









TOTAL E&P PNG LIMITED

PAPUA LNG

Upstream Environmental Impact Statement

Volume 2: Environmental and Social Baseline

Part 16
Upstream Community Health Baseline Report

TOTAL
TOTAL E&P PNG LIMITED

Upstream Community Health Baseline Report

Papua LNG Project

Total E&P PNG Limited

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EXECUTIVE SUMMARY

This Upstream Community Health Baseline Report is one of several stand-alone reports that will be used to compile the Environmental and Social Baseline Study (ESBS) Report for the Papua LNG Project (the Project). This report is limited to the upstream component of the Project.

PROJECT DESCRIPTION

Joint venture partners are currently planning the development of the Elk-Antelope gas field, which is located within Petroleum Retention License 15 (PRL-15) in the Gulf Province, Papua New Guinea. Total E&P PNG Limited (TEP PNG), a wholly owned subsidiary of TOTAL SA (TOTAL), has the largest interest in the Elk-Antelope gas field and is the Project operator on behalf of the other joint venture partners.

LEGISLATIVE AND REGULATIVE FRAMEWORK

Petroleum projects are regulated by the *Oil & Gas Act 1998* (Independent State of Papua New Guinea 2001). Section 49 of the Act states that a socio-economic impact statement must be submitted by the proponent to the Minister (for petroleum) and Ministry of Environment before a development forum shall be convened. A formal health impact assessment is not a Papua New Guinea legal or regulatory requirement; however, community health is a topic within the overall social baseline.

TOTAL has a social baseline study general specification (GS_EP_SDV_101) that describes the objectives, roles and responsibilities, process, and reporting requirements for social baseline studies. The TOTAL specification covers community health.

This report includes a review of International Finance Corporation (IFC) and International Petroleum Industry Environmental Conservation Agency (IPIECA) health baseline standards or requirements, both of which are referenced in TOTAL's social baseline study general specification.

STUDY AREA AND PROJECT AREA OF INFLUENCE

The project area of influence (PAOI) includes 39 villages and one government station with a combined population of 12,763 in mid-2016. It defines the priority that will be given by the Project to stakeholders, dependent on the degree to which the Project will potentially affect them. The upstream PAOI includes the immediate area of influence, meaning the footprint of physical infrastructure, facilities, and associated activities. The PAOI is described further in Section 3. The relevant primary health data are organized using the social baseline study data collection framework; meaning community and household survey results; focus group discussions (FGD) and key informant interviews (KII); and health facility morbidity data are presented as a unified dataset covering the entire PAOI.

UPSTREAM COMMUNITY HEALTH BASELINE REPORT

The following baseline data were used:

- Peer-reviewed publications.
- National Department of Health (NDOH) data at the national, provincial, district, and local health facility level.

- Relevant PNG Institute of Medical Research (PNG IMR) studies collected as part of the Project-sponsored Partnership in Health Program (PiHP).
- International agency data including the World Health Organization (WHO) and the World Bank Group.
- Multilateral funding agency data including the Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund), U.S. Agency for International Development (USAID), and the Australian Department of Foreign Affairs and Trade (DFAT).
- Non-governmental organization (NGO) data including materials from Médecins Sans Frontières (MSF).
- Private company sponsored studies, such as the 2012 InterOil study in PRL-15.
- TEP PNG sponsored studies covering all the communities in the PAOI.

Based on methodology published by IPIECA and IFC, data were organized into 12 defined[1] environment health areas (EHA):

1. **Health systems** – physical health infrastructure (e.g., capacity, equipment, staffing levels and competencies, future development plans) and program management delivery systems (e.g., malaria, tuberculosis, and HIV/AIDS initiatives and maternal and child health).
2. **Communicable respiratory diseases** – transmission of communicable diseases (e.g., acute respiratory infections, pneumonia, tuberculosis and meningitis) that can be linked to inadequate housing design, overcrowding, and housing inflation.
3. **Vector-borne diseases (VBD)** – mosquito-, fly-, tick-, and lice-related diseases, such as malaria, dengue, and yellow fever.
4. **Sexually transmitted infections (STI), including HIV/AIDS** – STIs such as syphilis, gonorrhea, chlamydia, hepatitis B, and, most importantly, HIV/AIDS.
5. **Water, Sanitation, and Hygiene (WASH)-related diseases** – diseases that are transmitted directly or indirectly through contaminated water, soil, or non-hazardous waste (e.g., diarrheal diseases).
6. **Food- and nutrition-related issues including food security** – adverse health effects such as malnutrition, anemia, or micronutrient deficiencies due to changes in agricultural and subsistence practices or food inflation; gastroenteritis; and food-borne trematodiases, among others.
7. **Non-communicable diseases (NCD)** – cardiovascular diseases, cancer, diabetes, and obesity.
8. **Accidents and injuries** – road and marine traffic- or work-related accidents and injuries (home and project related).

1 IFC Introduction to Health Impact Assessment, Section 3 (2009) and IPIECA Health Impact Assessment: A guide for the oil and gas industry 2016.

9. **Exposure to potentially hazardous materials** – includes exposure to pesticides, heavy metals, solvents or spills, and releases from road traffic. Noise, water, and air pollution (indoor and outdoor) as well as visual impacts are considered based on data developed in upstream baseline reports.

10. **Social determinants of health (SDH)** – includes psychosocial stress (due to resettlement, overcrowding, political or economic crisis, mental health, depression, gender issues, and domestic violence).

11. **Veterinary medicine and zoonotic diseases** – diseases affecting animals (e.g., bovine tuberculosis, swinepox, and avian influenza) or that can be transmitted from animal to human (e.g., influenza A subtypes H5N1 and leptospirosis).

12. **Cultural health practices** – role of traditional medical providers, indigenous medicines, and unique cultural health practices.

Summary of Key Environmental Health Area Findings

The following subsections summarize the key findings for each of the 12 EHAs. Detailed analysis, including priority health issue recommendations for TEP PNG and identification of medically susceptible individuals are described in the main text (Section 6).

Health Systems

The health facility infrastructure across the PAOI includes three levels: (1) aid posts, (2) sub-health centers, and (3) health centers. This structure and its associated programs are mandated by the PNG NDOH but managed by the Gulf Provincial Division of Health in the Gulf Province. Across all of Papua New Guinea, there is a mismatch between the NDOH program requirements and the actual delivery of services to communities. The situation in the PAOI is reflective of what is occurring nationally: aid posts have significant staffing problems and many have either closed or have irregular hours of operation. The burden of direct health care service and program delivery, such as immunizations and antenatal services, has primarily fallen on the Kapuna and Kerema health centers. Significant funding and staffing constraints impact Kapuna and Kerema health centers' performance—specifically, there is substantial difference between the mandated NDOH services and programs and the available funds and staff. A detailed analysis of the two health centers, including their strengths and weaknesses, is provided, as these facilities are the most important providers of health care across the PAOI. The fragility of the current PAOI health facilities (i.e., the high number of aid posts that are either closed or partially functioning) and the lack of a community medical emergency response system across the Gulf Province are priority issues that potentially affect all households across the PAOI.

Communicable Respiratory Diseases

The burden of respiratory diseases across the PAOI is significant—contributing more than 30% of health center morbidity caseload. The vaccination levels for children under age 5 are well below national and international standards (refer Section 6.3); hence, the risk of a highly communicable infectious disease outbreak (e.g., measles) is significant. Tuberculosis (TB) is at epidemic levels across the Gulf Province and is overwhelming the current health system. MSF and the Oil Search Foundation have been active supporters of the Gulf Province TB program efforts, with MSF playing an active role at the Kerema Health Center2. Otherwise, the level of international funding for TB

2 Also known as the Kerema General Hospital, refer to Section 6.2.2.2.

support in the Gulf Province is minimal despite the Gulf Province being recognized as a TB hot spot. TB is identified as a priority health issue in the PAOI. Individuals with a compromised immune system are at substantial risk for either new or reactivation TB infection. Young children are also susceptible to TB infection, particularly at extrapulmonary locations such as bone and the spinal cord (TB meningitis).

Vector-Borne Diseases

VBD data are available across the PAOI but focused on malaria and filariasis. Viral VBDs are uncharacterized, and the underlying potential burden of disease is unknown. Lymphatic filariasis is present in both Kerema and Kikori districts. Lymphatic filariasis is an Infection that occurs when filarial parasites are transmitted to humans through mosquitoes. Filariasis is a well-documented disease in Papua New Guinea. It has been documented in a few villages in the PAOI at a very low prevalence level–less than 4%. The overall prevalence of laboratory confirmed malaria parasitemia is extremely low (less than 1%) and declining. The bed net distribution and utilization level is high and is a major contributor to the observed decline in malaria parasitemia prevalence and the low prevalence of filariasis. In general, pregnant women and children under age 5 are at greatest susceptibility for VBD.

Sexually Transmitted Infections

Data for non-HIV STIs are minimal and undoubtedly under-reported across all PAOI health facilities. Based on data from Kapuna and Kerema health centers, HIV rates are low (less than 0.5% of sampled patients) and consistent with a remote rural location. The Papua New Guinea overall HIV prevalence rate is 0.9%. Longitudinal monitoring for HIV is identified as a priority issue, particularly during the construction phase when there is a risk of project induced in-migration. Young women of reproductive age are identified as a susceptible group for HIV infection.

Water- and Sanitation-Related Diseases

Water and sanitation issues are present across the PAOI; however, the documented morbidity burden of diarrhea is moderate (less than 10% of health center morbidity caseload). A difference between the modest objective clinical burden and the suboptimal WASH practices (for example, only 25% of household members routinely hand wash with soap) is documented. Access and availability of adequate volumes of water (typically 2-6 liters/day/person for basic hygiene practices) is a significant factor that impacts water-washed (hygiene) disease transmission. Field surveying indicates that household water volumes appear to be adequate. Most households use rainwater, which is considered a secure source; however, there are households that use shallow ground water for washing and drinking water. There is objective evidence that the shallow ground water is impacted by microbiological contamination.

Food- and Nutrition-Related Issues Including Food Security

The available PAOI health center (Kapuna and Kerema) data do not demonstrate a pattern of significant nutrition-related problems (such as anemia and malnutrition diagnoses); however, the PAOI health facility data cannot be disaggregated at a community or household level. Limited PAOI anthropometric data (height, weight, and age) do not demonstrate a significant malnutrition problem for sampled households. The 2012 InterOil anthropometric study also did not document significant levels of malnutrition. This represents a mismatch with overall Gulf Province levels of potential malnutrition. There is strong documentation that households have a wide variety of protein sources; for example, animal husbandry (primarily pigs and chickens) is found in 64% of PAOI households.

Non-Communicable Diseases

Households are primarily engaged in subsistence agricultural activities. In this situation, the burden of NCDs is expected to be modest. The future risk is the dietary transition triggered by migration from subsistence to a wage-based economy. During community visits, adults were commonly observed chewing betel nut, which is a known human carcinogen and associated with oral cancer. Betel nut is the main source of cash income in 48% of the surveyed villages.

Accidents and Injuries

Accidents and injuries (marine and river traffic, or associated with household activities), are an underappreciated morbidity burden across the PAOI (5-10% of health center morbidity caseload). The limited in- and out-patient data strongly suggest that accidents and injuries occur at high rates across the PAOI. There is no functioning community emergency medical response system in the PAOI.

Exposure to Potentially Hazardous Materials

Hazardous materials issues are a real, but modest, concern at this stage of the Project. There are some community perceptions (unverified) of exposure to hazardous materials release events; however, their actuality or cause have not been investigated as part of this study.

Social Determinants of Health

There are significant issues surrounding SDH, such as low socio-economic status, poor educational attainment and literacy (particularly for women), young age of marriage, high fertility, and a significant level of domestic violence.

Female educational attainment is a powerful predictor of household morbidity and mortality, particularly for young children as women are the primary caregivers. The early average age of marriage (age range 12–17) across PAOI households suggests that there is likely a problem with both maternal and early childhood morbidity and mortality.

Veterinary Medicine and Zoonotic Diseases

Zoonotics are potentially significant contributors to the observed morbidity burden in the PAOI. Baseline data documents significant animal husbandry across households. Hunting is common and is also a potential exposure source for a zoonotic illness.

Cultural Health Practices

The role of cultural health practices is significant across the PAOI and influences health decision-making and practices, particularly villages whose common practices include girls marrying at young ages and delivering babies alone in the bush. For Project stakeholders, understanding existing cultural health practices is an important issue for future development of any community and household level health education and outreach programs.

Conclusion

The combination of published NDOH clinical data, extensive literature searches, primary community and household level fieldwork, and use of other upstream social and environmental baseline reports (see Section 6) has created a detailed health baseline for the upstream PAOI.

The fragility of the overall health services across the PAOI, TB, the need for future STI monitoring, and the lack of a functioning community medical emergency response system are considered priority issues for the Project. For these key issues, where relevant, susceptible groups have been identified.

1 INTRODUCTION

This Upstream Community Health Baseline Report is one of several stand-alone reports that will be used to compile the Environmental and Social Baseline Study (ESBS) Report for the upstream component of the Papua LNG Project (the Project). The report has been prepared following research and studies conducted in Gulf Province in 2016.

1.1 PROJECT OVERVIEW

Joint venture partners are currently planning the development of the Elk-Antelope gas field, which is located within Petroleum Retention License 15 (PRL-15) in the Gulf Province, Papua New Guinea. Total E&P PNG Limited (TEP PNG), a wholly owned subsidiary of TOTAL SA (TOTAL) has the largest interest in the Elk-Antelope gas field and is the Project operator on behalf of the other joint venture partners.

The Elk-Antelope gas field is a significant gas discovery in Papua New Guinea consisting of a gas reservoir with several trillion cubic feet of gas reserves located approximately 120 kilometers (km) inland from the township of Kerema, and 340 km northwest of Port Moresby.

The Project will comprise upstream production well development and associated infrastructure at the gas field within PRL-15, construction of an upstream central processing facility (CPF), and gas and condensate delivery via onshore and offshore export pipelines to a liquefied natural gas (LNG) plant site at Caution Bay, Central Province, 20 km northwest of Port Moresby. The design life for the Project will be 25 years.

The Project area comprises the physical footprint of the following Project components and associated infrastructure:

- Production, processing, and related facilities (within PRL-15):
  - Well pads and the associated gathering system (including flowlines and trunkline).
  - CPF.
  - Logistics base and river offloading facilities, accommodation camps, airstrip, roads, and bridges.
  - Quarries and communications infrastructure.
  - Initial section of the onshore export pipeline.
- Onshore pipeline (outside PRL-15):
  - Remainder of the onshore export pipeline to landfall on the Gulf coast including valve stations.
  - Temporary laydown areas and camps.
  - Quarries, communications infrastructure.
- Transport (river) corridors:
  - River transport routes—the Purari, Ivo-Urika, and Wame-Varoi rivers.
- Offshore pipeline:
  - Offshore section of the export pipeline to a LNG plant site at Caution Bay.

1.2 OBJECTIVES

The following key objectives were established for the Upstream Community Health Baseline Report:

- Establish a general health profile for the potentially affected communities (PAC) in the direct project area of influence (PAOI).
- Provide a comparative local, district, provincial, and national analysis as appropriate and where data are available.
- Identify the presence or absence of local and regional health facilities, emergency facilities, health practitioners, and local and national health awareness and promotion programs in the PAOI.
- Identify potentially susceptible[3] groups, from a health perspective, within the PAOI.
- Meet the requirements of the relevant standards outlined in Section 2 Regulatory Framework and Standards.
- Identify priority health issues for management.

2 REGULATORY FRAMEWORK AND STANDARDS

This section provides background on how the assessment of community health fits into the requirement for social baseline studies (and more broadly, social impact assessments) for large-scale petroleum projects in Papua New Guinea. The overview provided in the national legislation section (Section 2.1) is adapted from the same section in the Upstream Community and Demographics Baseline Report (Finlayson 2016a).

2.1 NATIONAL LEGISLATION

Petroleum projects are regulated by the *Oil & Gas Act 1998* (Independent State of Papua New Guinea 2001). Section 49 of the Act states that a socio-economic impact statement must be submitted by the proponent to the Minister (for petroleum) and Minister responsible for environmental matters before a development forum shall be convened. The government agency responsible for environmental impact statement (EIS)/social impact assessment (SIA) regulation is the Conservation and Environmental Protection Authority (formerly the Department of Environment and Conservation).

Guidance in terms of the socio-economic impact statement is provided in the *Environment Act 2000* (Independent State of Papua New Guinea 2004). Section 50 of the Act stipulates the need for an environmental impact statement for level 3 activities. Level 3 activities include petroleum activities for which a Petroleum Development License or Pipeline License is required, or activities in which a Petroleum Processing Facility License is required (except for processing activities classified as level 2, category B).

3 Susceptibility is medically defined as the state of being predisposed to or lacking the ability to resist something, such as a pathogen.

Section 2 of the Act defines "environment" as including people and communities, human-made structures, and the social, economic, aesthetic and cultural conditions which affect people and the environment.

The Department of Environment and Conservation (now Conservation and Environmental Protection Authority) prepared an information guideline (2004, 3-4) that states the EIS should include several parts, including the following:

- Characteristics of the receiving environment, including the social structure and socio-economic data on the resource/land owners, local level government (LLG), the Province, and Papua New Guinea, and which may include the following details:
  - Demographic information.
  - Existing infrastructure information.
  - Public health issues information (if applicable).
  - Present economic status of the project area.
  - Description of existing social services.
  - Details of archaeological, historical, cultural, or religious features of the project area under consideration.
  - Environmental management, monitoring, and reporting, including information on a socio-economic management and monitoring strategy.

A working draft of the Social Impact Assessment Guideline was published by the Department of Environment and Conservation in 2001; however, it is not formally incorporated into the Environment Act. This draft discusses the interrelatedness of the social and biophysical environments and provides a list of key issues including "health."

No other official guidance has been provided on what constitutes or is required for a social baseline or socio-economic impact assessment in Papua New Guinea. There is no formal statutory/regulatory requirement for performing a stand-alone health impact assessment (HIA).

2.2 National Health Development Objectives

Papua New Guinea's development approach for health has been outlined in the following plans and strategies, which are described in chronological order:

- Papua New Guinea Vision 2050 (prepared 2008–2010) (National Strategic Plan Taskforce 2010).
- Papua New Guinea Development Strategic Plan 2010–2030 (Department of National Planning and Monitoring [DNPM] 2010a).
- Papua New Guinea National Health Plan 2011–2020 (National Department of Health [NDOH] 2010a).
- Medium Term Development Plan (MTDP) 2011–2015 (DNPM 2010b).
- National Health Service Standards for Papua New Guinea 2011–2020 (NDOH 2011a).
- National Strategy for Responsible Sustainable Development for Papua New Guinea (StaRS) (DNPM 2014).
- 2014 National Human Development Report (United Nations Development Programme [UNDP] 2014).
- MTDP 2 2016–2017 (DNPM 2015).

2.2.1 Papua New Guinea Vision 2050

For the years 2020–2050, the Vision 2050 strategy calls out the following key development projects:

- Better service delivery.
- Improved health services.
- Sound political leadership and structures.

The following specific health goals are identified in Vision 2050:

- Target a 20% level for health in terms of the Public Investment Budget Strategy.
- Ensure adequate access to health services.
- Ensure an adequate level of health infrastructure.
- Increase the role of churches in the provision of basic health services.
- Ensure that the referral hospitals are adequately equipped to international standards.
- Establish one aid post per ward area.
- Provide two health workers per ward area.
- Establish one basic health service center with two doctors and support personnel per district.
- Improve the terms and conditions of employment of health officers.
- Reduce HIV and AIDS prevalence to 0.1 percent for the population aged 15–49.
- Reduce tuberculosis (TB) prevalence from 51 per 100,000 to 10 per 100,000 of the population.
- Reduce malaria deaths from 65 per 100,000 to 10 per 100,000 of the population.
- Establish a Health Endowment Fund.

Vision 2050 includes a goal of lifting Papua New Guinea into the top 50 countries in the United Nation's (UN) Human Development Index. The Human Development Index was developed by the UN as a metric to assess the social and economic development levels of countries. Four principal areas of examination are used to rank countries: (1) mean years of schooling, (2) expected years of schooling, (3) life expectancy at birth, and (4) gross national income per capita. Papua New Guinea's current Human Development Index rank is 158th out of 188 countries (UNDP 2015).

2.2.2 Papua New Guinea Development Strategic Plan 2010–2030

The Strategic Plan's health goal is to "achieve an efficient health system which can deliver an internationally acceptable standard of health services" (DNMP 2010a, 47). However, as noted in the Plan, many key health indicators have not significantly improved since the mid-1990s. This deterioration "coincided with the transfer of responsibility for rural health services to the local level government under the *Organic Law on Provincial and Local Level Government (1995)*" (DNMP 2010a, 47). The following key causes in the overall health service decline are identified in the Plan:

- Poor access to quality health services and facilities such as specialist hospitals, aid posts, health centers and equipment—a situation made worse in the context of rapid population growth.
- Inadequate transportation infrastructure and other utilities, denying many people adequate access to health services.

- Law and order issues; for example, health facilities have been burned down or health workers have been attacked, resulting in the closure of service centers.
- Closure or limited operation of facilities due to shortage of staff (doctors, nurses and community health workers), insufficient medicines, malfunctioning equipment, and poor building maintenance—approximately 50% of rural health facilities are not functional.
- Lack of emphasis on primary and preventative health practices, healthy lifestyles, and dietary practices.
- Poor management of the highly decentralized and fragmented National Health System, including failure by provincial governments to adequately resource health services through their annual budgets.

According to the Strategic Plan, achieving the key performance indicator targets for 2030 "will require a complete transformation of the health system" (DNMP 2010a, 51). The Plan outlines the following strategies to develop the health system:

- **Management**. (1) Strengthen the capacity of management at all levels, including a clear demarcation of the functions of different levels of management and (2) centralize health services delivery through legislative changes and further reforms to the public health system.
- **Quality.** (1) Increase both the number and quality of health workers through better training; (2) upgrade and expand training facilities for medical practitioners, nurses, and community health workers; (3) modernize health facilities; and (4) establish bulk stores or warehouses, including an information technology network that will require all hospitals to monitor drug supply levels.
- **Access.** (1) Extend transportation, electricity, and utility services into rural areas; (2) ensure universal education, which will help people understand and address health issues; (3) recapitalize and upgrade existing health facilities; (4) develop strong partnerships with churches and other non-government organization (NGO) health service providers; (5) attract physicians to live and work in rural areas; and (6) develop outreach programs for rural populations.
- **Preventive health.** (1) Improve water and sanitation; (2) improve the immunization rate for vaccine-preventable diseases; (3) improve malaria and TB prevention programs; and (4) educate the population and encourage people to maintain healthy lifestyles.

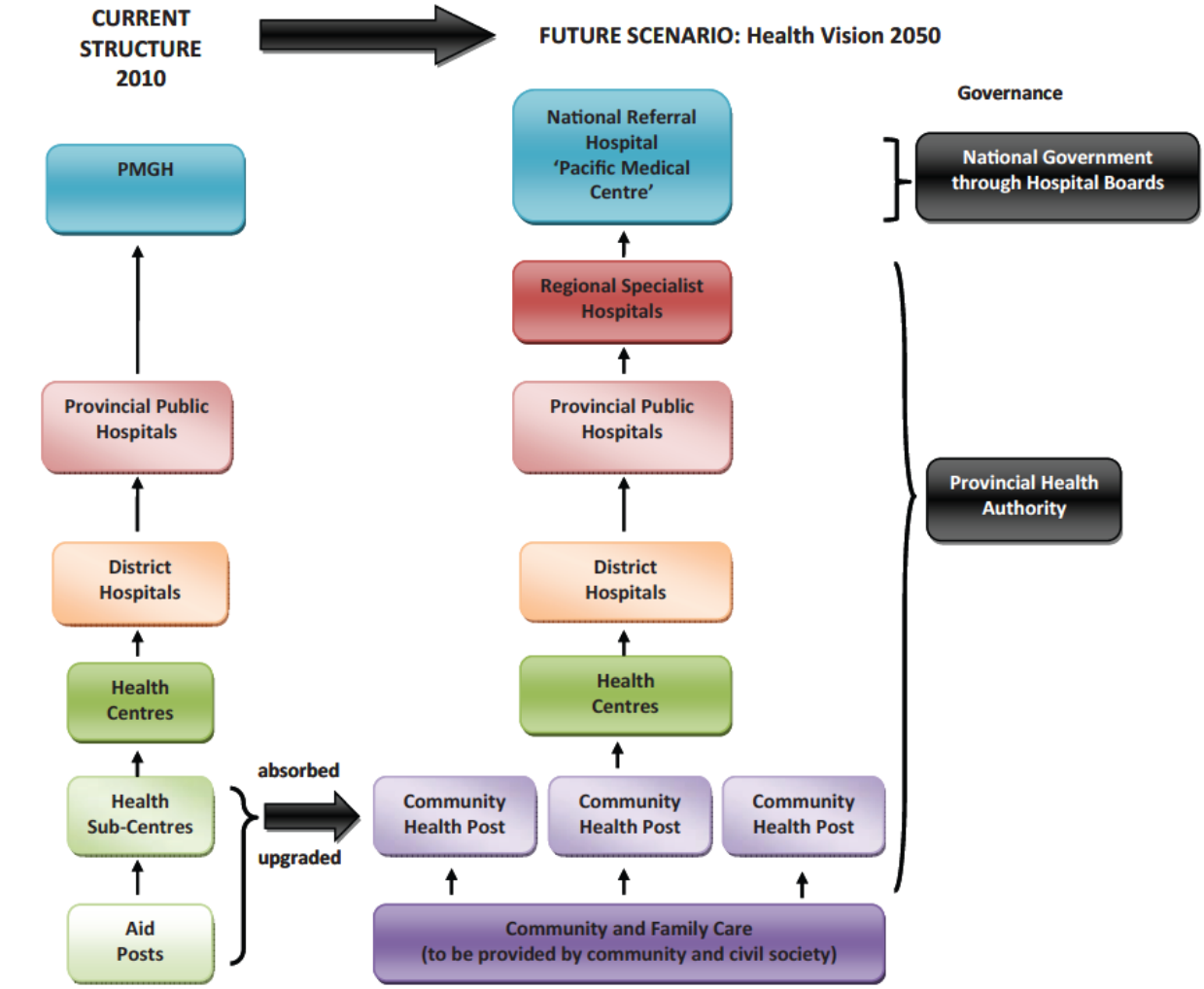
2.2.3 National Health Plan 2011–2020

The *National Health Administration Act 1997* (Independent State of Papua New Guinea 1997, Section 4[2]) mandates the National Health Plan as the single governing policy document for the health sector. The 2011-2020 Plan is the sixth National Health Plan for Papua New Guinea since 1974.

The National Health Plan 2011–2020 (NDOH 2010a) is a high-level roadmap for improving rural health care delivery systems. The Plan focuses on improving service delivery, primary health care, and capitalizing on opportunities for improved health services. The organizational structure described in the plan is shown in Figure 1.

The Plan emphasizes a "back to basics" approach, meaning concentrating on improving primary health care for the rural majority and urban disadvantaged. The Plan defines what needs to be done, in what manner, for which reasons, and by which players to return to the basics and enable fundamental improvements to the health system.

Figure 1. National Health Plan 2011-2020, "Health Vision 2050"



Source: NDOH 2010a, Vol. 1, 18

Section 6.2 of this report analyzes how the National Health Plan has been implemented across the PAOI.

2.2.4 Medium Term Development Plan 2011–2015

The MTDP, prepared by DNPM (2010), describes the resource envelope in which the National Government will operate over the 5-year period (2011–2015), and guides sector, provincial, district, and LLG plans.

The MTDP describes the current status (the report was published in 2010) in dire terms: "The current status of the [health] sector is depicted by low life expectancy brought about by unfavorable human development indicators such as high infant and neonatal mortality rates, high maternal mortality ratio, low literacy rates of adults as well as deteriorating conditions of infrastructure such as roads and bridges, health centers and hospitals" (DNPM 2010, 36).

Like other published strategies, the MDTP calls for a "back to basics" with rehabilitation of the primary and preventive health care system "…focusing on improving maternal health and child survival and reducing the burden of communicable diseases" (DNPM 2010, 37). A key focus of the MTDP is provincial health authority reforms to strengthen local level management of the health care

system. The MTDP has a series of key performance indicators (KPIs) and 5-year targets between 2015-2030. A select sample of these KPIs is shown in Table 1.

Table 1. MTDP Health KPIs 2015–2030

Indicator[1]	Baseline[2]	2015 Target	2020 Target	2025 Target	2030 Target
IMR	57/10.00 (2006)	43/1,000	35/1,000	26/1,000	<17/1,000
NNMR	29/1,000 (2006)	22/1,000	18/1,000	13/1,000	9/1,000
U5MR	75/1,000 (2006)	56/1,000	4/1,000	32/1,000	<20/1,000
MMR[3]	733/100,000 (2006)	500/100,000	360/100,000	230/100,000	<100/100,000
Life Expectancy	57 (2006)	62	64	66	70
1-year-old measles vaccination proportion	58% (2009)	73%	80%	87%	94%

Source: DNPM 2010, 38

[1]IMR= infant mortality rate per 1,000 live births; NNMR= neonatal mortality rate per 1,000 live births; U5MR= under 5 mortality rate per 1,000 live births; MMR= maternal mortality rate per 100,000

[2]Data from the 2006 PNG demographic health survey (2006 and 2009 update)

[3]MMR data have been controversial in Papua New Guinea since 2006; a new national survey is in progress

The MTDP KPIs and targets are further described in Section 6.

2.2.5 National Health Service Standards for Papua New Guinea 2011–2020

The National Health Service Standards (NDOH 2011a) provide both a strategic overview for the provision of health care services and a guide for local health services planning. These standards are designed to:

- Provide service planning strategies/protocols.
- Inform financial and infrastructure planning.
- Clarify governance arrangements of services provided at national, provincial and local level and by church organizations.
- Ensure safe and quality care delivery and services.

The Standards are detailed and define the essential functions for aid posts, sub-health centers, and health centers.

Rural aid posts comprise more than 70 percent of all health facilities and deliver basic health care including mother and childcare and community-based health promotion. Staffed by community health workers with 2 years of training, each aid post is designed to cover a population group of about 1,000. In the National Health Plan and Service Standards, health care in Papua New Guinea is envisioned as a hierarchical structure of seven levels with level one (aid post) as the least complex and level seven (national referral hospital) as the most complex.

Rural aid posts are intended to be the point of entry into the health system. Basic health care provided by aid posts in the PAOI varies by staffing, structures, medicines and supplies, transportation, and availability of a private confidential setting. To identify the operational status of health services in the PAOI in this report, facilities have been classified as operating, partially operating, or not operating. Operational services include trained staff that are recognized and paid by an organization (Catholic Health Services [CHS], United Health Services, Gulf Christian Services [GCS], government, or private companies such as International SOS [ISOS]). Operational services have staff that is accessible full time; provide care in a confidential, private setting; and have a dedicated area where medicines and supplies are properly stored. Partially operating services either do not have staff available full time, have only volunteer staff who are not recognized by an organization, or do not have the facilities for appropriate private, confidential health care or storage of supplies. The status of these aid posts can change rapidly and frequently, so this information describes the situation at the time of field visits.

Where aid posts have closed or cannot provide adequate staff or medical supplies, sub-health centers, health centers, and district hospitals have become the key primary care delivery facilities. Sub-health centers and health centers provide similar services, including chronic and acute conditions management, basic surgical care, deliveries, and pediatric care, and function as intermediary referral points between aid posts and district hospitals. The differences between a sub-health center and a health center are typically related to the size of the population served (i.e., a sub-health center serves 1 to 5,000 individuals while a health center services 5 to 20,000 individuals).

In the decentralized PNG health system, church groups often are responsible for the staffing and managing sub-health centers while the provincial government is responsible for named health centers (e.g., Kerema Health Center). However, there are exceptions as GCS (an interdenominal mission organization) manages both the Kapuna Health Center and Kikori Hospital.

The status and performance of PAOI health care facilities are assessed in Section 6.

2.2.6 National Strategy for Responsible Sustainable Development for Papua New Guinea

StaRS includes 21 guiding principles for inclusive and innovative sustainable development that emphasizes, among other things, equality and inclusiveness, social protection, basic human rights, access to essential services, and education. “Health” is described in general terms—for example, “quality education for all and a world class health system are key elements…” (DNPM 2014, 24). There are also discussions on environmental health and climate change.

2.2.7 2014 National Human Development Report

The National Human Development Report notes, “the overall health situation in Papua New Guinea remains a cause for concern” (UNDP 2014, 42). As of 2014, while there are “marked regional variations and some modest progress in terms of decreased mortality and morbidity (ill-health), the strong economic growth in Papua New Guinea has yet to translate into significant health status improvement for the population” (UNDP 2014, 42).

The 2014 review notes that overall mortality is driven by “preventable communicable and infectious diseases, and preventable pregnancy complications. Malaria, TB, vaccine-preventable diseases and diarrheal/water-borne diseases are among the top-five causes of morbidity and mortality.” (UNDP 2014, 42). The 2014 review highlights the following issues in Papua New Guinea:

- Lower respiratory infection (pneumonia) continues to be the leading cause of premature death.

- Malaria incidence has significantly declined; however, it is still endemic in every province and is considered a significant burden on the health care system.
- TB, including multi-drug resistant TB (MDR-TB), is rising dramatically. Treatment services lag far behind the clinical caseload. Accurate and timely diagnosis is a problem. TB is a resource-intensive disease and requires substantial investment in personnel and service delivery.
- Cholera is a concern due to poor water sanitation and poor hand hygiene associated with infection in peri-urban settlements. Control measures are also made difficult by the remoteness of some affected sites and by the often-crowded settlements on the outskirts of cities with no proper sewage systems and deteriorated environmental health conditions.
- Maternal mortality is high with substantial uncertainty and controversy surrounding the actual underlying rate. "Department of Health data indicates that the level of antenatal care has declined in the last 3 years in all regions, except in the Highlands region where it has slightly increased" (UNDP 2014, 43). "Obstetric hemorrhage, sepsis and eclampsia are the main proximate cause of maternal death compounded by high anemia often associated with malaria. Although a majority of women received some antenatal care from a skilled health personal, on average only 53% of them deliver with the assistance of a skilled health care worker (rural: 48% and urban: 88%) and only 44% of births occur in a hospital or health center" (UNDP 2014, 43).
- Neglected tropical diseases are endemic—for example, leprosy. Filariasis continues to present in some locations, including the Gulf Province.
- Sexually transmitted infection (STI) prevalence is high and "remains a major challenge for the health authorities of Papua New Guinea, as increasing population movement, introduction of new pathogens, insufficient health services and wider and often denser socio-sexual networks engendered by rapid social change provide favorable conditions for their spread" (UNDP 2014, 44).

As noted in the report, "There has been a gradual decline in the percentage of functioning health facilities in some parts of the country over the past 20 years: in 2013 only around 70 per cent of aid posts are operational nationally" (UNDP 2014, 46). It also notes the health workforce is in decline.

The report states, "Papua New Guinea is facing a serious crisis in terms of human resources for health delivery, both in the numbers and skills mix. This shortage is a major obstacle to the provision of quality health care services" (UNDP 2014, 46).

Based on 2010 data, the report further states:

> There is one doctor per 17,512 people, five nurses per 10,000 population, and seven Community Health Workers (CHWs) per 10,000 population. The health workforce is aging quickly, while at the same time the capacity to train all cadres of health staff has also been significantly reduced over the past 15 years. Other factors add to the burden of delivering quality health services across the population. These include, a relative absence of management capacity and technical skills in health-sector management, improving but still poor quality data collection systems, the fragmentation of organizational and administrative structures between the national, provincial, district and local government levels, poorly resourced laboratory diagnostic services, and vulnerability to sub-standard medical products due to relatively weak regulatory and law enforcement capacity (UNDP 2014, 46).

The 2014 National Human Development Report presents a health care system in significant decline.

2.2.8 Medium Term Development Plan 2016–2017

The MTDP 2016-2017, also known as MTDP2, incorporates the objectives outlined in StaRS and is limited to 2 years so that the medium-term, development planning framework will be aligned to the 5-year parliamentary cycle in the future.

In terms of the health sector, MTDP2 has the following priorities:

- Expanding health service delivery continuously at the community level through the following structure:
  - National referral and training hospital (Port Moresby General Hospital).
  - Regional referral hospitals.
  - Provincial hospitals.
  - District hospitals.
  - Urban clinics in all LLGs.
  - Health centers in Zone HQ (a Zone HQ is a cluster of wards).
  - Community health posts in wards.
- Expanding regional (specialist) hospitals in Lae (Angau), Mt. Hagen, Port Moresby, and other centers like Wewak (Boram) and Enga.
- Recruiting and training medical professionals and workers. Partnerships with church health services (mostly in rural areas) and with other private health providers will also undertake this work.
- Providing family planning and services for HIV/AIDS; malaria and TB; preventative healthcare; and emerging non-communicable diseases such as diabetes and asthma.

The MTDP2 provided a new set of KPIs and outcome targets for the health sector as listed in Table 2.

Table 2. MTDP2 KPIs and Targets

Indicators	Baseline		Targets 2017
	Value	Year	
Life expectancy at birth	60.2	2012	63
Proportion (%) of one-year old child immunized against measles	49.0	2012	77
Proportion (%) of births attended by trained health personnel	44.0	2012	64
Proportion (%) of pregnant women who had at least one antenatal care visit	66.0	2012	76
Proportion (%) of population with advanced HIV infection with access to antiretroviral drugs	79.0	2012	100
Death rates associated with Malaria per 100,000 population	40.0	2012	30
Death rates associated with Tuberculosis per 100,000 population	54.0	2012	44

Source: UNDP 2015, Table 3.4, 50

According to MTDP2, the primary responsibility for achieving the targets and improving the KPIs is the Department of Health; however, the responsibility is to "be exercised in concert with the important contribution made by the Churches, donors groups and other community-based organizations" (UNDP 2015, 51).

2.3 TOTAL Corporate Standards

Within its Sustainable Development framework, TOTAL has a social baseline study general specification (GS_EP_SDV_101) that describes the objectives, roles and responsibilities, process, and reporting requirements for social baseline studies (TOTAL 2014). GS_EP_SDV_101 states that "The introduction of O&G facilities and activities may have health impacts on communities" (TOTAL 2014, 13). Per the TOTAL specification (2014, 15), the assessment of community health should:

- Define and map national, regional, and local health facilities and services with some connection to the Project area.
- Define and map health facilities and services in the license and Project area and at regional and national levels.
- Define and map existing levels and utilization of health facilities and services in the license or Project area.
- Obtain quantitative and qualitative health baseline statistics for key health indicators, including the leading causes of morbidity and mortality and the situation of specific communicable and non-communicable diseases of interest including HIV/AIDS.
- Identify the key health challenges and issues facing the PACs in the Project area, especially vulnerable groups or individuals.
- Identify infrastructure and environmental factors with any impact on health—for example, waste collection and treatment.
- If relevant, identify potential impact of population influx on community health. A detailed population influx survey may be commissioned.
- Existing prevalence of commercial sex work and health impacts.
- Identify any impacts on access to basic services, particularly drinking water (quality and quantity) and sanitation.

This report includes a series of detailed maps that provide the locations of relevant health facilities/services for the PAOI. Section 6 provides detailed baseline health data for Gulf Province and the PAOI. PAOI data are presented as a unified dataset within specific defined environmental health areas (EHA). The EHA framework is recommended by the International Finance Corporation (IFC) and the International Petroleum Industry Environmental Conservations Association (IPIECA) (see Section 2.4).

2.4 Industry Standards and International Good Practice

This section presents a review of information relating specifically to health baseline standards or requirements of the IFC, IPIECA, and World Health Organization (WHO).

2.4.1 International Finance Corporation

Over the past two decades the IFC has applied environmental and social standards to projects it has financed. The adoption of the IFC standards under the Equator Principles greatly expanded their application. There are eight Performance Standards (PS), including PS 4, Community Health, Safety, and Security.

IFC PS 4 addresses the project proponent's responsibility to "…avoid or minimize the risks and impacts to community health, safety, and security that may arise from project related-activities, with particular attention to vulnerable groups" (IFC 2012, 27). It states (IFC 2012, 29):

- The client will avoid or minimize the potential for community exposure to waterborne, water based, water-related, and vector-borne diseases, and communicable diseases that could result from project activities, taking into consideration differentiated exposure to and higher sensitivity of vulnerable groups. Where specific diseases are endemic in communities in the project area of influence, the client is encouraged to explore opportunities during the project lifecycle to improve environmental conditions that could help minimize their incidence.
- The client will avoid or minimize transmission of communicable diseases that may be associated with the influx of temporary or permanent project labor.

There is no specific IFC requirement that an HIA be performed; however, IFC has issued an HIA Toolkit (2009) and Guidance Notes for PS No. 4 that present detailed information regarding HIA design and execution.

2.4.2 International Petroleum Industry Environmental Conservations Association

IPIECA was established in 1974 and aims to develop and promote socially and economically acceptable solutions to global environmental and social issues in the oil and gas industry. IPIECA has produced a range of good practice guidelines regarding HIAs. In terms of baseline health characterization, the 2016 IPIECA HIA guidance recommends performing several steps:

- Review literature systematically by environmental health area.
- Evaluate existing country survey and research data.
- Evaluate data obtained by community and household survey teams (including environmental and social).
- Evaluate health data from existing project workers, if available in sufficient quantity.

The baseline collection of field data should be "fit for purpose," meaning data collection efforts should match the complexity and practical needs of the HIA and should not be allowed to devolve into an academic exercise. Data should be relevant to the project and connected to the overall analysis of the project.

2.4.3 World Health Organization

In 2014, WHO, in collaboration with the European Public Health Association and the International Association for Impact Assessment published a monograph called "Health in Impact Assessments-Opportunities not to be missed" (WHO 2014a). This publication was designed to "…provide a detailed and balanced view on health in impact assessments". The monograph presents five key types of impact assessment: environmental impact assessment, strategic environmental assessment, social impact assessment, sustainability assessment, and HIA. It strongly notes the interdependencies between health and social/environmental assessment, and it presents pros and cons of a stand-alone HIA versus an integrated assessment. The WHO analysis "…suggests that the potential of impact assessments to protect and promote health is underutilized, and represents a missed opportunity. Ways need to be found to exploit the potential to a fuller extent" (WHO 2014a, Abstract).

3 STUDY AREA

This section discusses the PAOI, study area, climate, and anthropogenic setting for the Project.

3.1 PROJECT AREA OF INFLUENCE

IFC PS 1, Assessment and Management of Environmental and Social Risks and Impacts, requires proponents to define the PAOI by considering activities and facilities, predictable direct and indirect impacts, and cumulative impacts. World Bank Operational Policy 4.01 (1999) defines area of influence (AOI) as the area likely to be affected by the Project, including ancillary aspects and unplanned developments induced by the Project.

The PAOI is the area that is likely to be affected by the Project, its activities and its facilities that are directly owned, operated or managed by the upstream Project (including by Project contractors). This definition includes predictable direct, indirect and some associated and cumulative impacts arising from the upstream Project, including indirect impacts on biodiversity and ecosystem services upon which affected communities' livelihoods are dependent.

The upstream PAOI (hereafter referred to as PAOI) encompasses the areas associated with development of the upstream Project including:

- Facilities, infrastructure and related activities within Petroleum Retention License (PRL)–15 including well pads and gathering system, trunkline, central processing facility (CPF), logistics base, airstrip, accommodation camps, wharf and access roads.
- Export Pipeline Corridor onshore and offshore between the CPF and LNG Plant site at Caution Bay.
- Riverways along which Project vessels will travel to and from PRL-15.
- Marine transport route between Caution Bay and the upstream riverways route to PRL-15.
- Associated developments and activities such as quarries/borrow pits, logistical wharfs/terminals not operated by the Project.

It considers potential impacts resulting from activities such as:

- Induced in-migration (and associated implications such as increased pressure on resources, increased land clearance, the spread of communicable diseases, the development of existing infrastructure and services for increased populations (i.e., health, transport, waste)).
- Wealth distribution (i.e., from the expenditure of wages and/or income generated from the Project on local procurement of goods and services).
- Increased access to previously inaccessible land or resources including interactions with third parties leading to greater disturbance and access to primary resources, e.g., logging.

The boundary for the PAOI incorporates the communities and environment that are likely to be affected by the upstream Project and in doing so acknowledges the intricate link between the environment and the people who inhabit the area. Those people are dependent on the environment (land, air, water (fresh and marine) and natural resources) for their subsistence and as such any potential impact on the environment equates to potential impact on the livelihood and wellbeing of those people. The PAOI is shown in Figure 2 and Figure 3. Although not shown in Figure 2 and Figure 3 (due to scale) the provincial capital of Kerema is also considered to be within the PAOI, as it is likely that goods and services and workers will be sourced from or transit through this provincial center.

The upstream PAOI includes 39 villages and one government station with a combined population of 12,763.

It is recognized that the PAOI extends beyond local and regional boundaries in terms of cumulative impacts within Papua New Guinea, particularly related to royalties and benefits distribution, indirect employment, and business opportunities.

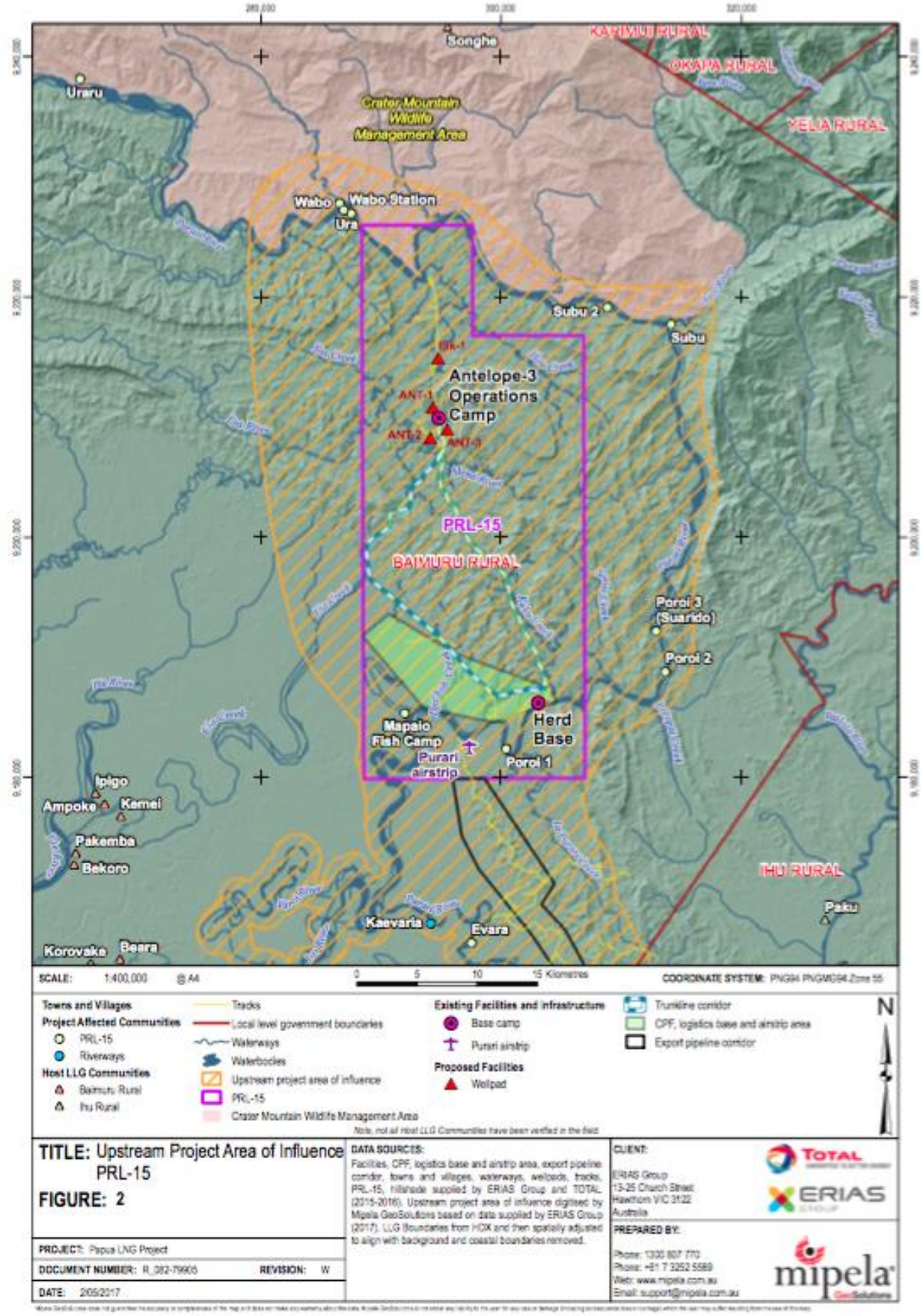
3.2 Study Area

While this Upstream Community Health Baseline Report is written as a stand-alone report, it is part of the suite of social and cultural reports prepared as part of the permitting and approvals requirements for the Project (refer Section 2). The suite includes community and demographics, governance and economics, cultural heritage, and land and natural resource use baseline characterization reports.

The local study area corresponds with the PAOI described previously. Health facilities that were assessed as part of this study are also shown in Figure 4, which also includes the overall PAOI boundaries. The PAOI is located within the Kikori District of Gulf Province and comprises the Baimuru Rural and Ihu Rural LLGs. Primary data were collected from the local study area.

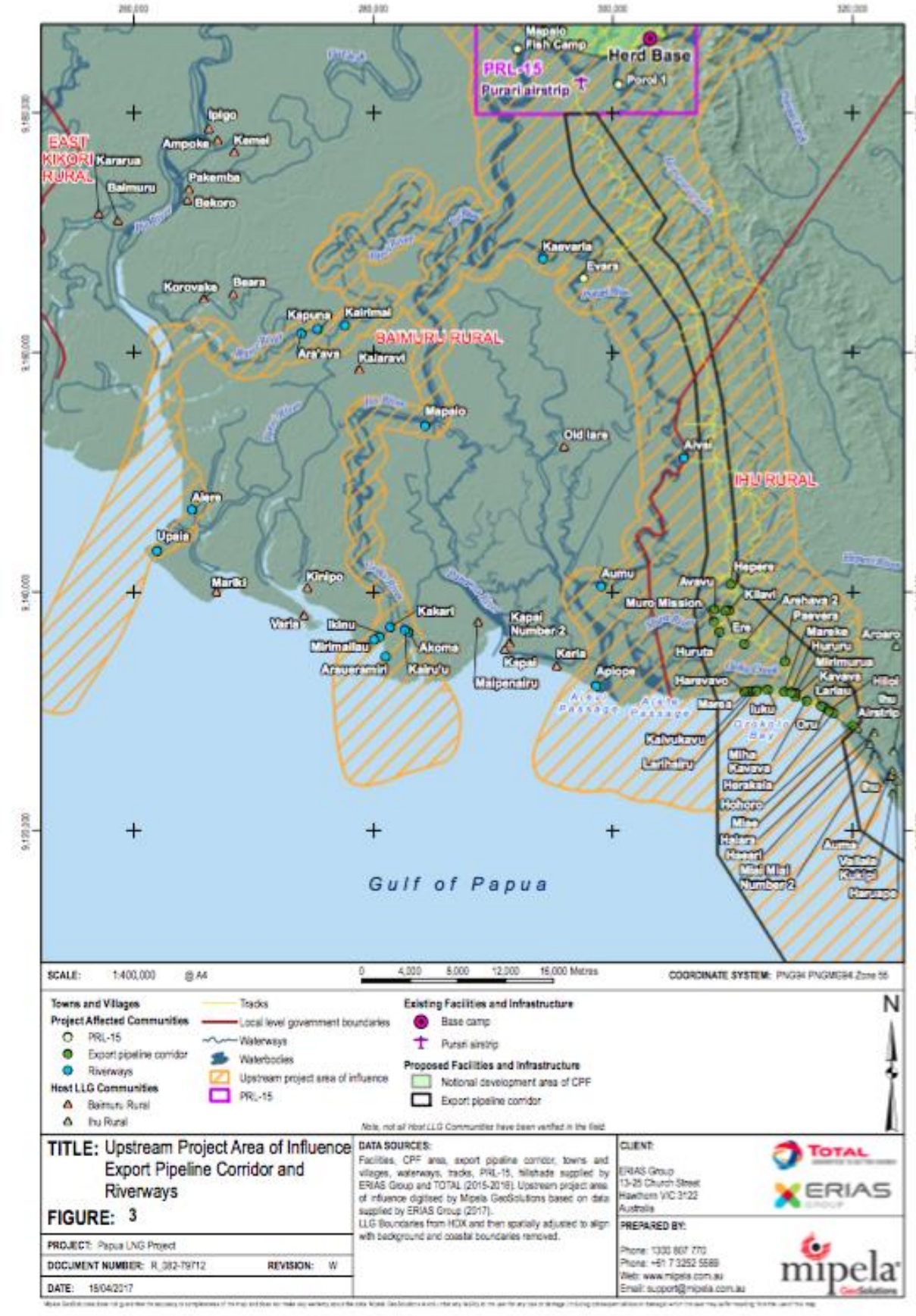
The regional study area extends across the whole of Gulf Province and is particularly relevant for the extrapolation and comparison of data when such is lacking from the PAOI (as is the case with clinical data, which was, in some cases, not obtainable from communities within the PAOI). National data are presented for comparisons and a broader context for the local and regional study areas. Secondary data were collected from the regional study area. Relevant peer-reviewed publications from the Gulf Province are cited as appropriate, such as the Cross et al. TB study (2014) from Kikori Hospital. Using and citing a study (such as Cross et al.) in no way implies that the Kikori geographical area is part of the PAOI, but rather presents comparable or representative data in the regional context. The Upstream Community Health Baseline Report uses the geographical boundaries defined by the social team and defined in the Upstream Community and Demographics Baseline Report (Finlayson 2016a).

Figure 2. PAOI – PRL-15 Area



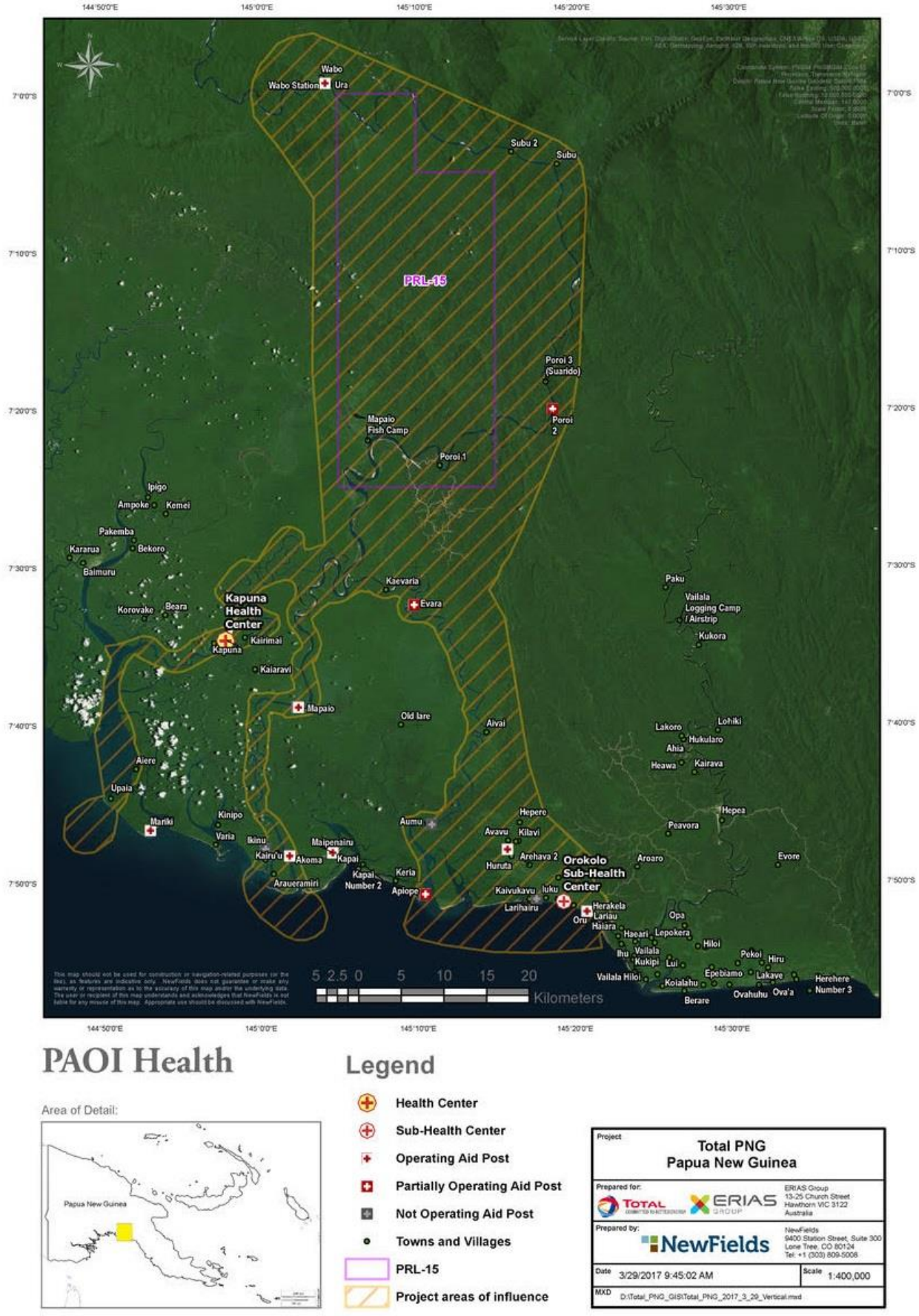
Source: ERIAS Group 2017

Figure 3. PAOI – Export Pipeline Corridor and Riverways



Source: ERIAS Group 2017

Figure 4. PAOI – Health



PAOI Health

Area of Detail:

Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- PRL-15
- Project areas of influence

Project: Total PNG Papua New Guinea

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Source: NewFields 2016

3.3 CLIMATE

The Purari catchment area has a tropical climate that is relatively hot and humid throughout the year, with humidity affected by the southeastern trade wind and the northwestern monsoon wind seasons. These two main seasons are broadly affected by the major airstreams from which they are named: the northwesterlies that occur from December to March ("wet season") and the southeasterlies that occur from May to October ("dry season"). Despite the recognition of these two main seasons, the climate and rainfall of the Purari catchment is dictated by the effect of topography (Evesson 1983). The Wabo area is at the convergence of complex terrain features and air flow effects and receives an average of 8,000 millimeters (mm) per year. Due to the topography, this area exhibits reverse seasonality, with the highest monthly rainfall occurring between May and October during the southeastern trade wind season (about 900 mm per month). Towards the coast, rainfall is lower and more evenly spread throughout the year (averaging around 300 mm per month) (Evesson 1983).

Papua New Guinea's climate varies considerably from year to year due to the El Niño-Southern Oscillation. This is a natural climate pattern that affects weather across the world. El Niño is a warming of the Pacific Ocean resulting in longer and cooler dry seasons (i.e., periods of drought), and a delay to the start of monsoon season. La Niña, the cold phase of the El Niño-Southern Oscillation, typically results in higher than average rainfall and warmer temperatures during the wet season, often leading to flooding events and landslides (Pacific-Australia Climate Change Science and Adaptation Planning 2015). Papua New Guinea also experiences neutral phases.

Climate variability and human health has been considered by the World Bank sponsored Global Facility for Disaster reduction and recovery (World Bank 2011). Based on this assessment, climate variability and change are expected to:

- Increase the incidence of this vector and water-borne diseases (presented in EHA 3 and EHA 5).
- Increase landslides and floods affecting both human safety and access to health centers, by blocking major communications and transportation arteries (presented in EHA 1 and 8).
- Impact food security, heightening the risk of malnutrition in areas where reliance on subsistence crops and fish stocks is high (presented in EHA 8).

Rising temperatures can alter the spread of vector-borne diseases (VBD) by changing mosquito breeding cycles (i.e., malaria generally thrives at temperatures of 22°C at an altitude of 670 meters above sea level). If temperatures continue to rise, the distribution of malaria can change and spread into areas with little or no experience with this disease. Outbreaks of water-borne diseases like cholera are related to sea surface temperature—a rising sea surface temperature increases the risk of a cholera outbreak. For many communities, access to health services is already difficult in the PAOI; hence, any physical alterations in existing transportation routes (e.g., flooding) can negatively affect the time required to access health services. Reliance on subsistence agriculture is substantial across the PAOI; therefore, negative climate effects on local gardening and/or fishing could affect household nutrition. Children, the elderly, and women of childbearing age are more medically susceptible to adverse changes in nutritional status.

3.4 ANTHROPOGENIC SETTING

PRL-15 is largely unsettled but owned and used by the Pawaian people who reside in villages along the Purari River. Most of these villages are outside of, but near to PRL-15, except for two small villages (Poroi 1 and Mapaio Fish Camp) that are located on the Purari River within the southern part of the license area. Aside from subsistence livelihood activities from the Pawaian people, the main

anthropogenic activities in PRL-15 relate to the recent and ongoing gas exploration activities, including the main operations camp at Herd Base, temporary camps at Antelope-3 Operations Camp (recently recommissioned), and Hou Creek Base (now demobilized), and activities and disturbances relating to well pads, access roads, and helipads.

The inland section of the export pipeline corridor is largely unpopulated; however, it has been modified by large-scale commercial logging. Near to and along the coast, the number and size of villages, and hence population density, increases. Anthropogenic activities resulting in decreased air, land and water quality and the exploitation of natural resources, for example, include forest clearing for settlements, subsistence agriculture (food gardens, sago planting, hunting, and fishing) and historical clearing for coconut plantations.

Along the Purari riverways, villages are predominately located on or near the upper reaches of the tidal influence where there is likely to be a greater resource availability. In addition to subsistence agriculture activities and logging, Project barges transporting supplies and equipment to Herd Base regularly travel along the Purari channels.

From a health perspective, the current level of anthropogenic activities, such as forest clearing for settlements and the exploitation of natural resources, is likely already reflected in the current burden of disease pattern across the PAOI.

4 EXISTING INFORMATION

Health data are available for Papua New Guinea; however, the volume, quality, and geographical coverage of the information are highly variable. The last countrywide demographic health survey (DHS) was completed in 2006. A new DHS is underway; however, these data will not be available for at least 12–24 months. Gulf Province health data are available through the NDOH Sector Performance Annual Review (SPAR) reports. The most current SPAR report was published in 2015. The Gulf Province has published health data for certain high-profile diseases, such as HIV/AIDs, malaria, and TB; however, the most current information source is the 2013 and 2015 SPAR reports. As described in Section 2, while there are many national level reports, data are not always disaggregated at the provincial level, let alone at a district level.

Education and economic statistics, including information from the 2011 National Population and Housing Census (National Statistics Office [NSO] 2013a) and 2009-2010 National Income and Expenditure Survey (NSO 2013b), are available.

Compared to other locations in Papua New Guinea, there have been relatively few peer-reviewed scientific publications based in the Gulf Province. The PNG LNG Project sponsored an important TB prevalence study in the Gulf (Kikori) (Cross et al. 2014). Multilateral agency (e.g., WHO and World Bank) reports typically report national level data that are rarely available at a provincial level, much less at a district level.

Other Gulf Province-specific health data that are available have been sponsored by NGOs, Médecins Sans Frontières (MSF) (TB program and management support in Kerema), and private companies, including Oil Search Foundation (TB support), TEP PNG-supported occupational health service outreach to local villages, and a 2012 InterOil sponsored cross-sectional health survey of villages within the InterOil Petroleum Development License area in the Gulf Province. Otherwise, there is limited existing health information available for the PAOI.

Due to the lack of information specific to the PAOI, various village, household, and key informant interviews (KII) have been conducted as part of the social baseline study. In addition, when available, local clinic morbidity and health service data were collected from PAOI aid posts, health centers, and the Provincial Health Information Department. The health center morbidity data (e.g., Kapuna and Kerema) are far more robust because health centers see large numbers of patients on an annual basis. Aid post data reporting is inconsistent and complete datasets were not available during the field collection effort.

5 METHODS

This section of the report discusses the methodology used to compile this report, including the general approach, data sources, limitations, and currency conversions.

5.1 General Approach

The general approach to the upstream health baseline characterization was to identify data requirements for health, identify villages in the PAOI, develop the sampling framework, develop a timeline, assemble the study team, implement surveys, consult stakeholders, and identify study challenges.

5.1.1 Identify Data Requirements for Health

All necessary socio-cultural data (including health) required for the social baseline study for the Project was collected as part of a coordinated effort, conducted over two campaigns in May and August 2016.

Following a review of existing information (see Section 4), gaps in information that were required to present a baseline characterization of the PAOI were identified. A number of survey instruments were designed to collect the missing information. Data collection methods included dedicated KIIs for health workers; semi-structured community health discussion; specific health-related questions in focus group discussion (FGD) instruments used with village leaders, women and youths; semi-structured stakeholder health discussions with health services providers (i.e., government and health center staff); and specific health-related questions in a household survey implemented across a sample of households in the PAOI. The dedicated KII instrument is presented in Attachment E. Other instruments are appended to the Upstream Community and Demographic Baseline Report (Finlayson 2016a).

5.1.2 Identify Villages in the Project Area of Influence

The upstream PAOI includes villages close to PRL-15, the export pipeline corridor, and the three main navigable channels of the Purari River. Drawing on existing maps and census data, 36 villages were initially identified—before conducting community level surveys—as being within the PAOI (Finlayson 2016a). The community level surveys were conducted in all PAOI villages first, noting that the health KIIs were conducted only where there was a health facility and/or health worker present (see Table 3). After completing the community level surveys, an additional four communities were identified to be included in the study because of their relationship with other communities in the PAOI or their proximity to Project components.

To identify the population potentially impacted by the Project, the missions at Kapuna and Muro were not included in the PAOI villages because the missions had few people (who were generally from other parts of Papua New Guinea) who worked in schools, health facilities, or the church (Finlayson 2016a). The residents of Wabo Station were included in the PAOI because Wabo Station accommodates a substantial number of people who have relocated from other parts of Papua New Guinea, and who are not health, education, or church workers, but have relocated in search of employment with the Project. It was therefore determined that the PAOI contained 39 villages and one government station (Wabo Station). The villages and station are shown in Figure 2 and Figure 3. Further discussion of the demography of the PAOI is provided in the Upstream Community and Demographics Baseline Report (Finlayson 2016a). The PAOI had a population of 12,763 in mid-2016. Village size ranged from 32 (Mapaio Fish Camp) to 962 (Kavava).

In total across the PAOI, there are 15 health facilities; 9 are operating, three are partially operating and three are not operating. The location of health facilities and the survey methods used at each village are listed in Table 3. Kerema Health Center (located in the provincial capital) was also assessed and is described at Section 6.2.2.2. Whilst within the PAOI, given its proximity to the other villages in the PAOI and the barriers to accessing the facility for most of those people, Kerema Health Center is discussed separately and not included within the tables herein.

Table 3. Health Facilities and Survey Conducted

Location	Health Facility	If Yes, Status*	Name of Facility	Survey Conducted	KII Participant
Aiere	No				
Aivai	No				
Akoma-Kairu'u	Yes	O	Akoma Aid Post	Yes	Community Health Worker (CHW)
Apiope	Yes	P/O	Apiope Aid Post	Yes	CHW
Ara'ava	No				
Aumu	Yes	N/O			
Avavu	No				
Ere-Kilavi	No				
Evara	Yes	P/O	Evara Aid Post	Yes	CHW
Harevavo	No				
Hepere	No				
Huruta	No				
Ikinu	Yes	N/O	N/A	Yes	Volunteer health worker
Iuku	Yes	N/O			
Kaevaria	No				
Kairimai	No				
Kaivukavu	No				
Kapai 2	No				
Kapuna Health Center	Yes	O	Kapuna Health Center	Yes	Medical doctors, nurses, CHWs, facility manager
Kavava	Yes	O	Orokolo Sub-Health Center	Yes	CHW
Larihairu	No				
Maipenairu	Yes	O	Maipenairu Aid Post	Yes	CHW
Mapaio	Yes	O	N/A	Yes	CHW
Marea	No				
Mareke	No				
Mariki	Yes	O	Mariki Aid Post	Yes	CHW
Muro Mission	Yes	O	Muro Mission Aid Post	Yes	CHW
Oru-Lariau-Herekela	Yes	O	Oru-Lariau Aid Post	Yes	CHW
Paevera	No				
Poroi 1	No				
Poroi 2	Yes	P/O	Poroi Aid Post	Yes	Group of residents and ISOS Health

Table 3. Health Facilities and Survey Conducted

Location	Health Facility	If Yes, Status*	Name of Facility	Survey Conducted	KII Participant
					Extension Officer (HEO)[t]
Poroi 3	No				
Subu	No				
Subu 2	No			Yes	Women's group and men's group
Upaia	No				
Ura	No				
Wabo Station	Yes	O	Wabo Station Aid Post	Yes	ISOS HEO[t], VBAs group

*O = operating; N/O = not operating; P/O = partially operating
[t] = HEOs are provided by ISOS under contract to TEP PNG.

5.1.3 Develop Sampling Framework

The community-level data provided the necessary information to identify sampling criteria for the selection of villages in which household surveys would be conducted and to estimate the number of households to be surveyed in each village (Finlayson 2016a).

Results of the community level data indicated that people speaking a common language shared a similar history, and people residing in the same ecological zone practiced similar activities on a day-to-day basis. The language group and ecological zone were therefore identified as key determinants of current lifestyles and social behavior, and were used as the key criteria to select villages for survey (Finlayson, 2016a). Community level surveys also demonstrated low variability in many of the social characteristics across villages in the PAOI. It was therefore deemed adequate, for the household survey to be conducted in a sample of villages and to include a sample of households from each survey village (Finlayson, 2016a).

The villages included in the household survey were therefore deliberately selected to ensure a stratified sample of villages from each language group and each ecological zone. The intention was to survey 20–30% of the households in each community, with the proportion of households surveyed increasing in villages with fewer households. The households selected from each village were selected systematically (every third house) from a village map and list of households prepared during the community-level surveys (Finlayson 2016a).

From a health perspective, the pattern and burden of morbidity and mortality likely follow the language and ecological zone framework; however, the PNG national and provincial level health information system (HIS) captures key data by aid post, health center, and hospital. The PNG HIS does not capture data by patient provenance (i.e., the village of residence for the individual[s] seeking medical attention). Experience in Papua New Guinea indicates that the location of a health facility, particularly aid posts, does not necessarily define patient catchment geography. As noted in Section 2, there has been a reduction in the number of aid posts that are staffed and in actual consistent operation; hence, villagers who seek health services could only be seen at health facilities that are far from their household. As part of the overall survey effort, either a social or health team member visited all the identified PAOI health facilities.

5.1.4 Develop Timeframe

Data collection occurred between May and September 2016, as shown in Figure 5.

Figure 5. Data Collection Schedule

Activity	2015	2016											
		J	F	M	A	M	J	J	A	S	O	N	D
Scoping visit													
Assemble team													
Identify data needs													
Finalize work program													
Fieldwork training													
Upstream community surveys													
Upstream household surveys													
Secondary data collection													
Data entry and analysis													
Report preparation													

Source: Finlayson 2016a

5.1.5 Assemble the Study Team

The team assembled for the coordinated data collection program included five PNG and six expatriate consultants. The health subject matter experts were Marci Balge RN, MSN, COHN-S[4] and Suparat Phuanukoonnon PhD. They each have extensive (more than 10 years) experience in Papua New Guinea and have worked on numerous health projects in the country. Dr. Phuanukoonnon is a fluent Tok Pisin speaker.

PNG consultants were involved in survey design to help ensure the survey instruments were appropriate in the cultural context.

All team members participated in detailed pre-survey training programs that aimed to (Finlayson 2016a):

- Familiarize team members with the Project and the PAOI.
- Provide a detailed understanding on the reason for collecting social baseline data and the importance of collecting accurate data.
- Ensure all team members understand all questions they may be required to ask and how they should be asked.
- Ensure all team members understand the importance of respectful behavior and techniques to appropriately ask sensitive questions.
- Ensure all team members understand their responsibility to check each questionnaire to ensure it is complete and legible before moving on to the next task.
- Ensure all team members are aware of the health and safety requirements of the Project and TEP PNG.
- Ensure all team members are not only recording data but able to contribute to the knowledge base and provide insight to the potential social impacts of the Project.

4 Registered Nurse (RN), Masters of Science in Nursing (MSN), Certified Occupational Health Nurse-Specialist (COHN-S).

The health members reviewed and analyzed all health-related data collected during the surveys. Community and household health survey data are discussed in Section 6 within the relevant EHA. Broader social data relevant to the health baseline, such as demography, educational attainment, literacy, and drug and alcohol use, are described in Section 6 by EHA.

5.1.6 Implement Surveys

The study team conducted two surveys: community level and household level surveys (described below), as well as semi-structured discussions with community members (previously called "semi-structured community health discussions") and stakeholders (health services providers) (previously called "semi-structured stakeholder health discussions"). The latter discussions aimed to explore health challenges and potential emerging issues, supplementing the information gained from the surveys. As shown in Figure 5, the initial community level surveys were completed in May/June 2016. Some additional community level surveys, along with the household surveys, were completed in August/September 2016. Community health discussions were conducted at 14 locations, as described in Table 4. The discussions were held with all operating and partially operating facilities (refer Table 3), as well as at Ikinu (at which the health facility was not operating but a volunteer health worker was operating), and at Subu 2 (at which no health facility exists, but discussions were held with community members). Table 4 summarizes the surveys completed in each village/station.

Table 4. Villages/Stations Surveyed

Surveys	Villages/Station	Number
Community-level surveys only	Kavava, Mapaio, Mareke, Ara'ava, Kaivukavu, Larihairu, Marea, Hepere, Avavu, Ikinu, Huruta, Aumu, Lariau, Oru, Arehava No. 2, Hohoro	16
Community-level and household surveys	Iuku, Harevavo, Evara, Wabo, Maipenairu, Herakela, Kapai 2, Kairu'u, Apiope, Poroi 2, Upaia, Akoma, Ura, Mariki, Kilavi, Ere, Kaevaria, Wabo Station, Aivai, Subu 2, Subu, Poroi 3 (Suarido), Poroi 1, Paevera, Kairimai	25
Community health discussions	Kapuna Health Center, Mapaio, Apiope, Akoma, Poroi 2, Wabo Station, Evara, Muro Mission, Kavava, Oru-Lariau-Herekela, Mariki, Ikinu, Maipenairu, Subu 2	14
Household surveys only	Aiere, Mapaio Fish Camp	2

Source: ERIAS Group 2016a; 2016b

According to Finlayson (2016a), several villages were combined for the community level surveys (after discussion with and approval by people from the respective villages), such as the adjoining villages of Ere and Kilavi or Akoma and Kairu'u. A limited village leaders survey was conducted in Arehava No. 2 due to time and logistical constraints. Logistical constraints prevented visiting Aiere; however, families from Aiere participated in the household survey when they paddled downstream to Upaia. Community level surveys were not completed at Mapaio Fish Camp as the village was mourning the death of a resident at the time of the survey. Key community information was, however, collected during the household survey (Finlayson 2016a).

The total number of household surveys completed was 354. This represented 33% of the households in the 27 communities included in the household survey (Finlayson 2016a).

5.1.6.1 Community Level Surveys

TEP PNG's community affairs officers conducted survey awareness approximately 2 weeks prior to the community level surveys, and again, 1 or 2 days before the surveys were scheduled in each village (Finlayson 2016a). On arrival in each village, TEP PNG and the study team held a meeting with

village members and provided a *tok save* (explanation). As part of the *tok save*, TEP PNG introduced ERIAS Group as an independent organization engaged by TEP PNG to conduct the EIS and indicated the visit was for the social baseline study, including health.

Following the *tok save*, the study team commenced the various FGDs and KIIs, and began mapping houses, village infrastructure, and other points of interest. The team generally completed the surveys in less than half a day, which allowed two villages to be completed on a single day when logistical arrangements allowed. Due to the large number of FGD and KIIs performed, sessions were simultaneously conducted by team members. Further information about the implementation of the community level survey is provided in the Upstream Community and Demographic Baseline Report (Finlayson 2016a).

5.1.6.2 Household Surveys

The health-specific questions in the household survey were designed by the health experts and administered by the social team.

TEP PNG's community affairs officers conducted awareness approximately 2 weeks prior to the household survey, and again, 1 or 2 days before the survey was scheduled for each village (Finlayson 2016a).

Again, following arrival in each village, a brief meeting was held with village members and a *tok save* provided by TEP PNG and the study team (reiterating the information presented on the previous occasion, as outlined previously). The selected households were then identified and surveys commenced. Households were only surveyed if one or more adults from the house were present and willing to participate in the survey. If household members were absent or otherwise occupied, a replacement household was identified. Generally, this was the nearest household to the one that needed to be replaced. One full day was generally required to complete the household surveys in each village (Finlayson 2016a). Further information about the implementation of the household survey is provided in the Upstream Community and Demographic Baseline Report (Finlayson 2016a).

5.1.7 Community and Stakeholder Discussions

During the study, discussions occurred with communities in the PAOI, health officials, clinical staff, and officers from TEP PNG and representatives from church groups, NGOs and the private sector (see Plate 1 and Plate 2). Attachment A provides a comprehensive list of the health facilities and aid posts visited. Attachment B provides maps showing health facility locations. Attachment C lists contacts who were interviewed during the process of data collection. Attachment C summarizes community and stakeholder discussions conducted by health professionals who are experts in the community health assessment field.

Plate 1. Community Health Discussion in Mapaio



Plate 2. Stakeholder Health Discussions in Kerema



5.1.8 Identify Study Challenges

The health team identified the following main study challenges:

- Identifying functioning health facilities within the PAOI before community surveys were conducted.
- Finding health staff at an identified health facility.

In addition to the listed challenges, some of the limitations described in Section 5.3 should be observed.

5.2 DATA SOURCES

This section provides an overview of the main sources of information used in this report. Peer-reviewed scientific/medical papers are presented and referenced in Section 6.

5.2.1 Literature Review

The following documents were used for the literature review for the Upstream Community Health Baseline Report:

- PNG legislation and international guidelines, policies, and standards relevant to the study (see Section 2 of this report).
- Project reports prepared for InterOil or TEP PNG.
- 2006 Demographic Health Survey (NSO 2009).
- 2010 PNG National Health Plan 2011–2020 (NDOH 2010a).
- 2011 PNG National Census (NSO 2013a).
- 2011 Household Income Expenditure Survey (NSO 2013b).
- SPAR reports (NDOH 2015).
- Medium Term Development Plan 2011–2015 (DNPM 2010b).
- MTDP2 (DNPM 2015).
- PNG Institute of Medical Research (PNG IMR) national level studies (e.g., malaria) (Hetzel et al. 2014a).
- PNG IMR location-specific sponsored research studies, such as the TB incidence and prevalence study (Cross et al. 2014) in Kikori and Gulf Province malaria prevalence surveys (Hetzel et al. 2014a).
- PNG IMR Partnership in Health Program (PiHP) studies (PNG IMR 2015; 2016).
- InterOil 2012 Baseline Health Survey performed in PRL-15 covering eight Pawaian speaking villages (InterOil 2012).
- International agency studies, such as the Australian Government Department of Foreign Affairs and Trade (DFAT, formerly known as AusAID); there are no DFAT sponsored studies in the Gulf Province; UN, WHO, World Bank, and UN International Children's Emergency Fund (UNICEF) data are typically based on NDOH original data with modelled extrapolation for 2014 to 2016.
- NGO studies (e.g., MSF TB efforts in Kerema).
- Peer-reviewed scientific studies.

5.2.2 Primary Data

Primary data have been collected using community level and household level survey instruments and semi-structured discussions, as described in Section 5.1. The community level survey instruments included the following FGDs and KIIs:

- Village leaders FGD.
- Social organization FGD.
- Women's FGD.
- Youth FGD.

- Land and natural resource use KII.
- Education KII.
- Health KII (Attachment D).
- Store KII.
- Market KII.

The household survey contained 26 multi-part questions of 67 in total, specifically designed to elicit health-related information, in addition to other questions relating to demographic and lifestyle aspects contributing to health. The household survey instrument is provided in Attachment D.

In addition, global positioning system (GPS) coordinates were recorded for community health facilities and other points of interest to compile village maps. Attachment B contains detailed maps of health facilities and PAOI villages. Further discussion on village access to care patterns is provided in Section 6.

5.2.3 Secondary Data

Official records, statistics, annual reports, and development plans have been accessed from relevant government agencies and private sector organizations to help prepare this report. Monthly and annual morbidity summary tally sheets were collected from aid posts, sub-health centers, and health centers. These data are summarized in Section 6. Public health agencies in Papua New Guinea routinely report public health surveillance data at various levels of disaggregation—national, regional, provincial, and district. NDOH occasionally presents data at the hospital and health center level; however, NDOH typically does not report aid post level data to avoid privacy violations (e.g., stigmatization) and problems with statistical analysis when case numbers are small (fewer than 10). Therefore, while all available data from functioning local aid posts and health centers were reviewed, individual aid post data sets are not presented as these data frequently have fewer than 10 reports for a given diagnostic category (e.g., STIs).

NDOH published summary provincial data in 2010, 2013, and 2015; these data rely on information from the years 2008–2009, 2008–2012, and 2011–2015, respectively. SPAR reports include summarized provincial and regional data, and overall national data. Hence, overall Gulf Province data can be compared to an individual province, by region as well as the national average. There are limited SPAR data at the district level. Provincial level data are not always presented for every defined SPAR key performance indicator.

International agencies, such as WHO, UNICEF, World Bank, and the UN Development Programme (UNDP) all publish country level (national) health key performance indicators and morbidity and mortality outcomes. These data are typically not collected by the given international agency, however, and instead rely upon the NDOH datasets. Occasionally, 2014/2015 data are presented; however, these data are often a modeling extrapolation exercise based on 2010–2012 NDOH data and rarely represent new data collection. These published figures should be interpreted cautiously as experience in Papua New Guinea indicates that these data may significantly misestimate the actual burden of disease present at a provincial, district, or community level.

5.3 LIMITATIONS

For villages in the PAOI, education and literacy levels are low. In addition, many questions are subjective and reflect the response provided by the person or people being interviewed. Health information is personal and sensitive and there may be a reluctance to fully answer questions. This problem can also occur in FGDs and KIIs, particularly regarding gender-based violence and STIs.

Results should therefore be treated with caution and the following limitations observed:

- Literacy levels are commonly overstated according to Finlayson (2016a).
- Data regarding smoking, drug, and alcohol usage is commonly underreported.
- Quality of household level drinking water has not been verified.
- Many aid posts are irregularly open and staffed; therefore, there are reporting gaps for monthly tally sheets.
- Data regarding time to access health care may be inaccurate, as individuals do not necessarily have watches. Travel times using canoes will vary by factors such as the weather, water flow, tide, who is paddling, and the load being carried. Travel times using motorized canoes or dinghies will vary according to the size of the outboard motor and load in the canoe or dinghy. Any estimates included in the report must therefore be treated with caution (Finlayson 2016a).

5.4 Currency Equivalent

Currency conversions applied within this report have been calculated at PGK1.00 = US$0.32. Australian dollar (A$) conversions to the U.S. dollar for multi-year funding; for example, a December 2010 Australian government funding announcement for a long-term 2011-2017 financial commitment is based on the quoted currency rate from January 2011.

6 BASELINE CHARACTERIZATION

This section describes the organization of the baseline health data and gives an overview and sources of information for each EHA, and key findings and issues for EHA 1.

6.1 ORGANIZATION OF THE BASELINE HEALTH DATA

Baseline health data are structured based on EHA methodology published by IFC (2009) and IPIECA (2016). EHAs are a standard set of health effects categories that have been developed by international multilateral lending institutions and the oil and gas industry. EHAs have been developed to capture a variety of determinants of health. The EHA approach includes all the biomedical and social concerns originally developed by key international health and development agencies—WHO and the World Bank Group. Health data were organized into the following 12 EHAs:

1. **Health systems** – physical health infrastructure (e.g., capacity, equipment, staffing levels and competencies, future development plans) and program management delivery systems (e.g., malaria, tuberculosis, and HIV/AIDS initiatives and maternal and child health).
2. **Communicable respiratory diseases** – transmission of communicable diseases (e.g., acute respiratory infections, pneumonia, tuberculosis and meningitis) that can be linked to inadequate housing design, overcrowding, and housing inflation.
3. **Vector-borne diseases (VBD)** – mosquito-, fly-, tick-, and lice-related diseases, such as malaria, dengue, and yellow fever.
4. **STIs, including HIV/AIDS** – STIs such as syphilis, gonorrhea, chlamydia, hepatitis B, and, most importantly, HIV/AIDS.
5. **Water, Sanitation, and Hygiene (WASH)-related diseases** – diseases that are transmitted directly or indirectly through contaminated water, soil, or non-hazardous waste (e.g., diarrheal diseases).
6. **Food- and nutrition-related issues including food security** – adverse health effects such as malnutrition, anemia, or micronutrient deficiencies due to changes in agricultural and subsistence practices or food inflation; gastroenteritis; and food-borne trematodiases, among others.
7. **Non-communicable diseases (NCD)** – cardiovascular diseases, cancer, diabetes, and obesity.
8. **Accidents and injuries** – road and marine traffic- or work-related accidents and injuries (home and project related).
9. **Exposure to potentially hazardous materials** – includes exposure to pesticides, heavy metals, solvents or spills, and releases from road traffic. Noise, water, and air pollution (indoor and outdoor) as well as visual impacts are considered based on data developed in upstream baseline reports.

10. **Social determinants of health (SDH)** – includes psychosocial stress (due to resettlement, overcrowding, political or economic crisis, mental health, depression, gender issues, and domestic violence).
11. **Veterinary medicine and zoonotic diseases** – diseases affecting animals (e.g., bovine tuberculosis, swinepox, and avian influenza) or that can be transmitted from animal to human (e.g., influenza A subtypes H5N1 and leptospirosis).
12. **Cultural health practices** – role of traditional medical providers, indigenous medicines, and unique cultural health practices.

Except for EHA 1 Health Systems (where the sequencing is slightly modified), the data are presented using this general sequence:

- Overview.
- Sources of information:
  - Peer-reviewed published literature.
  - PNG NDOH data (e.g., SPAR).
  - International agency data (e.g., WHO and UNICEF).
  - NGO data.
  - Private company sponsored data.
  - PAOI health facility data.
  - Project sponsored studies:
    - Social and environmental field work commissioned by TEP PNG (e.g., various upstream baseline reports).
    - Community surveys including FGDs and KIIs covering health issues.
    - Household surveys including general information relevant for understanding the health context and health specific questions.
    - Overall analysis including household level health susceptibility and identifying priority health issues for TEP PNG management.

For each EHA, the relevant primary data are presented as a unified dataset covering the entire PAOI. Health facility data has not been disaggregated by geographical location, as PNG health facilities do not record the provenance of individual patients. While patients may generally access a health facility near their home, this is not always true. PAOI health facilities, particularly local aid posts, are not consistently open or staffed; therefore, depending upon the acuity or seriousness of the medical issue, an individual may access a health care facility that is far from their residence.

For many EHAs, important data are in contemporary environmental and social baseline reports prepared by ERIAS Group or its sub-consultants. In general, these data tables are not fully reproduced but are summarized for health baseline relevance, such as demography, literacy, and educational attainment.

6.2 Environmental Health Area 1 – Health Systems

The health systems EHA is broad-based and designed to capture baseline information regarding the status and performance of the health care system in the PAOI. This assessment includes the suite of health care facilities and programs within the defined PAOI. The following considerations within this EHA are important:

- Mix of health care facilities (e.g., aid posts, sub- health centers, health centers).
- Physical state of the available infrastructure.
- Facility staffing.
- Equipment and supplies, particularly drugs and laboratory equipment.
- Kinds of programs that are being implemented (e.g., maternal and child care, vaccinations, and antenatal clinics); disease-specific programs such as HIV/AIDS, TB, and VBDs are considered in other named EHAs.
- Access to care.

Because of the complexity and length of the health systems EHA analysis, a brief, high-level overview of how the Gulf Province health care system is performing relative to national indicators is introduced. The NDOH SPAR, published by the Ministry of Health, is the key report where a set of uniform KPIs is used to evaluate all 19 PNG provinces. This overview benchmarks the subsequent health systems analysis across the PAOI. The health systems EHA analysis is then developed using primary source materials: FGDs, KIIs, direct field observations made by the health team, and relevant survey data.

6.2.1 Overview of the Gulf Province Health Care System

The SPAR provides a snapshot of health sector performance by province for 2015 and compares results over the last 5 years. The SPAR has 31 defined indicators that are tied to the overall National Health Plan 2011–2020 (NDOH 2010a). Indicators are a combination of outcomes, outputs, and inputs:

- Outcomes:
  - Case fatality rate for pneumonia children under age 5.
  - Percentage of underweight children under age 5.
  - Underweight births as percentage of total births.
  - Incidence of malaria per 1,000 population.
  - Percentage of pregnant women age 15-24 HIV+.
  - Incidence of diarrheal disease per 1,000 children under age 5.
  - Total injury discharges from health centers and hospitals for every 1,000 population.
- Output:
  - Ratio of rural outreach clinics held to children under age 5.
  - Percentage of children at 1-year old immunized against measles.
  - Percentage of children at 1-year old immunized with three doses of Triple Antigen/Pentavalent vaccine.
  - Percentage of births attended by skilled personnel at health facilities.
  - Percentage of total provincial hospital births that are referred from rural centers.
  - Percentage of women who attend at least one antenatal visit.
  - Family planning: couple years protection per 1,000 women of reproductive age.
  - Percentage of children under age 5 with fever who are treated with appropriate malaria drugs.
  - Percentage of children under age 5 sleeping under a treated bed net.
  - Percentage of HIV+ mothers who receive treatment to prevent mother-to-child-transmission.

- Case detection rate of all TB cases.
- TB treatment success rate.

- Inputs:
  - Percentage of government grants and development funds that are expended.
  - Percentage of estimated minimum health expenditure required that the provincial government expends.
  - Percentage of health centers that have received at least one supervisory support visit from district/provincial management during the year.
  - Average number of outpatient visits to hospitals/health centers per person per year.
  - Percentage of aid posts open.
  - Percentage of outbreaks NDOH identified and assessed within 48 hours.
  - Total budget allocation per capita.
  - Percentage of health facilities that have running water to delivery room.
  - Percentage of health centers/hospitals with functioning telecommunications.
  - Percentage of months that facilities do not have stock outs of supplies for more than a week in a month.
  - Percentage of hospitals that have 3 of 5 key specialties.
  - Number of health workers per 10,000 population.

The SPAR analyzes each province against the defined indicator and compares to the other named provinces from 2011 to 2015. NDOH categorizes Gulf Province as a “poor performer” relative to other provinces. Table 5 compares the 2015 Gulf Province and the Kerema and Kikori districts versus the 2015 national performance for the SPAR key indicators. The SPAR does not report all indicators for all provinces.

According to the NDOH, the increase in financial resources to the health sector did not translate into improved health outcomes across provinces, including Gulf Province. A few programs, like the malaria control program, were exceptions, with significant decline in the incidence and mortality from malaria. The malaria control program received sustained external funding and staffing. The status of malaria and other vector-borne diseases is described in VBD EHA.

Across Papua New Guinea, the number of outreach clinics continued to decline and more aid posts closed. The amount of supervision visits also decreased significantly over the last 5 years. In general, there is poor access to health services and deteriorating quality of services. These NDOH observations were confirmed as true for the PAOI health facilities during their fieldwork. These data are presented in the next sections.

With few exceptions across Papua New Guinea, there is no evidence of any improvements in most of the maternal and child health indicators. One exception is child mortality from pneumonia, which has been on the decline in most provinces. Child immunization, supervised births, and antenatal and family planning coverage continued to decline while diarrheal disease among children under age 5 increased over the last 5 reporting years.

Table 5. SPAR Indicators 2015 Gulf Province and Districts Versus National

Indicator	Gulf Province 2015	Kerema District	Kikori District	National 2015
% Pneumonia deaths children <5 at health facilities	1.39%	1.97%	0.0%	2.31%
% Children moderate severe weight for malnutrition	33%	31.5%	35.8%	23%
% Low birth weight babies	7%	6.34%	7%	7%
Malaria incidence/1,000 population	118	146	39	102
Incidence diarrheal disease children <5 per 1,000 children <5	321	355	322	300
Injuries at outpatients/1,000 persons	49	54	34	36
Outreach clinics per 1,000 children <5	9	11	4	37
% Measles coverage children <1	19.24%	16.6%	28%	39.21%
% 3rd dose Pentavalent coverage children <1	19%	17%	26%	54%
% Supervised births at health centers	34%	27.8%	54%	37%
Antenatal coverage at least 1 visit	54%	54.6%	55.2%	63%
Case Detection Rate TB	589	N/A*	N/A	349
TB sputum + cure rate	10%	N/A	N/A	52%
Supervisory visits	17%	N/A	N/A	29%
Outpatient visits per person per year	1.48	1.54	1.36	1.23
Health facilities with telecommunications	29% (2014)	N/A	N/A	37% (2014)
Availability of medical supplies	84%	90%	63%	87%

Source: NDOH 2015

*N/A = Not Available

6.2.2 Sources of Information

This subsection discusses the health providers, staffing, facilities, and services in the PAOI as well as provincial health information, medical supply and delivery, access to health care, and the RPHSDP.

6.2.2.1 Project Area of Influence Health Providers, Staffing, Facilities, and Services

PAOI health services are largely delivered by GCS, United Health Care, CHS, and ISOS's Community HEOs[5]. Government aid posts are present but not consistently staffed nor functional. Table 6 shows the absence of doctors from all facilities in the PAOI except Kapuna Health Center, but also the presence of some form of trained health worker at all other facilities (ranging from nurses to trained

5 Who, at the time of data collection, provided health support under contract with TEP PNG during the company's community affairs activities. The program has since been replaced by CHWs from the National Volunteer Service who are permanently based at Poroi 2 and Wabo for a two-year period.

village birth attendants [VBA]). The staffing and capabilities of these facilities are summarized in Table 6 and Table 7.

In Table 6, a medical doctor has a bachelor's degree in medicine and surgery, often a post-graduate qualification and extensive placement experience, a HEO has a Bachelor of Health Sciences in Rural Health and practical training, a nurse has a Bachelor of Nursing and practical training, a CHW has completed a two-year training program (using a standard national curriculum and overseen by NDOH), and a trained VBA is a volunteer who has completed a training program developed by NDOH.

In the PAOI, 58% of operating or partially operating health facilities received supervisory visits in the past couple of years, compared to the 2015 SPAR data that showed 17% in Gulf Province and 29% nationally. Components of the health facilities and infrastructure are described in the following subsection.

In the PAOI, one health center (Kapuna), which constitutes 8% of the total health facilities that are operating or partially operating in the PAOI, had radio communications compared to 2015 SPAR data showing 29% in the Gulf Province and 37% nationally. Only Kapuna Health Center had electricity (with the exception of one solar light at Evara). The majority had no water supply or toilet, and none except Kapuna Health Center had a boat, operational refrigerator, microscope, or laboratory. Types of services offered by facility are described in Table 8.

Table 6. PAOI Health Facilities, Operational Status, Staffing, and Supervision

Village/Facility	Health Facility, Sponsor, Operational Status*	Medical Doctor	HEO	Nurse	CHWs	Vacant Positions	Trained VBA	Non-Medical Staff	Supervision; Last Supervisory Visit
Akoma-Kairu'u	Aid Post, United Health Services, O[1]	0	0	0	1	1	0	0	2014
Apiope	Aid Post, United Health Services, P/O	0	0	0	1	0	0	0	2014
Aumu	Aid Post, N/O	0	0	0	0	0	0	0	None
Evara	Aid Post, Government, P/O	0	1 (2.5 times/month)[2]	0	1[3]	2	0	0	None
Ikinu	Aid Post, 1 volunteer, N/O	0	0	0	1	0	0	0	None
Kavava	Orokolo Sub-Health Center, United Health Services, O	0	0	0	7	3 Nurses 1 HEO	0	0	2015
Kapuna	Health Center; GCS, O	2	0	4	25	1	0	5	Ongoing contact with Church Medical Services
Maipenairu	Aid Post, United Health Services, O	0	0	0	2	0	Both CHWs	0	2015
Mapaio	Aid Post; United Health Services, O	0	0	0	2	1	0	0	None
Mariki	Aid Post, United Health Services, O	0	0	0	1	0	CHW is a trained VBA	0	2015
Muro Mission Aid Post	Aid Post, CHS, O	0	0	0	2	0	0	2 Volunteers	Unknown/None

Table 6. PAOI Health Facilities, Operational Status, Staffing, and Supervision

Village/Facility	Health Facility, Sponsor, Operational Status*	Medical Doctor	HEO	Nurse	CHWs	Vacant Positions	Trained VBA	Non-Medical Staff	Supervision; Last Supervisory Visit
Oru-Lariau-Herakela	Aid Post, CHS, O	0	0	0	1	0	0	0	2014 (by World Vision)
Poroi 2	Aid Post; Government, P/O	0	1 (weekly visits)[2]	0	1[3]	No data	4	0	None
Wabo Station	Aid Post; Government, O	0	1[2]	0	2	1	7	0	None

Source: ERIAS Group 2016a

[1]P/O = partially operating; N/O = not operating; O = operating

[2]HEO staff provided by ISOS under contract with TEP PNG who provide health support during the company's community affairs activities.

[3]CHWs not regularly present

Table 7. Health Facility Infrastructure (Operating and Partially Operating Only)

Villages	Health Facility	Physical Infrastructure Conditions							
		Building	Electricity	Water Supply	Toilet Latrine	Radio	Boat	Refrigerator	Microscope, Lab
Akoma-Kairu'u	Aid post	Present	No	Yes	Yes	No	No	Yes[1]	No
Apiope	Aid post	Works out of house	No	No	No	No	No	No	No
Evara	Aid post	Present, needs repair	1 Solar light	Yes	Yes	No	No	No	No
Kavava	Orokolo Sub-Health Center	Inadequate	No	Yes	Yes	No	No	No	No
Kapuna	Health center	Present, needs repair	Yes	Yes	Yes	Yes	Yes	Yes	Has micro-scope needs lab space
Maipenairu	Aid post	OK	No	No	No-	No	No	No	No
Mapaio	Aid post	Present, unfinished building, not used	No	No	No	No	No	No	No
Mariki	Aid post	Poor	No	No	No	No	No	No	No
Muro Mission	Aid Post	Inadequate	No	No	No	No	No	No	No
Oru-Lariau-Herekela	Aid post	Poor	No	Yes	Yes	No	No	No	No
Poroi 2	Aid post	Present, needs repair	No	No	No	No	No	No	No
Wabo Station	Aid post	Present, needs repair	Connected from TEP PNG office	Yes	Yes	No	No	No	No

[1]One 3-way refrigerator connected with gas; not used at present as gas ran out and/or is non-functioning.

Table 8. PAOI Health Services Provided

Village/Facility	Name of Health Facility; visits/month	Services Provided
Akoma-Kairu'u	Akoma Aid Post; 237 visits/month, 1 CHW	• General health care: coughs, fever, aches/pains, skin infections, gastrointestinal diseases, women's issues (abdominal or breast pain) • Minor injury care, minor suturing, burn care • Antenatal care and deliveries for women who cannot afford to travel to Kapuna • Referral center for outlying aid posts; provides referrals for further treatment at Kapuna • RDT* for malaria when available • Treatment for eye infections • Follow up TB DOTS* therapy, conducts outreach to area villages • Health education on TB, hygiene, and dental care; assistance with Kapuna health controls
Apiope	Apiope Aid Post, provides care underneath the aid post; 152 visits/month, 1 CHW	• General illness treatment (cough, general pain, fever) • Minor repair and stitches • Family planning • Antenatal care • Treatment for eye and skin infections • Minor injury care, burn care
Ikinu	No facility; volunteer CHW treats patients from home 2-4 patients/day	• Treats respiratory illnesses, diarrhea, malaria • RDTs recently available for malaria • Referrals to Kapuna

Table 8. PAOI Health Services Provided

Village/Facility	Name of Health Facility; visits/month	Services Provided
Kapuna	Kapuna Health Center; 1,332 visits per month	• Outpatient care, emergency services, antenatal care, general medical care: respiratory, fever, aches/pains, skin diseases, eye/ear infections, infectious diseases, STIs, women's issues (abdominal and breast pain) • Inpatient services (adult & pediatric), TB ward, TB isolation care, cholera care area, family housing, snake bite care • Labor and delivery, post-partum care, newborn care, newborn vaccinations, provision of health books • Minor surgery • Dental care (not available full time) • Laboratory (rapid tests for malaria, TB sputum analysis, & microscope) • Nutrition consultation (and food provisions) • Immunization and mobile health patrols; family planning
Kavava	Orokolo Sub-Health Center, 219 visits/month for 5 health staff	• Obstetrics (deliver over 100 babies per year [5-10 per month]) per the KII • Disease control (TB, leprosy), treatment for respiratory, skin, malaria, gastrointestinal, and eye/ear infections • Children's outpatient and adult outpatient (combined) • Simple emergency care, accidents, and injuries • Referrals to other facilities • Follow up TB DOTS therapy
Maipenairu	Maipenairu Aid Post; 69 visits/month for 1 CHW	• Obstetrics (approximately 3 deliveries per year) • Stitching • Injections • Set broken bones (not often) • Abscess drainage • Immunizations (helps Kapuna staff; no vaccines presently with no fridge)

Table 8. PAOI Health Services Provided

Village/Facility	Name of Health Facility; visits/month	Services Provided
Mapaio	Mapaio Aid Post: CHWs provide care from their homes	• General health care: respiratory, fever, aches/pains, skin infections, gastrointestinal diseases, women's issues (abdominal and breast pain) • Minor injury care, minor suturing • Antenatal care, labor/delivery (mainly at patients' houses with CHW assistance) • Post-partum care, newborn care • No inpatient care • Treatment for eye infections • Follow up TB DOTS therapy • Family planning (injection is the most popular choice)
Mariki	Mariki Aid Post	• Deliveries (if mother can't afford to go to Kapuna) • Minor suturing; respiratory, skin malaria treatments • Plaster orthopedic breaks • Give injections • Minor operations, abscess drainage • Referrals to other facilities
Muro Mission	Muro Mission Aid Post	• General health care: coughs, fever, aches and pains • Antenatal care and deliveries • RDT for malaria • Follow up TB DOTS therapy • Minor stitches • Treatment for eye and skin infections • Minor injury care, burn care

Table 8. PAOI Health Services Provided

Village/Facility	Name of Health Facility; visits/month	Services Provided
Oru-Lariau-Herakela	Oru-Lariau Aid Post: 561 visits/month, 1 CHW	• Antenatal, delivery (often referred to Orokolo Sub-Heath Center), but mothers refuse and often deliver on the floors at the aid post) • Outpatient treatment • Health promotion • Referrals to other facilities, as needed • Minor surgery/stitching
Poroi 1 & 2, Subu 1 & 2, Wabo/Ura, Mapaio Fish Camp, Evara, Herd Base Health Facility, & other villages covered by ISOS HEOs[t]	Poroi Aid Post, Wabo Aid Post, Herd Base Community facility, Evara Aid Post	• When Herd Base HEO is present, general health care: respiratory, fever, aches/pains, skin diseases, eye/ear infections • Minor injury care • Antenatal care (as allowed by customary practices with a male HEO) • Referrals for further treatment • RDTs for malaria when available • No inpatient care • Follow up TB DOTS therapy • Health education

*RDT = rapid diagnostic test; DOTS = directly observed treatment, short course. [t] = Under contract to TEP PNG.

6.2.2.2 Project Area of Influence Health Facilities Descriptions

This subsection describes key providers of health services, either through Herd Base or GCS and United Church Health Services, in more detail. Additional photos per health facility are provided in Attachment C.

Kapuna Health Center

Kapuna Health Center (see Plate 3), along with Kikori Hospital, are managed through GCS. A history of Kapuna Health Center can be found at: http://kapuna.org/wp/history/.

Plate 3. Kapuna Health Center





Kapuna Health Center includes the following staff:

- Dr. Valerie Archer and Dr. Lin Calvert (retired but active).
- Barbara and Colin Calvert (Life Skills School Coordinator and Outreach Program Coordinator).
- Dr. Elise Mulder and Wynand Mulder (Project Manager) – onsite for approximately 6 months.
- Paul Bubura (secretary of GCS).
- Four nursing officers.
- Twenty-five CHWs.
- There are no lab technicians or pharmacists at Kapuna Health Center.

Overview

Kapuna Health Center (through GCS) is the key organization providing health care and support to most of the health facilities in the PAOI, including government and other church organization medical services. The organization is undergoing a process to upgrade the facility to become a Level 4 Rural Hospital to receive additional government funding for staffing and operations; however, gaps and deficiencies in infrastructure have been identified that must be fixed before the approval can be processed. Kapuna Health Center runs the only CHW training program in the Province.

The health center remains open throughout the year, with consistent staffing and services. TEP PNG provides logistical support for staff, delivers supplies, and provides emergency transport at times. Health data are provided by staff to the provincial health division regularly per NDOH requirements. Health books are the primary method of record keeping and are maintained at the household level in the PAOI. According to Kapuna staff, due to government health expenditure reductions, health

books are no longer available from the NDOH; therefore, the Kapuna Health Center staff print and sell books to patients (gifting them to those who cannot afford to buy them). All patients are required to bring their health books before accessing the health center. The health center does not keep individual patient records and relies entirely on health books. The only records kept by Kapuna staff are the tally sheets required by NDOH. A health standards review committee was commissioned by NDOH, supported by the Oil Search Foundation, to assess the Gulf Provincial health centers and their compliance with national health standards. The Standards Review Committee flagged the lack of individual patient documentation as an issue during its visit to Kapuna in 2015.

According to Kapuna staff, overall funding for services was cut in 2016—operations costs were reduced 10% and salaries reduced 40%. According to Kapuna staff, services are provided anyway, often at the expense of the staff who provide them.

The leading cause of admissions to the inpatient service is TB. TB is treated using medications distributed by the international aid organization World Vision. Reagents for microscopy for TB diagnosis are supplied by the AMS from the Central Public Health Laboratory.

Services Provided

Kapuna health services include those provided at the health center facility and those provided in the community:

- Outpatient care (emergency services, antenatal clinics, immunizations).
- Inpatient care.
- Labor and delivery.
- Minor surgery.
- Basic laboratory services (no GeneXpert[6] capacity).
- Nutrition counselling and provision of food.
- Dental chair and room are available but no dentist is available.

Infrastructure

The recent facilities assessment conducted by the National Standards Committee provides detailed information regarding infrastructure, services and quality of care compared to NDOH Standards outlined in the National Health Plan. The draft report is currently being reviewed by the lead for the facilities assessment group in Port Moresby. Information obtained during field visits and interviews with Kapuna Health Center staff and one a representative from the NDOH standards team are summarized below.

The following infrastructure and equipment improvements are needed:

- Improve sources of power (such as solar power).
- Improve ventilation, according to the NDOH assessment team, in the LLG-built, TB-isolated ward (10 rooms) completed in 2014.
- Improve laboratory area/facility for diagnostics, including GeneXpert systems.

6 An automated, on-demand, rapid, diagnostic system for determining if a sputum sample is positive for TB; basic rifampicin drug resistance can also be determined.

- Repair, provide proper beds for patients (rather than allowing sleeping on the floor), create separated areas for privacy, provide proper post-natal beds in the inpatient wards/facilities.
- Provide proper sterilizing equipment, such as an autoclave; the current method is to use a steam sterilizer and to sterilize by cooking in a household oven.
- Construct a building to house x-ray equipment with proper ventilation and protection.
- Add HemoCue (device used to measure a patient's hemoglobin [Hb] level) point of care testing to assist with malnutrition diagnostics and malaria conditions.
- Enhance drug storage area.

Under the Provincial Health Services Improvement Program, Kapuna Health Center staff completed the application process for infrastructure upgrades to the center. The funds were reportedly approved; however, at the time of this writing, the funds have yet to be distributed for these improvements.

At the time of the health assessment, a technical team from Europe was conducting a study on solar power capabilities for the Kapuna Health Center, including the laboratory. The laboratory area, shown in Plate 4, is small and needs a separate space/facility, particularly for TB diagnostics. GeneXpert system capabilities are needed to accurately diagnose TB, although this will require a constant source of power and air conditioning to maintain the equipment, supplies, and specimens.

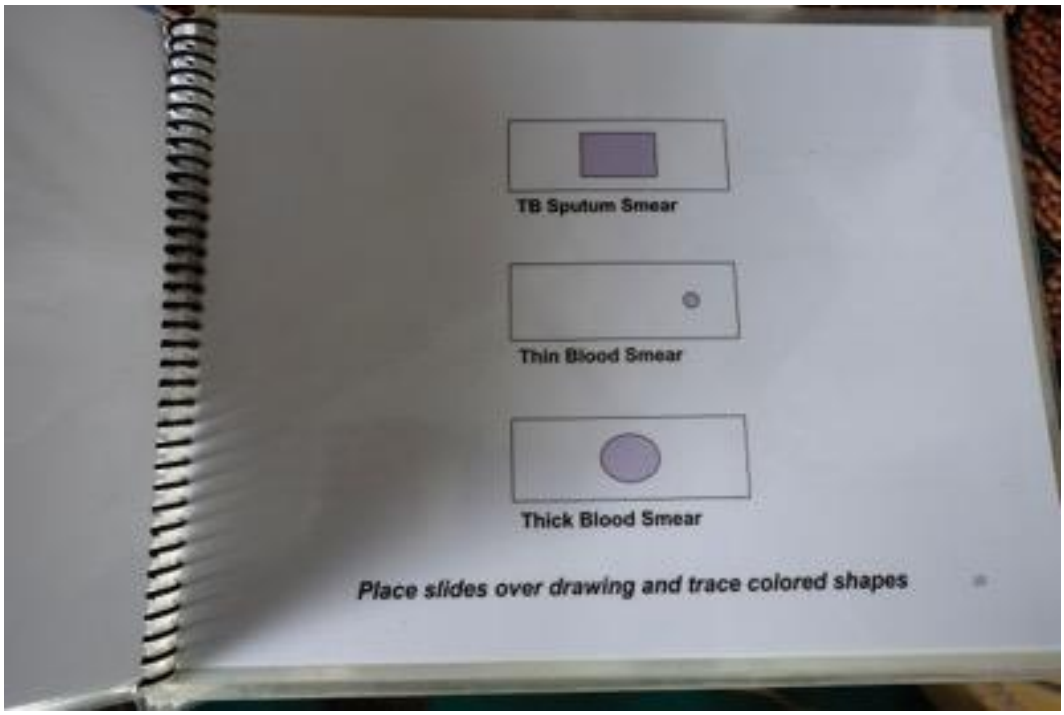
Plate 4. Kapuna Health Center Laboratory





Youth health NGO, Youth with a Mission (YWAM), provides logistical support for a laboratory technologist who provides diagnostic training for health center staff. YWAM has prepared a training manual for CHWs to use daily, as shown in Plate 5.

Plate 5. Kapuna Health Center Laboratory Training Manual



Patient waiting areas, inpatient wards, and outpatient facilities are shown in Plate 6, Plate 7 and Plate 8 respectively. Patients sleep on floors in most instances.

Plate 6. Kapuna Health Center Patient Waiting Area



One of the inpatient wards is shown in Plate 7.

Plate 7. Kapuna Health Center Inpatient Ward



Outpatient treatment areas are well organized and are shown in Plate 8.

Plate 8. Kapuna Health Center Outpatient Treatment Area



At the time of the health study team visit, the medicines and supplies storage area had just received a shipment of boxes; nevertheless, medicines and supplies were organized, labeled, and dated, as shown in Plate 9 and Plate 10. Inventory is taken several times per year with the assistance of the CHW students. Per interviews with the Kerema Health Center staff, because of issues with the medicine/supply/delivery system, out-of-date drugs are sometimes used throughout Gulf Province. Some of the smaller aid posts in the PAOI reported that they had received expired medicines and supplies from Kapuna Health Center.

Plate 9. Kapuna Health Center Medicines and Supplies Storage Area



Plate 10. Kapuna Health Center Medical Supplies Storage Area



Six buildings near the inpatient wards are for family members who stay in the health center to take care of their family member (see Plate 11). Each building is divided into rooms including sleeping and kitchen with food storage areas. Buildings provided are separated by tribe/language: Iare, Koriki, Gope, Urama, Pawaia, Varoi.

Plate 11. Family Accommodations at Kapuna Health Center



Kapuna Water/Sanitation Infrastructure

Rain water collection tanks and latrines are present at the health center and appear to be sufficient for patient use based on initial health team field observations. However, the NDOH assessment team recommends upgrading these facilities.

Kapuna CHW School

There is a CHW school at Kapuna (see Plate 12) funded by government (25%) and DFAT (ex-AusAID for 75%); tuitions are covered in this program for 11 students, with an additional 2 funded by the Oil Search Foundation and 1 by TEP PNG. The Kapuna CHW School is a certified program.

Plate 12. Kapuna Health Center CHW School



Kapuna village-based water and sanitation training (WATSAN program) is conducted by CHW students on a regular basis, particularly in the market area, as shown in Plate 13.

Plate 13. CHW Conducting WATSAN Training in the Market at Kapuna Health Center



Water and Sanitation (WATSAN) Program

According to Colin Calvert (WATSAN Coordinator for Kapuna), local river water is used as a general source for bathing, washing, cleaning, and defecation. Mr. Calvert has developed a community development program addressing rainwater tanks supplied to households in the Kapuna catchment villages. This program is said to be successful; however, this has not been validated or verified with evaluation against KPIs. The program is reportedly based on the World Bank/European Union's WATSAN program that was in place in Papua New Guinea recently (World Bank 2014). The WATSAN program was a multi-donor partnership administered by the World Bank to support the poor in gaining affordable, safe, and sustainable access to WATSAN services (World Bank 2014).

Kapuna Health Center Patrols

Kapuna Health Center is currently providing mobile health patrols to all health centers and aid posts that serve as referral points for the entire project area. Kapuna Health Center is not funded for this activity. The catchment areas and health centers that are supposed to manage area location aid posts are listed in Table 9. In addition, the villages where Kapuna Health Center has posted CHW students for short periods of time (shaded in black), and villages where the Kapuna WATSAN program is underway are listed (shaded in grey). Boats used for Kapuna Health Center patrols are shown in Plate 14 and Plate 15; the first is used for smaller routine patrols and the second is large enough to accommodate several CHW students. YWAM conducted one immunization program in some of the coastal and riverways areas last year.

Kapuna Health Center provides both mobile health clinics (including immunizations, as shown in Plate 16) and malaria patrols to all areas listed in Table 9 even though they are not funded to cover

the entire area. Additional programs related to health include the latrine program, whereby communities are trained to recognize WASH-related diseases. Many of the villages listed in the Baimuru and Karati catchment areas are not in the PAOI; nevertheless, they are serviced by Kapuna patrols. This effort requires significant staffing time and resources.

Table 9. Kapuna Health Patrols and WATSAN/Latrine Programs

Kapuna Patrols every 3 Months		Kapuna Patrols Once or Twice Per Year				Kapuna Patrol Once Per Year; Surrounding Villages Visit Orokolo	
#	Kapuna Catchment, GCS	#	Baimuru Catchment, Government Health	#	Karati Catchment, Government Health	#	Orokolo Catchment, United Church Health
1	Kapuna	1	Baimuru station	1	Meagoma	1	Apiope
2	Ara'ava	2	Bekoro	2	Gibi	2	Aumu
3	Kairimai	3	Palamba	3	Bavi	3	Aivai
4	Kaialavi	4	Ipiko	4	Buri	4	Evara
5	Small Mapaio	5	Karurua	5	Waitari	5	Evara Logging camp
6	Big Mapaio	6	Inaua	6	Titine	6	Muro villages
7	Poroi	7	Vaiamu	7	Aibegahii	7	Orokolo villages
8	Subu 1 & 2	8	Koravake	8	Ubuo'o		
9	Ura	9	Kuporo	9	Goilavi		
10	Wabo station	10	Aienea	10	Wowobo		
11	Wabo village	11	Upaia	11	Tovei		
12	Kaevaria	12	Mariki				
13	Logging camp	13	Erakiti				
14	Kereia	14	Imeia				
15	Kapai 1 & 2	15	Aimei				
16	Maipenairu	16	Nahoro				
17	Akoma	17	Eramaipu				
18	Kairu'u	18	Setau				
19	Ikinu	19	Morovamu				
20	Mirimailau	20	Marivepea				
21	Ikimiri	21	Kinaumene				
22	Varia	22	Aibegahe				
23	Kinipo	23	Larimia				

Table 9. Kapuna Health Patrols and WATSAN/Latrine Programs

Kapuna Patrols every 3 Months		Kapuna Patrols Once or Twice Per Year				Kapuna Patrol Once Per Year; Surrounding Villages Visit Orokolo	
#	Kapuna Catchment, GCS	#	Baimuru Catchment, Government Health	#	Karati Catchment, Government Health	#	Orokolo Catchment, United Church Health
24	Uraru	24	Kiwaumai				
25	Punjano (chopper)	25	Mirimailau				
26	Haia (chopper)	26	Gauri villages				
	Villages with Kapuna CHW Student Assignments				Villages undergoing Kapuna Latrine Program		

Source: Kapuna Health Center 2016

Plate 14. Kapuna Health Center Patrol Boat



Plate 15. Kapuna Health Center Patrol Boat for Large Patrol Staff



Plate 16. Kapuna Health Center Patrol Vaccination Materials



Poroi 2 Aid Post

There are two aid post buildings in Poroi 2: one is an old building situated at the front of the village that was damaged by floodwater in 2011 (see Plate 17). The other is a newer building, built by the community after the flood, located at the back of the village (see Plate 18). The newer building has a rotting floor and the stairs are unstable. However, it is the only building used hence there is considered to be only one aid post in Poroi 2. It was locked and not staffed with government health personnel at the time of the field visit. A key was found, however, and the health team observed the inside in significant structural disrepair; however, medications and supplies were available through the ISOS HEOs (under contract with TEP PNG) (see Plate 19). Because the government CHW is not present, the aid post is not fully operational, and ISOS HEOs from Herd Base staff the facility on a weekly basis.

Plate 17. Old Poroi Aid Post Building



Plate 18. Poroi 2 Newer Aid Post Building



Plate 19. Poroi 2 Aid Post Supplies Observed in the Newer Aid Post



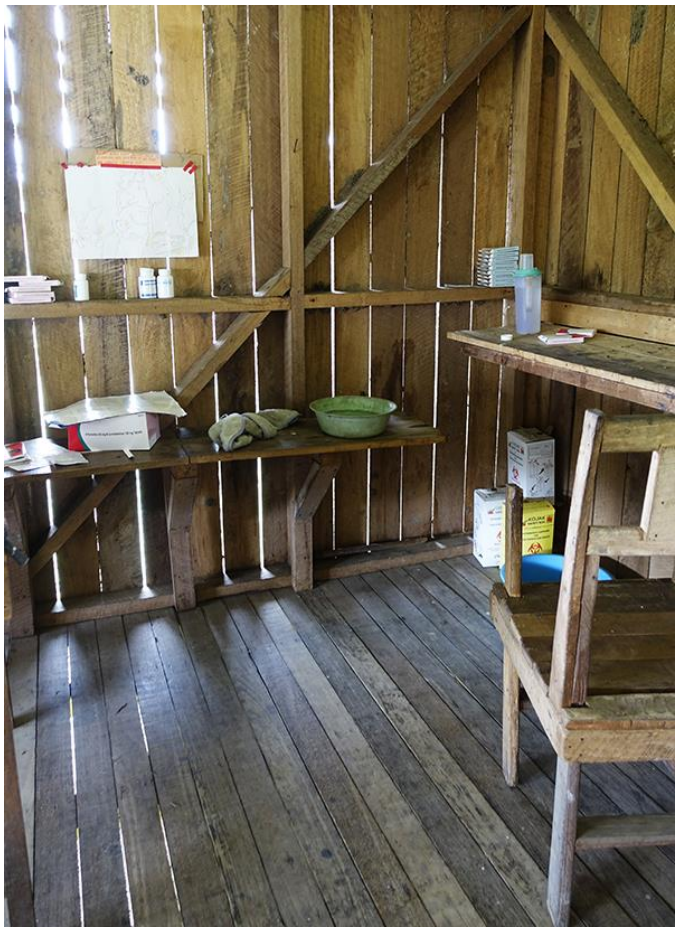
Akoma Aid Post

The aid post in Akoma is supposed to be a sub-health center, staffed with a nursing officer and several CHWs; however, the current staffing is one CHW, who was trained at the Kapuna CHW School and has been there for 16 years. The aid post is neat and clean, and medicines and supplies are organized. The CHW has an organized check-in system for treatment. As with all the other aid posts in the PAOI, the CHW often tries local traditional/herbal practices first, and then follows with modern medicines when the traditional/herbal treatments fail (see Section 6.14). Difficult cases are referred to Kapuna Health Center; however, patients often do not go due to the cost of travel and the expense to stay there. The CHW travels to Kerema to turn in clinical tally sheets every 6 months.

According to the CHW, she receives medications and supplies that have been ordered but also receives supplies that have not been ordered and that cannot be used. When medications run out, she obtains supplies from Kapuna Health Center. The CHW rarely receives supervisory visits and never receives in-service education.

The Akoma CHW is the one source of health care, education and outreach services to many surrounding villages. The aid post is kept organized; however, infrastructure improvements are needed. The treatment area is shown in Plate 20.

Plate 20. Akoma Aid Post Treatment Area



There is a structure available for inpatient use; however, there are holes in the flooring and walls, unstable flooring, and unsafe stairway access, so it is not used.

Plate 21. Akoma Inpatient Area



The Akoma CHW sees patients from 11 other villages, including the Orokolo area, as shown in Figure 6 (this image is shown in full size in Attachment C, along with other images of this aid post). Muro Mission Aid Post CHWs refer patients to the Akoma CHW when they experience complications. These referral patterns explain why patient diagnostic data collected in one village cannot be assumed to cover only that village. Additionally, patients will self-select where they go to seek health care based on the medical condition, staffing availability, transportation available, and weather conditions.

According to information obtained from discussions with United Health Care supervisors in Kerema, the Akoma Aid Post staff was reduced because the population numbers in the area did not support the number of staff provided.

Orokolo Sub-Health Center

Orokolo Sub-Health Center is a United Church Health Services facility that functioned with three wards until the 1980s. Currently, there is only one ward, and outreach activities (health patrols) do not occur as required by national guidelines. There is one nursing officer and eight CHWs on staff. There are eight vacant positions. There are no lights, water supply, or latrines present for patient use. According to the staff, referrals are to Kerema Health Center, primarily for snakebite and childbirth complications. In the past, there was a dinghy and motor for patient transport, but this is no longer available.

According to supervisory visits and health patrols conducted by the Kapuna Health Center team, Orokolo Sub-Health Center requires staff supervision and operations management. Service availability is unreliable. This health center is mandated to be the hub of care and provide outreach health patrols to all villages in this catchment; however, this is not occurring. Based on the KII conducted at Lariau and patient use data from 2012, it is evident that many patients seek care from the CHW at Lariau rather than at Orokolo Sub-Health Center. Images are provided in Attachment C.

Oru-Lariau Aid Post

The Oru-Lariau Aid Post is staffed by one CHW, sponsored by CHS. The CHW reports that she sees anywhere from 400 to 600 patients per month. The records obtained by the study team were from 2012. There are no beds, and there is only one available water tank that is shared by all community members. This tank runs out during the dry season. There is a pit toilet that is used to discard rubbish. According to the CHW, TB is common but referred to Orokolo Sub-Health Center. Most patients are reluctant to seek treatment and often request amoxicillin treatment instead. Images are provided in Attachment C.

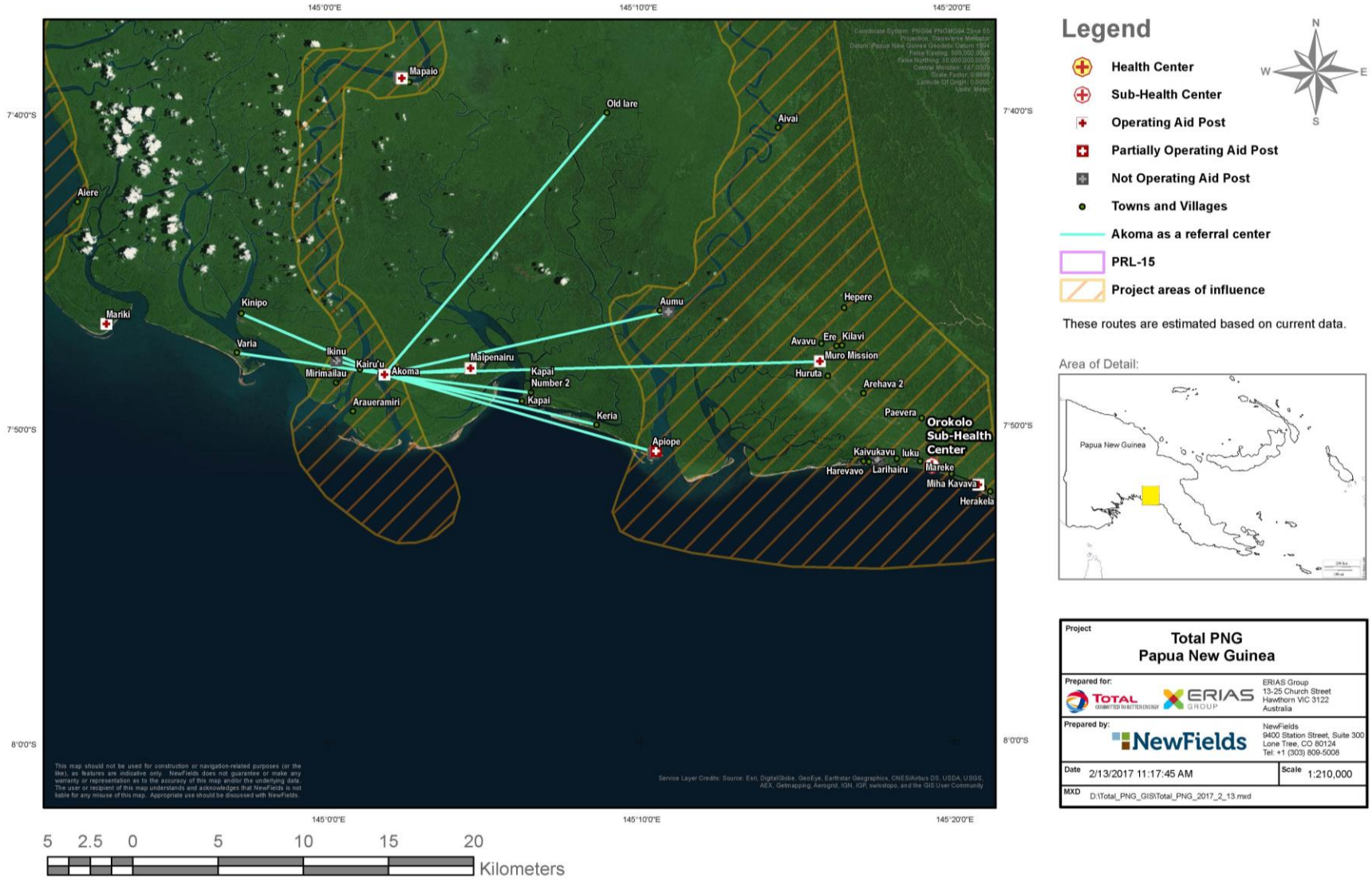
Maipenairu Aid Post

This aid post is staffed with two CHWs, both of whom are trained birth attendants. Reported attendance is approximately 45 to 85 patients per month. Patient referrals are to Akoma Aid Post and to Kapuna Health Center. According to the CHWs, the facility is provided by United Church Health Services and supervised by GCS. Images are provided in Attachment C.

Muro Mission Aid Post

Muro Mission Aid Post, supported by CHS, is staffed with two CHWs, who reportedly treat around approximately 600 patients per month, and two volunteers working with the TB program who collect sputum specimens and supervise TB treatment therapy. Key health issues reported by the staff include pneumonia, malaria, diarrhea, and TB. Images are provided in Attachment C.

Figure 6. Akoma as a Referral Center



Source: NewFields 2016

Kerema Health Center

The health center in Kerema is a referral center for village aid posts in the southern portion of the PAOI. The local and provincial communities refer to the Kerema Health Center as a hospital (known as Kerema General); however, it does not meet national standard requirements for a hospital. Therefore, in this document it will be referred to as the Kerema Health Center. Oil Search Foundation funded the National Health Service Standards Committee to conduct detailed health assessments of 22 facilities in Gulf Province per national requirements. This assessment covered both facilities and services. Both Kapuna and Kerema health centers were included in these assessments; however, the reports have not been completed or released. When available, these final reports are anticipated to provide valuable detailed information regarding National Health Standards and the required improvements necessary for each facility.

The following summary of observations and information was obtained during stakeholder interviews in Kerema:

- Communications and coordination between managers of PAOI church health services and government health services in Kerema are infrequent.
- Staffing vacancies and absences are common; staff recruitment is difficult.
- Facility infrastructure in patient care areas is falling apart (except in the new TB wards).
- There are no medical specialists, no surgeons, no proper operating room, no pediatrician, and no obstetrics/gynecology specialist.
- Nursing students just began rotations.
- MSF TB program (described below) appears to be one of the most effective medical services delivery program in the entire area.

Communications and Coordination

Communications and coordination between GCS and Provincial Health Services may be negatively impacted by recent provincial attempts to consolidate the management of church health services and government services. Joint planning and coordination meetings do not occur among the basic management units—Provincial, District, GCS (Kapuna catchment), United Church Health (Orokolo catchment), CHS (part of Orokolo catchment services), and Baimuru (government catchment). Although Baimuru catchment is not geographically within the PAOI, the deficiencies in health care and staffing impact the Kapuna catchment area. The Provincial TB Emergency Response Program will require cooperation among all health providers to succeed.

Staffing and Services

Based on an interview with the nursing director, staffing, services and comments per area for Kerema Health Center are shown in Table 10 and Table 11.

Table 10. Kerema Health Center Staffing – Inpatient and Outpatient Areas

Staff Categories	Number	Remarks
Inpatient/Wards		
General ward (medicine, pediatric, general surgery)		
Nursing officers	6	13-bed ward serving 3 disciplines combined; overcrowded, poor and unsafe working environment
CHWs	9	TB patients separated – 18 beds managed by MSF.
Administration	3	
Doctors	1	
Registrars	2	
HEOs	1	
Clerk	1	
Housekeeping, hygiene	1	
Total staff: 24		
Obstetrics, postnatal, special care nursing, gynecology		
Nursing officers	9	20 beds – combined services; operating in poorly ventilated environment, and overcrowded.
CHWs	12	Patient influx, staff overworked.
Administration	2	
Doctors	1	
HEO	1	
Clerk	1	
Housekeeping/hygiene	1	
Total staff: 27		
Outpatient and Accident and Emergency		
Operating theaters, central sterile supply department, anesthesia		
Nursing officers	2	
CHWs	7	
Administration	2	
Doctors	1	Surgeon.
Attending technical officers (ATO)	3	
HEOs		
Potters (orderlies)		Need for orderlies.
Clerk		
Housekeeping/laundry	1	
Total staff: 16		
Adult Outpatient Department/Accidents and Emergency		
Nursing officers	8	Adult outpatient and accident and emergency services are combined. Current patients can wait more than 72 hours for admission or discharge. Patient influx is the issue. Beds: 3 cubicles, 1 procedure bed, 1 injection bed, and 3 benches for patients.
CHWs	11	
Administration	2	
Doctors		
HEOs	2	
Clerk	1	
Housekeeping, hygiene	1	

Table 10. Kerema Health Center Staffing – Inpatient and Outpatient Areas

Staff Categories	Number	Remarks
	Total staff: 25	
Children's outpatient department		
Nursing officers	3	
CHWs	8	
Administration	2	
Doctors		
HEOs		
Clerk		
Housekeeping/hygiene	1	
	Total staff: 14	
Consultation clinics		
Nursing Officers	1	
CHWs	1	
Housekeeping/hygiene	1	
	Total staff: 3	

Source: Kerema Health Center 2016

Table 11. Kerema Health Center Staffing – Laboratory and Pharmacy

Laboratory			
Staff Category	**Number**	**Test Kits (Rapid Diagnostics)**	**Other Tests**
Doctor		Malaria	Urine microscopy – rape cases
Lab tech	4	Hepatitis B	GeneXpert- TB
Gen-expert	1	HIV	
Total staff:	**5**		
		Pregnancy test	
		Venereal Disease Research Laboratory test	
		Dengue Fever	
		Widal test (used in the diagnosis of Salmonella infections such as typhoid)	
Pharmacy			
Staff Category	**Number**	**Activities**	**Remarks**
Pharmacy officer	1	Procurement	Drugs and consumables are usually in short supply
Technical officers	2	Distribution	
Assistants		Ward impress system	
-Nursing officer	1		
-CHW	1	Dispensing daily to outpatient patients	
Total staff:	**5**		

Source: Kerema Health Center 2016

According to the MSF Director, many of the health staff at Kerema regularly go on strike due to lack of pay, medicines, supplies, and equipment. Provincial health representatives say that recruiting staff for Kerema, and particularly for the riverways areas, is difficult. In Kerema, new staff accommodations are currently under construction beside the health center as a plan to entice new staff and more effectively house existing staff. In the riverways areas, discussions are underway

regarding remote work incentive packages, such as improved housing and solar lighting. Rural health staff with families want to reside where there are schools; therefore, educational staff and facilities are closely tied to health staff.

According to the Provincial Health Manager, the last government administrative organizational structure for health staffing was approved in 2004, and recruiting new staff can only occur when the Provincial Administration Human Resources Department updates this structure. There are male/female staffing issues in smaller villages where females are not allowed to see a male health care provider. Population numbers are a factor in determining both staffing and aid post/health center classification, so if population numbers are incorrect, health staffing ratios are mismatched. The Provincial Health Manager is considering an agreement with Chimbu and Central provinces to help with staffing placement.

University of Papua New Guinea medical residents and Pacific Adventist University nursing students are potentially available for rotational services in the Gulf and PAOI. Pacific Adventist University nursing students are currently on rotation in the United Church health center in Malalau (east of Kerema) and just started at Kerema.

Infrastructure

Images of the Kerema Health Center are shown in Plate 22. The health center infrastructure is constructed from materials left over from building works at Port Moresby General Hospital. Laundry is done by the patient or their families.

Plate 22. Kerema Health Center Inpatient Facilities



Inpatient wards lack privacy, as shown in Plate 23. Floors and windows have openings to the ground and to the outside. Delivery wards are functional but may not fully meet national standards, as shown in Plate 24. Electricity is available.

An incinerator was recently installed by MSF, as shown in Plate 25. Infectious medical waste is incinerated, and then the ashes are disposed into a local landfill.

Plate 23. Kerema Health Center Inpatient Ward



Plate 24. Kerema Health Center Delivery Area



Plate 25. Kerema Health Center Incinerator



Challenges

The following challenges were identified for Kerema Health Center:

- Lack of common objectives:
  - Integration of TB activities with the rest of the hospital.
  - Infection control (hygiene).
  - Health worker training.
  - Human resources management and health worker absenteeism.
  - Standard Operating Procedures, training, and supervision.
- Drug and reagent shortages.
- TB screening for HIV patients (TB/HIV collaboration).

Provincial Health Staffing

The Gulf Province HIS office maintains staffing information for all health centers and aid posts in the province. The recorded staffing levels described at the provincial level are not accurate for the PAOI facilities based on ground truthing conducted by the health study team.

Table 12 lists data obtained from the provincial HIS department showing population served by health facility. These population data are estimated based on the census data.

Organizations that sponsor health services in the PAOI are listed in Table 13. The ambulance office is shown in Plate 26.

Table 12. Population Served by Health Facility

Health Facility	Population
Kapuna Health Center	7,588
Orokolo Sub-Health Center	7,411
Kerema Health Center	22,007

Table 13. Health Organizations

Organization	Organization Contact
Government Health Services	Ben Bal - Kerema
GCS	Paul Burbura - Kapuna
CHS	Frank Joseph - Kerema
United Church Health Services	Pisi Mairo – Kerema
Medecins Sans Frontieres	Philomena Tatireta - Lae

Plate 26. CHS Office – Ambulance



Provincial health staff (based in Kerema) summarized the following challenges to delivering health care:

- Accessibility to remote areas.
- Health worker follow-up with patient care.
- Sputum sample collection procedures/training.
- Transportation.
- Deteriorated health structures.
- Drug supply/storage/humidity.
- Waste management.
- Low vaccination coverage.
- Inappropriate drug supply storage effecting quality of drugs, such as TB medications.

Kerema TB facilities and services are described in Section 6.3.

6.2.2.3 Provincial Health Information Services

The following challenges at the provincial data collection and management level were identified:

- Only a few aid post staff submit monthly reporting sheets, and they are typically late since aid post staff are required to leave their post and travel several days to take the tally sheets to Kerema.
- Kapuna Health Center submits data for those seen at Kapuna only, although patients may come from surrounding villages. At the time of the health team visit, the provincial data managers believed that Kapuna receives, reviews, and submits all data from all aid posts in their catchment area. Health team field visits indicate that this is not correct.
- Provincial population data used to calculate rates are from the 2011 census, increased by 3.6%, which is the assumed population growth rate.
- Health data are potentially available and accessible electronically, although the data are likely 6 to 12 months old when entered.

6.2.2.4 Medical Supply and Delivery

The medical supply and delivery system functions per the following steps:

1. Dinghy contractors are supposed to pick up order forms and monthly statistics reports from aid posts every 3 months and bring the forms to Kerema, where the logistics officer at the medical store combines them with the provincial order and provides to the AMS in Port Moresby as a bulk order.
2. AMS receives order forms, fills the order, places a copy of the order form inside the order package, and contacts the logistics company for delivery.
3. Logistics company picks up orders from AMS and drives them to Kerema, stopping along the way to deliver supplies to aid posts and health centers that also submitted orders.
4. Once in Kerema, the packages are supposed to be delivered directly to a local contractor who has a motorized boat to deliver the supplies directly to the aid post/health center. These local contractors vary by availability.

5. Medications and vaccines that require refrigeration are transported in coolers that maintain temperatures for only 3 days of travel.
6. At times, packages are left at the Kerema Medical Store located on the health center grounds, as shown in Plate 27 and Plate 28. Refrigeration is available.
7. Once the order is delivered to the aid post, a signed copy of the order receipt is supposed to be collected by the logistics operator and transferred back to Kerema Medical Store.
8. Only health facility staff is permitted to open the package upon receipt.

Plate 27. Kerema Medical Store



Plate 28. Kerema Medical Store



Overall, the availability of medicines and supplies to health centers and aid posts in the PAOI is inadequate; however, Kapuna Health Center is generally effective at managing medicines and supplies. Kapuna Health Center serves as a resource to all aid posts in the PAOI when orders are submitted by the aid posts. MSF independently obtains medicines and supplies for TB treatment.

There is an ordering and distribution schedule and system that begins with the aid post/health center completing their order form and submitting it to the AMS in Port Moresby. For example, the ordering month for Gulf Province is May and distribution month is June. Orders are required to be received at the AMS in the first week of every ordering month. Order forms are either hand carried or emailed to the AMS. Smaller aid posts' staff can send an order form to Kapuna Health Center, and Kapuna can include the order with their form, but then is required to deliver the medicines and supplies to the aid post. Often received supplies do not include everything ordered. Some items that are sent by AMS are either not needed or not appropriate for the level of care available at the aid post.

Kerema is supposed to supply Kapuna and all the other facilities in the PAOI; however, due to difficulties receiving adequate and appropriate supplies in the past, Kapuna order forms are sent directly to the AMS in Port Moresby. Supplies are delivered to Motokea docking area where they are loaded on the vessels that travel to TEP PNG's Herd Base and transferred to Kapuna Health Center. Some medications and supplies are picked up directly from AMS by Kapuna Health Center staff.

6.2.2.5 Access to Health Care

The mode of travel to reach health care is usually by boat (either paddling or with motor; see Plate 29) by walking along the coastal areas, or through helicopter assistance from TEP PNG (in emergency situations). Household access and use of health services is one of the key factors in improving people's health and well-being. This subsection provides an evaluation of households' access to different types of health care facilities, available transportation means for the closest health facility, and time to get to the closest health facility.

Plate 29. Access to Health Care – Canoes



Access times to health care facilities for some villages in the PAOI requires days. Access routes and approximate access times per village that were obtained during fieldwork are shown in Attachment B. Most of the transportation methods are by either paddle canoe or motorized canoe/dinghy. Often, a village will have multiple locations where residents will seek care because many of the aid posts and Orokolo Sub-Health Center are often closed, requiring travel to another location. Of the

villages visited, 18 list Kapuna Health Center as a health facility visited, while 15 list Orokolo Sub-Health Center as the visited facility. Often, both Orokolo and Kapuna health facilities are listed because when Orokolo Sub-Health Center is closed, or the individual believes that Kapuna Health Center can better manage their condition, patients are required to travel to Kapuna after first stopping at Orokolo Sub-Health Center. The CHW at the Oru-Lariau Aid Post has a very high patient load because some patients from the Orokolo Sub-Health Center area prefer to be treated at Lariau, as the CHW is reportedly mostly present. A summary of travel times is listed in Table 14 and shown on detailed maps in Attachment B.

Table 14. Access Modes and Times to Reach Health Care

Access to Health Care	Time to Reach Health Care
Aivai to Orokolo Sub-Health Center	2-3 days (walk)
Aivai to Aumu Aid Post to Orokolo Sub-Health Center at Kavava	2-3 days (for deliveries women canoe to Aumu and walk to Orokolo Sub-Health Center at Kavava)
Aivai to Kapuna Health Center	2-3 days (canoe)
Akoma & Kairu'u to Kapuna Health Center	1 day (canoe)
Apiope to Kapuna Health Center	2 days (canoe); 1 day (motor dinghy)
Apiope to Maipenairu	1 day (canoe)
Ara'ava to Kapuna Health Center	30 minutes (canoe) 10 minutes (walk)
Aumu to Kapuna Health Center	3 days (canoe)
Aumu to Orokolo Sub-Health Center	1 day (canoe)
Avavu to Muro Mission Aid Post	20 minute (walk)
Ere-Kilavi to Muro Mission Aid Post	30 minute (walk)
Ere-Kilavi to Orokolo Sub-Health Center	3 hours (walk)
Evara to Kapuna Health Center	3 hours (motor dinghy)
Harevavo to Orokolo Sub-Health Center	1-2 hours (walk)
Hepere to Muro Mission Aid Post to Orokolo Sub-Health Center	4-5 hours (walk)
Huruta to Muro Mission Aid Post and Kapuna Health Center	3-4 hours (walk) to Orokolo Sub-Health Center; 1 day (motor dinghy) to Kapuna Health Center
Iuku to Orokolo Sub-Health Center	1-2 hours (walk)
Kaevaria to Mapaio to Kapuna Health Center	2 days (canoe)
Kairimai to Kapuna Health Center	5 minutes (motor dinghy); 25 minutes (canoe)

Table 14. Access Modes and Times to Reach Health Care

Access to Health Care	Time to Reach Health Care
Kairu'u to Akoma Aid Post	5 minutes (walk)
Kaivukavu to Kerema Aid Post	2 days (walk)
Kaivukavu to Orokolo Sub-Health Center	1-2 hours (walk)
Kapai 2 to Kapuna Health Center	2 days (canoe)
Kavava to Orokolo Sub-Health Center	1-5-minutes (walk)
Larihairu to Orokolo Sub-Health Center	1-2 hours (walk)
Maipenairu to Kapuna Health Center	1 day (canoe)
Mapaio to Kapuna Health Center	4 hours (canoe); 2 hours (motor dinghy)
Marea to Orokolo Sub-Health Center	1-2 hours (walk)
Mareke to Orokolo Sub-Health Center	30 minutes (walk)
Mariki to Kapuna Health Center	5-6 hours (canoe) 2-3 hours (motor dingy)
Orokolo to Kerema Health Center	No data to Ihu. At least 1.5 hours by powered boat to Hepea logging camp then 3 hours by road to Kerema Health Center
Oru, Lariau, Herakela to Orokolo Sub-Health Center	5 minutes (walk) to Lariau and 30 minutes (walk) to Orokolo Sub-Health Center
Paevera to Orokolo Sub-Health Center	1-3 hours (walk)
Poroi 2 to Kapuna Health Center	1 day (motor dinghy) to Kapuna, 10 minutes to RH logging camp and Herd Base clinic
Subu 2 to Kapuna Health Center	1 day (motor dinghy)
Subu to Wabo Aid Post	1 day (motor dinghy)
Upaia to Kapuna Health Center	2 days (canoe)
Ura to Wabo Aid Post	3-5 minutes (walk)
Wabo to Kapuna Health Center	30 minutes (canoe) to Wabo Station; 1-2 days (motor dinghy) to Kapuna

Sources: ERIAS Group 2016a; NewFields 2016

Key Informant Interviews and Discussions

Extensive health KIIs and discussions were held across the PAOI, as described in Section 5. The KIIs were focused on health care workers and were in small groups of one to five. The discussions involved between 10 to 50 community members.

Key Informant Interviews

During the KIIs, health care providers were asked to describe the main issues they thought were affecting village health. The following most common responses are in general order of frequency:

- Transportation.
- TB.
- Malaria.
- Cultural health beliefs.
- Water quality.
- Lack of medical supplies.
- Health facility condition.

These responses are consistent with the authors' experience with other remote rural communities in Papua New Guinea, such as Hela and Western provinces. The prominence of transportation is expected given the lack of a formal established transportation network (i.e., roads) across the PAOI. Based on extensive studies by the World Bank, transportation infrastructure has a profound influence on health outcomes (World Bank 2001). World Bank research indicates that infrastructure improvements, such as transportation, consistent provision of water, telecommunications, and housing improvements, can improve overall population health outcomes by almost 50% regardless of whether any changes are made to the underlying health system (World Bank 2001).

As described in Section 6.3 EHA 2 Communicable Respiratory Diseases, TB is a significant issue across the PAOI. Local health workers are being impacted by patient referrals back from the health center TB treatment facilities—TB is typically diagnosed at the health center level where laboratory equipment/supplies are available but the patient is sent back to the local health facility for further monitoring and follow up. Field data indicate that health workers across the PAOI are seeing a steady referral pattern of patients from the established health centers back to the community. Long-term treatment at a health center is not practical or affordable for patients who must typically provide their (and any accompanying family members) own food supply. To properly manage a TB patient's treatment, a health facility must be staffed and supplied as the treatment protocol in Papua New Guinea is "directly observed," meaning the health care worker must watch the patient directly take their medicine. TB is clearly a significant issue for the PAOI health care system. Further in-depth analysis of TB is in Section 6.3 EHA 2 Communicable Respiratory Diseases.

For the NewFields health team, the most striking finding again relates to TB. TB treatment is long (months) in comparison to malaria (days) and the demand for frequent medical follow up is substantial. TB is clearly a significant issue for the PAOI health care system. Further in-depth analysis of TB is in Section 6.3 EHA 2 Communicable Respiratory Diseases.

The prominence of malaria is also expected, as most health care workers have been trained to associate "fever" with malaria. Section 6.4 EHA 3 VBD discusses this conflation of fever and malaria in greater depth.

Cultural health belief/practice is a defined environmental health area (EHA 12) and is further described in Section 6.14.

Identifying "water quality" as a key issue affecting health is not surprising as local health care workers are aware that community households are not using improved water supplies. According to WHO (2017a), "an improved drinking water source is one that, by the nature of its construction and when properly used, adequately protects the source from outside contamination, particularly faecal matter." Improved sources of drinking water include public tap/standpipe, protected boreholes and wells, and properly collected rainwater. Surface water (river water) is considered an unprotected source.

The problems with the Papua New Guinea system of provisioning rural health facilities are well known (NDOH 2015; NDOH 2010). Similarly, the overall state of disrepair for many community health facilities has been previously described.

Some local health workers also identified health concerns at an individual patient level—adults (men versus women) and children. For men, TB, muscle aches, STIs, and malaria were mentioned at least once. For women, concerns included muscle aches, "belly pain," TB, lack of antenatal care, and STIs. For children, the focus was on diarrhea, malaria, cough, worms, and ulcers. The number of "mentions" is small (typically 1 or 2); hence, it is difficult to ascribe a pattern to these responses except for diarrhea in children, which was noted three times.

To further focus on the general observations made in the health worker KIIs, health workers were asked why they believed that their patients had difficulty accessing their health care facility. These results are shown in Table 15. As described in Table 4, a total of 14 KIIs were conducted. More than one response was provided on several occasions.

Table 15. Barriers to Attendance

Barriers to Attendance	Number of Responses	Percentage of Responses
Too far	8	36
Other (specify)	8	36
Unaffordable	3	14
Poor conditions	3	14

Source: ERIAS Group 2016a

The following "other" category responses were varied:

- Staffing problems.
- Cultural barriers.
- Lack of transportation.
- Building repair (building is present but requires repair).
- Delayed treatment (patients delay seeking treatment until very ill).
- Lack of medicine.
- Shyness.

Based on the health worker KIIs, distance to access the health care facility is the dominant barrier and confirms the data shown in Table 14 and Table 15 (i.e., it can be hours or days to access a

functioning health care facility). Attachment B has detailed maps of health facilities and access routes.

Part of the health care worker KIIs included discussions on difficulties/barriers that the workers themselves experienced in delivering care to their patients. Table 16 summarizes these issues across the PAOI. Again, more than one response was provided on several occasions.

Table 16. Problems for Health Staff Across the PAOI

Problems for Staff	Number of Responses	Percentage of Responses
Other	9	39
Payment of wages	7	30
Poor conditions	6	26
Remote location	1	4

Source: ERIAS Group 2016a

The following health care worker problems were categorized as "other":

- Transportation is needed to collect wages and medical supplies.
- Community members visit during all hours even when health care workers are 'off duty'.
- Uncertainty about how much salary the CHW should be paid.
- Lack of communication/radio communications to District Health Division.
- Little support and supervision from the government.
- Inadequate staff houses.
- No electricity; therefore, night time emergencies are dealt with using torch light.
- Lack of water supply and light.
- Shortage of medical supplies.
- Housing is condemned.
- As the previous health worker was still filling the position even though he was sick, the current CHW could not fill the position; therefore, she was working on a voluntary basis. Often villagers complain that she should not work as she is not paid.

While the "other" response category is diverse, the dominant concerns are wages and overall working conditions. Working conditions, including the physical condition of the health care facility, were further queried, as shown in Table 17. Table 17 shows the results of 13 of 14 KIIs (as there is no health facility at Subu 2).

Table 17. PAOI Health Facility Ratings Summary

Health Facility Ratings	Number of Responses	Percentage of Responses
Buildings		
Adequate	1	8
OK	1	8
Poor	6	46
Unsatisfactory	5	38

Table 17. PAOI Health Facility Ratings Summary

Health Facility Ratings	Number of Responses	Percentage of Responses
Trained Staff/Patient Ratio		
Adequate	0	0
OK	4	31
Poor	1	8
Unsatisfactory	6	46
No response	2	15
Medicine Stock		
Adequate	4	31
OK	3	23
Poor	2	15
Unsatisfactory	4	31
Medicine Range (variety)		
Adequate	4	31
OK	3	23
Poor	3	31
Unsatisfactory	3	23
Medicine Currency		
Adequate	3	23
OK	4	31
Poor	0	0
Unsatisfactory	5	38
No response	1	8
Consumable Materials (i.e., bandages)		
Adequate	1	8
OK	2	15
Poor	4	31
Unsatisfactory	6	46
Consumable Materials Range		
Adequate	1	8
OK	2	15
Poor	5	38
Unsatisfactory	5	38
Equipment		
Adequate	0	0
OK	3	23
Poor	3	23
Unsatisfactory	7	54

Table 17. PAOI Health Facility Ratings Summary

Health Facility Ratings	Number of Responses	Percentage of Responses
Water Supply		
Adequate	0	0
OK	2	15
Poor	4	31
Unsatisfactory	7	54
Toilets/Sanitation		
Adequate	0	0
OK	1	8
Poor	4	31
Unsatisfactory	7	54
No response	1	8

n=13. Source: ERIAS Group 2016a

The health facility ratings are consistently poor across all categories—meaning most categories except medicine stock and medicine currency have a "poor/unsatisfactory" combined rating of 50% or more. Sanitation (85% poor/unsatisfactory), water supply (85% poor/unsatisfactory), and buildings (84% poor/unsatisfactory) were the three worst rated categories. The health worker KIIs confirm field observations of a primary community level health care system in decay.

As previously noted, many Papua New Guinea primary health care facilities are either closed or irregularly open. Based on the KIIs, across the PAOI less than half of the health care facilities were open all year, 15% open most of the year, and 15% hardly ever, as shown in Table 18. Three communities that participated in the KIIs were unsure how often their facility was open.

Table 18. Health Care Facility Open Rates

Facility Open	Number of Facilities	Percentage of Facilities
All year	6	46
Most of year	2	15
Hardly ever	2	15
Unsure	3	23

n=13. Source: ERIAS Group 2016a

While expressed by participants in a variety of ways, the reason facilities were not open was consistently due to staff deficiencies (poor performing or absent):

- CHW is paid but does not perform.
- CHW commitments in Port Moresby.
- No health officers working and no medicines.
- Staff missing.

Development Support Received

Provincial, district, and local government development support across the PAOI health facilities was variable. Interviews revealed no government development support for the aid posts close to TEP PNG and no support at all for some facilities (those not listed in Table 19 – Muro Mission, Ikinu and Maipenairu). Conversely, other assessed PAOI health facilities did receive some government support (see Table 19).

Table 19. Health-Related Development Support Received

Health Facility	Support Provider	What	When
Akoma-Kairu'u	GCS	Building patients ward/staff house	10 years (~2006)
	MP	Building patients ward/staff house	6 years (~2010)
Apiope	Provincial Government	Aid post building (still incomplete and unused)	No data
Evara	RH logging	Building structure and water tank	No data
	TEP PNG	Solar light	No data
Kapuna	LLG	Building (isolated ward for TB patients)	2014
	European Union	Water tanks	2009-2013
Kavava (Orokolo)	Provincial Government	Medical supplies	Annual
Mapaio	Member from Kikori	Construction of aid post and staff houses (but incomplete)	No data
Mariki	LLG	Allocated K10,000	Unsure
	Kapuna/Baimuru district	Medicine	No data
Oru-Lariau-Herakela	Provincial Government	Medical supplies	Annual
	L&Z	Government supply delivery	September/October 2015
	Orokolo Sub-Health Center	Supplies	No data
Poroi 2	Others: Community	Built the aid post	No data
Wabo Station	TEP PNG	HEO support	Ongoing

Source: ERIAS Group 2016a

Health care workers were asked about their priorities for improving health across their communities. Table 20 presents the priorities and percentage of responses. As illustrated by these responses, there is a dichotomy between ranking a facility attribute, such as water/sanitation (poor/unsatisfactory), and whether it was perceived by the staff as a top priority (8%). “Staff issues” is the top priority and undoubtedly tied to timely payment of wages (see Table 20). More than one response was provided on several occasions.

Table 20. Priorities for Health According to Health Workers

Priorities	Number of Responses	Percentage of Responses	Extended Comments
More health staff	8	21	• Properly staff existing facilities, and pay staff
Improved salaries	1	3	• Require existing health staff that are paid salaries to show up to work and perform duties
Better visitation/supervision	2	5	• Provide supervision and training for local aid post and sub-health center staff • Elect functional village health committees to address existing problems hindering operations
Better health education	5	13	• Maternal child health services and staffing required, including family planning • Provide health staff training to update diagnostic skills, such as rapid diagnostic testing
Improved transportation	7	18	• Logistics needs for supply and medicine delivery, general access to health care, referrals, volunteer transportation, emergency transportation (including medical evacuations), transportation to collect pay, and transportation to Kapuna for deliveries
Improved infrastructure	7	18	• Aid post building: resolve political and landowner issue, furnish, and open clinic • New aid post completed, usable and including staff housing • Improve existing facilities • Aid post in every ward • Better aid post facilities: labor room, lights, treatment room • Fencing around the clinic/staff house • Latrines, toilet facilities required
Improved equipment and medical supplies	2	5	• Need x-ray, proper laboratory, GeneXpert capabilities for proper TB diagnosis • Sterilization equipment
Water tanks	4	10	• Water tanks, safe water supply
HIV/AIDs voluntary counseling and testing	1	3	• Needed for voluntary counseling and testing capabilities
More TB awareness/patrols	2	5	• More TB awareness/patrols required • Improve local health posts' capacity to identify and manage TB, train TB

Table 20. Priorities for Health According to Health Workers

Priorities	Number of Responses	Percentage of Responses	Extended Comments
			volunteers, and implement a food program for TB patients • Air-conditioned room required to keep medicines • Require more TB services

Source: ERIAS Group 2016a

As previously noted, the referral patterns between the primary community level health facilities and the established health centers are critical. The Kapuna Health Center is the primary referral facility for the functioning PAOI aid posts (see Table 21). More than one response was provided on several occasions.

Table 21. Patient Referrals from One Facility to Another Facility

Location	Number of Responses	Percentage of Responses
Kapuna Health Center	12	67.0
Kerema Health Center	3	17.0
Herd Base	1	5.5
Orokolo Sub-Health Center	1	5.5
Ihu Health Center	1	5.5

Source: ERIAS Group 2016a

Table 21 confirms the health team observation that the Kapuna Health Center is the most important PAOI health facility and likely has the most representative morbidity data for the overall PAOI.

An important issue that is tied to referrals is financial cost. While the actual treatment is generally provided at no cost to the patient (although not at Kerema Health Center), the patient (or their family) is required to cover the cost of transportation, food, and housing costs once patients and their families arrive at the referral center (see Table 22 and Plate 30). As noted in Table 23 the health care workers believe that financial considerations are a critical issue.

Table 22. Who Pays for Referrals?

Who Pays?	Number of Responses	Percentage of Responses
Patient only	8	62
Patients and other	5	38
Government	0	0

n=13. Source: ERIAS Group 2016a

The following comments were made by interviewees about who pays for referrals:

- Patients pay for transport, accommodation, and food when travel is required.
- It is better at Kapuna as treatment is free and the patient only pays a deposit to stay, whereas patients pay for treatment at Kerema.
- Patients paddle to Herd Base where treatment or referral decisions are made.

- Sometimes TEP PNG provides emergency evacuation to Kapuna.
- Sometimes Herd Base provides helicopter transport or referral to Kapuna with fuel.
- In the past, the health center used to meet the costs of referrals. Now patients and guardians cover the cost themselves, and often complain. The health center had a dinghy and motor; however, there is none now.

Plate 30. Payment Notification Board at Kerema Health Center

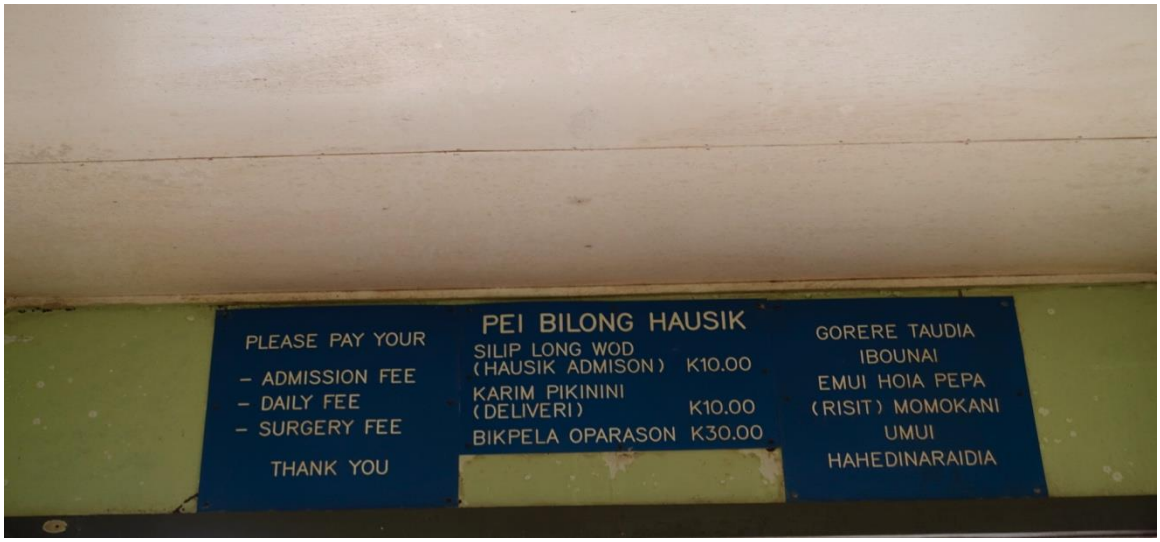


Table 23. Cost Implications

Cost Prevents Care	Number of Responses	Percentage of Responses
Almost always	8	62
Often	2	15
Sometimes	1	8
Rarely	2	15

n=13. Source: ERIAS Group 2016a

The following comments were made by interviewees in response to whether cost prevents patients from seeking treatment:

- For emergency cases, the immediate family pays the cost of fuel.
- Cost of travel (fuel, lodging, food while there) is an issue.
- Do not go to Kerema, and most often cannot go to Kapuna because of transportation and living costs; thus, some patients die [because they are unable to] travel.
- Approximately 25% of referred patients go to Kapuna Health Center due to the cost of travel.
- Cost of trip to Kapuna is a deterrent.
- Use traditional materials or wait until they get very sick.
- If it is serious, they will go to Kapuna even if they must paddle; if it is not serious, they may not go at all.

Focus Group Discussions

This subsection analyzes the community FGDs conducted in all villages within the PAOI. The following overall village health concerns are key findings from FGDs:

- Lack of transportation for supplies/treatment.
- Lack/deterioration of health facilities.
- Lack of water supply.

These findings generally align with the health worker observations. Transportation is a significant issue for communities, and they clearly perceive a relationship between access to health services and health outcomes. The physical deterioration of community health facilities is identified as a problem and is likely tied to a perception of quality of service. The NDOH National Health Service Standards (2011) recognize the connection between customer and outcome "quality." NDOH (2011) noted in its analysis and development of health facility standards that health facility infrastructure was significantly deteriorating and was a major cause of concern and patient dissatisfaction.

The water supply situation is described in Section 6.6 EHA 5 WASH-Related Diseases. As noted in the health worker KIIs, water supply is a prominent concern.

Focus Group Discussions – Women

Women were asked about the frequency of health clinics in their village during focus group discussions at 35 villages in the PAOI. Over 80% of villages reported that there had been a health clinic in their village during 2016. Most health clinics were conducted by Kapuna Health Center indicating that it is the critical health care provider for outreach services in the PAOI (see Table 24).

Table 24. Last Health Clinic Provider

Provider	Number of Responses	Percentage of Responses
Kapuna Health Center	29	83
TEP PNG	2	6
YWAM	1	3
None	3	9

n=35. Source: ERIAS Group 2016a

Similarly, most of the malaria patrols (see Table 25) were also conducted by Kapuna Health Center with support from DFAT.

Table 25. Last Malaria Patrol

Provider	Number of Responses	Percentage of Responses
Kapuna Health Center	26	74
Kapuna/AusAid (DFAT)	1	3
Kapuna/TEP PNG	1	3
YWAM	1	3
None or no response	6	17

n=-35. Source: ERIAS Group 2016a

Women also reported that most of the immunization patrols were conducted by Kapuna Health Center (see Table 26).

Table 26. Last Immunization Patrol Provider

Provider	Number of Responses	Percentage of Responses
Kapuna Health Center	29	83
YWAM	1	3
None or no response	5	14

n=35. Source: ERIAS Group 2016a

Table 24 through Table 26 confirm the critical role of the Kapuna Health Center across the PAOI. While Kapuna Health Center is the dominant service provider in the PAOI, there are other organizations that provide services (see Table 27).

Table 27. Additional Health Programs Provided

Provider	Number of Programs	Percentage of Responses
Kapuna Health Center	7	39
YWAM	5	28
Baimuru Health Center	3	17
InterOil	2	11
Gulf Province Health	1	6

Source: ERIAS Group 2016a

Other organizations provide the following health programs:

- HIV.
- Cholera.
- TB.
- Malaria.
- Mosquito net distribution.
- Tetanus injections for women.
- Health awareness.
- Medicine drop off (Gulf Provincial Health Division).

Village leaders, women, and youth were asked what medical conditions or problems they thought were causing poor health in their village. Multiple responses were given. These responses are listed in Table 28 and Table 29.

Table 28. Reasons for Poor Health – Village Leaders FGDs

Reason for Poor Health	Number of Responses	Percentage of Responses
Malaria	26	35
Other	29	39
Diarrhea	10	13
Respiratory infection	3	4
Skin infection	4	5
Cough	2	3
Typhoid	1	1

Source: ERIAS Group 2016a

Table 29. Reasons for Poor Health of Women, Children, and Youth – Women's and Youth FGDs

Reason for Poor Health	Poor Health in Women		Poor Health in Children		Poor Health in Youths	
	Number of Responses	Percentage of Reponses	Number of Responses	Percentage of Reponses	Number of Responses	Percentage of Reponses
Workload	24	55	0	0	23	23
Poor diet	5	11	12	26	9	9
Climatic factors	5	11	7	15	5	5
Poor hygiene	3	7	19	41	18	18
Lack of medicine	2	5	1	2	15	15
Lack of health workers	1	2	0	0	12	12
Other	4	9	7	15	17	17

Source: ERIAS Group 2016a

As previously described, the perceived dominance of malaria by village leaders is not confirmed by actual objective clinical data (see Section 6.4 EHA 3 VBD analysis). Interestingly, women clearly feel that their overall workload is the major contributing factor to their poor health. Women recognize that poor hygiene is a significant issue, a finding that is confirmed by the household health questions regarding hand washing and soap use (see Section 6.6 EHA 5 WASH-Related Diseases). Overall household hand washing and soap utilization practices were poor.

Table 30 shows who is consulted when an individual has a serious illness. Village leaders usually consult medical workers, while women and children consult both the traditional medicine provider and the medical worker. The use of traditional medicine providers is significant and further described in Section 6.13 EHA 12 Cultural Health Practices.

Table 30. Who is Consulted with Serious Illnesses?

Health Provider	Percentage of Response		
	Leaders	Women	Children
Medical worker	74	6	6
Traditional doctor and medical worker	9	77	77
Traditional doctor	3	3	3
Neither	0	3	3
Not sure or no response	14	11	11

n=35. Source: ERIAS Group 2016a

Women and Contraception

Responses to the question, "How many women in the village would use some kind of family planning?" are listed in Table 31. These data are for the entire PAOI. In 6% of villages surveyed, the women indicated that they did not use contraception. The majority of women in the villages surveyed had an understanding of different contraceptive methods (see Table 32). Similarly, most women knew how to access contraception (see Table 33). For most women, it was a shared decision (with their partner) whether to use contraception (see Table 34).

Table 31. How Many Would Use Family Planning?

Who	Number of Responses	Percentage of Responses
All people	5	14
Most people	14	40
Some people	9	26
Few people	1	3
None	2	6
Not sure or no response	4	11

n=35. Source: ERIAS Group 2016a

Table 32. Women Who Understand Different Contraceptive Methods

Who	Number of Responses	Percentage of Responses
All people know	10	29
Most people know	17	49
Some people know	3	9
Few people know	0	0
Not sure or no response	5	14

n=35. Source: ERIAS Group 2016a

Table 33. Women's Knowledge of Access to Contraception

Who	Number of Responses	Percentage of Responses
All people know	12	34
Most people know	16	46
Some people know	2	6
Few people know	0	0
Not sure or no response	5	14

n=35. Source: ERIAS Group 2016a

Table 34. Decision Making Regarding Contraception

Who Decides?	Number of Responses	Percentage of Responses
Woman	1	3
Man	0	0
Shared	14	40
Other	2	6
Not sure or no response	18	51

n=35. Source: ERIAS Group 2016a

Antenatal, Labor and Delivery Findings

Based on the household survey, approximately 85% of mothers attended at least one antenatal clinic during pregnancy, while 11% did not. This attendance level is significantly better than the 2015 overall Gulf Province level of 54% (NDOH 2015).

Another indicator of antenatal care service delivery is maternal and neonatal tetanus vaccination rates. To prevent maternal and neonatal tetanus, all pregnant women should receive the tetanus immunization. Across the PAOI, approximately 74% were vaccinated. Tetanus vaccination rate is not a SPAR KPI; however, a typical PNG national average is 70% (NDOH 2010). Kapuna Health Center conducts a maternal and child health program across many villages in the PAOI which likely contributes to this relatively high rate of immunization.

Only 31% of the villages in the PAOI had trained VBA (see Table 35); however, most villages have a traditional birth attendant (TBA) (see Table 36). The difference between a trained VBA and a TBA is formal training in delivery and management of complications.

Table 35. Villages with Trained VBAs

Trained VBA?	Number of Villages	Percentage of Villages
Yes	11	31
No	20	57
Not sure or no response	4	11

n=35. Source: ERIAS Group 2016a

Table 36. Villages with TBAs

TBA?	Number of Villages	Percentage of Villages
Yes	29	83
No	2	6
Not sure or no response	4	11

n=35. Source: ERIAS Group 2016a

The place of delivery for births across the PAOI is listed in Table 37. As shown in Table 37, across the overall PAOI, approximately 46% of children were born at a health center. This percentage is higher than the overall 2015 Gulf Province level of 34% (NDOH 2015). If a woman delivered in the bush, she delivered alone (47%), had a TBA (47%), had a trained birth attendant (3%), or another non-specified attendant (3%).

Table 37. Place of Delivery Overall PAOI

Where Born	Number of Children Born	Percentage of Children Born
Health center	185	46
Village	90	22
Hospital	60	15
Bush	38	9
Aid post	28	7
Other	3	1

Source: ERIAS Group 2016b

Of the children born at a PAOI health center, Kapuna Health Center has the most deliveries by location (40%) followed by Orokolo Sub-Health Center (31%). Most women travel by canoe (40%) or walk (31%) (ERIAS 2016a). Table 38 summarizes the time to travel for delivery.

Table 38. Travel Time to Deliver Babies

Travel Time	Number of Responses	Percentage of Responses
<1 hour	8	23
1-3 hours	1	3
4 hours to 1 day	14	40
>1 day	5	14
Not sure or no response	7	20

n=35. Source: ERIAS Group 2016a

In terms of antenatal care and labor and delivery, the overall PAOI performs at a level consistent with or modestly better than the overall Gulf Province (NDOH 2015). In Papua New Guinea, a significant effort at improving overall health services is the RPHSDP.

6.2.2.6 Rural Primary Health Services Delivery Project

The RPHSDP of the NDOH is tasked with strengthening the rural health system in selected provinces. To do so requires timely access to activity data and a functioning HIS. The NDOH awarded a contract to the PNG Remote Sensing Center Ltd in June 2014 to strengthen the National HIS with timely, accurate, and relevant data collection and reporting, using mobile phone/tablet technology to transmit data and to develop an existing geographic information system (GIS) interface to analyze and monitor the implementation of the National Health Plan 2011–2020 at national, provincial, district, and facility levels.

To strengthen the existing rural primary health system in Papua New Guinea, the project works through partnerships, builds human resource capacity in the health sector, improves health information and monitoring systems, and revitalizes rural health facilities, services, and staffing.

The project recently was reviewed by Asian Development Bank specialists who recommended that the electronic National Health Information System (eNHIS) pilot should be rolled out to the remaining 17 provinces, which would include Gulf Province. The review found that the eNHIS is capable of timely, reliable health data collection, analysis, and presentation in five of Papua New Guinea's 22 provinces, covering 184 health facilities. The solution has been crafted to meet the specific needs of Papua New Guinea's existing National HIS, the state of the country's communications systems, and its geography.

6.2.3 Key Findings/Issues

The health system infrastructure across the PAOI includes three levels: (1) aid posts, (2) sub-health centers, and (3) health centers. This structure and its associated programs are mandated by the NDOH but managed by Gulf Province. Across all of Papua New Guinea, there is a mismatch between the NDOH program requirement and the actual delivery of services to communities. As illustrated in this section, the situation in the PAOI is reflective of what is occurring nationally—aid posts have significant staffing problems and many have either closed or have irregular hours of operation. The burden of direct health care service and program delivery, such as immunizations and antenatal services, has primarily fallen on the health centers. Kapuna and Kerema health centers are the primary care and program delivery facilities across the PAOI. Significant funding and staffing constraints impact Kapuna and Kerema health center performance, specifically the mismatch between the mandated NDOH services and programs and the available funds and staff.

In an emergency, promptly accessing these health centers for medical care is potentially problematic for many households (See Section 6. 9 EHA 8 Accidents and Injuries). There is no provincial medical emergency response system (i.e., structured communication and transport system) for the Gulf

Province. A variety of medical problems, including acute trauma, obstetrical complications, and perinatal/neonatal infections have very limited time windows for efficient and effective treatment. The inability to access needed medical services in a timely manner can significantly impact morbidity and mortality, particularly for women and young children.

For TEP PNG, the primary issue is recognizing the fragility of the current PAOI health facilities and deciding the most practical, beneficial, and sustainable way to interact with the overall health system management structure at national, provincial, and local levels. In addition, the lack of a functioning medical emergency response system is a significant problem in the Gulf Province and should also be considered as a priority issue as both health facilities and communities are likely to request transportation support from TEP PNG for acute medical problems.

6.3 Environmental Health Area 2 – Communicable Respiratory Diseases

EHA 2 considers the burden of communicable respiratory diseases. The transmission of communicable respiratory diseases is strongly associated with overcrowding (high household occupancy); cooking/heating with wood as a primary fuel source; low immunization levels in children and adults; and poor hygiene, particularly hand washing practices (Baker et al. 2013). These data (hand washing and vaccination service delivery) are covered in detail in EHA 5 WASH-Related Diseases and EHA 1 Health Systems.

Based on health facility morbidity data (EHA 1 Health Systems), respiratory illness is the leading cause of reported morbidity across the PAOI. The actual microbiological etiology of this disease burden in the PAOI is unknown. However, interviews with relevant health professionals who provide services for the PAOI indicate that the TB situation in the Gulf Province requires in-depth assessment; hence, TB is a major focus of this EHA discussion.

6.3.1 Overview

Respiratory illness can be caused by many different etiologies, including numerous species of bacteria, virus, protozoa, and fungi. Although bacterial pathogens, particularly Hemophilus influenzae and Streptococcus pneumoniae, are typically identified as the major cause of acute lower respiratory illness, viral agents are also considered important agents in the disease process. Various studies have identified viral species as the etiological agent of acute lower respiratory tract infections (ALRI) in 20–48% of Papua New Guinea cases examined by research scientists (Hare et al. 2010; Greenberg and Leibovitz 2005; Zar et al. 2006; Johnstone et al. 2008; Jennings et al. 2008; Angeles et al. 2006; de Roux et al. 2004; Chidlow et al. 2012). Previous work by PNG IMR is consistent with these observations (Hare et al. 2010).

The level of vaccine-preventable illness across the PAOI is unknown but potentially significant given the low vaccination rates documented in children in Gulf Province. Similarly, there is undoubtedly a significant burden of vaccine preventable illness, like pneumonia, in adults. Papua New Guinea has one of the highest rates of adult pneumonia in the world (Riley 2010; Douglas 2010).

When community vaccination levels are low, typically less than 80% for the target group, there is a loss of “herd immunity.” According to VaccinesToday (2015), “herd immunity is a form of immunity that occurs when the vaccination of a significant portion of a population (or herd) provides a measure of protection for individuals who have not developed immunity.” Herd immunity rises when a high percentage of the population is protected through vaccination against a virus or bacteria, making it difficult for a disease to spread because there are so few susceptible people left to infect. Hence, the likelihood of a sudden infectious disease outbreak is significantly lessened. At a

community level, herd immunity can effectively stop the spread of a disease in a community even if a few isolated cases occur. The proportion of the population that must be immunized to achieve herd immunity varies for each disease. When immunization rates fall, herd immunity can break down, leading to an increase in the risk of a sudden disease outbreak. The risk of an outbreak of a communicable respiratory infection from either a community or workplace setting is described in subsequent sections.

Measles is an example of a highly communicable respiratory illness that can have explosive outbreaks when community herd immunity is low. In late 2013 in the Hela Province, there was a large measles outbreak with more than 2,600 cases (Global Alliance for Vaccines and Immunization 2015). In response to this outbreak there was a massive immunization effort lead by Tari Hospital, MSF, and the Oil Search Foundation. Over 2,300 cases were treated and 116,000 vaccinations were administered (Oil Search Foundation 2014). Historically, measles vaccination levels in Papua New Guinea are low—2015 nationwide levels were less than 40% for 1 year olds with Gulf Province levels at 19% (NDOH 2015). It is therefore highly unlikely that sufficient levels of herd immunity are present across most rural communities in the Gulf Province. In addition, prior to 2016, Papua New Guinea was one of only three WHO Western Pacific Region countries that had not included measles-rubella vaccine in its routine immunization schedule (Global Alliance for Vaccines and Immunization 2015).

TB is a significant issue in Papua New Guinea and in some locations, including Gulf Province, is at epidemic levels (Cross et al. 2014). The WHO defines an epidemic as “The occurrence in a community or region of cases of an illness, specific health-related behavior, or other health-related events clearly in excess of normal expectancy” (WHO 2008). According to WHO, TB kills more people in Papua New Guinea than any other infectious disease (WHO 2016a). TB is a complex disease to accurately diagnosis and manage, particularly in remote, rural settings. PNG health professionals at both national and provincial levels are increasingly voicing concerns not only regarding the high countrywide prevalence of TB, but also regarding the rise of MDR-TB and extensively drug resistant TB (XDR-TB).

As defined by WHO, MDR-TB is a form of TB where the mycobacterium is resistant to at least two of the primary first-line treatment medications (isoniazid and rifampin) (WHO 2016a). XDR-TB is defined as TB that has developed resistance to at least two first-line treatment drugs (rifampicin and isoniazid) as well as to any member of the quinolone family of drugs and at least one of the second-line anti-TB injectable drugs. MDR-TB is difficult to treat, and in a resource limited setting, has a very poor prognosis. XDR-TB has a dismal prognosis and is not treated in Papua New Guinea (cases have been transferred to Australia). The available TB services, programs, clinical data, and service providers relevant for the PAOI are presented in detail.

Finally, exposure to pollutants from indoor combustion of solid fuels in open fires or in traditional stoves increases the risk of ALRI and associated mortality amongst young children. Indoor air pollution from solid fuel use is estimated to cause 36% of all lower respiratory infections and 22% of chronic obstructive pulmonary disease (WHO 2002; WHO 2006). Despite a significant focus by WHO (WHO 2014a; WHO 2016b), there are limited data for indoor air pollution studies in Papua New Guinea (Anderson 1978; Ezzati and Kammen 2002) and no studies published from the Gulf Province. Baseline air quality studies sponsored by TEP PNG (SLR Consulting Australia Pty Ltd [SLR] 2017a), indicate that background levels of particulate matter are expected to be low, given the high rainfall, low wind speeds, and dense vegetation in the area. According to SLR (2017a), the main sources of background particulate matter include both natural sources (e.g., pollens) and anthropogenic activities (e.g., cooking fires, generators [if used], and agricultural activities). There are no indoor exposure measurements available for review.

6.3.2 Sources of Information

This subsection discusses the sources of information used for EHA 2.

6.3.2.1 Peer-Reviewed Published Literature

There are no peer-reviewed published studies of non-TB respiratory illness for the Gulf Province. As previously noted, PNG IMR has performed many non-Gulf Province respiratory illness studies.

Cross et al. (2014) is the only peer-reviewed study of TB incidence and prevalence for the Gulf Province. This study prospectively collected data on 274 patients presenting to Kikori Hospital with a presumptive diagnosis of TB and on hospital inpatients receiving TB treatment during the study period. Sputum was collected for microscopy, GeneXpert analysis, culture, and genotyping of isolates. The estimated incidence of TB in Kikori was 1,290 per 100,000 people (95% confidence interval: 1,140-1,460) in 2012. This estimated incidence rate is almost four times higher than the PNG national rate reported to WHO (see Table 39).

Table 39. TB Incidence Rates

Country	Per 100,000
South Africa	981.0
Kikori- PNG	1,290.0
PNG- National	303.0
China	80.0
Australia	6.3

Source: Cross et al. 2014; PNG IMR 2016

The proportion of Kikori TB patients co-infected with HIV was 1.9% (Cross et al. 2014). In contrast to the high TB incidence rates reported in African countries (Chaisson and Martinson 2008), the rate in Kikori is unusual as it is not associated with a high frequency of HIV co-infection. The Kikori TB incidence rate is one of the highest non-HIV co-infection driven rates in the world. As noted by Cross et al., “our incidence figure may be an underestimate of the true incidence, as only patients presenting to the hospital were included in the study and we did not perform active case finding in the community villages” (2014, 6).

In 2014, Ley et al. published a historical review of TB studies in Papua New Guinea. This paper pointed out the issue of HIV co-infection and TB in urban settings, particularly Port Moresby. Key risk factors included malnutrition, smoking, and diabetes. Diabetes is known to double or triple the risk of TB, and its prevalence is increasing in Papua New Guinea (see EHA 7 NCDs). The impact of increasing alcohol consumption and betel nut chewing are potential risk factors; however, this has not been systematically studied in Papua New Guinea (Ley et al. 2014). PAOI data for betel nut and alcohol consumption are presented in subsequent sections. Drug resistance testing began in 2014; hence, there is limited historical data. The ability to test for drug resistance is improving in terms of laboratory capacity and testing.

In 2016, Aia et al. published a large population-based survey regarding the burden of drug resistant TB in Papua New Guinea. This study was conducted in four provinces: Madang, Morobe, National Capital District, and Western Province. MDR-TB was detected in 2.7% of cases (1.1 to 4.3% confidence interval). No cases of XDR-TB were detected. As noted by Aia et al, “a large proportion of MDR-TB cases were identified from a single hospital in Western Province, suggesting that the prevalence of MDR-TB across the country is heterogeneous” (2016, 1–2).

There has been a substantial focus on the Western Province, and several papers have been published that document high incidence rates and significant levels of MDR-TB (Aia et al. 2016; Simpson et al. 2011; Gilpin et al. 2008).

There are no published studies of indoor air pollution and respiratory illness in the Gulf Province. There are a few Papua New Guinea based studies of indoor air pollution and respiratory illness (Anderson 1978; 1979); however, these papers are based on communities in the Highlands Region.

6.3.2.2 Papua New Guinea National Department of Health and National Tuberculosis Control Program

The National TB Control Program (NTP) functions within the overall umbrella of the NDOH. The NTP has issued a formal Papua New Guinea National Tuberculosis Management Protocol in 2011 (NDOH 2011b). The NTP has defined the main roles for the different levels of TB control at the national, provincial and district levels. NTP has the following primary goals:

- Reduce the impact of TB as a public health problem.
- Increase the detection of sputum smear positive TB.
- Cover 100% of the country's population with directly observed treatment, short-course (DOTS)[7].

While the NTP sets objectives and strategies, implementation is primarily at the provincial and district level. As previously described in EHA 1 Health Systems, there is often a tremendous gap between the high-level articulation of strategies and its actual on-the-ground local-level implementation.

The most current national and provincial level TB data are in the 2015 SPAR report. The 2015 SPAR KPI data for respiratory illness are focused on TB. Table 40 summarizes these data.

Table 40. Percentage of All New Sputum Positive Cases Cured*

Location	2011	2012	2013	2014	2015
Gulf Province	29	0	33	22	10
National	60	52	51	49	52

Source: NDOH 2015

*Cured refers to those cases that have converted to sputum negative status at the completion of treatment for at least sputum smears.

As illustrated by the data in Table 40, the TB cure rates are low for the Gulf Province. Incompletely/partially treated TB is a significant driver of MDR-TB.

NDOH reference and health profile data (NDOH 2010) were published in 2010; however, these data cover 2001 to 2008. The relevant respiratory illness data for the overall Gulf Province versus Papua New Guinea are shown in Table 41. These data must be viewed cautiously due to their age and concerns regarding accuracy and consistency of reporting by health facilities. The NDOH TB data are dated versus the more recently published peer-reviewed studies (Cross et al. 2014; Aia et al. 2016), and NDOH data are likely underestimating the actual burden of TB in the Gulf Province. The data from Cross et al (2014) and MSF (2016) confirm this observation.

[7] DOTS is the WHO-approved, internationally recognized strategy for TB control that includes five components: (1) political and financial commitment, (2) diagnosis by quality ensured sputum-smear microscopy, (3) standardized short-course treatment, (4) high-quality medications supply, and (5) standardized recording and reporting.

Table 41. NDOH Reference Data 2001–2008*

Location	Pneumonia Admissions	Pneumonia Deaths	Other Respiratory Admissions	Other Respiratory Deaths	TB Admissions	TB Deaths	Newly Detected Extra-Pulmonary Cases	New Sputum Positive Cases
Gulf Province	325	8	182	6	392	20	136	24
PNG National	470	14	97	6	131	11	292	34

Source: NDOH 2010
*All data are rates per 100,000 and shown as whole numbers

6.3.2.3 Multilateral Assistance Related to Tuberculosis

This subsection provides a high-level overview of some of the major multilateral assistance efforts for TB program support in Papua New Guinea.

The Global Fund to Fight AIDS, Tuberculosis, and Malaria

The Global Fund to Fight AIDS, TB, and Malaria (Global Fund) is the world's largest financier of anti-AIDS, TB, and malaria programs. The Global Fund is a financing mechanism and not an implementation agency. Implementation is overseen by Country Coordinating Mechanisms (CCM), which are committees that include government, NGOs, the UN, faith-based organizations, the private sector, and people living with the disease. In Papua New Guinea, the chairperson of the CCM is Lady Roslyn Morauta.

The CCM develops and submits grant proposals to the Global Fund based on the priority needs of the NDOH disease strategies. After grant approval, the CCM oversees progress during the implementation, playing a key role in grant oversight. Drawdown of funds is based on performance. The implementers/principal recipients for the new grants are Rotarians Against Malaria and Population Services International for malaria, and World Vision for TB. The TB grant also has an over-arching health system strengthening component.

Since 2004, the Global Fund has approved grants for Papua New Guinea worth US$187 million. In addition to this, a total of US$83 million has been approved by the Global Fund for Papua New Guinea for 2014–2017. The Government of Papua New Guinea's investment in Global Fund-supported programs is significant. For the period 2012–2014, the government contribution to the programs totaled US$62 million. This is expected to increase by 78% during 2015–2017, with an indicative budgeted amount of US$110 million.

In terms of TB support, there is an approved US$18-million grant, to be administered by the international and Australian divisions of World Vision. This grant is designed to reduce the incidence and prevalence of TB in Papua New Guinea. According to the CCM (World Vision International 2015), "the grant will be used to improve the recruitment and retention of clinical staff. It will also strengthen the systems needed to enable access to quality drugs and laboratory diagnostics for HIV, TB and Malaria, helping to build a stronger health system as a whole." World Vision operates in five geographical areas (National Capital District, Madang, Morobe, Western Province, and the Autonomous Region of Bougainville) in Papua New Guinea; however, the Gulf Province is not currently one of the five targeted locations.

Australian Government

In Papua New Guinea, the primary focus of Australian Government TB support has been for the Western Province (DFAT 2016). Australia has allocated A$60 million (US$60 million based on January 2011 currency rates) for the period 2011-2017 to a package of support:

- A$44.7 million (US$44.7 million based on January 2011 currency rates) allocated for Western Province.
- A$15.3 million (US$15 million based on January 2011 currency rates) allocated to the National Capital District and the National Response.

Australia's support is implemented by partners including the Papua New Guinea NDOH, WHO, World Vision, the Burnet Institute (Australia's largest virology and communicable disease research institute), Global Fund, and MSF.

Australia also provides core funding to multilateral partners who support the broader TB response. This includes A$50 million (US$36 million based on January 2017 currency rates) to the WHO over 2016 and 2017 and A$220 million (US$ 158.3 million based on January 2017 currency rates) to the Global Fund over 2017 to 2019 (DFAT 2016). The Australian support included funding for an external review of National TB Program in 2014 that identified the three hotspots for TB transmission: National Capital District, Gulf Province, and Western Province.

World Health Organization

The WHO panel of international TB experts provides internationally recognized technical and policy oversight to the TB interventions of all partners in Papua New Guinea. This WHO-sponsored panel of experts is known as the Western Pacific Regional Green Light Committee (rGLC WPR). rGLC WPR was established in 2011 to promote the rational scale-up of programmatic management of drug-resistant TB (Islam et al. 2015). As part of continued support to national efforts, rGLC WPR conducted its annual mission to Papua New Guinea in August 2016.

The following summary of international and Government of Papua New Guinea efforts were triggered by the rGLC WPR (WHO 2016c):

- **Increasing funding.** The Government of Papua New Guinea has committed funding to implement the accelerated response plan to address drug-resistant TB and released PGK8 million (US$2.6 million) in January 2016. The Australian Government and the Global Fund continue to provide significant financial support. Both the U.S. Agency for International Development (USAID) and the World Bank have started to provide support to the TB program of Papua New Guinea.

- **Improving patient support while on treatment.** To ensure all patients successfully complete their treatment, community-based treatment teams under the Daru Accelerated Response for Tuberculosis, have been established. Robust community-based care with nutritional support has been provided in Daru in Western Province and Kerema in Gulf Province. Patients now can receive treatment close to home.

- **Treating more patients successfully.** Since January 2016, none of the patients with drug-resistant TB in Daru and Kerema had dropped out of treatment when assessed 6 months after it was started. This indicates improvement in patient education and support as well as better clinical care, including management of adverse side effects.

- **Preventing transmission.** Infection prevention and control have been strengthened through administrative, mechanical, and personal protective measures. The hospital management in Daru developed an infection control plan, introduced a cough triage center, assigned an infection control focal person, and now regularly monitors health care staff using protective equipment in the drug-resistant TB ward. A new TB unit and drug-resistant TB ward were built with proper environmental infection control at Kerema Health Center.

World Bank Group

On October 26, 2016, the World Bank announced support for responding to the emerging TB epidemic in Papua New Guinea "through a Credit in the estimated amount of US$15 million" (World Bank 2016, 1). The World Bank (2016, 1) deemed the following aspects of TB management as critical for financing:

- Early detection of active TB patients, including population based screening for TB on Daru Island and supporting systematic screening in Western Province, and the National Capital District.
- Effective treatment of both drug susceptible and drug resistant TB including improvements to clinical management, strengthening the directly observed treatment, and supporting social mobilization.
- Strengthening the Government system to manage the TB response by supporting capacity building at central and local levels, build and strengthen the electronic TB information system, and Project management.

The funding documents cover two of the three established "TB hotspots": Western Province and National Capital District. The Gulf Province was not included in the October 2016 credit announcement.

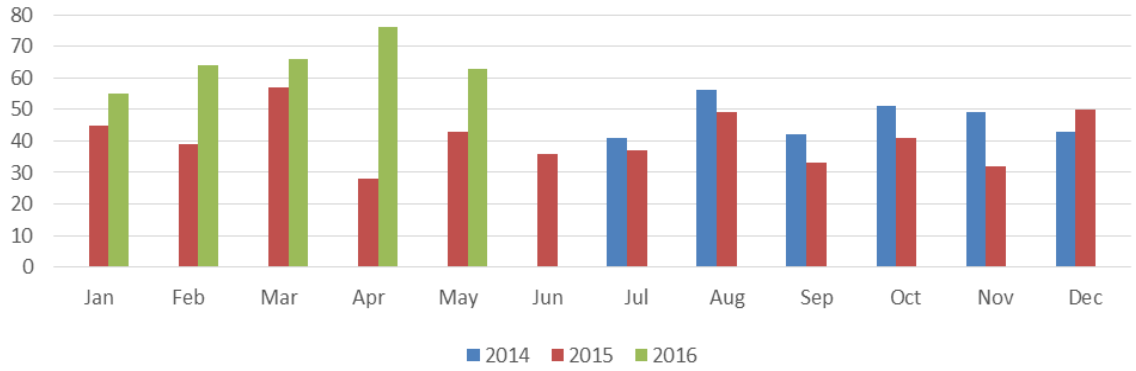
U.S. Agency for International Development

In June 2016, in response to a request from the Government of Papua New Guinea, USAID announced a program to provide targeted technical assistance to help detect and treat MDR-TB and XDR-TB. The USAID effort will directly assist the NTP. Rapid and systematic screening will be facilitated through GeneXpert machines. A funding level was not included in the announcement.

6.3.2.4 Non-Government Organization Studies and Data

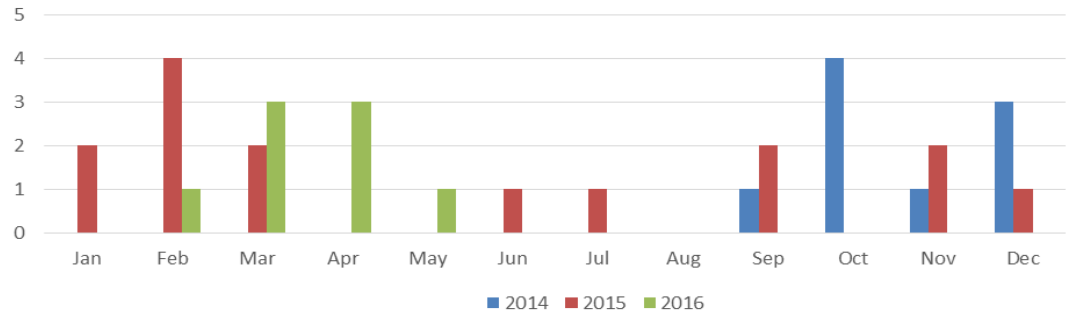
Since mid-2014, MSF has been the dominant NGO providing support for TB diagnosis and treatment management for the Gulf Province (at Kerema Health Center). A detailed overview of the MSF Gulf Province TB programs and activities is provided in subsequent sections. MSF estimates the incidence rate for the Kerema catchment area is 1,075–1,450 cases per 100,000. This level is consistent with the Cross et al (2014) incidence rate for Kikori and confirms a generalized TB epidemic across the Gulf Province. MSF estimates the death rate is 33 deaths per 100,000 cases, a level substantially higher than the Table 3 rate (20.1 per 100,000) published by NDOH for the Gulf Province. The drug sensitive and drug resistant data over the mid- 2014 to May 2016 period collected by MSF are shown in Figure 7 and Figure 8.

Figure 7. Drug Sensitive TB Patient Enrollment mid-2014 to May 2016*



Source: MSF and NDOH 2016
*Total enrollment is 1,386: 2014 (Q3/Q4: 286); 2015 (Q1-Q4: 776); 2016 (Jan-May: 324). Pulmonary TB cases: 467 with 52 (11%) under 15 years old.

Figure 8. Drug Resistant TB Case Detection mid-2014 to May 2016*



Source: MSF and NDOH 2016
*Total of 29 cases detected with 19 on treatment; three transfers, one treatment adjustment, four long-term follow-ups (referrals), one deceased, and one not enrolled.

The level of MDR-TB is approximately 2% over the 2014–2016 period and is consistent with the Cross et al. (2014) and Aia et al. (2016) datasets.

6.3.2.5 Private Company-Sponsored Studies

A 2012 health study commissioned by InterOil covered eight villages in PRL-15: Poroi 1, Poroi 2, Subu 1, Subu 2, Ura, Wabo, Wabo Station, and Urara. The InterOil study (2012) did not perform any laboratory or direct clinical assessment of respiratory illness. The InterOil study (2012) respiratory survey questions are different than those used by the PNG DHS and cannot be directly compared. In addition, there was a high non-response rate for several villages.

Fundamental TB epidemiological work in the Gulf Province in 2012 to 2013 was supported by the PNG LNG Project (i.e., the seminal 2014 Cross et al. paper).

The Oil Search Foundation has supported nurse and CHW training in the Kikori District. In addition, the Oil Search Foundation has supported food collection drives for in-patient TB patients at Kikori Hospital. Providing daily meals is a challenge for the Kikori Hospital, and many patients stop treatment to search for food. Patients ceasing treatment too early risk spreading TB and developing the multidrug-resistant strain of the disease. In 2015, Kikori Hospital recorded 330 new TB cases with

87 patients leaving treatment. From January to September 2016, 160 new cases were registered with zero patients leaving treatment after the food drive (Oil Search Foundation 2016).

6.3.2.6 Project Area of Influence Health Facility Data

Of the PAOI health facilities, Kapuna Health Center has the most consist and experienced clinical staff; in addition, some limited laboratory support is available. The Kapuna Health Center morbidity data are probably the most reliable and provide a reasonable snapshot of the basic burden of disease across the PAOI. The data are shown in Table 42 as a percentage of all diagnoses (approximately 10,000 over the reporting period) made on an outpatient basis.

Table 42. Kapuna Health Center Outpatient Data 2014–2015 (%)

Other	Respiratory[1]	Skin	Gastrointestinal	Accident & Injury	Eye/Ear	Malaria[2]	Anemia
53	16	11	5	4	4	3	1

[1]Includes TB

[2]Laboratory confirmed (RDT and/or slide)

Respiratory illness is a significant contributor to the overall disease burden and is five times higher than laboratory proven malaria.

The respiratory burden of disease analysis can be further evaluated by considering the outpatient data (shown as a percentage of total new diagnoses in Table 43) for three major health centers in the Gulf Province (Kapuna, Kerema, and Orokolo) and the overall 2010 NDOH Gulf Province outpatient morbidity data. Except for the malaria data, there is general consistency across the reporting health center and the overall Gulf Province. Detailed overall Gulf Province data after 2010 are not available. The 2010 Gulf Province data are reported by NDOH in the 2010 National Health Plan. As noted, 2015 SPAR data for malaria include both clinical and laboratory confirmed cases (the actual laboratory proven cases will be substantially smaller).

Table 43. Gulf Province Health Center Outpatient Data 2014–2015 (%)*

Health Center	Other	Respiratory[1]	Skin	Gastro-intestinal	Accident & Injury	Eye/Ear	Malaria	Anemia
Kapuna	55	16	11	5	4	4	3[2]	<1
Kerema	31	32	10	6	9	5	3[2]	<1
Orokolo	25	27	22	8	3	3	13[3]	1
Gulf Province 2010	25	14	14	5	3	3	35[3]	<1
Gulf Province SPAR 2015[4]				321/1,000	49/1,000		118/1,000	

Source: NewFields 2016; NDOH 2010; 2015

*Percentages shown as whole numbers

[1] Includes TB

[2] Laboratory confirmed

[3]Clinical diagnosis not laboratory confirmed

[4]SPAR data are incidence reported; malaria data include unconfirmed but treated malaria cases in addition to lab confirmed cases

In addition to outpatient data, inpatient health center data for 2014-2015 (shown as a percentage of total discharges) were collected for Kapuna and Kerema health centers and overall Gulf Province (NDOH 2010). These data are shown in Table 44. "Other" can include normal delivery and other obstetrical and perinatal conditions.

Table 44. Inpatient Health Center Diagnostic Data 2014–2015 (%)*

Health Center	Other	Respiratory	TB	Skin	Gastrointestinal	Accidents & Injury	Malaria
Kapuna	48	15	13	9	7	6	2
Kerema	72	13	10	<1	1	<1	1
Gulf Province 2010	57	10	10	N/A	6	11	6

Source: NewFields 2016; NDOH 2010

*Percentages shown as whole numbers

The inpatient data are generally consistent across the reporting health centers and for the overall 2010 NDOH Gulf Province data. When comparing the 2010 NDOH Gulf Province data set with the 2014-2015 data the major reporting categories have generally remained stable. However, the Kerema inpatient data do appear to demonstrate a different pattern of morbidity with substantially less gastrointestinal, skin, and accidents and injuries. Gastrointestinal/skin will be considered in the EHA 5 WASH analysis. Accidents and injuries data are presented within EHA 8 Accidents and Injuries.

The burden of inpatient TB is striking and consistent with Cross et al. (2014) and MSF 2014–2016 data. The health facility data are not driven by HIV co-infection as overall HIV rates are less than 1% (see Section 6.5 EHA 4 STIs).

The documented burden of TB in the Kapuna (see Plate 31) and Kerema health centers is significant. A July 2016 Gulf Provincial Health Division analysis (Gulf Provincial Health Division et al. 2016a) noted that the case notification rate was 767 per 100,000, a level that is more than double for the reported national incidence. TB case reporting in Gulf Province is passive, meaning patients present to a health facility. PNG IMR has actively and passively ascertained cases in the Hela and Central provinces, and has noted a substantial number of household cases that could be found by aggressive sputum sampling at a household level (PNG IMR 2016).

Plate 31. Tuberculosis Ward at Kapuna Health Center



6.3.2.7 Project Studies and Reports

Both the Upstream Community and Demographics Baseline Report (Finlayson 2016a) and the Upstream Governance and Economics Baseline Report (Finlayson 2016b) contain critical household level information that can be used to help understand the burden of communicable respiratory diseases observed in the PAOI:

- Average household size is 6.7 compared to national average of 5.3.
- The PAOI population pyramid demonstrates a large 0–9 age population.
- All (100%) households use wood as the main source of cooking fuel.
- All (100%) villages reported cooking indoors.
- Betel nut is widely used and sold across the PAOI with 15 villages reporting that betel nut sales are their main source of cash income (48% of villages surveyed).
- Some males consume alcohol from most villages in the PAOI; however, far fewer females consume alcohol in the PAOI. Individual male consumption rates are not known. It is very difficult to obtain reliable quantitative consumption data from a household survey.

High household occupancy levels significantly drive communicable respiratory disease transmission. According to WHO (2017b), "For communities, inadequate shelter and overcrowding are major factors in the transmission of diseases with epidemic potential such as acute respiratory infections, meningitis, typhus, cholera, scabies, etc. Outbreaks of disease are more frequent and more severe when the population density is high."

Baker et al. (2013) has performed an extensive literature review on household level overcrowding and the burden of respiratory illness. A meta–analysis of international studies (Baker et al. 2013) of pneumonia and ALRI unequivocally demonstrates that (1) large numbers of children under the age of 5 in a household, (2) bedroom sharing, and (3) high household occupancy levels are significant risk drivers. These risk factors are present across PAOI households.

In addition, project induced in-migration is a potential concern as average household occupancy can increase if there is a sudden wave of job seekers triggered by the construction phase of a project.

Similarly, temporary worker housing can trigger a communicable respiratory disease outbreak, such as chicken pox. Worker housing-related outbreaks of chicken pox have been documented globally—a 2001 episode in Saudi Arabia construction camp (Al-Tuhami et al. 2001) and during the construction of the project (IPIECA 2017).

Indoor cooking with wood as a fuel source is a well-known risk factor for respiratory illness, particularly for children under age 5 (Ezzati and Kammen 2002). Background air quality levels should reflect the absence of industrial sources; therefore, a baseline air quality monitoring program was not conducted (SLR 2017a). SLR estimated background particulate concentrations based on their experience collecting and reviewing fine and coarse particulate monitoring data for other projects and considering the local land use and high rainfall in the study area (SLR 2017a).

Betel nut chewing is associated with an increased rate of respiratory illness, particularly asthma (Garg et al. 2014). The impact of betel nut chewing and spitting on TB transmission is uncertain; however, Cross et al. (2014) speculated that these behaviors may be important factors that facilitate TB spread. Excessive alcohol consumption is also a well-established risk factor for respiratory disease (Sisson 2007).

6.3.2.8 Community Surveys

FGD participants were asked about "reasons for poor health." FGDs were conducted at 35 locations. Multiple responses were provided on several occasions. Table 45 presents the overall composite responses across all respondents.

Table 45. Reasons for Poor Health

Reason for Poor Health	Leaders	Women	Children (as reported by women)	Youth
Malaria	42			
Other	24			
Diarrhea	16			
Respiratory infection	7			
Skin infection	7			
Cough	4			
Workload		55	2	23
Poor Diet		12	25	10
Climatic Factors		12	13	7
Poor Hygiene		8	38	18
Lack of Medicine		4	2	14
Lack of Health Workers		4	Not mentioned	11
Other		4	21	16

Source: ERIAS Group 2016a

A specific question regarding household illness over the last year was directed toward women. Participants provided several responses. Sixty-five percent of the "complaints" occurred during the 2 weeks prior to the survey. The total responses are shown in Table 46.

Table 46. FGD Women – Illness Affecting the Village During the Past Year

Illness	Percentage of Response
Malaria	
Few	39
Many	42
Diarrhea	
Few	26
Many	16
Respiratory Infection	
Few	16
Many	6
Fever	
Few	3
Many	10
Cough	
Few	23
Many	19
Other	
Few	35
Many	42

Source: ERIAS Group 2016a

Superficially, the findings in Table 45 and Table 46 suggest that malaria is the dominant driver of the household and village burden of disease. Experience in both Papua New Guinea and other developing country settings indicates, however, that community members typically conflate respiratory symptoms with malaria (i.e., fever, cough, chest pain, and sweats) (D'Acremont et al. 2010).

As part of the Project-sponsored PiHP studies, PNG IMR documented that most women were unable to accurately document the most important symptoms of a respiratory illness for a child under the age of 5 (PNG IMR 2016). Thus, it is not surprising, given the massive attention to malaria, that symptom conflation is occurring.

As described in Section 6.4 EHA 3 VBDs, clinical malaria is vastly over diagnosed when objective laboratory testing is introduced—the number of clinical cases of malaria that are laboratory confirmed decreases by 50–90% (PNG IMR 2015; D'Acremont et al. 2010). This pattern has been observed and documented by PNG IMR (2016). Similarly, the SPAR data clearly demonstrates that Gulf Province malaria rates have fallen by 50% from 2011 to 2015 (NDOH 2015).

To work through the understandable problem of inaccurate "diagnosis attribution" at the community FGD level, a series of specific symptom questions were asked as part of the household level survey.

6.3.2.9 Household Surveys

Standard symptom questions regarding fever, cough, and diarrhea were asked as part of the household survey. The questions were based on the content style and format used in the international DHS survey.

Table 47 lists the results of the fever question "how many people in your family have been ill with a fever in the last 2 weeks?" In each household, up to five people were asked if they displayed the symptoms. The second part of the table shows how many households had what number of patients. The number of patients per household with fever is also presented. Table 48 lists the treatment location for "Person 1" (in Table 47) affected by fever.

Table 47. Fever – Individuals and Households Affected

Individuals with Fever*	Number of Cases		Percentage of Cases	
	Yes	No	Yes	No
Person 1	104	250	29	71
Person 2	34	320	10	90
Person 3	7	347	2	98
Person 4	5	349	1	99
Person 5	5	349	1	99
Households Affected**	**Number of Households**		**Percentage of Households**	
Households with 5 patients	2		1	
Households with 4 patients	1		0	
Households with 3 patients	4		1	
Households with 2 patients	23		7	
Households with 1 patient	74		21	

*n=354. ** n=104. Source: ERIAS Group 2016b

Table 48. Fever Treatment Location

Location	Treatment (percentage of "yes" cases)
Aid post	40
Health center	27
Your home	29
Other home	2
N/A or no response	2

n=104. Source: ERIAS Group 2016b

As shown in Table 47 and Table 48, a substantial number of individuals reported to have "fever" within the 2 weeks prior to the survey. Approximately two-thirds of those persons with a fever were seen at a health care facility.

As previously noted, it is difficult to know what percentage of the reported fever cases are respiratory-related versus other infectious, or even non-infectious, etiologies. Therefore, a subsequent survey question about how many family members were ill with a cough in the 2 weeks prior to the survey was asked. Table 49 lists the answers and the households affected. In each household, up to five people were asked if they displayed the symptoms. The second part of the

table shows how many households had what number of patients. Table 50 lists the treatment location for "Person 1" (in Table 49) affected by cough.

Table 49. Cough – Persons and Households Affected

Individuals with Cough	Number of Cases		Percentage of Cases	
	Yes	No	Yes	No
Person 1	109	245	31	69
Person 2	41	313	12	88
Person 3	13	341	4	96
Person 4	7	347	2	98
Person 5	5	349	1	99
Households Affected	**Number of Households**		**Percentage of Households**	
Households with 5 patients	3		1	
Households with 4 patients	2		1	
Households with 3 patients	8		2	
Households with 2 patients	23		7	
Households with 1 patient	73		21	

*n=354. ** n=109. Source: ERIAS Group 2016b

Table 50. Cough Treatment Location

Location	Treatment (percentage of "yes" cases)
Aid post	28
Health center	28
Your home	39
Other home	2
N/A or no response	3

n=109. Source: ERIAS Group 2016b

Similar percentages of individuals report fever or cough within the 2 weeks prior to the survey. Cough can be a presenting symptom of malaria. Malaria can produce pharyngeal congestion and features that mimic mild bronchitis. Conversely, persistent cough can be a presenting symptom of TB; therefore, to better differentiate the underlying cause of the individuals affected by fever and/or cough, more detailed questions were asked.

The household survey asked a commonly used set of clinical questions to find out if someone in a household might be an active TB case (see Table 51). These questions have been used and validated in numerous clinical studies in a developing country setting (Corbett et al. 2010; Tattevin et al. 1999; Cohen et al. 1996; WHO 2004).

Key questions are related to the presence or absence of specific symptoms over the 2 weeks prior to the survey. While there are numerous medical conditions that can produce many of these symptoms individually or in combination (e.g., malaria and pneumonia), the likelihood of TB rises as the number of symptoms for a given individual rises. In the Corbett et al. study (2010), of the HIV negative group who were TB positive, almost 10% had at least one symptom: weight loss (5%), night sweats (4%), and chronic cough lasting 2 weeks or more (3%).

Table 51. Has Anyone in Your Household Had These Problems in the Last 2 Weeks?

Problems in Household	Number of cases	Percentage of Individuals
Fever	100	4
Fatigue	92	4
Night sweat	64	2
Loss appetite	51	2
Cough >3/week	50	2
Weight loss	48	2
Chest pain	40	2
Cough blood	5	<1
None	2,117	82

n=2,567. Source: ERIAS Group 2016b

Across the PAOI, there were 58 individuals (27 males and 31 females) who had 3 or more of the common symptoms associated with active TB. It is unknown what percentage (if any) of these 58 individuals has active TB. Clinical evaluation and testing would be required to fully understand the true burden of communicable respiratory diseases across the PAOI.

Current survey data indicate there is likely a substantial burden of respiratory infections across PAOI households as most reports of cough and/or fever (without diarrhea) are likely to be respiratory related rather than malaria. As discussed in Section 6.4 EHA 3 VBDs, recent malaria surveys in the Gulf Province (PNG IMR 2015; InterOil 2012) indicate the prevalence of malaria is quite low (less than 5%). The percentage of fever/cough reports that potentially represent a TB case is unknown.

The household survey questions are not designed to provide prevalence and/or incidence rate data. A formal TB survey would require a dedicated research effort, which is beyond the parameters of a household baseline health survey. Hence, the next subsection presents the fieldwork related to understanding the TB programs that are relevant for the PAOI.

6.3.2.10 Gulf Province Tuberculosis Control Program – Kerema

The most comprehensive TB diagnostic and treatment management program, fully supported by MSF, is based out of Kerema Health Center.

Médecins Sans Frontières Tuberculosis Program Assistance

At the time of the study team visit, TB services at Kerema Health Center, including the management of drug resistant TB were supported by MSF. The in-house MSF coordinator is Alexander Pinto. At the time of the KII, Mr. Pinto had been working with Kerema for 10 months. The MSF team and the Kerema Health Center team had begun an aggressive program to manage TB issues and to address the following management problems:

- Staffing – CHWs frequently go on strike due to lack of pay, equipment, and support.
- Management – Basic health management units are not functioning adequately nor providing reports.
- Capacity – Health system has limited capacity to provide mobile and outreach services.
- Supervision – Supervisory systems that are intended to support health facilities and staff appear to be functioning well below desirable levels.
- Logistics – There are logistical constraints in reaching remote villages.

The MSF role is to support and work closely with the National Tuberculosis Program (NDOH). MSF explicitly states that their efforts are not to develop a parallel system but to stay within the objectives of the national strategy (MSF and NDOH 2016). The MSF program has the following intervention objectives:

- Reduce the burden of TB by minimizing TB-related morbidity and mortality in the three basic management units that MSF had initially planned to support.
- Implement a decentralized and replicable model of TB care.
- Demonstrate a model of TB care for remote communities.

MSF's first general objective is focused on the following medical strategy:

- Set-up TB out and inpatient departments.
- Renovate and increase the capacity of TB clinics.
- Support TB lab – microscopy, GeneXpert, and cultures processing.
- Support TB drug supply (temporary back-up solution: procure/supply/manage by MSF).
- Decentralize diagnosis, treatment, and follow up to basic management units with capacity.
- Increase outreach/mobile TB clinics to remote villages.
- Strengthen case detection, diagnosis, and clinical management of TB (implement protocols/guidelines).
- Improve health education (health center and community based).
- Improve TB/HIV integration.
- Ensure logistics support to the medical activities.

The second general objective is focused on human resources:

- Staff with expatriates with TB experience initially.
- Build capacity to support existing NDOH staff.
- Recruit additional human resources to meet the expected increased demand of activities.

In 2014, the first focus of the MSF program was to improve TB care in the health center by separating TB patients from the rest of the patients and improving diagnostic capacity, equipment, and skills.

Mobile clinics were enhanced with TB awareness and outreach services. Despite these efforts, during May to August 2014, the team lost contact with Ihu and Orokolo due to rough seas and lack of transport. No follow up occurred with TB patients; therefore, many defaulted their treatment and drugs expired. This experience indicates the logistical complexities of working in the Gulf Province.

Beginning in October 2015, MSF began supplying the TB treatment drugs and began training basic management units regarding human resource management, educating CHWs, and training lab assistants in proper diagnostics.

MSF made the following additional improvements:

- Constructed an outreach TB structure at Ihu (a government station near Kerema) to be used as a TB clinic. The facility has a laboratory, solar panels for electricity, and a trained laboratory technician, although currently there is no microscope available. Sputum samples are collected and transported to Kerema for analysis. An experimental drone program was initiated to transfer samples to Kerema, but without success.
- Started an epidemiological mapping system to conduct contact tracing and to focus on where treatment needs to be fulfilled. An outreach team has been created, including an HEO, a nurse, logistics support, and a CHW. This team travels to villages requiring TB follow up once per month with supplies, TB drugs, training, support, and education. A mobile clinic travels to Ihu, Orokolo, and surrounding wards (wards 19, 20 and 21), although follow up by river travel is difficult.
- Improved outpatient department activities, including expatriate and local staff recruitment, data cleaning, and record keeping improvement.
- Added CHWs for treatment following established WHO protocols.
- Enhanced the laboratory by implementing GeneXpert and collaborating with the Kerema Health Center laboratory and the Central Public Health Laboratory in Brisbane, Australia.

In March 2016, 18 inpatient beds were opened for TB patients at Kerema. Two wings were added: one for inpatient and one for outpatient care, as shown in Plate 32. MDR-TB patients are segregated from drug sensitive patients. Staff was added, and the drug supply system, supplementing diets of inpatients, and waste management and hygiene were all improved. Security services were added to ensure that all persons entering and exiting the TB facilities wore appropriate personal protective equipment. Overall infection control was significantly improved and an infection control technician was added.

Plate 32. TB Ward at Kerema Health Center



MSF indicated that there are many challenges related to the management of TB in the Gulf Province:

- Accessibility to health services due to geographical constraints (TB investigations/data collection).
- Commitment/common operational strategy/collaboration.
- TB drug storage/supply.

- Health structures (renovation/support plan).
- Human resources (absenteeism/supervision/support/trainings).
- Large number of patients who are lost to follow-up and do not complete treatment.
- Few laboratory capacities for diagnosis of TB.
- Poor recording and reporting of provincial data:
  - Data is not properly recorded in TB registers.
  - Case finding data are incomplete.
  - Outcomes are not properly updated.
  - Site of infection are (i.e., whether extra-pulmonary or pulmonary are not properly recorded.
  - Follow up smear results are not updated (conversion rates difficult to assess).

At the Kerema Health Center level, MSF has interviewed staff and documented the following challenges:

- Common objectives (integration of TB activities with the rest of the health center):
  - Infection control (hygiene).
  - Health workers in TB inpatient department.
- Management absenteeism.
- Lack of standard operating protocols.
- Inadequate training and supervision.
- Drug/reagent shortages.
- TB screening for HIV patients (TB/HIV collaboration).

The MSF discussions confirmed that TB is recognized as the most significant infectious disease issue across the Gulf Province. MSF has recognized that interim emergency management plans were needed and sponsored a June 2016 planning workshop that included an analysis and review of provincial TB data as well as current national and international guidelines and policies on TB. The following key partners were represented:

- Provincial health division.
- Kerema Health Center.
- Kikori District Health.
- Kerema District Health.
- MSF.
- Oil Search Foundation.
- GCS.
- NDOH.
- WHO.

The workshop identified the following major issues and needs:

- Communication and coordination (leadership, governance, link between plans and funding, communication between facilities).
- Training (of health workers).
- Human resources (staff shortages and supervision).

- Infrastructure, logistics, and resources (lack of transportation, facilities, accommodations, equipment, drug supply and storage, vaccination coverage).
- Local issues (low literacy rates, cultural beliefs).

A key output of the workshop is a Gulf Province Emergency TB Plan to guide the provincial response from 2016 through 2018 with the following objectives:

- Increase access.
- Diagnose early.
- Have a patient-centered approach.
- Increase capacity.
- Create effective leadership, coordination, and partnership.

Budgets, roles, and responsibilities have been prepared in the document; however, full funding for this program had not been allocated.

Several factors are probably contributing to the high incidence of TB in the Gulf Province, including delayed presentation, difficulties in managing patient follow-up, infectious burden, high household size, and the interplay between local environmental factors and immunity. The remoteness of some villages precluded early access to medical care and compromised treatment and follow up. The late presentation of cases and inefficient treatment access and delivery may contribute to prolonged transmission risk and very high infectious burdens of TB. All these TB transmission drivers are present in the PAOI.

The Cross et al. (2014) Kikori study highlights that overcrowding, spitting as a cultural phenomenon (high use of betel nut), and the heavy TB burden in most cases, could translate to a high infectious load, resulting in a cycle of infection, repeated exposure, onset of clinical disease, and further disease transmission. Drivers of clinical disease in Kikori might include malnutrition, exposure to household smoke, and excessive alcohol usage. Multiple cases of MDR-TB (8%) were also documented (Cross et al. 2014). Again, some of these factors are present across the PAOI, such as substantial betel nut use, indoor exposure to wood fuels as a cooking source, and alcohol consumption (if excessive).

6.3.3 Analysis

The burden of non-TB respiratory diseases across the PAOI is significant, and there is a general consistency across all reported data sources. The transmission of highly communicable respiratory diseases, such as measles and chicken pox, is a potentially critical issue during the construction period when dedicated worker camps are developed. Many forms of pneumonia are vaccine preventable; an outreach vaccination program could potentially lower the underlying morbidity and mortality burden. Any outreach vaccination effort should be aligned and coordinated with existing national and provincial programs and guidelines. Children under age 5, adults older than age 65, and individuals with pre-existing medical conditions, such as HIV, are considered more susceptible to non-TB respiratory diseases.

The TB situation across the Gulf Province is critical. All current data indicate that the underlying burden of TB is at epidemic levels. Individuals with an underlying compromised immune system are significantly more susceptible to TB infection (for example, co-infection with HIV). Based on the Cross et al. study (2014) and consistent with the Aia et al. (2016) study, HIV co-infection rates are

low in rural Papua New Guinea. As previously described, other risk factors, such as high housing occupancy rates, appear to be more important drivers of the Gulf Province TB epidemic.

While the Gulf province is recognized as a TB hotspot, the focus of international multilateral funding is on the Western Province and National Capital District. Relative to the Western Province and National Capital District, there appears to be substantially less multilateral and NGO efforts directed towards the Gulf Province with the notable exception of MSF and the Oil Search Foundation. MSF and the Oil Search Foundation are clearly the most important external organizations supporting TB programs in the Gulf Province.

From a TEP PNG perspective, the experience with other petroleum projects in Papua New Guinea is illustrative. PNG LNG recognized that TB management was a critical project priority issue. Detailed and comprehensive management plans were developed and executed for all workplaces at all locations. The PNG LNG Project commissioned TB incidence and prevalence studies for key upstream and downstream communities (i.e., Hides and Hiri) (PNG IMR 2015). In addition, PNG IMR worked with local community health facilities to improve diagnostic and treatment practices.

In general, multi-disciplinary strategies (e.g., the MSF program) are required to interrupt transmission and treat active TB. Theron et al. (2015) has presented both a top-down and bottom-up set of recommendations/strategies that would be applicable to the situation faced by TEP PNG. Overall, Theron et al.'s recommendations largely mirror the MSF program developed and implemented for Kerema General Hospital. The MSF program would potentially be transferable to Kapuna Health Center, which is the most important health care facility for the PAOI. The MSF TB intervention is fully endorsed by both national and provincial health authorities and is already making significant progress.

Overall, TEP PNG should consider communicable respiratory diseases as one of the highest priority health issues both for the workplace and local communities within the PAOI.

6.4 Environmental Health Area 3 – Vector-Borne Diseases

VBDs relevant to the PAOI setting include malaria, filariasis, the flaviviruses (e.g., dengue, Japanese encephalitis, Zika, and chikungunya) and less common alphaviruses like Ross River. In addition, Burkitt lymphoma (BL), an important adolescent malignancy caused by Epstein-Barr virus, is strongly associated with areas of malaria transmission (Moorman and Bailey 2016; Lavu et al. 2005). BL is well documented in Papua New Guinea, particularly in the Gulf Province.

6.4.1 Overview

In Papua New Guinea, malaria has been the dominant VBD and has been studied for decades, primarily by PNG IMR in partnership with other international institutions (PNG IMR 2015). There are a substantial number of PNG IMR longitudinal studies that have documented the significant drop in malaria prevalence rates across Papua New Guinea (Hetzel et al. 2015; PNG IMR 2015; Maraga et al. 2011). While there has been unambiguous and substantial improvement in the malaria prevalence across the Gulf Province, there is still an underlying burden of malaria across the PAOI. The objective level of non-malaria VBD is substantially less well characterized across the PAOI.

6.4.2 Sources of Information

This subsection discusses the sources of information used for EHA 3.

6.4.2.1 Peer-Reviewed Published Literature

Peer-reviewed literature for EHA 3 focused on malaria and lymphatic filariasis (LF).

Malaria

The most important peer-reviewed paper discussing the general epidemiology of malaria in Papua New Guinea is by Muller et al. (2003). This paper is cited by the NDOH National Malaria Strategic Plan 2014-2018 (NDOH 2014) as a key publication for understanding the diversity and complexity of malaria across Papua New Guinea. Muller et al. (2003) does not specifically describe the burden of malaria in the Gulf Province. However, the Gulf Province malaria prevalence rate is described in a 2015 paper by Hetzel et al. The 2015 Hetzel et al. paper examined the prevalence of malaria across Papua New Guinea after a 2004-2009 long-lasting insecticidal net (LLIN) distribution effort sponsored by the Global Fund. The LLIN distribution effort is described in Hetzel et al. 2014a. A 2011 paper by Maraga et al. (2011) looked at the Southern Highlands Province and a few areas in the Kikori LLG (Kaiam, Kopi, and Ero). Actual field studies were conducted in 2003-2004. Malaria prevalence rates were variable, ranging from 18.1% in Kaiam to 5.3% in Ero. These sample locations pre-date the massive LLIN bed net distribution effort in the Gulf Province and are geographically distant from the PAOI.

In the Hetzel et al. (2015) paper, the age-standardized Gulf Province parasite prevalence rate was 1.3%. The parasite rate is the number of persons with parasitemia per 100 individuals of similar ages. In areas of intense malaria transmission, parasitemia rates for children under age 5 are typically greater than 60 to 70%. The low parasitemia rate in the most susceptible age group indicates that general malaria population prevalence rates are likely to be quite low. As will be described in the subsequent subsections (NDOH and private company data), this prediction has been confirmed by general malaria prevalence surveys conducted in the Gulf Province.

As described by Hetzel et al. (2015), the large-scale distribution of LLIN resulted in prevalence rates comparable to the levels achieved during the 1970s with indoor residual spraying of dichlorodiphenyltrichloroethane (DDT) insecticide. The bed net utilization rates for the Southern Region (which includes the Gulf Province) were almost 95% (Hetzel et al. 2015).

A connection between BL and malaria endemicity is well established (Moormann and Bailey 2016). In the high malaria transmission belt in sub-Saharan Africa, the incidence of BL is 10 times higher compared to BL diagnosed in non-malarious regions in the world (Moormann and Bailey 2016; Maziarz et al. 2017). The mechanisms by which malaria contributes to BL development are uncertain (Moormann and Bailey 2016; Maziarz et al. 2017). The connection between malaria and BL has been documented in the Gulf Province. Lavu et al. (2005) published a large Papua New Guinea case study (1998–2003), which indicated significant differences in BL incidence rate across Papua New Guinea. The Gulf Province BL rate (13.4 per 100,000) was almost nine times higher than the overall national incidence rate of 1.7 per 100,000. Due to the small number of cases of BL (36), results of this study should be cautiously interpreted.

Lymphatic Filariasis

LF occurs when filarial parasites are transmitted to humans through mosquitoes. Infection is usually acquired in childhood causing hidden damage to the lymphatic system (WHO 2017c). The distribution of LF in Papua New Guinea tends to be extremely “patchy” (Graves et al. 2013). Literature reviews of filariasis surveys across Papua New Guinea indicate that Kerema and Kikori districts are impacted. Kerema is considered to have high endemicity (greater than 5%) while Kikori is classified as low (less than 5%) (Graves et al. 2013). National and international programs to address the LF burden in Papua New Guinea are discussed in subsequent sections.

6.4.2.2 National Department of Health Data

NDOH data reviewed for EHA 3 focused on malaria and LF.

Malaria

The NDOH National Malaria Strategic Plan 2014–2018 (2014) only reports data at the national and regional level. Within NDOH, the Gulf Province is part of the Southern Region, which includes Milne Bay, Central, National Capital District, Western Province, and Oro. Hence, these regional data may not be relevant for considering disease burdens at either district or local levels.

NDOH data from 2000 to 2012 suggest that the number of malaria cases (outpatients and inpatients) and deaths have declined dramatically since 2007 (NDOH 2014). As noted by NDOH, "While these trends may represent a real reduction in malaria burden (as a result of malaria control interventions, improving socio-economic status, vector habitat destruction, etc.) they could also reflect a change in NHIS [National HIS] data collection processes, or changes in the reporting rate of health facilities (or a combination/all of the above). They therefore require careful interpretation" (NDOH 2014, 24).

Provincial level NDOH malaria data are described in the 2015 SPAR report and in a NDOH-sponsored national malaria survey published by PNG IMR in 2014 (Hetzel et al. 2014b). SPAR identifies the following KPIs for malaria:

- Incidence of malaria per 1,000 population.
- Proportion (%) of children under age 5 with fever who are treated with appropriate anti-malarial drugs.
- Proportion (%) of children under age 5 sleeping under a treated bed net.

SPAR data for the Gulf Province are only shown for the malaria incidence per 1,000. The SPAR rate includes both laboratory confirmed cases and unconfirmed cases that were not tested but treated as malaria. As previously described, including unconfirmed cases will significantly increase the incidence per 1,000 (D'Acremont et al. 2010). Table 52 summarizes the SPAR malaria incidence data for the Gulf Province versus the national levels over the same period (2011–2015). The Kerema and Kikori districts data for 2015 are also in the 2015 SPAR report and shown in Table 52.

Table 52. 2015 SPAR Malaria Incidence Data* – Gulf Province Versus National

Location	2011	2012	2013	2014	2015
Overall Gulf Province	274	275	227	124	118
Kerema District	N/S	N/S	N/S	N/S	146
Kikori District	N/S	N/S	N/S	N/S	39
National	205	171	151	109	102

Source: NDOH 2015

*Rate per 1,000 confirmed and unconfirmed

N/S = not shown

As illustrated in Table 52, there is marked decline in the overall malaria incidence per 1,000 from 2011 to 2015. The Kerema and Kikori districts data are not available over the same period. There is a marked difference between the Kerema and Kikori districts incidence rates; however, the SPAR report does not provide additional explanation or commentary. Whether there is a true four-fold difference in malaria rates between the Kerema and Kikori districts is uncertain.

The largest and most important malaria survey that included the Gulf Province was performed by PNG IMR (Hetzel et al 2014b). The PNG IMR survey was part of the National Malaria Control Program

(2009–2014) and was a required part of the Global Fund grant to Papua New Guinea. Both bed net use and parasite incidence were assessed. As previously described, the bed net data were published in the peer-reviewed literature (Hetzel et al. 2015). This study had the following primary impact indicators:

- Parasite prevalence: Percentage of children aged 6–59 months with malaria infection.
- Annual parasite incidence: Number of malaria cases detected per 1,000 population per year.
- All-cause mortality rate among children under age 5.

These impact indicators are not fully reported at a provincial level—only the malaria parasite prevalence for children aged 6–59 months, year 2014. Based on a sample of 504 Gulf Province children, the overall parasite prevalence rate was 0.02%. All positives were for *P. falciparum (Pf)*. There were no *P. vivax (Pv*) or mixed infections (*Pf + Pv*) documented. The Gulf Province results are lower than the overall combined national results for children aged 5–59 months (3.0%) and consistent with the Southern Region rate of 0.1% for the same age group.

As reported by Hetzel et al. (2014b, 11-12):

> In survey villages below 1600 m altitude, 1.8% (95% CI 1.2, 2.8) of the general population [all ages] was infected with malaria parasites. Prevalence of *P. falciparum* amounted to 1.6% (95% CI 1.0, 2.5) and *P. vivax* to 0.5% (95% CI 0.3, 0.8). No infections with *P. malariae* or *P. ovale* were found. Mixed infections of *P. falciparum* and *P. vivax* were rare (17 cases; 0.2%, 95% CI 0.1, 0.5). In the target group of children 0.5-5 years of age in these villages, prevalence was 3.0% (95% CI 1.7, 5.2) with any species, 2.0% (95% CI 0.9, 4.2) with *P. falciparum* and 1.7% (95% CI 0.8, 3.5) with *P. vivax*. Mixed infections with *P. falciparum* and *P. vivax* were found in 9 children (0.8%, 95% CI 0.3, 2.1).

The Gulf Province data clearly indicate that malaria, while present, is at a low level. The PNG IMR (Hetzel et al. 2014b) findings are consistent with the data obtained by InterOil during their 2012 health survey of PRL-15 villages.

Lymphatic Filariasis

NDOH has a plan for addressing the observed burden of LF in Papua New Guinea (NDOH 2010b). The NDOH strategy is mass drug administration (MDA) through the international Elimination of Lymphatic Filariasis program (WHO 2011b). As previously described by Graves et al. (2013) while there have been repeated rounds of MDA, the results have been mixed—LF is still present but highly concentrated in small geographical areas. The Gulf Province has not had MDA since 2007/2008.

6.4.2.3 Private Company-Sponsored Data

In 2012, InterOil performed a baseline health survey for eight PRL-15 villages (see Section 6.3 EHA 2 Communicable Respiratory Diseases for village listing). As part of the InterOil survey, 366 people (age breakdown not provided) were tested for malaria using a rapid diagnostic test. Three people (less than 1%) tested positive for *P. falciparum*. *P. vivax* and mixed infections were not detected. According to the study authors, "the low prevalence of malaria was unexpected' (InterOil 2012, 35); hence a follow-up study (n=175) was conducted using both rapid testing and slide microscopy. A single-slide confirmed case was documented. As noted in the 2012 report, "Both studies, then, were consistent in the finding of a low prevalence of malaria disease in the surveyed population" (InterOil 2012, 35). The InterOil malaria results are consistent with the PMG IMR survey (Hetzel et al. 2014b) and confirm that the underlying objectively confirmed prevalence of malaria parasitemia is low.

The InterOil 2012 baseline study also conducted filariasis testing using a portable BinaxNOW® rapid diagnostic kit. There were 365 people tested for LF, of which 15 (4%) tested positive. The InterOil study confirms that LF is present, at relatively low levels, within the PAOI.

Overall, the peer-reviewed literature, NDOH, and private company studies confirm that VBDs are present, but at low levels, across the PAOI. The next section presents the results of community and household field studies sponsored by TEP PNG.

6.4.2.4 Community Surveys

Community FGDs and KIIs identified that malaria is considered one of the most significant issues impacting communities and households across the PAOIs. Section 6.2 EHA 1 Health Systems summarized these findings with malaria listed along with other locally perceived health problems, including TB, diarrhea, and skin diseases. However, as described in Section 6.3 EHA 2 Communicable Respiratory Diseases and in this VBD section, community members often consider fever symptoms to be malaria rather than related to a more likely diagnosis of communicable respiratory illness.

6.4.2.5 Household Surveys

The household health questions focused on fever and bed nets. Fever is typically the most presenting symptom for malaria; however, as described in Section 6.3 EHA 2 Communicable Respiratory Diseases, all clinical fevers are not necessarily laboratory confirmed malaria. The fever data were presented in EHA 2 and will not be repeated. The bed net utilization data are shown in Table 53 and Table 54.

As illustrated by Table 53, virtually 100% of households have bed nets. Fifty percent of households have three to six bed nets. Given an average household size of 6.7, the data indicate that not everyone in a given household is consistently sleeping under a bed net. This is not surprising as some adults find bed nets hot and uncomfortable. Household bed net utilization is shown in Table 54.

If households are accurately reporting their use, Table 55 indicates that bed net use is potentially high. Who uses a bed net is different than how often someone uses a bed net. The NDOH target bed net utilization goal is 80% (NDOH 2015) for children under age 5. Table 55 and Table 56 present the data for how often nets are used and by whom.

Table 53. How Many Mosquito Nets Does This Household Have?

Number of Nets	Number of Households	Percentage of Households
0	3	1
1	4	1
2	38	11
3	46	13
4	51	14
5	54	15
6	31	9
7	22	6
8	17	5
9	14	4

Table 54. How Many Mosquito Nets Does This Household Have?

Number of Nets	Number of Households	Percentage of Households
10	28	8
11	5	1
12	10	3
13	5	1
14	6	2
15	10	3
16	2	1
18	1	<1
20	6	2
No response	1	<1

n=354. Source: ERIAS Group 2016b

Table 55. Who in Your Household Uses the Net?

Who Uses the Net?	Number of Households	Percentage of Households
Everybody	292	82
Female only	2	1
Male only	1	<1
Mother+children only	30	8
Children only	0	0
Pregnant/mother only	0	0
Father+mother only	0	0
Other (specify)	13	4
No one	14	4
No response	2	1

n=354. Source: ERIAS Group 2016b

Table 56. How Often Does the Household Use the Net?

How Often?	Number of Households	Percentage of Households
Every night	224	63
Some nights only	33	9
Every night except hot	16	5
Seasonal	69	19
Never used	6	2
Other (specify)	4	1
No response	2	1

n=354. Source: ERIAS Group 2016b

Table 57. Who Slept Under a Net Last Night?

Who Slept Under a Net	Number of Households	Percentage of Households
Everybody	235	66
Female only	7	2
Male only	3	1
Mother+children only	32	9
Children only	2	1
Pregnant/mother only	5	1
Father+mother only	1	<1
Other (specify)	15	4
No one	46	13
No response	8	2

n=354. Source: ERIAS Group 2016b

Based on the household survey data, it is likely that households in the PAOI are meeting the NDOH 80% bed net utilization target for young children. Finally, the survey asked whether the bed net had been treated and when. Treated bed nets are significantly more effective than non-treated nets in preventing malaria transmission. Treatment, under normal usage can last 1 to 5 years, often longer than the bed net physically lasts. Table 57 presents the bed net treatment data results.

Table 58. When Was the Bed Net(s) Soaked or Dipped?

Date	Number of Households	Percentage of Responses	Percentage of Households
2013	1	7	<1
2015	2	14	1
2016	11	79	3

n=354. Source: ERIAS Group 2016b

The household survey data confirm the findings by Hetzel et al. (2015) that bed net utilization is high. It is not surprising that confirmed malaria prevalence across the PAOI is low. At the FGD and KII level, the conflation of "fever" with malaria is not surprising given the massive education and communication efforts that have been part of the bed net distribution effort.

6.4.3 Analysis

VBD data are available across the PAOIs but focused on malaria and LF. Viral VBDs are uncharacterized and the underlying potential burden of disease is unknown. LF is present, in both Kerema and Kikori districts. The overall prevalence of laboratory confirmed malaria is low. Clinical malaria cases should be scrutinized and not used as a basis for public health planning. Overall the presence of malaria is real, but low and declining. The bed net distribution and utilization program has clearly been a success. The association between BL and malaria is scientifically interesting and important. The incidence of BL in the Gulf Province appeared to be elevated relative to the national rate; however, this observation has not been confirmed by other studies.

LF is present, but likely at low endemicity levels across the PAOI; however, LF distribution tends to be focal. Across the Gulf Province, there is no documentation that shows MDA efforts have occurred since 2007/2008. Hence, it is not surprising the LF is still present.

Children between the ages of 5–59 months and pregnant women are the most susceptible for malaria. Individuals with a compromised immune system (e.g., HIV positive) are also susceptible to VBD.

For TEP PNG, VBDs are present across the PAOI and are potentially an important project worker issue; however, the underlying prevalence of malaria is clearly declining. Nevertheless, the PAOI is still at risk for outbreaks of VBDs, such as malaria, dengue, Zika, and chikungunya. It is essential that households continue to receive and use LLIN. In conjunction with local health authorities, support for LF MDA is an obvious high-impact intervention.

6.5 Environmental Health Area 4 – Sexually Transmitted Infections

STIs are a critical issue for large infrastructure projects that have significant and geographically widespread construction phases. There is significant concern and focus on HIV transmission resulting from project-related induced in-migration, large-scale movement of workers across previously remote areas, and sudden increases in disposable incomes that can increase drug use (alcohol and marijuana) and transactional sexual activity.

6.5.1 Overview

Papua New Guinea has among the highest prevalence of HIV, syphilis, and other STIs in the Asia-Pacific region (Vallely et al. 2016; Vallely et al. 2010). The HIV epidemic is primarily linked to heterosexual transmission, with over half of reported HIV diagnoses coming from three of its 22 provinces (Vallely et al. 2016; Vallely et al. 2010). Adult HIV prevalence is currently estimated at 0.9%; however, prevalence of 12–17% has been reported among women and men who sell and/or exchange sex, and antenatal HIV prevalence around 2% has been reported from several Highland provinces. Papua New Guinea is among 12 high-burden countries selected by the WHO for intensified support to eliminate mother to child syphilis transmission. Papua New Guinea also has one of the highest estimated burdens of cervical cancer globally, with an age-standardized incidence of 23.7 per 100,000, compared to 5.0 per 100,000 in Australia. Cervical cancer is considered an STI caused by specific strains of the human papillomavirus (HPV) (Center for Disease Control [CDC] 2017).

STIs are associated with significant adverse reproductive health outcomes, particularly among women. A woman's anatomy can place her at higher risk because the lining of the vagina is thinner and more delicate than the skin on a penis, so it's easier for bacteria and viruses to penetrate. The vagina is a good environment for bacteria to grow. Women are less likely to have symptoms of common STIs compared to men. Women are more likely to confuse symptoms of an STI for something else. Genital ulcers can occur in the vagina and may not be easily visible, while men may be more likely to notice sores on their penis. Social and economic dependency may limit a woman's ability to refuse unsafe sex or negotiate safer sex. Women striving to survive economically are also drawn into the sex industry. STIs in women tend to go untreated because they are often asymptomatic. In pregnant women with untreated early syphilis, 25% of pregnancies result in stillbirth and 14% in neonatal death (Vallely et al. 2016; Vallely et al. 2010). Up to 35% of pregnancies among women with untreated gonococcal infection are estimated to result in spontaneous abortion and premature deliveries, and up to 10% in perinatal death (Vallely et al. 2016; Vallely et al. 2010). In the absence of prophylaxis, 30–50% of infants born to mothers with untreated gonorrhea and up to 30% of infants born to mothers with untreated chlamydia will develop *ophthalmia neonatorum*, which can lead to blindness if not diagnosed and treated promptly.

Untreated chlamydia or gonorrhea can result in chronic salpingitis, leading to infertility or ectopic pregnancy. Infection with certain high-risk sub-types of HPV is associated with cervical epithelia dysplasia and cancer of the cervix, particularly types 16 and 18, while HPV-6 and HPV-11 cause genital warts. In addition to their direct effects on reproductive health, many STIs have been shown to biologically enhance the transmission and acquisition of HIV, so that their effective management may play an important role in HIV prevention, particularly in resource-limited settings (Vallely et al. 2016; Vallely et al. 2010). Herpes simplex virus (HSV)-2 is the virus that causes genital herpes. HSV-1 causes cold sores or fever blisters, primarily around the mouth.

6.5.2 Sources of information

This subsection discusses the sources of information used for EHA 4.

6.5.2.1 Peer-Reviewed Published Literature

There are no peer-reviewed published STI studies of the Gulf Province; however, there are a variety of peer-reviewed STI studies that consider the national level STI situation in Papua New Guinea (Vallely et al. 2016; Vallely et al. 2010).

High prevalence rates of HIV, STIs, and genital infections have been reported among men and women in Papua New Guinea compared to other countries in the Asia-Pacific region. A recent systematic review and meta-analysis of HIV/STI prevalence in community and clinic-based settings in Papua New Guinea has been published (Vallely et al. 2016; Vallely et al. 2010; PNG IMR 2015) (see Table 58). There were no HPV or HSV-2 data available for Papua New Guinea until the 2013/2014 PNG LNG Project-sponsored study performed by PNG IMR (Dr. Andrew Vallely, Lead Investigator) (PNG IMR 2015).

Table 59. Summary of Published Data on Antenatal HIV/STI Prevalence Among Pregnant Women in Papua New Guinea[1]

Study Population	206 Pregnant Women Attending First Antenatal Clinic Visit at Port Moresby General Hospital	155 Women Presenting in Labor to Goroka Base Hospital[2]	581 Women Presenting in Labor to Goroka Base Hospital[3]
Bacterial vaginosis	23.3 (17.7, 29.7)	-	-
C. trachomatis	17.7 (12.4, 24.0)	36.8 (29.2, 44.9)	34.1 (30.2, 38.1)
N. gonorrhoeae	-	-	-
Syphilis	-	-	-
T. vaginalis	18.9 (13.8, 25.0)	-	-
HIV	-	-	-
HSV-2	-	-	-

Source: Vallely et al. 2010

[1]Data shown as percentage with 95% confidence intervals

[2]1997 study by Mgone et al

[3]1999 study by Suarkia et al

The reasons for the differences in the epidemiology of HIV and STIs in Papua New Guinea compared to other countries in the Asia-Pacific region are unclear, but are likely to be the result of locally specific interactions between the behavioral determinants, socio-cultural dimensions, and structural contexts that frame sexual agency, sexuality, and sexual health (Vallely et al. 2016). These include

gender power disparities, sexual violence, and the societal roles of men and women; low levels of male and female condom use and male circumcision; limited access to STI treatment services due to poor transportation and health systems infrastructure; and limited success in the design and implementation of culturally-relevant behavior change interventions among both general population and at-risk groups, such as truck drivers and male and female sex workers and their clients.

6.5.2.2 Human Papillomavirus and Cervical Cancer in Papua New Guinea

Papua New Guinea has one of the highest rates of cervical cancer in the world, with an estimated age-standardized incidence of 23.7 per 100,000 compared to 5.0 per 100,000 in Australia and New Zealand (Vallely et al. 2016; Vallely et al. 2010). Cervical cancer is the most common cancer and a leading cause of premature death among women in Papua New Guinea. An estimated 1,500 women die every year in Papua New Guinea due to cervical cancer. The PNG IMR has now published initial findings regarding HPV prevalence in Papua New Guinea (Vallely et al. 2016). The PNG LNG Project sponsored the first systematic study of HPV and HSV prevalence in Papua New Guinea (PNG IMR 2015). Levels of HPV and HSV were 43% and 28%, respectively, in a study of 765 pregnant women across three sentinel surveillance sites (Hiri, Hides, and Asaro) (PNG IMR 2015).

6.5.2.3 National Department of Health Data

The appropriate testing capacity, skills, equipment, and supplies for accurately diagnosing STIs at aid posts (that are staffed) in the Project area are, for the most part, unavailable. The diagnosis and treatment of STIs is determined purely on symptoms presented by the patient. STI diagnoses are kept sensitive and are subject to medical confidentiality rules.

There are a few STI prevention educational activities provided through the Kapuna Health Center at their facility, when they conduct patrols, and at some of the area aid posts (Akoma and Mapaio) as time is available. The only voluntary counseling testing center in the Project area is at Kapuna Health Center.

Periodic syphilis and HIV sero-surveys are conducted by the NDOH to support routine antenatal surveillance. In 2009, estimated antenatal syphilis prevalence was 6.9% and HIV prevalence 0.7% in urban areas (N=4,623), and 4.2% and 0.5%, respectively, in rural areas (N=3,180) (Vallely et al. 2010). The Joint UN Program on HIV/AIDS (UNAIDS) 2015 national prevalence rate is reported as 0.8% (0.7%–0.9%) for adults aged 15–49 (UNAIDS 2017). The 2015 SPAR data do not divide HIV antenatal prevalences by province. The 2015 SPAR data only report antenatal clinic data from Port Moresby General Hospital, as NDOH believes "…these data are the most important for the HIV estimates and projection exercise because of its long consistencies in keeping good records" (NDOH 2015, 5). Prior to the 2013/2014 PNG IMR study, there were no prevalence estimates of HSV-2 or HPV (Vallely et al. 2016; PNG IMR 2015).

The diagnosis of STIs in Papua New Guinea aid posts is uncommon. STIs as a diagnosis rarely are greater than 1–2% of the total aid post caseload. Outpatient data from Kapuna and Kerema health centers consistently show small percentages of STIs (less than 2% of total visits). This is not surprising due to the cultural stigma associated with an STI diagnosis. While overall STI data across the PAOI are sparse, there are consistent data for HIV from antenatal and outpatient clinics for both Kapuna (2015 0.4% rate) and Kerema health centers (less than 0.5%). These health center data are consistent with national HIV data for rural locations (less than 1% prevalence rate). Data regarding the level of individuals on HIV drug treatment for HIV are available for Kerema and indicate three individuals in 2016 on treatment and 20 for 2015.

6.5.2.4 Private Company-Sponsored Sexually Transmitted Infection Data, Including Behavior Studies of the Workforce

In a behavioral surveillance survey conducted with 463 Oil Search Foundation workers, links were made in qualitative interviews between drinking alcohol and decreased inhibitions, increased sexual desires, increased sexual activities, and rape (National Research Institute 2011). Drunkenness was also associated with violence, threats, physical abuse, disturbance, and destruction of property. Almost a third (32.4%) reported not having used a condom at last sex. Of those who had not used a condom at last sex, the reasons given included trusting their partner (34.6%), that condoms were not available (15.4%), that condoms reduce pleasure (13.5%), that they were drunk, (11.5%), that they were not comfortable (7.7%), that they did not think of it (5.8%), that they simply did not like condoms (3.8%), or that their partner objected (3.8%). When asked how often they had used a condom with a non-regular partner during the last 3 months, nearly a half (48.6 %) reported that they always use a condom. Close to a quarter (23.7%) of the Oil Search Foundation workforce surveyed who had had sex in the last year, reported having paid for sex with either cash or other goods (National Research Institute 2011). The Oil Search Foundation data include workers from the Gulf Province—4.1% of the study cohort.

As part of the 2012 InterOil study, 283 people aged 15–49 years were offered HIV testing using the OraQuick HIV-1/2 saliva test. Of these, 4 people refused and 1 was defective and not readable. Of the actual tests that were performed and readable (n=278), 1 (0.4%) tested positive. The low (0.4%) positive percentage is consistent with the health center data previously described.

6.5.2.5 Project Baseline Reports

The Upstream Community and Demographics Baseline Report (Finlayson 2016a) contains village survey information regarding drug use (alcohol and marijuana) and prostitution:

- Male alcohol consumption is common across the PAOI. Alcohol consumption is substantially lower for females.
- Some home brew is made and consumed locally, while other alcohol is brought in from Port Moresby or other urban areas. There are no bottle shops in the PAOI.
- Alcohol abuse is regarded as a law-and-order problem in the PAOI, particularly as it is associated with various criminal activities, including fighting, domestic violence, and obscene or abusive language.
- Most villages in the PAOI contain some males who smoke marijuana. Village leaders and the women interviewed indicated that the use of marijuana is common and widespread, particularly among young males. Relatively few females smoke marijuana in the PAOI.
- The women's groups indicated that men were involved in prostitution in 40% of villages in the PAOI, while women were involved in prostitution in 33% of villages. Again, it was difficult to identify any patterns grouping these villages together as often a women's group would acknowledge prostitution occurring, only for it to be vehemently denied in the neighboring village.

6.5.2.6 Community Surveys

Community groups were asked about their knowledge of the prevalence of and understanding of STIs, including how they are transmitted and how they are treated. Responses per group are shown in the Table 59 and Table 60.

Table 60. Beliefs About Prevalence of STIs (%)

Prevalence STIs	Village Leaders	Women's Groups	Youth Groups
None	63	52	24
1-2 cases only	3	16	7
Several cases	7	0	7
Many cases	3	0	0
Not sure	23	32	62

n=35. Source: ERIAS Group 2016a

Table 61. Responses About Understanding Transmission of STIs (%)

Understand Transmission STIs	Village Leaders	Women's Groups	Youth Groups
Everyone knows	33	16	14
Most know	13	10	10
Some know	10	26	3
Few know	23	29	41
Not sure	20	19	31

n=35. Source: ERIAS Group 2016a

Based on FGDs, the communities do not see STIs as a significant issue; however, these local beliefs should be cautiously interpreted, as the medical/scientific knowledge base of respondents is likely quite low.

6.5.3 Analysis

Data for non-HIV STIs are minimal and likely under reported across all PAOI health facilities. Nevertheless, reported HIV data indicate that underlying prevalence rates are undoubtedly low and consistent with a remote rural location (i.e., less than 1% for adults ages 15–49). Physiologically, women are more susceptible to HIV transmission as they have a much larger transmission surface area than men (vagina versus urethral membrane). According to UNAIDS, gender-based violence is a significant risk factor for HIV transmission, particularly for young women. Women who have experienced violence, typically from an intimate partner, are more than three times more likely to become HIV infected (UNAIDS 2010). The importance of a gendered analysis of HIV prevention, care and treatment in Papua New Guinea is critical (Redman-MacLaren et al. 2013).

Increases in STIs related to potential project-induced in-migration and increased cash incomes of workers and households are future concerns, and are typically raised in association with large infrastructure projects. Despite intense pre-project concern, the PNG LNG Project did not find that significant changes in STIs occurred at the community level. Longitudinal monitoring from 2007-2016 demonstrated stability in STI morbidity across all surveillance locations (Kumar et al. 2017). Whether this experience would be transferrable to the PAOI is unknown; however, concerns regarding Project-related impacts to the underlying STI burden (and particularly HIV) will be inevitably voiced, with potential collateral company reputational risk.

6.6 Environmental Health Area 5 – Water- and Sanitation-Related Diseases

This EHA considers diseases and conditions that are related to quantity and quality of water used by households, such as diarrheal diseases. Access to water is an important consideration. Personal hygiene, such as hand washing behaviors and access and use of soap, are also considered. General community sanitation is evaluated, particularly related to contact with non-hazardous wastes and soils.

6.6.1 Overview

In Papua New Guinea, only approximately 40% of people have access to a safe water supply and adequate sanitation (WHO 2011b; Prüss-Üstün et al. 2008), one of the lowest rates in the world. Related risk factors are also an important source of sudden disease outbreaks: interaction with fecally-contaminated environmental sources, such as local drinking supply; swimming and washing in rivers; and the ingestion of fecal-contaminated fresh produce.

Diseases related to unsafe water, poor sanitation, and lack of hygiene are some of the most common causes of infectious disease epidemics, like cholera. It is estimated that improved WASH could prevent at least 9.1% of the global disease burden (WHO 2011b; Prüss-Üstün et al. 2008).

Approximately 80% of the PNG population is without access to improved sanitation (WHO 2013); however, one other creditable source suggests better access, estimating that "only" 55% of the population lack access to sanitation (UNICEF 2016). This discrepancy does not mask the fact that access to WASH remains poor, and that there has been little improvement in the past 25 years (WHO 2013).

6.6.2 Sources of Information

This subsection discusses the sources of information used for EHA 5.

6.6.2.1 Peer-Reviewed Published Literature

There are no peer-reviewed published studies regarding WASH in the Gulf Province.

In Papua New Guinea, diarrheal disease is one of the leading causes of morbidity and mortality, accounting for 8% of deaths among children under age 5 (WHO 2013).

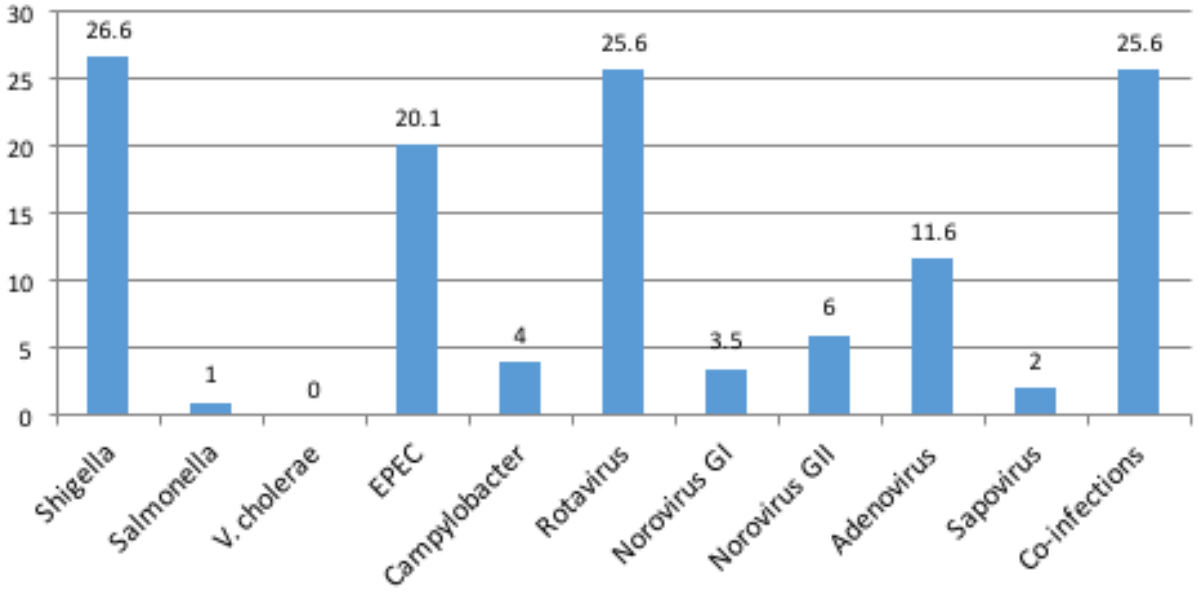
The etiological agent of acute watery diarrhea was investigated for 199 children admitted to Goroka General Hospital (see Figure 9). An enteric pathogen was detected in 67.8% (n=135) of the samples tested. *Shigella* spp. (26.6%), rotavirus (25.6%), enteropathogenic *Escherichia coli* (20.1%), and enteric adenovirus (11.6%) were the pathogens most commonly detected. All other pathogens were detected at varying rates below 10%. Mixed infections were detected in 25.6% diarrheal cases, with rotavirus (n=26) and *Shigella* spp. (n=25) the most commonly detected in co-infections.

Some of these diseases will vary, depending upon animal husbandry practices. If there are pigs close to living areas, there will be more campylobacter; if chickens are close, salmonella and *Shigella* spp.

In Papua New Guinea, the burden of enteric illness is not restricted to children. Outbreaks of cholera and shigellosis in the recent past highlight the risk to the broader population of enteric disease outbreaks (Rosewell et al. 2011; Horwood et al. 2011); and endemic illnesses such as typhoid fever continue to cause illness (Siba et al. 2012). PAOI coastal communities are potentially at risk from a cholera outbreak, particularly considering the community sanitation practices.

The cholera outbreak is of interest because cholera had not been reported in Papua New Guinea prior to 2009. New incursions of cholera often follow natural or human-induced disasters (e.g., Haiti and Zimbabwe) (Cumberland 2009; CDC 2010); however, the cholera epidemic in Papua New Guinea was not preceded by any such disaster. The 2009 cholera outbreak spread along the northern coast of Papua New Guinea and resulted in over 15,500 cases and approximately 500 deaths, with a case fatality rate of 3.2% (Horwood et al. 2011). It has been postulated that lack of sanitation and hygiene in Papua New Guinea was key to its spread throughout the country (Horwood and Greenhill 2012). Changing climate conditions and rainfall variability could be significant future issues and drive water-related disease outbreaks.

Figure 9. Etiology of Pediatric Acute Watery Diarrhea at Goroka General Hospital



Source: PNG IMR 2016

6.6.2.2 National Department of Health Data

Diarrheal disease is an important cause of outpatient morbidity across the PAOI. The following outpatient levels of gastrointestinal/diarrhea morbidity at key PAOI health facilities are listed as a percentage of overall caseload:

- Kapuna Health Center: 5%.
- Kerema Health Center: 6%.
- Orokolo Sub-Health Center: 8%.

The 2010 NDOH gastrointestinal/diarrhea data for the entire Gulf Province was 5%. The 2015 SPAR data use a different metric (incidence of diarrheal disease in children less than 5 years per 1,000 children less than 5 years) and are not directly compatible to the health facility data. The SPAR 2015 incidence rate was 321 cases per 1,000 children. The Gulf Province rate is greater than the national statistic of 300 cases per 1,000 children, and is approximately 30% higher than the 2011 Gulf Province rate.

The inpatient gastrointestinal morbidity data for Kapuna Health Center is 9% and only 1% for Kerema Health Center. The NDOH 2010 overall Gulf province inpatient level was 6%. There is a marked discrepancy between the Kapuna and Kerema health centers data, but the cause for this difference is unknown. At the local aid post level, the gastrointestinal outpatient morbidity is generally

consistent with the Kapuna data. Aid post data are impacted by overall caseload numbers (i.e., the data are shown as percentages of the overall caseload denominator). Hence, aid post data should be cautiously used. The Kapuna Health Center data are considered more representative and robust.

6.6.2.3 Project Baseline Reports

Upstream Community and Demographics Baseline Report (Finlayson 2016a) contains substantial household survey information regarding WATSAN (see Subsection 6.2.7.3 of that report). The following key findings are relevant for health:

- Main source of drinking water is from rainwater catchments (37% of households), tanks (32% of households), rivers and creeks (16% of households), and shallow wells (8% of households); only 3% have piped water.
- Most people in the PAOI identified secondary sources of drinking water as rivers/creeks, wells, and other rainwater catchments.
- Thirty-six percent of the secondary water sources are located more than 10 minutes from the village, and for 21% of villages, the source is more than an hour from the village.
- Eighty-eight percent of villages access their main source of drinking water within a 10-minute walk from the village. The villages that need to walk further include Kairimai (10 to 20 minutes), Ara'ava (10 to 15 minutes), Wabo (30 minutes), and Subu 2 (3 hours).
- Women from 74% of villages indicated that all household members collected water; however, in none of the villages did women have the primary responsibility for water collection. In some villages, including Ere and Kilavi, men are forbidden to collect water due to customary beliefs.
- Seventy-six percent of villages wash in a river or creek. Other than Maipenairu, where people are said to use tank water for washing, the remainder use well water. Those using well water are villages from or near the coast.
- In the Purari delta and along the Orokolo coast, where fresh surface water is uncommon and groundwater is often salty, rainwater tanks are often regarded as providing the highest quality drinking water.
- Thirty-four percent of households indicated that they did not use a toilet, but used the bush, river, or sea.
- The most common types of toilets in the PAOI are traditional pit latrines and improved pit latrines. Toilets built over the river were not common in any village.
- Fifty-nine percent of households in the PAOI who use a toilet use their own toilet. The remaining 41% use a shared toilet. This calculation excludes those households who do not use a toilet.
- Tins and batteries are commonly thrown in the bush, sea, or river in 56% of villages in the PAOI. Tins and batteries are commonly buried in 27% of villages and burned in 6% of villages.
- Most villages dispose of paper and plastic items by burning (50%); throwing in the bush, river, or sea (27%); and burying (15%).

The Upstream Surface Water and Sediment Quality Baseline Report (BMT WBM 2016) includes two important considerations:

- Household level water quality source data, such as tanks and other catchment/storage container sampling, are not currently available.

- All PRL-15 sites had total coliforms above 80 colony-forming units (CFU) per 100 milliliters (mL) (concentrations higher than this could not be detected as samples were not able to be diluted in the laboratory due to quarantine restrictions). It is not known whether actual concentrations were above the guideline value of 200 CFU per 100 mL; therefore, a complete medical assessment of the water quality used by communities cannot be made at this time.

The Upstream Groundwater Baseline Report (SLR 2017b) confirms that coastal communities and inland villages within the export pipeline corridor extensively use shallow groundwater. The groundwater is used both for washing and drinking, depending upon location and time of year (wet versus dry season). According to SLR, "The quality of the water encountered largely met the relevant quality criteria for it intended use (drinking water standards) with respect to chemical properties. However, widespread microbiological contamination is evident" (SLR 2017b, 3).

6.6.2.4 Community Surveys

Community FGDs raised water supply and quality concerns. In addition, during KIIs, health care workers expressed concerns regarding water access and supply for their health care facility.

6.6.2.5 Household Surveys

The household survey addressed water quality issues by asking whether anyone in the household has been ill with diarrhea within the 2 weeks prior to the survey. This is a standard question used in international demographic health surveys, including ones performed in Papua New Guinea. Table 63 and Table 64.

Table 62 shows the diarrhea survey data. In each household, up to five people were asked if they displayed the symptoms. The second part of the table shows how many households had what number of patients. Table 62 provides data regarding potential treatment of diarrhea.

These data indicate that diarrhea complaints, while common, are far less symptomatically prevalent than fever and cough (see Section 6.3 EHA 2 Communicable Respiratory Diseases). The reported household diarrhea percentage is consistent with the health center data (less than 10%).

Hygiene and sanitation were also queried in the household survey. These results are shown in Table 63 and Table 64.

Table 62. How Many People Have Been Ill with Diarrhea in the Last 2 Weeks?

Individuals with Diarrhea*	Number of Responses		Percentage of Responses	
	Yes	No	Yes	No
Person 1	34	320	10	90
Person 2	8	346	2	98
Person 3	0	354	0	100
Person 4	0	354	0	100
Person 5	2	352	1	99
Households Affected**	**Number of Households**		**Percentage of Households**	
Households with 5 patients	0		0	
Households with 4 patients	0		0	
Households with 3 patients	0		0	
Households with 2 patients	7		2	
Households with 1 patient	30		8	

*n=354, **n=37. Source: ERIAS Group 2016b

Table 63. Where Did You Seek Advice or Treatment for the Diarrhea?

Location	Number of Treatments Sought	Percentage of Treatments Sought (% yes cases)
Aid post	14	32
Health center	13	30
Your home	16	36
Other home	1	2

n=44. Source: ERIAS Group 2016b

Table 64. Do People in This Household Usually Wash Hands Before Cooking Food, Eating, After Going to the Toilet?

Wash Hands	Number of Households	Percentage of Households
All	244	69
Some	110	31
None	0	0

n=354. Source: ERIAS Group 2016b

Table 65. Do Most People Use Soap to Wash Their Hands?

Use Soap	Number of Households	Percentage of Households
All	89	25
Some	220	62
None	44	12
No response	1	<1

n=354. Source: ERIAS Group 2016b

The hand washing and soap utilization data are important, as these are critical hygiene behaviors. The results indicate minimal levels of hygiene. To put these data in perspective, a specific hand washing study was completed by PNG IMR (2015) as one of the PiHP household studies. In this study, the proportion of households having both water and soap for hand washing was 92% in the PAOI coastal villages. In this study about 10% of households had no water or soap for hand washing.

Additional hygiene data were obtained by asking about household toilet facilities (see Table 65 and Table 66).

Table 66. What Type of Toilet Facility Does This Household Mainly Use?

Toilet Facility	Number of Households	Percentage of Households
Traditional pit	122	34
Bush (no facility)	113	32
Improved pit	90	25
Closet over sea/river	19	5
Sea/river (no facility)	7	2
Other (specify)	2	1
Bucket system	1	<1

n=354. Source: ERIAS Group 2016b

Table 67. Is the Toilet for Use Only by This Household or Shared with Others?

Toilet Facility Shared or Owned	Number of Households	Percentage of Households
Shared	165	47
Owned	154	44
No toilet or no response	35	10

n=354. Source: ERIAS Group 2016b

Toilet facility data are consistent with the WATSAN data in Finlayson (2016a) and indicate that there are low/modest levels of household sanitation as the improved pit percentage is only 25%. To put these data in perspective, the proportion of households having improved sanitation facilities in the PNG LNG Project Hiri coastal villages (i.e., Laelae, Boera, Papa, and Porebada) was almost 100% (PNG IMR 2015).

As noted in Finlayson (2016a), there is no organized waste disposal system across the PAOI.

6.6.3 Analysis

The population using improved sources of drinking water are those using any of the following types of supply: piped water (into dwelling, compound, yard or plot, public tap/standpipe), tube well/borehole, protected well, protected spring, and rainwater collection. The household survey data across the PAOI indicate that a significant percentage of household use a protected source (i.e., rainwater). There is generally good access to water sources and collection times (a measure of access) are generally quite good. Secondary water sources (see Plate 33) have been characterized in the Upstream Surface Water and Sediment Baseline Report (BMT WBM 2016). Coliform contamination impacts surface water and sediment, which is expected. The use of shallow groundwater by local communities for washing and as a potential drinking water source is described in the Upstream Groundwater Baseline Report (SLR 2017b). The shallow groundwater sources appear to be unprotected and are documented to have significant microbiological contamination (SLR 2017b). Nevertheless, despite the variability of protected (secure) versus unprotected sources, the overall PAOI diarrhea/gastrointestinal morbidity burden is modest.

Hand washing and soap use across the PAOI is suboptimal, with only 25% of survey respondents consistently hand washing with soap.

WATSAN issues are clearly present across the PAOI; however, the documented morbidity burden of diarrhea is relatively low. A difference between the objective clinical burden of disease and the overall suboptimal WASH practices is noted. Water access and available household water volumes can impact disease transmission via hygiene (e.g., hand washing); however, the available field reporting indicates that household level water volumes appear to be adequate.

Those communities with greater than 20–30-minute access to water sources would, from a health perspective, be considered more susceptible to water washed disease problems. Water washed infections are those whose incidence or severity can be reduced by augmenting the availability of water without improving its quality (Bartram and Cairncross 2010). Access to water is a critical driver of overall water volumes available at the household level, which is the crucial factor for water washed-related diseases.

Community members view water supplies and quality as significant issues. Low-income households are more likely to be impacted as they may lack the economic ability to purchase water storage equipment.

There will likely be community requests for improved water supplies. For local health facilities, water supplies and related hygiene concerns are important and are a priority issue.

Plate 33. Secondary Water Source



6.7 Environmental Health Area 6 – Food- and Nutrition-Related Issues Including Food Security

This EHA considers the situation regarding community and household levels of nutrition and food security. Nutrition is strongly tied to a wide variety of health outcomes, including anemia, micronutrient deficiencies, and anthropometric outcomes such as height and weight for age in children and adults.

6.7.1 Overview

Nutrition is at the heart of the public health challenges faced by most developing countries today. Many people and communities in Papua New Guinea still face the threat of under-nutrition (Duke 1999; Gibson et al.1991; Temu et al. 2009). In Papua New Guinea, 80% of its population still lives a traditional lifestyle of subsistence farming, hunting, and fishing. This EHA analysis relies upon the Upstream Land and Natural Resource Use Baseline Report (Booyong Forest Science 2017) and the Upstream Governance and Economics Baseline Report (Finlayson 2016b) for critical data and analysis. A standard method of non-invasively evaluating nutritional status is the use of anthropometry.

According to WHO (1995), anthropometric measurements assess body size and composition and reflect inadequate of excess food intake, insufficient exercise, and disease. Anthropometry is considered the single most universally applicable, inexpensive, and non-invasive method available to assess the size, proportions, and composition of humans (WHO 1995).

Other indirect, but slightly more invasive measures of nutritional status include whether an individual is anemic based on a finger-stick measurement of Hb. Anemia is a condition in which the number of red blood cells (and consequently their oxygen-carrying capacity) is insufficient to meet the body's physiologic needs. Iron deficiency is thought to be the most common cause of anemia globally, but other nutritional deficiencies (including folate, vitamin B12, and vitamin A); acute and chronic inflammation; parasitic infections; and inherited or acquired disorders that affect hemoglobin synthesis, red blood cell production, or red blood cell survival can all cause anemia (WHO 2011d). Hb concentration alone cannot be used to diagnose iron deficiency. Nevertheless, WHO recommends Hb measurement even though not all anemia is caused by iron deficiency (WHO 2011d). WHO has published standard levels to diagnose mild, moderate, and severe anemia for children and adults (WHO 2011d).

6.7.2 Sources of Information

This subsection discusses the sources of information used for EHA 6.

6.7.2.1 Peer-Reviewed Published Literature

Between 1995 and 1997, Ulijaszek (2003) performed an analysis of mean height, weight, and body mass index (BMI)[8] of 292 adults (ages 20–85) located in three villages in the Purari delta: Koravake, Mapaio, and Ara'ava. Mapaio and Ara'ava are villages within the defined PAOI. The three villages had a combined population of 1,160. According to Ulijaszek (2003), the age distribution of the sample was very similar to that of the village based census data.

In terms of BMI categorization, a level below 18.5 is considered underweight, a BMI greater than 25 but less than 30 is overweight, and a BMI greater than 30 is obese. Ulijaszek (2003) had the following summary findings:

- Twenty-three percent of males and 24% of females had a BMI greater than 25.
- One percent of males and 6% of females had a BMI greater than 30.
- Thirteen percent of females had BMI below 18.5 compared with 5% of males.
- Mean stature of younger adults was greater than that of older adults.
- For females, weight was positively associated with income and the number of years of education.
- BMI was positively associated with income and having urban relatives but not with urban dwelling per se.

Overall, Ulijaszek's (2003) analysis demonstrated that while income is strongly associated with weight and BMI for both males and females, and with stature for the males, education was also an important correlate of adult body size. The number of years of education was positively associated with stature and weight for the females.

6.7.2.2 National Department of Health Data

SPAR 2015 data provides an overview of nutritional related indicators for Gulf Province. SPAR Indicator #2 is the "% Children with moderate and severe weight for age malnutrition." This indicator is defined as the percentage of children under 5 years who attend maternal and child health clinics that are moderately (60–80% weight for age) or severely (less than 60% weight for age).

8 BMI is defined as a person's weight in kilograms (kg) divided by his or her height in meters squared.

The 2011 to 2015 SPAR Indicator #2 data are shown in Table 67.

Table 68. Percentage of Children with Moderate and Severe Weight for Age Malnutrition

Location	2011	2012	2013	2014	2015
Gulf Province	28	30	36	33	33
Southern Region	29	29	29	29	27
National	28	26	25	24	23

Source: NDOH 2015

Relative to the other PNG provinces, the Gulf Province has a higher percentage of underweight children under age 5: 33% (Gulf) versus 23% for the national average.

SPAR data also evaluate the percentage of low birth weight babies (the percentage of live births in facilities that weigh less than 2,500 grams). Gulf Province has from 2011 to 2015: 10% (2011) to 7% (2015). The 7% level matches the national level and is within the NDOH target of 9%.

While the overall Gulf Province underperforms versus national averages, indicating a potential nutrition issue, the PAOI health facility data indicates low levels (less than 1%) of either malnutrition or anemia diagnoses. The anemia data should be viewed cautiously as field observations indicated that neither aid posts nor health centers had the correct equipment for routine Hb measurement.

6.7.2.3 Private Company-Sponsored Studies

As previously described in Section 6.3 EHA 2 Communicable Respiratory Diseases, InterOil sponsored a large health survey (n=853) of eight Pawaian villages. Not all villagers participated in all health studies—the total number of participants for a given study (e.g., height/weight measurements) was typically less than 853. Specific overall study numbers are shown per the available data from the original study. The InterOil study (2012) included both anthropometric and finger-stick Hb measurements for children and adults. The following key findings are from the InterOil adult anthropometric study:

- Most women (64%, n=64) and 47% (n=55) of men had normal BMIs.
- Slightly more women (3%) than men (2%) recorded BMI in the less than 18.5 BMI range.
- A greater proportion of men (47%) than women (27%) were overweight.
- For the obese category (BMI greater than 30), there were more women (6%) than men (4%).

These data are consistent with the previously described results by Ulijaszek (2003).

The childhood anthropometric results were unremarkable for weight-for-age and height-for-age. The weight-for-height graph curves with a slight left skew, suggesting the possibility of a group of children (absolute numbers not provided in the original study) who may be suffering from malnutrition.

The InterOil study (2012) provided results for both children under age 5 and women between ages 15-49. For children aged 5 years and under, just over 34% had normal Hb concentrations. For the two-thirds of children with anemia, 5% of the total number of children surveyed had severe anemia. Moderate (60%) and severe (9%) levels of anemia were more prominent in younger children (6 months to 2 years). Again, absolute study numbers were not provided in the report. For women, the majority (71%) had mild anemia, while 8% had severe anemia. According to the study report, “the laboratory findings on hemoglobin concentration indicate a relatively high prevalence of mild to-

moderate anemia in children below the age of 5 and, to a lesser extent, in women aged 15 to 49 years" (InterOil 2012, 39).

The InterOil study (2012) results do not demonstrate findings consistent with high levels of malnutrition in either adults or children. However, the Hb data indicate that significant levels of mild to moderate levels of anemia are present in adults and children, at levels far in excess to those reported by PAOI health facilities. Routine Hb measurement is not a defined SPAR indicator.

In Papua New Guinea, anemia is strongly related to both malaria parasitemia intestinal parasite infection (ascaris and hookworm) (Senn et al. 2010). While the level of malaria parasitemia across the PAOI is extremely low, the burden of intestinal parasitic infections is extremely high (InterOil 2012). The InterOil health study collected and studied stool samples for intestinal parasite infection. Of the stool samples analyzed, ascaris species were detected in 104 (81%) of the analyzable samples and hookworms were detected in 94 (73%) samples. The InterOil data indicate a high level of intestinal parasitemia in the study cohort; however, as noted by the study authors, "caution should be applied to these findings because of the limited number of respondents who returned analyzable samples and the possibility of bias" (InterOil 2012, 45).

6.7.2.4 Project Baseline Reports

Both the Upstream Governance Baseline Report (Finlayson 2016b) and the Upstream Land and Natural Resource Use Baseline Report (Booyong Forest Science 2017) provide a wealth of information regarding PAOI household subsistence practices. Members of most households in all villages carry out fishing across the PAOI (Booyong Forest Science 2017). The PAOI villages are documented to have a diversity of protein sources with a wide diversity of nutritional value. While documentation across villages varied, the overall study assessment was that all groups had access to a variety of animal foods (Booyong Forest Science 2017).

6.7.2.5 Community Surveys

Food security and subsistence issues were addressed during the FGDs and KIIs, particularly with women. There is substantial variability across villages in terms of participants' perceptions of food security and whether household nutrition is believed to be adequate (according to participants) — some participants believe that food security is a significant concern, while others disagreed. It was noted that "many people in the PAOI believe (there has been) a reduction in fish stocks over the past decade or so" (Booyong Forest Science 2017, xiv).

6.7.3 Analysis

The available data do not demonstrate a pattern of significant nutritionally related problems across the PAOI; however, health facility data must be cautiously considered and significant underreporting is possible. The available anthropometric data, the Ulijaszek (2003) and InterOil (2012) studies, do not demonstrate a serious pattern of widespread malnutrition; however, pockets of malnutrition cannot be ruled out based on the available data. The likelihood of widespread intestinal parasitemia is quite high and is probably a significant driver of mild to moderate anemia observed in the InterOil study (2012). Children under the age of 5 and women of reproductive age are more susceptible to the effects of malnutrition. Experience with other large resource projects in Papua New Guinea indicates that during active construction periods there can be a movement from subsistence activities towards wage labor and a surge in food inflation. These concerns are best formally monitored, using methods such as longitudinal anthropometrics.

6.8 Environmental Health Area 7 – Non-Communicable Diseases

This EHA considers the situation regarding NCDs: cardiovascular, diabetes, obesity, and cancer.

6.8.1 Overview

NCDs are largely driven by a change from subsistence foods to a more Western-style diet. Changes in income, particularly conversion from subsistence to wage based, can drive increased western-style trade-store product, alcohol, and cigarette consumption.

NCDs and associated risk factors, such as smoking, excessive alcohol consumption, obesity, hypertension, abnormal cholesterol and lipid profiles, and physical inactivity, have not been well investigated in Papua New Guinea. Several relatively small studies conducted among specific populations have identified an increasing or relatively high prevalence of diabetes, cardiovascular disease, and cancers (Ogle 2001; Dowse et al. 1994; Misch 1988; Kende 2001; Ulijaszek 1998; Henderson and Aiken 1979; Martin et al. 1980). Available evidence further suggests variation in NCD risk within Papua New Guinea based on ethnic origin (Natsuhara et al. 2000; Jamrozik 1985; Atkinson et al. 1982) and lifestyle and living environment (Benjamin 2007; Saweri 2001). For example, the Wanigela people of Port Moresby have some of the highest rates of diabetes recorded in the Pacific (Dowse et al.1994), and urban dwellers of any ethnic origin in Papua New Guinea are more at risk of NCDs relative to their rural peers (Benjamin 2007; Kende 2001), although even rural populations appear to be increasingly prone to NCDs (Ulijaszek 1998).

6.8.2 Sources of Information

This subsection discusses the sources of information used for EHA 7.

6.8.2.1 Peer-Reviewed Published Literature

There is one peer-reviewed publication regarding NCDs and the Gulf Province. In 1995, Ulijaszek (1998) studied 103 individuals above the age of 18 in the Purari delta village of Koravake. Koravake is not a PAOI village; however, it is geographically close to other PAOI villages (Ara'ava and Kapuna).

Ulijaszek (1998) noted that the presence of obesity had increased since an earlier 1980 study; however, he observed that blood pressure was not associated with height or weight but rather fat patterning (i.e., increased truncal fatness was associated with greater systolic blood pressure in both males and females). Ulijaszek (1998) also observed an increase in western-store foods. Sixteen percent of men and 22.6% of women ages 18–44 had blood pressure at a level defined as hypertensive (140/90 mmHg). Hypertension in older adults (older than 45 years of age) was more common for women (31.6%) versus men (13.2%). As noted by Ulijaszek, "the ability to obtain money by various sources including the sale of foods at market, fishing, logging and cash-cropping has been important in raising people's standard of living, a health-related consequence of this being increased body fatness and hypertension" (1998, 70).

6.8.2.2 National Department of Health Data

NCDs currently account for a minor proportion of outpatient and inpatient admissions within the Kapuna and Kerema health centers. Given the acknowledged shortcomings of the PNG health system, it is likely that many (if not most) forms of NCDs are equally undetected or untreated. There are no SPAR KPIs related to NCDs.

6.8.2.3 Private Company-Sponsored Studies

The InterOil 2012 study measured cholesterol and glucose levels across 285 adult survey participants. Significant elevations of either cholesterol or elevated blood glucose levels were not

observed. Blood pressure monitoring was also performed, and only 6% of respondents had an elevated systolic blood pressure (140 millimeter of mercury [mmHg]) and only 2% had a diastolic reading greater than 90 mmHg. The hypertension findings are significantly lower than the Ulijaszek (1998) study; however, there is a marked difference in study time frame (1995 versus 2012) and the two study areas.

6.8.2.4 Project Baseline Reports

Information from the household surveys conducted in the PAOI in 2016 indicates that most food consumed is derived from subsistence sources (Finlayson 2016b; Booyong Forest Science 2017). Across the PAOI, 63% of males and 76% of females aged 16 years and older were engaged primarily in subsistence activities. Betel nut, a known human carcinogen, is the main source of cash income in 15 villages (or 48% of villages surveyed) in the PAOI, and was particularly common among Orokolo villages. Other factors affecting the burden of NCDs include drinking, smoking, and use of betel nut. As previously described in Section 6.5 EHA 4 STIs, there is a high level of alcohol consumption and marijuana smoking across the PAOI. The level of store-bought cigarette consumption is unknown.

Issues surrounding NCDs were not noted during the FGDs. NCDs were not a topic of concern during the KIIs with health personnel.

6.8.3 Analysis

There is minimal morbidity data related to NCDs across the PAOI. PAOI households are primarily engaged in subsistence agricultural activities. In this situation, the burden of NCDs is expected to be modest. The future risk is the dietary transition triggered by migration from subsistence to a wage-based economy. Increased consumption of western-style food products is a known risk factor for NCDs. High use of betel nut chewing is documented, which is a known human carcinogen and associated with oral cancer.

Experience indicates that a local workforce can dramatically change their dietary habits with substantial adverse consequences if an *ad libitum* mess hall is available during the construction and operations.

6.9 Environmental Health Area 8 – Accidents and Injuries

This EHA considers the underlying burden of trauma related morbidity in local communities. Road, river and marine traffic patterns are considered.

6.9.1 Overview

Injuries are a neglected epidemic in developing countries, causing more than 5 million deaths each year, roughly equal to the number of deaths from HIV/AIDS, malaria, and TB combined (Gosselin et al. 2009). The Global Burden of Disease and Risk Factors study forecasts that by 2020, 20% of ill-health in the world will be injury related (Gosselin et al. 2009).

More than 90% of injury deaths occur in low- and middle-income countries, where preventive efforts are often nonexistent and health care systems are least prepared to meet the challenge. As such, injuries clearly contribute to the cycle of poverty and have an impact on individuals, communities, and societies. There are many dimensions to injuries: human (victim, caregiver) environment (infrastructure, legislation), and vector (motor and marine and river vehicles for injuries, weapons for violence, open fires for burns).

6.9.2 Sources of Information

This subsection discusses the sources of information used for EHA 8.

6.9.2.1 Peer-Reviewed Published Literature

There are no peer-reviewed publications regarding accidents and injuries for the Gulf Province.

6.9.2.2 National Department of Health Data

Across the PAOI, the documented outpatient and inpatient burden of disease for accidents/injuries is significant. The following outpatient accident and injury data are for key PAOI health care facilities:

- Kapuna Health Center: 4% of total caseload.
- Kerema Health Center: 8.6%.
- Orokolo Sub-Health Center: 8%.
- Gulf Province (2010): 3%.
- SPAR 2015: 321 per 1,000 (incidence rate not a percentage).

Data from aid posts are generally consistent with the health center percentages (2–10%). Some facilities occasionally show a higher percentage; however, this is artifactual as the caseload denominator is quite small.

The following inpatient data are for the Kapuna and Kerema health centers:

- Kapuna Health Center: 6%.
- Kerema Health Center: less than 1%.

As reported by NDOH, the Gulf Province 2010 inpatient percentage is 11%.

There are no emergency response services in any of the PAOI villages, except for those provided by TEP PNG personnel. In general, there are minimal emergency services in Gulf Province, and less than 3% of health centers have an ambulance (Howes et al. 2014).

6.9.2.3 Private Company-Sponsored Data

There are no published data regarding traumatic accidents and injuries in the 2012 InterOil study or other studies relevant to the PAOI.

6.9.2.4 Project Baseline Reports

Domestic violence and crime data are described in the Upstream Community Demographics Baseline Report (Finlayson 2016a). Gender-based violence data are considered in Section 6.11 EHA 10 Social Determinants of Health.

The main safety concerns expressed by the village leaders were sorcery (mentioned in nine villages) and naturally occurring problems, including snakes, crocodiles, and floods (mentioned in two villages). Seven of the women's groups indicated that they were not safe: four due to sorcery and three due to social or cultural norms that put them at risk of domestic violence, sexual assault, or other forms of violence.

There are no public roads in the PAOI, thus no incidence of motor vehicle accidents or injuries caused to passengers or pedestrians from motor vehicles.

Balloch (2017) presents marine and river traffic and transport patterns across the PAOI. Relevant to community health are the following factors:

- Nearshore small watercraft traffic is common alongshore of Orokolo Bay where there is a large number of villages. Community members use dugout canoes, outrigger dugout canoes and outboard-driven banana boats and dinghies to travel.

- Commercial river traffic in the PAOI includes two TEP PNG Papua LNG Exploration contracted barge landing crafts that travel between Port Moresby and Herd Base, and logging ships that travel the Purari to access the logging camp at Evara. They conduct approximately 189 return trips/year and 24 return trips/year respectively.

- Village watercraft use is an integral part of life for people living along the rivers who travel primarily by dugout canoe to fish, transit and transport goods/collect materials at an estimated density of 3.3 vessels/km.

Community level surveys indicated that some villagers were concerned about the safety of dugout canoe travel past larger vessels that cause bow waves or propeller wash that could inundate canoes and cause them to capsize (Balloch 2017).

Community level surveys (and observations made during survey field work) also indicated that accidents and injuries occur periodically from a range of daily activities – clearing gardens with bush knives, encountering snakes during gardening, using blunt utensils to prepare food, children playing with dangerous objects (such as bush knives), encountering crocodiles on river banks (several reports of injury and death from crocodile attacks was reported during the surveys) and fighting between community members, sometimes with bush knives. Women reported the laborious tasks such as beating sago and working gardens as contributing to muscular-skeletal injuries and general aches and pains.

Gender-based violence is an issue, particularly in women FGDs, and is extensively presented and described in Finlayson (2016a). Accidents/injuries were not a topic of concern during the KIIs with health personnel.

6.9.3 Analysis

Accidents and injuries are an underappreciated morbidity burden across the PAOI. The limited inpatient and outpatient data strongly suggest that accidents and injuries are a potentially significant issue. The overall social and economic impact of a significant accident/injury on households can be devastating. Serious accidents and injuries are associated with substantial morbidity and mortality and can significantly impact overall household well-being and stability.

There is no community emergency medical response across the PAOI. Experience from the PNG LNG Project indicates that community demands for emergency evacuation and transport for accident/injury events can be substantial.

6.10 Environmental Health Area 9 – Exposure to Potentially Hazardous Materials

This EHA considers whether there is significant underlying hazardous material exposure to individuals and communities, such as pesticides, heavy metals, and petroleum hydrocarbons. Water and air pollution along with noise, vibration, and illumination are considered, although these are typically covered in environmental assessments.

6.10.1 Overview

Potential exposures to hazardous materials are typically not a major issue in a rural subsistence agriculture environment. Hazardous materials issues are typically much more prominent during either project construction or operation.

6.10.2 Sources of Information

This subsection discusses the sources of information used for EHA 9.

6.10.2.1 Peer-Reviewed Published Literature

There are no peer-reviewed publications regarding hazardous materials exposure issues for the Gulf Province.

6.10.2.2 National Department of Health Data

There are no health facility data regarding hazardous materials exposure issues.

6.10.2.3 Private Company-Sponsored Data

There are no published data regarding exposure to hazardous materials in the 2012 InterOil study or other studies relevant to the PAOI.

6.10.2.4 Project Baseline Reports

Detailed day and night time baseline background noise levels were measured and extensive documentation is in the Upstream Noise Baseline Report (SLR 2017c).

6.10.2.5 Community Surveys

During the community health discussions, community members raised several concerns regarding potential exposure to hazardous materials:

- Mapaio:
  - Possible contamination of the river due to the community members cleaning fuel containers in the river.
  - Barges dumping waste to the river.
  - Increases in skin rashes due to increased industrial activity.
- Wabo:
  - Potential drilling waste discharge into the river.
  - In 2014, during the flood, empty drums were carried downstream and retrieved by residents who said that one drum was still full.

The veracity of these claims was not assessed as part of this study and they are reported as KII feedback only. There are no household survey data related to exposures to potentially hazardous materials.

6.10.3 Analysis

Hazardous materials issues are a real, but modest, concern at this stage of the Project. An extensive baseline noise survey has been performed that indicates the ambient noise environment is generally dominated by local insect noise, with levels generally increasing during the night period.

There should be continued careful documentation, monitoring, and control of any Project-related potentially hazardous materials.

6.11 Environmental Health Area 10 – Social Determinants of Health

This EHA considers the standard SDH plus psychosocial issues including alcohol, drugs, and gender-based violence. There is a significant overlap with the social assessment as many of these topics are covered in detail in the Upstream Community and Demographics Baseline Report (Finlayson 2016a).

6.11.1 Overview

SDH are the conditions in which people are born, grow, live, work, and age, and include the state of the health system with which they interact (described in Section 6.2 EHA 1 Health Systems). These circumstances are shaped by the distribution of money, power, and resources at global, national, and local levels, which are themselves influenced by policy choices. The SDH are often responsible for health inequities—unfair and avoidable differences in health status seen within a country, such as rural versus urban Papua New Guinea.

It is well established that health follows a social gradient: better health with increasing socio-economic status, literacy, and educational attainment, particularly for women. All of these elements are associated with a higher housing standard, healthier working conditions, and better access to health care and health education.

Substance abuse including alcohol, tobacco, or other drugs is not only an important health determinant but also closely linked to mental health. Misuse is associated with crime, transactional sex, and domestic violence.

6.11.2 Sources of Information

This subsection discusses the sources of information used for EHA 10.

6.11.2.1 Peer-Reviewed Published Literature

There are no peer-reviewed publications regarding SDH for the Gulf Province.

6.11.2.2 National Department of Health Data

SPAR data do not directly address SDH, such as income and educational attainment, or psychosocial issues such as drugs/alcohol and gender-based violence. The health facility morbidity does not directly capture SDH—tally sheet data cannot be sorted by village location, age, marital status, income, or education.

6.11.2.3 Private Company-Sponsored Data

The InterOil 2012 survey did not address SDH in detail. The 2012 InterOil survey documented high levels of alcohol (42% within the last 12 months), tobacco (48% currently smoking), and betel nut (not measured but widely observed) usage in the eight surveyed villages.

6.11.2.4 Project Baseline Reports

Finlayson (2016a) presents detailed baseline data covering key social determinants: demography, educational attainment, literacy, crime/security information, gender-based violence, and drug/alcohol usage. The available baseline survey data are extremely detailed and comprehensive. The following key highlights are relevant for health:

- PAOI is characterized by a very young population, with relatively low life expectancy given the few people reaching 50 years of age and large household size.
- Three percent of marriages are polygamous.
- Divorce and separation are not common.
- No males under 20 years of age were married; however, 10% of females under 20 years of age had been married.
- There is a very young age that women are typically married within the PAOI, particularly among the Pawaian (average starting age 12) and Ahia villages (average starting age 12); the other language groups average starting age for marriage is 15-17.
- Substantially more than 12% of the school-aged population do not attend school.
- Thirty-one percent of boys and girls aged 6 to 15 years attend school.
- More than half of the females from Pawaian villages aged 16 years and older have never attended school.
- Most school-aged children are not attending school, even in the Orokolo area, where the majority of children have relatively good access to schools.
- Nine percent of males and 33% of females aged 16 years and older indicated that they could not read or write.
- Women indicated a higher level of fighting and domestic violence than that portrayed by the village leaders (who were generally male).
- Commonly cited law-and-order problems were domestic violence (63% of villages) and stealing (53% of villages).
- Male alcohol consumption is common across the PAOI. Alcohol consumption is substantially lower for females.
- Some home brew is made and consumed locally, while other alcohol is brought in from Port Moresby or other urban areas. There are no bottle shops in the PAOI.
- Alcohol abuse is regarded as a law-and-order problem in the PAOI, particularly as it is associated with various criminal activities, including fighting, domestic violence, and obscene or abusive language.
- Most villages in the PAOI contain some males who smoke marijuana. Village leaders and the women interviewed indicated that the use of marijuana is common and widespread, particularly among young males. Relatively few females smoke marijuana in the PAOI.
- The women's groups indicated that men participated in prostitution in 40% of villages in the PAOI, while women were involved in prostitution in 33% of villages. Again, it was difficult to identify any patterns grouping these villages together, as often, a women's group would acknowledge prostitution occurring, only for it to be vehemently denied in the neighbouring village.
- Sixty-three percent of males and 76% of females aged 16 years and older were engaged primarily in subsistence activities.
- Approximately 15% of males and 7% of females were employed or involved in business activities.
- A relatively low proportion of males and females were retired or disabled.
- Twelve percent of males and 7% of females were attending school.

- Approximately 8% of all males and 5% of all females aged 16 years and older indicated that they were unemployed but looking for work. Particularly high numbers of people from Pawaian and Iare villages and Evara indicated they were looking for work.
- One hundred males and 43 females from the households surveyed included people with current employment. The most common jobs included teachers, village court officials and ward councilors, pastors, carpenters, cooks, and laborers.
- PAOI communities are no longer willing to live a subsistence lifestyle. Cash income is required for clothes, housing materials, household items, batteries, soap, tea, travel, and education costs.
- The most common main sources of cash income were fish (20% of households), sago and betel nut (both 14% of households), and garden produce (12% of households).
- Wages provided the main source of income for 9% of households, and business activities the main source of income for an additional 7% of households.

Key SDH issues were addressed during the FGDs and KIIs, particularly with women. Issues like domestic violence, education, and income opportunities were described. Child marriage was a significant issue in several of the health KIIs. Child marriage is a significant risk factor for a variety of negative health outcomes. The Upstream Community and Demographics Baseline Report (Finlayson 2016a) provides additional detail regarding FGD and KII social determinant discussions.

The household survey health questions looked at several maternal outcomes that are tied to social determinants: fertility (giving birth) and neonatal, perinatal, and under/over age 5 mortality.

Eighty-seven percent of the surveyed women reported having given birth. This is consistent with the demographic data that shows a large 0–9 age population pyramid base. General childhood mortality was queried by asking whether any of the household children have died and when. These data are shown in Table 68 and Table 69.

Table 69. Children Who Have Died

Number of Child Deaths	Number of Mothers	Percentage of Mothers with Births
1	66	21
2	26	8
3	10	3
4	3	1

n=309. Source: ERIAS Group 2016b

Table 70. When Did the Child Die?

Period of Death	Percentage of Cases Child 1	Percentage of Cases Child 2	Percentage of Cases Child 3	Percentage of Cases Child 4
Childbirth-2 months	30	8	2	1
2–12 months	11	4	4	1
Within 5 years	11	3	0	0
After 5 years	13	9	2	1

n=137. Source: ERIAS Group 2016b

The mortality pattern is consistent with a high neonatal and perinatal mortality rate. This is not surprising given the large number of women who have been pregnant coupled with the extremely low average age of marriage that is observed in some villages (Nour 2009).

6.11.3 Analysis

The social determinants data indicate that there are issues surrounding SDH: low socio-economic status, poor educational attainment and literacy (particularly for women), young age of marriage, high fertility, and a significant level of domestic violence.

Female educational attainment is a powerful predictor of childhood morbidity and mortality. The early average age of marriage is an important observation that suggests there is likely a significant problem with both maternal mortality and neo and perinatal mortality.

Given the extremely young average age of marriage across the PAOI and particularly in the Pawaian (average starting age 12) and Ahia villages (average starting age 12), these women and their children are at higher risk for a variety of adverse medical outcomes, particularly related to maternal morbidity/mortality and perinatal and infant mortality.

The SDH are significant issues; however, addressing the underlying factors would be a daunting, complex, and long-term undertaking.

6.12 Environmental Health Area 11 – Veterinary Medicine and Zoonotic Diseases

This EHA considers the underlying burden of diseases transmitted from animals to humans.

6.12.1 Overview

Diseases that originate from animals but can be transmitted to humans are known as zoonotic illnesses. There are multiple causal factors for zoonotic illness emergence and spread, including intensification of livestock production, increased human travel and food-associated trade, and reduction of and encroachment on wildlife habitat (Bordier and Roger 2013). There is some understanding with respect to the ecological systems within which new or previously unknown pathogens can emerge (Keesing et al. 2010). The role of trade networks has also been demonstrated, particularly in the spread of avian influenza (Fournie et al. 2013). It is also important to recognize the continuous and widely underestimated challenge for human and animal health through emergence of resistant pathogens resulting from evolutionary pressure exerted by antimicrobial usage (Orton et al. 2013). There is a small surveillance program in Papua New Guinea for zoonotics as part of the National Agriculture and Quarantine Inspection Agency.

6.12.2 Sources of Information

This subsection discusses the sources of information used for EHA 11.

6.12.2.1 Peer-Reviewed Published Literature

There are no peer-reviewed publications regarding zoonotic diseases for the Gulf Province.

6.12.2.2 National Department of Health Data

The health facilities in the PAOI do not have the laboratory capability to reliably diagnosis a zoonotic illness. Some percentage of the diarrhea cases is undoubtedly zoonotic in origin. PNG IMR investigations regarding febrile illness demonstrated that animal husbandry (e.g., pigs and chickens)

was a clear contributory factor to diarrheal febrile illnesses across the PAOI surveillance sites (PNG IMR 2015).

6.12.2.3 Private Company-Sponsored Data

The InterOil 2012 survey did not address zoonotic diseases, and no other studies have been conducted that are relevant to the PAOI.

6.12.2.4 Project Baseline Reports

Both the Upstream Land and Natural Resources Use Baseline Report (Booyong Forest Science 2017) and the Upstream Governance and Economics Baseline Report (Finlayson 2016b) document the level of household animal husbandry across the PAOI.

The level of household animal husbandry is significant, but not surprising. In rural Papua New Guinea, there is a close association between animals and household, particularly pigs and chickens. Thirty-six percent of households in the PAOI had one or more pigs. The highest rates of pig ownership and the largest herds were reported in the Kaimare, Koriki, and Maipua villages located on the coast and in the Mangroves ecological zone. The average herd sizes were usually between five and six (but as high as nine in the Maipua village of Apiope). Occasionally, herds of 15 to 25 were recorded but these are unusual in the PAOI.

The lowest rates of pig ownership, rarely above 10% of households, were recorded among the Iare villages living along the Purari River above the marine tidal influence in the Delta Swamps and Plains ecological zone. Immigrant families living in the Pawaia area around Subu, Wabo, and Ura villages have introduced some new husbandry practices based on methods used in the highlands.

Sixty-four percent of overall PAOI households had one or more chickens. In the overall PAOI, the lowest rates of chicken husbandry were recorded in the Pawaia villages from the Middle Purari Hills ecological zone (42%) and Koriki villages from the Mangroves zone (48%), and the highest rates in the Kaimare villages (83%) and the Ahia village of Evara (86%).

Five of PAOI households had cassowary and 2% had crocodiles.

Hunting is extremely common, with 42% of males engaged in this activity within the last 2 weeks of the survey; female participation was 5%. Hunting is less common in coastal villages.

Zoonotic issues were not highlighted by any respondents during FGDs or KIIs.

6.12.3 Analysis

Zoonotics are potentially an important contributor to the observed morbidity burden in the PAOI, particularly diarrheal diseases. PNG IMR (2015) has documented the relationship between diarrheal illness cases and infectious agents associated with animals, particularly pigs and chickens. Hunting is common and is also a potential exposure source for a zoonotic illness.

Susceptibility to zoonotic diseases is related to underlying individual health status and direct exposure to animals via hunting and husbandry practices. Young children, pregnant women, and individuals with a compromised immune system (e.g., HIV) are at greater risk.

6.13 Environmental Health Area 12 – Cultural Health Practices

This EHA considers the role of traditional medical providers, medicines, and cultural beliefs that influence health behaviors and outcomes.

6.13.1 Overview

The analysis of cultural health practices applies a medical anthropology lens to a community's knowledge, attitude, and practices regarding health and illness. All cultures have systems of health beliefs to explain what causes illness, how it can be cured or treated, and who should be involved in the process. The extent to which patients perceive health education as having cultural relevance for them can have a profound effect on their reception to information provided and their willingness to use it.

Cultural differences affect patients' attitudes about medical care and their ability to understand, manage, and cope with the course of an illness, the meaning of a diagnosis, and the consequences of medical treatment. In addition, culture specific values influence patient roles and expectations. In many cultures, including Papua New Guinea, sorcery is an important and powerful social phenomenon and a way of explaining the causation of disease (Franklin 2010).

As noted by Franklin (2010), in Tok Pisin, words used in the etic genre of sorcery are *poisen, poisen man, poisen meri, puripuri, pawa, blak pawa, kawawar, marila,* and *tambaran* (man). Franklin writes, "…it is important to note that in the folk beliefs there is no separation of what happens in the so-called spiritual realm on the one hand and the natural on the other" (Franklin 2010, 5). Franklin also notes:

> Nevertheless, *poisen* is generally (and generically) used in Tok Pisin for sorcery and as a substance that is allegedly placed in food or other places to cause sickness and even death. There are *poisen* types, such as *maus poisen* (words that are performatives, spoken or called out to direct the power of the word towards an individual), and *poisen* men and women (*poisen meri*), who can kill people by supernatural means, sometimes removing or damaging their organs. (Franklin 2010, 5)

According to Franklin, "sorcery, especially the violent *sanguma*, is prevalent in PNG and shows no signs of diminishing" (2010, 9). Sanguma has been glossed in English as both "witchcraft" and "assault sorcery" (Franklin 2010).

6.13.2 Sources of Information

This subsection discusses the sources of information used for EHA 12.

6.13.2.1 Peer-Reviewed Published Literature

There are no peer-reviewed publications regarding cultural health practices in the Gulf Province.

6.13.2.2 National Department of Health Data

There are no available data regarding cultural health practices across the Gulf Province.

6.13.2.3 Private Company-Sponsored Data

The InterOil 2012 survey did not address cultural health practices, and no other studies have been conducted that are relevant to the PAOI.

6.13.2.4 Project Baseline Reports

Finlayson (2016a) documented the importance of sorcery as a major issue across PAOI villages. The Provincial Police Constable indicated that in both Baimuru and Ihu the main crimes are sorcery, domestic violence, consumption of marijuana, and crimes against the person (assault and verbal abuse).

Finlayson (2016a) collected substantial and detailed information regarding community level safety and security:

- Leaders of several villages identified a range of serious crimes, including rape, murder, sorcery, and domestic violence.
- Sorcery was identified as a serious issue in most villages within the PAOI during the social baseline study.
- The main safety concerns expressed by the village leaders were sorcery (mentioned in all nine villages) and naturally occurring problems, including snakes, crocodiles, and floods (mentioned in two villages).
- Seven of the women's groups indicated that they were not safe: four due to sorcery and three due to social or cultural norms that put them at risk of domestic violence, sexual assault, or other forms of violence. While this fear was greatest among some Pawaian villages, the women from seven additional villages did mention that they feared sorcery, despite initially indicating they were safe in their village.
- Sorcery was said to be most commonly practiced by men, and could be presented as crocodiles, snakes, or illness. A young girl was killed by a crocodile in a river near Harevavo in 2016. The death was attributed to sorcery and prevented many people from fishing, swimming and/or, washing in the general vicinity.
- One of the main safety concerns expressed by respondents was the fear of sorcery, which was felt to influence what some people do and where some people go.

Health KIIs consistently identified that health care workers felt that cultural health beliefs were extremely important. Sorcery was also identified as an important issue. Within the PAOI, traditional medicine practitioners are often the first option for care. Information obtained during FGDs and KIIs are described below. Table 70 presents data collected about cultural health beliefs. Data are presented in an overall summarized fashion as a function of condition/activity versus practice/belief.

Table 71. Cultural Health Beliefs

Condition/Activity	Practice/Belief
Cough	Squeeze the bark of the Bulu tree to obtain the juice. Children should drink 50ccs and adults 100ccs every morning for 4 days. Patients with cough should not eat fatty foods and/or sugar. Eat pineapple.
Fever	Fever means "skin hot." Patients should boil guava, lemon, or papaya leaves, add it to a bath, and bathe in it for 2-3 days in a row. They should also eat more fruits and vegetables. For fever with shivering, sleep next to the fire.
Diarrhea (pekpek wara)	Drink coconut juice, boil guava leaves and drink. Boil water with banana and sweet potato, then drink. Suggestions are to avoid eating meats and oily foods. Coconut water or boiled sweet potato with water and drink the soup.
Muscle pain	Use the leaf called Salli to rub the areas that have pain (see Plate 35).
Injury (cut wound)	Using moss, cover the wound (as natural gauze) and change the moss when it gets wet. Using bark of Polu, boil with water and salt then apply directly on the wound.
Snake bite	If it is a poisonous snake bite, the wound mark will be 2 fangs. Cut the wound using a broken bottle, then use the Jenny tree by drinking juice from squeezing the bark and putting the juice on the wound.
Burns	Dip the wounded area in cold water, then wrap it with sago dust. Cover the wound with new sago.

Table 71. Cultural Health Beliefs

Condition/Activity	Practice/Belief
Birth control	Drink the juice from the special palm tree bark 2-3 times per month and say the magic words.
Problems with teeth	Use bush medicine and eat chilies.
Access to care	Traditional medicine is predominantly used for treatment due to the excessive time required to reach the nearest health facility.
Prevention of mosquito bites	To prevent the mosquito from biting, burn a coconut cut in half with meat. The smell will expel mosquitos away. It is used more in the bush when men go out for hunting and collecting food.
Skin diseases	Use "Pri Kanai" leaves boiled with water, let it cool and bathe with it (see Plate 35).
Head lice	Scrape coconut meat out, squeeze it, put it on hair with lemon.
Fever with shivering	Sleep next to the fire.
Malaria	Traditional herbs ("ura", lemon grass) are used to treat malaria.
TB	Deaths from TB are believed to be linked to sorcery.
Cooking food	Taboos relating to food and drinks applied to women who experienced their menstrual period during which time a woman was not allowed to cook for the family. Another still-practiced taboo was that a woman must wash her hands in the morning before cooking a meal for her family if she had sex with her husband the previous night. Cooking without washing her hands may cause her family to become ill.

Plate 34. Leaves Used for Traditional Medicine in Poroi 2



The larger leaves appear to be *Morinda citrifolia*, known as Noni in the region. The smaller leaf appears to be *Laportea decumana*, which is known as *salat* in Tok Pisin.

Plate 35. Pri Kanai Leaves Used for Treatment of Skin Diseases - Akoma



Additional cultural health beliefs and practices related to maternal and child health are described in Table 71.

Women and children can be affected by cultural beliefs.

6.13.3 Analysis

The role of cultural health practices is significant across the PAOI. The following key observations are summarized:

- Traditional health practitioners, medicines, and beliefs are common across the PAOI.
- Cultural attitudes towards birth practices, particularly in Pawaian villages, may be contributing to significant maternal and child morbidity and mortality.

Understanding cultural health beliefs is critical, as these beliefs will impact the acceptance and success of health education interventions for both the community and workforce.

Table 72. Cultural Practices Related to Maternal Child Health

Condition/Activity	Practice/Belief
Giving birth	According to KIIs conducted, the majority give birth in the bush by themselves. Mother and baby will stay in the bush for at least 1 week, foods will be delivered by her mother or female family members; however, the participants mentioned that husbands will assist if there is no one to help. This custom is respected, even women from the outside, will need to follow the rules. It is against cultural norms to deliver babies in the community areas, so giving birth at home is not acceptable. The custom belief is that the secretion from women (during delivery including menstruation) will cause sickness to men. By inhaling this "dirty water," men will get sick, only in lungs, such as shortness of breath, asthma, then developing illnesses as severe as TB. Therefore, pregnant women either give birth at the Kapuna Health Center or in the bush with the support from their female family members. There are four VBAs (in the Wabo/Ura area) trained by Kapuna Health Center since 2011, however, there were only three patients who reported using VBAs. Delivery places are in the bush, far away from the village across the river. Giving birth in the bush is a very hard condition, as there are no proper, clean locations for delivery. The mother and baby will stay in the bush until the umbilical cord is dried and removed and this will take up to 2 weeks. The family will provide food for the mother while in the bush. If there is a complication such as prolonged labor, post-partum hemorrhage, the villagers will seek assistance from Herd Base. To travel to Herd Base by canoe, despite worries about contamination from the woman's secretions, men will paddle the canoe to Herd Base. Men will paddle in a standing position and turn their face to the direction of travel, which will not expose them to the smell of secretions. Comments from local male PRL-15 villagers: • "Our customary practice has been that men will select young girls, as young as 10 years old, and take them into the bush to make them their wives." • "At times, an older man will make an agreement with a pregnant woman that if her newborn is a female, she will eventually become his wife."
Post-partum	Women are not allowed to cook or give food or sleep with their husbands for a period of 3 weeks after the birth of their child for fear of making the husband ill. Women are not allowed to cook or give food to their husbands when they are menstruating. The placenta will be buried right after delivery to prevent its use for sorcery against the woman and her family.
Menstruation	Taboos relating to food and drinks applied to women who experienced their menstrual period during which time a woman was not allowed to cook for the family.

Table 72. Cultural Practices Related to Maternal Child Health

Condition/Activity	Practice/Belief
Women in general	Another still-practiced taboo is that a woman must wash her hands in the morning before cooking a meal for her family if she had had sex with her husband the previous night. Cooking without washing her hands may cause her family to become ill.
Family planning	In some villages, only a few women understood different contraceptive methods; therefore, most women used herbs and magical spells to prevent them from having babies. Sometimes women who make the decision alone results in domestic violence. Eating a tree bark called *kauri* to prevent pregnancies.
Women's health	Access to birth control requires consent from the husband and the husbands' family. Women are not allowed to tend gardens after childbirth; it is forbidden to engage in sexual activities before making a garden. After childbirth, a woman is not allowed to eat pig, fish, coconut, breadfruit seed, yam, and taro until after the baby's umbilical cord has fallen off. Women also practiced traditional family planning methods (eating a tree bark called *kauri)* to prevent pregnancies.
General health	Often the aid post at Muro Mission is out of medical supplies; thus, villagers resort to using traditional methods of healing. Traditional medicines are important and are considered more effective and more reliable than medicines obtained from the poorly equipped Orokolo Sub-Health Center. Cases of malaria are treated using traditional methods. It is usual practice to cut the forehead with sharp objects such as razor blades in the belief that it released the bad blood causing a headache. Sorcery is highlighted as the main cause of illness or death.

7 CONCLUSIONS

Based on the EHA framework, this Upstream Community Health Baseline Report is a systematic presentation of the following generally available health information for the PAOI:

- Peer-reviewed publications.
- NDOH data at the national, provincial, district and local health facility level.
- Relevant PNG IMR studies collected as part of the PNG LNG Project-sponsored PiHP.
- International agency data including WHO and the World Bank Group.
- Multilateral funding agency data including Global, Fund, USAID, and DFAT.
- NGO data including materials from MSF.
- Private company sponsored studies (the 2012 InterOil study in PRL-15).
- TEP PNG-sponsored studies covering all the communities in the PAOI.

The following are key findings of this report:

- There is strong evidence of the overall fragility of the PAOI health care facilities. A substantial number of aid posts are closed, and staffing levels and functionality of those aid posts that are open is uncertain.

  The Kapuna and Kerema health centers are the most important providers of health care for PAOI communities. Consistent outpatient and inpatient morbidity data are available from both health centers; however, the data consistency and quality from the aid posts is more problematic. Timely access to health care is a key issue for many PAOI communities, particularly if emergent health problems occur.

- Communicable respiratory diseases are likely the most important cause of the observed burden of disease across the PAOI. TB is at epidemic levels across the Gulf Province. With exception of the significant MSF effort at Kerema Health Center and focused efforts by the Oil Search Foundation at Kikori Hospital, the level of international and multilateral TB funding across the Gulf Province is modest, particularly compared to the efforts in the Western Province. Given the TB levels (including MDR-TB) documented by both MSF and the Cross et al. 2014 study, this is surprising as the Gulf Province is recognized by NDOH, WHO, and international aid agencies as a “TB hot spot.”

- VBD are at modest levels across the PAOI. Both recent PNG IMR and the InterOil parasitemia prevalence studies confirm this finding. Bed net distribution efforts have been successful across the PAOI and is a major reason for the generally low level of laboratory proven malaria. The actual level of proven malaria is mismatched with the community and household perceptions of malaria (i.e., household members believe that malaria is the most significant cause of disease in their villages). LF is present but at low levels; however, systematic prevalence studies covering all PAOI villages are not available.

- The level of HIV disease is low and consistent with a remote rural setting (less than 1%). The burden of non-HIV STIs is uncharacterized and likely substantially higher than indicated by PAOI health facility data.

- WASH-related burden of disease appears to be relatively modest—less than 10% of the outpatient cases seen at PAOI health centers. Field studies indicate that shallow ground water supplies for many PAOI households are likely impacted by microbiological contamination. However, many households have rainwater catchment devices that are acting as a relatively safe and secure water supply source.

- There is a mismatch between the overall Gulf Province level of potential malnutrition and the data available from the Kapuna and Kerema health centers (i.e., reported clinic levels of malnutrition and anemia are very low based on health center data). The 2012 InterOil anthropometric study did not document significant levels of malnutrition; however, a high burden of mild to moderate anemia was observed. The anemia is likely due to intestinal parasite infection, which was found to be high.

- There is no functioning emergency medical response system across the PAOI.

- The SDH are complex across the PAOI given the geographical and ethnic diversity of communities. Literacy and educational attainment levels, particularly for women are low. The early age of marriage for many ethnic groups is a significant potential health problem that is likely influencing the underlying level of maternal and perinatal/infant morbidity and mortality.

- There is a high level of animal husbandry across the PAOI with substantial numbers of households raising chickens and pigs. Given the close interaction between households and their animals, there is likely a real burden of associated, but undiagnosed, zoonotic diseases.

- Cultural health practices are prominent across the PAOI and they influence health decision-making and practices, particularly villages whose common practices include girls marrying at young ages and delivering babies alone in the bush.

The fragility of the overall health services across the PAOI, TB, the need for future STI monitoring, and the lack of a functioning medical emergency response system are considered priority issues that are likely to impact TEP PNG. For these key issues, where relevant, medically susceptible groups have been identified. Overall, sufficient information has been collected, analyzed, and presented in this report to meet the specific objectives outlined in Section 1.2.

8 STUDY TEAM

Marci Balge and Gary Krieger prepared the Upstream Community Health Baseline Report. The health experts on the field team were Marci Balge and Dr. Suparat Phuanukoonnon. The field team is described further in Subsection 5.1.5.

9 GLOSSARY AND ABBREVIATIONS

AIDS	Acquired Immune Deficiency Syndrome
ALRI	Acute lower respiratory infections
AMS	Area medical store
AOI	Area of influence
BL	Burkitt lymphoma
BMI	Body Mass Index
CCM	Country Coordinating Mechanism
CDC	Center for Disease Control
CHS	Catholic Health Services
CFU	Colony-forming units
CHW	Community health worker
CPF	Central processing facility
DDT	Dichlorodiphenyltrichloroethane
DFAT	Australian Government Department of Foreign Affairs and Trade
DHS	Demographic health survey
DNPM	Department of National Planning and Monitoring
DOTS	Directly observed treatment, short-course
EHA	Environmental health area
EIS	Environmental impact statement
eNHIS	Electronic National Health Information System
ESBS	Environmental and Social Baseline Study
FGD	Focus group discussions
GCS	Gulf Christian Services
GIS	Geographic information system
GPS	Global positioning system
Hb	Haemoglobin
HEO	Health Extension Officer
Hg	Mercury
HIA	Health impact assessment
HIS	Health information system
HIV	Human Immunodeficiency Virus
HPV	Human papillomavirus
HSV	Herpes simplex virus
IFC	International Finance Corporation
IMR	Infant mortality rate
IPIECA	International Petroleum Industry Environmental Conservations Association
KII	Key informant interviews
Km	Kilometer

KPI	Key performance indicator
LF	Lymphatic filariasis
LLG	Local level government
LLLIN	Long-lasting insecticidal net
LNG	Liquefied natural gas
MDR	Multi-Drug Resistance
MDR-TB	Multi-drug resistant tuberculosis
mL	Milliliter
mm	Millimeter
mmHg	Millimeters of mercury
MMR	Maternal Mortality Ratio
MSF	Médecins Sans Frontières
MTDP	Medium Term Development Plan
NCD	Non-communicable diseases
NDOH	The National Department of Health
NGO	Non-governmental organization
NMR	Neonatal mortality rate
NSO	National Statistics Office
NTP	National Tuberculosis Control Program
PAC	Potentially affected community
PAOI	Project area of influence
PiHP	Partnership in Health Project
PNG	Papua New Guinea
PNG IMR	Papua New Guinea Institute of Medical Research
PNG LNG	Papua New Guinea Liquefied Natural Gas
PRL	Petroleum Resource License
PS	Performance Standard
RDT	Rapid diagnostic tests
rGLC WPR	Western Pacific Regional Green Light Committee
RPHSDP	Rural Primary Health Services Delivery Project
SDH	Social determinants of health
SIA	Social impact assessment
SPAR	Sector Performance Annual Review
StaRs	National Strategy for Responsible Sustainable Development for Papua New Guinea
STI	Sexually transmitted infections
TB	Tuberculosis
TBA	Traditional birth attendant
TEP PNG	Total E&P PNG Limited
U5	Children under 5 years of age
UN	United Nations

UNAIDS	Joint United Nations Program on HIV/AIDS
UNICEF	United Nations Children's Fund
UNDP	United Nation Development Programme
USAID	United States Agency for International Development
VBA	Village birth attendant
VBD	Vector-borne diseases
WASH	Water, sanitation, and hygiene
WATSAN	Water and sanitation
WHO	World Health Organization
XDR-TB	Extensively drug resistant tuberculosis
YWAM	Youth with a Mission

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Attachment A – Health Facilities by Village

Location	Health Facility Present? Yes/No	If Yes, Operational Status	Name of Facility	KII Conducted	KII Participant	Aid Post/Health Center Facility Comments.[1]
Aiere	No					
Aivai	No					
Akoma-Kairu'u	Yes	O	Akoma Aid Post	Yes	CHW	
Apiope	Yes	P/O	Apiope Aid Post	Yes	CHW	Aid Post not used – CHW operates from under his house.
Ara'ava	No					
Aumu	Yes	N/O	N/A	No	N/A	Health worker not present.
Avavu	No					
Ere-Kilavi	No					
Evara	Yes	P/O	Evara Aid Post	Yes	CHW	Partially operating at the time of field work. ISOS HEO[2] visits 2.5 times per month.
Harevavo	No					
Hepere	No					
Huruta	No					
Ikinu	Yes	N/O	N/A	Yes	Volunteer health worker	Volunteer CHW treats patients with supplies from Kapuna Health Center.
Iuku	Yes	N/O	N/A	No	N/A	
Kaevaria	No					TEP PNG HEO visits approximately monthly.
Kairimai	No					

[1] Access to care information is provided in Section 6.2.2.5
[2] ISOS HEO supported by TEP PNG

Location	Health Facility Present? Yes/No	If Yes, Operational Status	Name of Facility	KII Conducted	KII Participant	Aid Post/Health Center Facility Comments.[1]
Kaivukavu	No					
Kapai 2	No					
Kapuna Health Center	Yes	O	Kapuna Health Center	Yes	Medical doctors, nurses, CHWs, facility manager	Key facility in the PAOI.
Kavava	Yes	O	Orokolo Sub-Health Center	Yes	CHW	Listed under Kavava in the database.
Larihairu	No					
Maipenairu	Yes	O	Maipenairu Aid Post	Yes	CHW	
Mapaio	Yes	O	N/A	Yes	CHW	Aid Post is not used – CHW operates full time from home.
Marea	No					
Mareke	No					
Mariki	Yes	O	Mariki Aid Post	Yes	CHW	
Muro Mission	Yes	O	Muro Aid Post	Yes	CHW	Listed under Ere-Kilavi in database.
Oru-Lariau-Herekela	Yes	O	Oru-Lariau Aid Post	Yes	CHW	
Paevera	No					
Poroi 1	No					
Poroi 2	Yes	P/O	Poroi Aid Post	Yes	Group of residents and TEP PNG HEO	Aid post partially operating through ISOS HEO[3] weekly visits. KII conducted by health team with group of residents and with the HEO at the Aid Post facility.

[3] ISOS HEO supported by TEP PNG

Location	Health Facility Present? Yes/No	If Yes, Operational Status	Name of Facility	KII Conducted	KII Participant	Aid Post/Health Center Facility Comments.[1]
Poroi 3	No					
Subu	No					
Subu 2	No					No health facility. KII conducted by health team with group of residents, and with ISOS HEO[4] who sees patients in the village.
Upaia	No					
Ura	No					
Wabo Station	Yes	O	Wabo Station Aid Post	Yes	HEO (from Wabo CA office), VBAs group	Located at Wabo Station. Listed in the database as Ura. Staffed by TEP PNG HEO, and one CHW.

O = operating
P/O = partially operating
N/O = not operating
N/A = not applicable
VBA = village birth attendant

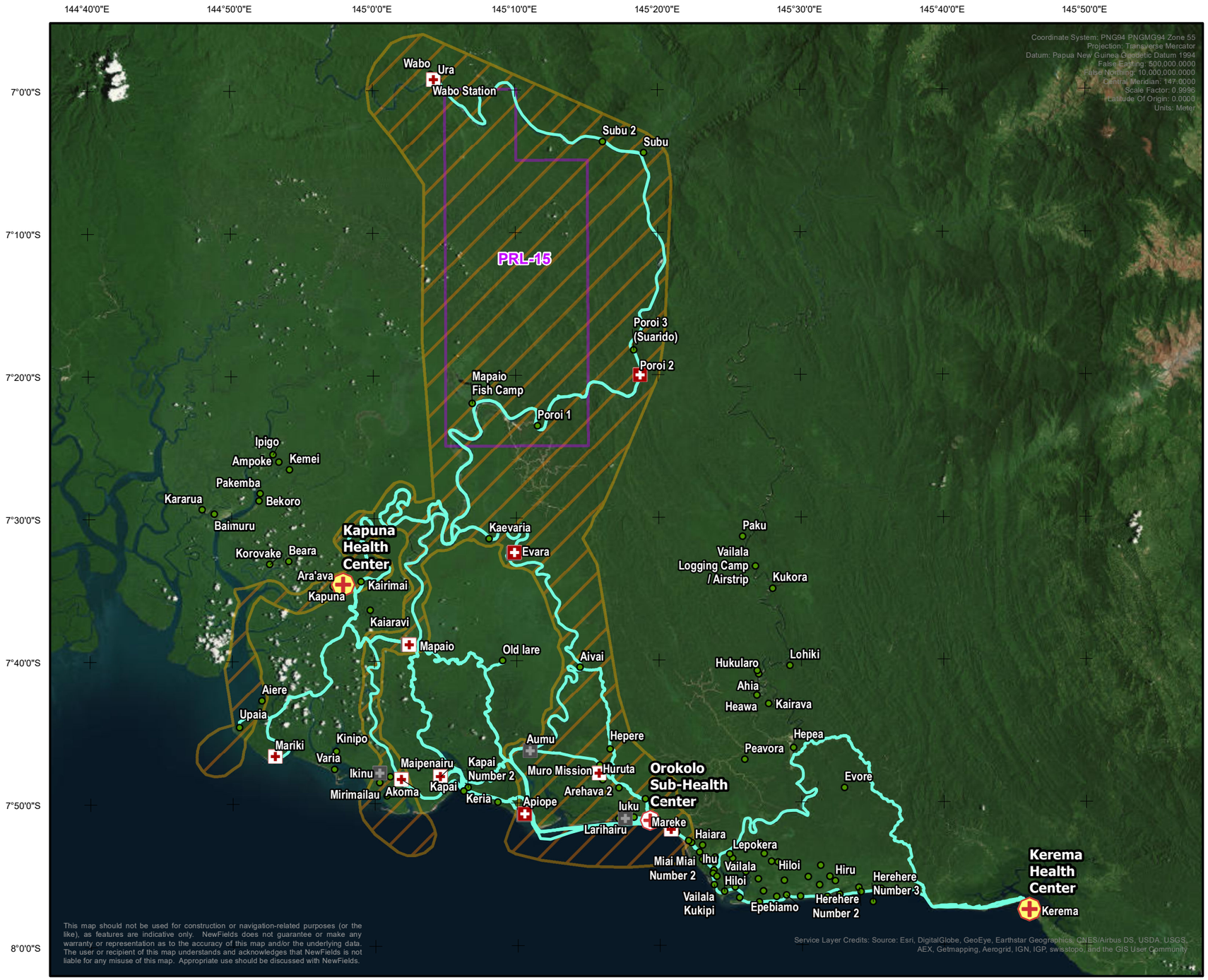
[4] ISOS HEO supported by TEP PNG

Attachment B – Access to Care

These access-to-care routes were obtained through key informant interviews and focus group discussions. The routes indicate where villagers travel to access health care and, where travel time data are available, approximately how long it takes to reach their destination. As indicated by the maps, there is variability in the route and travel times as an individual will typically travel to the closest location but then may change their destination, depending upon whether the aid post is open and/or more complex treatment is required.

These maps should not be used for construction or navigation-related purposes (or the like), as features are indicative only. NewFields does not guarantee or make any warranty or representation as to the accuracy of this map and/or the underlying data. The user or recipient of these maps understands and acknowledges that NewFields is not liable for any misuse of these maps.

Access to Care

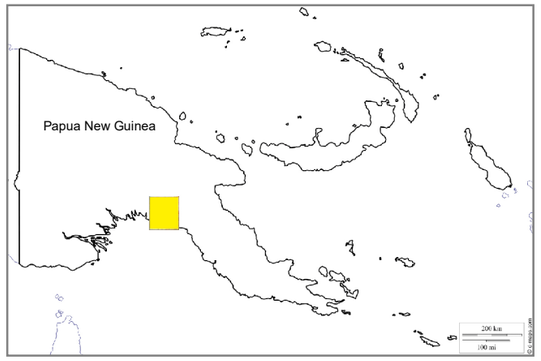


Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Access to Care
- PRL-15
- Project areas of influence

These routes are estimated based on current data.

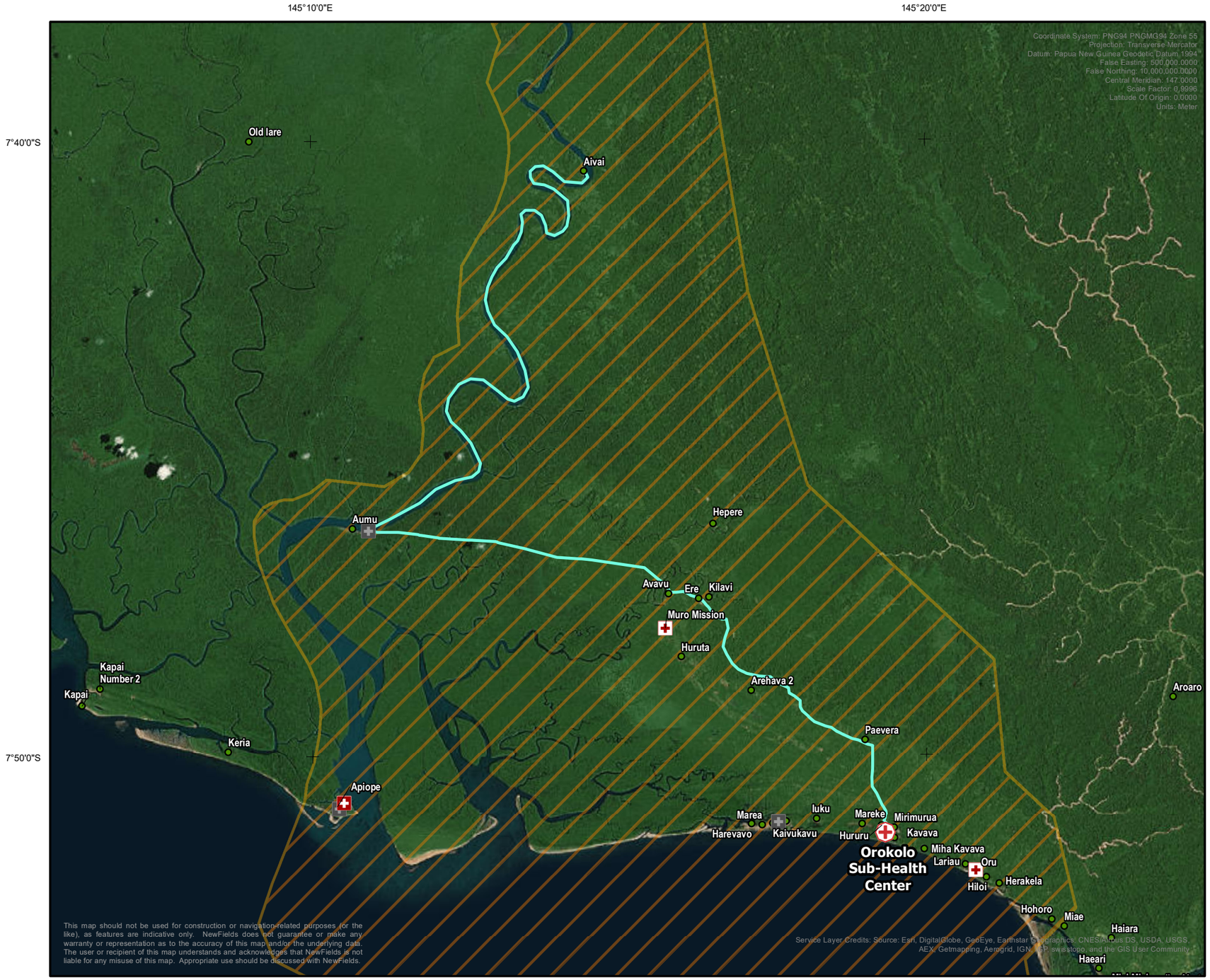
Area of Detail:



Project	**Total PNG Papua New Guinea**
Prepared for:	ERIAS Group 13-25 Church Street Hawthorn VIC 3122 Australia
Prepared by:	NewFields 9400 Station Street, Suite 300 Lone Tree, CO 80124 Tel: +1 (303) 809-5008
Date 2/10/2017 4:50:47 PM	**Scale** 1:560,000
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Aivai to Aumu Aid Post to Orokolo Sub Health Center

Travel time: 2 - 3 days (for deliveries women canoe to Aumu & walk to Orokolo Sub Health Center)



3 1.5 0 3 6 9 12

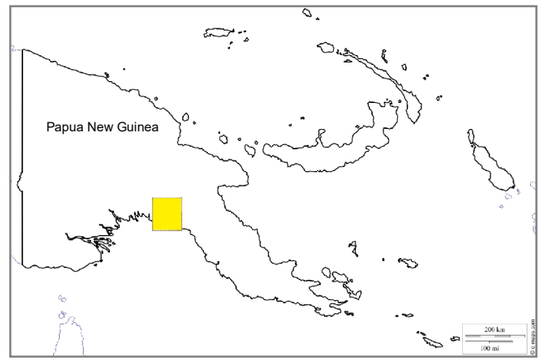
Kilometers

Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Aivai to Aumu Aid Post to Orokolo Sub Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:



Project

Total PNG
Papua New Guinea

Prepared for:

TOTAL COMMITTED TO BETTER ENERGY ERIAS GROUP

ERIAS Group
13-25 Church Street
Hawthorn VIC 3122
Australia

Prepared by:

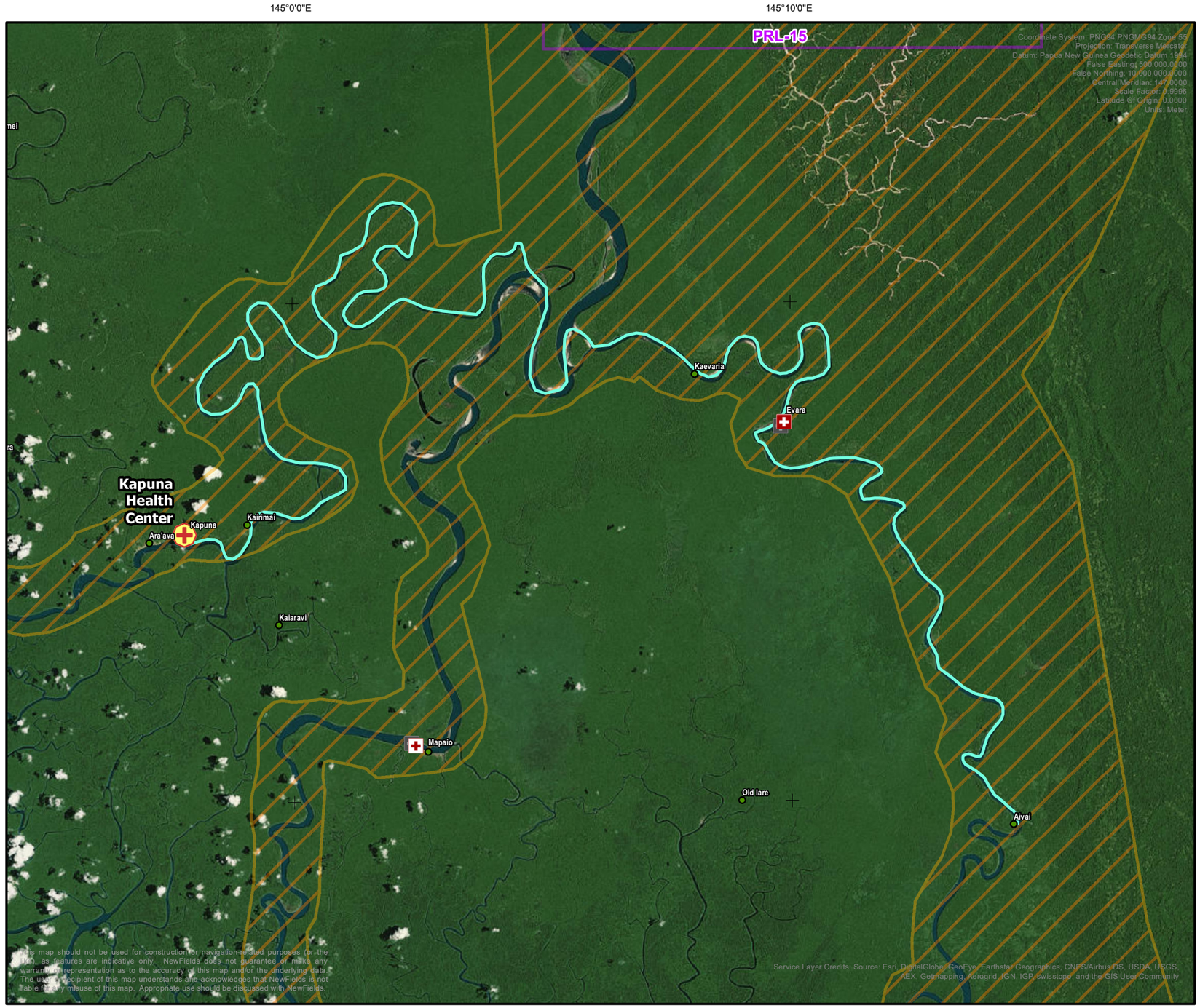
NewFields

NewFields
9400 Station Street, Suite 300
Lone Tree, CO 80124
Tel: +1 (303) 809-5008

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MXD	D:\Total_PNG_GIS\Total_PNG_2017_2_10.mxd		

Aivai to Kapuna Health Center

Travel time: 2 - 3 days (canoe)



4 2 0 4 8 12 16

Kilometers

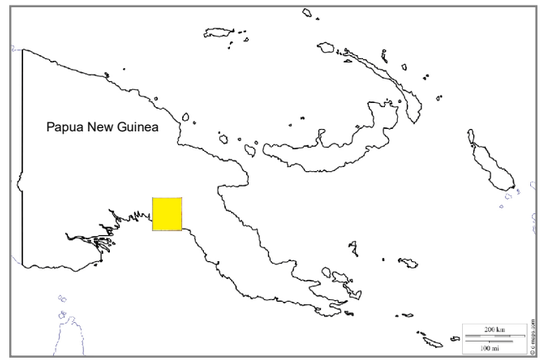
Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Aivai to Kapuna Health Center
- PRL-15
- Project areas of influence

N W E S

This route is estimated based on current data.

Area of Detail:



Project

Total PNG
Papua New Guinea

Prepared for:

TOTAL COMMITTED TO BETTER ENERGY

ERIAS GROUP

ERIAS Group
13-25 Church Street
Hawthorn VIC 3122
Australia

Prepared by:

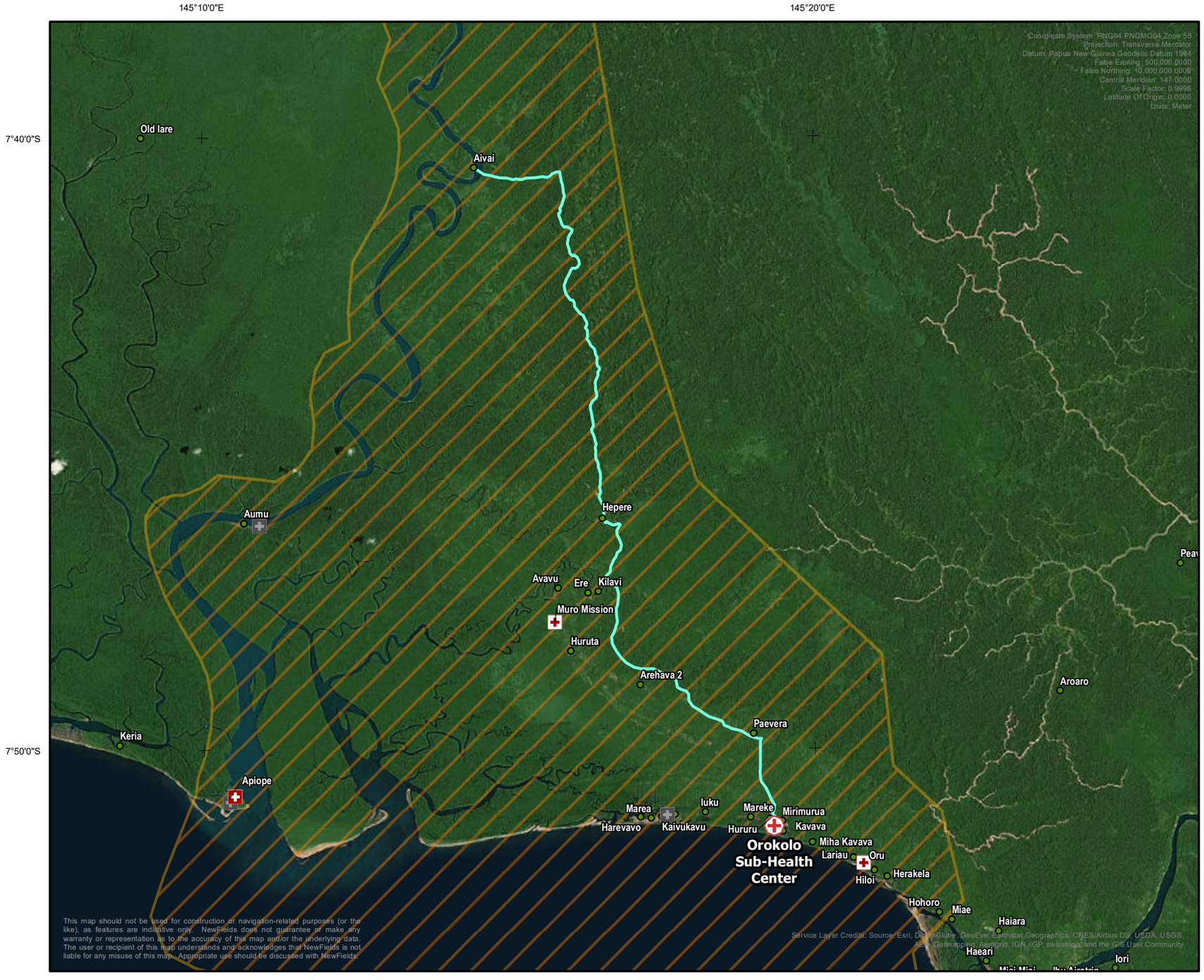
NewFields

NewFields
9400 Station Street, Suite 300
Lone Tree, CO 80124
Tel: +1 (303) 809-5008

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Aivai to Orokolo Sub Health Center

Travel time: 2 - 3 days (walk)



3 1.5 0 3 6 9 12

Kilometers

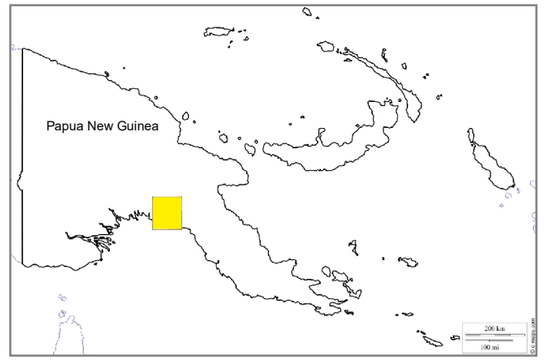
Legend

N W E S

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Aivai to Orokolo Sub Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:



Project	**Total PNG Papua New Guinea**
Prepared for:	ERIAS Group 13-25 Church Street Hawthorn VIC 3122 Australia
Prepared by:	NewFields 9400 Station Street, Suite 300 Lone Tree, CO 80124 Tel: +1 (303) 809-5008
Date 2/10/2017 11:31:07 AM	**Scale** 1:130,000
MXD D:\Total_PNG_GIS\Total_PNG_2017_2_10.mxd	

Akoma & Kairu'u to Kapuna Health Center

Travel time: 1 day (canoe)



4 2 0 4 8 12 16

Kilometers

Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Akoma & Kairu'u to Kapuna Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:

Project

Total PNG
Papua New Guinea

Prepared for:

ERIAS Group
13-25 Church Street
Hawthorn VIC 3122
Australia

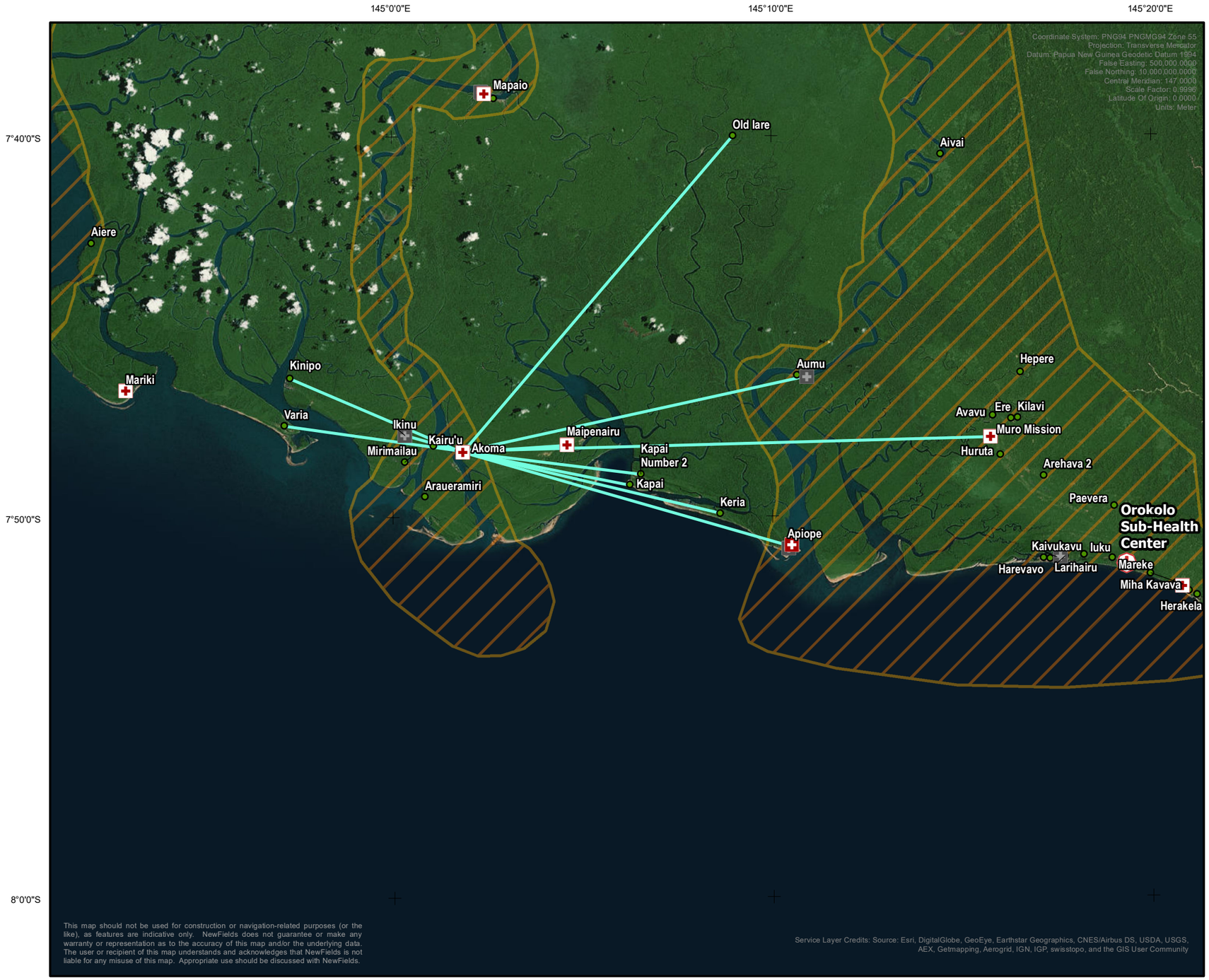
Prepared by:

NewFields
9400 Station Street, Suite 300
Lone Tree, CO 80124
Tel: +1 (303) 809-5008

Date	Scale
2/10/2017 11:31:07 AM	1:165,000

MXD D:\Total_PNG_GIS\Total_PNG_2017_2_10.mxd

Akoma as a Referral Center



Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Akoma as a referral center
- PRL-15
- Project areas of influence

These routes are estimated based on current data.

Area of Detail:

Project

Total PNG
Papua New Guinea

Prepared for:

ERIAS Group
13-25 Church Street
Hawthorn VIC 3122
Australia

Prepared by:

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9400 Station Street, Suite 300
Lone Tree, CO 80124
Tel: +1 (303) 809-5008

Date 2/13/2017 11:17:45 AM	**Scale** 1:210,000
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Apiope to Akoma Aid Post

Travel time: 1 day (canoe)



2 1 0 2 4 6 8

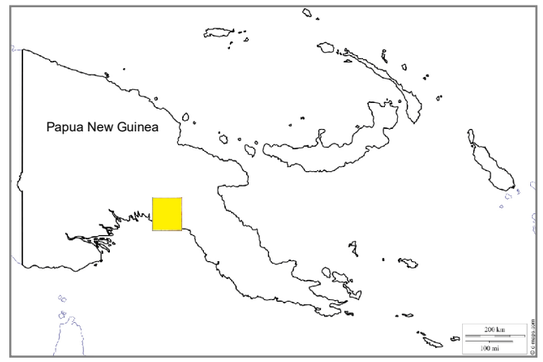
Kilometers

Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Apiope to Akoma Aid Post
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:



Project

Total PNG
Papua New Guinea

Prepared for:

ERIAS Group
13-25 Church Street
Hawthorn VIC 3122
Australia

Prepared by:

NewFields
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Lone Tree, CO 80124
Tel: +1 (303) 809-5008

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Apiope to Kapuna Health Center

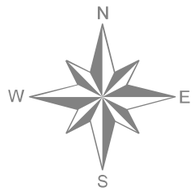
Travel time: 2 days (canoe); 1 day (motor dinghy)



5 2.5 0 5 10 15 20

Kilometers

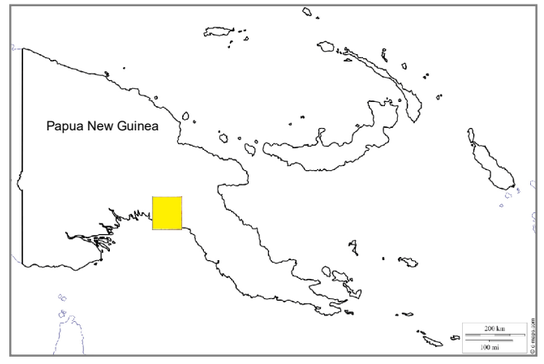
Legend



- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Apiope to Kapuna Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:



Project	**Total PNG Papua New Guinea**
Prepared for:	ERIAS Group 13-25 Church Street Hawthorn VIC 3122 Australia
Prepared by:	NewFields 9400 Station Street, Suite 300 Lone Tree, CO 80124 Tel: +1 (303) 809-5008
Date 2/10/2017 11:31:07 AM	**Scale** 1:195,000
MXD D:\Total_PNG_GIS\Total_PNG_2017_2_10.mxd	

Apiope to Maipenairu Aid Post

Travel time: 1 day (canoe)



1 0.5 0 1 2 3 4

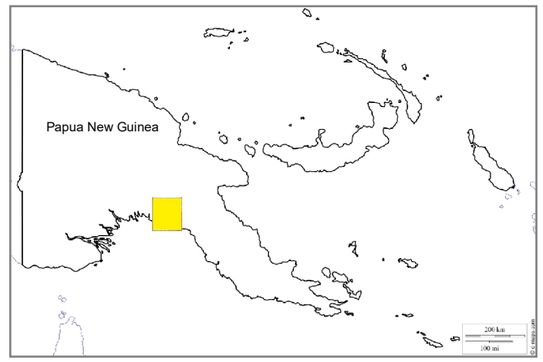
Kilometers

Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Apiope to Maipenairu Aid Post
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:



Project	**Total PNG** **Papua New Guinea**
Prepared for:	ERIAS Group 13-25 Church Street Hawthorn VIC 3122 Australia
Prepared by:	NewFields 9400 Station Street, Suite 300 Lone Tree, CO 80124 Tel: +1 (303) 809-5008
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Ara'ava to Kapuna Health Center

Travel time: 30 minutes (canoe); 10 minutes (walk)



0.15 0.075 0 0.15 0.3 0.45 0.6

Kilometers

Legend

N

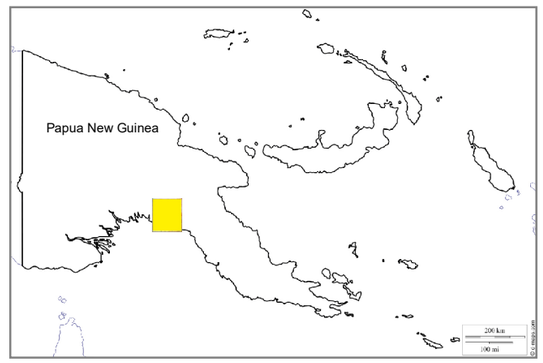
W E

S

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Ara'ava to Kapuna Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:



Project

Total PNG
Papua New Guinea

Prepared for:

TOTAL COMMITTED TO BETTER ENERGY ERIAS GROUP

ERIAS Group
13-25 Church Street
Hawthorn VIC 3122
Australia

Prepared by:

NewFields

NewFields
9400 Station Street, Suite 300
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Date 4/25/2017 11:42:15 AM	**Scale** 1:6,260
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Aumu to Apiope Aid Post



Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Aumu to Apiope Aid Post
- PRL-15
- Project areas of influence

N W E S

This route is estimated based on current data.

Area of Detail:



Project	**Total PNG Papua New Guinea**
Prepared for:	ERIAS Group 13-25 Church Street Hawthorn VIC 3122 Australia
Prepared by:	NewFields 9400 Station Street, Suite 300 Lone Tree, CO 80124 Tel: +1 (303) 809-5008
Date 2/13/2017 11:05:36 AM	**Scale** 1:60,000
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Aumu to Maipenairu Aid Post



1.5 0.75 0 1.5 3 4.5 6

Kilometers

Legend

N

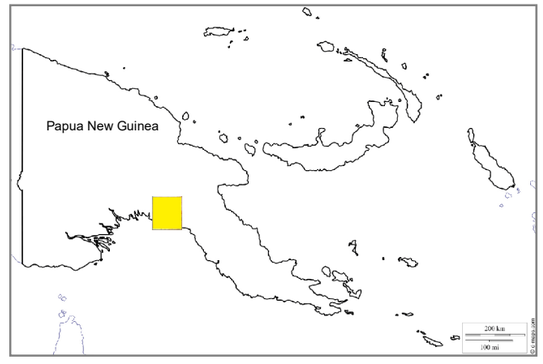
W E

S

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Aumu to Maipenairu Aid Post
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:



Project	**Total PNG** **Papua New Guinea**
Prepared for:	ERIAS Group 13-25 Church Street Hawthorn VIC 3122 Australia
Prepared by:	NewFields 9400 Station Street, Suite 300 Lone Tree, CO 80124 Tel: +1 (303) 809-5008
Date 2/13/2017 11:05:36 AM	**Scale** 1:65,000
MXD D:\Total_PNG_GIS\Total_PNG_2017_2_10.mxd	

Aumu to Orokolo Sub Health Center

Travel time: 1 day (canoe to Orokolo Sub Health Center); 2 days canoe to Kapuna)



Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Aumu to Orokolo Sub Health Center
- PRL-15
- Project areas of influence

N W E S

This route is estimated based on current data.

Area of Detail:



Project	**Total PNG Papua New Guinea**
Prepared for:	ERIAS Group 13-25 Church Street Hawthorn VIC 3122 Australia
Prepared by:	NewFields 9400 Station Street, Suite 300 Lone Tree, CO 80124 Tel: +1 (303) 809-5008
Date 2/10/2017 3:09:40 PM	**Scale** 1:100,000
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Avavu to Muro Station Aid Post

Travel time: 20 minutes (walk)



0.25 0.125 0 0.25 0.5 0.75 1

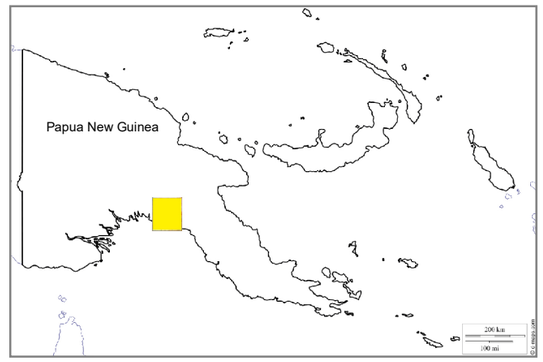
Kilometers

Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Avavu to Muro Station Aid Post
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:



Project	**Total PNG** **Papua New Guinea**
Prepared for:	ERIAS Group 13-25 Church Street Hawthorn VIC 3122 Australia
Prepared by:	NewFields 9400 Station Street, Suite 300 Lone Tree, CO 80124 Tel: +1 (303) 809-5008
Date 2/10/2017 3:09:40 PM	**Scale** 1:10,000
MXD D:\Total_PNG_GIS\Total_PNG_2017_2_10.mxd	

Ere Kilavi to Muro Station Aid Post

Travel time: 30 minutes (walk)



0.25 0.125 0 0.25 0.5 0.75 1

Kilometers

Legend

N

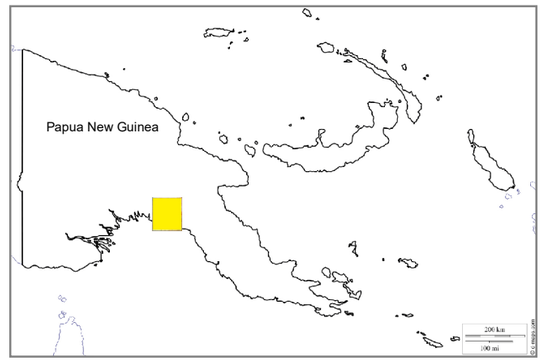
W E

S

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Ere Kilavi to Muro Station Aid Post
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:



Project

Total PNG
Papua New Guinea

Prepared for:

TOTAL COMMITTED TO BETTER ENERGY

ERIAS GROUP

ERIAS Group
13-25 Church Street
Hawthorn VIC 3122
Australia

Prepared by:

NewFields

NewFields
9400 Station Street, Suite 300
Lone Tree, CO 80124
Tel: +1 (303) 809-5008

Date 2/10/2017 3:09:40 PM

Scale 1:10,000

MXD D:\Total_PNG_GIS\Total_PNG_2017_2_10.mxd

Ere Kilavi to Orokolo Sub Health Center

Travel time: 3 hours (walk)



1 0.5 0 1 2 3 4

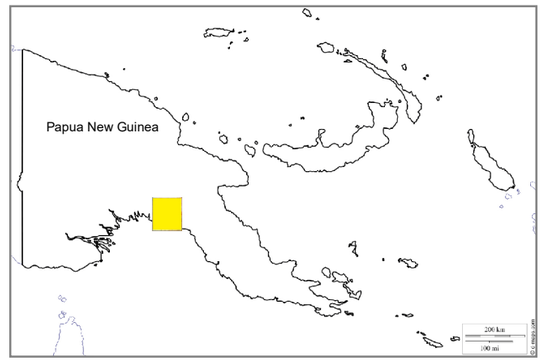
Kilometers

Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Ere Kilavi to Orokolo Sub Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:



Project

Total PNG
Papua New Guinea

Prepared for:

TOTAL COMMITTED TO BETTER ENERGY · ERIAS GROUP

ERIAS Group
13-25 Church Street
Hawthorn VIC 3122
Australia

Prepared by:

NewFields

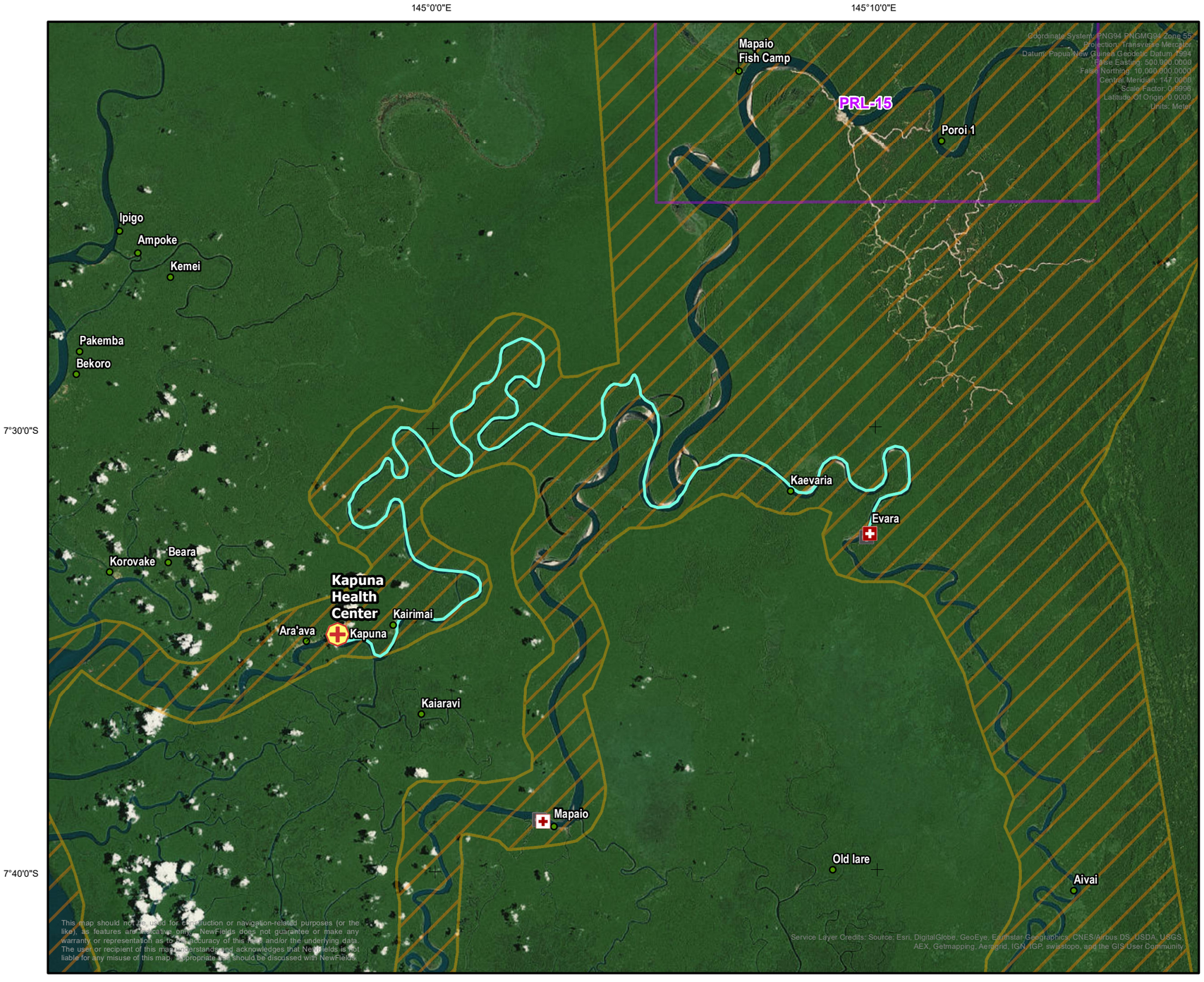
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9400 Station Street, Suite 300
Lone Tree, CO 80124
Tel: +1 (303) 809-5008

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MXD D:\Total_PNG_GIS\Total_PNG_2017_2_10.mxd

Evara to Kapuna Health Center

Travel time: 3 hours (motor dinghy)



4.5 2.25 0 4.5 9 13.5 18

Kilometers

Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Evara to Kapuna Health Center
- PRL-15
- Project areas of influence

N W E S

This route is estimated based on current data.

Area of Detail:

Project

Total PNG
Papua New Guinea

Prepared for:

TOTAL COMMITTED TO BETTER ENERGY · ERIAS GROUP

ERIAS Group
13-25 Church Street
Hawthorn VIC 3122
Australia

Prepared by:

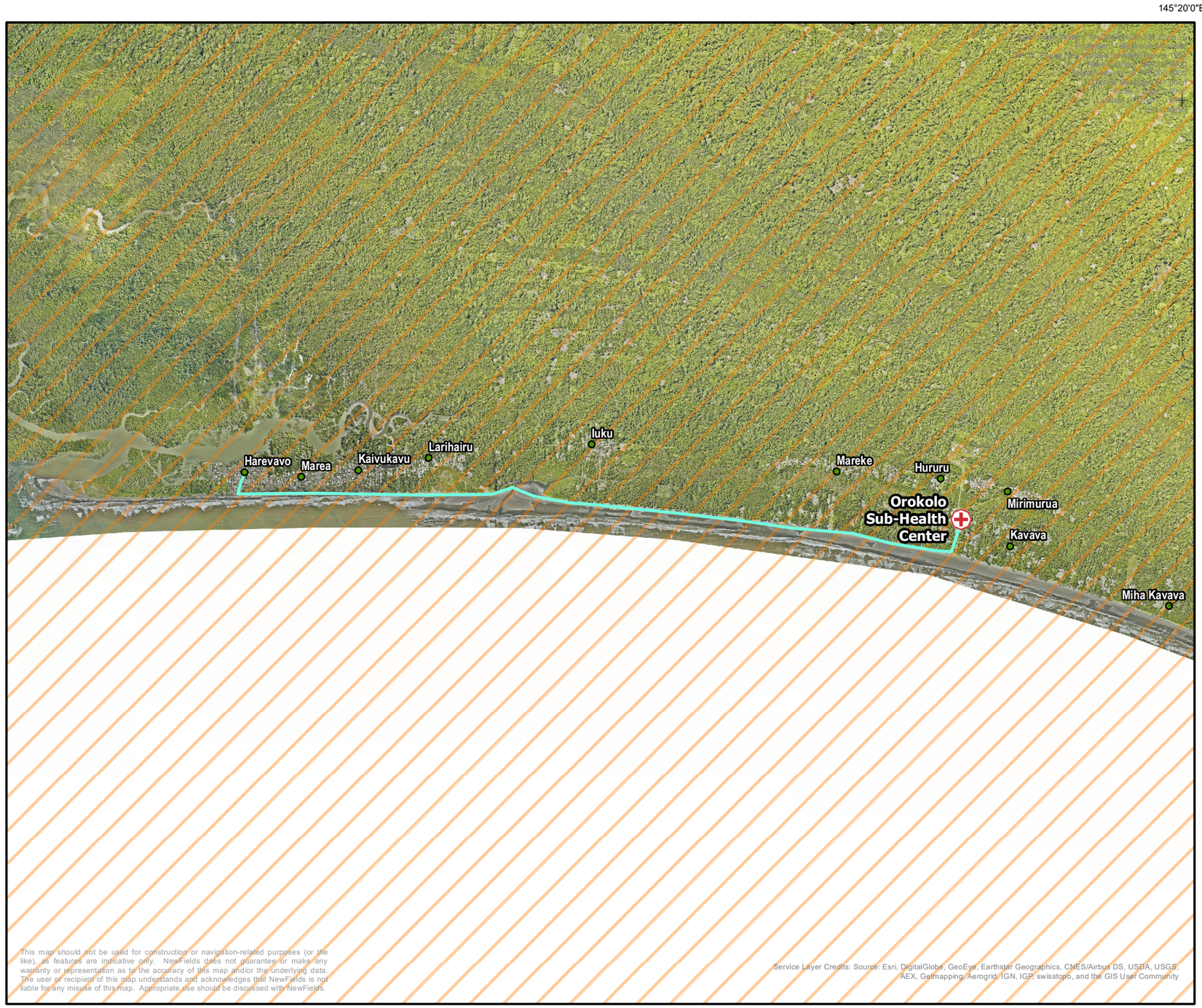
NewFields

NewFields
9400 Station Street, Suite 300
Lone Tree, CO 80124
Tel: +1 (303) 809-5008

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Harevavo to Orokolo Sub Health Center

Travel time: 1-2 hours (walk)



0.6 0.3 0 0.6 1.2 1.8 2.4

Kilometers

Legend

N

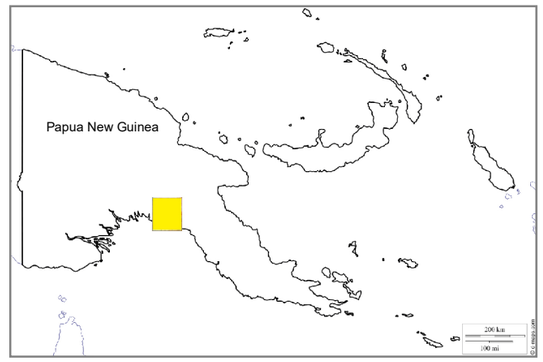
W E

S

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Harevavo to Orokolo Sub Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:



Project

Total PNG
Papua New Guinea

Prepared for:

TOTAL COMMITTED TO BETTER ENERGY ERIAS GROUP

ERIAS Group
13-25 Church Street
Hawthorn VIC 3122
Australia

Prepared by:

NewFields

NewFields
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Lone Tree, CO 80124
Tel: +1 (303) 809-5008

Date	2/10/2017 3:22:06 PM	Scale	1:25,000
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Hepere to Muro Station Aid Post to Orokolo Sub Health Center

Travel time: 4-5 hours (walk) to Orokolo Sub Health Center



1.5 0.75 0 1.5 3 4.5 6

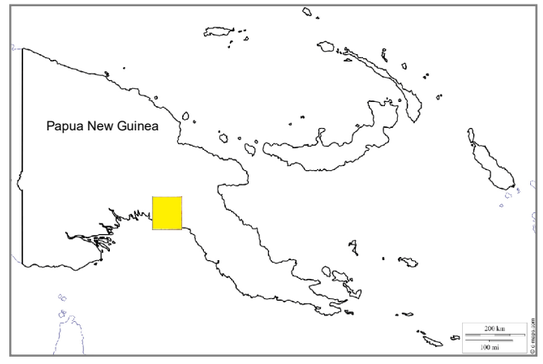
Kilometers

Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Hepere to Muro Station Aid Post to Orokolo Sub Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:



Project

Total PNG
Papua New Guinea

Prepared for:

TOTAL COMMITTED TO BETTER ENERGY · ERIAS GROUP

ERIAS Group
13-25 Church Street
Hawthorn VIC 3122
Australia

Prepared by:

NewFields

NewFields
9400 Station Street, Suite 300
Lone Tree, CO 80124
Tel: +1 (303) 809-5008

Date	2/10/2017 3:22:06 PM	Scale	1:65,000
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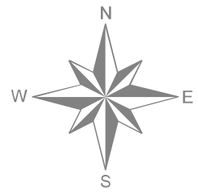
Herakela, Hiloi, Lariau, to Oru Aid Post



0.1 0.05 0 0.1 0.2 0.3 0.4

Kilometers

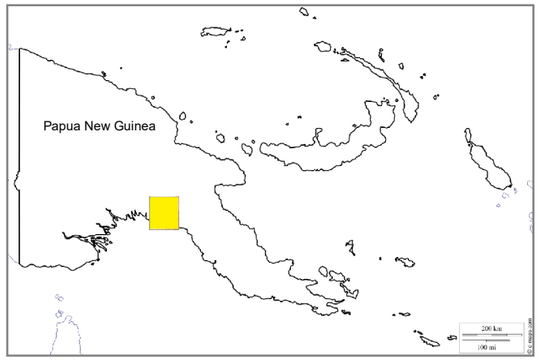
Legend



- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Herakela, Hiloi, Lariau, to Oru Aid Post
- PRL-15
- Project areas of influence

These routes are estimated based on current data.

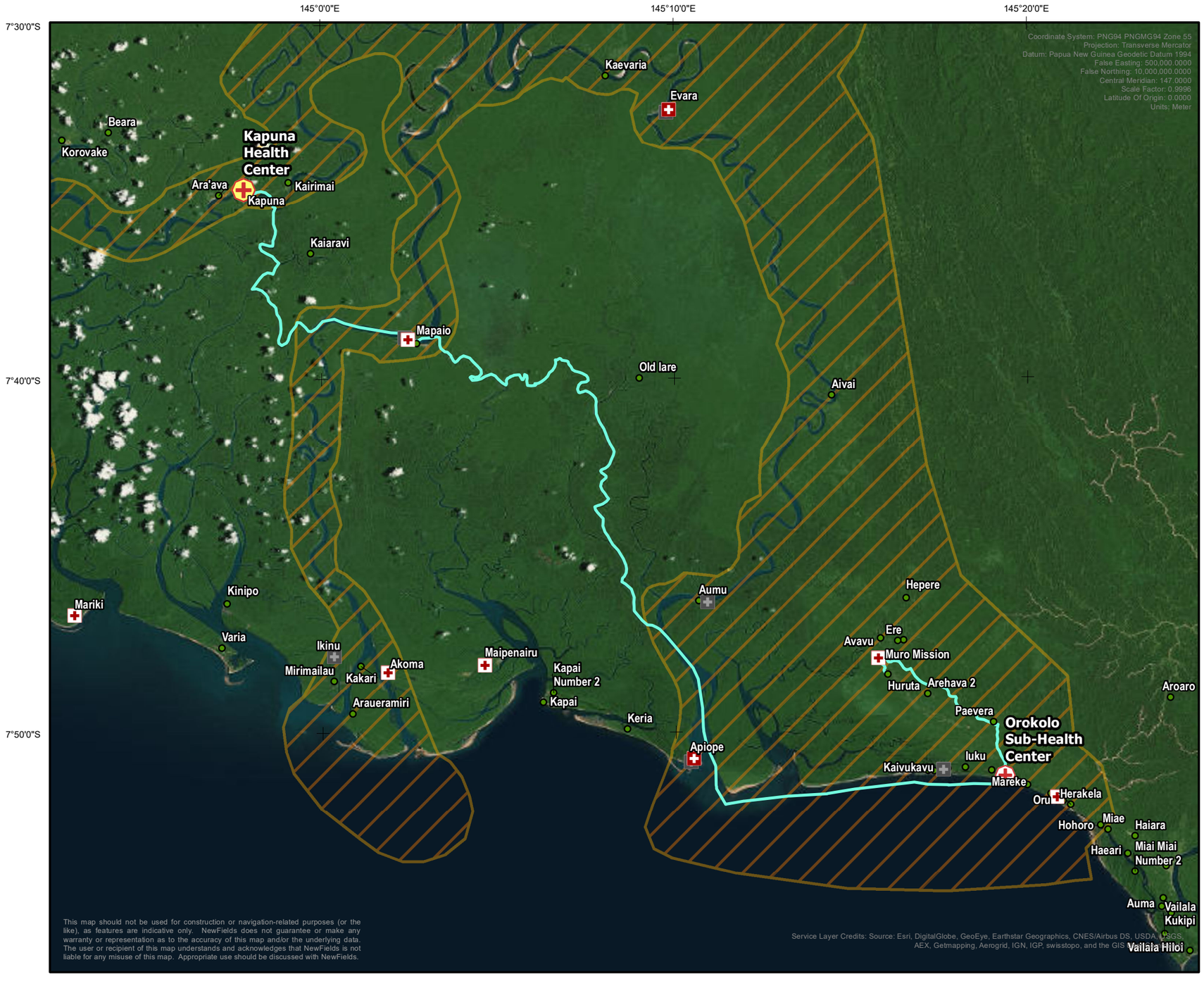
Area of Detail:



Project	**Total PNG** **Papua New Guinea**
Prepared for:	ERIAS Group 13-25 Church Street Hawthorn VIC 3122 Australia
Prepared by:	NewFields 9400 Station Street, Suite 300 Lone Tree, CO 80124 Tel: +1 (303) 809-5008
Date 2/10/2017 4:50:47 PM	**Scale** 1:4,770
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Huruta to Muro Station Aid Post and Kapuna Health Center

Travel time: 3-4 hours (walk) to Orokolo Sub Health Center; 1 day by Dinghy to Kapuna Health Center



5.5 2.75 0 5.5 11 16.5 22

Kilometers

Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Huruta to Muro Station Aid Post and Kapuna Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:

Project	**Total PNG Papua New Guinea**
Prepared for:	ERIAS Group 13-25 Church Street Hawthorn VIC 3122 Australia
Prepared by:	NewFields 9400 Station Street, Suite 300 Lone Tree, CO 80124 Tel: +1 (303) 809-5008
Date 2/10/2017 3:22:06 PM	**Scale** 1:225,000
MXD D:\Total_PNG_GIS\Total_PNG_2017_2_10.mxd	

Iuku to Orokolo Sub Health Center

Travel time: 1-2 hours (walk)



0.25 0.125 0 0.25 0.5 0.75 1

Kilometers

Legend

N

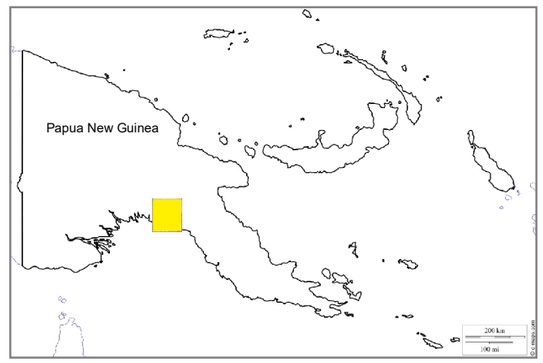
W E

S

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Iuku to Orokolo Sub Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:



Project

Total PNG
Papua New Guinea

Prepared for:

TOTAL COMMITTED TO BETTER ENERGY ERIAS GROUP

ERIAS Group
13-25 Church Street
Hawthorn VIC 3122
Australia

Prepared by:

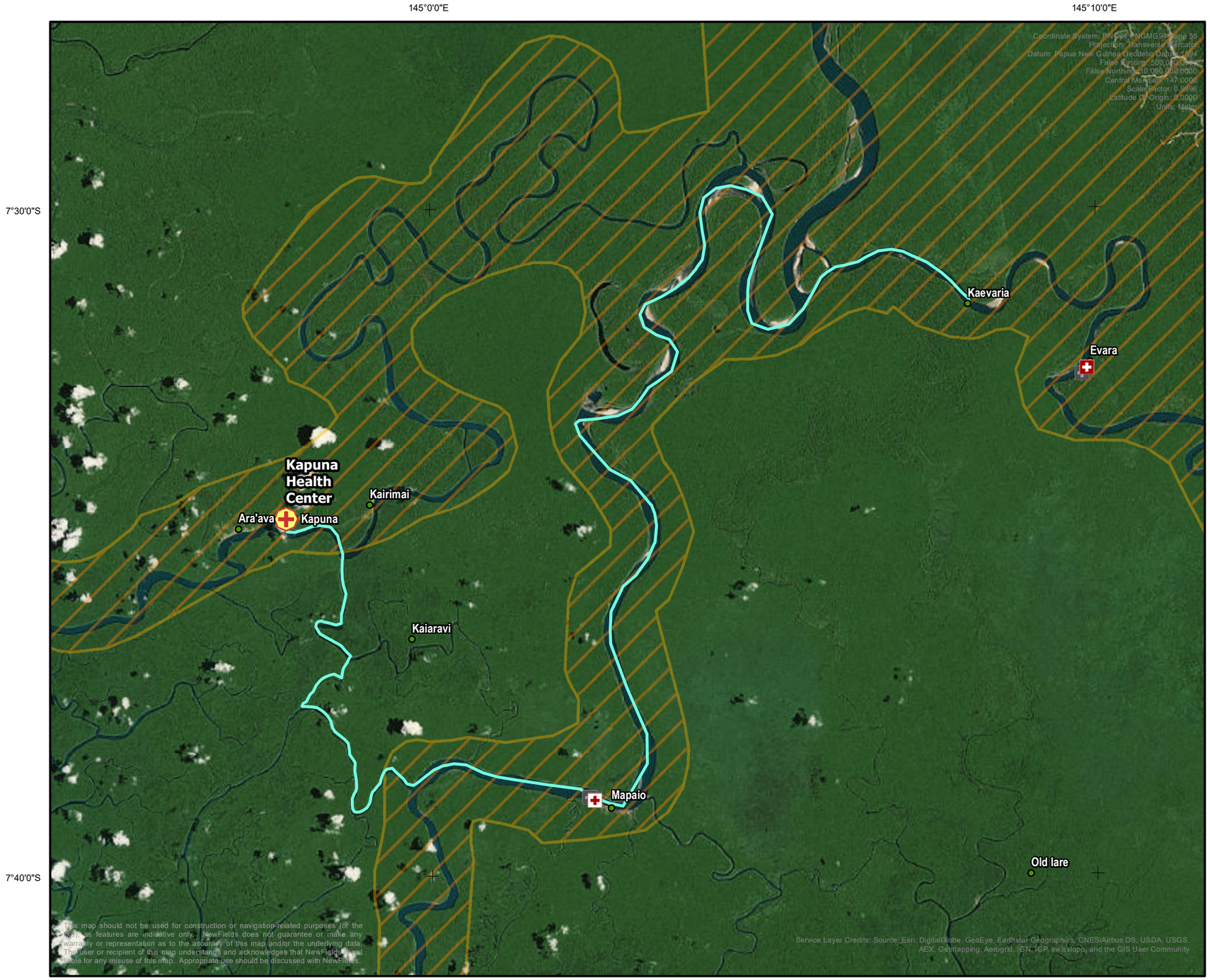
NewFields

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Date	2/10/2017 3:22:06 PM	Scale	1:10,000
MXD	D:\Total_PNG_GIS\Total_PNG_2017_2_10.mxd		

Kaevaria to Mapaio to Kapuna Health Center

Travel time: 2 days (canoe); stop at Mapaio



3 1.5 0 3 6 9 12

Kilometers

Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Kaevaria to Mapaio to Kapuna Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:

Project

Total PNG
Papua New Guinea

Prepared for:

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ERIAS GROUP

ERIAS Group
13-25 Church Street
Hawthorn VIC 3122
Australia

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Tel: +1 (303) 809-5008

Date 2/13/2017 11:05:36 AM

Scale 1:120,000

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Kairimai to Kapuna Health Center

Travel time: 5 minutes (motor dinghy); 25 minutes (canoe)



0.350.175 0 0.35 0.7 1.05 1.4

Kilometers

Legend

N

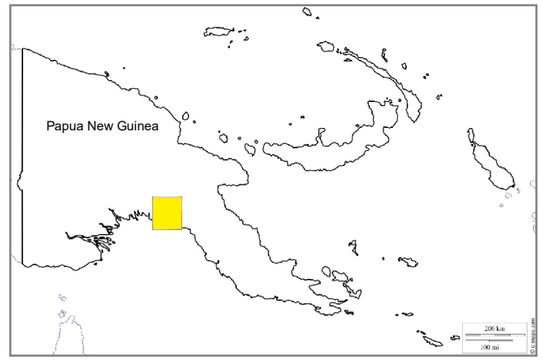
W E

S

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Kairimai to Kapuna Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:



Project

Total PNG
Papua New Guinea

Prepared for:

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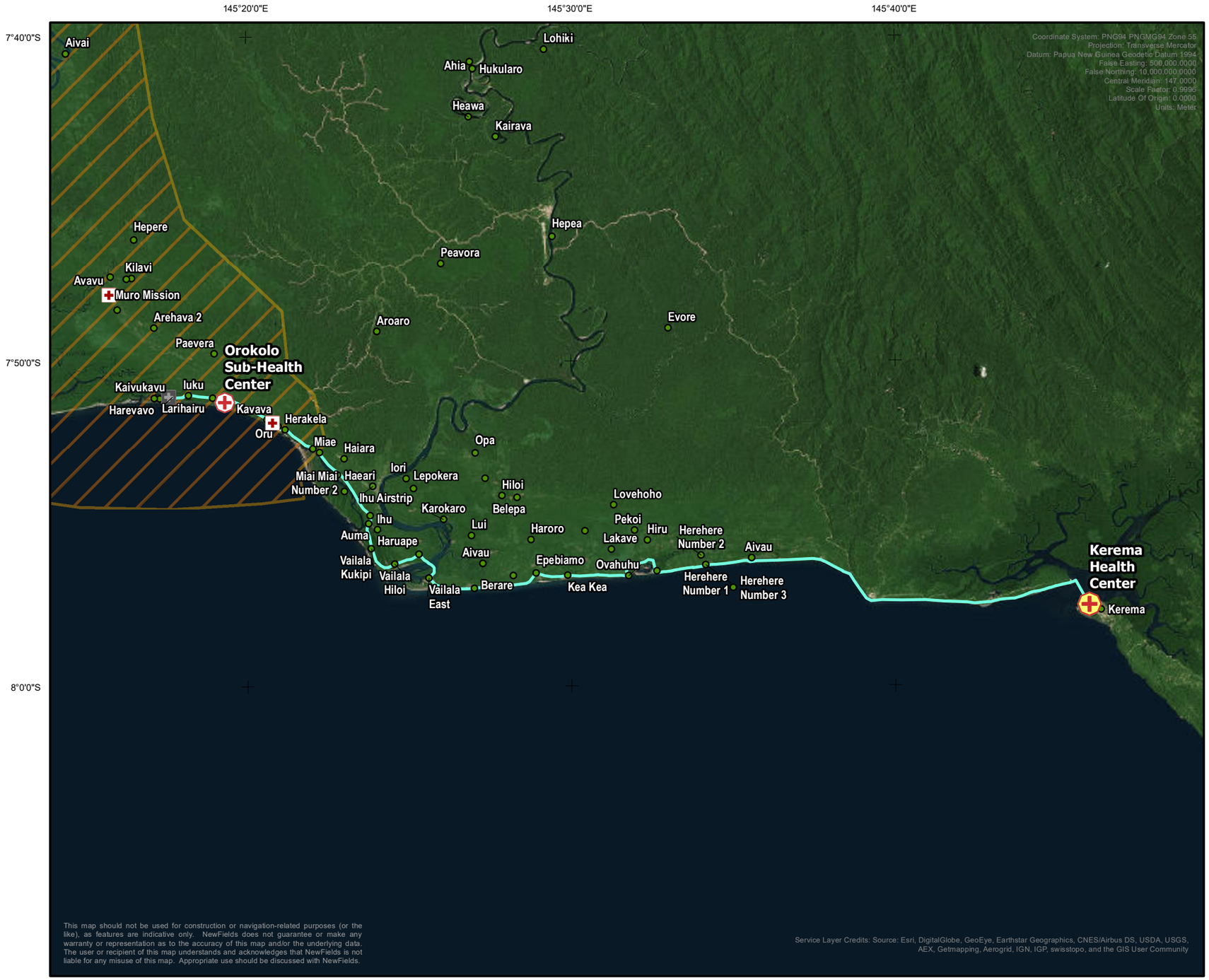
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Kaivukavu to Kerema Health Center

Travel time: 2 days (walk)

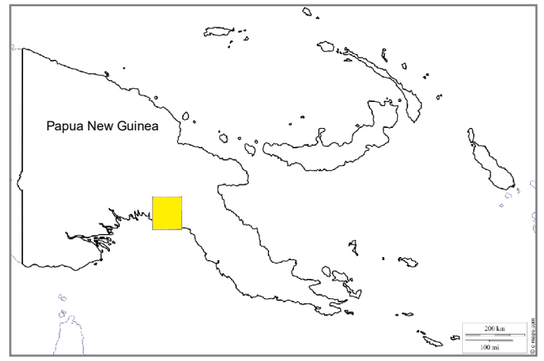


Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Kaivukavu to Kerema Health Center
- PRL-15
- Project areas of influence

These routes are estimated based on current data.

Area of Detail:



Project	**Total PNG Papua New Guinea**
Prepared for:	ERIAS Group 13-25 Church Street Hawthorn VIC 3122 Australia
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Kaivukavu to Orokolo Sub Health Center

Travel time: 1-2 hours (walk)



0.5 0.25 0 0.5 1 1.5 2

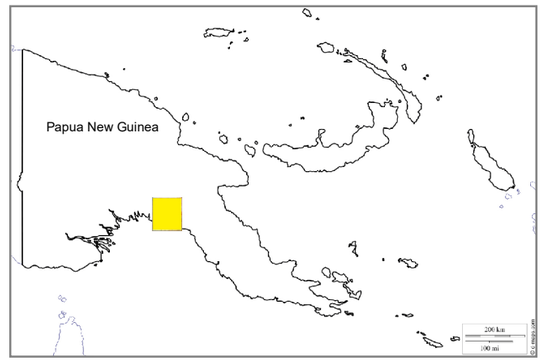
Kilometers

Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Kaivukavu to Orokolo Sub Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

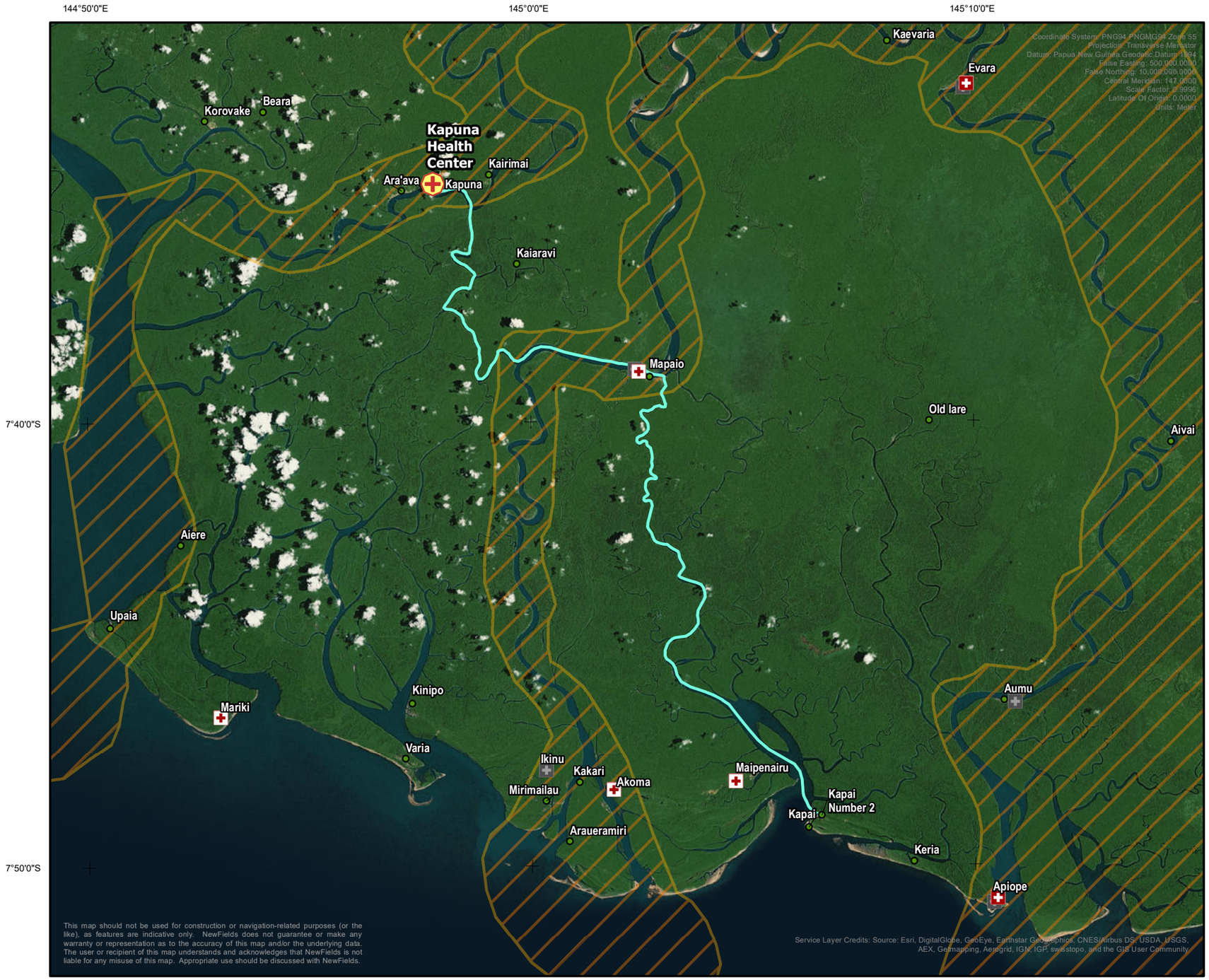
Area of Detail:



Project	**Total PNG** **Papua New Guinea**
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Prepared by:	NewFields 9400 Station Street, Suite 300 Lone Tree, CO 80124 Tel: +1 (303) 809-5008
Date 2/10/2017 3:22:06 PM	**Scale** 1:20,000
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Kapai 2 to Kapuna Health Center

Travel time: 2 days (canoe)



4.5 2.25 0 4.5 9 13.5 18

Kilometers

Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Kapai 2 to Kapuna Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:

Project

Total PNG
Papua New Guinea

Prepared for:

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Date 2/13/2017 11:17:45 AM

Scale 1:180,000

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Kavava to Orokolo Sub Health Center

Travel time: 1-5 minutes (walk)



0.1 0.05 0 0.1 0.2 0.3 0.4

Kilometers

Legend

N

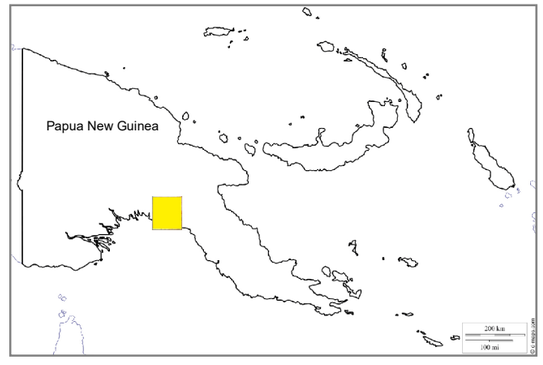
W E

S

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Kavava to Orokolo Sub Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:



Project	**Total PNG** **Papua New Guinea**
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Larihairu to Orokolo Sub Health Center

Travel time: 1-2 hours (walk)



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0.35 0.175 0 0.35 0.7 1.05 1.4

Kilometers

Legend

N

W E

S

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Larihairu to Orokolo Sub Health Center
- PRL-15
- Project areas of influence

These routes are estimated based on current data.

Area of Detail:



Project

Total PNG
Papua New Guinea

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Maipenairu to Kapuna Health Center

Travel time: 1 day (canoe)



4 2 0 4 8 12 16

Kilometers

Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Maipenairu to Kapuna Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:

Project	**Total PNG Papua New Guinea**
Prepared for:	ERIAS Group 13-25 Church Street Hawthorn VIC 3122 Australia
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Date: 2/13/2017 11:17:45 AM	Scale: 1:170,000
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Maipenairu to Orokolo Sub Health Center



3.5 1.75 0 3.5 7 10.5 14

Kilometers

Legend

N W E S

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Maipenairu to Orokolo Sub Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:

Project

Total PNG
Papua New Guinea

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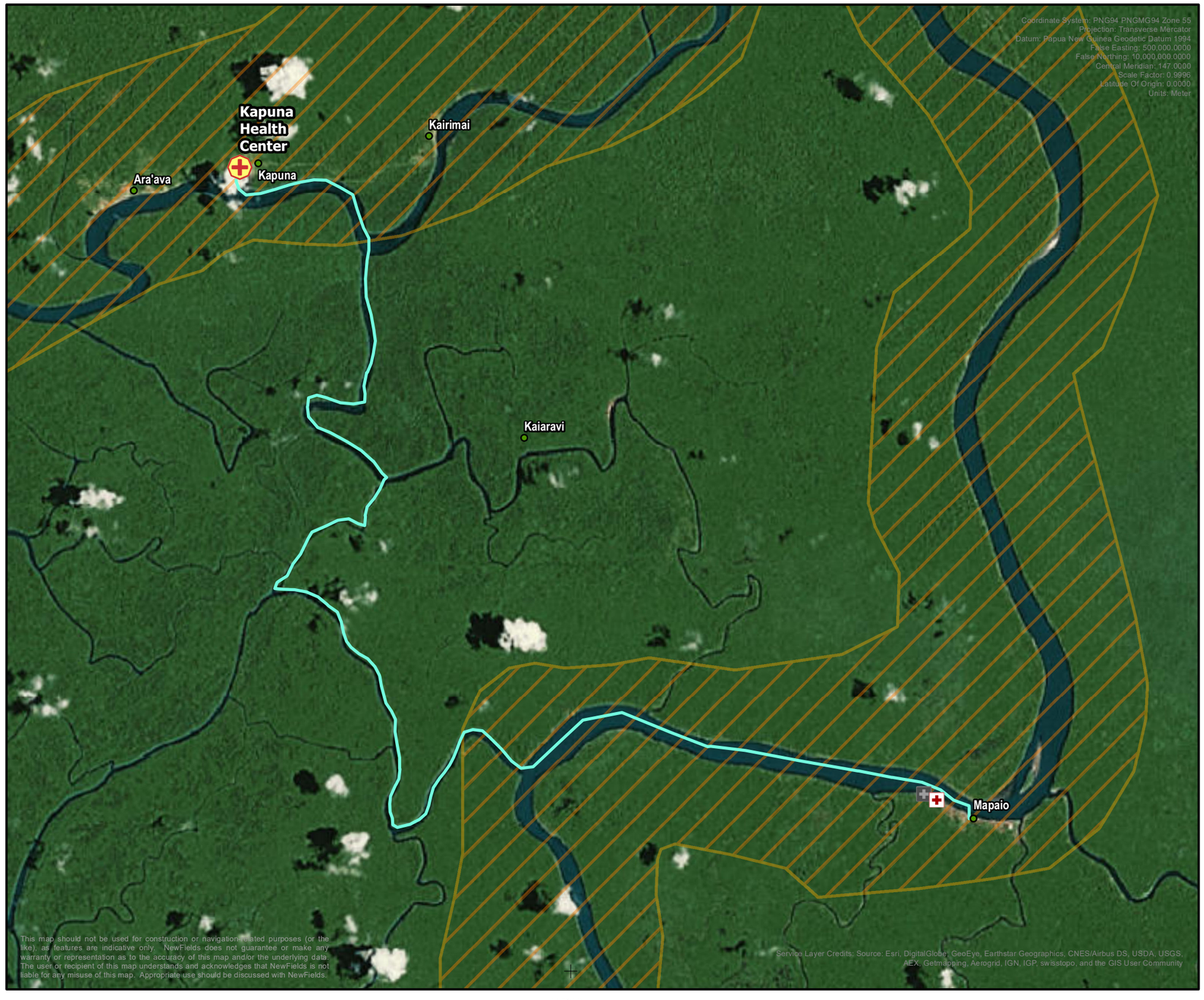
Scale 1:155,000

MXD D:\Total_PNG_GIS\Total_PNG_2017_2_13.mxd

Mapaio to Kapuna Health Center

Travel time: 4 hours (canoe); 2 hours (motor dinghy)

145°0'0"E



7°40'0"S

145°0'0"E

1 0.5 0 1 2 3 4

Kilometers

Legend

N

W E

S

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Mapaio to Kapuna Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:

Project

Total PNG
Papua New Guinea

Prepared for:

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Australia

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Date	2/10/2017 3:22:06 PM	Scale	1:55,000
MXD	D:\Total_PNG_GIS\Total_PNG_2017_2_10.mxd		

Marea to Orokolo Sub Health Center

Travel time: 1-2 hours (walk)



0.75 0.375 0 0.75 1.5 2.25 3

Kilometers

Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Marea to Orokolo Sub Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:



Project

Total PNG
Papua New Guinea

Prepared for:

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Hawthorn VIC 3122
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Date	2/13/2017 11:17:45 AM	Scale	1:30,000
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Mareke to Orokolo Sub Health Center

Travel time: 30 minutes (walk)



0.1 0.05 0 0.1 0.2 0.3 0.4

Kilometers

Legend

N

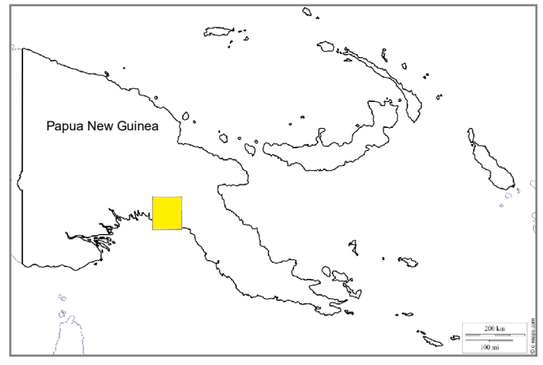
W E

S

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Mareke to Orokolo Sub Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:



Project

Total PNG
Papua New Guinea

Prepared for:

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Hawthorn VIC 3122
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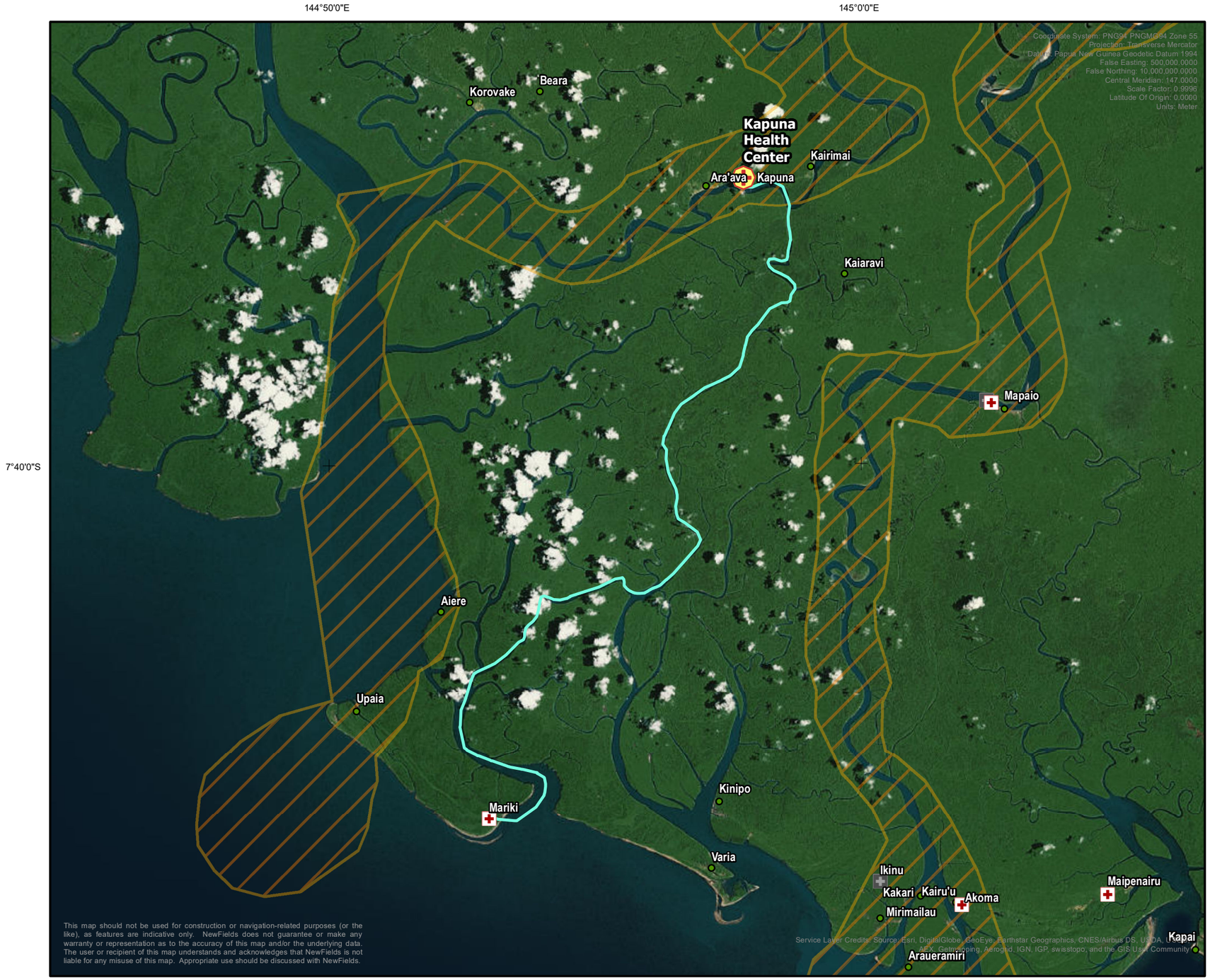
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MXD D:\Total_PNG_GIS\Total_PNG_2017_2_10.mxd

Mariki to Kapuna Health Center

Travel time: 5-6 hours (canoe) 2-3 hours (motor dingy)



3.5 1.75 0 3.5 7 10.5 14

Kilometers

Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Mariki to Kapuna Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

N W E S

Area of Detail:

Project

Total PNG
Papua New Guinea

Prepared for:

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Hawthorn VIC 3122
Australia

Prepared by:

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Date	2/10/2017 4:23:01 PM	Scale	1:150,000
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Orokolo to Akoma Aid Post



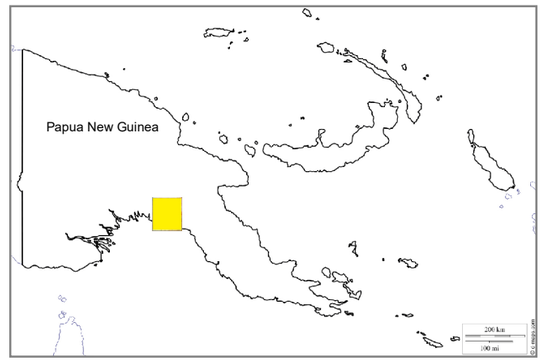
Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Orokolo to Akoma Aid
- PRL-15
- Project areas of influence

This route is estimated based on current data.

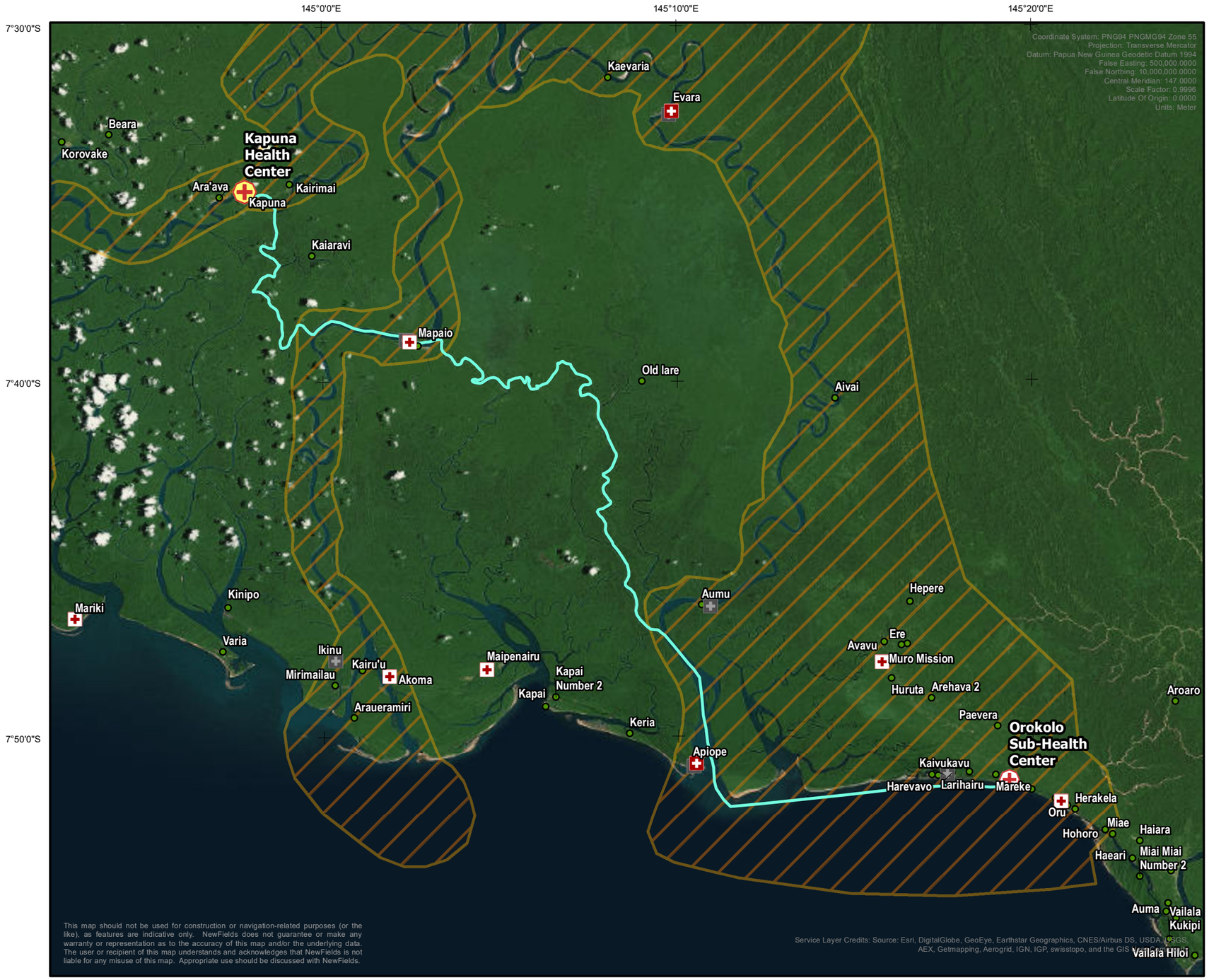
N W E S

Area of Detail:



Project	**Total PNG Papua New Guinea**
Prepared for:	ERIAS Group 13-25 Church Street Hawthorn VIC 3122 Australia
Prepared by:	NewFields 9400 Station Street, Suite 300 Lone Tree, CO 80124 Tel: +1 (303) 809-5008
Date 2/10/2017 4:23:01 PM	**Scale** 1:180,000
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Orokolo to Kapuna Health Center



5.5 2.75 0 5.5 11 16.5 22

Kilometers

Legend

N W E S

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Orokolo to Kapuna Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:

Project

Total PNG
Papua New Guinea

Prepared for:

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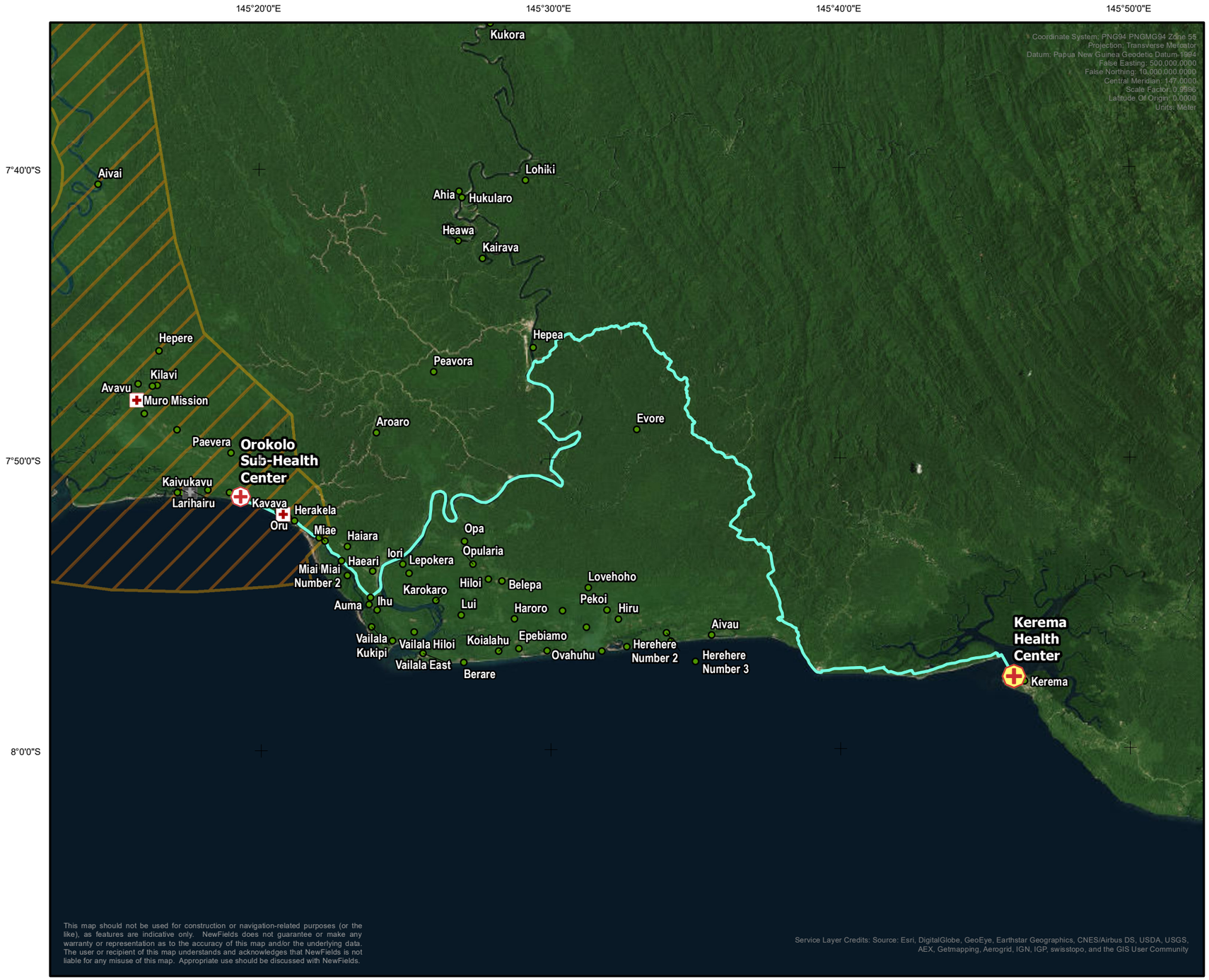
Date 2/10/2017 4:23:01 PM

Scale 1:225,000

MXD D:\Total_PNG_GIS\Total_PNG_2017_2_10.mxd

Orokolo to Kerema Health Center

Travel time: No data to Ihu, 1.5 hrs by powered boat to HEPEA logging camp then 3 hrs by road to Kerema Health Center



7 3.5 0 7 14 21 28

Kilometers

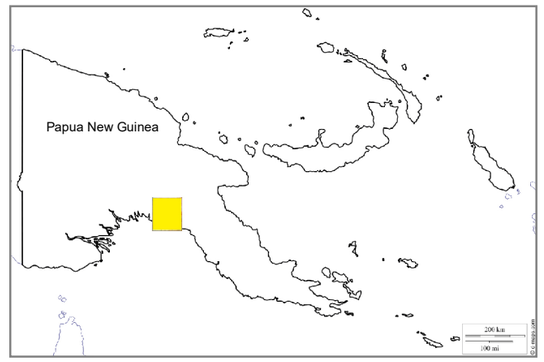
Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Orokolo to Kerema Health Center
- PRL-15
- Project areas of influence

N W E S

This route is estimated based on current data.

Area of Detail:



Project	**Total PNG Papua New Guinea**
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Oru, Lariau, Herakela to Orokolo Sub Health Center

Travel time: 5 minutes walk to Lariau & 30 minutes (walk)



0.5 0.25 0 0.5 1 1.5 2

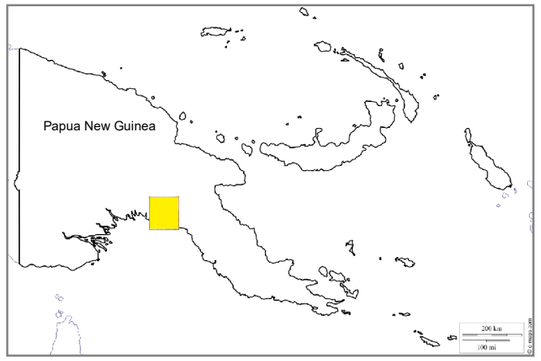
Kilometers

Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Oru, Lariau, Herakela to Orokolo Sub Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:



Project	**Total PNG Papua New Guinea**
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MXD D:\Total_PNG_GIS\Total_PNG_2017_2_10.mxd	

Paevera to Orokolo Sub Health Center

Travel time: 1-3 hours (walk)



0.5 0.25 0 0.5 1 1.5 2

Kilometers

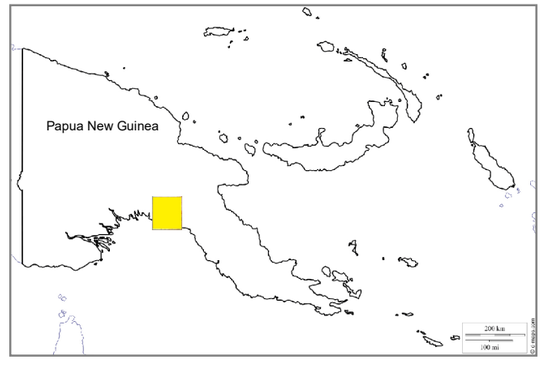
Legend

N W E S

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Paevera to Orokolo Sub Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

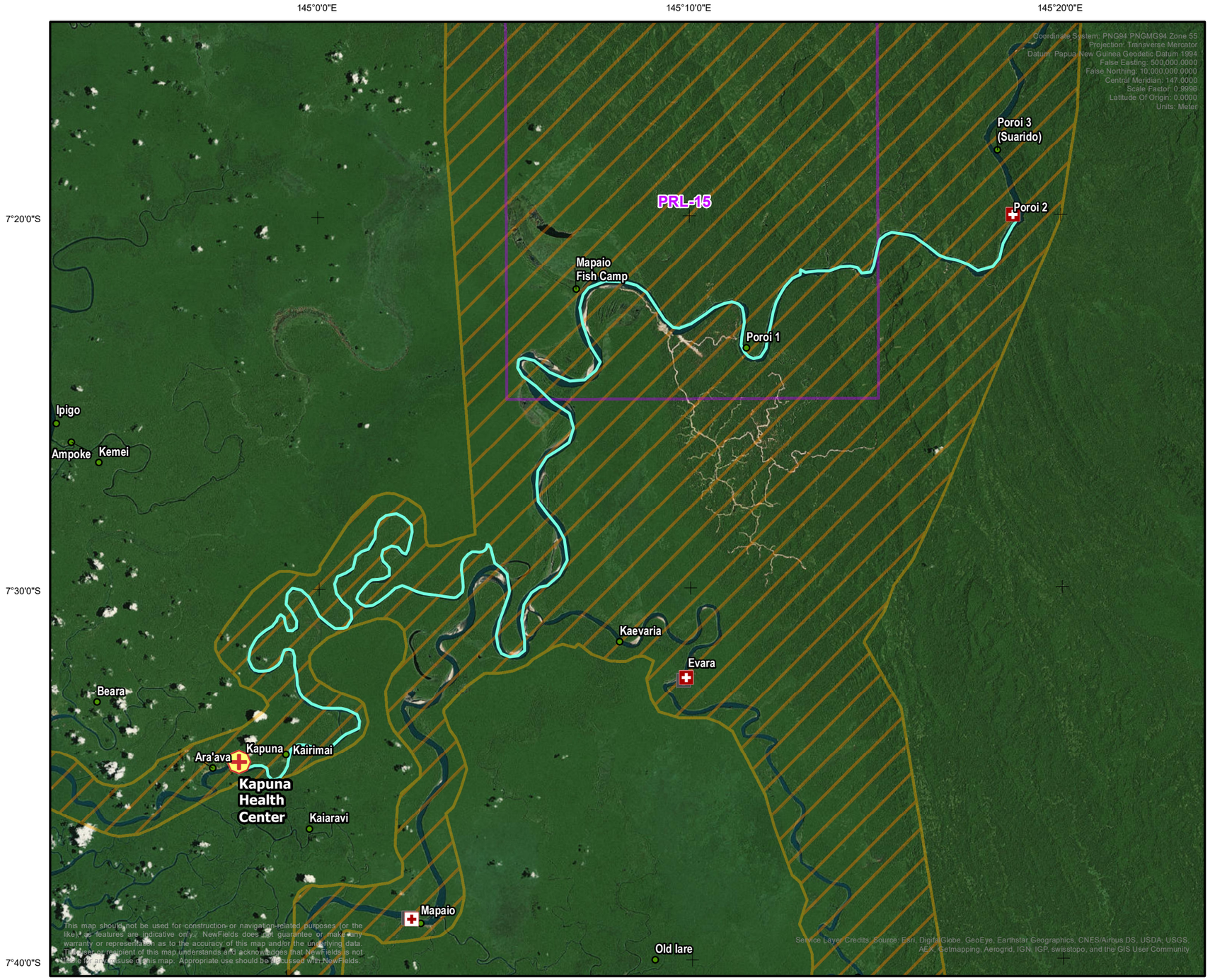
Area of Detail:



Project	**Total PNG Papua New Guinea**
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Date 2/10/2017 3:22:06 PM	**Scale** 1:20,000
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Poroi 2 to Kapuna Health Center

Travel time: 1 day motor dinghy to Kapuna, 10 minutes to RH logging camp and Herd Base clinic



5.5 2.75 0 5.5 11 16.5 22

Kilometers

Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Poroi 2 to Kapuna Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:

Project

Total PNG
Papua New Guinea

Prepared for:

TOTAL COMMITTED TO BETTER ENERGY

ERIAS GROUP

ERIAS Group
13-25 Church Street
Hawthorn VIC 3122
Australia

Prepared by:

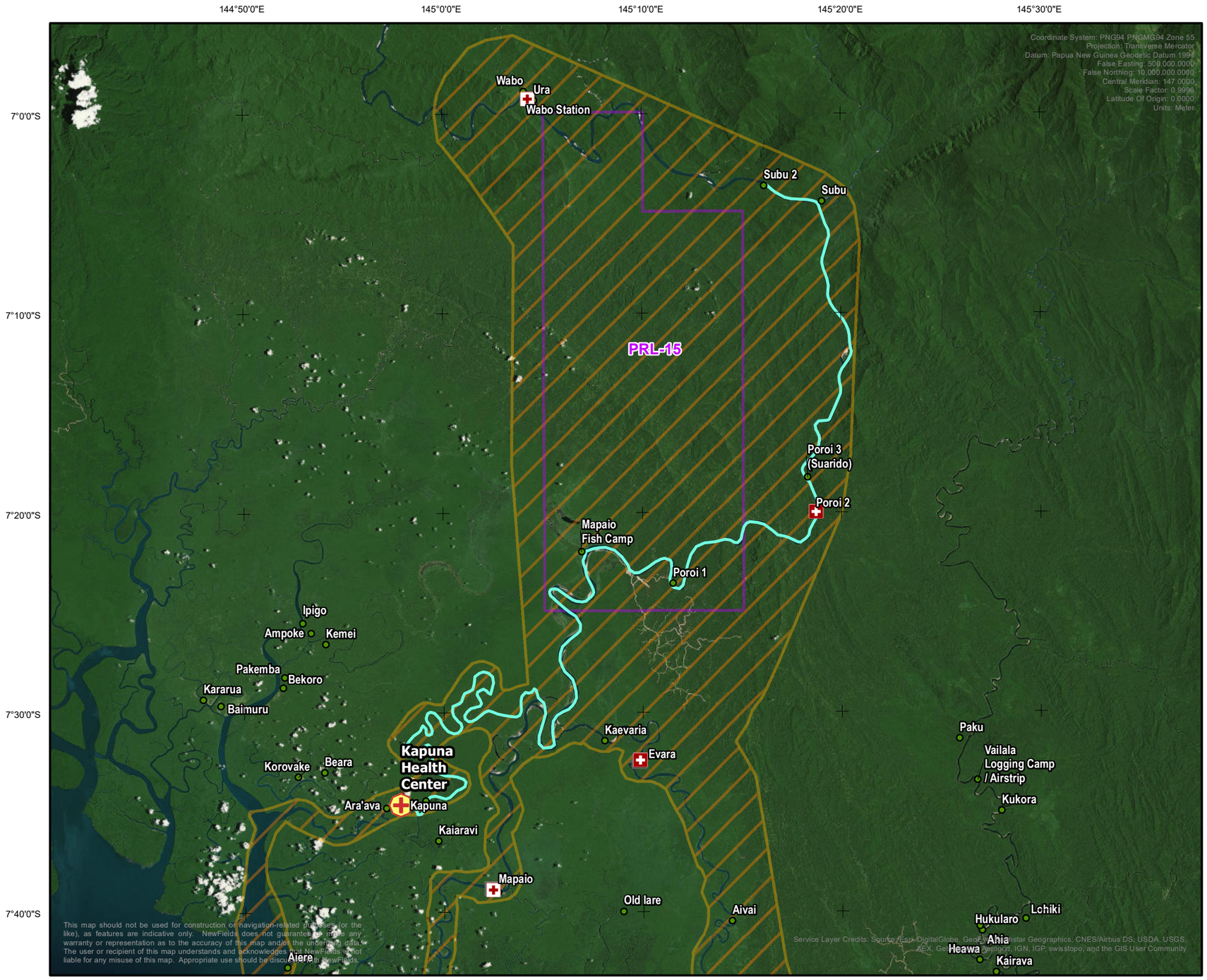
NewFields

NewFields
9400 Station Street, Suite 300
Lone Tree, CO 80124
Tel: +1 (303) 809-5008

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Subu 2 to Kapuna Health Center

Travel time: 1 day (motor dinghy)



10 5 0 10 20 30 40

Kilometers

Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Subu 2 to Kapuna Health Center
- PRL-15
- Project areas of influence

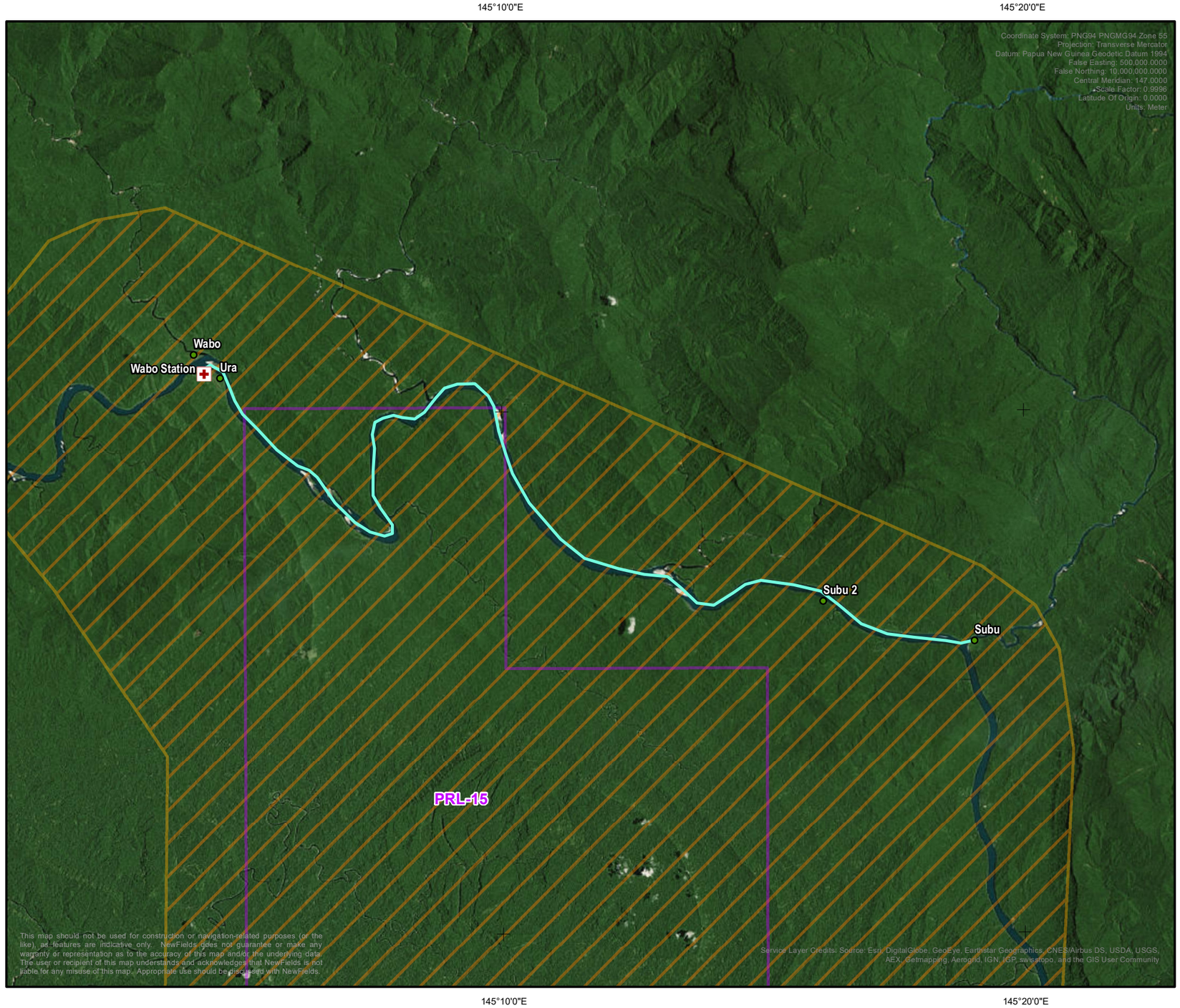
This route is estimated based on current data.

Area of Detail:

Project	**Total PNG Papua New Guinea**
Prepared for:	ERIAS Group 13-25 Church Street Hawthorn VIC 3122 Australia
Prepared by:	NewFields 9400 Station Street, Suite 300 Lone Tree, CO 80124 Tel: +1 (303) 809-5008
Date 2/10/2017 3:22:06 PM	**Scale** 1:400,000
MXD D:\Total_PNG_GIS\Total_PNG_2017_2_10.mxd	

Subu to Wabo Aid Post

Travel time: 1 day (motor dinghy)



3.5 1.75 0 3.5 7 10.5 14

Kilometers

Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Subu to Wabo Aid Post
- PRL-15
- Project areas of influence

N W E S

This route is estimated based on current data.

Area of Detail:



Project

Total PNG
Papua New Guinea

Prepared for:

TOTAL COMMITTED TO BETTER ENERGY · ERIAS GROUP

ERIAS Group
13-25 Church Street
Hawthorn VIC 3122
Australia

Prepared by:

NewFields

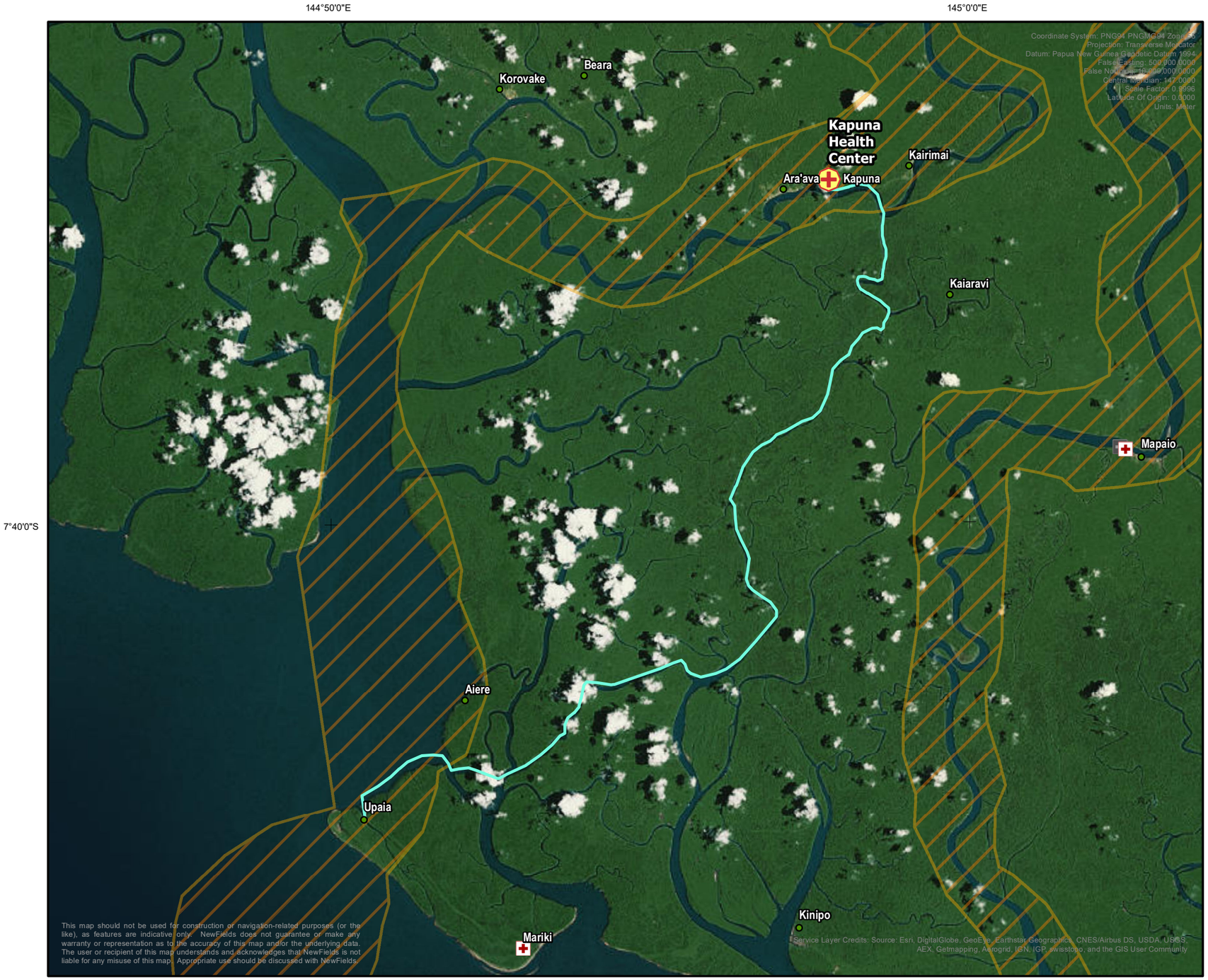
NewFields
9400 Station Street, Suite 300
Lone Tree, CO 80124
Tel: +1 (303) 809-5008

Date	Scale
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Upaia to Kapuna Health Center

Travel time: 2 days (canoe)



3 1.5 0 3 6 9 12

Kilometers

Legend

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Upaia to Kapuna Health Center
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:

Project

Total PNG
Papua New Guinea

Prepared for:

TOTAL COMMITTED TO BETTER ENERGY

ERIAS GROUP

ERIAS Group
13-25 Church Street
Hawthorn VIC 3122
Australia

Prepared by:

NewFields

NewFields
9400 Station Street, Suite 300
Lone Tree, CO 80124
Tel: +1 (303) 809-5008

Date 2/10/2017 3:22:06 PM

Scale 1:125,000

MXD D:\Total_PNG_GIS\Total_PNG_2017_2_10.mxd

Ura to Wabo Aid Post

Travel time: 3-5 minutes (walk)



0.1 0.05 0 0.1 0.2 0.3 0.4

Kilometers

Legend

N

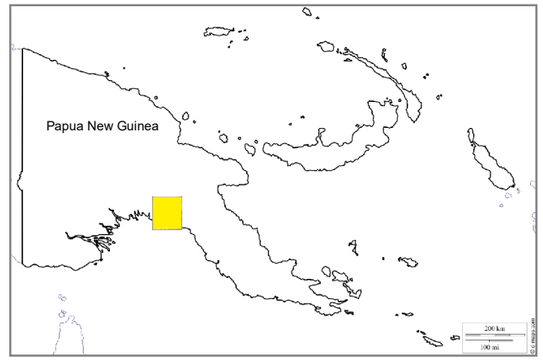
W E

S

- Health Center
- Sub-Health Center
- Operating Aid Post
- Partially Operating Aid Post
- Not Operating Aid Post
- Towns and Villages
- Ura to Wabo Aid Post
- PRL-15
- Project areas of influence

This route is estimated based on current data.

Area of Detail:



Project

Total PNG
Papua New Guinea

Prepared for:

TOTAL COMMITTED TO BETTER ENERGY ERIAS GROUP

ERIAS Group
13-25 Church Street
Hawthorn VIC 3122
Australia

Prepared by:

NewFields

NewFields
9400 Station Street, Suite 300
Lone Tree, CO 80124
Tel: +1 (303) 809-5008

Date 2/10/2017 3:22:06 PM

Scale 1:5,000

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Attachment C – Aid Post/Health Center Photo Gallery

Akoma Aid Post



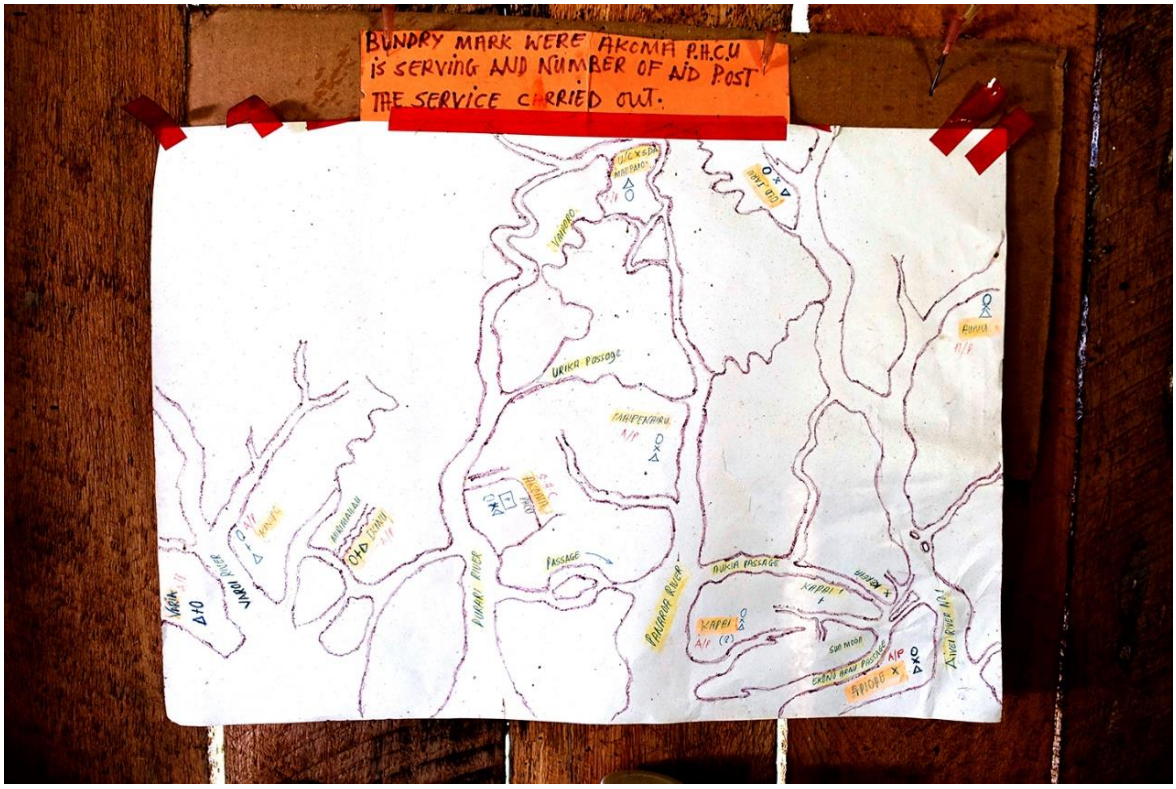
Aid post entry.



Patient treatment area.



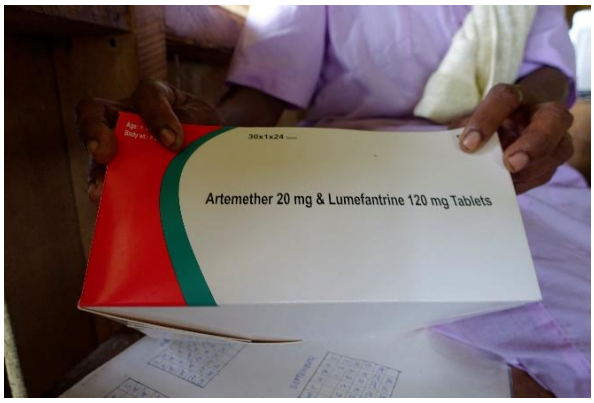
Patient treatment area.



Akoma village catchment area.



CHW home.





Medicines and Supplies.





Left: Medicines and supplies. Right: Standard aid post kits containing medicines, received from the National Department of Health.

Apiope



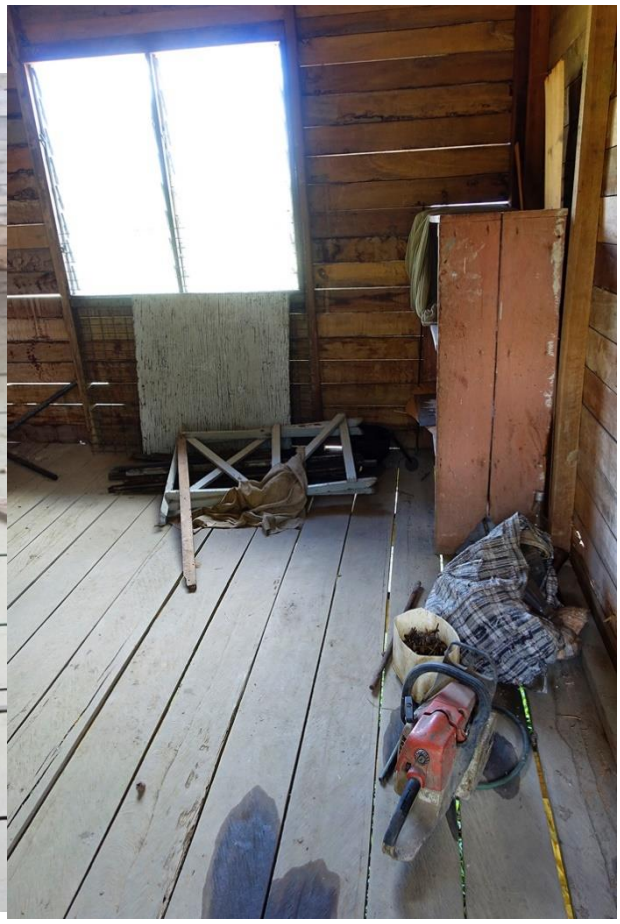


Medicine stocks at Apiope.

Evara

Patient treatment areas used as storage.





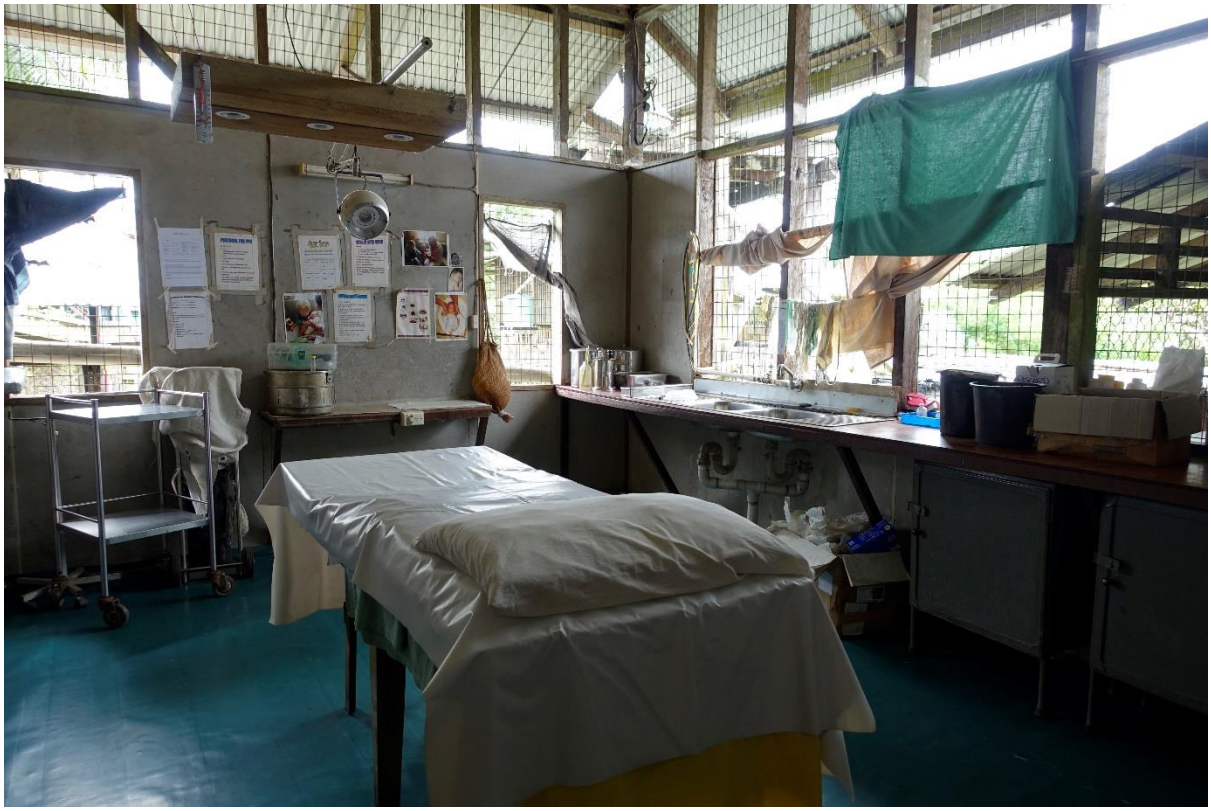
Kapuna Health Center



Kapuna compound.



Kapuna patient treatment area.



Kapuna patient treatment area.



Kapuna compost latrines.

Kavava (Orokolo Sub-Health Center)



Orokolo Sub-Health Center.





Inside the Orokolo Sub-Health Center, medical supplies and equipment.

Maipenairu Aid Post



Medical stocks and supplies.

Mapaio Aid Post





Aid Post buildings not used – stairs not attached.



Mapaio - CHW home where patients are evaluated and treated.

Mariki Aid Post



Inside the Mariki Aid Post – consulting room



Medicine Stock.

Oru-Lariau Aid Post



Labor Room



Oru-Lariau Aid Post

Wabo Station Aid Post





CHW house at Wabo Station.



Wabo Station patient treatment area.



Health education building at Wabo Station.

Muro Mission Aid Post



Medical Supplies



The “black stone” is used to treat snake bite at Muro Mission Aid Post.

Health Community and Stakeholder Interviews

Date	Organization	Location	Contacts
2 May 2016	PNG School of Medicine TB Lab	Port Moresby	Laboratory Manager TB Specialist
3 May 2016	Rotarians Against Malaria	Port Moresby	Logistics Manager Program Manager
3 May 2016	Rural Primary Health Services Development Project (RPHSDP)	Port Moresby	Gender Specialist
5 May 2016	GCS	Kapuna	Medical Doctors (3) Operations Manager Life School teacher WATSAN Program Director Business Manager
6 May 2016	TEP PNG	Wabo/Ura	Klanpis Minalu – Herd Base HEO
6 May 2016	Community	Wabo/Ura	Birth Attendants (7)
7 May 2016	Community	Evara	CHW Women's group health discussion
8 May 2016	Community	Mapaio	CHW Women's group health discussion
9 May 2016	TEP PNG	Poroi 2	Melvin Mek – Community HEO
9 May 2016	Community	Poroi 2	Women's group health discussion; Men's group health discussion
10 May 2016	Community	Subu 2	Women's group health discussion Men's group health discussion
13 May 2016	Oil Search Foundation	Port Moresby	Oil Search Foundation Director
13 May 2016	Port Moresby Area Medical Store (AMS)	Port Moresby	AMS Supervisor and Operations Clerk
14 May 2016	CHS	Port Moresby	CHS Director – Gulf Province CHS Director – Western Province
14 May 2016	Salvation Army Health	Port Moresby	Medical Director
18 May 2016	Community	Akoma	CHW
18–19 May 2016	TEP PNG	Herd Base & Port Moresby	Kritoe Keleba Armand Leblois Dr. Luc Leguyer Search and Rescue Systems team Thierry Couderc Tony Uechtritz Jeremy Roeygens David Albert Richard Kassman
16 August 2016	Provincial Health	Kerema	Provincial Health Manager
16 August 2016	Provincial Health	Kerema	Ekaloa Mefaraupu
16 August 2016	Provincial Health	Kerema	Philip Pane
16 August 2016	Provincial Health	Kerema	Kevin Kaumi
16 August 2016	Provincial Health	Kerema	Gregory Damien

Health Community and Stakeholder Interviews

Date	Organization	Location	Contacts
16 August 2016	Kerema Health Center/Hospital	Kerema	Ian Kauyet
16 August 2016	MSF	Kerema	MSF Coordinator
16 August 2016	Kerema Health Center/Hospital	Kerema	Henry Ori, Monica Abraham, Sari Tamasi, Alphonse Tauma, David Duna, Nares Mewagi, Sr. Pisi, Sr. Fiona Puku
17 August 2016	Provincial Health	Kerema	Ekaloa Mefaraupu
17 August 2016 18 August 2016	MSF	Kerema	MSF Coordinator
18 August 2016	Provincial Health	Kerema	Ekaloa Mefaraupu
18 August 2016	CHS	Kerema	CHS Director – Gulf Province
19 August 2016	GCS	Kapuna	Kapuna Health Center personnel
20 August 2016	International SOS	Herd Base	Dr. Luc Leguyer Community HEOs
20 August 2016	TEP PNG	Herd Base	Community engagement officers
21 August 2016	TEP PNG	Herd Base	TEP PNG Field Assessor
22 August 2016 24 August 2016	Port Moresby General	Port Moresby	Rural Health Facility Assessment Team Member
22 August 2016	Port Moresby General	Port Moresby	Rural Health Facility Assessment Team Lead
23 August 2016	RPHSDP	Port Moresby	GIS Manager
23 August 2016	RPHSDP	Port Moresby	Project Manager
22 August 2016	Consultant	Port Moresby	Health Consultant
23 August 2016	TEP PNG	Port Moresby	Jeremy Roeygens