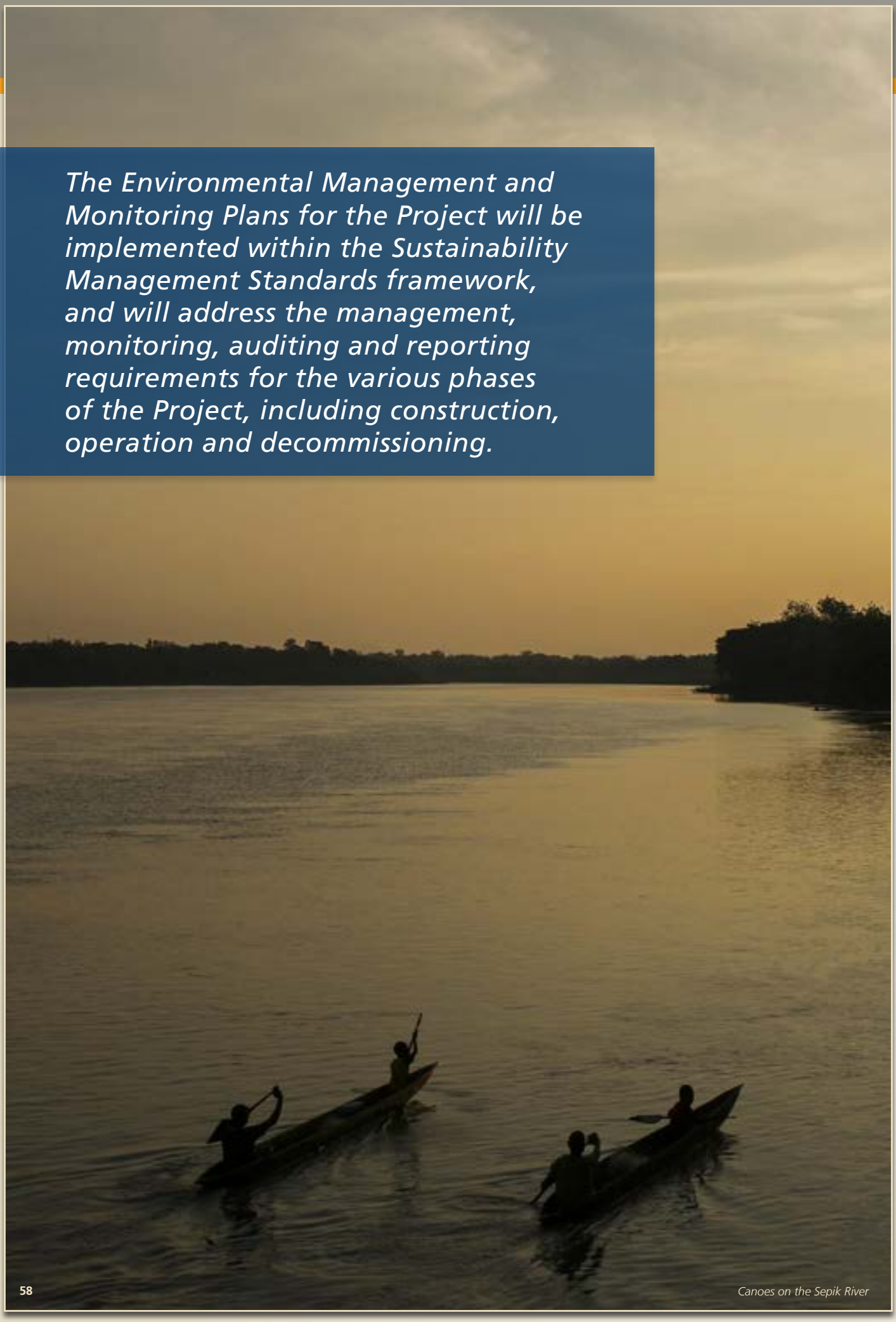
6.5 Cumulative Impacts

A total of ten projects were assessed to determine whether they were eligible and would contribute to the cumulative impacts of the Project. From the assessment, six credible projects had spatial and temporal relationships with the Project and were considered to have the potential for a cumulative effect:

- Bewani Oil Palm Plantations.
- Idam-Siawi Agroforestry.
- Sandaun Special Economic Zone.
- Sepik Plains Agriculture Project.
- Turubu Oil Palm Project.
- Hotmin to Telefomin Road.

Cumulative impacts from vegetation clearance, sedimentation, road use, shipping and construction workforce demand are possible. However, management strategies for mitigating the potential cumulative effect for each aspect will be developed as part of the Project mitigation strategies and programs in consultation with those other project developers. This will provide an overarching framework to cater for changing conditions. The two provincial governments of Sandaun and East Sepik will be encouraged to incorporate these management strategies into their development plans to manage increases in population and the economy while also managing impacts to the environment.

The Environmental Management and Monitoring Plans for the Project will be implemented within the Sustainability Management Standards framework, and will address the management, monitoring, auditing and reporting requirements for the various phases of the Project, including construction, operation and decommissioning.



Canoes on the Sepik River

7. MANAGEMENT, MONITORING, AUDITING AND REPORTING FRAMEWORK

The Project will be managed under the governance of the PanAust Group Sustainability Policy. The Sustainability Policy is supported by 14 Sustainability Management Standards relating to leadership, risk management, health and safety, training, environment, stakeholder engagement and community, which have been developed by PanAust to ensure consistent sustainability-related outcomes across the business.

The Environmental and Social Impact Assessment process, as reflected in the EIS and described in Section 6, identified a number of predicted physical, biological and socio-economic impacts. A range of management measures have been proposed and commitments made to address these, with a focus on limiting the potentially negative impacts of the Project and enhancing the potential benefits where possible.

7.1 Management

The Project's environmental management and monitoring plans (EMMPs) will be implemented within the Sustainability Management Standards framework and will address the management, monitoring, auditing and reporting requirements for construction, operation and decommissioning. The EMMPs currently address the construction phase only, with one exception, and will be updated prior to commissioning to address the operations phase.

EMMPs specific to each of the interdependent projects that make up the Project have been prepared as follows:

- Frieda River Copper-Gold Project EMMP.
- Frieda River Hydroelectric Project EMMP.
- Sepik Infrastructure Project: Public Road from Vanimo to Hotmin EMMP.
- Sepik Infrastructure Project: Green River Airport EMMP.
- Sepik Infrastructure Project: Vanimo Ocean Port EMMP.
- Sepik Power Grid Project EMMP.

The EMMPs reflect the commitments contained in the EIS, particularly in chapters 8 and 9, and describe the programs that support their implementation. The processes for monitoring, auditing and checking for compliance against these commitments are also described.

The aims of the EMMPs are to:

- Document FRL's approach to environmental management including the environmental management system, schedule for environmental management and organisational structure and responsibilities.
- Describe how the Project's environmental risks will be addressed, together with the social management plans, based on the 'in principle' commitments described in the EIS.
- Detail an integrated program to monitor, manage, audit and report on the environmental impacts and compliance with regulatory permits and licences. In particular, this program will validate and monitor impact predictions.
- Document auditable commitments made by the Project for reference in future internal and external audits.

Issue-specific management sub-plans describe the environmental objectives and management measures that will be implemented to mitigate impacts that may occur. The sub-plans typically included in each EMMP are as follows:

- Air Quality, Noise and Vibration Management Sub-Plan.
- Biodiversity Management Sub-Plan.
- Cultural Heritage Management Sub-Plan.
- Emergency Response and Fire Management Sub-Plan.
- Erosion, Sediment and Soils Control Management Sub-Plan.
- Hazardous Materials, Fuel Handling and Spill Response Management Sub-Plan.
- Rehabilitation Management Sub-Plan.
- Traffic and Transport Management Sub-Plan.
- Waste Management Sub-Plan.
- Water Management Sub-Plan.
- Weed, Pest and Quarantine Management Sub-Plan.

*Victoria's crowned-pigeon (*Goura victoria*)*

The FRCGP EMMP will also include an Acid and Metalliferous Drainage sub-plan. Given the importance of this sub-plan and the Water Management Sub-Plan, these sub-plans cover both the construction and operation phases of the Project.

FRL will also develop and implement management plans to address the social aspects of the Project, aimed at maximising benefits to stakeholders and minimising adverse impacts, during construction, operation and closure. These plans will include:

- Community Development Plan.
- Business Development, Supply and Procurement Plan.
- Human Resource and Localisation Plan.
- Project-induced In-migration Management Strategy.
- Resettlement Plan.

Site-specific resettlement action plans will also be developed under the overarching Resettlement Plan.

The social management framework includes the Stakeholder Engagement and Management Plan and the grievance mechanism, which are essential for maintaining a constructive dialogue with potentially affected individuals and communities. The inclusion of the FRCGP Conceptual Mine Closure Plan and FRHEP Conceptual Closure Plan within the framework also provides a reference for the management plans to promote capacity development aimed at mitigating the social impacts of eventual mine closure.

7.2 Monitoring

The purpose of environmental monitoring for the Project will be to verify the impact predictions contained in this EIS, confirm effective implementation of environmental management measures and to demonstrate compliance with regulatory permits and licences. Where necessary, corrective action will be taken should monitoring indicate that management measures are not effective.

Monitoring for the construction of the Project is described in each of the EMMPs. Monitoring programs will be further developed as the Project proceeds into detailed design and will take into consideration the conditions of the environment permit. The monitoring programs will typically include the environmental aspects relevant to each Project-related activity, descriptions of the components to be monitored, and frequency of monitoring and purpose, where the latter will address both routine ongoing monitoring and intensive 'validation' surveys aimed at validating the predicted impacts for operations, with monitoring frequency then being reduced.

The parameters to be measured will be reviewed and expanded with specific key performance indicators, monitoring locations and frequencies in subsequent iterations of the EMMPs.

Environmental monitoring will be undertaken by the Project's suitably experienced and qualified personnel and monitoring results will be presented in regular internal reports. The results will also be summarised and reported to government regulators as required by applicable legislation or the Environment Permit.

7.3 Auditing, Reviewing and Reporting

The Project's success in achieving the environmental and social management objectives and targets will be reviewed annually during operations. The EMMPs, social management plans and the procedures outlined within them will be regularly reviewed during construction and operations to ensure that:

- Project activities are undertaken in compliance with statutory obligations.
- The environmental and social objectives of the Project are achieved.
- The environmental and social management measures are effectively implemented.
- A system of continuous improvement is established.
- Further information is incorporated into the plans as it becomes available.

Audits will be undertaken on a regular basis against relevant standards and criteria to ensure compliance with the environmental management procedures and Environment Permit conditions and to inform continual improvement of the management systems and processes for the Project.

Monitoring reports will be submitted to CEPA and other regulatory authorities as required by the Environment Permit conditions. Compliance with the EMMPs will be described in these reports as well as recommendations for corrective action. In PNG, this is typically in the form of an Annual Environment Report.

FRL will formally disclose annual 'river health cards' that present the results of the downriver environmental monitoring program in a straightforward format readily understood by local communities. These annual report cards will provide information on aspects such as:

- Surface water quality.
- Drinking water quality.
- Edibility of aquatic resources.
- Community feedback received.

FRL will establish an independent advisory committee to assist FRL in addressing the environmental and related social impacts of its mining activities upon the local and downstream communities. The committee will be established prior to the commencement of construction and will comprise prominent PNG citizens and local and international technical specialists. The committee will provide direction and technical oversight for monitoring and investigations of the environmental and social impacts in the FRHEP and FRCGP area and downstream and will improve public understanding of the Project's impacts and independently review FRL's environmental performance and accountability. The findings of the committee will routinely be made public.

*White-lipped tree frog (*Litoria infrafrenata*)*

FRIEDA RIVER

Frieda River Limited

Sepik Development Project

Environmental Impact Statement

Volume A - Executive Summary

FRIEDA RIVER LIMITED

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