


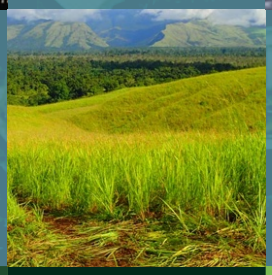


Chapter 12

Socioeconomic Environment Characterisation

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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**").

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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.

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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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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.

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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.

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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.

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12. SOCIOECONOMIC ENVIRONMENT CHARACTERISATION

This chapter of the environmental impact statement (EIS) reports the results of socioeconomic baseline studies conducted for the Project as described in the Wafi-Golpu Project Socioeconomic Baseline Report (Appendix T). The purpose of this chapter is to provide a concise and thorough description of the socioeconomic features of areas located in proximity to, and therefore potentially affected by, the Project, referred to in this chapter as 'study areas'. The information presented in this chapter informs the Socioeconomic Impact Assessment (Chapter 18).

This chapter defines the four study areas investigated for the socioeconomic baseline (Section 12.1), describes the data collection methods used (Section 12.2), provides contextual socioeconomic information at a national and provincial level (Section 12.3), and presents the findings of the socioeconomic baseline studies for each of the study areas (Section 12.4 to 12.7).

12.1. Study Areas

Study areas referred to in this chapter 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. In this chapter, 'village' refers to customary landowners living in a self-identified group of households. 'Settlement' refers to non-landowners living in a self-identified group of households, either under an arrangement with customary landowners (formal settlements) or with no customary arrangement or other entitlement (informal settlements). 'Community' is used generically to include villages and settlements, and refers to a set of people who interact socially.

Figure 12.1 presents the four study areas adopted for the socioeconomic baseline as follows:

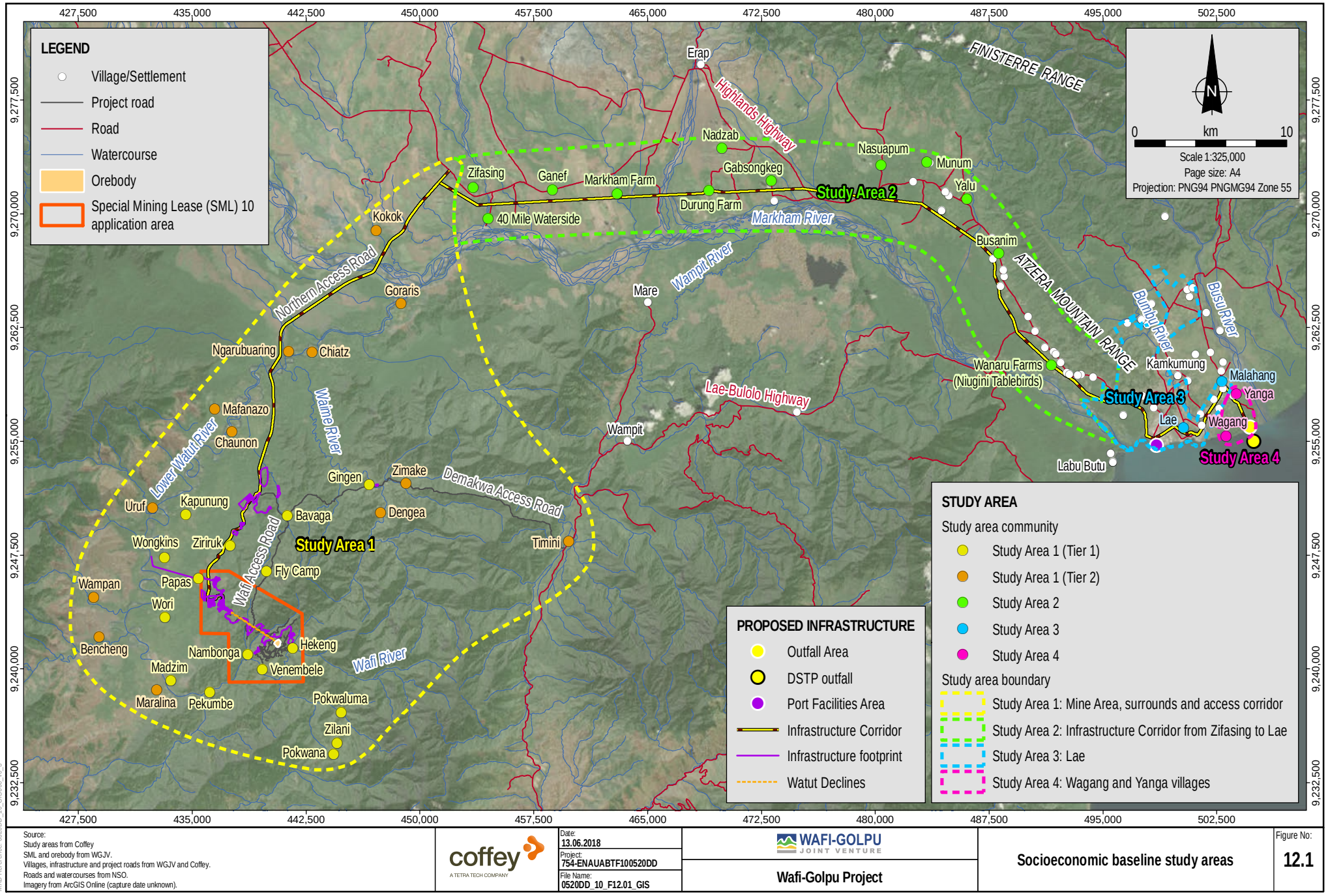
- Study Area 1: Mine Area, surrounds and access corridors
- Study Area 2: Infrastructure Corridor from Zifasing to Lae
- Study Area 3: Lae
- Study Area 4: Wagang and Yanga villages

Taken together, the four study areas encompass the three geographic areas comprising the Project Area (i.e., the Mine Area, Infrastructure Corridor and Coastal Area). However, the socioeconomic study areas are broader than the Project Area because communities beyond the Project Area may nonetheless be impacted by the Project.

This section provides further information on the communities included in each of the four study areas.

12.1.1. 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 (and only this study area) are further divided into two tiers: Tier 1 (those in closest proximity to the Mine Area, and which belong to the Hengambu, Yanta and Babuaf cultural groups); and Tier 2 (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).



MXD Reference: 0520DD_10_GIS060_v0_3

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: **12.1**

Tier 1 comprises 16 villages which 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

Tier 2 villages are those situated along or near the Demakwa Access Road and proposed Northern Access Road, 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.

Thirteen villages were identified as Tier 2 villages within Study Area 1:

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

12.1.2. 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 Local-level Government (LLG). This study area spans a total linear distance of approximately 50 kilometres (km) and traverses parts of Zifasing, Ganef, 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 assessed as part of Study Areas 1, 3 and 4 (refer to Figure 12.1).

12.1.3. 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. This study area extends up to and includes the Malahang area, and is contiguous with Study Area 4 which is located further east.

Project facilities located within this study area will include both 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) and the Port Facilities Area.

The study area is not restricted to the Infrastructure Corridor in Lae and the Port Facilities Area as people within the broader city of Lae are expected to have a variety of interests in and interactions with the Project. Some may live near or adjacent to, or work at businesses near or adjacent to, land through which the Infrastructure Corridor will traverse. Some may be involved in, or have greater exposure to, Project operations at the Port of Lae. Some will own or utilise land upon which Project facilities are planned, while other residents may merely take an active interest in the Project and its impacts.

12.1.4. 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 3 km east of Lae. People within this study area are the landowners through which the Infrastructure Corridor will traverse (specifically the terrestrial tailings pipeline), and on which the Outfall System will be situated.

12.2. Socioeconomic Baseline Studies

The socioeconomic baseline characterisation is 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 socioeconomic studies completed for the Project is shown in Figure 12.2.

12.2.1. Baseline Studies for Study Area 1

Information for Study Area 1 (Mine Area, surrounds and access corridors) was obtained through the review of secondary data sources, and from household and village surveys of social conditions, social infrastructure, education, visual amenity, health status, land and water resource use, and traffic. Table 12.1 describes the data collection activities undertaken for Study Area 1 between 2010 and 2017. A number of earlier studies also informed the socioeconomic baseline for this study area, including:

- 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).
- Household Survey: Statistical Report prepared by PNG University of Technology and Richard Jackson (Jackson, 2004).
- Wafi Mining Limited Baseline Health Survey (CEH, 2007).

Table 12.1: Data collection activities for Study Area 1 (2010–2017)

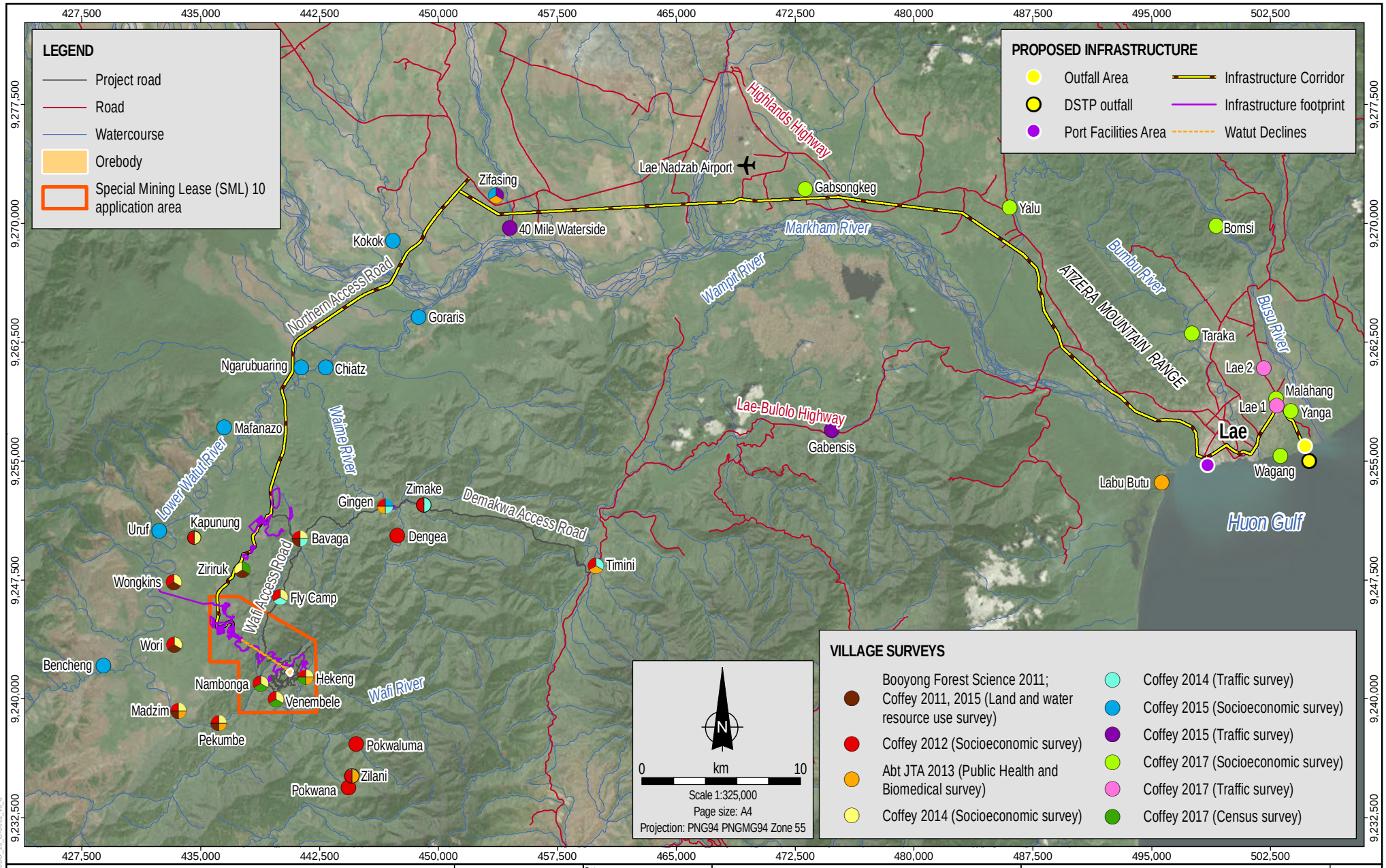
Year	Study	Methods
Social surveys		
2012	Social baseline surveys of 17 villages including 13 Tier 1 villages and four Tier 2 villages.	• Household surveys, which have sought to develop accurate estimates of population, household composition, age, education, skills employment experience and diet. • Key informant surveys, which have typically involved women (though do not exclude men) to gather information on governance, law and order, and land and water resource use. • Store and/or market surveys, which have been used to collect information on the range and price of village store products. Surveys were undertaken by Coffey and SIA and Development (see Coffey Environments, 2013; 2014a; SIA and Development, 2013).
2014	Additional social baseline data collection for 11 of the Tier 1 villages surveyed in 2012.	
2015	Social baseline data collection for one Tier 1 village and 10 Tier 2 villages located along the Northern Access Road and Lower Watut River.	
2014	Social mapping: Identification of power dynamics, institutional and organisational influences, individual and family dynamics and community perceptions of village leadership of eight Tier 1 communities.	Participatory rapid assessment including open discussions; preparation of Venn diagrams, tribal/call trees and matrix tables; focus group discussions; observations; and one-on-one interactions with village residents. The participatory rapid assessment was undertaken by Gari Consultancy Services (2014a-h).

Year	Study	Methods
2013, 2016	Landscape and Visual Impact Assessments	Qualitative and quantitative assessment, evaluating landscape change and sensitivity of surrounding landscape to such change. Landscape and Visual Impact Assessments were conducted by Urbis (2013, 2016). Note: results from this study are not included in this EIS because the assessments had assumed that a Tailings Storage Facility was to be part of the Project design. For further discussion, refer to Chapter 7, Assessment of Alternatives.
2017	Venembele, Hekeng, Nambonga and Ziriruk villages household survey update	• Field observations and household mapping. • Census surveys. Surveys were undertaken by Coffey in February, April and May 2017.
Health surveys		
2012–13	Public health and biomedical survey involving five Tier 1 communities and three Tier 2 communities	Methods ranged from individual medical examinations and anthropometric measurements, urine and capillary blood samples, field haemoglobin and treponema serology tests, to a local health facility questionnaire and drinking water coliform presence/absence tests. Surveys were undertaken by Abt JTA (2013a, 2013b).
Land and water resource use surveys		
2010	Terrestrial flora survey involving three Tier 1 villages	Interviews with community representatives from Bavaga (Hengambu) and Madzim and Wonkgins (Babuaf) to ascertain which local plant species were of use to local people and how these species were used. Surveys were undertaken by Booyong Forest Science (2011).
2011	Land and water resource use survey involving four Tier 1 villages	Community surveys and focus groups involving representatives from Bavaga (Hengambu), Wori, Wongkins (Babuaf) and Pekumbe (Yanta) to ascertain the dependency of communities on land and water resources. Surveys were undertaken by Coffey (2011).
2015	Land and water resource use participatory mapping exercise for Babuaf villages.	Men's and women's focus groups at Wori, Wongkins, Madzim and Ziriruk (one day at each village), during which participants mapped where and how terrestrial and aquatic resources are utilised. Surveys were conducted by Coffey Environments (2015).
Traffic and road user surveys		
2014	Demakwa Access Road survey across five locations including Zimake, Gingen, Bavaga, Fly Camp and Timini (Demakwa)	• Observed traffic count surveys (collecting data on vehicle numbers, vehicle type and ownership). • Opportunistic resident surveys (to establish purpose and frequency of road usage). • Opportunistic pedestrian surveys (to establish destination, purpose of travel and any safety or other concerns pertaining to the use of the road). • Roadside stallholder surveys (to capture information relating to income generation and the types of goods sold by roadside stallholders). • Observational survey of river traffic (collecting data on number and types of river vessels). Surveys were undertaken by Coffey Environments (2014).

Note: Cultural heritage studies are reported in Chapter 13, Cultural Heritage Characterisation.

12.2.2. Baseline Studies for Study Area 2

Except for Zifasing village, baseline studies for Study Area 2 (Infrastructure Corridor from Zifasing to Lae) were undertaken by Coffey from February through May 2017. Information for Zifasing was largely gathered during baseline studies for Study Area 1 (2010 to 2015); subsequent changes to the project description and associated refinement of the study areas led to the inclusion of Zifasing in Study Area 2.



MXD Reference: 0520DD_10_GIS061_v0_3

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

Studies undertaken in the socioeconomic study areas to date

Figure No: **12.2**

The primary objective for investigations in this study area was to characterise existing land use within and near the Infrastructure Corridor. A secondary objective was to identify services (e.g., schools) utilised by communities near the proposed Infrastructure Corridor, to identify whether access would be impacted by construction activities.

The principal 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. These conversations were not structured, but conducted to clarify the observations made. Where the corridor was not accessible during field surveys (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' refers to discussions conducted with village leaders. 'Focus groups' are discussions held with multiple participants and one or more members of the survey team. 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)

Cultural heritage studies were undertaken along the Infrastructure Corridor between 7 and 18 May 2017 (Muke and Skelly, 2017; see also Appendix U, Cultural Heritage Baseline and Impact Assessment). These studies focused on (but were not limited to) a 50-metre-wide corridor. Relevant information from these studies is included in the Study Area 2 socioeconomic baseline; however, cultural heritage baseline information is discussed in Chapter 13, Cultural Heritage Characterisation.

12.2.3. Baseline Studies for Study Area 3

Field observations of Study Area 3 were undertaken in August 2017, for the portion of the Infrastructure Corridor within this study area. Representatives from WGJV Community Affairs traversed the corridor, and land uses along the corridor were recorded.

A Traffic Count Survey was conducted in May 2017, near the intersection of Independence Drive and Busu Road at Malahang over a period of four days (Friday to Monday). This area was chosen because Busu Road provides access to Sipaia Road, the only road to Wagang.

The Traffic Count Survey was complemented by two questionnaires, the Pedestrian Traffic Questionnaire and the Traffic and Transport Questionnaire, which gathered additional information from road users on road use at the traffic survey location.

12.2.4. Baseline Studies for Study Area 4

Studies for Study Area 4 (Wagang and Yanga villages) were undertaken by Coffey in February 2017. Socioeconomic data for Wagang village was obtained using the following data collection methods:

- Separate men's and women's focus group discussions (discussing land and water resources, health, education, transport, community governance, and law and order).
- Key informant interviews with village leaders (focusing on land and water resources).
- Field observations of land and water resource use locations.

- Household surveys, 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.

Socioeconomic data for Yanga village was obtained using the following data collection methods:

- Separate men's and women's focus group discussions (discussing land and water resources, health, education, transport, community governance, and law and order)
- Key informant interviews with village leaders (focusing on land and water resources)

12.3. 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 sections 12.4–12.7.

12.3.1. National Context

12.3.1.1. People and Governance

Papua New Guinea is a 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 cultural and language groups (The Economist, 2017), and geographically is characterised by rugged mountainous terrain, swamps, large lowland rivers and tropical forests all of which 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, 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 (comprising Morobe, Madang, East Sepik and Sandaun Provinces). Morobe Province is the most populous province, containing almost 9.3% of the country's total population (NSO, pers. com., 2016).

Papua New Guinea is a constitutional monarchy, with Her Majesty Queen Elizabeth II being the Head of State, and operates as a democratic state. The 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 (National Parliament of PNG, n.d.). 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 (National Parliament of PNG, n.d.). 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.

Local-level governments 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 (CLGF, 2015). In turn, LLG planning contributes to provincial planning, which contributes to national planning.

The majority of elected officials in PNG are male, with no women elected to the National Parliament in 2017. Of the 176 countries surveyed for the Corruption Perceptions Index 2016 (Transparency International, 2016), PNG rated 136 out of 176, with the rating of 1 being perceived to be the least corrupt.

12.3.1.2. 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.). Approximately 85% of PNG's population resides in traditional rural communities and secures 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, 2016). 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 (STIs) are amongst the highest in the Pacific. Law and order issues remain a challenge, 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 (DFAT, 2012), 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). PNG receives significant support from bilateral and multilateral donors, including Australia's Department of Foreign Affairs and Trade, and the World Bank.

12.3.1.3. Economic Overview

The four key sectors in the PNG economy are (World Bank, 2017):

- Agriculture, forestry and fishing
- Oil and gas extraction
- Wholesale and retail trade
- Mining and quarrying

Together, these sectors contribute over half of PNG's Gross Domestic product (GDP) (ibid). From the mid-2000s, PNG experienced over a decade of comparatively robust economic growth (with 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, growth slowed to 2% in 2016 due to the collapse in the prices for commodities that PNG exports, including natural gas, oil, gold, nickel, copper, hardwood logs, palm oil and coffee (National Research Institute, 2017).

Economic growth is projected to remain moderate over the short to medium term (World Bank, 2017).

Of importance to livelihoods in PNG is the on-going development and operation of the 'informal economy' (CIMC, 2016) as formal employment is not widely available, particularly in rural areas that depend on subsistence agriculture. CIMC (2016) describes the informal economy as people who 'get by' without formal employment, earning an income however they can. Conroy (2011) suggests that the informal economy represents 'a gap…between the subsistence economy and the formal SME [small-to-medium enterprises] and corporate sectors'. People in the informal economy do not pay income tax, are not counted in the workforce, do not work regular hours and are 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 (CIMC, 2016).

The informal economy is estimated to support more than 80% of the population (National Research Institute, 2017). The effective operation of the informal economy is also of particular relevance to women, as women tend to '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).

The informal economy is seen by the State of PNG as a 'fundamental part of the whole economic system, an equal partner in economic growth and development' (National Research Institute, 2017). In 2011, the State of PNG released its National Informal Economy Policy (2011–2015) (Department for Religion and Community Development, 2011) to protect and promote its development through two policy approaches: financial inclusion, and the provision of public goods and services. The Policy was reviewed during 2016 and the *Informal Sector Development and Control Act 2004* may be revised or superseded in the near future as a result of the review (Department for Religion and Community Development, 2017).

12.3.2. Morobe Province Context

12.3.2.1. Place, People and Governance

Morobe Province borders Madang and Eastern Highlands provinces to the west, Gulf, Central and Oro provinces to the south, and West New Britain to the northeast. The Province has a land area of approximately 34,000 square kilometres (km^2) (NSO, 2011). The physical geography of Morobe Province 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. Further information on the physical geography of Morobe Province is provided in Chapter 8, Physical and Biological Environment Characterisation.

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 was 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 the 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). Morobe Province's annual population growth rate of 2.1% was relatively low compared to that of PNG (3.1%).

Administrative units in Morobe Province comprise nine Districts and 34 LLGs (Morobe Provincial Government, n.d.). The Provincial Legislature is termed the 'Tutumang', a name derived from the Kote language and referring to a meeting of the people or leaders (ibid). 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 (ibid). The Morobe Sam Sewe is the executive arm of the Morobe Provincial Government (i.e., the Provincial Executive Council) (ibid).

12.3.2.2. Infrastructure

The administrative and commercial centre of Morobe Province is the city of Lae. 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 Cooperation Agency (JICA, 2017).

Major transport corridors in Morobe Province include the Highlands Highway extending from Lae to Kaiapit at the western end of the Markham Valley (and continuing through to Madang), 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.

The Port of Lae is PNG's largest and busiest port, and handles the greatest volume of cargo. 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 (Department of Transport and Infrastructure, 2013). The port has significant development potential based on utilisation of the Lae Tidal Basin 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, although tuna fishing is undertaken outside the Huon Gulf (Appendix S, Fisheries and Marine Resource Use Characterisation).

The main airport in Morobe Province is Nadzab Airport, located 35km west of Lae. It has a runway length of 2,438m, 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.

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 18 megawatt (MW) currently being added through the Yonki Toe-of-Dam project (The National, 2013). The PNG Power Limited (PPL) transmission line corridor 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. The Infrastructure Corridor follows the PPL transmission line corridor from Zifasing to Yalu. Due to ongoing power supply issues in Lae, PPL has engaged an independent power producer (Posco Daewoo) to construct a new 30MW thermal power station at Munum just outside Lae to act as a backup station to Ramu, catering for about three quarters of the city of Lae's requirements (Giame, 2017).

12.3.2.3. Health and Education 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 Morobe Province, there are 49 health facilities (one General Hospital, two Rural Hospitals, 18 Health Centres, 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 (NGOs) 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. By contrast, the World Health Organisation (WHO) estimates that countries with fewer than 230 healthcare professionals per 100,000 people would struggle to deliver essential maternal and child health services, posing a major barrier to achieving health-related Millennium Development Goals (WHO, 2010).

World Health Organisation 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 (WHO, 2012). The human immunodeficiency virus (HIV) prevalence rate of Morobe Province was, in 2010, the fifth highest in PNG (NACS, 2010; more recent data not available). Prevalence of HIV appears to be concentrated particularly in urban areas, along key transport routes (e.g., the Highlands Highway) and around areas of industrial activity (PEPFAR, 2012). Prostitution increases the risk of HIV transmission, and studies of village life describe widespread practices that are not considered prostitution, but which involve courting couples exchanging gifts or money for sex, and married women offering sex to young men in return for money, gifts or garden food (Decock, et al., 1997; Connell and Negin, 2012). Such practices increase the risks of contracting HIV.

In Morobe Province, there are 738 elementary schools, 333 primary schools, 17 secondary schools and 7 vocational schools (DoE, 2015). The average class size is 33 students per teacher – the seventh lowest student–teacher ratio in PNG (ibid).

12.3.2.4. Natural Resources and Economic Activity

The economy of Morobe Province is driven primarily by mining and agriculture, with manufacturing and services making major contributors to the economy. Mining employs 2.5% of the formal workforce, and contributes 53% of provincial GDP which is approximately double the contribution of mining to national GDP (JICA, 2017). While mining is dominated by large-scale mining at Hidden Valley and exploration activities at Wafi-Golpu, small scale alluvial gold 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 is involved in alluvial gold mining at some time, producing in the order of one thousand kilograms per year (or approximately USD40 million at a gold price of USD1,200 per ounce) (Moretti, 2007).

Agriculture is also a growing sector. An assessment of land use change in the Morobe Province by JICA (2017) showed that, between 1975 and 2000, agricultural land use increased by 58% (citing Ningal et al., 2008). Most new agricultural land was developed from the clearance of primary forest. Forest is cleared for agriculture to service increasing population, migration, the general economic situation and access to land resources. Forest area decreased from 9.8 hectares (ha) per person in 1975 to 4.4 ha per person in 2000 (JICA, 2017; citing Ningal et al., 2008). According to JICA (2017), agriculture (including fishing and forestry) employs 73% of the provincial workforce contributing 15% of provincial Gross Domestic product (GDP). 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 (Bourke and Harwood, 2009). 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 PPL (PNG Biomass, 2018). 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 important contributions to the Morobe Province economy, particularly in Lae. The manufacturing sector contributes 7% to the provincial GDP and 23% of the GDP for Lae-Nadzab area (JICA, 2017). Employment in the transport and storage sector in Lae is about four times the national level, contributing around 6% of the Lae-Nadzab GDP (ibid). For the wholesale and retail sector, employment is around twice the level found nationally.

Subsistence fishing is important to the people living along the coast and nearshore islands of the Huon Gulf. Fish and other marine produce are an important source of protein in their daily diet (Appendix S, Fisheries and Marine Resource Use Characterisation). 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 take 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 6.5km northwest of the Salamaua Peninsula) and reefs around the Salamaua Peninsula itself. These areas targeted for subsistence and artisanal fishing range from approximately 5km south of Lae (i.e., from the nearshore waters near Labu) to 33km 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. Many of the villages along the Huon Gulf south coast trade fish and crustaceans with inland villages, in return for sago, sweet potato and pig meat (ibid).

Lae is the home port to a number of tuna fishing vessels and the site of a number of tuna processing plants and canneries, which are located in the Malahang Industrial Area. This industry has created substantial numbers of direct and indirect jobs. The combined capacity of the existing plants is estimated at 10,861 direct jobs and 24,125 indirect jobs (Appendix S, Fisheries and Marine Resource Use Characterisation). It is estimated that approximately 75% of the PNG tuna processing labour comprises female workers (ibid). Four canneries are operational with a further two approved by the PNG Government, which may result in a further 3,000 direct jobs.

12.4. Socioeconomic Baseline: Study Area 1 (Mine Area, Surrounds and Access Corridors)

This section presents the socioeconomic baseline for Study Area 1 and covers the following themes:

- Biophysical setting overview
- History
- Population
- Transport infrastructure
- Income
- Housing
- Health and wellbeing
- Education
- Subsistence resources
- Traditions and culture
- Law and order and social cohesion

12.4.1. Biophysical Setting

This section provides an overview of the physical geography and climate of Study Area 1. Refer to Chapter 8, Physical and Biological Environment Characterisation, for further information.

Land in the vicinity of the Mine Area is steep, mountainous and heavily forested, transitioning to the generally flat Lower Watut River floodplain to the west. The Mine Area has been subject to mineral exploration for over 30 years and, as a result, the local landscape is modified with scattered clearings and exposed areas. Tier 1 villages are located amid the steeper terrain (Hengambu and Yanta villages) and on the Lower Watut floodplain (Babuaf villages). Forest has been cleared around villages to establish gardens for food production.

Tier 2 villages (with the exception of Zimake, Dengea and Timini) are located along the Lower Watut River, and in the case of Kokok near the confluence of the Lower Watut River (which flows to the north) and the Markham River (which flows to the east). The landform is flat to slightly undulating and the rivers are fringed with dense riparian vegetation. Within the river valleys, the vegetation is modified, with regular clearings for food gardens as well as plantations for commercial crops such as cocoa. Zimake, Dengea and Timini are located near the Demakwa Access Road, which runs from its intersection with the Wafi Access Road to the west, and traverses valleys and foothills until it reaches the Lae–Bulolo Highway to the east.

The region's climate is characterised by frequent tropical storms, heavy rainfall, long periods of calm and the impacts of El Nino and La Nina patterns. At the Mine Area, the northwest monsoon (wet) season occurs annually between November and April and is characterised by north-westerly winds bringing in low-pressure troughs and heavy rainfall. The southeast monsoon (dry) season, occurs annually between May and October and has predominately south-easterly winds.

The main waterways include the Wafi, Lower Watut, Markham and Bavaga rivers and the Hekeng, Nambonga, Chaunong and Buvu creeks. The Mine Area is located within the Lower Watut River catchment that flows in a northerly direction to its junction with the Markham River.

The heavy rainfall and the steep, unstable slopes within the Mine Area result in high sediment loads in local rivers and creeks after rainfall. The water and sediment quality of watercourses in the Project Area is generally consistent with that found in other regions of PNG sharing similar catchment geology, ore-bearing deposits and artisanal mining activities. The exception to this is significantly elevated levels of mercury which have been measured in the water within the Mine Area (for reasons that have yet to be determined).

Baseline ambient air quality and noise levels in the study area were found to reflect the remote, forested area. The main influences on air quality were found to be fires either used for cooking, forest clearance (for subsistence gardens and growing cocoa) and dust lift-off from traffic on dirt roads. Baseline ambient noise sources were found to be predominantly natural in origin (such as wind, insects and domesticated animals) and the activities of daily village life.

12.4.2. History

Tier 1 villages identify as part of the Yanta, Babuaf and Hengambu groups. According to the Yanta and Hengambu oral histories, both groups originated from settlements in the Mumeng Valley (Ballard and Kanasa, 1993). They moved into the headwaters of the Wafi, Wampit and Waime river catchments, southeast of the Golpu deposit, potentially more than 200 years ago (ibid). The groups then dispersed, establishing and then abandoning village settlements at regular intervals, over the past century. The Yanta and Hengambu speak slightly different dialects of a common Mumeng language (Adams and Lauck, 1985; Ballard and Kanasa, 1993).

The Babuaf report that their ancestors originally lived just below Wafi Exploration Camp adjacent to Mt Golpu, and later moved to a number of locations on the eastern side of the floodplain of the Lower Watut River and the western foothills of the Watut Range. They then crossed the river to live at Efafan Creek further upstream on the Lower Watut River (Tovue, 1989). Muke et al., (2007) noted that the Babuaf were probably distributed across a much wider area than the five main villages in which they are located today, and that the impacts of Lutheran missionaries in the 1920s and 1930s, who encouraged them to congregate into fewer, larger settlements, contributed significantly to their present geographic distribution. The Babuaf speak an Austronesian language that has been labelled by Holzknecht (1989) as Middle Watut (and sometimes referred to as Central Watut).

According to social surveys conducted in 2014, 2015 and 2017 (see Table 12.1), there are strong social ties between the villages associated with each cultural group. For instance, residents of the Babuaf villages (Wori, Wongkins, Madzim, Kapunung, Papas and Ziriruk) interrelate and communicate regularly. Intermarriage between residents of different villages of the same cultural group is common. Similarly, residents from the Yanta villages (Nambonga, Pekumbe, Pokwaluma, Pokwana, Zilani and Venembele) and the Hengambu villages (Bavaga, Fly Camp, Gingen and Hekeng) reported strong social ties with other villages from the same cultural group.

Furthermore, within each of the Babuaf, Yanta and Hengambu groups are various clans. Kinship ties and social relationships are very strong between members of the same clan. Socioeconomic surveys found that there are two predominant clans across the Babuaf villages (Leron and Wafes), whilst in the Yanta and Hengambu villages, up to six clans can be found living together in a village.

By comparison, social relations between members of different cultural groups are uncommon and tenuous. As reported by the social mapping study completed by Gari Associates (2014a-h), there has been very little inter-marriage between the Babuaf, Hengambu and Yanta cultural groups and there is minimal formal social interaction between

members of these groups, though they are presently working together with respect to the Project.

Table 12.2 describes the settlement of Tier 1 villages, based on social baseline studies between 2014 and 2017. Access to services, habitation of more productive land and road access were given as the most common reasons for the movement and relocation of villages.

Table 12.2: Settlement of Tier 1 villages

Village	Brief Description
Babuaf Villages	
Kapunung	Kapunung was established along the Watut River 30 years ago and consists of numerous hamlets scattered out over several hundred metres (m). 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, in 2004, flooding forced the residents to resettle in the current location.
Madzim	Madzim is the first Babuaf village on the eastern side of the Watut River. People came to Madzim from Babuaf to access better land and services.
Wongkins	Wongkins has been located in its present location for approximately 30 years and was founded when Babuaf people decided to move north from Madzim and Wori to farm new lands.
Wori	Wori is located on the Lower Watut River. It was settled in 2004, after floods destroyed the original village of Seraf. Seraf was initially established by settlers from Madzim for farming purposes about 30 years ago.
Papas	The hamlet of Papas was established following the construction of the Wongkins aid post in 2010–11.
Ziriruk	Ziriruk was established after severe floods in 2012, predominantly by people from Wori.
Hengambu Villages	
Bavaga	Bavaga was established in the valley formed by the Bavaga River, which runs through the village. It has been settled for approximately for 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 2km south of Bavaga. The hamlet has formed as a result of families moving out of Bavaga in 2002–2003 to a clearing previously occupied by a temporary exploration camp. Other families have gradually moved to the locality over the last 6 years.
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 Geng in the northwest plains.
Hekeng	Hekeng has been in its present location for approximately 40 years.
Yanta Villages	
Nambonga	The people from Nambonga came originally from Parakris in Zenag (Mumeng). They settled for more than 30 years at Venembele before resettling in Nambonga approximately 10 years ago.
Pekumbe	Pekumbe was established by people from the Yanta villages of Zilani and Pokwana. The village location provides an important point of access to the Lower Watut River, which in turn provides access to Lae by boat.
Pokwaluma	Pokwaluma was established by people from Zilani and Venembele villages approximately 30 years ago. It served as a rest area for Yanta travellers between the Pekumbe and the villages of Zilani and Pokwana.
Pokwana	Pokwana has existed for a long time and its origins were not able to be provided by respondents to the socioeconomic survey.

Village	Brief Description
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.
Zilani	It is believed by those surveyed that Zilani has been long established as one of the original Yanta villages. It sits at the lower end of the mountain range approximately 2km northeast of Pokwana.

Settlement information was also collected for several Tier 2 villages. Along the Demakwa Access Road, the 2012 household surveys identified that Dengea was settled approximately 40 years ago by people from Toangela to the south, while Zimake was settled approximately 35 years ago by the Towangala cultural group who were attracted to the area's fertile lands, alluvial gold mining and access to the Zindaga School. Socioeconomic surveys undertaken in 2015 recorded that Goraris was settled by people from the Sepik region.

The villages of Chiatz and Gabensis generally comprise Wampar speakers, who inhabit the alluvial plains of the lower Markham Valley. According to their origin stories, the Wampar previously occupied the hilly Watut country to the south, including the area around Mt Golpu (Fischer, 1976; Sack, 1976; see also Holzknecht, 1989).

The village of Ngarubuaring, located approximately 20 km to the southwest of Zifasing, comprised settlers from Tapakainantu in the Markham District. People from Tapakainantu are regular visitors to Ngarubuaring and stay for prolonged periods, planting and selling peanuts to earn cash income before returning to Tapakainantu.

12.4.3. Population

The 16 villages comprising Tier 1 had an estimated population of 3,869 persons in 2017, based on extrapolation of census data and population counts over the period 2004 to 2014. 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

The highest rates of population growth between 2012 and 2014 occurred in Gingen, Fly Camp, Venembele and Kapunung, as shown in Table 12.3. 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.

Residents in Yanta villages suggested that the low or negative population growth between 2012 and 2014 in Pokwana, Zilani and Pokwaluma occurred because residents from these villages had relocated to Pekumbe or Venembele, in order to be closer to the Mine Area.

Of the villages surveyed in 2017 (Hekeng, Nambonga, Venembele and Ziriruk), Nambonga had the highest population growth rate between 2014 and 2017. Venembele and Hekeng appear to be growing at a rate slightly above the Huon Gulf District average (2.4%), with the growth rate in Venembele slowing appreciably between 2014 and 2017 compared to the period 2004–2014.

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).

Population data for Tier 1 and Tier 2 villages are presented in Table 12.3 and Table 12.4 respectively.

Table 12.3: Population data and extrapolated 2017 population of Tier 1 villages

Village	2017 Population*	2014 Population	2012 Population	2004 Population	Average Annual Population Growth	
					2004-2012	2012-2014
Babuaf Villages						
Kapunung	375	341	296	n/a	n/a	7.3%
Madzim	209	190	167	n/a	n/a	6.7%
Wongkins	203	185	193	n/a	n/a	-2.1%
Wori	131	119	114	n/a	n/a	2.2%
Papas	29	26	n/a	n/a	n/a	n/a
Ziriruk	103	50	n/a	n/a	n/a	n/a
Hengambu Villages						
Bavaga	380	346	331	90	17.7%	2.2%
Fly Camp	80	73	57	n/a	n/a	13.2%
Gingen	589	467**	347	252	4%	16%
Hekeng	291	252	240	161	5.1%	2.5%
Yanta Villages						
Nambonga	105	66	99	n/a	n/a	-18.4%
Pekumbe	322	293	277	134	9.5%	2.8%
Pokwaluma	143	n/a	130	142	-1%	n/a
Pokwana	188	n/a	171	170	0%	n/a
Venembele	405	350	285	161	7.4%	10.8%
Zilani	316	n/a	287	259	1.3%	n/a

*2017 Population estimates are based on extrapolation from available data (Jackson 2004; Coffey Environments, 2013, 2014a 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.

Table 12.4: Population data and extrapolated 2017 population of Tier 2 villages

Tier 2 Village	2017 Population*	2015 Population	2012 Population	2004 Population	Average Annual Population Growth	
					2004-2012	2012-2015
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

Tier 2 Village	2017 Population*	2015 Population	2012 Population	2004 Population	Average Annual Population Growth	
					2004-2012	2012-2015
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 Environments, 2013, 2014a and 2015) and an average annual growth of 2.4%.

12.4.4. Transport Infrastructure

Villages within Study Area 1 are generally remote and isolated. The primary routes to the city of Lae from villages in this study area are:

- The Wafi Access Road, Demakwa Access Road and Bulolo Highway to the city of Lae
- By boat down the Lower Watut River to the Markham River, then via the Highlands Highway to the city of Lae

The Wafi Access and Demakwa Access roads are existing gravel roads, used by local residents on a daily basis (Figure 12.3). The Wafi Access Road runs from the existing Wafi Camp to Bavaga, before continuing on as the Demakwa Access Road from Bavaga to Demakwa where it joins the Bulolo Highway. Due to the mountainous topography, the roads are undulating and winding with some sharp (blind) corners and steep sections (gradient exceeding 15%). There is no separation of vehicle and pedestrian traffic and road shoulders are heavily overgrown in some sections. In the years 2011 to 2017, 11 fatalities occurred on the Demakwa Access Road in three separate accidents (not involving WGJV vehicles).

The primary mode of transport for villagers in the study was reported to be by foot. Traffic studies identified that foot traffic was higher than the number of vehicles recorded and comprised between 20 to 100% of total traffic recorded. Access to gardens, hunting and fishing grounds was given as the primary purposes of trips. Numerous walking paths have also been established linking villages to key locations such as water sources, gardens, crops and hunting and fishing areas.

Riverine transport was another commonly reported mode of transport, by canoes, rafts and motorised boats (Figure 12.4). For some villages (Wori, Wongkins and Pekumbe), the most convenient transport route is the Lower Watut River to the Markham River, where villagers trade goods and services and have access to other transportation modes. For travel by road, most local people catch public motor vehicles (PMVs), with travel to the city of Lae reported to cost approximately PGK20 (JICA, 2017).

12.4.5. Income

For Tier 1 villages, the exploration phase of the Project provided the main source of wage employment in the area. This declined over 2014–2015 as the Project moved to its next phase, leading to fewer opportunities for employment.

Photo credit: Coffey, 2017

Figure 12.3
Demakwa Access Road

Photo credit: Coffey, 2017

Figure 12.4
Transporting produce on the Lower Watut River by raft

In addition to wage employment, Tier 1 village surveys also highlighted the significance of alluvial gold mining (undertaken by 29% of surveyed households), cash crops (29%) and business activities such as trade stores and stalls (14%) to total household income across the villages. Sales of livestock and river and forest products, and the receipt of wages, compensation payments, gifts and remittances also contribute to household income.

Survey results indicate that income levels and the main sources of income vary substantially between Tier 1 villages. In surveys undertaken in 2014 and 2015:

- Wage employment contributed the highest proportion of income in Fly Camp and Hekeng (Hengambu).
- Alluvial gold mining contributed the highest production of income in Nambonga, Venembele, Pekumbe (Yanta) and Ziriruk and Wori (Babuaf), i.e., communities living along the Wafi and Lower Watut rivers or with access to creeks.
- Businesses contributed the highest proportion of income in Kapunung (Babuaf).
- Cash crops contributed the highest proportion of income in Wongkins (Babuaf) and Gingen (Hengambu).

Average household income levels in Tier 1 villages varied between PGK241/fortnight in Gingen (Hengambu) to PGK1,966/fortnight in Nambonga (Yanta), however the majority of households in the villages surveyed earned less than PGK200/fortnight. Households recording the highest income levels were generally involved in one or more business activities, often including trade stores, gold buying and selling, and/or the breeding and sale of chickens.

In Tier 1 villages, alluvial gold mining provided a source of income for 24% of households in the fortnight preceding the survey, and for 55% of households in the past year. The practice is more frequently undertaken in the villages along the Wafi River, where families often construct a diversion channel in a river or stream (creating a stretch of water that is lower or slower than the main channel) to dive for nuggets or use sluices and panning.

Alluvial gold mining also occurs in the Lower Watut River as a secondary source of cash income to cocoa, which is the main cash crop in the Lower Watut River valley. Households on the Lower Watut River commonly use a sluice box to extract gold from areas of river sand or from sand beds on the river plains.

While 24% of the population of Tier 1 villages aged 15 and above had previous employment experience, only 7% of the population of Tier 2 villages aged 15 and above had previous employment experience. This is again an indication of the significance of exploration employment as a source of wage employment for Tier 1 villages.

The most common business activities in Tier 2 villages were the operation of informal stalls (often at a person's house), village trade stores, river transport (canoe and outboard motor hire) and agricultural production. The most common agricultural products included cocoa, peanuts and watermelon.

For Tier 2 villages including Maralina, Bencheng, Wampan, Uruf and Manfanzo located along the Lower Watut River, cocoa is the main cash crop. Surveys conducted in 2015 indicated that 83% of households in Uruf and Bencheng had sold cocoa in the past fortnight, and 93% had sold cocoa in the past year. Cocoa also contributed the majority of income of villages along the Infrastructure Corridor, including 74% of household income in Goraris and 78% of household income in Chiatz, and was preferred by households over alluvial gold mining and other sources of income. The median household income for Tier 2 villages for the previous fortnight was PGK350 in 2015.

12.4.6. Housing

The majority of houses in the surveyed villages are made from local materials: wooden posts and frames, timber planks or bamboo for walls and some floors, and sago leaves (or occasionally grass) on the roof (Figure 12.5 and Figure 12.6). Within Tier 1, the majority of Yanta houses have 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 and is cooler, in response to the high temperatures experienced at lower altitudes (Coffey Environments, 2014a). Within Tier 2, surveys conducted in 2015 recorded that 5% of houses were made of permanent materials, 12% were semi-improved (usually *kappa* (iron roof) on the roof of an otherwise traditional house) and 83% were made of traditional materials.

Practically all houses had a *haus kuk* (external kitchen) and external pit toilet. The majority of households cooked on open fires and rely on torches and fires as the main source of lighting. Houses in Study Area 1 reported having no access to power and the majority indicated using kerosene lamps for lighting and firewood for cooking. Household surveys (Coffey Environments, 2014a) identified the frequency of households owning generators varied from 75% in Nambonga to 11% in Wongkins.

Households predominantly comprised direct family members (a married couple and their children); however, it was not uncommon for the household to include an uncle, aunt or cousin who is residing in the household for a period of time. The average household size across Tier 1 was recorded as 5.9 persons per household, comparable to an average household size of 5.6 persons across the population of PNG (Coffey Environments, 2014a). Tier 2 households had an average of 5.6 persons.

12.4.7. Health and Wellbeing

The median age of residents for Tier 1 communities was estimated to be 18 years in 2015, which is slightly lower than the median age of 19.7 years for the population of PNG. This lower proportion of the population aged 65 years and above in Tier 1 communities compared to PNG as a whole suggests a lower life expectancy than the population of PNG (62 years for males and 65 years for females).

Tier 2 communities recorded a median age (20 years) and the proportion of the population aged over 65 years (2.1%) was comparable to the population of PNG.

The most prevalent causes of death reported in the 2012 socioeconomic surveys included malaria (21.2%) and general illness (14.9%). Deaths from child birth and deaths attributed to 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).

The 2012 household survey found the most prevalent illnesses were flu and colds, followed by malaria and fever. Data obtained from the health clinics at Wafi and Zifasing indicated that simple coughs were the most commonly treated condition in January and February 2015. The 2012 Public Health and Biomedical Survey found acute respiratory infections to be the most frequent acute illness among those surveyed (Abt JTA, 2012).

All villages surveyed had some degree of malnutrition and/or over nutrition (i.e., obesity). Approximately half of survey participants reported not having enough food to feed their families on ‘some’ or ‘most’ days. The degree of isolation, economic status and access to formal employment has been proposed as determinants for nutritional status (CEH, 2007). Gardening was identified as the most important source of food and garden products the most commonly consumed food, supplemented by hunting, collecting, fishing and store purchased foods.

Photo credit: Coffey, 2017

Figure 12.5
House made of traditional material, Venembele

Photo credit: Coffey, 2017

Figure 12.6
House made of range of materials, Hekeng

Tier 1 communities live in reasonable proximity to health facilities, primarily due to the establishment (with WGJV support) of the Wafi health clinic, and the Wongkins and Timini aid posts. The Pokwaluma and Uruf aid posts and Zindaga health sub-centre have also been renovated and rebuilt with WGJV support. Tier 2 communities have varying access to health facilities, with some village residents travelling up to two hours by foot to access the nearest health facility. Lack of supplies and/or staff availability means facilities are often closed and there is continued reliance on traditional medicine in most villages within the study area (Booyong Forest Science, 2011; Muke and Skelly, 2017; see also Appendix U, Cultural Heritage Baseline and Impact Assessment).

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. As with other areas in PNG, some households may also use smoke as mosquito deterrent.

12.4.8. Education

In Tier 1 villages surveyed in 2014 and 2015:

- 46% of males and 32% of females aged 10 years and above had completed Grade 6.
- 15% of males and 6% of females aged 10 years and above had completed Grade 10.
- 2% of persons aged 10 years and older had completed a degree or course at a vocational school, a technical college or a university.
- 17% of males and 32% of females aged 10 years and above had no formal education.

Due to the distance required to travel to elementary and primary schools, residents of Fly Camp and Hekeng (Hengambu), and Venembele, Nambonga, Pekumbe, Pokwaluma, Zilani and Pokwana (Yanta) reported being unable to access formal education facilities.

In 2013, the WGJV constructed elementary schools and provided basic materials (desks, chairs, blackboards and teaching materials) in Hekeng (Hengambu), Venembele, Pekumbe (Yanta), and Kapunung and Madzim (Babauf). These schools are now operational. However, respondents to socioeconomic surveys in 2014 and 2015 reported some reluctance to send children to schools that serve different cultural groups, as children may be seen and treated as outsiders by their peers. This reluctance influences school attendance.

Tier 2 villages with the least distance to travel to educational facilities (up to 2km) included the villagers of Dengea, Timini, Chiatz, Uruf, Bencheng and Goraris. Children of these villages attended schools in Timini, Kapunung, Wongkins, Chiatz, Mafanazo, Bencheng or Uruf.

A relatively low percentage of Tier 2 villages surveyed had completed Grade 10 education (18% of males and 10% of females). This is not dissimilar to PNG as a whole (7% of males and 3% of females) and is possibly a reflection of the difficulty in accessing high schools from the survey villages. Fewer than 4% of people in Tier 2 communities had completed a degree or course at a vocational school, a technical college or a university.

Vocational training that had been undertaken by villagers in Tier 2 had less focus on mining activities and more focus on agriculture (predominantly cocoa) and business and refresher courses for jobs such as village magistrates, policemen, teachers and health workers. Some training is also applicable to the mining industry, including training in basic trades (mechanical and electrical), security and machinery operators.

There are no secondary schools in the study area and access to these requires up to three days' return travel. The majority of secondary school students therefore attend boarding schools or live with family members located in proximity to schools.

12.4.9. Subsistence Resources

Villages were surveyed to further WGJV's understanding of village land use and the use of water resources for sustenance and habitation, socio-cultural practices and business.

Gardens, typically located within 3km of villages, are the predominant source of food. The tending of gardens by women typically occurs within 1km to 2km of villages, while resource use by men occurs over a larger area, particularly for those men living near the Lower Watut River who reported hunting in the adjacent hills. According to socioeconomic surveys in 2014 and 2015, the most commonly grown produce (as a percentage of households in the villages) included bananas (97%), greens/kumu (94%), kau kau (sweet potato) (92%), taro (92%) and sugar cane (85%). No demarcation in the use of areas between villages was recorded. Male villagers also hunt for larger animals, such as pigs, cassowaries and cuscus (*kapul*) on a regular basis, typically within 5km of villages.

Tier 1 communities reported that food gardens in Hekeng, Venembele, Nambonga and Pekumbe are under pressure due to population increases, with people experiencing food shortages in recent years. In addition, gardens are generally abandoned after one to two years, due to being located on steep slopes with poor soil. To counter low yields, villagers reported having to travel further, or to establish gardens on steep land, leading to greater erosion and sedimentation in the Wafi River.

Cocoa was the most commonly reported cash crop in Babuaf and other Lower Watut River villages, supplemented by peanuts and occasionally bananas and taro. The Hengambu and Yanta villages did not report growing cash crops; however, surplus garden produce, peanuts and tobacco were reported as being sold for income.

Trees and other plants are used extensively in the construction of housing, canoes, and domestic tools and furnishings (e.g., brooms, baskets and mats). A variety of plants are also used for medicinal and ablutionary purposes, while some have spiritual significance, such as those used in sorcery and for making traditional clothes such as grass skirts.

Tier 1 communities reported relying on the Wafi and Lower Watut rivers for their livelihoods. These watercourses provide a major source of cash income (through alluvial gold mining) and are also used for fishing, washing, and in the case of the Lower Watut River, a transport route. Drinking water is predominantly sourced from springs and streams. Many of the villages have basic, gravity-fed reticulated systems, which deliver water from springs and streams to a central location within the village. Some systems are up to 30 years old, although the WGJV has provided newer reticulated water systems in many of the Tier 1 communities. Having received WGJV-supported training on maintaining these systems, villages are now responsible for maintenance and upkeep. Drinking water was also sourced directly from springs, streams and creeks in the surrounding area.

Tier 2 communities reported utilising trees and other plants (both farmed and gathered) as a significant source of food (i.e., gardens) and for a range of subsistence lifestyle purposes including the construction of housing and sources of energy (firewood), transportation (canoes) and medicine (Booyong Forest Science, 2011). Native fauna of this landscape is hunted as a source of food, and rivers and streams are important to the communities of the Lower Watut River, who use the river for fishing, washing and as a transport route.

12.4.10. Traditions and Culture

Surveys undertaken by Coffey (Appendix T, Socioeconomic Baseline) and Gari Consultancy Services (2014a-h) identified that customary practices continue to be a part of village life, though some survey respondents commented that these practices are not as prevalent as they once were. Practices identified include sing-sings with neighbouring villages, dancing, physical separation of women while pregnant to a separate house or area, rituals with respect to the productivity of gardens (particularly when establishing new gardens), medicinal practices, drinking and eating customs and respect for elders. In the case of the Wampar villages of Chiatz and Gabensis, an oral tradition called *dzob* a *mamafe* was reportedly maintained, comprising many stories which account for the coming into being of aspects of Wampar culture or the environment (Hitchcock, 2012). Some of these stories make reference to cultural heritage story sites, for example, story beings that turned into stones. Many stories also make reference to place names and a general movement northwards down the Lower Watut River valley to the Markham River valley, providing some evidence for Wampar migration history.

Cultural heritage investigations for the Project have, through consultation, identified numerous oral tradition sites of contemporary importance across the study area. Archaeological evidence of habitation has also been uncovered (refer to Chapter 13, Cultural Heritage Characterisation).

12.4.11. Law and order and social cohesion

Communities in Study Area 1 generally adhere to a three-tiered hierarchy of law and order with customary law (village law) covering breaches of customary law, inter-personal or inter-household disputes and petty offences. Any offences that could not be resolved at this level were escalated to the District Court, while more serious legal issues were addressed under national law in the National Court (located in the city of Lae for the Morobe Province). Police were not stationed at any of the villages but could be summoned from the city of Lae when required. Unarmed and untrained auxiliary police volunteers assisted in village matters.

Baseline data collected in 2014 indicated that law and order problems were generally limited to drug and alcohol abuse and relatively minor offences, including stealing of garden produce, fighting or arguing and swearing which, in turn, led to law and order problems. Those who participated in the social mapping (Ballard, 1992; Ballard and Kanasa, 1993) used similar findings as an illustration of the predominating influence that the Lutheran church and its teachings had (and likely continues to have) on the behavior of residents. People felt that the central tenet of their Christian faith was the avoidance of disputes or violence and the maintenance of communal peace. This conclusion was mirrored in the studies undertaken by Gari Consultancy Services (2014a-h), which investigated the village governance systems of eight of the Tier 1 community villages (Hekeng, Kapunung, Madzim, Wongkins, Wori, Nambonga, Pekumbe and Venembele).

Gari Consultancy Services (2014a-h) also found that, with respect to external matters, the residents of different villages of the same cultural group will commonly adopt a consensus position. This approach is reflected by each cultural group having a single landowner association (i.e., the Hengambu Landowner Association, the Wale Babuaf Landowner Association and the Yanta Landowner Association).

There is a history of violence between the cultural groups that extends back to pre-European contact, when warfare between the groups led to the Hengambu and Yanta living in fortified villages (refer to Chapter 13, Cultural Heritage Characterisation). As reported by Gari Consultancy Services (2014a-h), there has been very little inter-marriage between the Babuaf, Hengambu and Yanta cultural groups and there is minimal formal social interaction between members of these groups.

12.5. Socioeconomic Baseline: Study Area 2 (Infrastructure Corridor from Zifasing to Lae)

This study area relates to the portion of the Infrastructure Corridor from Zifasing up to (but not including) Lae. The Infrastructure Corridor will largely follow (offset yet adjacent to) an existing PPL transmission line corridor, approximately 50m wide. This study area traverses through or near a number of villages (including Ganef, Gabsongkeg, Munum and Yalu), their associated hamlets and settlements, and industrial and commercial premises. An image of the transmission line corridor, taken approximately 1.5km southeast of Zifasing, is provided as Figure 12.7.

The baseline information in this section is structured according to villages and key landmarks. The identification of villages in this section does not constitute a statement of landownership.

12.5.1. Zifasing and Ganef

Zifasing village is located near the intersection of the Northern Access Road and the Highlands Highway. Socioeconomic studies in 2015 recorded a population of 2,372 persons (estimated population of 2,608 in 2017), which is over double the population of any village in Study Area 1. The population of Zifasing in 2015 had a median age of 24 years, a 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%.

Zifasing has two main markets, 40-Mile Market which is operated during daylight hours and in which merchants are restricted to residents of Zifasing (Figure 12.8), and another that is a night market and has merchants from Zifasing and other communities. A wide range of garden produce is sold, including bananas, root crops, peanuts and melons. Cash crops (primarily cocoa but also watermelon) are also sold in or near Zifasing; crops sold include those grown in Study Area 1 and taken to Zifasing for sale. According to the 2015 socioeconomic surveys, approximately 58% of households in Zifasing sold cocoa in the year prior to the survey.

The average household income of Zifasing was reported as PGK1,045 per fortnight, according to the 2015 socioeconomic surveys. With the exception of Venembele and Nambonga (where income from alluvial gold mining was received), the average income at Zifasing was higher than any village in Study Area 1.

Ganef village is located approximately 5km east of Zifasing on the Highlands Highway. 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 estimated population of 317 persons in 2017.

Private gardens were observed near Ganef. Conversations with community members indicated that crops planted included cucumbers (Figure 12.9), cassava, bananas and coconuts. Some of these crops were grown for subsistence, with some produce also sold in Lae.

12.5.2. Markham Farm

Markham Farm is located approximately 9km east of Zifasing. Markham Farm refers to the premises of Markham Agro Pty Ltd, which acquired a cocoa, coconut and palm oil plantation at this location in 2008 (Markham A. 2017). The PPL transmission line corridor runs east-west through the plantation.

Photo credit: Coffey, 2017

Figure 12.7
PPL transmission line corridor near Zifasing

Photo credit: Coffey, 2017

Figure 12.8
40 Mile Market, Zifasing

Photo credit: Coffey, 2017

Figure 12.9
Cucumber garden at Ganef village

Photo credit: Coffey, 2017

Figure 12.10
Offices of Markham Agro Pty Ltd

Markham Agro Pty Ltd has established a settlement near the plantation which houses its workforce and their family members (ibid). In the 2011 Census (NSO, 2011), 41 persons were recorded as living at Markham Farm. An image of the Markham Agro Pty Ltd offices is provided as Figure 12.10.

12.5.3. Durung Farm

Durung Farm (also referred to as Durum Farm) is located approximately 15km east of Zifasing, and 2.5km south of Nadzab. Durung Farm is a village which, according to unpublished data from the 2011 Census, had a population of 334 persons in 66 households (approximately 386 persons in 2017). A commercial poultry farm is located within the study area near Durung Farm, owned by 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 Provincial Government in 2011 for the purpose of leasing to Niugini Tablebirds (The National, 2011a, 2011b).

Houses serviced by a vehicle track were observed approximately 1.5km east of the Niugini Tablebirds facility, adjacent to the PPL transmission line corridor (Figure 12.11). A chicken hatchery was also observed at this location. 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 (Figure 12.12).

12.5.4. Gabsongkeg and Surrounds

Gabsongkeg village (sometimes spelt 'Gapsongkeg' or 'Gabsonkec') is located approximately 19km east of Zifasing. The main part of the village is located immediately north of the PPL transmission line corridor, and extends approximately 700m 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 and Skelly, 2017) found that Gabsongkeg people identify as Wampar, with the Wampar language generally spoken in the village. The present-day location of Gabsongkeg was established in the early 20th century. For further information on tangible and intangible heritage located in this area, see Chapter 13, Cultural Heritage Characterisation, and Appendix U, Cultural Heritage Baseline and Impact Assessment.

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 primarily subsistence lifestyles and sourced food by gardening, hunting and fishing. Drinking water was reportedly sourced from springs and wells, with nearby creeks an alternative source of water.

Access to the main part of the village is reached via Gabsongkeg Road, which runs southwards from the main village and across the PPL transmission line corridor, before turning eastwards to join the Highlands Highway towards the city of Lae.

Focus group respondents also indicated that fishing occurs in the Markham River to the south and village residents living in the main part of Gabsongkeg walk across the PPL transmission line corridor to reach the Markham River. Figure 12.13 indicates the locations of education and health facilities reportedly used by communities in this study area.

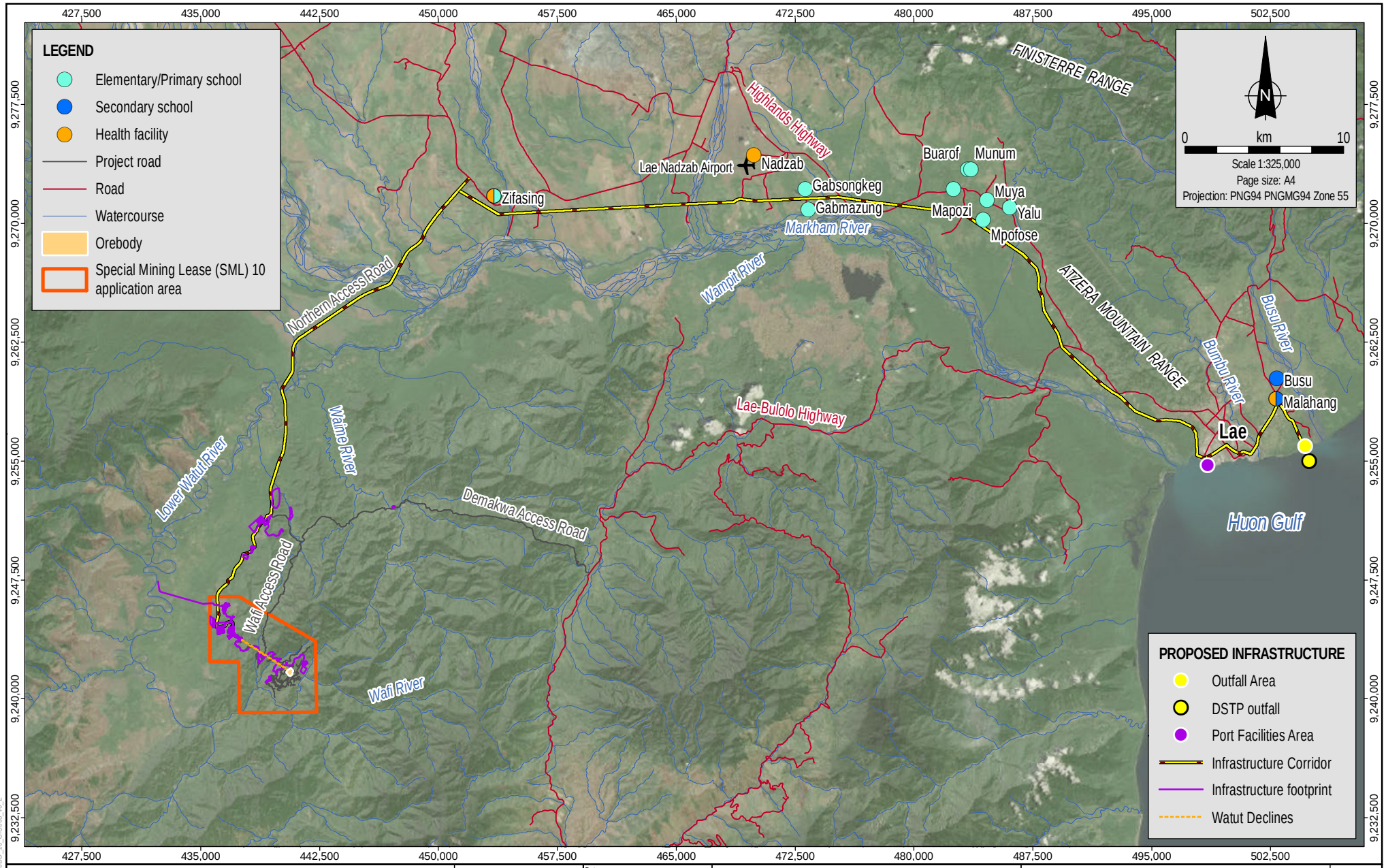
A number of rice fields are located within the study area near Gabsongkeg village, which are reportedly operated by TruKai Rice (a PNG rice company). Field observations in 2017 indicated that these rice fields were untended (Figure 12.14).

Photo credit: Coffey, 2017

Figure 12.11
House and water well east of Niugini Tablebirds

Photo credit: Coffey, 2017

Figure 12.12
Chicken hatchery of local individual in business with Niugini Tablebirds



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: 13.06.2018
Project: 754-ENAUABTF100520DD
File Name: 0520DD_10_F12.13_GIS

WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Educational and health facilities accessed by Study Area 2 residents

Figure No: **12.13**

MXD Reference: 0520DD_10_GIS065_v0_2

Photo credit: Coffey, 2017

Figure 12.14
Rice fields no longer in use within the study area near Gabsongkeg

Photo credit: Coffey, 2017

Figure 12.15
House within Study Area 2, approximately 2km east of Gabsongkeg village

Photo credit: Coffey, 2017

Figure 12.16
Water source for residents living in houses 2km east of Gabsongkeg

East of Gabsongkeg village, the Highlands Highway traverses the study area twice. Residential areas and gardens were observed, as well as creeks used as water sources (Figure 12.15 and Figure 12.16). According to informal conversations with local people, some of the houses observed are landowners' residences, while other houses are occupied by settlers who had paid landowners for the right to occupy the land.

12.5.5. Munum

Munum village is located approximately 30km east of Zifasing, and 22km 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).

Munum people migrated from Wafi in the 15th or 16th century, over time establishing themselves in the Atzera Mountain Range 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 (Muke and Skelly 2017; see also Appendix U, Cultural Heritage Baseline and Impact Assessment). People at Munum identify as Wampar and Wampar is spoken as the *tok ples* (local language), 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 (ibid).

A community focus group of over 150 attendees was held at Munum village in February 2017. Respondents indicated that Munum residents lead primarily subsistence lifestyles and food is sourced from fishing, gardening, and hunting. Water is sourced primarily from ponds and springs located approximately 30 minutes' walk from the village. Respondents reported that the water quality is unsatisfactory, due to perceived lack of cleanliness of the water.

Focus group respondents reported that fishing spots and sago stands are located along the Markham River, approximately 5km south of the village. To reach the Markham River, a person would walk up to 3 hours, taking a route which crosses the PPL transmission line corridor.

Field observations showed that Munum hamlets are located within the study area near (less than 100m from) the PPL transmission line corridor (Figure 12.17 and Figure 12.18).

According to focus group participants, the main elementary schools attended by children of Munum village are St John Elementary, Mapozi Elementary, Buarof Elementary, Munum Elementary and Muya Elementary. The main primary school is Munum Primary School. High school students generally attend Salamaua High School, which reportedly requires a two-hour commute via PMV and a speed boat. See Figure 12.13 for the locations of schools within this study area.

12.5.6. Yalu

Yalu village is adjacent to Munum village. The main part of Yalu village (where most residences are located) is situated approximately 20km northwest of Lae and north of the Highlands Highway. According to unpublished data from the 2011 Census, the population of Yalu village was 659 persons, living in 140 households. The population in 2017 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).

Photo credit: Coffey, 2017

Figure 12.17
Garden at a Munum hamlet

Photo credit: Coffey, 2017

Figure 12.18
Houses located near Munum village within 100m from the PPL transmission line corridor

According to Muke and Skelly (2017; see also Appendix U, Cultural Heritage Baseline and Impact Assessment), people in Yalu are Aribwaungg people (also spelt Aribwaung, Aliwang and other similar variations: see Holzknecht, 1989). The ancestral migration stories of the Yalu clans are confidential, although anecdotal evidence indicates that some clans migrated from the coastal regions east of the Atzera Mountain Range into the Markham River valley in the 14th or 15th centuries (Muke and Skelly, 2017; see Appendix U, Cultural Heritage Baseline and Impact Assessment).

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 at Ngaluchangetz hamlet, located approximately 1km south of the main village. This hamlet was occupied by an extended family unit living in approximately 10 households.

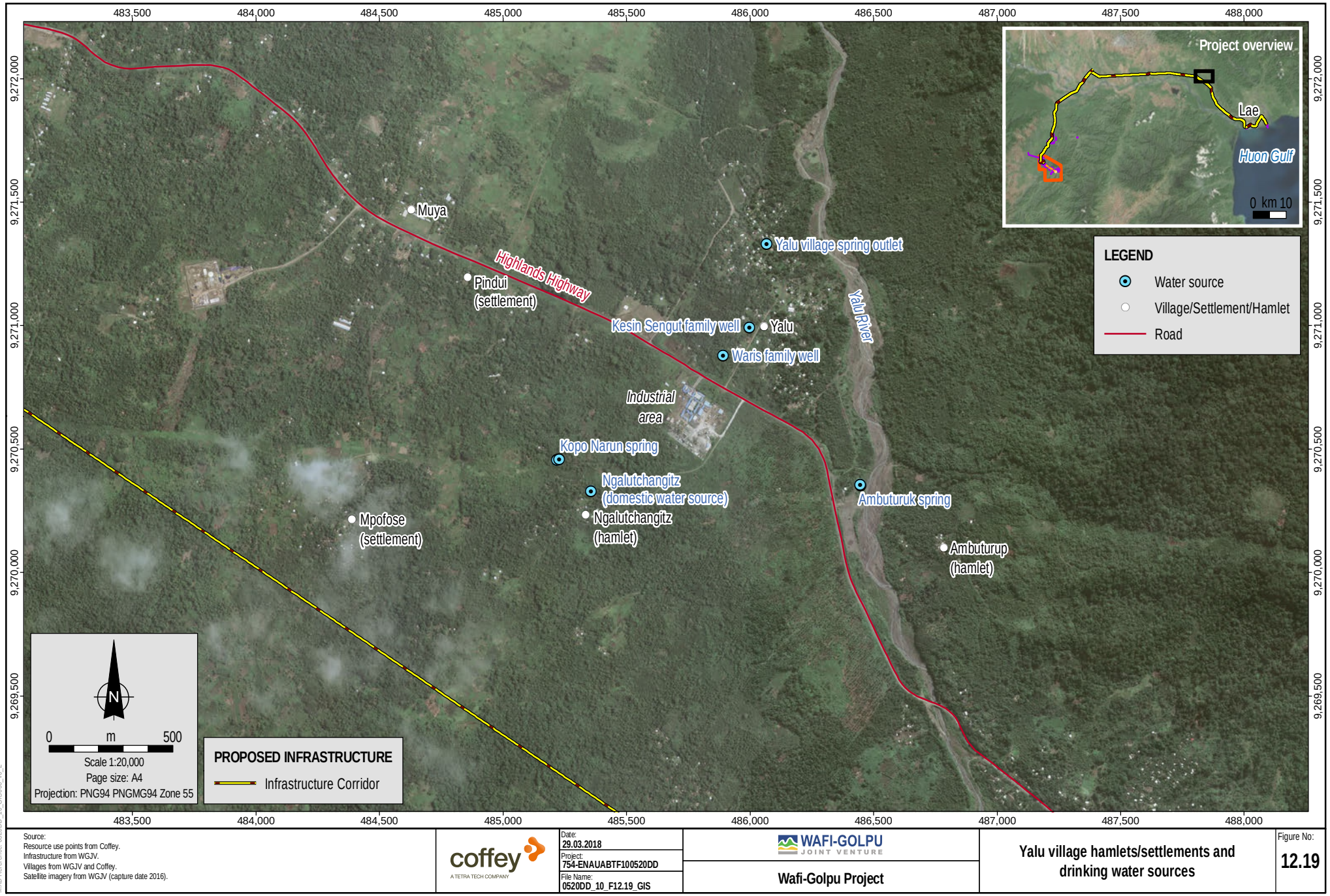
The men's and women's focus groups indicated that water for domestic use (drinking, washing and bathing) is primarily delivered via a pipe to the village, and ultimately sourced from the Yalu River. Secondary sources of water were reported as being creeks and springs. Two springs were recorded in the key informant interview: one located near an industrial compound to the south of the main village, and another near Ngauchangetz hamlet. Spring water was reported to be of satisfactory quality, and available all year round. Figure 12.19 presents the locations of drinking water sources used by residents of Yalu village and associated hamlets.

At Yalu village, food was reported as generally sourced from gardening, hunting, fishing, gathering and the raising of livestock. Participants in the key informant interview stated that gardens are the most important food source for residents in Yalu. Most households indicated having their own gardens, and gardening is undertaken by men and women several times a week. Key crops include 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 are also grown. Sago is grown by Yalu villagers, and sago stands are located south of the village by the Markham River. At Ngaluchangetz hamlet, gardens were observed on the PPL transmission line corridor.

Similarly, gardens have been established adjacent to the PPL transmission line corridor at Mpofose settlement, residences of which are located 1.6km southwest of the main part of Yalu village. Mpofose settlement includes two communities of people from Hagen and Markham regions. The head of Ngaluchangetz hamlet indicated that these communities settled at Mpofose 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 are 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 occurs 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 are located up to 8km to the northeast towards the Busu River, 6km east across the Yalu River, and 4km south towards the Markham River. The women's focus group added that hunting is undertaken for both food and traditional purposes. Both groups suggested that hunting is done only occasionally (less frequently than monthly).



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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WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Yalu village hamlets/settlements and drinking water sources

Figure No: 12.19

MXD Reference: 0520DD_10_GIS066_v0_2

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 4km), and to the north and east with bush materials gathered up to 5km away from the main village.

12.5.7. From Yalu to Outskirts of Lae

This section presents socioeconomic baseline information for the segment of Study Area 2 between Yalu and the western boundary of Lae Urban LLG. This segment of the study area is 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 key informant interview at Yalu village indicated that this part of the study area is situated on Yalu land. Settlers were observed living within this section of the study area. Figure 12.20 depicts a settler house which is well established, well-tended and seemingly permanent. Informal conversations 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 stand was also observed within the study area (Figure 12.21); 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 study area traverses land used for commercial agriculture. Enterprises observed included Wanaru Farm (premises used by Niugini Tablebirds to raise chickens; Figure 12.22), premises occupied by Mainland Holdings (which operates a crocodile farm), and premises used by PNG Steel Limited as a laydown area. These commercial premises are located in the vicinity of 3 Mile, up to 3km west of the border of Lae Urban LLG.

12.6. Socioeconomic Baseline: Study Area 3 (Lae)

This section describes the socioeconomic context of Study Area 3 (Lae). Specific information is provided in relation to the southern and eastern parts of the study area, through which the Infrastructure Corridor is proposed to traverse.

12.6.1. Population and Settlement

The city of Lae is PNG's second largest city. The 2011 Census (NSO, 2011) 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 2000 and 2011 censuses was 2% per annum; applying this rate would suggest a population in 2017 of approximately 168,000 persons.

The customary landowners within Lae include the Ahi and Labu peoples (Holzknecht, 1989; Sinclair, 1998). They include people of the Aribwaungg (also known as Aliwang and Aribwaung) language group and the Bukawa (also known as Kawac or Bugawac) language group. 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 regulated by 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.

Photo credit: Coffey, 2017

Figure 12.20
Settler house near the Highlands Highway between Yalu village and Lae

Photo credit: Coffey, 2017

Figure 12.21
Sago stand within Study Area 2 near Lae

Photo credit: Coffey, 2017

Figure 12.22
Wanaru Farm (Niugini Tablebirds)

In an informal settlement, occupants reside on land to which they have no customary or other legal claim, or any formal agreement with the landowner (see Kaitilla, 1994). 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 (JICA, 2017; Jones, 2012). A recent review of land use in Lae indicated that there has been further growth in informal settlements, particularly along Independence Drive (Back Road) (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 (Kumul Consolidated Holdings, 2014). 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. The Lae Urban LLG and the Morobe Provincial Government are also reported to perceive informal settlements as a hindrance to the urban growth potential of the city (ibid).

12.6.2. Urban Land Use

This section describes land use within Lae. An overview of land use for Lae is provided, followed by a more detailed description of land use along the Infrastructure Corridor which is proposed to traverse the south and east of Lae.

12.6.2.1. 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, wholesale and retail, 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'). International companies, such as Coca-Cola Amatil, Nestle and Dulux, have their local headquarters in the city.

Table 12.5 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 the 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 expansion in the Lae Urban LLG boundaries.

During field observations in 2017, gardens were observed in some settlement areas, potentially providing a food source for low-income residents of Lae.

Table 12.5: Land use types in Lae

Land use category	2003		2015	
	Area (ha)	Percentage (%)	Area (ha)	Percentage (%)
Residential	560	20%	510	14%
Informal residential (informal settlements)	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)

12.6.2.2. Land Use in the Southern and Eastern Parts of Lae

Land use adjacent to the Infrastructure Corridor (in the south and east of the study area) 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 and adjacent to 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 12.23:

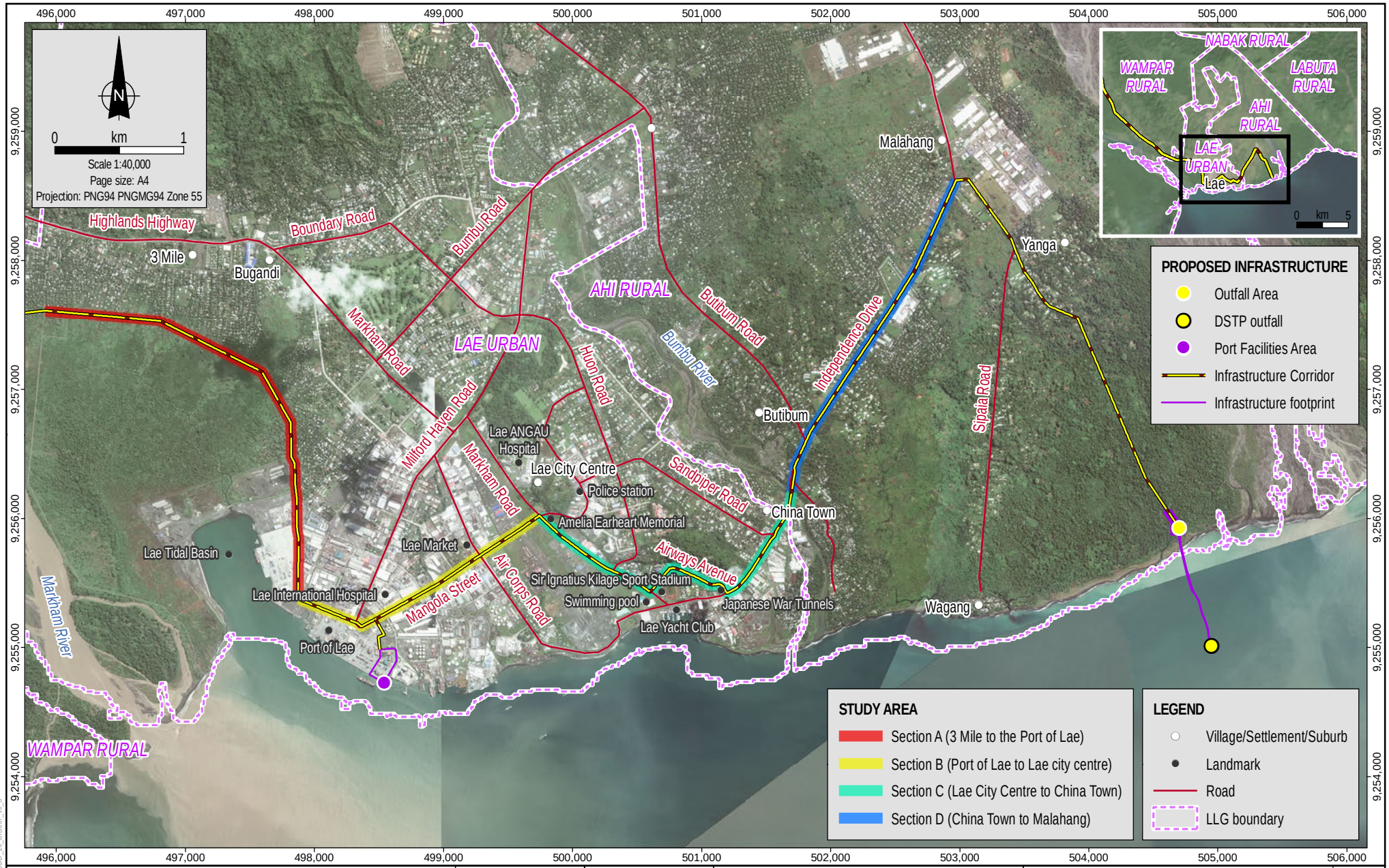
- From 3 Mile to the Port of Lae (marked as Section A in Figure 12.23).
- From the Port of Lae to Lae City Centre (marked as Section B).
- From Lae City Centre to China Town (marked as Section C).
- From China Town to Malahang (marked as Section D).

12.6.2.2.1. 3 Mile to Port of Lae (Section A)

In this part of the study area, the Infrastructure Corridor traverses through or near 3 Mile, Bugandi, Dowsett (suburbs of Lae) and the Lae Tidal Basin.

At 3 Mile, the area is characterised by commission housing and settlements (Figure 12.24 and Figure 12.25), along with scattered roadside stalls selling fruit and vegetables. Where not occupied by residential structures, the land is predominantly used for settlers' gardens. A police station is located at 3 Mile.

The neighbouring suburb of Bugandi is a residential area, reportedly populated by settlers. Figure 12.26 shows a settler house and garden.



MXD Reference: 0520DD_10_GIS067_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).

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WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Field observation locations within Study Area 3

Figure No: **12.23**

Photo credit: Coffey, 2017

Figure 12.24
Housing commission in 3 Mile

Photo credit: Coffey, 2017

Figure 12.25
Settler house in 3 Mile

Photo credit: Coffey, 2017

Figure 12.26
Settler house and garden in Bugandi

12.6.2.2.2. Port of Lae to Lae City Centre (Section B)

In this part of the study area, the proposed Infrastructure Corridor will traverse Bumbu Road near the Port of Lae for approximately 400m, and continue along Mangola Road for approximately 2km towards the centre of Lae. Along Bumbu Road, the area is characterised by numerous industrial warehouses and port facilities, including Consort Express Lines Limited (a shipping company) (Figure 12.27) 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), manufacturing businesses, Lae Market and Brian Bell Plaza, the largest retail mall in Lae (Figure 12.28). Lae International Hospital is also located on Mangola Street, near the Port of Lae.

12.6.2.2.3. Lae City Centre to China Town (Section C)

In this part of the study area, the proposed Infrastructure Corridor would traverse from the city centre of Lae along Markham Road for approximately 1km before turning left onto Airways Avenue for about 800m and continuing in a northeast direction through China Town. This area is mixed commercial and residential, and also includes schools, Balob Teachers' College (Figure 12.29), churches and a cemetery. The Australian New Guinea Administrative Unit (ANGAU) Hospital, the second largest hospital in Papua New Guinea, is located 150m from the junction of Mangola and Markham Road, through which the proposed Infrastructure Corridor will traverse.

Community assets located adjacent to the Infrastructure Corridor within this section of the study area include the Amelia Earhart Memorial, a swimming pool, the Sir Ignatius Kilage Sport Stadium (Figure 12.30) and World War II Japanese War Tunnels.

Residences are located at the eastern end of this section of the study area, adjacent to the Infrastructure Corridor. They are serviced by numerous small business such as supermarkets (Figure 12.31) and Bumbu Market, which is located near the Bumbu River (Figure 12.32). Industries are also located in this area, including a Nestle chocolate factory (Figure 12.33).

12.6.2.2.4. China Town to Malahang (Section D)

From China Town, the proposed Infrastructure Corridor will run approximately 3km along Independence Drive to Malahang. The predominant land uses in this section of the study area are commercial businesses and industrial facilities, including the Majestic Seafood Company (Figure 12.34), a scrap metal recycling plant, the Malahang Industrial Centre (which has offices for approximately 50 business; Figure 12.35), and a number of other business compounds (Figure 12.36).

Settler houses and gardens were also observed adjacent to Independence Drive. Figure 12.37 shows a small store and a settler residence behind a fence, in a settler district east of Independence Drive. Figure 12.38 is a settler garden within the Malahang area.

Two schools are located adjacent to Independence Drive – a primary school run by the Assembly of God (Figure 12.39), and Malahang Technical High School, which is located opposite the Malahang Industrial Centre. Malahang Market is located on Independence Drive near the Malahang Industrial Centre. The Malahang Health Centre is located off 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.

Photo credit: Coffey, 2017

Figure 12.27
Premises of Consort Express Lines Limited, situated along Bumbu Road

Photo credit: Coffey, 2017

Figure 12.28
Brian Bell Plaza (a retail mall)

Photo credit: Coffey, 2017

Figure 12.29
Balob Teachers College adjacent to Butibum Road (near Chinatown)

Photo credit: Coffey, 2017

Figure 12.30
Sir Ignatius Kilage Sports Stadium in Lae along Airways Avenue

Photo credit: Coffey, 2017

Figure 12.31
Supermarket in Chinatown

Photo credit: Coffey, 2017

Figure 12.32
Bumbu Market (near Bumbu River) along Butibum Road

Photo credit: Coffey, 2017

Figure 12.33
Nestle chocolate factory on Butibum Road

Photo credit: Coffey, 2017

Figure 12.34
Majestic Seafood Company premises on Independence Drive

Photo credit: Coffey, 2017

Figure 12.35
Business premises at Malahang Industrial Centre adjacent to Independence Drive

Photo credit: Coffey, 2017

Figure 12.36
A business compound adjacent to Independence Drive, Malahang area

Photo credit: Coffey, 2017

Figure 12.37
Settler residence and store in Malahang area

Photo credit: Coffey, 2017

Figure 12.38
Settler garden in Malahang area

Photo credit: Coffey, 2017

Figure 12.39
Assembly of God Primary School on Independence Drive

Photo credit: Coffey, 2017

Figure 12.40
Bumbu River along Butibum Road

12.6.3. Water and Sanitation

Many residents of the city of Lae have access to piped water, but also use 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) (Figure 12.40), or create a rudimentary rainwater harvesting system.

The lack of access to clean drinking water is a recognised issue, 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).

The majority of the city of Lae has trunk sewers with sewage 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 system, 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). The ever-increasing rural–urban movement of people coming to stay with friends and family, and the building of new settlements to accommodate in-migrants, exacerbates the situation.

12.6.4. Utilisation of Marine Resources

Lae and surrounding villages are located on the Huon Gulf. Artisanal fishing groups in the Huon Gulf are small-scale, low-technology, low-capital fishing operations. 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 a few individuals from the same village and operate communally. The most common fishing methods observed by regular fishers from Labu were hand-lining using ‘drop-stone’ techniques, vertical long-lining and trolling (Appendix P, Deep-slope and Pelagic Fish Characterisation). Discussions with locals at the fish market at the Department of Civil Aviation Point (known locally as ‘DCA Point’; Appendix P, Deep-slope and Pelagic Fish Characterisation) identified that handline methods targeted both demersal and pelagic fishes in water depths usually between 50m and 100m, while trolling targeted fishes in shallower areas to depths of 10m. Fishing depths were estimated from discussions with local people 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 10m 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 (Appendix P, Deep-slope and Pelagic Fish Characterisation). At the DCA Point fish market, a string of small mackerel (up to 20cm long) costs PGK10–20. A medium fish (20–50cm long) costs approximately PGK30. A larger fish weighing 3kg costs approximately PGK60.

Deep-water or deep-slope fish are caught in the Huon Gulf with bottom longlines or droplines. Discussions with local Labu villagers, located to the south of Lae, identified that dropline fishing using baited hooks targeted demersal fish species in water depths usually between 50m and 100m, but generally not deeper than 100m (Appendix P, Deep-slope and

Pelagic Fish Characterisation). 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, rely heavily on the coastal fishery (Quinn and Kojis, 1987) including the Labu Lakes, Markham River and near-shore marine waters. Fishing is 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 them to be caught by subsistence and artisanal fishers (Rosegrant et al., 2015).

Fish that are not used for subsistence purposes are usually sold or given to friends and relatives. A formal fish market (with facilities maintained by the Lae Urban LLG) has recently opened at the National Fisheries Authority's (NFA) Voco Point site (Kapin, 2017). There are also informal fish markets (established as ad hoc stalls by vendors) at Voco Point and DCA Point. In addition, fish are 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 which contributes to promoting employment, increasing cash income and securing food for the coastal community involved in the fishery (NFA, pers. com., 2016).

The west Pacific leatherback turtle (*Dermochelys coriacea*) is known to nest along beaches of the Huon Gulf south coast (Appendix S, Fisheries and Marine Resource Use Characterisation), and this region represents the largest nesting population in PNG. West Pacific leatherback turtle nests were observed in the Labu villages south of Lae, near Labu Butu and Labu Tale in November 2016 (Appendix R, Nearshore Marine Characterisation), but not in Lae itself. Turtle eggs found may be sold at markets including markets in Lae (Appendix S, Fisheries and Marine Resource Use Characterisation; see also Kinch, 2006).

Various turtle recovery projects have been established along the southwestern Huon Coast nesting area near Labu Butu, Labu Tale, Busama, Salamaua and in locations further south (Kinch, 2006; PNG Ports Corporation, 2007). Local people from Labu Butu and Labu Tale stated they previously conserved west Pacific 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-legally binding tri-national partnership Memorandum of Understanding. These programs were devised to explore methods for governments, communities and institutions to manage and conserve nesting sites, feeding areas and turtle migration routes (Kinch, 2006). Since the cessation of conservation program funding, or lack of tangible economic benefit from conservation initiatives (Kinch, 2006), local people interviewed 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.

With respect to non-fishing marine resource use, 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 (MarineTraffic, 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 traffic includes outrigger dugout canoes and outboard-motor–driven banana boats and dinghies, which are used by local people regularly carrying goods and passengers 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 (Appendix S, Fisheries and Marine Resource Use Characterisation). Along the Huon Gulf north coast, small watercraft traverse routes between Lae and the coastal villages east of Wagang in the area of the Outfall System.

The main recreational activities in the Huon Gulf include game fishing, diving and snorkelling on coral reefs and shipwrecks, and bathing and swimming. According to EnviroGulf (see Appendix S, Fisheries and Marine Resource Use Characterisation), diving and snorkelling sites are generally located off the Salamaua Peninsula (approximately 30km south of Lae), and there is a shallow dive wreck near Labu Tale (approximately 9km south of Lae). Recreational fishing is undertaken generally south of the Markham River, and at Tami Islands approximately 90km east of Lae. Bathing and swimming occur close to Lae and in surrounding villages (see section 12.7.3.3.5 for a description of recreational swimming at Wagang village).

12.6.5. Economy

12.6.5.1. Economic Infrastructure

Lae is host to a range of industries. Compared with many other parts of PNG, Lae has fairly well developed economic infrastructure including the Highlands Highway (which connects Morobe Province to the Central Highlands Region), the Ramu Highway (which connects Morobe Province to Madang), the country's largest port, a domestic airport and, more recently, a 30MW thermal power station.

The Port of Lae is the largest port in PNG (JICA, 2017). It has six berths and is capable of handling a range of freight from break-bulk, liquid fuels, containers and commercial tuna catches. The port handles approximately 250 vessels per month (Appendix S, Fisheries and Marine Resource Use Characterisation; MarineTraffic, 2017). 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 infrastructure. At time of writing, there has been limited uptake of the facilities at the Lae Tidal Basin.

Lae (Nadzab) Airport is located approximately 50km from Lae. The airport replaced the Lae Airfield as the primary airport servicing Lae in 1977. Nadzab Airport has a runway length of 2,438m with a width of 30m. Currently, it services domestic flights only and there are plans to upgrade the airport.

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 the Ramu 2 Hydropower Project (a proposed hydroelectric power station on the Ramu River). It will cater for approximately three quarters of the city of Lae's power requirements (Giame, 2017).

12.6.5.2. 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 purse-seine tuna fishing grounds are located well to the north and east of the Huon Gulf (Appendix S, Fisheries and Marine Resource Use Characterisation). Furthermore, 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 (Appendix S, Fisheries and Marine Resource Use Characterisation). A further three foreign-owned canneries propose starting commercial operations in Lae in the coming years potentially 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 (Appendix S, Fisheries and Marine Resource Use Characterisation). The Morobe Fisheries Management Authority is promoting the development of a Wagang fishery port southeast of the city of Lae to boost further the cannery business opportunities within the region (JICA, 2017).

As noted above, a fish market (operated by Lae Urban LLG) has recently opened at NFA's Voco Point site (The National, 2017). There are also informal fish markets at Voco Point and DCA Point. Fish are also sold at the formal Lae Main Market at various fish stalls, albeit in small quantities.

12.6.5.3. 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 48% of households interviewed) and PGK1,000-5,000 (32%). Approximately 19% indicated receiving less than PGK500 per month.

There is a large disparity in employment opportunities between the city of Lae and surrounding rural areas (JICA, 2017). Generally, there are more employment opportunities within the city of Lae for people with appropriate skills and experience. However, employers in Lae have reported difficulties filling job vacancies in the formal sector with reliable staff possessing basic technical and life skills, such as discipline and reliability, even for semi- and low-skilled 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).

12.6.6. Education

Compared to other parts of PNG and the Morobe Province as a whole, residents of Lae Urban LLG have high education levels and better access to secondary and tertiary education (JICA, 2017). According to 2011 Census data, 25.8% had enrolled in secondary education and 15.3% in tertiary education (NSO, 2011). 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 five tertiary institutions (including vocational institutions). Tertiary institutions include the University of Technology, Lae Technical College (including the associated Forestry College at Bulolo), Balob Teachers College, the Martin Luther Seminary and the Lae School of Nursing (PNG Division of Education, 2007).

12.6.7. Health

12.6.7.1. Access to Health Services

There are 13 health facilities within the Lae Urban LLG (JICA, 2017). These include two hospitals, 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 and 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 each other within the hospital leading to inefficiencies in service delivery.

Furthermore, the draft Master Plan Report concluded that ANGAU Hospital's capacity is stretched due to the Lae population's limited access to healthcare outside of the facility, placing a further significant strain on the hospital's already limited resources (Hassal and 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 an inadequate level of treatment for most patients in the region (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 Province (including the city of Lae) (JICA, 2017).

12.6.8. Law and Order

Despite scarce statistics, studies have identified the Highlands Highway to be a hotspot of criminal activity (Dinnen, 2001; Weber, 2008). Crime (including criminal *raskol* gang activity) has been identified as concentrating in urban areas (Dinnen, 2001), although criminal gang members are often also integrated within both rural and urban societies (Goddard, 1995). In-migration to Lae, partly driven by the pursuit of employment opportunities, has been identified as a key source of conflict (JICA, 2017). As in-migrants often settle in informal settlements, informal settlements within Lae have become centres of conflict and crime.

In Lae, crime levels are consistently high, with robbery and assault 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 and 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 (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 had 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 the Lae urban area. Responses to incidents such as accidents, fires and crimes cannot always be provided immediately (JICA, 2017). Crime levels have been increasing in the Lae region to the point that an increased police and security presence is 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.

12.6.9. 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; IFC, 2012).

Informal settlers within Lae may be considered a vulnerable group. 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 and 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 and 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 such services indicates that people with a disability have high potential to experience disadvantage within the community.

12.6.10. Traffic and Transport

This section describes traffic and transport within Lae, with emphasis on roads in which the Infrastructure Corridor is proposed to be constructed in the south and east of the study area.

12.6.10.1. Management of Roads, Traffic and Transport

Within Lae, four key organisations undertake road management (JICA, 2017):

- Department of Transport
- Department of Works
- Morobe Provincial Administration (Division of Works and Transport, and Traffic Registry)
- Lae Urban LLG

Roads within 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 road management and policy at the national, provincial, district and LLG levels. JICA (2017) notes that many roads in Lae remain unsealed, and susceptible to closure during heavy rain.

12.6.10.2. Public transport

Lae is serviced by seven 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 12.41 provides a route map for PMV services in Lae. Urban Routes 13 and 14, and Rural Route 2 service parts of the Lae City Centre, China Town, Butibum and Malahang.

12.6.10.3. Traffic along Infrastructure Corridor within Lae

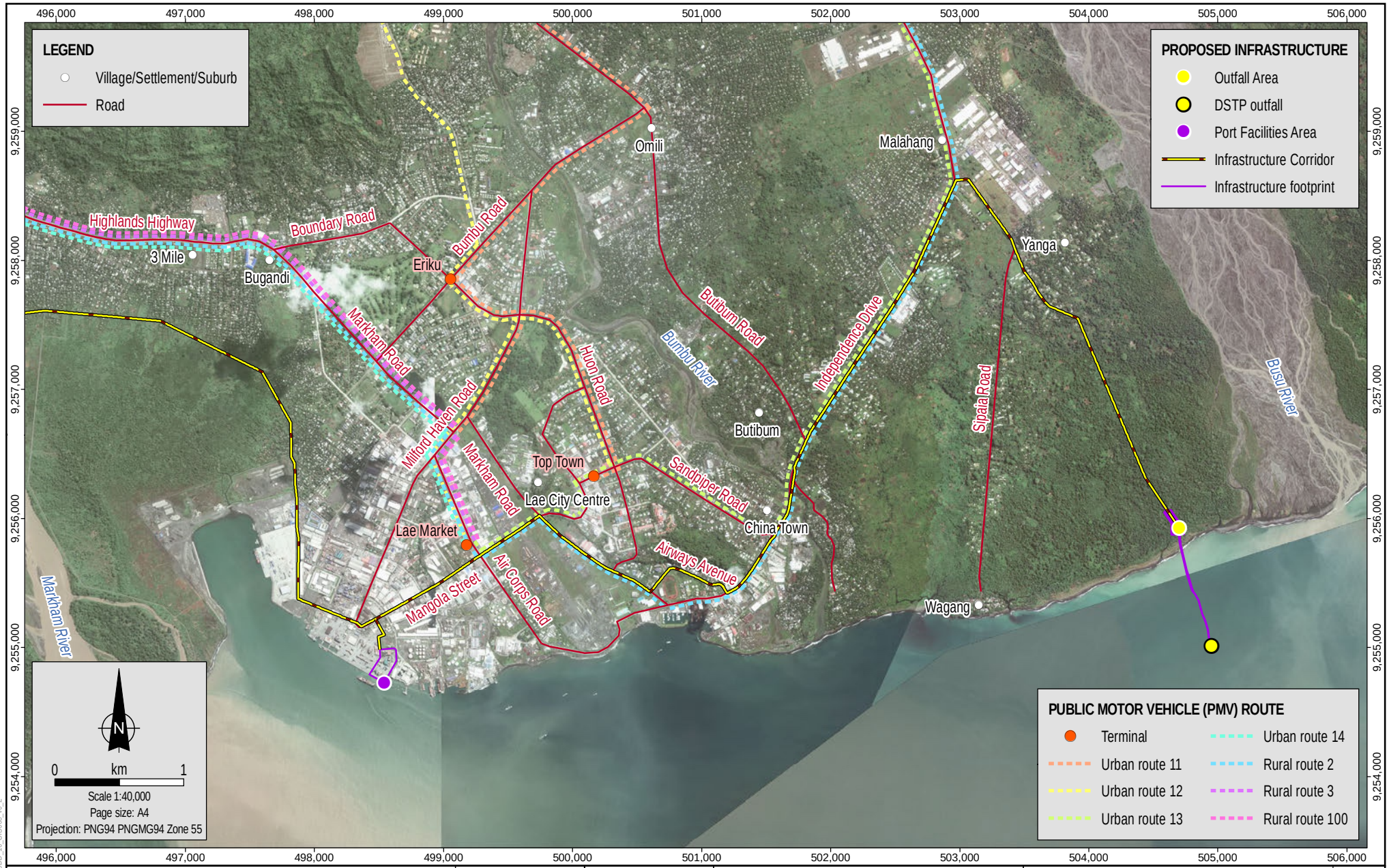
As described above, the proposed Infrastructure Corridor will traverse along urban roads from the Port of Lae, through the city centre of Lae, China Town and Malahang, before turning southeast towards the proposed Outfall Area.

JICA (2017) has projected traffic loads for main roads in Lae for the year 2025, as shown in Figure 12.42. 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 volume of traffic at Mangola Street is predicted to be at capacity in 2025. Markham Road is predicted to be below capacity in the same period. Butibum Road and Independence Drive are 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 on Independence Drive at Malahang to characterise current traffic loads at that location. 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. The traffic count was undertaken over a period of four days (Friday to Monday) between 06:30 and 17:30.

On weekdays (Friday and Monday), the number of vehicle movements over the 11-hour period from 06:30 to 17:30 was around 6,000, with weekend traffic being in the order of 50% less. This location exhibited distinct morning and afternoon peaks (07:30 to 08:30, and 16:30 to 17:30 respectively), as well as a minor peak from 12:30 to 13:30 during the lunch period. The average vehicle movement per hour was recorded as 500–600 vehicles.



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: 12.41

MXD Reference: 0520DD_10_GIS088_v0_2

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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WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Volume-to-capacity ratio of roads in Lae (2025 projection)

Figure No: 12.42

MXD Reference: 0520DD_10_GIS069_v0_2

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 traffic was heaviest on Monday, with approximately 3,500 movements recorded. There are distinct busy periods in the morning (07:30 to 08:30) and afternoon (15:30 to 16:30) coinciding with school commencement and finish times. The average hourly pedestrian movement was approximately 200.

12.7. Socioeconomic Baseline: 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. Information is presented according to the following themes:

- Population and settlement
- Cultural overview
- Land and water resource utilisation
- Housing
- Economy
- Education
- Health
- Law and order
- Vulnerable and disadvantaged groups
- Traffic and transport

12.7.1. Population and Settlement

Wagang is a coastal village located approximately 3km east of Lae. It is accessed via Sipaia Road and Busu Road, which connects the village to Independence Drive at Malahang. Wagang had a population of 542 persons in 2011 (NSO, 2011). Residents of Wagang live in houses located by the shore, as well as on either side of Sipaia Road. Yanga is located approximately 3km 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. 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 (NSO, 2011). The median age for Wagang was also higher than for Study Area 1, which was recorded as 18 years. The dependency ratio (the proportion of persons under 16 and over 59 years of age, relative to persons between 16 and 59 years) was 60% in Wagang, lower than the dependency ratio of PNG (73%), and for Study Area 1 (74% for Tier 1 villages and 68% for Tier 2 villages). Average household size recorded in Wagang (6.2 persons) was slightly higher than that recorded for PNG in the 2011 Census (5.3 persons).

The people of Wagang identify as Ahi people (Muke and Skelly, 2017; see also Appendix U, Cultural Heritage Baseline and Impact Assessment). The original Wagang village (known as Wagang 1) was located to the northeast of the existing village (ibid). During World War II, people sought refuge west of the Busu River, and Wagang 1 (now the site of Alanghu village) was abandoned. 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, and Wagang villagers have maintained contact with people east of the Busu River (Muke and 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). Field observations in 2017 indicated that above-ground portions of this wreck have largely been removed from the village, although parts of it are observable underwater from the beach.

The 2017 Household Surveys at Wagang village sought to ascertain the degree of in-migration into Wagang village. Over half (53%) of respondents stated that household members had been born in Wagang. Nearly a quarter of respondents (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.

12.7.2. Cultural Overview

According to Muke and Skelly (2017; see also Appendix U, Cultural Heritage Baseline and Impact Assessment), the *tok ples* (local language) is the Yabem language, which was introduced to Wagang by Lutheran missionaries in the early 1900s who 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. For further information, refer to Chapter 13, Cultural Heritage Characterisation.

12.7.3. Land and Water Resource Utilisation

Wagang and Yanga villages' utilisation of land and water resources is discussed in this section.

12.7.3.1. Utilisation of Land Resources

12.7.3.1.1. Gardens

In Wagang, gardening has reportedly diminished in importance over the last decade or so, with people increasingly dependent on store-bought and market foods. This trend may indicate a decreasing reliance on subsistence farming. Household surveys estimated that 40% of food consumed in Wagang village was harvested from gardens.

Key informant interview respondents indicated that gardens are mostly located in the area east of Sipaia Road, to the east and northeast the village. They estimated that a half-hour walk is necessary to reach gardens. Some gardens are also located west of Sipaia Road, about half an hour walk away.

Respondents reported that land for gardens had gradually extended further from the village and Sipaia Road. Existing gardens were reportedly moved and re-established to the east (and, to a lesser extent, to the west) of the village due to additional houses being built along the road to meet population growth of Wagang village.

The most commonly grown produce reported by household survey respondents is greens (*kumu*) (56%) and coconut (30%). The women's focus group added that sweet potato (*kau kau*), tapioca, sugar cane, *pit pit* (a type of cane), cucumber and beans are also grown.

In Yanga, survey respondents stated that food is primarily sourced at the village trade store, secondly from gardens and thirdly from Lae markets. This indicates that food from gardens is one of several sources of food for this village. Gardens are attended to twice a week on average by both men and women. Garden produce is consumed within the household and sold at local markets.

Banana, taro, yam, greens (*kumu*) and sweet potato (*kau kau*) were reported as the key crops grown. Other crops grown in Yanga are *marita* (a type of pandanus fruit), cassava, cocoa, sugar cane, peanuts, betel nut, tobacco (*brus*), coconut and sago. Sago was not identified as a staple food item and was only reported as being important in times of food shortages, with the palm being harvested and processed on average once a year.

Respondents indicated that gardens are located up to 1km east and 2-3km southeast of the village, between the village and the Busu River. They reported that a half hour walk is required to reach gardens from the village. While respondents did not directly state that they lack 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. Gardens are usually re-established in the same (rather than new) locations.

12.7.3.1.2. Hunting and Gathering

In Wagang, participants in the women's focus group suggested that meat sourced from hunting is not an important part of their regular diet. Hunting is, however, seen as important for special feasts. The key informant interview revealed that hunting is undertaken two or three times per year and it has reportedly declined in recent years, due to a decrease in game. This decrease was attributed to the disruption of animal habitats, although the nature of disruption was not discussed. Respondents reported hunting bandicoot (locally called *mumut*), flying fox, wild pigs, lizards and cuscus.

Hunting grounds are reported as located northeast of the village, east of 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. Firewood, building materials, bush fruit and vegetables, logs for making canoes, and traditional medicines are also gathered.

As in Wagang, interview participants in Yanga suggested that hunting does not occur regularly and hunted meat is not essential for regular village diets and is generally reserved for special feasts. On average, hunting is undertaken once a month and generally by younger males only. Typical species hunted include bandicoots, flying foxes, wild fowls, wild pigs, birds and lizards.

Hunting areas are similar to garden areas, approximately 1km to the east and 2–3km southeast of Yanga, west of the Busu River. Respondents reported that hunting is undertaken using spears, traps, sling-shots and hunting dogs.

Gathering of bush resources occurs to the east of the village, between the village and the Busu River in similar areas as hunting and garden activities. Items gathered include firewood, building materials, bush fruits, vegetables, and medicinal plants. These items are used for household consumption and income generation. That gathering, hunting and gardening were all reported to occur in the same general location indicates subsistence dependency on the confined area between the village and Busu River.

12.7.3.2. Utilisation of Water Resources

12.7.3.2.1. Drinking and Domestic Uses

In Wagang, residents reported sourcing drinking water from springs, creeks, rainwater tanks and wells. Two communal tap stands were installed in January 2017, each with three taps (Figure 12.43). The source of water for these taps is a well, from which water is pumped into a water tower (Figure 12.44). This infrastructure was reported as a local and district government initiative, with the community responsible for upkeep and maintenance.

Photo credit: Coffey, 2017

Figure 12.43
Communal tap stand at Wagang

Photo credit: Coffey, 2017

Figure 12.44
Water tower feeding communal tap stands at Wagang

Photo credit: Coffey, 2017

Figure 12.45
Rainwater tank installed at private home in Wagang

Participants estimated that 40 households (approximately 35% of households) in the village have rainwater tanks (Figure 12.45).

Households located adjacent to Sipaia Road are further away from the tap stands, and tend to rely on rainwater tanks, springs, and wells. Some households own private wells, with both hand pumps and powered pumps. Only one well-owner was available for an interview; he stated that his well was 3m deep. Other households collect water from creeks and springs, located to the east of Sipaia Road.

Figure 12.46 shows the locations of drinking water sources within Wagang village, as of February 2017. In the case of creek water sources, only creek mouths are marked.

Areas in the network of creeks around Wagang village are designated as bathing areas, and as areas for washing laundry and dishes. Men and women's bathing areas are separated. These creeks are located to the east of Sipaia Road, and on either side of the village. Key informant interview respondents stated that water sourced from springs, creeks and wells is available all year and of satisfactory quality.

Residents of Yanga village reported sourcing drinking water from streams, springs, rainwater tanks and wells (Figure 12.47). Bukaho Creek, located approximately 1km east of the village, is perennial and the main water source for the village. Drinking water is sourced from this location daily for those in the village without an alternative water source, which requires a half-hour return walk from the village. Survey respondents stated that the main water source is perennial and had never dried up in their lifetimes. They were not satisfied with the quality of water from the Bukaho Creek, which was considered poor due to sediment from the Busu River entering Bukaho Creek.

It was reported that a reticulated water supply system was 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 working at the time of the survey (in February 2017) and there was no connection to houses from the main connection pipe.

Domestic water used for cooking, bathing and laundry is supplied from the same sources mentioned above for drinking water, with rainwater tanks and reticulated water systems only functional during the wet season. Men and women predominantly bathe in a creek (10-minutes' walk from the village), and also use well water.

12.7.3.2.2. Sanitation

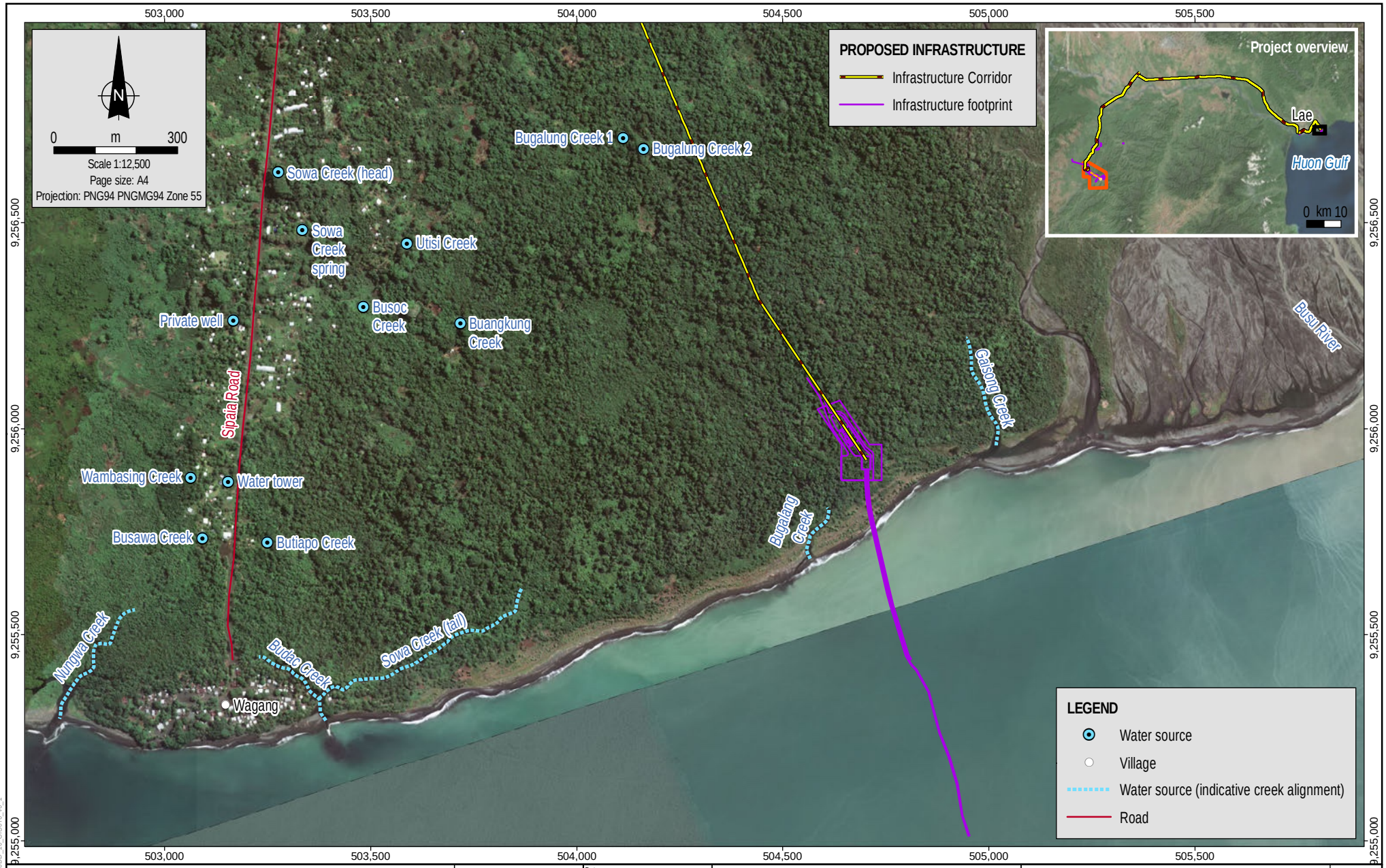
In Wagang, key informant interview respondents stated that pit latrines and composting toilets are used in the village. The composting toilets were built in 2012 and 2016 by a team from the University of Melbourne and the PNG University of Technology (Bower Studio, 2017a, 2017b), and reportedly led to a decline in the number of pit toilets (Bower Studio, 2017b). Figure 12.48 shows the exterior of one composting toilet.

In Yanga, survey respondents indicated that pit latrines and outside toilets are used in the village.

12.7.3.3. Marine and Estuary Resources

12.7.3.3.1. 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 engage in some kind of fishing. Similarly, in Yanga, fishing was reported as a common activity for men, women and children, both individually and in small groups.



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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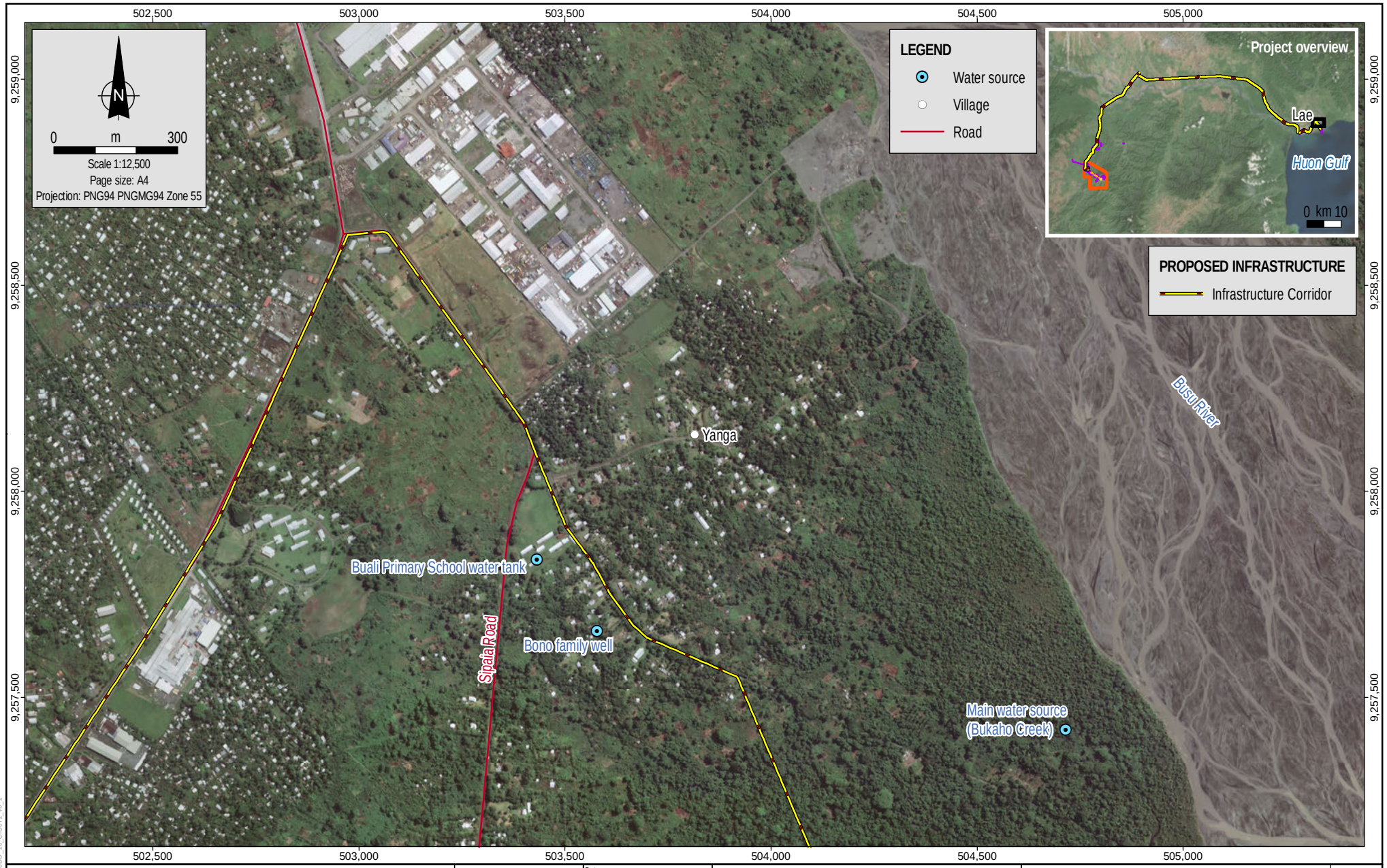
WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Wagang village drinking water sources

Figure No: **12.46**

MXD Reference: 0520DD_10_GIS070_v0_1



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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WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Yanga village drinking water sources

Figure No: **12.47**

MXD Reference: 0520DD_10_GIS071_v0_1

Photo credit: Coffey, 2017

Figure 12.48
Composting toilet (exterior) at Wagang village

Figure 12.49 shows the fishing areas as reported by men and women in the focus groups in Wagang. The most popular location for fishing is the beach. Of all households that undertake fishing, 80% reported fishing from the beach (Figure 12.50). Other common fishing locations include mangroves and rivers/creeks, with 52% and 60% of respondents targeting these areas respectively.

Of the households that fish, 28% fish offshore. In the key informant interview, respondents reported that they do not travel further than 500m from the shore. Respondents also stated that there are no reefs in the area; however, interviews undertaken on 2 May 2017 for the Fisheries and Marine Resource Use Characterisation (Appendix S) suggest that there is a narrow nearshore rocky reef between Wagang and the Busu River. Bathymetric data collected in other studies show this feature may be part of a ridge feature that extends some 750 m along the coast. It was also reported that locals fish for 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 and Skelly, 2017; Appendix U, Cultural Heritage Baseline and Impact Assessment) also identified the presence of an offshore reef in this area which is a fishing ground called Boc, although 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 is a communal activity – some people have 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.

Participants of the key informant interview reported that fishing occurs in Wagang daily, although the household surveys found that only 3% of households fish every day. Other households fish as required or not at all.

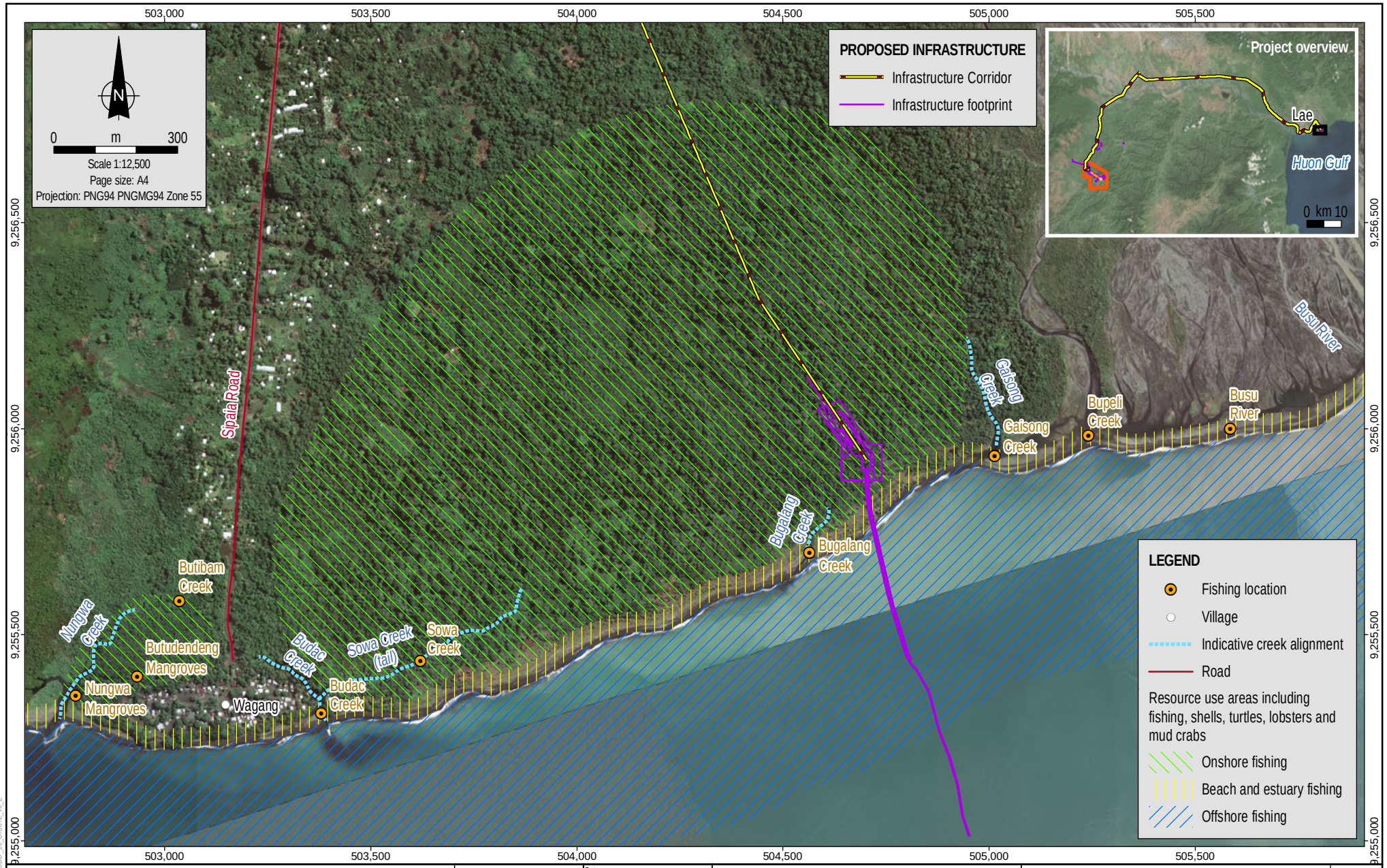
Figure 12.51 presents the fishing frequency for fin fish across all households in Wagang. Approximately one third of households reported fishing for fin fish daily or several times a week, while another third reported fishing on either a weekly or monthly basis. The remaining third indicated that they do not fish.

Compared to fin fish, invertebrate aquatic resources (such as prawns, crabs and shellfish) are less commonly collected, as shown in Figure 12.52. The majority of households (62%) do not collect invertebrates. Approximately 6% of households surveyed reported collecting them monthly, and 32% reported catching them either weekly or several times a week

12.7.3.3.2. Fishing and Boating Equipment

Household survey respondents reported that the predominant type of fishing gear used is handlines, made either from synthetic materials (e.g., nylon) or natural materials (e.g., sago palm). Of the households who undertake fishing, 80% indicated using handlines. Other common pieces of gear include 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%) are also used. No traditional methods of fishing (such as poison or shark calling) were reported. Figure 12.53 presents the types of fishing gear used by residents of Wagang.

Figure 12.54 shows a net used for fishing. Some nets reportedly measure 50m in length, and extend to a depth of 3m underwater when deployed. Mesh sizes observed were typically 2 to 4 inches.



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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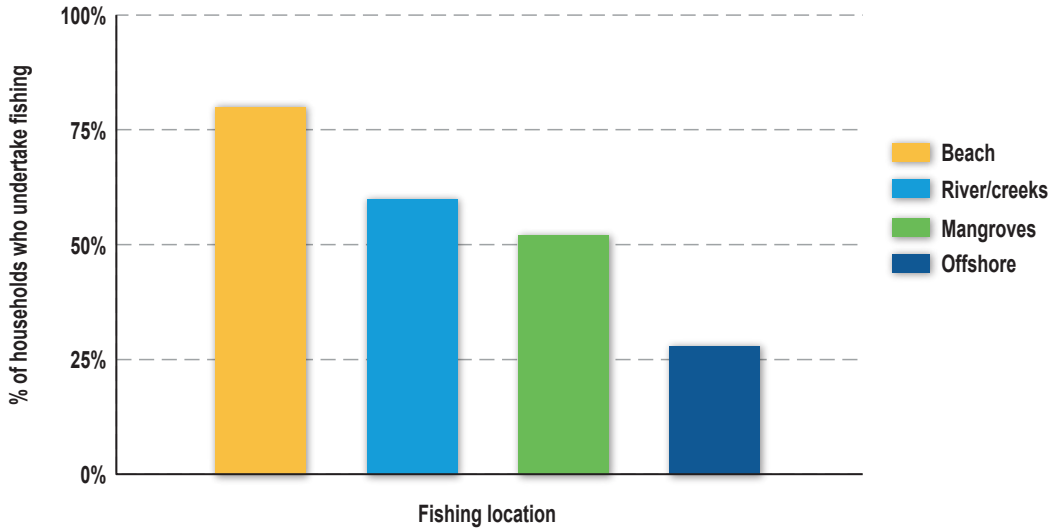
WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

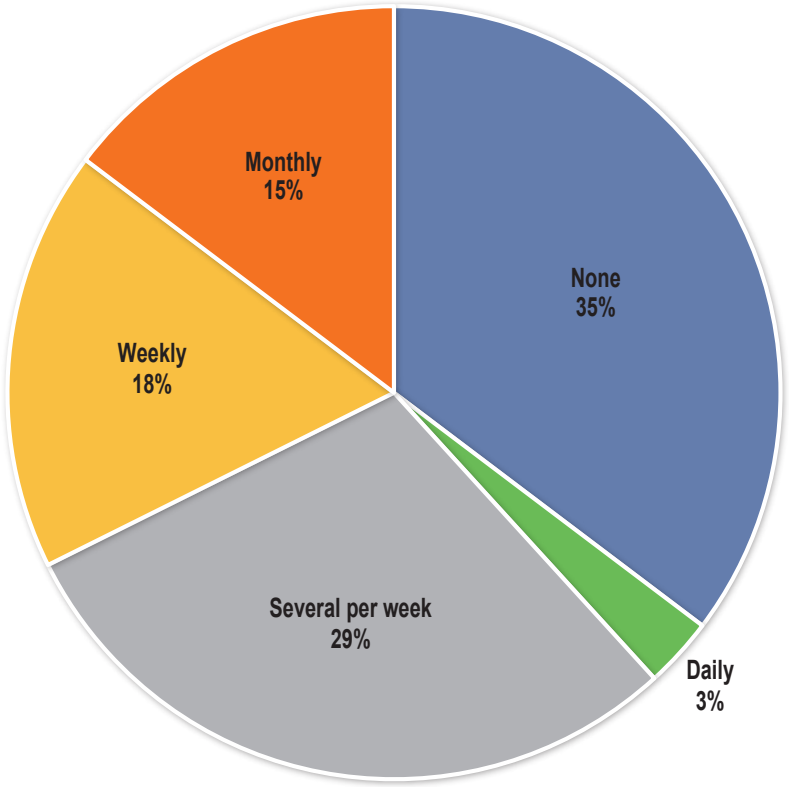
Wagang village fishing areas

Figure No: **12.49**

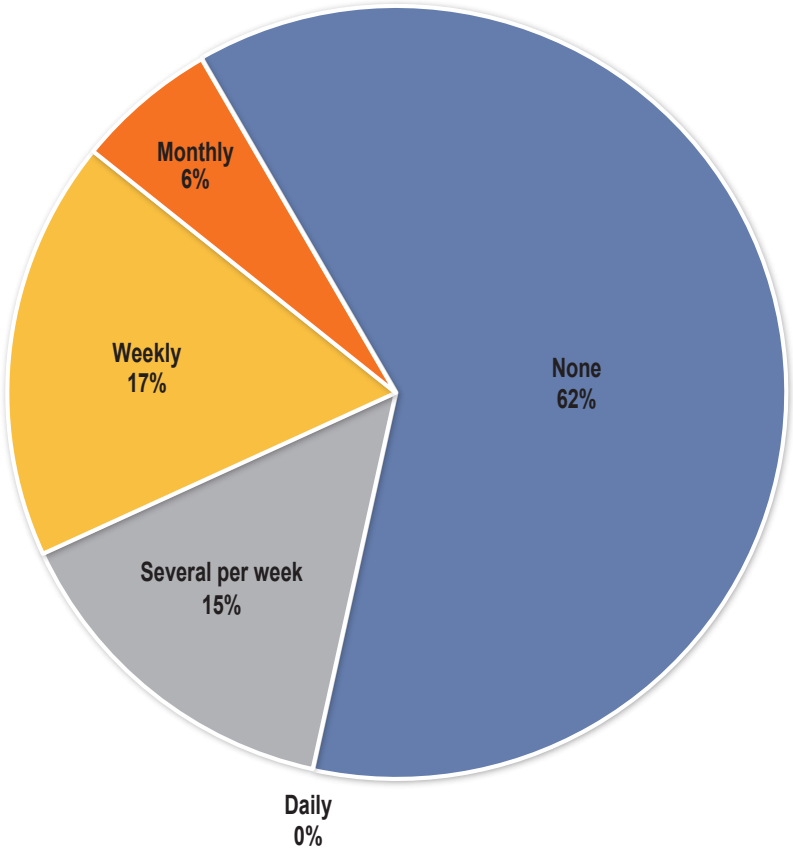
MXD Reference: 0520DD_10_GIS072_v0_2



	coffey A TETRA TECH COMPANY	Date: 29.03.2018 Project: 754-ENAUABTF100520DD File Name: 0520DD_10_F12.50_GRA	WAFI-GOLPU JOINT VENTURE Wafi-Golpu Project	Popular fishing locations for residents of Wagang village	Figure No: 12.50

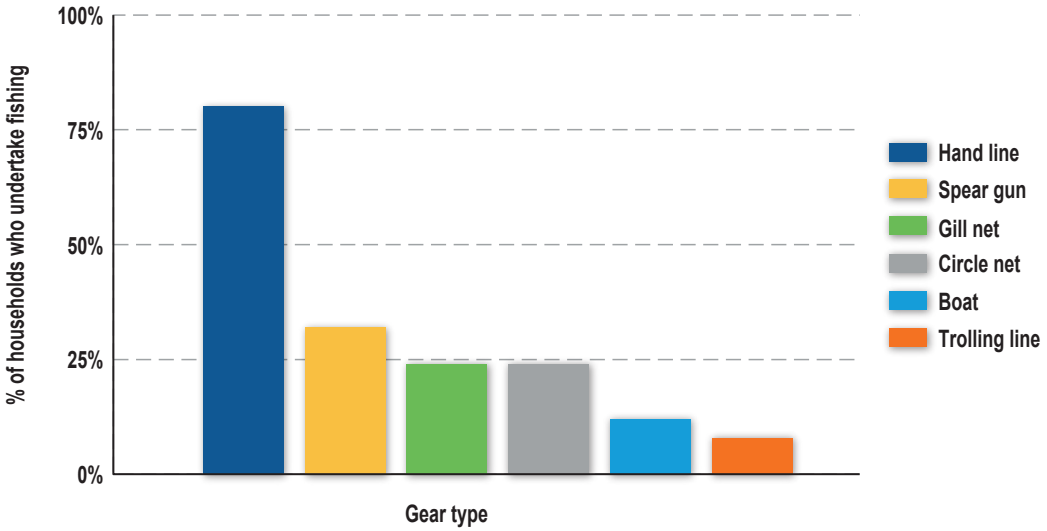


	coffey A TETRA TECH COMPANY	Date: 22.03.2018 Project: 754-ENAUABTF100520DD File Name: 0520DD_10_F12.51_GRA	WAFI-GOLPU JOINT VENTURE Wafi-Golpu Project	Fishing frequency (fin fish) reported by residents of Wagang village	Figure No: 12.51



	coffey A TETRA TECH COMPANY	Date: 22.03.2018 Project: 754-ENAUABTF100520DD File Name: 0520DD_10_F12.52_GRA	WAFI-GOLPU JOINT VENTURE Wafi-Golpu Project	Fishing frequency (invertebrates) reported by residents of Wagang village	Figure No: 12.52

INDD Reference: 0520DD_10_GRA107.indd



	coffey A TETRA TECH COMPANY	Date: 29.03.2018 Project: 754-ENAUABTF100520DD File Name: 0520DD_10_F12.53_GRA	WAFI-GOLPU JOINT VENTURE Wafi-Golpu Project	Types of fishing gear used by residents of Wagang village
				Figure No: 12.53

Photo credit: Coffey, 2017

Figure 12.54
Fishing net in Wagang village

Photo credit: Coffey, 2017

Figure 12.55
Fishing rod and reel, and two handlines at Wagang village

The household surveys did not prompt whether rod-and-reel equipment is used (and as such no household data was gathered), but the key informant interview recorded that fishing rods are commonly used in Wagang village. Figure 12.55 depicts a fishing rod alongside two handlines. The fishing gear observed did not appear to enable deep-sea fishing due to the length of line.

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. Figure 12.56 depicts a type of boat known locally as a 'banana boat' (due to its curved profile), while Figure 12.57 shows a canoe observed in the village.

While some boats and canoes are used for fishing, respondents indicated that fishing does not occur further than 500m from the shore. Water depths offshore from Wagang exceed 100m within about 500m from shore and are greater than 250m within about 1,000m from shore. Villagers did not report regularly attempting to catch deep slope fish. In addition, the findings of the deep slope and pelagic fish study conducted by Coffey (see Appendix P, Deep-slope and Pelagic Fish Characterisation) 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.

In Yanga, fishing takes place predominantly in estuaries and within mangrove areas due to Yanga's location approximately 3km from the coast. People from Yanga village also walk approximately 30 minutes to the coastline to fish in the ocean from the beach, mostly at the mouth of the Busu River.

Survey respondents from Yanga village reported fishing several times a week for approximately half a day. Typical catches are fewer than 10 fish and less than 5kg in total; fishing was is generally 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.

12.7.3.3.3. 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 12.6 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. Figure 12.58 and Figure 12.59 show a sample of shells presented to the survey team during the women's focus group.

Photo credit: Coffey, 2017

Figure 12.56
'Banana' boats on Wagang beach

Photo credit: Coffey, 2017

Figure 12.57
Canoe (right) on Wagang beach

Photo credit: Coffey, 2017

Figure 12.58
Shellfish caught by Wagang villagers ('rainy shell' in bowl, kina shell white at front, 'long tail' front, far right)

Photo credit: Coffey, 2017

Figure 12.59
Shellfish caught by Wagang villagers (called 'black shells' or 'gaha koc')

Table 12.6: Shellfish types collected by residents of Wagang village

Local name (English)	Local name (*tok ples*)	Scientific 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*	

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 are 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 west Pacific leatherback turtle nesting period), or during a follow up visit to Wagang on 2 May 2017 (Appendix R, Nearshore Marine Characterisation). An interview undertaken by Coffey on 2 May 2017 determined that west Pacific leatherback turtles are opportunistically caught and eaten and their nest harvested for eggs. According to Wagang villagers interviewed on 2 May 2017, three leatherback turtles (or fewer) are caught each year, on the beach between Wagang and the Busu River. Caught turtles are consumed by villagers, typically 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.

Dugongs were reported as very rarely seen, and were not reported as a hunted species.

12.7.3.3.4. 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 undertaken in 2017, respondents recorded consuming fresh fish and other seafood twice a week. Households appear to be more dependent on canned fish, which is consumed on average six days per week.

Fresh fish and other seafood is commonly caught by households, reported as the primary source of fresh fish and seafood by 41% of households surveyed. The second most common source of fresh fish is 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 are limited commercial uses of fish and other marine or estuary resources. Participants stated that no organised fishing ventures take place in Wagang (e.g., fishing cooperatives), and fish are 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 are collected in this area. Aquatic plants are also

grown and harvested in the area east of Sipaia Road. According to the key informant interview, watercress and sago are harvested for food and sale, although the latter was stated by the women's focus group to be a seasonal staple (harvested about once a year).

In Yanga, fishing is a common activity. Respondents reported that fish and shellfish caught by people are relied upon for consumption at home. No organised fishing or interaction with commercial fishing industries was reported and fish caught is not typically sold at local markets.

In Yanga, freshwater aquatic resources harvested included watercress and prawns. These aquatic resources are available all year around. It was stated that freshwater plants and animals have very little commercial value or use to people of Yanga village, and are only harvested for household consumption. Respondents also indicated that they collect firewood and building materials from rivers and streams nearby Yanga village that have been washed down the Busu River.

12.7.3.3.5. Sociocultural Uses of Marine and Estuary Resources

The beach in Wagang is a recreational destination for people residing in Lae, who go to Wagang beach to swim, have picnics and socialise. On weekends, PMVs convey visitors from Lae to the beach (Figure 12.60). A one-way fare costs PGK1 from Malahang to Wagang, a distance of approximately 4km. Others may reach the beach by walking down Sipaia Road. No fee was reported to be payable by visitors for visiting Wagang beach (as distinct from travel fares).

Near the beach is a beer stall, which services Wagang residents and visitors alike (Figure 12.61). Wagang residents also set up markets to sell coconuts, betel nut, bananas and other snacks to visitors (Figure 12.62). These businesses indicate that the beach is valued both as a recreational attraction and as a source of income.

12.7.4. 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. Houses at Yanga village were observed to be similarly constructed.

12.7.5. Economy

There is limited 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.

Residents of Wagang appear 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. A key secondary source of lighting was solar power, used by nearly 30% of respondents.

Household income in Wagang is largely generated from wages, with respondents to the 2017 Household Survey indicating that it contributed 52% of total household income. Business activities represent the second largest source of income, contributing 21% to total household income.

Photo credit: Coffey, 2017

Figure 12.60
PMV conveying visitors to Wagang beach on a Saturday

Photo credit: Coffey, 2017

Figure 12.61
Beer store at Wagang beach

Photo credit: Coffey, 2017

Figure 12.62
Market at Wagang beach on a Sunday

12.7.6. Education

Educational facilities accessed by Wagang and Yanga residents are shown on Figure 12.63. 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 is a 10-minute walk from the village, whereas Busu Secondary School requires a 10-minute drive in a PMV.

12.7.7. Health

12.7.7.1. Access to Health Services

Health facilities accessed by Wagang and Yanga communities are shown in Figure 12.63 above. Malahang Health Centre is the closest health facility to Wagang (45-minute walk) and to Yanga (15-minute walk).

The 2017 surveys also gathered information on maternal health care within Wagang and Yanga communities. In Wagang, 80% of babies were estimated to have been born in the village. In Yanga, 5% were born in the village, likely reflecting the proximity to the Malahang Health Centre. In both cases, a trained village birth attendant supervised births.

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.

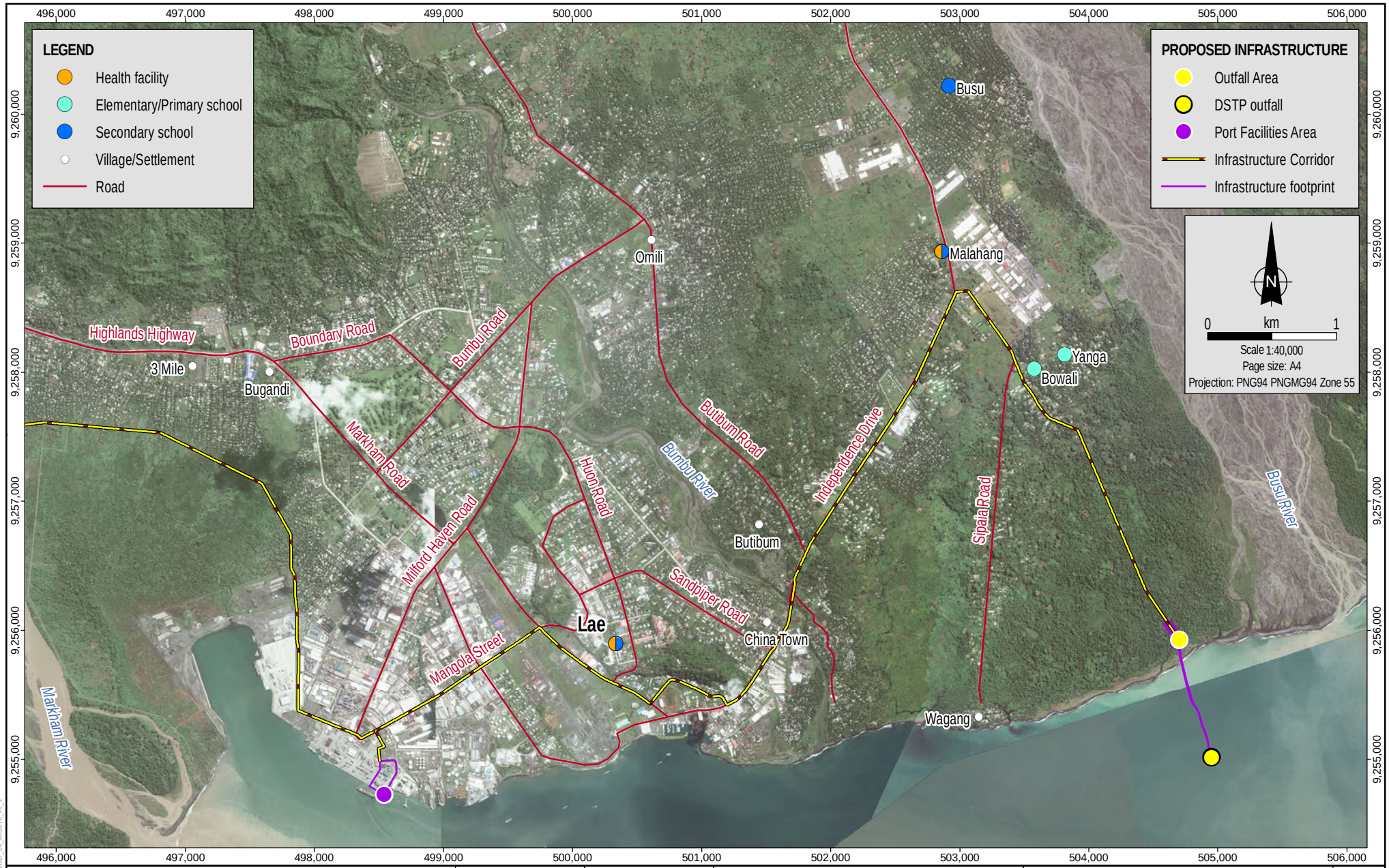
12.7.7.2. Food and Nutrition

Respondents 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). 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.

No data was available for Yanga village, but due to its proximity to Lae, it is expected that food consumption patterns would be similar to those found at Wagang.

12.7.8. Law and Order

In Wagang, community perceptions on law and order issues were recorded through the 2017 household surveys. As shown in Table 12.7, the main law and order issue reported by the 34 respondents interviewed was alcohol-related (91.2%). Disturbance/nuisance, drug use, domestic violence and land conflict were also major issues. Focus group participants in Wagang stated that gambling was a minor issue in the community.



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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WAFI-GOLPU JOINT VENTURE

Wafi-Golpu Project

Educational and health facilities accessed by Wagang and Yanga residents

Figure No: **12.63**

MXD Reference: 0520DD_10_GIS073_v0_1

Table 12.7: 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, 2017

When participants in Yanga focus groups were asked about village administration and law and order, they reported that law and order issues included illegal drugs and alcohol, domestic violence, adultery (potentially as a driver for other law and order issues), 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.

12.7.9. 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 receives no government assistance and reportedly survives on the proceeds of a trade stall, a small garden and a few chickens.

12.7.10. Traffic and Transport

Residents of Wagang travel to Lae via Sipaia Road, a partially sealed road running due north from Wagang approximately 2.8km, to Busu Road. Busu Road runs northwest for 700m before intersecting Independence Drive, near Malahang. As discussed in Section 12.6.10 (Traffic and transport for Study Area 3), this road is often congested during weekday morning and afternoon peak times. Similarly, Yanga residents would reach Lae by travelling northwest along Busu Road to Independence Drive. On weekends, visitors from Lae travel to Wagang via Sipaia Road, to swim and socialise at the beach (see Section 12.7.3.3.5).

In Wagang, responses to the 2017 household survey indicate that the majority of respondents traveling to and from Lae use PMVs (72%). The second most common form of transport is car (21%). Fifty per cent of respondents indicated that they travel to Lae between one to ten times per month. The top reasons for travel provided by respondents were to access shops/market stalls to sell and purchase goods and attend school.

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