TOTAL E&P PNG LIMITED

PAPUA LNG

Upstream Environmental Impact Statement

Volume 2: Environmental and Social Baseline

Part 21
Upstream Landscape and Visual Amenity Baseline Report

TOTAL
TOTAL E&P PNG LIMITED

global environmental solutions

Papua LNG Project

Upstream Landscape and Visual Amenity

Baseline Report

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Papua LNG Project

Upstream Landscape and Visual Amenity

Baseline Report

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Executive Summary

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 has the largest interest in the Elk-Antelope gas field and is the operator of the Papua LNG Project (the Project) on behalf of the other joint venture partners.

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 delivery of gas and condensate via onshore and offshore export pipelines to a LNG Plant site at Caution Bay, Central Province, 20 km northwest of Port Moresby.

This report characterizes the baseline landscape and visual amenity characteristics in the upstream Project area. The objectives of this study are as follows:

- Describe environmental values in order to report in general terms the existing character of the landscape that could be affected by the Project.
- Collect landscape and visual amenity information to support the impact assessment for the Project.

The impact assessment will assess the potential Project-related impacts on visual and aesthetic value components of the existing environment as described in this baseline study.

The key findings of this baseline study have been:

- The majority of the upstream Project area consists of vast expanses of previously undisturbed and very dense native vegetation.
- This vegetation occurs in an often rugged, sometimes inundated/flood prone and largely inaccessible region of PNG.
- The upstream Project area is very sparsely populated, with the exception of numerous villages along the coastline of the Gulf of Papua whose communities are mainly small and subsistence based.

Due to the dense vegetative cover, remoteness, and physical terrain there are limited locations within the upstream Project area that are likely to have significant visual divergence from the surrounding visual landscape.

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1 INTRODUCTION

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 has the largest interest in the Elk-Antelope gas field and is the operator of the Papua LNG Project (the Project) 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 km inland from the township of Kerema, and 340 km northwest of Port Moresby (**Figure 1**).

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 delivery of gas and condensate via onshore and offshore export pipelines to a 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 various Project components and associated infrastructure as detailed below.

- Production, processing and related facilities (within PRL-15):
    - Wellpads and the associated gathering system (including flowlines and trunkline);
    - CPF;
    - Logistics base and river offloading facilities, accommodation camps, airstrip, roads and bridges;
    - Quarries, 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, Caution Bay.

This report characterizes the baseline landscape and visual amenity of the upstream Project area.

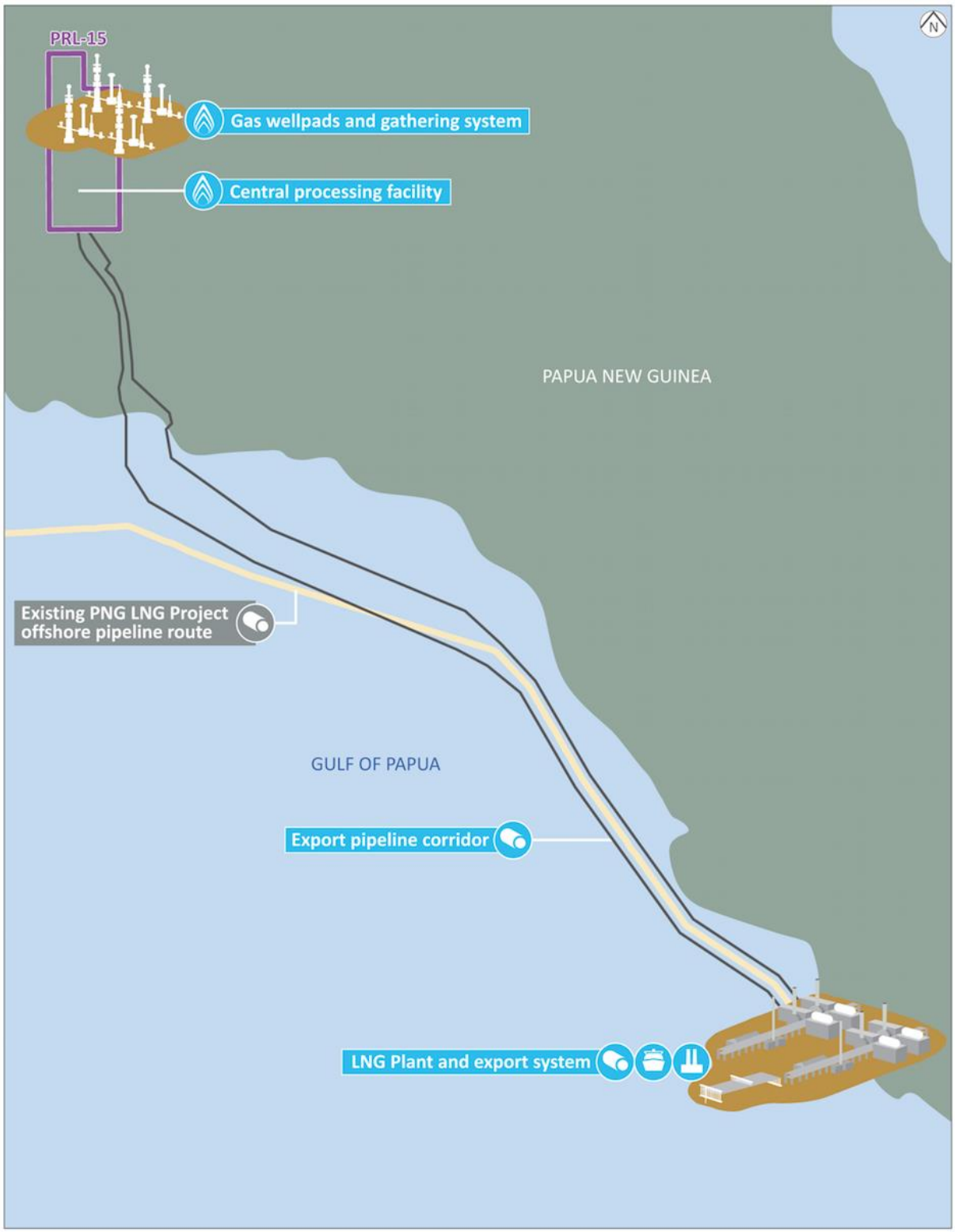

Figure 1 Project Schematic

1.2 Study Objectives

SLR Consulting Pty Ltd (SLR) has been commissioned by ERIAS Group on behalf of TEP PNG to undertake a landscape and visual amenity baseline study for the upstream Project area.

The objectives of the landscape and visual amenity baseline assessment study for the upstream component of the Project are to:

- Describe environmental values in order to report in general terms the existing character of the landscape that could be affected by the Project.
- Collect landscape and visual amenity information to support the impact assessment for the Project. The impact assessment will assess the potential Project-related impacts on visual and aesthetic value components of the existing environment described in this baseline study.

The landscape and visual amenity baseline study is a desktop only study. No fieldwork was undertaken by the study team as part of this study, however, photographic evidence has been collated from other Project teams during their visits to the upstream Project area.

2 REGULATORY FRAMEWORK AND STANDARDS

2.1 Papua New Guinean Authorities and Legislation

In February 2014, the Papua New Guinea (PNG) Parliament passed an Act to set up a new Conservation and Environment Protection Authority (CEPA). CEPA has replaced the Department of Environment and Conservation (DEC) as the government agency responsible for administering the Environment Act 2000.

The *Environment Act 2000* (Environment Act) is the primary legislation in PNG, which regulates the environmental impact of development activities and how adverse effects of such activities should be avoided, remedied or mitigated. The Environment Act caters for the sustainable management of the biological and physical components of the land, air and water resources of the country.

While the information guideline - *Guideline For Conduct Of Environmental Impact Assessment & Preparation Of Environmental Impact Statement*, produced by the then PNG DEC in January 2004 does not specifically mention landscape and visual amenity, it does require a characterization of the existing environment and this baseline study contributes to establishing the characteristics of the receiving environment, particularly with regard to topographic and other aspects of the physical environment.

As PNG does not currently have any prescriptive landscape and visual amenity standards, a review of relevant guidelines set by other agencies has been performed.

2.2 International Standards and Guidelines

There are a number of guidelines (detailed below) that may be applied to the delivery of a landscape and visual impact assessment, and the baseline component of such an assessment

2.2.1 IFC Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts

IFC Performance Standard 1 (IFC, 2012a) was developed by the IFC to establish the importance of integrated assessment to identify the environmental and social impacts, risks, and opportunities of projects. In reference to baseline studies, Performance Standard 1 states that the identification of risks and impacts is to be based on recent environmental and social baseline data "*at an appropriate level of detail".*

In addition, when assessing the potential environmental impacts from a project, the cumulative impacts that may result from the incremental impact of the project in addition to other "*existing, planned or reasonably defined developments*" at the time the assessment is conducted are to be considered.

In Guidance Note 1 (IFC, 2012b) for Performance Standard 1 it is noted that:

> *"reference to secondary information on the project's area of influence is acceptable, but it may still be necessary to gather primary information from field surveys to establish baselines appropriate to the proposed project's potential impacts and risks. Relevant data may be available from various host governmental agencies, nongovernmental organizations and academic studies".*

2.2.2 IFC Performance Standard 3: Resource Efficiency and Pollution Prevention

IFC Performance Standard 3 (IFC, 2012c) outlines a project-level approach to resource efficiency and pollution prevention and control in line with internationally disseminated technologies and practices.

> *For the purposes of this Performance Standard, the term "pollution" is used to refer to both hazardous and non-hazardous chemical pollutants in the solid, liquid, or gaseous phases, and includes other components such as pests, pathogens, thermal discharge to water, GHG emissions, nuisance odors, noise, vibration, radiation, electromagnetic energy, and the creation of potential visual impacts including light*

In regard to the consideration and assessment of baseline conditions, IFC Performance Standard 3 states:

> *To address potential adverse project impacts on existing ambient conditions, the client will consider relevant factors, including, for example:*
>
> *(i) existing ambient conditions;*
>
> *(ii) the finite assimilative capacity of the environment (ie, the capacity of the environment for absorbing an incremental load of pollutants while remaining below a threshold of unacceptable risk to human health and the environment);*
>
> *(iii) existing and future land use;*
>
> *(iv) The project's proximity to areas of importance to biodiversity; and the potential for cumulative impacts with uncertain and/or irreversible consequences.*

Guidance Note 3 (IFC, 2012d) for Performance Standard 3 states that when developing a new project:

> "Considerations should include background ambient conditions (that may occur due to natural and/or anthropogenic causes not related to the project), the presence of local communities, environmentally sensitive receptors (such as potable water supplies or protected areas), the expected project demand for water, and the availability of waste disposal facilities. Potential for cumulative impacts should also be reviewed".

2.2.3 IFC Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources

IFC Performance Standard 6 (IFC, 2012e) recognizes that *"protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development"*.

This IFC Performance Standard states that:

> *"Ecosystem services are the benefits that people, including businesses, derive from ecosystems. Ecosystem services are organized into four types: (i) provisioning services, which are the products people obtain from ecosystems; (ii) regulating services, which are the benefits people obtain from the regulation of ecosystem processes; (iii) cultural services, which are the nonmaterial benefits people obtain from ecosystems; and (iv) supporting services, which are the natural processes that maintain the other services."*

The cultural services mentioned in (iii) above may include natural areas that are sacred sites and areas of importance for recreation, and aesthetic enjoyment.

Guidance Note 9 (IFC, 2012f) for IFC Performance Standard 6 recommends: *"As part of the ESIA, baseline studies should be conducted for the relevant biodiversity attributes and ecosystem services. Baseline studies should comprise some combination of literature review, stakeholder engagement and consultation, in-field surveys and other relevant assessments. The extensiveness of the baseline will vary depending on the nature and scale of the project".*

2.2.4 IFC – World Bank Group - Environmental, Health and Safety Guidelines for Onshore Oil and Gas Development

Environmental, Health and Safety Guidelines for Onshore Oil and Gas Development (IFC, 2007) contains guidelines and technical reference documentation relevant to onshore oil and gas developments and therefore the Project. The key guideline of relevance to landscape and visual issues for the Project states:

> *"The visual impact of permanent facilities should be considered in design so that impacts on the existing landscape are minimized. The design should take advantage of existing topography and vegetation, and should use low profile facilities and storage tanks if technically feasible and if the overall facility footprint is not significantly increased. In addition consider suitable paint color for large structures that can blend with the background."*

The landscape and visual amenity baseline study for the upstream Project area should be used to inform the design phase of the project to assist in the minimization of Project impacts. There are numerous specific design and mitigation principles detailed in this guideline that relate specifically to landscape and visual amenity.

2.2.5 The Landscape Institute and Institute of Environmental Management & Assessment's Guidelines for Landscape and Visual Impact Assessment

Environmental Impact Assessment (EIA) is a very important tool for predicting and evaluating the wide range of effects of development on the environment and on people. Landscape and Visual Impact Assessment (LVIA) is a separate but closely linked process that operates within the overall framework of EIA. It specifically aims to ensure that all possible effects of change and development both on the landscape itself and on views and visual amenity are taken into account in decision-making.

The Landscape Institute and the Institute of Environmental Management and Assessment (and its predecessor the Institute of Environmental Assessment) have worked together since 1995 to publish guidelines on good practice in LVIA. These guidelines are used widely in Europe and the UK to ensure LVIAs produce useful reports for EIA and design decision-making.

The initial step in any LVIA is to establish the baseline landscape and visual conditions. The information collected will, when reviewed alongside the description of the proposed change or development, form the basis for the identification and description of the landscape and visual effects of the proposal.

The purpose of baseline studies for landscape is to provide an understanding of the landscape in the area that may be affected – its constituent element, its character and patterns in the way that character varies, its condition, the way the landscape is experienced, and the value or importance attached to it. For visual amenity the aim is to establish the area in which the proposed development may be visible, the viewpoints from which it can be seen, the people who experience views at those points, and the nature of the views.

The format of this baseline study will be based on principles contained within The Landscape Institute and Institute of Environmental Management and Assessment's Guidelines for Landscape and Visual Impact Assessment (GLVIA3, 2012) and is aimed at providing a relevant baseline for the assessment phase.

The GLVIA method observes and accords with European Directives on Environmental Assessment and international best practice, and has been applied by SLR Consulting (SLR) successfully in Australasia, Africa and the Middle East.

2.3 TOTAL Company Standards and Commitments

While there is little specific guidance on landscape and visual amenity in any of the TOTAL general specification documents, there are minor references throughout the general specifications that relate to landscape and visual amenity and minimization of Project footprint.

2.3.1 Environmental Baseline and Monitoring Studies: Onshore Sites

TOTAL general specification, GS EP ENV 111, *Environmental Baseline and Monitoring Studies: Onshore Sites* (TOTAL, 2012) sets out technical instructions for the establishment of the baseline environmental status and for carrying out environmental monitoring of an onshore site.

Section 7 Bibliographic study content makes note that:

> *Physical and geographical context, access: landscapes, topography, roads, access to sensitive areas,…*

Is a key aspect that should be considered in any Bibliographic study.

Section 8.4.2 details sampling methods for soils and sediments and states that any excavations should not "generate visual impact in the environment and landscape"*.*

2.3.2 Environmental Requirements for Project Design and E&P Activities

The TOTAL general specification document GS EP ENV 001 *Environmental requirements for project design and E&P activities* discusses minimization of the environmental footprint of the project. Section 5.1 states that:

> *"The minimisation of the environmental footprint of the project in any of its phase and including construction shall be systematically implemented. Particular attention shall be paid to areas where biodiversity is particularly rich or sensitive."*

And that:

> *"Local environmental and social sensitivities shall be taken into account to determine the followings:*
>
> - *Onshore: site selection, land use, layout of the installation, safety and security distances, pipeline RoW width limitation, pipe route selection, access, visual impact limitation, clearing limitation, landscaping and site conservation, erosion control, etc."*

3 STUDY AREA

3.1 Study Area

This landscape and visual amenity baseline study predominantly focuses on the area that encompasses the upstream components of the project as described in **Section 1.1** and situated within the Project area of influence (PAOI) as shown in **Figure 1**.

Landscape and visual amenity may be affected by the Project through the construction and operation of the following Project components:

- Production, processing and related facilities
    - Gasfield area within PRL-15 (wellpads, upstream gathering system, CPF and associated infrastructure and support facilities, i.e., construction camp, laydown area, wharf, airstrip, access roads).
- Onshore pipeline
    - Export gas and condensate pipeline system from the CPF to the coast at Orokolo Bay, together with associated infrastructure and construction support facilities.
- Transport (river) corridors
    - West of the onshore export pipeline corridor and downstream of proposed Project facilities within PRL-15. The study area includes potential barge transport routes along each of the Purari River's three main delta distributaries—the Purari, Ivo-Urika and Varoi-Warne rivers.
- Offshore export pipeline
    - Offshore section of the export pipeline to a LNG Plant site, Caution Bay

While the Project may impact landscape and visual amenity at the national and regional scales, the greatest potential will occur close to the construction and operation of Project infrastructure. Therefore, when defining the study area, most effort was concentrated on characterising the baseline landscape and visual conditions within close proximity to these Project components.

The following sections 3.2 – 3.4 provide general information pertaining to the entire study area. These general environmental conditions will be considered in conjunction with the baseline landscape characterization when the impact assessment is undertaken.

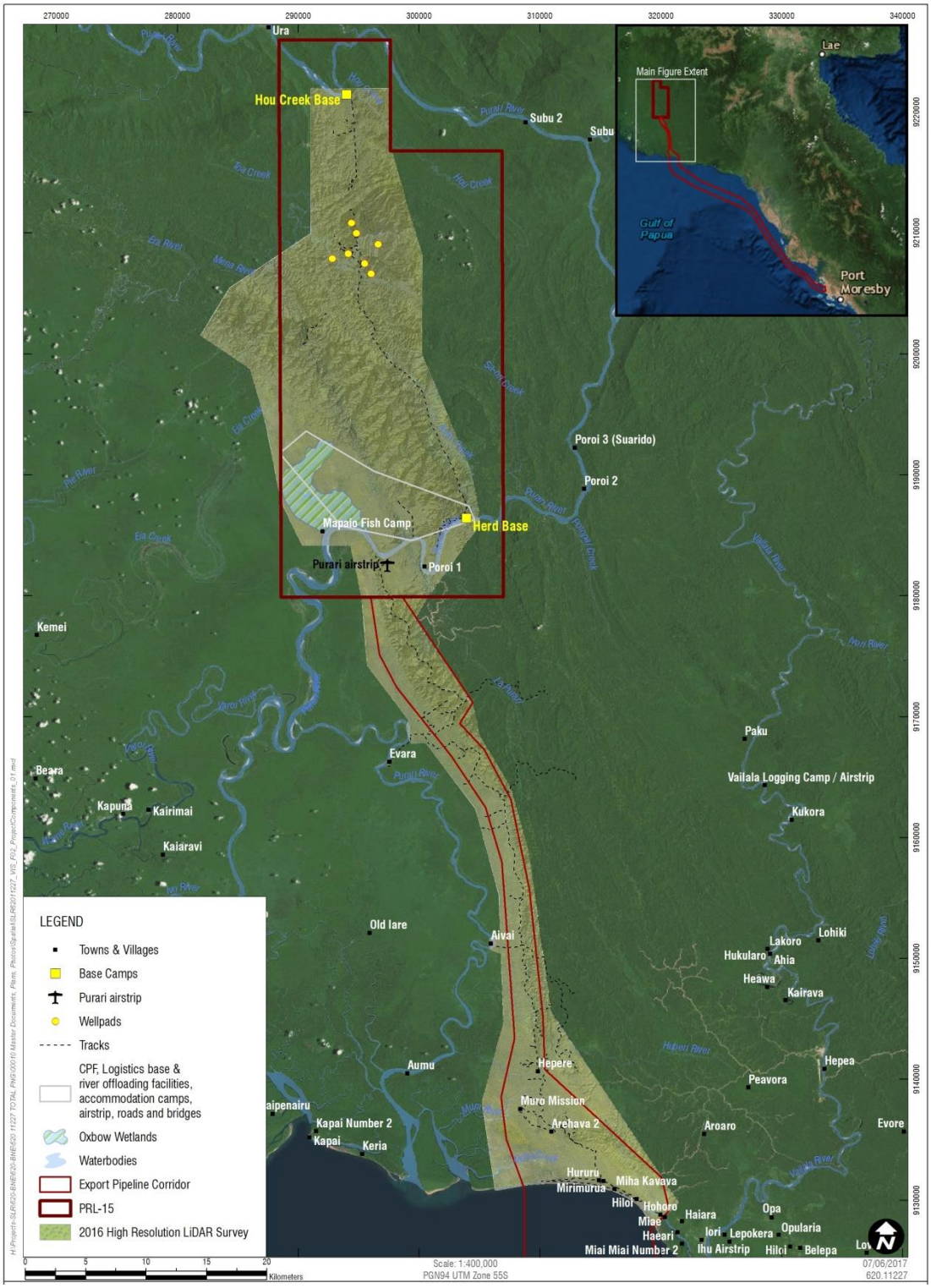

Figure 2 Project Component Locations

3.2 Climate

Climatic conditions greatly influence the formation of landscape and the type and amount of vegetation cover, both factors that are considered to determine the absorptive capability of a receiving environment. A brief overview on the general climate of the Project area is provided below for reference purposes.

Papua New Guinea has a tropical, monsoonal climate. The coastal and islands regions tend to be hot and humid, with temperature averages ranging between 20°C to 32°C, relative humidity levels ranging from 70% to 90% and high rainfall year-round.

Seasonal climate changes in the study area are controlled by two mass air movements. Typically the easterly trade wind season occurs from April/May to October/November and the northwest monsoon occurs from November/December to March/April. There are transitions at the cross over of each season.

Papua New Guinea's climate varies considerably from year to year due to the El Niño-Southern Oscillation (ENSO). 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 ENSO, typically results in higher than average rainfall and warmer temperatures during the wet season, often leading to flooding events and landslides (PACCSAPP, 2015). Papua New Guinea also experiences neutral phases.

A dominant climatic factor in the upland areas is cloud and fog; and for most of the year, they are important sources of moisture. Western and northern parts of Papua New Guinea experience the most precipitation, since the north- and westward-moving monsoon clouds are heavy with moisture by the time they reach these more distant regions. However, on rare occasions, vegetation of the uplands can become dry enough to burn, as happened during a severe drought in 2015 when fires spread from the Highlands to West New Britain across to Milne Bay province in the latter half of the year. Towards the coast, rainfall is lower and more evenly spread throughout the year (averaging around 300 mm/month) (Evesson, 1983).

Temperatures in the study area are mild and remain relatively consistent throughout the year. Temperature is altitude dependent, with hot and humid conditions associated with lower altitudes and cooler conditions at higher altitudes.

Tropical cyclones affect southern Papua New Guinea between November and April. In the 41-year period between 1969 and 2010, 23 tropical cyclones passed within 400 km of Port Moresby, an average of less than one cyclone per season. From 1969–2010, cyclones occurred more frequently in neutral phases of the El Niño-Southern Oscillation (PACCSAPP, 2015).

3.3 Topography and Land Form

As shown in **Figure 3**, PRL-15 is characterized by mountains, hills and levee plain landforms. The northern two-thirds of the PRL-15 is dominated by northwest to southeast trending ridges and folded terrain of the lower Eastern Highlands, up to approximately 450 m asl in places. Terrain in the southwestern portion of PRL-15 lowers to the plains of the Purari River basin that are typically subject to frequent inundation from overbank river flows during the wet season.

The existing well pads from previous appraisal drilling within PRL-15 are primarily located on steep ridges, some up to 250 m asl. The proposed CPF, Logistics base and river offloading facilities, accommodation camps, airstrip, roads and bridges site is located on the flood plain of the Purari River bounded to the south by the Purari River main channel and to the east by its tributary, Kuku Creek. The generally flat terrain of the site has a maximum elevation of about 50 m asl, but is more generally below this elevation. Some areas within the site are prone to inundation from the Purari River.

From the north, the export pipeline corridor traverses extensive ranges of asymmetrical mountains and hills, which descend into alluvial plains and composite levee plains, coastal mangroves and final beach ridges and beach plains.

The Purari, Ivo-Urika and Varoi-Warne rivers are the largest rivers in the Study Area. The Purari is the third largest river in Papua New Guinea, with a catchment area of 33,000 km2. The Study Area intersects numerous waterways including the Huperi River, Mura River and Oeha Creek, along with the Boa Creek, Djo'boh Creek, Eia Creek, Hou Creek, Ingkeni Creek, Kuku Creek, Mena River, Nea Creek and Oyomo Creek catchments. These waterways vary in size, flow and navigability. However the Purari, Ivo-Urika and Varoi-Warne rivers provide accessibility and transportation routes from the coast to the upstream Project components.

The topography where the onshore pipeline corridor intersects the coastal zone at Orokolo Bay is very low lying. Beaches are regularly interrupted by rivers, coastal lagoons and inlets.

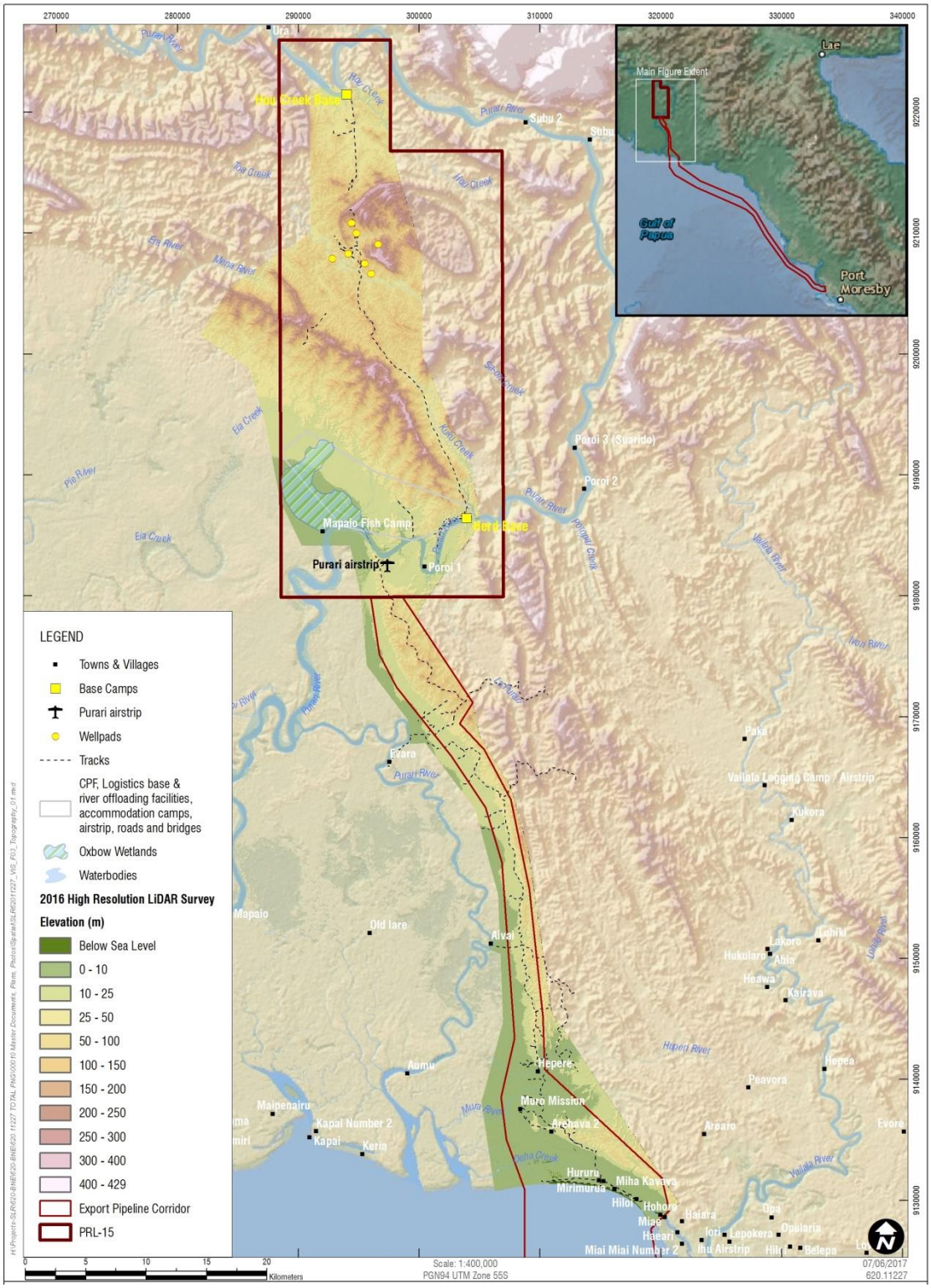

Figure 3 Topography

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 and Hou Creek Base (both now demobilized), and activities and disturbances relating to wellpads, access roads, and helipads.

The inland section of the export pipeline corridor is largely unpopulated however has been modified by large-scale industrial logging. Near to and along the coast, the number and size of villages, and hence population density, increases. Anthropogenic activities include clearing of forest 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 in the vicinity of the upper reaches of the tidal influence where there is likely to be a greater availability of resources. In addition to subsistence agriculture activities, logging and Project commissioned barges transporting supplies and equipment to the base, regularly travel along the Purari channels.

4 EXISTING INFORMATION

4.1 Prior Studies within the Study Area

No prior landscape and visual amenity studies have been conducted within the study area. However there have been a number of studies that provide context for this baseline study report.

The ELK/ANTELOPE Gasfield Project Environmental Impact Statement prepared by Douglas Environmental Services (DES) December 2008 (DES, 2008) has provided useful background information regarding the location and setting of the upstream study area. No specific data, photographs or other information from DES (2008) has been included in this report.

The Engineering Consultancy Report - Desktop Study Elk Antelope Block PRL 15 Papua New Guinea by Fugro November 2014 (FUGRO, 2014) provides insight into a range of landscape related factors including topography, land form and land uses across the study area, however none of this information has been directly included or referenced in this report.

Likewise the following documents have provided background information pertaining to the underlying landscape, history and location of recent disturbance activities in the study area:

- Antelope South-1. Environmental Impact Assessment and Environmental Management Plan (GHD, 2015a).
- Antelope-4. Environmental Impact Assessment and Environmental Management Plan (GHD, 2015b).
- Antelope-5. Environmental Impact Assessment and Environmental Management Plan (GHD, 2015c).
- Antelope-6. Environmental Impact Assessment and Environmental Management Plan (GHD, 2015d).

4.2 Studies in Neighboring Regions

Through bibliographic review, no similar landscape and visual amenity studies have been conducted in neighboring regions. In 2008 an Environmental Impact Statement (EIS) was prepared for the ExxonMobil PNG LNG Project. The PNG LNG Project is similar to the Papua LNG Project in the development of gas fields with onshore and offshore pipelines to deliver the gas resource to an LNG plant close to Port Moresby. The ExxonMobil PNG LNG EIS included the following landscape and visual impact assessment; however its scope was limited to the LNG Facility at Caution Bay and offshore marine terminal which is of limited relevance to the upstream Papua LNG Project area:

- PNG LNG EIS - Landscape and Visual Impact Assessment EDAW/AECOM November 2008 (EDAW/AECOM, 2008).

No information from the PNG LNG landscape and visual impact assessment has been included in this report.

4.3 Summary

The review of prior studies within the study area and neighboring regions outlined above shows that there is no detailed or specific landscape or visual amenity information for the study area

5 METHODS

The following methodology has been developed in order to meet the study objectives of:

- Describing environmental values in order to report in general terms the existing character of the landscape that could be affected by the Project, and
- Collecting landscape and visual amenity information to support the impact assessment, i.e., the next phase. The impact assessment will assess the potential Project-related impacts on visual and aesthetic value components of the existing environment described in this baseline study.

5.1 General Approach – Landscape and Visual Impact Assessment

The two components of a landscape and visual amenity impact assessment LVIA are:

- Landscape effects assessment: deals with changes to landscape as a resource. Society as a whole has an interest in this and it is recognized as one of the key dimensions of environmental interest, alongside matters such as biodiversity, and cultural heritage. It is concerned with issues like protected landscapes, the contribution of landscape character to sense of place and quality of life for all, and the way that change may affect individual components of the landscape;
- Visual effects assessment: is concerned with how the surroundings of individuals or groups of people may be specifically affected by change in the landscape. This means assessing changes in specific views and in the general visual amenity experienced by particular people in particular places.

This study compiles information in order to set a baseline for the above two components of an LVIA.

5.2 General Approach - Study Area

As detailed in **Section 3.1** the study area is within the upstream PAOI. The greatest potential for landscape and visual impacts from Project activities will be within close proximity to construction and operational infrastructure.

Project footprints resulting from construction activities tend to be temporary in nature and are likely to include pipeline construction right-of-way and associated shoo-fly, access tracks, wellpads, workforce base camps, pipeline and material storage yards, workshops, airstrips and helipads, equipment staging areas, and construction material extraction sites (including borrow pits and quarries). Operational footprints may include wellpads, CPF, transmission and storage facilities, pipeline easements, access roads, ancillary facilities and communication facilities, all of which generally have a longer impact duration.

These typical project components will each have some form of landscape and visual impact, impacts may also be cumulative and could include loss of, or damage to, terrestrial habitat, creation of barriers to wildlife movement, soil erosion, disturbance to water bodies including possible sedimentation and the establishment of non-native invasive plant species, all of which may contribute to overall landscape and visual disturbance.

In order to describe in general terms the existing character of the landscape within the study area, and how the study area interacts with the broader landscape, information has been collected using a hierarchy of scales. Information pertaining to the landscape and visual setting of the study area is presented below in Chapter 6 at national, regional (provincial), and local (study area) scales.

The baseline characterization at the national and regional scales will support the landscape effects assessment component of the future LVIA, while the information collated and presented at local scales are will inform the visual effects assessment portion of the LVIA. Here the assessment will consider both extent of Project disturbance, location, and characteristics of the existing vegetation, topographic features and waterways.

The baseline characterizations detailed in **Section 6** describe topography, vegetation & land cover, built form and structures, land use and landscape values, and have been compiled using available existing information including:

- recently captured aerial photography,
- recently captured topographic survey,
- recent satellite imagery,
- photographs and physical observations collected by other SLR specialist teams (noise, geology, terrain and soils) following their visits to the upstream Project area.

Photographs were acquired with a focus of documenting the surrounding landscape and vistas and providing general information for collation/inclusion into a variety of baseline reports. They were also acquired by the specialist teams on an opportunistic basis at the locations available to them.

Field survey locations for the SLR noise, geology, terrain and soils teams were selected in conjunction with ERIAS Group and TEP PNG on the basis of a site's potential sensitivity. Factors including a locations proximity to likely Project infrastructure, distance to sensitive receptors (including visually sensitive locations), vegetative cover and accessibility were among those considered when field survey locations were chosen. Some of these field survey locations have been used in this report as representative sites to provide generalized landscape and visual baseline characterisations of the study area.

5.3 Data Sources

The following list details the primary sources of information used in the generation of this baseline study:

- 2016 AAM LiDAR & Imagery Survey Data, Rev01 – TOTAL 2016,
- Project development GIS Data – TOTAL 2016,
- Project general GIS data – TOTAL 2016,
- Forest Inventory Mapping System (FIMS), (FIMS, 1995),
- SLR acoustics, geology, terrain and soils field surveys.

5.4 Field Surveys

No fieldwork was undertaken by the study team as part of this landscape and visual baseline study.

5.5 Protocols Used

No field studies were performed as part of the landscape and visual baseline study, hence no protocols were developed.

5.6 Permits Obtained

No field studies were performed as part of the landscape and visual baseline study; hence no permits were required or obtained.

5.7 Limitations

The baseline study has been limited to the available data sources and the observations of the other SLR specialist teams.

6 BASELINE CHARACTERIZATION

The following sections provide descriptions of landscape character components at varying scales. The descriptions provided are generalized and the locations/scales detailed have been selected so as to provide an overview of the landscape character that will be encountered within the upstream Project area. Each of the following tables provides baseline information describing relevant landscape features and is supported by photographs of topographic information and representative locations for each of the characterized areas.

6.1 National Landscape Character Description

Table 1 describes Papua New Guinea's general landscape characteristics at a national scale. **Figure 4** and **Figure 5** indicate the location of the proposed facility in a global and regional setting, and **Figure 4** displays the location of the upstream Project area within PNG.

Table 1 National Context

Landscape Character	Landscape Description
Topography	Papua New Guinea's topography is dominated by a central system of mountain ranges (commonly referred to as the highlands), extending in the west from Indonesia's Irian Jaya to East Cape in Papua New Guinea at the termination of the Owen Stanley Range as shown in. **Figure 6**. Highland country gives way to foothills and coastal lowlands, including wetlands, of varying extents on either side of the central range. The coastline consists of coral and sand beaches, and there are numerous islands and offshore reef areas. The study area is located in low foothills and coastal lowlands on the southern side of the central range.
Vegetation / Land Cover	The mountain scapes of PNG are typically dominated by dense tropical forest which can be seen in the satellite imagery in **Figure 7** with limited access. Near the capital, Port Moresby, the landscape is dominated by cleared grazing and cultivation areas, with pockets of remnant vegetation, including heavily disturbed forest. Coastal villages generally include some plantations and subsistence gardens, lowlands comprising grasslands and regenerating scrub. In some regions riverine deltas and their associated wetlands are the predominant coastal vegetation form.
Built form / structures	Port Moresby and other major cities such as Lae are urban-scapes that you might typically expect to see in any number of developing countries. The built form across PNG varies from multi-story hotels, offices and apartments, commercial warehouses, suburban houses and very simple traditional dwellings. In the more remote areas small shacks, village enclaves, traditional housing and isolated farms are the norm.
Land Use	Urban land uses are generally confined to Port Moresby and regional centers including Lae and Madang. Outside of Port Moresby the larger villages occur either in the highlands or along the coastal lowlands. Villages are mainly subsistence based with limited commercial agricultural activities. Many villages along the coastal lowland regions have coconut groves, papaya, jack fruit, betel nut plantations and some other non-commercial food cultivation such as yams. Areas of the forested mountain regions have been subject to formal and informal logging. Throughout the country there are numerous operational extractive industries. These include large and small scale Gold, Copper, Silver, Nickel and Cobalt mining operations. In addition, significant gas reserves have been discovered both onshore and off the PNG coast resulting in commercialization of these reserves and recent expansion of PNG's extractive industries to include oil and gas. There are a number of gazetted National Parks and Wildlife Management Areas scattered through the country.
Landscape Value	The majority of upstream project components (production, processing and related facilities, onshore pipeline and transport corridors) occur in a remote and predominantly undisturbed location in the Gulf Province of PNG. It encompasses both mountain foothills and coastal terrain fairly typical of numerous other locations in PNG.

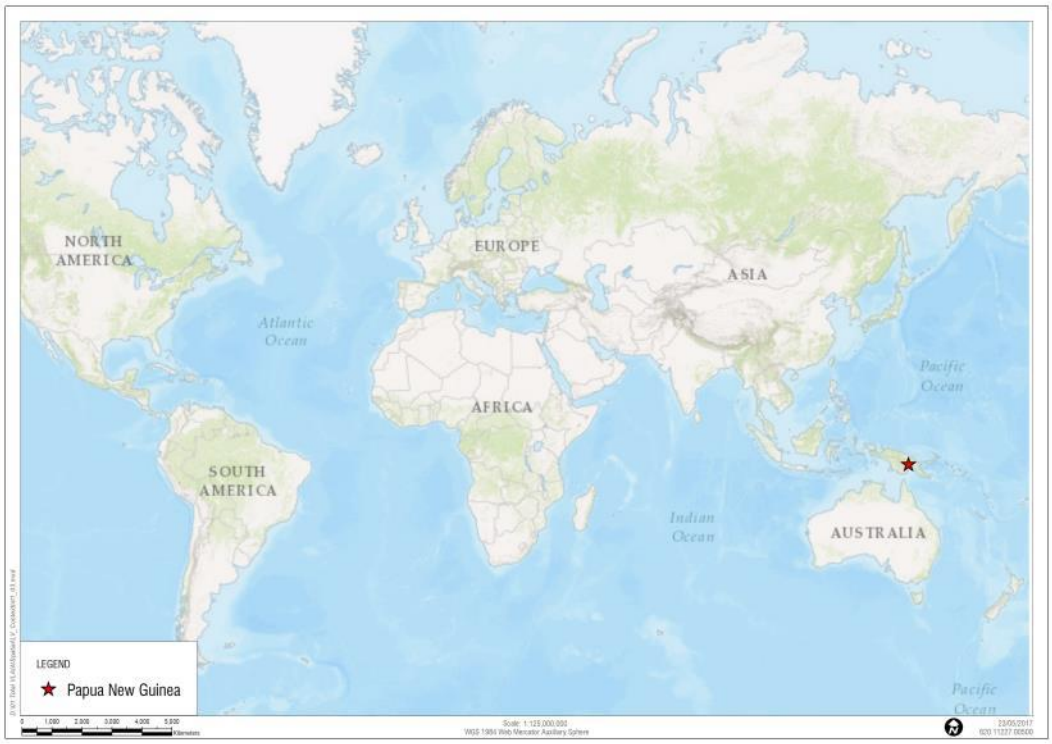

Figure 4 PNG – Global Context

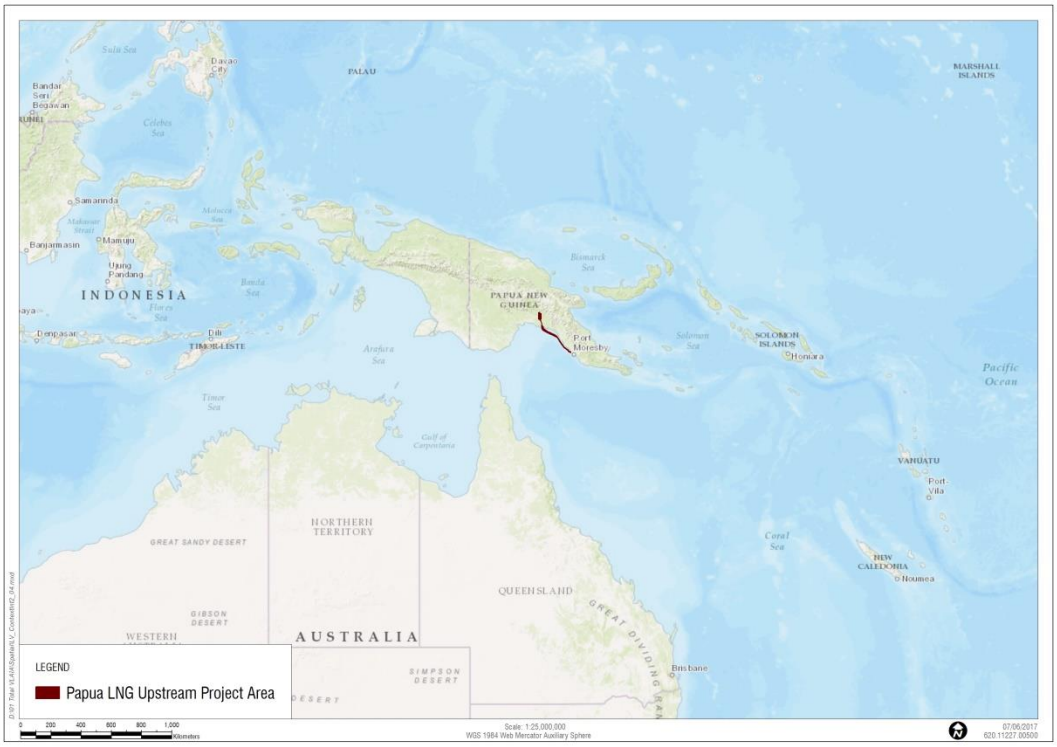

Figure 5 PNG – Regional Context

Figure 6 PNG – Upstream Project Area

Figure 7 PNG - Satellite Imagery

6.2 Gulf Province Landscape Character Description

The upstream Project area comprising the proposed production, processing and related facilities (within PRL-15), the onshore pipeline corridor (outside PRL-15), and the transport (river) corridors all reside within PNG's Gulf Province as shown in **Figure 8** and **Figure 9. Table 2** describes the general landscape characteristics of Papua New Guinea's Gulf Province.

Table 2 Provincial Context

Landscape Character	Landscape Description
Topography	The Gulf province contains highly varied topographic features (**Figure 9**). The Gulf Province contains areas of rugged mountain scapes with elevations to 1673m above sea level, as well as considerable coastal lowlands including riverine deltas at or below sea level. The highland country rapidly gives way to coastal lowlands, river deltas and inundation areas including wetlands. The coastal environs consist of sand and mud/silt beaches and considerable estuarine systems.
Vegetation / Land Cover	The satellite imagery in **Figure 10** shows mountain scapes dominated by dense tropical forest. Access routes are predominantly along the river systems. **Figure 11** displays PRL-15 and the onshore pipeline corridor overlaid recent satellite imagery. Highland villages are remote and small and do not tend to be vastly cleared of vegetation. Coastal villages generally include some plantations and subsistence gardens, cleared coastal lowlands comprised of grasslands and regenerating scrub and some coastal flats.
Built form / structures	Villages are small scale and not densely populated. The built form tends to be simple traditional dwellings, and some limited community facilities. Building materials tend to comprise of locally sourced timbers, with traditional thatch roofs and woven walls. Some evidence of more modern building materials is evident, but the remoteness of the villages and lack of transportation facilities has limited the extent of this.
Land Use	Urban land uses are confined to the provincial capital of Kerema. Outside of Kerema the larger villages occur along the coastal fringes or locations where boat access is available. Villages are mainly subsistence based with very limited commercial agricultural activities. Many villages along the coastal lowland regions have coconut groves, papaya, jack fruit, betel nut plantations and some other non-commercial food cultivation such as yams. Areas of the forested mountain regions have been subject to formal and informal logging.
Landscape Value	The production, processing and related facilities, onshore pipeline and transport corridors are proposed to occur in a remote and predominantly undisturbed location in the Gulf Province of PNG. The Gulf Province, whilst being unique, does contain landscapes that are found in other parts of PNG, these being coastal lowlands giving way to foothills and mountainous terrain. The Purari River is PNG's third largest river. The Purari River delta system is a significant hydrological system covering approximately 34,000 km^2 and is a prominent natural feature within the Gulf Province. The area's remoteness and lack of previous significant disturbance is of note.

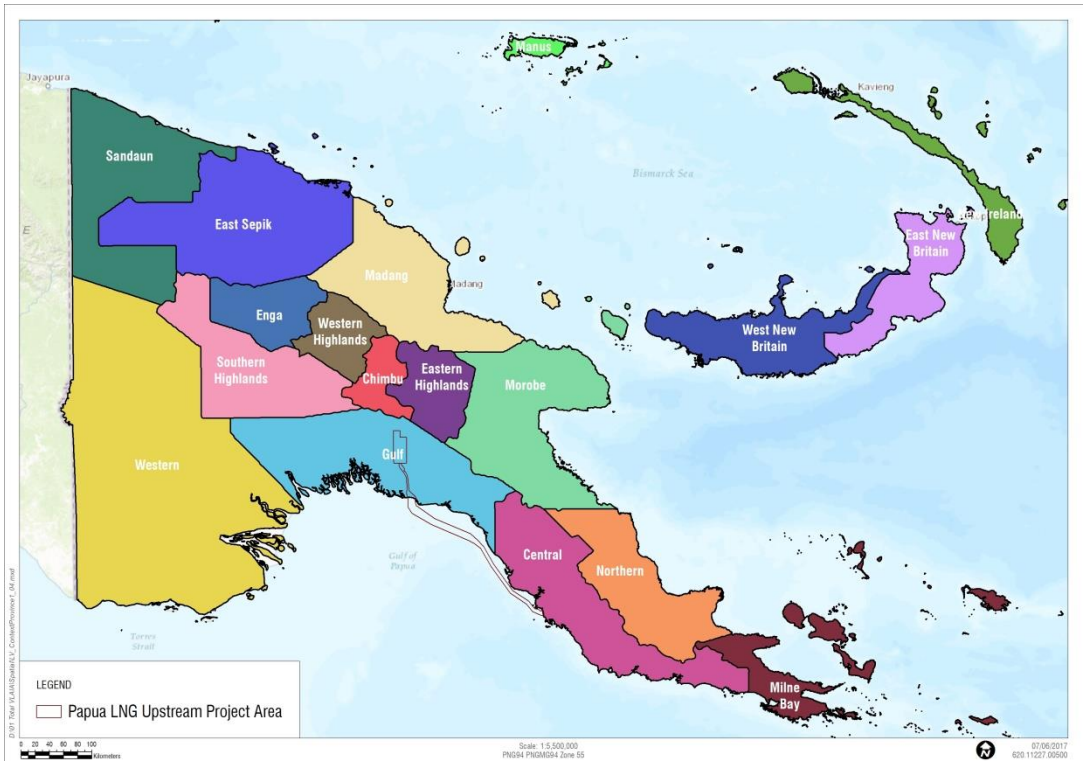

Figure 8 PNG – Provinces

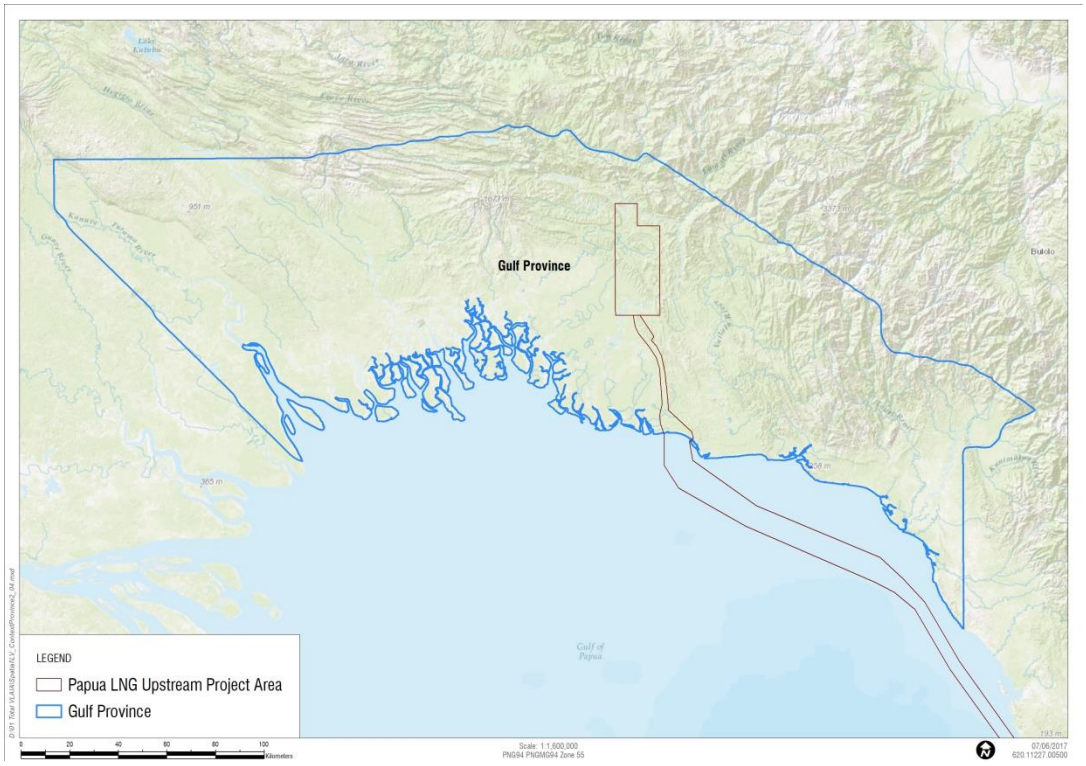

Figure 9 Gulf Province Topography

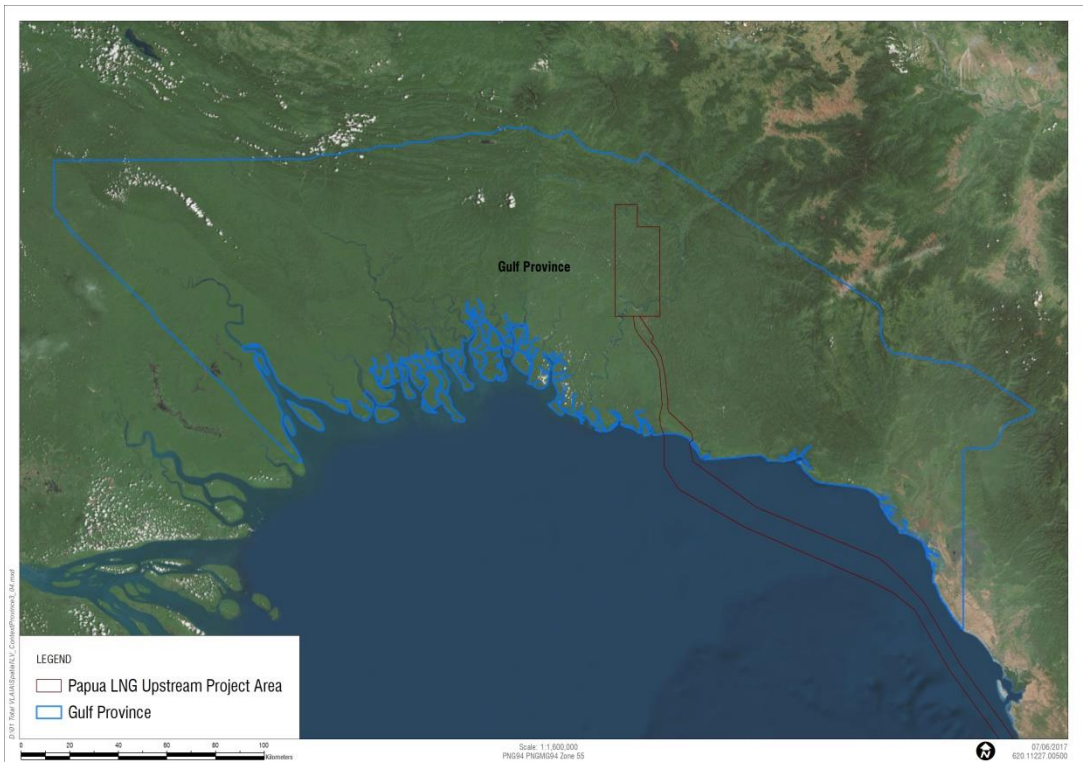

Figure 10 Gulf Province Satellite Imagery

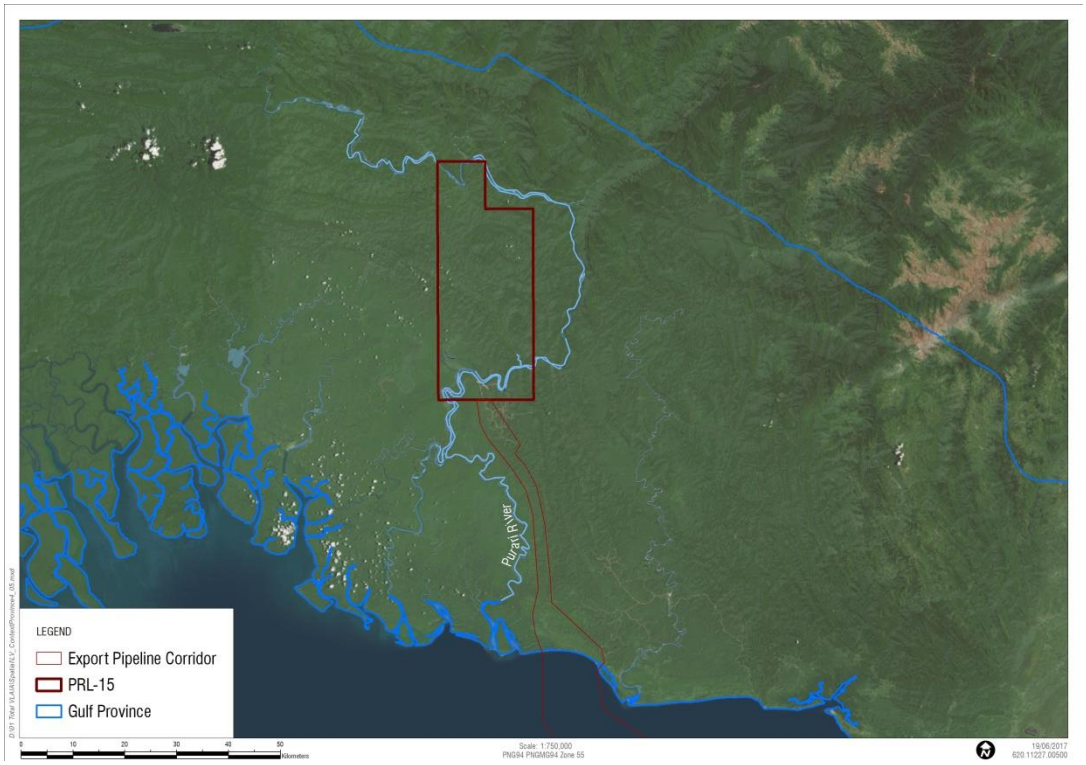

Figure 11 PRL-15 & Export Pipeline Corridor

6.3 Study Area

6.3.1 PRL-15 Landscape Character Description

PRL-15, as shown in **Figure 12, Figure 13, Figure 14,** and **Figure 15** is the location of the proposed gas field and will contain the majority of permanent infrastructure components related to the upstream Project area. It is joined to the south by the export pipeline corridor **Table 3** describes the general landscape characteristics of PRL-15. **Figure 16** shows the location of **Photo 1** to **Photo 8** in PRL-15.

Table 3 PRL-15 Context

Landscape Character	Landscape Description
Topography	PRL-15 is largely dominated by rugged and steeply sloped mountainous terrain (**Figure 12**). The southern portion consists of some alluvial flatlands/floodplain that to the south of PRL-15 adjoin the Purari River delta. Moving north from the alluvial flats around the Purari River will encounter mountain foothills and a dominant southeast to northwest trending range as highlighted by the hill shading of 2016 LiDAR survey in **Figure 13** Elevations range from close to sea level, up to 430m above sea level. Low-relief (10-50m) ridge-and-ravine country is typical of the soft mudstone adjacent to the Purari River. The steeply sloped (**Figure 14**) high-relief (100-400m) ridge-and-ravine landform is underlain by thickly bedded to massive sandstone to the northeast of the project area, with significant cliffs, forms the dominant topographic features. The landform of the area is recurrently scarred by slumps, landslides and by gullying. In the south western area of PRL-15, the PRL-15 oxbow wetlands occur.
Vegetation / Land Cover	The mountain scapes as displayed in **Photo 1, Photo 2, Photo 3** and **Photo 4** are dominated by dense tropical forest with very limited access. The lower lying alluvial plains in the southern and western portions of the area are also densely vegetated with tropical forest dominated by species tolerant of seasonal waterlogging. The oxbow wetlands include open lake and temporary cut-off wetland areas where herbaceous and swamp forest species are present (**Photo 8**). Sago palm features throughout this area and seed is collected from here for propagation by villagers. The wetlands feature endemic and introduced aquatic vegetation.
Built form / structures	The only 2 villages within the PRL-15 area (Mapaio Fish Camp and Poroi 1) are remote, small and located along the Purari River as seen in **Photo 5**. These villages are very small and not densely populated. The built form tends to be only simple traditional dwellings. Building materials tend to comprise of locally sourced timbers, with traditional thatch roofs and woven walls (**Photo 6)**. Also within PRL-15 is the established Project logistics location known as Herd Base. The base is located immediately adjacent to the Purari River as shown in **Photo 3.** Demountable buildings have been installed, along with sheds, storage facilities and aircraft hangers.
Land Use	There are no urban land uses within the PRL-15 area. The very few settlements are family based and are mainly subsistence based relying mainly on the river for protein sources. There is limited evidence of forestry operations in the area at the time of baseline surveys. The area is predominantly dense forest with very limited access.
Landscape Value	There is considerable variance in landscape across the PRL-15 area. From low lying intermittent swampy wetlands, through to the foothills of the southern extension of the central ranges. Consistent however is the dense vegetation and restricted access based upon river transportation and a very limited network of existing tracks and trails. The PRL-15 oxbow wetlands (**Photo 7, Photo 8**) consists of a series of freshwater lakes and wetlands and is considered to be an area of potential high environmental sensitivity as it is also a regionally rare example of an isolated open water lake ecosystem, and is a spirit site of high cultural importance to the Pawaian people. The large size of PRL-15 and the dense vegetation (as highlighted in **Photo 1 – Photo 8**) shows limited significant visual divergence from most vantage points.

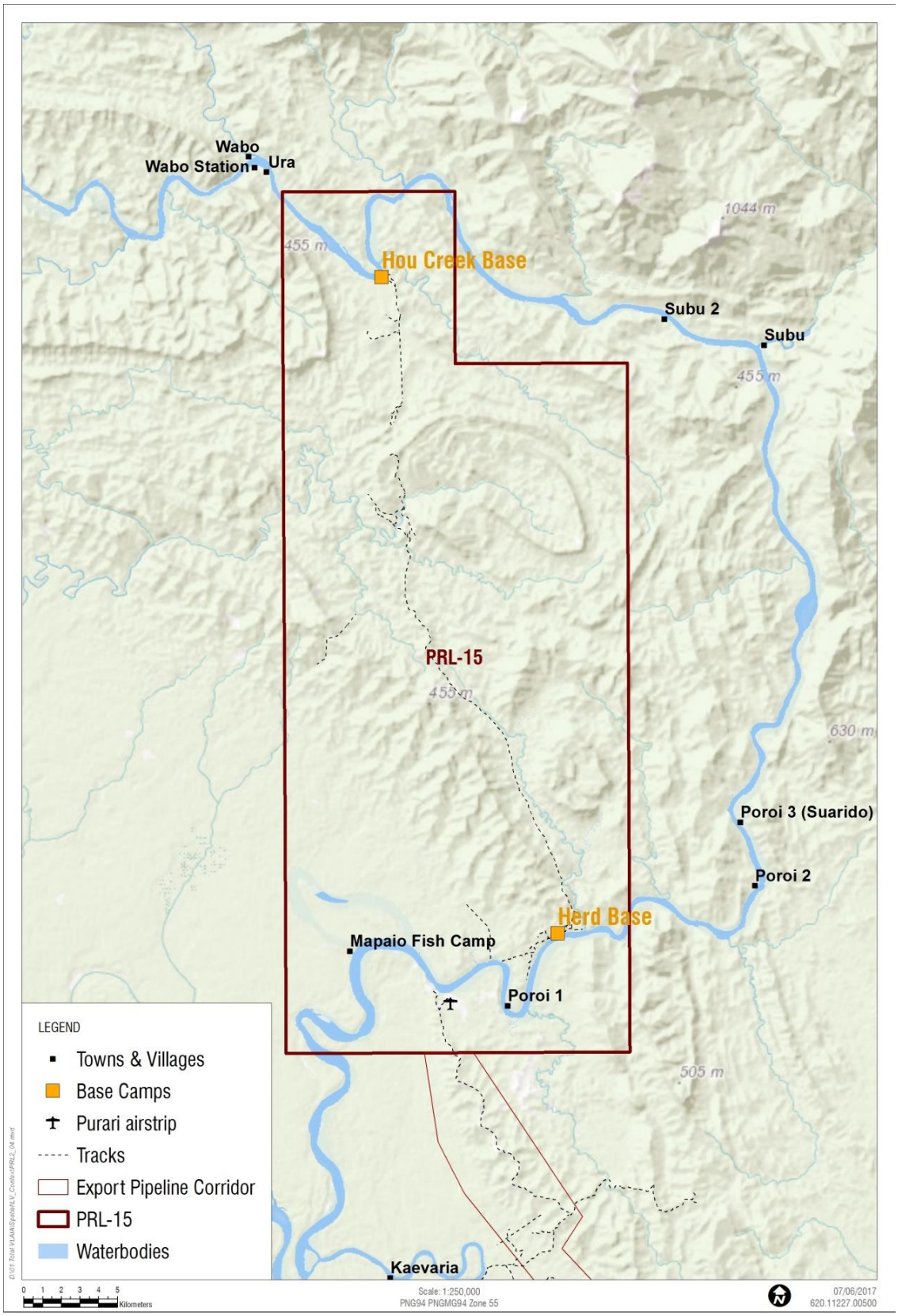

Figure 12 PRL-15 Topography

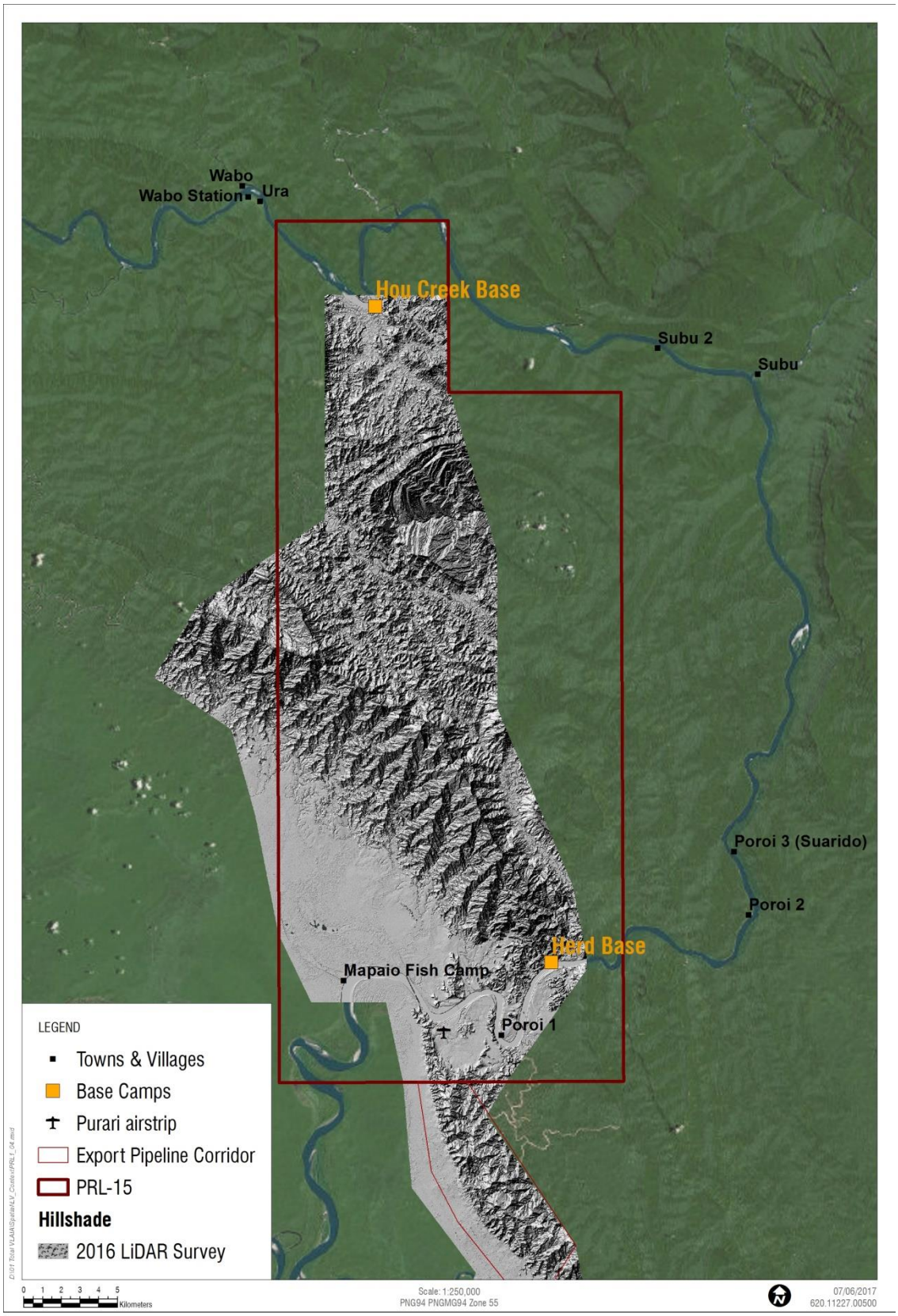

Figure 13 PRL-15 Hill Shading

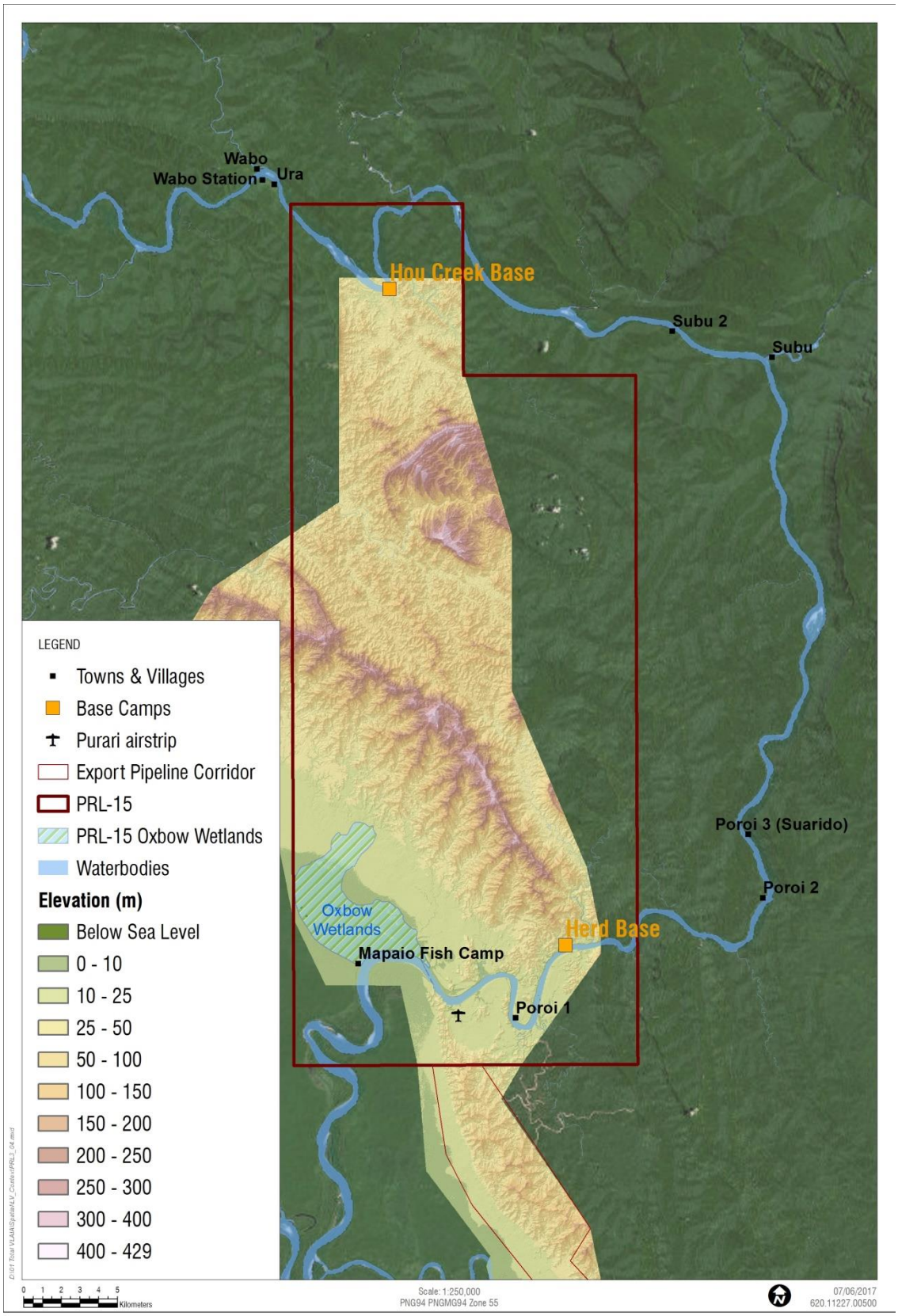

Figure 14 PRL-15 Topographic Elevation

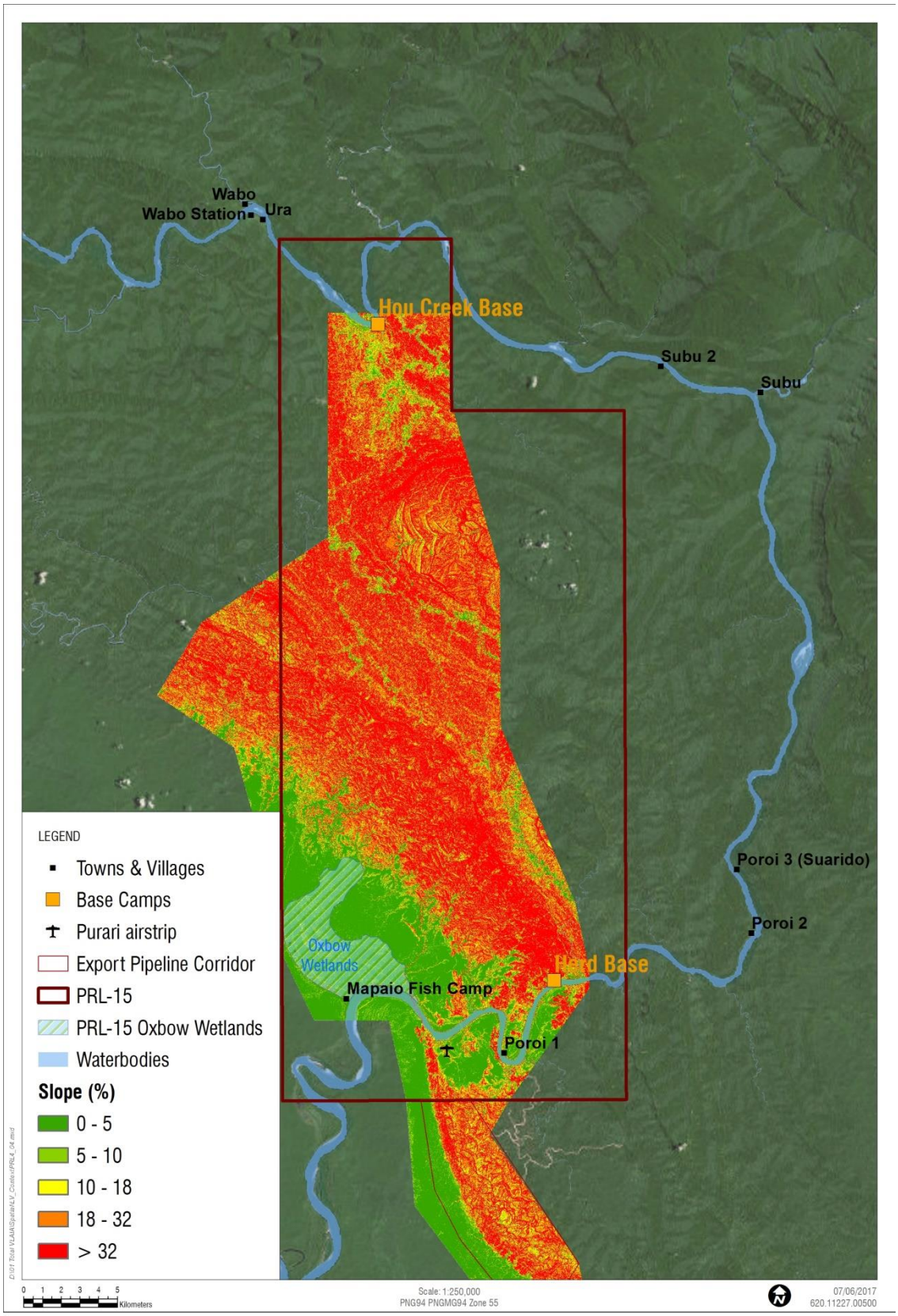

Figure 15 PRL-15 Slope

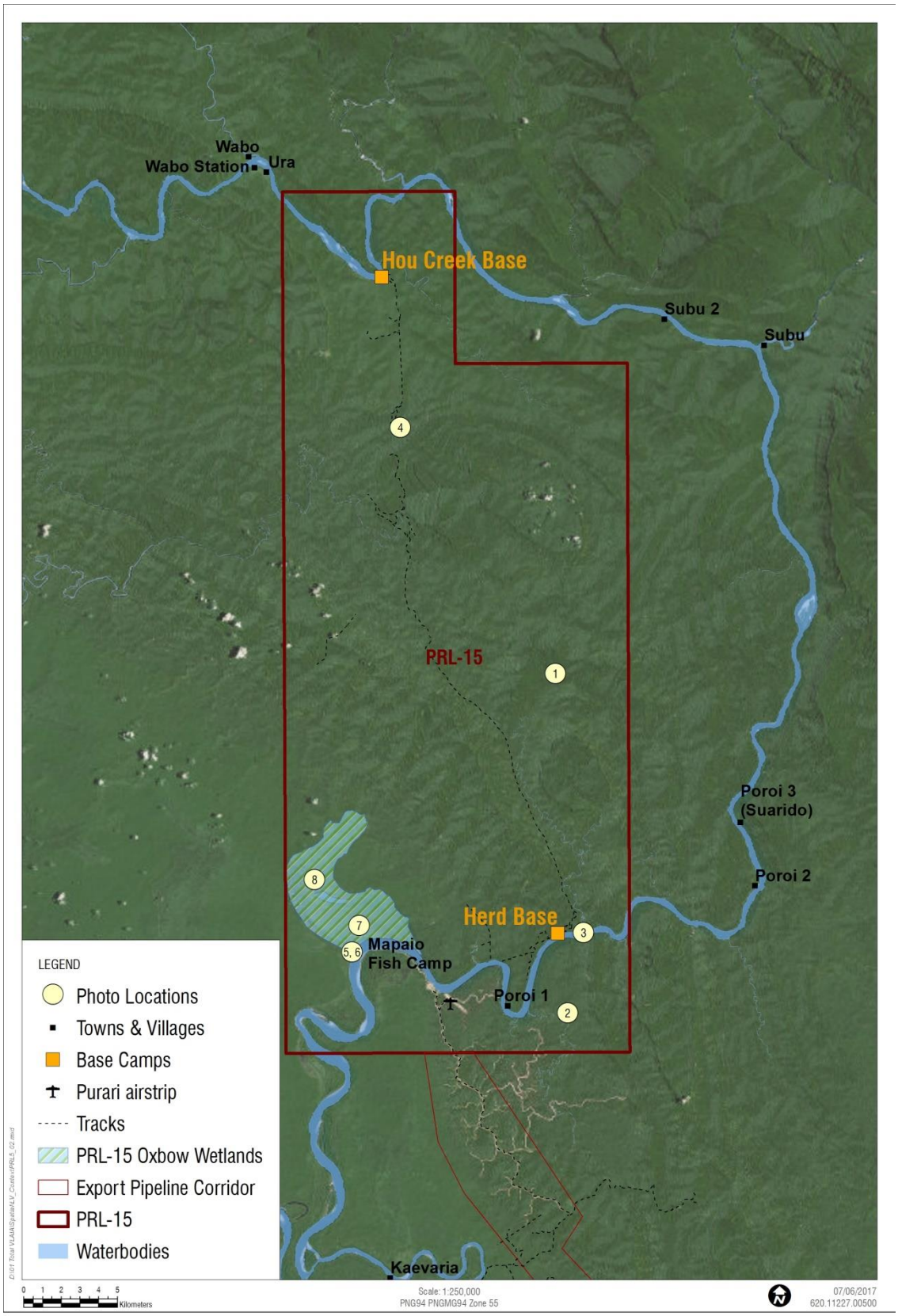

Figure 16 PRL-15 Photo Locations

Photo 1 PRL-15 Dense Tropical Forest & Mountain scape

Photo 2 PRL-15 Dense Tropical Forest & Purari River

Photo 3 PRL-15 Purari River & Dense Forest Surrounds

Photo 4 PRL-15 Dense Tropical Forest & Topography

Photo 5 PRL-15 Purari River – Mapaio Fish Camp

Photo 6 PRL-15 – Mapaio Fish Camp Traditional Dwelling

Photo 7 PRL-15 Oxbow Wetlands and Purari River

Photo 8 PRL-15 Oxbow Wetlands freshwater lake

6.3.1.1 Herd Base Landscape Character Description

Herd Base is a logistics base that was established during the exploration phase of the project. Herd Base is adjacent to the Purari River in the southern section of PRL-15. This location is typical of what any future riverside logistics hubs might incorporate. **Table 4** contains descriptions of Herd Base's general landscape characteristics. **Figure 17** shows the location of Herd Base within PRL-15, while **Figure 18** shows the location of **Photo 9** - **Photo 14** that were taken in and around Herd Base.

Table 4 Herd Base Context

Landscape Character	Landscape Description
Topography	Herd Base is located on the northern bank, and adjacent to the Purari River in the southern section of PRL-15 (location displayed in **Figure 17**). It is located on a straight section of the Purari River just to the west of Kuku Creek, a tributary of the Purari River. The base has been established on the northern bank of the river which is elevated over the southern bank as can be seen from the high resolution aerial imagery in **Figure 18** and **Figure 19**. The base is nestled between the river to the south and the immediately elevating foothills and mountains to the north. Elevations range from 6m asl at the rivers edge, through to 15-20m asl where the majority of infrastructure has been installed. These lower elevations give way quickly in the north and west to steep foothills that rise quickly to elevations of 75-95m asl as highlighted by the elevation contours in **Figure 20**.
Vegetation / Land Cover	The camp has been cleared of vegetation (**Figure 19**) for access and logistic purposes. The vegetation immediately surrounding the base is partially disturbed while further afield the vegetation is dense undisturbed forest. Access tracks lead from the camp into the mountainous surrounds and along the river as displayed in **Photo 10**.
Built form / structures	Hardstand areas as well as demountable buildings have been established and are shown in **Figure 19**, **Photo 9**, **Photo 11**, **Photo 12** and **Photo 13**. There are also power generators with sheds, storage facilities and aircraft hangers.
Land Use	This location is an accommodation camp and logistics base for the upstream Project. Herd Base is accessed via the Purari River (proximity can be seen in **Photo 14**) and by air from the nearby Purari Airstrip which is located approximately 7km to the south west on the southern bank of the river. This is currently a key transport hub for helicopters (**Photo 9**) and vehicles used for the Project.
Landscape Value	The landscape at Herd Base within PRL-15 is modified from its natural state. The disturbed area is quite small considering the scale and size of the Purari River and the vast stretches of largely primary forest within close proximity, that remain undisturbed. Located along a typical stretch of the Purari River, like many such locations within PRL-15, Herd Base is geographically constrained by the Purari River, mountain foothills and in this case the adjacent Kuku Creek. The vegetation clearance for operational purposes is evident and this does generate an area of visual deviation from the surrounding undisturbed forested landscape, particularly from vantage points on or in the immediate vicinity along the river.

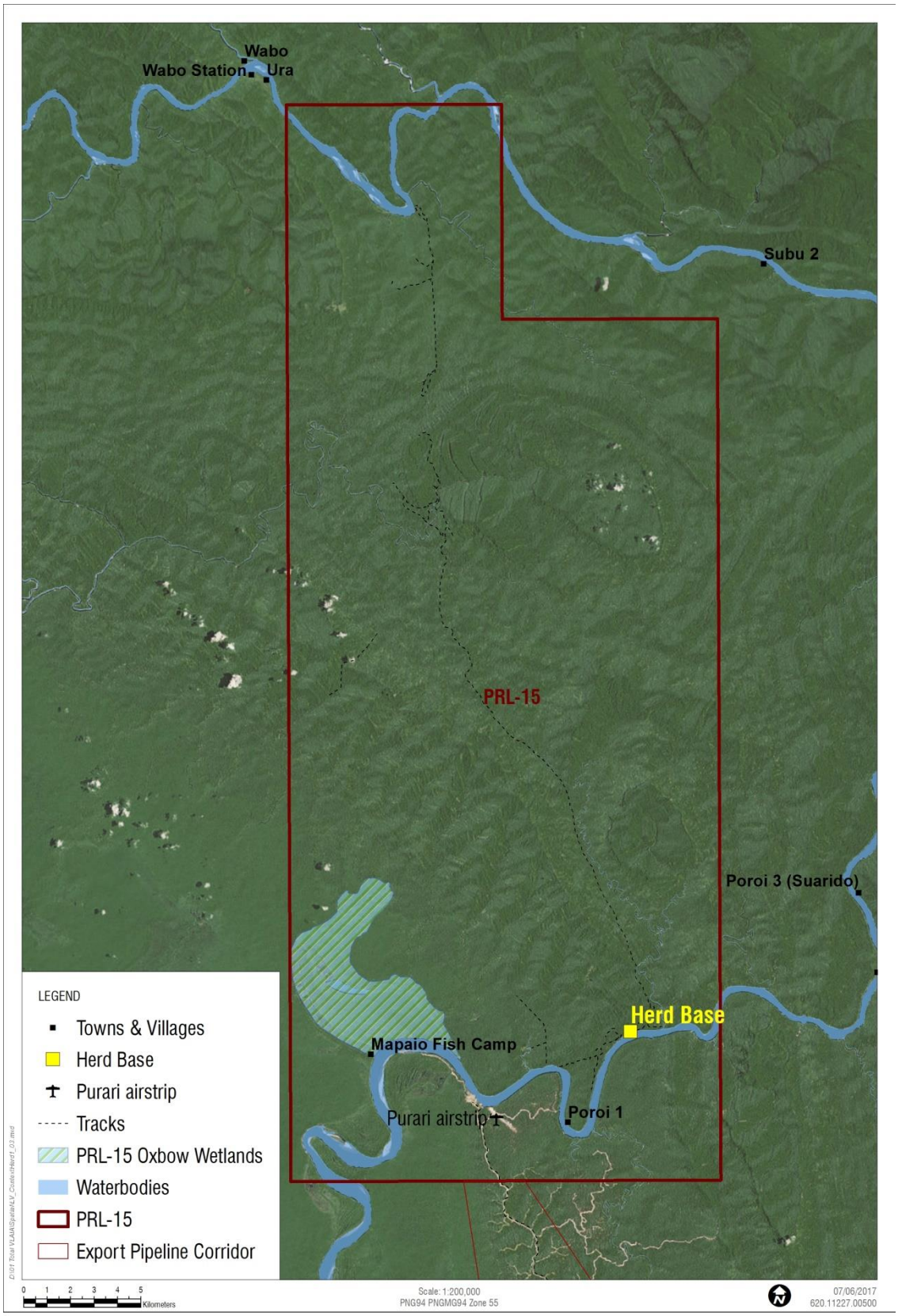

Figure 17 PRL-15 Herd Base Location within PRL-15

Figure 18 Herd Base Aerial Photo (April 2016) and Photo Locations

Figure 19 Herd Base Loading Wharf, buildings & hardstand (Aerial Photo April 2016)

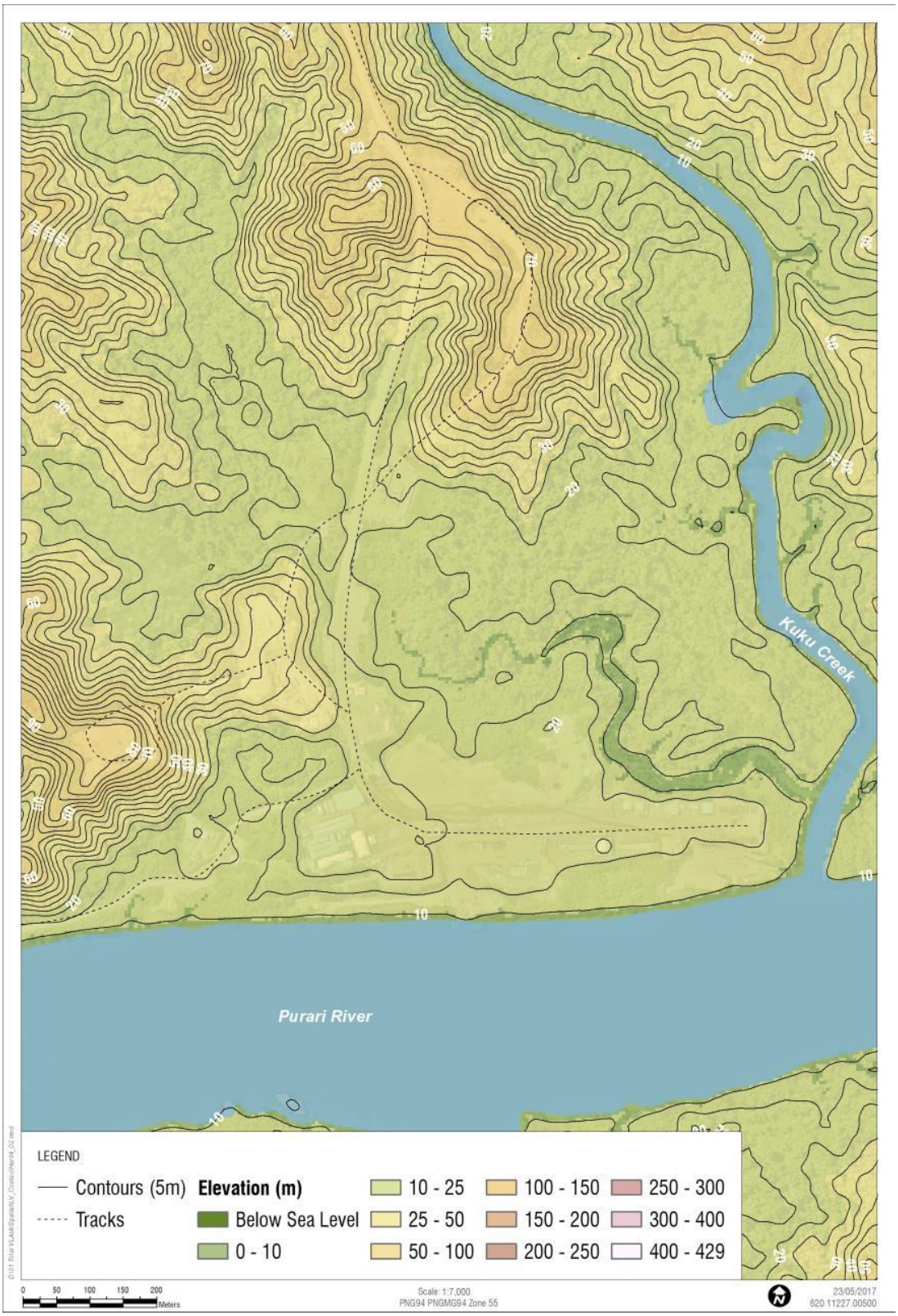

Figure 20 Herd Base Topographic Elevations (5m Contour intervals)

Photo 9 Herd Base Heli Pad

Photo 10 Herd Base South Eastern Aspect

Photo 11 Herd Base North Western Aspect

Photo 12 Herd Base Hardstand

Photo 13 Herd Base Accommodation

Photo 14 Herd Base from Purari River

6.3.1.2 CPF, Logistics Base & Airstrip Area Landscape Character Description

The CPF, logistics base and airstrip area is a region that has been identified within PRL-15 to potentially accommodate the upstream central processing facility (CPF), an upstream project logistics base and dedicated airstrip. The precise location for these project components has not been determined (approximate location within PRL-15 is shown in **Figure 21**) and therefore **Table 5** generally describes the 6440Ha region that has been identified**. Figure 22** shows the location of **Photo 15** – **Photo 18** that were captured in various locations within the CPF, Logistics base & Airstrip Area.

Table 5 CPF Area Context

Landscape Character	Landscape Description
Topography	The potential area for the CPF, logistics base and airstrip is located in the southern section of PRL-15 as illustrated in **Figure 21**, predominantly occurs on the floodplains to the north of the Purari River (**Figure 22**). **Figure 23** shows the topographic elevations of the area, and **Figure 24** reveals the steeper slopes of the foothills and the gentle terrain of the wetlands and floodplains that are intersected by minor tributaries of the Purari River such as shown in **Photo 18**. Elevations in this area range from 7m above sea level in the flattest south western section, through to 200m above sea level in the steeply sloping mountainous northern and eastern areas.
Vegetation / Land Cover	The majority of this area is densely vegetated with tropical forest. Much of the area is previously undisturbed similar to that shown in **Photo 15**; however there are some access tracks through the area related to ongoing and future potential development. Limited clearing has occurred at Herd Base camp which is located near the south eastern limit of the area. In the lower areas to the south and west of the proposed region there are intermittent wetlands and the Oxbow wetlands complex, with considerable land being prone to inundation from the Purari River. The lower lying alluvial plains in the southern and western portions of the area are densely vegetated with tropical forest and species tolerant of seasonal waterlogging. The oxbow wetlands feature herbaceous and swamp forest species as well as sago palm and endemic and introduced aquatic vegetation, some of which are harvested by local villagers.
Built form / structures	There are no built structures in this area except for those identified at Herd Base and detailed in **Table 4**.
Land Use	This location is currently predominantly undisturbed (**Photo 17)** however is used by local villagers and some Poroi clans for hunting and gathering of native fauna as well as edible flora species. This is particularly true in the Oxbow wetland area which contains considerable ecological diversity. Some prior disturbance occurred through the exploration stage of the Project as can be seen in **Photo 16**.
Landscape Value	There is considerable variance in landscape across the CPF, logistics base and airstrip area. Landscape ranges from low lying intermittent swampy wetlands, through to mountain foothills. Densely vegetated and predominantly undisturbed the dense vegetation provides limited visual diversity from the river transport corridor which contains the majority of currently traversed vantage points into this area.

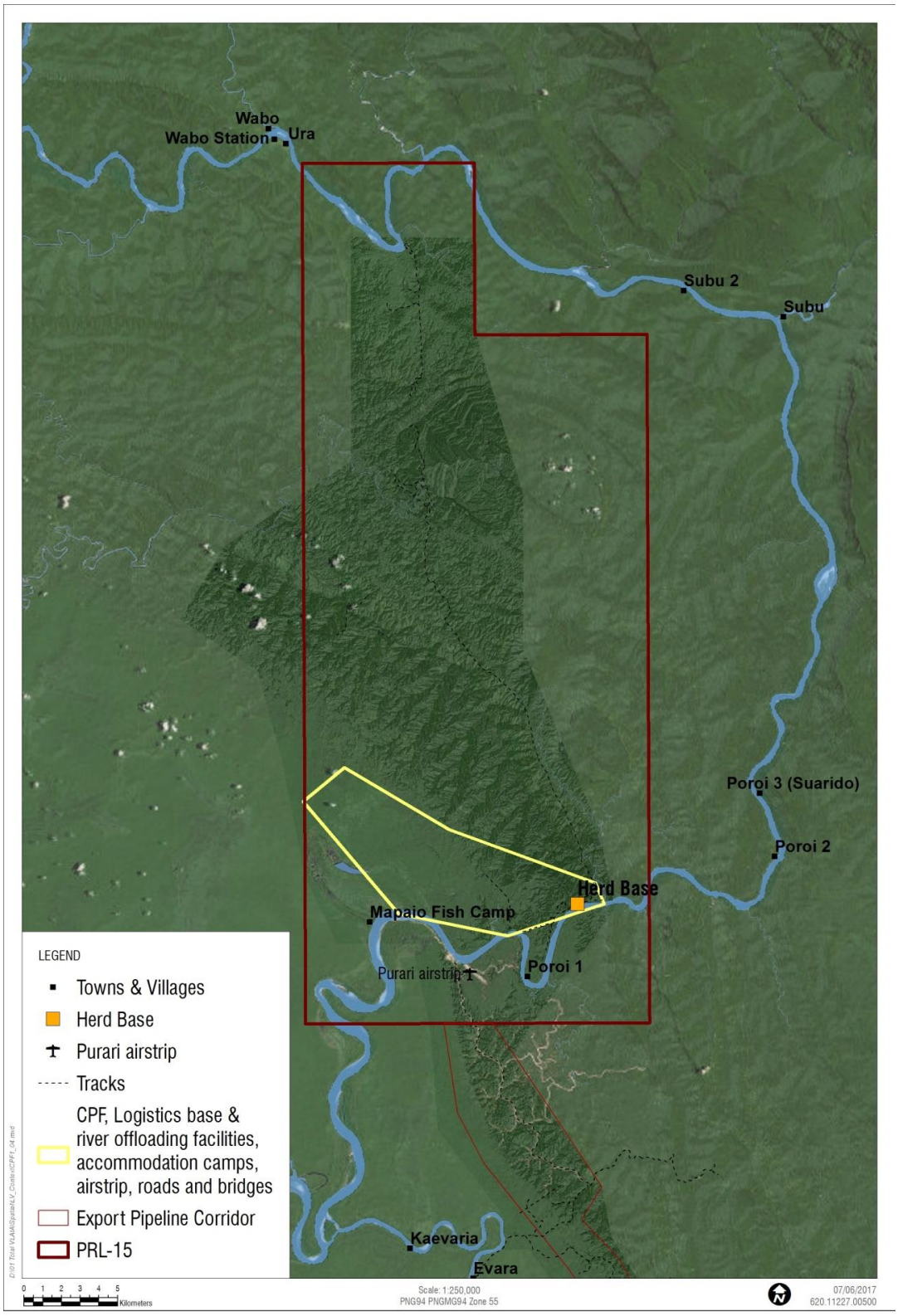

Figure 21 PRL-15 CPF, Logistics Base & Airstrip Area

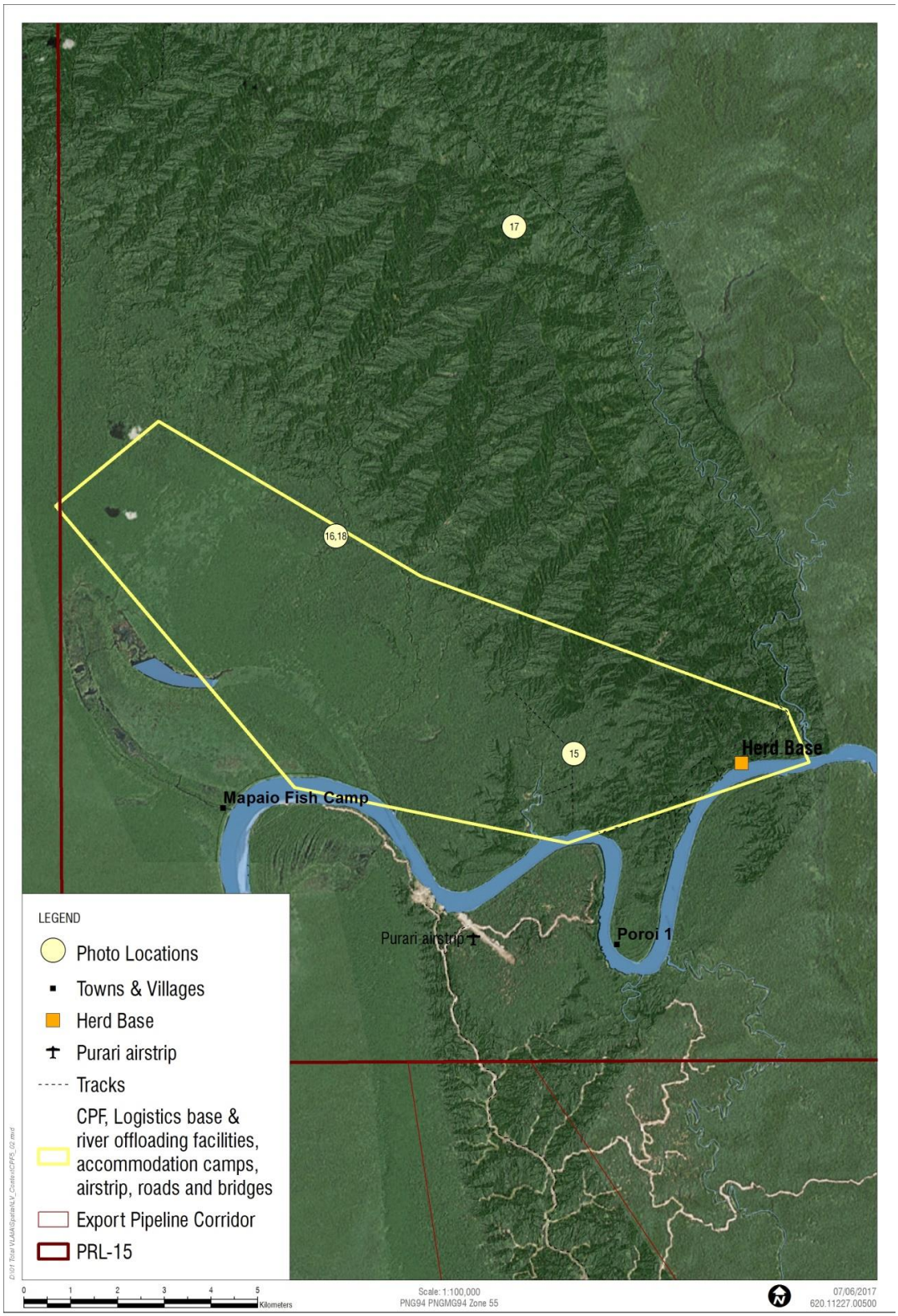

Figure 22 CPF, Logistics Base & Airstrip Area Photo Locations

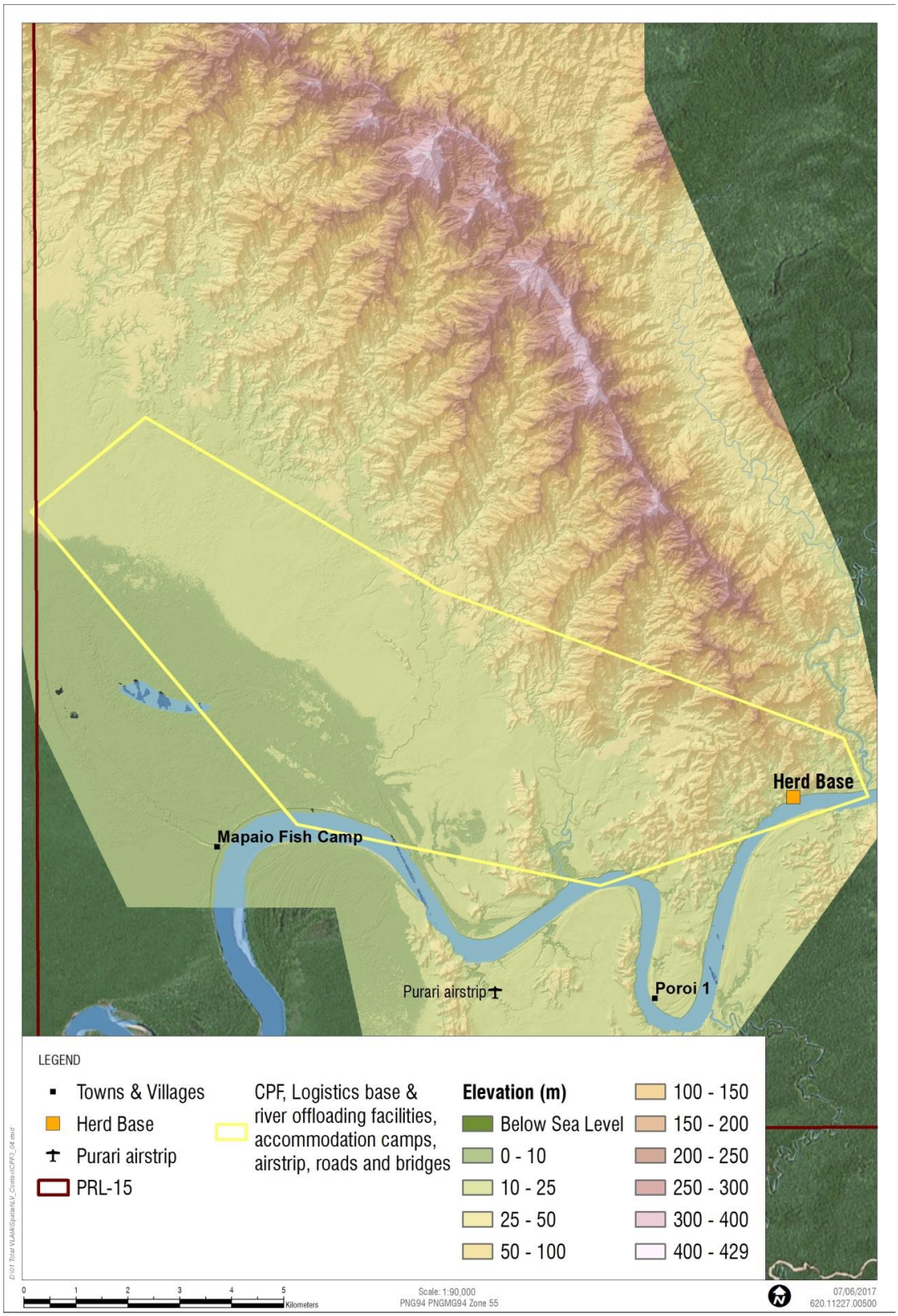

Figure 23 CPF, Logistics Base & Airstrip Area Topographic Elevation

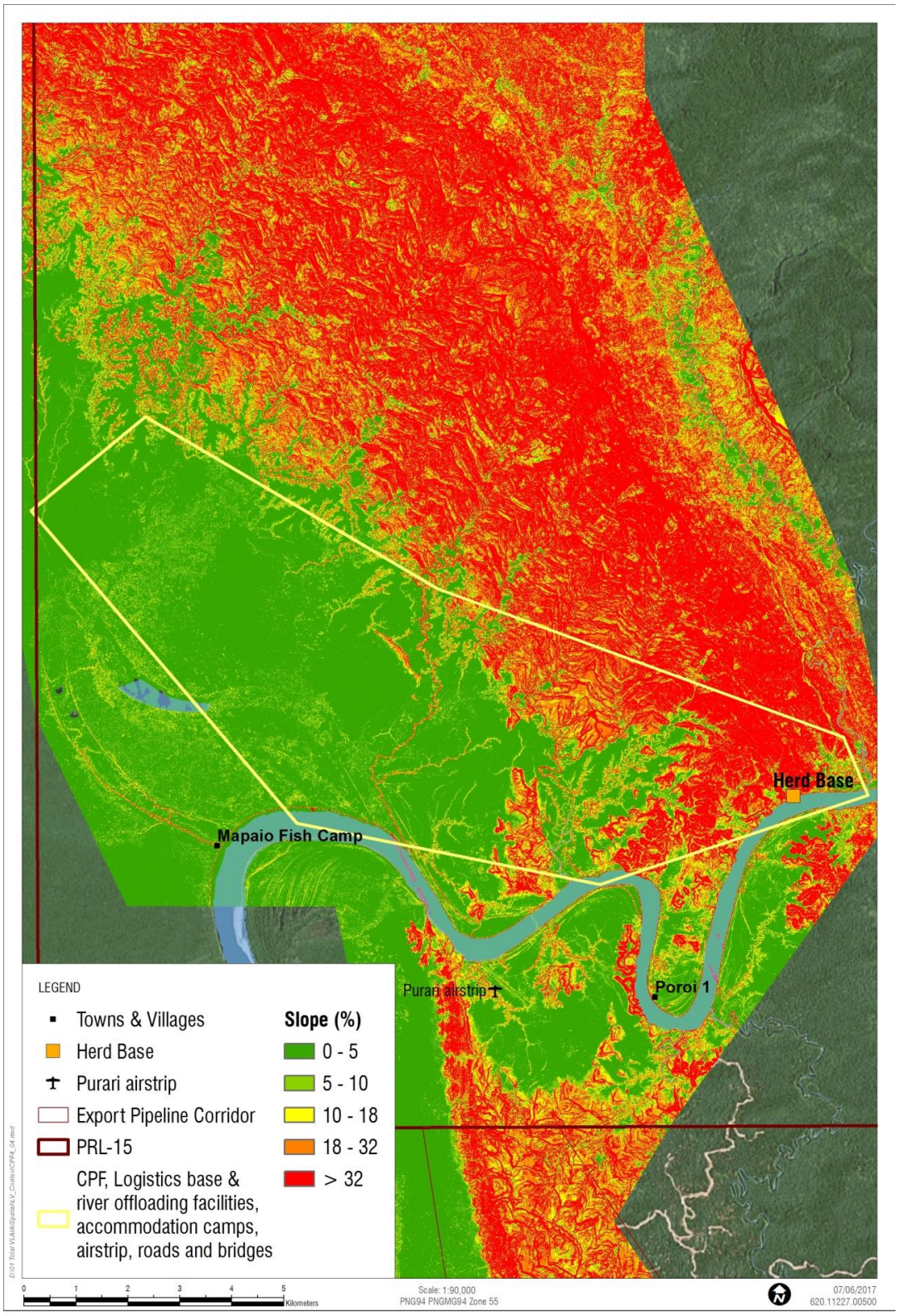

Figure 24 CPF, Logistics Base & Airstrip Area Slope

Photo 15 Undisturbed vegetation - Aerial Photo April 2016

Photo 16 Previously disturbed temporary access site, vegetation regeneration

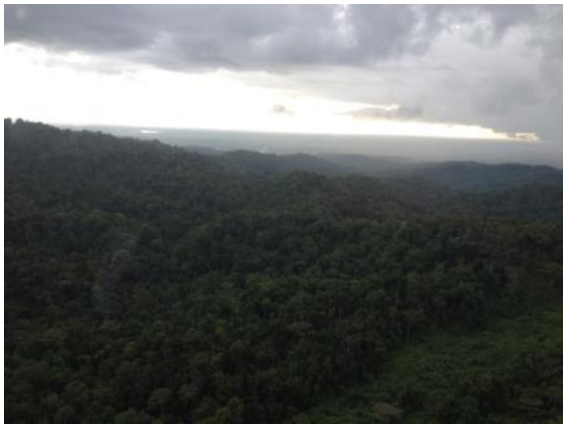

Photo 17 Densely vegetated mountain foothills

Photo 18 Creek and riparian vegetation

6.3.1.3 Wellpad ANT-3 Landscape Character Description

ANT-3 is one of several exploration wellpads that have been constructed within PRL-15. These wellpads occur in the mid to northern part of PRL-15 as shown in **Figure 25**. It will likely form part of the gas gathering infrastructure for the Project. **Table 6** describes the general landscape characteristics of ANT-3. **Figure 26** shows the location of displayed photographs (**Photo 19** & **Photo 20**) taken in the vicinity of Wellpad ANT-3.

Table 6 Wellpad ANT-3 Context

Landscape Character	Landscape Description
Topography	Levelled area surrounded by steep mountainous topography adjacent to Boa Creek. Elevations (**Figure 27**) immediately surrounding the cleared and levelled wellpad and infrastructure area range from 45m asl to 130m asl. Very steep slopes surround the wellpad and other infrastructure as highlighted in **Figure 28**.
Vegetation / Land Cover	This wellpad location has been cleared of vegetation as shown in **Figure 26**, but the surrounding area is densely vegetated with forest species **Photo 19**. The surrounds of this wellpad area remain undisturbed; however an access track does traverse this location.
Built form / structures	There are several built structures (**Photo 19**) in this area that remain from the development of the well. There is also considerable hardstand located at this site.
Land Use	The surrounds to this location are predominantly undisturbed as exemplified by **Photo 20** of Boa Creek and its undisturbed surrounds. The wellpad itself is disturbed and intended for collection of gas.
Landscape Value	This location is entirely typical of the surrounding mountainous terrain that dominates PRL-15. The vegetation clearance for gas exploration drilling purposes is evident and this creates an area visually divergent from the immediate surrounds. However the cleared area of ANT-3 Wellpad is entirely surrounded by dense vegetation and steep topography as can be seen in **Photo 19** and **Photo 20** below**.**

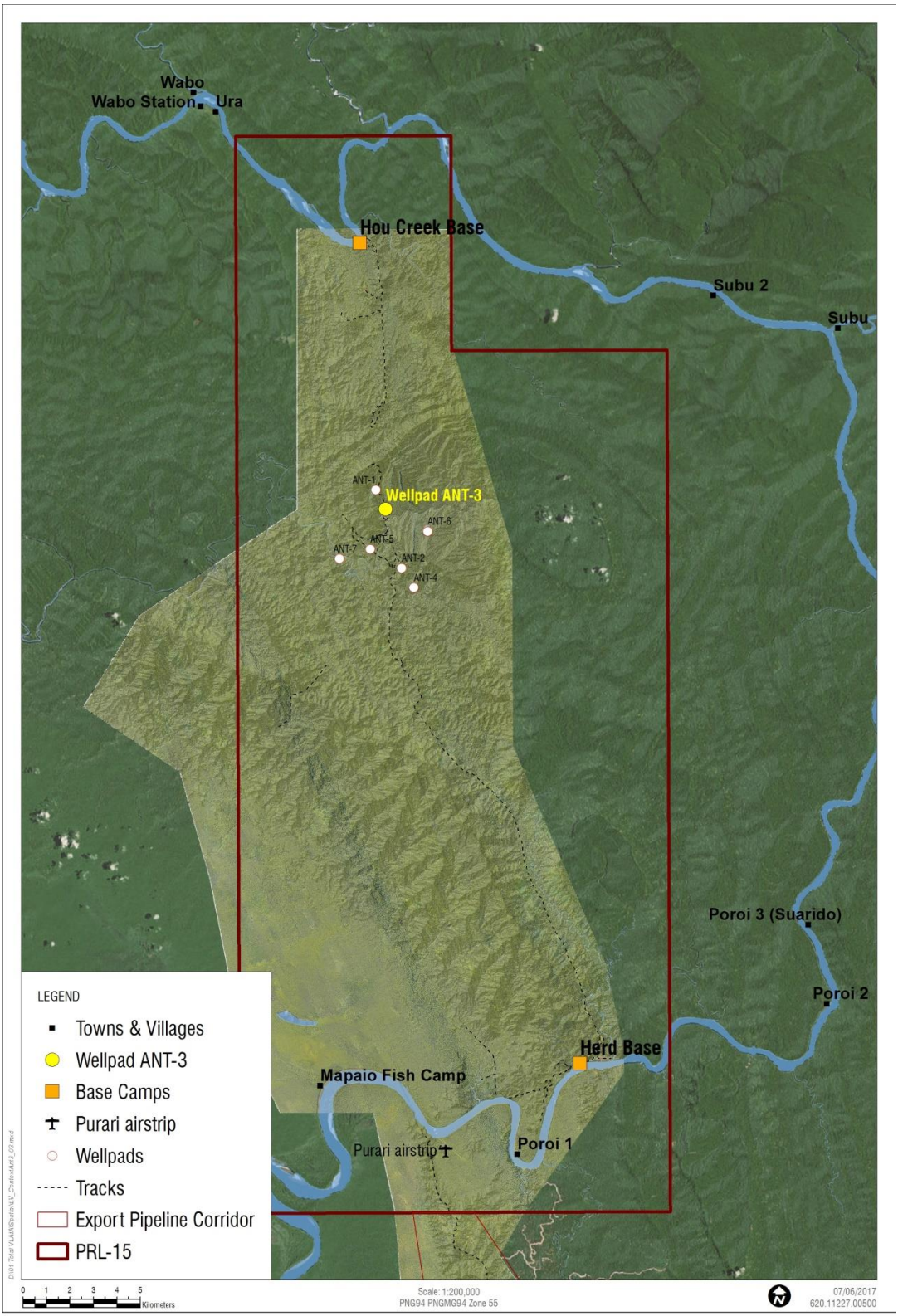

Figure 25 PRL-15 Wellpad ANT-3

Figure 26 Wellpad ANT-3 Aerial Photo (April 2016) & Photo Locations

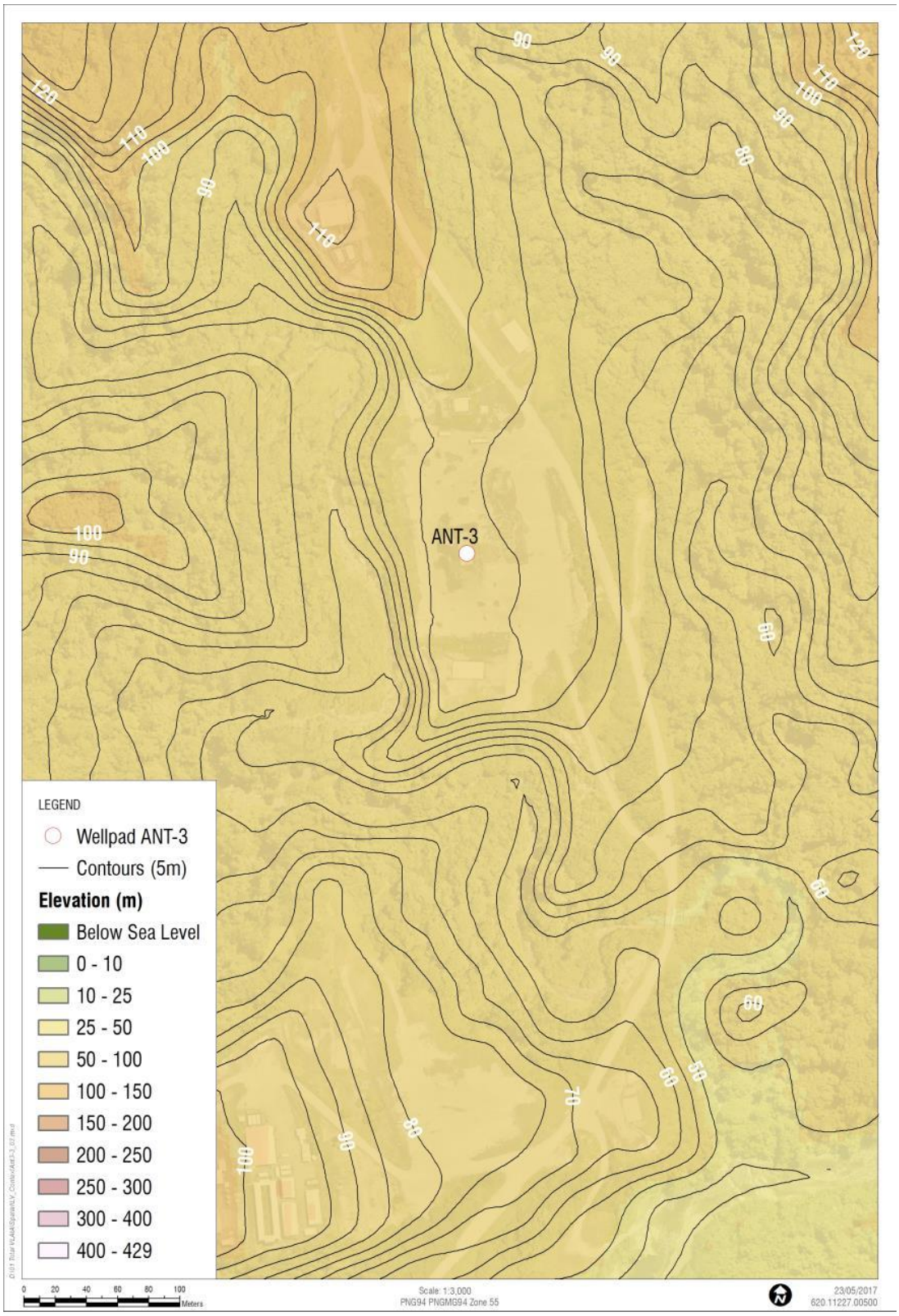

Figure 27 Wellpad ANT-3 Topographic Elevation (5m contour intervals)

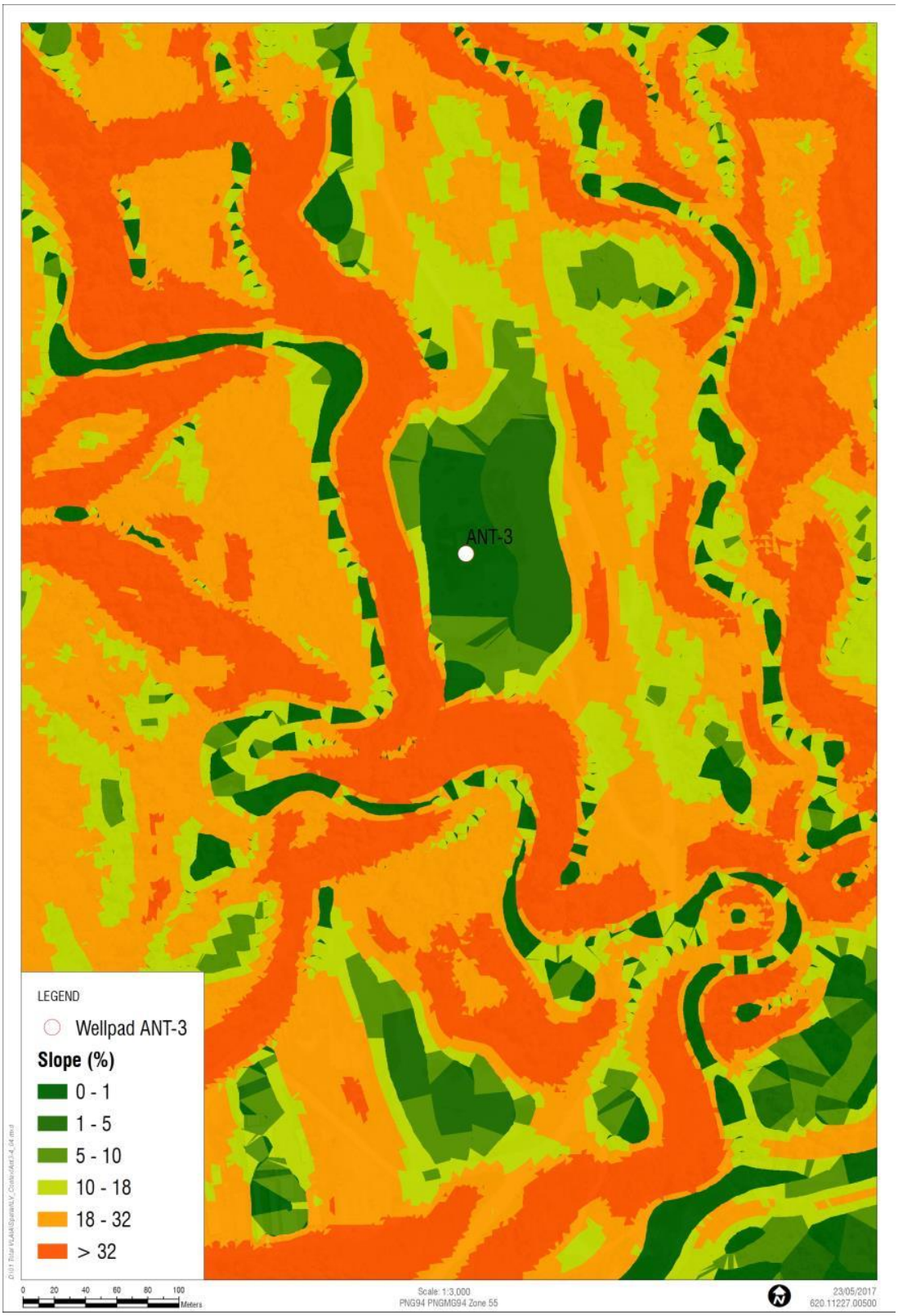

Figure 28 Wellpad ANT-3 Slope

Photo 19 Wellpad ANT-3 From the Air

Photo 20 Boa Creek and undisturbed surrounds

6.3.2 Onshore Pipeline Corridor Landscape Character Description

The onshore pipeline corridor component of the upstream Project area lies to the south of PRL-15 and stretches from the southern boundary of PRL-15 through to the coastline of the Gulf of Papua. **Table 7** generally describes the onshore pipeline corridor. **Photographs 21, 22, 23 and 24** display features of the onshore pipeline corridor**,** and their geolocations are shown on **Figure 29**.

Table 7 Onshore Pipeline Corridor Context

Landscape Character	Landscape Description
Topography	Topography in this area varies considerably as shown in **Figure 30** and **Figure 31**. Elevations range from sea level (and below) to 190m asl. Beaches and coastal plains where coastal villages (**Figure 30**) occur in the south (see **Table 8**). The coastal villages are low lying and occur adjacent to networks of creeks and channels that pass into tidal inlets, lagoons, swamp and inundation areas (**Photo 24**). Moving north, the corridor encompasses soft mudstone areas typical of the low-lying Purari River delta as well as low-moderate relief (10-100m asl) ridge-and-ravine country. The ridge and ravine country highlighted in **Figure 32** are typically steeply sloped while the coastal floodplains are mostly flat terrain, with both terrain types highlighted in the hill shading displayed in **Photo 23**.
Vegetation / Land Cover	The onshore pipeline corridor is dominated by dense scrub (**Photo 22**), marsh and mangroves in the far south, giving way to dense forest on the ridges and ravines to the north. In the immediate surrounds to villages there are small areas cleared for plantations and used for subsistence agriculture. Many areas are below sea level and subject to inundation, and as a result many wetland species are present. The majority of this area is undisturbed although some partially cleared access tracks and trails do exist for transportation between villages.
Built form / structures	Villages on the coast (see aerial imagery in **Photo 21**) consist of mainly of simple traditional dwellings (see Table 8). Non coastal villages are small, and as a result of their relative isolation and remoteness, buildings tend to be small in scale and use traditional and locally sourced building materials. Away from the coastal and lowland villages there is little to no built infrastructure.
Land Use	The area is predominantly densely vegetated with limited access. Outside the coastal and lowland villages the existing land use is mainly undisturbed vegetation. The villages are mostly residential living and subsistence farming. There are some small pockets of agricultural activity for food and trading and there is evidence of significant logging activity throughout upland sections of the pipeline corridor.
Landscape Value	There is considerable variance in landscapes across the onshore pipeline corridor area. From low lying intermittent swampy wetlands, through to the foothills of the ranges. Consistent however is the dense vegetation and limited accessibility. The large expanse of the onshore pipeline corridor (approximately 70km from north to south), and the dense vegetation (as highlighted in the **Photos 21, 22 and 24**) shows limited visual divergence from most vantage points.

Figure 29 Onshore Pipeline Corridor & Photo Locations

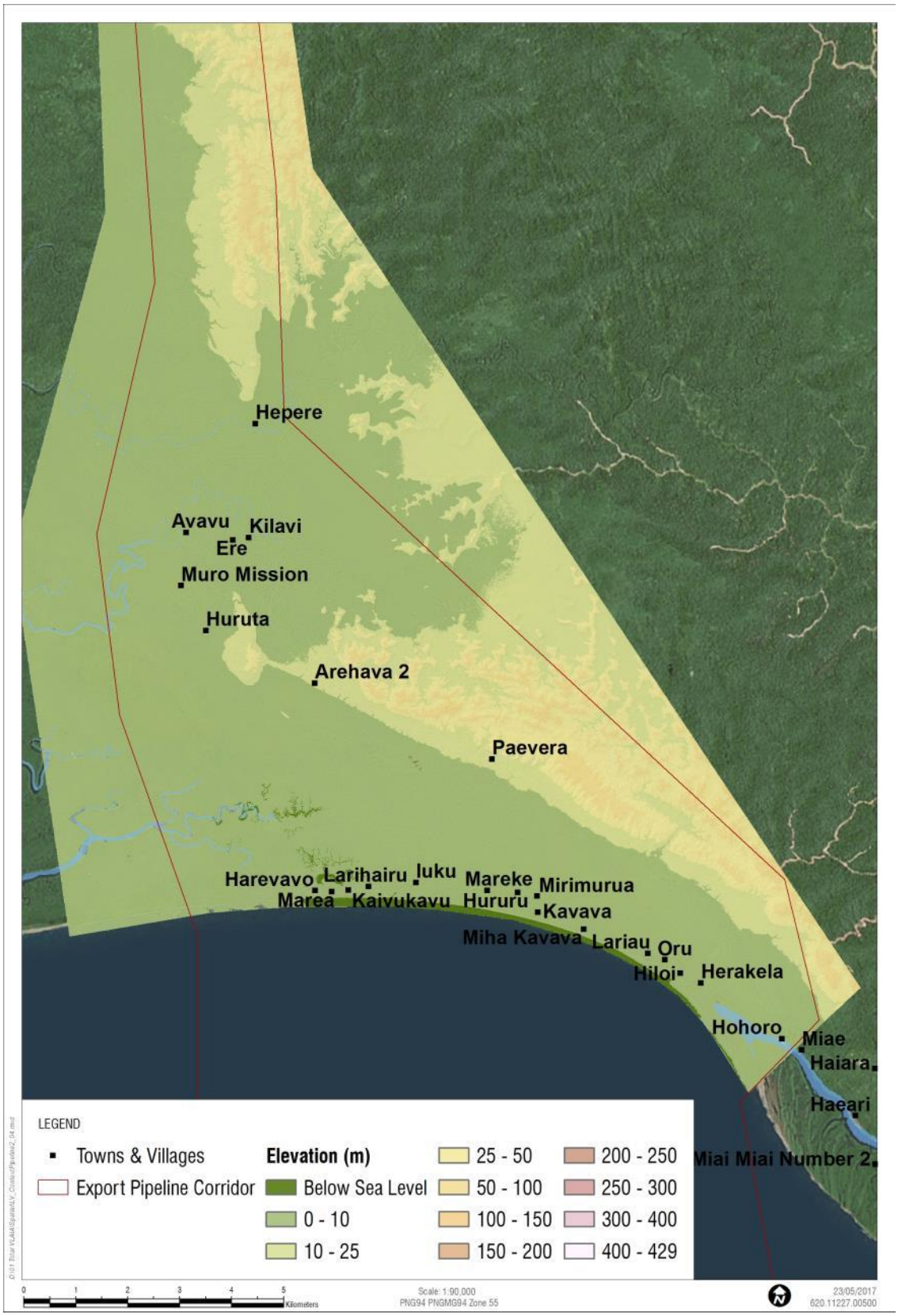

Figure 30 Onshore Pipeline Corridor Coastal and Hinterland Villages

Figure 31 Onshore Pipeline Corridor Topographic Elevation

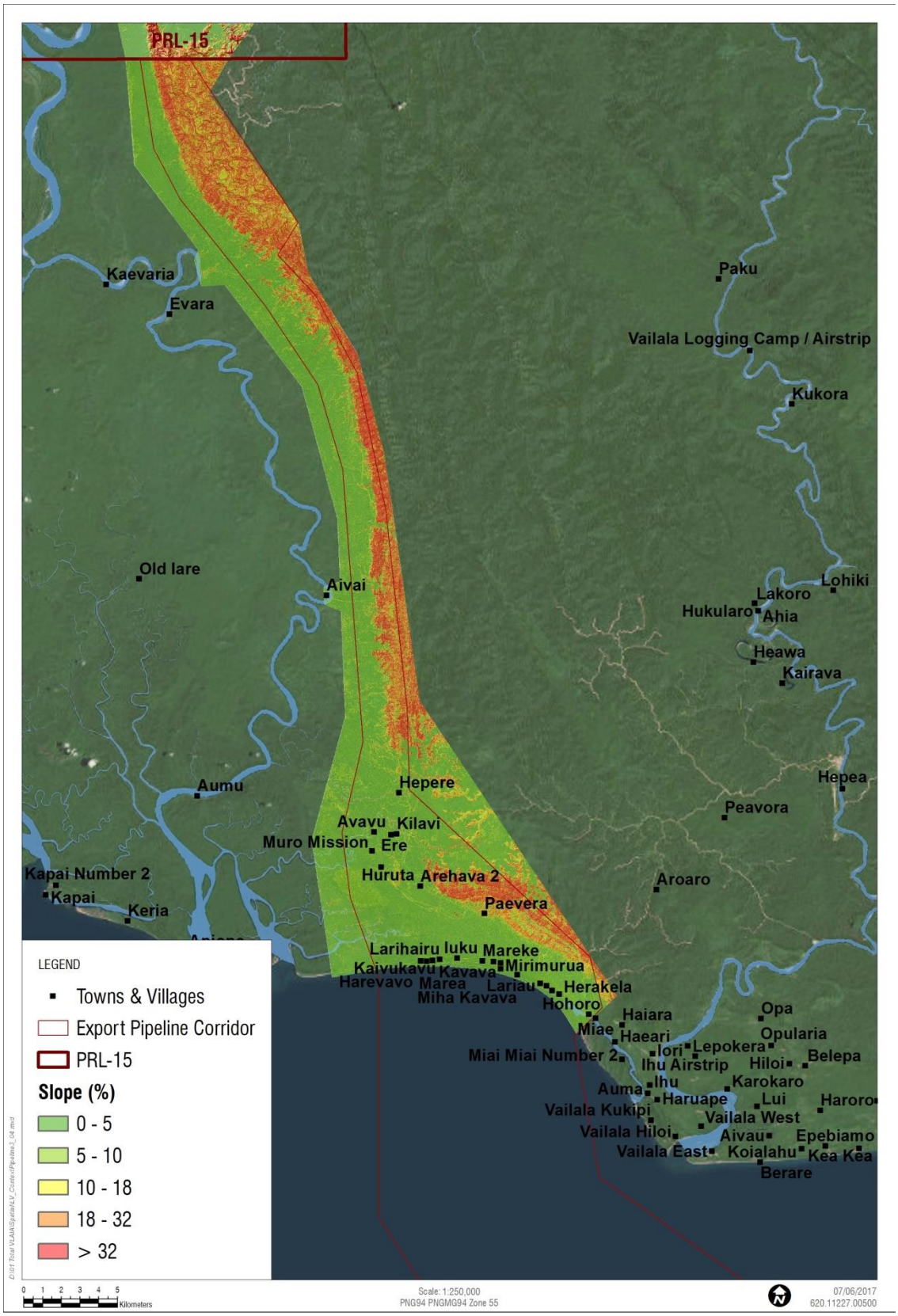

Figure 32 Onshore Pipeline Corridor Slope

Photo 21 Coastal Villages and inundation areas
Aerial Photo April 2016

Photo 22 Typical dense vegetation
Aerial Photo April 2016

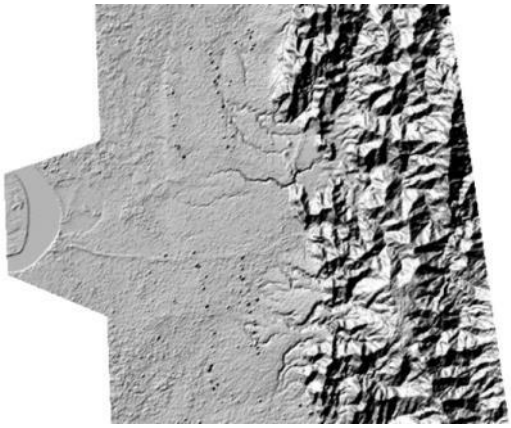

Photo 23 Typical landform including river, floodplain, lowlands and hills

Photo 24 River, lowlands and dense vegetation

6.3.2.1 Coastal Villages Landscape Character Description

While the precise route for the onshore pipeline is not yet known, the proposed corridor has been defined and is shown in **Figure 33**. The corridor does intersect with numerous existing villages along the Gulf of Papua coast; these have been surveyed and shown over satellite imagery in **Figure 34**. **Table 8** describes the typical landscape characteristics of many of these villages. **Figure 35** shows the locations of **Photo 25** - **Photo 30** which were captured in the vicinity of the Coastal Villages.

Table 8 Coastal Villages Context

Landscape Character	Landscape Description
Topography	Low lying areas immediately adjacent to the Gulf of Papua (**Figure 35**). Elevations range from sea level (and below) up to the coastal ridges at 100m asl. Sand and mud/silt beaches backed to the north by beach ridge complexes and beach plains which comprise the Orokolo Bay area. Beach ridge systems and beach plains are composed of recent sediments shaped as long parallel ridges and swales (Löffler et al., 1974). **Figure 36** reveals the coastal ridges are steeply sloped while the coastal lowlands have limited gradients. Networks of creeks and channels pass into tidal inlets, lagoons, swamp and inundation areas and can easily be distinguished from the air as shown in **Photo 25** and **Photo 26**.
Vegetation / Land Cover	The surrounds of coastal villages near the proposed pipeline corridor are dominated by dense scrub and marsh (**Photo 26**). There are areas of cleared land that have been established as to coconut groves, bread fruit, sago palm and betel nut plantations (**Photo 28**, **Photo 29**). There are many areas below sea level and subject to inundation with natural vegetation comprising alluvial and mangrove forests, the latter largely present in the western portion of the corridor away from settlements and closer to the Purari River channel
Built form / structures	Villages on the coast are further developed and more heavily populated than the foothills and mountainous areas to the north of the upstream Project area. The built form tends to be simple traditional dwellings with examples displayed in **Photo 27**. Building materials tend comprise of locally sourced timbers, with traditional thatch roofs and woven walls. Some more modern building materials such as corrugated roofing and milled timber are present.
Land Use	The land use of these coastal villages is mostly residential living and subsistence fishing and farming (example of a fishing canoe is shown in **Photo 30**). There are some pockets of agricultural enterprise for food stuffs and trading (such as the betel nut, coconut and bread fruit plantations).
Landscape Value	The coastal villages typify the interface between the Gulf of Papua and PNG's landmass. There are diverse landscape features and these villages support the majority of the population within the onshore export pipeline corridor. There is variance in the visual environment in this coastal area; however the typical low-lying and partially disturbed landscape is similar across the different villages in the study area.

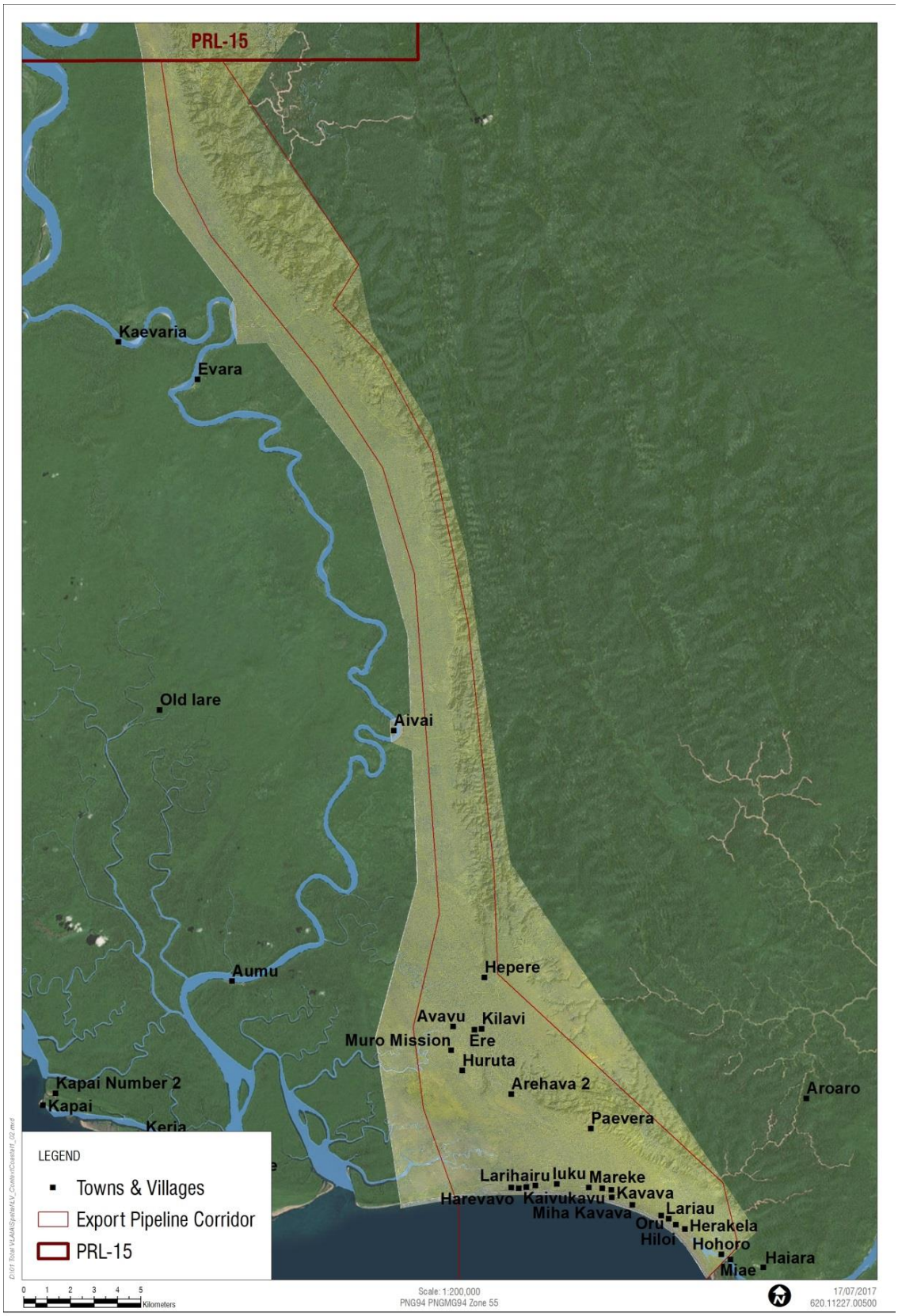

Figure 33 Onshore Pipeline Corridor

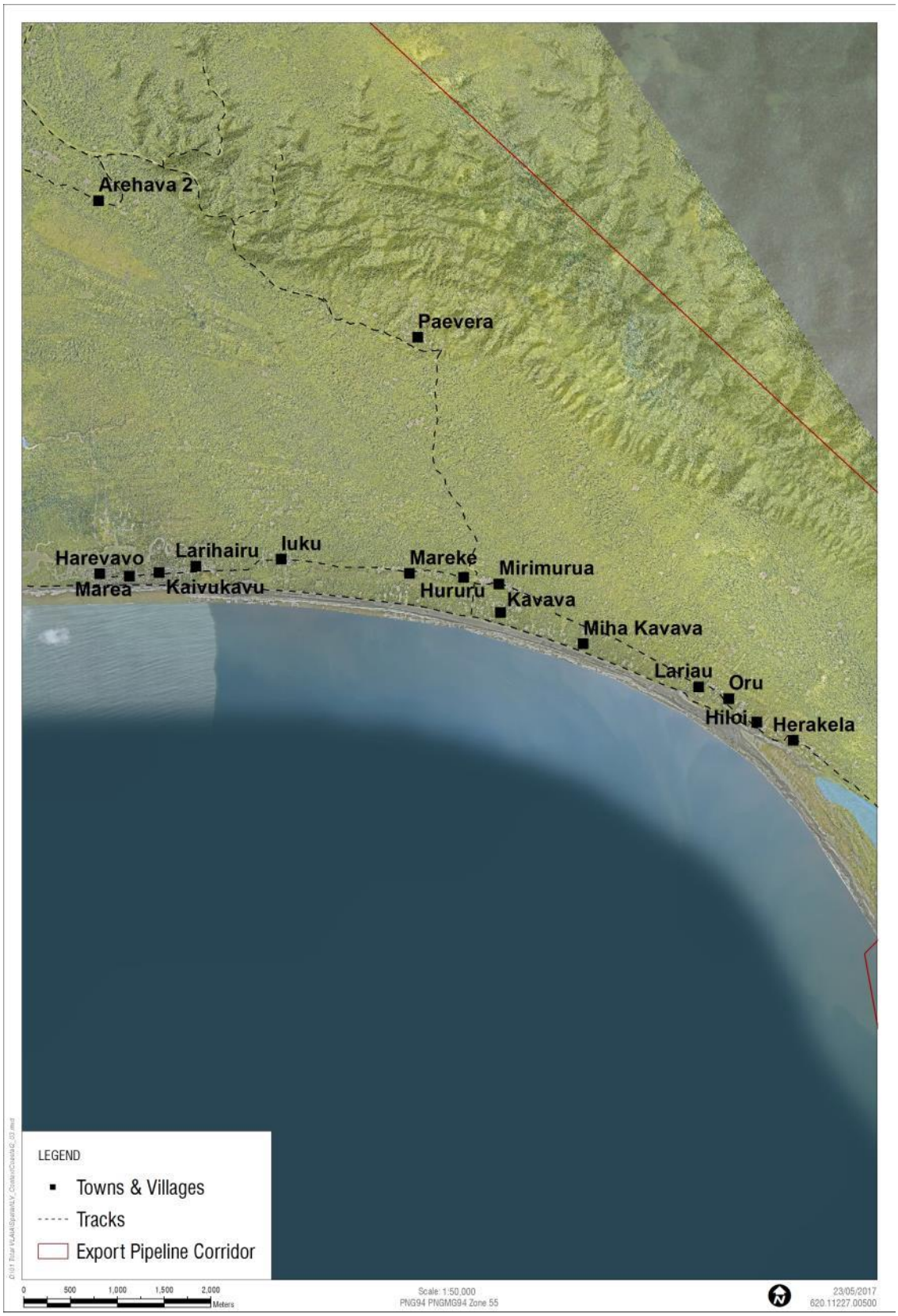

Figure 34 Onshore Pipeline Coastal Villages

Figure 35 Coastal Villages Photo Locations

Figure 36 Coastal Villages Topographic Elevation

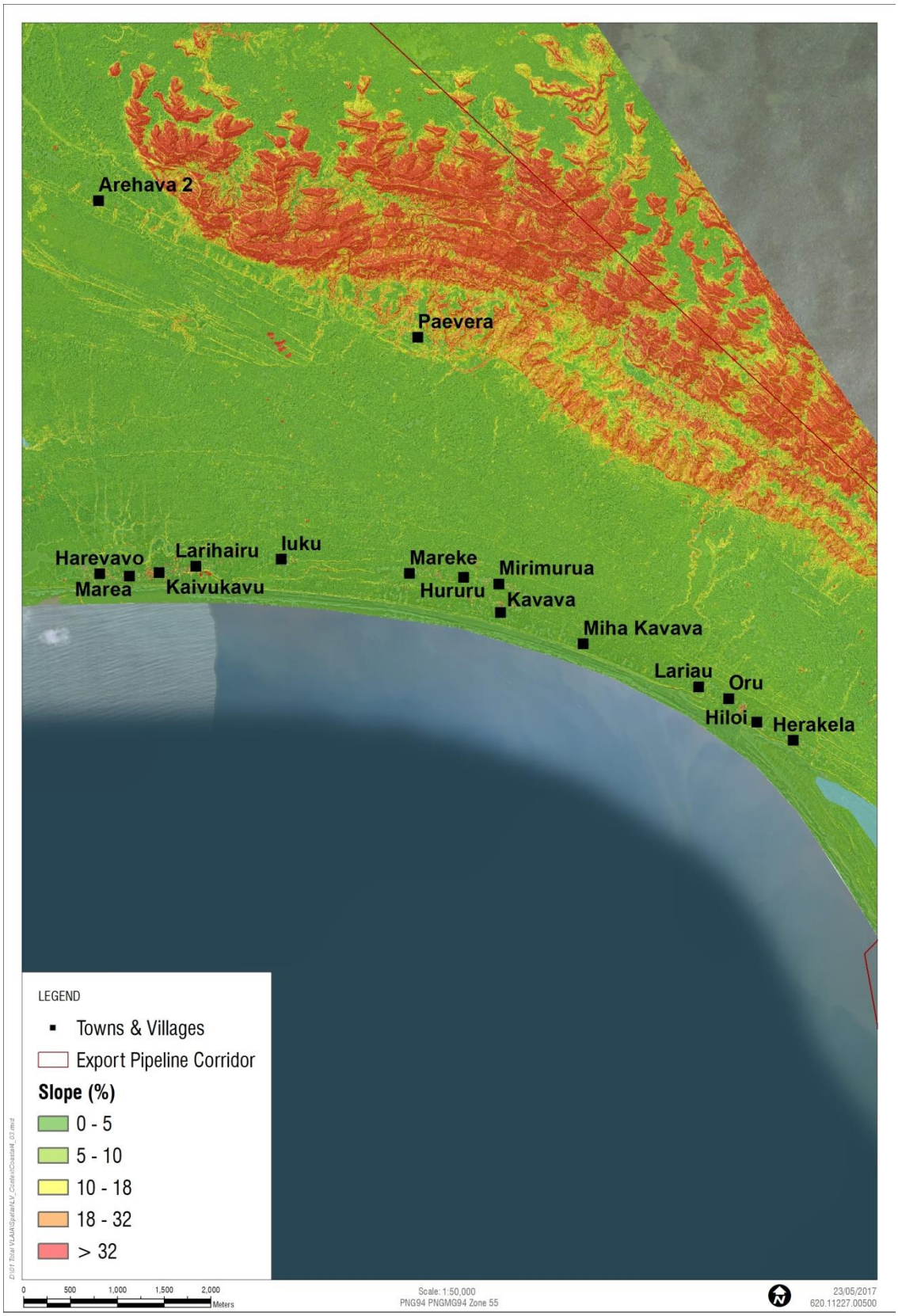

Figure 37 Coastal Villages Slope

Photo 25 Coastal Villages From the Air Northerly Aspect

Photo 26 Coastal Villages From the Air Easterly Aspect

Photo 27 Coastal Village Buildings

Photo 28 Coastal Village Bread Fruit

Photo 29 Coastal Village Coconut Grove

Photo 30 Coastal Village fishing canoe

6.3.3 River Transport Corridor

The river transport corridor component of the upstream Project area lies to the west of the onshore pipeline corridor as shown in **Figure 38**; stretching from the southern boundary of PRL-15 through to the coastline of the Gulf of Papua. The transport routes have not yet been confirmed as the final routes that will be used for the Project and are therefore indicative only. **Table 9** generally describes the potential river transport routes which include the Purari, Ivo-Urika and Varoi-Warne rivers. **Figure 38** also shows the locations of **Photo 31** - **Photo 34** captured along the river transport corridor.

Table 9 River Transport Corridor Context

Landscape Character	Landscape Description
Topography	Topography in this area, as detailed in **Figure 39** varies considerably as the transport corridor extend from the coast (shown in **Figure 40**) through to the mountain foothills beginning near the southern boundary of PRL-15. Elevations surrounding the river transport corridor range from sea level (and below) to 20m asl. Known as the Purari River delta, the areas adjacent to the Purari River consist of low lying networks of creeks and channels that pass into tidal inlets, lagoons, swamp and inundation areas. The Purari's main channel varies in width, from approximately 300m at Herd Base (**Photo 34**) to nearly 1km at the coastal inlet, while the Varoi-Warne and Ivo-Urika provide consistent river corridors of 200-300m across.
Vegetation / Land Cover	The river transport corridor vegetation is dominated by dense scrub, marsh and mangroves in the far south, with wetland communities and forest on the ridges and ravines to the north. Riparian vegetation as shown in **Photo 32** & **Photo 33** is thick and in some locations impenetrable. Many adjacent areas and minor tributaries close to the coast have areas that are close to or below sea level and subject to inundation, and as a result many wetland species are present.
Built form / structures	There are a small number of villages along the corridor such as Aivai shown in **Figure 41**. These villages consist mainly of simple traditional dwellings (similar to those described in **Table 8**). River villages are small, and as a result of their relative isolation and remoteness, buildings tend to be small in scale and use traditional and locally sourced building materials. Some non-traditional building materials can be found as a result of these villages proximity to the river as a transport mechanism. There is evidence of clearing in and around the villages with plantations. There is little to no built infrastructure away from the river.
Land Use	**Photo 31** was taken from a river transport vessel and shows a typical view across the Purari River. The rivers are used for transportation purposes both for Project and non-Project related activities. Multiple routes from the coast to Herd Base (see **Photo 34**) and further upstream facilitate movement of people, supplies and equipment. The rivers are used extensively by locals for fishing and hunting. Away from the riverside villages, the predominant land use is undisturbed vegetation. The river villages are mostly residential living, fishing and subsistence farming.
Landscape Value	The river transport corridor include low lying intermittent swampy wetland landscapes, through to the foothills of the ranges. Vegetation, including the riparian zone close to the river edges is dense and, apart from the rivers themselves, have limited accessibility. The rivers are significant in their capacity as transport corridors where riverine traffic may impact their waterform and riparian quality.

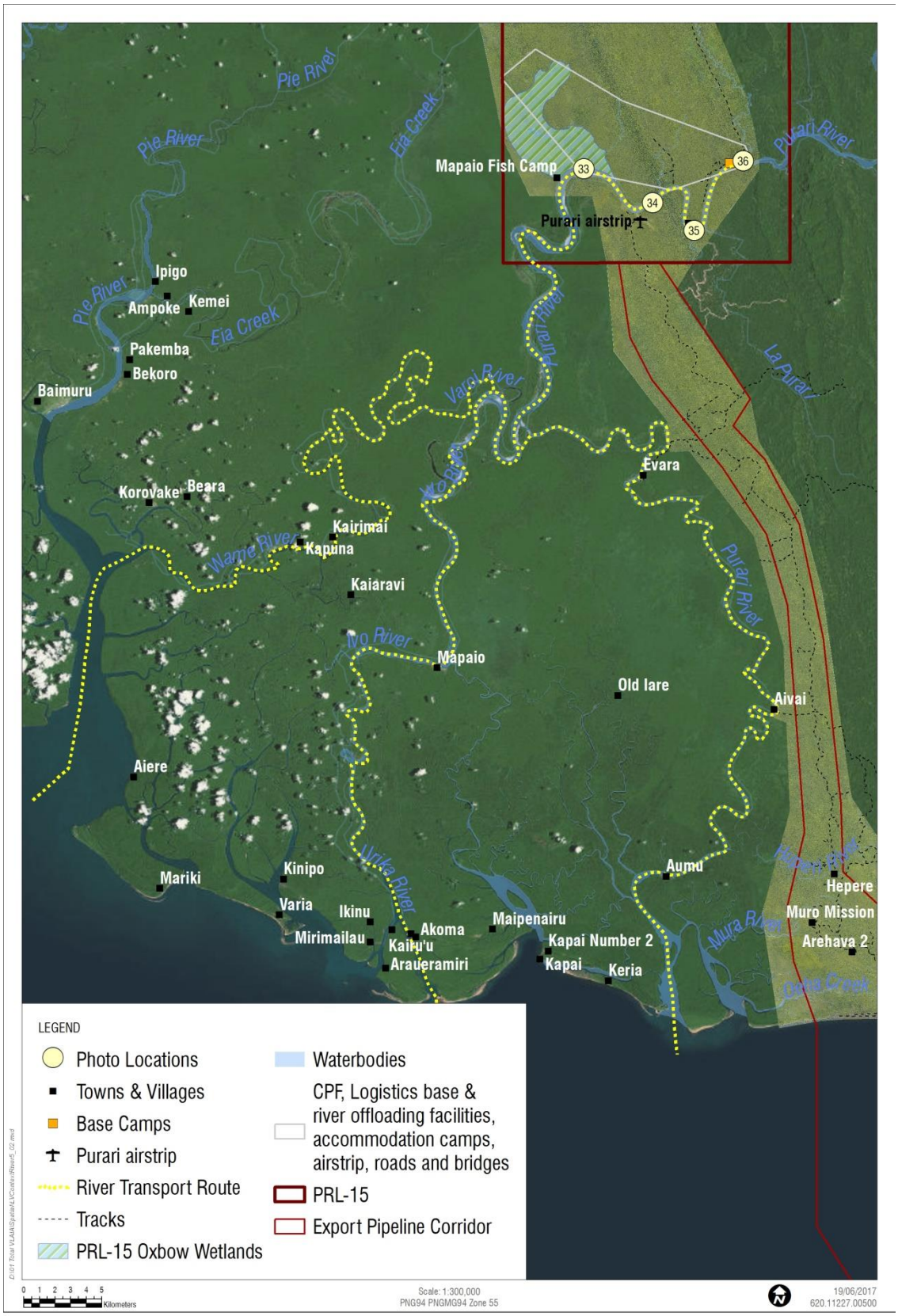

Figure 38 River Transport Corridor & Photo Locations

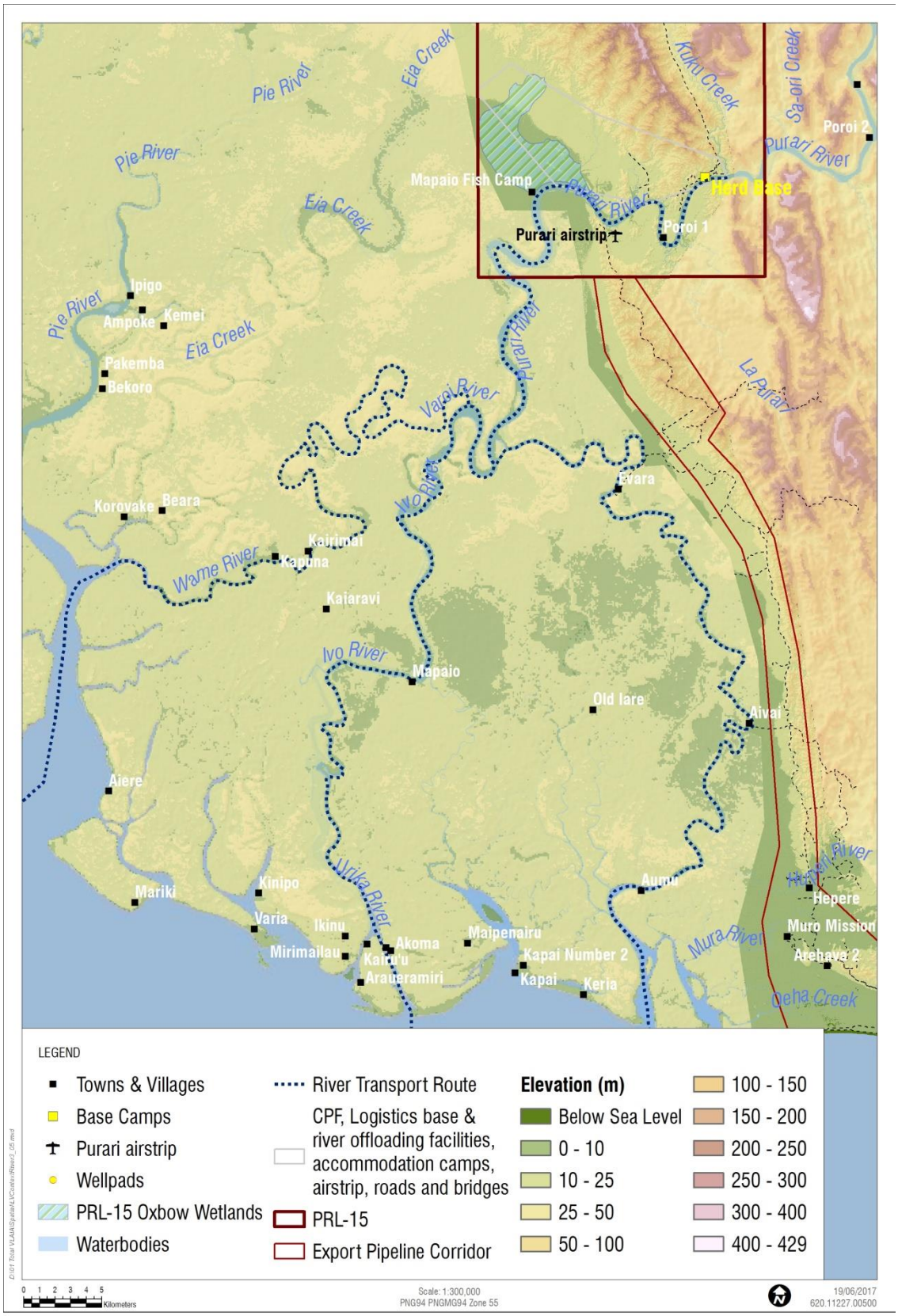

Figure 39 River Transport Corridor Topographic Elevation

Figure 40 River Transport Corridor (Southern/Coastal Section Purari River Route)

Figure 41 River Transport Corridor – Purari River Route and Aivai Village (Aerial Photo April 2016)

Photo 31 Transport Route – boat transport perspective

Photo 32 Typical dense riparian vegetation

Photo 33 Mudbanks and dense riparian vegetation

Photo 34 Purari River at Herd Base

6.3.4 Offshore Pipeline

The offshore pipeline corridor component of the upstream Project area stretches from the onshore pipeline at Orokolo Bay to an LNG Plant proposed at Caution Bay in PNG's Central Province. The pipeline corridor is shown in **Figure 42, Figure 43**, **Figure 44**, and **Figure 45**. **Table 10** generally describes the offshore pipeline corridor. **Photographs 35, 36, 37 & 38** document features of the Offshore Pipeline Corridor**,** and their geolocations are shown on **Figure 46**.

Table 10 Offshore Pipeline Corridor Context

Landscape Character	Landscape Description
Topography	Not relevant to this part of the study area.
Vegetation / Land Cover	Not relevant to this part of the study area.
Built form / structures	Not relevant to this part of the study area.
Land Use	Commercial prawning and fishing occurs offshore in designated fishing zones while the entire coastline is used by villagers for transportation, fishing and other subsistence uses (**Photo 38)**. Fishing and other commercial vessels including LNG carriers commonly navigate the waters of the Gulf of Papua.
Landscape Value	The low lying intermittent wetland landscapes, coastal plains and coastal foothills as shown in the oblique aerial photographs (**Photo 35**, **Photo 36**) tend to be heavily vegetated, along the length of coast traversed by the offshore pipeline corridor, and views of the densely vegetated coastal plains and northern foothills are common (**Photo 37**). Shipping traffic is already present offshore.

Figure 42 Offshore Pipeline Corridor

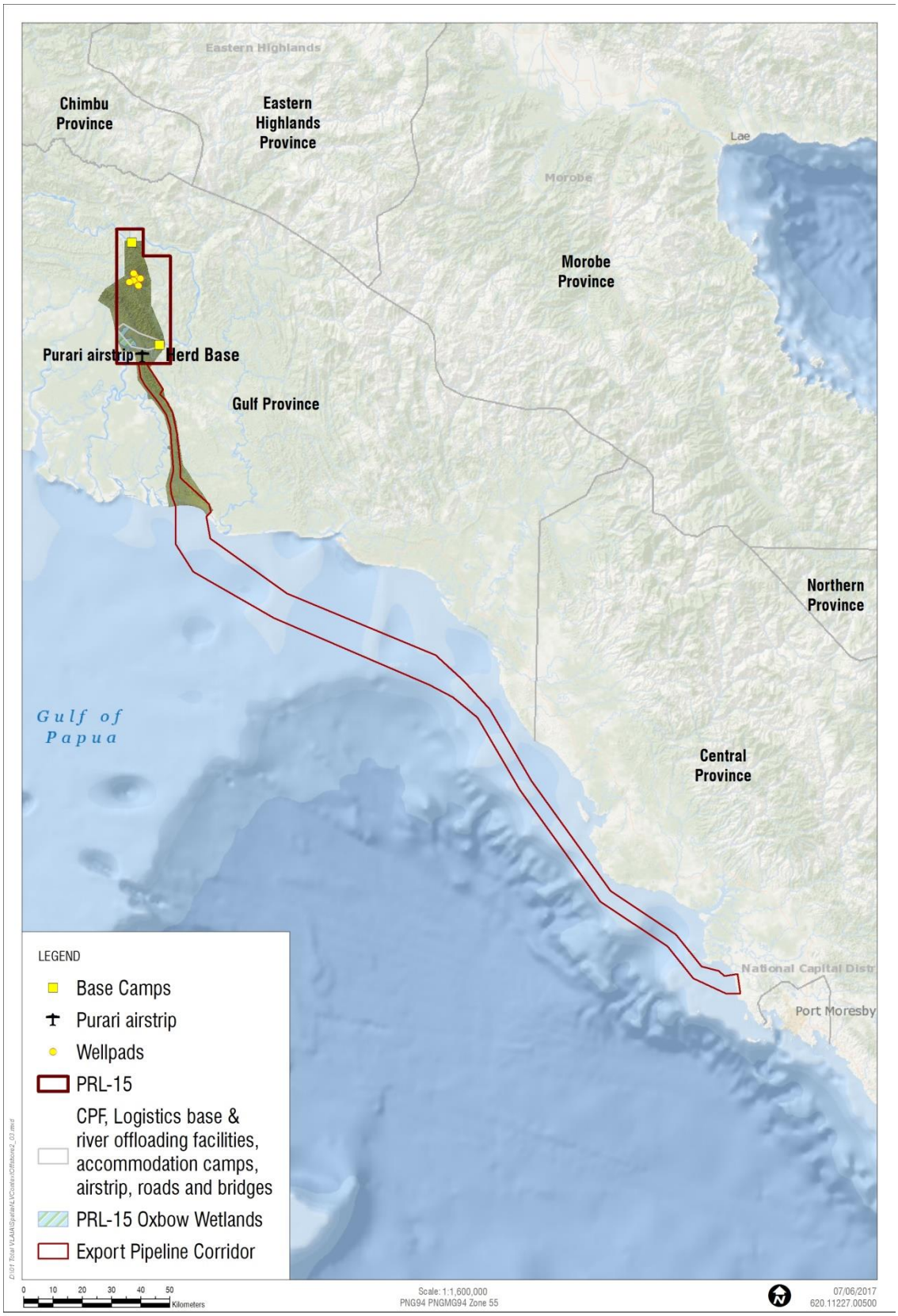

Figure 43 Offshore Pipeline Corridor (Gulf of Papua mapping)

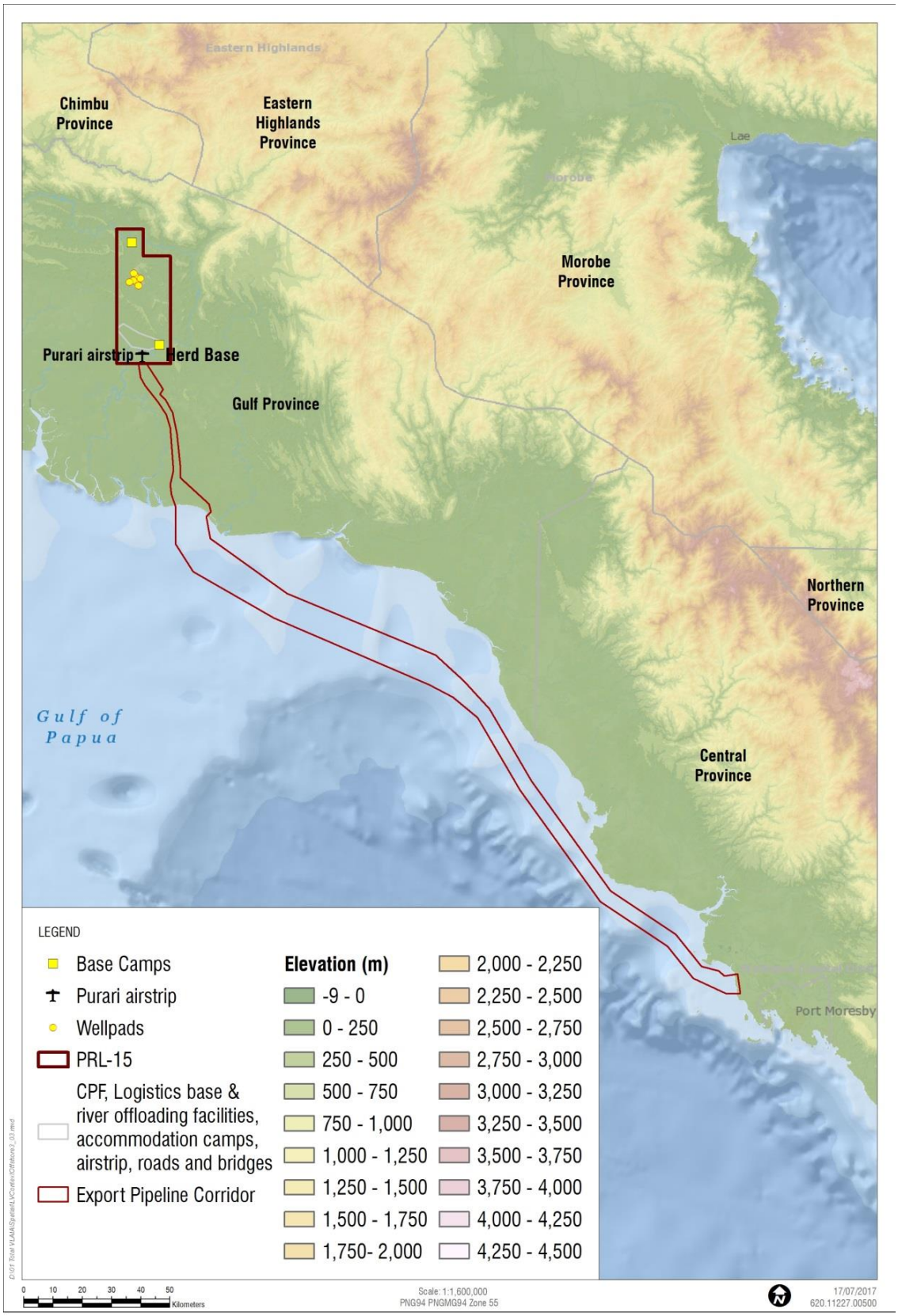

Figure 44 Offshore Pipeline Corridor and PNG Topographic Elevation

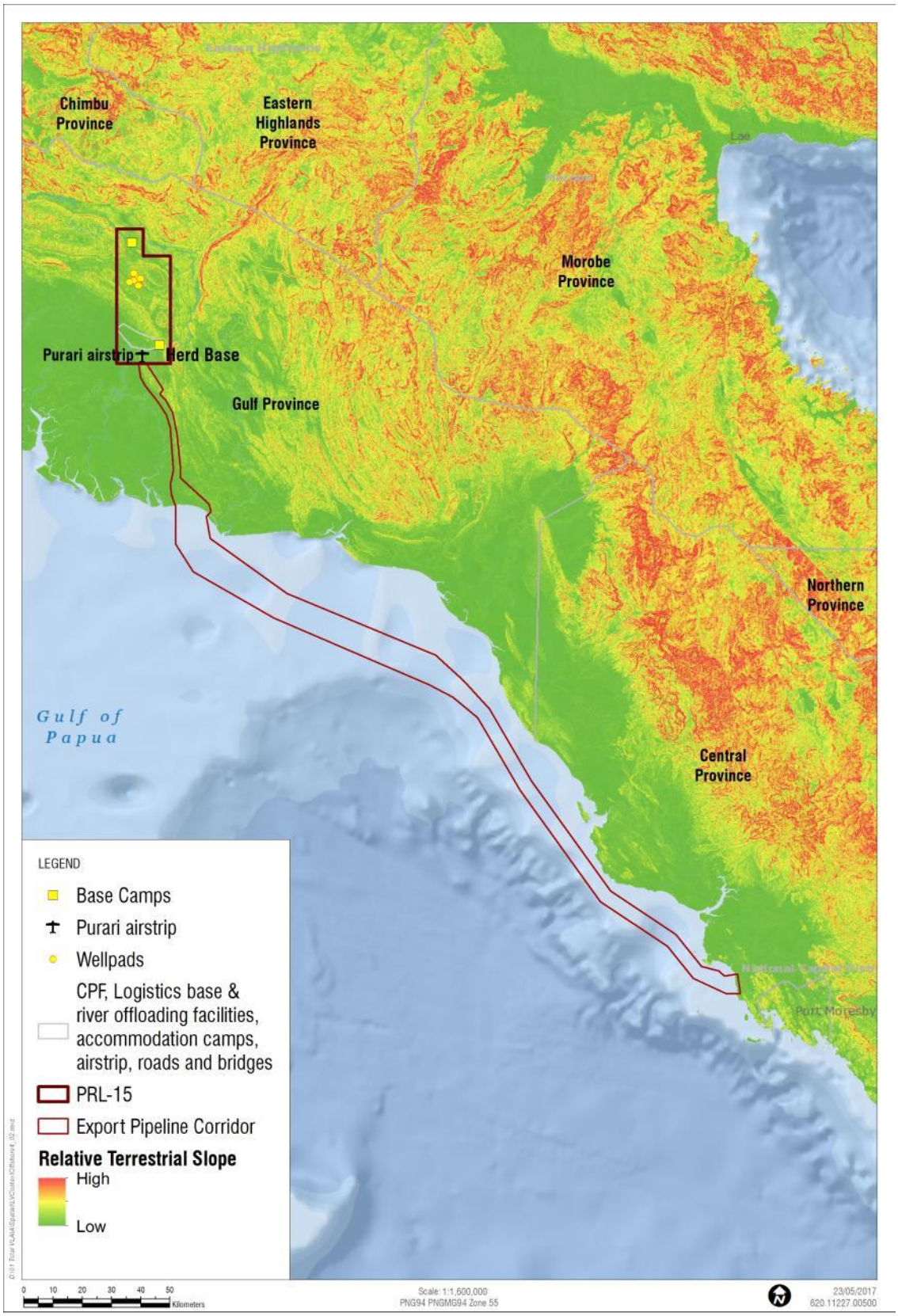

Figure 45 Offshore Pipeline Corridor and PNG Terrestrial Slopes

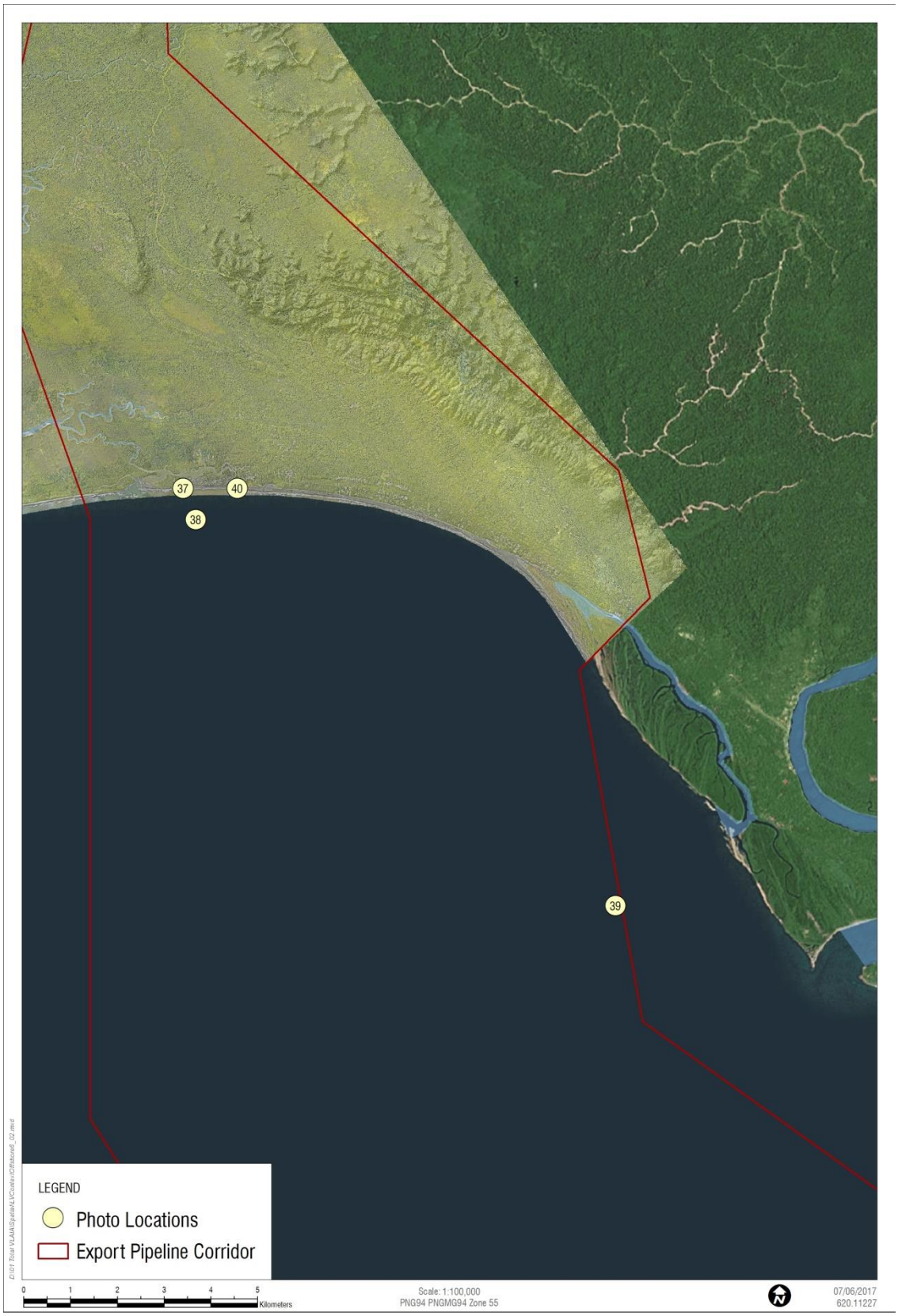

Figure 46 Offshore Pipeline Corridor Photo Locations

Photo 35 Orokolo Bay coastline

Photo 36 Onshore view (Aerial) of Orokolo Bay Coast

Photo 37 Onshore view (sea level) of Orokolo Bay Coast

Photo 38 Prawn netting (Gulf of Papua Coast)

7 CONCLUSIONS

The landscape and visual amenity baseline study for the upstream Project has:

- Described environmental values in terms of the existing character of the landscape that could be affected by the Project.
- Collected landscape and visual amenity information to support the impact assessment for the Project.

This has been achieved through the review of documentation, photographic and other evidence collated from existing data sources and from photographic and ground-truthing of the landscape as part of field surveys by other SLR teams during their visits to the upstream Project area.

This baseline assessment shows that there is considerable variation in landscape form and visual amenity within the upstream onshore Project area which encompasses lowland coastal and riverine landforms as well as ridge-and-ravine environments which reflect a range of elevations and slopes.

The production, processing and related facilities, onshore export pipeline and transport (river) corridor are proposed to occur in a remote, predominantly densely vegetated and mostly undisturbed location in the Gulf Province of PNG. There are a few isolated villages located on the banks of Purari River in the south of PRL-15, but distant from the proposed production, processing and related facilities. Villagers and users of the Purari River present as visual receivers in this area.

The inland part of the onshore export pipeline corridor consists of similar vegetation and topography to PRL-15, transitioning from the hills to coastal plains and beaches where coastal villages occur adjacent to networks of creeks, tidal inlets and lagoons. These coastal villages are more densely populated and present as sensitive visual receivers in these areas.

The Purari River delta comprising the Purari, Ivo-Urika and Varoi-Warne distributary channels provide important travel and transport links for communities in the delta, coast and inland riverine areas. In addition, these rivers are important sources of subsistence aquatic and riverine resources for surrounding communities. Users of these waterways present as sensitive receptors for any Project transport activities.

The offshore pipeline export corridor component of the upstream Project area stretches from the onshore export pipeline at Orokolo Bay to an LNG Plant proposed at Caution Bay in Central Province. For the most part, the offshore export pipeline corridor is located in open waters that are regularly navigated by fishing and other commercial vessels including LNG carriers. The coastline along the corridor comprises low lying intermittent wetland landscapes, coastal plains interspersed with villages and is backed to the north by coastal foothills. Coastal villagers, particularly subsistence fishers and other users of the inshore waters of the Gulf of Papua present as sensitive receptors to marine activities.

Overall the receiving environment contains large areas of undisturbed dense vegetation which due to its remoteness, has limited locations that are likely to have significant visual divergence from the surrounding visual landscape.

8 STUDY TEAM

Nathan Thompson (SLR Consulting – Technical Director Landscape & Visual Amenity & Spatial Services)

Nathan is the project manager for the landscape and visual amenity studies. Nathan is responsible for all data collation, analysis and reporting

9 GLOSSARY AND ABBREVIATIONS

Term	Definition
asl	Measure of height above mean sea level
alluvial	Material deposited by water moving across the land surface
°C	degrees Celsius
CEPA	Conservation and Environment Protection Authority
condensate	a product of condensation, as a liquid reduced from a gas or vapor
CPF	Central Processing Facility
DEC	Department of Environment and Conservation
divergence	characterized by deviation or departure from an accepted norm or standard
EIS	Environmental Impact Statement
ENSO	El Niño-Southern Oscillation
GIS	Geographic Information System
GHG	Green House Gasses
IFC	International Finance Corporation
km	kilometer
Landscape and Visual Impact Assessment (LVIA)	a tool used to identify and assess the likely significance of the effects of change resulting from development both on the landscape as an environmental resource in its own right and on people's views and visual amenity
Landscape qualities	a term used to describe the aesthetic or perceptual and intangible characteristics of the landscape such as scenic quality, tranquility, sense of wildness or remoteness. Cultural and artistic references may also be described here
Laydown area	space of ground or pavement located near or at the construction site that is for the receipt, storage and partial assembly of the project equipment and materials to be installed or constructed
LiDAR	[remote sensing] Acronym for light detection and ranging. A remote-sensing technique that uses lasers to measure distances to reflective surfaces
LNG	liquefied natural gas
logistics	dealing with procurement, supply, and maintenance of equipment, with the movement, evacuation, and hospitalization of personnel, with the provision of facilities and services, and with related matters

Term	Definition
PNG	Papua New Guinea
PRL-15	Petroleum Retention License 15
RoW	Right of Way
topography	mapping data that represents the vertical and horizontal positions of features, showing relief in some measurable form, such as contour lines, hypsometric tints, and relief shading
schematic	a diagram, plan, or drawing

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