



Appendix T

Socioeconomic Baseline

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This Environmental Impact Statement, including the Executive Summary, and all chapters of and attachments and appendices to it and all drawings, plans, models, designs, specifications, reports, photographs, surveys, calculations and other data and information in any format contained and/or referenced in it, is together with this disclaimer referred to as the "**EIS**".

Purpose of EIS

The EIS has been prepared by, for and on behalf of Wafi Mining Limited and Newcrest PNG 2 Limited (together the "**WGJV Participants**"), being the participants in the Wafi-Golpu Joint Venture ("**WGJV**") and the registered holders of exploration licences EL 440 and EL1105, for the sole purpose of an application (the "**Permit Application**") by them for environmental approval under the Environment Act 2000 (the "**Act**") for the proposed construction, operation and (ultimately) closure of an underground copper-gold mine and associated ore processing, concentrate transport and handling, power generation, water and tailings management, and related support facilities and services (the "**Project**") in Morobe Province, Independent State of Papua New Guinea. The EIS was prepared with input from consultants engaged by the WGJV Participants and/or their related bodies corporate ("**Consultants**").

The Permit Application is to be lodged with the Conservation and Environment Protection Authority ("**CEPA**"), Independent State of Papua New Guinea.

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The EIS is intended and will be made available to CEPA, for review by CEPA and other applicable agencies of the Government of the Independent State of Papua New Guinea ("**Authorised Agencies**"), for the purpose of considering and assessing the Permit Application in accordance with the Act ("**Authorised Purpose**"), and for no other purpose whatsoever.

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The EIS is based in part on information not within the control of either the WGJV Participants or the Consultants. While the WGJV Participants and Consultants believe that the information contained in the EIS should be reliable under the conditions and subject to the limitations set forth in the EIS, they do not guarantee the accuracy of that information.

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The basis of the Consultants' engagement is that the Consultants' liability, whether under the law of contract, tort, statute, equity or otherwise, is limited as set out in the terms of their engagement with the WGJV Participants and/or their related bodies corporate.

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The WGJV Participants acknowledge and agree that, for the Authorised Purpose, the EIS may be:

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Development of Project subject to Approvals, Further Studies and Market and Operating Conditions

Any future development of the Project is subject to further studies, completion of statutory processes, receipt of all necessary or desirable Papua New Guinea Government and WGJV Participant approvals, and market and operating conditions.

Engineering design and other studies are continuing and aspects of the proposed Project design and timetable may change.

NEWCREST MINING LIMITED DISCLAIMER

Newcrest Mining Limited ("**Newcrest**") is the ultimate holding company of Newcrest PNG 2 Limited and any reference below to "Newcrest" or the "Company" includes both Newcrest Mining Limited and Newcrest PNG 2 Limited.

Forward Looking Statements

The EIS includes forward looking statements. Forward looking statements can generally be identified by the use of words such as "may", "will", "expect", "intend", "plan", "estimate", "anticipate", "continue", "outlook" and "guidance", or other similar words and may include, without limitation, statements regarding plans, strategies and objectives of management, anticipated production or construction commencement dates and expected costs or production outputs. The Company continues to distinguish between outlook and guidance. Guidance statements relate to the current financial year. Outlook statements relate to years subsequent to the current financial year.

Forward looking statements inherently involve known and unknown risks, uncertainties and other factors that may cause the Company's actual results, performance and achievements to differ materially from statements in this EIS. Relevant factors may include, but are not limited to, changes in commodity prices, foreign exchange fluctuations and general economic conditions, increased costs and demand for production inputs, the speculative nature of exploration and project development, including the risks of obtaining necessary licences and permits and diminishing quantities or grades of reserves, political and social risks, changes to the regulatory framework within which the Company operates or may in the future operate, environmental conditions including extreme weather conditions, recruitment and retention of personnel, industrial relations issues and litigation.

Forward looking statements are based on the Company's good faith assumptions as to the financial, market, regulatory and other relevant environments that will exist and affect the Company's business and operations in the future.

The Company does not give any assurance that the assumptions will prove to be correct. There may be other factors that could cause actual results or events not to be as anticipated, and many events are beyond the reasonable control of the Company. Readers are cautioned not to place undue reliance on forward looking statements. Forward looking statements in the EIS speak only at the date of issue. Except as required by applicable laws or regulations, the Company does not undertake any obligation to publicly update or revise any of the forward looking statements or to advise of any change in assumptions on which any such statement is based.

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Newcrest results are reported under International Financial Reporting Standards (IFRS) including EBIT and EBITDA. The EIS also includes non-IFRS information including Underlying profit (profit after tax before significant items attributable to owners of the parent company), All-In Sustaining Cost (determined in accordance with the World Gold Council Guidance Note on Non-GAAP Metrics released June 2013), AISC Margin (realised gold price less AISC per ounce sold (where expressed as USD), or realised gold price less AISC per ounce sold divided by realised gold price (where expressed as a %), Interest Coverage Ratio (EBITDA/Interest payable for the relevant period), Free cash flow (cash flow from operating activities less cash flow related to investing activities), EBITDA margin (EBITDA expressed as a percentage of revenue) and EBIT margin (EBIT expressed as a percentage of revenue). These measures are used internally by Management to assess the performance of the business and make decisions on the allocation of resources and are included in the EIS to provide greater understanding of the underlying performance of Newcrest's operations. The non-IFRS information has not been subject to audit or review by Newcrest's external auditor and should be used in addition to IFRS information.

Ore Reserves and Mineral Resources Reporting Requirements

As an Australian Company with securities listed on the Australian Securities Exchange (ASX), Newcrest is subject to Australian disclosure requirements and standards, including the requirements of the Corporations Act 2001 and the ASX. Investors should note that it is a requirement of the ASX listing rules that the reporting of Ore Reserves and Mineral Resources in Australia comply with the 2012 Edition of the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (the JORC Code) and that Newcrest's Ore Reserve and Mineral Resource estimates comply with the JORC Code.

Competent Person's Statement

The information in the EIS that relates to Golpu Ore Reserves is based on information compiled by the Competent Person, Mr Pasqualino Manca, who is a member of The Australasian Institute of Mining and Metallurgy. Mr Pasqualino Manca, is a full-time employee of Newcrest Mining Limited or its relevant subsidiaries, holds options and/or shares in Newcrest Mining Limited and is entitled to participate in Newcrest's executive equity long term incentive plan, details of which are included in Newcrest's 2017 Remuneration Report. Ore Reserve growth is one of the performance measures under recent long term incentive plans. Mr Pasqualino Manca has sufficient experience which is relevant to the styles of mineralisation and type of deposit under consideration and to the activity which he is undertaking to qualify as a Competent Person as defined in the JORC Code 2012. Mr Pasqualino Manca consents to the inclusion of material of the matters based on his information in the form and context in which it appears.

HARMONY GOLD MINING COMPANY LIMITED DISCLAIMER

Harmony Gold Mining Company Limited ("**Harmony**") is the ultimate holding company of Wafi Mining Limited and any reference below to "Harmony" or the "Company" includes both Harmony Gold Mining Company Limited and Wafi Mining Limited.

Forward Looking Statements

These materials contain forward-looking statements within the meaning of the safe harbor provided by Section 21E of the Securities Exchange Act of 1934, as amended, and Section 27A of the Securities Act of 1933, as amended, with respect to our financial condition, results of operations, business strategies, operating efficiencies, competitive positions, growth opportunities for existing services, plans and objectives of management, markets for stock and other matters. These include all statements other than statements of historical fact, including, without limitation, any statements preceded by, followed by, or that include the words "targets", "believes", "expects", "aims", "intends", "will", "may", "anticipates", "would", "should", "could", "estimates", "forecast", "predict", "continue" or similar expressions or the negative thereof.

These forward-looking statements, including, among others, those relating to our future business prospects, revenues and income, wherever they may occur in this EIS and the exhibits to this EIS, are essentially estimates reflecting the best judgment of our senior management and involve a number of risks and uncertainties that could cause actual results to differ materially from those suggested by the forward-looking statements. As a consequence, these forward-looking statements should be considered in light of various important factors, including those set forth in these materials. Important factors that could cause actual results to differ materially from estimates or projections contained in the forward-looking statements include, without limitation: overall economic and business conditions in South Africa, Papua New Guinea, Australia and elsewhere, estimates of future earnings, and the sensitivity of earnings to the gold and other metals prices, estimates of future gold and other metals production and sales, estimates of future cash costs, estimates of future cash flows, and the sensitivity of cash flows to the gold and other metals prices, statements regarding future debt repayments, estimates of future capital expenditures, the success of our business strategy, development activities and other initiatives, estimates of reserves statements regarding future exploration results and the replacement of reserves, the ability to achieve anticipated efficiencies and other cost savings in connection with past and future acquisitions, fluctuations in the market price of gold, the occurrence of hazards associated with underground and surface gold mining, the occurrence of labour disruptions, power cost increases as well as power stoppages, fluctuations and usage constraints, supply chain shortages and increases in the prices of production imports, availability, terms and deployment of capital, changes in government regulation, particularly mining rights and environmental regulation, fluctuations in exchange rates, the adequacy of the Group's insurance coverage and socio-economic or political instability in South Africa and Papua New Guinea and other countries in which we operate.

For a more detailed discussion of such risks and other factors (such as availability of credit or other sources of financing), see the Company's latest Integrated Annual Report and Form 20-F which is on file with the Securities and Exchange Commission, as well as the Company's other Securities and Exchange Commission filings. The Company undertakes no obligation to update publicly or release any revisions to these forward-looking statements to reflect events or circumstances after the date of this EIS or to reflect the occurrence of unanticipated events, except as required by law.

Competent Person's Statement

The Wafi-Golpu Joint Venture is an unincorporated joint venture between a wholly-owned subsidiary of Harmony Gold Mining Company Limited and a wholly-owned subsidiary of Newcrest Mining Limited.

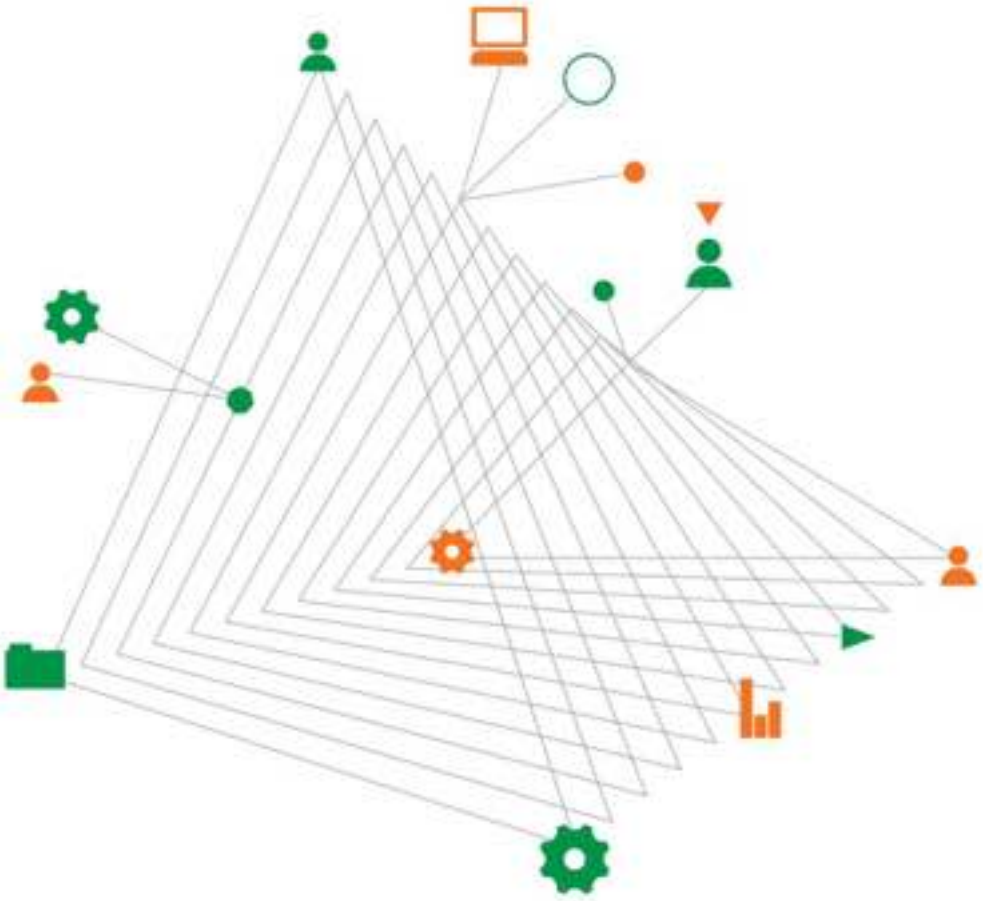
The information in the EIS that relates to Golpu Ore Reserves is based on information compiled by the Competent Person, Mr Pasqualino Manca, who is a member of The Australasian Institute of Mining and Metallurgy. Mr Pasqualino Manca, is a full-time employee of Newcrest Mining Limited or its relevant subsidiaries, holds options and/ or shares in Newcrest Mining Limited and is entitled to participate in Newcrest's executive equity long term incentive plan, details of which are included in Newcrest's 2017 Remuneration Report. Ore Reserve growth is one of the performance measures under recent long term incentive plans. Mr Pasqualino Manca has sufficient experience which is relevant to the styles of mineralisation and type of deposit under consideration and to the activity which he is undertaking to qualify as a Competent Person as defined in the JORC Code 2012. Mr Pasqualino Manca consents to the inclusion of material of the matters based on his information in the form and context in which it appears.

Wafi-Golpu Joint Venture

Wafi-Golpu Project

Socioeconomic Baseline

25 June 2018



Experience comes to life when it is powered by expertise

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Wafi-Golpu Project

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Revision	Description	Date	Author	Reviewer	Approver
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Rev B	Final	25 June 2018	Anthony Kung	Daniel Moriarty	Daniel Moriarty

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Executive summary

Wafi Mining Limited and Newcrest PNG 2 Limited (WGJV Participants) are equal participants in the Wafi-Golpu Joint Venture (the WGJV). The WGJV is investigating the feasibility of constructing, operating and (ultimately) closing an underground copper-gold mine and associated ore processing, concentrate transport and handling, power generation, water and tailings management, and related support facilities and services (hereafter the "Wafi-Golpu Project" or the "Project") in the Morobe Province of the Independent State of Papua New Guinea (PNG). The proposed mine is located beneath Mt Golpu, approximately 300 kilometres (km) north-northwest of Port Moresby and 65 km southwest of Lae. The Project includes a deep sea tailings placement (DSTP) system for tailings management, access roads to the mine and related support facilities.

This report presents the findings of the socioeconomic baseline study, which encompasses a range of investigations undertaken for the WGJV Participants. Study areas were defined to group together people and communities who live in similar geographic regions and who may experience qualitatively similar impacts should the Project be developed. The four study areas adopted for the socioeconomic baseline are:

- Study Area 1: Mine Area, surrounds and access corridors.
- Study Area 2: Infrastructure Corridor from Zifasing to Lae.
- Study Area 3: Lae.
- Study Area 4: Wagang and Yanga villages.

The study areas are presented in Figure ES-1. Taken together, the four study areas encompass the three geographic areas of the Project (Mine Area, Infrastructure Corridor and Coastal Area). They are not limited to these areas, however, as they instead relate to the geographic location of the communities studied and which may experience impacts arising from the Project.

The socioeconomic baseline study will inform the socioeconomic impact assessment (SEIA), which is being prepared as part of the environmental impact statement (EIS) for the Project. The socioeconomic baseline study will also inform the development of strategies to enhance potential beneficial impacts and to avoid or reduce potential adverse impacts that are identified in the SEIA.

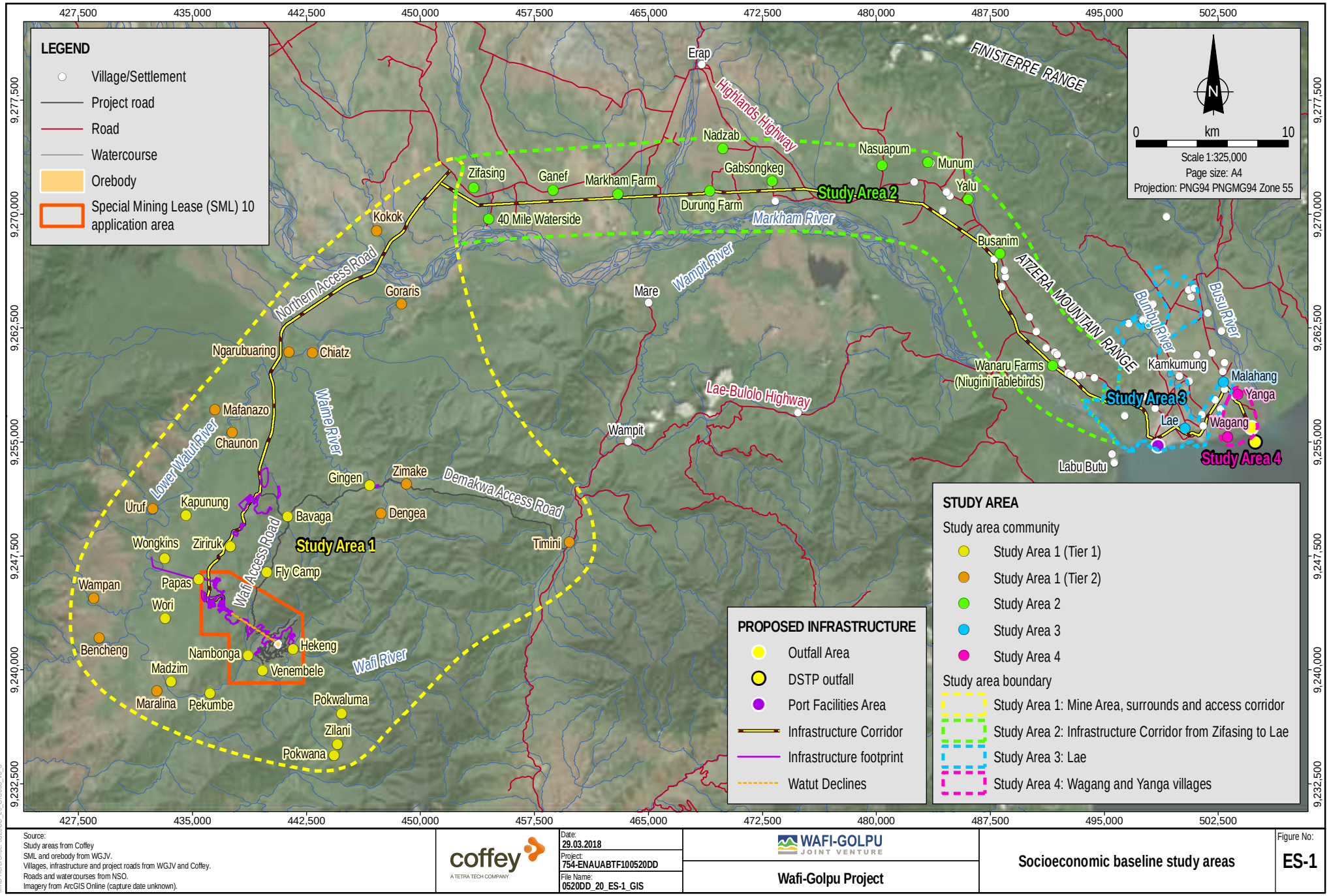
Study areas

Study Area 1: Mine Area, surrounds and access corridors

This study area comprises 29 villages, located near the Mine Area, along the Demakwa Access Road, and along the proposed Northern Access Road. Villages within this study area are further divided into two tiers, Tier 1 (those in closest proximity to the Mine Area) and Tier 2 (those more distant from the Mine Area, namely those villages other than Tier 1 villages located near the Lower Watut River or along proposed or existing access routes).

Tier 1 comprises sixteen villages inhabited by people of the Hengambu, Yanta and Babuaf cultural groups. These villages have been categorised as Tier 1 within this study area due to their proximity to and ownership of land on which mining and associated activities would be conducted. Tier 1 villages and corresponding cultural groups are:

- **Hengambu cultural group:** Hekeng, Fly Camp, Bavaga and Gingen.
- **Yanta cultural group:** Venembele, Nambonga, Pekumbe, Pokwaluma, Pokwana and Zilani.
- **Babuaf cultural group:** Madzim, Wori, Wongkins, Kapunung, Papas and Ziriruk.



MXD Reference: 0520CC_20_GIS003_v0_8

Source:
Study areas from Coffey
SML and orebody from WGJV.
Villages, infrastructure and project roads from WGJV and Coffey.
Roads and watercourses from NSO.
Imagery from ArcGIS Online (capture date unknown).

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WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Socioeconomic baseline study areas

Figure No:
ES-1

Tier 2 villages are those situated along or near the Demakwa Access Road and proposed Northern Access, and those located on the west side of the Lower Watut River (villages located on the east side of the Lower Watut River are within Tier 1). Tier 2 villages include owners of land through which access routes pass, as well as villages in proximity to the Lower Watut River whose residents have the ability to utilise these access routes (the proposed Northern Access Road in particular, which would be located in the section of the Infrastructure Corridor proposed to run north from the Mine Area to the village of Zifasing on the Highlands Highway). Thirteen villages were identified as Tier 2 villages within Study Area 1:

- **Villages along/near the Northern Access Road:** Kokok, Chiatz, Ngarubuaring, Mafanazo, Chaunon.
- **Villages along/near the Demakwa Access Road:** Timini, Dengea, Zimake.
- **Villages along/near the Lower Watut River:** Uruf, Wampan, Bencheng, Maralina, Goraris.

Study Area 2: Infrastructure Corridor from Zifasing to Lae

Study Area 2 relates to the portion of the Infrastructure Corridor from Zifasing village to the western border of Lae Urban Local-level Government (LLG). This study area spans a total linear distance of approximately 50 km and traverses parts of Zifasing, Ganef, Durung Farm, Gabsongkeg, Munum and Yalu. Communities within this study area include owners and settlers of land through which the infrastructure corridor will traverse.

The remaining portions of the Infrastructure Corridor are captured in the other three study areas. This study area is not subdivided into tiers.

Study Area 3: Lae

This study area comprises the city of Lae and surrounds. For analytical purposes, the city of Lae is defined as Lae Urban LLG, although baseline studies focused mainly on the southern and eastern parts of the city through which the Infrastructure Corridor would traverse. This study area extends up to and includes the Malahang area, and is contiguous with Study Area 4 which is located further east. It is not subdivided into tiers.

Project facilities located within this study area would include the Port Facilities Area, and the Infrastructure Corridor (with the concentrate pipeline and fuel pipeline terminating at the Port of Lae, and the terrestrial tailings pipeline continuing east within city roads toward the village of Wagang).

The study area is not restricted to the Infrastructure Corridor in Lae and the Port Facilities Area, because people within the broader city of Lae are expected to have a variety of interests in and interactions with the Project. Such interests and interactions may include: people who live, work or use services near land through which the Infrastructure Corridor would traverse; people who may be involved in Project operations at the Port of Lae; people who own or utilise land upon which Project facilities are planned; and people who take an active interest in the Project and its impacts.

Study Area 4: Wagang and Yanga villages

This study area is contiguous with Study Area 3, and comprises the villages of Wagang and Yanga, two peri-urban villages which are located approximately 3 km east of Lae. People within this study area are the owners of land through which the Infrastructure Corridor would traverse (specifically the terrestrial tailings pipeline). They are also the owners of land where the Outfall System (i.e., the mix/de-aeration tank, seawater intake pipelines and DSTP outfall pipelines) and associated facilities will be located. This study area has not been subdivided into tiers.

Key findings

Study Area 1: Mine Area, surrounds and access corridors

Approximately 9,935 people live in this study area, with an estimated 3,869 people in Tier 1 villages and 6,066 people in Tier 2 villages. Subsistence agriculture was reported to be the most important livelihood activity across the study area. Villagers generally reported being dependent on the natural environment for food, housing materials, firewood and medicine, which were either grown in gardens or gathered from the surrounding forests. Hunting and fishing were commonly practiced subsistence activities.

Difficult terrain and lack of access to transport and electricity limited the ability of these villagers to participate in commercial activities. Income sources included alluvial gold mining, growing of cash crops (primarily cocoa), business activities such as trade stores and stalls, and the sale of livestock. Wage employment was limited, with the WGJV Participants and their contractors being the main source of employment in Study Area 1. Levels of formal employment fluctuated with the level of exploration activity occurring at the time.

The majority of individuals identified as Christian (Lutheran), the practices of which were combined with traditional activities such as dances and sing-sings (a type of festival) with neighbouring villages. Other traditional practices included the physical separation of pregnant women to a separate house or area, rituals regarding the productivity of gardens (particularly those newly established), traditional medicines, and certain drinking and eating customs. Belief in sorcery was reported, but sorcery itself was not openly reported as being practiced.

Sharing of goods (e.g. surplus garden produce or fish) was reported as being common, especially among neighbouring households and close kin. Gifts were reciprocated in-kind or in cash, either immediately or at a later date.

Governance practices and capabilities were similar across all villages within this study area. Generally, church leaders, village magistrates, village councillors and community leaders provided authority and administered law and order. Adjudication of disputes in court was rare, with the nearest district court located in Lae. Usually, the male head of the household had the lead role in household decision-making; however, women had varying degrees of involvement and influence with regard to household functions such as child care, household upkeep and gardening.

Education was limited in some villages due to the distance required to travel to school. Residents of Fly Camp, Venembele, Nambonga and Pokwana reported being unable to reach any formal education facility because of a lack of road access. Residents of Gingen, Kapunung, Wongkins, Dengea, Timini, Chiatz, Uruf, Bencheng, Goraris and Zifasing were able to attend schools less than 2 km from their village. Of the villages surveyed in 2014 and 2015, 31% of boys and 41% of girls aged seven to 14 years of age had no formal education.

Most villages have access to health facilities, including the Wafi health clinic, Zindaga health sub-centre and Wongkins, Timini and Pokwaluma aid posts – all established or renovated by the WGJV. Travel to these facilities can, however, take up to two hours by foot for residents of some villages. Residents of other villages reportedly had to travel up to three hours (one-way) by foot, boat and public motor vehicles (PMVs) to access the nearest health facility.

A majority of people in the study area reported no or only minor public order issues in their villages. The main law and order issues were alcohol-related, with stealing, drug use and domestic violence also raised as public order issues.

There were several disadvantaged groups identified in this study area, including people living with a disability or sickness, the elderly and single mothers. Illiterate persons, and families who do not have literate members, were also identified as disadvantaged. Local families and various community organisations reportedly provided a strong support network to vulnerable people in this study area.

For transport, an extensive system of bush tracks provided access between villages within this study area. Villagers also used the Watut River, travelling by raft or canoe, to access markets downstream. The Link Road and the Watut Valley Road facilitate access from the village of Bavaga to the village of Papas, located on the Watut River floodplain. The Wafi Access Road and Demakwa Access Road, which were developed with the consent of the landowners to access the Mine Area during the exploration phase, are also used by public transport to provide vehicular access to Lae and beyond.

Study Area 2: Infrastructure Corridor from Zifasing to Lae

This study area traverses a wide range of existing land uses. From Zifasing to Yalu, the proposed Infrastructure Corridor will largely follow an existing powerline corridor approximately 50 m wide. It will pass through or near Ganef village, Markham Farm (an agricultural facility), Durung Farm (a village), Gabsongkeg village, Munum village and Yalu village. Field observations indicated that the proposed Infrastructure Corridor will traverse through or near gardens maintained by residents of villages and settlers. Key informant interviews and focus group discussions indicated that such gardens were relied upon for subsistence and for cash income. In addition, field observers found that residents within this study area would traverse the proposed Infrastructure Corridor in order to reach services (e.g. schools) and land for subsistence activities (e.g. gardens, hunting grounds and the Markham River for fishing).

The proposed Infrastructure Corridor will be situated to the west of the Highlands Highway from Yalu leading into the outskirts of the city of Lae. Interviews at Yalu village indicated that much of this land is customary Yalu land. Numerous businesses and industrial facilities, and at least two schools, are located adjacent to the Highlands Highway. The Infrastructure Corridor as proposed will not be situated closer than 150 m from the Highlands Highway at its nearest point, near premises occupied by Mainland Holdings (which operates a crocodile farm) as well as premises used by PNG Steel Limited as a laydown area.

Study Area 3: Lae

Within this study area, particular focus was given to parts of Lae within or adjacent to the proposed Infrastructure Corridor and Port Facilities Area.

General

Lae has an estimated population of 168,000 in 2017, making it PNG's second largest city. It is the national industrial centre, hosting a range of industries including meat processing, beverage manufacturing, flour milling, cement processing and fish canning. Other industries include transportation, commercial, wholesale and retailing, oil and petrol distribution and cartage. The city is well connected to the rest of the country via the Highlands Highway, a domestic airport and the country's largest port. International companies, such as Coca-Cola Amatil, Nestle and Dulux, have their local headquarters in the city.

At a more local scale, participation in the formal economy in Lae has provided its residents generally higher incomes, employment rates and education levels compared to most other parts of PNG and Morobe Province (JICA, 2017). Healthcare is more readily available in Lae than the other socioeconomic baseline study areas, with one hospital, seven clinics and four aid posts. Despite the range of services available, a shortage of healthcare facilities and health workers, relative to the population of Lae, has been reported (ibid).

The population of Lae has been expanding, with informal settlers comprising the fastest growing population group (JICA, 2017). 'Informal settler' refers to migrants to an area (i.e., Lae), who establish homes with neither formal legal rights, nor arrangements with customary landowners. Informal settlements comprise 42% of Lae's land area, having nearly doubled since 2003 (ibid). Informal settlements often lack basic infrastructure and services (such as running water and electricity), and informal settlers are often job-seekers who may not be employed, and migrants from other parts of

PNG who do not have family networks or other resources to support them. Informal settlers are therefore considered by WGJV to constitute a group of disadvantaged people within Lae (Lahoc, 2014).

The city of Lae experiences high crime levels, with robbery and assault the most commonly reported crimes. Homicide rates of 66 per 100,000 persons in Lae are double those of Port Moresby, and among the highest rates in the world (World Bank, 2014). Family and social violence are also common (Lakhani & William, 2014). Riots and mass prison breakouts have also occurred in the city in recent years; the most recent breakout from the Buimo prison was in May 2017. Informal settlements have been identified as parts of Lae in which law and order issues are especially prolific, possibly due to conflicts arising between migrants from different regions and of different ethnicities (JICA, 2017).

Port of Lae

The Port of Lae is PNG's largest and busiest port. It handles about half of the throughput of the 22 declared ports of PNG, and more than 60% of registered international and coastal trade, generating more than 50% of PNG Ports Corporation revenue (PNG Department of Transport and Infrastructure, 2013). The port has significant development potential based on utilisation of the Lae Tidal Basin expansion completed as part of the Lae Port Development Project in 2014 (Kumul Consolidated Holdings, 2014). Twenty-seven purse seining vessels operate out of Lae, representing 43.5% of PNG's purse seine fleet of 62 vessels, though tuna fishing is undertaken outside the Huon Gulf (EnviroGulf, 2018).

The Port of Lae is located in a heavily industrialised area, characterised by numerous industrial warehouses and port facilities. Along Bumbu Road, industries include Consort Express Lines Limited (a shipping company) and the National Agriculture Quarantine and Inspection Authority (NAQIA).

Infrastructure Corridor

The Infrastructure Corridor will pass along the western perimeter (Markham River side) of 3 Mile and Bugandi (a suburb of Lae), both predominantly residential areas with settlement housing, settler gardens and roadside stalls, before arriving at the Port of Lae, where the concentrate and fuel pipelines will split off.

The proposed Infrastructure Corridor will also traverse from the industrialised area of the Port of Lae through the city centre of Lae enroute to the village of Wagang. This section of the proposed corridor will be wholly constructed beneath public roads, adjacent to which numerous industrial facilities, businesses, health facilities and community premises are located. These include the Lae office of the National Agriculture Quarantine and Inspection Authority, Brian Bell Plaza (the largest retail mall in Lae), Lae International Hospital, the Lae Yacht Club and the Sir Ignatius Kilage Sport Stadium. The Infrastructure Corridor will also pass within 150 m of the Australian New Guinea Administrative Unit (ANGAU) Hospital, which is the second largest hospital in Papua New Guinea.

From the city centre of Lae, the proposed Infrastructure Corridor will traverse along Independence Drive, through Chinatown to Malahang. Chinatown is a mixed residential and commercial area, with numerous businesses including Bumbu Market and the Nestle chocolate factory. Malahang is also a mixed residential (settler) and commerical area. Two schools were observed in Malahang in the vicinity of the proposed Infrastructure Corridor; a primary school run by the Assembly of God, and Malahang Technical High School, which is located opposite Malahang Industrial Centre (an industrial estate with over 50 business premises).

The section of Independence Drive between Chinatown and Malahang is projected to be heavily congested in the future, with traffic volumes predicted to exceed road capacity by at least 50% (JICA, 2017). It was observed that peak traffic (for pedestrians and vehicles) occurred between 6:30 to 8:30 in the morning, and 15:30 to 17:30 in the afternoon. These peak times coincide with school and work commencement and finish times.

Study Area 4: Wagang and Yanga villages

Wagang village is a coastal village located approximately 3 km east of Lae. It had an estimated population of 626 persons in 2017, living in households of approximately 6.2 persons per house, slightly larger than the PNG average of 5.3. Yanga village, to the north of Wagang, is an inland village bordered by the Busu River to the east, Wagang village customary land to the south and west, and the Malahang area of Lae to the north and west. It had an estimated population of 620 persons in 2017. Both villages identify as being Ahi people, who likely established themselves in the area in the late 1800s or early 1900s.

Although being a peri-urban community affords greater opportunity to access employment compared to the other study areas, residents in both Wagang and Yanga villages engage in subsistence activities, such as gardening, fishing, gathering and hunting. Surplus produce (e.g. garden crops or fish) were reportedly sold for income. On weekends, PMVs were observed to convey residents of Lae to Wagang beach, where they could swim and have a picnic. These visitors provided an economic opportunity for Wagang residents, who sold food, drinks and other goods to visitors.

For Wagang village, terrestrial subsistence activities generally take place in the area to the east of Sipaia Road (which runs north-south between the village and Malahang), where the terrestrial tailings pipeline is proposed to pass through. Terrestrial subsistence activities for Yanga village take place adjacent to the northeast of this area, between Wagang land and the Busu River. For both villages, the land available for subsistence activities is bounded by the Busu River, the city of Lae and the shoreline, resulting in limited capacity to accommodate population growth and increased levels of subsistence activities. In the key informant interview at Wagang, village leaders indicated that land availability for future generations is the primary concern of the village.

Wagang village (and the beach to the east of the village) is a fishing location used by Wagang villagers, Yanga villagers, and visitors from Lae who visit Wagang beach on weekends. According to the 2017 household surveys, approximately 65% of households in Wagang regularly engage in some kind of fishing, for either fin fish or other seafood resources (e.g. shellfish), with the most popular location being the beach. Other common fishing locations include mangroves and river/creeks, with 52% and 60% of respondents targeting these areas respectively.

Of the households that fish, 28% fish offshore. Key informant interviews indicated that fishing does not occur further than 500 m from the shore, where water depths exceed 100 m and are greater than 250 m within about 1,000 m from shore. Villagers did not report regularly attempting to catch deep slope fish. Additionally, the fishing gear observed did not appear to enable fishing at depths much greater than 100 m. It cannot be ruled out that some people at Wagang may attempt to catch deep slope fish, some of the time, although the findings of the deep slope and pelagic fish study (also completed for the EIS by Coffey, 2018a) reported anomalously low catches of deep slope fish species in the waters offshore from Wagang (and elsewhere in the Huon Gulf) compared to the results from other similar studies in PNG. These findings suggest that there is not a large population of deep slope fish for local people to target, or that they do not have the gear to fish for them should they wish to do so.

In Yanga, the studies in 2017 indicated that fishing predominantly takes place further inland in estuaries and within mangrove areas due to Yanga's distance from the beach area; however, people do travel to the coastline to fish in the ocean from the beach, mostly at the mouth of the Busu River.

Information on cultural heritage sites recorded within this study area is provided in the Cultural Heritage Baseline and Impact Assessment (Green & Muke, 2018).

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Glossary

Abbreviations

ANGAU	Australian New Guinea Administrative Unit Hospital
CEPA	Conservation and Environment Protection Authority
DEC	Department of Environment and Conservation
DSTP	deep sea tailings placement
EIS	environmental impact statement
GDP	Gross Domestic product
ha	hectares
IFC	International Finance Corporation
ICMM	International Council on Mining and Metals
kg	kilograms
kg/ha	kilogram per hectare
km	kilometre
km^2	square kilometres
km/hr	kilometre per hour
LLG	Local Level Government
m	metre
m^2	square metres
MMJV	Morobe Mining Joint Ventures
NFA	National Fisheries Authority
NSO	PNG National Statistics Office
PGK	Papua New Guinea currency
PMV	public motor vehicle
PNG	Independent State of Papua New Guinea
SEIA	Socioeconomic Impact Assessment
SIA	Social Impact Assessment
t	tonnes
UNDP	United Nations Development Program
WGJV	Wafi-Golpu Joint Venture
WGJV Participants	Wafi Mining Limited and Newcrest PNG2 Limited
WHO	World Health Organization

Terms

Coastal Area	The Coastal Area includes the proposed Port Facilities Area and the proposed Outfall Area.
Decline	A sloping underground mine opening excavated to provide access for services, mobile equipment and personnel from level to level or from surface.
Infrastructure Corridor	The area encompassing the proposed Project infrastructure linking the Mine Area and the Coastal Area, being corridors for pipelines and roads and associated laydown areas. The proposed concentrate pipeline, terrestrial tailings pipeline and fuel pipeline will connect the Mine Area to the Coastal Area. A proposed Mine Access Road and Northern Access Road will connect the Mine Area to the Highlands Highway. New single-lane bridges are proposed over the Markham, Watut and Bavaga rivers. Laydown areas will be located at key staging areas.
Mine Area	The area encompassing the proposed block cave mine, underground access declines and nearby infrastructure, including a portal terrace and waste rock dump supporting each of the Watut and Nambonga declines, the Watut Process Plant, power generation facilities, laydown areas, water treatment facilities, quarries, wastewater discharge and raw water make-up pipelines, raw water dam, sediment control structures, roads and accommodation facilities for the construction and operations workforces.
Outfall System	Includes mix/de-aeration tank, seawater intake pipelines and DSTP outfall pipelines. Located in the Outfall Area.
Outfall Area	The area encompassing the Outfall System, pipeline laydown area, choke station access track and parking and turnaround area.
Port Area	Port of Lae including the Lae Tidal Basin and surrounds.
Port Facilities Area	The area encompassing the proposed facilities located at the Port Area, including the concentrate filtration plant, materials handling, storage and ship loading facilities and filtrate discharge pipeline.
Project	The proposed construction, operation and (ultimately) closure of an underground copper-gold mine and associated ore processing, concentrate transport and handling, power generation, water and tailings management, and related support facilities and services.
Project Area	The land that is the subject of the proposed Project activities and Project facilities being: • The Mine Area. • The Infrastructure Corridor. • The Coastal Area.
Study areas	Any of the four study areas as defined in Section 3.2 of this report, being: • Study Area 1: Mine Area, surrounds and access corridors. • Study Area 2: Infrastructure Corridor from Zifasing to Lae. • Study Area 3: Lae. • Study Area 4: Wagang and Yanga villages.
Tailings	A combination of the solid material remaining after the recoverable metals and minerals have been extracted from mined ore, and any remaining process water.
Outfall System	Includes mix/de-aeration tank, seawater intake pipeline and DSTP outfall pipelines.
Vulnerable groups	Defined by the IFC Performance Standards on Environmental and Social Sustainability as people who are disadvantaged as a result of one's race, colour, sex, language, religion, political opinion or origin, gender, age, culture, literacy, sickness, physical or mental disability, economic status or dependence on unique natural resources
Wafi-Golpu Joint Venture	Wafi-Golpu Joint Venture (WGJV), being an unincorporated joint venture between the WGJV Participants.
WGJV Participants	The participants in the Wafi-Golpu Joint Venture, at the date of this Environmental Impact Statement, being presently Wafi Mining Limited and Newcrest PNG2 Limited.

1. Introduction

1.1. Background

Wafi Mining Limited and Newcrest PNG 2 Limited (WGJV Participants) are equal participants in the Wafi-Golpu Joint Venture (the WGJV). The WGJV is investigating the feasibility of constructing, operating and (ultimately) closing an underground copper-gold mine and associated ore processing, concentrate transport and handling, power generation, water and tailings management, and related support facilities and services (hereafter the "Wafi-Golpu Project" or the "Project") in the Morobe Province of the Independent State of Papua New Guinea (PNG). The proposed mine is located beneath Mt Golpu, approximately 300 kilometres (km) north-northwest of Port Moresby and 65 km southwest of Lae, as shown in Figure 1.1. The Project includes a deep sea tailings placement (DSTP) system for tailings management, access roads to the mine and related support facilities.

Geographically, the Project occupies a mine to coast footprint that extends from the Mine Area to the Coastal Area with an Infrastructure Corridor that links the two areas. Together these discrete areas make up the proposed Project Area:

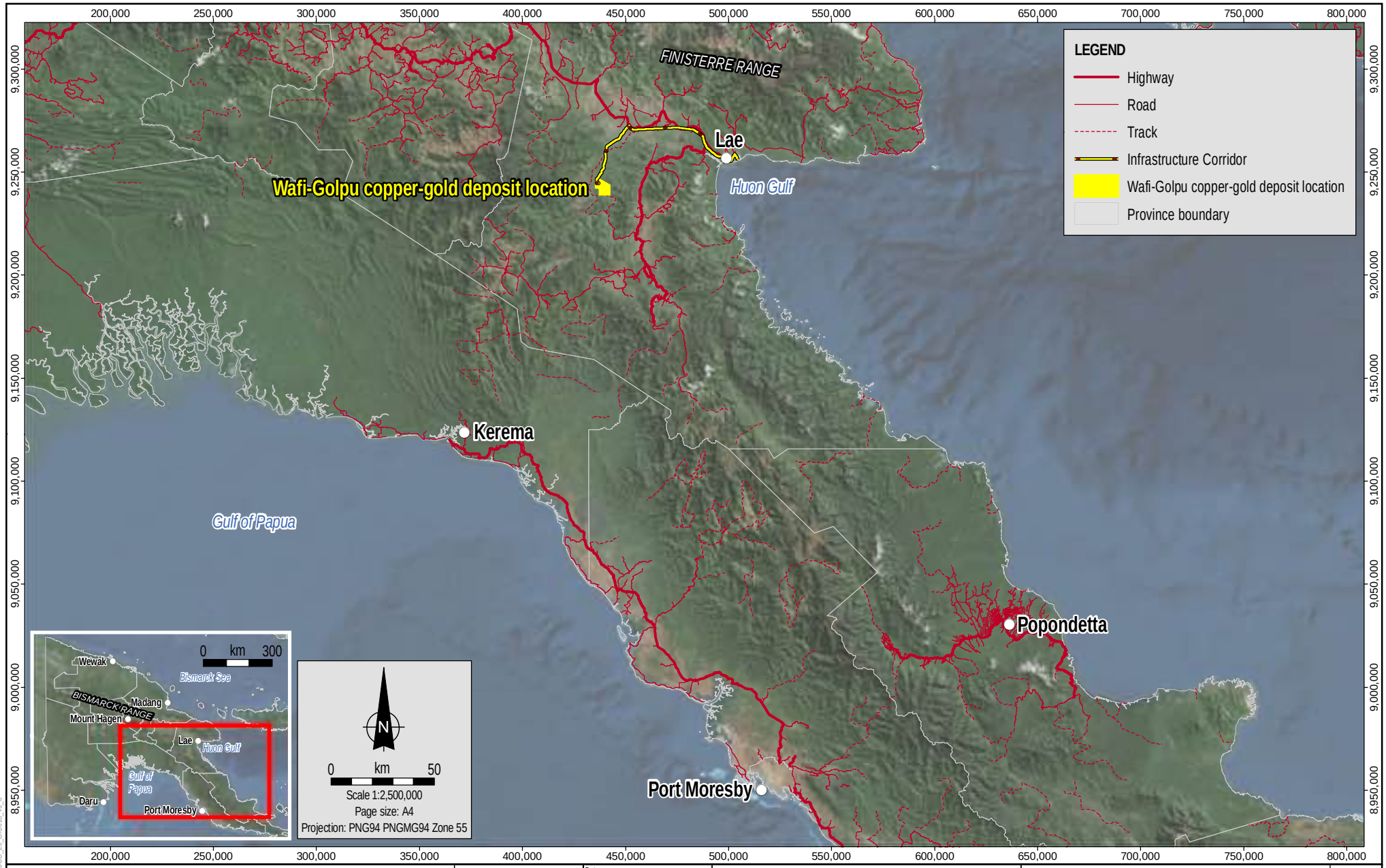
- **Mine Area.** The area encompassing the proposed block cave mine, underground access declines and nearby infrastructure, including a portal terrace and waste rock dump supporting each of the Watut and Nambonga declines, the Watut Process Plant, power generation facilities, laydown areas, water treatment facilities, quarries, wastewater discharge and raw water make-up pipelines, raw water dam, sediment control structures, roads and accommodation facilities for the construction and operations workforces.
- **Infrastructure Corridor.** The area encompassing the proposed Project infrastructure linking the Mine Area and the Coastal Area, being corridors for pipelines and roads and associated laydown areas. The proposed concentrate pipeline, terrestrial tailings pipeline and fuel pipeline will connect the Mine Area to the Coastal Area. A proposed Mine Access Road and Northern Access Road will connect the Mine Area to the Highlands Highway. New single-lane bridges are proposed over the Markham, Watut and Bavaga rivers. Laydown areas will be located at key staging areas.
- **Coastal Area.** The Coastal Area includes the proposed Port Facilities Area and the proposed Outfall Area:
    - Port Facilities Area. Located at, or in proximity to, the Port of Lae, with a site adjacent to Berth 6 (also known as Tanker Berth) nominated as the preferred option. The proposed facilities will include the concentrate filtration plant and materials handling, storage, ship loading facilities and filtrate discharge pipeline.
    - Outfall Area. Located approximately six kilometres east of the port. The proposed facilities will include the Outfall System comprising the mix/de-aeration tank and associated facilities, seawater intake pipelines and DSTP outfall pipelines, pipeline laydown area, choke station, access track and parking turnaround area.

The WGJV has commissioned a range of studies to inform the Project's Feasibility Study Update and to prepare an environmental impact statement (EIS).

The location of key Project components is shown on Figure 1.2.

Future development of the Project remains subject to ongoing deep orebody drilling and definition (after underground access has been achieved), technical studies, completion of statutory permitting processes and securing Government and WGJV Participants' approvals.

Engineering design and other studies, including environmental studies, are continuing and there is potential that aspects of the proposed Project design, layout and timetable may change.



Source:
Wafi-Golpu gold-copper deposit location amd infrastructure from WGJV.
Highways and roads from NSO.
Provinces from PNGRIS.
Imagery from ArcGIS Online (capture date unknown).

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File Name: 0520DD_20_F01.01_GIS

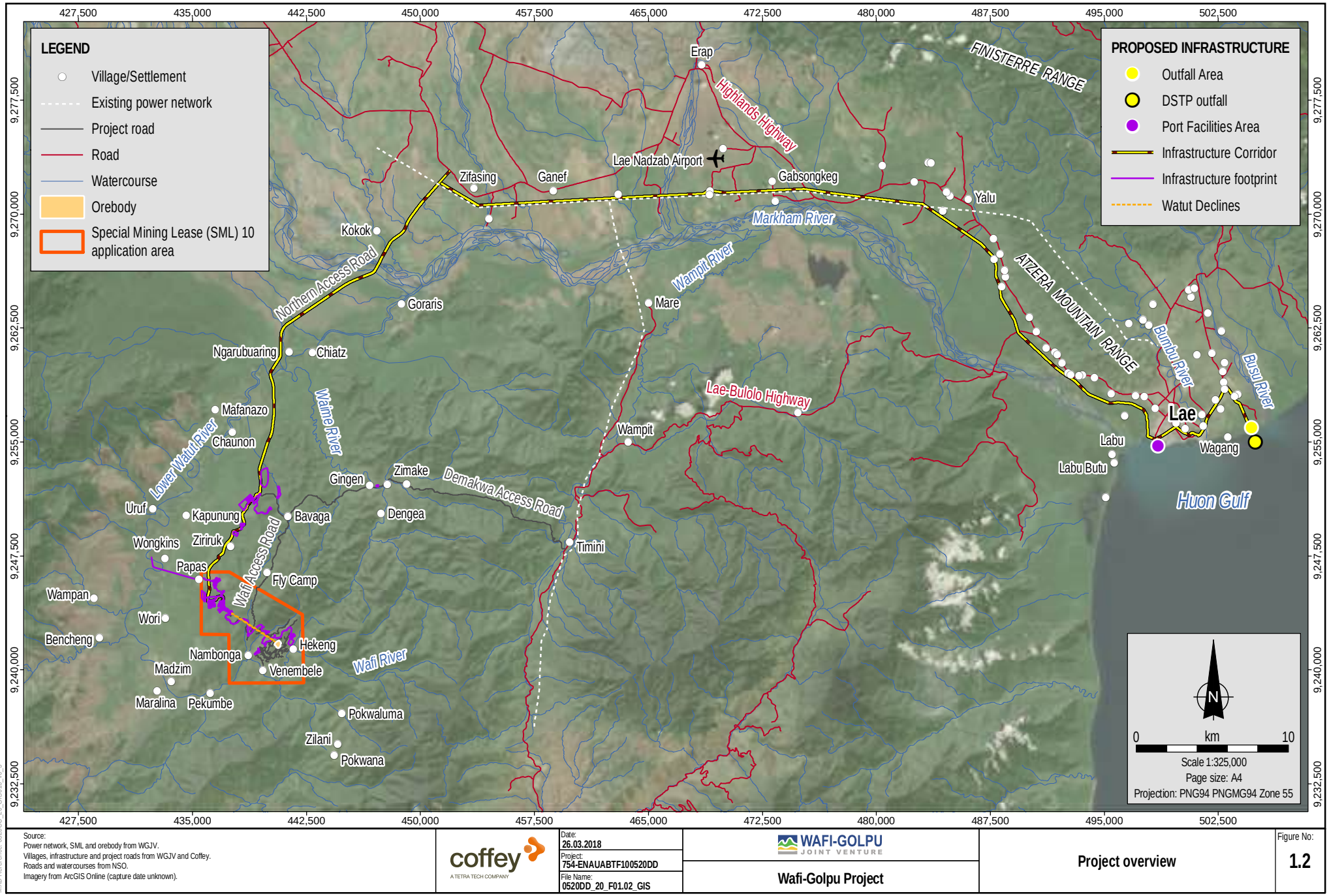
WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Project location

Figure No: 1.1

MXD Reference: 0520CC_20_GIS015_v0_3



Source:
Power network, SML and orebody from WGJV.
Villages, infrastructure and project roads from WGJV and Coffey.
Roads and watercourses from NSO.
Imagery from ArcGIS Online (capture date unknown).

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Project: 754-ENAUABTF100520DD
File Name: 0520DD_20_F01.02_GIS

WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Project overview

Figure No: 1.2

MXD Reference: 0520CC_20_GIS016_v0_5

This report describes the findings of the socioeconomic baseline study. This study relates to a range of investigations undertaken in the Project Area. Four study areas were delineated:

- Study Area 1: Mine Area, surrounds and access corridors.
- Study Area 2: Infrastructure Corridor from Zifasing to Lae.
- Study Area 3: Lae.
- Study Area 4: Wagang and Yanga villages.

The socioeconomic baseline will inform the socioeconomic impact assessment (SEIA), which is being prepared as part of the environmental impact statement (EIS) for the Project. The socioeconomic baseline study will also inform the development of strategies to enhance potential beneficial impacts and to avoid or reduce potential adverse impacts that are identified in the SEIA.

1.2. Project history

Gold mining in Morobe Province began following the discovery of gold in the lower parts of the Ramu River in 1898. A German syndicate subsequently worked gold in the Waria River from 1901 to 1904 (Williamson & Hancock 2005). In 1910, Arthur Darling identified gold in what became the Morobe Goldfield (ibid, p. 9), which focused on the Wau and Bulolo areas, although other reports indicate that alluvial mining commenced considerably later, at Koranga Creek in 1921 (Burton 2001, p.13).

First exploration at Wafi-Golpu dates back to a nationwide porphyry copper search in the 1960s that identified copper resources at Yandera, Panguna, Frieda, Ok Tedi and Wafi (Williamson & Hancock 2005, p.12). CRA Exploration Ltd was responsible for the discoveries at Panguna, Ok Tedi and Wafi.

However, it was not until a substantial rise in the price of gold that further exploration, which commenced in 1977, led to the delineation of gold mineralisation in the Wafi-Golpu area. A succession of companies continued exploration in the Wafi-Golpu area, including CRA Exploration Ltd and Elders, Aurora Gold and Abelle Limited. Harmony Gold Mining Company Ltd assumed control of the Wafi-Golpu resource by way of its acquisition in 2003 of Abelle Limited, at that time the ultimate parent company of Wafi Mining Limited.

The Project is located within Exploration Licence (EL) 440 and EL 1105, granted in 1980 and 1995 respectively. Together, these tenements cover an area of 128 km^2.

Wafi Mining Limited, and subsequently WGJV, has continued exploration activities since 2003 and several studies have been undertaken, including:

- A Concept Study for the Wafi Golpu deposit (2009).
- A Pre-Feasibility Study for the Golpu deposit (2012).
- A Pre-Feasibility Optimisation Study for the Golpu deposit (2014).
- A Feasibility Study for the Golpu deposit (2016).

The 2016 Feasibility Study was updated in 2018 to account for further studies and design work including optimisation investigations.

2. Legal requirements and international and company standards

2.1. PNG legislative requirements and policy

PNG legislation does not explicitly stipulate that socioeconomic elements are to be addressed as part of project development. However, the *Mining Act 1992, Environment Act 2000* and PNG mining policy create a framework that requires a mining lease applicant to adequately provide for the protection of the environment, which by definition includes people and communities.

2.1.1. Mining Act 1992

The *Mining Act 1992* regulates mining in PNG (with the exception of the Ok Tedi mine, which has its own Act). The Act stipulates that in assessing the application for a mining lease (ML) or special mining lease (SML), the Mining Advisory Board shall consider whether the proposal submitted by the applicant provides adequately for the protection of the environment, as per the requirements of the Department responsible for environmental matters. Presently, the Conservation and Environment Protection Authority (CEPA) is responsible for environmental matters legislated under the *Environment Act 2000*, which includes social and cultural matters. (Note: the Environment Act was amended in 2014 to establish CEPA as the agency responsible for administering the Act; prior to the 2014 amendments, CEPA was known as the Department of Environment and Conservation.)

The Mining Act also requires the holder of a mining tenement to pay compensation, in respect of its entry or occupation of land the subject of the tenement, to landholders for all loss or damage suffered or foreseen to be suffered by them as a result of the tenement holder's exploration, mining or ancillary operations (section 154(1)). However, the Act prohibits payment of compensation for permitting entry onto the land for such purposes, or in respect of the value of any mineral which is or may be on the land, or by reference to any rent, royalty or other amount assessed in respect of the mining of the mineral (section 154(4)). In the event that the tenement holder and landholders cannot agree upon compensation, the amount of compensation payable is determined by a Warden under the Act.

Under the Act, the Minister for Mining is required to convene a development forum before granting an SML. The development forum provides an opportunity for the national, provincial and local governments, landowners and the mining proponent to agree on the distribution of direct financial benefits payable as a result of a project, such as royalties as well as other non-monetary benefits to the community. Following a development forum, a Memorandum of Agreement between the State of PNG, landowners and the mining proponent is usually negotiated to deal with matters agreed at the development forum.

2.1.2. Environment Act 2000

The *Environment Act 2000* is the principal legislation for regulating the environmental impacts of development activites in PNG. It aims to promote sustainable development of the environment and the economic, social and physical well-being of people by safeguarding the life-supporting capacity of air, water, soil and ecosystems for present and future generations, and by avoiding, remedying and mitigating any adverse effects of activities on the environment. This aim is primarily achieved by requiring project proponents to obtain authorisation (an environment permit) before undertaking activities that may cause environmental harm. This permit must be granted before the applicable work can commence.

The holder of a permit under the Act is liable to pay compensation to the owners and occupiers of, and any person with customary rights in, any private land in relation to their several interests, in respect of entry on the land or occupation of the land by the holder (section 87(1)). In determining the

amount of compensation payable, amounts already received (eg under the *Mining Act 1992*) must be taken into consideration and deducted.

The Act's definition of 'environment' highlights social and cultural values as matters of importance. In Section 2 the Act defines the environment to include:

> *(a) ecosystems and their constituent parts including people and communities and including human-made or modified structures and areas; and*
>
> *(b) all natural and physical resources; and*
>
> *(c) amenity values; and*
>
> *(d) the qualities and characteristics of locations, places and areas, however large or small, that contribute to their biological diversity and integrity, intrinsic or attributed scientific value or interest, amenity, harmony and sense of community; and*
>
> *(e) the social, economic, aesthetic and cultural conditions which affect the matters stated in [the above] paragraphs of this definition or which are affected by those matters.*

The importance attached to social and environmental values in PNG is highlighted in Section 5 of the Environment Act, which states:

> *All persons exercising powers and functions under this Act shall recognise and provide for the following matters of national importance:*
>
> *(a) The preservation of PNG traditional social structures; and*
>
> *(b) The maintenance of sources of clean water and subsistence food sources to enable those Papua New Guineans who depend upon them to maintain their traditional lifestyles; and*
>
> *(c) The protection of areas of significant biological diversity and the habitats of rare, unique or endangered species; and*
>
> *(d) The recognition of the role of land-owners in decision-making about the development of the resources on their land; and*
>
> *(e) Responsible and sustainable economic development.*

2.1.3. Mining policy

The Department of Mineral Policy and Geohazards Management is currently assessing new policy proposals that may, if enacted, result in changes to the statutory social impact management requirements for the Project at some point in the future.

2.1.4. Guidelines for completing an EIS

Information guidelines prepared by the Department of Environment and Conservation (DEC; now CEPA) states that the EIS must document all environmental and social issues and indicate commitments to the employment of relevant mitigation measures in relation to the development activity (DEC, 2004, p.1). The guideline also states that the EIS should include:

- A description of the proposed development activity.
- The development timetable.

- Characteristics of the receiving environment, including the social structure and socioeconomic data on the resource/land owners, Local Level Government (LLG), the Province and PNG as a whole, and which may include:
  - Demographic information.
  - Information on existing infrastructure.
  - Information on public health issues (if applicable).
  - Information on present economic status of the Project Area.
  - Description of existing social services.
  - Details of archaeological, historical, cultural or religious features of the Project Area under consideration.
- Environmental management, monitoring and reporting, including information on a socioeconomic management and monitoring strategy (DEC, 2004, pp.2-4).

The guideline also recommends that environmental (and socioeconomic) management, monitoring and reporting requirements are separated during the various stages of the development (DEC, 2004, p.4).

2.2. International practice for socioeconomic impact assessment and management

A review of methodologies for assessing socioeconomic impacts has been undertaken to inform the methodology used for this report, as this report will ultimately inform the SEIA for the Project. The review focused on SEIA objectives and process, derived primarily from two documents published by the International Finance Corporation and the International Association for Impact Assessment respectively:

- Good Practice Note: Addressing the social dimensions of private sector projects (IFC, 2003).
- Social Impact Assessment: Guidance for assessing and managing the social impacts of projects (Vanclay et al., 2015).

The SEIA also has regard to the following standards of practice:

- **International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability (IFC, 2012)**.
- **Equator Principles III (Equator Principles Association, 2013).** The Equator Principles are 10 principles adopted by signatory financial institutions to ensure large infrastructure and resource projects are executed in a manner that is both environmentally and socially responsible. The Equator Principles require the application of appropriate environmental and social standards, which for non-designated countries are deemed to be the IFC Performance Standards on Environmental and Social Sustainability (IFC, 2012). Designated countries are 33 countries which the Equator Principles designate as having sufficiently robust environmental and social standards; PNG is not a 'designated country'.
- **International Council on Mining and Metals (ICMM) (ICMM, 2015) Sustainable Development Framework (ICMM, 2015).** The ICMM is made up of 24 mining and metals companies and over 30 associations. Its focus is on addressing key sustainable development challenges faced by the industry. It has an established set of 10 sustainable development principles and 6 position statements which encompass ethical business practices, partnering for development, human rights and the rights of Indigenous People. Newcrest Mining Limited (Newcrest), the parent company of one of the WGJV Participants, is a signatory to 'Enduring Value – the Australian Mining Industry Framework for Sustainable Development', which adopts the ICMM Framework for Sustainable

Development. The Enduring Value Framework aims to drive continuous improvement on social, safety and environmental performance in the minerals industry.

- **Voluntary Principles on Security and Human Rights (Voluntary Principles) (Voluntary Principles Initiative, 2015).** The Voluntary Principles are a multi-stakeholder initiative involving governments, companies and non-government organisations that promote the implementation of a set of principles that guide oil, gas and mining companies when engaging with public or private security for their operations in a manner that respects human rights. Newcrest Mining Limited is a participant in the Voluntary Principles Initiative and WGJV conducts business in a manner that seeks to align with the Voluntary Principles.

2.3. WGJV policies and standards

The Wafi-Golpu Joint Venture has a Sustainable Business Management System that integrates policies and standards to guide the achievement of a sustainable business vision as shown in Figure 2.1.

The WGJV Social Responsibility Policy seeks to benefit the communities in which it operates through sustainable socioeconomic programs, mining and business skills development, ethical behaviour, safety, health and environmental management (WGJV, 2012a).

The associated standards include a Social Impact Assessment and Management Standard, which states that:

- A Social Impact Assessment will be completed for new business opportunities.
- The Social Impact Assessment will identify baseline conditions, potential impacts (both adverse and beneficial) and include community development and support strategies to mitigate adverse impacts and enhance community benefits.

SUSTAINABLE BUSINESS VISION STATEMENT

POLICIES	GOVERNANCE, LEADERSHIP & CULTURE	ENTERPRISE RISK MANAGEMENT	HEALTH & SAFETY	PEOPLE	ENVIRONMENT	SOCIAL RESPONSIBILITY	OPERATIONAL MANAGEMENT, IMPROVEMENT & INNOVATION	SUSTAINABLE BUSINESS GROWTH
STANDARDS	**GOV01** Values & Culture	**RSK01** Hazard & Risk Management	**SAF01** Occupational Health, Safety & Wellbeing	**PEO01** Personnel Management	**ENV01** Environmental Impact Assessment & Management	**COM01** Social Impact Assessment & Management	**OPS01** Operational Systems	**BUS01** Financial Management & Reporting
	GOV02 Policy & Commitment	**RSK02** Incident Reporting & Management	**SAF02** Consultation & Involvement	**PEO02** Responsibilities & Accountabilities	**ENV02** Waste Rock Management	**COM02** Stakeholder Consultation & Involvement	**OPS02** Purchasing & Procurement	**BUS02** External Customer Requirements
	GOV03 SBMS Overview	**RSK03** Emergency & Crisis Management	**SAF03** Injury & Illness Management	**PEO03** Induction, Training & Competency	**ENV03** Tailings Management	**COM03** Community Development & Support	**OPS03** Document, Information & Knowledge Management	**BUS03** Stakeholder & Investor Focus
	GOV04 Legal Obligations	**RSK04** Asset Protection & Access Control	**SAF04** Hazardous Substances & Chemical Management	**PEO04** Recruitment	**ENV04** GHG & Carbon Management	**COM04** Resettlement & Displacement of People	**OPS04** Auditing & Assessment	**BUS04** New Business
	GOV05 Strategy, Planing & Objectives	**RSK05** Project Management	**SAF05** Plant, Equipment & Materials	**PEO05** Internal Communication	**ENV05** Rehabilitation & Closure	**COM05** External Stakeholder Reporting	**OPS05** Performance Management, Improvement & Innovation	
		RSK06 Change Management		**PEO06** Contractors & Third Parties		**COM06** Community Baseline Studies		
						COM07 Cultural Heritage		
						COM08 Land Access & Compensation		

Supporting Processes & Documentation
corporate & Site Tools

INDD Reference: 0520DD_20_GRA004.indd_4

	coffey A TETRA TECH COMPANY	Date: 07.12.2017 Project: 754-ENAUABTF100520DD File Name: 0520DD_20_F02.01_GRA	WAFI-GOLPU JOINT VENTURE Wafi-Golpu Project	Sustainable Business Management System	Figure No: 2.1

3. Study method

3.1. Aim and objectives

The overarching aim of the socioeconomic baseline study is to derive a robust and concise body of information describing the existing socioeconomic conditions of areas potentially affected by the Project and supports the completion of the SEIA.

Specific objectives of the socioeconomic baseline study are to:

- Provide socioeconomic information to characterise areas potentially affected by the Project, with respect to: demography and settlement, culture, governance, land and water resource utilisation, housing, economics, education, health, law and order, and traffic and transport.
- Establish a body of information to inform the SEIA and other Project planning activities.
- Identify the socioeconomic factors that may constrain the location of Project facilities and/or which may otherwise require particular management.

3.2. Study areas

Study areas were defined to group together people and communities who live in similar geographic regions and who may experience qualitatively similar impacts should the Project be developed. The four study areas adopted for the socioeconomic baseline are:

- Study Area 1: Mine Area, surrounds and access corridors.
- Study Area 2: Infrastructure Corridor from Zifasing to Lae.
- Study Area 3: Lae.
- Study Area 4: Wagang and Yanga villages.

Taken together, the four study areas encompass the three geographic areas of the Project (Mine Area, Infrastructure Corridor and Coastal Area). They are not limited to these areas, however, as they instead relate to the geographic location of the communities studied and which may experience impacts arising from the Project.

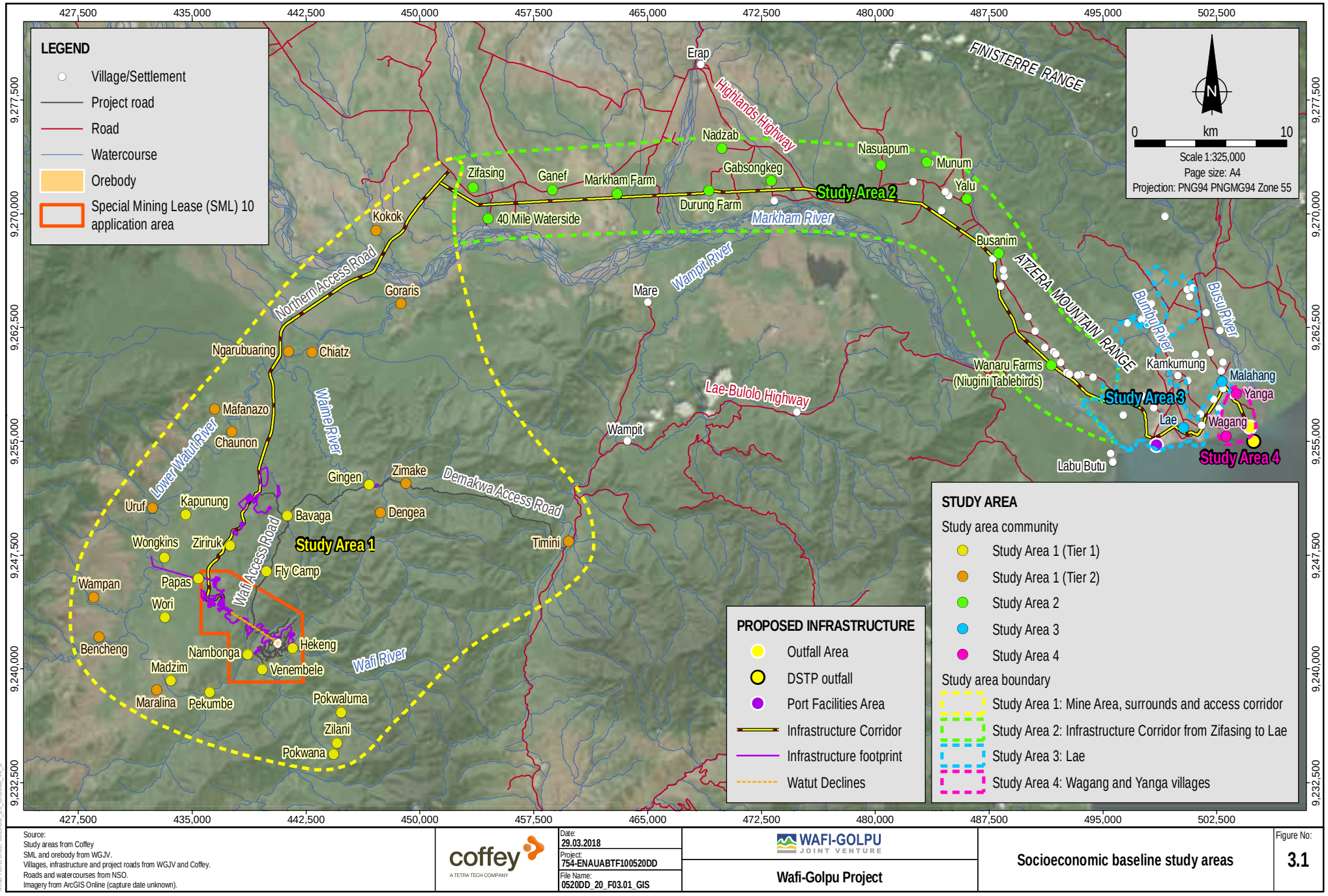
Figure 3.1 presents the location of each study area. This section describes each study area in detail.

3.2.1. Study Area 1 – Mine Area, surrounds and access corridors

This study area comprises 29 villages, located near the Mine Area, along the Demakwa Access Road, and along the proposed Northern Access Road. Villages within this study area are further divided into two tiers, Tier 1 (those in closest proximity to the Mine Area) and Tier 2 (more distant from the Mine Area, located on the west side of the Lower Watut River or along proposed or existing access routes).

Tier 1 comprises sixteen villages inhabited by people of the Hengambu, Yanta and Babuaf cultural groups. These villages have been categorised as Tier 1 within this study area due to their proximity to and ownership of land on which mining and associated activities would be conducted. Tier 1 villages and corresponding cultural groups are:

- **Hengambu cultural group:** Hekeng, Fly Camp, Bavaga and Gingen.
- **Yanta cultural group:** Venembele, Nambonga, Pekumbe, Pokwaluma, Pokwana and Zilani.
- **Babuaf cultural group:** Madzim, Wori, Wongkins, Kapunung, Papas and Ziriruk.



MXD Reference: 0520CC_20_GIS003_v0_8

Source:
Study areas from Coffey
SML and orebody from WGJV.
Villages, infrastructure and project roads from WGJV and Coffey.
Roads and watercourses from NSO.
Imagery from ArcGIS Online (capture date unknown).

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WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Socioeconomic baseline study areas

Figure No: **3.1**

Tier 2 villages are those situated along or near the Demakwa Access Road and proposed Northern Access, and those located on the west side of the Lower Watut River (villages located on the east side of the Lower Watut River are within Tier 1). Tier 2 villages include owners of land through which access routes pass, as well as villages in proximity to the Lower Watut River whose residents have the ability to utilise these access routes (the proposed Northern Access Road in particular, which would be located in the section of the Infrastructure Corridor proposed to run north from the Mine Area to the village of Zifasing on the Highlands Highway). Thirteen villages were identified as Tier 2 villages within Study Area 1:

- **Villages along/near the Northern Access Road:** Kokok, Chiatz, Ngarubuaring, Mafanazo and Chaunon.
- **Villages along/near the Demakwa Access Road**: Timini, Dengea and Zimake.
- **Villages along/near the Lower Watut River:** Uruf, Wampan, Bencheng, Maralina and Goraris.

3.2.2. Study Area 2 – Infrastructure Corridor from Zifasing to Lae

Study Area 2 relates to the portion of the Infrastructure Corridor from Zifasing village to the western border of Lae Urban LLG. This study area spans a total linear distance of approximately 50 km and traverses parts of Zifasing village, Gabsongkeg village, Munum village and Yalu village. Communities within this study area include owners and settlers of land through which the Infrastructure Corridor will traverse.

The remaining portions of the Infrastructure Corridor are captured in the other three study areas. This study area is not subdivided into tiers.

3.2.3. Study Area 3 – Lae

This study area comprises the city of Lae and surrounds. For analytical purposes, the city of Lae is defined as Lae Urban LLG, although baseline studies focused mainly on the southern and eastern parts of the city through which the Infrastructure Corridor will traverse. Project facilities located within this study area will include the Port Facilities Area, and the Infrastructure Corridor (with the concentrate pipeline and fuel pipeline terminating at the Port of Lae, and the terrestrial tailings pipeline continuing east within city roads toward the village of Wagang).

The study area is not restricted only to the Infrastructure Corridor in Lae and the Port Facilities Area, because people within the broader city of Lae are expected to have a variety of interests in and interactions with the Project. Such interests and interactions may include: people who live, work or use services near land through which the Infrastructure Corridor will traverse; people who may be involved in Project operations at the Port of Lae; people who own or utilise land upon which Project facilities are planned; and people who take an active interest in the Project and its impacts.

This study area includes the Malahang area east of Lae, and is contiguous with Study Area 4 which is located further east. It is not subdivided into tiers.

3.2.4. Study Area 4 – Wagang and Yanga villages

This study area is contiguous with Study Area 3, and comprises the villages of Wagang and Yanga, two peri-urban villages which are located approximately 3km east of Lae. People within this study area are the owners of land through which the Infrastructure Corridor will traverse (specifically the terrestrial tailings pipeline). They are also the owners of land where the Outfall System (i.e., the mix/de-aeration tank, seawater intake pipelines and DSTP outfall pipelines) and associated facilities will be located. This study area has not been subdivided into tiers.

3.3. Baseline studies

This socioeconomic baseline has been informed by an extensive body of information generated through studies completed for the Project. This section provides an overview of the studies conducted to date, categorised by study area. An overview of all studies completed for the Project is shown in Figure 3.2.

3.3.1. Baseline studies for Study Area 1

A range of studies has been conducted for Study Area 1 (Mine Area, surrounds and access corridors), including social mapping, demographic and socioeconomic studies, land and water resource utilisation studies, health studies, landscape and visual study, and traffic and transport studies. Zifasing village, which is reported as part of the Study Area 2 (Infrastructure Corridor from Zifasing to Lae), was included in some of these studies; subsequent changes to the project description and associated refinement of the study areas has led to Zifasing's inclusion in Study Area 2, rather than Study Area 1.

Social mapping

Social mapping is a broad term which refers to the spatial representation of social data (see James et al., 2012). This may include the diagrammatic representation of a community's genealogy, and its institutional and decision-making structures. The following social mapping studies were undertaken in Study Area 1 for the Project, and sought to understand the history, cultural identity and functioning of the communities studied:

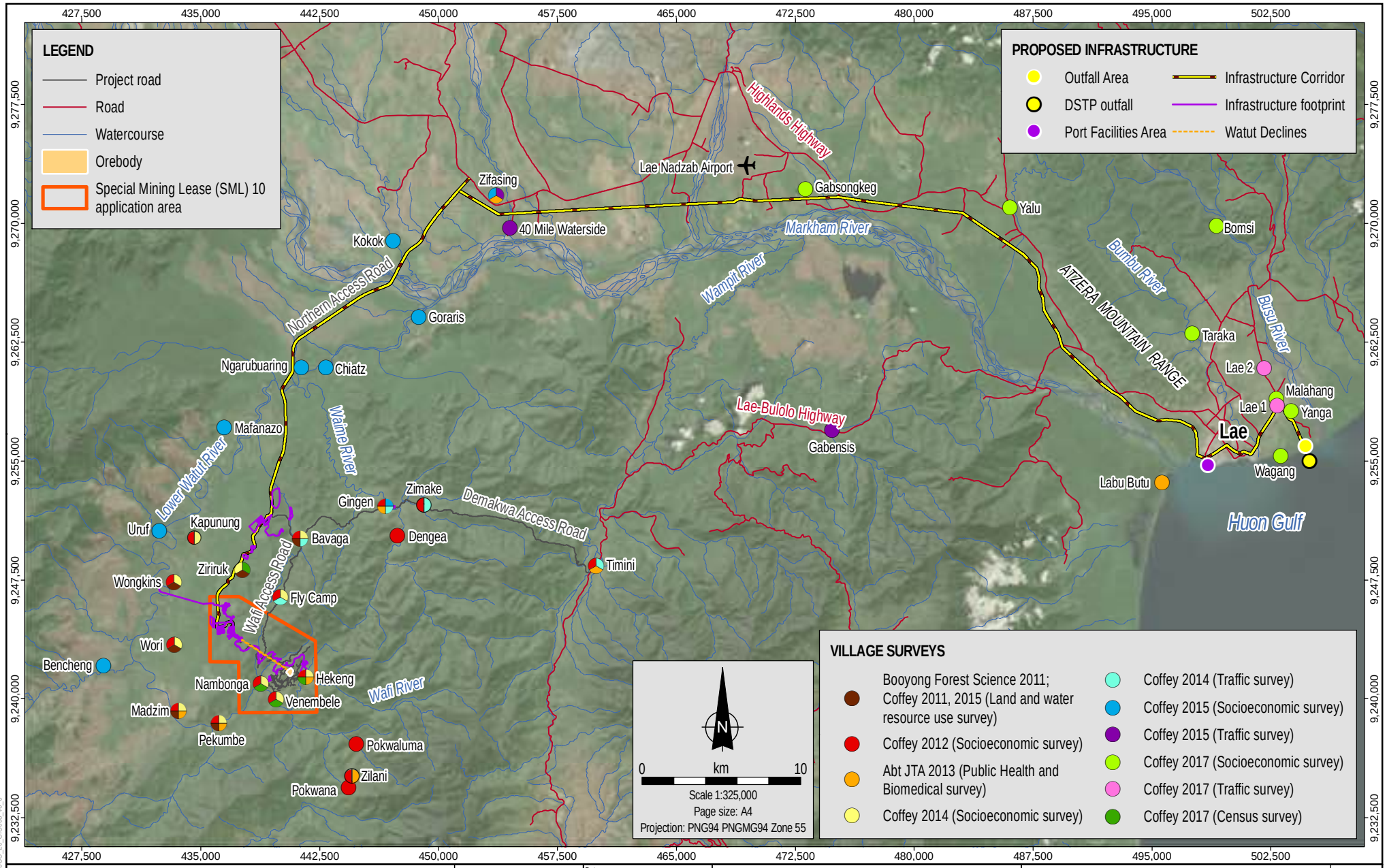
- The Hahiv: social mapping studies at Golpu (Wafi) Prospect. Report prepared by Unisearch (PNG) and the Australian National University 1992 (Ballard, 1992).
- Babuaf and Piu: A background study. Report prepared by the Australian National University, 1993 (Ballard, 1993).
- Wafi Golpu Social Mapping reports (Gari Consultancy Services, 2014a-h).

The most recent set of social mapping studies (Gari Consultancy Services, 2014a-h) focused on:

- Power/authority dynamics in the village and clans.
- Institutional and organisational influences.
- Individual and family power dynamics.
- Perceptions of the people regarding village leadership.
- Gender and geneaology.

The study applied a Participatory Rapid Assessment approach to carry out data collection and qualitative analyses which included:

- Open and semi-structured discussions.
- Venn diagrams, tribal/clan trees and matrix tables.
- Focus group discussions.
- Observations.
- One-on-one interactions with village residents.



MXD Reference: 0520CC_20_GIS008_v0_6

Source:
Survey sites from Coffey.
SML and orebody from WGJV.
Villages, infrastructure and project roads from WGJV and Coffey.
Roads and watercourses from NSO.
Imagery from ArcGIS Online (capture date unknown).

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WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Surveys undertaken in the study areas to date

Figure No: **3.2**

The social mapping team which spent several days in each village included:

- Three staff from Gari Consultancy Services.
- A facilitator.
- A recorder.
- A female staff member specifically to carry out women's focus group discussions.

The methodology used in the study facilitated an assessment of the distribution of power at each level of social structure (village, clan and family) and informed the assessment of existing organisations such as the church and government as to their degree of influence in the community.

The assessment villages were chosen based on proximity to Project infrastructure and therefore focused on: the Babuaf villages of Kapunung, Madzim, Wori and Wongkins; the Yanta villages of Nambonga, Pekumbe and Venembele; and the Hengambu village of Hekeng.

Demographic and socioeconomic features

This section describes the socioeconomic studies which were undertaken for Study Area 1, and which informed this socioeconomic baseline. The following studies are described in this section:

- Household Survey: Statistical Report prepared by PNG University of Technology and Richard Jackson (Jackson, 2004).
- Socioeconomic Baseline Report: Wafi-Golpu Advanced Exploration Project (Coffey, 2013).
- Supplementary Community Baseline Assessment (Coffey, 2014a).
- Demography and socioeconomic surveys including household, focus group and stall owner surveys (Coffey, 2015).
- Census surveys at Hekeng, Nambonga, Venembele and Ziriruk (unpublished; conducted by Coffey, in 2018).

Further details on each of these studies are provided below.

Household Survey: Statistical Report, PNG University of Technology and Richard Jackson

A household survey was completed in 2004 for Wafi Mining Ltd by Richard Jackson, the PNG University of Technology in Lae, and Morobe Provincial Administration (Jackson, 2004). It covered 306 households in Bavaga, Geng, Gingen, Hekeng, Pekumbe, Pokwaluma, Pokwana, Venembele, Zilani, Madzim, Zimake and Dengea. The study recorded, for each household:

- Age and gender of household members.
- Education levels.
- Health status and treatment.
- Economy and occupation (including cash crops and alluvial mining).
- Gardening, fishing and hunting activities.
- Governmental relations, law and order.
- Opinions and concerns regarding the Project.

A key finding of the Household Survey Report was that, while some respondents raised concerns about the potential for adverse impacts that might eventuate from development of the Project, the majority advocated for the Project to proceed in anticipation of perceived benefits.

2012 Socioeconomic Baseline: Wafi-Golpu Advanced Exploration Project (Coffey)

Coffey with the assistance of the WGJV completed a baseline community assessment in 2012 which included household surveys in 17 villages that were most likely to be affected by the Project activities planned at that time (Coffey, 2013). Information was collected at the household level in each village, including population, household composition, age, level of education, employment experience, a description of any additional training that individuals have undertaken, household expenditure, household income and food consumed the previous day. Households were defined as a group of people living together and generally sharing resources. This typically included a nuclear family and several other household members, usually extended family members. Absent individuals were included as household members if they relied on the household for support (e.g., children attending boarding school), but were not included if visiting on a temporary basis or if they resided elsewhere and were financially independent.

The 2012 household surveys were undertaken by a survey team comprising two consultants from Coffey, two full-time staff from the WGJV, and six casually employed Community Affairs officers (Plate 3.1). PNG nationals, who were studying or had graduated from the University of Technology in Lae, were employed on a casual basis for the purpose of delivering the 2012 surveys. A number of the members of the survey team could speak the *tok ples* (local language) of villages in the study area, and all were fluent in Tok Pisin.

Appendix 1 provides a full description of the training provided to the survey team, along with the dates and localities of data collection.

The following villages were surveyed as part of this exercise: Bavaga; Dengea; Fly Camp; Gingen; Hekeng; Kapunung; Madzim; Nambonga; Pekumbe; Pokwaluma; Pokwana; Timini; Venembele; Wongkins; Wori; Zilani; and Zimake. A Socioeconomic Baseline Report was prepared along with community profiles for each of the 17 villages surveyed.

2014 Supplementary Community Baseline Assessment (Coffey)

Additional socioeconomic surveys for Study Area 1 were undertaken in 2014 to gather specific information related to the key areas of alluvial mining, water resource use, income and expenditure. Information was collected through a household survey (as described above), along with a key informant survey which focussed on issues surrounding governance, law and order and resource use (Coffey, 2014a). The key informant survey targeted a small group of prominent women, as they are most often intimately involved in the resources in question, including, for example, the collection of water and activities including fishing and gardening.

Plate 3.1: Completing household survey

The supplementary socioeconomic baseline also included a store survey which collected information on the range and price of store products, particularly food items, from trade stores and any stalls in each of the villages surveyed. Price data was also collected in Lae which enabled comparison of prices to those in the villages, to ensure affordability could be assessed in an appropriate context.

The design of survey instruments was an iterative process involving specialists from Coffey and WGJV personnel. Initial survey instruments were drafted by Coffey which were subsequently reviewed by senior WGJV socioeconomic impact specialists. All survey instruments were then thoroughly tested and refined through role plays involving the survey team, many of whom were from the local area. This process enabled the production of final survey instruments which were tailored specifically to the social context being assessed.

In 2014, there were two separate survey campaigns, one in March which surveyed four villages followed by one in May which surveyed a further seven villages. The survey team was largely consistent throughout both survey efforts. The survey team comprised a consultant from Coffey, a consultant from SIA and Development Pty Ltd, eight employees from the MMJV Social Impact Monitoring Unit and Community Affairs officers. Many of the team had previous survey experience and all had strong communication skills. Many of the team had graduated, or were in the process of completing, the Communication for Development Studies course at the University of Technology in Lae. Refer to Appendix 1 for a full description of the training provided to the survey team, and the dates and localities of data collection.

Supplementary socioeconomic surveys were completed in the villages of Hekeng, Nambonga, Venembele, Pekumbe, Wongkins, Wori, Madzim, Kapunung, Bavaga, Fly Camp and Ziriruk. Findings from the surveys were presented in the Supplementary Socioeconomic Baseline Report (Coffey, 2014a).

2015 Socioeconomic Surveys (Coffey)

Additional socioeconomic surveys were undertaken in 2015. These surveys focussed on gathering information in villages which had not previously been surveyed, but which, due to changes to the Project configuration in 2015, had potential to experience Project impacts. These were primarily in the vicinity of the proposed Northern Access Road or along the Watut River. As in 2014, the survey instruments included a household survey, key informant survey and store survey.

In 2015 the survey team included a consultant from SIA and Development Pty Ltd and 12 WGJV and Hidden Valley Joint Venture personnel - four from the Regional and Economic Development Department, two from the Social Impact Monitoring Unit and six Community Affairs officers. (At the time of the survey, both WGJV and the Hidden Valley Joint Venture were owned by the WGJV Participants. The Hidden Valley Mine is now solely owned and operated by Harmony Gold.) All were experienced with regard to community relations and undertaking community surveys. Personnel were not deployed simultaneously; rather, six participated in the first week of the survey who were replaced (due to shift scheduling) by six personnel in the second week of the survey.

Supplementary socioeconomic surveys were completed in 2015 in the villages of Zifasing, Goraris and Chiatz, Gingen, Bencheng Uruf, Kokok, Mafanazo, and Ngarubuaring. Refer to Appendix 1 for a full description of the training provided to the survey team, and the dates and localities of data collection.

Land and water resource utilisation

The socioeconomic baseline for Study Area 1 draws on information generated through the following land and water resource utilisation studies:

- Terrestrial Flora Survey for Wafi Golpu Project (Booyong Forest Science, 2011).
- Land and Water Resource Use Report: Wafi-Golpu Project (Coffey, 2011).
- Land and Water Resource Use Participatory Mapping Exercise for Babuaf Villages (Coffey, 2015).

The 2011 and 2015 surveys by Coffey gathered data on land and water resource use on the Watut floodplain in Study Area 1. The 2011 surveys related to the Project Feasibility Study and potential impacts from decline development. The 2015 surveys were undertaken better understand potential effects associated with the proposed Watut Tailings Storage Facility (TSF). Further detail on each of these studies is presented below.

2011 Terrestrial Flora Study (Booyong Forest Science)

A terrestrial flora survey was conducted in 2011 predominantly along the Wafi Access Road (now known as the Wafi Access Road between Wafi Camp and Bavaga, and Demakwa Access Road between Bavaga and Demakwa) and the Watut River (Booyong Forest Science, 2011). Interviews with community representatives from Bavaga, Madzim and Wongkins were conducted to identify which local plant species were of use to local people and for what purposes.

People from the village of Bavaga identified 57 species of plants which were utilised by the community for a total of 69 uses. People from Wongkins and Madzim identified 110 species of plants with a total of 129 uses including as sources of food, building materials, medicine and a variety of other uses.

2011 Land and Water Resource Use Study (Coffey)

The Land and Water Resource Use Study (Coffey Environments, 2011) documented the use of land and water resources by local people through a participatory mapping exercise and facilitated focus group discussions. The study recorded:

- Use of land resources for domestic purposes.
- The nature and potential extent of fishing and alluvial mining activities.
- The nature and potential extent of gardening and hunting activities.
- Use of water for domestic purposes.
- Use of water for commercial purposes, including river transport.
- Potential impacts on the use of land and water resources.

Surveys were undertaken in the villages of Bavaga, Wongkins, Wori and Pekumbe by a study team consisting of one consultant from Coffey accompanied by two WGJV Community Affairs officers. The study confirmed that residents of these villages led predominantly subsistence lifestyles and depended upon natural land and water resources, as is typical of rural villages in PNG.

2015 Land and Water Resource Use Surveys (Coffey)

In 2015, field investigations were undertaken to gather further information on terrestrial and aquatic resource use by Babuaf villagers in order to inform the assessment of potential impacts associated with the development of a TSF on the Watut floodplain. A three-person team from Coffey, accompanied by a WGJV Community Affairs officer, spent a day in each of the Babuaf villages of Wori, Wongkins, Madzim and Ziriruk over four consecutive days.

As resource use in PNG is often a collaborative effort by community members, the team implemented an exercise in community resource mapping through facilitated men's and women's focus groups. This process enabled the production of maps which highlight where and how terrestrial and aquatic resources are utilised by villages.

A key finding was that there is active use of the floodplain east of the Watut River into the foothills for livelihood activities (food gardens, growing cocoa trees, hunting small animals, accessing household water supplies, fishing in streams, harvesting forests for timber and other products). There did not appear to be any demarcation of used areas by village residence status, with extensive overlap of land utilisation between residents of Wori and Madzim, and between residents of Ziriruk and Wori and Wongkins. The hunting area in the hills and alluvial gold areas along the Watut appear to be available to all Babuaf people.

Health

The socioeconomic baseline for Study Area 1 draws on information generated through the following health studies:

- Wafi Mining Limited Baseline Health Survey (CEH, 2007).
- Morobe Mining Joint Ventures Public Health and Biomedical Report (Abt JTA, 2013a).
- Wafi-Golpu Advanced Exploration Project Health Impact Assessment (Abt JTA, 2013b).

An overview of these studies is presented below.

Baseline Health Survey (Centre for Environmental Health)

A baseline health survey was completed in March 2007 by the Centre for Environmental Health (CEH, 2007). Surveys and anthropometric measurements were undertaken in Gingen, Hekeng, Pekumbe, Zilani, Madzim, Timini and Zimake, across 83 households.

The study expanded on a previous survey by Jackson (2004) and recorded:

- Demography, age and gender.
- Education levels.
- Health status and living conditions related to health and sanitation.
- Nutritional and medical status.

The survey found that malaria, pneumonia, respiratory infections and perinatal/obstetric conditions were the most common causes of mortality. Isolation and a lack of access to formal education were noted as the main determinates for nutritional intake and overall wellbeing.

Public Health and Biomedical Survey Report (Abt JTA)

Information presented in the socioeconomic baseline describing community health is primarily derived from the Public Health and Biomedical Survey completed by Abt JTA in November 2012 (Abt JTA, 2013a). The survey was conducted in 15 villages neighbouring Hidden Valley mine and the Project. Of the 15 villages in which the survey was undertaken, nine relate specifically to the Project - Gingen, Hekeng, Madzim, Pekumbe, Timini, Uruf, Zifasing, Zilani and Labu Butu. The aim of the survey was to describe the health status of the host population of the two projects. To do this the survey was designed to capture both potential mining related health impacts and measure other biological, socioeconomic or non-mining related environmental determinants on health.

The Abt JTA survey included various data collection methods including the following:

- Household health status, environment and behaviour surveys.
- Village environmental health surveys.
- Local health facility questionnaire.
- Drinking water coliform presence/absence tests.
- Individual medical examinations.
- Individual anthropometric measurements.
- Field haemoglobin tests.
- Field urinalysis tests for proteinuria and glycosuria.
- Field lymphatic filariasis serology tests.
- Field treponema serology tests.
- Samples of capillary blood from 6-15 year olds and samples of venous blood to test of lead, selenium, cadmium and mercury content.
- Samples of urine for 16-65 year olds to test for cadmium, mercury and arsenic content.

In order to meet the survey scope and optimise results, the survey design previously implemented by the Centre for Environmental Health (CEH, 2007) was enhanced to include:

- Additional information to optimise data capture and utilise available field tests (including water total coliform tests, filaria, Treponemal serology (yaws and syphilis), and capillary blood lead in 6 to 16-year-old children).
- A statistical calculation of required sample size to meet the required statistical confidence taking into account population size, sample selection method, anticipated frequency of disease, acceptable confidence limits, and design effect.
- Collection, review and reporting of available time-series government health information. This was included with an understanding of the limitations of such data, but also appreciating that, given the context and the survey limitations, such data would provide valuable information in terms of disease burden, historic and existing local and national health priorities and programs, and the context within which the Project operates.

The Abt JTA Survey team consisted of two Medical Doctors, four Health Extension Officers, one Environmental Health Specialist and a Data Manager. The field team were supported by a Port Moresby-based Senior Stakeholder Engagement Officer, Medical Officer and Project Administrator, as well an Australian-based Technical Director and Project Manager. While in the field, the field team were accompanied by two District Health Officers and a Community Affairs officer.

Health Impact Assessment (Abt JTA)

In 2013 Abt JTA completed a community-focused Health Impact Assessment of the Wafi-Golpu Advanced Exploration Project (Abt JTA, 2013b). Fourteen villages were identified as being located within the Health Impact Assessment's study area. Drawing on data from the Public Health and Biomedical Survey Report (Abt JTA, 2013a), the Health Impact Assessment included screening, scoping, primary and secondary data collection and analyses and a preliminary assessment of identified impacts.

Traffic and transport

The following traffic and transport surveys have been undertaken for Study Area 1:

- Wafi-Golpu Project Traffic and Human Interaction Report (Coffey, 2014b).
- Traffic and human interaction surveys (Coffey, 2015).

Each study is described in greater detail below.

Traffic and Human Interaction Surveys (Coffey)

Data describing the volume and type of traffic were generated through field surveys undertaken in 2014 (Coffey, 2014b). Information relating to traffic and transport on the Wafi Access Road, Demakwa Access Road and the Bulolo Highway (at Timini) was collected in 2014 through three survey instruments: an observed traffic count survey, a resident survey and a pedestrian survey. The observed traffic count survey was designed to record traffic volumes and types of traffic at each of the survey locations. It entailed the recording of all observed traffic movements at different locations over comparable timeframes. All traffic movements in both directions were recorded. Traffic movements were recorded according to the type of vehicle (e.g. light vehicle, truck, PMV) along with the owner of the vehicle.

The resident survey was conducted on a one-to-one basis by a member of the survey team to a resident of a village located along the Demakwa Access Road, the Wafi Access Road or the Bulolo Highway. It included questions which generated responses on how, how often and for what purpose people used the road. The resident survey was conducted on an opportunistic basis. As the survey locations were all situated close to villages, residents of the village commonly came and inquired as to what work was being undertaken and in the course completed a resident survey.

The pedestrian survey was a short survey designed to capture basic information from people who walked past where the survey team had set up for the observed traffic count survey. This included information on where people were going, the purpose for their trip and whether they had any safety or other concerns when walking along the road. The pedestrian survey was completed on an opportunistic basis. Pedestrian movements along the road were common and a member of the survey team simply requested people who were passing by if they would like to complete a brief survey. Refer to Appendix 1 for a full description of the dates and localities of data collection. The Traffic and Human Interaction Report (Coffey Environments, 2014b) presents key findings from the surveys.

In 2014, surveys were carried out by a team comprising one consultant from Coffey and eight employees from the WGJV and Hidden Valley Joint Venture. These were the same employees who undertook the socioeconomic baseline surveys and were from the Social Impact Monitoring Unit or from the Community Affairs team at WGJV or Hidden Valley Joint Venture. Data was collected over four consecutive days at five localities: Timini, Zilani, Gingen, Bavaga and Fly Camp.

2015 Traffic Surveys (Coffey)

In 2015, traffic-count surveys and resident surveys were undertaken at two locations. One location was on the Lae–Bulolo Highway at the village of Gabensis, approximately 25 km from the junction of the Lae–Bulolo Highway and the Demakwa Access Road (at Timini village). This locality was selected so the data collected could be compared against data collected in 2014 at Timini, in order to draw inferences about the usage of the Lae–Bulolo Highway. The second location was on the Markham River, near 40 Mile. This locality was selected so that waterborne traffic could be observed. For these surveys, the team comprised two WGJV and Hidden Valley Joint Venture full-time employees from the Community Affairs team along with the Village Liaison Officer from Timini.

Also in 2015, traffic-count surveys and pedestrian surveys were undertaken over a consecutive four-day period on the Highlands Highway. This was at a location close to the village of Zifasing, near to

where the proposed Northern Access Road would join the Highlands Highway. These surveys were undertaken by three WGJV and Hidden Valley Joint Venture Community Affairs officers utilising survey materials supplied by Coffey.

3.3.2. Baseline studies for Study Area 2

Studies for Study Area 2 (Infrastructure Corridor) were undertaken by Coffey from February through May, 2017. The survey team comprised four consultants from Coffey, three of whom were PNG nationals with past experience and familiarity with the study area. As noted above, data on Zifasing village was also collected in baseline studies for Study Area 1, due to its proximity to that study area.

For this study, the primary data collection method was field observations along the proposed Infrastructure Corridor. This involved visiting and documenting observed land uses observed within and adjacent to the corridor. Informal conversations with community members were recorded in field notes as part of the field observations.

Data was also georeferenced using the software, Collector for ArcGIS by Esri (the 'Collector app'). The Collector app enabled each point of interest observed to be entered onto a digital map of the Project and surrounds, along with photos and field notes.

Where the corridor was not accessible to the survey team (e.g. due to difficult terrain or dense vegetation), socioeconomic information was obtained through key informant interviews and/or focus group discussions. Key informant interviews were conducted with village leaders. Although initially intended to be one-on-one interviews with the village leader, in practice, a number of villagers would join the discussion, turning it into a group interview. In focus groups, one or two members of the survey team directed a discussion with multiple participants from each village. Focus groups differed from key informant interviews in that participants were not necessarily village leaders. Moreover, where practicable, focus groups were split into men's and women's groups, so as to encourage alternative perspectives to be presented in the data. The following focus groups and/or key informant interviews were undertaken within Study Area 2:

- Gabsongkeg village (men's and women's focus groups).
- Yalu village (men's and women's focus groups; key informant interviews).
- Omaru hamlet within Yalu (community focus group).
- Munum village (community focus group).

Within Study Area 2, the primary purpose of undertaking key informant interviews and focus groups was to identify existing land uses within or adjacent to the Infrastructure Corridor, as a substitute for field observations where the corridor was not accessible to the survey team. A secondary purpose was to identify services (e.g., schools) utilised by the community near the proposed Infrastructure Corridor, to identify whether access would be impacted by construction activities.

In conducting field observations, focus groups and key informant interviews, WGJV Community Affairs officers obtained landowner permission to undertake the fieldwork prior to any data collection activities.

Additionally, cultural heritage studies were undertaken along the Infrastructure Corridor between 7 and 18 May 2017 (Muke & Skelly, 2017). These studies focused on, but were not limited to a 100m wide corridor. Cultural heritage information from this study (in particular, information relating to settlement and traditional activities) has been included in the baseline information for this study area to provide demographic and cultural context. Further cultural heritage information on the Infrastructure Corridor is provided in the Cultural Heritage Baseline and Impact Assessment (Green & Muke, 2018).

3.3.3. Baseline studies for Study Area 3

Traffic surveys were undertaken in Study Area 3 in May 2017 (see Appendix 5). The 2017 Observed Traffic Count Survey was conducted on Independence Drive at Malahang over a period of four days (Friday to Monday) between 6:30 and 17:30 (see Figure 3.2). This location was situated close to the intersection of Busu Road and the Wagang village access road (also known as Sipaia Road). This location was selected because the construction of the proposed Infrastructure Corridor may cause potential impacts to road users, pedestrians, residents, businesses and other urban service-providers in the vicinity. All vehicles and pedestrians travelling either to or from Mahalang which passed the survey locations were recorded.

The Observed Traffic Count Survey was complemented by two questionnaires, the Pedestrian Traffic Questionnaire and the Traffic and Transport Questionnaire (see Appendix 5). These were administered opportunistically as short, informal interviews with road users to gather descriptive information on road use at the traffic survey locations described above.

Field observations were undertaken in August 2017, for the portion of the Infrastructure Corridor within Lae. Representatives from WGJV Community Affairs completed a drive-through of this part of the corridor, and land uses were recorded.

3.3.4. Baseline studies for Study Area 4

Studies for Study Area 4 (Wagang and Yanga villages) were undertaken by Coffey in February 2017. The survey team comprised four consultants from Coffey, three of whom were PNG nationals with past experience and familiarity with the study area.

Additionally, cultural heritage studies were undertaken in Study Area 4 between 7 and 18 May 2017 (Muke & Skelly, 2017). Information collected on traditional activities has been included in the Study Area 4 socioeconomic baseline.

Socioeconomic data for Wagang village was obtained using three primary data collection methods:

- Men's and women's focus groups to collect socioeconomic data at a village level, including land and water resource use (see Appendix 2).
- Key informant interviews with village leaders designed specifically to elicit information on land and water resource use (see Appendix 3). Land and water resource use interviews were undertaken to gather information on terrestrial, freshwater and marine resource use, in order to inform the assessment of potential impacts associated with the terrestrial tailings pipeline from Yalu to Wagang and the Outfall Area. In addition to the interview itself, the study team sought to visit some of the key land and water resource use areas, in particular locations where drinking water was sourced.
- Household surveys to collect socioeconomic data at a household level (see Appendix 4). A total of 34 households were surveyed, representing over 30% of the households at Wagang. A sample of 30% was considered sufficient to characterise the broad socioeconomic characteristics of the village. The majority of the survey was focused on socioeconomic data collection, however there was also a section on marine resource use.

At Yanga village, men's and women's focus group discussions were held, as well as key informant interviews with village leaders as described above for Wagang village.

In both Wagang and Yanga, the processes for conducting key informant interviews and focus groups included the following steps:

- The study team's visit was scheduled with the village by WGJV Community Affairs staff prior to the study team's arrival.

- A venue was established for conducting the surveys within the village.
- A *Tok Save* (information session) was held by WGJV Community Affairs staff with members of the village and Coffey's study team. The WGJV Community Affairs staff introduced themselves, the proposed Project and the Coffey survey team. A Coffey team member would introduce Coffey's study team, the purpose of the study and the data collection activities that would be taking place. The Coffey team member also emphasised that any person could refuse to participate in whole (e.g. by declining to be interviewed) or in part (e.g. by choosing not to provide a response to a particular question). All were undertaken in Tok Pisin.
- For focus groups, village participants were divided into two groups separated by gender. The intent of this was to ensure that women were expressly provided with an opportunity to publicly voice their ideas, opinions and concerns, and so that gender-specific practices and issues could be discussed without male involvement.
- For key informant interviews, village leaders were invited to participate in the interview conducted by a Coffey team member. As noted above, additional participants sometimes joined the meeting.
- Focus group and key informant participants were briefed on the purpose of the survey and were provided with an opportunity to ask questions and to seek clarification about the survey questions and process. The survey leader then reiterated the need for the team to obtain free, prior and informed consent.
- Focus group and key informant interviews were conducted openly and everyone heard and witnessed the interviews throughout. People from the village who were not part of the focus group or key informants were free to remain present during the surveys, and they also contributed and clarified some points during the interviews. In this way, the content of the survey reached a broader group in each of the villages than just those who formed the focus groups and key informants.
- The survey team obtained anecdotal information, logged observations, recorded all information obtained via the survey template, and collated all issues and concerns raised.
- All communication was undertaken in Tok Pisin.

In Wagang, villagers were advised that household surveys would be conducted during the *Tok Save*. Thereafter, the process for conducting household surveys included the following steps:

- Each member of Coffey's study team would approach a household, selected to ensure approximately even geographic distribution but otherwise randomly selected. Permission would be sought to approach the household and ask questions of a resident of the household competent to speak on behalf of the household (e.g. an adult).
- The interviewer would state the purpose of the survey and invite questions or comments. The interviewer would then ensure the respondent understood that he or she was free to withdraw from the survey, or choose not to answer any question.

The survey was undertaken by asking all of the applicable questions in the survey instrument. Any anecdotal information, observations, additional data, or concerns or issues raised were recorded.

3.3.5. Quality control and quality assurance

Primary research conducted by Coffey involved two key quality control/ quality assurance mechanisms: pre-survey training and post-survey data verification.

Survey team training

Prior to commencing data collection activities, the Coffey survey leader provided training to the survey interviewers regarding the survey material and the methods to be used. This training included the provision of:

- Training relating to the use of GIS hardware and software for field observations.
- For household surveys, focus group discussions and key informant interviews, a script to be followed which explained to participants the purpose of the survey and how information would be used.
- Instructions about the interviews to be delivered.
- Methods for engaging people that allowed them the opportunity to provide information freely, to inform them of the purpose of the survey, and to obtain their free, prior and informed consent regarding participation in the survey.

The members of the survey team conducting the primary data collection were PNG nationals; consequently, it was not necessary to provide training in translating survey material into Tok Pisin. All were fluent English speakers with tertiary qualifications.

Post-survey data verification

To follow-up on the training of the survey team, and to ensure quality control, the survey leader reviewed each of the completed survey sheets with the interviewer after the survey to clarify any outstanding matters. At the end of each day, interviewers rewrote or annotated the surveys completed that day, in order to provide clarification and/or additional detail.

4. National and provincial context

This section provides an overview of socioeconomic characteristics of PNG and Morobe Province. The purpose of this overview is to contextualise the socioeconomic baseline information for each of the Study Areas presented in Section 5.

4.1. National context

4.1.1. People and governance

PNG is a relatively young, low-to-middle income developing country, marking its 40th anniversary of Independence in 2015. It has a rich cultural diversity, with over 800 languages and hundreds of indigenous ethnic groups, and geographically is characterised by rugged mountainous terrain, swamps and large lowland rivers and tropical forests that pose significant transport and connectivity issues between population centres. Population is growing at an annual growth rate of 3.1%, with the 2011 Census recording a total population of 7,275,000 (which is more than double the population of approximately 3 million in 1980). It is projected that the population will be 9 million by 2020 (UNDP, n.d.). Around 40% of the population reside in the Highlands region, while a further 26% reside in the Momase region (comprised of Morobe, Madang, East Sepik and Sandaun Provinces). Morobe Province is the most populous province out of the 20 provinces in PNG, containing almost 9.3% of the country's total population (PNG NSO, 2016).

PNG is a constitutional monarchy, with Her Majesty Queen Elizabeth II being the Head of State, and operates as a democratic state. The independent justice system comprises the Supreme Court, the National Court, and local and village courts. There are three levels of government (national, provincial and local) with elections for the 111 seat National Parliament held every five years. There are 89 single-member electorates and 22 regional electorates which correspond to PNG's 20 provinces, as well as the Autonomous Region of Bougainville and the National Capital District. The Prime Minister is appointed (and dismissed) by the Governor General on the proposal of Parliament. Members from regional electorates also serve as provincial Governors with each province having its own provincial assembly and administration.

Each province contains one or more districts. The term 'district' refers to a framework in which groups of local-level governments coordinate administrative activities. Each district is governed by a District Development Authority (DDA), made up of the Member of Parliament in that electorate, the heads of the local-level governments falling within the district's boundaries, the Chief Executive Officer of the DDA (a public servant appointed to manage the committee), and up to three other members. Unlike provinces and local-level governments, districts are not a level of government, but an administrative division of provincial government.

Local-level governments (LLGs) have limited funding and capacity, and tend to rely on the provincial government administration to carry out administrative and service delivery responsibilities. Each LLG is subdivided into wards, which participate in LLG planning. In turn, LLG planning contributes to provincial planning, which contributes to national planning. However, progression of planning and development has been slow. In particular, wards and LLGs have limited resources and receive minimal support from the province and district, resulting in few local government development plans being prepared or implemented.

The majority of elected officials in PNG are male, with no women elected to the National Parliament in 2017. This reflects the domination of patrilineal tribes and culture in PNG. Administrative ineffectiveness and corruption remain a challenge. Of the 176 countries surveyed for the Corruption Perceptions Index 2016 (Transparency International, 2016), PNG rated 136 out of 176, with one being perceived to be the least corrupt.

4.1.2. Social status and constraints

The social status of PNG can be contextualised using the Human Development Index, which is a measure of wellbeing developed by the United Nations Development Programme (UNDP). It is a globally recognised index accounting for a range of 'human development' indicators across three dimensions: standard of living, knowledge (education), and long and healthy life (UNDP, 2016).

Out of 188 countries listed on the Human Development Index, PNG is ranked 154 and classified as having low human development (UNDP, 2016, p.204). Approximately 40% of the PNG population live on less than USD1.25 per day, indicating a high degree of poverty (UNDP, n.d.). However, food security is not generally an issue, with approximately 85% of PNG's population residing in traditional rural communities and securing their livelihoods from subsistence gardens and small scale cash cropping (ibid). According to the UNDP (ibid), just 7% of the population has access to the electricity grid and a reticulated water system; adult literacy is around 50%; 40% of health/sub-health centres and rural health posts have no electricity or essential medical equipment; 45 infants out of every 1,000 die before their first birthday; and life expectancy at birth is less than 63 years of age.

Within PNG, family and sexual violence is endemic (UN, 2013), with some of the highest rates of violence against women and children in the world: PNG ranks in the bottom twenty countries of the Gender Inequality Index (HDR, n.d.). While disability statistics for PNG are not available, the global disability rate (including sight or hearing impairment, and physical or intellectual impairment) is estimated to be about 15% (NDRAC, 2014). Rates of sexually transmitted infections are among the highest in the Pacific. Law and order issues pose a particular problem for authorities, with rural–urban drift exacerbating crime in urban areas and tribal fighting being a particular issue in Highland provinces.

Despite these development challenges, PNG is seeking to achieve upper middle-income country status by 2050 (PNG Vision 2050). Sector priorities, as set out in the PNG Government's 2012 Alotau Accord, include education, health, law and justice, infrastructure and sustainable economic growth. PNG's economic growth agenda focuses upon investments in high impact infrastructure, job skills development and partnering with the private sector. PNG also has a strong focus on improving service delivery at the local level through the introduction of District Development Authorities (DDAs; DFAT, 2015).

As PNG receives significant support from bilateral and multilateral donors, it is instructive to consider the types of support being provided to address constraints to social and economic development. Australia, through the Department of Foreign Affairs and Trade, provides approximately 68% ($540 million) of PNG's Official Development Assistance. Key sectoral investment priorities in 2015/16 included education (19%), health (16%) and infrastructure (19%), with the major portion of funding (36%) being dedicated to effective governance programs. The World Bank, which has recently increased its assistance to PNG, has adopted a strategy with three main pillars focussing on (World Bank, 2017):

- Physical and financial infrastructure (improving and upgrading key national and provincial roads; increasing coverage of rural areas by mobile networks and broadband internet; increasing access to financial services, including credit for small-medium enterprises, the number of women with bank accounts, and access to banks in rural areas; updating policies to support increased access to electricity).
- Livelihoods projects with improved gender equity (expanding yields for smallholders growing 'cash crops' such as coffee, cocoa and copra; improving the sustainability and resilience of these crops to price and weather volatility; and improving market chain infrastructure; providing disadvantaged young people – particularly those in urban areas - with training, apprenticeships and short-term employment to increase their employability, and create job opportunities; encouraging public-private collaboration opportunities to facilitate business and investment, while removing impediments and inefficiencies in regulation and reducing business costs).

- Prudent management of revenues and benefits (improving minerals revenue management and extractives industries transparency, strengthening the quality of public expenditure and public finance management, and supporting gender-equitable community development and benefits management; strengthening environmental and social performance standards by extractives companies).

4.1.3. Economic overview

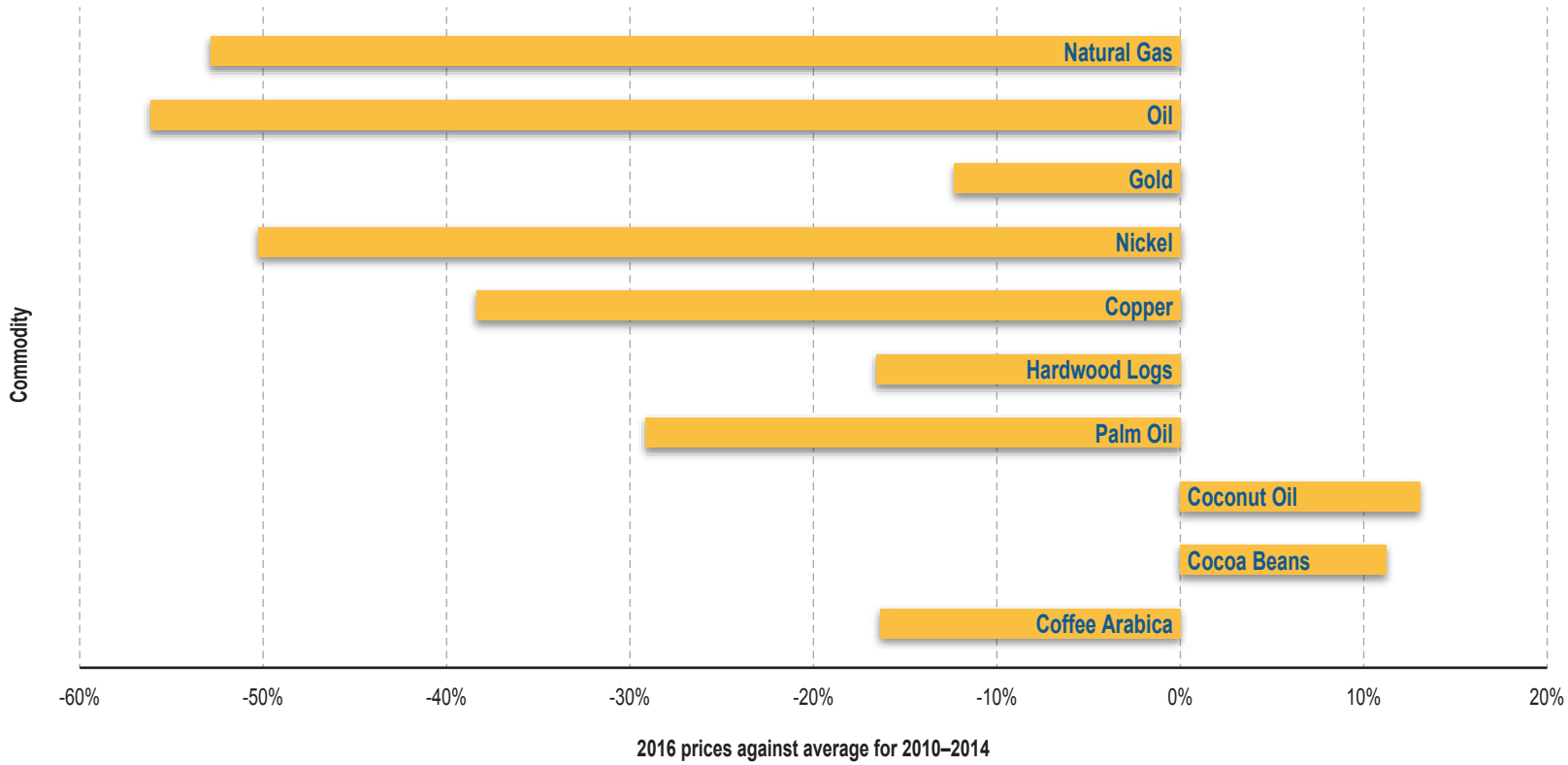
The PNG economy is dominated by four sectors: agriculture, forestry and fishing (where the majority of the labour force is engaged informally); oil and gas extraction; wholesale and retail trade; and mining and quarrying (World Bank, 2017). Together these sectors contribute approximately 50% of PNG's Gross Domestic product (GDP). From the mid-2000s, PNG experienced over a decade of comparatively robust economic growth (real GDP per capita growth averaging 3%), with expanding formal employment opportunities and strong growth in government expenditure and revenues. This economic performance was driven by high international prices for PNG's exports (including for agriculture), conservative fiscal policies and construction activity associated with the PNG LNG Project (ibid). Economic growth peaked in 2014 with the start of exports from the PNG LNG Project, however slowed to 2% in 2016. This slowing of growth was primarily due to the collapse in the prices for commodities that PNG exports over the previous 2 to 3 years, as illustrated in Figure 4.1.

Despite PNG's overall economic growth, the country faces growing fiscal challenges. Lower commodity prices (illustrated in Figure 4.1) and successive budget deficits have placed pressure on the government's fiscal position, which has required significant expenditure cuts since 2015 in order to maintain macroeconomic stability (DFAT, 2015). The PNG Treasury 2015 Final Budget Outcome indicates that expenditure overall was cut by 14.3%, with key service delivery areas of education, health and transport and infrastructure expenditures cut by 30, 37 and 36% respectively (Lowy Institute, 2016).

While the economic outlook remains positive, economic growth is projected to remain moderate over the short to medium term (ibid). Low standards of law and order, a lack of infrastructure, complex governance arrangements, weak public service, inequality between men and women, and rapidly growing population are challenges to future prosperity. Improved electricity, telecommunications, road and other transport infrastructure remain critical to enabling private sector-led growth (World Bank, 2017).

Of crucial importance to livelihoods in PNG is the on-going development and operation of the 'informal economy' (James et al., 2012) as formal employment is not widely available, particularly in rural areas that depend on subsistence agriculture. CIMC (n.d.) describes the informal economy as people 'getting by' without formal employment, earning an income however they can. People in the informal economy do not pay income tax, are not counted in the workforce, do not work regular hours and often denied the rights and protection of workers in the formal economy. Most people in the informal economy work in the rural sector including food production and cash crops (James et al., 2012).

The informal economy is estimated to support more than 80% of the population, and in 2011 the PNG government released its *National Informal Economy Policy (2011-2015)* (The Department for Community Development, 2011) to protect and promote its development through two policy approaches, these being financial inclusion and the provision of public goods and services (The National Research Institute, Papua New Guinea, 2017). It is understood that the Policy has been reviewed during 2016 and that a revised Act called *The National Informal Sector Development and Control Act* will be submitted to Parliament later in 2017 or early in 2018 (PNG Department for Religion and Community Development, 2017).



Source:
National Research Institute, Papua New Guinea. 2017. Review and forecast of the PNG economy: July 2016 Issue. Discussion Paper No. 153 (published January 2017). Boroko, PNG.

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WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Price collapse for PNG's commodities: 2016 prices against average for 2010–2014

Figure No: **4.1**

AI Reference: 0520CC_20_GRA003.ai_4

The focus on the concept of an 'informal economy', rather than the 'informal sector', has been deliberate and aimed at promoting a vibrant informal economy as a 'fundamental part of the whole economic system, an equal partner in economic growth and development' (The National Research Institute, Papua New Guinea, 2017). Conroy (2011) states that:

> *'Monetized informal economic activity is thought to need facilitation and support for several reasons. These include the relatively limited extent of such activity in PNG to date, together with the opportunities it presents for the poor. This situation reflects the continuing importance in PNG of a large non-monetized subsistence agricultural sector. An informal economy inadequate in scale, scope and value represents a gap (a kind of 'missing middle') between the subsistence economy and the formal SME and corporate sectors'.* (Conroy, 2011)

The effective operation of the informal economy is also of particular relevance to women, as they:

> *'engage in informal enterprises out of necessity to generate income that can enable them to meet basic needs such as putting food on the table, paying school fees, and managing socio-cultural obligations' (ibid).*

4.2. Morobe Province context

4.2.1. Place, people, and governance

Morobe Province is located between 6 degrees and 8 degrees S latitude and 146 degrees and 148 degrees E longitude on the north coast of PNG, sharing borders with Madang and Eastern Highlands provinces to the west, Gulf, Central and Oro provinces to the south, and West New Britain in the northeast. It has a land area of approximately 34,000 square kilometres and a coastline of 400km. Geography of the province in general is characterised by a narrow coastal plain, broad inland valleys surrounding the major river systems in the lowlands (the Markham River flowing from the northwest of the province to the mouth in the east at Lae, and the Watut River flowing north from Bulolo to the Markham River), areas with low mountains and hills, and highland areas characterised by rugged terrain with steep slopes and high altitudes. Tectonic instability, heavy rainfall and steep slopes result in unstable landforms in the mountainous areas.

At the 2011 Census, Morobe Province was PNG's largest province accounting for 9.3% (646,876) of PNG's population with a low population density (20 persons per square kilometre). Approximately 44% of the population were under 18 years of age and the population growth rate was 2.1% per annum. A significant part of the population (22.1%) lived in Lae Urban LLG. The three main urban centres in the Morobe Province and the respective population of each centre (based on the 2011 census) are Lae (148,334), Wau/Bulolo Urban (10,598) and Finschafen Urban (2,890) (NSO, 2011).

Table 4.1 shows census data available from the 2000 and 2011 censuses to compare annual population growth rates. Morobe Province's annual population growth rate of 2.1% was relatively low compared to that of PNG (3.1%).

Table 4.1: Census population and growth rates since 2000

Province/District	Major Centre	Population 2000 Census	Population 2011 Census	Households 2011 Census	Average annual population growth rate 2000 to 2011
PNG	Port Moresby	5,190,786	7,275,324	1,374,644	3.1%
Morobe Province	Lae	539,404	646,876	132,993	2.1%
Bulolo District	Bulolo	77,232	100,211	20,639	2.5%
Huon Gulf District	Wampar	59,523	85,038	17,515	2.4%
Lae District	Lae	119,178	148,334	23,661	2.0%

Source: NSO, 2014; Coffey

People have migrated from less-developed areas of PNG, either temporarily or permanently, to Morobe Province generally for economic reasons, including gold mining, employment opportunities with resource projects, for education, and more recently, due to its growing industrial base. Lae serves as a hub and service centre for provincial agriculture, forestry, mining and fishing activities as well as for the Highlands and the New Guinea Islands region. It is estimated that approximately 40% of the population in the Lae-Nadzab area have migrated from other regions, with a third of those having migrated from other areas of Morobe Province. The principal source areas for migrants from outside of Morobe Province include the provinces of Chimbu, Eastern Highlands and East Sepik (JICA, 2017).

Administrative units in Morobe Province comprise nine Districts and 28 LLGs, as shown in Figure 4.2. (District and LLG data is taken from the PNG Resource Information System; cf. the 2011 (NSO) Census which shows 33 LLGs). The Provincial Legislature is termed the Tutumang, a name derived from the Kote Language and referring to a meeting of the people or leaders. The current Tutumang comprises ten National Members of Parliament (representing the nine Open Electorates and the Regional Member who is the Governor) and four appointed members (representing the Church, Community, Business and Women in Morobe Province) to total 14 members. The Morobe Sam Sewe is the executive arm of the Morobe Provincial Government, i.e., the Provincial Executive Council.

4.2.2. Settlement, infrastructure and services

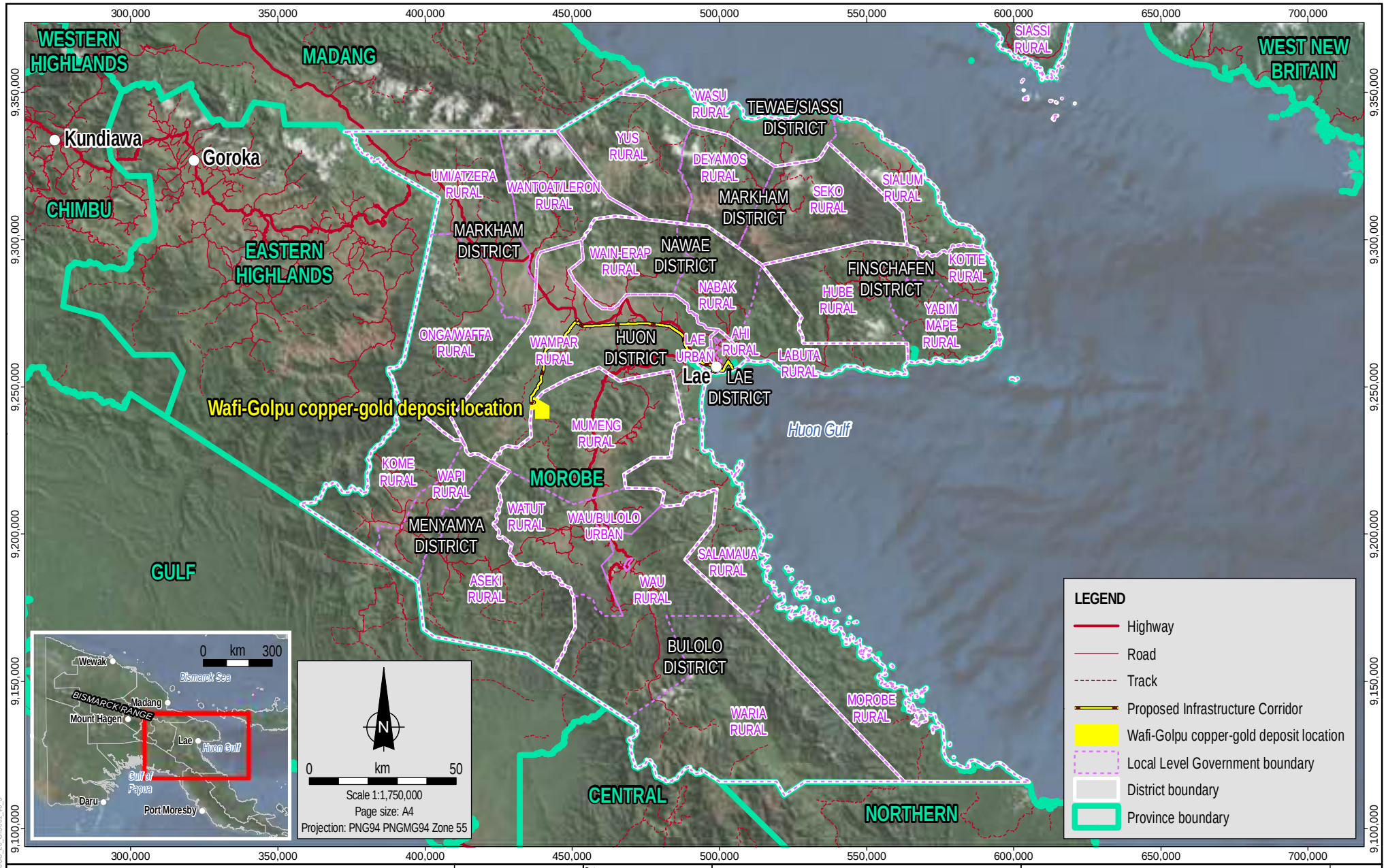
Settlement

The administrative and commercial centre of Morobe Province comprises the city of Lae and neighbouring Ahi Rural LLG. Other significant population centres are Finschafen and Wau/Bulolo. Significant population growth and settlement is occurring west from Lae following the Highlands Highway toward Nadzab, in an area currently the subject of a major urban development plan supported by the Japanese International Development Agency (JICA, 2017).

Infrastructure

Major transport corridors in Morobe Province comprise the Highlands Highway extending from Lae to Kaiapit at the western end of the Markham Valley, the Bulolo Highway extending south from Lae to the township of Wau, and the Lae-Finschafen Road extending east from Lae along the southern coast of the Huon Peninsula. Other existing and proposed main and district roads are shown on Figure 4.3.

The Port of Lae is PNG's largest and busiest port, and handles the greatest volume of cargo. As shown in Table 4.2, it handles about half of the throughput of the 22 declared ports of PNG, and more than 60% of registered international and coastal trade, generating more than 50% of PNG Ports Corporation revenue. It serves as a gateway linking the rest of the world to a large hinterland comprising Morobe province, the city of Lae (PNG's industrial and commercial center), and five resource-rich provinces in the Highlands. The port has significant development potential based on utilisation of the Lae Tidal Basin expansion completed as part of the Lae Port Development Project in 2014. About 50% of PNG exports, including 90% of coffee exports, are shipped from the port. Twenty-seven purse seining vessels operate out of Lae, representing 43.5% of PNG's purse seine fleet of 62 vessels, though tuna fishing is undertaken outside the Huon Gulf (EnviroGulf, 2018).



Source:
Wafi-Golpu gold-copper deposit location amd infrastructure from WGJV.
Highways and roads from NSO.
Provinces, districts and LLG boundaries from PNGRIS.
Imagery from ArcGIS Online (capture date unknown).

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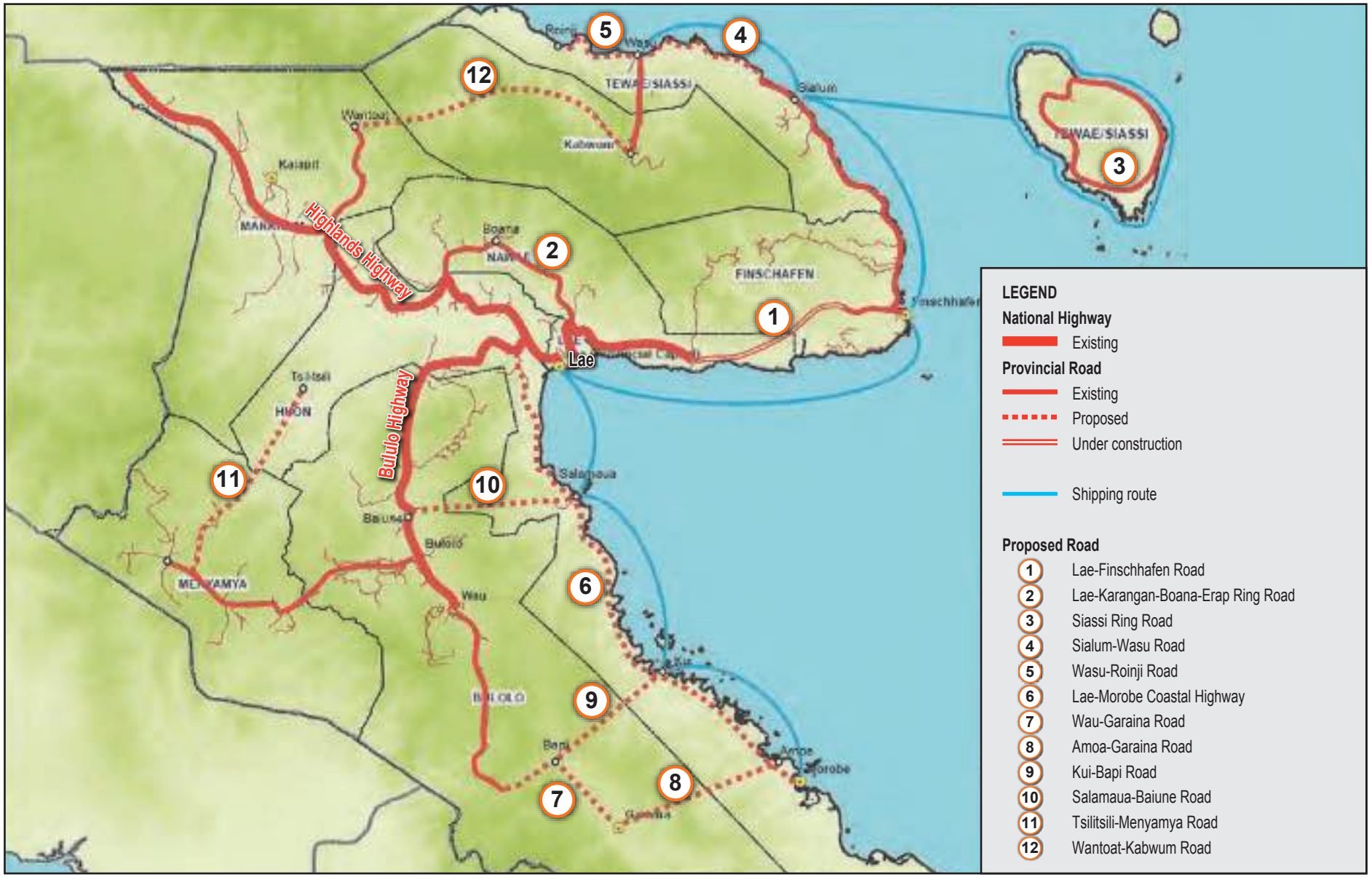
WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Morobe Province, District and Local Level Government boundaries

Figure No: **4.2**

MXD Reference: 0520CC_20_GIS001_v0_5



Source:
Adapted from JICA report, 2017

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WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Morobe land transport network

Figure No: **4.3**

AI Reference: 0520CC_20_GRA002.ai_2

Table 4.2: Traffic through PNG Ports, 2010

Port	Province	Operator / Status	Total Cargo million revenue tonnes	% International	Containers Twenty Foot Equivalent Units '000s	Ship calls '000s
Lae	Morobe	PNG Ports	3.3 (48.5%)	60	150	1.26
Port Moresby	Central/NCD	PNG Ports	1.5 (22%)	62	80	1.43
Total (all of PNG)		PNG Ports	6.8 (100%)	60	265	6.33

Source: PNG National Transport Strategy, Volume 3, Table 7 (PNG Department of Transport and Infrastructure, 2013)

Nadzab is the main airport located in the Markham Valley 35 km west of Lae. It has a runway length of 2,438 m, and handles approximately 300,000 passengers per year. It is subject to consideration of a major rehabilitation project as runway width and pavement strength deficiencies currently precludes some common commercial aircraft (e.g., Boeing 737 aircraft).

Power supply in Morobe Province is mainly drawn from the Ramu hydro-electric scheme at Yonki in the Eastern Highlands Province, with additional capacity of 18MW currently being added through the Yonki Toe-of-Dam project. A transmission line from Yonki runs the length of the Markham Valley to Lae (currently being duplicated to ensure a higher level of reliability), with a spur line from Erap heading south to Bulolo. Due to on-going power supply issues in Lae, PNG Power Limited has engaged an independent power producer (Posco Daewoo) to construct a new 30MW thermal power station at Munum just outside Lae, catering for about three quarters of the city of Lae's requirements.

Services

The delivery of government services in health and education is a significant challenge in rural and remote areas due to extremely high transport costs for patients and health service providers imposed by the difficult terrain. In the Morobe Province there are 49 health facilities (one General Hospital, two Rural Hospitals, 18 Health Centres and 19 sub-Health Centres and nine Urban Clinics) and over 279 aid posts (Abt JTA, 2013a), however at any time a significant proportion of the facilities may be non-operational (Apeng, 2010). The Morobe Provincial Government Division of Health (Morobe Health) partners with non-governmental organisations and faith-based organisations to deliver health care. The ratio of rural health staff to population in the Momase Region (which includes Morobe Province) is in the order of 80 per 100,000 people which is below the national average.

World Health Organisation (WHO) mortality data for PNG (WHO, 2012) suggest that deaths in the population are largely infectious in origin, with diseases such as malaria, pneumonia, diarrhoea, and tuberculosis featuring among the leading causes of mortality in each jurisdiction. This burden mix presents both challenges and opportunities, and highlights that significant improvement can be achieved with proven disease transmission-inhibiting interventions (such as vector control), clean water and adequate sanitation, improving housing quality, and having the capacity to treat causes of disease and prevent person-to-person transmission (WHO, 2012).

Table 4.3 shows the ten leading causes of annual outpatient visits per 1,000 population (2007 to 2008) in Morobe Province, with malaria being the leading cause of morbidity.

Table 4.3: Leading causes of morbidity in Morobe Province (2007 to 2008)

Ranking	Cause	Outpatients per 1,000 Population
1	Malaria	284
2	Simple cough	81
3	Skin disease	75

Ranking	Cause	Outpatients per 1,000 Population
4	Other respiratory	48
5	Pneumonia	45
6	Diarrhoea	28
7	Accidents	24
8	Ear infection	10
9	Eye infection	9
10	Genital conditions	5

Source: NDoH, 2010
Note: 2007-2008 data is the most recent available data

The number of schools in the Morobe Province, Bulolo District and Huon Gulf District at different levels of education is shown in Table 4.4 (NRI, 2010).

Table 4.4: Type and number of schools in Morobe Province in 2013

Jurisdiction	Educational Facilities			
	Elementary	Primary	Secondary	Vocational
Morobe Province	617	336	19	9
Bulolo District	82	36	2	2
Huon Gulf District	62	53	3	1

Source: DoE, 2015a

Data for 2014 (DoE, 2015b) indicated that Morobe Province had 38 elementary schools, 333 primary schools, 17 secondary schools and 7 vocational schools. The average class size was nearly 33 students per teacher – the seventh lowest student–teacher ratio in PNG (ibid).

The data indicate that elementary and primary schools comprise the bulk of educational facilities. The lack of secondary schools in Bulolo and Huon Gulf Districts, and the higher number in the city of Lae (five secondary schools, according to DoE, 2015a), suggest that students typically need to leave their home areas to access secondary education.

Net enrolment rates, for which a high percentage value denotes a high degree of coverage for the official school-age population, are shown in Table 4.5, Table 4.6 and Table 4.7 for elementary, primary and secondary levels for Morobe Province. Key points include:

- Increasing enrolments in elementary schools between 2010 and 2013.
- Primary enrolment rates have significantly increased between 2010 and 2012, however the female enrolment rate has not increased to the same extent as the male enrolment rate.
- Since 2010, male and female secondary net enrolment rates have declined in the Morobe Province, indicating that the provision of additional secondary schools has not kept pace with population growth.

Table 4.5: Elementary school net enrolment rates by gender 2010 to 2013 in Morobe Province

Gender	2010	2011	2012	2013
Male	58.2%	60.5%	69.8%	73.5%
Female	55.8%	56.8%	65.9%	69.5%
Total	57.1%	58.8%	67.9%	71.5%

Source: DoE, 2015b.

Table 4.6: Primary school net enrolment rates by gender 2010 to 2013 in Morobe Province

Gender	2010	2011	2012	2013
Male	46.1%	58.2%	68.2%	63.3%
Female	39.8%	50.4%	58.5%	54.9%
Total	43.1%	54.5%	63.5%	59.2%

Source: DoE, 2015b.

Table 4.7: Secondary school net enrolment rates by gender 2010 to 2013 in Morobe Province

Gender	2010	2011	2012	2013
Male	14.3%	14.3%	13%	10.6%
Female	10.9%	9.7%	8.6%	7.4%
Total	12.7%	12.1%	10.9%	9.1%

Source: DoE, 2015b.

Major public post-school training facilities in Lae include the PNG University of Technology (UniTech), the Telikom Training College, the Balob Teacher's College, the National Polytechnic Institute of Papua New Guinea (NPIPNG, formerly the Lae Technical College), and the Timber and Forestry Training College. There are also a number of private training organisations that deliver short vocational courses on a fee-for-service basis. The Mineral Resources Authority's Small Scale Mining Training Centre operates out of Wau.

Natural resources and economic activity

As shown in Table 4.8 and Table 4.9, the economy of Morobe Province is driven by primary industry (mining, agriculture), with a substantial component of manufacturing and services. The most recent available data that could be sourced on natural resources and economic activity came from an assessment of land use change in the Morobe Province (33,933km^2) using topographic maps created in 1975 and Landsat TM images from 1990 and 2000 (Ningal et al, 2008). This showed that between 1975 and 2000 agricultural land use increased by 58%. Most new agricultural land was taken from primary forest. Forest is cleared for agriculture to service increasing population, migration, the general economic situation and access to land resources. The forest area decreased from 9.8 ha per person in 1975 to 4.4 hectares per person in 2000 (Ningal et al, 2008).

Agriculture (including fishing and forestry) employs 73% of the provincial workforce contributing 15% of provincial GDP (JICA, 2017). Mining, which employs 2.5% of the formal workforce, contributes 53% of provincial GDP which is approximately double the contribution of mining to national GDP (ibid). While mining is dominated by large-scale mining at Hidden Valley and exploration activities at Wafi-Golpu, small scale alluvial mining in the Wau-Bulolo area is also a significant regional economic contributor. It is estimated that up to 75% of the population in the Wau-Bulolo District are involved in alluvial mining at some time, producing in the order one thousand kilograms per year (or approximately USD40 million at a gold price of USD1,200 per ounce) (Moretti, 2007). The Bulolo area also hosts large pine plantations, and is the base for PNG Forest Products which produces timber and prefabricated timber products in addition to managing plantations.

While most communities in the province are active in small-scale cash cropping of coffee, cocoa, betel nut, peanuts, copra, and food crops, many communities in the lowland valleys also operate small-scale livestock projects raising chickens, cattle and pigs. However, a feature of Morobe Province, particularly in the Markham Valley, is the development of large-scale agribusiness. The largest commercial agriculture venture in the province is Ramu Agro Industries Limited, which is located on the Madang-Morobe border. It is engaged in the production of oil palm, sugar and cattle, and includes PNG's only sugar factory. A biofuel project has also been initiated in the Markham Valley by Oil Search and PNG Power (PNG Biomass, 2016). The area surrounding Nadzab also hosts large-

scale chicken farms and rice projects and is subject to proposals for the further development of oil palm.

The manufacturing, wholesale and retail, and transport and storage sectors make an important contribution to the Morobe Province economy, particularly in Lae. The manufacturing workforce is about twice the level in the national economy, with the sector contributing 6.6% to provincial GDP and 23% of the GDP for Lae-Nadzab area. Employment in the transport and storage sector in Lae is about four times the national level, contributing around 6% of the Lae-Nadzab GDP. For the wholesale and retail sector, employment is around twice the level found nationally. Of note is that Morobe Province contributes approximately 16% of national GDP, while the Lae-Nadzab area contributes approximately one quarter of the provincial GDP.

Subsistence fishing is extremely important to the people living along the coast and nearshore islands of the Huon Gulf, and fish and other marine produce is an important source of protein in their daily diet (Coffey, 2018b). Artisanal fishing is limited along the Huon Gulf north coast given the narrowness of the continental shelf, limited nearshore fishing areas and limited stocks of fish, which are mainly exploited for subsistence consumption. However, opportunistic trolling catches of mackerel and rainbow runners can supply sufficient surplus fish for sale at the formal (Lae main market) and informal (Voco Point and DCA Point) fish markets in Lae (ibid). Both subsistence and artisanal fishing takes place in nearshore waters along the coast between the Markham River mouth and the Salamaua Peninsula, as well as at offshore locations such as in the vicinity of the wreck of the Imperial Japanese Navy (IJN) *Kongo Maru*, the Benalla Banks (a shallow, less than 100 m-deep shoal area about 6.5 km northwest of the Salamaua Peninsula) and reefs around the Salamaua Peninsula itself. These areas targeted for subsistence and artisanal fishing range from approximately 5 km south of Lae and the Outfall Area (i.e. the nearshore waters near Labu) to 33 km south of Lae and the Outfall Area (i.e. near Salamaua Peninsula). Fish catches that are surplus to family and extended family needs are sold at the Lae fish markets, especially at DCA Point, which is a 10-minute journey from the Labu villages by banana boats (the main means of sea transit). Many of the villages along the Huon Gulf south coast trade fish and crustaceans with inland villages, and receive sago, sweet potato and pig meat in return (ibid).

Lae is also home port to a number of tuna fishing vessels that fish in the offshore industrial tuna fishery and host to a number of tuna canneries in the Malahang Industrial Area that have created substantial numbers of direct and indirect jobs, possibly in the order of 6,000 (Gillett, 2016). It has been estimated that approximately 75% of the PNG tuna processing labour comprises female workers. Four canneries are operational with a further two approved by the PNG Government, which may result in a further 3,000 direct jobs.

Table 4.8: Employment composition in PNG, Morobe Province and Lae-Nadzab area

Industry	Employment by Industry			Employment composition (%)		
	PNG	Morobe Prov	Lae-Nadzab	PNG	Morobe Prov	Lae-Nadzab
Agriculture, hunting and forestry	2,482,609	216,605	26,017	75.9%	73.1%	39.8%
Fishing	17,679	1,028	183	0.5%	0.3%	0.3%
Mining and quarrying	24,743	7,277	420	0.8%	2.5%	0.6%
Manufacturing	25,243	4,154	3,446	0.8%	1.4%	5.3%
Electricity, gas, steam and hotwater	3,734	400	309	0.1%	0.1%	0.5%
Construction	64,147	6,407	4,231	2.0%	2.2%	6.5%
Wholesale, retail, motor vehicle repair and personal/household goods	359,223	33,464	12,281	11.0%	11.3%	18.8%
Hotel and restaurants	6,511	522	443	0.2%	0.2%	0.7%

Industry	Employment by Industry			Employment composition (%)		
	PNG	Morobe Prov	Lae-Nadzab	PNG	Morobe Prov	Lae-Nadzab
Transport, storage and communications	38,952	4,059	2,987	1.2%	1.4%	4.6%
Financial intermediation	4,931	340	300	0.2%	0.1%	0.5%
Real estate, renting and business service activities	54,830	6,480	5,362	1.7%	2.2%	8.2%
Other	189,424	15,578	9,317	5.8%	5.3%	14.3%
Total	3,272,026	296,314	65,288	100%	100%	100%

Source: JICA (2017) based on data from the National Statistical Office

Table 4.9: GDP for PNG, Morobe Province and Lae-Nadzab area (2011 estimates)

	Papua New Guinea				Morobe Province			Lae-Nadzab		
	GDP (million PGK*) (A)	% to GDP	Employment (Persons) (B)	GDP per capita (PGK) C=A/B	Employment (Persons) (D)	GDP (PGK m) C*D	% to GDP	Employment (Persons) (E)	GDP (PGK m) C*E	% to GDP
Agriculture, forestry and fishing	6,978	27.%	2,500,288	2,791	217,633	607.41	15.1%	26,200	73.12	7.7%
Mining, quarrying and petroleum	7,248	28.%	24,743	292,926	7,277	2,131.62	53.1%	420	123.03	13.0%
Manufacturing	1,600	6.2%	25,243	63,387	4,154	263.31	6.6%	3,446	218.43	23.0%
Electricity, gas and water	542	2.1%	3,734	145,024	400	58.01	1.4%	309	44.81	4.7%
Construction	2,448	9.5%	64,147	38,159	6,407	244.48	6.1%	4,231	161.45	17.0%
Wholesale and retail trade	1,945	7.5%	365,734	5,317	33,986	180.70	4.5%	12,724	67.65	7.1%
Transport, storage and communications	717	2.8%	38,952	18,416	4,059	74.75	1.9%	2,978	54.84	5.8%
Financing, Insurance, Real estate and business services	136	0.5%	59,761	2,278	6,820	15.54	0.4%	5,662	12.90	1.4%
Community, social and personal services	3,022	11.7%	189,424	15,952	15,578	248.50	6.2%	9,317	148.62	15.6%
Other	1,222	4.7%	-	-	-	189.77	4.7%	-	-	4.7%
Total	25,857	100%	3,272,026	-	296,314	4,014	100%	65,288	905	100.0%
						16% of PNG GDP			23% of Morobe GDP	

* Papua New Guinea Kina currency (PGK)
Source: JICA (2017) based on data from the National Statistical Office

5. Socioeconomic baseline information

5.1. Study Area 1 (Mine Area, surrounds and access corridors)

Socioeconomic baseline information for Study Area 1 (Mine Area, surrounds and access corridors) is presented according to the following themes:

- Demography and settlement (Section 5.1.1).
- Governance (Section 5.1.2).
- Cultural overview (Section 5.1.3).
- Land and water resource utilisation (Section 5.1.4).
- Housing (Section 5.1.5).
- Economy (Section 5.1.6).
- Education (Section 5.1.7).
- Health (Section 5.1.8).
- Law and order (Section 5.1.9).
- Vulnerable and disadvantaged groups (Section 5.1.10).
- Traffic and transport (Section 5.1.11).

As discussed in Section 3.2.1, villages within this study area have been divided into Tier 1 and Tier 2, according to impacts potentially experienced if the Project were to proceed.

5.1.1. Demography and settlement

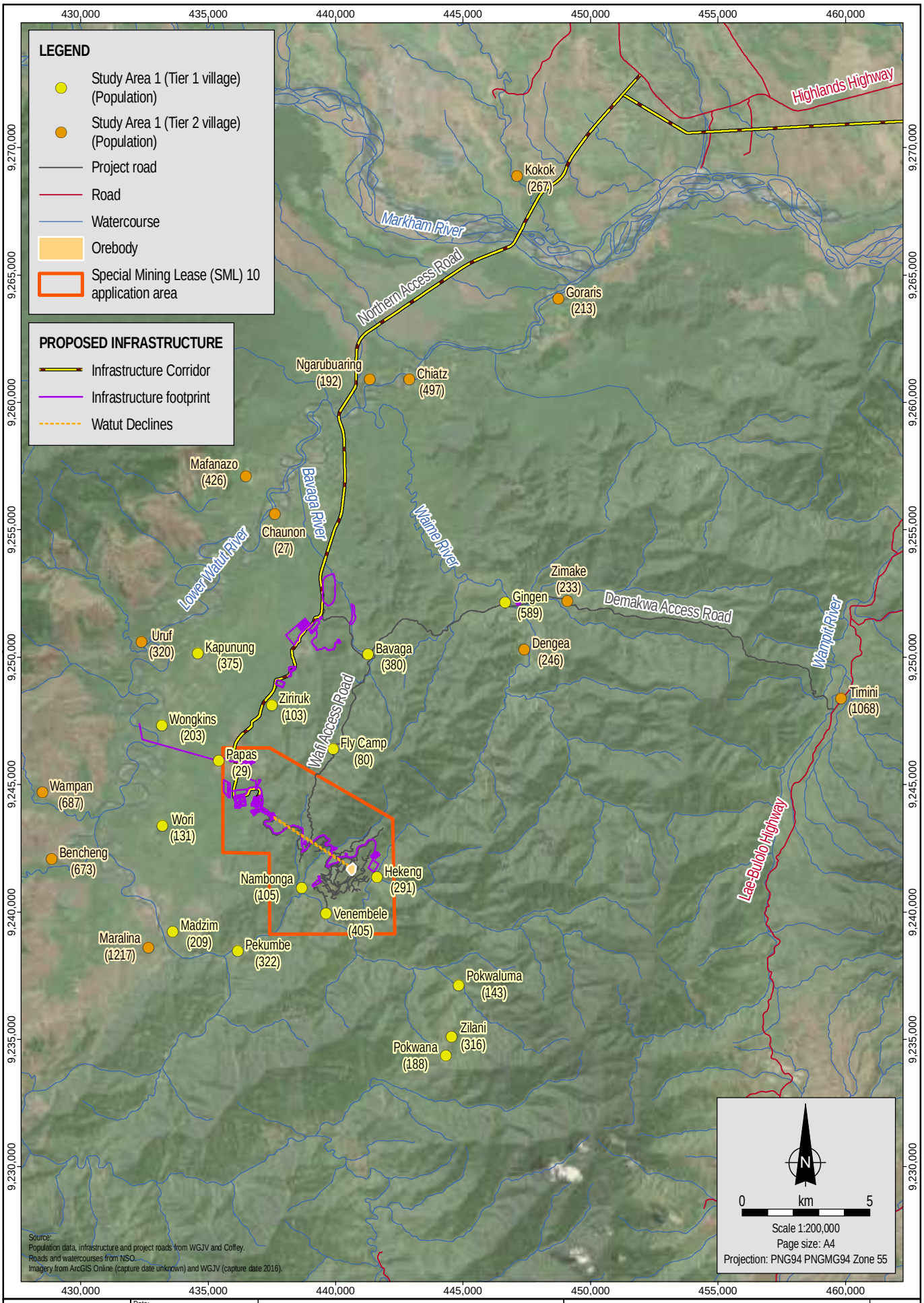
This section provides an overview of demographic features of Study Area 1 including population, population growth, age, gender and settlement history.

Demography

Populations recorded by the 2012, 2014, 2015 socioeconomic surveys in Tier 1 and 2 communities, and the April 2017 census surveys at Venembele, Hekeng, Nambonga and Ziriruk are presented in Table 5.1 and Table 5.2, as well as Figure 5.1. The 2017 populations in Table 5.1 and Table 5.2 were estimated by applying the average annual growth rate for Huon Gulf District (2.4%) to the most recent population record of respective villages, except for Hekeng, Nambonga, Venembele and Ziriruk where census surveys were undertaken in 2017.

In total, the 16 villages comprising Tier 1 had an estimated population of 3,869 persons in 2017. The most populous villages were Gingen (589 persons), Venembele (405 persons) and Bavaga (380 persons). The total population according to respective language groups was:

- Yanta: 1,479 persons.
- Hengambu: 1,340 persons.
- Babuaf: 1,050 persons.



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WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Population figures in Study Area 1 (2017 estimate)

Figure No: **5.1**

With respect to population growth, the highest rates of growth between 2012 and 2014 have occurred in Gingen, Fly Camp, Venembele and Kapunung. The reasons for high growth occurring in these villages are not clear; however, it was notable that those villages with road access tended to record higher rates of growth than those accessible only by foot. Mobility between villages of the same language group may account for some of the variation in growth rates. For the villages potentially requiring resettlement, Nambonga and had the highest population growth rate (off a low base) between 2014 and 2017. Venembele and Hekeng appeared to be growing at a rate slightly above the Huon Gulf District average, with the growth rate in Venembele slowing appreciably from the earlier periods. While not a village potentially requiring resettlement, Ziriuk was also surveyed as a part of the resettlement surveys to understand its growth rate following a recent rapid expansion. Alongside Nambong, Ziriuk was found to have experienced the highest increase in population between 2014 and 2017 among the villages surveyed.

In total, the 13 villages comprising Tier 2 had an estimated population of 6,066 persons in 2017. The largest villages were Maralina (1,217) and Timini (1,068 persons). Demographic data for Tier 1 and Tier 2 villages are presented in Table 5.1 and Table 5.2.

Table 5.1: Population data and extrapolated 2017 population of Tier 1

Tier 1Village	2017*	2014	2012	2004	Average Annual Population Growth		
					2004 to 2012	2012 to 2014	2014 to 2017
Hekeng	291	252	240	161	5.1%	2.5%	2.9%
Venembele	405	350	285	161	7.4%	10.8%	3.0%
Nambonga	105	66	99	n/a	n/a	-18.4%	9.7%
Pekumbe	322	293	277	134	9.5%	2.8%	n/a
Madzim	209	190	167	n/a	n/a	6.7%	n/a
Wongkins	203	185	193	n/a	n/a	-2.1%	n/a
Wori	131	119	114	n/a	n/a	2.2%	n/a
Kapunung	375	341	296	n/a	n/a	7.3%	n/a
Ziriruk	103	50	n/a	n/a	n/a	n/a	5.6%
Bavaga	380	346	331	90	17.7%	2.2%	n/a
Fly Camp	80	73	57	n/a	n/a	13.2%	n/a
Gingen	589	467**	347	252	4.1%	16%	n/a
Pokwaluma	143	n/a	130	142	-1.1%	n/a	n/a
Pokwana	188	n/a	171	170	0%	n/a	n/a
Zilani	316	n/a	287	259	1.3%	n/a	n/a
Papas	29	26	n/a	n/a	n/a	n/a	n/a

*2017 Population estimates are based on extrapolation from available data (Jackson 2004; Coffey, 2012, 2014 and 2015) and an average annual growth of 2.4%, except for Hekeng, Nambonga, Venembele and Ziriruk where census surveys were undertaken in 2017
**Population for Gingen was extrapolated from 2015 census data collected by Coffey in the village.

With regard to Tier 1 villages the median age recorded was 18 years, which was lower than the PNG median age of 22.9 years (CIA, 2016). There is variation across the Tier 1 villages particularly in the villages of Pokwana, Nambonga and Ziriruk, which recorded a median age substantially below or higher than that of the combined average for Tier 1 villages.

Table 5.2: Population data and extrapolated 2017 population of Tier 2

Tier 2 Village	2017 Population*	2015 Population	2012 Population	2004 Population	Average Annual Population Growth	
					2004 to 2012	2012 to 2015
Timini	1,068	971	902	n/a	n/a	n/a
Dengea	246	224	208	123	6.8%	n/a
Zimake	233	212	197	116	6.8%	n/a
Goraris	213	194	n/a	n/a	n/a	n/a
Chiatz	497	452	n/a	n/a	n/a	n/a
Uruf	320	291	n/a	n/a	n/a	n/a
Mafanazo	426	387	n/a	n/a	n/a	n/a
Wampan	687	625*	n/a	n/a	n/a	n/a
Bencheng	673	612	n/a	n/a	n/a	n/a
Maralina	1,217	1,107	n/a	n/a	n/a	n/a
Kokok	267	243	n/a	n/a	n/a	n/a
Ngarubuaring	192	175	n/a	n/a	n/a	n/a
Chaunon	27	25	n/a	n/a	n/a	n/a

*Estimate only, based on available data (Jackson 2004; Coffey, 2012, 2014 and 2015) and an average annual growth of 2.4%.

On average, the proportion of the population below 15 years of age was similar to (though slightly higher than) that recorded for PNG during the 2011 Census (NSO) (35.5%); however, there were noteworthy differences between villages, with Ngarubuaring recording a particularly high proportion (65%) being aged under 15 years. With the exception of Venembele, Ziriruk and Madzim, the proportion of the population over 65 years of age was lower in the Tier 1 villages than that of PNG. In contrast, Tier 2 villages recorded a proportion of population aged over 65 years which was slightly higher than that of PNG. However, considerable variation occurred between villages, as presented in Table 5.3.

Table 5.3: Basic demographic data for Tier 1 and 2 villages

Village	Median age (years)	Population <15 years	Population >65 years	Dependency ratio	Sex ratio	Household size
Tier 1						
Hekeng	17.0	43.8%	2.0%	85	103	6.0
Venembele	19.0	40.1%	3.0%	76	113	6.2
Nambonga	12.5	51.5%	1.5%	113	200	5.5
Pekumbe	18.0	42.7%	1.7%	80	103	6.4
Madzim	20.0	38.2%	2.2%	69	96	5.2
Wori	18.0	36.1%	1.9%	62	143	6.0
Wongkins	19.0	36.2%	2.0%	66	123	5.6
Kapunung	19.0	41.6%	1.2%	76	104	5.3
Ziriruk	23.5	37.2%	2.3%	65	213	4.8
Gingen	18.0	43.7%	1.1%	81	100	6.0

Village	Median age (years)	Population <15 years	Population >65 years	Dependency ratio	Sex ratio	Household size
Bavaga	17.0	44.7%	0.3%	84	122	5.6
Fly Camp	20.0	33.3%	0.0%	51	154	5.7
Pokwaluma	15.5	44.6%	1.0%	83	137	6.1
Pokwana	12.0	47.7%	0.0%	91	171	5.9
Zilani	18.0	35.0%	2.0%	60	118	7
Papas	19.0	30.0%	0.0%	43	100	6.7
Tier 2						
Timini	18.0	34.8%	1.0%	55	110	6.6
Dengea	21.0	36.5%	2.0%	62	146	5.2
Zimake	17.0	38.0%	0.0%	62	118	5.5
Goraris	15.0	47.0%	1.2%	94	134	5.7
Chiatz	21.0	34.3%	2.2%	58	106	6.2
Uruf	17.0	41.3%	4.8%	88	133	4.7
Mafanazo	n/a	39.2%	3.1%	73.3	114	5.2
Wampan	n/a	n/a	n/a	n/a	n/a	n/a
Bencheng	19.0	40.4%	2.8 %	76	126	5.8
Maralina	n/a	n/a	n/a	n/a	n/a	n/a
Kokok	n/a	47.7%	n/a	n/a	113	4.7
Ngarubuaring	n/a	64.6%	n/a	n/a	108	6.5
Chaunon	n/a	40%	4%	79	127	n/a
Comparators						
Zifasing	24.0	29.3%	4.1%	52	97	5.6
PNG	19.7	40.2%	2.1%	73	109	5.6

* The sex ratio denotes the number of males per 100 females.
Source: Coffey 2012, 2014 and 2015, NSO 2001.

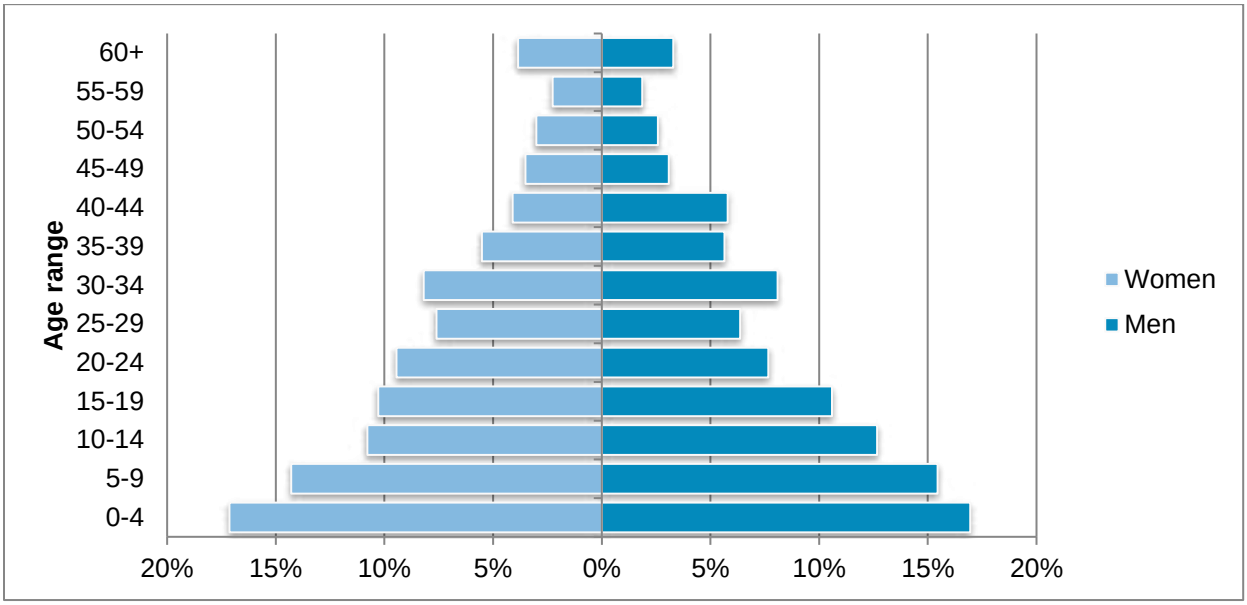
The dependency ratio provides a basic indication of the level of development or 'work capacity' of a population. It is calculated by dividing the number of persons who are not available for work (people aged under 16 years and those over 59 years) by the number of those that are (those aged between 16 and 59). More highly developed countries typically have a low development ratio (approximately 40) whereas lesser developed countries typically have development ratios of 80 or above. There was substantial variation in terms of the dependency ratios recorded for villages in this study area. In Tier 1 villages Fly Camp (51) recorded low scores whilst Pokwana (91) and Pokwaluma (83) recorded relatively high scores. The highest overall score of 113 was recorded for the Tier 1 village of Nambonga. The average dependency ratio score of Tier 1 (74.1) villages was slightly higher than that of Tier 2 villages (71.8) and that of PNG (73).

Also provided in Table 5.3 is the recorded sex ratio (i.e., number of males per 100 females) in respective villages. Again, there was substantial variation across different villages. For instance, Ziriruk and Nambonga recorded a male/female ratio of 2:1 whereas Madzim recorded fewer male than female residents. For the combined population of Tier 1 villages, the proportion of the population which was male was 53% and the proportion of the population which was female was 47%, which equates to a sex ratio of

112. For Tier 2 villages, the average sex ratio was 120 males per 100 females (i.e. 55% male and 45% female). For Study Area 1 as a whole, the sex ratio was higher than that of Zifasing or PNG.

Household size varies between 5.0 to 7.0 persons per household in the Tier 1 villages, with an average of 5.9 across all Tier 1 villages. This is slightly higher than the average household size recorded for PNG in the 2000 census of 5.6.

Figure 5.2 presents the population pyramid for Tier 1 villages. It is relatively balanced with the greatest difference between the proportion of males against females in particular age brackets occurring in the 10-14 and 25-29 age groups.



Source: Coffey 2012, 2014 and 2015

Figure 5.2: Population pyramid for Tier 1 Villages

Settlement

Information regarding the history and movement of settlements in Tier 1 villages and some Tier 2 villages was gathered as part of socioeconomic surveys in 2012 and 2014 and by Gari Associates in 2014, along with a review of secondary information. This section provides a summary of findings. Where socioeconomic surveys were not undertaken in Tier 1 and Tier 2 communities, only desktop study findings are presented.

Many of the Tier 1 villages were found to have only been established in the past 40 years as people have migrated into the area or have broken away from existing villages and relocated to create new communities and hamlets.

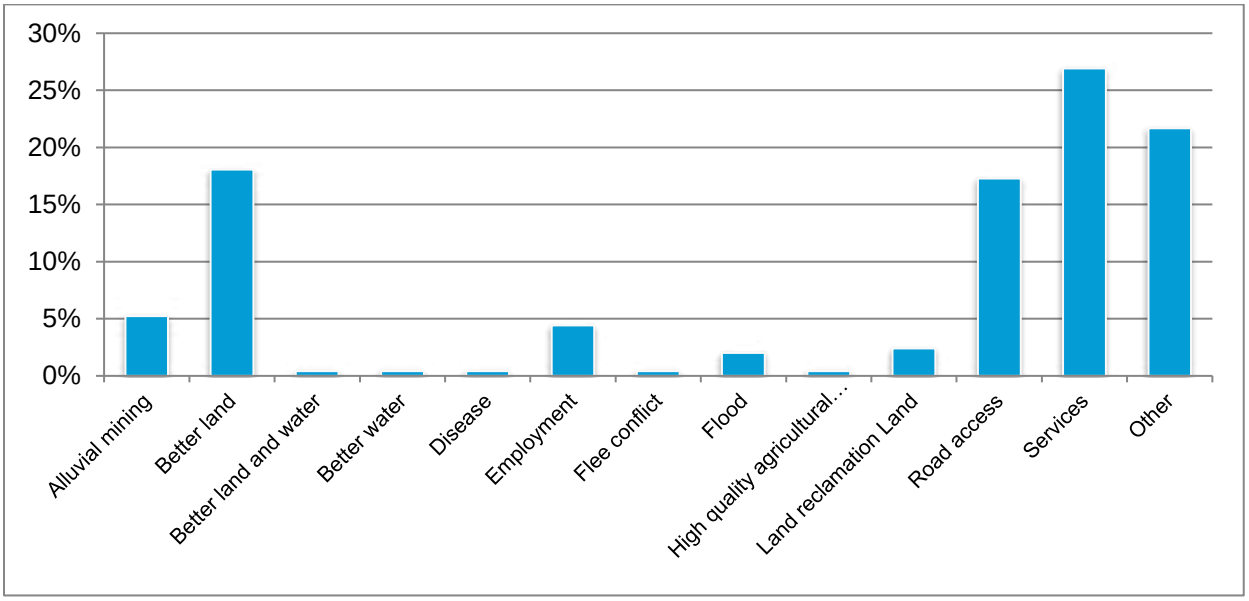
Residents reported that people had been attracted to the villages in this study area to seek employment with the exploration companies who held tenements at Wafi and access medical and education services. In some communities the opportunity to mine alluvial gold has been an attraction, particularly to river settlement locations. Conversely, the village of Ziriruk which is at a higher elevation than the other Babuaf villages located on the Watut floodplain, was reportedly established in October 2013 by some residents of Wori and Kapunung, following severe flooding of the Watut River in 2012.

A brief overview as to the recorded establishment of respective Tier 1 villages is provided in Table 5.4. This information is based on residents' responses provided in the 2012 Household Survey and the 2014 social mapping study, and provides only a general indication of when the villages were founded.

The 2012 Household Survey sought to gain an appreciation of the factors influencing the voluntary relocation and movement of villages in Tier 1. A variety of reasons were provided as to why the village had been relocated as presented in Figure 5.3. The most prevalent responses provided were access to services such as schooling and health (27%), habitation of better lands (18%) and to be closer to road access (17%). Other reasons as to why each village had moved or relocated were concerned with the individual circumstances of that village. For instance, some had moved to flee conflict, whilst others were based on opportunistic reasons to improve their standard of living, such as through alluvial gold mining, improved access to productive lands or access to services.

Information regarding settlement history was only collected for some of the Tier 2 villages. Along the Demakwa Access Road, it was recorded by the 2012 Household Surveys that Dengea was settled approximately 40 years ago by people from Toangela to the south and that Zimake was settled approximately 35 years ago by people who were attracted to the area by fertile lands, alluvial mining and access to the Zindaga School. In the socioeconomic surveys undertaken in 2015, it was recorded that the village of Goraris was settled by people from the Sepik region.

Of the Tier 2 villages, some (including Mafanzo and Chiatz) identify as Wampar. Oral traditions indicate that the ancestors of the Wampar originally resided in the area now occupied by South Watut speakers (Holzknecht, 1989). This area is geographically identified by villages such as Dangal, Sanang and Wewas, located to the southwest of the WGJV Exploration Licence (EL) 440, which contains the Wafi-Golpu mineral deposits (Carter et al., 2014). According to these traditions, the Wampar succeeded in clearing the Lower Watut and lower Markham Valleys of their original inhabitants, displacing many groups in the process. From genealogical evidence, this movement into the Markham Valley appears to have taken place no more than 200 years ago, and was still in progress at the time of first European contact in the late 1890s and early 1900s (Holzknecht, 1989).



Source: Coffey Environments, 2013

Figure 5.3: Reasons for village relocation in Study Area 1 (Household surveys, 2012)

Table 5.4: Settlements – Tier 1 villages

Village	Brief Description
Hekeng	Hekeng has been in its present location for approximately 40 years. Hekeng is the most southerly of the Hengambu villages. It is also the most eastern of the Hengambu villages.
Venembele	The people from Venembele originally came from Parakris in Zenag (Mumeng) and initially settled in the two villages upstream: Pokwana and Zilani. They settled in Venembele within the last 40 years.
Nambonga	The people from Nambonga originally came from Parakris in Zenag (Mumeng). They settled for more than 30 years at Venembele before relocating in Nambonga approximately 10 years ago.
Pekumbe	Pekumbe was reportedly established by people from the Yanta villages of Zilani and Pokwana to provide an important point of access to the Watut River which enables access through to Lae via boat.
Madzim	Madzim is reportedly the first Babuaf village on the eastern side of the Watut River. People reportedly came to Madzim from Babuaf many years ago to access better land and services.
Wori	Wori is located on the Watut River. It was reportedly settled in 2004, after floods destroyed the original village of Seraf (now known as Wori). Seraf was initially established by settlers from Madzim for farming purposes about 30 years ago.
Wongkins	Wongkins has reportedly been located in its present location for approximately 30 years and foundered when Babuaf people decided to move north from Madzim and Wori to farm new lands.
Kapunung	Kapunung was established along the Watut River approximately 40 years ago and consists of numerous hamlets scattered out over several hundred metres. Kapunung was founded when people decided to move further north from Madzim, Wori and Wongkins to access good quality land for agriculture. They initially settled in Seraf (old Wori village). Later on, in 2004, flooding forced them to relocate to the current location.
Ziriruk	Ziriruk was established after severe floods in 2012, predominantly by people from Wori and Kapunung.
Gingen	Gingen has been in its present location for approximately 30 years to access the road and services. It was reported that older people in the village had moved from their ancestral village of Hengambu which is located to the south of Gingen, as well as from Geng in the northwest plains.
Bavaga	Bavaga was established in a valley formed by the Bavaga River, which runs through the village. It has been settled for approximately 30 years. It was reported that older people in the village had moved from their ancestral village of Hengambu which is located to the south of Bavaga to access the Demakwa Access Road and services.
Fly Camp	This small hamlet is located approximately 2 km south of Bavaga. The hamlet has formed a result of families moving out of Bavaga in 2002/03. Additional families have gradually moved to the locality over the last 6 years.
Pokwaluma	Pokwaluma was reportedly established by people from Zilani and Venembele villages some 35 years ago. It served as a rest area for Yanta travellers between the Pekumbe and the villages of Zilani and Pokwana.
Pokwana	Pokwana has reportedly been established for a long time and its origins were not able to be provided by respondents to the socioeconomic survey.
Zilani	It is believed that Zilani has been long established as one of the original Yanta villages. It sits at the lower end of the mountain range approximately 2 km northeast of Pokwana.
Papas	The hamlet of Papas was established following the construction of the Wongkins aid post in 2010/11.

Source: Coffey, 2012; 2015

5.1.2. Governance

Recorded governance and law and order practices and capabilities were similar across all Tier 1 villages. Generally, church leaders, village magistrates, village councillors and community leaders provided authority and administered law and order. Occasionally, matters were taken to court. No governance and law and order practices and capabilities data was collected for Tier 2 villages.

It was reported in the surveys that Tier 1 villages adhered to a three-tiered hierarchy of law and order:

- Village law (or customary law), for breaches of customary law, disputes and petty offences.
- District court, which addressed matters that could not be resolved by the village magistrate and/or village elders.
- National law, which addressed major issues that could not be resolved by the district court.

The church held predominant power and influence in Tier 1 villages. A further source of power and influence is held by the landowner associations which have been established by each of the primary landowner groups in Tier 1 villages:

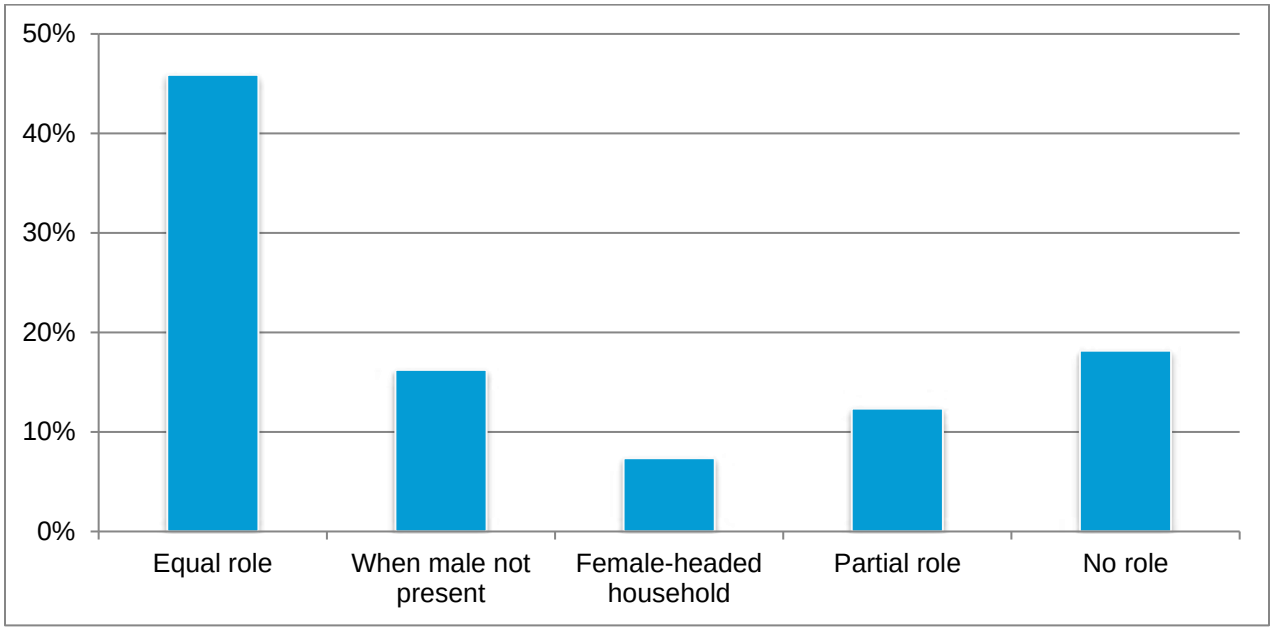
- Hengambu Landowner Association.
- Wale Babuaf Landowner Association.
- Yanta Development Association.

It was reported that any external matters particularly relating to government and mineral exploration were issues to be considered within the context of respective landowner associations.

Domestic decision-making processes refer to the manner in which male and female members of the household contribute to the definition of household roles and responsibilities. Socioeconomic surveys attempted to gain an understanding of household decision-making processes through open ended questions relating to how household decisions were made and specifically the level of influence which female members of the household had in relation to such processes. The level of involvement in decision making processes with regard to expenditure of household income was one question posed to respondents to gauge the level of influence held by female members of the household.

There was general recognition that the male head of the household had the lead role in household decision making; however, results indicated that females had varying degrees of involvement, as outlined in Figure 5.4. It was reported that in 62% of households, women had a level of involvement in decision-making processes including acting as a surrogate for male authority when the head male is absent. Respondents generally indicated that female members of the household had a moderate level of influence with regard to household functions in which they were activity involved such as child care, household upkeep and gardening and that this influence included financial decisions concerned with these aspects of the household.

The 2014 Social Mapping Study found that a common observation throughout all participating Tier 1 villages was that women did not speak out; they sat at the back of meeting halls and other locations and waited for the men to speak. Across most villages, women and the youth kept their distance from the discussion with leaders. Women were often silent in communal discussions; however, women leaders were quickly identified for participation in the Key Informant Surveys undertaken as part of the 2014 and 2015 Socioeconomic surveys in which women were direct and upfront in describing aspects of village life. In contrast, participation by the youth were limited and they had little involvement in decion-making processes. The respect the youth showed to the elders of the village was also evident.



Source: Coffey Environments, 2013

Figure 5.4: Female role in household decision-making in Tier 1 villages

The number of households which had a female head of the household was recorded as part of the 2012 Household Survey. These were commonly in circumstances when the husband was deceased. The highest rates of female headed households were recorded in Madzim (17%) and Pekumbe (15%) whilst in Pokwana, Wori and Wongkins no female headed households were recorded.

5.1.3. Cultural overview

This section provides a cultural overview of villages in Study Area 1 including distribution and language, religious and cultural practices and community groups.

Distribution and language

Distribution and language information relating to Tier 1 and Tier 2 communities has been drawn from the results of the household surveys and social mapping studies described in Section 3.3.1.

Tier 1 communities

There are three primary language groups identified within Tier 1 communities. These are Hengambu, Yanta and Babuaf.

As described in Section 3.2.1, the three tribes include the following villages:

- Yanta: Pekumbe, Venembele, Nambonga, Pokwaluma, Pokwana and Zilani.
- Hengambu: Bavaga, Gingen, Fly Camp and Hekeng.
- Babuaf: Kapunung, Wori, Wongkins, Papas, Madzim and Ziriruk.

According to the Yanta and Hengambu oral histories, these two groups originated from settlements in the Mumeng Valley (Ballard & Kanasa, 1993). They moved into the headwaters of the Wafi, Supgo and

Waime river catchments, southeast of the Wafi-Golpu deposit, potentially more than 200 years ago. They then dispersed, establishing and then abandoning village settlements at regular intervals, over the past century. The Yanta and Hengambu speak a common Mumeng language (ibid).

The Babuaf claim that their ancestors originally lived just below Wafi Exploration Camp on Mount Golpu, and later moved to a number of locations on the eastern floodplain of the Watut River and the western foothills of the Watut Range (Tovue, 1989). They then crossed the river to live at Efafan Creek further upstream on the Watut River. It is noted that the Babuaf were probably distributed across a much wider area than their current locations due to the influence of Lutheran missionaries who, in the 1920s and 1930s, encouraged them to congregate into fewer but larger settlements. The Babuaf speak a Markham language (ibid).

A key finding of the 2014 social mapping reports was that marriage and kinship ties are strong between villages within the Babuaf, Hengambu and Yanta language groups, and within their respective affiliated groups in the broader region. However, there has been little inter-marriage across the three language groups.

Landholder boundaries are not clear, despite a number of major court decisions. The Yanta, Hengambu and Babuaf tribes all lay claim to the Mine Area. In 1984, the Land Court decided that 80% of EL 440 and EL 1105 belonged to the Hengambu and 20% to the Yanta. In 1985 the Land Court changed this ruling to 50% Hengambu and 50% Yanta.The ruling was also applied to an area beyond the exploration licenses, including a portion of land on the northern side of the Watut River that was not claimed by either the Hengambu or Yanta. Further, the 1985 Land Court decision stated that the Babuaf had ‘undiminished rights’ without defining what that meant.

A special Lands Title Commission was established to investigate the ownership of EL 440 and EL 1105, and after two years’ work it was revoked in 2011 before a determination was made. The Mineral Resources Authority will facilitate the resolution of land ownership matters for the Project.

Tier 2 communities

The Demakwa Access Road crosses several tribal groups, including the Hengambu, the Omalai (generally residing in Dengea), Towangala (who reside in Zimake), Bupu, who are from the Mumeng area to the south, and two clans from Timini.

The proposed Infrastructure Corridor between the mine and Zifasing crosses land belonging to a number of clans including Hengambu (at the southern end of the alignment), Babuaf and Wampar. Clan ownership has been delineated in the Land Investigation Report compiled by the Department of Lands.

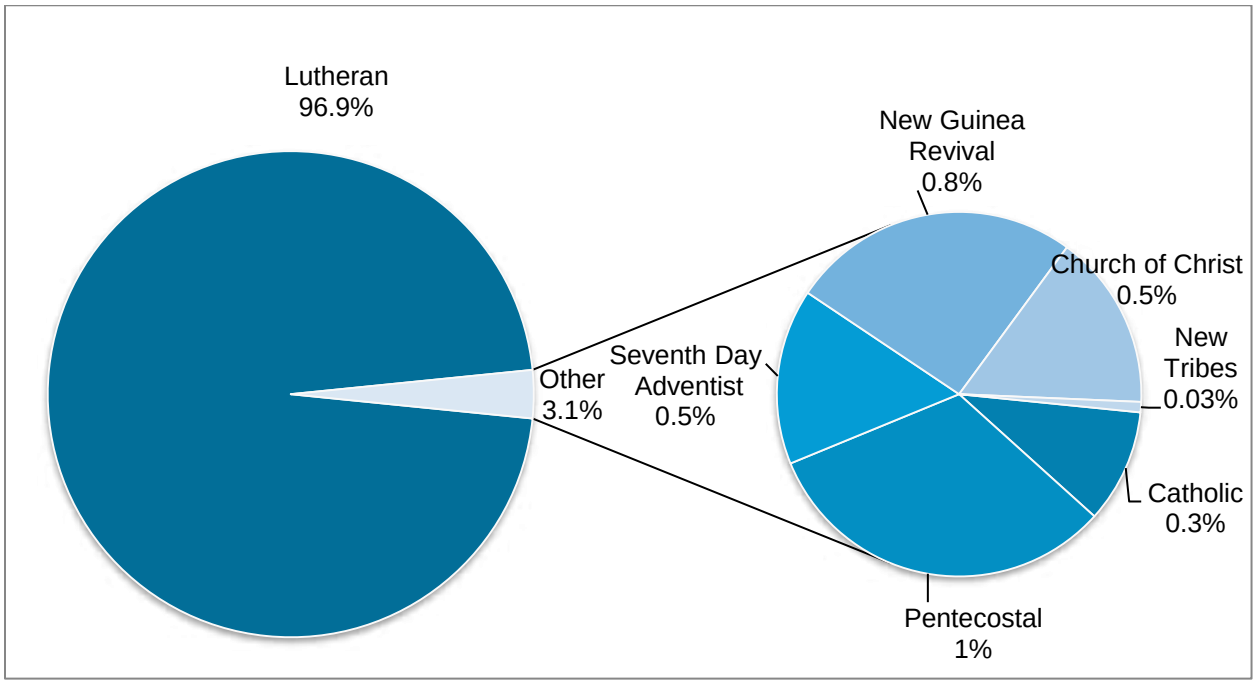
Religious and cultural practices

Following the colonisation of the area by Germany, Lutheran missionaries were active throughout the Morobe Province resulting in the widespread adoption of the Lutheran faith. As shown in Figure 5.5, a majority of respondents to the 2012 Household Survey reported as being members of the Lutheran Church. Of the 3.1% that reported following other faiths, Pentecostal, New Guinea Revival and Seventh Day Adventist were the most prevalent.

The 2014 Social Mapping Study by Gari Associates found that, in the Tier 1 villages studied, the Lutheran Church was the dominant source of social power. The influence of the church extended to all Hengambu, Yanta and Babuaf villages in the area. All events and social gatherings were scheduled and operated according to the church calendar and it was noted that church activities dominated the village plans (Gari Associates, 2014a-h).

Within Study Area 1, all villages surveyed in the 2012 Household Survey indicated that customary practices continued to be a part of village life. Respondents noted traditional activities such as sing-sings with neighbouring villages and traditional dancing as cultural activities which were regularly practiced. Sing-sing is a gathering to perform songs and dances, often traditional in nature. Whilst typically sing-sings involve more than one village coming together to demonstrate their singing and dances to each other, it may also be just the members of a single village coming together to celebrate. Participants may wear traditional costumes or paint and decorate themselves for sing-sings.

Other traditional practices identified were the physical separation of women whilst pregnant to a separate house or area, rituals regarding the productivity of gardens (particularly newly established), medicinal and drinking and eating customs. Sorcery and mystical beliefs were prevalent whilst not openly practiced. A large number of older people advised that traditional rituals and knowledge was not as widely practiced as was once the case.



Source: Coffey Environments, 2013

Figure 5.5: Religious affiliations of household survey respondents in Study Area 1

The 2012 Household Survey gathered information regarding participation in festivals or special events. Respondents described a mix of traditional and Christian occasions. Church celebrations, which include both regular Sunday mass and major church events such as Easter and Christmas, was the most prevalent response provided. Independence Day celebrations were also identified which commonly involves villages coming together for sporting and other events to celebrate PNG achieving independent nationhood. Bride price, whereby the village often comes together to witness the exchange of goods in relation to a marriage, was also identified along with singing and dancing and sports events.

Community groups

The 2012 Household Surveys identified numerous community groups and organisations. These included women's groups such as Mama Giamsao and the Hengambu Women's Association and a variety of sporting and youth groups. Such community groups were commonly associated with the Lutheran Church. Given the limited presence of government agencies, individuals, families and village groups play

an important role in caring for the sick, elderly and disabled, and anyone else that is disadvantaged in any way. Families in particular have a strong sense of responsibility for caring for anyone in their family that is disadvantaged. This care not only includes the provision of shelter, food and clothing, but also integrating the disadvantaged members of the community into everyday society as much as possible.

There was a strong sense of community organisation and union across study area villages. Sharing of goods was reported as being common, especially amongst neighbouring households and those of close kin. Goods may be distributed when there is a harvest or surplus fish catch. Reciprocation comes in the form of returning goods in kind if they are available immediately. Otherwise, it is reciprocated in cash or kind at a later date when the receiving household obtains surplus goods. Each household makes that extra effort either in gardening, hunting or, for those employed, bringing home extra cash to maintain the cycle of giving and paying off what is owed.

5.1.4. Land and water resource use utilisation

This section provides a description of land and water resource utilisation in Study Area 1.

Biophysical setting

The topography within this study area is steep and mountainous, transitioning to the generally flat Watut River floodplain to the west. Tier 1 villages are located amid the steeper terrain (Hengambu and Yanta villages) and on the flat Watut floodplain (Babuaf villages). Village clearings are the result of gardening for food production. Tier 2 villages are located amid steeper terrain along the proposed Northern Access Road, on the lower Watut floodplain and along the Demakwa Access Road.

Substantial mineral exploration has occurred within this study area over the past 30 years. Surface exploration programs have resulted in scattered clearings and exposed areas. The lower Watut River valley contains large tracts of intact and relatively unmodified primary lowland rainforest.

Major waterways in the study area include the Wafi, Watut, Markham and Bavaga rivers and the Hekeng, Nambonga, Chaunong and Buvu creeks. The proposed mine location is situated within the Watut River catchment that flows in a northerly direction to its junction with the Markham River. Heavy rainfall and steep, unstable slopes result in high sediment loads in local rivers and creeks after rainfall. The water and sediment quality of watercourses in the study area is generally consistent with that found in other regions of PNG, with the exception of significantly elevated levels of mercury which have been noted within the study area (the cause of which is unknown).

Air quality and noise levels in the study area reflect its generally remote, forested location. Noise sources are predominantly natural: wind, insects, animals and the activities of daily village life. The main influences of air quality are fires either used for cooking, forest clearance (for subsistence gardens and growing cocoa) and dust lift-off from traffic on dirt roads.

Utilisation of land resources

The various land resource uses and dependencies relevant to the study area are described in this section. It details how the surveyed villages indicated how they use land resources to satisfy sustenance and habitation requirements, as well as socio-cultural and commercial uses in the study area.

Gardens

In all Tier 1 villages in the study area village gardens were established and tended by households as a key source of food. Almost all households reported having gardens and nominated gardens as their primary source of food.

It was recorded by the 2012 Household Survey that residents on average spent 3.6 days per week undertaking garden duties. A small proportion reportedly went to their gardens on a daily basis (9.8%), whereas very few respondents went only once a week (1.5%).

It was apparent that there were gender-related differences as to the establishment and maintenance of gardens. It was indicated that females spent more time in the gardens than males. Males were more involved with garden establishment and females were more involved with tending and harvesting of produce.

The baseline data show the sale of garden crops for income was commonly reported in Timini, which is located near a major roadway and has markets on the roadside in which a wide range of garden crops are sold. Sale of garden crops for income was less common in other villages due primarily a lack of ready access to a market. Crops reported as being sold included bananas, root crops, peanuts, melons and other crops. Peanuts are also being grown as an important cash crop in villages along the Watut River, predominantly because peanuts are quick to grow and easy to transport and sell very well in urban and road side markets. Tier 1 villages only had access to localised, ad hoc markets where limited produce is occasionally sold as an income-generating activity.

Location of gardens

Within Tier 1 and 2 communities, a number of factors affect the location of gardens including land ownership boundaries, soil quality, slope and the optimal growing conditions for particular crops. Such factors result in households commonly establishing gardens in a variety of locations within a reasonable walking distance from the village. In general, the majority of gardens (90%) were located within 3 km of the village. Residents estimated that they took between 30 minutes to 2 hours to walk to their gardens. Despite the steep terrain surrounding Hekeng, Venembele, Nambonga, Pekumbe and Fly Camp, these areas are predominantly used for agriculture. A slash and burn technique is used when clearing intact forest for food gardens.

In 2015 specific information on gardens and associated terrestrial and aquatic resource use by residents in the Babuaf villages of Wori, Madzim, Wongkins and Ziriruk was collected. As resource use in PNG is often a collaborative effort by community members, information on terrestrial and aquatic resources was recorded using a community resource mapping approach amongst men's and women's focus groups – refer to Plate 5.1 and Plate 5.2 and Appendix 6. It was found that the floodplain east of the Watut River into the foothills is actively used for livelihood activities (food gardens, growing cocoa trees, hunting small animals, accessing household water supplies, fishing in streams, harvesting forests for timber and other products).

Plate 5.1: Women's focus group session, Madzim Village

Plate 5.2: Men's focus group session in Wori Village

It was found that the tending of gardens and collection terrestrial resources by women generally occurs closer to villages, typically within a radius of one to two kilometres, however resources are accessed along some creeks which are further afield and which drain from the hills westward into the floodplain (such as Ziriruk Creek, Womul Creek and Boganchong Creek). Chaunong Creek and its associated riparian habitat were an important resource use area for its entire length up to the confluence with Babul Creek. Resource use by men occurs over a larger area, particularly on the Watut River and in connection with hunting in the hills. There did not appear to be any demarcation of use areas by village residence status, with extensive overlap between Wori and Madzim village, and between Ziriruk and Wori and Wongkins villages as shown in Figure 5.6.

Produce grown in gardens

A variety of fruit and vegetables were reported to be grown in gardens of Tier 1 and 2 communities in the study area. Annual crops are generally planted for one year only, possibly due to the shallow, erodible soils. However, a range of perennial crops are also planted and provide foods in subsequent years, typically including pitpit, sugar cane, bananas, marita, papaya, coconuts, breadfruit and other fruit trees. Gardens produce food all year round. The survey results indicate that there is no preferred or favourable season for sowing, growing or harvesting. This is most likely due to the generally uniform climate and, as a consequence, gardens can be established and made productive at any time of the year. The only seasonal crop identified was the yam, which was planted in January and February and harvested in July and August.

The most commonly grown produce was banana with 97% of households responding that they grew bananas in their gardens. The next most common types of plants reportedly grown by households for consumption were greens/kumu (94%), kau (sweet potato) (92%), taro (92%) and sugar cane (85%). Further information on food consumption patterns is provided in Section 5.1.8.

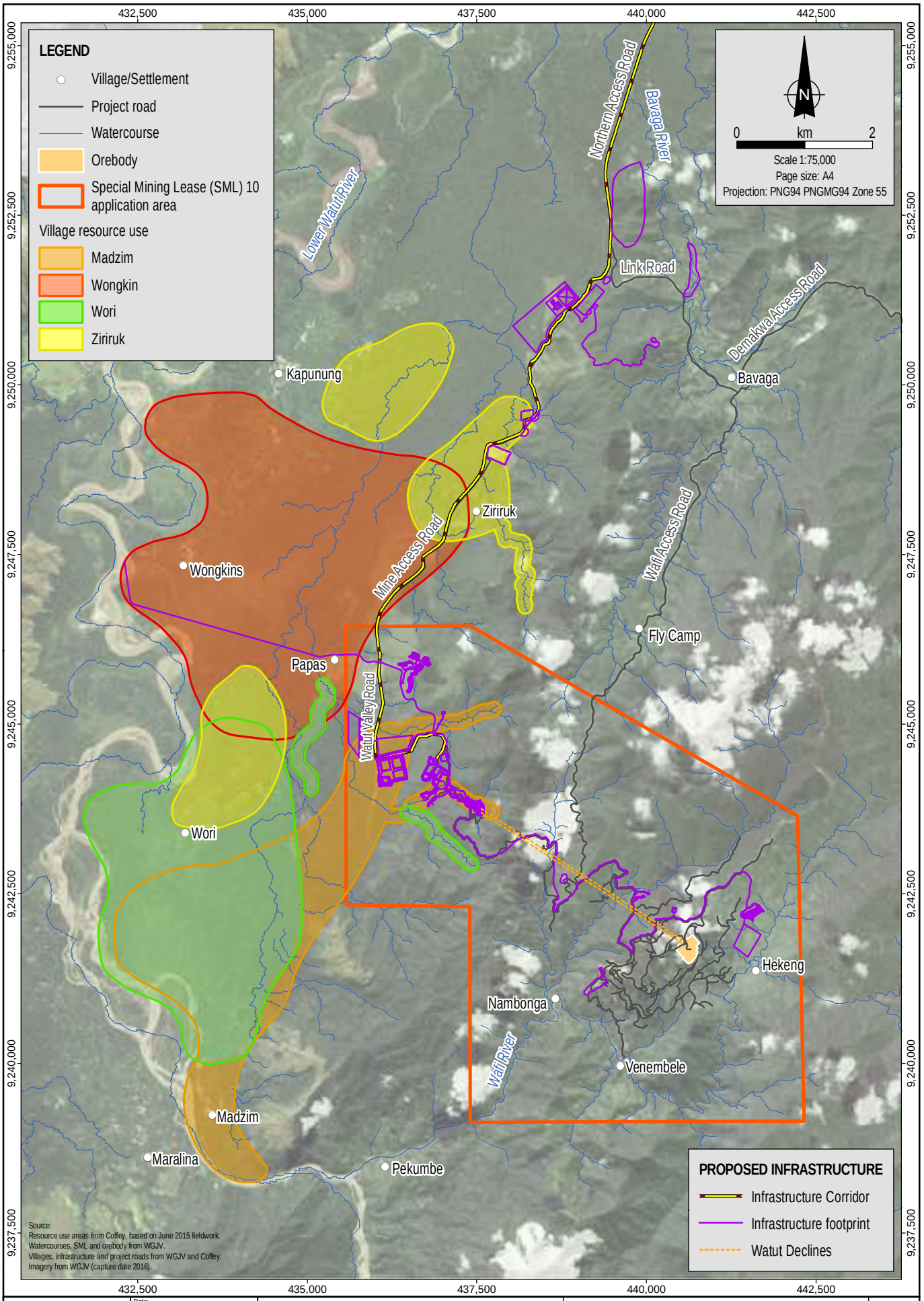
The period of fallow (before new gardens are made on the abandoned garden site) appears to be relatively short based on the limited size of regrowth typically being cleared for gardens. The short fallow may be an indication of limited suitable agricultural land in the vicinity of villages within this study area.

Hunting

In Study Area 1, householders reported that the hunting of terrestrial fauna is an important activity for the provision of food. Local residents hunt animals such as wild pigs, cassowaries, marsupials including bandicoot and other small mammals, wild fowl, flying foxes, grubs and lizards. Access tracks to the areas in which the residents hunt was important for these expeditions.

Most households in Tier 1 villages hunted regularly. Hunting is commonly conducted by males with the reported frequency of hunting trips varying between more than once a week to monthly. In the 2012 household surveys, across the study area, 57% of households indicated that they hunted once or more per week, and 22% of households hunted on a monthly basis.

Table 5.5 details the prevalence of hunting methods within Study Area 1.



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coffey A TETRA TECH COMPANY	Date: 26.03.2018 Project: 754-ENAUABTF100520DD File Name: 0520DD_20_F05.06_GIS	WAFI-GOLPU JOINT VENTURE Wafi-Golpu Project	Babuaf village resource use areas	Figure No: 5.6

Table 5.5: Prevalence of hunting methods in villages within Study Area 1

Method of Hunting	Prevalence of Usage Among Respondents
Bow and arrow	10%
Bush knife	21%
Traps	19%
Dogs	81%
Spears	58%
Other	0%

The use of dogs (81%) was the most prevalent method of hunting reported in Study Area 1. The next most prevalent methods were the use of spears (58%), and bush knives (21%) and traps (19%).

The location where hunting was undertaken by Tier 1 villages varied depending on the type of animal being hunted, with the majority of hunting reported to be within 5 km of the village. Key factors influencing the locality of hunting were natural features such as water sources and the types of foliage and forest and land ownership boundaries - between the three language groups rather than between the individual villages within each language group. For instance, as depicted in Figure 5.6, the Watut floodplain is utilised by all Babuaf villages and there is considerable overlap in terms of areas utilised for hunting.

Types of animals hunted

A variety of animals were reported to be hunted by households in this study area. The type and prevalence of animals reportedly hunted by residents in Tier 1 and Tier 2 villages as recorded by the 2012 Household Survey is provided in Table 5.6.

The most prevalent species reportedly hunted was bandicoot (68%). These were commonly hunted with the use of dogs and traps. Bandicoots were hunted on a day to day basis often opportunistically when travelling to and from gardens. The next most prevalent species was wild pig (64%). These were hunted with use of a spear and dogs. Wild pigs were commonly hunted for a celebration or special occasion.

Several people indicated that while people continue to hunt, there are fewer animals than in previous years, particularly wild pigs and cassowary. While people tend to blame exploration for this (in particular, the animals being scared by noises such as helicopter engines), it is likely that a combination of factors has contributed to the perceived decline in hunting productivity, including an increase in population, which has increased both hunting pressure and the area of land cleared for food gardens.

Table 5.6: Species type and percentage hunted within Study Area 1

Type of Species Hunted	Percentage Hunted
Bandicoot	68%
Wild pig	64%
Possum	34%
Lizards	12%
Snake	8%
Bush fowl	37%
Other birds	19%
Cuscus	12%
Other	3%

Commercial purposes

Within Tier 1 and 2 communities, commercial land uses include the production of cash crops, such as cocoa, betel nut, and coffee along with the commercial production of livestock. Betel nut was previously an important cash crop throughout the study area; however, a disease has severely affected the production and commercial viability of the plant since 2005.

Cash income from mustard and betel nut sales was reportedly common in 2007 in villages such as Zilani, Madzim, Pekumbe, Zimake, Gingen, Hekeng and Timini. However, this betel nut is likely to have been purchased in Lae in bulk and re-sold in the village. A similar practice was observed in the Project Area in 2015. Cash crops were also found to be a significant source of income in Timini due to road access to markets (CEH, 2007).

Residents of the Babuaf villages, and other villages in the lower Watut (and some residents of Bavaga) have planted cocoa. Cocoa is the main cash crop in these villages, supplemented by peanuts and occasionally bananas and taro. Some crops are sold in or near Zifasing, where a wide range of agricultural commodities are sold in markets along the Highlands Highway. The Hengambu and Yanta villages do not have traditional cash crops, however surplus garden produce is sold, along with some peanuts and tobacco. Betel nut was a major cash crop in the area before its decline due to disease in 2005. The absence of any significant cash crop in the villages of Hekeng, Venembele, Nambonga, Pekumbe and Fly Camp is due to:

- The limited area of land suited to cash cropping.
- The distance and expense to take products to market.
- The existence of an alternative source of income (alluvial mining or wage employment since Wafi-Golpu exploration activities were initiated) that can provide immediate and substantial returns.

Livestock was only kept for subsistence and cultural purposes; no households keep livestock for commercial purposes. A summary of livestock kept by households in the Study Area 1 is provided in Table 5.7. The most common livestock reportedly were chickens (34%), followed by pigs (19%).

Table 5.7 Livestock kept by households in Study Area 1

Type of Livestock	Number of Households
Pig	19%
Chicken	34%
Duck	3%
Other	6%

Social and cultural infrastructure

In addition to the direct provision of the plants and animals that support human consumption, land resources were also significant in terms of social and cultural infrastructure.

All villages in Tier 1 and 2 were located in relatively isolated areas and considerable forest cover remains. Trees and plants were utilised for a variety of social infrastructure purposes including the construction of housing and other buildings, as a source of energy (firewood), transportation (canoes) and medicine (Booyong Forest Science, 2011).

A number of different land resources to satisfy habitation requirements were utilised by residents in the study area, with trees and plants used extensively for purposes including:

- **House Construction**. Included plants (timber) used for house posts, rafters, flooring and walls. Roofs were generally thatch (sago palm) with rattan rope used for tying down roofing and rafters.
- **Domestic Uses**. A broad range of plants were used for matting, brooms and weaving baskets.
- **Cultural Uses**. A variety of plants were reported to have some spiritual significance, such as those used in spiritual practices and for making traditional clothes such as grass skirts.
- **Firewood**. Includes trees that were either burned for cooking or used as smouldering matches.
- **Medicinal**. A variety of plants were reported to have medicinal uses when used orally or externally.
- **Canoe Construction**. Trees used for dugout canoes and outriggers.
- **Hunting and Fishing**. Included plants used as fishing lines, bows, arrows, spears, sling shots, making animal traps and provision of poison for stunning fish.
- **Other Uses**. Other uses of plants ranged from shampoo to production of fuel sources.

The common use of timber planks in Yanta houses, made using axe and wedge, indicated that the forest contains a good supply of timber species, however there had been no commercial logging in the areas surrounding Yanta village. Refer to Appendix 7 for a full list of useful plants as identified by botanists from the PNG Forest Research Institute in 2011.

The flora survey by Booyong Forest Science (2011) was able to identify:

- 57 local plant species with 69 uses in Bavaga.
- 110 local plant species with 129 uses in Wongkins and Madzim.

Utilisation of water resources

The rivers and streams were emphasised as being vital to people's lifestyles and livelihoods in most study area villages, particularly those located on the banks of the Wafi and lower Watut Rivers. The rivers and streams provided a major source of cash income (through alluvial mining), and were also used for fishing, washing and, along the Watut, as a transport route. As such, the availability of water resources was of central importance to human settlements. This section presents an overview of water use in Study Area 1, focusing on water sources, sanitation, freshwater aquatic biota, and commercial and socio-cultural purposes.

The general features of the biophysical environment relating to water resources include:

- Watercourses and Wetlands. Numerous perennial and intermittent watercourses drain through the study area, the most important of which were the Watut, Wafi, Womui, Bavaga and Waime rivers.
- Catchment Area. Hill forest dominates on the steep terrain featured in the study area. Forests have an important role in maintaining water quality. In addition, such terrain affects the type and prevalence of water sources.

The information contained in this section relates predominantly to Tier 1 villages, which were specifically surveyed in relation to water resource utilisation.

Drinking and domestic uses

Most of the Tier 1 villages in the study area were located near major rivers or streams. Several Tier 2 villages are also located in close proximity to the Watut River. While providing an important source of water, water from the river was reportedly not used for drinking (except as a secondary source) because the river water often contained sediment or detritus which affected taste and perceived water quality.

The villages which were located furthest away from a major river or stream were Pokwaluma, Zilani and Pokwana, along with the hamlet of Fly Camp. These villages relied on springs as a key source of water for drinking and domestic uses.

The majority of villages surveyed relied on piped water as their primary source of drinking water with the exception of Wori and Ziriruk, which relied on groundwater or a nearby creek as shown in Table 5.8. Generally, piped water supply was sourced from springs or streams (untreated) at an elevation higher than the village, which was tapped and piped into a central locality within the village (Plate 5.3). Water outlets were shared communally by all households. One third of the villages (Bavaga, Madzim, Papas and Ziriruk) had no secondary source of drinking water with the remaining villages relying on creeks, springs and water holes, which surround the villages, or groundwater and rainwater.

Many villages in the study area have basic reticulated systems, some of which were installed up to 30 years ago.

For bathing, villagers predominately used water from nearby rivers and creeks followed by piped water (Plate 5.3). Groundwater was not used for washing. Only four villages (Hekeng, Kapunung, Papas and Pekumbe) had a tank to collect rainwater; which was generally attached to a school or aid post.

Table 5.8 Village sources of domestic water in Study Area 1

Village	Primary source of drinking water	Secondary source of drinking water	Water for bathing	Number of rainwater tanks
Bavaga	Piped water	No secondary source	River	0
Fly Camp	Piped water	Creek	Creek	0
Gingen	Piped water	Rain water or water from the creek	River	0
Hekeng	Piped water	Spring fed water hole at Wigo Creek	Piped water (primary source), Hekeng Creek and Wigo Creek (secondary source)	1
Venembele	Piped water	Wafi creek	Piped water	3
Kapunung	Piped water	Water hole along the Watut River bank	Piped water	1
Madzim	Piped water	No second source	River or piped water	0
Nambonga	Piped water	Buvu Creek, Nambongo Creek and Wafi Creek	Communal water taps (primary source) and creeks (secondary source)	0
Papas	Piped water (Wongkins Aid Post, WGJV supplied)	No second source	Piped water	1
Pekumbe	Piped water	Springs and small creeks along the Wafi Creek	Wafi Creek	1

Village	Primary source of drinking water	Secondary source of drinking water	Water for bathing	Number of rainwater tanks
Wongkins	Piped water (from small streams)	Groundwater	Piped water	0
Wori	Groundwater (shallow wells throughout the village)	Spring and creek	River	0
Ziriruk	Creek	No second source	Creek	0
Uruf	Piped water (sourced from 'Unum' area – water dam source)	Uruf River	Uruf River and piped water	0
Mafanazo	Piped water	Creek and spring	River	0
Ngarubuaring	Ngarubuaring River	Watut River	Ngarubuaring River	0
Chiatz	Piped water (sourced from foot of mountains; damaged pipes)	Creek (approximately 30 mins walk away)	Watut River	0
Goraris	Piped water (sourced from Ngankirompon dam)	Watut River (villagers dig wells along Watut River)	Watut River and piped water	0

Note: Not all Tier 1 and 2 villages are included in Table 5.8 as data on sources of domestic water was not collected for all study area villages.

Plate 5.3: Piped water supply in Wongkins village

Water source reliability and quality

It was reported by 24% of household respondents to the 2012 Household Survey (Tier 1 and 2) that each respective village's main source of water was not available all year round. This is most likely due to the smaller streams utilised for piped water supply drying up in periods of low rainfall. Commonly, the alternative water sources were springs located at varying distances surrounding the village, rivers and creeks or drums to catch water from the roof, along with shallow wells. As part of the socioeconomic surveys conducted between 2010 and 2015 in the study area, residents were asked how they rated the quality of water. Whilst there was variation in responses even within villages which share the same water source, in most villages water quality was reported as being 'good'. However, in some villages the quality of water was reported by residents as being poor, as it contained dirt, debris and insects, which affected the taste and smell of the water.

As outlined in Table 5.9, 80% of reticulated water systems were reported to have failed at some point in the 12 months prior to the survey and the majority of systems (80%) were repaired since their installation. Most common issues with the reticulated water systems as stated by survey respondents were the contamination of water with dirt, sediments and dust in periods of high rainfall.

Table 5.9: Reliability and common issues for reticulated water systems (Tier 1 and selected Tier 2 villages)

Village	Reticulated system failed in the last 12 months	Repaired since installation	Common issues
Bavaga	Yes	Yes	Water contains dirt and sediment in periods of high rainfall.
Fly Camp	Yes	No	No issues stated.
Gingen	Yes	No	Water contains mud during heavy rain.
Hekeng	No	Yes	No issues stated.
Kapunung	Yes	Yes	Water contains sediment in periods of high rainfall.
Madzim	No	Yes	No issues stated.
Nambonga	Yes	Yes	At times water changes colour (from clear to milky) or contains high amount of dust.
Papas	Yes	Yes	No issues stated.
Pekumbe	Yes	Yes	One of the piped water systems was not working and people relied on water from small creeks and springs which contains dust and dirt.
Wongkins	Yes	Yes	No issues stated.
Wori	No reticulated water system in this village.		
Ziriruk	No reticulated water system in this village.		
Uruf	Yes (but damaged by flood)	Yes (for half the village) (pipeline to Warof villagers downstream of Uruf not repaired)	Piped water not treated and can carry debris/dirt following heavy rains; secondary source not considered safe; used by Tapa Kainantu and Morom people upstream.
Mafanazo	Yes	No	Variable quality in high rain; reasonable system, lots of outlets, could do with more pressure.
Ngarubuaring	No reticulated water system in this village.		

Village	Reticulated system failed in the last 12 months	Repaired since installation	Common issues
Chiatz	Yes	No	Piped water is dirty after rain events and insects in pipes; dead snakes and frogs sometime found near secondary source (creek)
Goraris	Yes	No	Water not treated, comes with debris, ants etc. and is small and dries up in dry season; secondary source (Watut River) is dirty but no other available source

With regard to water quality, water sources in nine villages in Study Area 1 (Gingen, Hekeng, Madzim, Pekumbe, Timini, Uruf and Zilani) were tested for the presence of thermo-tolerant coliforms as part of the 2012 Public Health and Biomedical Survey. It was reported that only one in five (20%) water sources had been tested in the preceding 12-month period. While 93% of the water samples were assessed as aesthetically acceptable (clear, not cloudy and odourless), 49 of the 55 samples (89%) tested positive for presence of thermo tolerant coliforms. Conclusive determination of safety of water for human consumption in terms of bacterial count requires counts for specific coliforms; however, this high number of positive thermo-tolerant coliform test, together with high rates of diarrhoeal disease, does indicate a possible potable water issue in Study Area 1 (Abt JTA, 2013b).

Sanitation

Sewerage reticulation or treatment did not exist at any of the Tier 1 villages; rather, households commonly utilised pit-latrines. The use of household pit latrines varied between villages with sanitary wastes being sometimes discharged to the surrounding environment. Sometimes one toilet was available per household, but in other cases one toilet was shared amongst several households.

The majority of households (81%) reported they had access to one toilet in the village. Of surveyed households, 17% reported that they did not have access to a toilet. Of particular note was the lack of pit latrines in the Babuaf villages of Madzim, Wongkins, Wori and Kapunung. In these localities the water table is very shallow which prevents the installation of pit latrines.

Flooding

The creeks and rivers all flood periodically. The villages of Madzim, Wori, Wongkins and Kapunung are all located on the Watut floodplain and are susceptible to flooding, although many houses are elevated. Some new houses in Nambonga and Venembele have been built in flood-prone positions as well as some houses near creeks in Bavaga and Fly Camp. The elementary school at Hekeng is also located in a low-lying area adjacent to Wigo Creek and as such, is susceptible to flooding.

Gardens in the vicinity of Madzim, Wori, Wongkins and Kapunung are all susceptible to flooding as are some gardens in the other villages which have been built near streams or rivers. Flooding of the Watut River valley floodplain forest appears to occur annually.

With the exception of Ziriruk and Pekumbe, houses in all surveyed Tier 1 villages were impacted by flooding in the 12 months prior to the survey. Similarly, with the exception of Ziriruk, in all Tier 1 villages gardens were exposed to flooding as shown in Table 5.10.

Table 5.10: Tier 1 villages affected by flooding in the 12 months prior to the 2012 survey

	Bavaga	Fly Camp	Gingen	Hekeng	Kapunung	Madzim	Nambonga	Papas	Pekumbe	Wongkins	Wori	Ziriruk
Houses flooded	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No
Gardens flooded	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

Note: The Tier 1 villages of Venembele, Zilani, Powaluma and Pokwana have not been included as data on flooding was not collected in these villages.

Uses of freshwater aquatic biota

Freshwater aquatic biota used by villagers within Study Area 1 includes animals, such as fish and prawns, and aquatic plants, such as kangkong and watercress, which is consumed as kumu (leafy green vegetables).

The primary use of freshwater aquatic biota in the villages of the study area is as a source of food with households supplementing garden produce and hunting of terrestrial animals with aquatic animal species such as fish, eels, and prawns. While Pekumbe, Madzim, Chiatz, Goraris, Bencheng and Uruf have fish ponds, most villages rely on nearby rivers, streams and lakes for fishing and the collection of other aquatic biota.

A variety of aquatic fauna were reported consumed as food by households. The type and prevalence of aquatic fauna reported in Tier 1 and 2 villages is provided in Table 5.11.

The most common species caught in the study area were eels, catfish and carp. Prawns were also identified as an important source of food in some villages, along with turtles and crocodiles.

Table 5.11: Aquatic animal catches (Study Area 1)

Type of Aquatic Animal	Proportion of Catch
Eels	75%
Catfish	69%
Other fish	68%
Carp	36%
Prawns	11%

Fishing is a commonly practiced activity in all villages surveyed and was carried out by 79% of households on a weekly basis, inclusive of 3% of households who reported as fishing on a daily basis. The remaining households (21%) reportedly fished on a monthly basis. No seasonal changes to fish species caught were reported.

The most prevalent methods employed for hunting of aquatic biota were use of hand lines (77%), spear (15) and diving (15%). In Wori residents use a poison from a root (Derris), locally referred to as ‘monok’, which is used in small streams and lakes to poison fish.

It was reported that commonly a whole day may be spent fishing, resulting in a catch consisting of fish or other aquatic animals. Fishing is commonly undertaken by household groups rather than as a communal

activity. Expeditions were sometimes organised prior to special occasions such as marriages or church events.

The 2012 Household Survey recorded some information relating to the quantity of catch reported by households. It was reported by 64% of respondents that, when they fished, they caught between 1 and 5 fish. It was reported by 15% of respondents that they caught 'many' fish which was more than 10 fish per trip. Larger catch sizes were commonly associated with use of a net and such fishing trips having a purpose such as for a celebration or feast.

Several people indicated that there are fewer fish and prawns than previously. While this is often attributed to mine exploration, and particularly increased sedimentation, it is likely to also reflect increased disturbance and sedimentation resulting from alluvial mining, and increased fishing pressure as a result of rapid population growth.

Commercial purposes

Commercial uses of water resources in Study Area 1 include small-scale gold mining in rivers and streams, the quarrying of gravel and sand from river beds and the farming or harvesting of aquatic biota for commercial purposes.

Rivers and streams are exploited as a source of alluvial gold. Methods of alluvial gold mining varied and included diving in deeper rivers and streams for small nuggets, panning and the use of small-scale pumps and filtering systems. Alluvial mining is an activity generally undertaken by males, with the frequency varying between two to six days a week. Survey responses indicated that the practice of alluvial mining was regular and was relied on as a means of earning additional income when required.

The quarrying and sale of sand and gravel was an activity which was only reported in the villages of Gingen and Dengea and had limited commercial application.

The farming or harvesting of aquatic biota for commercial purposes was not reported in any of the villages in this study area. A lack of market opportunities and difficulties transporting such goods inhibited such practices.

Access and transportation

Rivers and streams provide important transportation routes in Study Area 1, particularly in areas where there is no road and where terrain and thick vegetation hamper other modes of transport. Villages such as Wongkins, Pekumbe, Kapunung, Wori and Madzim on the Watut River have landing spots on the riverbank. Canoes, rafts and motorised boats are the primary means of transport. The Watut River is the only transport corridor connecting these villages to the Markham River from which road connection to Lae is possible enabling villagers to trade goods and services. Traffic and transport associated with the Watut River is discussed in Section 5.1.11.

Sociocultural purposes

Many of the water sources of the streams provide recreational areas for children for swimming and as places for women to meet and chat. Specific sites for recreation were not recorded. Fishing was also an important pastime in many of the households surveyed. Fishing usually involved women and children. Water resources also provide a source from which aquatic materials such as plants can be derived for medicinal and cultural purposes. Stones used to retain heat for cooking were also collected from watercourses.

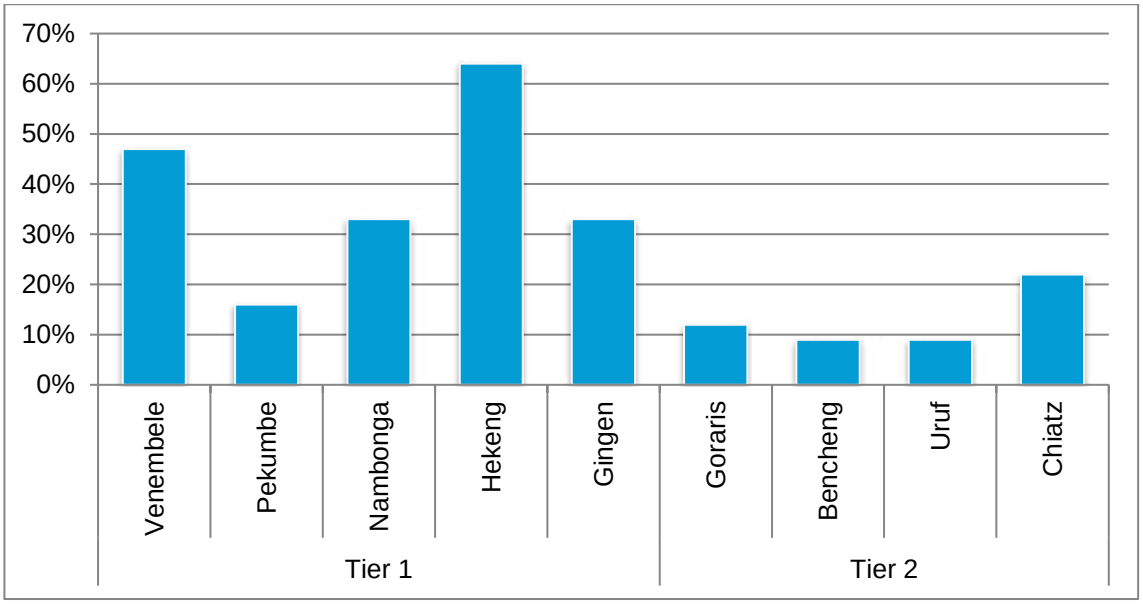
Water also has a cultural significance to people of the Tier 1 communities. Springs, waterfalls and lakes feature as sacred sites and places of cultural importance.

The socioeconomic baseline study did not include the recording of culturally important sites as this aspect of the EIS is addressed through a dedicated cultural heritage study (Green & Muke, 2018).

5.1.5. Housing

The vast majority of houses in all villages surveyed were made from local materials: wooden posts and frames, timber planks or bamboo for walls and some floors, and sago leaves or kunai grass on the roof. The majority of Yanta houses had split timber walls, which may be a tradition from when they lived in more elevated areas, where it was wet and often cool. In contrast, a high proportion of Babuaf houses use bamboo, which provides more ventilation which suits the high temperatures experienced on the Watut Plains.

The most common improvements made to houses, is to place *kapa* (iron sheets) on the roof, often with iron ridge-capping on the roof, which in both instances aims to reduce leakage when it rains. The proportion of houses with a kapa roof in a selection of Tier 1 and Tier 2 villages is shown in Figure 5.7.



Source: Coffey Environments, 2013 and 2015

Figure 5.7: Proportion of houses in Tier 1 and 2 villages with a kapa roof

The higher proportion of houses with kapa in Hekeng, Venembele and Gingen is likely to be a reflection of higher income levels (particularly when exploration employment levels were higher) and the high cost and difficulty of transporting kapa to the other villages, which do not have road access.

Many of the older houses have a large, traditional design, typical of that shown in Plate 5.4. However, the interior is quite dark, ventilation is quite poor, and the interior of the houses can be lined with soot.

Plate 5.4: House made of traditional material, Venembele village

Some of the newly constructed houses are substantially smaller. These may be houses for newly married couples, and may be restricted in size due to labour availability. A number of houses, particularly in Hekeng, utilise a combination of materials to construct houses, as shown in Plate 5.5.

Plate 5.5: House made of a range of materials, Hekeng village

In the Tier 2 villages surveyed in 2015, 5% of houses were made of permanent materials, 12% were classified as semi-improved (usually kapa on the roof of an otherwise traditional house), and 83% were made of traditional materials.

Practically all houses had an external pit toilet (e.g. top right of Plate 5.4) and haus kuk (external kitchen), as shown in Plate 5.5. All Tier 2 households surveyed in 2015 indicated that they cooked on open fires, although one household also used a kerosene stove.

5.1.6. Economy

This section presents details of the economy of the study area including economic infrastructure, employment and skill level, income, expenditure, roadside stalls and stores, banking and commercial scale business activities.

Economic infrastructure

The data demonstrate there is little existing economic infrastructure in Tier 1 and 2 villages. Direct road access is limited to Wafi Camp, Bavaga, Gingen, Dengea, Hekeng, Venembele, Ziriruk and Zimake, although the road to Venembele is closed on occasion due to damage caused by heavy rain. The lack of road access constrains economic opportunities in the remaining villages within this study area. Villagers along the Watut River rely on a combination of motorized canoes or bamboo rafts and PMVs to access markets and transport goods. River traffic in the study area is discussed in Section 5.1.11.

As there is no access to an electricity grid, the majority of households in Study Area 1 rely on torches and fires as the main source of lighting. However, solar panels are becoming more common as a source of lighting, particularly in villages along the lower Watut. A solar lighting system, including solar panels, battery, lights and wires, can cost as little as PGK300 to PGK400 to buy and can power five or six globes throughout the night. The different sources of lighting in Tier 1 villages are shown in Figure 5.8.

No economic infrastructure surveys were undertaken for Tier 2 villages.

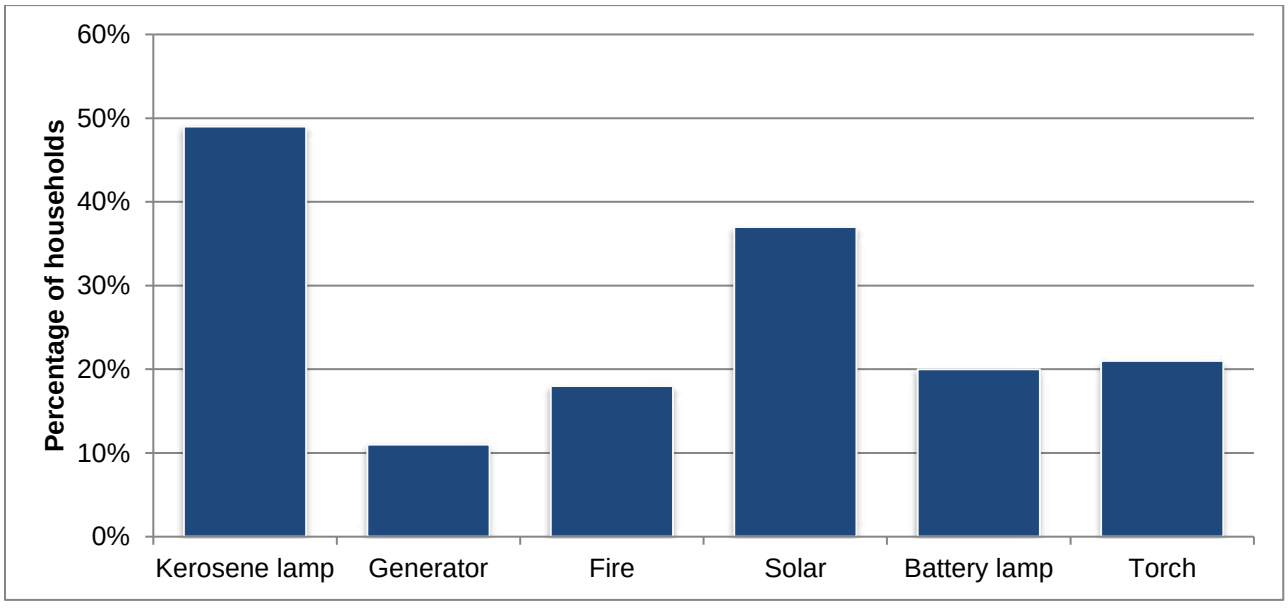


Figure 5.8: Sources of lighting, Tier 1 villages

Employment and skill levels

The WGJV and their contractors are the main employers in the study area. However, significant reductions in exploration employment occurred in 2013 and again in 2014, therefore current employment levels may therefore be lower than those recorded in 2012 and 2014.

In the 12 Tier 1 villages surveyed in 2014 and 2015, 86 people were employed at the time of the survey, and an additional 335 had previous employment experience. Of those with current employment, 75 were men (87.2%) and 11 were women (12.8%). This represented approximately 10.6% of the male population and 1.7% of the female population aged 15 years of age and above. The WGJV or their contractors employed the overwhelming majority of people employed in 2014. The majority worked on a full-time basis.

While 6.3% of the population aged 15 and above were employed at the time of the survey in Tier 1 villages, only 4.7% of the population aged 15 and above were employed from Tier 2 villages surveyed in 2014 and 2015. This is an indication of the significance of exploration employment as a source of income to Tier 1 villages.

The main occupations for those people employed at the time of the 2014 and 2015 surveys, for both Tier 1 and Tier 2 villages, are summarised in Figure 5.9.

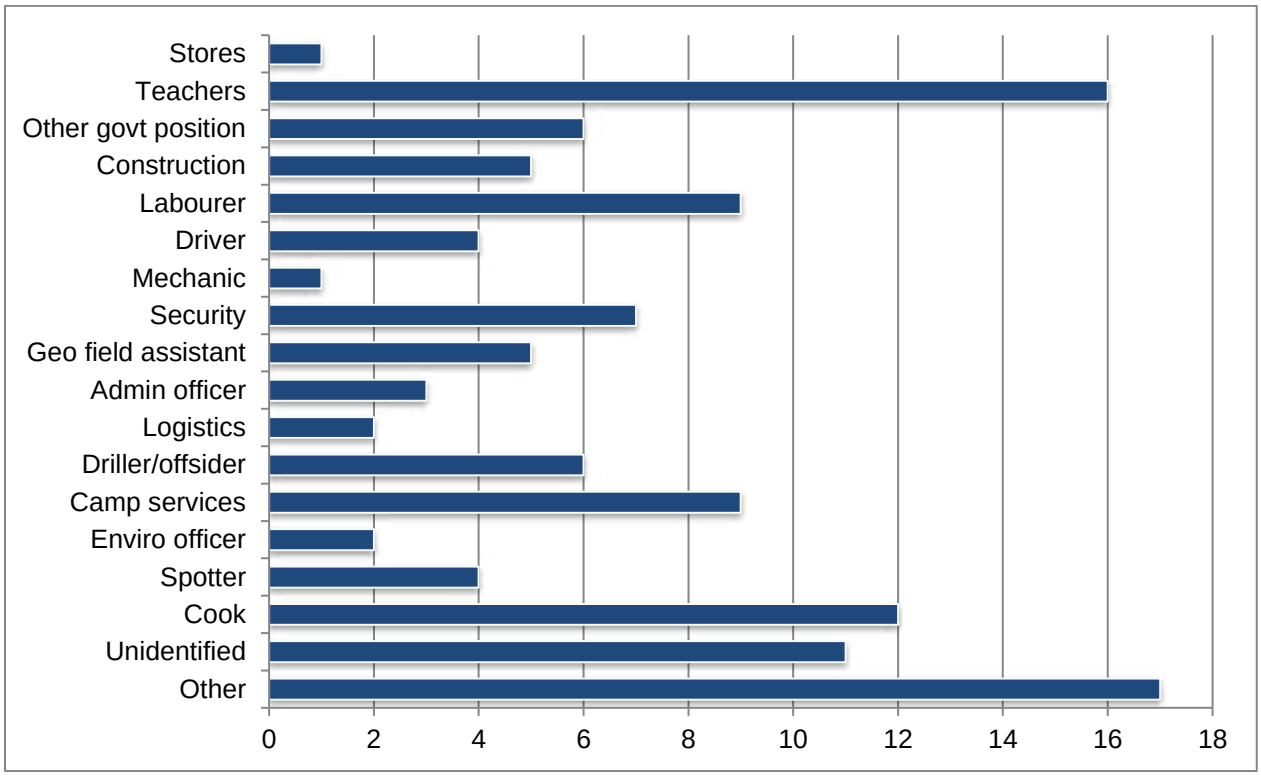


Figure 5.9: Main occupation in Study Area 1 in 2014 and 2015

In the 12 Tier 1 villages surveyed in 2014 and 2015, 335 men and women aged 15 and above had previous employment. This meant that approximately 52.2% of the recorded male population, aged 15 and above, was either employed at the time of the survey or had some formal employment experience in the past, compared to only 7.8% of females.

While 24.4% of the population aged 15 and above had previous employment experience in Tier 1 villages, only 7.4% of the population aged 15 and above had previous employment experience from Tier 2 villages. Again, this is an indication of the significance of exploration employment as a source of income to Tier 1 villages. It also reflects the extended time period in which exploration has occurred.

Of the 309 people who were not employed at the time of the survey of Tier 1 villages in 2014, but had previous employment experience, 55% ended their employment in the previous 16 months (i.e. during 2013 or the first four months of 2014). This confirmed the high levels of employment recorded during the 2012 household surveys, in which 41% of households indicated they had received wage income in the past week (Coffey 2013, p.78). This compares to 19% of Tier 1 households receiving wages in the past fortnight in the 2014 survey, and 9% of Tier 1 households receiving wages in the past fortnight in the 2015 survey.

The main occupations for those people who have previous employment experience are summarised in Figure 5.10.

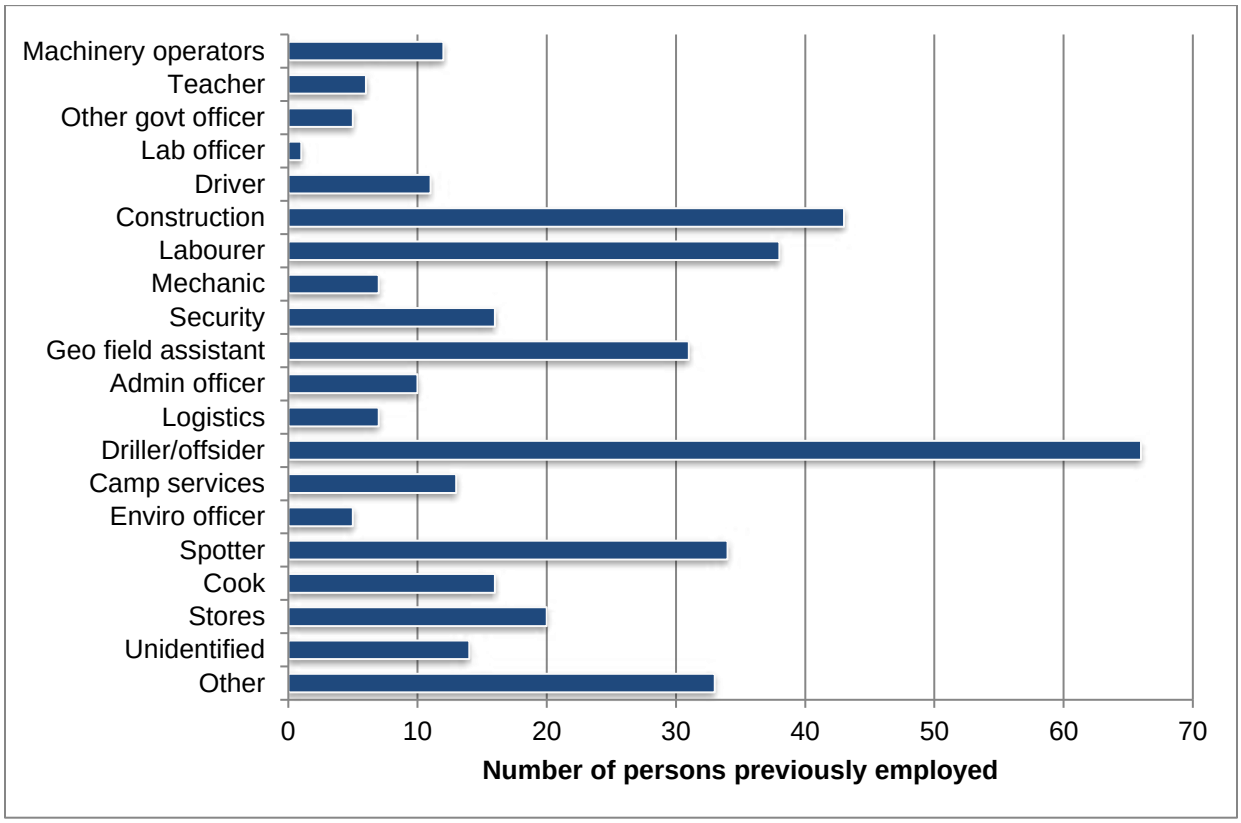


Figure 5.10: Main occupation in Study Area 1 – previously employed

Although some employment dates back to the 1960s and 1970s, the majority of those people with previous employment experience finished their employment in the past decade. The age of people with previous employment experience indicates that the majority of former employees are still of working age.

Employment and income

Household income levels of the 17 villages surveyed in Study Area 1 in 2014 and 2015 averaged PGK674 in the past fortnight, which equates to an average annual per capita income level of PGK3,102. Figure 5.11 depicts the sources of income and the fortnightly household income of Tier 1 and Tier 2 villages.

The main income sources for residents of these villages are shown in Figure 5.12. While highlighting the significance of alluvial mining (29% of total household income), cash crops (29% of total household income) and business activities (14% of total household income), it also highlights the wide range of income sources available from within the survey villages.

Surveys conducted in Tier 1 and 2 communities in 2004 estimated annual income at PGK300 per person, with wages contributing 60% of total income, alluvial gold 17% and sales of betel nut 17% (Jackson 2004, p.18). Even adjusting for inflation, income levels in this study area appear to have increased substantially over the past decade, and to some degree, diversified when compared to the previous dependency on wage employment. This can be largely attributed to access to the Wafi Access and Demakwa Access roads, which has provided a range of income opportunities for many villages, and (as discussed further below) the support provided by the WGJV to cocoa producers in villages along the lower Watut.

As discussed, the main employer in Study Area 1 is the WGJV, although there was a substantial decline in employment levels in 2013 and 2014 as the Project moved into a different phases. Additional details on the main employees, the main types of business activity and cash crops, and alluvial mining, are discussed below.

The sale of livestock represented 7% of recorded household income in the study area households surveyed. This is predominantly the sale of chickens, and could also be classified as a business activity. Sales of produce from the rivers, streams and forest contributes 3% of household income, and includes fish, prawns, sago, wild nuts and other forest products.

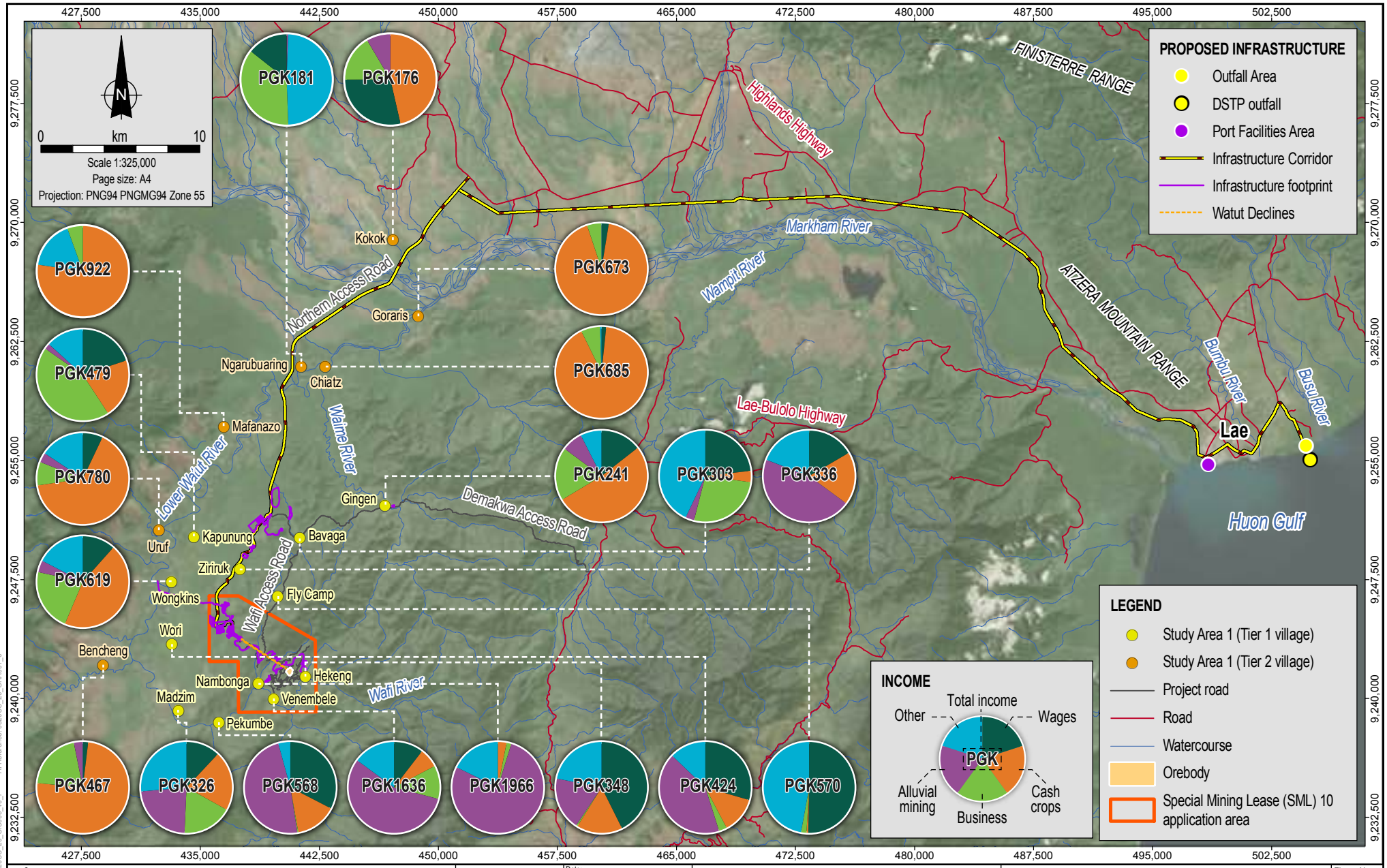
Other income sources include compensation payments, gifts and remittances, and contributed only 6% of total household income.

Some factors that may have affected income levels as recorded by surveys in 2012, 2014 and 2015 include:

- A reduction in exploration employment levels in the year prior to the 2014 surveys, which may have resulted in an increase in alluvial mining activity.
- A significant reduction in the price of gold since the highs of 2011 and 2012.
- An increase in the price of cocoa prior to the 2015 surveys.
- Drought conditions in 2015 which are likely to have affected income earned through cash crops.

Average income levels over the previous fortnight varied significantly between villages within this study area, as shown in Figure 5.13. Data on Zifasing (as the nearest large village connected to a major road) is provided as a comparator.

As shown in Figure 5.13, average household income levels were highest in Venembele and Nambonga due to income from alluvial mining, exceeding the reported average in Zifasing. In all other study area villages, the average income was lower than Zifasing, possibly because they are relatively more remote. The lowest average household income levels were recorded in Bavaga and Gingen.



Source:
SML and orebody from WGJV.
Income data, villages, infrastructure and project roads from WGJV and Coffey.
Roads and watercourses from NSO.
Imagery from ArcGIS Online (capture date unknown).

coffey
A TETRA TECH COMPANY

Date: 23.03.2018
Project: 754-ENAUABTF100520DD
File Name: 0520DD_20_F05.11_GIS_GRA

WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Fortnightly household income and income sources in Study Area 1

Figure No: **5.11**

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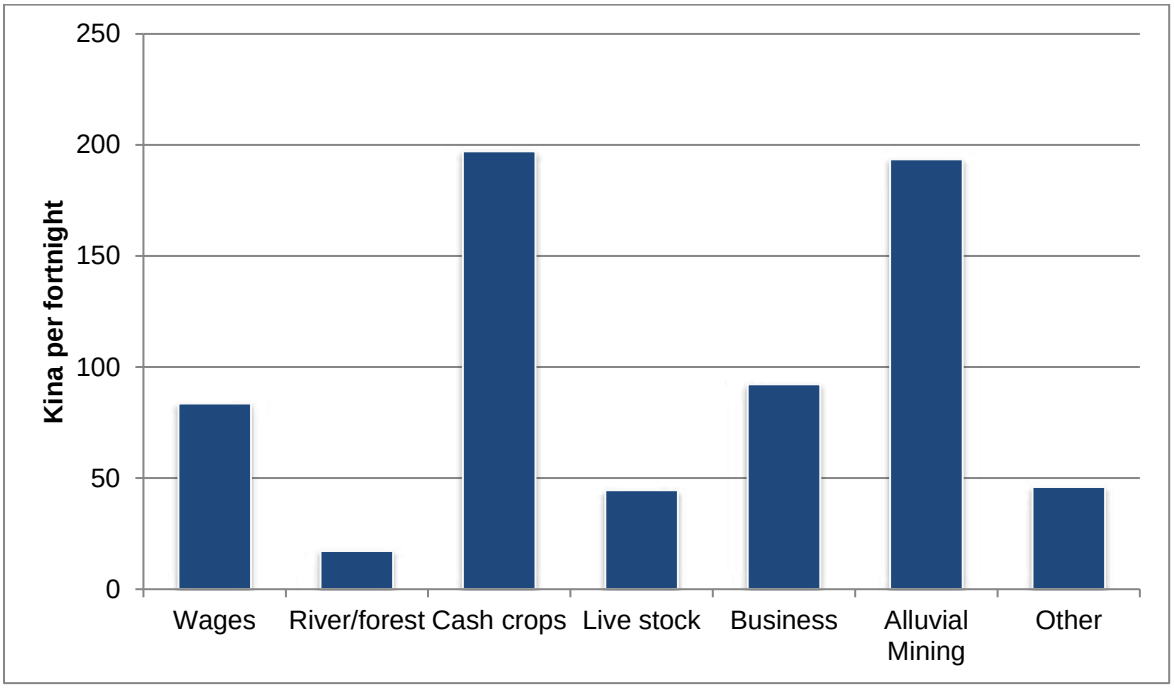

Figure 5.12: Fortnightly income sources in Study Area 1

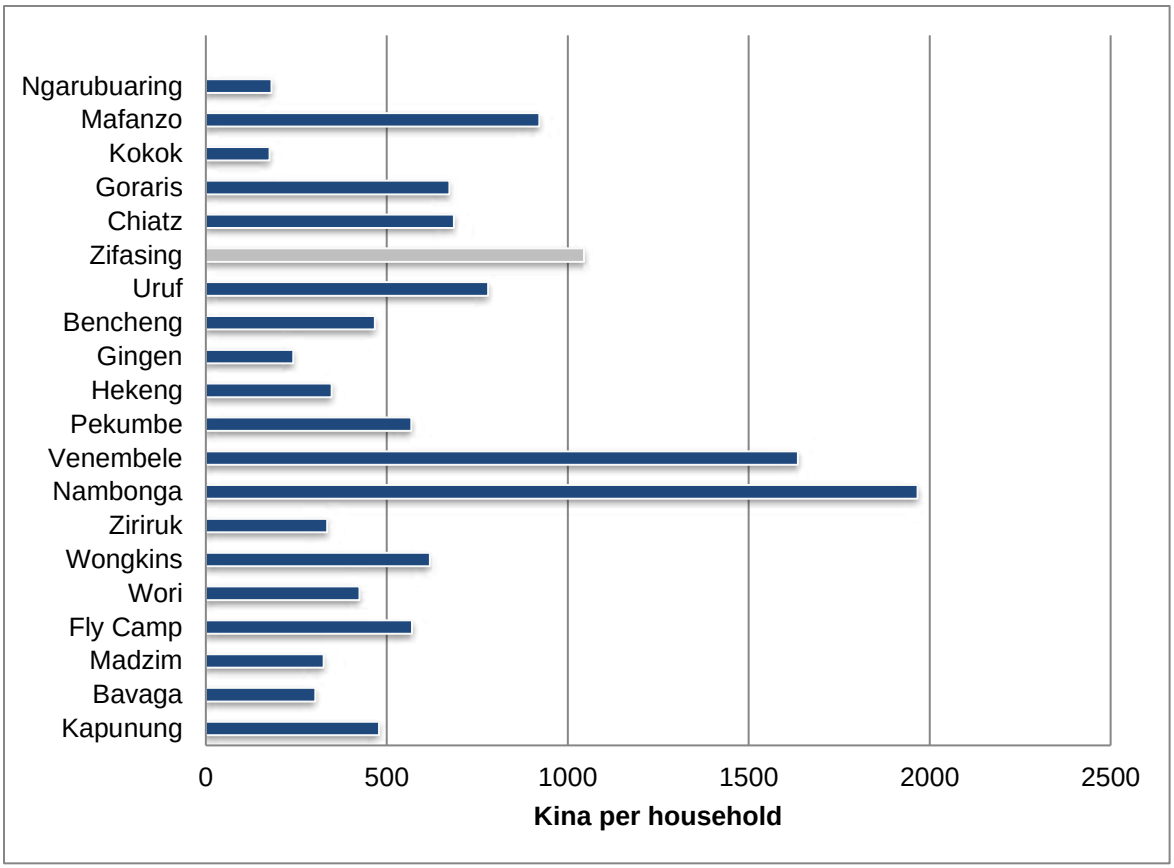

Figure 5.13: Fortnightly income by village in Study Area 1

Survey results indicate that not only do income levels vary substantially between villages, but as shown in Figure 5.14, so do the main income sources:

- Wage employment contributed the highest proportion of income in Fly Camp and Hekeng.
- Alluvial mining contributed the highest proportion of income in Nambonga, Venembele, Pekumbe, Ziriruk and Wori.
- Businesses contributed the highest proportion of income in Kapunung.
- Cash crops contributed the highest proportion of income in Wongkins, Gingen, Goraris, Bencheng, Uruf, Mafanazo, Kokok, Ngarubuaring and Chiatz.

The main cash crop in the study area was cocoa, however, other crops grown for sale included peanuts and watermelon. Surplus production of staple foods, such as bananas and taro, were also sold.

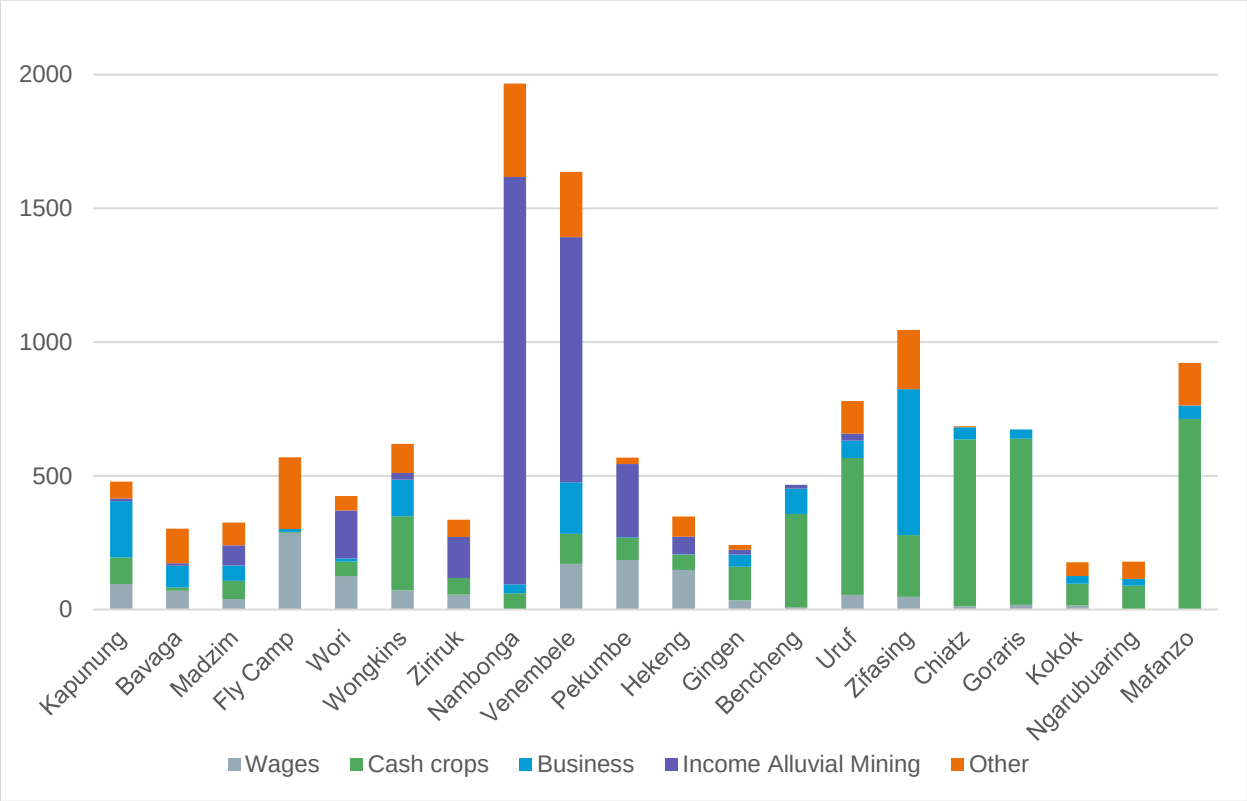

Figure 5.14: Household income sources by village (Study Area 1)

Survey results indicate that not only do income levels vary substantially between villages, but as shown in Figure 5.14, so do the main income sources:

- Wage employment contributed the highest proportion of income in Fly Camp and Hekeng.
- Alluvial mining contributed the highest proportion of income in Nambonga, Venembele, Pekumbe, Ziriruk and Wori.
- Businesses contributed the highest proportion of income in Kapunung.
- Cash crops contributed the highest proportion of income in Wongkins, Gingen, Goraris, Bencheng, Uruf, Mafanazo, Kokok, Ngarubuaring and Chiatz.

The main cash crop in the study area was cocoa, however, other crops grown for sale included peanuts and watermelon. Surplus production of staple foods, such as bananas and taro, were also sold.

Although average household income levels varied from PGK241/fortnight in Gingen to PGK1,966/fortnight in Nambonga, substantially greater variation occurred between households in the study area, as shown in Figure 5.15:

- 14% of households recorded no income in the previous fortnight, although the proportion was considerably higher for Tier 1 villages at 20%.
- 17% of households recorded more than PGK1,000 income in the previous fortnight, with a similar proportion between Tier 1 and Tier 2 households.
- 13 households (two percent of those surveyed) recorded income between PGK5,000 and PGK20,000 in the previous fortnight.

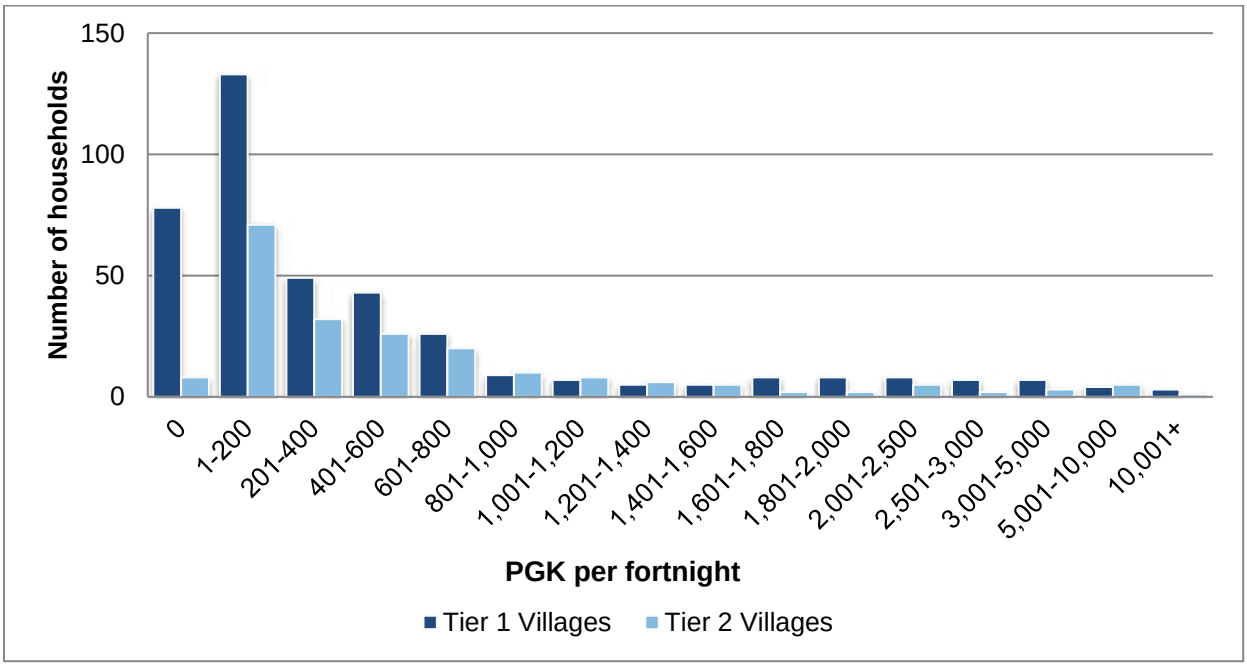

Figure 5.15: Household income distribution in Study Area 1

The households recording the highest income levels in the previous fortnight were from Venembele, Mafanazo and Nambonga. With the exception of those from Mafanazo, high income households were generally involved in one or more business activities, often including trade stores, gold buying and selling, and/or production of chickens. In Mafanazo, the high-income households were those which had recently sold a crop of cocoa beans.

The median recorded for the previous fortnight was PGK200 within Tier 1 villages and PGK350 within Tier 2 villages. This equates to household income of PGK5,200 per annum for Tier 1 villages and PGK9,100 within Tier 2 villages. Closer analysis of the data indicates that the relatively high proportion of Tier 1 households with low income in the previous fortnight may be due to the infrequent sale of gold, which appears to be undertaken on a periodic basis and only when additional cash income is required. Many people in Study Area 1 keep some alluvial gold as a form of savings.

Alluvial mining

Across all Tier 1 villages, the sale of gold provided 15% of total income recorded in the previous fortnight. Alluvial mining provided a source of income for 24% of households in the past fortnight, and 55% of households in the past year. Areas used include the Bavaga River, Zumadia Creek, Bipu River and Tin Okin Lakes (Bavaga); Mari Creek and Watut River (Wori), the Watut River (Wongkins) and the Watut and Wafi Rivers (Pekumbe). However, none of the households surveyed had sold gold in the past fortnight from Fly Camp, Goraris, Chiatz, Kokok, Mafanazo or Ngarubuaring. Villages in the lower part of the Watut (Chiatz and Goraris) do not have access to areas suitable for alluvial mining. The proportion of households selling gold from those villages that sold gold in the past fortnight is illustrated below.

As shown in Figure 5.16, alluvial mining is more frequently undertaken in the villages along the Wafi River than those along the Watut River. While relatively few households from villages located along the Wafi Access Road sold gold in the past fortnight, it remains an important source of income in these areas, and has led to three streams along the Wafi Access Road being referred to as Australian and New Zealand Bank, Westpac and Bank South Pacific.

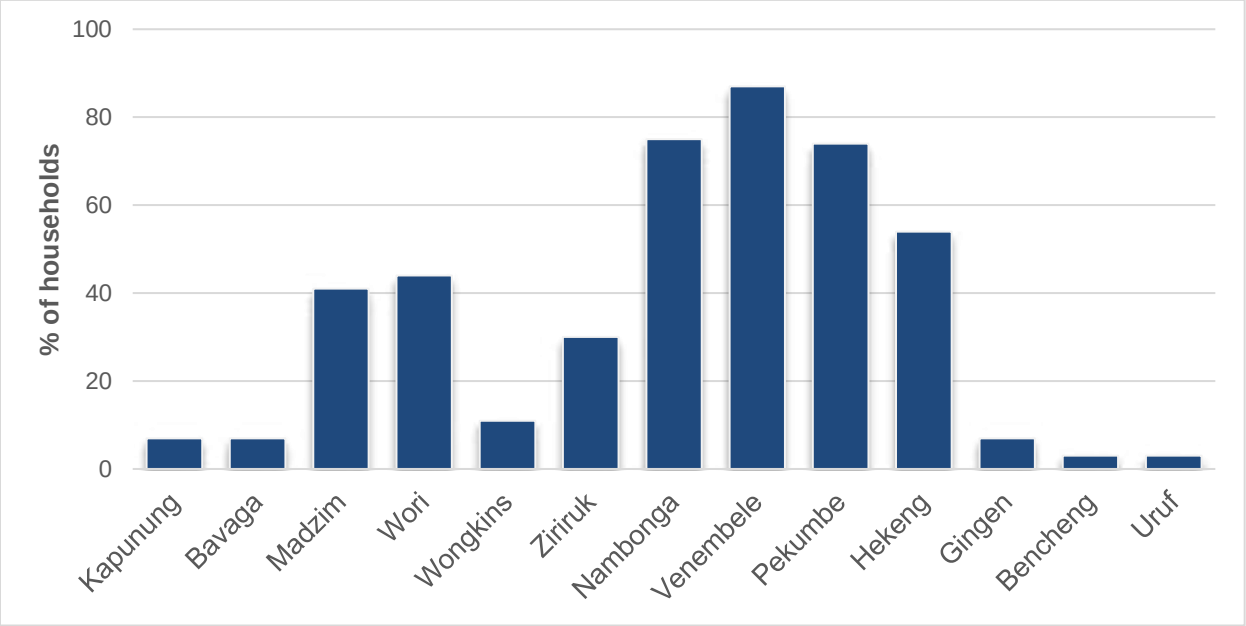

Figure 5.16: Proportion of households in selected Study Area 1 villages selling alluvial gold in the past fortnight

Numerous households in the study area indicated that, despite finding gold in the previous fortnight, they had not sold it yet, or they had sold only a proportion needed to buy food and other items, saving the rest for a future point in time.

In the Wafi River, working for gold (wok gol) often involves the construction of a diversion channel in the river or stream (Plate 5.6), allowing the family to focus on a stretch of water that is often lower and slower than the main channel, and family members will then dive for nuggets (wearing goggles), and then pan and use a sluice (Plate 5.7).

Plate 5.6: Diversion in Wafi River

Plate 5.7: Gold pan being used in Wafi River

Gold mining techniques are said to have been passed down from several generations. Some families 'wok gol' in close proximity to the village, others travel a distance up or down stream and may stay for extended periods in a makeshift shelter. Families were scattered along the full stretch of water between Nambonga and Pekumbe during the survey period. Various people interviewed indicated that they believe sediment from exploration activities is the main risk to their livelihood, as sediment covers the sand and gravel they like to work.

The data show that mercury is not apparently used, or commonly used in Hekeng, Venembele or Nambonga, as nuggets or flakes of gold are found, and generally contain no or few impurities. Mercury is commonly used at Pekumbe and in villages along the Watut River, both during panning and heating, as methods to extract impurities. At the time of the survey, no people from outside the Mine Area had come in and set up alluvial mining activities along Wafi River. Several people indicated that this would not be allowed on their customary owned land. However, people from Pekumbe did indicate that their relatives from other Yanta villages (e.g. Zilani) did visit to earn income from gold.

The alluvial mining method used along the Watut River is quite different to the alluvial mining method along Wafi River. A sluice box is the most common method used to extract gold from areas of river sand, or on occasion, from sand beds on the river plains a metre or more below the surface.

Although some residents of all study area villages surveyed along the Watut River indicated that they had sold gold in the past year, many people indicated that cocoa had now replaced alluvial mining as the main source of cash income, and alluvial mining was only undertaken when additional income was required.

Local-scale business activities

Many households in the Tier 1 and 2 villages are engaged in small-scale business activities. These businesses are not generally registered, and while some are long-term activities, many operate on a periodic or opportunistic basis. As shown in Figure 5.17, the most common business activities in Tier 1 villages were the operation of village trade stores, informal stalls, buying gold and producing chickens.

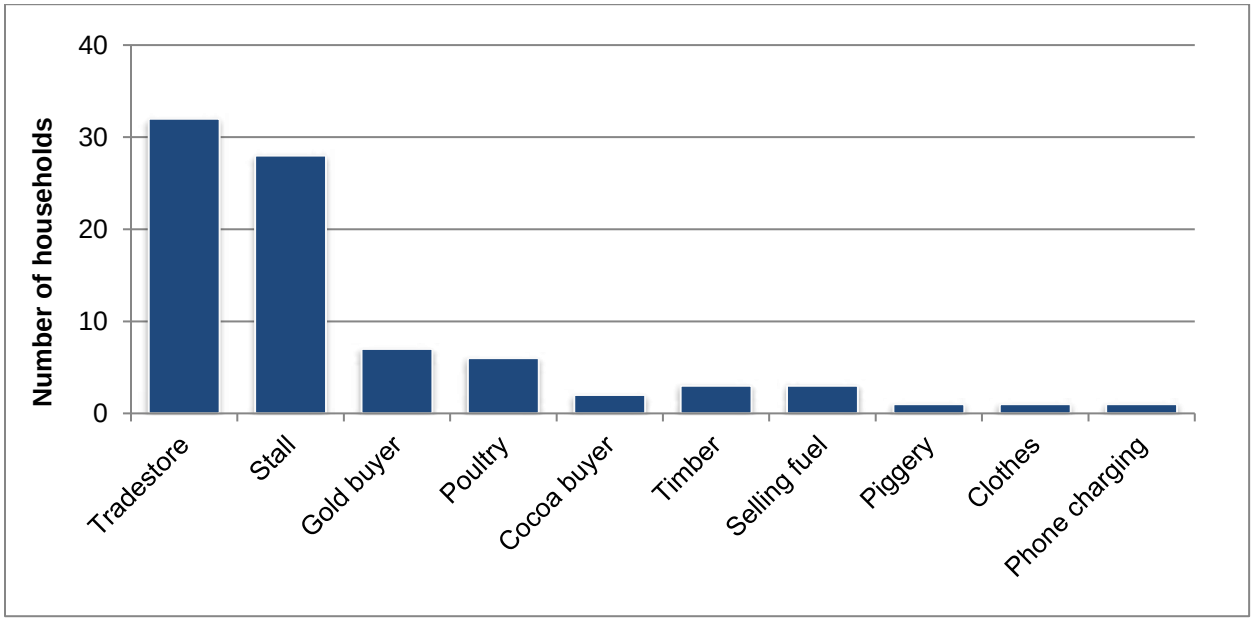

Figure 5.17: Type of business activities, Tier 1 villages

Stores were operating in Bavaga (seven), Hekeng (two), Venembele (three), Pekumbe (two), Madzim (one), Kapunung (two), Wongkins (three), Wori (one), Gingen (three) but not in Nambonga, Fly Camp or Ziriruk. This equated to one house in 18 operating a store. The stores, particularly in Venembele, were well stocked and recorded high turnover. The store owners in Venembele indicated that products were also sold to people from more distant villages, including Pokwaluma, Zilani and Pokwana.

The relatively high number of stores and stalls is indicative of the relatively high income levels, and the opportunities available due to the distance and cost to travel to Lae. It costs approximately PGK20 to catch a PMV from villages in this study area to Lae. Due to road conditions, the trip generally takes approximately three hours each way despite being only 98km.

Several store owners also raised chickens on a commercial basis and some operated as gold or cocoa buyers. Day-old chicks and chicken feed are purchased in Lae, and chickens sold after five weeks at PGK35 each. A store owner in Venembele organised darts and bingo, and was in the process of building a 'beer hall', while another was in the process of procuring a pool table. Again, the types of income-generating activities in a village setting are a reflection of relatively high income levels.

The majority of gold found in Venembele appears to be sold to buyers from within the village, whereas in other villages it is sold either to buyers from the village or buyers from Lae or Timini. The price of gold in the villages varied from PGK50 to PGK70 per gram. This equates to approximately USD700/oz, or 59% of the international price at the time of the survey (assuming no impurities). One of the gold buyers in Venembele indicated he generally bought and sold approximately100 grams of gold per week, which equates to weekly turnover of PGK7,000.

As shown in Figure 5.18, the most common business activities in Tier 2 villages were the operation of informal stalls, village trade stores, river transport (canoe and outboard motor hire) and the operation of cocoa fermentaries.

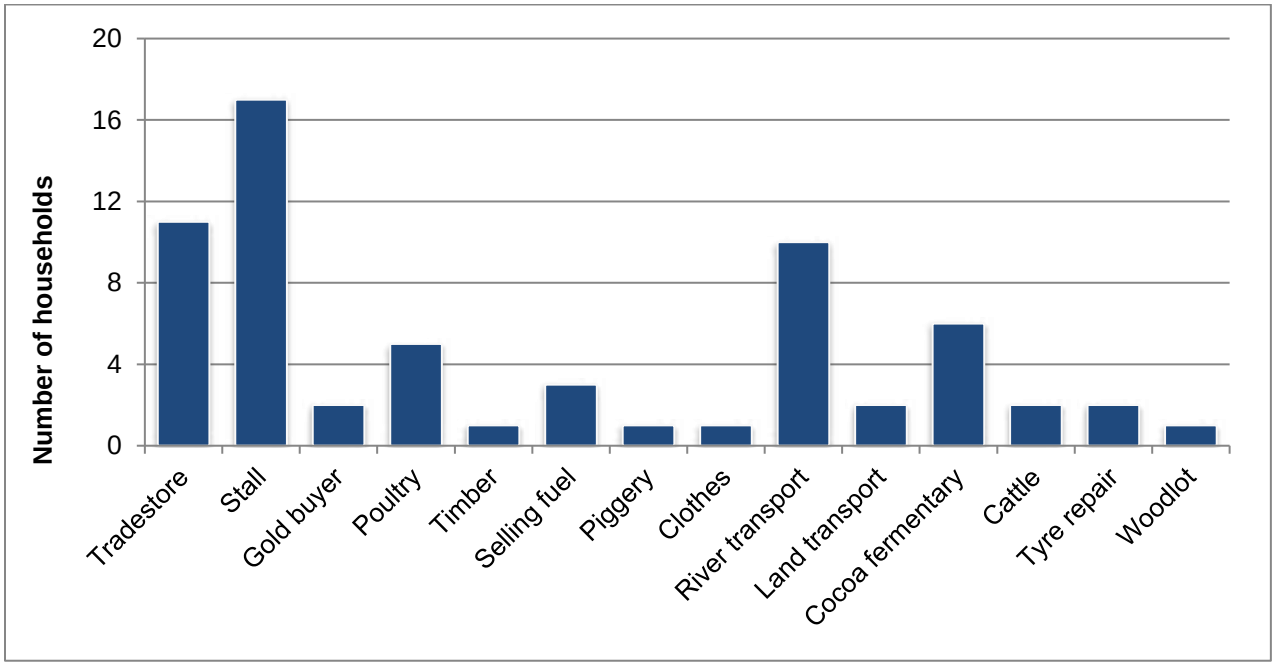

Figure 5.18: Type of business activities, Tier 2 villages

Stalls usually operated at the person's house and sold a limited number of goods, generally purchased in Lae in bulk and sold individually (such as cigarettes, betel nut and some food items), or locally made food

items such as scones, ice blocks and sweets. There can be a substantial mark-up when selling products individually, particularly betel nut. A stall operator in Timini indicated that a bag of betel nut purchased in Lae for PGK150 could generate PGK700 in revenue when the nuts are sold individually. Although providing less mark-up, a packet of cigarettes can be purchased in Lae for PGK18 and the contents sold for PGK25 when sold individually.

The vast majority of Tier 2 villages also identified agricultural production as a business activity. Although excluded from the above business summary, the most common agricultural products grown for sale included cocoa, peanuts and watermelon.

Cash crops

As previously mentioned, betel nut was the main cash crop in the study area until a fungal disease killed the betel nut palms in 2005. Cocoa was subsequently introduced to villages along the lower Watut River, but production was low due to poor varietal selection and poor husbandry practices. The WGJV provided substantial support between 2010 and 2014, including 160,000 high yielding seeds, technical advice, the establishment of three cocoa fermentaries (see Plate 5.8), and logistical support. The cocoa introduced by the WGJV reportedly has a yield of approximately 1,000 kg of wet bean per hectare in comparison to the older cocoa that produce approximately 300 kg/ha.

Cocoa is now the main cash crop in the lower Watut and an important cash crop in much of the Markham Valley. Surveys conducted in 2015 indicated that 83% of households in Goraris, Chiatz, Uruf and Bencheng had sold cocoa in the past fortnight, and 93% had sold cocoa in the past year. This compared to 46% of households in Zifasing who had sold cocoa in the past fortnight, and 58% who had sold cocoa in the past year.

Plate 5.8: Cocoa fermentary, Chiatz

The sale of cocoa contributed the majority of income in villages along the lower Watut, as shown in in Figure 5.19 (Zifasing data is included for comparison). This includes 74% of household income in Goraris

and 78% of household income in Chiatz. By comparison, cocoa sales only contributed 9% of household income in Zifasing.

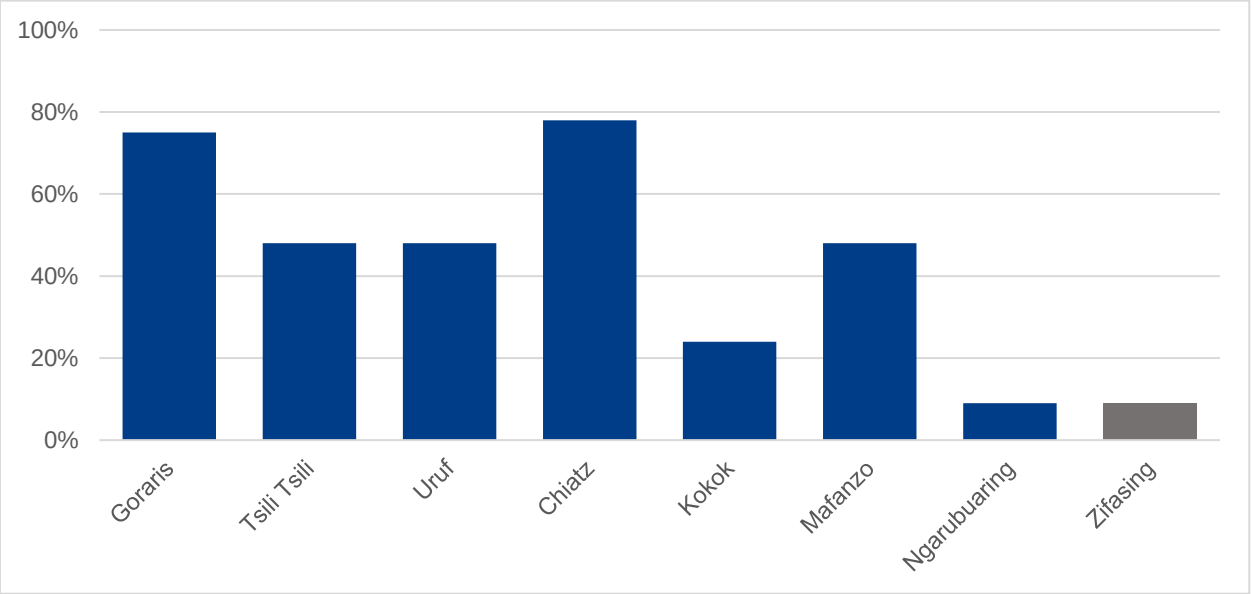

Figure 5.19: Proportion of household income derived from cocoa

It should be noted that the price of wet beans (cocoa seeds) increased from less than K1 per kg in 2014 to K1.50 per kg in May 2015. This increase may have contributed to the focus on cocoa in villages along the lower Watut. However, discussions in May 2015 indicated a strong preference for generating income from cocoa over alluvial mining or other alternative sources of income. The main constraint to production is the cost and length of time to transport cocoa to buyers in Lae.

Cocoa support has been provided by WGJV in collaboration with Cocoa Coconut Institute, Business for Development (B4D) and Mondelez International, through its subsidiary Kraft Foods. The farmers have also established the Lower Watut Farmers' Cooperative Society, which helps maintain standards (through ongoing links with the Cocoa Coconut Institute) and markets the cocoa on behalf of the growers. Cocoa development has been successful, with 1,000 growers cultivating some 600 hectares of cocoa, worth approximately PGK4 million per annum.

The Wafi-Golpu Joint Venture has had success using the model farmer approach in recent years. It is simply working with farmers that are keen to be involved in the development of new crops, fish or livestock, and/or new production and/or processing techniques. Technical advice and support is provided to the model farmers, who effectively demonstrate the new products/techniques in a village setting. Once shown to be viable, other farmers in the village are then willing to adopt the new products and techniques. The approach is proposed to be used for cocoa, citrus and other crops.

As noted above, other than cocoa, the main cash crops in the study area include peanuts and watermelon. Surplus production of staple foods, such as bananas and taro, is also sold. Peanuts are a common cash crop in villages along the lower Watut as they are easy and quick to grow and have a high value to weight ratio, which reduces transport costs.

High transport costs limit the sale of bananas and taro from villages along the lower Watut. To reduce the transport costs, people will often float the produce down the Watut River on rafts (Plate 5.9), however, this will take several hours and can result in damage to or the loss of produce.

Plate 5.9: Transporting produce to 40 Mile by raft

Expenditure

Within Tier 1 and 2, household expenditure levels averaged PGK635 in the past fortnight. The level of expenditure equates to an annual per capita expenditure level of PGK2,950.

Average fortnightly income and expenditure levels for villages surveyed in 2014 and 2015 are shown in Figure 5.20. At a village level, there is a reasonably high correlation between average household income and average household expenditure levels – savings are minimal. Note that Figure 5.20 reports data for Zifasing, as a comparator.

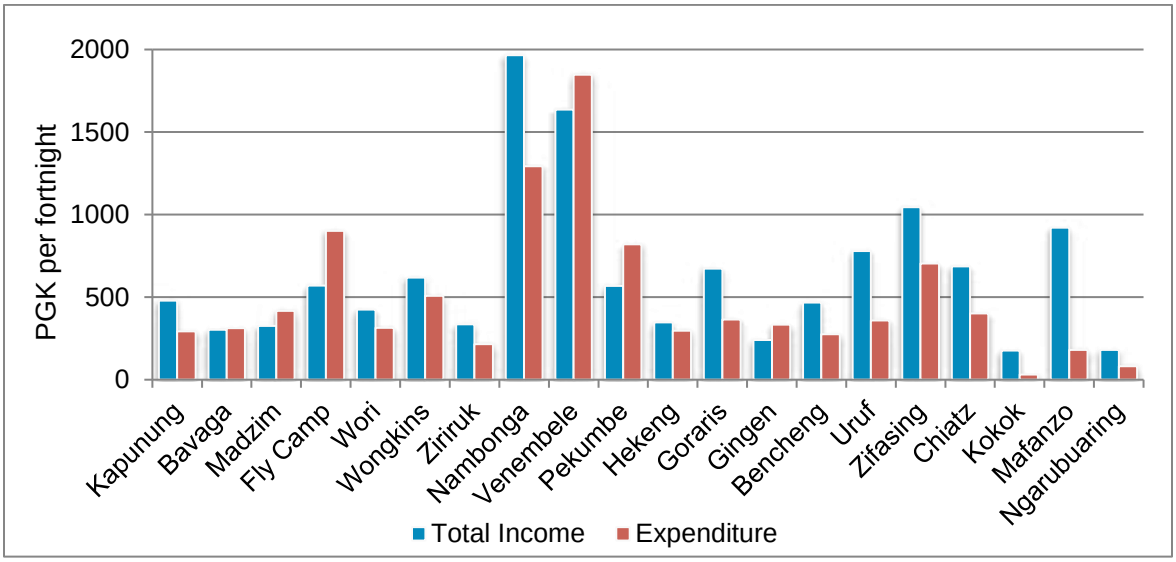

Figure 5.20: Average income and expenditure levels, Study Area 1 (Zifasing included for comparison)

The main items purchased by the residents of the 17 surveyed villages in the previous two-week period are illustrated in Figure 5.21.

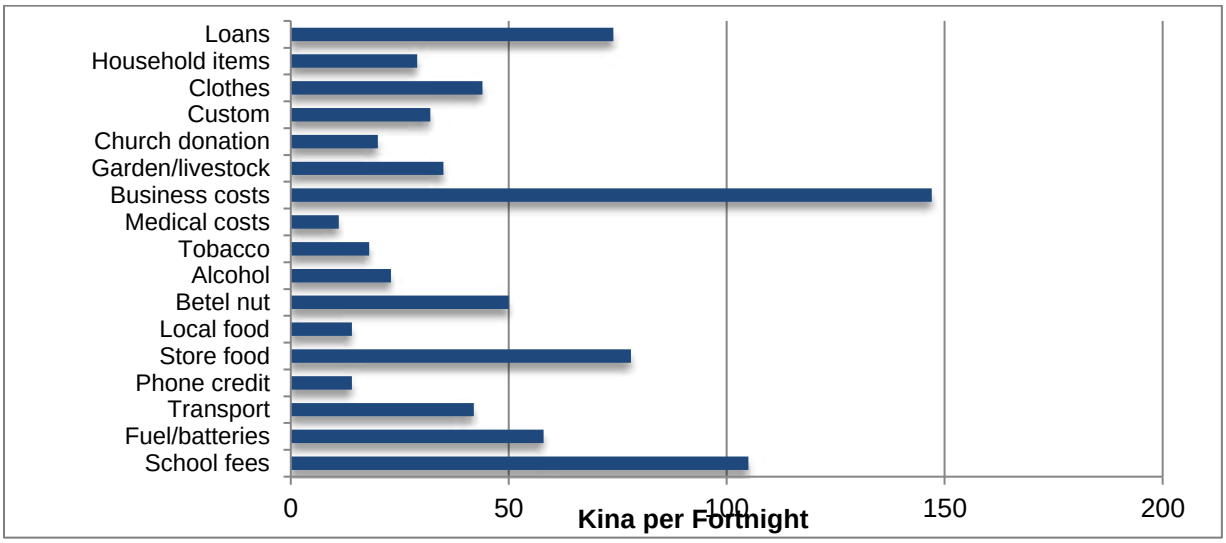

Figure 5.21: Fortnightly expenditure in villages (Study Area 1)

As shown in Figure 5.21, the majority of money is expended on business costs (28%), education (12%), store food (11%), fuel/batteries (7%) and transport costs (7%).

Although the National Government introduced its Tuition Fee Free Policy in 2012 (which provides for free tuition up to and including Grade 10), education costs include school project fees, travel to school, school clothes, food (while staying with relatives) and pocket money.

Survey results indicate considerable difference in expenditure between villages in this study area, as shown in Figure 5.22.

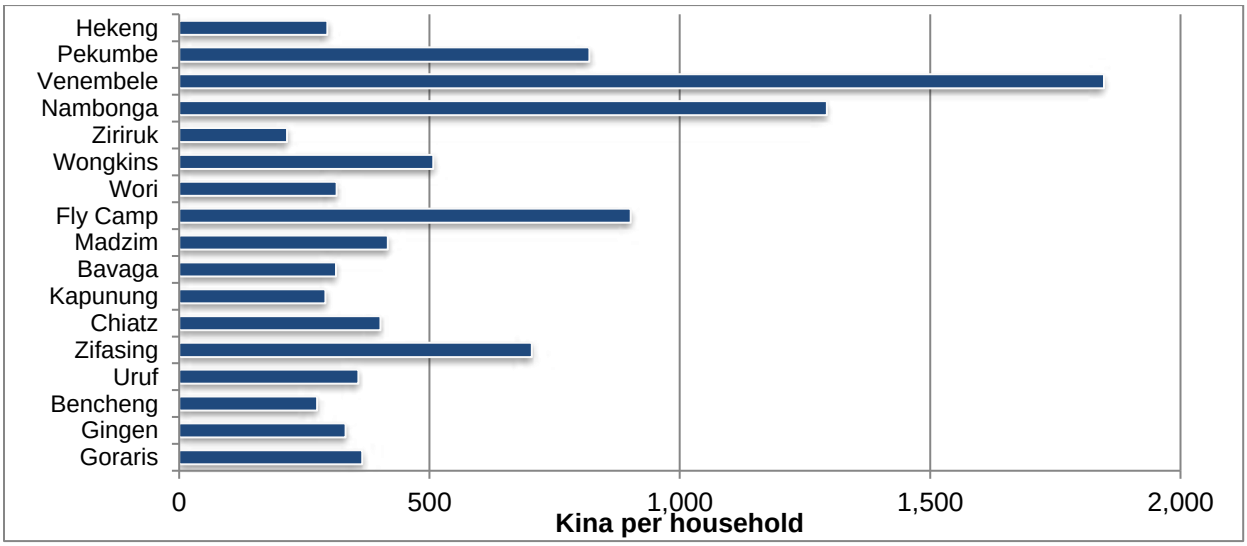

Figure 5.22: Fortnightly expenditure by villages in Study Area 1 (Zifasing included for comparison)

The highest levels of both average household income and average household expenditure occurred in Venembele and Nambonga. The lowest average level of expenditure occurred in Ziriruk, although low average expenditure also occurred in Kapunung, Wori and Bencheng. Some factors that may have affected the survey results include:

- An increase in expenditure at Zifasing as the two-week expenditure recording included the Easter period.
- An increase in expenditure at Chiatz as the two-week expenditure recording included the funeral of a prominent member of the community.

The distribution of household expenditure levels in villages surveyed in 2014 and 2015 is illustrated in Figure 5.23.

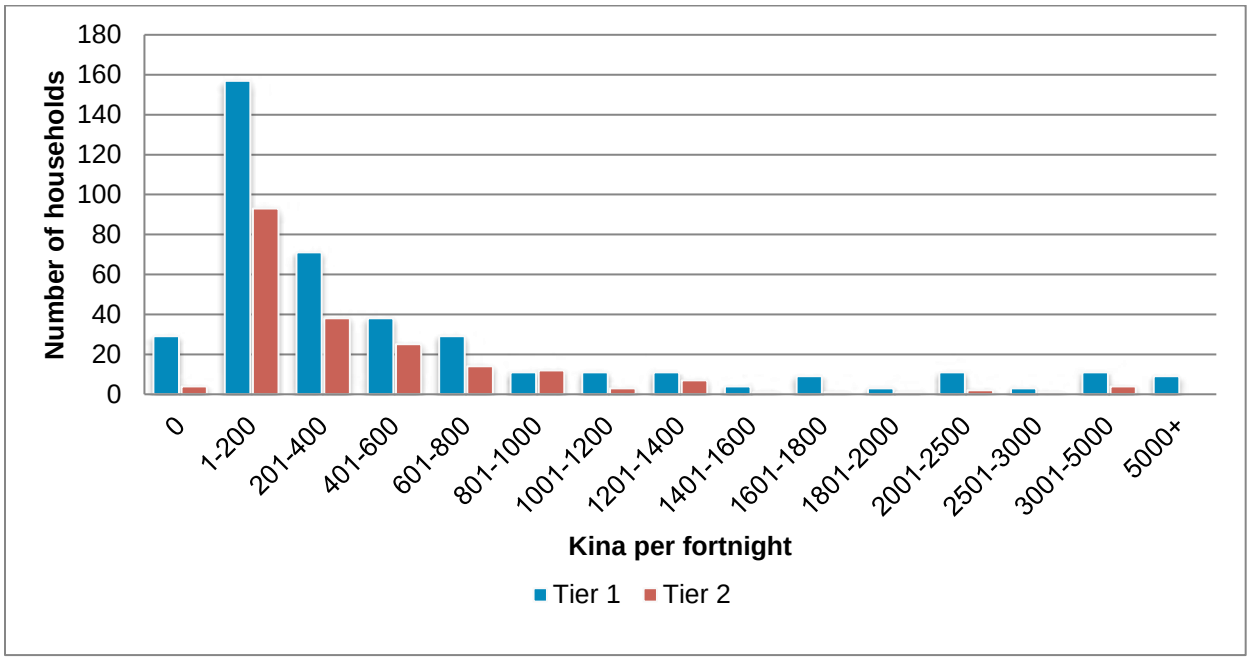

Figure 5.23: Household expenditure distribution, Tier 1 and Tier 2 villages

As shown in Figure 5.23, there is substantial variation in expenditure levels. Approximately 5% of households recorded no expenditure in the previous fortnight. Households with low expenditure were often (i) elderly people who relied heavily on relatives for food and other needs, or (ii) families that had been absent from the village (e.g. alluvial mining) and had no access to stores.

Survey respondents were asked if the level of expenditure was higher or lower than usual:

- 35% of respondents indicated their expenditure was higher than usual.
- 47% of respondents indicated their expenditure was about the same as usual.
- 18% of respondents indicated their expenditure was lower than usual.

While 85% of households recorded fortnightly expenditure of K1,000 or less, nine households (which represents about 1.5% of the total households surveyed) has fortnightly expenditure that exceeded K5,000. This level of expenditure was generally associated with business costs, such as buying store goods.

The median expenditure for the previous fortnight, which may be a more accurate reflection of 'typical' household expenditure levels, was PGK210 within Tier 1 villages and PGK215 within Tier 2 villages. This equates to per capita expenditure of approximately PGK1,000 per annum.

Expenditure decisions

Survey results from 2014 and 2015 indicated that in Tier 1 villages the husband and wife generally made shared expenditure decisions in approximately 60% of households. This is higher than results from 2012 Household Survey, which indicated that decisions on the use of income were shared between the husband and wife in 43% of households. However, almost 80% of households surveyed from Tier 2 villages indicated that the husband and wife made shared expenditure decisions.

Roadside stalls and stores

Information on stores and roadside stalls in Tier 1 and 2 was recorded during surveys in 2014 and 2015. The number of surveyed roadside stalls and stores at each village is provided in Table 5.12.

Table 5.12: Number of surveyed stalls and stores in selected villages of Tier 1 and 2

Village	Number of surveyed stalls	Number of surveyed stores
Zimake	4	-
Gingen	6	1
Bavaga	4	-
Fly Camp	2	-
Uruf	-	2
Bencheng	-	2
Chiatz	-	2

A record was made of the items for sale at each stall and store surveyed in Study Area 1. Betel nut and brus (tobacco) were the most prevalent items for sale across all roadside stalls. Mobile phone charge cards, food and drinks and garden produce are also common items for sale at roadside stalls. The trade stores generally contained a wide range of food items, particularly in comparison to trade stores in other relatively isolated parts of PNG. Many stores also sold a wide range of soaps, shampoo, other cleaning products, mobile phone credit, batteries, cooking utensils and other household items, cigarettes, beer and clothes.

As part of the survey, vendors were requested to nominate income earned through the sale of products for the previous week. The average income earned by stallholders and stores in each village is presented in Table 5.13. The average income recorded for the stalls in Bavaga was substantially higher than that recorded in the other villages. It is noted that there were only four stalls recorded in Bavaga in spite of it being a large village (recorded population in 2014 was 346 people) (Coffey, 2014a). There was a higher amount of traffic generated by WGJV and WGJV contractor vehicles which passed Bavaga yet did not continue through to Gingen and Zimake, which may have resulted in higher amounts of trade for stallholders.

Table 5.13: Average weekly income from sale of products at stalls and stores

Village	Average income at stalls (PGK/week)	Average income at store (PGK/week)
Zimake	714	-
Gingen	1,605	n/a

Village	Average income at stalls (PGK/week)	Average income at store (PGK/week)
Bavaga	2,454	-
Fly Camp	155	-
Uruf	-	363
Bencheng	-	140
Chiatz	-	270

Source: Coffey 2014 and 2015

Village trade stores were also operating in Hekeng (two), Venembele (three), Pekumbe (two), Madzim (one), Kapunung (two), Wongkins (three) and Wori (one). Several stores were not operating, and had generally been closed since 2013, when wage employment with the WGJV and their contractors ceased (in relation to that phase of Project development).

Store owners with road access (e.g. Bavaga, Gingen, Hekeng and Venembele) made regular trips to Lae to buy stock, often on a weekly basis. Trips from Pekumbe and villages along the Watut River were less frequent due to the additional travel costs and time required. A PMV from Hekeng to Lae costs PGK20 each way, and freight costs for cargo may cost PGK50 to PGK100 depending on the quantity of cargo. A return trip can be made in a day. From Uruf, it costs PGK50/person by boat to Forty Mile landing, K5/person to the Highlands Highway, and another PGK5/person to Lae, and approximately PGK800 to hire a boat to bring cargo back to Uruf or other nearby villages from Forty Mile. A round trip will generally take three days.

All but one store was privately run: this was a store in Pekumbe that was owned by the local youth group, with profits allocated to musical instruments and other products that could be utilised by the youth in the village.

Some trade stores were made of local materials, while others were made predominantly of iron sheets, as in Plate 5.10. Some store owners indicated that iron sheets provided added security, and were therefore less likely to have goods stolen.

Plate 5.10: Trade store, Venembele

Store foods and prices

The 2014 average price of selected store foods available in Hekeng, Venembele, Pekumbe, Kapunung Madzim and Timini is shown in Figure 5.24, along with a price of similar products from Lae.

As indicated in Figure 5.24, the prices in this study area are substantially higher than in Lae. When compared to prices in Lae, the average price of the five products shown in Figure 5.24 was 25% higher in Timini, 28% higher in Kapunung, 54% higher in Madzim, 65% higher in Venembele, 72% higher in Hekeng and 113% higher in Pekumbe. The higher prices are a reflection of the transport costs involved, however, given the relatively lower prices in Kapunung and Madzim, the prices in Hekeng, Venembele and Pekumbe appear to be artificially high, possible due to the relatively high income levels in these villages or their relative isolation south of the mine site.

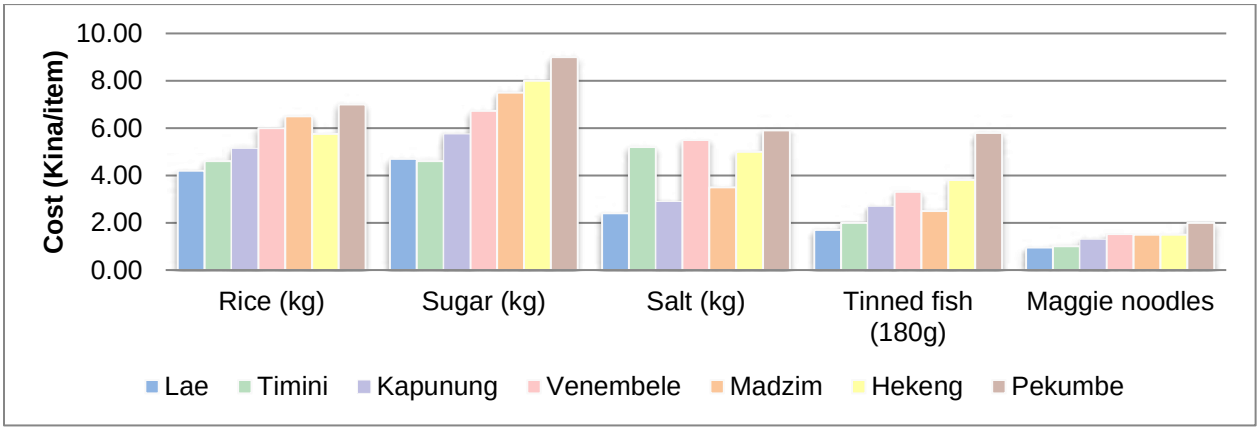

Figure 5.24: Price of common store goods in Study Area 1, 2014 (Lae presented for comparison)

As shown in Figure 5.25, additional price surveys conducted in 2015 for villages to the west and north of the mine site indicated similar disparities between food prices in Lae and villages in Study Area 1. When compared to prices in Lae, the average price of the five products shown in Figure 5.25 was 22% higher in Chiatz, 32% higher in Uruf, 34% higher in Gingen and 53% higher in Bencheng. By comparison, prices in Zifasing were lower than in the study area villages surveyed, although still 19% higher than in Lae. As for store prices in 2014, the prices in Gingen appear to be artificially high given the relative ease at accessing Lae from Gingen.

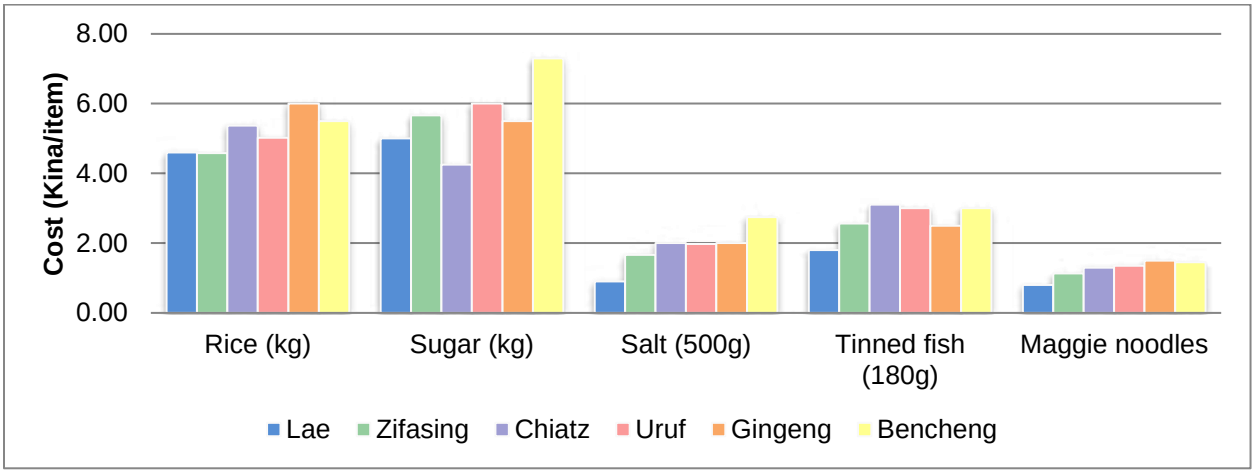

Figure 5.25: Price of common store goods, 2015 (Lae and Zifasing presented for comparison)

Banking

In the 2012 Household Survey, 35% of households in the study area indicated they had a bank account. The nearest branches or ATMs in Morobe Province are in Lae or Bulolo. However, many survey respondents indicated that gold is commonly used as a store of wealth, kept safely until needed. In addition, an average of PGK74 or 9% of total household expenditure was allocated to loans or loan repayments. This indicates there is likely to be a large informal credit market.

Commercial-scale business activities

No commercial-scale business operations were recorded in the study area.

5.1.7. Education

This section describes access to educational infrastructure and services, educational attainment and skills development in Study Area 1.

Access to educational infrastructure and services

Education is currently limited in several Tier 1 and 2 villages due to the distance required to travel to school. There were nine educational facilities identified in the study area (Figure 5.26) as outlined below.

The Zindaga School (located between Dengea and Gingen) provided grades Elementary 1 to Grade 8. Responses in the survey indicated that in 2012 there were eight male and three female teachers at the Zindaga School.

The WGJV has supported the construction of elementary schools in Hekeng, Pokwaluma, Zilani and Pekumbe (Plate 5.11) and provision of basic materials such as desks, chairs, blackboards and teaching materials. These schools became operational in 2015 even though they were in varying degrees of registration, with the WGJV providing allowances to teachers teaching in as-yet unregistered schools.

The Timini Elementary School provided Grade 1 to Grade 2 and Timini Primary School provided Grade 3 to Grade 8. Responses in the 2012 survey indicated that there were 11 male and five female teachers at the Timini School.

The Babuaf Christian Academy was a private school in Kapunung and has five teachers. There was also an elementary school at Wongkins which had three teachers. The numbers of students attending these schools is not known. Previously, there had been a primary school in Pokwaluma but this closed in 2007.

Chiatz, Bencheng and Zifasing have elementary and primary schools, which are also used by students from other villages. The Huon Gulf District Development Authority was constructing a new vocational school in TsileTsile at the time of survey (comprises Bencheng and Wampan in 2016).

Students from Goraris also attend Mafazano elementary school, which takes approximately one day’s travel to reach.

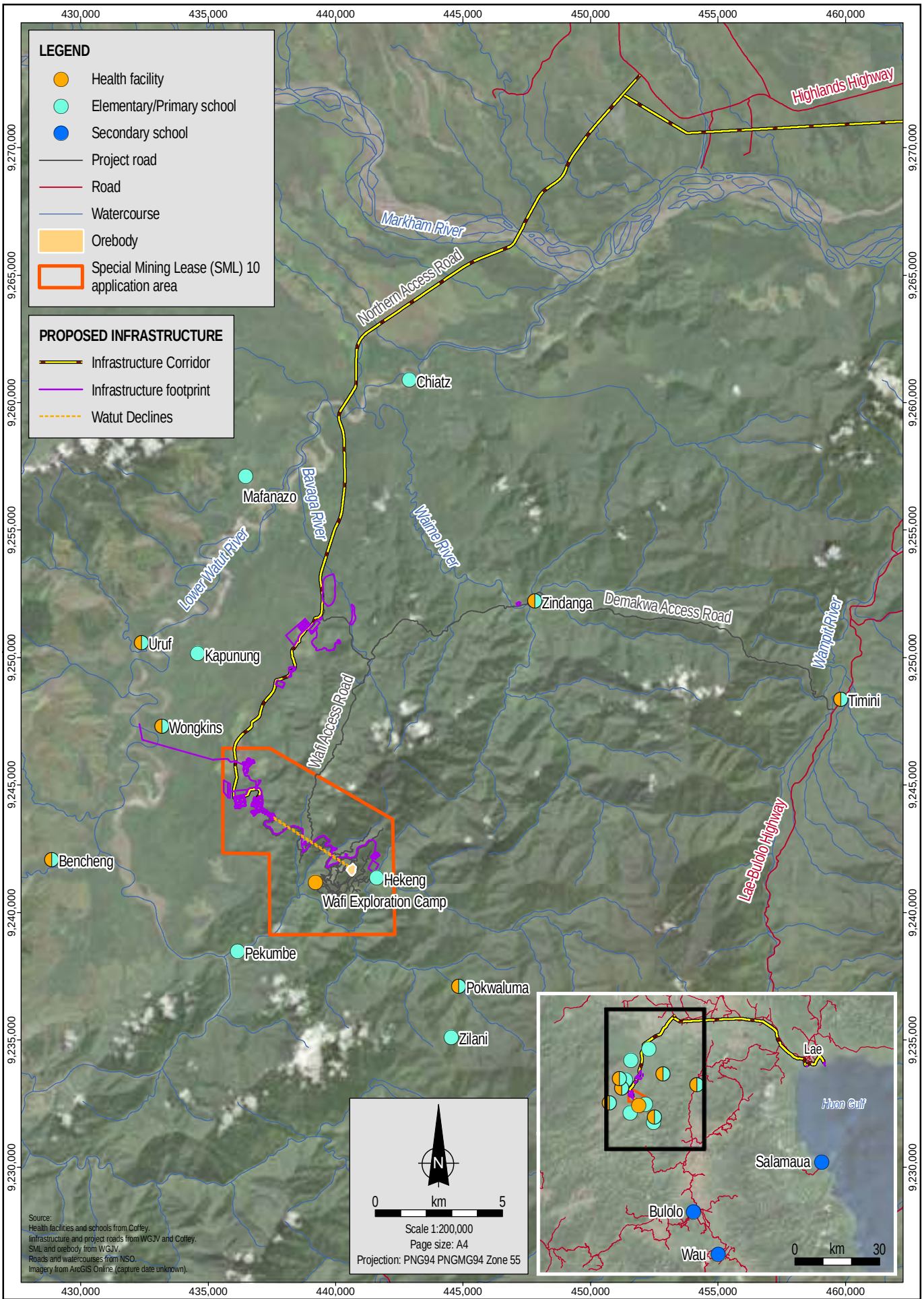

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Plate 5.11: New elementary school at Pekumbe, March 2014

Uruf has a primary school which is also accessed by residents from the villages of Wori, Madzim, Wongkins and Kapunung.

Modes of travel and travel times to these schools varied significantly. There were irregular transport services (generally trucks) running to and from villages with road access to schools in the study area. However, many Tier 2 villages often have no road access and therefore residents had to walk (and swim) to schools. Due to this access constraint, the residents of the following villages are not able to access any formal education facility:

- Fly Camp.
- Venembele.
- Nambonga.
- Pokwana.

Residents of Gingen, Kapunung, Wongkins, Dengea, Timini, Chiatz, Uruf, Bencheng and Goraris had the least distance to travel to educational facilities (up to 2 km), and attended schools in Zindaga, Timini, Kapunung, Wongkins, Chiatz, Mafazano, Bencheng, Zifasing or Uruf.

There are no secondary schools within Tier 1 and 2. Therefore, students attend the secondary school in Salamaua, Busu (Malany) Secondary School, Markham Valley Secondary School, Bugandi Secondary School, Baiyun or Grace Memorial Secondary schools. As travel times to these schools can take up to three days, the majority of secondary school students are at boarding schools or live with family members. At the time of survey, it was reported a new Wampar High School was being constructed by the Huon Gulf District Development Authority in 2016 at Wawin.

Educational attainment

In the Tier 1 and 2 villages surveyed in 2014 and 2015, 17% of males and 32% of females aged 10 years and above had no formal education. Although comparing favourably with results for PNG from the 2000 Census (Figure 5.27), it is low for a country that aspires to nine years of basic education (DoE, 2004).

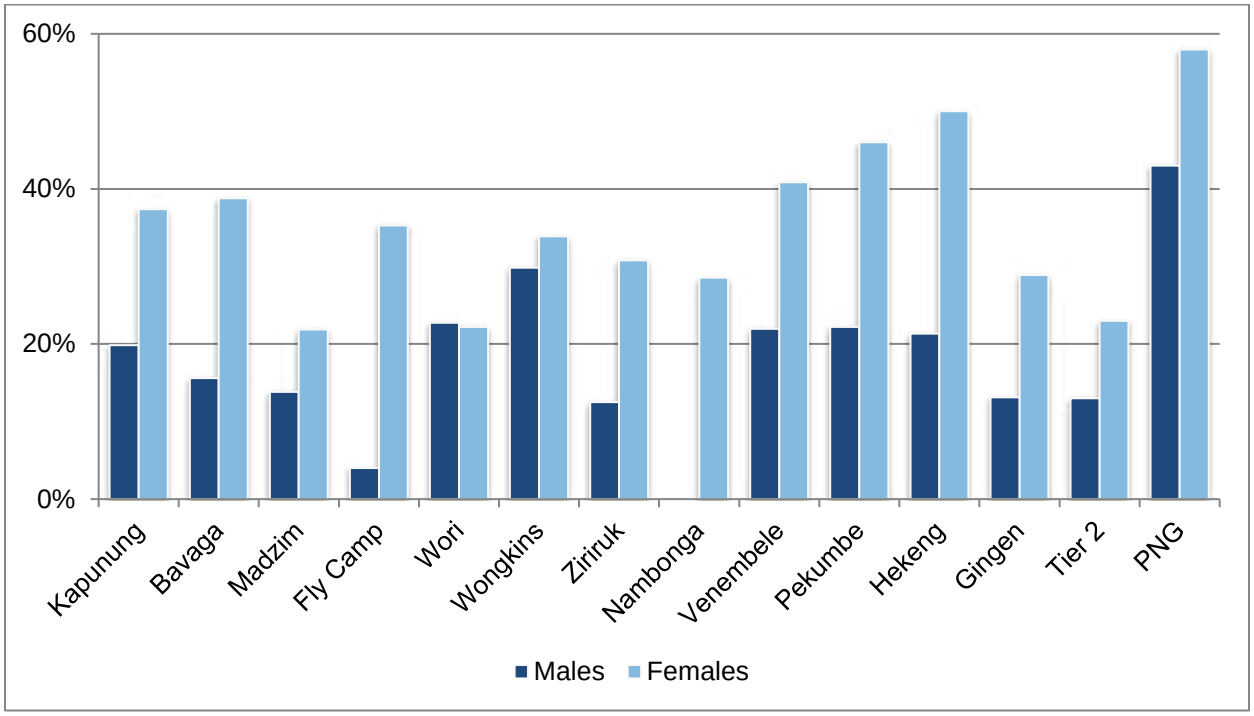


Figure 5.27: People aged 10 years and above with no formal education (Study Area 1)

The proportion of males with no education is highest in Wongkins (30%), while the highest proportion of females aged 10 years and above with no education is in Hekeng (50%), Pekumbe (46%) and Venembele (41%).

In the Mine Area villages surveyed in 2014 and 2015, 46% of males and 32% of females aged 10 years and above had completed Grade 6, and 15% of males and 6% of females aged 10 years and above had completed Grade 10. The proportion of males and females completing Grade 6 was low in comparison to PNG data for 2000, but the proportion completing Grade 10 is similar to results for PNG as a whole. The proportion of males and females aged 10 years and above who had completed Grade 6 and Grade 10 is presented by village in Table 5.14.

The relatively low proportion of people completing Grade 10 is possibly a reflection of the difficulty in accessing high schools or secondary schools from villages in this study area. The designated high school for those villages located in the Mumeng Rural LLG (Hekeng, Venembele, Nambonga, Pekumbe, Bavaga and Fly Camp) is at Bulolo, which was difficult to access prior to the construction of the Wafi Access and Demakwa Access roads, and remains difficult for villages without direct road access (such as Nambonga and Pekumbe). The remaining villages are located in the Wampar Rural LLG, and their designated high school is Salamaua High, which requires substantial travel from the Babuaf villages (Madzim, Wori, Wongkins, Kapunung or Ziriruk). The reported plan to construct the Wampar High School at Wawin in 2016 will serve to improve access to secondary education for these villages.

Table 5.14: Proportion of males/females completing Grade 6 and Grade 10 (Study Area 1)

Village	Males		Females	
	Grade 6	Grade 10	Grade 6	Grade 10
Hekeng	40%	8%	18%	1%
Venembele	34%	19%	22%	10%
Nambonga	48%	20%	57%	7%
Pekumbe	43%	19%	21%	3%
Madzim	26%	9%	23%	3%
Wongkins	21%	6%	16%	3%
Wori	41%	11%	25%	6%
Kapunung	35%	11%	14%	4%
Bavaga	42%	10%	28%	5%
Fly Camp	48%	16%	29%	0%
Ziriruk	44%	0%	23%	8%
Gingen	58%	18%	36%	7%
Tier 1	39%	13%	23%	5%
Tier 2	58%	18%	49%	10%
Survey villages	46%	15%	32%	6%
PNG	37%	7%	24%	3%

Source: NSO, 2001. Household Survey, 2014 and 2015.

The attendance rate for children of elementary and primary school age in Tier 1 and 2 is similarly low. The Department of Education intends that all children aged six to eight years should be attending elementary school, while children aged nine to 14 should be attending primary school (DoE, 2009). Figure 5.28 shows the proportion of children in these age groups who have no formal education.

Overall, in the Tier 1 and 2 villages surveyed in 2014 and 2015, 31% of boys and 41% of girls aged seven to 14 years of age had no formal education. As shown in Figure 5.28, the proportion of boys not attending school was highest in Wori, Ziriruk, Hekeng, Fly Camp and Venembele, while the proportion of girls not attending school was highest in Fly Camp, Hekeng, Bavaga, Wori and Pekumbe. Relatively few children from Hekeng, Bavaga and Fly Camp attend school, despite having direct road access and public motor vehicles (PMVs) that takes children to and from school on a daily basis. A higher proportion of children from Tier 2 villages attend school, but results are not consistent: a low proportion of children from Chiatz, Uruf and Bencheng had no formal education in comparison to Goraris, Tier 1 villages and Zifasing. Note that the WGJV provided a PMV to each of the Yanta and Hengambu groups, and these PMVs are used to transport children to and from school.

One reason for low school attendance in the study area may be that limited access to schooling is exacerbated by cultural barriers to attending a particular school. During surveys, it was revealed that some parents are reluctant to send children to schools serving different tribes, for fear of being seen as outsiders and teased. For example, one survey respondent stated that children from Venembele are more likely to attend primary school at Pokwaluma (a full day's walk in steep terrain), rather than at Zindaga (reached via PMV).

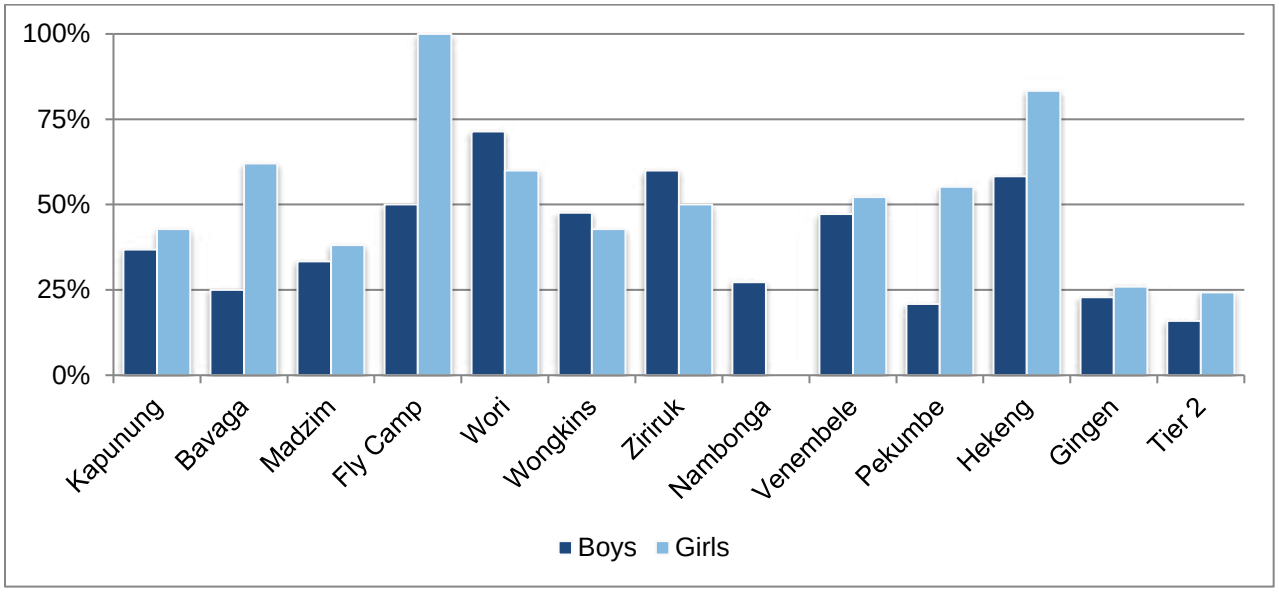


Figure 5.28: Proportion of school-aged children with no formal education in Study Area 1

Vocational training and higher education

As there are no vocational training or higher education institutions in Tier 1 and 2, the number of persons with a higher degree is very low. Only 4% of persons of Tier 2 villages aged 10 years or older had completed a degree or course at a vocational school, a technical college or a university. The construction of a vocational school in TsileTsile in 2016 will improve access to vocational training.

Non-school training was recorded for 87 household members from Tier 1 villages, which represented 11% of the population aged 15 years and above. The majority of training was directly related to current or previous employment with the WGJV, their predecessors or contractors. This included technical training (e.g. training to be a cook, computer training, truck driving, heavy machinery operation) and general training (e.g. inductions, safety, firefighting and emergency response training). The remainder of the training recorded included a range of technical and vocational training courses (e.g. welding, carpentry, mechanic, agriculture, police training, marketing, business). In addition, several people have been involved in short training courses provided by the WGJV, including alluvial mining, how to start a business, operating a trade store, etc.

Training in Tier 2 villages had less focus on mining activities and more on agriculture (predominantly cocoa), business and refresher courses for jobs such as village magistrates, policemen, teachers and health workers. However, some training could also be applicable to the mining industry, including training in basic trades (mechanical and electrical), security and machinery operators.

5.1.8. Health

This section provides an overview of health in Study Area 1 including access to health services, life expectancy and mortality, disease and infection, food and nutrition, and tobacco, betel nut and alcohol consumption. The information in this section was gathered during the studies listed in Section 3.3.1.

Overall, access to health services within the study area is variable, with Tier 1 communities benefiting from the establishment and support of health services by the WGJV. Among the main illnesses suffered

are respiratory infections, malaria and diarrhoea, with additional issues arising in relation to maternal health care and nutrition.

The Centre for Environmental Health Wafi Mining Limited Baseline Health Survey reported that overall there was a high proportion of villagers in Tier 1 and 2 whose health status in the previous 12 months was perceived as good or very good, varying between 70% (Gingen) and 96% (Pekumbe and Timini). In the villages of Gingen and Hekeng, there was a significant proportion of respondents who that reported their health as 'fair', 27.8% and 21.3% respectively. Villagers' self-reported common complaints over the previous 7 days included a high prevalence of fever (associated with malaria), diarrhoea, and cough (CEH, 2007).

Access to health services

With regard to Tier 1 villages, in 2015 there were four recorded health related facilities:

- Wongkins aid post.
- Zindaga School aid post (now the Zindaga health sub-centre).
- Wafi health clinic located adjacent to existing project exploration camp.
- Pokwaluma aid post.

In 2015 the following health related facilities were recorded in or in close proximity to Tier 2 villages:

- ANGAU Hospital in Lae.
- Labu Butu aid post.
- Zindaga aid post.
- Zifasing aid post.
- Timini aid post (constructed in 2015).
- Tsile Tsile aid post (not operating in 2015).
- Uruf Aid Post.
- Wampar (Chamber) sub-health centre in Nadzab.

The locations of the health facilities in relation to Tier 1 and 2 communities is shown in Figure 5.26 in Section 5.1.7. Table 5.15 provides a summary of the closest aid facility, the distance from villages in Study Area 1 and the means by which residents most commonly access the facility.

Tier 1 villages generally had reasonable access to a health facility. This is primarily due to the support provided by the WGJV which resulted in the establishment of the Wafi health clinic, Wongkins aid post and recently the Timini aid post. Additionally, WGJV recently renovated the Pokwaluma aid post. The villages with lowest accessibility to a health facility were the Babuaf villages of Madzim and Kapunung which do not have road access and are located some distance from the Wongkins aid post.

There is varying access to health facilities across the Tier 2 villages, with some village residents travelling up to two hours by foot to access the nearest health facility. A benefit is relative proximity to the highest order health facilities in the region such as the ANGAU Hospital in Lae and Wampar health clinic in Nadzab.

Table 5.15: Distance to nearest health infrastructure in Tier 1 and 2 communities

Village	Closest health facility	Approximate distance	Most common means of access/ approximate time
Tier 1			
Hekeng	Wafi clinic	3.0 km	Walk/ 1 hour
Venembele	Wafi clinic	2.5 km	Walk/ 1 hour
Nambonga	Wafi clinic	1.5 km	Walk/ 1 hour
Pekumbe	Wafi clinic	3.5 km	Walk/ 3 hours
Madzim	Wongkins aid post	5.0 km	Walk/ 3 hours Boat (30 mins)
Wori	Wongkins aid post	2 km	Walk/ 1 hour
Wongkins	Wongkins aid post	2 km	Walk/ 1 hour
Kapunung	Wongkins aid post	4.5 km	Walk/ 3 hours Boat (30 mins)
Ziriruk	Wongkins aid post	4.5 km	Walk/ 3 hours
Papas	Wongkins aid post	<1 km	Walk/ 10 mins
Gingen	Zindanga aid post	2 km	Walk/ 1 hour
Bavaga	Wafi clinic	8 km	Walk/ 2.5 hours
Fly Camp	Wafi clinic	4 km	Walk/ 2 hours
Pokwaluma	Pokwaluma	<1 km	Walk/ 10 mins
Pokwana	Wafi clinic	3 km	Walk/ 1.5 hours
Zilani	Wafi clinic	2 km	Walk/ 1 hour
Tier 2			
Timini	Timini aid post	<1 km	Walk/ 10 mins
Dengea	Zindaga aid post	2 km	Walk/ 1 hour
Zimake	Zindaga aid post	2 km	Walk/ 1 hour
Goraris	Zifasing aid post	6.5 km	Boat 30 mins and Walk 1 hour or PMV 10 Mins
Chiatz	Zifasing aid post	14.5 km	Boat 1 hour and Walk 1 hour or PMV 10 mins
Uruf	Uruf aid post	<1 km	Walk/ 10 min.
Mafanazo	Uruf aid post	7.7 km	Walk/ 1 hour
Kokok	Zifasing aid post	5.5 km	Walk/ 2 hours
Ngarubuaring	Zifasing aid post	12 km	Boat 1 hour and Walk 1 hour or PMV 10 mins
Wampan	Tsile Tsile aid post (Wafi clinic as Tsile Tsile not operating)	4 km (9 km)	Walk/ 2 hours (Boat 40 mins and Walk 3 hours)
Bencheng	Tsile Tsile aid post (Wafi clinic as Tsile Tsile not operating)	2 km (8 km)	Walk/ 1 hour (Boat 30 mins and Walk 3 hours)
Maralina	Wafi clinic	6 km	Boat 10 mins and Walk 3 hours

However, proximity to health facilities does not necessarily translate to access to health services. Commonly, aid posts are closed due to there being no staff on duty or no supplies to administer. The Tsile Tsile aid post for instance was not operating at the time when socioeconomic surveys were undertaken in 2015. Similarly, the Wongkins aid post reportedly is commonly closed. It was reported by residents of most villages that accessing medicines was difficult because they cannot be obtained at local trade stores when aid posts are closed. This promoted a continued reliance upon bush medicines.

A key measure to overcome the inaccessibility of health services in PNG is medical patrols administered by the Provincial Government through respective Local Level governments. It was reported that the Mumeng LLG Health Patrol had visited some of the Tier 1 and some of the Tier 2 villages in 2014. Similarly, the Wampar LLG Health Patrol had visited some of the Tier 1 villages and some of the Tier 2 villages in 2013 and 2014.

With regard to access to maternal health services in Tier 1 and 2 villages, the 2012 Public Health and Biomedical Survey (Abt JTA, 2013a) found that whilst there was little evidence of pre- or post-natal services, that self-reported access to such services was quite good with the majority of child-bearing women reportedly having received prenatal care (77%), tetanus vaccination during pregnancy (77.8%), iron supplementation (77.3%), and antimalarial drug prevention (78.3%) during their most recent pregnancy. The rate of supervised delivery was fairly high among the surveyed women, with supervision either being by a trained birth attendant (50.3%), or a health worker (33.3%) (Abt JTA, 2013a). The WGJV have supported the training of village birth attendants in villages in the study area.

The 2015 socioeconomic surveys gathered some information on maternal health care for Tier 1 and 2 villages as presented in Table 5.16.

Table 5.16: Village birth information for Tier 1 and 2 villages

Village	Percentage of babies born in village (%)	Supervisor of village births
Chiatz	10	Trained village birth attendant
Gingen	10	Trained village birth attendant
Goraris	99	Trained village birth attendant
Bencheng	50	Trained village birth attendant
Uruf	99	Trained village birth attendant
Zifasing	20	Trained village birth attendant
Mafanazo	15	Trained village birth attendant and traditional birth attendant
Kokok	10	Traditional birth attendant
Ngarubuaring	50	Traditional birth attendant

Source: Coffey Environments, 2015 and Abt JTA, 2013a

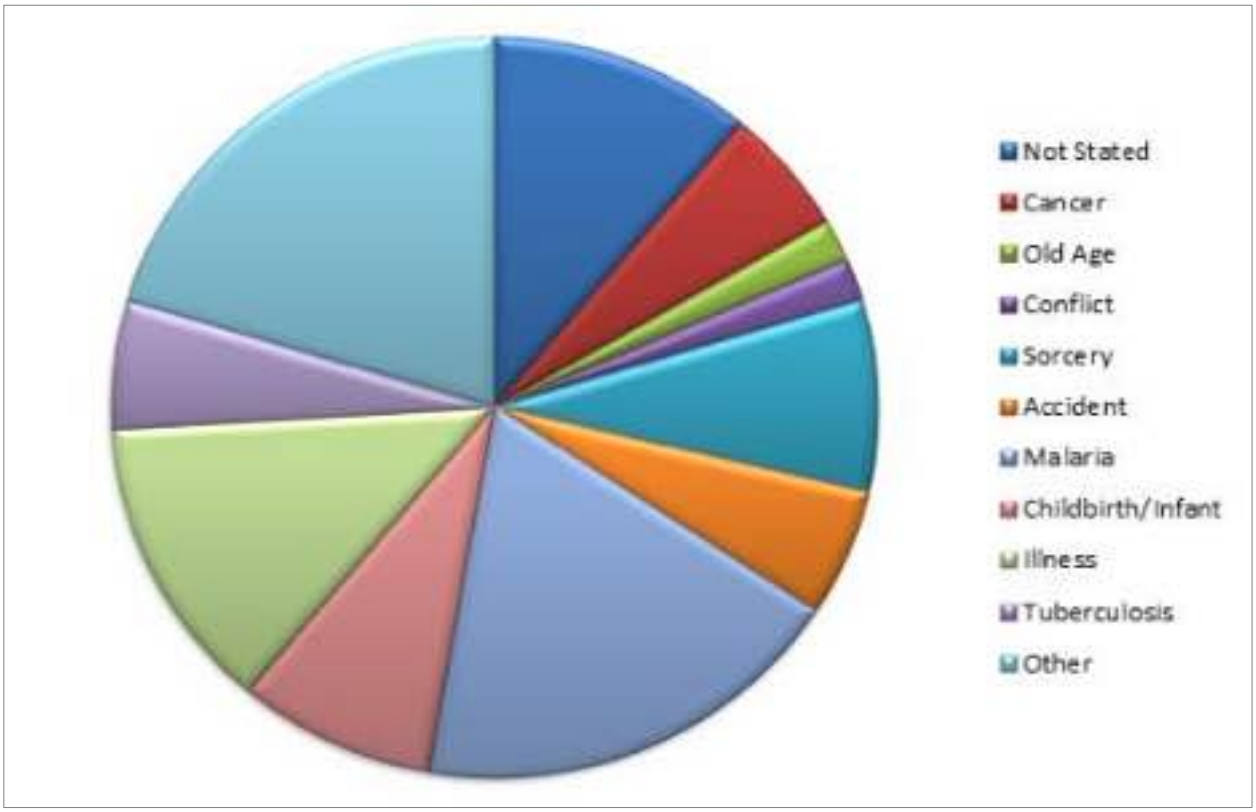
Whilst indicative only, it was clear that most villages within Study Area 1 had a trained village birth attendant who supervised births in the village. There were varying results with regard to proportion of babies born in the village. In Uruf and Goraris almost all babies were born in the village while in Gingen, Chiatz and Kokok comparatively few babies were born in the village. Access to road is the notable differentiator between these villages as Gingen and Chiatz all have road access while Goraris and Uruf are on the Watut River and are not connected to the road network.

Life expectancy and mortality

The demographic data collected through socioeconomic surveys provide an indication of life expectation and mortality in the study area. The average age of residents of Tier 1 villages was estimated to be 18 years in 2015. This was slightly lower than the average age of the population of PNG which is estimated to be 19.7 years. Additionally, the proportion of the population aged over 65 years (1.4%) was lower than the proportion of the population of PNG aged over 65 years (2.1%). This suggests that average life expectancy of residents of Tier 1 villages is lower than that of PNG (62 years for males and 65 years for females). It is notable that there was substantial variation across Tier 1 villages. For instance, the average age of residents of Pokwana was just 12 years with no persons aged over 65 years, whilst in Madzim the average age was 20 years with 2.1% of the population aged over 65 years.

Tier 2 villages recorded an average age (19 years) and proportion of the population aged over 65 years (2.1%) which was comparable with that of the population of PNG.

Socioeconomic surveys undertaken in 2012 collected information regarding the cause of death of those who had recently died (in the last year). The reasons provided for cause of death are displayed in Figure 5.29. The most prevalent reported cause of death was malaria (21.2%), followed by general illness (14.9%). Death from child birth and sorcery were both reported to be 9.6%, which was higher than tuberculosis (6.4%), accidents (6.4%) and cancer (6.4%) (Coffey Environments, 2013).



Source: Coffey Environments, 2013

Figure 5.29: Reported causes of death in Tier 1 and 2 villages

Illness and infection

Within the Tier 1 and 2 communities, respiratory infections, diarrhoea and parasites (malaria and lymphatic filariasis) are among the major illnesses suffered. The 2012 Household Survey requested each household identify any illnesses which had occurred in the last month. In the 17 villages surveyed, it was reported that 318 persons had been ill in the last month. Table 5.17 summarises survey results asking respondents to self-identify what illnesses were suffered in the month prior to the survey. While self-diagnosis must be treated with some scepticism, the results do indicate the general nature of illnesses suffered at the time of survey, with flu and cold reportedly the most common illness, followed by malaria and fever. The most commonly afflicted member of the household were adult females, followed by male child and adult.

Note that 'not specified' relates to households which had indicated that someone had been ill in the last month but did not specify the illness nor who was afflicted.

Table 5.17: Illnesses reported in Study Area 1 in the month prior to September 2012

	Adult male	Adult female	Male child	Female child	Children	Not specified	Total
Malaria	16	13	21	12	6	-	68
Flu/cold	18	17	12	9	14	-	70
Fever	9	5	17	13	6	-	50
Tuberculosis	2	1	1	-	1	-	5
Injury	-	-	1	-	1	-	2
Headache	4	4	1	2	-	-	11
Backache	5	15	-	1	-	-	21
Chest-pain	-	1	-	-	-	-	1
Other	-	11	3	2	5	69	90
Total	54	67	56	39	33	69	318

Respiratory infections

The 2012 Public Health and Biomedical Survey (Abt JTA, 2013a) found acute respiratory infections, including tuberculosis, to be the most frequent acute illness amongst those surveyed. (HIV and malaria were beyond the scope of the survey.) A total of 18.3% of survey respondents from Study Area 1 reported acute respiratory infections symptoms in the seven days prior. Two villages, Madzim and Hekeng, reported acute respiratory infections symptom rates of 29.4% indicating possible outbreaks of respiratory illnesses in those villages at the time of the survey.

According to the 2012 Public Health and Biomedical survey (Abt JTA, 2013a), indoor air quality and household density are known risk factors for respiratory illness. Reduced air quality, for example from indoor fires or tobacco smoking, is particularly hazardous for children who have smaller airways which are more prone to irritation. Close proximity of household residents (for example, while sleeping) increases the opportunity for droplet-borne pathogens to transmit from person to person. The reported median household occupancy amongst those surveyed was five people, with an average of 2.5 persons sleeping in each room used for sleeping. In 66% of surveyed households, indoor wood fires without flues were used for cooking. This form of cooking is particularly harmful to respiratory health as atmospheric dispersion of suspended particulate matter generated by the fire is inhibited by the walls and ceiling of the house, thus increasing exposure among residents.

Diarrhoea

Diarrhoea was also commonly reported in the study area. The 2012 Public Health and Biomedical survey recorded that 13.9% of the surveyed population self-reported diarrhoea in the 12 months prior to the survey. As part of the survey, primary water sources were tested for the prevalence of faecal coliform, the most common cause of diarrhoea. It was found that in 10 of the 11 villages in which the survey was undertaken that faecal coliform levels were elevated. The only village in Study Area 1 in which faecal coliform was not detected in the water source was Gingen.

Lymphatic filariasis and malaria

Two mosquito-borne parasites were also reported: lymphatic filariasis and malaria. With regard to lymphatic filariasis, the 2012 Public Health and Biomedical Survey found (using a field Immunochromatographic tests filariasis antigen detection kit) an overall lymphatic filariasis seroprevalence of 1.8% (9/508) of the population. This result means that Study Area 1 falls into WHO's Global Program for the Elimination of Lymphatic Filariasis' 'low endemic' category for lymphatic filariasis. The village of Gingen reported the highest sero-prevalence rates of all surveyed villages at 12% (highly endemic) of the surveyed population (Abt JTA, 2013a).

The prevalence of malaria is not known, because testing for malaria was outside of the scope of the 2012 Public Health and Biomedical Survey. However, the subsequent report by Abt JTA provides some insights. It states that 70% of malaria cases are due to *P. falciparum*, with *P. vivax* accounting for the majority of other cases. Around the existing Wafi/Golpu camp, there is a medium to high risk of malaria transmission, with the highest risk occurring during the rainy season. Around the Wafi-Golpu proposed site for the new camp, malaria transmission risk is high, occurring all year round. Mosquito vector species likely to be present around the mining sites include *Anopheles (An). hinesorium*, *An. kolinsis*, and *An. punctulatus* (Root et al., 2010). These Anopheles mosquitos depend on the presence of stagnant, unpolluted water, as well as favourable climatic conditions such as high temperature and high humidity, to breed and transmit malaria.

In June 2012, the WGJV commissioned Oil Search Health Foundation to develop and implement a five-year Malaria Management Project which sought to decrease the impact of malaria in communities surrounding the Wafi-Golpu Project (Oil Search Health Foundation, 2013). Prior to the Oil Search Health Foundation project, in 2011, the WGJV commissioned Montrose to undertake a review of malaria risk and control measures at the existing Wafi accommodation camp and the (then) proposed Finchif accommodation camp. The study found that malaria was the most commonly recorded presentation at the Wafi health clinic and concluded that both the Wafi and Finchif accommodation camps were located in areas which provided a very high risk of malarial infection (Montrose, 2011).

Prevention and treatment of illnesses and infections

The 2012 Public Health and Biomedical Survey collected information regarding immunisation, all surveyed villages received relatively high BCG (tuberculosis) vaccine coverage; however, coverage of the first dose of measles and pentavalent vaccine was generally inadequate (Abt JTA, 2013a).

Records from the Wafi Health Clinic and the Zifasing Health Clinic for the months of January and February 2015 are provided in Table 5.18. Simple cough was the most commonly treated condition at both Zifasing Aid Post and Wafi Medical Centre. Wafi Medical Centre had significantly higher rates of respiratory illness. Malaria was diagnosed more frequently at Wafi Medical Centre but this could be due to better diagnostics. Clinical diagnosis was not available at Zifasing and the aid post relied on slide and rapid diagnostic test diagnosis.

Table 5.18: Outpatient treatments at Wafi Health Centre and Zifasing Aid Post

		January				February			
		Zifasing		Wafi Medical Centre		Zifasing		Wafi Medical Centre	
		Male	Female	Male	Female	Male	Female	Male	Female
Measles		-	-	-	-	-	-	-	-
Simple cough		60	70	57	60	68	66	30	26
Pneumonia	**<1 year**	4	5	2	2	4	7	-	2
	1 to 4 years	8	8	1	2	9	5	-	-
	5 years+	14	7	5	4	16	15	1	1
Chronic obstructive pulmonary disease		-	-	2	1	-	-	1	-
Other respiratory		6	3	56	54	6	5	19	28
Diarrhoea	**<1 year**	2	1	1	-	0	1	-	-
	1 to 4 years	10	0	1	-	13	5	1	-
	5 years+	2	0	3	3	1	2	2	1
Malaria	**Slide or rapid diagnostic test diagnosis**	5	3	4	4	9	8	7	4
	Clinical diagnosis	-	-	18	22	-	-	6	11
Anaemia		1	0	1	2	2	0	-	-

Food and nutrition

The 2012 Health and Biomedical Survey (Abt JTA, 2013a) found indicators of all forms of nutritional imbalances in Study Area 1. Survey Body Mass Index results showed that a notable proportion of the surveyed population were both underweight (7.29% of adults and 7% of children) and overweight or obese (24.74% of adults and 11% of children). Middle upper arm circumference measurement results showed that three children less than five years of age - all from Zilani - were either moderately or severely malnourished.

Anaemia is a commonly used biomarker for population nutritional status. Among the surveyed villages anaemia was notably high with 37% of children (five to 14 years); 19% of non-pregnant women; and 13% of adult men suffering some form of anaemia. All villages surveyed had some degree of malnutrition and over nutrition; the patterns of nutritional disorder varying within and between surveyed communities. Approximately half of the survey participants reported not having enough food to feed their families ‘some’ or ‘most’ days. This indicates food inequity issues as some villages are experiencing food insecurity issues, while others have over nutrition. The degree of isolation, economic status and access to formal employment were proposed as determinants for nutritional status. Hekeng and Madzim reported both poorer nutritional status compared to other study villages, as well as higher food insecurity.

The Centre for Environmental Health 2007 health survey of villages in Study Area 1 also identified nutritional differences within and between the communities surveyed. The degree of geographic isolation and access to formal employment (and hence income) were found to be major determinants to nutritional sufficiency (CEH 2007). The Centre for Environmental Health (CEH, 2007) found that the adult male

weights in Timini (62.4 kg) and Madzim (67.5 kg) were markedly higher than other villages studied (range of 54.5 to 57 kg). The Centre for Environmental Health hypothesised that the difference in these villages was due to higher levels of employment (within the mining sector) and socioeconomic standard.

The traditional diets in all villages in Study Area 1 rely on garden produce, supplemented by hunting, collecting and fishing. The main garden staples include bananas, sweet potato and taro. Gardening often remains a daily activity, while hunting and fishing is also undertaken on a regular basis. As these villages have relatively high-income levels, the diets are also supplemented by a range of store foods. Figure 5.30 presents the findings of the 2012 household survey by Coffey in relation to the frequency with which foods were consumed on the day prior to the survey. This indicates that a wide variety of foods were consumed in the villages surveyed. The consumption of store foods was found to be high despite the relative isolation of many of the villages: rice was consumed the day before the survey by 43% of respondents, tinned fish/meat by 33% of respondents. The consumption of store food appears to have risen substantially in the last decade. Jackson (2004) reported that only 4% of survey respondents consumed tinned fish or tinned meat with their previous evening meal, in comparison to 21% who consumed locally caught fish, meat from wild animals, or eggs.

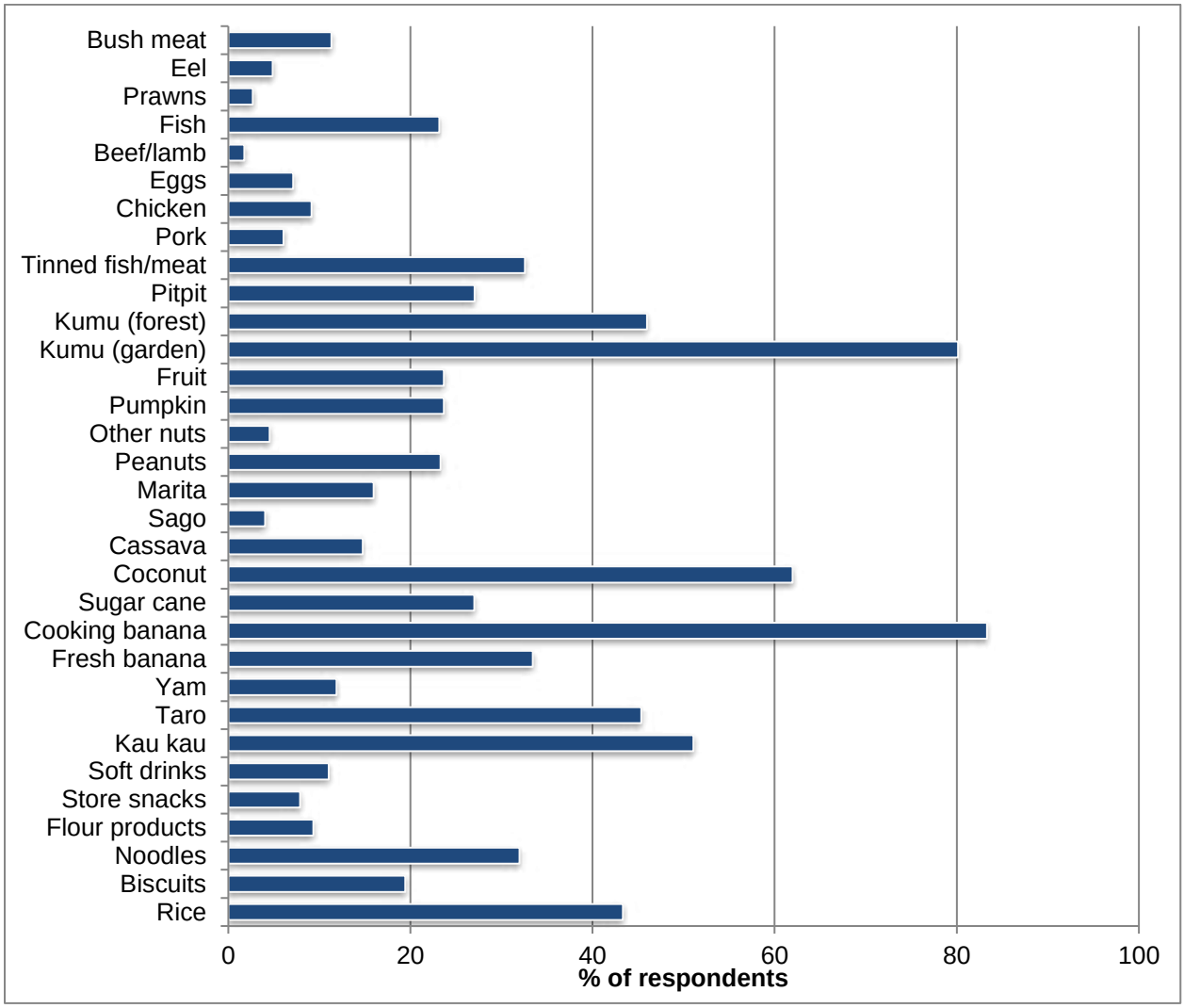


Figure 5.30: Type of food consumed by perecentage of survey respondents

Due to the network of social obligations that operates even when household members do not or cannot hunt, meat is provided to them by extended family members or other kin. This is particularly the case with new households that are comprised of young people with babies. A large animal catch or fish haul may be shared amongst several households and is reciprocated in kind at another time with meat or surplus garden crops.

A summary of the importance of different sources of food to households in this study are is provided in Table 5.19. (Some respondents nominated multiple sources as having equal rank; therefore, the sum total of each column exceeds 100%.)

Table 5.19: Sources of food in Study Area 1

Source	Rank	Highest	Second highest
Gardens	1	97.19%	2.62%
Store	2	4.23%	37.32%
Hunting	3	1.63%	22.76%
Fishing	4	1.36%	38.01%
Market	5	1.50%	5.26%

Garden produce was identified as the most important source of food and most commonly consumed type of food in Study Area 1. Of all households surveyed 97.2% identified gardens as the highest-ranking source of food. This is followed by store foods and fishing.

Some differences in the frequency in which foods were consumed were observed between males and females. As shown in Figure 5.31, a higher proportion of males in Tier 2 villages consumed taro, fresh banana, fish and bush meat, while a higher proportion of females consumed biscuits, soft drinks and other fruit. There was little difference in the proportion of males or females who consumed rice, cooking banana, coconut, kumu or tinned fish/meat. It is difficult to explain the differences shown in Figure 5.31, as the sample size is considered adequate (124 males and 58 females). However, there is a potential for different food consumption habits between males and females.

Households in Study Area 1 spent an average of PGK69 on store foods in the previous fortnight, which equates to 11% of total household expenditure. An additional PGK13 per household was expended on other locally available food in the past fortnight. Despite significant expenditure on store foods, locally produced foods form the core component of the diet. The most frequently consumed garden foods on the day prior to the survey were cooking bananas (consumed by 83% of respondents), garden kumu (leafy green vegetables grown in food gardens, 80%), coconut (62%), sweet potato (51%), forest kumu (leaves, shoots and ferns from the forest, 46%) and taro (45%).

In addition to cultivated crops, a number of foods were commonly consumed from the local waterways and forest. The most frequently consumed foods from the surrounding environment included forest kumu (46%), fish (23%), wild animals (11%), eels (5%) and prawns (3%).

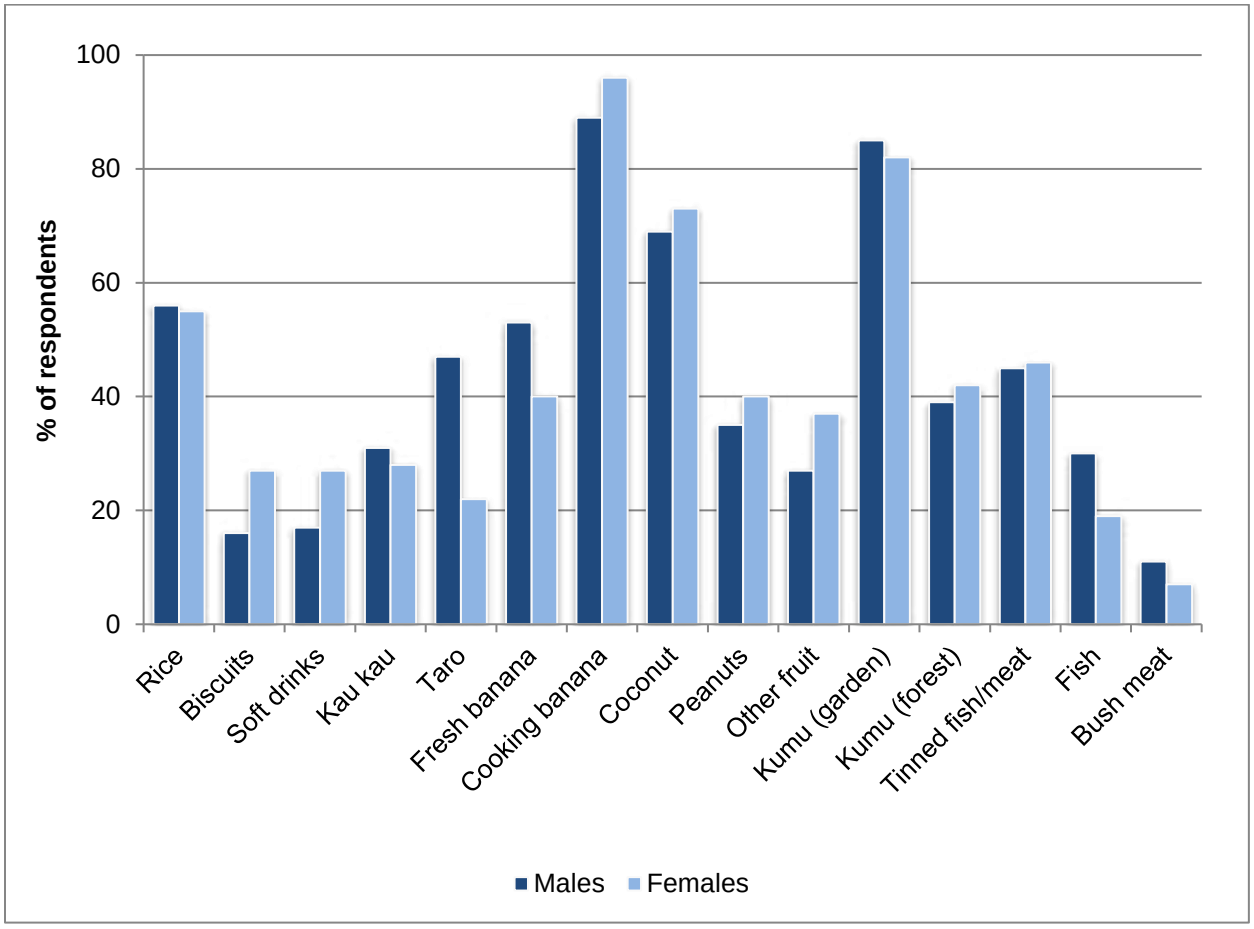


Figure 5.31: Type of food consumed by percentage of survey respondents in Tier 2 villages

There was little difference in the food consumption patterns between Tier 1 and Tier 2 villages, although there was considerable difference between individual villages. As a comparison between a village with relatively low levels of accessibility (i.e., no road access) and a village with high levels of accessibility (i.e., on the Highlands Highway) the frequency in which residents of Pekumbe and Zifasing consumed store and other purchased foods is shown in Figure 5.32.

As shown in in Figure 5.32, survey respondents from Zifasing consumed most store foods far more frequently than survey respondents from Pekumbe. This is expected to be a result of several factors:

- Income levels in the fortnight prior to the survey were higher in Zifasing.
- The price of store foods in Pekumbe is higher than in Zifasing.
- The residents of Pekumbe are likely to have a more traditional diet due in part to the limitations of accessing store food, and due in part to the relative abundance of fish, wild animals and various forest products (in comparison to Zifasing, that has a relatively high population density and a long history of relatively intensive cultivation).

To some degree, the food consumption patterns of Zifasing residents are likely to be replicated in other study area villages in the future as income levels rise, access to Lae improves, and the residents have a desire to consume more store foods.

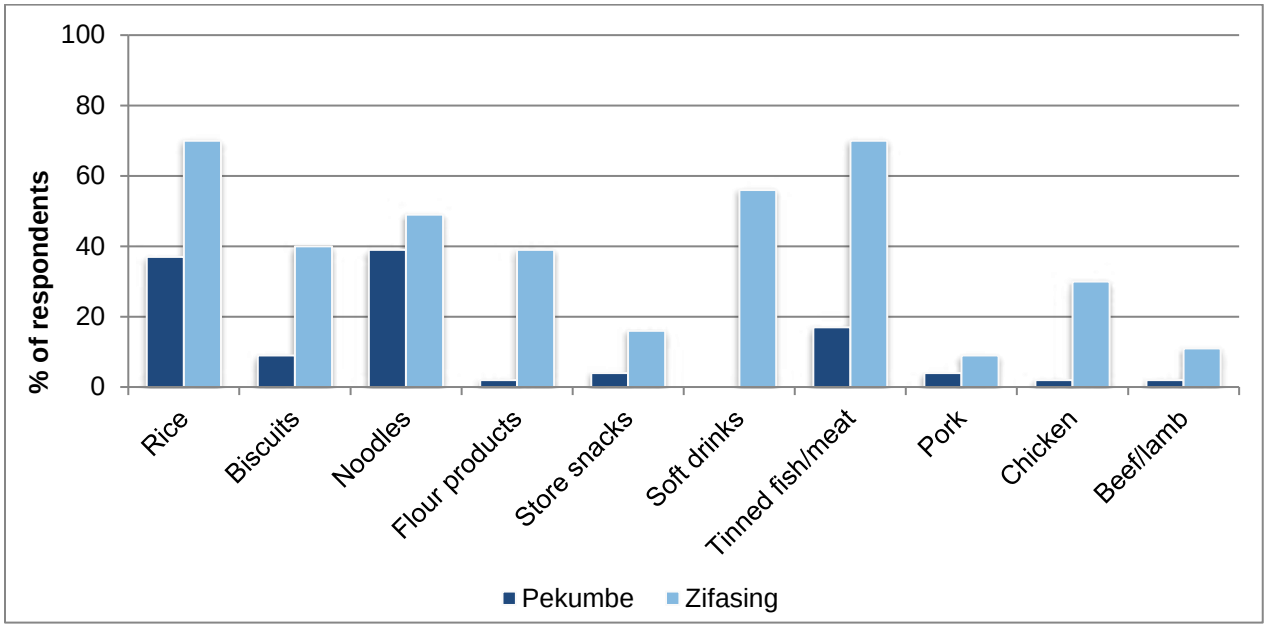


Figure 5.32: Consumption of purchased foods, Pekumbe and Zifasing

Tobacco, betel nut and alcohol consumption

The frequency in which tobacco products and betel nut was consumed in study area villages surveyed is shown in Figure 5.33.

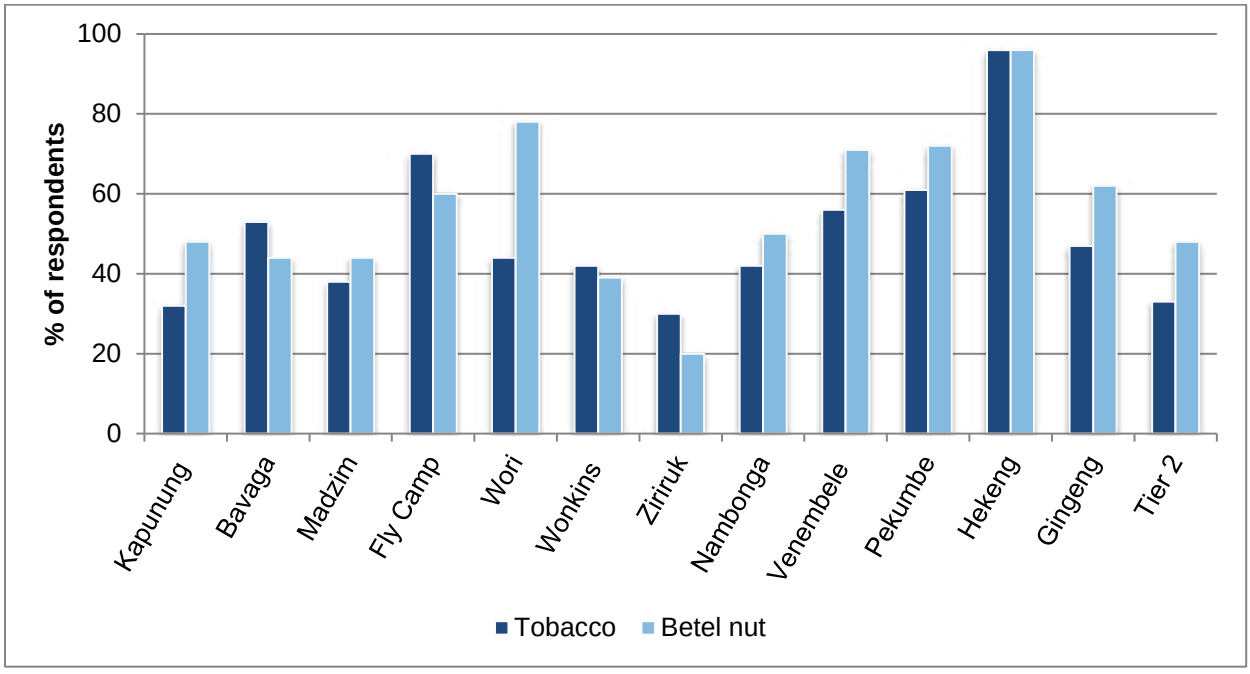


Figure 5.33: Frequency of betel nut and tobacco consumption in Study Area 1

As shown in Figure 5.34, the majority of survey respondents consumed tobacco (47%) and betel nut (59%) on the day prior to the survey. This is a high proportion of tobacco and betel nut consumers, and would be expected to develop into long-term adverse health impacts. Consumption of alcohol was much lower, with only 2% of respondents indicating that they had consumed alcohol on the day prior to the survey.

The proportion of males and females consuming tobacco, alcohol and betel nut on the day prior to the survey is shown in Figure 5.34.

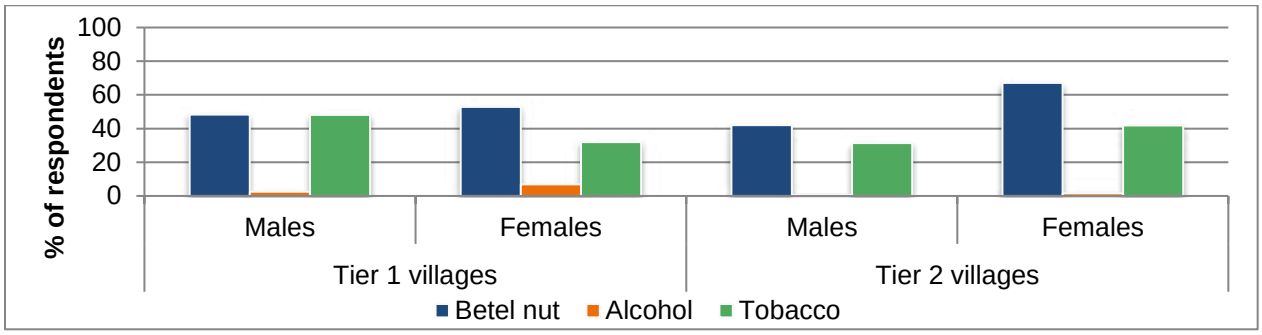


Figure 5.34: Consumption of alcohol, tobacco and betel nut in Tier 1 and 2 villages

As shown in Figure 5.34, 35% more of the women surveyed in Tier 2 villages reported, smoking tobacco than men on the day prior to the survey, and 60% more of the women disclosed chewing betel nut. This is considered to be a significant difference between males and females. The frequency that men and women consumed alcohol on the day before the survey was low and similar.

The level of expenditure on tobacco, alcohol and betel nut appears to have a positive correlation with household income levels, as the highest expenditure occurred in the villages of Nambonga and Venembele, which recorded the highest income levels. The average level of expenditure on (i) food and (ii) alcohol, tobacco and betel nut for Tier 1 and Tier 2 villages is shown in Figure 5.35.

Expenditure on food averaged PGK82 per household in the previous fortnight, compared to average expenditure of PGK65 on alcohol, tobacco and betel nut. People in Hekeng, Pekumbe and Gingen spent the highest percentage of their income on stimulants while people in Kapunung and Wongkins spent the lowest.

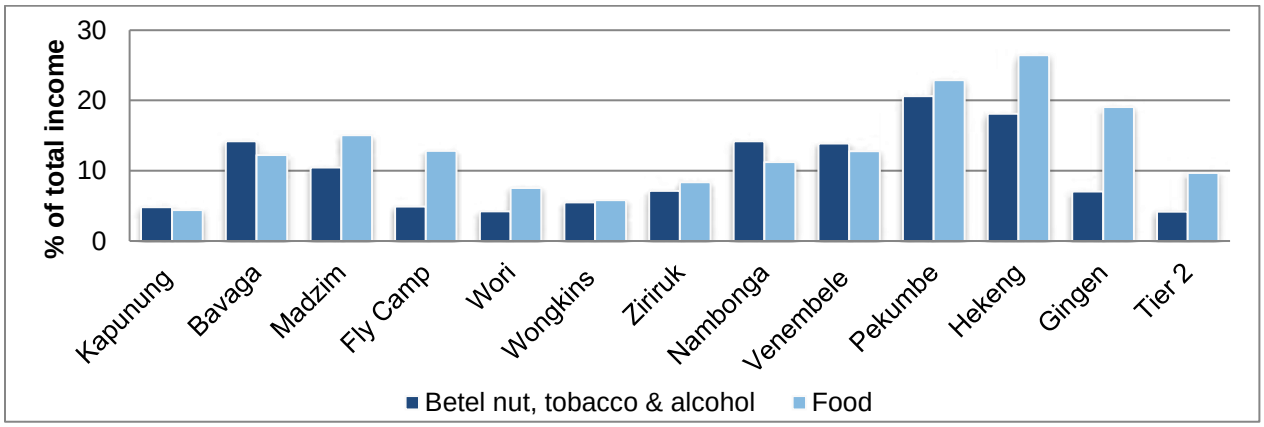


Figure 5.35: Average expenditure on food and alcohol, tobacco and betel nut in Tier 1 and 2 villages

5.1.9. Law and order

Lae was reported to be the location of the nearest district court, jail and police station for villages in Study Area 1. No formal police, that is, police who are trained and paid by the National Government, were stationed at any Tier 1 village. In some villages surrounding Lae, auxiliary police volunteers (who did not possess uniforms or weapons) reportedly assisted with law enforcement. Auxiliary police participated in village court hearings, resolved customary law and order issues and responded to law and order issues.

Socioeconomic surveys undertaken in Tier 1 villages in 2012, 2014 and 2015 recorded community perceptions on law and order issues. A majority of respondents reported no or only minor public order issues in their villages. The severity of law and order issues experienced in villages differed across the study area with some villages not identifying any major law and order issues. As presented in Table 5.20, the main law and order issue was alcohol-related, reported by over 60% of respondents. Stealing, drug use and domestic violence were also major issues, each reported by over 40% of respondents.

Table 5.20: Major law and order issues in Study Area 1

Type of law and order Issues	Percent of villages identifying the issue
Alcohol	60.2%
Stealing	49.3%
Drug use	47.2%
Domestic violence	41.2%
Safety and security of children	15.9%
Land conflict	10.2%
Inter-village conflict	8.8%
Other	7.0%
Disturbance/ nuisance	5.3%
Sexual violence	3.9%

Source: Coffey Environments, 2013

Elaborating on these issues, community leaders and women's representatives stated that marijuana use was becoming a problem among the men in the villages, and was purchased from traders who themselves smoked the drug. Domestic violence was reported as occurring in all villages surveyed but was not reported as occurring in all households. The highest prevalence of domestic violence was recorded in Hekeng where it was reported by 87.5% of respondents to be a law and order concern. Overall, however, serious crimes were reportedly very rare.

The 2012 Household Survey recorded responses to three similar questions regarding the administration of law and order in their village. Responses to all questions were generally consistent as presented in Table 5.21.

Table 5.21: Administration of law and order in Study Area 1

Responses	Who administers law and order?	How are law and order issues resolved?	How are conflicts within the village resolved?
Village Leaders	22.1%	39.7%	48.3%
Village Dialogue	0.8%	3.2%	4.9%
Councillors	45.4%	24%	19.5%

Responses	Who administers law and order?	How are law and order issues resolved?	How are conflicts within the village resolved?
Church Leaders	34.9%	56.7%	48.3%
Household Head	11.3%	22.3%	21.7%
National Police	1.3%	2.8%	4.3%
Village or Auxiliary Police	12.4%	7.1%	5.8%
Peace Committee or similar	10.7%	11.8%	7.3%
Village and Church Leaders	11.3%	22.3%	21.7%
Village Magistrate or Councillor	57.4%	34.1%	36.1%

Note that survey respondents could nominate more than one option and subsequently columns do not equate to 100%. Source: Coffey Environments, 2013.

A further survey question related to how conflicts with neighbouring villages were resolved, to which 64% of respondents indicated that village leaders resolved such conflicts. National Police (34%) and church leaders (23%) were also identified as having an important role in resolving inter-village conflicts.

It was evident from the responses provided, that the church has an important role in the resolution of minor issues that arise between individuals, family members or households in the study area. Church leaders were highly regarded in that they were considered to have a fair understanding of law and to act as facilitators of peace. Issues were usually resolved amicably with exchange of goods or small fees to appease the offended party. The 2014 Gari Associates Social Mapping Study reported that people felt that a central tenet of their Christian faith was the avoidance of disputes or violence and the maintenance of communal peace. Leaders of the village church, who were most often the village elders on the Hevi Komiti (heavy committee), took the lead in resolving disputes by stressing harmonious social relationships. This involved mediation led by the elders, ritual resolution and confession.

Key informant surveys undertaken in Tier 1 and Tier 2 villages in 2014 and 2015 included questions on village administration and law and order. It was evident from the responses provided that there was a communal component to the administration of law and order whereby broader discussion and involvement would often take place before the ultimate decision was made by recognised leaders.

5.1.10. Vulnerable and disadvantages groups

There were several disadvantaged groups identified in Tier 1 and Tier 2 communities. Disadvantaged groups include, for example, people living with a disability or sickness, the elderly and single mothers. The families and various community organisations provide a strong support network to vulnerable people. However, there is a strong sense of family in the study area communities and relatively few families from other areas, other than teachers and health workers. Although many people with a disability may not be enrolled in school, they are generally cared for in terms of basic necessities (food, clothing and shelter) and often integrated and involved in community activities. Similarly, while those people with a debilitating disease may not be able to access adequate health care, they are generally cared for by their families and the broader community. Those people living with a disability or sickness, and the elderly, will depend heavily on family and community support if they need to repair their house, establish a new garden or relocate to another area.

It was observed when undertaking household surveys that the children of single mothers were generally cared for and integrated within the mother's family. This ensures the child is cared for and provides the mother an opportunity to participate in other aspects of village life, although young mothers often withdraw from school and experience some level of discrimination.

Illiterate persons, and families who do not have literate members, may also experience heightened levels of disadvantage. As discussed in Section 5.1.7, education and literacy levels are low, particularly among women. Girls may be less likely to attend school because of the distance required to travel to reach schools and the risks to personal safety which can be associated with travel. In addition to low education and literacy levels, women face a number of barriers in Study Area 1. This includes cultural norms that see men primarily responsible for business activities which can limit economic opportunities, such as marketing produce in Lae.

5.1.11. Traffic and transport

This section describes road networks and transport routes within the Mine Area.

Road networks

There are currently three primary transport routes relevant for the villages in Tier 1 and 2:

- Demakwa Access Road / Wafi Access Road.
- Bulolo Highway.
- Watut and Markham Rivers.

The Highlands Highway is not directly accessible to Study Area 1 communities for road transport to Lae.

Transport routes

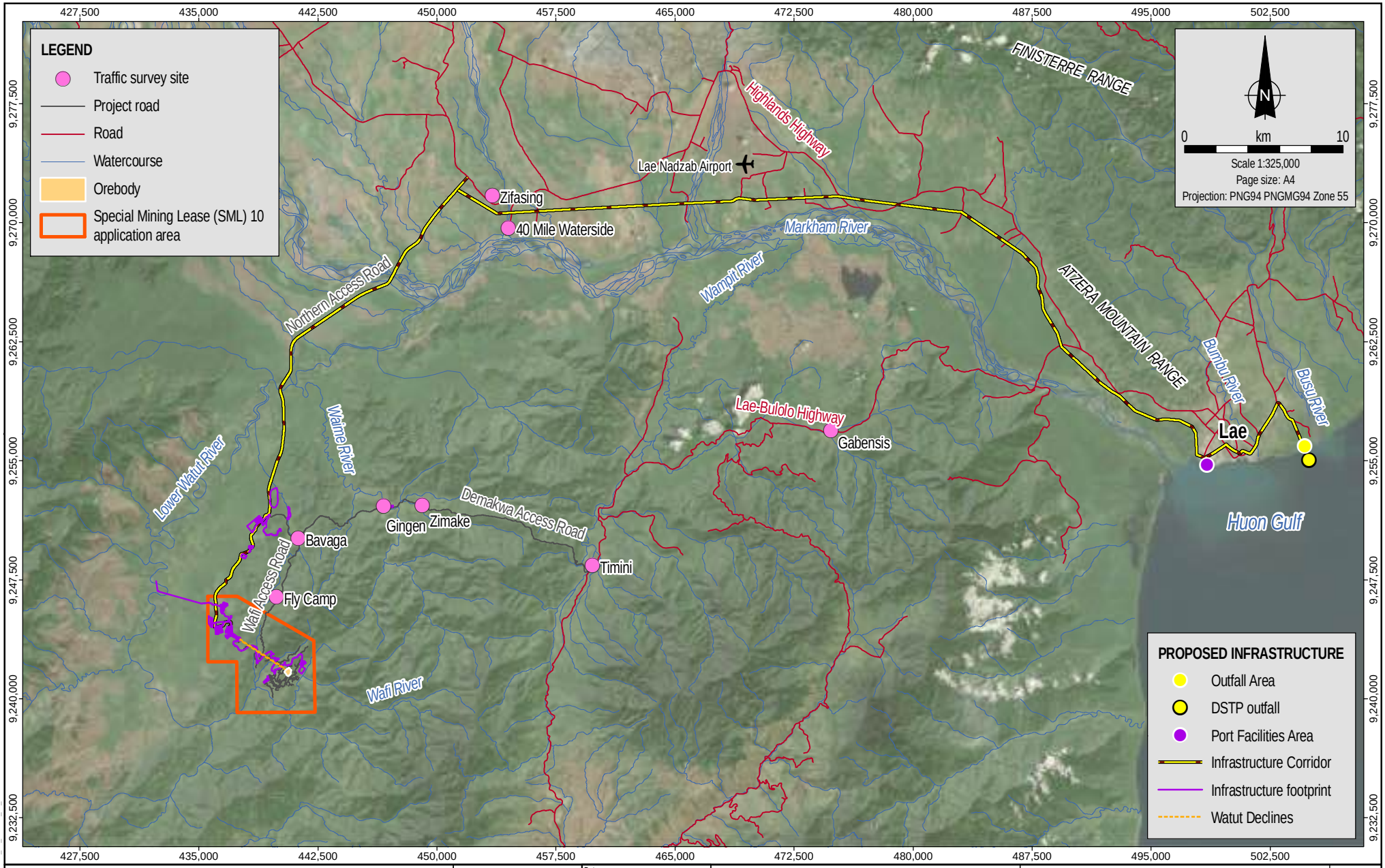
This section describes the primary transport routes of Study Area 1. Transport routes and traffic survey locations across all study areas are shown in Figure 5.36.

Demakwa Access Road

The Demakwa Access Road is an existing access gravel road approximately 23.5 km in length which runs from Bavaga to Demakwa where it joins the Bulolo Highway. At Bavaga, the Demakwa Access Road joins with the Wafi Access Road, which runs up to the existing Wafi Camp, and Link Road, which connects with the Finchiff Camp. Of particular relevance to the study area are the villages of Zimake, Gingen and Bavaga, which are located within 100 m of the current alignment of the Demakwa Access Road. The village of Dengea is located approximately 2 km from the road. Furthermore, Zindaga Elementary and Primary School is located just off the Demakwa Access Road between the villages of Gingen and Zimake.

The Demakwa Access Road was initially built by CRA Exploration Ltd in the 1980s and has subsequently been improved and refined. It is a gravel road which has been constructed utilising locally-sourced, high-quality materials (crushed rock and fines) with a top layer more than 50 mm thick. The width of the road varies along its course from approximately 5 m to 12 m. Due to the prevailing mountainous topography, it is undulating and winding with some sharp (blind) corners (Plate 5.12).

Upgrades to the Demakwa Access Road were completed in 2013. These included the construction of three bridges (Bailey type) at Demakwa (close to the junction with the Bulolo Highway), Zimake and Gingen. In addition, five box culverts were installed at Westpac Creek, Zimake, Gingen and Bavaga villages (Plate 5.13).



Source:
Survey sites from Coffey.
SML and orebody from WGJV.
Villages, infrastructure and project roads from WGJV and Coffey.
Roads and watercourses from NSO.
Imagery from ArcGIS Online (capture date unknown).

coffey
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Date: 23.03.2018
Project: 754-ENAUABTF100520DD
File Name: 0520DD_20_F05.36_GIS

WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Transport routes and traffic survey locations

Figure No: 5.36

MXD Reference: 0520CC_20_GIS006_v0_7

These upgrades have served to reduce the impact of traffic on the residents of Gingen and Bavaga. Prior to construction, passing traffic used to disrupt community use of rivers and streams in these localities. The construction of bridges and culverts has substantially reduced such disruptions.

Based on Austroads criteria for gravel roads (2014), the condition of the Demakwa Access Road as assessed in 2014 was “Good” to “Fair” with moderate dust generation and very few potholes or corrugations throughout the length of the road. Drainage of water off the road surface appeared to be good and there were no signs of rutting or muddy patches even following a heavy rain event which occurred during the survey period.

One aspect of the Demakwa Access Road relating to access to markets was the observed practice of planting gardens very close to the road. Land is cleared and gardens are planted along the roadside. This facilitates access to the garden and the transportation of produce to markets for sale.

Plate 5.12: Undulating Demakwa Access Road

Plate 5.13: Bailey Bridge constructed in 2013 at Gingen

Wafi Access Road

The Wafi Access Road runs from Bavaga, where it connects with the Demakwa Access Road and Link Road, to the Wafi Camp. It is a gravel road approximately 13.5 km in length and was constructed at the same time as the Demakwa Access Road using locally-sourced crushed rock and fines. It is a steep road with several sections having a gradient greater than 20% and with numerous sharp corners. Road width ranges from 5 m to 8 m and there are intermittent vehicle passing bays to facilitate traffic travelling in opposite directions. The hamlet of Fly Camp is located adjacent to the Wafi Access Road, with houses established on both the eastern and western sides of the road. The condition of the Wafi Access Road as assessed in 2014 with reference to the Austroads criteria (2014) was considered to be “Good” to “Fair”, however due to the steepness of the road and high rates of rainfall experienced in the area, the road is subject to rapid deterioration and requires regular maintenance. Major repair work was undertaken in late 2016 following a landslip.

Throughout this section, baseline information relating to the volume and type of vehicular and pedestrian movements, transport costs and perceptions of safety for both the Demakwa Access Road and the Wafi Access Road are combined (when data was initially compiled in 2014, there was no Project differentiation between these two roads and the data set does not lend itself to being split).

Bulolo Highway

The Bulolo Highway is a National Route and links the urban centres Wau and Bulolo with the city of Lae and its port facilities. The Bulolo Highway branches off from the Highlands Highway to the west of Lae before crossing the Markham River and heading first westwards and the southwards to the mining area near Wau. It is a sealed road of national importance. However, in 2011 the Bulolo Highway was reported as being only in “fair” condition due to a lack of maintenance work (Department of Works, 2011), in particular in the section between Bulolo and Wau. Many sections of the Highway are in poor condition with large potholes and washouts.

Of relevance to this study area, the Tier 2 village of Timini is located on the Bulolo Highway. Information regarding levels of traffic usage on the Bulolo Highway was collected in 2014 and 2015 and is presented below.

Watut River

Study Area 1 is located within the western section of the Wafi River catchment and in the larger Watut River catchment (5,396 km²), an area of very high rainfall with average annual rainfall of 2,800 mm. Such high rainfall results in high turbidity and fast flowing rivers. The Watut River catchment forms a large portion of the Markham River catchment (12,580 km²).

The Wafi River drains an area of 120 km² before joining the Watut River downstream of Pekumbe village. Downstream of this confluence, the Watut River flows for approximately 2 km before emerging into the lower Watut River floodplain. The system meanders for 60 km across the floodplain before joining with the Markham River. The lower Markham River flows easterly towards its mouth at Lae.

Tier 1 and 2 villages which are located along the Watut River (see Figure 3.1 in Section 3.2) include:

- Pekumbe
- Madzim
- Wongkins
- Uruf

- Wori
- Kapunung
- Mafanazo
- Chaunon
- Ngarubuaring
- Chiatz
- Goraris

Highlands Highway

The Highlands Highway links Lae to the fertile and populous PNG Highlands. The highway begins in Lae and travels through Morobe province. From the Markham Valley one branch runs through the Ramu Valley in Madang Province and ends at Madang. The other branch of the highway continues up from the Markham Valley and into the Eastern Highlands Province to Goroka. From here it travels over the Daulo Pass and crosses into Simbu Province and through to its capital Kundiawa. Typical market stalls and vehicles associated with the Highlands Highway are shown in Plate 5.14 and Plate 5.15 respectively.

After Kundiawa it travels through the Western Highlands Province continuing through to Mount Hagen. At Togoba, a southern branch continues on to the Southern Highlands province and its capital Mendi before going on to Tari. The other branch goes to Enga province and its capital of Wabag before ending at the mining town of Porgera.

The section of highway from Mount Hagen to Porgera is maintained by the Porgera Gold Mine, which uses the highway to transport goods and equipment from the Port of Lae. In 2006 the Australian government AusAid Program resurfaced the eastern section of the highway between Lae and Goroka.

Information regarding levels of traffic usage on the Highlands Highway was collected in 2015 and is presented below.

Plate 5.14: Market on the side of the Highlands Highway

Plate 5.15: Typical vehicles on the Highlands Highway

Usage of transport routes

This section presents the findings of road and river traffic surveys undertaken in 2014 and 2015 for Study Area 1.

The 2014 Observed Traffic Count Survey was conducted at seven assessment sites over a period of four days between 6:30 and 17:30. All vehicles and pedestrians which passed the survey location were recorded regardless of the direction of travel. As the purpose of the survey was to provide a record of total traffic movements, it was not considered necessary to record direction of travel. Over the four-day survey periods, a total of 6,435 vehicle movements and 5,910 pedestrian movements were recorded.

The River Use Surveys were conducted over three days in April 2015, recording the type of vessel, number of passengers and what resources were on board. The river survey was conducted at a site referred to as 40 Mile waterside, on the north bank of the Markham River, approximately 1 km downstream from the Watut River and Markham River confluence. All river traffic originated from the Watut. Over the three-day period, a total of 29 vessels (banana boats, rafts and logs) were recorded.

Demakwa Access Road / Wafi Access Road

As presented in Figure 5.37, the number of pedestrian movements was far higher than vehicle movements over the four-day survey period on the Demakwa Access Road/Wafi Access Road. Pedestrian movements were generally along the side of the road, however it was not uncommon for groups of pedestrians, commonly travelling between the village and gardens, to occupy a substantial proportion of the road width. The number of vehicles was spread fairly even across the four days, with the highest number of vehicles (232) being recorded on Monday.

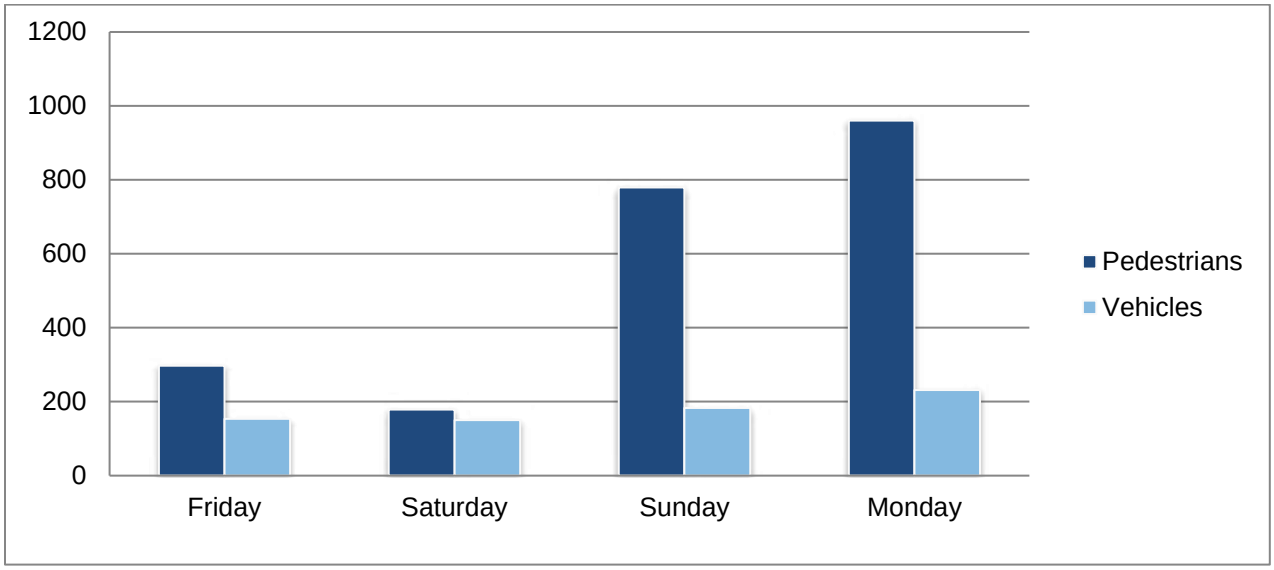


Figure 5.37: Total movements per day – Demakwa Access Road/Wafi Access Road

The highest number of vehicles (94) was recorded in the beginning of the day and in the afternoon. It is assumed that this is due to work hours at the WGJV. The lower number of vehicle movements from 8:30 to 10:30 and from 11:30 to 13:30 is assumed to be due to drivers having morning and luncheon breaks (see Figure 5.38). The majority of vehicles using the Demakwa Access Road/Wafi Access Road were the WGJV vehicles or contractor vehicles.

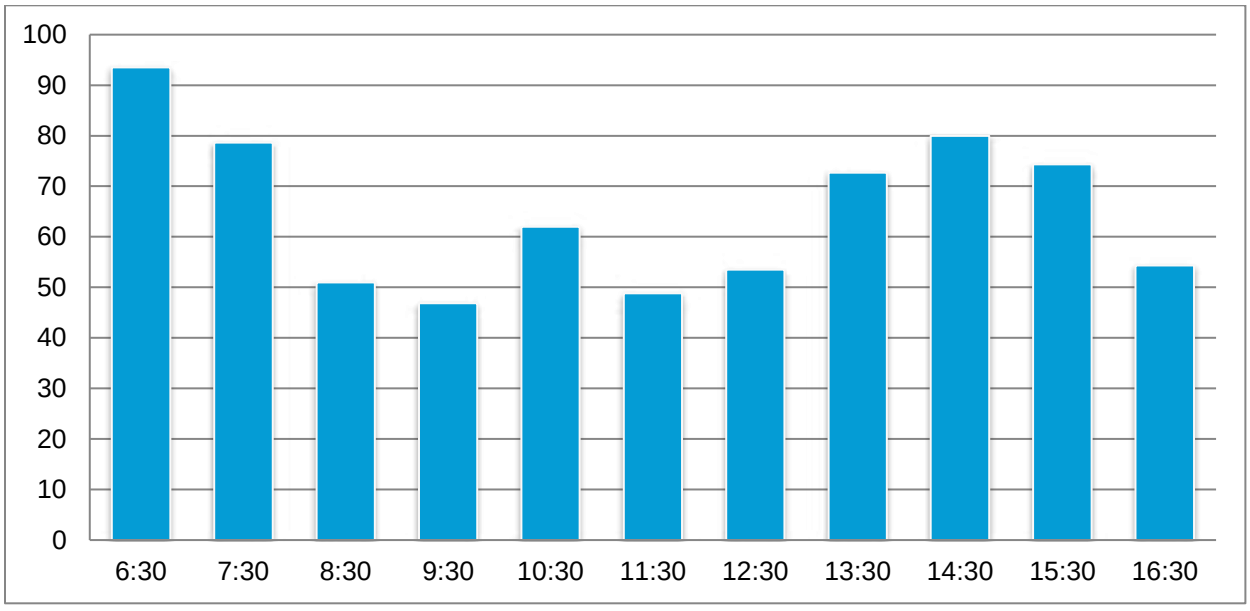


Figure 5.38: Vehicle movements per day – Demakwa Access Road/Wafi Access Road

Figure 5.39 shows that there was a significant peak in pedestrian movements at 8:30 with 378 pedestrians. It is assumed that this is due to people going to school, work or gardens. The low number of pedestrian movements (94) at 11:30 is presumably due to people having lunch.

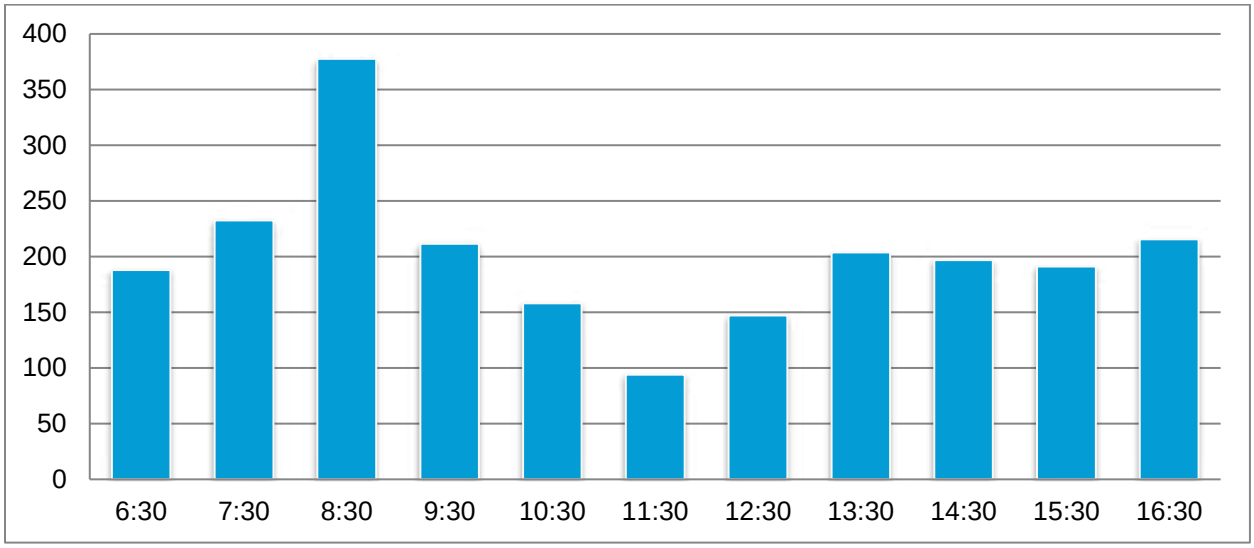


Figure 5.39: Pedestrian movements per day – Demakwa Access Road/Wafi Access Road

Source of traffic

The proportion of total traffic attributed to each of the source categories is presented in Figure 5.40. It shows that in Bavaga and Fly Camp the proportion of traffic attributed to the WGJV was approximately 50% of all traffic which is higher than that recorded at Zimake (41%) and Gingen (35%). This further supports the assumption that WGJV (and WGJV contractor) vehicles are travelling between Wafi Camp and the Bavaga fuel farm/lay down area and do not travel through to Gingen or Zimake.

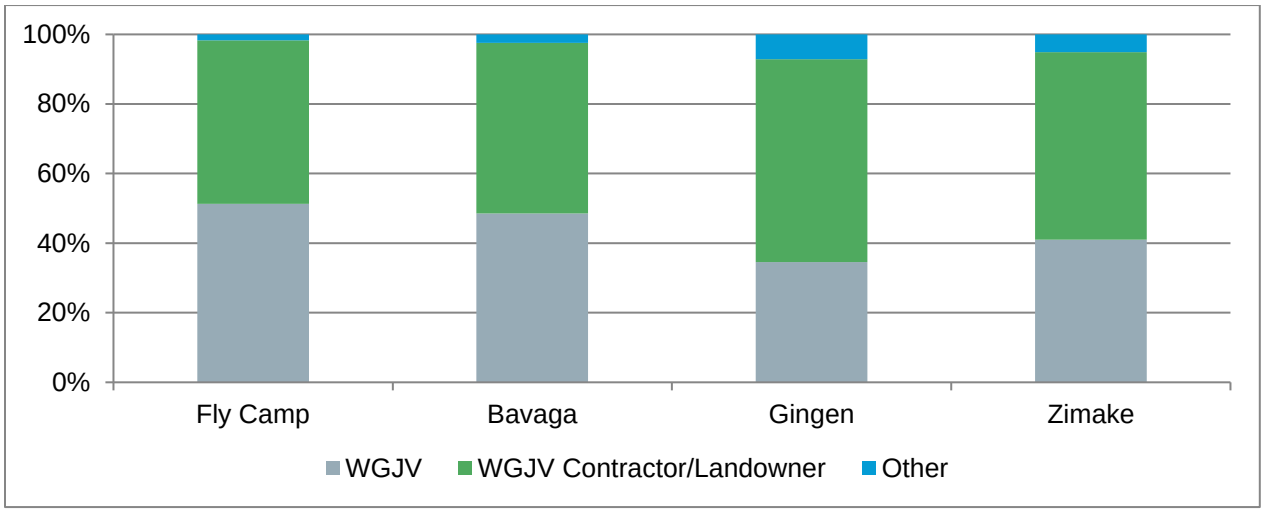


Figure 5.40: Source of traffic on the Demakwa Access Road/Wafi Access Road

Types of traffic

Presented in Figure 5.41 is the proportion of traffic recorded on the Demakwa Access Road/Wafi Access Road only attributed to the various vehicle types including the vehicle owner or operator. It indicates that for all traffic recorded on the Demakwa Access Road/Wafi Access Road, 65% were light vehicles and of these light vehicles, 65% were WGJV vehicles.

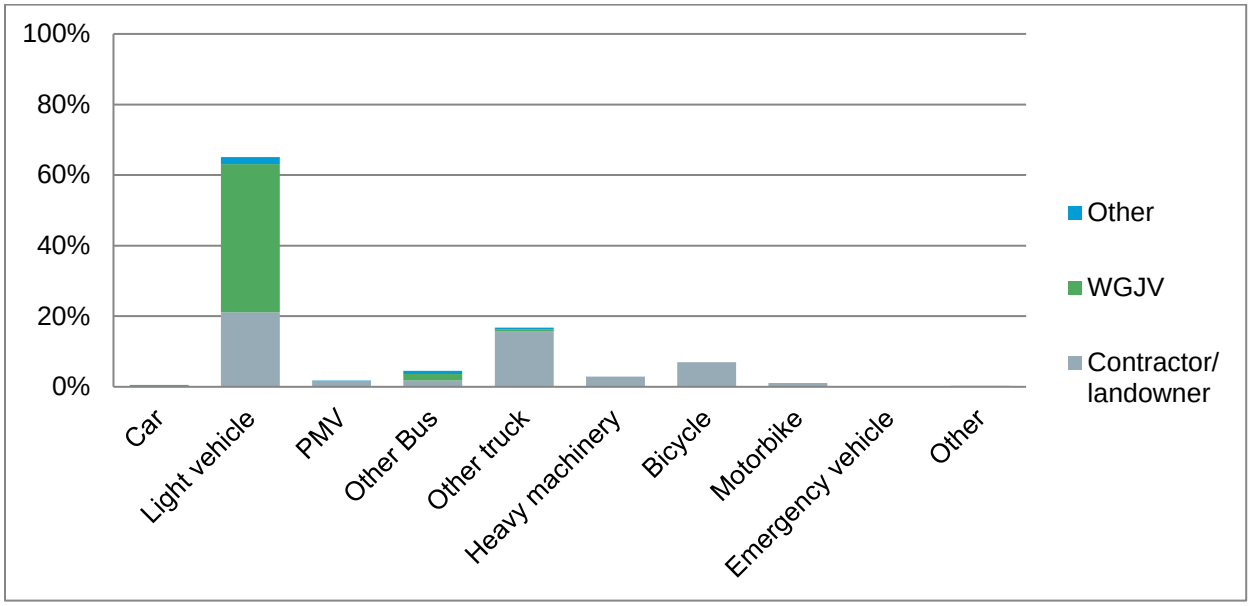


Figure 5.41: Types of vehicles on the Demakwa Access Road/Wafi Access Road

Bulolo Highway

As presented in Figure 5.42, over the four-day survey period on the Bulolo Highway a total of 2,706 vehicle movements and 1,725 pedestrian movements were recorded. The highest vehicle movements occurred on Saturday (762) and Monday (755). The highest pedestrian movements were recorded on Monday with 562 persons.

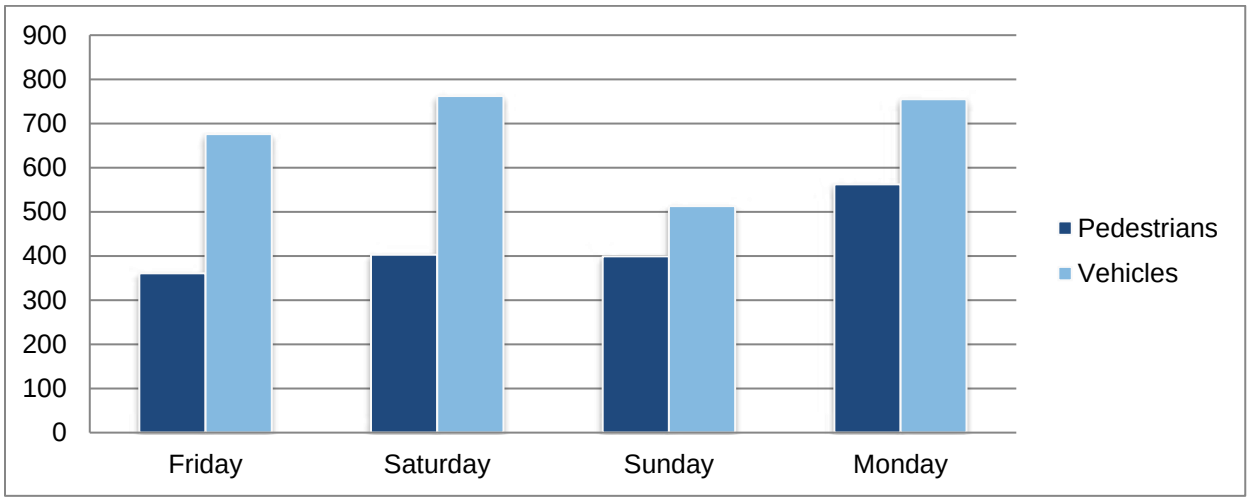


Figure 5.42: Total movements per day – Bulolo Highway

Figure 5.43 presents the total vehicle movements according to the time of the day. Vehicle movements on the Bulolo Highway are spread relatively even across different times of the day. The most distinct change in vehicle movements occurs at the end of the observation time at 16:30 where the number of vehicles significantly increases before dropping sharply. It is assumed that this is due to the fact that both surveyed villages (Gabensis and Timini) are not a final destination for drivers and/or workers and as such are less frequented at the end of work shifts.

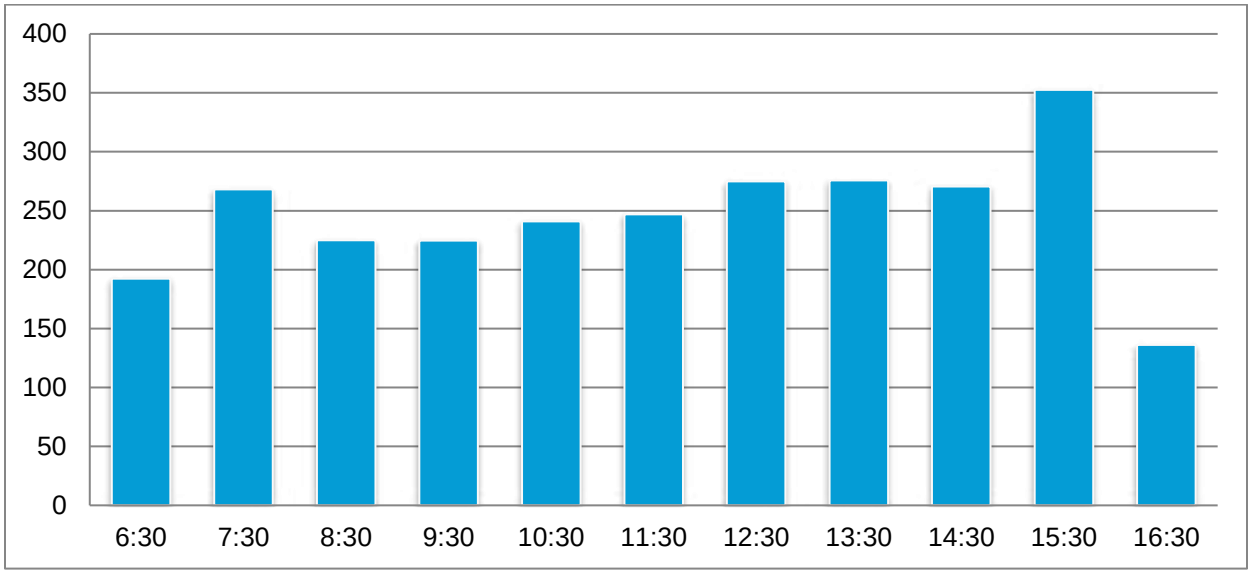


Figure 5.43: Vehicle movements per day – Bulolo Highway

Pedestrian movements on the Bulolo Highway are less evenly spread across the day than vehicle movements (Figure 5.44). During the Traffic Observation Survey, the highest number of pedestrian movements occurred in the morning (253) and the late afternoon (320). It is assumed that this is due to people going to or returning from work, school, gardens or markets.

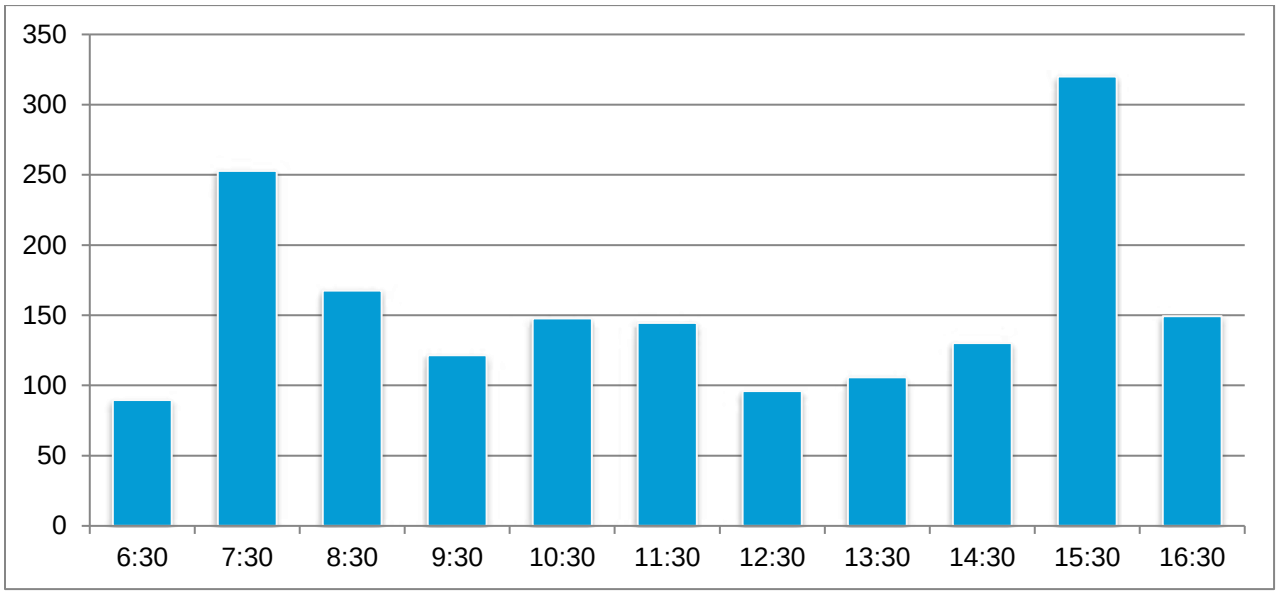


Figure 5.44: Pedestrian movements per day – Bulolo Highway

Source of traffic

The source of traffic refers to the entity which owned or was responsible for the vehicle. The rationale for recording the source of the vehicle is to better understand who the primary road users are and their respective contribution to total traffic. All observed traffic movements were categorised according to three broad sources as outlined in Table 5.22.

Table 5.22: Categories for the source of vehicles

Category	Description
WGJV	Any vehicle which is owned or operated by direct WGJV staff and being used as part of the Wafi-Golpu Project.
WGJV Contractors and Landowners	Any vehicle owned or operated by a contractor to the Wafi-Golpu Project. In addition, any vehicle which is owned or operated by a landowner organisation (such as NKW) or permanent resident of villages within the Wafi Golpu exploration area as defined by the three relevant landowner groups (Babuaf, Hengambu and Yanta along with the villages of Dengea and Zilani.)
Other	Any vehicle which is not being utilised by WGJV, WGJV contractors or landowners.

As expected, the source of traffic on the Bulolo Highway was predominately classified as in the 'other' category. It was recorded that 23% of traffic in Timini and 16% of traffic recorded in Gabensis was a WGJV or WGJV contractor vehicle (see Figure 5.45).

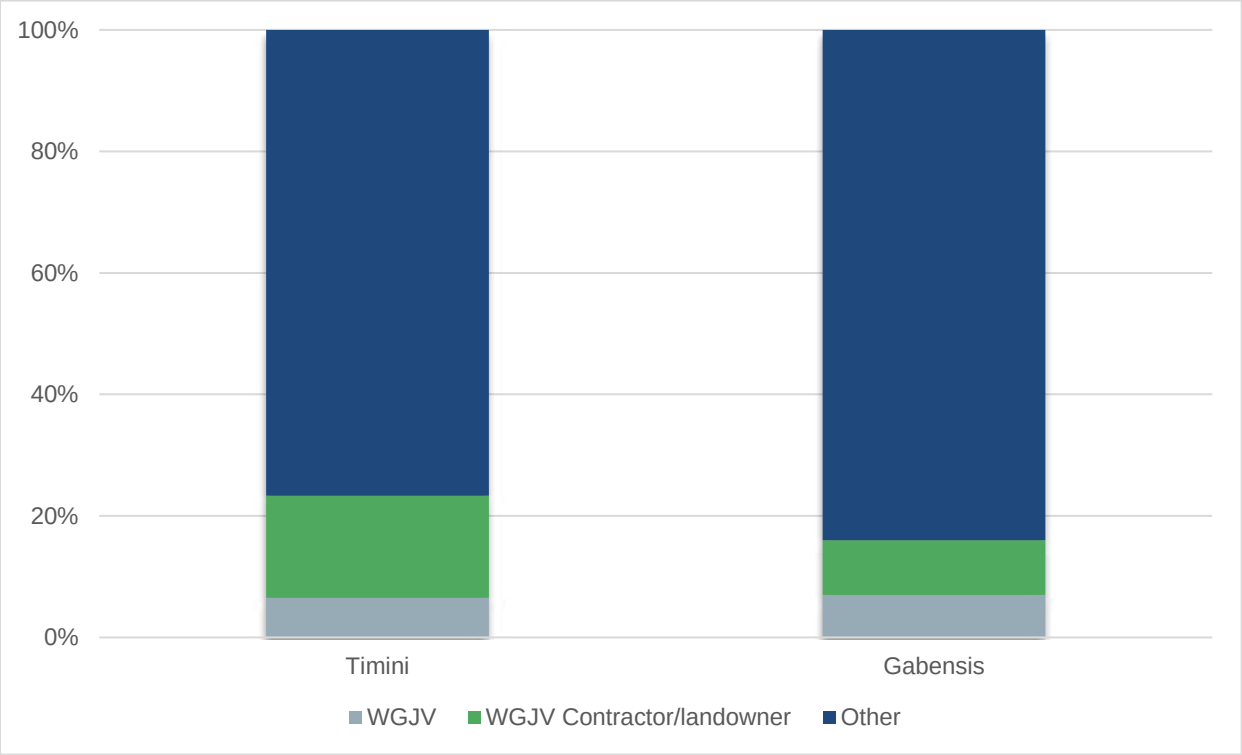


Figure 5.45: Source of traffic on the Bulolo Highway

Types of traffic

In addition to recording all traffic movements, the type of vehicle was also recorded. This provides an insight into the sorts of vehicles which are utilising the road and therefore the suitability of the road to support such traffic.

Buolo Highway traffic movements were categorised as outlined in Table 5.23.

Table 5.23: Types of vehicles

Type	Description
Car	All forms of car (sedan, station wagon etc.)
Light vehicle	All utilities and four-wheel drive vehicles
Public Motor Vehicle (PMV)	All vehicles used for the transportation of people for a fee including both buses and trucks
Bus	All non-PMV buses
Truck	All non-PMV trucks including flat bed, semi-trailers, dump trucks etc.
Heavy machinery	Any heavy machinery including tractors, front-end loaders, excavators and bull dozers
Emergency vehicle	Police, ambulance or fire service vehicles. Does not include private security vehicles
Bicycle	All bicycles
Motorbike	All motorbikes, quad bikes of three wheelers

Vehicles travelling on the Bulolo Highway were predominantly light vehicles (43%) followed by PMVs (25%) and other trucks (16%). As presented in Figure 5.46, approximately 26% of light vehicles, 17% of other buses and 13% of trucks were WGJV or WGJV contractor vehicles.

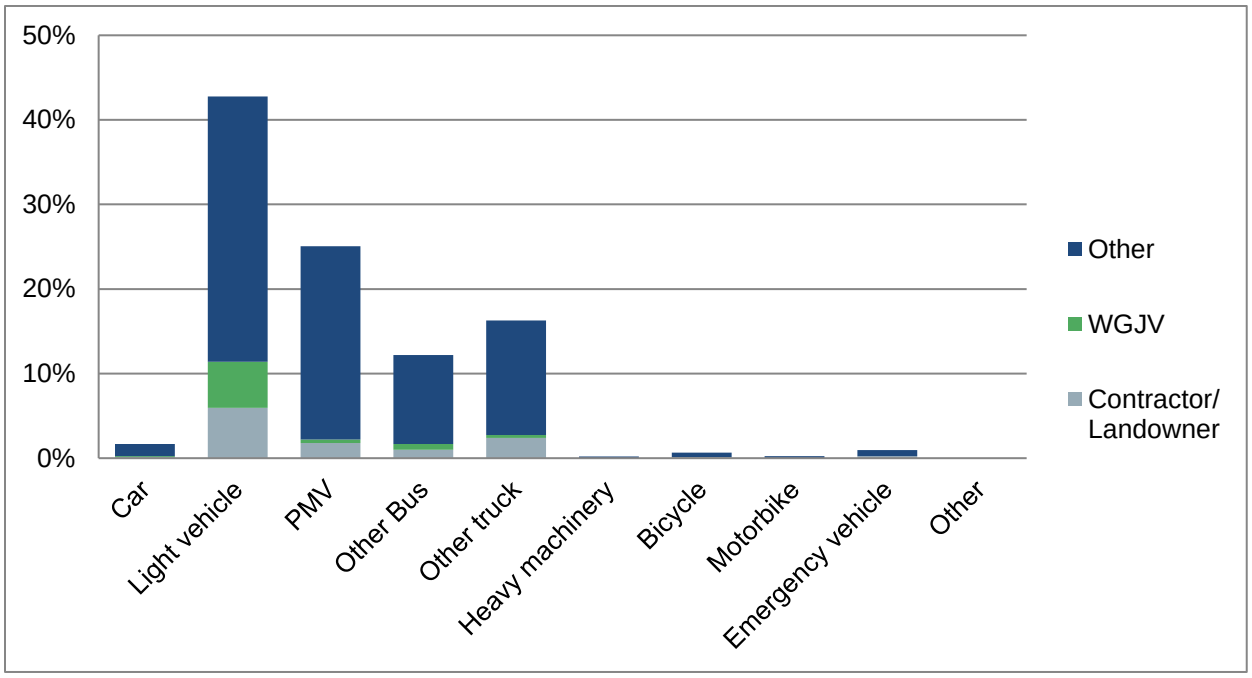


Figure 5.46: Types of vehicles travelling on the Bulolo Highway

Watut River

The highest number of vessel movements (21) was recorded on Monday with 72% of all recorded vessels on the Watut River on this day (see Figure 5.47).

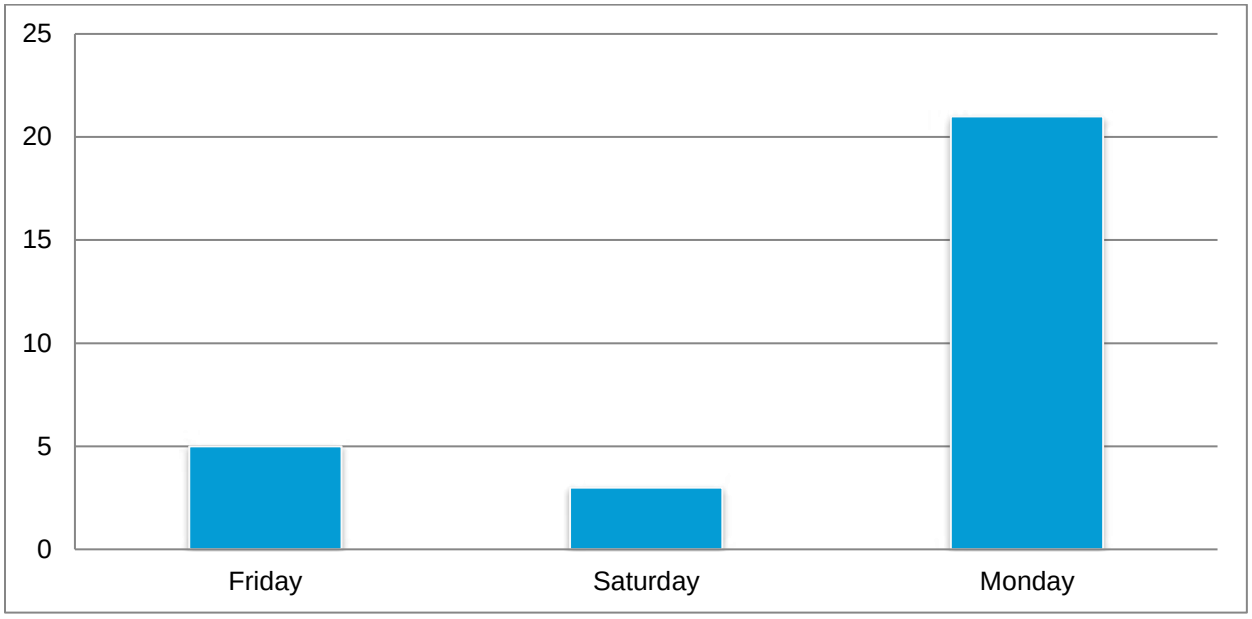


Figure 5.47: Vessel movements per day – Watut River

Figure 5.48 presents the number of people using the river as a means of transport. The highest number of passengers travelling on the Watut River was recorded on Monday with 90 persons. Generally people travel down to 40 Mile on Mondays and Tuesdays, back upstream on Wednesdays and Thursdays, with little river traffic on Fridays, Saturdays or Sundays.

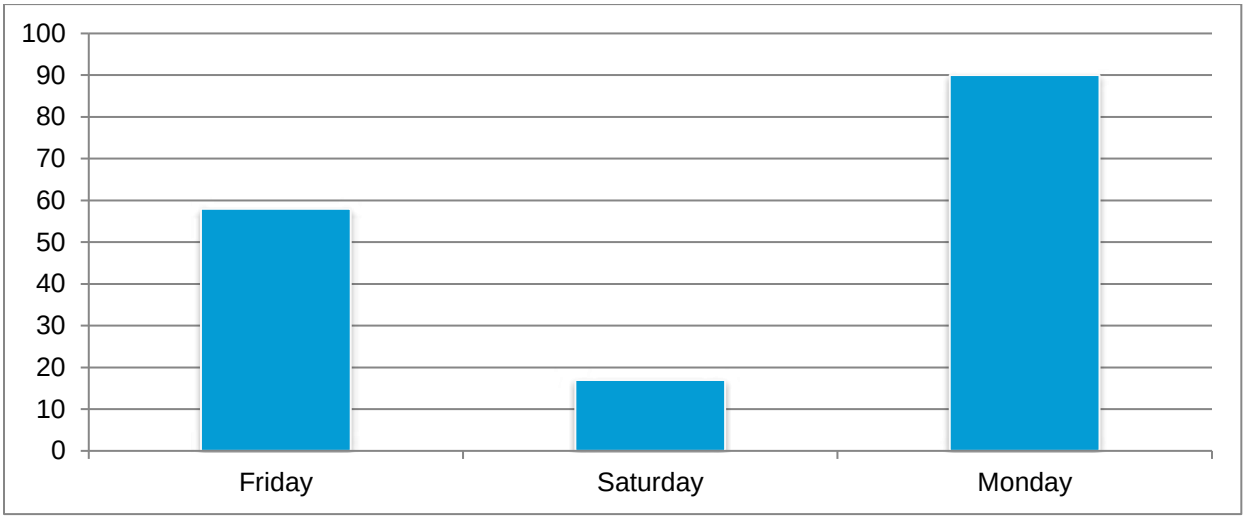


Figure 5.48: Number of passengers per day – Watut River

Highlands Highway

A traffic observation survey was undertaken near the proposed intersection of the Highlands Highway and the Northern Access Road near Zifasing. Traffic count data was not available from government sources and was therefore limited to the data collected by Coffey. Consequently, data was not available for other sections of the Highlands Highway, such as between Yalu and Lae.

As presented in Figure 5.49, over the four-day survey period on the Highlands Highway a total of 3,010 vehicle movements and 1,968 pedestrian movements were recorded. The highest vehicle movements occurred on Friday (929). The highest pedestrian movements were recorded on Monday with 707 persons.

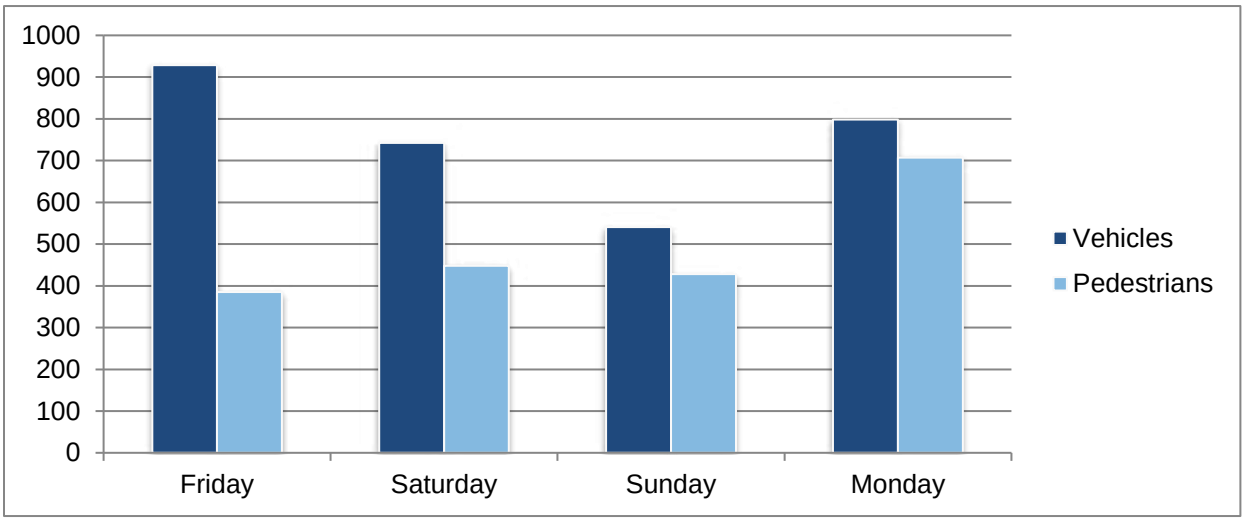


Figure 5.49: Total movements per day – Highlands Highway

Figure 5.50 presents the total vehicle movements according to the time of the day. Vehicle movements per hour on the Highlands Highway were slightly lower in the morning than the afternoon with the highest number of vehicles recorded between 16:30 and 17:30.

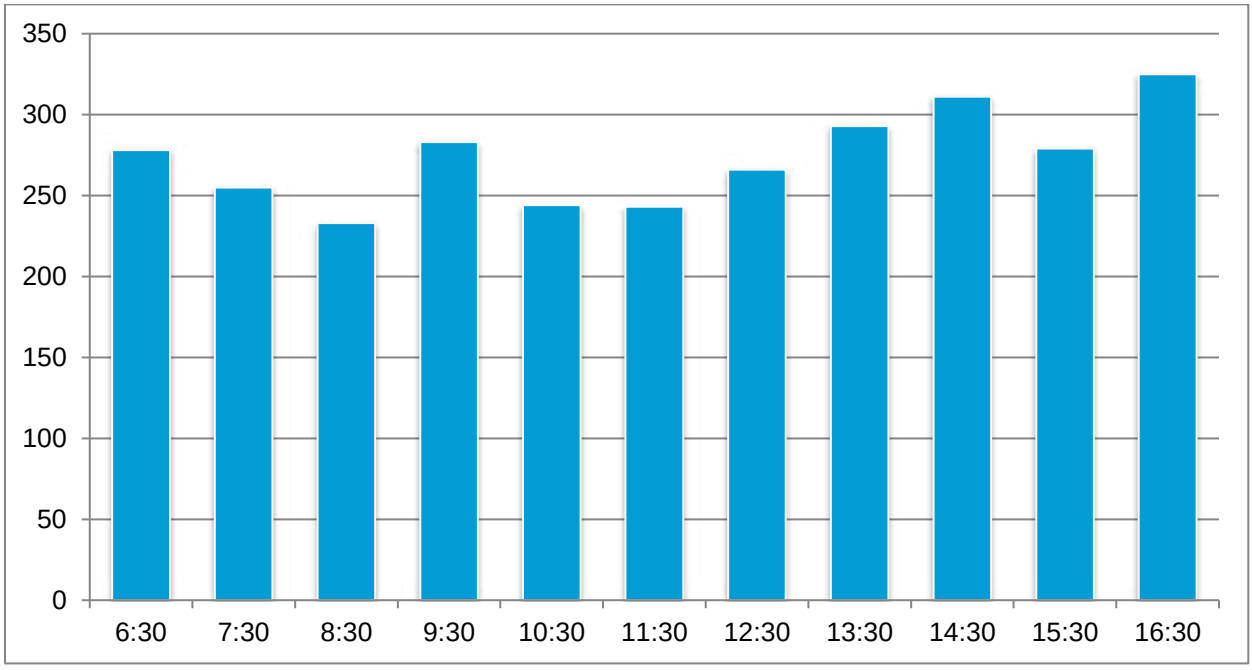


Figure 5.50: Total vehicle movements per day and per hour – Highlands Highway

When separated according to travel direction, it becomes apparent that vehicle traffic to Lae is higher in the morning hours whereas vehicle traffic from Lae is higher in the afternoon, as presented in Figure 5.51.

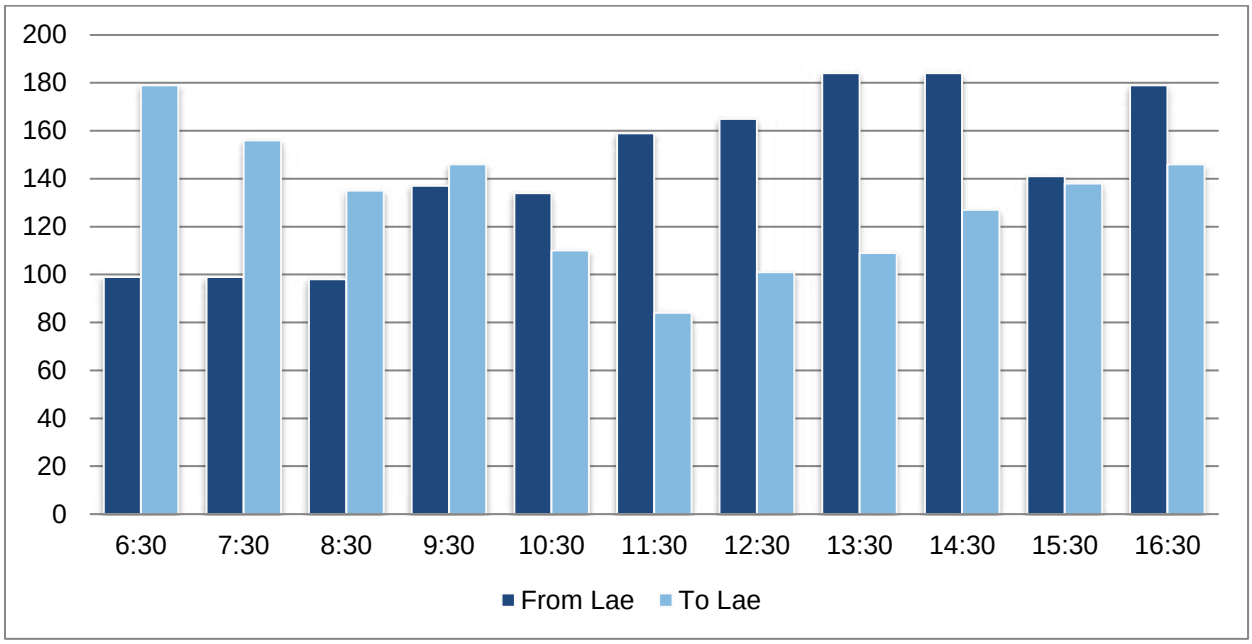


Figure 5.51: Vehicle movements per day, hour and direction – Highlands Highway

It is assumed that this is due to people travelling to Lae in the morning to access employment, markets and services such as medical and governmental facilities and returning home in the afternoon.

Pedestrian movements on the Highlands Highway fluctuated throughout the day (see Figure 5.52). During the Traffic Observation Survey, the highest number of pedestrian movements occurred in the early morning (240) and the late afternoon (221). It is assumed that this is due to people going to or returning from work, school, gardens or markets.

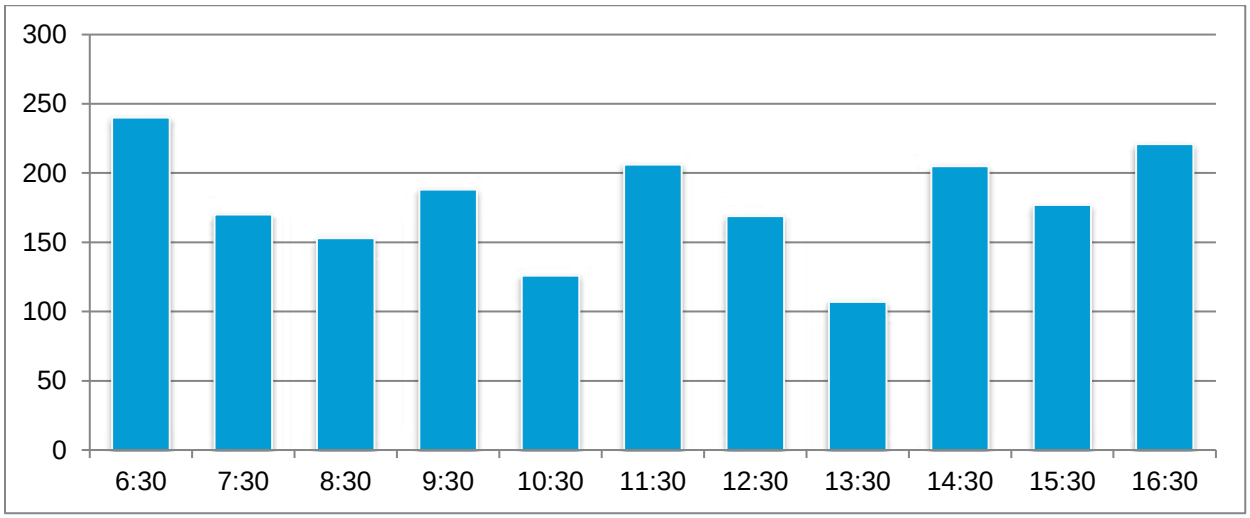
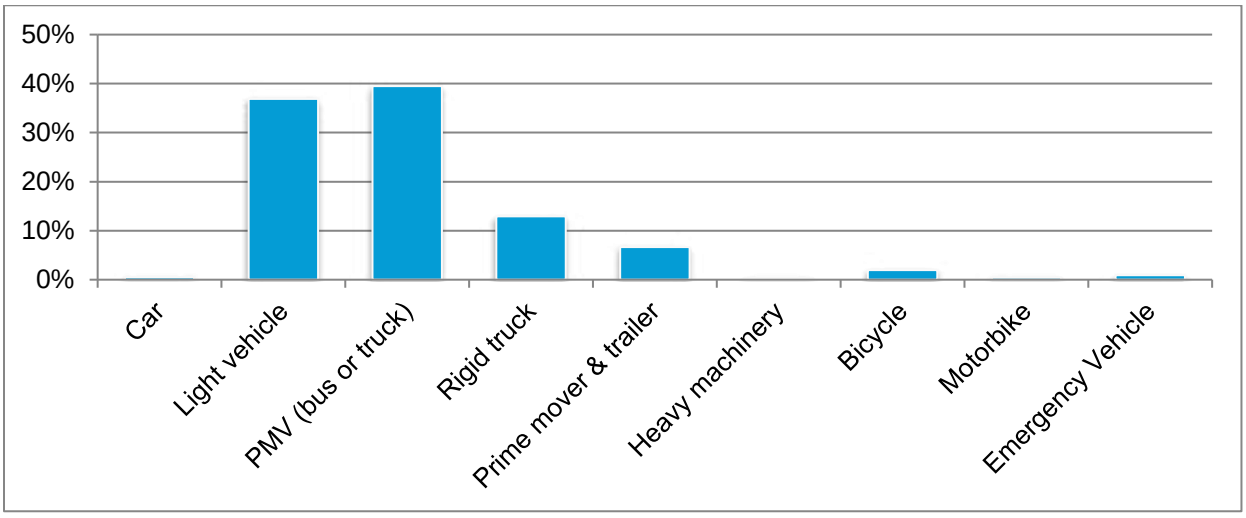


Figure 5.52: Pedestrian movements per day – Highlands Highway

Types of traffic

In addition to recording all traffic movements, the type of vehicle was also recorded as shown in Figure 5.53. This provides an insight into the sorts of vehicles which are utilising the road and therefore the suitability of the road to support such traffic.



Note: For a description of vehicle types, please see Table 5.23.

Figure 5.53: Types of vehicles on the Highlands Highway

As presented in Figure 5.53 the predominant type of vehicle travelling on the Highlands Highway was PMVs (39%) followed by light vehicles (37%) and rigid trucks (13%).

Population interaction with transport routes

In addition to traffic and pedestrian observations, a survey was undertaken in Tier 1 and 2 to gather additional information on how the Demakwa Access Road and the Bulolo Highway are utilised by the residents of villages which are located along the transport route. Furthermore, cost and travel time estimates were collected and participants asked how safe they felt when using or operating a stall on the roadside.

Information was also gathered regarding time, costs and safety perceptions of people using the Watut River (and subsequently the Highlands Highway) to access markets or services in Lae.

Demakwa Access Road / Wafi Access Road

As presented in Figure 5.54, the main means of travel was walking, followed by PMVs and light vehicles. The vast majority of respondents used Demakwa Access Road/Wafi Access Road on a daily basis with a significant number of persons using it more than once daily. The most prevalent purpose of trips was visiting relatives followed by attending church, accessing gardens, hunting or fishing grounds, and going to markets.

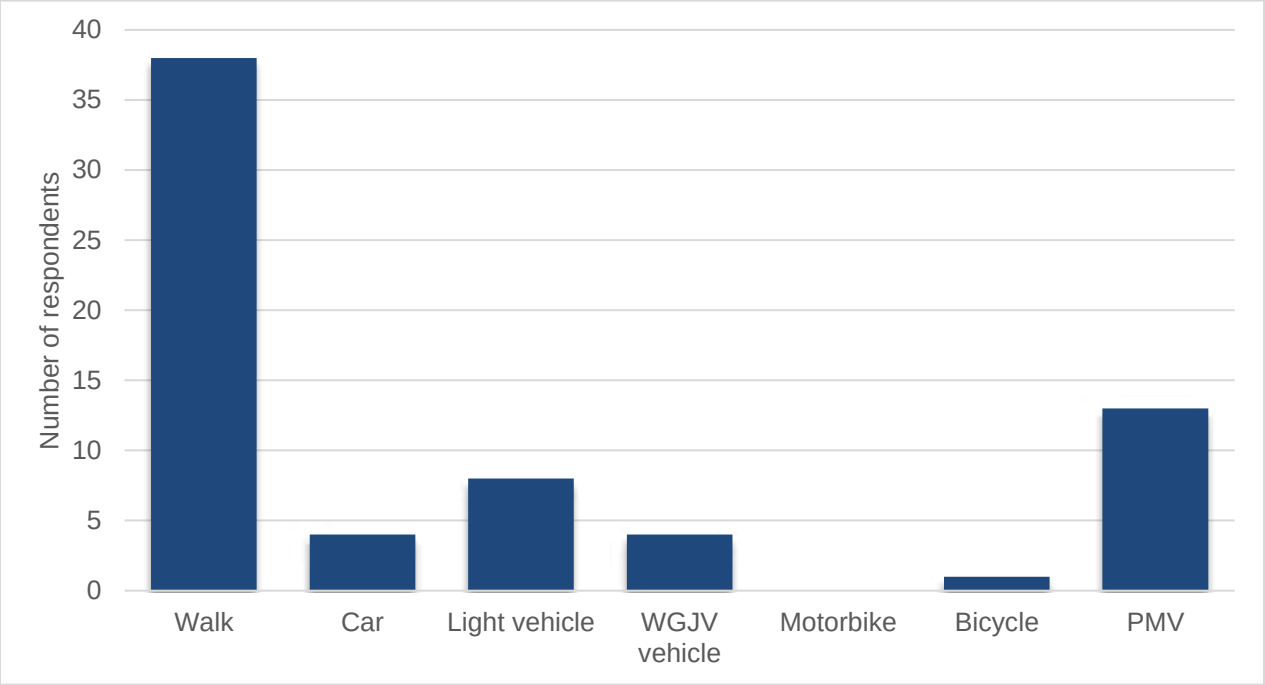


Figure 5.54: Means of travel – Demakwa Access Road/Wafi Access Road

Costs of transport for persons travelling from Tier 1 villages along Demakwa Access Road/Wafi Access Road (Fly Camp) are presented in Table 5.24.

Table 5.24: Costs and time to travel to Lae (Demakwa Access Road/Wafi Access Road)

Village	Mode of Transport	Average Time	Costs (in PGK)
Zimake	PMV Truck/ Bus	3 hours	NA
Gingen	PMV Truck/ Bus	3 hours	15
Bavaga	PMV Truck/ Bus	3.5 hours	NA
Fly Camp	PMV Truck/ Bus	4.5 hours	NA
Hekeng	Walk, PMV Truck / Bus	6 hours (estimate)	20

Safety

As outlined above, the Demakwa Access Road/Wafi Access Road (see Plate 5.16) is a gravel road which is steep in sections, winding and has many sharp (blind) corners throughout its length. Road width varies from approximately 12 m down to 5 m which is only sufficient for a single lane of traffic. There is no separation of vehicular and pedestrian traffic and there are four villages located adjacent or within 100 m of the road. The road shoulders are heavily overgrown which restricts sight distances and the there is no fencing off of the road. At the time of the assessment, the road was sufficiently dusty to have an effect upon visibility for both drivers and pedestrians. If following another vehicle, visibility restrictions due to dust generation required a minimum of 50 m of separation between vehicles when driving at 40 km/hr.

Plate 5.16: Demakwa Access Road / Bulolo Highway intersection

Road safety refers to methods and measures that are issued to reduce risks of injury, death or harm to drivers, passengers or pedestrians. There are a number of measures which have been put in place to improve road safety on the Demakwa Access Road/Wafi Access Road. Signage (see Plate 5.17) has been erected along much of the route alerting drivers to steep inclines/declines, sharp corners and approaching villages.

Plate 5.17: Road signage

The stipulated speed for vehicles travelling on the Demakwa Access Road/Wafi Access Road is 40 km per hour. The stipulated speed within 200 m of a village is 20 km per hour. The Wafi-Golpu Joint Venture has fitted electronic speed sensors to its vehicles which automatically registers if these speed limits are exceeded and alerts Wafi security. There are penalties, such as temporary loss of licence, imposed on the WGJV staff and contractors for repeated speed offences.

These measures, along with the condition of the road, which at the time of the assessment was in fair condition, serve to reduce the inherent safety issues outlined above.

An issue raised by many pedestrians surveyed along the Demakwa Access Road/Wafi Access Road was the safety of children walking along the road. Children are often walking the Demakwa Access Road/Wafi Access Road unaccompanied by adults when traveling to and from school, between villages or going to gardens. It was mentioned by several respondents that there was a need for increased public awareness on the dangers of walking on the road and importance of keeping off the road as much as possible.

When asked for their safety concerns of using the Demakwa Access Road/Wafi Access Road, the most prevalent response provided by respondents was the inhalation of dust and the effect which dust has upon visibility and safe driving (54%). The next most prevalent reason provided for not feeling safe on the road was fear of being hit by a vehicle (32%) followed by speeding vehicles (11%) and careless or alcohol/ drug affected drivers (4%). It should be noted that at the time of the survey there had been a prolonged period of hot and dry conditions resulting in elevated dust levels.

Bulolo Highway

A number of different types of vehicles (trucks, motorbikes, light vehicles) travel along the Bulolo Highway. The majority of survey respondents using the Bulolo Highway walk, use light vehicles or use private motor vehicles (PMVs) to access gardens, hunting or fishing areas or other villages and towns, in most cases on a daily basis (see Figure 5.55).

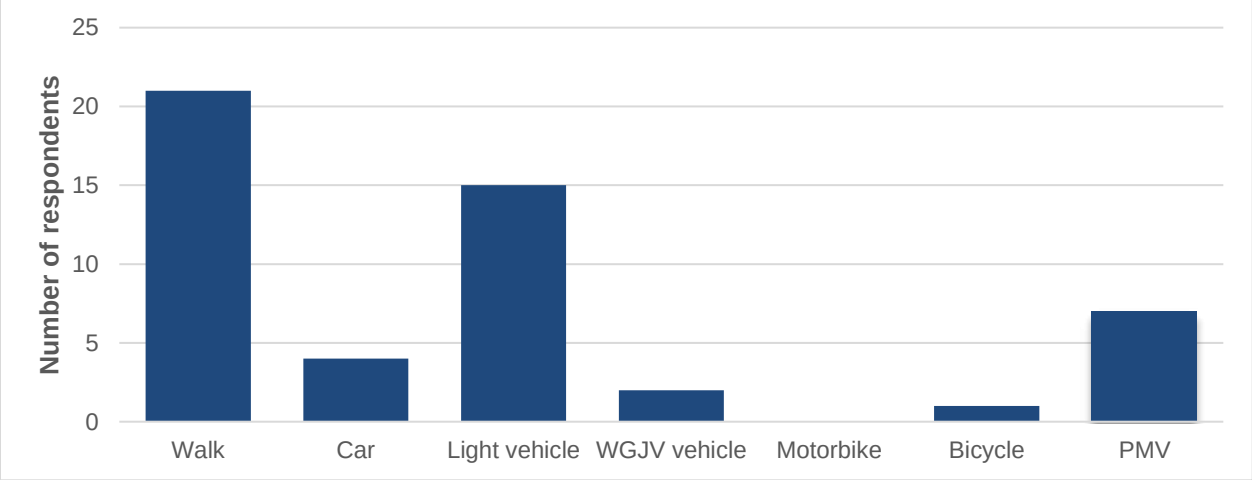


Figure 5.55: Means of Travel – Bulolo Highway

Costs of transport for persons travelling from Timini or Gabensis along the Bulolo Highway are presented in Table 5.25.

Table 5.25: Costs and time to travel to Lae via the Bulolo Highway

Village	Mode of Transport	Average Time	Costs (in PGK)
Timini	PMV	2 hours	10
Gabensis	PMV	1 hour	7

When asked for their perception of safety, 69% of respondents stated that they do not feel safe when walking on the highway. The main reasons for not feeling safe were speeding cars with 42% of responses, accidents (33%), dust (17%) and careless drivers.

Watut River

Over the course of three days, 19 banana boats, eight rafts and two log rafts were recorded (see Figure 5.56). Motorised banana boats and rafts were used for passenger transport and cargo, with rafts being the financially more affordable option for travelling downstream. Due to the strong current, only banana boats are able to move upstream. Logs rather than rafts or boats are also used by people to save money.

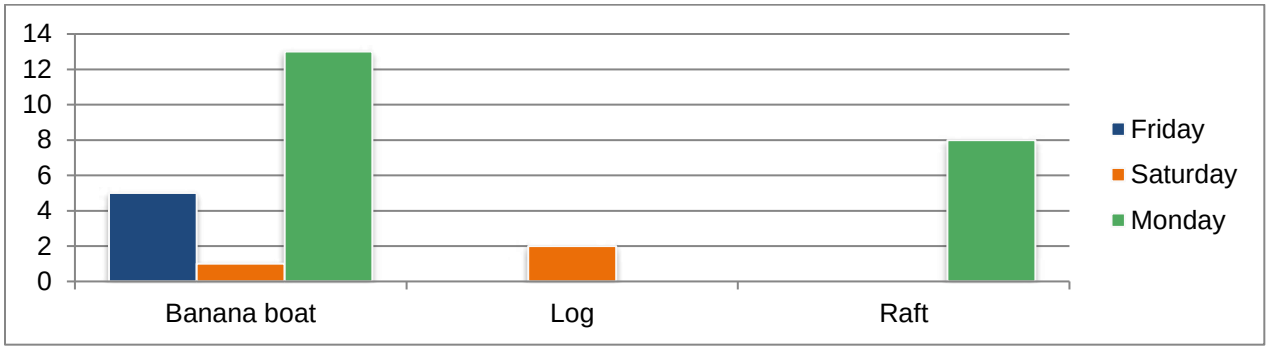


Figure 5.56: Types of vessel used on the Watut River

Within Study Area 1, costs for persons travelling to Lae are the highest for villages along the Watut River without direct road access as shown in Table 5.26. The costs for travelling on a banana boat from Bencheng to 40 Mile was approximately PGK60, one-way. In order to transport goods from/to Uruf along the Watut, persons can hire a banana boat for approximately PGK400 for a round-trip.

Table 5.26: Costs and time to travel to Lae via the Watut River/Highlands Highway

Village	Mode of Transport	Average Time	Costs (in PGK)
Bencheng	Canoe and PMV	4 hours (canoe) and 1 hour (PMV)	70 - 75
Chiatz	Canoe and PMV	1 hour (canoe) and 1 hour (PMV)	40 - 45
Uruf	Canoe and PMV	4 hours (canoe) and 30 min (PMV)	40 - 45
Zifasing	PMV Truck/ Bus and walking	1 hour (PMV) and 30 min (walking)	10

The majority of stallholders using the Watut River (and Highlands Highway) (82%) reported that they did not feel safe (Figure 5.57) on the river and/or road. The main concern for respondents was criminals (37%) followed by being hit by a vehicle and capsized boats (each 26%). Speeding vehicles and the quality of the road both concerned 5% of the respondents. Dust, being the main concern on the Demakwa Access Road, was not mentioned by respondents using the Highlands Highway.

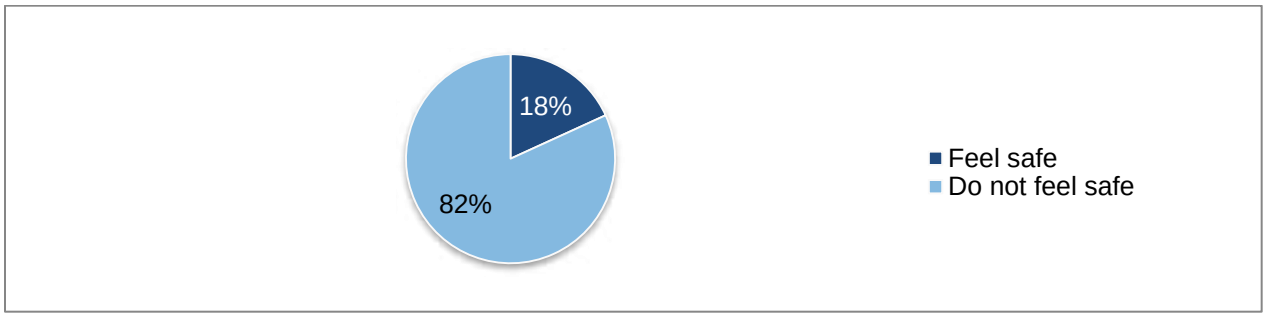


Figure 5.57: Safety perception Watut River

Highlands Highway

In conjunction with the traffic observation survey, a pedestrian survey was undertaken to determine the purpose as well as the frequency of travel. The majority of survey respondents using the Highlands Highway were travelling to access gardens, hunting or fishing areas (see Figure 5.58).

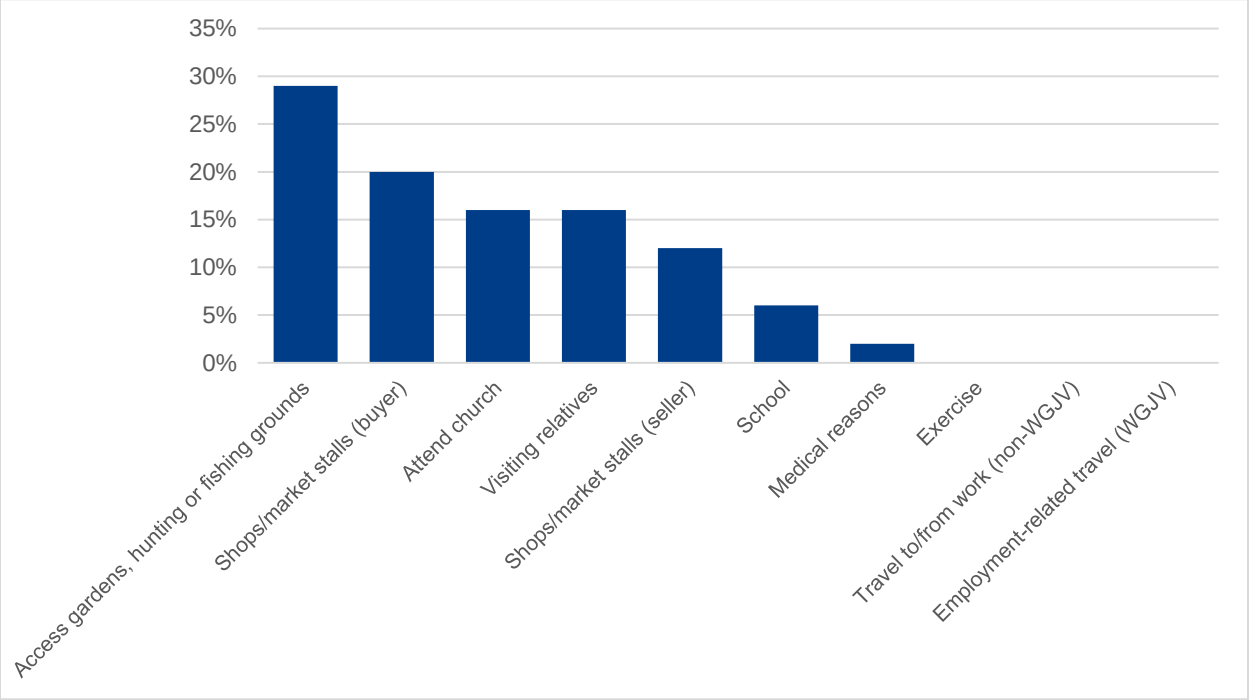


Figure 5.58: Reason for travel on the Highlands Highway

Almost half of the respondents (47%) reported that they travel on the Highlands Highway two to three times per week (see Figure 5.59) with a further 43% using the Highlands Highway for four to six trips per week.

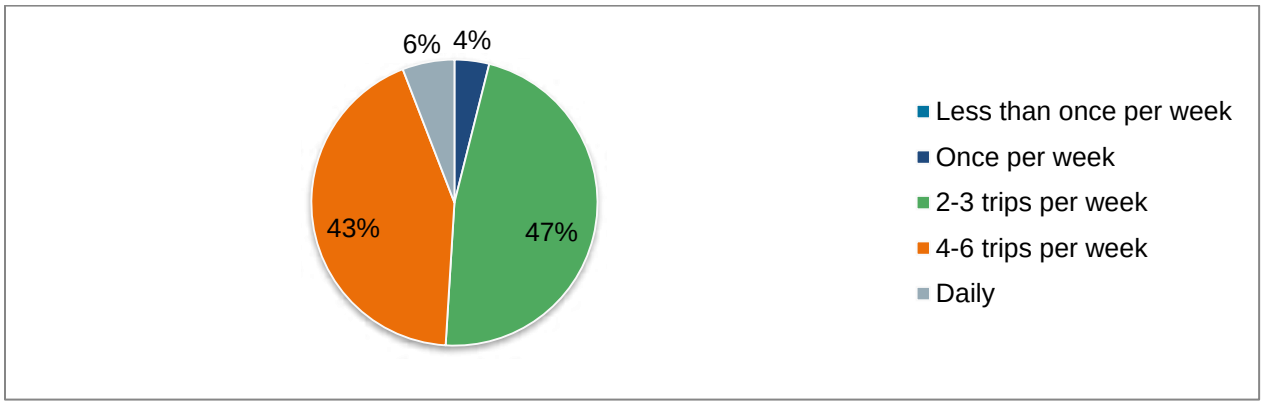


Figure 5.59: Frequency of travel on the Highlands Highway

When asked for their perception of safety, 90% of respondents stated that they do not feel safe when walking on the highway (Figure 5.60).

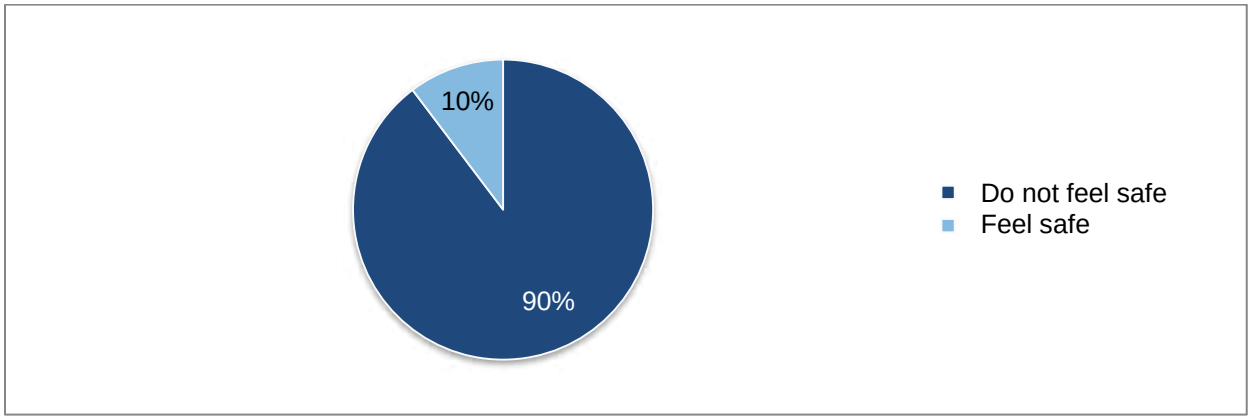


Figure 5.60: Safety perceptions of the Highlands Highway

5.2. Study Area 2 - Infrastructure Corridor (Zifasing to Lae)

This study area relates to the portion of the Infrastructure Corridor from Zifasing up to (but not including) Lae. Potential socioeconomic impacts within this study area would mostly arise from the construction of the concentrate, fuel and terrestrial tailings pipelines. Potential impacts would be limited mostly to the construction phase of the Project, and largely (but not exclusively) to areas within and immediately adjacent to the Infrastructure Corridor.

Because most potential impacts would likely be short-lived and restricted to a narrow area, the main focus for this study area was to characterise existing land use within and near the Infrastructure Corridor. The primary data collection method was on-ground observation of socioeconomic uses of land throughout the proposed Infrastructure Corridor (e.g. visiting and documenting land uses observed within and adjacent to the corridor). Informal conversations with community members were recorded in field notes as part of the field observations. Where the corridor was not accessible during field surveys (e.g. due to difficult terrain or dense vegetation), socioeconomic information was obtained through focus group discussions and/or interviews with landowners. These field surveys were conducted in February, March and May 2017. Further details of these study methods are presented in Section 3.3.2. In all cases, landowner permission was sought prior to conducting any data collection activity.

As noted in Section 3.3, Zifasing was the subject of more detailed studies: socioeconomic surveys undertaken by Coffey in 2015, and the public health and biomedical survey undertaken by Abt JTA in 2012 (Abt JTA, 2013a).

The portion of the Infrastructure Corridor comprising Study Area 2 would traverse through or near Ganef, Gabsongkeg, Munum and Yalu villages, associated hamlets and settlements, and a number of industrial and commercial premises. The following information is structured according to villages and key landmarks. The information presented in this baseline is not intended to constitute a statement of landownership, and further surveys would be required to understand landownership if the Project were to proceed.

5.2.1. Zifasing and Ganef

The Infrastructure Corridor will largely follow (offset yet adjacent to) an existing PNG Power transmission line corridor approximately 50 m wide. An image of the powerline corridor, taken from the proposed Infrastructure Corridor approximately 1.5 km southeast of Zifasing, is provided as Plate 5.18.

Zifasing village is located near the intersection of the Northern Access Road and the Highlands Highway. The 2015 socioeconomic surveys recorded a population of 2,372 persons, with a median age of 24 years, sex ratio of 97 males for every 100 females, and an average household size of 5.6 persons per household. The percentage of the population younger than 15 years of age was approximately 30%. Applying the provincial growth rate of 2.1% per annum between 2000 and 2011, Zifasing village would have an approximate population of 2,608 persons in 2017, over double the population of any other village in Study Area 1.

Zifasing has two main markets, one that is operated during daylight hours and is restricted to residents of Zifasing (Plate 5.19), and one that is a night market and has sellers from both Zifasing and outside areas. A wide range of garden crops are sold, including bananas, root crops, peanuts and melons. Cash crops (primarily cocoa but also watermelon) are also sold in or near Zifasing (including those crops grown in Study Area 1 and taken to Zifasing for sale). According to the 2015 socioeconomic surveys, approximately 58% of households in Zifasing had sold cocoa in the year prior to the survey.

The average household income of Zifasing was 1,045 PGK per fornight, according to the 2015 socioeconomic surveys. With the exception of Venembele and Nambonga (where income from alluvial mining was received), the average income at Zifasing was higher than any village in Study Area 1.

Ganef village is located approximately 5 km east of Zifasing. The PNG National Statistics Office (NSO) has not made census-unit data from the 2011 Census available to the public; however, anecdotal information suggests that Ganef had a population of 274 persons in 2011, living in 59 households. Applying the provincial growth rate of 2.1% per annum between 2000 and 2011, Ganef village would have an approximate population of 317 persons in 2017.

Field observations indicated that gardens were kept within the Infrastructure Corridor near Ganef. Conversations with community members indicated that crops planted included cucumbers, cassava, bananas and coconuts. Some of these crops were consumed, with produce also conveyed to Lae for sale at markets. A cucumber garden owned by a resident of Ganef village is shown in Plate 5.20.

Plate 5.18: PNG Power transmission line corridor to be followed by Infrastructure Corridor near Zifasing

Plate 5.19: 40 Mile Market, Zifasing

Plate 5.20: Cucumber garden at Ganef village

5.2.2. Markham Farm

Further east, approximately 9 km east of Zifasing, Markham Farm is located. Markham Farm was recorded as a census unit in the 2011 Census, with a population of 41 persons (approximately 48 persons in 2017). The name 'Markham Farm' may also refer to the premises of Markham Agro Pty Ltd, which acquired a cocoa, coconut and palm oil plantation at this location in 2008 (Markham, 2017). The PNG Power transmission line corridor runs east-west through the plantation, as would the proposed Infrastructure Corridor. An image of the Markham Agro offices, approximately 100 m north of the proposed Infrastructure Corridor, is provided as Plate 5.21.

Adjacent to Markham Farm and within the proposed Infrastructure Corridor is a settlement of houses. According to informal conversations during field observations, plantation workers (including former workers) have lived in the settlement for over 12 years.

Plate 5.21: Offices of Markham Agro Pty Ltd

5.2.3. Durung Farm

Durung Farm (also referred to as Durum Farm) is located approximately 15 km east of Zifasing, and 2.5 km south of Nadzab (Lae) Airport. Durung Farm is a village which, according to unpublished data from the 2011 Census, had a population of 334 persons in 66 households in 2011 (approximately 386 persons in 2017). The proposed Infrastructure Corridor will pass approximately 60 m north of an industrial chicken facility of Niugini Tablebirds, a major supplier in PNG of chicken and chicken products. This facility is reportedly located on land which was owned by Durung Farm landowners, and which was

bought by the Morobe government in 2011 for the purpose of leasing to Niugini Tablebirds (The National, 2011a, 2011b).

At a point approximately 1.5 km east of the Niugini Tablebirds facility, the proposed Infrastructure Corridor intersects a vehicle track. Houses were observed adjacent to this vehicle track (Plate 5.22). A chicken hatchery was also observed within 500 m of the Infrastructure Corridor. Informal conversations with local people indicated that this hatchery was owned by a local resident who raises chickens under a commercial arrangement with Niugini Tablebirds (Plate 5.23).

Plate 5.22: House and water well east of Niugini Tablebirds

Plate 5.23: Chicken hatchery of local individual in business with Niugini Tablebirds

5.2.4. Gabsongkeg and surrounds

Gabsongkeg village (sometimes spelt ‘Gapsongkeg’ or ‘Gabsonkec’) is located approximately 19 km east of Zifasing. The main part of the village is located immediately north of the proposed Infrastructure Corridor, and extends approximately 700 m northwards. According to unpublished data from the 2011 Census, 772 persons lived in 148 households in 2011 (approximately 900 persons in 2017).

The Wafi-Golpu Joint Venture cultural heritage field survey (Muke & Skelly, 2017) found that Gabsongkeg people identify as Wampar, with the Wampar language generally spoke in the village. The present-day location of Gabsongkeg was established in the early 20th century, after six generations of migration driven by marriage disputes and a desire for better subsistence resources. Traditional sing-sing ceremonies, traditional medicines and spritiual traditions are practiced today. Tangible cultural heritage was identified, including ancestral village sites, pottery sherds and stone tools, ancestral heirlooms (e.g. stone axes), trees of cultural significance, and unexploded ordnance from World War II (Muke & Skelly, 2017).

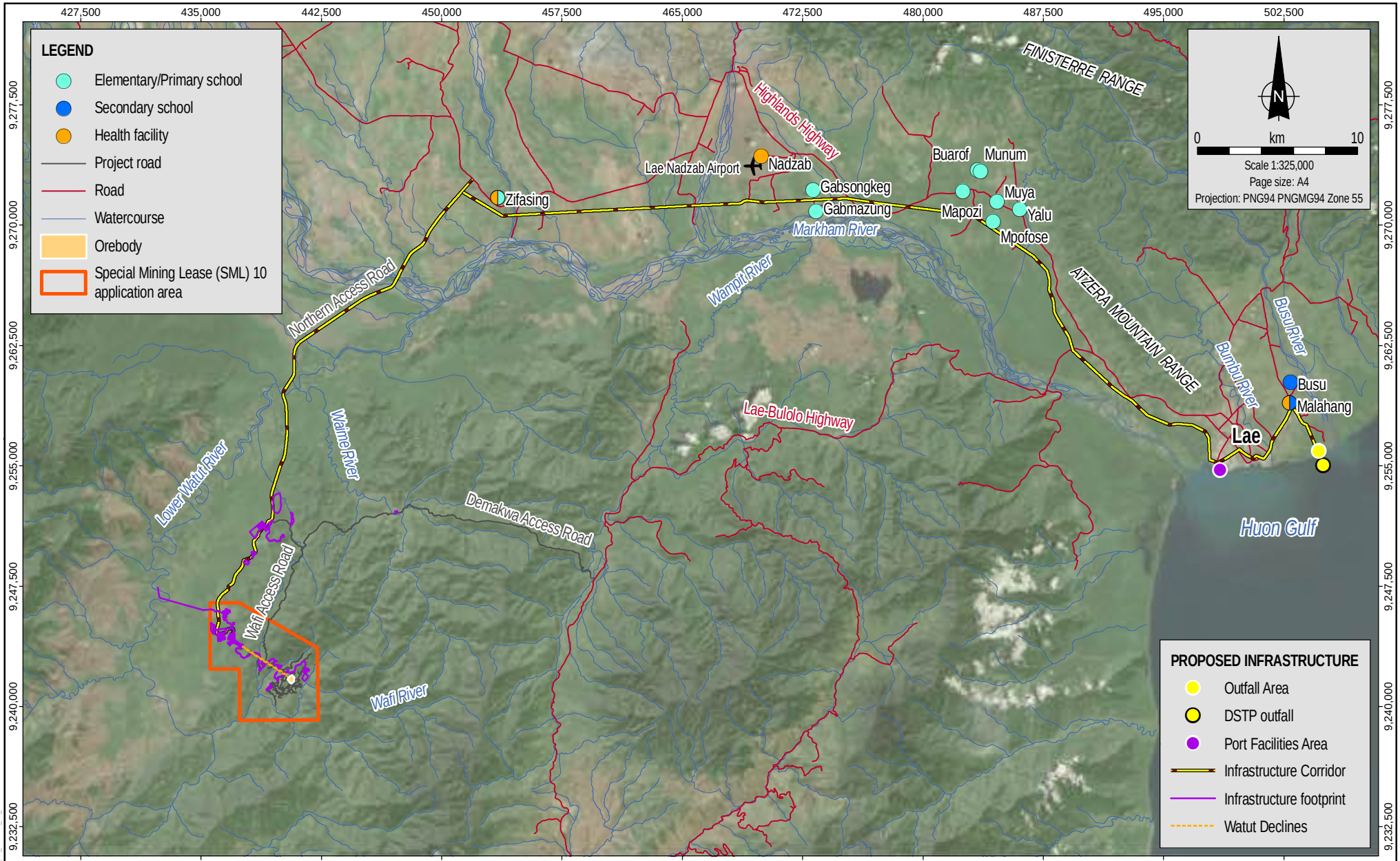
A men’s focus group and a women’s focus group were held at Gabsongkeg village, with over 50 attendees participating in each. Respondents from both groups reported leading generally subsistence lifestyles, sourcing food by gardening, hunting and fishing. Drinking water was reportedly sourced from springs and wells, with nearby creeks an auxiliary source of water.

Access to the main part of the village is reached via Gabsongkeg Road, which runs southwards from the main village, past the proposed Infrastructure Corridor, before turning eastwards to join the Highlands Highway towards the city of Lae.

It was reported in focus group discussions that the main primary school attended by students from Gabsongkeg was Gabmazung Primary School. Gabmazung Primary School is located along Gabsongkeg Road, approximately 400 m south of the proposed Infrastructure Corridor. Focus group respondents indicated that most students walked to school via Gabsongkeg Road, with some students walking past the proposed Infrastructure Corridor to reach school. Focus group respondents also indicated that fishing occurred in the Markham River to the south – villagers residing in the main part of Gabsongkeg would walk past the proposed Infrastructure Corridor to reach the Markham River. Figure 5.61 indicates the locations of education and health facilities reportedly used by communities in this study area.

At Gabsongkeg village, the Infrastructure Corridor will also traverse a number of rice fields reportedly operated by TruKai Rice (a PNG rice company). Field observations in 2017 indicated that these rice fields were untended (Plate 5.24).

East of Gabsongkeg village the Infrastructure Corridor will cross the Highlands Highway twice. This portion of the corridor traverses residential areas and gardens (Plate 5.25). Informal interviews with local people suggested that some of these houses were landowners’ residences, while others were settlers who had paid landowners for the right to occupy the land. The landowning village could not be ascertained. It was observed that the proposed Infrastructure Corridor will traverse several creeks, which were used as water sources for nearby residents (Plate 5.26).



Source:
Health facilities and schools from Coffey.
SML and orebody from WGJV.
Villages, infrastructure and project roads from WGJV and Coffey.
Roads and watercourses from NSO.
Imagery from ArcGIS Online (capture date unknown).

coffey
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Date: 23.03.2018
Project: 754-ENAUABTF100520DD
File Name: 0520DD_20_F05.61_GIS

WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Educational and health facilities accessed by Study Area 2 residents

Figure No: **5.61**

MXD Reference: 0520CC_20_GIS009_v0_7

Plate 5.24: Rice fields no longer in use within the Infrastructure Corridor near Gabsongkeg

Plate 5.25: House within proposed Infrastructure Corridor, 2 km east of Gabsongkeg

Plate 5.26: Water source adjacent to proposed Infrastructure Corridor

5.2.5. Munum

Munum village is located approximately 30 km east of Zifasing, and 22 km northwest of Lae. The 2011 Census indicated that Munum village was split into two parts (Munum and Munum 2). Combined, the village had a population of 1,299 persons in 287 households (approximately 1,500 persons in 2017).

According to the WGJV cultural heritage field survey (Muke & Skelly, 2017), people at Munum identify as Wampar. Wampar is spoken as the *tok ples*, although younger generations tend to blend the Wampar language with elements of *Tok Pisin* and English, leading to reported communication difficulties between younger and older generations. Munum people migrated from Wafi in the 15th or 16th century, over time establishing themselves in the Atzera foothills. A culturally significant day is 25 February 1909, when Lutheran missionaries brokered a peace between warring tribes, and is remembered as a pivotal event in Munum cultural history. Traditional sing-sing, dress, hunting rituals and medicinal knowledge are still practiced, although Munum villages adhere to Christian values. Ancestral settlement sites were identified as tangible cultural heritage.

A community focus group was held at Munum village in February 2017, with over 150 attendees. Respondents indicated that residents at Munum generally led subsistence lifestyles, with food sourced from fishing, gardening, and hunting. Water was sourced primarily from ponds and springs located approximately 30 minutes' walk from the village. Respondents reported that the water quality was unsatisfactory, due to perceived lack of cleanliness of the water.

Fishing was conducted by local people at the Markham River, located approximately 5 km to the south. Sago trees were also reportedly located adjacent to the Markham River. To reach the Markham River, a person would walk 2 to 3 hours, taking a route which would cross the proposed Infrastructure Corridor.

Field observations showed that there were Munum hamlets located within the proposed Infrastructure Corridor. A garden and a group of houses located within the proposed Infrastructure Corridor are presented as Plate 5.27 and Plate 5.28 respectively.

Plate 5.27: Garden at Munum hamlet within proposed Infrastructure Corridor

Plate 5.28: Houses located within proposed Infrastructure Corridor, near Munum village

According to focus group participants, the main elementary schools attended by children of Munum village were St John Elementary, Mapozi Elementary, Buarof Elementary, Munum Elementary and Muya Elementary. The main primary school was Munum Primary School. High school students generally attended Salamua High School, which reportedly required a two-hour commute via public motor vehicle (PMV) and a speed boat. Figure 5.61 (above) presents the locations of schools within this study area. Depending on the relative location of a student's school and house, travelling to school may require a student to cross the proposed Infrastructure Corridor.

Source:
Resource use points from Coffey.
Infrastructure from WGJV.
Villages from WGJV and Coffey.
Satellite imagery from WGJV (capture date 2016).

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Date: 29.03.2018
Project: 754-ENAUABTF100520DD
File Name: 0520DD_20_F05.62_GIS

WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Study Area 2 - Yalu village hamlets/settlements and drinking water sources

Figure No: 5.62

MXD Reference: 0520CC_19_GIS004_v0_10

5.2.6. Yalu

Yalu village is adjacent to Munum village. The main part of Yalu village (where most residences are located) is situated approximately 20 km northwest of Lae. According to unpublished data from the 2011 Census, the population of Yalu village was 659 persons, living in 140 households. In 2017, the population is estimated to be approximately 760 persons. The name 'Yalu' sometimes refers to a broader group of villages and settlements (James et al., 2012, p.130), which in 2011 totalled 3,098 persons (approximately 3,580 persons in 2017).

According to the Wafi-Golpu Joint Venture cultural heritage field survey (Muke & Skelly, 2017), people in Yalu are Aliwang people (also spelt Aribwaung, Aribwaungg and other similar variations: see Holzknecht, 1989). The ancestral migration stories of the Yalu clans are reportedly confidential, although it is known that some clans migrated from the coastal regions east of the Atzera Mountains into the Markham Valley in the 14th or 15th centuries. Oral traditions related to spirits sites and practices, and traditional sing-sing, dress and medical knowledge continue to be practiced. Pottery sherds and unexploded ordnance may be found in the vicinity of Yalu villages. In February 2017, a key informant interview, men's focus group and women's focus group were held at the main part of Yalu village. Field observations and informal interviews were also held with Ngaluchangetz hamlet, located within 800 m of the proposed Infrastructure Corridor. This hamlet was occupied by an extended family unit living in approximately 10 households.

The men's and women's focus groups indicated that water for domestic use (drinking, washing and bathing) was primarily delivered via a pipe to the village, and ultimately sourced from the Yalu River. Secondary sources of water were reported as being creeks and springs. Two springs were recorded in the key informant interview: one located near an industrial compound to the south of the main village, and another near Ngauchangetz hamlet (Plate 5.29). Spring water was reported to be of satisfactory quality, and available all year round. Figure 5.62 presents the locations of drinking water sources used by residents of Yalu village and associated hamlets.

Plate 5.29: Spring located at Ngaluchangetz hamlet

At Yalu village, food was generally sourced from gardening, hunting, fishing, gathering and the raising of livestock. Participants in the key informant interview stated that gardens were the most important food source for residents in Yalu. Most households indicated having their own gardens, and gardening was reportedly undertaken by men and women several times a week. Key crops included banana, taro, yam, sweet potato (kaukau), cassava, peanuts and cucumbers. The women's focus group added that greens (kumu), sugar cane, cocoa, pineapple, pumpkin, pitpit and paw paw were also grown. Sago was also grown by Yalu villagers, located south of the village by the Markham River – these trees would be accessed by a route that would intersect with the proposed Infrastructure Corridor. At both Ambuturup and Ngaluchangetz hamlets, gardens were observed directly below the powerline and therefore adjacent to/within the proposed Infrastructure Corridor.

Similarly, gardens are established within or adjacent to the Infrastructure Corridor at Mpofose settlement, residences of which are located 1.6 km southwest from the main part of Yalu village and within 400 m of the corridor. Mpofose settlement includes two communities of people from Hagen and Markham regions. The Hagen community is situated within and adjacent to the Infrastructure Corridor, while the Markham community is located further to the south. The head of Ngaluchangetz hamlet indicated that the Hagen community settled at Mpofose approximately 15 years ago, through an arrangement made with the previous head of Ngaluchangetz (the current head's father).

Fish and other aquatic resources (e.g. prawns) were reported as a food and income source for Yalu residents, although the focus groups indicated that aquatic resources were not a main food source. In the key informant interview, participants ranked it as the fifth most important food source out of five choices, behind gardening, buying from markets in Lae, buying from village trade stores and hunting. Fishing generally occurred in the Yalu River, at a location east of the main part of Yalu village.

Hunting was stated by men's focus group participants as not essential for the regular diet of villagers at Yalu. Hunting grounds were located up to 8 km to the northeast towards the Busu River, 6 km east across the Yalu River, and 4 km south towards the Markham River. The women's focus group added that hunting was undertaken for both food and traditional purposes. Both groups suggested that hunting was done only occasionally (less frequently than monthly).

Yalu village residents reported gathering firewood, bush fruit, building materials, edible plants, medicines and materials for art and craft from the forests. According to the key informant interview, these forests are located south of Yalu towards the Markham River (approximately 4 km), and to the north and east with bush materials gathered up to 5 km away from the main village.

5.2.7. From Yalu to outskirts of Lae

This section presents socioeconomic baseline information for the Infrastructure Corridor segment between Yalu and the western boundary of Lae Urban LLG.

This segment of the proposed Infrastructure Corridor will be situated to the west of the Highlands Highway leading into the city of Lae. Numerous businesses and industrial facilities, and at least two schools, are located adjacent to the Highlands Highway. The Infrastructure Corridor as proposed would not be situated closer than 400 m from the Highlands Highway, likely leaving most of these premises minimally impacted during Project activities.

The key informant interview at Yalu village indicated that the Infrastructure Corridor will be situated on Yalu land. It was observed that there were settlers living within and adjacent to the proposed corridor. Plate 5.30 depicts a settler house which is well established, well tended and seemingly permanent. Informal interviews with local people indicated that these settlers had paid Yalu landowners for the right to live in this area, and considered themselves permanent settlers. A sago plantation was also observed

within the proposed Infrastructure Corridor (Plate 5.31); it could not be ascertained whether the sago was planted by the settlers or by Yalu landowners.

Further to the south, this segment of the Infrastructure Corridor will traverse land used for commercial agriculture. The proposed corridor will run through or near Wanaru Farm, premises used by Niugini Tablebirds to raise chickens (Plate 5.32). Similarly, the proposed corridor will run through or near premises occupied by Mainland Holdings (which operates a crocodile farm) as well as premises used by PNG Steel Limited as a laydown area. These commercial premises are generally located 1 to 3 km beyond the border of Lae Urban LLG.

Plate 5.30: Settler house near the Infrastructure Corridor and the Highlands Highway

Plate 5.31: Sago stand within the proposed Infrastructure Corridor

Plate 5.32: Wanaru Farm (Niugini Tablebirds), within the proposed Infrastructure Corridor

5.3. Study Area 3 – Lae

This section describes the socioeconomic context within the city of Lae. For analytical purposes, Lae city is defined as Lae Urban LLG, although the analysis below focuses mainly on the southern part of the city where the Port of Lae and the proposed Infrastructure Corridor are situated. People within this study area have the potential to experience impacts from Project activities at or near the Port of Lae, from construction activities within the portion of the Infrastructure Corridor inside Lae, and from infrastructure and activities associated with the Outfall Area. These include direct and indirect impacts.

Contextual information on the Labu villages located to the south of Lae (Labu Butu, Labu Miti and Labu Tale) is also included in this study area, because Labu people live close to and conduct activities in Lae. In particular, Labu villages have been affected by developments which have occurred at the Port of Lae, as discussed below.

5.3.1. Population and settlement

The city of Lae is PNG's second largest city. The 2011 Census recorded the population of Lae District, within which the city is situated, as being 148,934 persons. This population accounted for 22% of the total population of Morobe Province. The district growth rate between the 2011 and 2000 censuses was 2% per annum; applying this rate would suggest a population in 2017 of approximately 168,000 persons. Labu villages located to the south of Lae include Labu Butu (788 people), Labu Miti (712 people) and Labu Tale (788 people) (NSO, 2011).

The customary landowners within Lae include the Ahi and Labu peoples (Holzknecht, 1989; Sinclair, 1998). Some landowners are understood to subdivide land and lease blocks of land to migrants for a rental fee (Armitage, 2001). While such arrangements reflect an agreement between tenant and landowner, they are not governed under legislation (Armitage, 2001). As such, tenants have no express legal rights to the land. People living on land under such arrangements are sometimes referred to as 'formal settlers', acknowledging the existence of an agreement with the landowner.

By contrast, in an informal settlement, occupants reside on land to which they have no customary or other legal claim or formal agreement with the landowner. (See generally Kaitilla, 1994, who provides an overview of the distinction between informal and formal settlements in Lae.)

In 2012, approximately 50% of Lae's population was estimated to live in informal settlements, often arriving from other parts of Morobe province or the Highlands region (Jones, 2012; JICA, 2017). A recent review of land use in Lae indicated that there has been a further growth in informal settlements, particularly along Busu Road (Back Road) and Independence Drive (JICA, 2017). Informal settlements typically lack basic infrastructure and services, and present an urban planning challenge (JICA, 2017; Lahoc, 2014).

In recent times, there have been landowner disputes, particularly in relation to the Lae Port Development Project (an upgrade to the Port of Lae) which necessitated the resettlement of 544 households across four settlements within the Lae Tidal Basin. The proposed resettlement site north of the Lae Port Development Project area was on customary land owned by the Bup clans of the Ahi people. Negotiations to acquire this land were unsuccessful due to disagreements among the different clans. Households were then provided with a cash assistance package to resettle in locations of their choosing. This saw all of the 544 affected persons relocate themselves to almost 16 provinces across the country in early 2010, with over half relocating elsewhere within Morobe Province (Kumul Consolidated Holdings, 2014).

More generally, JICA (2017) has attributed landownership disputes within the city and surrounds to in-migration and customary land changing hands. In-migration has also resulted in the establishment of informal settlements on customary land which the LLG and provincial government see as hindering the urban growth potential of the city (JICA, 2017).

Land in villages surrounding Lae, including the Labu villages, Wagang and Yanga is largely customary land owned by the Labu and Ahi people respectively (Kumul Consolidated Holdings, 2014; Armitage, 2001). Within the city of Lae the Ahi people were the former customary owners of the land which is now state land under alienated title (Armitage, 2001). Although people from surrounding villages live outside of Lae, as outlined in Section 5.3.6, they regularly visit Lae to access employment, goods and services.

5.3.2. Urban land use

This section describes land use within Lae. An overview of land use for Lae as a whole is provided, before a more detailed description of land use along the proposed Infrastructure Corridor route through Lae.

Lae overview

As the industrial centre of PNG, Lae hosts a range of industries including meat processing, beverage manufacturing, soft drink manufacturing, flour milling, cement processing and fish canning. Other industries include transportation, commercial, wholesale and retailing, oil and petrol distribution and cartage (Morobe Provincial Government, 2004). The city is well connected to the rest of the country via the Highlands Highway, a domestic airport and the country's largest port. Lae has one university (the PNG University of Technology, locally known as 'Lae Uni Tech'), and international companies, such as Coca-Cola Amatil, Nestle and Dulux, have their local headquarters in the city.

Table 5.27 presents a breakdown of land use within the city of Lae, as assessed by JICA (2017). Data from 2003 and 2015 is presented, indicating changes over time. The JICA report comments that there has not been much change in formally developed residential land, despite the ostensible decrease in percentage from 20% to 14%; JICA attributes this difference to an inaccuracy in the 2003 data that led to

an overestimate of land area used for formal residential purposes. The informal residential area has doubled, indicating an increase in informal settlements within Lae. Commercial agriculture and industrial land uses have also seen increases in the absolute area of land used, although the proportional area remained the same due to an increase in the overall land area of Lae.

Table 5.27: Land use types in Lae (% by area)

Land use category	2003		2015	
	Area (ha)	Percentage (%)	Area (ha)	Percentage (%)
Residential	560	20%	510	14%
Informal residential	740	27%	1,530	42%
Traditional/ subsistence	100	4%	160	4%
Commercial	50	2%	50	1%
Commercial agriculture	50	2%	70	2%
Industrial	250	9%	340	9%
Public institutional	630	23%	640	18%
Open space	300	11%	280	8%
Infrastructure	70	2%	70	2%
Total	**2,750**	**100%**	**3,650**	**100%**

Source: JICA (2017)

The extent to which food is grown in Lae has not been investigated through primary data collection. Due to their access to commercial food sources and employment, a majority of residents of Lae are not expected to rely on gardens as a major food source. During field observations in 2017, gardens were observed in some settlement areas, although it could not be ascertained whether these gardens belonged to formal or informal settlers. Gardens might therefore be an important food source for low-income residents of Lae. A review of secondary information found no evidence that hunting is practiced by residents of the city of Lae. This may be attributed to the unavailability of animals and plants within the city and access to employment and commercial food stores. Similarly, low levels of hunting are expected to occur in the Labu villages as they are considered more likely to be reliant on fishing and to a lesser extent, store food.

Land use adjacent to Infrastructure Corridor

Within Lae, the land use adjacent to the Infrastructure Corridor was characterised by driving through the Infrastructure Corridor (where access was available) and observing the land uses on either side of the vehicle. The observations were taken on a Sunday morning; consequently, the images below do not show typical weekday foot and vehicular traffic. This approach enabled less obstructed views of the land use along the Infrastructure Corridor. Assessing traffic volumes was not an objective of the observations; hence, it was not necessary to undertake observations during other times of the week. Observations took place in August 2017.

Results from field observations are reported by dividing the Infrastructure corridor into four sections, as shown in Figure 5.63:

- From 3 Mile to the Port of Lae (marked as Section A in the figure).
- From the Port of Lae to the city centre of Lae (marked as Section B).
- From the city centre of Lae to China Town (marked as Section C).

- From China Town to Malahang (marked as Section D).

Figure 5.63 also presents key roads and landmarks.

3 Mile to Port of Lae (Section A)

This segment of the Infrastructure Corridor will traverse through or near 3 Mile, Bugandi, Dowsett (suburbs of Lae) and the Lae Tidal Basin.

At 3 Mile, the area is characterised by settlements and commission housing (Plate 5.33 and Plate 5.34), along with scattered roadside stalls selling fruit and vegetables. Where not occupied by residential structures, the land is predominantly used for settlers' gardens. The 3 Mile police station is located adjacent to the Infrastructure Corridor.

The neighbouring suburb of Bugandi is similarly a residential area, reportedly populated by settlers. Plate 5.35 shows a settler house and garden. The land that the Infrastructure Corridor traverses is occupied by more industrialised uses closer to the Lae Tidal Basin, as described below.

Port of Lae to the city centre of Lae (Section B)

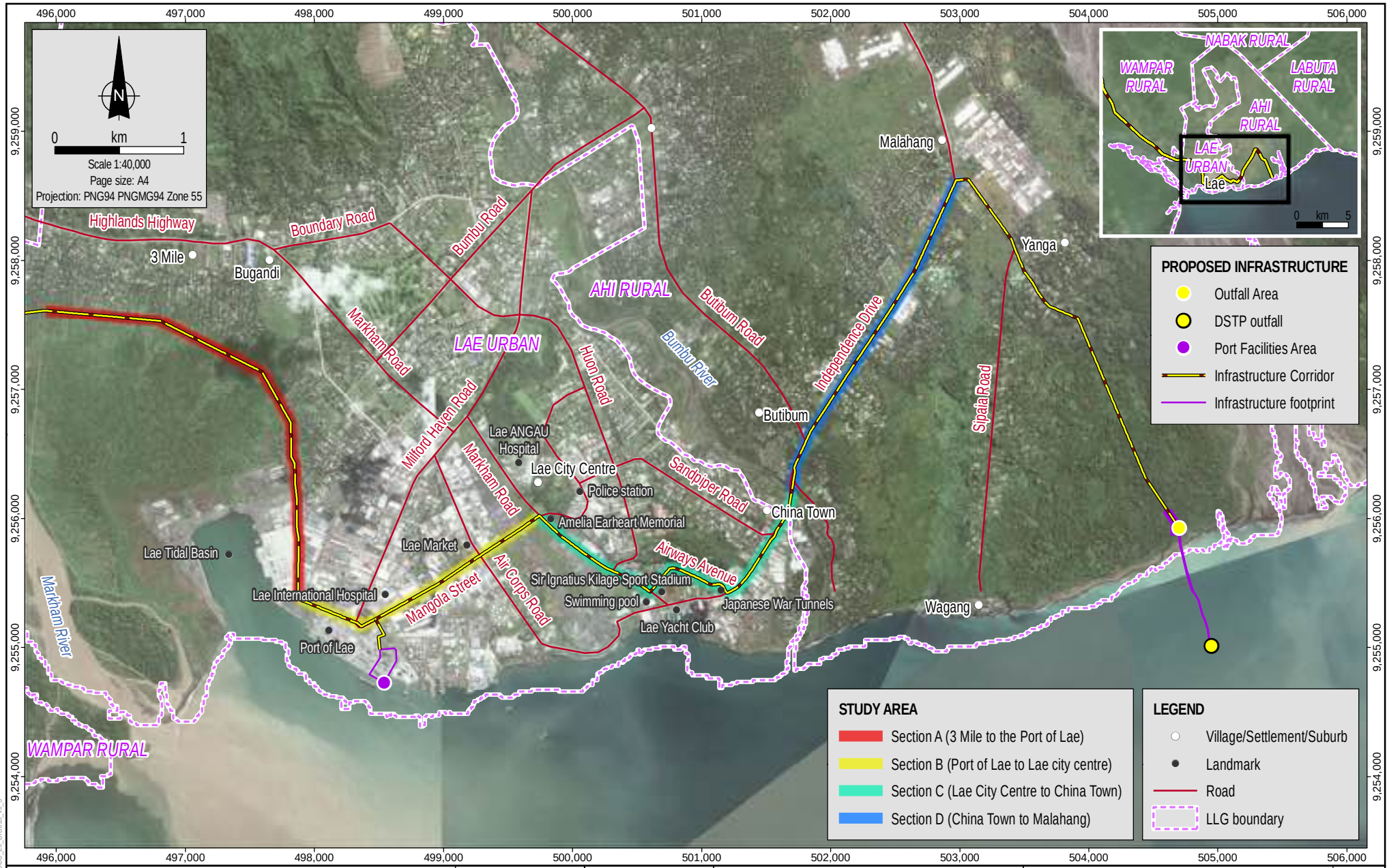
This segment of the infrastructure corridor will traverse through Bumbu Road near the Port of Lae for approximately 400 m, and continue on Mangola Road for approximately 2 km towards the centre of the city of Lae. As discussed above, the Port of Lae is a heavily industrialised area, characterised by numerous industrial warehouses and port facilities. Along Bumbu Road, industries include Consort Express Lines Limited (a shipping company) (see Plate 5.36) and the National Agriculture Quarantine and Inspection Authority (NAQIA).

A range of businesses and services are located along Mangola Street. These include banks, agricultural businesses (such as Zenag Chicken Limited), and manufacturing businesses. Lae Market is also located adjacent to the proposed Infrastructure Corridor, as well as the Brian Bell Plaza, the largest retail mall in Lae (Plate 5.37). Lae International Hospital is located on Mangola Street, and would be adjacent to the proposed Infrastructure Corridor.

City centre of Lae to Chinatown (Section C)

This section of the proposed Infrastructure Corridor will traverse from the city centre of Lae along Markham Road for approximately 1 km before turning left onto Airways Avenue for about 800 m and continuing in a northeast direction through Chinatown. This area is mixed commercial and residential, with schools, Balob Teachers' College (Plate 5.38), churches, a cemetary and other services in the vicinity. Notably, the Australian New Guinea Administrative Unit (ANGAU) Hospital (the second largest hospital in Papua New Guinea) is located 150 m from the junction of Mangola and Markham Road, through which the Infrastructure Corridor will traverse.

A number of community features are located along Markham Road, Airways Avenue and Butibum Road near the city centre. The Amelia Earhart Memorial, a swimming pool, the Sir Ignatius Kilage Sport Stadium (Plate 5.39) and World War II Japanese War Tunnels are located immediately adjacent to the proposed Infrastructure Corridor.



MXD Reference: 0520CC_20_GIS018_v0_5

Source:
Study areas and roads from Coffey.
Infrastructure from WGJV.
Villages from WGJV and Coffey.
LLG boundary from PNGRIS.
Imagery from WGJV (capture date 2016) and ArcGIS Online (capture date unknown).

coffey
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Date: 29.03.2018
Project: 754-ENAUABTF100520DD
File Name: 0520DD_20_F05.63_GIS

WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Field observation locations within Study Area 3

Figure No: **5.63**

Plate 5.33: Housing commission in 3 Mile

Plate 5.34: Settler house in 3 Mile

Plate 5.35: Settler house and garden in Bugandi

Plate 5.36: Premises of Consort Express Lines Limited, situated along Bumbu Road

Plate 5.37: Brian Bell Plaza (a retail mall)

Plate 5.38: Balob Teachers College adjacent to Butibum Road (near Chinatown)

Plate 5.39: Sir Ignatius Kilage Sports Stadium in Lae along Airways Avenue

Towards the eastern end of this section, the proposed Infrastructure Corridor will cross Butibum Road heading in a northeast direction through Chinatown and towards Butibum. Residences are located in this area, and are serviced by numerous small business such as supermarkets (Plate 5.40), as well as Bumbu Market (near the Bumbu River; see Plate 5.41). Industrial-scale businesses are also located in this area, including a Nestle chocolate factory (Plate 5.42).

Plate 5.40: Supermarket in Chinatown

Plate 5.41: Bumbu Market (near Bumbu River) along Butibum Road

Plate 5.42: Nestle chocolate factory on Butibum Road

Chinatown to Malahang (Section D)

From Chinatown, the proposed Infrastructure Corridor will run approximately 3 km along Independence Drive to Malahang. Field observations of the corridor along this sub-segment indicated that business and industrial facilities were located adjacent to Independence Drive. These included a facility for the Majestic Seafood Company (Plate 5.43), a scrap metal recycling plant, the Malahang Industrial Centre (pictured in Plate 5 44; the offices of approximately 50 businesses were observed), and a number of other business compounds (Plate 5.45).

Plate 5.43: Majestic Seafood Company premises on Independence Drive

Plate 5 44: Business premises at Malahang Industrial Centre adjacent to Independence Drive

Plate 5.45: A business compound adjacent to Independence Drive, Malahang area

Settler houses and gardens were also observed adjacent to Independence Drive. Plate 5.46 shows a small store and a settler residence behind a fence, in a settler district east of Independence Drive and extending eastwards for 600 m to the Busu River. Plate 5.47 is a settler garden within the Malahang area.

Plate 5.46: Settler residence and store in Malahang area

Plate 5.47: Settler garden in Malahang area

Two schools were observed adjacent to Independence Drive and along the Infrastructure Corridor – a primary school run by the Assembly of God (Plate 5.48), and Malahang Technical High School, which is located opposite Malahang Industrial Centre. A permanent market was also observed within the proposed Infrastructure Corridor (known as Malahang Market), and adjacent to Independence Drive near the Malahang Industrial Centre. The Malahang Health Centre is located less than 200 m from Independence Drive.

Informal conversations with local people indicated that residents living near Independence Drive walk to the main road, which provides access to services such as schools, shops, public transport, health centres and markets.

Plate 5.48: Assembly of God Primary School on Independence Drive

5.3.3. Water and sanitation

Many residents of the city of Lae have access to piped water as well as relying on water tanks and wells. Piped water is sourced from groundwater, with Water PNG Limited providing 30 million litres of treated water daily to residents of the city of Lae and surrounding villages (Water PNG, 2017). Water is pumped from groundwater bores located in Taraka, before being treated at the Taraka Water Treatment Plant and distributed via two trunk systems (Water PNG, 2017). Drinking water is available for purchase at many stores and markets throughout the city of Lae. Some Lae residents (particularly those living in informal settlements) may collect water from nearby watercourses (e.g. Bumbu River; see Plate 5.49), or create a rudimentary rainwater harvesting system.

Plate 5.49: Bumbu River along Butibum Road

The lack of access to clean drinking water is a recognised issue within the news media, with the Mayor of Lae recently suggesting that 10,000 people lacked potable water (The National, 2016). In 2012 and 2009, cholera outbreaks affected Lae and other parts of Morobe Province (ABC, 2012; MSF, 2009). South of Lae, people of Labu Lakes do not have access to piped water. Potential water sources include springs, creeks, rainwater tanks and wells.

The majority of the city of Lae has trunk sewers; however, sewage is largely discharged directly into the sea without any treatment (JICA, 2017). The sewage outfall station is located at the industrial area near the Port of Lae (ibid). Most residents in the city of Lae are not connected to the sewerage, relying instead on on-site sanitation including septic tanks and pit latrines. Sanitation has been acknowledged as a development priority in Lae and elsewhere by the PNG government (DNPM, 2013).

5.3.4. Utilisation of marine resources

The Huon Gulf is located immediately offshore from Lae, as well as from the Labu villages south of Lae and Wagang and Yanga villages to the east. This section describes the utilisation of marine resources (primarily fishing) in the Huon Gulf near Lae and the Labu villages. Marine and estuary resource utilisation in Wagang and Yanga villages are discussed under Study Area 4 (see Section 5.3.4).

Artisanal fishing groups in the Huon Gulf are small-scale, low-technology, low-capital fishing groups. These groups generally comprise a number of fishing units usually having one or more outboard motor-

driven banana boats or dinghies plus several outrigger dugout canoes. These fishing groups tend to be owned by few individuals from the same village but will operate communally. The most common fishing methods observed by regular fishers from Labu were handlining using 'drop-stone' techniques, vertical long-lining and trolling (Coffey, 2018a). Discussions with locals at the fish market at the Department of Civil Aviation Point (known locally as 'DCA Point'; Coffey, 2018a) indicated that handline methods targeted both demersal and pelagic fishes in water depths usually between 50 m and 100 m, while trolling targeted fishes in shallower areas to depths of 10 m. Fishing depths were estimated from discussions with locals at the market at DCA Point based on the number of rolls of fishing line that they noted as being dispensed from the reel, with each roll comprising 10 m of fishing line. Species caught by local fishers and sold at DCA Point fish markets were found to be seasonally variable and include mackerel (often used as bait), saddletail snapper, sharptooth jobfish, emperors and various reef fishes (Coffey, 2018a).

Deep-water or deep-slope fish are caught in the Huon Gulf with bottom longlines or droplines. Discussions with local Labu villagers identified that dropline fishing using baited hooks targeted demersal fish species in water depths usually between 50 m and 100 m, but generally not deeper than 100 m (Coffey, 2018a). Curved hooks baited mainly with locally caught mackerel tuna (*Euthynnus affinis*) are used by Labu fishers in deeper offshore water areas.

The Labu people, located near the mouth of the Markham River, were known to rely heavily on coastal fishery (Quinn and Kojis, 1987) including the Labu Lakes, Markham River and near-shore marine waters. Fishing remains important to the Labu people for both subsistence and commercial purposes. Fish, prawns, crabs and shellfish are commonly harvested through use of handlines, gill and seine nets (the latter having smaller mesh), small hand-held nets and collection of shellfish by hand. Marine snails (*Faunus ater*) are collected from the mangroves and burnt to make lime, which is sold in markets to use when chewing betel nut (Haskoning Nederland BV, 2007). There is also an inshore anchored floating Fish Aggregating Device located off the coast of Lababia which can draw tuna to nearshore areas, allowing subsistence and artisanal fishers to catch them (Rosegrant et al., 2015).

Fish caught that are not used for subsistence purposes are usually sold or given to friends and relatives. A formal fish market has recently opened at the NFA's Voco Point location (The National, 2017; see Section 5.3.5) and there are also informal fish markets at Voco Point and DCA Point. In addition, fish are also sold at the formal Lae Main Market at various fish stalls, albeit in small quantities. A fish trap net trial fishery was established in October 2015 in an area offshore of Labu Miti village (see Section 5.3.6) which contributes to promoting employment, increasing cash income and securing food for the coastal community involved in the fishery (NFA, pers. com., 2016).

The Western Pacific Leatherback turtle (*Dermochelys coriacea*) is known to nest along beaches of the Huon Gulf south coast (EnviroGulf, 2018). Western Pacific Leatherback turtle nests were observed south of Labu Miti near Labu Butu and Labu Tale (approximately 7 km south of Labu Lakes) in November 2016 (Coffey, 2018b). Nesting activity occurs during the dry season from November to March, with peak nesting occurring between December and January when the sea is relatively calm and soft sand covers most beaches. During the last decade, leatherback turtles we Further east, approximately 9 km east of Zifasing re consumed at Kobo, Ewa (south of Kobo), Sapa, Maiama, Salus, Paiawa and Busama and their eggs harvested (EnviroGulf, 2018; see also Kinch, 2006). In general, turtle eggs are either consumed immediately or within a village; though some may be sold at market to generate income.

Along the southwestern Huon Coast nesting area near Labu Butu, Labu Tale, Busama, Salamaua and further south, various turtle recovery projects have been established, given this represents the largest nesting population in PNG (Kinch, 2006; PNG Ports Corporation, 2007). Locals from Labu Butu and Labu Tale stated they previously conserved Leatherback turtles on behalf of various conservation programs (starting in 2003) including those established by the Western Pacific Regional Fishery Management Council and the WWF Bismarck Solomon Seas Ecoregion non-legal binding tri-national partnership

Memorandum of Understanding. These were devised to explore methods for governments, communities and institutions to manage and conserve nesting sites, feeding areas and turtle migration routes (Kinch, 2006). Other agencies support, or have previously supported, leatherback sea turtle conservation initiatives in the area. Since the cessation of conservation program funding, or lack of tangible economic benefit from doing so (Kinch, 2006), locals stated that they no longer protect turtles and instead consume leatherback turtle eggs and green sea turtle meat.

Small numbers of crocodiles are occasionally caught by villagers in rivers along the Huon Gulf south coast rivers between the Salamaua Peninsula and the mouth of the Gira River. Along the Huon Gulf north coast, crocodiles are rarely found in the urban coastline of Lae or between Wagang and Busu River.

The Port of Lae is the largest port in PNG for imports and exports, and is the main access point for goods delivered or brought by road from towns in the Highland Region (e.g., Mount Hagen and Goroka). Annual throughput in the Port of Lae has been growing at about the rate of PNG population growth with import/export tonnages (increasingly containerised) accounting for about a third of the total and most of the growth (Marine Traffic, 2017). An average of 10 vessels (both international and national) arrive and depart from Lae each day (MarineTraffic, 2017) carrying oil, gas, chemicals, cargo and passengers. Small watercraft includes outrigger dugout canoes and outboard motor-driven banana boats and dinghies, which are used by local people regularly carrying goods and people to and from the various markets in Lae. The busiest routes are between Lae (mainly Voco Point and the fish market at DCA Point) and the villages of Labuta Rural and Yabim Rural LLGs along the Huon Gulf north coast and the villages of Wampar Rural and Salamaua Rural LLGs along the Huon Gulf south coast (EnviroGulf, 2018). Along the Huon Gulf north coast, small watercraft transit routes between Lae and the coastal villages east of Wagang across the location of the Outfall System.

The main recreational activities in the Huon Gulf include game fishing, diving and snorkelling on coral reefs and shipwrecks, bathing and swimming.

5.3.5. Economy

This section provides information on economic infrastructure, key industries, and income and employment within Lae.

Economic infrastructure

As outlined in Section 5.3.1, Lae is host to a range of industries. Compared with many other parts of PNG, it has fairly developed economic infrastructure including the two-lane Highlands Highway, the country's largest port, a domestic airport, and more recently a 30MW thermal power station.

The existing Port of Lae is the largest port in PNG (JICA, 2017). It has six berths and is capable of handling containers. Studies undertaken by MarineTraffic (EnviroGulf, 2018) showed that the port handles approximately 250 vessels per month. The first phase of an upgrade of the Port of Lae was completed in December 2014. New facilities in the Lae Tidal Basin include a multi-purpose berth and terminal works including buildings, storage areas, roads, drainage, water, electricity and sewerage. At time of writing, there has been limited uptake of the facilities at the Lae Tidal Basin, and it is understood that the PNG Ports Corporation is currently seeking an operator to manage the Port's affairs. A proposed second stage of the upgrade will triple the capacity of the Port.

Lae (Nadzab) Airport is located approximately 50 km from Lae. The airport replaced the Lae Airfield as the primary airport servicing Lae in 1977. Currently, there are plans to upgrade the airport. Nadzab Airport has a runway length of 2,438 m with a width of 30 m and services domestic flights only. Air services available from Nadzab Airport are provided in Table 5.28.

Table 5.28: Air services from Nadzab Airport

Provider	Destinations
Air Niugini	Buka, Hoskins, Lorengau, Port Moresby
Airlines PNG	Alotau, Goroka, Hoskins, Madang, Popondetta, Port Moresby, Rabaul
Travel Air	Hoskins, Madang, Port Moresby, Rabaul, Wewak, Vanimo
North Coast Aviation	Bulolo, Finschhafen, Kabwun, Lablab, Omora, Satwag Wau, Yalumet

A new 30MW thermal power station at Munum just outside of the city of Lae has also recently been constructed. Posco Daewoo's power station was due to be commissioned in June 2017 and act as a backup station to Ramu. It will cater for approximately three quarters of the city of Lae's power requirements (Giame, 2017).

Key industries

Business investments in Lae are predominantly driven by private investors and landowner companies, such as Ipili Porgera Investments, which is an investment company derived from the Porgera Mine in Enga Province. Other major business interests in Lae include Halla Cement (a cement manufacturer with headquarters in South Korea), Trukai Rice (a leading supplier of rice in PNG), SP Brewery (a PNG producer of beer) and South Pacific Steel (a manufacturer and distributor of roofing and sheet metal products).

The National Fisheries Authority (NFA) advises that there is no commercial fishing in the Huon Gulf, and all of the purse-seine tuna fishing grounds are located well to the north and east of the Huon Gulf. Further to this, no commercial fishing is allowed within 12 nautical miles from land. However, Lae is the hub of an expanding fish processing industry in PNG (JICA, 2017). Existing fish processing plants in Lae include the Malaysian owned International Food Corporation Besta mackerel cannery, the Philippines owned Frabelle tuna processing plant, the Philippine-Taiwanese owned Nambawan Seafood and the Thai-Philippine owned Majestic Seafood Ltd which operates a tuna processing plant (EnviroGulf, 2018). A further three foreign-owned canneries are due to start commercial operation in Lae in the coming years bringing employment opportunities for approximately 10,000 workers (JICA, 2017). These include the Chinese owned Zhoushan Zhenyang Deep-Sea Fishing Company and the Korean owned Dongwon Fishing and (EnviroGulf, 2018). The Morobe Fisheries Management Authority is promoting the development of a Wagang fishery port southeast of the city of Lae to further boost the cannery business opportunities within the region (JICA, 2017).

A formal fish market has recently opened at the NFA's Voco Point location (The National, 2017). The Overseas Fishery Cooperation Foundation of Japan helped finance this jointly-owned NFA and Morobe Fisheries Management Authority project. The Overseas Fishery Cooperation Foundation has installed modern equipment including a plate ice machine, a blast freezer, cool storage, an office, a cool room and a small fish selling and buying point (i.e., a mini fish market). There are also informal fish markets at Voco Point and DCA Point. In addition, fish are also sold at the formal Lae Main Market at various fish stalls, albeit in small quantities.

A fish trap net trial fishery was established in October 2015 in an area offshore of Labu Miti village, south of Lae, in the inner Huon Gulf (OFCF, 2017; NFA, pers. com., 2016). The fish trap net installed is of a type called a 'drop net' that is widely used on the coast of Japan. The NFA considers that the fish trap net fisheries contribute to promoting employment, increasing cash income and securing food for the coastal community involved in the fishery, and is one of the key measures for coastal fishery development in PNG (NFA, pers. com., 2016).

Income and employment

Household interviews conducted in 2014 (JICA, 2017) indicate that monthly household income in the Lae Urban LLG is generally between PGK500-1,000 (comprising 47.5% of households interviewed) and PGK1,000-5,000 (31.8%).

There is a large disparity in employment opportunities between the city of Lae and surrounding rural areas (JICA, 2017). While the majority of the working age population in rural areas work in primary and informal sectors due to the lack of other employment opportunities, there are more employment opportunities within the city of Lae for people with the right skills and experience. However, employers in Lae have reported difficulties in filling job vacancies in the formal sector with reliable staff with basic technical skills and life skills, such as discipline and reliability, even for semi and relatively low-skill requirement jobs (Kanaparo et al., 2014). In a 2014 study of unemployment of the urban youth in Lae, 67% were found to be unemployed, 31% worked in the informal sector and 2% in the formal sector (Kanaparo et al., 2014).

Economic infrastructure in Labu villages is limited. The villages are also fairly isolated from the industrial activities of the city of Lae due to poor road access (JICA, 2017).

5.3.6. Education

Compared to other parts of PNG and the Morobe Province as a whole, residents of the Lae Urban LLG have high education levels and relatively good access to secondary and tertiary education (JICA, 2017). According to 2011 census data for the final enrolled education level, 25.8% had enrolled in secondary education and 15.3% in tertiary education. This compares to 12.1% and 11.8% enrolled in secondary education in PNG and Morobe Province respectively and 5.5% enrolled in tertiary education in PNG and Morobe Province. Within the city of Lae there are seven elementary/primary schools, three secondary schools and three tertiary institutions. Tertiary institutions include the University of Technology, Lae Technical College, Balob Teachers College, the Martin Luther Seminary and the Lae School of Nursing (PNG Division of Education, 2007).

Labu villages have poor access to education with insufficient schools to serve students (JICA, 2017). Some parents send their children to boarding school within the Lae Urban LLG, particularly for secondary school due to the lack of services in Labu, but this is too costly for many families (JICA, 2017).

5.3.7. Health

Access to health services

There are 12 health facilities within the Lae Urban LLG (JICA, 2017). These include one hospital (the Australian New Guinea Administrative Unit (ANGAU) Hospital), seven clinics and four aid posts. The ANGAU Hospital is the second largest in PNG with a capacity of over 400 beds and provides a range of services including surgery, paediatric, oncology and obstetrics (JICA, 2017). While ANGAU Hospital has certified medical staff, it lacks the capacity to service the community adequately. The Draft ANGAU Memorial Hospital Facilities Master Plan Report (Hassal & Frame, 2015) identified a range of capacity and capability limitations of the hospital including:

- The current physical structure of the hospital is in disrepair with large parts of the current facility unusable or unfit for purpose.
- The hospital is understaffed and faces challenges in recruitment, retention and staff absenteeism.

- The current stock of equipment is inadequate to provide complex services and supply of critical inputs and support services is unreliable and/or inadequate.
- Complementary services are not located in proximity to the hospital leading to inefficiencies in service delivery.

Furthermore, the Master Plan Report concluded that the ANGAU Hospital's capacity is stretched due to the Lae population's limited access to healthcare outside of the facility, which places a significant strain on the hospital's already limited resources (Hassal & Frame, 2015). Outside ANGAU Hospital, services offered at clinics include family health services, disease control and pharmaceutical services while the aid posts offer more limited outpatient services (JICA, 2017).

Despite the range of services available for the city of Lae residents, there are substantial shortages of healthcare facilities and health workers relative to the population of the area. Except for ANGAU Hospital, most healthcare facilities are run only by community health workers and nurses who are not certified as medical doctors or physicians, resulting in most patients in the region not being treated adequately (JICA, 2017). The Morobe Provincial Administration in its Lae, Huon Gulf and Nawaeb District Development Plan aims to improve healthcare services and provide equal services to the people of Morobe (including the city of Lae), however insufficient funding from the provincial government has stalled actions to improve health facilities and services (JICA, 2017).

5.3.8. Law and order

Despite scarce statistics, studies have identified the Highlands Highway to be a hotspot of criminal activity (Weber, 2008; Dinnen, 2001). Crime (including criminal *raskol* gangs) has been identified as concentrating in urban areas (Dinnen, 2001), although criminal gang members were often also integrated within both rural and urban societies (Goddard, 1995), and consequently difficult to manage. The increasing number of people migrating to urban areas of Morobe province, such as Lae, in search of employment opportunities has been identified as a key source of conflict (JICA, 2017). This has resulted in informal settlements around Lae becoming the source of conflict and crime between tribes.

In Lae, crime levels are consistently high, with robbery and assault the most commonly reported crimes. Homicide rates of 66 per 100,000 in Lae are double those of Port Moresby and among the highest in the world (World Bank, 2014). Family and social violence in Lae is also common with one health clinic in Lae stating that approximately half of all the treatment given to employees was to female workers subjected to violence (Lakhani & William, 2014). This high level of violence is considered to be the result of the failure of both traditional and formal institutions to manage the stresses that have arisen with rapid economic growth and the resultant social changes (Lakhani & Willman, 2014). Riots and mass prison breakouts have also occurred in the city in recent years; the most recent breakout from the Buimo Prison was in May 2017 (The National, 2017). In this incident, several of the 58 inmates who broke out of Buimo Prison had been remanded and awaiting trial for over nine years after having their cases deferred (The National, 2017). The prison has experienced overcrowding and outbreaks of tuberculosis which has also led to high levels of frustration among inmates with multiple breakout attempts. In the May 2017 breakout, 17 inmates were shot dead by police (ibid).

Police stations are located mainly in Lae urban area except one station at Nadzab Airport. Therefore, services required by local communities for incidents such as accidents, fires and crimes cannot be provided immediately (JICA, 2017). Crime levels have been increasing in the Lae region to the point that an increased police and security presence has been required (JICA, 2017). A mobile police squad was established in Lae to assist in managing the increasing levels of crime and shortage of police. It is deployed to different parts of the city and region as required.

5.3.9. Vulnerable and disadvantaged groups

Significant aspects of socioeconomic vulnerability and disadvantage include: lack of access to resources; limited access to political power and representation; diminished social capital (e.g. including social networks and connections); inadequacy of housing and accommodation; and frail or physically limited health (Cutter et al., 2003; Smyth & Vanclay, 2017).

As discussed in Section 5.3.1, informal settlers within Lae may be considered a vulnerable group within this study area. Informal settlers lack land rights and tend to have limited access to infrastructure and services. Many have migrated from other parts of PNG, and may lack employment and connections to family and friends that would ordinarily provide support.

Physically and mentally disabled people are also vulnerable groups within this study area. While no published study specific to PNG relating to this social aspect could be sourced, it has been estimated that only 2% of all disabled persons in PNG receive governmental support and many communities lack the knowledge and resources to effectively care for people with a disability (NDRAC, 2014; see also Byford & Veenstra, 2004; Jenkin et al., 2017). While little is known about the level of disadvantage experienced by people with a disability within individual communities, their vulnerability can be influenced by factors such as a lack of education and remoteness (Grech, 2016a, 2016b; Hanass-Hancock & Mitra, 2016).

The city of Lae offers some, albeit limited, support services for people with disabilities. One service is the Lae Disabled Home which provides temporary housing as well as training and rehabilitation services to over 30 residents to enable them to then live semi-independently within the community (The National, 2016). It is not known whether other disability support services exist within Lae but the lack of funds to support services such as this indicates that people with a disability have a high potential to experience disadvantage within the community.

Within the more isolated Labu villages it is expected that people with a disability are cared for at home with limited sources of income and no government assistance to support them.

5.3.10. Traffic and transport

This section describes traffic and transport within Lae. A particular focus is given to roads along, within, across or adjacent to which the proposed Infrastructure Corridor will traverse.

Management of roads, traffic and transport

Within Lae, five key organisations undertake roads management (JICA, 2017):

- Department of Transport.
- Department of Works.
- Morobe Provincial Administration (Division of Works and Transport, and Traffic Registry).
- Lae Urban LLG.
- Traffic Police.

Roads with Lae are classified as national roads, provincial roads, Lae city roads and district roads, with corresponding governmental responsibility for each classification. More broadly, the National Transport Strategy (PNG Department of Transport and Infrastructure, 2013) guides roads management and policy at the national, provincial, LLG and district levels. JICA (2017) notes that many roads in Lae remain unsealed, and susceptible to closure during heavy rain.

Public transport

Lae is serviced by seven public motor vehicle (PMV) routes: Urban Routes 11, 12, 13 and 14, and Rural Routes 2, 3 and 100. Urban services run approximately ten times per day with standard fares costing PGK1 or less. Rural services within Morobe Province (routes 2 and 3) run twice a day and cost between PGK2 and PGK15. Rural Route 100 is an inter-province service reaching Hagen and Madang.

Figure 5.64 is a route map for PMV services in Lae. Note that Urban Route 13 and Rural Route 2 traverse parts of the ciy centre of Lae, Chinatown, Butibum and Malahang, along or adjacent to the proposed Infrastructure Corridor.

Traffic along Infrastructure Corridor within Lae

As noted in Section 5.3.2, the proposed Infrastructure Corridor will traverse along urban roads from the Port of Lae, through the city centre of Lae, Chinatown and Malahang, before turning southeast towards the Outfall Area.

JICA (2017) has projected traffic loads for main roads in Lae for the year 2025, as shown in Figure 5.65. The projected volume-to-capacity ratio (VCR) is shown. For any particular section of road, a VCR less than 1.00 suggests little or no congestion; a VCR greater than 1.00 suggests that the volume of traffic will exceed the capacity of the road.

The portion of the Infrastructure Corridor from the Port of Lae to Markham Road (i.e. along Mangola Street) is predicted to be at capacity in 2025. Markham Road is predicted to be below capacity. The portion of the Infrastructure Corridor along Butibum Road and Independence Drive is predicted to be above capacity by 2025, with heavy congestion immediately south of the intersection between Butibum Road and Independence Drive.

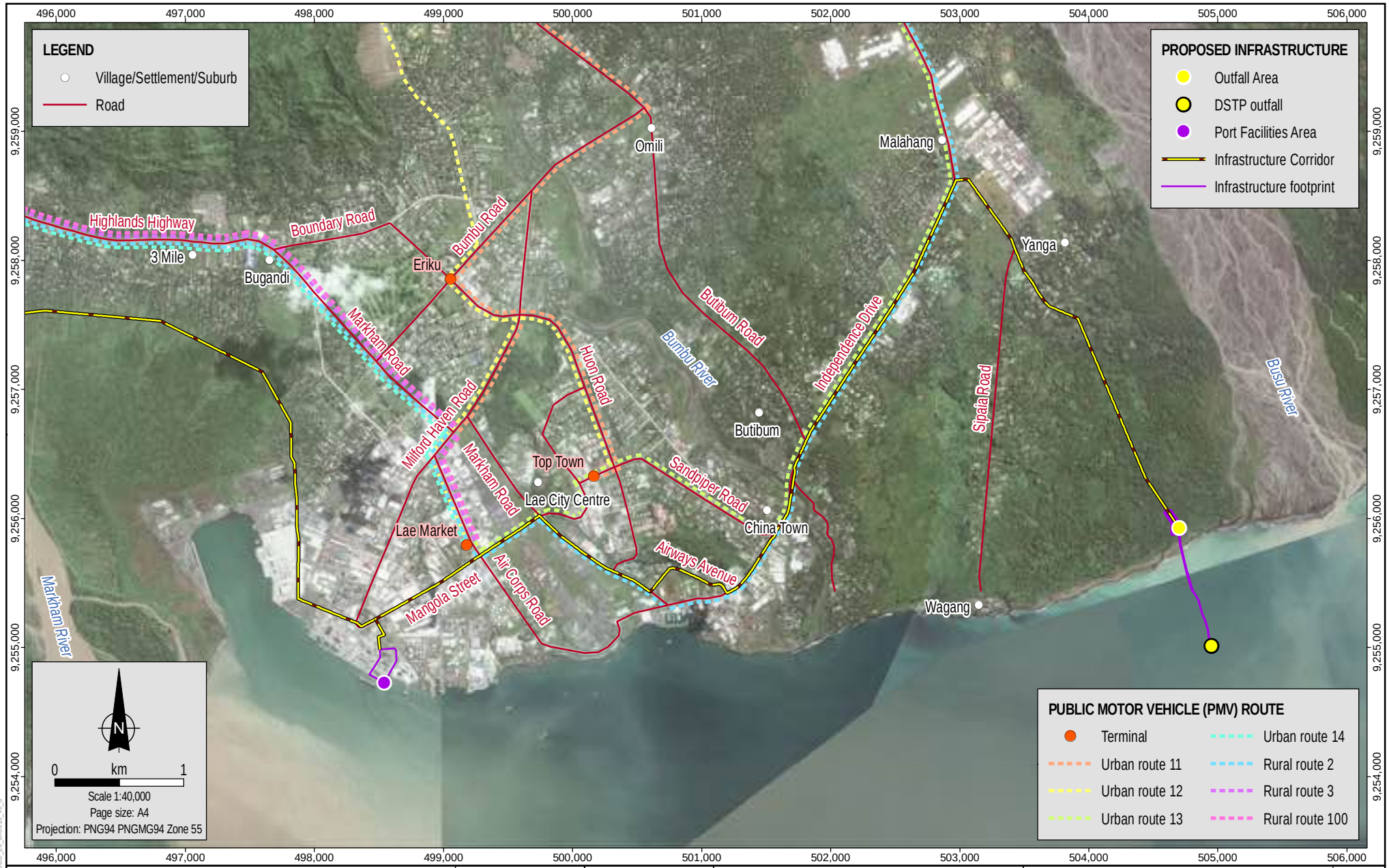
The 2017 Observed Traffic Count Survey was conducted in Malahang at Independence Drive, to characterise current traffic loads at that location. This traffic count was undertaken over a period of four days (Friday to Monday) between 6:30 and 17:30. All vehicles and pedestrians travelling either to or from Mahalang which passed the survey locations were recorded.

Data from the surveys at this location are shown in Figure 5.66, Figure 5.67 and Figure 5.68. This location was selected as it is close to major trip generators, such as the Malahang Industrial Area, a high school and primary school, and a market close to the industrial area.

On weekdays (Friday and Monday), the number of vehicle movements over the 11-hour period from 6:30 to 17:30 was around 6,000, with weekend traffic being substantially less (in the order of 50% less). This location exhibits distinct morning (7:30 to 8:30) and afternoon (16:30 to 17:30) peak periods, as well as a minor peak periods from 12:30 to 13:30 during the lunch period. The average vehicle movement per hour was between 500 and 600. Up until about 10:30 in the morning the dominant traffic flow was toward the city of Lae from Malahang, while from 10:30 for the rest of the day the dominant traffic flow was toward Malahang from the city of Lae.

Traffic composition at this location comprised principally cars and light vehicles (50%), PMVs (30%) and heavy commercial vehicles (rigid trucks and semi-trailers, 17%).

Pedestrian movements at Independence Drive at Malahang over the four-day survey period are shown in Figure 5.69 and Figure 5.70. Monday appears to be a day when there is a lot of traffic activity with around 3,500 movements. There are distinct busy periods in the morning (7:30 to 8:30) and afternoon (15:30 to 16:30) coinciding with school commencement and finish times. The average hourly pedestrian movement is in the order of 200.



Source:
PMV data digitised by Coffey (indicative only) from JICA. 2017. The project for the study on Lae-Nadzab urban development plan in Papua New Guinea: final report. February. Report prepared by Japan International Cooperation Agency, with Yachiyo Engineering Co. Ltd. and Kokusai Kogyo Co. Ltd, p.6-8.
Infrastructure from WGJV. Villages from WGJV and Coffey.
Imagery from WGJV (capture date 2016) and ArcGIS Online (capture date unknown).

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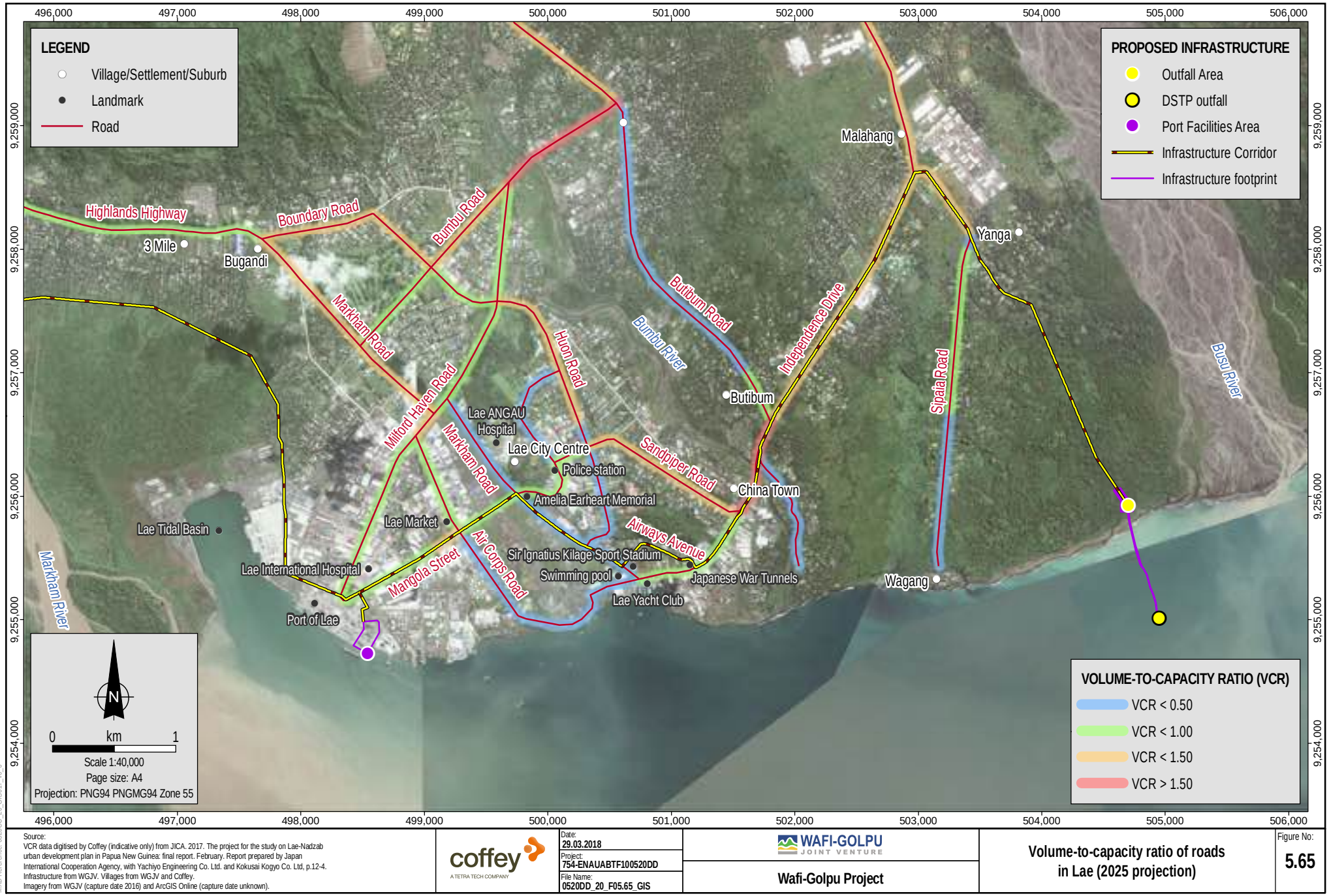
WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Public motor vehicle routes servicing Lae

Figure No: 5.64

MXD Reference: 0520CC_20_GIS019_v0_3



Source:
VCR data digitised by Coffey (indicative only) from JICA. 2017. The project for the study on Lae-Nadzab urban development plan in Papua New Guinea: final report. February. Report prepared by Japan International Cooperation Agency, with Yachiyo Engineering Co. Ltd. and Kokusai Kogyo Co. Ltd, p.12-4.
Infrastructure from WGJV. Villages from WGJV and Coffey.
Imagery from WGJV (capture date 2016) and ArcGIS Online (capture date unknown).

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Date: 29.03.2018
Project: 754-ENAUABTF100520DD
File Name: 0520DD_20_F05.65_GIS

WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Volume-to-capacity ratio of roads in Lae (2025 projection)

Figure No: 5.65

MXD Reference: 0520CC_20_GIS017_v0_6

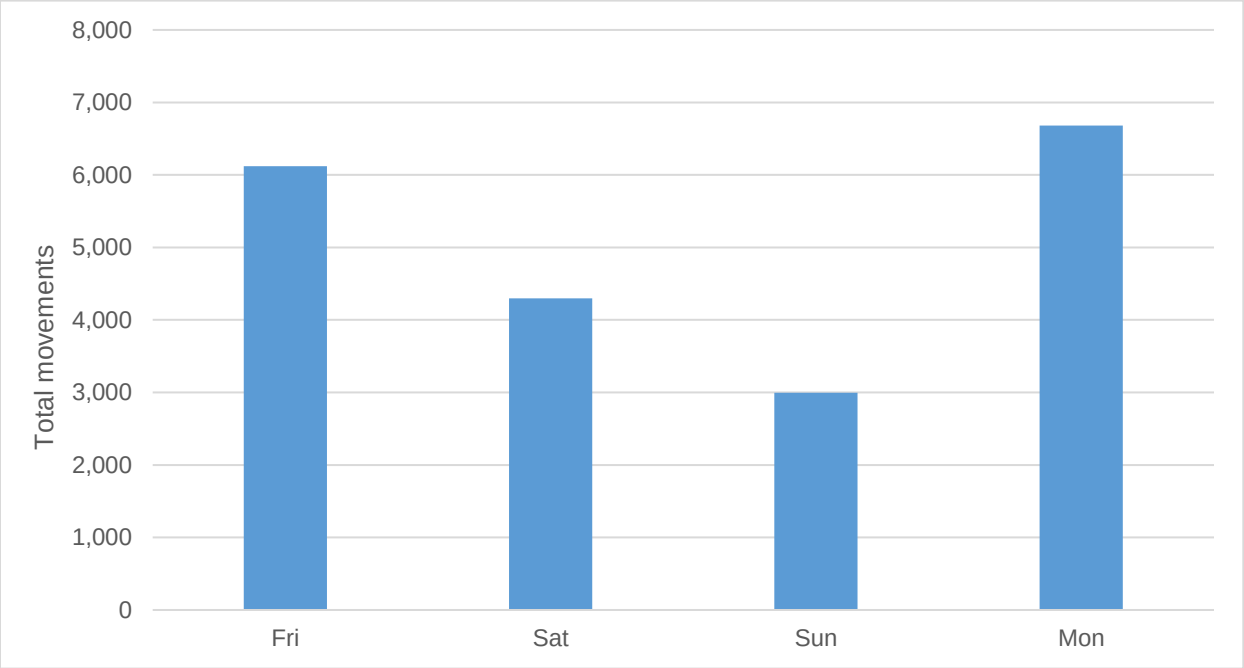


Figure 5.66: Independence Drive at Malahang: vehicle movements (Friday to Monday), 6:30–17:30

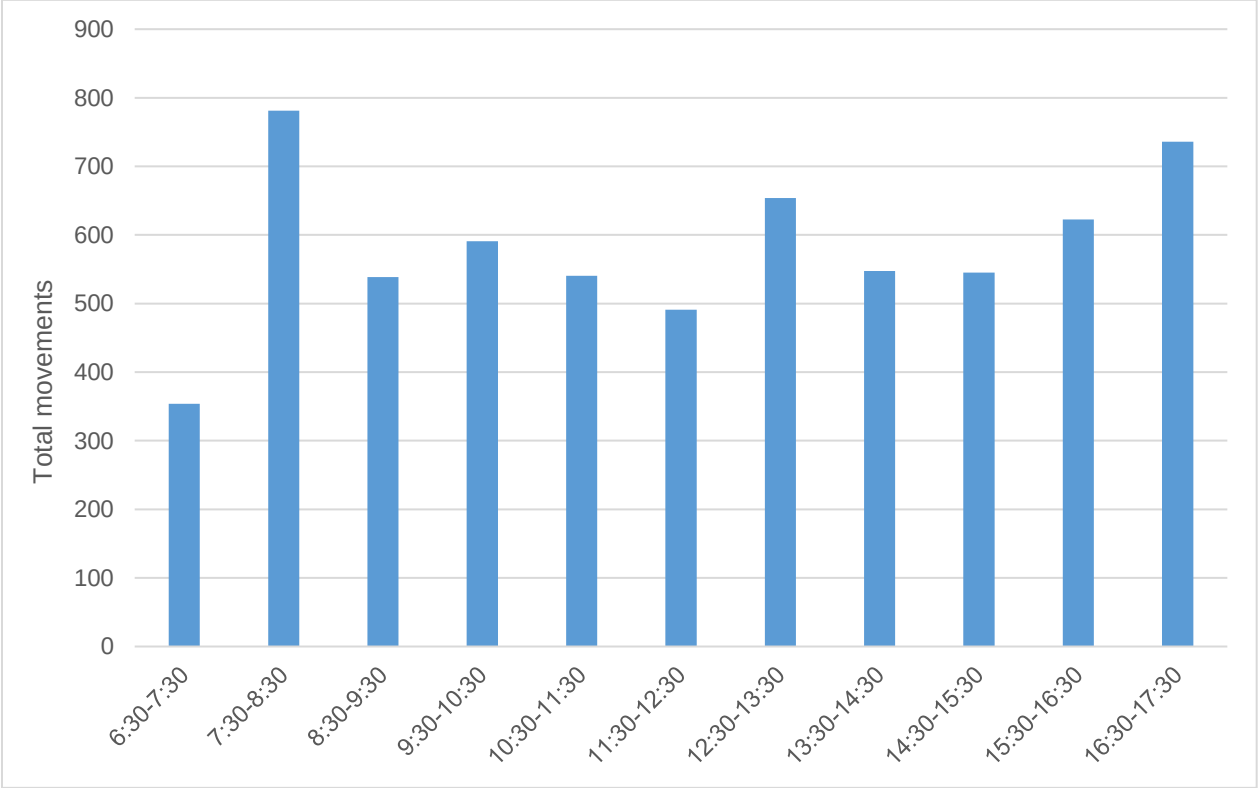


Figure 5.67: Independence Drive at Malahang: vehicle movements (Friday & Monday), 6:30–17:30

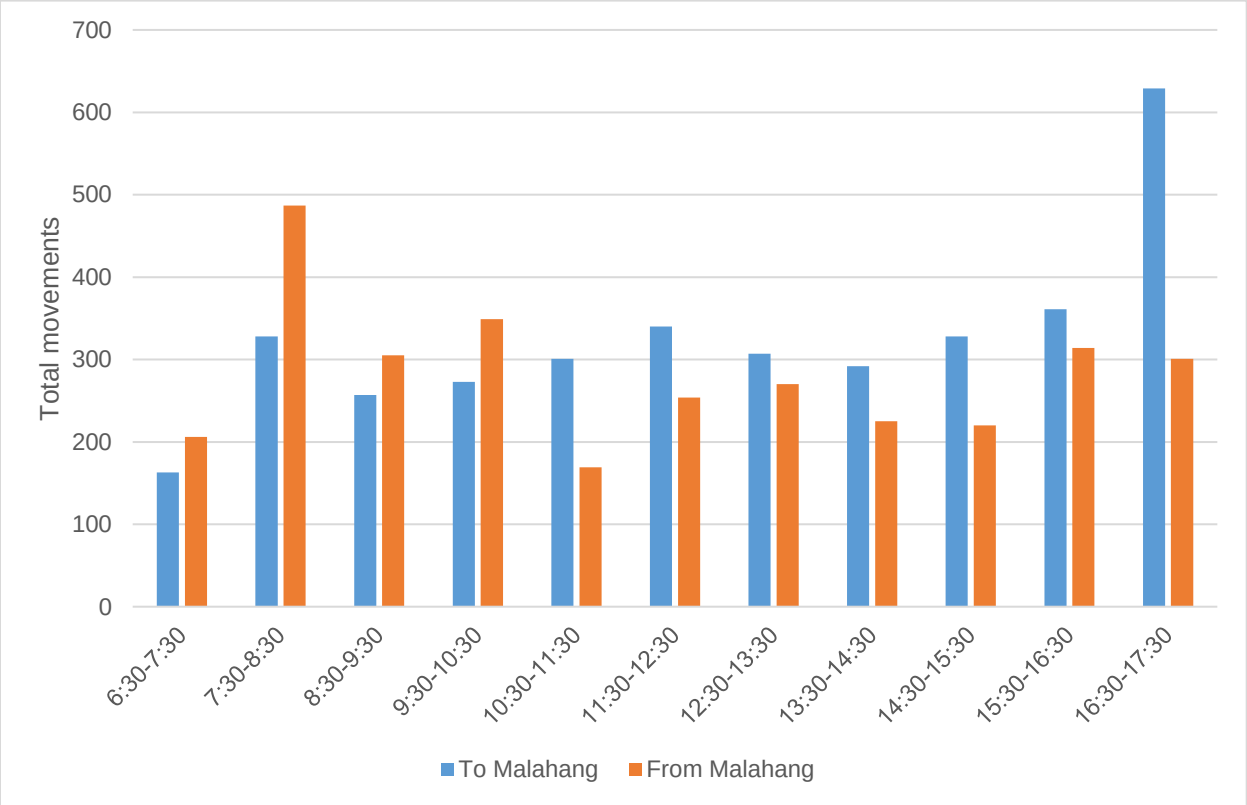


Figure 5.68: Independence Drive at Malahang: vehicle movements on Monday 15 May 2017

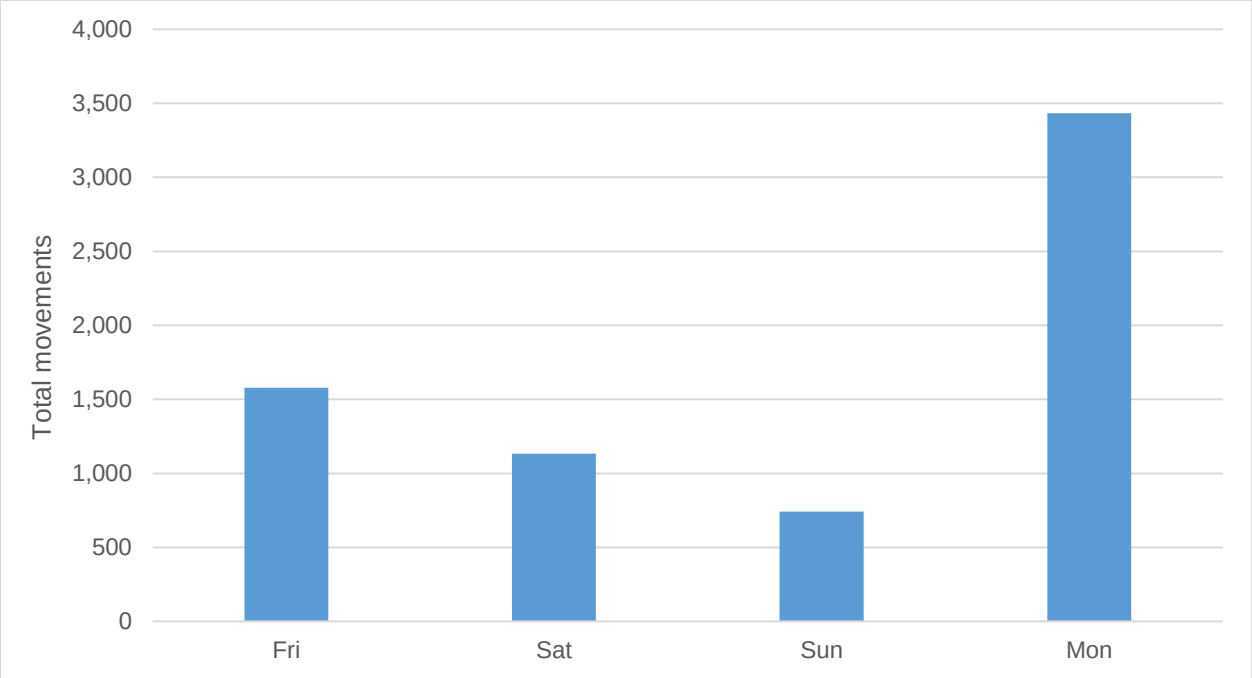


Figure 5.69: Independence Drive at Malahang: pedestrian movements (Friday to Monday), 6:30–17:30

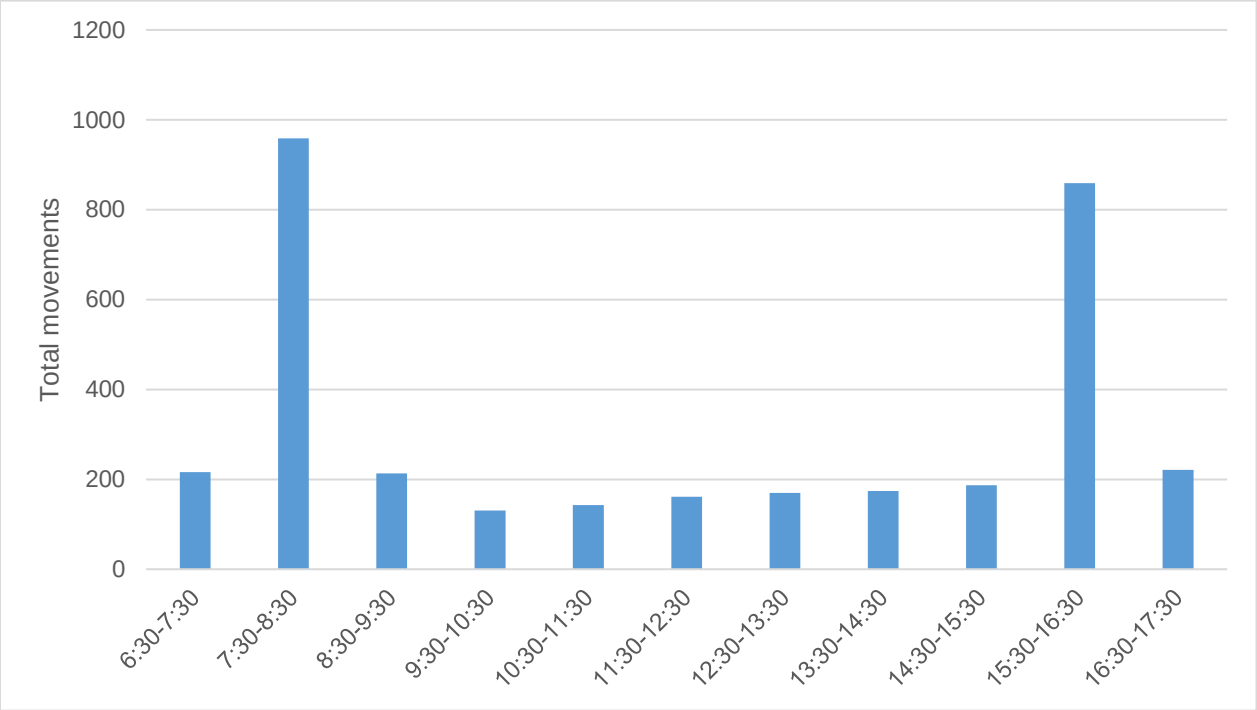


Figure 5.70: Independence Drive at Malahang: pedestrian movements on Monday 15 May 2017

5.4. Study Area 4 – Wagang and Yanga villages

This section describes socioeconomic baseline characteristics for Study Area 4, which comprises the peri-urban villages of Wagang and Yanga. Data was gathered in the 2017 socioeconomic surveys, which used household surveys, focus group discussions, key informant interviews and field observations, as described in Section 3.3.4.

5.4.1. Population and settlement

Wagang is a coastal village located approximately 3 km east of Lae. It can be accessed via Sipaia Road, which runs northwards from the village. Wagang had a population of 542 persons in 2011. Residents of Wagang live in houses located by the shore, as well as on either side of Sipaia Road, leading north-south from Independence Drive into the coastal part of the village.

Yanga is located approximately 3 km north of Wagang and is also accessible via Sipaia Road. Yanga had a population of 536 persons in 2011 (NSO, 2011).

Household surveys were conducted in 2017 in Wagang to obtain information on the demography, household composition, education, employment experience and health of residents. Table 5.29 provides a summary of basic demographic information for Wagang obtained from this survey. This indicates that at the time of the survey, the median age of residents recorded was 21 years, which was slightly higher than the PNG median age of 19.7 years in 2000 (2011 age data has not been released). The median age for Wagang was also higher than for Study Area 1 (Mine Area, surrounds and access corridors), which was recorded as 18 years. The dependency ratio score for Wagang (60) was lower than PNG's (73), and for Study Area 1 (74.1 for Tier 1 villages and 68.4 for Tier 2 villages). Household size recorded in Wagang (6.2) was slightly higher than that recorded for PNG in the 2011 census (5.3).

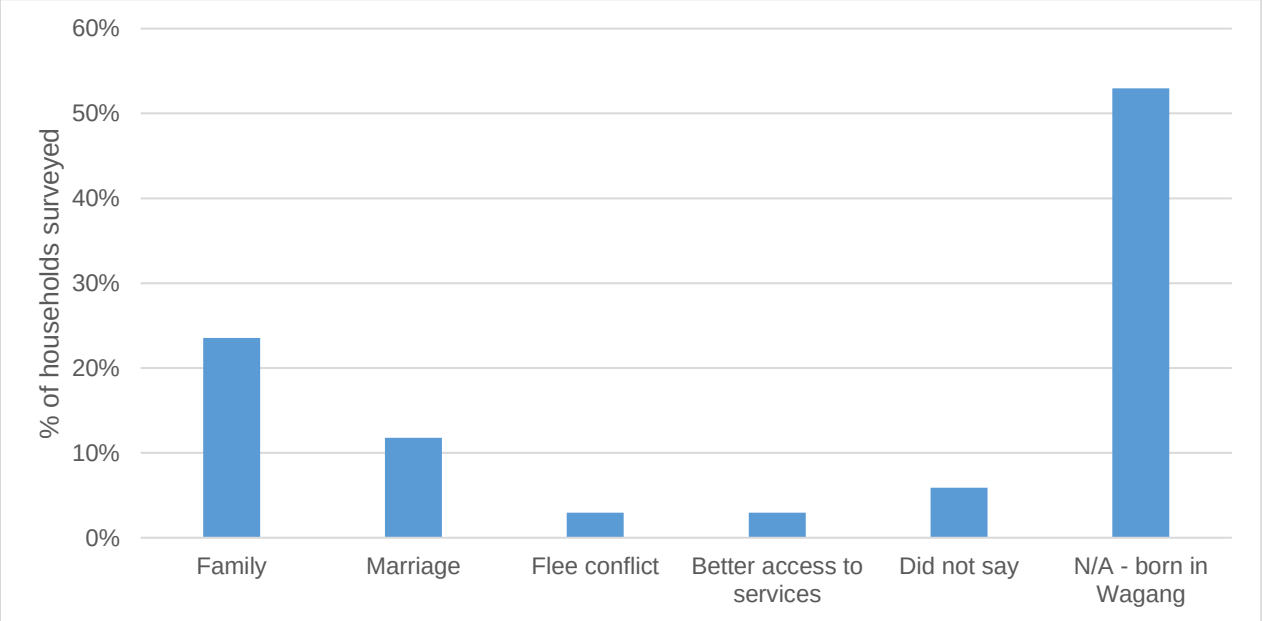
Table 5.29: Basic demographic data for Wagang

Village	Median age (years)	Population <15 years	Population >65 years	Dependency ratio	Sex ratio	Household size
Wagang	21	30.3%	2.8%	60	93	6.2

Source: Coffey, 2018

The people of Wagang self-identify as Ahi people. The original Wagang village (known as Wagang 1) was located to the northeast of the existing village (Muke & Skelly, 2017). During World War II people sought refuge west of the Busu River and Wagang 1 (now the site of Alanghu Village) was abandoned. Wagang villagers have maintained close contact with people west of the Busu River. Following World War II, villagers moved back to Wagang 1. They then relocated to present-day Wagang in 1950. The community moved closer to the coast to maintain good access to coastal resources (Muke & Skelly, 2017). The village's present site was formed over a World War II shipwreck, the *Myoko Maru*, which was beached in 1943 (Pacific Wrecks, 2017).

The 2017 Household Surveys at Wagang village sought to ascertain the degree of in-migration into Wagang village. Respondents were asked to state whether their household members had been residents of Wagang since birth, and if not, to identify the reason for moving to Wagang. Over half (53%) of respondents stated that household members had been born in Wagang. Of those that had moved to Wagang, 24% indicated moving for family reasons, and 12% had moved for marriage. Fleeing conflict (3%) and moving to be closer to services (3%) were other reasons given. Figure 5.71 presents this data.



Source: Coffey, 2018

Figure 5.71: Reasons for village relocation, Wagang

5.4.2. Cultural overview

The Wafi-Golpu Joint Venture cultural heritage field survey (Muke & Skelly, 2017) gathered information on cultural practices at Wagang village. According to that report, the *tok ples* is the Yabem language,

which was introduced to Wagang by Lutheran missionaries in the early 1900s. These missionaries had translated Christian doctrines into Yabem. The Yabem language, as well as Lutheran beliefs, were adopted by the Wagang people. Prior to the introduction of Yabem, Ahi language was used.

Although traditional sing-sing is still undertaken, traditional spiritual, ritual and sacred traditions have largely been replaced by Christian values. Sing-sing undertaken in the present day incorporates Christian themes. Totem animals, however, still have cultural importance; in particular cuscus, a frilled lizard called *pap*, and a species of python called *angula*.

5.4.3. Land and water resource utilisation

Land and water resource studies conducted in 2017 focused on the villages of Wagang and Yanga because of their proximity to the infrastructure and activities associated with the Outfall System. In particular, the Outfall Area would be approximately 1 km northeast from the coastal village of Wagang and the section of the Infrastructure Corridor between Malahang and Wagang also has the potential to directly impact the village of Yanga.

Utilisation of land resources

Gardens

In Wagang, gardening has reportedly diminished in importance over the last few years (it was not specified how many years), with people in Wagang increasingly dependent on store food and market foods. This trend may indicate a gradual transition away from subsistence lifestyles. Respondents to key informant interviews indicated that they attended to gardens once or twice a week. Both men and women participated in gardening. Respondents estimated that 40% of food consumed in Wagang village was harvested from gardens (this figure should be treated as an approximation only).

Key informant interview respondents indicated that gardens were mostly located in the area east of Sipaia Road, to the northeast of the coastal part of the village. They estimated that a half-hour walk was necessary to reach gardens. Some gardens were also located west of Sipaia Road, which was also considered to be approximately half an hour walk away.

Respondents reported that land for gardens had gradually extended further from the coastal part of the village and from Sipaia Road. Existing gardens were reportedly displaced and re-established to the east (and, to a lesser extent, to the west) of the village due to additional houses being built to meet a growth in population of Wagang village.

The most commonly grown produce reported by household survey respondents was kumu (56%) and coconut (30%). The women's focus group added that sweet potato (*kaukau*), tapioca, sugar cane, *pit pit* (a type of cane), cucumber and beans were also grown. Key crops and harvest frequency identified by key informant interview respondents in Wagang village gardens is shown in Table 5.30.

Table 5.30: Key crops and harvest frequency in Wagang village gardens

Crop type	Harvest frequency
Banana	6 months
Taro	6 months
Casava	3 months
Greens	2 months

In Yanga, survey respondents stated that they sourced food primarily at the village trade store, secondarily from household gardens and thirdly at Lae markets. This indicates that food sourced from subsistence practices are one of several sources of food for this village. Gardens were reportedly attended to two times a week on average by both men and women. Garden produce was relied upon for household consumption and to generate income by selling items at local markets.

Respondents indicated that gardens were located up to 2 km east and southeast of the village, between the village and the Busu River. They reported that a half hour walk was required to reach gardens from the village. Gardens were usually re-established in areas previously containing gardens. While respondents did not directly state that they lacked new land for gardens, land availability does appear constrained by the Busu River to the east, Wagang village to the south and west, and the Malahang area of Lae to the north and west.

As shown in Table 5.31, banana, taro, yam, greens *(kumu)* and sweet potato *(kaukau)* were reported as the key crops grown. Other crops reportedly grown in Yanga were marita, cassava, cocoa, sugar cane, peanuts, betel nut, tobacco (*brus*), coconut and sago. Sago was not identified as a staple food item and was only considered important in times of food shortages, with the palm being harvested and processed on average once a year.

Gardens were cultivated for one year before being left fallow for two years and then cultivated again.

Table 5.31: Key crops and harvest frequency in Yanga village gardens

Crop type	Harvest frequency
Banana	6 months
Taro	6 months
Yam	Annually
Greens	3 months
Sweet potato (*kaukau*)	4 months

Hunting and gathering

In Wagang, participants in the women's focus group suggested that meat sourced from hunting was not an important part of their regular diet. Instead, hunting was seen as important for special feasts. The key informant interview revealed that hunting was undertaken two or three times per year. Hunting had reportedly declined in recent years, due to a decrease in game. This decrease was attributed to the disruption of animal habitats. Respondents reported primarily hunting bandicoot (locally called *mumut*), flying fox, wild pigs, lizards and cuscus.

Hunting grounds were reportedly located northeast of the coastal part of Wagang, further east than the gardens, and generally undertaken by men only, using spears, traps, bows and arrows, and dogs.

Participants in the key informant interview stated that the area east of Sipaia Road is used for gathering of terrestrial resources in addition to gardens. In these areas, firewood, building materials, bush fruit and vegetables, logs for making canoes, and traditional medicines were reportedly gathered.

As in Wagang, interview participants in Yanga suggested that hunting did not occur regularly and meat sourced was not essential for regular village diets but important for special feasts. On average, hunting was undertaken once a month and generally by younger males only. Typical species hunted included bandicoots, flying foxes, wild fowls, wild pigs, birds and lizards.

Hunting areas were similar to garden areas, approximately 2 to 3 km east and southeast of Yanga, between the village and the Busu River. Respondents reported that hunting was undertaken using spears, traps, sling-shots and hunting dogs.

Gathering of bush resources occurred to the east of the village, between the village and the Busu River in similar areas as hunting and garden activities. Items gathered included firewood, building materials, bush fruits and vegetables, and medicine. These items were reportedly used for both subsistence living and income generation. That gathering, hunting and gardening were all reported to occur in the same general location indicates subsistence dependency upon the confined area between the village and Busu River.

Utilisation of water resources

Drinking and domestic uses

In Wagang, residents reported sourcing drinking water from springs, creeks, rainwater tanks and wells. In the coastal part of the village, two communal tap stands were installed in January 2017, each with three taps (Plate 5.50). The source of water for these taps is a well, from which water is pumped into a water tower (Plate 5.51). This infrastructure was reportedly a local and district government initiative, with the community responsible for upkeep and maintenance.

The women's focus group identified these taps as a key source of drinking water for Wagang village, as well as rainwater tanks which were in use prior to the installation of the tap stands. Participants estimated that 40 households (approximately 35% of households) in the village have rainwater tanks (Plate 5.52).

Plate 5.50: Communal tap stand at Wagang

Plate 5.51: Water tower feeding communal tap stands at Wagang

Plate 5.52: Rain tank installed at private home in Wagang

Households located adjacent to Sipaia Road are further away from the tap stands, and tend to rely on rainwater tanks, springs, and wells. During the surveys, it was observed that some households owned private wells, with both hand pumps and powered pumps (Plate 5.53). Only one well-owner was available for an interview; he stated that his well was 3 m deep. Other households collect water from creeks and springs, located to the east of Sipaia Road.

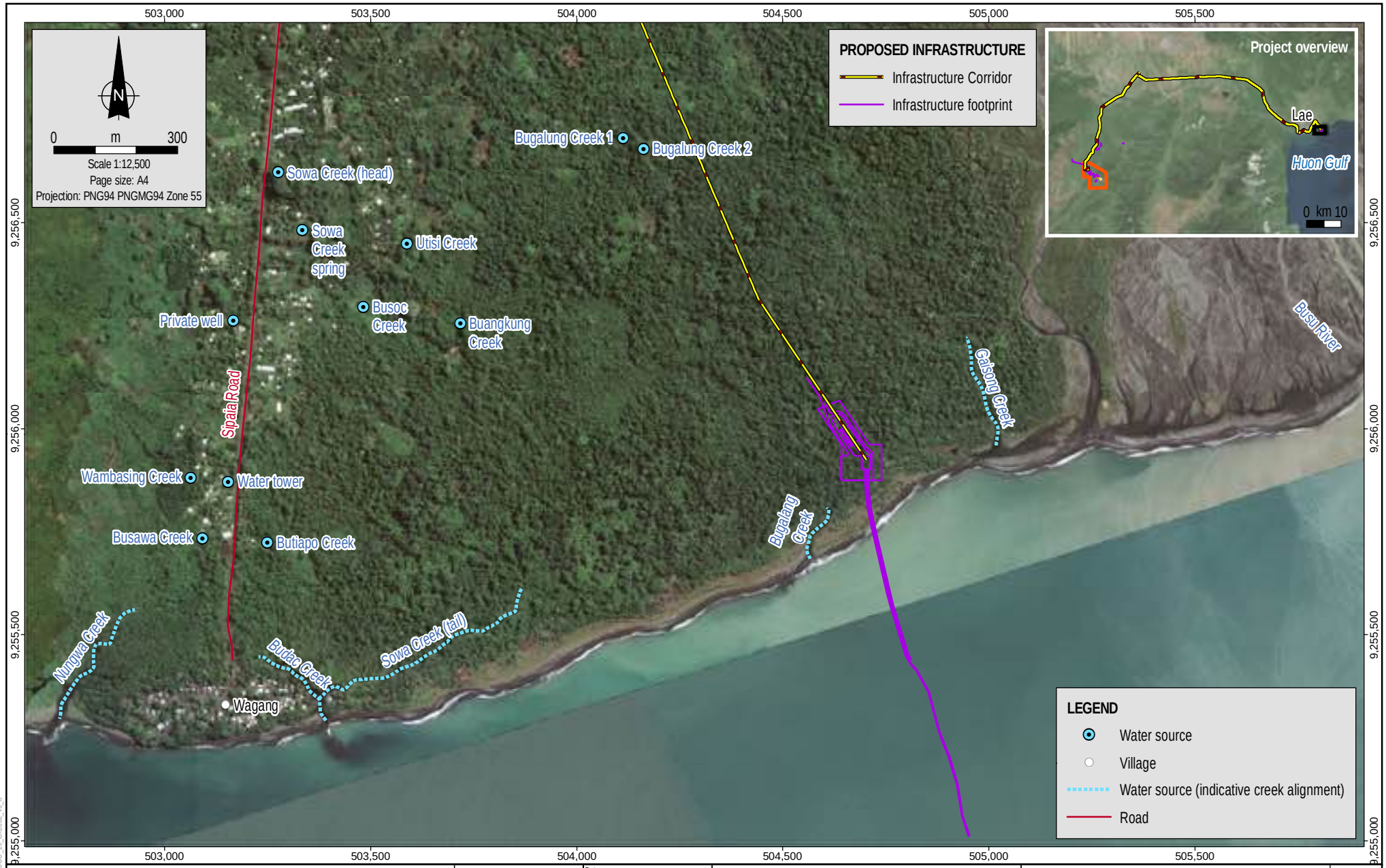
Plate 5.53: Private well with motorised and hand pump at Wagang

Figure 5.72 presents the locations of drinking water sources within Wagang village. In the case of creek water sources, only creek mouths are marked. The survey team was taken to drinking water collection points at creeks and springs, but did not walk the length of each stream so and so did not complete comprehensive mapping of the network of streams and creeks north of Wagang.

Areas in the network of creeks around Wagang village were designated as bathing areas, and as areas for washing laundry and dishes. Men and women's bathing areas were separated. These creeks are located to the east of Sipaia Road, and on either side of the coastal portion of the village.

Key informant interview respondents stated that water sourced from springs, creeks and wells was available all year and of satisfactory quality. Rainwater was noted as being seasonal and of unsatisfactory quality, although reasons were not provided.

Residents of Yanga village reported sourcing drinking water from streams, springs, rain tanks and wells (Figure 5.73). Bukaho stream, located approximately 1 km east of the village, is perennial and the main water source for the village (Plate 5.54). Drinking water was sourced from this location daily for those in the village without an alternative water source, which required a half-hour return walk from the village. Survey respondents stated that the main water source was perennial and had never dried up in their lifetimes. They were not satisfied with the quality of water from the Bukaho stream, which was considered poor due to sediment from the Busu River entering Bukaho stream.



Source:
Resource use points and lines from Coffey.
Infrastructure from WGJV.
Village from Coffey.
Satellite imagery from WGJV (capture date 2016).

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Project: 754-ENAUABTF100520DD
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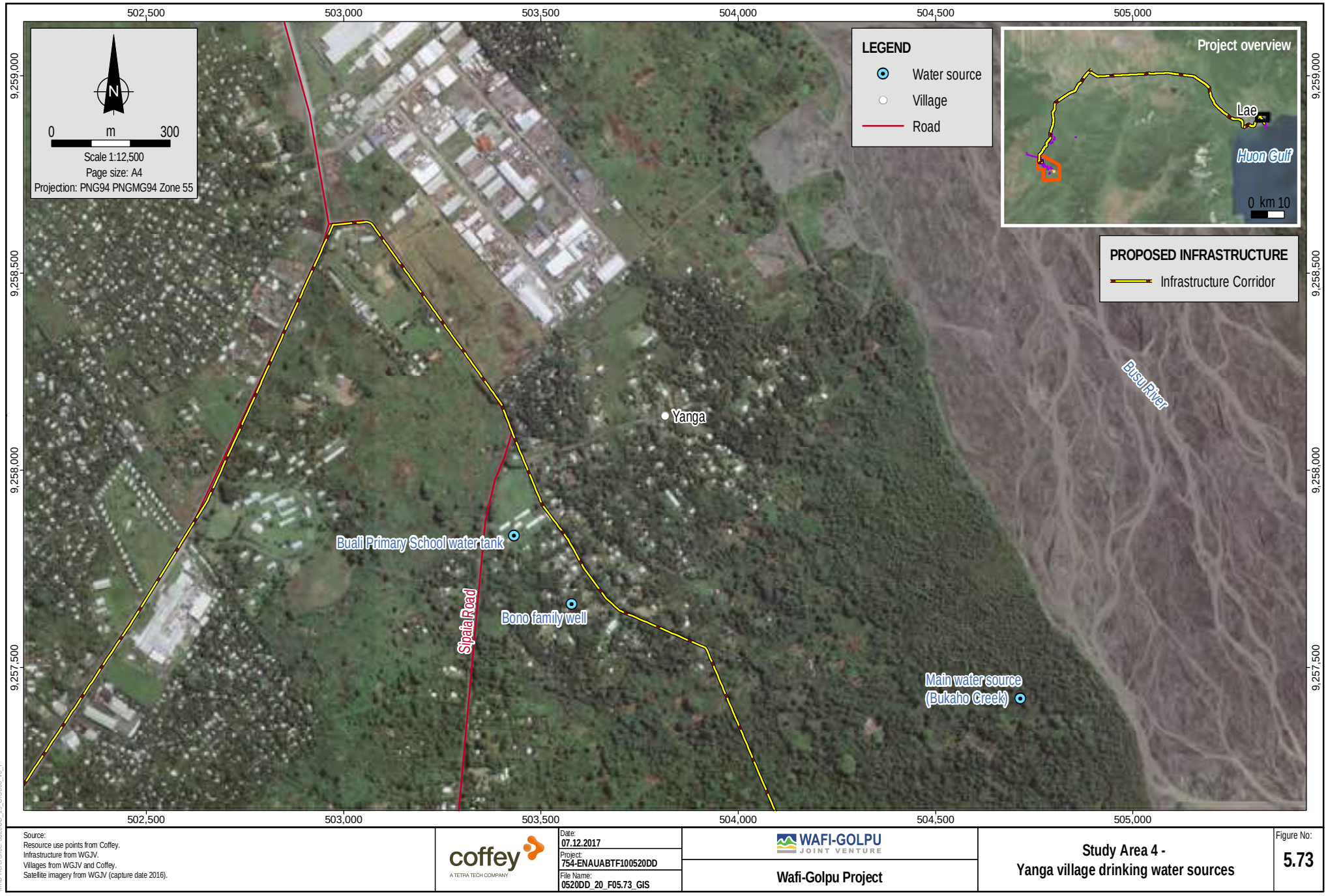
WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Study Area 4 - Wagang village drinking water sources

Figure No: **5.72**

MXD Reference: 0520CC_19_GIS002_v0_8



Source:
Resource use points from Coffey.
Infrastructure from WGJV.
Villages from WGJV and Coffey.
Satellite imagery from WGJV (capture date 2016).

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File Name: 0520DD_20_F05.73_GIS

WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Study Area 4 - Yanga village drinking water sources

Figure No: **5.73**

MXD Reference: 0520CC_19_GIS006_v0_7

Plate 5.54: Drinking water spring at Yanga village

Domestic water used for cooking, bathing and laundry was supplied from the same sources mentioned above for drinking water, with water tanks and reticulated water systems only functional during the wet season. Men and women predominantly bathed in a creek a 10-minute walk from the village, and also bathed in well water.

Some households used rainwater tanks during the wet season, as did the village church and school. Survey respondents were not satisfied with the quality of tank water. Tank water quality was considered poor due to the sun bearing down on the tanks and affecting the taste of the water. It was noted that the taste of stream and tank water differed. Other houses relied on wells approximately 6m deep for drinking water, such as the Bono family well (see Figure 5.72).

A reticulated water supply system was reportedly installed in the village in 1997. The system was re-installed by the Ahi LLG in 2012, with a main connection pipe located at the school headmaster's house. However, the system was not operational during the field work and there is no connection to houses from the main connection pipe.

Sanitation

In Wagang, key informant interview respondents stated that pit latrines and composting toilets were used in the village. The composting toilets were built in 2012 and 2016 by a team from the University of Melbourne and the PNG University of Technology (Bower Studio, 2017a, 2017b), and reportedly led to a decline in the number of pit toilets (Bower Studio, 2017b). Plate 5.55 shows the exterior of one composting toilet.

In Yanga, survey respondents indicated that pit latrines and outside toilets were used in the village.

Plate 5.55: Composting toilet (exterior) at Wagang village

Marine and estuary resources

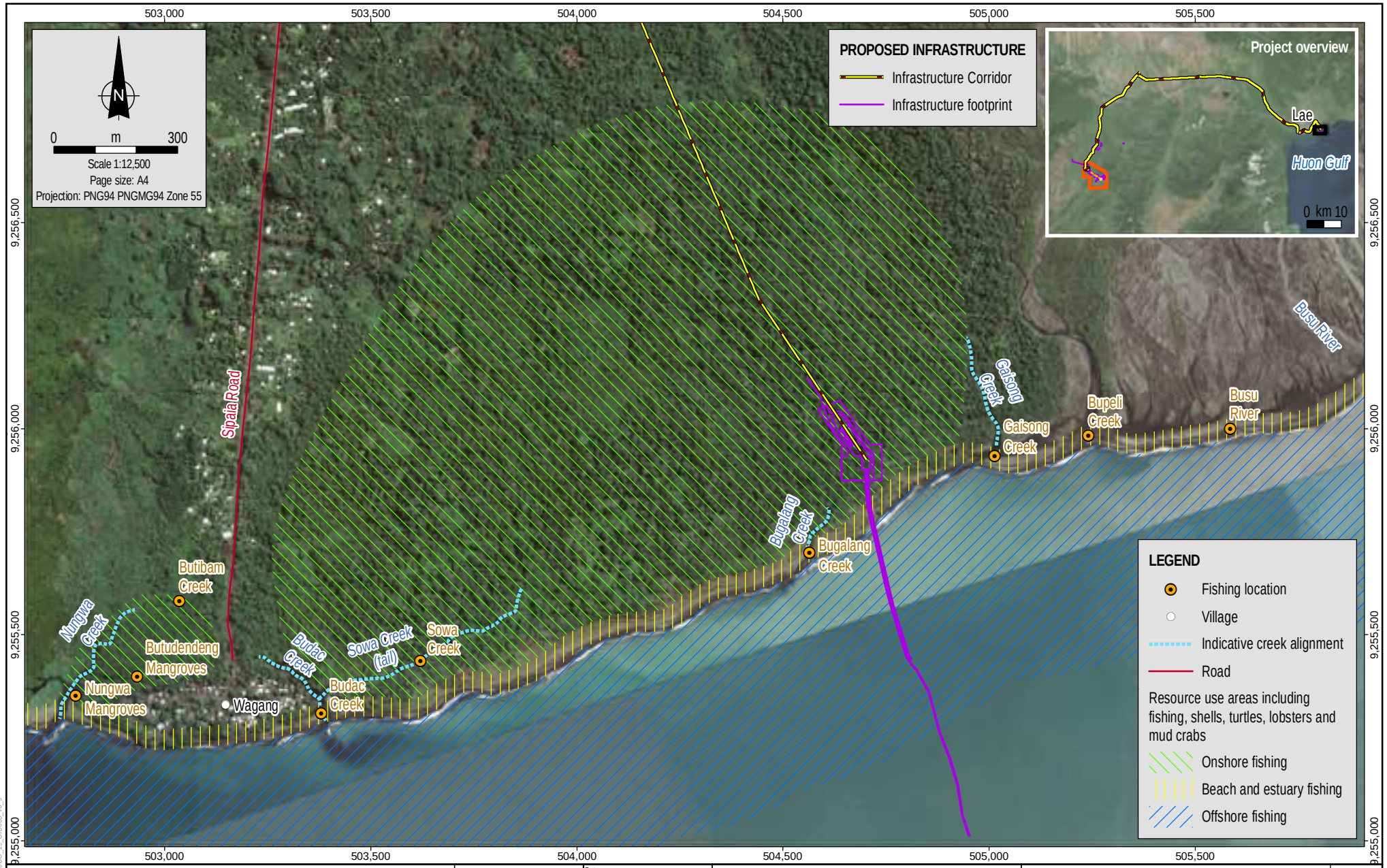
Fishing frequency and locations

Fishing is a common activity in Wagang and Yanga villages. Household surveys in Wagang suggest that approximately 65% of households regularly engaged in some kind of fishing. Similarly, in Yanga, fishing was reportedly a common activity for men, women and children, both individually and in small groups.

Figure 5.74 shows the fishing areas as reported by men and women in the focus groups in Wagang. Of the households that fish, for either fin fish or other seafood resources (i.e. shellfish), the most popular location was the beach. Of all households who undertake fishing, 80% reported fishing from the beach (Figure 5.75). Other common fishing locations included mangroves and river/creeks, with 52% and 60% of respondents targeting these areas respectively. Of the households that fish, 28% fished offshore. In the key informant interview, respondents reported that they do not travel further than 500 m from the shore. Key informant interview respondents stated that there were no reefs in the area; however, interviews undertaken on 2 May 2017 for the Fisheries and Marine Resource Use Study suggested that there is a narrow nearshore rocky reef between Wagang and the Busu River. Bathymetric data collected in other studies shows this feature may be part of a ridge feature that extends some 750 m along the coast. It was reported that locals fish for target species such as red emperor, trevally and grouper and snapper species and that most fishing is conducted from shore near the mouth of the Busu River.

The cultural heritage field survey (Muke & Skelly, 2017) also identified the presence of an off-shore reef in this area which is a fishing ground called Boc. Local opinion is that the location of the reef is anomalous because reefs do not usually occur close to the coast where mainland waterways feed in to the sea.

According to the key informant interview in Wagang, a typical fishing trip takes approximately half a day. The women's focus group suggested that fishing was a communal activity – some people have wantoks (friends and family) who live near or beyond the Busu River, and they meet on a beach between the two residences to fish. On a monthly basis, group fishing in the Huon Gulf is undertaken by Wagang villagers using multiple boats to increase the size of the fish catch, which is consumed by fishers and their families or by the wider village community.



Source:
Resource use points, lines and polygons from Coffey.
Infrastructure from WGJV.
Villages from Coffey.
Satellite imagery from WGJV (capture date 2016).

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WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Study Area 4 - Wagang village fishing areas

Figure No: **5.74**

MXD Reference: 0520CC_19_GIS003_v0_9

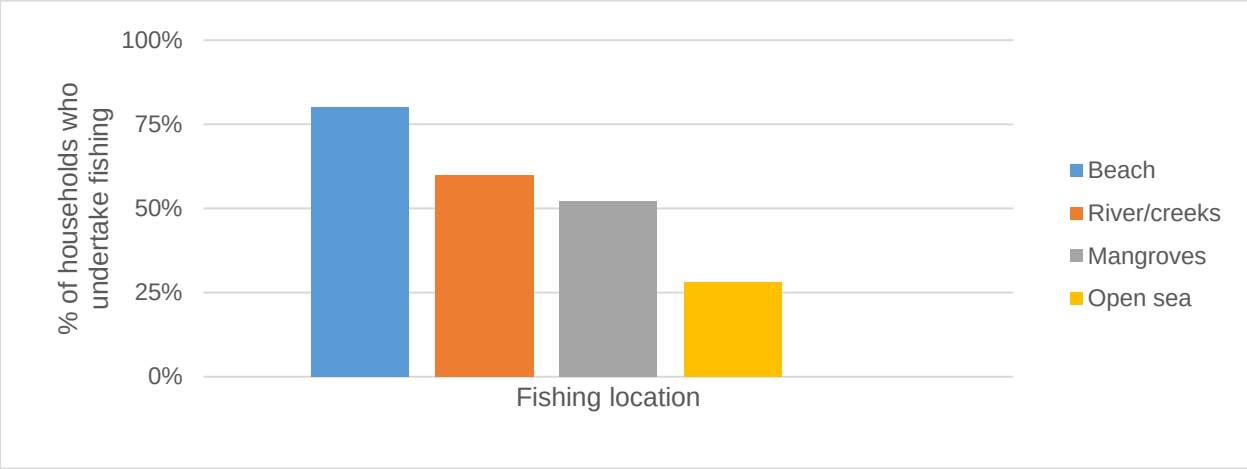


Figure 5.75: Popular fishing locations for residents of Wagang village

Participants of the key informant interview reported that fishing occurred in Wagang daily, although the household surveys found that only 3% of households fish every day. These findings suggest that there is neither designated nor proscribed days for fishing (hence, fishing occurs daily at the village), but individual households tend not to fish daily.

Figure 5.76 presents the fishing frequency for fin fish (i.e. not shellfish) across all household surveys in Wagang. Approximately one third of households reported fishing for fin fish daily or several times a week, while another third reported fishing on either a weekly or monthly basis. The remaining third indicated that they did not fish.

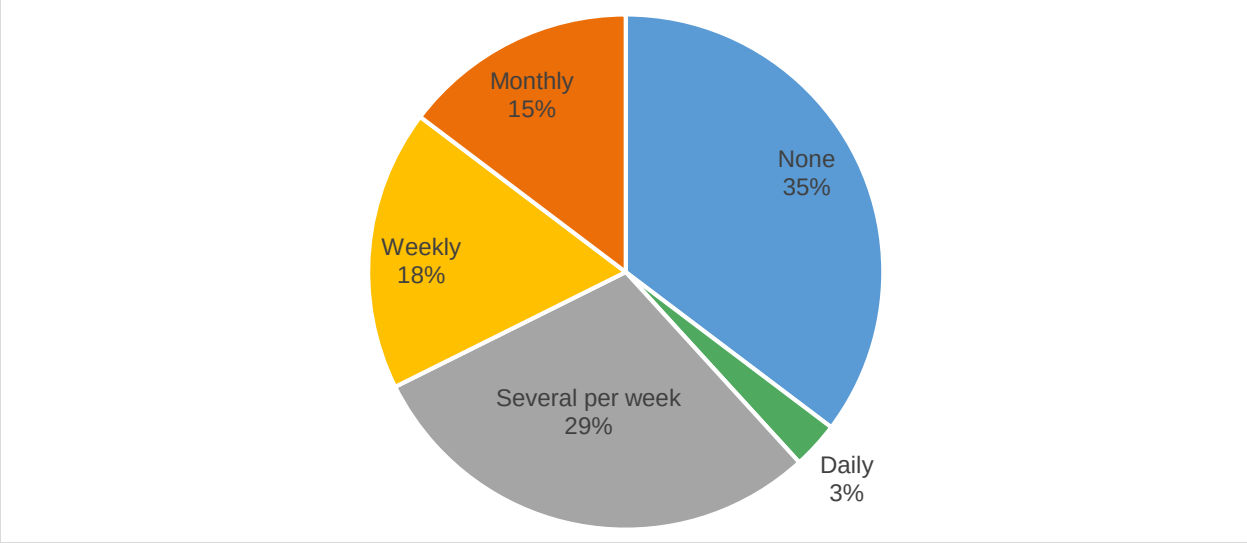


Figure 5.76: Fishing frequency (fin fish) reported by residents of Wagang village

Compared to fin fish, invertebrate aquatic resources (such as prawns, crabs and shellfish) are less commonly collected, as shown in Figure 5.77. The majority of households (62%) did not collect invertebrates. Of those who did report collecting invertebrates, approximately 38% reported collecting them monthly, 32% reported catching them either weekly or several times a week and the remaining 6% collected them on a monthly basis.

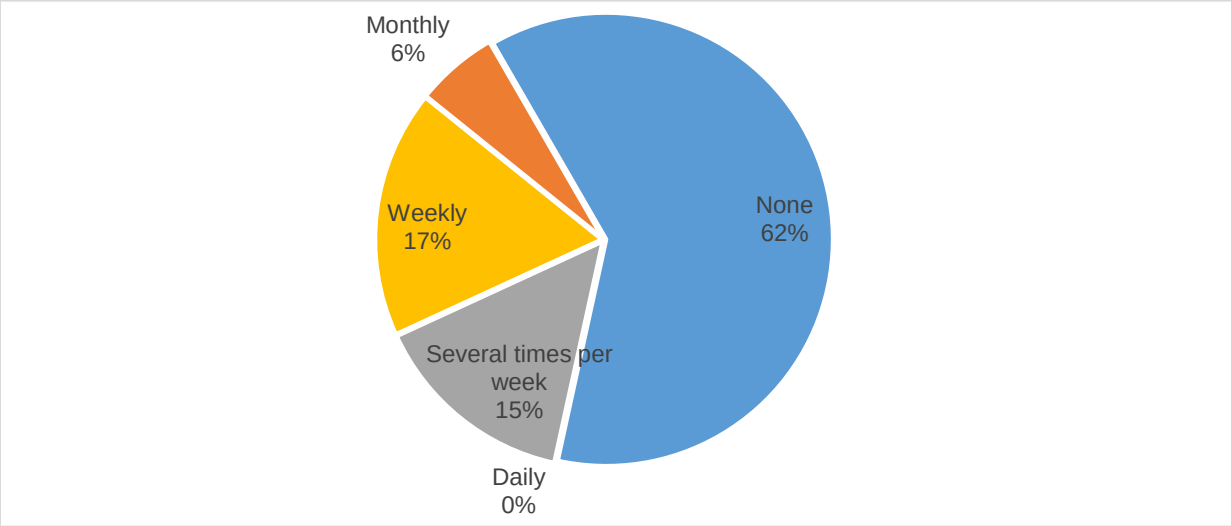


Figure 5.77: Fishing frequency (invertebrates) reported by residents of Wagang village

Fishing and boating equipment

Household survey respondents reported that the predominant type of fishing gear used was handlines, made either from synthetic materials (e.g., nylon) or natural materials (e.g., sago palm). Of the households who undertook fishing, 80% indicated using handlines. Other common pieces of gear included spear guns, which were reported by 32% of households that undertook fishing, as well as gill nets and circle nets (24%). Boats (12%) and trolling lines (8%) were also used. No traditional methods of fishing (such as poison or shark calling) were reported. Figure 5.78 presents the types of fishing gear used by residents of Wagang.

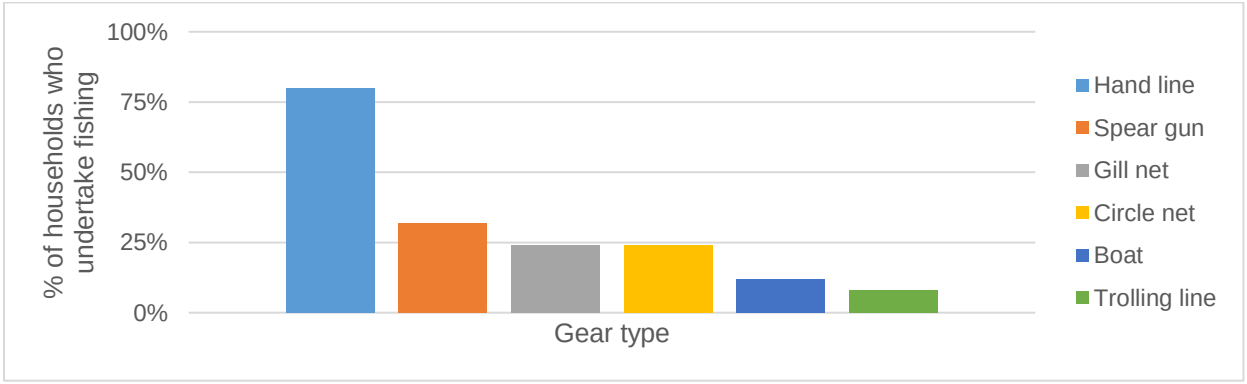


Figure 5.78: Types of fishing gear used by residents of Wagang village

Plate 5.56 shows a net used for fishing. Some nets reportedly measure 50 m in length, and extend to a depth of 3 m underwater when deployed. Mesh sizes were typically 2–4 inches.

The household surveys did not prompt whether rod-and-reel equipment was used (and as such no household data was gathered), but the key informant interview recorded that fishing rods were commonly used in Wagang village. Plate 5.57 depicts a fishing rod alongside two handlines.

Three households of the 34 households surveyed recorded owning boats, with one respondent owning six two-metre long canoes, another owning two three-metre long canoes and one owning a fibreglass dinghy and motor. All boats were recorded as being in a fair to very good condition. Plate 5.58 depicts a type of boat known locally as a 'banana boat' (due to its curved profile), while Plate 5.59 shows a canoe observed in the village.

While some boats and canoes were used for fishing, respondents indicated that fishing did not occur further than 500 m from the shore. Water depths offshore from Wagang exceed 100 m within about 500 m from shore and are greater than 250 m within about 1,000 m from shore. Villagers did not report regularly attempting to catch deep slope fish. Additionally, the fishing gear observed did not appear to enable fishing at depths much greater than 100 m. However, it cannot be ruled out that some people at Wagang may attempt to catch deep slope fish, some of the time. Notwithstanding this, the findings of the deep slope and pelagic fish study also conducted by Coffey (2017a) reported anomalously low catches of deep slope fish species in the waters offshore from Wagang (and elsewhere in the Huon Gulf) compared to the results from other similar studies in PNG. This suggests that there is not a large population of deep slope fish for local people to target, should they wish to do so.

Plate 5.56: Fishing net in Wagang village

Plate 5.57: Fishing rod and reel, and two handlines at Wagang village

Plate 5.58: 'Banana' boats on Wagang beach

Plate 5.59: Canoe (right) on Wagang beach

In Yanga, fishing predominantly took place in estuaries and within mangrove areas due to Yanga's location approximately 3 km from the coast. People from Yanga village also walked approximately 30 minutes to the coastline to fish in the ocean from the beach, mostly at the mouth of the Busu River. It was not reported whether people from Yanga village fish offshore in boats.

Survey respondents from Yanga village reported fishing several times a week for approximately half a day. Typical catches were fewer than 10 fish and less than 5 kg; fishing was reported as not relied upon as a household food source.

Fishing gear and methods used by people in Yanga village included cast nets and gill nets, line fishing using bait including hand line, rods and anchored longlines, and spear guns. People in Yanga village did not report owning or fishing from boats and no traditional methods such as poison or shark calling were reported being used.

Types of fish and invertebrates caught

In the Wagang key informant interview participants identified the types of fish caught as red emperor, trevally and shark (type of shark not specified), as well as crabs, prawns and shellfish. Several types of shellfish were presented in the women's focus group. These were reportedly collected for meat and shells (the latter is sold to make lime to accompany betel nut consumption).

Table 5.32 lists the English and local names of shellfish collected. A description is also provided; although no comprehensive study of shellfish species was undertaken, a possible scientific identification is included. While these shells were described in the women's focus group as having been collected in 'streams', they appear not to be freshwater species but rather species that would live in brackish waters in the lower reaches of creeks where some mangrove trees are present. Plate 5.60 and Plate 5.61 show a sample of shells presented to the survey team during the women's focus group.

Table 5.32: Shellfish types collected by residents of Wagang village

Local name (English)	Local name (*tok ples*)	Description
Rainy shell	Sugu	Mangrove nerite snails of the family *Neritidae*. Named 'rainy shell' because they appear during and after rains, when they are collected.
Long tail	Susun	Likely a type of mangrove mud snail, possibly in the family of horn snails (*Potamididae*).
Kina shell	Gaha ampom	Likely a type of mangrove mud clam (e.g. *Polymesoda erosa*).
Black shell	Gaha koc	

Plate 5.60: Shellfish caught by Wagang villagers ('rainy shell' in bowl, kina shell white at front, and 'long tail' front, far right)

Plate 5.61: Shellfish caught by Wagang villagers (called 'black shells' or 'gaha koc')

In Yanga village, types of fish caught included trevally, red emperor, tilapia, carp, eels and invertebrates including prawns, king shells and salt-water and mud crabs. Respondents also reported occasionally catching crocodiles for consumption. Marine turtles and their eggs were not harvested by people of Yanga village.

No marine turtles or turtle nests were observed along the shore between Lae and the Busu River during the November 2016 or February 2017 surveys (during the leatherback turtle nesting period), or during a follow up visit to Wagang on 2 May 2017 (Coffey, 2018b). An interview undertaken by Coffey on 2 May 2017 visit determined that west Pacific leatherback sea turtles are opportunistically caught and eaten and their nest harvested for eggs. According to some Wagang villagers interviewed on 2 May 2017, three leatherback turtles (or fewer) were claimed to be caught between Wagang and the Busu River and were consumed by villagers each year between November and February, with approximately 150 to 200 eggs harvested per nest when found. Wagang residents also noted the presence of turtles resembling the hawksbill sea turtle and green sea turtle along the coast near Wagang, occasionally being visible in the water when surfacing for air. It was stated that a turtle (species not determined) was caught by a fisherman and eaten approximately 2 months prior to the survey.

Dugong was very rarely seen, and was not reported as a hunted species.

Subsistence and commercial uses of marine and estuary resources

Participants in the key informant interview in Wagang nominated fishing and gardening as equally important subsistence activities undertaken in the village. In household surveys, respondents recorded consuming fresh fish and other seafood twice a week. By comparison, households appear to be more dependent on canned fish, which was reportedly consumed on average six days per week.

The most common source of fresh fish and other seafood was that caught by household members, reported by 41% of households surveyed. The second most common source of fresh fish was that purchased from shops and markets, with 35% of respondents recording this method as their primary source of fresh fish.

As noted above, some shells are sold at markets, to be ground into lime powder to accompany betel nut consumption. Aside from this commodity, the key informant interview confirmed that there were limited commercial uses of fish and other marine or estuary resources. Participants stated that no organised fishing ventures took place in Wagang (e.g., fishing cooperatives), and fish were rarely sold at markets. Overall, fishing in Wagang appears to be undertaken largely for subsistence and/or recreational purposes.

The network of creeks to the east of Sipaia Road were reported to be a source of food and materials for the village. Participants in the women's focus group stated that fin fish, eels, freshwater turtles, crabs and crayfish were collected in this area. Aquatic plants were also reportedly grown and harvested in the area east of Sipaia Road. According to the key informant interview, watercress and sago were harvested for food and sale, although the latter was stated to be a seasonal staple (harvested about once a year) by the women's focus group.

In Yanga, fishing is a common activity. Respondents reported that fish and shellfish caught by people were relied upon for consumption at home. No organised fishing or interaction with commercial fishing industries was reported and fish caught was not typically sold at local markets.

In Yanga, freshwater aquatic resources harvested included watercress (edible plant) and prawns. These aquatic resources were available all year around. It was stated that freshwater plants and animals had very little commercial value or use to people of Yanga village, and were only harvested for household consumption. Respondents also indicated that they collected firewood and building materials from rivers and streams nearby Yanga village that had been washed down the Busu River.

Sociocultural uses of marine and estuary resources

The beach in Wagang was reportedly a recreational destination for people residing in Lae, who go to Wagang beach to swim, have picnics and socialise. On weekends, public motor vehicles (PMVs) convey visitors from Lae to the beach (Plate 5.62). A one-way fare costs PGK1 from Malahang to Wagang, a distance of approximately 4 km. Others may reach the beach by walking down Sipaia Road. No fee was reported to be payable by visitors for visiting Wagang beach.

Near the beach is a beer stall, which services Wagang residents and visitors alike (Plate 5.63). Wagang residents also set up markets to sell food items such as coconuts, betel nut and bananas to visitors (Plate 5.64). These businesses indicate that the beach is valued both as a recreational attraction and as a source of income.

Plate 5.62: PMV conveying visitors to Wagang beach on a Saturday

Plate 5.63: Beer store at Wagang beach

Plate 5.64: Market at Wagang beach on a Sunday

5.4.4. Housing

In Wagang, the 2017 Household Survey identified that 48% of houses were made of permanent materials, 32% were classified as semi-permanent, made from metal sheeting and local materials, and 19% were made of traditional materials.

5.4.5. Economy

There is minimal economic infrastructure in Wagang. The unsealed Sipaia Road provides the key land access to the village and a small number of trade stores and a food store operate in the village. A beer stall is located near the beach (Plate 5.63).

Residents of Wagang do appear, however, to have good access to electricity from the grid. In the 2017 Household Survey it was reported as the major source of lighting for residents among 52% of respondents. As shown in Figure 5.79, the other key source of lighting was solar power.

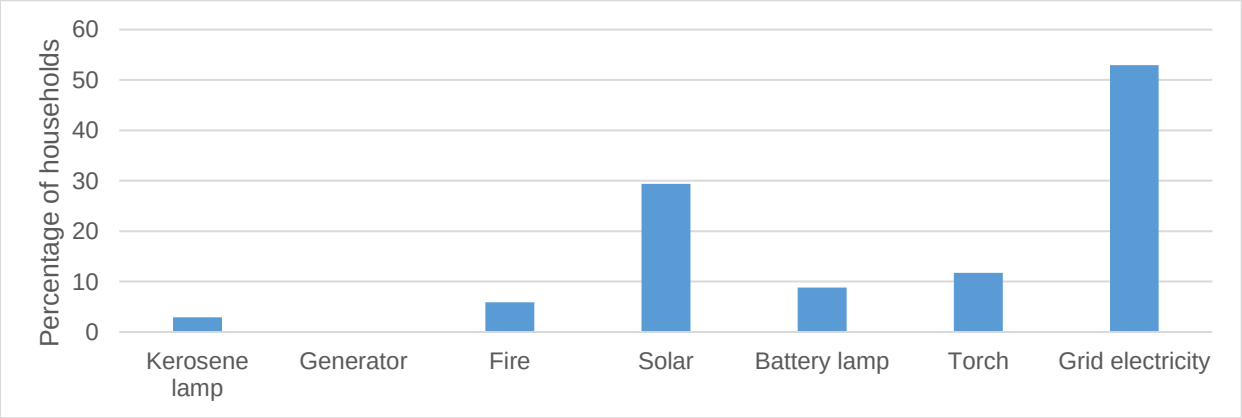


Figure 5.79: Sources of lighting in Wagang

Household income is Wagang is largely generated from wages, with respondents to the 2017 Household Survey indicating that it contributed 52% of total household income (Figure 5.80). Business activities represent the second largest source of income, contributing 21% to total household income.

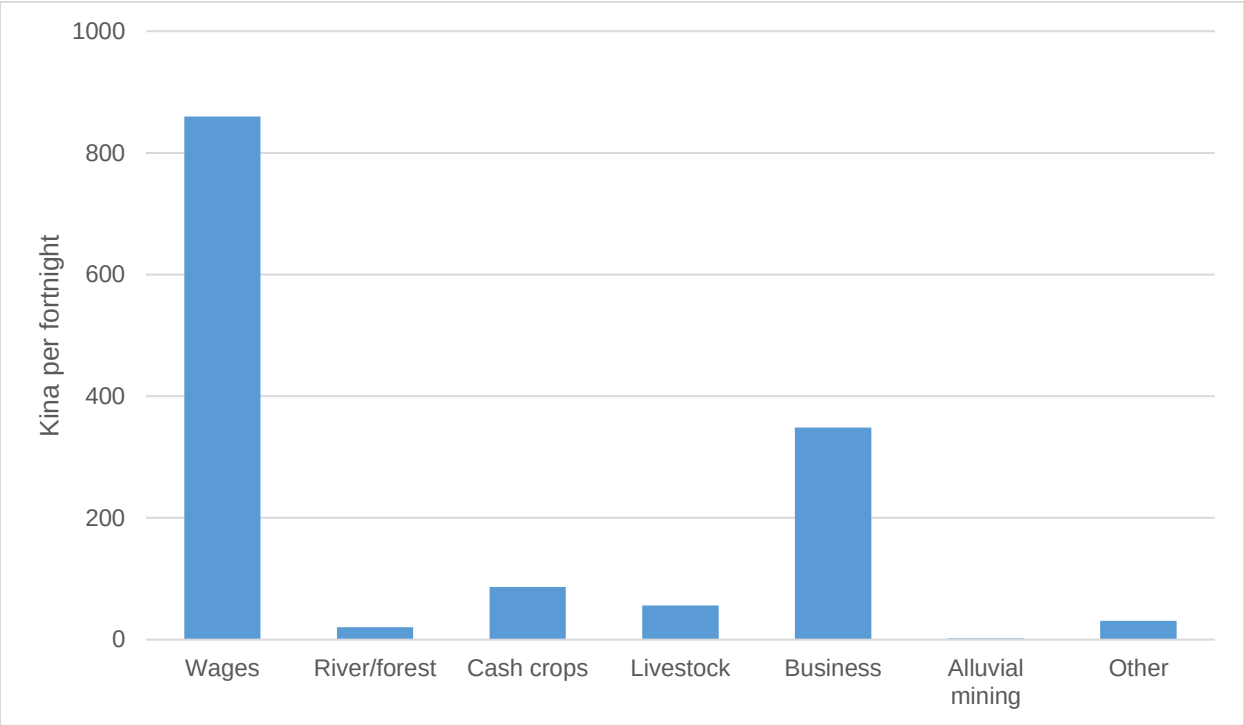
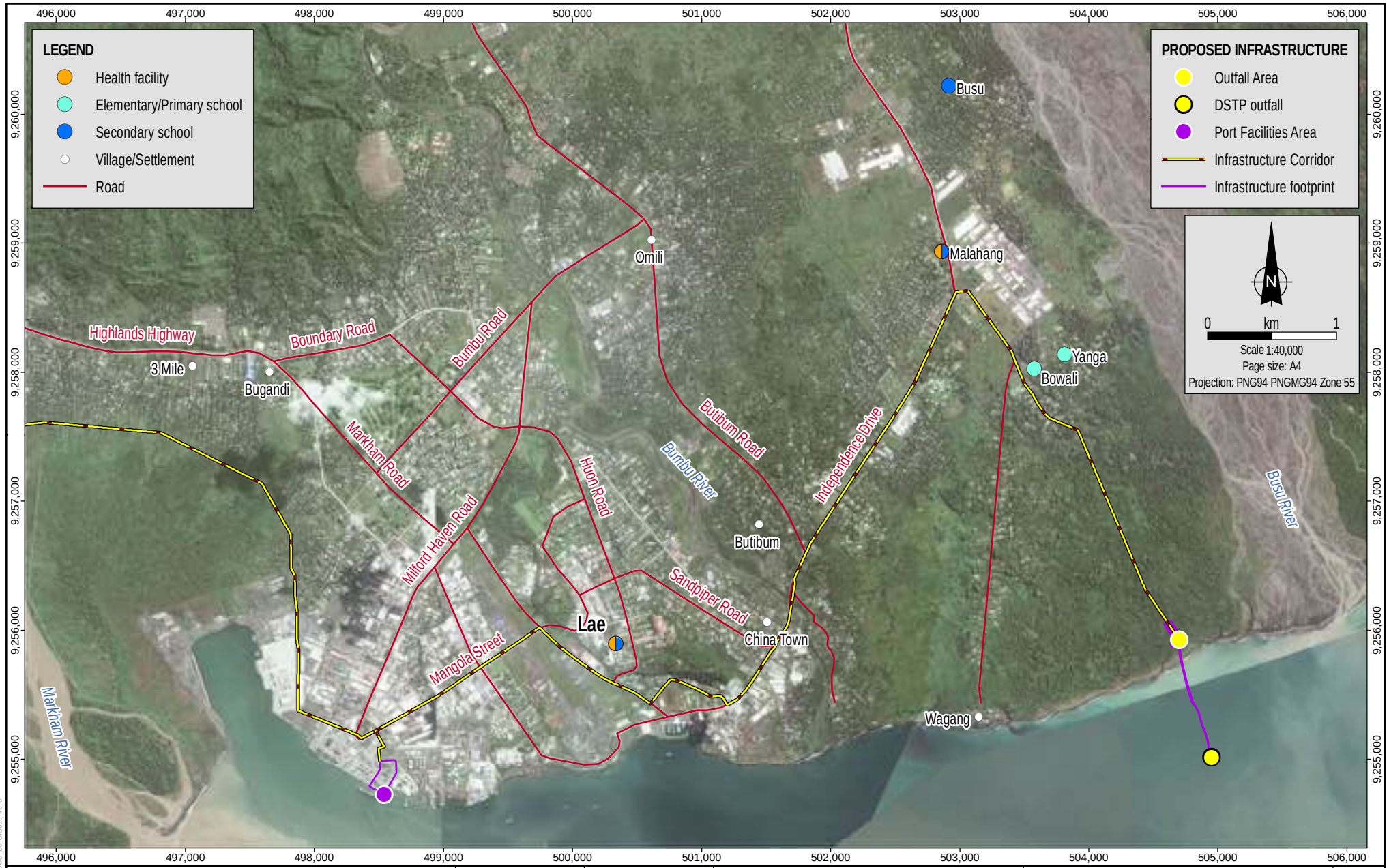


Figure 5.80: Fortnightly income sources in Wagang

5.4.6. Education

Educational facilities accessed by Wagang and Yanga residents are shown on Figure 5.81. Within the coastal village of Wagang there was no elementary or primary school for children to attend. Focus group respondents stated that most children attended elementary school and primary school at Yanga and Bowali respectively, both of which were an approximate 45-minute walk from the village. Malahang Secondary School was the most common high school attended by children of Wagang village, which took approximately one hour to walk to from the village.

In Yanga, children attended elementary school within the village. Like Wagang village, children generally attended primary school at Bowali, which was a five-minute walk from the village. Children usually attended one of two high schools, Malahang Secondary School and Busu Secondary School. Malahang Secondary was a 10-minute walk from the village whereas Busu Secondary School required a 10-minute drive in a PMV.



Source:
Health facilities, schools and roads from Coffey.
Villages/Settlements, landmarks and infrastructure from WGJV and Coffey.
Imagery from ArcGIS Online (capture date unknown) and WGJV (capture date 2016).

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File Name: 0520DD_20_F05.81_GIS

WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Educational and health facilities accessed by Wagang and Yanga residents

Figure No: **5.81**

MXD Reference: 0520CC_20_GIS010_v0_5

5.4.7. Health

Access to health services

Health facilities accessed by Wagang and Yanga communities are shown in Figure 5.81. Table 5.33 provides a summary of the closest aid facility to these communities, the means by which residents most commonly access the facility and the approximate time taken to access the facility.

Table 5.33: Distance to nearest health infrastructure

Village	Closest health facility	Most common means of access/ approximate time
Wagang	Malahang Health Centre	Walk/ 45 min
Yanga	Malahang Health Centre	Walk/ 15 min

Source: Coffey Environments, 2013, Coffey, 2018 and Abt JTA, 2013a

Respondents of focus group surveys undertaken in 2017 with residents of Wagang and Yanga indicated that the Malahang District Health Centre had visited the villages in July 2016. Residents of Yanga also stated that a doctor of the ANGAU Hospital had visited the village in 2016.

The 2017 surveys also gathered information on maternal health care within Wagang and Yanga communities (Table 5.34).

Table 5.34: Village birth information for Wagang and Yanga villages

Village	Percentage of babies born in village (%)	Supervisor of village births
Wagang	80	Trained village birth attendant
Yanga	5	Trained village birth attendant

Wagang and Yanga had trained village birth attendants. People of Yanga village stated that there were ex-nurses and midwives available to assist with births, however only 5% of babies were born in the village. This is likely due to the village's proximity to Malahang District Health Centre (approximately 15-minute walk). A high percentage of babies were born in Bumsi and Wagang villages, likely due to their greater distance to health care centres.

Respondents to the 2017 Household Survey in Wagang indicated that respiratory infections, and parasites (malaria and lymphatic filariasis) were among the major diseases suffered in the past month. Table 5.35 provides a summary of the results.

Table 5.35: Illnesses in month prior to February 2017 (Wagang village)

	Adult male	Adult female	Male child	Female child	Children	Not specified	Total
Malaria	7	4	4	2	-	-	17
Flu/cold	3	3	3	1	-	-	10
Fever	1	1	4	0	-	-	6
Tuberculosis	0	0	0	0	-	-	0
Injury	0	0	0	0	-	-	0
Headache	3	0	2	0	-	-	5
Backache	2	3	0	0	-	-	5

	Adult male	Adult female	Male child	Female child	Children	Not specified	Total
Chest-pain	3	0	0	0	-	-	3
Other	0	1	1	4	-	-	6
Total	19	12	14	7	-	-	52

Source: Coffey, 2018

Food and nutrition

As shown in Figure 5.82 respondents of the 2017 Household Survey in Wagang reported consuming a wide variety of foods. Staples were rice (consumed the day before the survey by 97% of respondents), kumu (consumed by 82% of respondents) and tinned fish/meat (consumed by 76% of respondents).

As shown in Figure 5.83, when asked to recall food consumed on the previous day, respondents reported consuming high levels of store foods. This may be associated with their access to store food and income levels.

A total of 38% of respondents reported consuming betel nut and 26% reported consuming tobacco on the day prior to the survey. Approximately 9% of respondents indicated that they had consumed alcohol on the day prior to the survey.

Expenditure on food in Wagang survey respondents averaged PGK238 per household in the previous fortnight, compared to average expenditure of PGK132 on alcohol, tobacco and betel nut.

5.4.8. Law and order

In Wagang, community perceptions on law and order issues were recorded through the 2017 Household Survey. As shown in Table 5.36, the main law and order issue reported by respondents was alcohol-related (91.2%). Disturbance/nuisance, drug use, domestic violence and land conflict were also major issues within the community. Focus group survey respondents in Wagang stated that gambling was a minor issue in the community.

When Yanga focus groups participants were asked about village administration and law and order, the reported law and order issues included illegal drugs and alcohol, domestic violence, adultery and land disputes. It was also reported that a murder occurred in Yanga village in 2010. The murder was investigated by police and the guilty person was sentenced to time in jail.

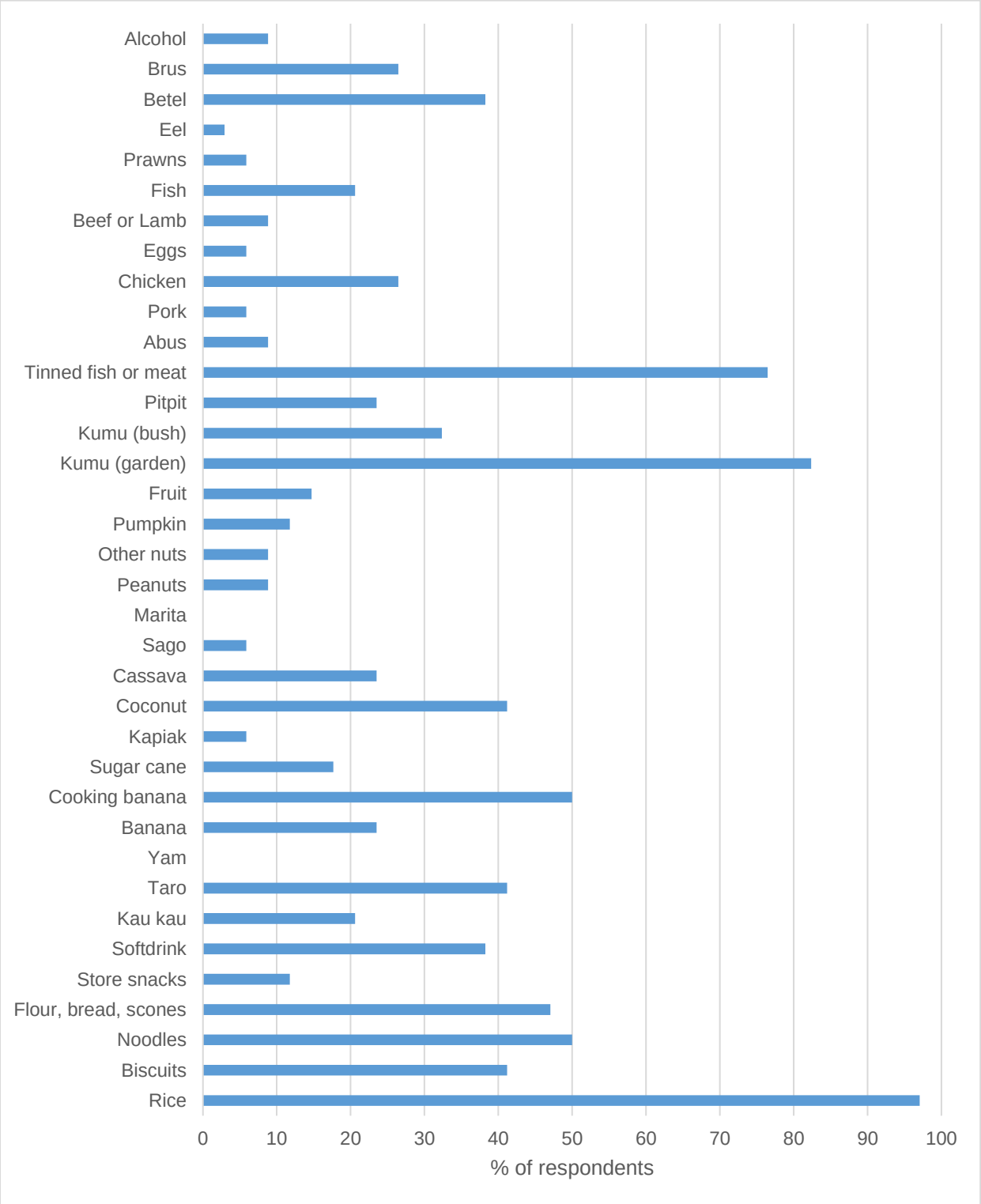

Figure 5.82: Type of food consumed by percentage of survey respondents, Wagang

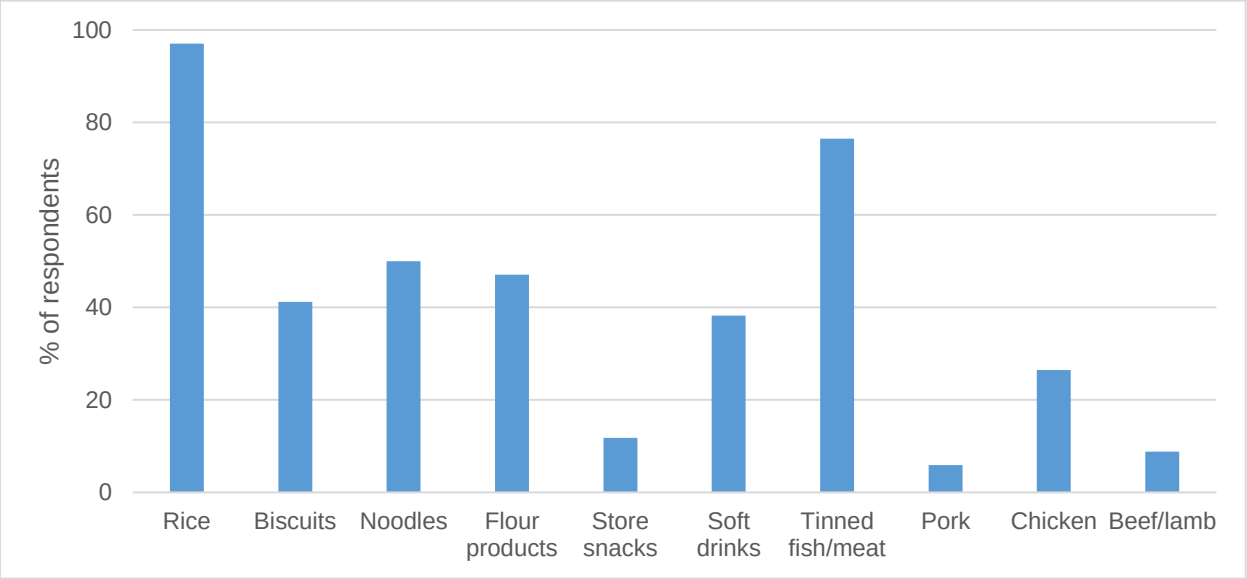

Figure 5.83: Consumption of purchased foods, Wagang

Table 5.36: Major law and order issues in Wagang

Type of law and order issues	Percent of Wagang households identifying the issue
Alcohol	91.2%
Disturbance/ nuisance	58.8%
Drug use	58.8%
Domestic violence	35.3%
Land conflict	35.3%
Inter-village conflict	20.6%
Stealing	20.6%
Sexual violence	11.8%
Safety and security of children	5.9%
Other	5.9%

Source: Coffey, 2018

5.4.9. Vulnerable and disadvantaged groups

Systematic data on vulnerable and disadvantaged groups was not available at the village scale. However, in Wagang, one respondent of the 2017 Household Survey indicated that he was blind with a deaf son. He stated that his family received no government assistance and reportedly survived on the proceeds of a trade stall, a small garden and a few chickens. While this account was based on one household's experience, it is illustrative of the potential for disabled persons in this area to receive very little government assistance.

5.4.10. Traffic and transport

Residents of Wagang travel to Lae via Sipaia Road, which runs due north from Wagang approximately 2.8km, and intersects with Busu Road. Busu Road runs westwards for 700 m before intersecting Independence Drive, near Malahang. As discussed in Section 5.3.10, this road is often congested during weekday morning and afternoon peak times. Similarly, Yanga residents would reach Lae by travelling west along Busu Road to Independence Drive.

Sipaia Road is a partially sealed road. As discussed in Section 5.4.3, on weekends, visitors from Lae travel to Wagang via Siapaia Road, to swim and socialise at the beach.

In Wagang, responses to the 2017 Household Survey indicate that the majority of respondents traveling to and from Lae use PMVs (Figure 5.84). The second most common form of transport is car.

As shown in Figure 5.85, the top reasons for travel provided by respondents were to access shops/market stalls to purchase goods, access shops/market stalls to sell goods and attend school. Furthermore, 50% of respondents indicated that they travel to Lae between one to ten times per month.

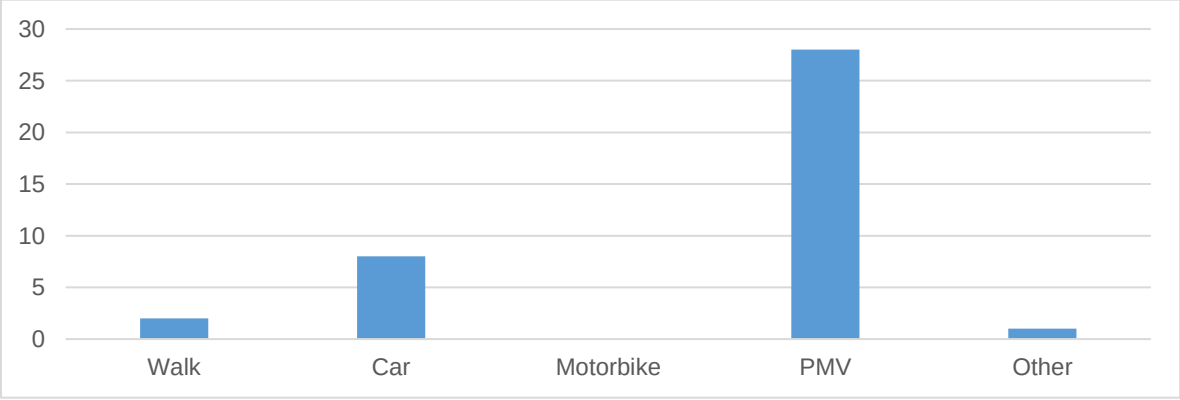

Figure 5.84: Means of travel to/from Lae

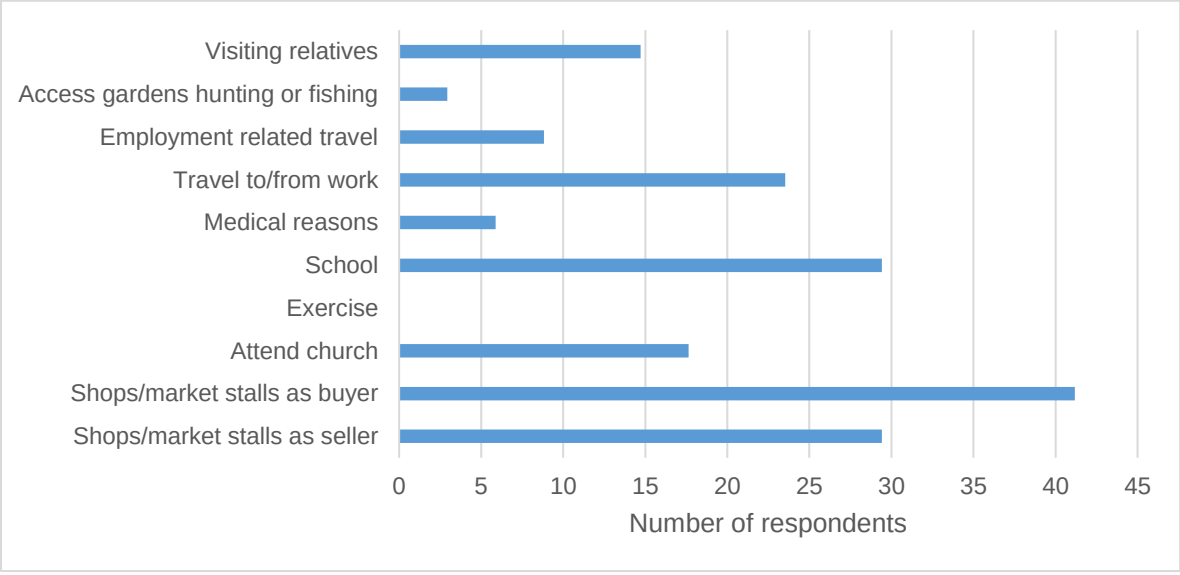

Figure 5.85: Reasons for travel between Wagang and Lae

6. Concluding remarks

This socioeconomic baseline study is the product of numerous studies undertaken for the Project. Socioeconomic information relevant to the four study areas has been presented:

- Study Area 1: Mine Area, surrounds and access corridors.
- Study Area 2: Infrastructure corridor from Zifasing to Lae.
- Study Area 3: Lae.
- Study Area 4: Wagang and Yanga villages.

By presenting this information, this report aims to establish a body of information on which to base the SEIA. The information presented herein is only part of a suite of studies informing the overall EIS for the Project. This socioeconomic baseline should be interpreted in the context of the EIS and other studies undertaken to support it.

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Appendix 1

Study method details: socioeconomic, traffic and health baseline data collection (Coffey 2012, 2014, 2015, 2017)

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Collection of socioeconomic, traffic and health baseline information

Overview

This appendix to the socioeconomic baseline provides an overview of the way in which primary socioeconomic baseline information was collected. It includes an explanation of the following:

- Training.
- Data collection dates and localities.
- Limitations of the surveys completed.

Training and data collection

This section provides an overview of methods of training and data collection employed by the socioeconomic, traffic and health surveys in 2012, 2014, 2015 and 2017.

Training - Socioeconomic and traffic and transport surveys

Prior to commencing the 2012 socioeconomic surveys, a three-day training workshop involving all members of the survey team was held at the WGJV office at 9 Mile in Lae. Led by Coffey and WGJV, training covered all aspects of survey design and delivery with a focus on building an appreciation of the need to obtain free, prior and informed consent (FPIC), how to record responses to quantitative and qualitative questions and how to ask questions designed for subjective responses. The training also focused on approach, sensitivity and attention to capturing the detail of what was being conveyed by respondents and included role plays in which all members of the team practiced delivering the survey. This served to both familiarise team members with the survey and test whether survey questions were appropriately worded in the context of the social environment in which they were to be asked.

Before embarking on the 2014 socioeconomic surveys the team undertook a two-day training workshop, again held at the WGJV office at 9 Mile in Lae. Training for the Traffic and Transport surveys was also completed as part of this workshop as team members were going to be undertaking both socioeconomic and traffic and transport surveys. All members of the team participated with the training following a similar format to that undertaken in 2012. Role plays and testing of the surveys before going into the field was again a priority of the training and served to substantially improve and familiarise team members with the survey instruments.

For the 2015 socioeconomic surveys there was a one-day training workshop held at 9 Mile in Lae. Again, training for the Traffic and Transport surveys was integrated into the same training workshop. As all members of the survey team were experienced in the delivery of socioeconomic surveys and were familiar with the communities being surveyed, there was a lesser requirement for investment in training. Again, survey instruments were tested by the survey team and amended accordingly.

The 2017 surveys included several days' training for the four Coffey team members, as well as briefings with WGJV Community Affairs staff and security contractors. Training was held at the WGJV office, which had relocated to 11 Mile in Lae. Training for the socioeconomic surveys for Wagang, Yanga, Lae and the Infrastructure Corridor was conducted in February 2017. This session also included training for resettlement surveys conducted in April 2017 (at Venembele, Hekeng, Nambonga and Ziriruk), with refresher training undertaken immediately prior to deployment in April. Training for traffic count surveys in May 2017 occurred immediately prior to deployment.

Training - Health surveys

Due to the nature of the health surveys which included medical examinations and tests, the survey team was comprised of medical specialists. Subsequently there was no training of WGJV personnel associated with the public health and biomedical survey.

Data collection - Socioeconomic surveys

Each of the socioeconomic survey efforts (2012, 2014, 2015) were completed in alignment with the principal of free, prior and informed consent. As the first step in generating free, prior and informed consent, communities participating in the survey were contacted prior to the arrival of the survey team by staff from WGJV's Community Affairs Department. The purpose of the survey was fully explained and agreement was sought for involvement in the survey. The second step was the delivery of a Tok Save in each village prior to the commencement of the Household Survey; that is, a general discussion of the purpose of the survey. The Tok Save presented why the information was being sought, what the information would be used for and who would have access to the information. Posters were used to present in a visual format the process that the survey team would undertake. Further discussion took place with participants in each household prior to the commencement of the survey. Each participant provided verbal agreement to participate in the survey which was recorded by the interviewer. This approach was complied with in the delivery of all surveys.

The 2012 socioeconomic surveys entailed a Household Survey delivered in each household across 17 villages. Questions were asked of both male and female household heads to ensure women participated in the survey. The Survey was delivered in 563 individual households in August and September 2012. The date and location of Household Surveys undertaken in 2012 are provided in Table 1.2.

Table 1.1 Dates and locations of Household Survey – 2012

Village	Date surveyed
Gingen	31/08/2012; 01/09/2012
Bavaga	01/09/2012; 13/09/2012
Hekeng	03/09/2012
Venembele	04/09/2012
Zimake	05/09/2012
Dengea	06/09/2012; 08/09/2012
Wongkins	06/09/2012
Kapumum	07/09/2012; 25/09/2012
Fly Camp	07/09/2012; 14/09/2012
Nambonga	07/09/2012; 14/09/2012
Madzim	08/09/2012
Timini	09/09/2012; 10/09/2012; 12/09/2012; 24/09/2012
Pekumbe	11/09/2012; 14/09/2012
Zilani	11/09/2012; 14/09/2012
Wori	24/09/2012
Pokwaluma	26/09/2012
Pokwana	27/09/2012

The 2014 socioeconomic surveys included a Household Survey, a Key Informant Survey and a Store Survey. In the course of 2014 a total of 358 Household Surveys were completed along with 11 Key

Informant Surveys and 17 Store Surveys. The date and location of socioeconomic surveys undertaken in 2014 are provided in Table 1.2.

Table 1.2 Dates and locations of socioeconomic surveys – 2014

Village	Date surveyed
Venembele	06/03/2014; 07/03/2014; 11/03/2014
Nambonga	06/03/2014
Pekumbe	08/03/2014
Hekeng	11/03/2014
Bavaga	29/04/2014; 30/04/2014; 03/05/2014; 04/05/2014
Madzim	30/04/2014
Kapunung	01/05/2014
Wongkins	06/09/2012
Wori	03/05/2014
Fly Camp	03/05/2014
Ziriruk	13/05/2014, 30/05/2014

In the course of the 2015 surveys a total of 251 Household Surveys were completed along with 6 key informant surveys and 12 store surveys. The date and location of socioeconomic surveys undertaken in 2015 are outlined in Table 1.3.

Table 1.3 Dates and locations of socioeconomic surveys – 2015

Village	Date surveyed
Zifasing	14/04/2015; 15/05/2015
Goraris	17/04/2015
Uruf	18/04/2015
Bencheng	20/04/2015
Chiatz	21/04/2015
Gingen	22/04/2015
Wori	23/06/2015
Wongkins	24/06/2015
Madzim	25/06/2015
Ziriruk	26/06/2015

In the 2017 surveys, 61 Household Surveys were completed, along with eight focus group discussions and three key informant surveys. Five store surveys were also undertaken, as well as field observations along the proposed Infrastructure Corridor. The date and location of surveys undertaken in 2017 are outlined in Table 1.4.

Table 1.4 Dates and locations of socioeconomic surveys – 2017

Location	Date surveyed
Wagang village	18/02/2017; 19/02/2017; 20/02/2017
Yanga village	19/02/2017
Yalu village (and associated hamlets)	21/02/0217; 22/02/2017;
Lae (field observations)	23/02/2017–26/02/2017; 02/03/2017–03/03/2017; 09/05/2017–10/05/2017; 30/07/2017

Table 1.4 Dates and locations of socioeconomic surveys – 2017 (cont'd)

Location	Date surveyed
Infrastructure Corridor from Zifasing to Yalu (including Gabsongkeg and Munum villages)	27/02/2017–01/03/2017
Venembele village	04/04/2017–06/04/2017
Hekeng village	07/04/2017–08/04/2017
Nambonga village	09/04/2017
Ziriruk village	09/04/2017

All questionnaires and survey instruments were checked on completion, generally before leaving the survey location. This helped ensure that the responses provided to all questions were completed and legible.

On completion of surveys the survey team and additional Community Affairs officers (who facilitated the field program), held a (debrief) session which focused on the following:

- General impressions on each village, including education levels, employment, training, income, expenditure, food recall, trade stores, water/other resources, housing, crime, community groups, and access to health and education facilities.
- The effectiveness of the sketch maps/household lists.
- The accuracy of the data collected.
- Potential improvements to survey and questionnaire design.
- The forward plan for data entry, analysis, report preparation and preparing summary reports for each of the four villages.

These sessions served to clarify any survey responses which were vague or ambiguous and how particular questions could be re-framed to facilitate a more accurate response from survey participants.

Data collection- Traffic and transport surveys

Traffic and transport surveys were undertaken in both 2014 and 2015. The 2014 surveys focused on the Demakwa- Bavaga Road which is a gravel road of approximately 37 km in length that runs from the Bulolo Highway to Wafi Camp. Of particular relevance to the survey were the human settlements located in close proximity to the Demakwa Road (Zimake, Gingen, Bavaga and Fly Camp). The southern periphery of the village of Timini is located just 100m from the junction of the Demakwa Road and the Lae – Bulolo Highway and subsequently Timini was also included. The collection of survey data was undertaken at each of these five locations over four consecutive days:

- Friday 8 March.
- Saturday 9 March.
- Sunday 10 March.
- Monday 11 March.

Survey locations were selected on the basis of being a vantage point from which all vehicular and pedestrian traffic movements on the road could be observed. Specific survey locations were also selected with reference to key nodes of traffic generation. For instance, the survey locations for both Gingen and Zimake was situated so that all traffic going to and from the Zindaga school was able to be observed and recorded. Similarly in Bavaga, the survey location was situated at the junction of the Demakwa Road and the road which links with the Finchiff Camp area to ensure that all traffic movements were captured.

The 2015 traffic and transport surveys focussed on the Lae- Bulolo Highway and on the Markham River. Information was collected on usage of the Lae- Bulolo Highway through completion of the Observational, Resident and Pedestrian surveys at the village of Gabensis which is located approximately 25 km from the junction of the Lae- Bulolo Highway and the Demakwa Road (at Timini). The locality was selected as the information generated through the surveys would enable comparison against the data previously collected (2014) at Timini regarding usage of the Lae Bulolo Highway. The collection of survey data at Gabensis was undertaken over four consecutive days:

- Friday 17 April.
- Saturday 18 April.
- Sunday 19 April.
- Monday 20 April.

An Observational Survey of river traffic was also conducted in 2015. The survey was conducted at a site referred to as '40 Mile waterside'. It is on the north bank of the Markham River, approximately 800m downstream from the confluence of the Watut River. From this location all river traffic on both the Markham and Watut Rivers could be observed and recorded. The river traffic survey at 40 Mile waterside was undertaken over three days:

- Friday 17 April.
- Saturday 18 April.
- Monday 20 April.

An Observational Survey of road traffic in Lae was conducted in 2017. The survey involved two locations, at Malahang and further north on Independence Drive. Due to changes to the route of the proposed Infrastructure Corridor, results from the latter location became irrelevant for the purposes of the study. Traffic observations were undertaken over four days:

- Friday 12 May.
- Saturday 13 May.
- Sunday 14 May.
- Monday 15 May.

Data collection - Health surveys

Ethics approval for the Public Health and Biomedical Survey was sought and provided by the National Department of Health's (NDoH) Medical Research and Advisory Council. Prior to commencing the Survey, the Provincial Government, Provincial Health Authority and District Health Officers were informed of the intent, purpose and methods for the proposed Survey. These authorities endorsed the Survey on the provision that Provincial and Local Government Units and villages were likewise consulted and their informed consent gained. Individual participants were oriented to the Survey design, methods and purpose by the MMJV Community Affairs Unit in the weeks prior to implementation and again by the field Team Leader before village-based activities commenced. Further, villages, households and individuals were again informed and individuals asked to provide written consent for both their participation in the Survey and for the collection of biological specimens.

A sample size calculation was applied to determine a minimum number of individual points of data required to return a sufficient level of statistical confidence (i.e. a 90% confidence level) for specimen analysis. A typical sample size for frequency in a population formula was applied.

The 9 villages associated with the Golpu Project which were included in the Survey were selected by the WGJV Community Affairs team based on those villages visited by previous health surveys conducted in 2003 and 2007 (CEH 2003; CEH 2007), their geographical proximity to the MMJV Project, and taking into account transport, security and ongoing stakeholder engagement activities. On review by Abt JTA, it was

confirmed that the selected villages provide a reasonable cross-section of village types, locations and potential hazardous pathway exposures across the impact area.

Within each Survey village, a consecutive sampling method was used to select a minimum of seven households. Each selected household was approached and invited to participate in the Survey. The number of households required was determined based on a previously reported household population density of 6.7 people (CEH 2007), and the Government of Papua New Guinea's (GoPNG) reported population demographic structure in the region (NSO 2013). Anticipating absenteeism, the target number of households was rounded up to 10 per village. The inflated target number of households to visit in each village allowed the field team to overcome unforeseen or logistical constraints while still meeting the minimum requirement of seven.

Table 1.5 presents a list of the Survey villages and the number of surveyed individuals in each village.

Table 1.5 Locations and number of persons covered by Health Survey

Village	Date	Est. Village Population	No. Households Surveyed	No. Individuals Surveyed			
				Male	Female	Not Recorded	Total
Gingen	10/08/2012	400	12	15	26	0	41
Hekeng	10/08/2012	120	7	10	7	1	18
Labu	10/08/2012	1,600	19	22	49	0	71
Madzim	10/08/2012	170	10	15	19	0	34
Pekumbe	10/08/2012	279	10	14	27	0	41
Timini	10/08/2012	1000	10	30	32	1	63
Uruf	10/08/2012	200	11	26	27	0	53
Zifasing	10/08/2012	3,000	13	32	31	0	63
Zilani	10/08/2012	303	10	15	24	0	39

(Source: Abt JTA, 2013a)

Limitations

Socioeconomic and traffic and transport surveys

As with any research of this nature, the schedule and logistical arrangements for the socioeconomic surveys only allowed for limited time to be spent in each location. To some degree, this requires information to be accepted at face value as reported. Comprehensive accuracy checks were not possible, however, surveys were generally undertaken at the interviewee's house, which helped validate some answers. The validity of information gathered is also supported by the uniformity of responses.

Due to the lack of formal record keeping in many of the villages surveyed, a significant number of participants could not provide definite answers to some questions in the household survey, particularly in relation to age, income and expenditure. Many adults estimate their own age while most children have clinic birth records against which age can be verified. With regard to income and expenditure, some participants provided answers that were considered inaccurate and unrealistic due to misinterpretation of the question. In instances where the response recorded is certainly incorrect, it was omitted from analysis. Overall, these incidences were very low.

Notwithstanding these constraints, the information gathered provides a comprehensive and robust socioeconomic baseline for the study area, and may be used in the prediction of likely socioeconomic impacts to inform the Golpu Project Environmental Impact Statement (EIS). Coffey entered all collected survey data to computer and employed Quality Control (QC) during the data entry process to ensure the validity and reliability of data. A QC accuracy assessment of household surveys (10% of all surveys) was completed. It was found that there were no endemic errors and overall accuracy was very high (99%+ accuracy).

Health surveys

There were a number of constraints and limitations associated with the Public Health and Biomedical Survey. Table 1.6 presents the main limitations faced and how these limitations were addressed.

Table 1.6 Limitations and how they were addressed- health surveys

Limitation	How Limitation was Addressed
Many working aged men were absent from villages and hence not able to participate in the Survey	The Survey implementation was adapted to maximise the opportunity to collect data from working age men. Adaptations included visiting villages later in the day and into the evening and rescheduling village visits to Saturdays or Sundays (when men would more reportedly more likely be in the village and not working).
Logistical constraints (distances between houses) resulted in Wori village not being surveyed as originally planned	Survey village selection and sample calculations allowed for some villages to not be surveyed due to logistic and weather constraints
The same level of detail was not collected at each of the four aid posts in the Survey area due to unavailability of health workers.	Where the Survey was unable to collect detailed information about an aid post, secondary data is available from government and MMJV Health survey sources
HIV out of scope of Survey	HIV is a disease of growing concern in Papua New Guinea. Significant ethical, technical and legal restrictions exist regarding the inclusion of HIV testing in population surveys such that Abt JTA advises private sector clients to facilitate and draw on public sector data regarding HIV prevalence and patterns. Secondary data was gathered to inform this aspect
Malaria out of scope of the Survey	Malaria was excluded from this Survey as a separate malaria specific survey was commissioned by MMJV
Collection of primary data regarding tuberculosis (TB) was out of scope of the Survey	TB is amongst the leading causes of mortality and morbidity in the Survey area. Population screening for TB is possible using tuberculin skin tests, and useful for disease surveillance if repeated every three to five years. TB surveillance was out of scope for this Survey due to financial, technical and logistical limitations (e.g., skin tests require survey participants to be present for tests administration, then again two to three days later for observation of results). National TB Program data regarding TB prevalence is available in place of primary data

(Source: Abt JTA, 2013a)

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Appendix 2

2017 Focus Group Interview Instrument

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Focus Group Interview

Village: _____

Interviewer: _____

Date: _____/_____/2017

A. INTRODUCTION

Good morning / afternoon. I am conducting a survey for WGJV and would be grateful if you could answer some questions about general living conditions in this village, including water supply, other natural resources, health, education, transport and law & order.

Your answers will remain confidential. You may choose not to answer a question or to withdraw at any time. Before starting I want to be sure that you understand why we are collecting information and that you agree to participate.

Participants (note position if applicable; e.g. chief)

Name & position	*Agree to participate?*	*Name & position*	*Agree to participate?*
	YES / NO		YES / NO
	YES / NO		YES / NO
	YES / NO		YES / NO
	YES / NO		YES / NO
	YES / NO		YES / NO

B. WATER SUPPLY

What is the **main** source of drinking water in this village? *Tick box*

Pipeline	**River**	**Creek**	**Pond**	**Spring**	**Tank**	**Other**

******Show on map******

- How far away is it (approx. time to walk) _____ minutes (one way)
- Has this water supply dried up in the past 12 months (Yes/No): _____
- Has this water supply dried up in the past 10 years (Yes/No): _____
- Are you satisfied with the water quality (Yes/No): _____
- If not, why not?
  _____

What is the **secondary (or back-up)** source of drinking water in this village? *Tick box*

Pipeline	River	Creek	Pond	Spring	Tank	Other

******Show on map******

- How far away is it (approx. time to walk)? _____ minutes (one way)
- Has this water supply dried up in the past 12 months (Yes/No): _____
- Has this water supply dried up in the past 10 years (Yes/No): _____
- Are you satisfied with the water quality (Yes/No): _____
- If not, why not?
  _____

How many houses have **rainwater tanks** in the village? _____

How many other buildings have rainwater tanks? _____

If the village has a **reticulated water supply**:

- Is the system currently working (Yes/No): _____
- What year was it installed: _____
- Who paid for the infrastructure: _____
- Who is responsible for maintenance/repair: _____
- Has it ever been repaired (Yes/No): _____

C. WASHING

Where do men generally wash? *Tick box*

River	Creek	Pond	Piped water	Other

How far away is it (approx. time to walk) _____ minutes (one way)

Where do women generally wash? *Tick box*

River	Creek	Pond	Piped water	Other

How far away is it (approx. time to walk) _____ minutes (one way)

******Indicate on the map the location of water supplies and washing areas.******

D. FLOODS

Do houses in the village get flooded (Yes/No): _____

If yes, when was the last time this occurred: _____/_____
month year

How many times in the past year has this occurred: _____

Do food gardens get flooded (Yes/No): _____

If yes, when was the last time this occurred: _____/_____
month year

How many times in the past year has this occurred: _____

E. FISHING

Where do people in the village generally fish *(**indicate on map**).*

How do people generally travel to the fishing areas? _____

How long does it take to get to the fishing areas?

Closest _____ minutes on way, Furthest _____ minutes one way

Main species caught: _____, _____

_____, _____,

_____

Do people in the village catch prawns (Yes/No): _____

Are prawns caught in the same areas as fish (Yes/No): _____ *If caught in a different area, **indicate on map**.*

Do people in the village catch crabs (Yes/No): _____

Are crabs caught in the same areas as fish (Yes/No): _____ *If caught in a different area, **indicate on map**.*

What other food or materials are caught/collected from the river/creeks:
_____,

_____, _____

How many fish ponds are there in the village? _____

F. HUNTING

How important is hunting in the village? (*Tick boxes that apply*)

- ❑ Very important part of regular diet
- ❑ Important part of regular diet
- ❑ Not essential for regular diet
- ❑ Important for special feasts

How much hunting do villagers do? (*Tick box that applies*)

- ❑ Large amount (most households each week)
- ❑ Modest amount (most households monthly)
- ❑ Limited amount (only occasionally)

Who does the most hunting? (*Circle which applies*)

❑ Older males ❑ Younger males ❑ Women

How many are excellent hunters (*nambawan sutman*)?

What are the main animals hunted? (Please name and list)

_____

_____

When hunting, are animals now (*Circle which applies*)

❑ Easy to find (olsem bipo)	❑ More scarce now (Hat lik lik long painim)	❑ Very scarce (Hat tru long painim)

What do villagers usually use to hunt with?

❑ Bow and arrow ❑ Rifle ❑ Trap ❑ Spear ❑ Knife

Where do villagers usually hunt? (Circle which applies)

❑ Close to village (0-1km)	❑ Medium distance (longwe lik lik, no overnight)	❑ Long distance (Longwe tru, camp out 1 or 2 nights)

How much food do people usually obtain per hunting expedition? _____

_____

G. AGRICULTURE & FORESTRY

Gardening

Where do people from this village generally make new gardens? *Tick box*

Virgin forest	*Secondary forest*	*Grasslands*	*Old garden areas*	*Along the river*	*Other*

How long does it take to travel to the gardens?

- ❑ Less than 10 minutes
- ❑ 10-30 min
- ❑ 30 min – 1 hour
- ❑ More than 1 hour

Mode of transport: _____

What crops are grown in gardens?

- ❑ Banana
- ❑ Greens/kumu
- ❑ Kau (sweet potato)
- ❑ Taro
- ❑ Sugar cane
- ❑ Cocoa
- ❑ Coffee
- ❑ Vanilla
- ❑ Betel nut
- ❑ Brus (tobacco)
- ❑ Sago
- ❑ Other: _____
- ❑ Other: _____

How many years are gardens generally cultivated before being left? _____ years

How many years are garden areas left fallow before being cultivated again: _____ years

Commercial logging

Has there been any commercial logging in this area (Yes/No): _____

If yes, between what years? Year started: _____ Year finished: _____

******Identify any logged areas on a map.******

Is there a good supply of timber and other resources for making houses (Yes/No): _____

Sago growing

Do you have areas of **sago** (Yes/No): _____ *If yes,* ***identify sago areas on a map.***

How important is sago as a food source? *Tick box*

Staple, very important	*Seasonal staple*	*Only in times of food shortage*	*Not important*	*Other*

If a food source, when is sago made (which months, or year round)?_____

_____

When sago is made, do families stay there for a few days before returning: YES / NO

Do you have plenty of sago for housing materials/food, etc.? YES / NO

H. HEALTH

Which health facility do people generally go to seek medical attention? _____

What is the most common method of transport to reach the health facility: _____

How long does it take to reach the health facility? _____ hours (one way)

About what percentage of babies are born in the village? _____%

For babies born in the village, is there any supervision *(tick box).*

Qualified medical officer	Trained village birth attendant (VBA)	Traditional VBA	Other

What year did the last medical patrol to the village occur: _____

Who did the last medical patrol: _____

I. EDUCATION

***** Please show schools on map*****

Which **elementary** school to most children attend? _____

Most common method of transport to reach this school: _____

Time taken to reach the school: _____ minutes (one way).

Which **primary** school to most children attend? _____

Most common method of transport to reach this school: _____

Time taken to reach the school: _____ minutes (one way).

Which **high/secondary** school to most children attend? _____

Most common method of transport to reach this school: _____

Time taken to reach the school: _____ minutes (one way).

J. TRANSPORT

How do people generally travel to Lae: _____

Time taken to reach Lae: _____ minutes (one way).

K. ALLUVIAL MINING

Do people from this village ***wok gol*** (Yes/No): _____

If yes, indicate the main location on a map, or describe below if in another area.

Which methods are used? *Tick box*

Diving	*Panning*	*Sluice box*	*Pumps*	*Digging*	*Other*

Do people from other villages pan for gold in this area (Yes/No): _____

If yes, where do they come from:

_____

Do buyers come to the village to buy gold (Yes/No): _____

Where do the buyers come from: _____

L. ADMINISTRATION

Does this village have the following. *Tick box*

	Yes	No	
Councillor			If no, nearest:
Ward Development Committee			
Village Court Magistrate			If no, nearest:
Police Officer			If no, nearest:
Women's group			
Church group			
Youth group			
Sports club			
Other village organisation			If yes, what:

M. PROBLEMS

What are the main problems in this village? *Discuss first, then list in order.*

1. _____

2. _____

3. _____

4. _____

N. LAW & ORDER

What are the main law & order problems in this village? *Discuss first, then list in order. Record level of consensus (did everyone agree easily, or was there a lot of debate?)*

1. _____

2. _____

3. _____

4. _____

When was the last time a serious crime occurred in this village (e.g. a crime that should be investigated by the Police).

Year: _____

Crime: _____

Did the Police investigate (Yes/No): _____

Appendix 3

2017 Land and Water Resource Use Key Informant Interview

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Wafi-Golpu Project
Land & Water Resource Use Study

Key Informant Survey

Feb 2017

Date:	
Interviewer:	
Translator/record keeper:	
Village Name:	
Number of participants:	
Participants' names:	
Location of focus group:	
Photo ref:	

Free, prior and informed consent

Interviewer

All participants have agreed to participate. They understand that they may withdraw consent at any time, and that they may refuse to answer any questions.

Signature **Date**

…… **……**

1. Land Use

1A Describe the land resources used by the village.

Source	**Description** *(include location, distance from village centre, frequency of use)*	**Use** *(circle all that apply)*
Gardens		Food source (subsistence)
		Income
		Other (specify):
Bush		Food source (subsistence)
		Income
		Building materials
		Transport
		Recreation
		Firewood
		Medicine
		Worship/traditional activity
		Other (specify):

1B How does the village source most of its food?

Household garden	Fishing	Hunting	Trade store (village)	Markets (Lae)
Other (specify):				

1C Gardening

Do most families in the village have their own gardens?	Household gardens	Family gardens	Communal gardens
How often do village members work in their gardens?	Every day	Several times a week	Less than weekly
Where are the gardens primarily located? (Describe)			
How long does it take most families to travel to their gardens? How far?	Hours	Minutes	Kilometres
What are the main garden products grown? Indicate frequency of crop and how often it is harvested.	Type		Frequency

Who works in the gardens?	Men only	Women only	Men and women

1D Hunting

How often would village members hunt?	❑ Daily ❑ Weekly ❑ Monthly ❑ Never		
How long does a hunting expedition go for?	❑ One day	❑ Two days	❑ More than two days
Who goes hunting?	❑ Men only	❑ Women only	❑ Men and women
Where do village members primarily hunt? (Describe the general directions, distance)			

What are the main species village members hunt for?
What methods do village members use to hunt (e.g., using spear, trap, bow & arrow, knife)?
❑ Bow & arrow ❑ Spear ❑ Trap ❑ Knife ❑ Rifle ❑ Dogs ❑ Other: _____
What quantities do village members usually obtain per expedition?

1E Gathering

What resources do village members gather from the bush or river? (Circle)			
Bush		**River**	
Fire wood	Building material	Fire wood	Building material
Bush fruit	Bush vegetables	Logs for canoe making	Reeds
Medicines	Art & craft material	Edible plants	Art & craft material
Other (specify):		Other (specify):	

2. Water Use

2A Describe the freshwater sources used by the village.

Note: Recreation is often forgotten – be sure to prompt about recreational uses.

Source	**Description** *(include location, distance from village centre, frequency of use)*	**Use** *(tick all that apply)*
River/stream		❑ Drinking water ❑ Domestic water ❑ Waste disposal ❑ Transport ❑ Food source (subsistence) ❑ Income ❑ Recreation ❑ Worship/traditional activity ❑ Other (specify):
Lake		❑ Drinking water ❑ Domestic water ❑ Waste disposal ❑ Transport ❑ Food source (subsistence) ❑ Income ❑ Recreation ❑ Worship/traditional activity ❑ Other (specify):
Rain (tank)		❑ Drinking water ❑ Domestic water ❑ Waste disposal ❑ Transport ❑ Food source (subsistence) ❑ Income ❑ Recreation ❑ Worship/traditional activity ❑ Other (specify):

Source	**Description** *(include location, distance from village centre, frequency of use)*	**Use** *(tick all that apply)*
Spring		❑ Drinking water ❑ Domestic water ❑ Waste disposal ❑ Transport ❑ Food source (subsistence) ❑ Income ❑ Recreation ❑ Worship/traditional activity ❑ Other (specify):
Well		❑ Drinking water ❑ Domestic water ❑ Waste disposal ❑ Transport ❑ Food source (subsistence) ❑ Income ❑ Recreation ❑ Worship/traditional activity ❑ Other (specify):
Sea / ocean *(if applicable)*		❑ Drinking water ❑ Domestic water ❑ Waste disposal ❑ Transport ❑ Food source (subsistence) ❑ Income ❑ Recreation ❑ Worship/traditional activity ❑ Other (specify):

DRINKING WATER

2B What are the main sources of <u>drinking</u> water for the village? *(Circle)*
2C What are their condition? *(Circle)*
2D What are their availability? *(Circle)*

Source			**Condition**		**Availability**	
Ret. Water	Piped into household or yard	Piped into shared location	Satisfactory	Unsatisfactory	All year	Seasonal
Well water	Well/bore in yard	Public well/bore	Satisfactory	Unsatisfactory	All year	Seasonal
Surface water	Spring	River/stream	Satisfactory	Unsatisfactory	All year	Seasonal
Tanks	Household rain water tank	Public rain water tank	Satisfactory	Unsatisfactory	All year	Seasonal

*******Photograph the main sources of drinking water for this village.*******
*******Use iPad********

2E How long does it take to collect drinking water (there and back)?

Hours	Minutes

DOMESTIC WATER

2F What are the sources of <u>other domestic</u> water for the village? *(Circle)*
2G What are their condition? *(Circle)*
2H What are their availability? *(Circle)*

Source			Condition		Availability	
Ret. Water from mains	Piped into house/yard	Piped into shared location	Satis-factory	Unsatis-factory	All year	Seasonal
Ret. Water (local source)	Piped into house/yard	Piped into shared location	Satis-factory	Unsatis-factory	All year	Seasonal
Well water	Well/bore in yard	Public well/bore	Satis-factory	Unsatis-factory	All year	Seasonal
Surface water	Spring	River/stream	Satis-factory	Unsatis-factory	All year	Seasonal
Tanks	Household rain water tank	Public rain water tank	Satis-factory	Unsatis-factory	All year	Seasonal
Ocean	-	-	Satis-factory	Unsatis-factory	All year	Seasonal

2I What is domestic water used for? *Circle all that apply.*

Flush Toilet	Bathing	Cooking
Laundry	Stock watering	Water garden
Other (specify)		

SANITATION & WASTE DISPOSAL

2J What kind of toilets exist in the village? *(Circle all, indicate primary)*

Flush Toilet	Pit Latrine (long drop)	No toilet (bush)
Toilet inside	Toilet outside	

2K How does the village dispose of rubbish? *(Circle all, indicate primary)*

Burn	Bush (scattered)	Household rubbish dump	Ocean
River/creek	Bush (designated)	Communal / designated rubbish dump	Other (specify)

FRESHWATER RESOURCES

2L Describe the plants and animals that are harvested from the river/lake for <u>personal use</u>? Indicate availability.

Plant or animal	**Use** *(describe ie, food, medicine, building materials, recreation, worship)*	**Availability** *(Always/seasonal)*

2M Describe the plants and animals that are harvested from the river/lake for <u>economic purposes</u>? Indicate availability.

Plant or animal	**Use** *(describe ie, food, medicine, building materials, recreation, worship)*	**Availability** *(Always/seasonal)*

3. Marine Resource Use (WAGANG ONLY)

3A How often do you go fishing?

Every day	Several times a week	Less than weekly	Never

3B On each trip, how long do you go fishing for?

Half day	Full day	Two days or more

3C Who do you go fishing with?

By myself	With a few others	In a big group with multiple boats

3D Who usually goes fishing (e.g., men, women, children)?

Men only	Women only	Men and women

3E Is there any organised fishing? *(Circle as many as are relevant)*

Fishing venture
Cooperatives
Ice plants
Collection system for species such as trochus shell, beche de mer etc.
Interaction with commercial fishing
Other:

3F Where do you catch fish?

Estuary	Reef	Beyond reef	Other:

3G Are there any fishing grounds that are only allowed to be used by people in your clan or village?

❑ YES
❑ NO
(If yes, mark on map)

3H What gear do you use to catch fish?

Method	*Further details if applicable*	*Further details if applicable*
❑ Active netting	❑ Beach (haul) seining ❑ Cast nets ❑ Cover pots – cane ❑ Bag nets – scoop, push, etc. ❑ Other:	Mesh size (inches): _____ Length (m): _____ Depth (m): _____
❑ Traps	❑ Baskets ❑ Barrier – stone ❑ Other:	
❑ Gillnets / Tangle nets	❑ Monofilament ❑ Multifilament ❑ Drift nets	Mesh size (inches): _____ Length (m): _____ Depth (m): _____
❑ Line fishing	*Watched* ❑ Hand line ❑ Rod ❑ Troll fishing *Unwatched* ❑ Anchored longline ❑ Drift longline Other: _____	Bait: _____ Line strength: _____ Sinker weight: _____ Hook size: SMALL / LARGE
❑ Spear		
❑ Boat	❑ Banana boat ❑ Canoe ❑ Other: _____	

3I Do you use any traditional methods to catch fish? For example, poison, or shark calling?

Comments

3J How many fish do you catch per trip, or per day?

Number of fish	<10	10 to 50	>50
Weight of catch	<5 kg	5 to 25 kg	<25 kg

3K What type of fish do you catch?

Estuarine fish	**Number of fish**	<10	10 to 50	>50
	Weight of catch	<5 kg	5 to 25 kg	>25 kg
Reef fish	**Number of fish**	<10	10 to 50	>50
	Weight of catch	<5 kg	5 to 25 kg	>25 kg
Deep-slope fish	**Number of fish**	<10	10 to 50	>50
	Weight of catch	<5 kg	5 to 25 kg	.25 kg
Pelagic fish	**Number of fish**	<10	10 to 50	>50
	Weight of catch	<5 kg	5 to 25 kg	>25 kg

3L Do you catch different fish at different times of the year? What fish do you catch in each season?

NB: *Summer = Dec–Feb, Autumn = Mar–May, Winter = Jun–Aug, Spring = Sep–Nov*

Comments

3M What happens to the fish you catch (e.g., consumed at home, sold at local market, sold to commercial outlet)?

Consumed at home	Sold at local market	Sold to commercial outlet	Trade for garden produce or other items	Other:

3N What is more important for food, fishing or gardening?

Fishing	Gardening	Rely on both

3O At what time of year are turtles and turtle eggs available to eat?

How often do you catch turtles?	Every day	Several times a week	Less than weekly
How many turtles do you catch?	<3	3 to 12	>12
How often do you collect turtle eggs?	Every day	Several times a week	Less than weekly
How many turtle eggs do you collect?	<50	50 to 150	>150
Where do you catch turtles and eggs from? *(Describe at right and mark on map)*			

3P At what time of year do you see whales and dugongs?

During that time:

How often do you see whales?	Every day	Several times a week	Less than weekly
How many whales do you see?	<1	1 to 5	>5
How often do you see dugongs?	Every day	Several times a week	Less than weekly
How many dugongs do you see?	<3	3 to 10	>10
Where do you see whales and dugongs? *(Describe at right and mark on map)*			

3Q Are there any religious constraints on what you eat?

Comments

COASTAL TRAFFIC (WAGANG ONLY)

3R Describe the coastal traffic passing this village.

1	Estimate the number of boats in one day	
2	Describe the type of boats	**Tick**
	Canoe	
	Banana boat	
	Barge	
	Other *(specify)*	
	Other *(specify)*	
3	Describe the nature of boats	**Tick**
	Canoe transporting people	
	Canoe transporting cargo	
	Traders	
	Other *(specify)*	
	Other *(specify)*	

3S Describe and photograph the coastal traffic infrastructure of this village.
****Take photo if possible****

Eg. Jetty, wharf, mooring, ramp.

4. Land, Water & Marine Resource Values

4A Discuss and note the most important land resources to this village. Record why they are so important.

Comments

4B Discuss any concerns village members have about land resources.

Comments

4C Discuss and note the most important water resources to this village. Record why they are so important.

Comments

4D Discuss any concerns village members have about water resources.

Comments

4E Discuss and note the most important marine resources to this village. Record why they are so important.

Comments

4F Discuss any concerns village members have about marine resources.

Comments

FOR RESEARCHER ONLY:

Use the iPad to record the following features.
Use an aerial photograph to create a back-up map.

- ❑ Land resources (ie, naturally occurring (grove, stands) and gardens)
- ❑ The location of water sources used by community
- ❑ Any permanent use of riverbanks (ie, for fishing, markets, jetties, etc)
- ❑ Fishing materials/equipment
- ❑ Extent of village fishing grounds

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Appendix 4

2017 Household Survey Instrument

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Household Survey

A. Introduction

Good morning / afternoon. I am conducting a survey for WGJV and would be grateful if you could answer some questions about who lives in your house, education, employment, income, expenditure, food consumed and health.

Your answers will remain confidential. You may choose not to answer a question or to withdraw at any time. Before starting I want to be sure that you understand why we are collecting information and that you agree to participate.

Do you agree to participate:

Village: _____

Interviewer: _____

Date: _____/_____/2017

Respondent: _____ _____
First name Last name

Gender: ❑ Male ❑ Female

B. Housing

Do you own the house you are living in (Yes/No): _____

If yes, what is the house made from: _____

[categorise as permanent (kapa & sawn timber), semi-permanent (kapa & local materials) or traditional].

Main sources of lighting: _____, _____

[1=fire, 2=kero lamp, 3=generator/electric lights, 4=other_____]

Main fuels for cooking: _____, _____

[1=firewood, 2=kero stove, 3=electric stove, 4=other_____]

C. Household Composition

First name	Surname	Rel. to HHH*	Age	Gender (M/F)	Level of education completed**	Do they smoke (Y/N)	Most recent job			Any additional training (describe)	Wage last fortnight (Kina)
							Occupation	Employer	Year ended/or ongoing		

Codes: *Relationship to Household Head: 1=HHH, 2=wife, 3=son/daughter, 4=parent, 5=brother/sister, 6=other relative, 7=not related

**Education: 1 to 12 (highest school grade completed), VS=vocational school, TC=technical college, U=University

D. Alluvial Mining (if applicable)

Has anyone in this household searched for gold in the past year (Yes/No): _____

- How often:

Most days	At least once a week	At least once a month	Irregularly
❑	❑	❑	❑

- How long does it take to travel to the location where you search for gold: _____hr
- How much money have you earned from gold in the past year: K_____
- When you *wok gol*, how long do you usually sleep away from the village: ____days

Ensure income from alluvial mining is recorded as household income.

E. Business

Has anyone in this household operated a business in the past year (Yes/No): _____

If yes, please complete the following for each type of business.

	# 1	# 2	# 3
Type of business			
Year commenced			
Still operating	Y / N	Y / N	Y / N
Income in past 2 weeks			
Costs in past 2 weeks			

Ensure business income and costs are recorded as part of household income and expenditure.

F. Household Income

Please indicate income sources for the past year *(tick appropriate boxes)* and estimate how much income all household members have received in the past 2 weeks.

Income source	**Has anyone earned income in past year? *Tick boxes***	**Income in past 2 weeks (Kina)**
Wages (refer page 2)		
Cocoa		
Coffee		
Vanilla		
Betel nut		
Brus		
Other cash crops		
Garden produce		
Fish from fish ponds		
Fish from streams		
Prawns		
Eels		
Crabs		
Pigs		
Chickens/ducks		
Other livestock		
Abus (bushmeat)		
Sago		
Other forest/garden produce		
Wok gol (alluvial mining)		
Business income (gold buying/selling, trade store, stall, PMV, etc)		
Bride price or customary payments		
Remittances (money received from others)		
Compensation payments		
Other (specify)		
TOTAL INCOME		

G. Household Expenditure

Please estimate how much money you spent on each of the following in the last 2 weeks (include all members of the household).

Item	Kina
School fees	
Fuel for generator	
Fuel for motorised canoe	
Fuel (other)	
Kerosene	
Batteries	
Transport (PMV)	
Transport (boat)	
Transport (other)	
Mobile phone credit	
Charing mobile phones	
Local market produce	
Store food/drink	
Other food (abus, etc)	
Betel nut	
Alcohol	

Item	Kina
Cigarettes, brus, spia	
Clothes/shoes	
Medicine, health care	
Household items (pots, kapa)	
Church donation	
Money sent/lent to others	
Money repaid to others	
Business costs (eg. store goods)	
Livestock (chickens/fish, etc)	
Gardening equipment (eg. tools, fertiliser)	
Fishing equipment	
Customary payments (e.g. bride price)	
Haus krai, burial costs	
Other (1)	
Other (2)	
TOTAL EXPENDITURE	

How does the above expenditure compare to usual expenditure?

Higher ☐ Same ☐ Lower ☐

If higher or lower, why?

_____

Who in the household decides what money is spent on? *Tick box*

Husband	Wife	Shared decision	Managed separately	Not applicable (e.g. single HH head)	Other (specify)

H. Food Recall

Yesterday, what foods did you eat? *(Prompt what foods were eaten in the morning, during the day, in the afternoon, at night, in the garden or visiting other people). Tick boxes.*

Source:

***G** = **g**rown in village (includes bought from others in village).*
***M** = produce bought in **m**arket (grown locally by others outside village).*
***TS** = **s**hop food (manufactured commercially, but bought locally.*
***L** = bought at a shop in **L**ae*

Rice	❑	G/M/TS/L	Coconut	❑	G/M/TS/L	Pig meat (pork)	❑	G/M/TS/L
Biscuits	❑	TS/L	Cassava	❑	G/M/TS/L	Chicken meat	❑	G/M/TS/L
Noodles	❑	TS/L	Sago	❑	G/M/TS/L	Eggs	❑	G/M/TS/L
Flour, bread, scones	❑	TS/L	*Marita*	❑	G/M/TS/L	Beef/lamb	❑	G/M/TS/L
Store snack foods	❑	TS/L	Peanuts	❑	G/M/TS/L	Fish	❑	G/M/TS/L
Coke, soft drinks	❑	TS/L	Other nuts	❑	G/M/TS/L	Prawns	❑	G/M/TS/L
Kau kau	❑	G/M/TS/L	Pumpkin	❑	G/M/TS/L	Eel	❑	G/M/TS/L
Taro	❑	G/M/TS/L	Fruit	❑	G/M/TS/L	Betel nut	❑	G/M/TS/L
Yam	❑	G/M/TS/L	*Kumu* (garden)	❑	G/M/TS/L	*Brus*, cigarettes	❑	TS/L
Banana *mau*	❑	G/M/TS/L	*Kumu* (bush)	❑	G/M/TS/L	Alcohol	❑	TS/L
Cooking banana	❑	G/M/TS/L	*Pit pit*	❑	G/M/TS/L	Other (1)		
Sugar cane	❑	G/M/TS/L	Tinned fish/meat	❑	TS/L	Other (2)		
Kapiak (breadfruit)	❑	G/M/TS/L	*Abus* (bushmeat)	❑	G/M/TS/L	Other (3)		

I. Transport

Does your family own any of the following items?

- ❑ Canoe
- ❑ Dinghy
- ❑ Outboard motor
- ❑ Vehicle
- ❑ Motorbike

In the past month, how many times have any family members travelled to Lae: _____

For the last visit made to Lae:

- ❑ What was the purpose of the visit?
  - ❑ 1. school
  - ❑ 2. haus sik
  - ❑ 3. business
  - ❑ 4. shopping
  - ❑ 5. selling produce
  - ❑ 6. raun tasol
  - ❑ 7. other _____

- ❑ How many family members travelled to Lae: _____

- ❑ How did you travel to and back from Lae
  - ❑ 1. Boat/canoe
  - ❑ 2. PMV
  - ❑ 3. Private car
  - ❑ 4. Motorbike
  - ❑ 5. other _____

- ❑ How many nights did you stay in Lae: _____

J. Health

For families with one or more children under 5 years of age (if mother is present).

Child's first name			
Age			
Sex (M/F)			
Where was the child born (hospital, health centre, aid post, village, other)			
If born in the village, who supervised delivery (APO, trained VBA, traditional VBA, other)			
Did the mother attend an anti-natal clinic during pregnancy (Yes/No/Not sure)			
Was the mother vaccinated for tetanus during pregnancy (Yes/No/Not sure)			
How many does of Triple Antigen has the child received (usually 2, 4 & 6 months)			
Has the child been immunized against measles (usually 9-11 months of age)			
Does the child sleep under a bed net (always, sometimes, no)			

ADDITIONAL QUESTIONS

K. People & Places

Reasons for village relocation

Were you born in this village? YES / NO

If not, how long have you lived here? _____years

Where did you live previously? _____

Why did you move here? _____

Religious affiliation

What church do you belong to?

- ❑ Lutheran
- ❑ SDA
- ❑ New Guinea Revival
- ❑ Church of Christ
- ❑ New Tribes
- ❑ Catholic
- ❑ Pentecostal
- ❑ Other (specify) _____

Law and order issues

What are the major law & order issues affecting your village?

- ❑ Alcohol
- ❑ Stealing
- ❑ Drug use
- ❑ Domestic violence
- ❑ Safety and security of children
- ❑ Land conflict
- ❑ Inter-village conflict
- ❑ Disturbance/ nuisance
- ❑ Sexual violence
- ❑ Other (specify) _____

L. Energy

Is there access to grid electricity? YES / NO

How reliable is it?

- ❑ Available all the time
- ❑ Available every day but not all day
- ❑ Available a few days a week: _____ days/week
- ❑ Available once a week or less

Sources of lighting used?

- ❑ Kerosene lamp
- ❑ Generator
- ❑ Fire
- ❑ Solar
- ❑ Battery lamp
- ❑ Torch
- ❑ Grid electricity (lightbulb)
- ❑ Other: _____

M. Health

Disease

In the last month, has anyone been sick? YES / NO

What was the illness? (*tick; ✓✓ for two people)*

	Adult male	Adult female	Male child	Female child
❑ Malaria				
❑ Flu/cold				
❑ Fever				
❑ Tuberculosis				
❑ Injury				
❑ Headache				
❑ Backache				
❑ Chest pain				
❑ Other				
❑ Don't know				

Morbidity (SENSITIVE)

Has anyone in your household died in the past year? YES / NO

What was the cause of death?

- ❑ Cancer
- ❑ Old age
- ❑ Conflict
- ❑ Sorcery
- ❑ Accident
- ❑ Malaria
- ❑ Childbirth MOTHER / CHILD
- ❑ Tuberculosis
- ❑ Unspecified illness
- ❑ Other: _____
- ❑ Prefer not to say

N. Travel

In a usual week, how often do you travel outside the village?

Weekdays

- ❑ Every weekday
- ❑ Several days per week
- ❑ About once a week
- ❑ Less often

Weekends

- ❑ Usually both Saturdays & Sundays
- ❑ Most Saturdays
- ❑ Most Sundays
- ❑ Occasional trip

Please describe your typical travel (when, frequency, reason, destination, etc.)

e.g. Tuesday mornings at 9 o'clock for shopping in Lae

Where do you go? _____

Why do you go?

- ❑ Shops/market stalls: seller
- ❑ Shops/market stalls: buyer
- ❑ Attend church
- ❑ Exercise
- ❑ School
- ❑ Medical reasons
- ❑ Travel to/from work
- ❑ Other, please specify _____
- ❑ Employment related travel
- ❑ Access gardens, hunting or fishing
- ❑ Visiting relatives

How do you get there?

- ❑ PMV
- ❑ Private car
- ❑ Motorbike
- ❑ Walk
- ❑ Boat/canoe
- ❑ Other _____

How long does it take? _____

If PMV, what does it cost? _____

What is the usual traffic condition?

❑ Congested ❑ Busy, but flowing ❑ Clear

Describe traffic conditions further:

e.g. it is OK on Tuesdays at 9 o'clock, but it is very congested at 8 o'clock as you get closer to Lae.

Road safety: How safe do you feel when travelling on the roads?

- ❑ Very safe
- ❑ Mostly safe
- ❑ Neither safe nor unsafe
- ❑ Quite dangerous
- ❑ Very dangerous

O. Marine Resource Use (Wagang Only)

How often & how much time do household members fish/ collect other seafood resources?

	Fin fish	*Invertebrates*
How often?	❑ Daily ❑ Several times per week ❑ Weekly ❑ Monthly	❑ Daily ❑ Several times per week ❑ Weekly ❑ Monthly
How many hours per trip?		
Who does the fishing? (*add detail if necessary*)	❑ Always men ❑ Mostly men ❑ Men and women equally ❑ Mostly women ❑ Always women	❑ Always men ❑ Mostly men ❑ Men and women equally ❑ Mostly women ❑ Always women

What locations does the household usually target for fishing/ seafood collection?

** Please mark areas on map/ aerial photo.*

Location	*Types of catch targeted (e.g. mud crab, snapper)*
❑ Beach	
❑ Mangroves	
❑ River/ creeks	
❑ Reef areas	
❑ Open sea	

Type of boats owned

Type	*How many?*	*Condition*	*Length (ft/ m)*	*Outboard horsepower*
Canoe paddle		❑ Very good ❑ Fair ❑ Poor ❑ Unserviceable		n/a
Canoe sail		❑ Very good ❑ Fair ❑ Poor ❑ Unserviceable		n/a
Canoe + motor		❑ Very good ❑ Fair ❑ Poor ❑ Unserviceable		
Fibreglass dinghy + motor		❑ Very good ❑ Fair ❑ Poor ❑ Unserviceable		
Aluminium dinghy + motor		❑ Very good ❑ Fair ❑ Poor ❑ Unserviceable		

Type of fishing gear mainly used within household?

- ❑ Gill net
- ❑ Circle net
- ❑ Hand line
- ❑ Trolling line
- ❑ Spear gun

In last 10 years, have you noticed changes in the number of fish caught?

- ❑ More now than before
- ❑ About the same
- ❑ Less now than before
- ❑ Much less now than before

Seafood consumption: during an average/ normal week, how many days do you prepare fresh fish, other seafood or canned fish for your family?

	# days per week						
	7	6	5	4	3	2	1
Fresh fish							
Other seafood							
Canned fish							

How much fish do you cook <u>per day</u>?

Type	**Size**	**How many?**
Finfish		
	S / M / L	
	S / M / L	
	S / M / L	
	S / M / L	
	S / M / L	
Other seafood		
	S / M / L	
	S / M / L	
	S / M / L	
	S / M / L	
	S / M / L	

On a days when you use canned fish, how many cans would you use for the household?

Size	*# per day*
Small can	
Medium can	
Large can	

Where do you get your <u>fresh fish</u> from?
1 = most common source, 3 = least common source.

Caught by household member	
Given by someone else (no payment)	
Purchased from _____	

How much do you pay for fresh fish?

Type	*Large*	*Medium*	*Small*
	_____kina		

Where do you get your <u>other seafood</u> from?
1 = most common source, 3 = least common source.

Caught by household member	
Given by someone else (no payment)	
Purchased from _____	

How much do you pay for other seafood?

Type	*Amount (e.g. kilos)*	*Cost*
		_____kina

P. Conclusion

Thank you!

Any additional comments:

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Appendix 5

2017 Traffic Survey Instrument

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Road: _____Malahang_____ Location: _____
Day/Date: Surveyor Name: Lane Direction: ❑ To Malahang ❑ **From Malahang**

Time Start	Time End		Car	Total	Light vehicle	Total	PMV (bus or truck)	Total	Rigid truck	Total	Prime mover & trailer	Total	Heavy machinery	Total	Bicycle	Total	Motorbike	Total	Emergency Vehicle	Total	Pedestrian	Total	Other	Total
6:30	7:30																							
7:30	8:30																							
8:30	9:30																							
9:30	10:30																							
10:30	11:30																							
11:30	12:30																							
12:30	13:30																							
13:30	14:30																							
14:30	15:30																							
15:30	16:30																							
16:30	17:30																							

Road: __Malahang_____ Location: ___ _____
Day/Date: Surveyor Name: Lane Direction: ❑ **To Malahang** ❑ From Malahang

Time Start	Time End		Car	Total	Light vehicle	Total	PMV (bus or truck)	Total	Rigid truck	Total	Prime mover & trailer	Total	Heavy machinery	Total	Bicycle	Total	Motorbike	Total	Emergency Vehicle	Total	Pedestrian	Total	Other	Total
6:30	7:30																							
7:30	8:30																							
8:30	9:30																							
9:30	10:30																							
10:30	11:30																							
11:30	12:30																							
12:30	13:30																							
13:30	14:30																							
14:30	15:30																							
15:30	16:30																							
16:30	17:30																							

Both directions

Time Start	Time End		Car	Total	Light vehicle	Total	PMV (bus or truck)	Total	Rigid truck	Total	Prime mover & trailer	Total	Heavy machinery	Total	Bicycle	Total	Motorbike	Total	Emergency Vehicle	Total	Pedestrian	Total	Other	Total
6:30	7:30			0		0		0		0		0		0		0		0		0		0		0
7:30	8:30			0		0		0		0		0		0		0		0		0		0		0
8:30	9:30			0		0		0		0		0		0		0		0		0		0		0
9:30	10:30			0		0		0		0		0		0		0		0		0		0		0
10:30	11:30			0		0		0		0		0		0		0		0		0		0		0
11:30	12:30			0		0		0		0		0		0		0		0		0		0		0
12:30	13:30			0		0		0		0		0		0		0		0		0		0		0
13:30	14:30			0		0		0		0		0		0		0		0		0		0		0
14:30	15:30			0		0		0		0		0		0		0		0		0		0		0
15:30	16:30			0		0		0		0		0		0		0		0		0		0		0
16:30	17:30			0		0		0		0		0		0		0		0		0		0		0

Pedestrian Traffic Questionnaire

Section A: Interview details

Place of interview _____

Date _____ Time _____

Interviewer 1 _____

Section B: Respondent details

Do you agree to participate in this survey? ❑ Yes ❑ No

Name _____

Age _____ Gender ❑ Male ❑ Female

Place of residence _____

Section C: Main interview

C1 What is your destination? _____

C2 What is the main purpose of your trip? (<u>select one only</u>)

❑ Shops/market stalls as seller
❑ School
❑ Employment related travel
❑ Shops/market stalls as buyer
❑ Medical reasons
❑ Access gardens, hunting or fishing grounds
❑ Attend church
❑ Travel to/from work
❑ Visiting relatives
❑ Exercise
❑ Other, please specify _____

C3 How many times do you travel on this road?

❑ Less than once a week
❑ Once a week
❑ 2-3 trips per week
❑ 4-6 trips per week
❑ Daily

C4 Do you feel safe when travelling on the road?

❑ Yes ❑ No

C4-1 If no, why do you feel unsafe?

_____

_____

C5 Identify any goods being carries (if any)

_____

_____

Traffic and Transport Questionnaire

Section A: Interview details

Place of interview _____

Date _____ Time _____

Interviewer 1 _____

Interviewer 2 _____

Section B: Respondent details

Do you agree to participate in this survey? ❑ Yes ❑ No

First Name _____

Surname _____

Age _____ Gender ❑ Male ❑ Female

Place of residence _____

Section C: Main interview

Road Use

C1 How do you usually travel on the Highlands Highway? (<u>select 1 response only</u>)

❑ Walk ❑ Car ❑ Light Vehicle

❑ PMV ❑ Other bus ❑ Motorbike

❑ Bicycle ❑ Other, please specify _____

C2 How many times do you travel on this road?

❑ Less than once per week ❑ Once per week ❑ 2-3 trips per week

❑ 4-6 trips per week ❑ Daily ❑ More than once daily

C3 What was the main purpose of the trip/s you made in the last week? (<u>select all applicable</u>)

❑ Shops/market stalls as seller ❑ School ❑ Employment related travel

❑ Shops/market stalls as buyer ❑ Medical reasons ❑ Access gardens, hunting or fishing grounds

❑ Attend church ❑ Travel to/from work ❑ Visiting relatives

❑ Exercise ❑ Other, please specify _____

C4 What days of the week are busiest on the road (<u>select all applicable</u>)

❑ Monday ❑ Tuesday ❑ Wednesday ❑ Thursday
❑ Friday ❑ Saturday ❑ Sunday

C5 Do you know why these days are busier? (<u>select all applicable</u>)

❑ Market days ❑ Religious/ church activities ❑ Employment related travel
❑ School days ❑ Medical reasons ❑ Village meetings/ activities
❑ Other, please specify _____

C6 What do you think about the road?

Positives

_____
_____
_____
_____

Negatives

_____
_____
_____
_____

C7 Is there a PMV service operating that is accessible to you?

❑ Yes ❑ No

C7-1 If yes, do you use this service?

❑ Yes ❑ No

C7-2 If no, why not?

_____
_____

C7-3 Cost of travel to Lae? _____

C8 How do you feel about walking/ travelling on the road?

_____
_____
_____
_____

Appendix 6

Field report for land and water utilisation study (Babuaf villages), 2015

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Land and Water Utilisation- Babuaf

1. Introduction

A three person team from Coffey Environments, accompanied by two Wafi Project Community Affairs personnel, visited the following Wafi project villages over four consecutive days:

Wori: Tuesday 23rd June

Madzim: Wednesday 24th June

Wongkins: Thursday 25th June

Ziriruk: Friday 26th June.

The team comprised Team Leader Pat Vidler (Coffey Environments, Brisbane), Ora Gairo and Merilyn Gairo (Coffey casual contractors, Port Moresby), Cesley Aiong (Community Affairs logistic support officer), and Jerry Mugu (Babuaf Village Liaison Officer)

2. Purpose

The purpose of the consultation was:

To gather further qualitative information on terrestrial and aquatic resource use by Babuaf villagers in order to assess potential impacts from development of a Tailings Storage Facility (TSF) on the Watut floodplain.

3. Method

In developing the method for execution of the consultation the following points were considered:

a) A review of previous village household surveys, completed between 2011 and 2014, gave broad indications of resource use, though with limited insight into geographic areas utilised for different purposes

b) Limited time in villages (1 day each) precluded key informant and household interviews supplemented by GPS delineation of resource areas

Consequently, as resource use in PNG is often a collaborative effort by community members, the team opted to implement an exercise in *community resource mapping* by facilitated men's and women's focus groups. The steps in this exercise included:

1. The preparation of large scale maps of the project area on butchers paper with key geographic features marked (but NOT the location of the TSF, as this may have unduly influenced group responses)
2. The provision of a variety of illustration materials (coloured pens, stickers, postit notes etc) to enable different resource use to be marked on the maps by the participants themselves
3. On entry to the village, holding a combined meeting of villagers to introduce the team, explain the purpose of the exercise, describe the broad approach to resource mapping, and to answer any queries about the exercise
4. Separation into a men's focus group (facilitated by Ora Gairo and Jerry Mugu) and a women's focus group (facilitated by Merilyn Gairo and Cesley Aiong) to undertake the resource mapping exercise. Pat Vidler moved back and forth across groups to lend support if required, and undertook one-on-one conversations with community members in regard to the exercise or any project issues raised for discussion

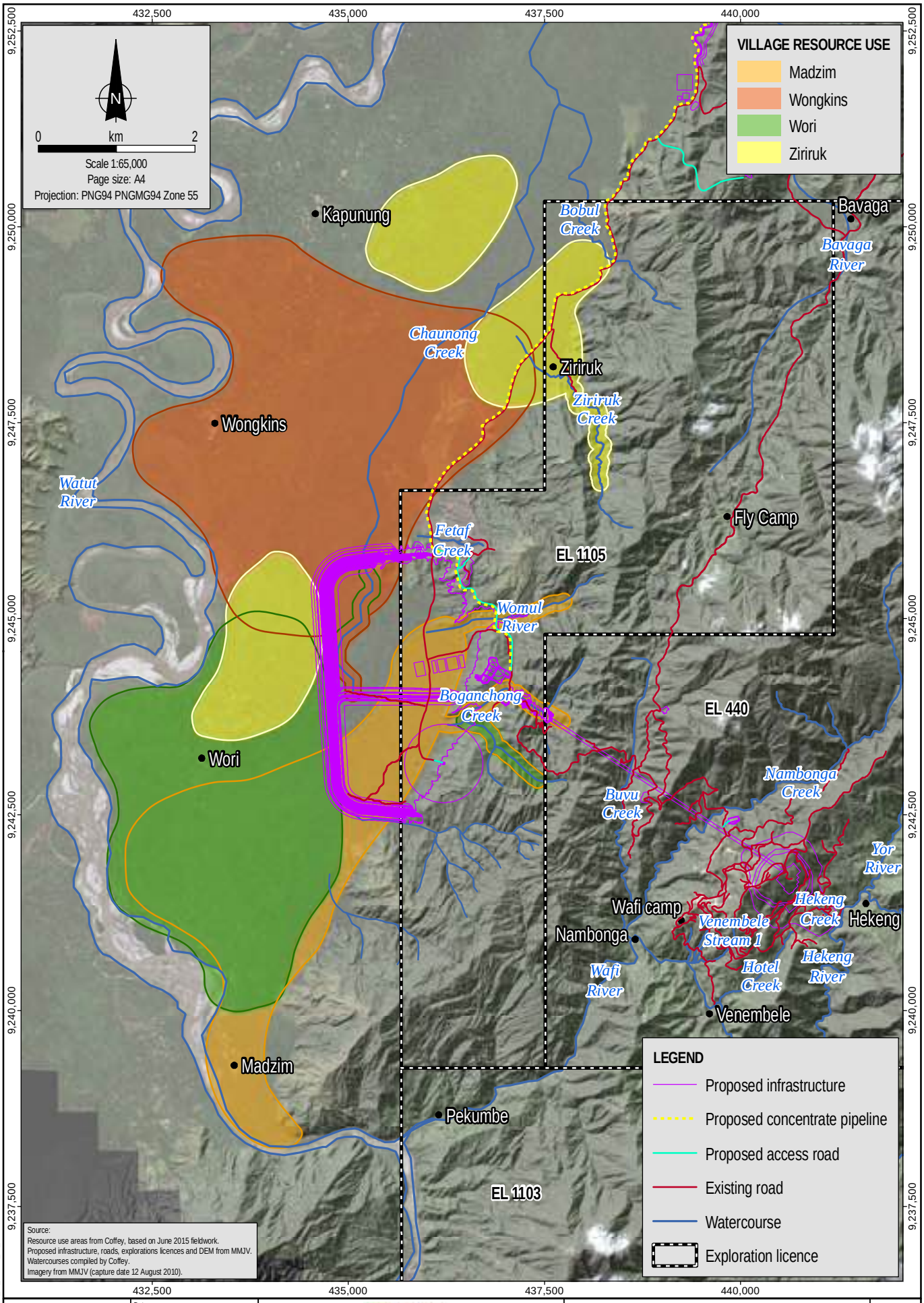
5. Re-convening as one group following the mapping exercise to answer further questions or discuss issues that may have arisen during the course of the mapping exercise
6. Concluding the visit by thanking the community for their participation and sharing food prepared for the team
7. Post-visit assessment of men's and women's resource maps, and recording of issues and comments derived from the facilitated group meetings.

4. Summary findings

Individual village assessments are appended to this memorandum. In summary, these assessments indicate:

- Active use of the floodplain east of the Watut River into the foothills for livelihood activities (food gardens, growing cocoa trees, hunting small animals, accessing household water supplies, fishing in streams, harvesting forests for timber and other products).
- Hunting of larger animals (such as pigs) by floodplain residents (mainly men) occurs for about one to two kilometres into the hills to the east of the floodplain.
- Alluvial gold workings can occur at any location on the Watut River downstream from Madzim.
- Resource use by women generally occurs closer to villages, typically within a radius of one to two kilometres, however resources are accessed along some creeks which are further afield and which drain from the hills westward into the floodplain (such as Ziriruk Creek, Womul River and Boganchong Creek).
- Chaunong Creek and its associated riparian habitat appears to be an important resource use area for its entire length up to the confluence with Babul Creek.
- Resource use by men occurs over a larger area, particularly on the Watut River and in connection with hunting in the hills.
- There does not appear to be any demarcation of use areas by village residence status, with extensive overlap between Wori and Madzim Village, and between Ziriruk and Wori and Wongkins Villages. The hunting area in the hills and alluvial gold areas along the Watut appear to be available to all Babuaf people.
- The TSF area is used, though not for intensive gardening, by Madzim, Wori and Wongkins residents, particularly for hunting and gathering of forest products (including timber), and for fishing in the Chaunong Creek section.
- There was no clear expression at this stage of support for or against the siting of the TSF on the floodplain, probably because there is no appreciation of the exact location of the facility, or of the process for construction and operation of the facility. Ziriruk representatives expressed support for locating the TSF in the proposed location, while a representative from Wongkins said there would be no problem if the TSF was in the area east of a mark that had already been agreed between the villagers and MMJV, though it was not possible to explore this further.
- There is a strong preference not to be re-located should the TSF proceed, and there is an evident need for further structured consultation around the current investigations, and approach to the construction, staged development, use and operational management and closure/decommissioning of the facility if acceptance of the option is to gain broad support.
- There are concerns and the requirement for information to be provided on dam structural integrity (will the wall withstand a major earthquake?); how it can be sealed to prevent seepage of toxic material into the surrounding environment (and how it can be repaired if it leaks at some time post construction); and how it will be operated (to manage/ensure spillway discharges are not harmful to the environment).
- Associated with these concerns are the potential effects of the structure on the floodplain hydrology (flood depth, duration of inundation, flow velocity and associated potential for erosion etc) as this is a major influence on local livelihoods.

An indication of the floodplain areas used by residents of villages is shown in Figure 1.



coffey	Date: 22.09.2015 Project: ENAUBRIS09436AA File Name: 9436_01_F04.09_GIS	Wafi-Golpu Socio-economic Baseline	Babuaf village resource use areas	Figure No: 1

MXD Reference: 9436_01_GIS004_v0_3

WORI VILLAGE – 23/06/2015

Table 1 Attendance List Wori Village

	Men	Women
1	Barang Gamet	Lebu Parats
2	John Gamet	Yatu Charles
3	Joram Isaiah	Maria Ezera
4	Charles Barang	Rebecca Bingmalu
5	Rafef Muku	Etau Moaiyap
6	Ezera Yawising	Geyam Raref
7	Maiyaf Yatap	Geyam Raref
8	Yatap Nuk	Ruth Yawising
9	Israel Yawising	Priscilla Jephtha
10		Orofo Yalambing
11		Nancy Alphonse
12		Irene Yawising

Table 2 Description of men's and women's resource use - Wori Village

Women's resource use
• Southern tributary of Boganchong Creek indicated as important for gardening/fishing and sourcing fresh water by women, as well as hunting small animals and wildfowl eggs during trips to the area • Headwaters of Chaunong Creek are important for fishing and sourcing fresh water • The internal TSF area and hills to the immediate east noted for gathering forest products (medicinal plants, sago thatch, building timber, bush rope etc) • The Watut River south-west and north-west of Wori is used for alluvial mining and fishing • Land within a 1-2 km radius of the village is used for food gardens, firewood and water collection • The area 2-3 km east of the village (including land within the TAS area) is used for hunting small animals
Men's resource use
• Intensive use of the floodplain from Madzim area to 3km north of Wori (gardens, cocoa, trees) • Alluvial mining along Watut River to about 3km north of Wori • Hunting in the hill area 2km from madzim through to about 3km north of Wori, then between Chaunong Creek and the hills to the east • Fishing occurs in the Boganchong, Wadgink and Wassing Creeks, plus an area north of the village • Within the TSF area, resource use mainly centres on timber gathering and fishing, with some gardening and groeing of cocoa • Tumbuna sites are mainly in the forested hill area to the east of the TSF • The group indicated that they had access to land in the area to the west of the Watut River, opposite Madzim, however indicated no desire to be re-located.

Table 3 Comments made during focus group session - Wori Village

Men	Women
They have land access rights opposite Madzim, either through traditional ties, family lineages, their own land, or just rights over land through hunting and fishing boundaries. The following locations are options for land access and use for the Wori population: • From Magarina to Gurumpu/Bobul (all opposite Madzim), • From Waim to Seberam (Waim shares borders with Omara, Bupu, Tongola and Sebaram shares its borders with Pu) They were able to identify sacred sites, and identify plants for food such as tulip, bilum making and medicinal plants (herbs).	• They have no other areas to do gardening. Gardening at the proposed TSF site is tended 3 times per week. They also collect drinking water and fishing when they are out gardening. • Very good fertile soil at the mountain area • Income comes from gold panning • Income comes from cash crops such as cocoa and buai • They were concerned that they may be relocated when the TSF is constructed

Plate 1 Women's resource map – Wori Village

Plate 2 Men's resource map – Wori Village

Plate 3 Men's focus group session – Wori Village

MADZIM VILLAGE – 24/06/2015

Table 4 Attendance List Madzim Village

	Men	Women
1	Joram Isaiah	Lakele Joram
2	Jemen Joshua	Catherine Joseph
3	Shield Samuel	Annie John
4	Jobwanof Gabriel	Roselyne Jobby
5	Joram Goff	Rebecca John
6	Rogger Wadim	Leah Nas
7	Yohan Goff	Gabiyam Kelly
8	Nash 2 Bingmalu	Susan Jemen
9	Anno Karok	Julie John
10	John Tatip	Anna Paul
11	Jerry Joram 1	Lina Moses
12	Simmie Joram 1	Tangawanu Jemen
13	John Joram 1	Josephine Etsorap
14	Kitum Toro	Samariti Nas
15	Nason Toro	Dianna Israel
16	Ronald Joram	Cathy Simi
17	Malae 1 Bingmalu	Susan Peter
18	Jeffry Malae	Mirriam Joram
19	Jimmie Daniel	Mirriam Aran
20	Gennie Toro	Menang Sil
21	Ontang Nash 1	Gari Roger
22	Yateng Nash 1	Linda Jimmy
23	Nash Bailamun	Gina Geni
24	Malae 2 Joseph	Penan Daniel
25	Ezolap Bailamun	Susan Roland
26	Joshua Benjamin	
27	Chris Nash 2	
28	Uthin Nenkie	
29	John Kisah	
30	Thomas Fredah	
31	Lowren Andrew	

Table 4 Attendance List Madzim Village (cont'd)

	Men	Women
32	Taikika Kalep	
33	Paul Daniel	
34	Samuel Anno	
35.	Malakae Yanah	

Table 5 Description of men's and women's resource use – Madzim Village

Women's resource use
• Generally use an area from the confluence of the Wafi and Watut Rivers to approximately 3km north of Madzim • No indicated use of the area inside the TSF, but use of land up to the southern boundary of the TSF which could be affected by drainage around the TSF • Fishing in the Watut River to the west of Madzim, and also in Normang and Mari lake • Sacred sites indicated in the foothills north to Wassing Creek and also at Mari Lake • Expressed a belief that the area they use will be impacted bythe TSF • Any land access to the west of the Watut River will put them into conflict with residents of Mararina Village
Men's resource use
• Significant hunting, and limited timber gathering, carried out in the forest in the mountains bounded by the Wafi River, Buvu Creek, Womul River • Intensive use of the floodplain (gardens, cocoa, timber and kunai for housing) from where the Watut River emerges from the mountains up to about Wori Village • The TSF area used for gardens and timber with some hunting • Womul River and Boganchong Creek indicated as important for fishing • Indicated potential for land access opposite Madzim to the west of the Watut River, but highlighted difficulties as well as a reluctance to re-locate, believing land and gardens would just be appropriated and occupied by in-migrants

Table 6 Comments made during focus group session – Madzim Village

Men	Women
The Madzim have land access rights opposite their village on the other side of Watut river. They stated that the Mararina's were settled in after the first missionaries came in and so they can have that as an option to move freely for hunting, fishing, and gathering food and building materials. It may pose as a problem to do gardening in the land defined (refer to the butcher paper for names of the locations). They may not negotiate with Mararina's for any future resettlement there.	• Gardening at the valley closer to the proposed TSF site is done twice a week since it is a long walk away. During the week, they get produce from nearby gardens for consumption. • Jetzang Creek is the source of the water piped to the village. Other creeks highlighted in the map are for drinking during gardening only. • All building material for the house includes posts, bamboo and palm tree for the flooring is represented by the red dot on the map.

Table 6 Comments made during focus group session – Madzim Village (cont'd)

Men	Women
They want to remain in Madzim as they don't want illegal settlers or outsider's coming in their village and land area if the mine is developed so they would rather remain where they are currently. They were able to identify cultural heritage sites (ples tumbuna) and also named them. They even mentioned old village sites one of which is right where the current Wafi mine camp is located.	• The women believed that all their sites as indicated in the map will be affected when the TSF is constructed. • They have nowhere else to go if the environment is damaged. • They have land on the other side of the river but this has been claimed by the Mararina.

Plate 4 Women's focus group session – Madzim Village

Plate 5 Men's focus group session – Madzim Village

Plate 6 Women's resource map – Madzim Village

Plate 7 Men's resource map – Madzim Village

WONGKINS VILLAGE – 25/06/2015

Table 7 Attendance List – Wongkins Village

	Men	Women
1	Pastor	Leah Kalep
2	Kalep Saking	Neo Paul
3	Jack Leuleu	Sara Yagiding
4	Maiayeki Nengki	Usi Agus
5	Iuwatu Ponijo	Febe Ben
6	Uzin Eforon	Martina Taikika
7	Suwina Yakam	Inam Guwatu
8	Yagiding Apolo	Kamfe Samuel
9	Ben Dawa	Monica Ben
10	Agus Martin	Amos Eferon
11	Ila Barang	Anna Agus
12	Simon Zubaulo	Including 9 young girls below 15
13	Eforon Apolo	
14	Seth Samuel	
15	Jerot Apolo	
16	Nelson Apolo	
17	Yagiding Agus	
18	Saking Martin	
19	Bailamon Boaras	
20	Liwai Paul	
21	Nganining Taikika	
22	Yawising Samuel	
23	Ngayang Seth	

Table 8 Description of men's and women's resource use – Wongkins Village

Women's resource use
• Generally use an area south-east of the village within a 2km radius and west of Chaunong Creek, and in an area between the village and the Watut River. • Fishing occurs in the Watut River and the upper section of Chaunong Creek • There a number of sacred sites to the east of the village bordering the foothills area • Hunting area is predominately to the south-east of the village • Indicated use of a small area in the north-west corner of the TSF area • Use the Watut River along a 2-3km length west of the village, though no indication of engagement in alluvial gold mining

Table 8 Description of men's and women's resource use – Wongkins Village (cont'd)

Men's resource use
• Extensive garden usage of area from about 1.5km north of Wori north to Kapumum, generally to the west of Chaunong Creek, with significant planting of cocoa trees • Use Chaunong Creek for fishing from source up to a point about 1km north of Ziriruk • Use the Watut River for fishing and alluvial gold mining from Madzim to Uruf • Hunt from a point about 2km east of the village to a point 2km into the hills, along a 6km front • Indication of use of the northern half of the TSF area for hunting and fishing, with minor garden use.

Table 9 Comments made during focus group session – Wongkins Village

Men	Women
Pastor's comments: • He wanted to know the level of damages from the mine's impact on the locals, • He compared the HV damages in terms of water quality and land destruction, • He wanted a tailings dam with other smaller ones after to reduce the acidity of the waste if it goes into the local water streams, • He asked if the company had plans to restore, reclaim land areas damaged for use by future generations, • He wanted the mine to have chaplains for workers to share the gospel with them, Water Supply: was discussed with the youths who mentioned they stopped using the Watut in 2011 after water became polluted. All places where there are gardens, they have planted cocoa and coconut trees. Names of Old Villages: Key on Chart shows 01-04, 01 – Mari 02 – Mogiafas 03 – Fere 04 – Boasasono There are cultural heritage sites but were not named on the chart. **Land access sites:** They (men) commented that they had nowhere else to go apart from their current location. If we are to move or be relocated, we want a place just like our current home which should be accessible to garden land, hunting, fishing, and seed and plant gathering areas (medicinal and for fishing). The company must replace what we will loose from our current site onto the new place of resettlement. We will not move out of here unless required by the company.	• Days for assisting in cleaning up in the school and so forth is done on Tuesdays • They have women's meeting including village clean ups for their Women's Fellowship (Mama Geyamsao) on Wednesdays • Currently they have Adult Literacy classes on Mondays, Wednesdays and Fridays • Gardening and Fishing is done after the activities listed above and normally done at the same time. • They have nowhere to move to in order to sustain themselves • The village was flooded in 2013 which destroyed all their gardens and cash crops. After the flood they believe the land is more nutritious to plant food. • One woman raised a comment that they are concerned more about their bush, river and resources for their children's sake. Our basic needs should be met by the company before actually constructing the dam (TSF), said one of the women.

Plate 8 Men's resource map – Wongkins Village

Plate 9 Women's resource map – Wongkins Village

ZIRIRUK VILLAGE – 26/06/2015

Table 10 Attendance List – Ziriruk Village

	Men	Women
1	Loben	Swama Ezara
2	Yakam M	Sara Yasang
3	Nuri U	Getu Ezara
4	Brian U	Kiaring Manase
5	Onno Z	Atson Ono
6	Yagas E	Betty Ono
7	Jems E	Giringo Ono
8	Manase E	
9	Jeack K	
10	Takika J	
11	Ezera K	
12	Glanen	
13	Utin K	
14	Gideon E	
15	Francis E	
16	Saom O	
17	Yasang E	
18	Yasiling A	

Table 11 Description of men's and women's resource use – Ziriruk Village

Women's resource use
• Use generally in an area east of Chaunong Creek, and north of the Womul River to Bobul Creek, and within a 2km radius of the village • Fishing is based on Ziriruk Creek which is also used for sourcing drinking water • Indicated a source of clay for making cooking pots near the northern end of the TSF area
Men's resource use
• Cocoa trees in gardens between the village and Kapumum, and in an area between Chaunong Creek and the village • Hunting and gathering of medicinal plants in the hills to the east of the village • An area of coconut and cocoa gardens to the north of Wori, which is remnant from earlier residence at Wori • Indicated extensive fishing in all creeks and rivers, including the Watut River • Limited use of the area within the TSF footprint • Alluvial mining on the Watut River north-east of Wori and to the east of Uruf • Have identified masalai places at the point where the Watut enters the floodplain, in hills in proximity to the northern end of the TSF, and in the floodplain of Bobul Creek.

Table 12 Comments made during focus group session – Ziriruk Village

Men	Women
Houses: There are about 10 houses (with household head, his wife and children) and young men who are now starting to build their houseboys. There used to be a lone family member and his children who lived in Ziriruk prior to be joined by others recently after 2013. Jacob Kwako (family leader) stated that as soon as the young men reached the age of 17 or 18 years of age they were required to live on their own and not be living with their parents. The hamlet population is made up of Wori family members who moved to higher grounds in fear of flooding caused by the Watut River. Kwako mentioned he could not continue to live in the flooded villages every time as it may have future consequences on his children who were younger. The number of houses may increase in the future. **Mobility of Locals** The village people are active gardeners, hunters, fishermen and gatherers who move frequently around to as far as Wori and the Watut river in search for protein and undertaking alluvial mining activities. They hunted and go out fishing a lot or regularly as part of their livelihood. **Land Access** They mentioned that they had no land rights access areas apart from Wori Village (former village), but they could easily move around with some access to the following areas as listed below; Fetef Mogi Gawan Lampok Chaonong (is a lake at the lower plains of Watut used for fishing) The land areas listed can be used as optional sites after the construction of TSF site and related earthworks. They mentioned that the sites above would be used for hunting, fishing, medicinal plants, building materials and gardening. **Garden Sites** All Garden sites have with the Cocoa and Coconut planted around them. The cocoa also provides shade for the food crops to grow in. **Medicinal Plants** Plant trees are used for medicine when they are sick. **Cultural Sites (tumbuna ples and masalai ples)** They also indicated 13 cultural sites and named them all. Some of their Masalai sites were also Old Village Sites or vice versa as stated on the butcher paper. **Cemetery (old and new)** Burial sites were linked with the settlement sites as the dead were more or less buried within their doorsteps/closer in the vicinity of their homes due to fear of sorcery and witchcraft activities that followed straight after burial. This is still practiced today. (refer to Tumbuna ples which may link their cemeteries).	• Garden sites included betelnuts, coconuts and cocoa trees. Gardens are mainly found along the main road and towards the mountain area. • Fishing is done either on Fridays or Saturdays • Bush Fowl eggs is mainly found along the access roads and creeks and are found during gardening • Tulip and wild vegetable are also found in the same area where the gardens are. • Tulip bark is used for making bilums and grass skirts for singsings • Tulip leaves is used as greens • Sago leaves is used for house roofing • Sago fronds as brooms • Sago shoots for making grass skirts • Sago bark for blinds around their houses • Sago grubs for eating or fishing • There are labour sites away from the village as well. Women give birth then come back and reside in a makeshift house built near the village for a month and then move back into the village. • The otsong is a special tree that is used for weaving. They weave bilums, grass skirts, head bands and arm bands from this. • Medicinal plants and vines are used to cure sores, coughing, diarrhoea. • Women normally get the clay for the clay pot from the site and the men get to mould and shape the clay pot. • They believed food cooked in the clay pot tastes better than food cooked in the manufactured pots • They get drinking water from upstream of the Ziriruk creek while they wash downstream. • Bamboo is used for cooking food inside as well as storing water for drinking. • They are concerned that their gardens, labour areas and pottery sites will be disturbed if the TSF was constructed. • They are happy to work with MMJV and see changes that will benefit them.

Plate 10 Women's resource map – Ziriruk Village

Plate 11 Men's resource map – Ziriruk Village

Appendix 7

Traditional plants used within Study Area 1, 2011

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PNG Forest Research Institute, 2011

TRADITIONALLY USEFUL PLANTS AROUND WAFI- GOLPU PROJECT AREA

In PNG, about 97 % of the land is traditionally owned by the local people and they depend very much on the natural environment for their livelihoods. The environment provides food, medicine, construction materials, weapons, materials to practice and support traditional beliefs, hunting and fishing grounds, sacred sites, habitat for wildlife, drinking water sources, etc. Most rural areas are disadvantaged in receiving basic government goods/services, and their only hope is to turn to the natural environment for their immediate needs. The people of Hengembu, Yanta and Babuaf depend on the natural environment for their many needs as evident from the discussions from which an inventory has been derived.

For ethno botany purposes, the plants and trees that were encountered in the plots were collected, sorted out at the field camp and information on the uses were recorded. The local guides gave the plant names in their local language and further provided uses of the plants (Bano language - spoken by the Yanta and Hengembu), Mumeng District, Morobe Province). The enumerated plants from Bavaga natural forest represented 30 families from which 36 species have specific uses. This information is summarized in Table 1 below.

In the Babuaf primary forest, 47 families of 128 species were noted as having various uses by the local people. Specific plant parts that were used and plants that have medicinal uses as well were recorded. For some plants that have no uses, only names were given in the local language spoken at Babuaf (Wafes language, Huon District, Morobe Province). The information for plants encountered with their ethno botanical information is summarized in Table 2.

Table 1. List of traditionally used plants in Bavaga village with local names in Bano language, Mumeng, Morobe.

№	Family	Botanical name	Local name	Medicinal	Housing	Others
1	Agavaceae	*Cordyline terminalis* Kunth	Tambit	√		Leaves for bath, medicinal
2	Anacardiaceae	*Semecarpus* sp.	Welef		√	Leaves for covering animals
3	Anacardiaceae	*Dracontomelon dao* (Blanco) Merr. & Rolfe	Zinam		√	
4	Annonaceae	*Pseudouvaria* sp.	Anilhenil			Fishing trap
5	Annonaceae	*Uvaria* sp.	Anasappa			
6	Apocynaceae	*Alstonia scholaris* (L.) R. Br.	Bunde	√	√	Sap for cough remedy
7	Araceae	*Pothos rumphii* Schott	Kepa			Birds' fruits
8	Arecaceae	*Arenga microcarpa* Becc.	Gumba			Food, singsing, bow & arrow
9	Arecaceae	*Calamus hollrungii* Becc.	Wehi		√	
10	Arecaceae	*Calamus humboldtianus* Becc.	Kuwayin		√	Bow string
11	Aspleniaceae	*Tectaria* sp.	Tandu			
12	Caesalpiniaceae	*Maniltoa lenticelata* C. T. White	Kererel		√	
13	Clusiaceae	*Garcinia latissima* Miq.	Nui		√	
14	Clusiaceae	*Garcinia* sp.	Yena		√	Traditional trap
15	Combretaceae	*Terminalia kaernbachii* Warb.	Nea		√	Fruits edible
16	Datiscaceae	*Octomeles sumatrana* Miq.	Tim		√	Canoe making
17	Dilleniaceae	*Tetracera* cf. *nordtiana* F. Muell.	Zulik	√		Sore treatment
18	Dioscoreaceae	*Dioscorea* sp.	Weyanglu			
19	Dracaenaceae	*Dracaena angustifolia* Roxb.	Tambik			
20	Ebenaceae	*Diospyros lolinopsis* Kosterm.	Kenzubelen		√	
21	Euphorbiaceae	*Pimelodendron amboinicum* Hassk.	Kari		√	
22	Fabaceae	*Pterocarpus indicus* Willd.	Yia		√	
23	Flacourtiaceae	*Homalium foetidum* (Roxb.) Benth	Ba		√	
24	Flagellariaceae	*Flagellaria indica* L.	Kongowa		√	
25	Gesneriaceae	*Boea* sp.	Hanguna			Dogs sensitive (hunting)
26	Gnetaceae	*Gnetum gnemon* L.	Kasiago			Leave edible, fibers for bilums
27	Icacinaceae	*Gonocaryum litorale* (Blume) Sleumer	Wenem		√	

28	Lauraceae	*Cryptocarya* cf. *massoy* (Oken) Kosterm.	Wezuma		√	
29	Leeaceae	*Leea indica* (Burm.f.) Merr.	Gofonge			Clear off spiritual attacks
30	Meliaceae	*Aglaia* sp.	Bin		√	Traditional trap
31	Moraceae	*Ficus copiosa* Steud.	Wewi			Leaves edible
32	Moraceae	*Ficus wassa* Roxb.	Momonde			Leaves edible
33	Moraceae	*Ficus pachystemon* Warb.	Eiwa			
34	Myristicaceae	*Myristica subalulata* Miq.	Welema		√	
35	Myrtaceae	*Syzygium corymbosum* DC.	Drenda		√	Pig trap
36	Piperaceae	*Piper aduncum* L.	Kapin	√		Treat sores/ulcer
37	Rubiaceae	*Pyschotria* sp.	Katunde			
38	Rutaceae	*Lunasia amara* Blanco	Bin			Pig trap
39	Sapindaceae	*Cupaniopsis* sp.	Zee		√	
40	Sapindaceae	*Pometia pinnata* J. R. Forst. & G. Forst.	Longe		√	
41	Sterculiaceae	*Pterocymbium beccarii* K. Schum.	Hemuo		√	
42	Ulmaceae	*Celtis latifolia* Planch.	Wengenda		√	
43	Zingiberaceae	*Alpinia* sp.	Guela welon			

Table 2. List of traditionally used plants in Babuaf village and the local name in Wafes language, Huon district, Morobe.

№	Family	Botanical name	Local name	Medicinal	Housing	Others
1	Acanthaceae	*Hemigraphis reptans* (Forst.) T. Andr. & Hemis.	Boareng			
2	Adiantaceae	*Pteris pacifica* Hieron	Birobiro			
3	Agavaceae	*Cordyline terminalis* Kunth	Bomac	√		Boundary land mark
4	Anacardiaceae	*Mangifera minor* Blume	Iwo	√	√	Snake bite, fruits edible
5	Anacardiaceae	*Dracontomelon dao* (Blanco) Merr. & Rolfe	Anga		√	
6	Anacardiaceae	*Semecarpus* sp.	Konas		√	
7	Anacardiaceae	*Buchanania arborescens* F. Muell.	Guromb		√	
8	Annonaceae	*Polyalthia oblongifolia* C. B. Rob.	Ngamonkac		√	
9	Annonaceae	*Uvaria* sp.	Suofangka	√		Treat ulcer sore
10	Apocynaceae	*Melodinus* sp.	Wao		√	
11	Apocynaceae	*Alstonia scholaris* (L.) R. Br.	Inkomb	√	√	Sap use for cough
12	Apocynaceae	*Cerbera floribunda* K. Schum.	Yanef 3			
13	Araceae	*Rhaphidophora* sp.	Pikung	√		Treat asthma, sore
14	Araceae	*Homalomena* sp.	Galgal			
15	Araceae	*Rhaphidophora* sp.	Fekang			
16	Araceae	*Pothos hellwighii* Engl.	Chefa Chefa			
17	Araceae	*Amorphophallus campanulatus* Blume ex Decne	Bantek			
18	Arecaceae	*Arenga microcarpa* Becc.	Fogumb			Food
19	Arecaceae	*Calamus hollrungii* Becc.	Wumpong		√	
20	Arecaceae	*Licuala* sp.	Zome		√	
21	Arecaceae	*Caryota rumpiana* Mart.	Zunko		√	Food, axe handle,
22	Arecaceae	*Hydriastele costata* F. M. Bailey	Makoru		√	Mat
23	Arecaceae	*Caryota* sp.	Wokarol		√	
24	Arecaceae	*Calamus humboldtianus* Becc.	Poafok		√	Fruits edible
25	Aspleniaceae	*Bolbitis* sp.	Kuangamb			Leaves edible
26	Aspleniaceae	*Asplenium* sp.2	Bosom			Bed leaf
27	Barringtoniaceae	*Planchonia papuana* P. Knuth	Murul 2		√	

28	Blechnaceae	*Stenochlaena palustris* (Burm.) Bedd.	Wogowak			
29	Burseraceae	*Haplolobus floribundus* (K. Schum.) H. J. Lam	Nekak		√	
30	Burseraceae	*Canarium schlechteri* Lauterb.	Nekak		√	
31	Caesalpiniaceae	*Intsia bijuga* Kuntze	Gef		√	
32	Caesalpiniaceae	*Maniltoa psilogyne* Harms	Sensen		√	
33	Caesalpiniaceae	*Maniltoa lenticelata* C. T. White	Kamel			
34	Caesalpiniaceae	*Kingiodendron novoguineensis* Veldk.	Kocha		√	
35	Clusiaceae	*Garcinia hollrungii* Lauterb.	Mafan		√	
36	Clusiaceae	*Garcinia latissima* Miq.	Ngamang		√	
37	Clusiaceae	*Garcinia* sp.	Pos		√	
38	Combretaceae	*Terminalia complanata* K. Schum.	Yanet		√	
39	Combretaceae	*Terminalia kaernbachii* Warb.	Ngalonka		√	Fruits edible
40	Convolvulaceae	*Merremia peltata* (L.) Merr.	Kafek	√		Treat cough
41	Cycadaceae	*Cycas scratchleyana* F. Muell.	Totom	√		Treat ulcer
42	Cyperaceae	*Scleria littosperma* Sw.	Pepes			
43	Datiscaceae	*Octomeles sumatrana* Miq.	Resok		√	Canoe
44	Davalliaceae	*Nephrolepis* sp.	Sesel	√		Treat stomach ache
45	Davalliaceae	*Nephrolepis* cf. *biserrata* (Sw.) Schott	Marapanok	√		Stop stomach ache
46	Dennstaedtiaceae	*Dennstaedtia* sp.	Gangtepel 2			
47	Elaeocarpaceae	*Elaeocarpus amplifolius* Schltr.	Yanef 2		√	
48	Elaeocarpaceae	*Elaeocarpus sphaericus* K. Schum.	Damban ngag.		√	
49	Euphorbiaceae	*Bischofia javanica* Blume	Murul	√	√	Healthy living
50	Euphorbiaceae	*Pimelodendron amboinicum* Hassk.	Momon	√	√	Treat malaria
51	Euphorbiaceae	*Endospermum medullosum* L. S. Sm.	Bongpong			
52	Euphorbiaceae	*Macaranga* sp.	Imuf		√	
53	Euphorbiaceae	*Melanolepis multiglandulosa* Rch. & Zoll.	Zikipa	√		Snake bite, sore
54	Euphorbiaceae	*Breynia cernua* (Poir.) Airy Shaw	Kotagal			
55	Euphorbiaceae	*Macaranga aleuritoides* F. Muell.	Yemuf		√	
56	Euphorbiaceae	*Acalypha* cf. *insulana* Mull. Arg.	Bimpu			
57	Euphorbiaceae	*Mallotus philippensis* (Lam.) Mull. Arg.	Gangtot		√	
58	Fabaceae	*Derris* sp.	Kiluk			

59	Fabaceae	*Canavalia* sp.	Kepik			
60	Fabaceae	*Derris* sp.	Wasec songa			
61	Flacourtiaceae	*Ryparosa javanica* Koord. & Valeton	Sungkof		√	
62	Flacourtiaceae	*Casearia* sp.	Pas			
63	Flacourtiaceae	*Pangium edule* Reinw.	Sokeng	√		Treat sore, fruits edible
64	Flacourtiaceae	*Casearia* sp.	Sekang			
65	Flacourtiaceae	*Homalium foetidum* (Roxb.) Benth	Fek		√	
66	Flagellariaceae	*Flagellaria indica* L.	Moangkeng		√	
67	Gnetaceae	*Gnetum gnemon* L.	Iko		√	Leaves edible, bilums
68	Gnetaceae	*Gnetum costatum* K. Schum.	Inko			Leaves edible
69	Gnetaceae	*Gnetum latifolia* Blume	Bunumpin			Make fishing net
70	Heliconiaceae	*Heliconia* sp.	Wapep			Covering up food
71	Icacinaceae	*Gonocaryum litorale* (Blume) Sleumer	Woksasape			Bilum string
72	Icacinaceae	*Rhyticaryum longirostris* (K. Schum.) Lauterb.	Mungkuf			
73	Icacinaceae	*Medusanthera laxiflora* (Miers) R. A. Howard	Galam			
74	Lamiaceae	*Premna obtusifolia* R. Br.	Konkak			
75	Lamiaceae	*Callicarpa pentandra* Roxb.	Mumpu bimpu		√	
76	Lamiaceae	*Vitex quinata* Druce	Pas		√	
77	Lamiaceae	*Gmelina moluccana* Backer ex K. Heyne	Sinpumb		√	
78	Lauraceae	*Endiandra* cf. *leptodendron* B. Hyland	Gakidint		√	
79	Lauraceae	*Cryptocarya multinervis* Teschn.	Sankaf		√	
80	Lauraceae	*Cryptocarya* cf. *massoy* (Oken) Kosterm.	KopuZ		√	
81	Lauraceae	*Listea timoriana* Span.	Mang		√	
82	Lauraceae	*Litsea guppyi* (F. Muell.) Foreman	Sampo		√	
83	Leeaceae	*Leea indica* (Burm.f.) Merr.	Pakap			Chases spirits away
84	Loganiaceae	*Fagraea racemosa* Jack ex Wall.	Kopang		√	
86	Marantaceae	*Phrynium macrophyllum* Baker	Nambongpuk			Covering animals
87	Marantaceae	*Phrynium* sp.	Gongtupok			
88	Marantaceae	*Donax cannaeformis (*G. Forst.) K. Schum.	Zumb			Leaf for sago making
89	Meliaceae	*Dysoxylum arborescens* (Blume) Miq.	Ngaziang regi		√	
90	Meliaceae	*Aglaia* sp.	Gabuarel		√	

91	Meliaceae	*Chisocheton lasiocarpus* (Miq.) Valeton	Tintif			
92	Meliaceae	*Dysoxylum macranthum* C. DC.	Ngaziang		√	
93	Meliaceae	*Aphanamixis polystachya* (Wall.) R. N. Parker	Sorumbia		√	
94	Melicaceae	*Chisocheton* sp.	Ezins		√	
95	Menispermaceae	*Tinospora* sp.	Wokpos			
96	Moraceae	*Ficus* sp.1	Ozo			Birds' fruit tree
97	Moraceae	*Artocarpus* sp.	Boangke			Make dog sensitive
98	Moraceae	*Ficus nodosa* Teijsm. & Binn.	Kondunk	√		Treat sore
99	Moraceae	*Antiaris toxicaria* Lesch.	Lefzi			Tapa clothe
100	Moraceae	*Ficus pachystemon* Warb.	Siriruk			
101	Moraceae	*Ficus* sp.2	Donkomb			
102	Moraceae	*Artocarpus sepicanus* Diels	Zenemb		√	Canoe
103	Moraceae	*Maclura sp.*	Telicfaga			
104	Moraceae	*Ficus wassa* Roxb.	Mugu			Leaves edible
105	Moraceae	*Ficus* sp.3	Wokmuku			
106	Moraceae	*Ficus gul* K. Schum. & Lauterb.	Mugu			
107	Moraceae	*Ficus* sp.4 *(climber)*	Bunungping			
108	Moraceae	*Ficus mollior* Benth.	Numpu			
109	Moraceae	*Ficus variegata* Blume	Kondunt			
110	Musaceae	*Musa* sp.	Ponz			
111	Myristicaceae	*Horsfieldia irya* Warb.	Zerel	√	√	Bark for sore
112	Myristicaceae	*Horsfieldia spicata* (Roxb.) J. Sinclair	Mosangkang		√	
113	Myristicaceae	*Myristica globosa* Warb.	Zerel	√	√	Healthy living
114	Myristicaceae	*Horsfieldia subtilis* (Miq.) Warb.	Zerel			
115	Myristicaceae	*Myristica buchneriana* Warb.	Zerel	√	√	Treat new cut sore
116	Myristicaceae	*Myristica* sp.	Zerel		√	
117	Myrsinaceae	*Conandrium polyanthum* (Lauterb. & K. Schum.) Mez.	Kopo		√	Make dog sensitive
118	Myrtaceae	*Syzygium corymbosum* DC.	Ozo		√	
119	Myrtaceae	*Decaspermum* sp.	Minul		√	
120	Myrtaceae	*Syzygium* sp.1	Bomac	√	√	
121	Myrtaceae	*Syzygium* sp.2	Ngasemsem		√	

122	Myrtaceae	*Syzygium malaccense* (L.) Merr. & L. M. Perry	Bomac			
123	Nctaginaceae	*Pisonia longirostris* Teysm. & Binn.	Kik			
125	Pandanaceae	*Pandanus* sp.1	Sinz			Killing bandicoot, mat
126	Pandanaceae	*Pandanus* sp. *2*	Namben		√	Bed leaf
127	Phormiaceae	*Dianella ensifolia (*L.) DC.	Kenob	√		Healthy living
128	Piperaceae	*Piper aduncum* L.	Pakapel	√		Treat sore
129	Piperaceae	*Piper* sp.	Banang	√		Treat ulcer sore
130	Poaceae	*Imperata cylindrica (*L.) P. Beauv.	Asa		√	
131	Poaceae	*Coelorachis rottboellioides* (R. Br.) A. Camus	Ponenge			
132	Poaceae	*Themeda* sp.	Ngul			
133	Poaceae	*Leptapsis banksii* R. Br.	Bibo			
134	Poaceae	*Leptapsis urceolata* (Roxb.) R. Br.	Kiomagots			
135	Polypodiaceae	*Microsorum rampans* (Baker) Parris	Wokowak			
136	Pteridaceae	*Pteris ensiformis* Burm.f.	Marek marek			
137	Ranunculaceae	*Clematis* sp.	Mingung	√		For cough remedy
138	Rhizophoraceae	*Carallia brachiata* (Lour.) Merr.	Damban nga.		√	
139	Rosaceae	*Prunus schlechteri* (Koehne) Kalkman	Waras		√	
140	Rubiaceae	*Uncaria* sp.	Kamel	√		Treat cough
141	Rubiaceae	*Pyschotria* sp.	Kip			
142	Rubiaceae	*Timonius timon* (Spreng.) Merr.	Guaru		√	
143	Rubiaceae	*Ophiorrhiza* sp.	Zingenzing			
144	Rutaceae	*Flindersia pimenteliana* F. Muell.	Seges		√	
145	Rutaceae	*Euodia* sp.	Bensen		√	
146	Sapindaceae	*Pometia pinnata* J. R. Forst. & G. Forst.	Sung		√	Fuelwood
147	Sapindaceae	*Cupaniopsis* sp.	Siasia		√	
148	Sapindaceae	*Tristiropsis acutangula* Radlk.	Ngaziang		√	
149	Sapindaceae	*Ganophyllum falcatum* Blume	Ngaziang regi		√	
150	Sapindaceae	*Dictyoneura obtusa* Blume	Zingezing		√	
151	Sapindaceae	*Lepisanthes* sp.	Siase		√	
152	Sapindaceae	*Harpullia* cf. *longipetala* Leenh.	Sung		√	
153	Sapindaceae	*Mischocarpus longifolius* Radlk.	Monkif		√	

154	Sapindaceae	*Cupaniopsis* sp.	Siase		√	
155	Sapotaceae	*Chrysophyllum roxburghii* G. Don	Mafang		√	
156	Sapotaceae	*Palaquium* sp.	Ninitz		√	
157	Sapotaceae	*Pouteria* sp.	Ninitz		√	
158	Simaroubaceae	*Ailanthus integrifolia* Lam. ex Steud.	Isoc		√	
159	Smilacaceae	*Smilax* sp.	Bualofgongtu			
160	Sterculiaceae	*Pterocymbium beccarii* K. Schum.	Popomak		√	
161	Sterculiaceae	*Commersonia bartrania* (L.) Merr.	Gumlene		√	
162	Sterculiaceae	*Sterculia schumaniana* (Lauterb.) Mildbr.	Gunungking			
163	Sterculiaceae	*Kleinhovia hospita* L.	Chofuz		√	
164	Stilaginaceae	*Antidesma olivaceum* K. Schum.	Fogumb		√	
165	Theaceae	*Adinandra* sp.	Yagop	√		Snake bite
166	Thelypteridaceae	*Sphaerostephanos* sp.	Saresil			Leaves edible
167	Thelypteridaceae	*Thelypteris* sp.	Gangtepel 1			
168	Thelypteridaceae	*Pneumatopteris sogerensis* (A. Gepp) Holttum	Saresil			
169	Thelypteridaceae	*Sphaerostephanos* sp.	Birobiro			
170	Thymelaeaceae	*Phaleria macrocarpa* (Scheff.) Boerl.	Wok			
171	Tiliaceae	*Microcos grandiflora* Burret	Sankak motoc			
172	Ulmaceae	*Celtis philippinensis* Blanco.	Baron		√	
173	Urticaceae	*Nothocnide repanda* (Blume) Blume	Sosopok		√	
174	Urticaceae	*Dendrocnide* sp.	Nol			
175	Xanthophyllaceae	*Xanthophyllum papuanum* Whitmore ex Meijden	Gawam		√	
176	Zingiberaceae	*Hornstedtia* sp.	Sirinkon			Fruits edible
177	Zingiberaceae	*Tapeinochilos* sp.	Kionggontuc	√		Tooth ache treatment
178	Zingiberaceae	*Amomum* sp.	Asazo	√		Fruits edible