Initial Environmental Examination

47256-002

March 2021

Papua New Guinea: Power Sector Development Project

Prepared by PNG Power Ltd for the Department of Petroleum and Energy, PNG, and the Asian Development Bank

CURRENCY EQUIVALENTS
(as of 10 March 2021)

Currency unit	–	kina (K)
K1.00	=	$0.29
$1.00	=	K3.51

ABBREVIATIONS

ADB	–	Asian Development Bank
AIFFP	–	Australian Infrastructure Financing Facility for the Pacific
CEMP	–	Contractor Environmental Management Plan
DNPM	–	Department of National Planning and Monitoring
EMP	–	environment management plan
FIRR	–	financial internal rate of return
GBV	–	gender-based violence
IEE	–	initial environmental examination
kV	–	kilovolt
km	–	kilometer
MW	–	megawatt
PAM	–	project administration manual
PMU	–	project management unit
PNG	–	Papua New Guinea
PPL	–	PNG Power Limited
ROW	–	right-of-way
SCADA	–	supervisory control and data acquisition
SOE	–	state-owned enterprise
STEM	–	Science, Technology, Engineering, and Mathematics
TEIP	–	Town Electrification Investment Program

NOTE

In this report, “$” refers to United States dollars unless otherwise stated.

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ABBREVIATIONS

ADB	-	Asian Development Bank
BCD	-	Bid and contract document
CCP	-	Communications and consultation plan (of the Project)
CEMP	-	Construction environmental management plan (of the contractor)
CEPA	-	Conservation and Environment Protection Authority
CSS		Country safeguard system
DPE	-	Department of Petroleum and Energy
DSC	-	Design and supervision consultant
EIA	-	Environmental Impact Assessment
EIS	-	Environmental Impact Statement
ELCOM	-	PNG Electricity Commission
EMP	-	Environmental management plan
EP	-	Environment Permit
EPAR	-	Environment (Prescribed Activities) Regulation 2002 (under the CSS)
ESO	-	Environmental and safety officer (in contractor's team)
GFP		Grievance Focal Point
GRC		Grievance Redress Committee
GRM		Grievance Redress Mechanism
HSP	-	Health and Safety Plan
IEE	-	Initial Environmental Examination
IES	-	International environmental specialist (in the DSC)
LLG	-	Local Level Government
MSMP	-	Materials and Spoils Management Plan
NDGEP	-	National Distribution Grid Expansion Plan 2016
NES	-	National Environmental Specialist (in the DSC)
PMU	-	Project Management Unit (within PPL)
PNG	-	Papua New Guinea
PPL	-	PNG Power Ltd
PSDP	-	Power Sector Development Project
SE	-	Site Engineer (contractor)
SPS	-	Safeguard Policy Statement 2009 (of ADB)

ELECTRICAL TERMINOLOGY

GWh	Gigawatt-hour	-	1,000 MWh
kV	kilovolt	-	1,000 volts
kVA	kilovolt-ampere	-	1,000 VA
kW	kilowatt	-	1,000 watts
kWh	kilowatt-hour	-	1,000 Wh
MVA	Megavolt-ampere	-	1,000 kVA
MW	Megawatt	-	1,000 kW
MWh	Megawatt-hour	-	1,000 kWh
TWh	Terawatt-hour	-	1,000 GWh
V	Volt	-	Unit of voltage
VA	Volt-ampere	-	Unit of apparent power
VAr	volt-ampere reactive	-	Unit of reactive power
W	Watt	-	Unit of active power
Wh	watt-hour	-	Unit of Energy

Distribution System	The distribution portion of the electric grid comprises lower voltage power lines that deliver electricity to end-users. 33 kV, 22 kV, 11 kV and 400 V lines
Transmission System	High-voltage transmission lines typically carry the electricity to a substation 132 kV and 66 kV lines.
Substation	Substations are used to condition electricity as it moves through the grid. Substations can include switching, protection, and control equipment; capacitors; voltage regulators; and transformers.
SC TML	Single Circuit Transmission Line
DC TML	Double Circuit Transmission Line

EXECUTIVE SUMMARY

Background. The Government of Papua New Guinea (PNG) (the government) has requested the Asian Development Bank (ADB) to provide support through technical assistance (TA 9428-PNG) to prepare a standalone project to finance investments through Power Sector Development Project (PSDP) in PNG. This standalone project is also co-financed the Government of Australia represented by the Department of Foreign Affairs and Trade (AUS-DFAT) through funding under the Australian Infrastructure Financing Facility for the Pacific (AIFFP).

The project will be implemented over a period of 4 years with a total value of approximately USD305 million. The project will support the improvement of socioeconomic conditions in PNG consistent with the government's Vision 2050, by improving access to electricity in provincial and urban centres through the expansion of transmission and distribution network and improving system efficiencies.

The Project. The primary aim of the PSDP is to provide for the rehabilitation, reinforcement, and extension of approximately 235 (kilometer) km transmission lines, the construction and upgrade of 11 substations and switchyards, 2,274 km of distribution lines including a new mini grid in West New Britain (WNB) with 56,000 household (HH) connections, including 5,600 households headed by women headed by women or disadvantaged households, using PPL's pro-poor tariff subsidies and/or connection schemes. The secondary objective is to develop the necessary executing agency, implementing agency and private sector capacity to deliver the project. The scope of work under the PSDP comprises three categories of subprojects: (i) construction and upgrade of 132 kilovolts (kV) and construction of 66 kV transmission lines; (ii) construction or upgrade of substations and switchyards; and (iii) construction of distribution lines (22kV, LV) and household connections. All three categories of subprojects are proposed for the three geographically separated grid systems across PNG, these being: The Gazelle system (East New Britain); the Ramu system (including Lae City, Madang); and the Port Moresby system (Gomore and Motukea) as well as WNB.

Implementation arrangements. The executing agency will be the Treasury Department. A Project Management Unit (PMU) will be established within PPL to implement the project. PPL will provide full-time staff, and the PMU will be supported by individual project management consultants (PMCs) and a construction supervision consultant (CSC). The PMU will be responsible for contracting all consulting services, equipment, and civil works. A project steering committee will oversee implementation, monitor progress, and provide guidance to the executing agency. The committee will meet at least quarterly and will be chaired by the Department of National Planning and Monitoring (DNPM). PMU will host the steering committee and act as the secretariat.

Policy and legal framework. PNG's country safeguard system includes the Environment Act 2000 which requires that projects and activities are screened against a list of activities contained in Schedule 2 'Prescribed Activities' of the Environment (Prescribed Activities) Regulation 2002 (EPAR) according to the anticipated potential environmental impact. Level 2 and 3 activities require environmental assessment. All activities, irrespective of level, are required to prepare a Notification of Preparatory Works which is submitted to Conservation and Environmental Protection Authority (CEPA).

Under the requirements of the Environment Act 2000, all of the subprojects considered under this project are designated under Schedule 2 'Prescribed Activities' of the EPAR 2002 according to the anticipated potential environmental impact, and as such are required to prepare a Notification

of Preparatory Works which is submitted to CEPA for review and advise as to the level of investigations required. Level 2 and 3 activities are permitted activities that may pose significant or major impact on the environment, with level 3 activities required to undergo full environment impact assessment.

For the purpose of the Project, the Subcategory 12.6 - Prescribed Activities lists “Construction of Electricity Transmission Lines or Pipelines Greater than 10 km in Length” are designated as a Level 2 activity. This prescribed activity refers to construction of new transmission lines and may also include upgrading works of existing transmission lines greater than 10km.

Government environmental clearance and development consent (and other permits) must be obtained before any works commence. Accordingly, a formal Notification will be prepared for all the subprojects under consideration in this Initial Environmental Examination (IEE), and it is expected that CEPA will advise PPL that the development has been assessed as a Level 2B activity. This will require PPL to submit an environmental permit (EP) application (which is in a similar format to this IEE) for each subproject. Following approval CEPA will issue a Level 2B EP for the subprojects, respectively.

ADB safeguard requirements. ADB requires the consideration of environmental issues in all aspects of its operations as described in the Safeguard Policy Statement 2009 (SPS). This requires environmental assessment of all project loans, program loans, sector loans, sector development program loans, loans involving financial intermediaries, and private sector loans.

The PSDP has been screened as Category B for environment according to the requirements of the SPS. Based on the project’s potential adverse environmental impacts which are considered to be site-specific, low to minimal, and mitigation and control measures readily available. An IEE is the appropriate level of assessment for a Category B project. This IEE also adheres to the environment safeguard policies of DFAT and is subject to additional safeguard contractual requirements in an updated EMP for bidding documentation. To ensure all impacts are mitigated, the PMU assisted by the CSC/PMU shall update the IEE based on detailed design and recommended additional impact assessments. The updated IEE will be included in the bid and contract documents.

Environmental impacts. This IEE has been prepared for the transmission lines (66kV/132kV), substations/switchyards, and the 22kV distribution lines and household connections. The key environmental impacts associated with these activities primarily relate to the planning, construction and operation of the transmission and distribution lines and substations, and include minor impacts such as land clearance, earthworks for the substation and formation of foundation pads for the new poles and pylons and waste disposal.

The scale of the works proposed under the project, together with the fact that substations and transmission line are to be located on existing roadway reserves and other cleared lands away from sensitive receivers, it is expected that the environmental impacts associated with the project will be minimal and primarily associated with construction site issues (waste management; construction materials management; erosion and runoff control; drainage management and health and public safety). The operation of the subproject should have beneficial effects on the environment overall through more efficient provision of electrical power from renewable resources and improved environmental management within PPL.

Environmental management plans. Two EMPs are provided in this IEE covering activities and impacts of substations and switchyards and transmission and distribution lines for the four grid upgrade subprojects under the project.

The purpose of the EMPs is to avoid, and where avoidance is not possible, minimize, mitigate, and/or offset adverse impacts of the project, and enhance positive impacts where possible. Mitigation measures, environmental monitoring, and capacity development are required to minimize the environmental impacts in the pre-construction and construction phases. Implementation of internationally recognized good construction environmental practices forms the basis of the EMPs, and covers issues such as erosion and sedimentation control, materials sourcing and spoil management, waste management, minimization of habitat disturbance, as well as worker and community health and safety.

The EMPs will form part of the construction contract documents and the contractor will be required to prepare a construction environmental management plan (CEMP) based on the Project EMP (contained in the IEE which will be updated based on detailed design). The contractor will prepare and submit the CEMP to PMU, CSC and ADB for review and comment and then CSC/PMU approval prior to commencement of any works (including clearing and grubbing). The CEMP will be approved by ADB and will include management plans which will form part of the contract documents and will include: (i) waste management (ii) construction materials management (iii) erosion and runoff control (iv) drainage management and (v) health and public safety.

COVID 19 Response. Due to the COVID 19 situation, the contractor will also be required to prepare a COVID 19 Response Plan for the approval of the PMU, DSC and ADB prior to the mobilisation of any workers to PNG or within PNG. The plan will detail how the contractor will comply with PNG Government COVID 19 requirements as well as describe the measures the contractor will put in place to prevent exposure to COVID 19, detect COVID 19 and respond to possible cases of COVID 19.

Information disclosure and stakeholder consultation. The stakeholder consultation process disseminated information to the general public, project affected communities and key environmental stakeholders. Information was provided on the scale and scope of the project and the expected impacts and the proposed mitigation measures through consultation with government departments, local authorities and the general public in meetings. The process also gathered information on relevant concerns of the local community for the project so as to address these in the project design and implementation stages. The communications and consultation plan (CCP) prepared for the Project will guide PPL in requirements for project-wide communications and consultations at each stage of implementation.

Grievance redress mechanism. A grievance redress mechanism (GRM) will be established early in implementation to receive, evaluate, and facilitate the resolution of affected people's concerns, complaints, and grievances about any aspect of the Project including environmental and social performance. The GRM is based on accepted and standard practices in PNG and will provide an accessible, time-bound, and transparent mechanism for the affected persons to voice and resolve social and environmental concerns linked to the Project.

Conclusions and recommendations: This IEE concludes that the potential environmental impacts arising from the project will be minor, localized, largely occur during the construction stage and can be managed to acceptable levels provided that the mitigation measures set out in the EMP are incorporated into the design and implemented properly. Key findings from the IEE are summarized as follows:

(i) The examination of the subprojects under this project indicate that the potential environmental impacts are largely minor and restricted to the construction phase of the subproject components. Public consultations were carried out at all subproject locations to document any issues/concerns and to ensure that such concerns are addressed in the project design. No significant environmental concerns were raised during consultations and the local communities were generally very supportive of the proposed project activities.
(ii) Any potential impacts arising from the design, construction and operation can be mitigated to standard levels without difficulty through proper engineering design and the incorporation or application of recommended mitigation measures and procedures set out in the EMPs and monitoring plans under this IEE.
(iii) Impacts associated with construction disturbances such dust, noise, traffic disruptions, erosion and sedimentation, and public and worker safety can be managed effectively with standard construction practices (e.g., IFC/World Bank 2007).
(iv) The substation and transmission/distribution subprojects under the project will be mostly undertaken in highly disturbed locations. Upgrades will be undertaken on some existing substation's, as well as new substations constructed on disturbed or secondary regrowth vegetative areas. No substations will be located in ecologically or a culturally significant sites or protected area.
(v) Transmission line subprojects will be mostly undertaken in existing transmission line right-of-way of PPL and over highly disturbed or secondary regrowth vegetation areas. Anticipated environmental impact is low and manageable using best practice standards and controls. None of the transmission line subproject is to be undertaken within ecologically or culturally sensitive areas or protected area. Distribution Line subprojects will be mostly undertaken along existing roads right-of-way and high anthropogenic activity areas.
(vi) In general, the subprojects under PSDP will have negligible to low impacts on the environment. The few potential medium ranked impacts listed in the EMP are manageable or can be reduced through proper induction of project employees and implementing of EMP and approved CEMP.
(vii) The EMPs for the subprojects will provide guide in the implementation of the subprojects. The EMPs identify potential environmental impacts arising from the project along with a corresponding schedule of recommended mitigation measures that will be implemented at each stage of subproject implementation to ensure potential impacts are maintained at insignificant levels and that international best practice is applied.
(viii) Environmental monitoring of each subproject will consist of routine systematic checking that the environmental management measures adopted in the EMP and CEMP are implemented effectively during each stage of the project.

In conclusion, this IEE and the respective EMPs covering substation, switchyard, transmission, and distribution line subprojects are considered sufficient to comply with the SPS and country system environmental requirements for Schedule 2 of the Prescribed Activities Regulation 2002 and the Environment Act 2000 (as amended).

The IEE will be made available at public locations in the project areas (ward and district offices) and will be disclosed to a wider audience via the ADB website. The consultation process will be extended through project implementation to ensure that stakeholders are fully engaged in the project and have the opportunity to participate in its development and implementation.

I. INTRODUCTION

A. Project Overview

1. The Government of Papua New Guinea (the government) has requested the Asian Development Bank (ADB) to provide technical assistance to help prepare a standalone project to facilitate investments through the proposed Power Sector Development Project (PSDP).

2. The PSDP will be implemented over a period of 4 years and will support the improvement of socioeconomic conditions in Papua New Guinea (PNG) consistent with the government's Vision 2050, by improving access to electricity in provincial and urban centres through the expansion of transmission and distribution network and improving system efficiencies. The primary aim of the project is to provide for the rehabilitation, reinforcement, and extension of approximately 235 km transmission lines, as well as the construction and upgrade of 11 substations and switchyards, 2,274 km of distribution lines and 56,000 HH connections. The secondary objective is to further develop PNG Power Ltd (PPL) as the implementing agency and private sector capacity to deliver the project.

3. **Implementation arrangements**. The executing agency for the project is the Department of Petroleum and Energy (DPE). The implementing agency will be PNG Power Ltd (PPL) through its Project management Unit (PMU) established to implement development partner financed projects. Additional resources, as required, will be seconded to the PMU as the PMU will manage and lead implementation of all subprojects under PSDP as well as its other ongoing projects. PPL will engage a construction supervision consultant (CSC) to support the PMU design and manage the construction of the project. The PMU will be assisted by the CSC and the facilities will be operated by PPL. The PMU will engage the contractors for construction and will monitor the implementation of environmental and social safeguards by the contractors on all the subprojects under the project, assisted by the environmental and social safeguards specialists in the CSC.

4. **Impacts and outcomes**. The project responds to the government's national development and sector strategies by: (i) promoting sustainable development in peri urban and rural areas and by increasing the grid penetration from 13% (7.0% connected to PPL system) to approximately 20% by 2028 and increase connectivity in line with the government's targets; (ii) improve access to electricity in provincial and urban centres of PNG through expansion of transmission and distribution network, and improving system efficiencies; and (iii) enhance operational efficiency of PPL and address institutional capacities, build institutional capacity in PPL including grid modelling, planning, procurement and implementation.

5. **Key outputs.** The key outputs from the project will include:

   (i) **Output 1: Transmission network upgraded and expanded.** Output 1 includes: (a) the construction of 100 km of new 66 kV transmission line and 11 new/upgraded (including three switchyards) substations in Gazelle (including one SCADA system), Ramu and POM;[1] and (b) the upgrade of the existing 135 km transmission line from 66 kV to 132 kV in Ramu. This output will: (a) strengthen existing grids to underpin economic development and improve security and quality of supply, and (b) allow connection of new customers to help meet the national 70% access target.

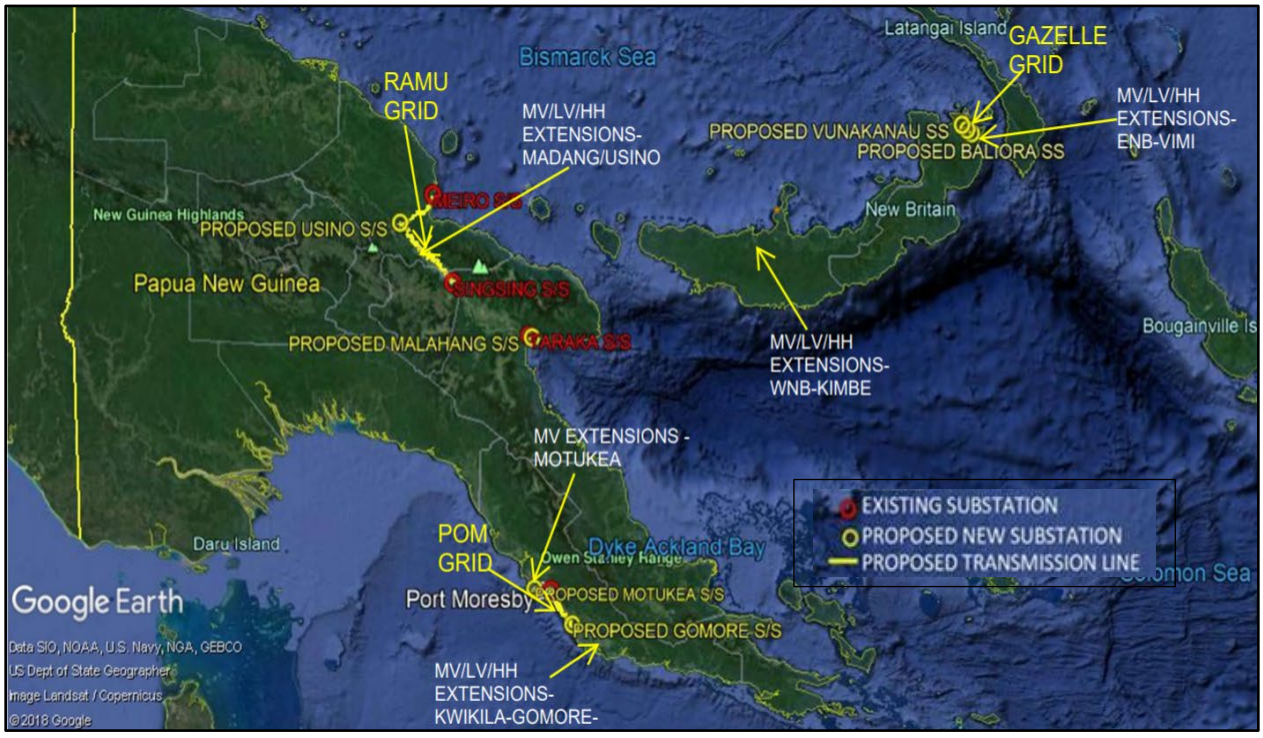
[1] For Motukea substation, PSDP will finance only one transformer (second unit) for N-1. The first unit will be funded by PPL, which falls outside of the PSDP scope.

(ii) **Output 2:** Output 2 will construct 2,274 km medium and low voltage new power distribution lines in Gazelle, Ramu and POM, and mini-grids in West New Britain. This output will enable PPL to serve 56,000 new customers (including 5,600 female headed or disadvantaged households using pro-poor tariff subsidies/connection loans)[2] and focus on expanding existing power grids to peri-urban and rural communities to support the national 70% access target.

(iii) **Output 3: Capacity Building.** This output involves: (a) improving capacity in power grids modelling and planning, procurement, and implementation; (b) performing a comprehensive diagnostic assessment of the utility's performance against standard industry indicators, encompassing all aspects of operations; (c) assessing the utility's financial management and accounting systems and procedures adequacy in terms of identification and recording of all the utility's costs and its sources of revenue, disaggregated across all of the utility's activities;[3] and (d) improving women's participation in technical roles in the energy sector.

6. **Scope of works**. As shown in Figure 1, the project includes a scope of work comprising four groups of subprojects: (i) construction of new 66kV transmission lines; (ii) upgrade of existing 66 kV transmission lines to 132kV; (iii) construction or upgrade of substations and switchyards; and (iv) construction of distribution lines (22kV, LV) and household connections. All three groups of subprojects are proposed for the four geographically separated grid systems across PNG, these being: Gazelle system (East New Britain); Ramu system (Lae-Madang); Port Moresby system (Gomore and Motukea); and WNB.

Figure 1: Location of PSDP Subproject Groups



[2] This includes 39,340 customers in Gazelle and Ramu-Lae, which will be funded by AIFFP.

[3] Items (b) and (c) will be initially financed under TA9425. If any cost-overrun occurs, the project will finance it.

B. Purpose, Objectives, and Scope of the IEE

7. **Purpose and objectives**. ADB requires the consideration of environmental and social issues in all aspects of its operations, and the requirements for environmental protection and management are described in the Safeguards Policy Statement 2009 (SPS). The SPS requires environmental assessment of the appropriate level for all investments irrespective of financing modality.

8. The objectives and scope of this initial environmental examination (IEE) are to: (i) assess the existing environmental conditions; (ii) identify potential environmental impacts from the proposed subproject; (iii) evaluate and determine the significance of the impacts; (iv) develop an environmental management plan (EMP) detailing mitigation measures and monitoring activities; and (v) facilitate public consultations to ensure that issues/concerns are addressed in the project design. This IEE will be disclosed to the public by PPL and on the ADB website.

9. **Scope of the IEE**. This IEE report has been prepared for transmission and distribution lines and substations/switchyards identified above, including baseline environment (physical, biological, and socioeconomic) and impact assessment (design/pre-construction, construction, operation). Given that the nature and extent of impacts associated with these subprojects will be similar in the three provinces and taking account of the relatively minor civil and other types of work as well as scale of impacts associated with these works, it was agreed with ADB that one IEE would be prepared which covers the transmission lines (66kV/132kV), substations/switchyards, and the 22kV distribution lines and household connections at the three grid system locations and the new mini-grid in WNB.

10. This IEE assesses the environmental impacts associated with the construction and operation of all the transmission and substation/switchyard in the three grid systems: Gazelle (East New Britain), Ramu (Madang/Morobe), Port Moresby/Kwikila and WNB and is intended to meet the requirements of the SPS for projects screened as category B for environment[4] as well as meet the government's environmental assessment requirements as applicable. The IEE will be updated after further detailed design and recommended additional impact assessment and surveys are carried out at the pre-construction stage.

11. **Structure**. The IEE consists of ten sections: (i) executive summary; (ii) introduction; (iii) policy and legal framework; (iv) description of the subprojects; (v) description of the environment; (vi) anticipated environmental impacts and mitigation measures; (vii) public consultation, disclosure, and grievance redress; (viii) environmental management plan; (ix) conclusions; and (x) refences and appendices.

II. POLICY AND LEGAL FRAMEWORK

A. Country Safeguard System

12. The PNG country safeguard system (CSS) for environment includes the Environment Act 2000 and its accompanying regulatory instruments including the Environment (Prescribed Activities) Regulation 2002 (EPAR) and the Guideline for Conduct of Environmental Impact Assessment and Preparation of an Environmental Impact Statement 2004 as well as other acts

[4] A proposed project is classified as category B for environment under the SPS if its potential adverse environmental impacts are site specific, few are irreversible and in most cases mitigation measures can be designed more readily than for category A projects.

and regulations governing other aspects of environmental management and biodiversity protection.

13. The Act and regulations are administered by the Conservation and Environment Protection Authority (CEPA), formerly the Department of Environment and Conservation. CEPA's mission (*approved by the National Executive Council on 22 August 1989*) is to ensure natural and physical resources are managed to sustain environmental quality and human well-being. The Authority's two key mandated functions are to conserve the country's natural environment and regulate development activities to ensure sustainability.

14. **The Environment Act 2000.** This Act provides the basis and procedures for environmental impact assessment (EIA). It is a three-tiered system whereby all development activities are classified as Level 1, 2 or 3, depending on the extent of the impact of the activity on the environment and human health. Level 1 activities are those activities that will have minimal impact on the environment and are not permitted or licensed but relevant environmental guidelines or codes of practices must still be adhered to. These activities are left to the provincial and local level governments to regulate if they so wish. Level 2 and 3 activities are permitted activities that may pose significant or major impact on the environment, with level 3 activities required to undergo full environment impact assessment.

15. The EPAR categorizes projects as "Prescribed Activities" in two schedules according to the anticipated potential environmental impact. Schedule 1 consists of Level 2 activities that are subdivided into two categories (Category A and B). Category B has 13 subcategories with sub-category 12.6 specifically stating that "Construction of Electricity Transmission Lines or Pipelines Greater than 10 km in Length" are classified as Level 2 activities, and hence necessitate the preparation of a 'Notification of Preparatory Works', which are to be submitted to the CEPA for review. CEPA will then remit a notification to PPL advising the level of investigation and environmental assessment required. All of the sub-projects proposed under PSDP involve the construction of new transmission lines and upgrading works of existing transmission lines greater than 10km, and hence require an environment permit (EP).

16. Table 1 shows a summary of expected environmental regulatory compliance required for the types of subprojects proposed under the project. Some Level 1 category activities may be regulated by provincial government and may be required to have in place a Code of Environmental Practice to manage environmental impacts. Further verification and clarification of provincial requirements for environmental compliance should be sought during project implementation.

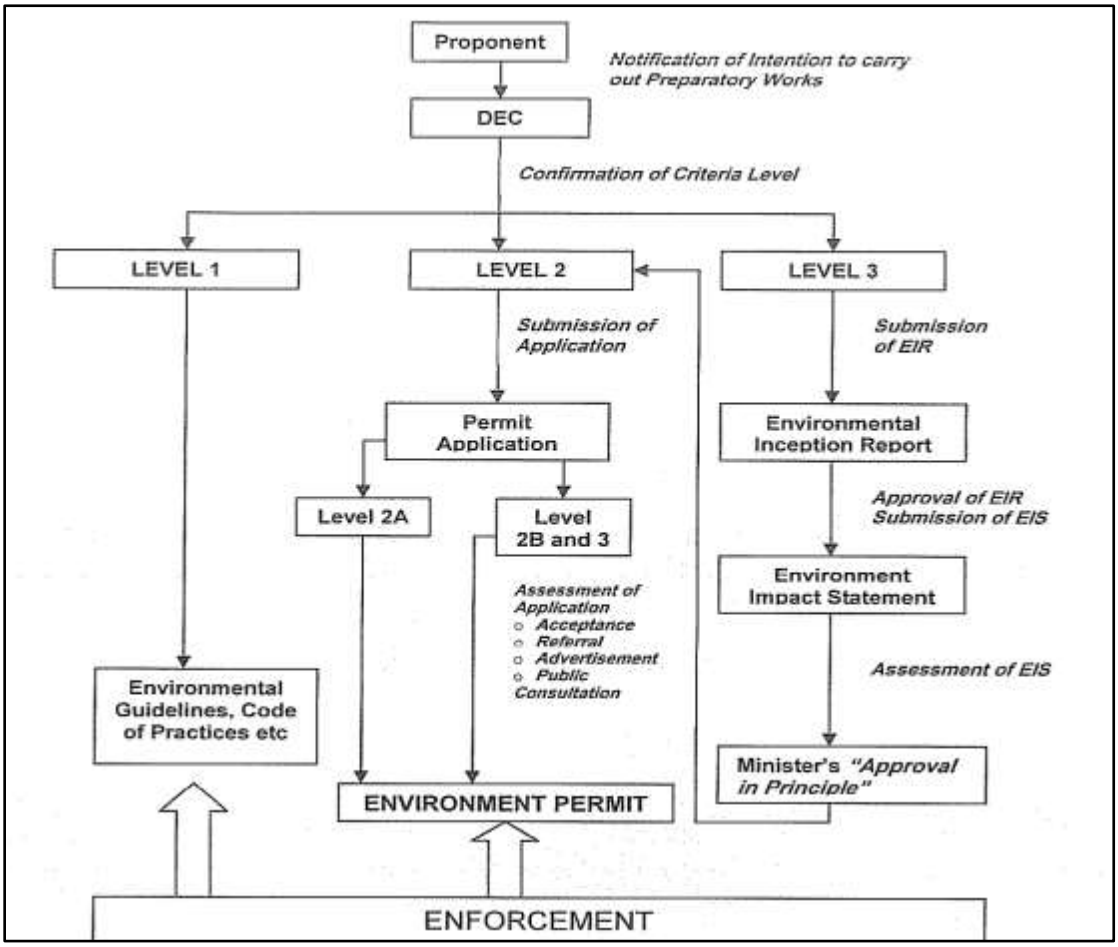
Table 2: Environmental Compliance Requirements for PSDP Subprojects

Component Description	PNG		ADB	
	Category under EPAR	Environmental Assessment	Category under SPS	Environmental Assessment
Construction of transmission line >10km	Level 2B	NPW EIS and EMP	Category B	IEE and EMP
Construction of transmission line < 10km	Level 1	Follow relevant codes of practice	Category B	IEE and EMP
Construction and/or upgrade of substation	Level 1	Follow relevant codes of practice	Category B	IEE and EMP

Component Description	PNG		ADB	
	Category under EPAR	Environmental Assessment	Category under SPS	Environmental Assessment
Construction of feeders to distribution network (22kV), LV distribution and HH connections	Level 1	Follow relevant codes of practice	Category B	IEE & EMP

17. **EIA procedures.** The EIA process involves the proponent notifying the Director-CEPA in writing of its intention to carry out preparatory works. The format and information required in this notification is set out in the Guideline for Notification of Preparatory Work on Level 2 and Level 3 Activities. Accordingly, formal Notification's will be prepared for the subprojects under consideration in this IEE, and it is expected that CEPA will advise PPL that the development has been assessed as a level 2B activity, which require the PPL to submit an EP application (which is in a similar format to this IEE). Following approval CEPA will issue a Level 2B EP for the subprojects. No work can commence until the EP is issued, as shown in Figure 2.

Figure 2: Environment Permit Process



18. **Land legislation**. The Land Act 1996 is the fundamental legislation to manage land issues in PNG. The country has only 3% of the land that is under the state. 97% of the land is still under customary land tenure. For the purpose of the Project, the relevant provisions in the Act are in Division 10, which deals with Urban Development Leases. Where there is an urban development

lease on a site and the road easement and allotments are clearly marked and identified, the land is confirmed to be under state (or private) ownership and therefore there is no infringement on customary land ownership.

19. **Other permitting**. Guideline for submission of an application for an environmental permit to discharge waste. GL-Env/03/2004. These include: (i) noise discharges - IB-ENV/03/200; (ii) air discharges - IB-ENV/02/2004; and (iii) water and land discharges - IB-ENV/04/2004.

20. **Other legislation**. The following legislation may also apply to the project:

(i) **The Forestry Act, 1991.** The main objective of the Forestry Act is to manage, develop and protect the Nation's forest resources and environment in such a way as to conserve and renew them as an asset for succeeding generations.
(ii) **The Employment Act, 1978.** An act relating to the employment of nationals and non-citizens. The act covers recruitment, conditions of employment as well as health and safety aspects.
(iii) **The National Cultural Property (Preservation) Act 1965.** An Act relating to the preservation and protection of objects of cultural or historical importance to PNG.
(iv) In addition, felling of trees, waste disposal, etc should abide by the *PNG Logging Code of Practice* and the *Department of Works and Supply Roads and Bridges Design Specification*.

21. **International agreements**. PNG is a signatory to the following international agreements with environment-conservation implications:

(i) International Plant Protection Convention, Rome 1951.
(ii) International Convention for the Prevention of Pollution of the Sea by Oil, London 1954.
(iii) Plant Protection Agreement for the South East Asia and Pacific Region, n
(iv) International Convention on Civil Liability for Oil Pollution Damage, Brussels 1969.
(v) International Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter, London, Mexico City, Moscow 1972.
(vi) Wild Fauna and Flora, Washington 1973 (CITES Treaty).
(vii) International Convention on the Conservation of Nature in the South Pacific, Apia 1976.
(viii) International Convention on the Prohibition of Military or any other Hostile Use of Environmental Modification Techniques, New York 1976.
(ix) United Nations Convention on the Law of the Sea, Montego Bay 1982. International Convention for the Protection of the Natural Resources and Environment of the South Pacific, 1986 (SPREP Convention).
(x) International Convention on Biological Diversity, Rio de Janeiro 1992.

B. ADB Environmental Safeguard Requirements and Policies

22. The implementation of the PSDP must also comply with the environmental safeguard requirements of ADB and DFAT. The SPS sets out the policies and principles for the protection of the environment and communities. ADB safeguard requirements[5] are the operational policies that seek to avoid, minimize, or mitigate adverse environmental and social impacts, including protecting the rights of those likely to be affected or marginalized by the development process. ADB's safeguard policy consists of three safeguard requirements: environment, involuntary resettlement and Indigenous Peoples.

[5] ADB. 2009. Safeguard Policy Statement. Manila, Philippines.

23. The SPS requires that through a process of screening, categorization and assessment any ADB-financed investment will: (i) reflect fully the policy objectives and relevant policy principles and safeguard requirements during preparation and implementation of projects and/or components; (ii) explain the general anticipated impacts of the investment and/or components; (iii) specify the requirements that will be followed for information disclosure, meaningful consultation, and grievance redress mechanism; (iv) describe implementation procedures and responsibilities, including budgets, institutional arrangements, and capacity development requirements; and (v) specify monitoring and reporting requirements.

24. This will be achieved through the identification of the impacts associated with activities of the subprojects and the establishment of appropriate mitigating measures to avoid and/or minimize/manage adverse impacts and risks (and/or provide compensation for impacts that cannot be avoided) as established by the process and procedures included in the CSS and the SPS. The ADB and DFAT will review, evaluate and assess the capacity of the borrower/client to properly manage the environmental and social impacts and risks of the project and to implement the relevant national laws and regulations and the ADB requirements. If gaps are identified relative to the existing national laws for safeguards and ADB and DFAT's requirements or if there are apparent gaps in the borrower/client capacity, details of the specific requirements to fill gaps will need to be incorporated in the EMP to ensure that the policy and principles of the ADB's SPS and DFATs safeguard policies are complied with.

25. Following the SPS, this IEE has been carried out to ensure that potential adverse environmental impacts associated with the subprojects are addressed according to the SPS. Other principles that apply include:

(i) Occupational and community health and safety - includes impacts on workers and communities involved in both construction and operation. The SPS requires that the World Bank Group's Environmental Health and Safety Guidelines (EHSG) are complied with.
(ii) Biodiversity conservation and sustainable natural resource management- impacts on diversity of living systems, their conservation and whether or not the project is sustainable from a natural resource perspective.
(iii) Pollution prevention and abatement - efficient use of resources, wastes and hazardous materials analyzed, treated and mitigated, pesticides mitigated, and greenhouse gas minimized.
(iv) Physical cultural resources - protection through environmental assessment and management via screening, consultation, management, chance find and removal.

C. Screening and Categorization of Subproject Components

26. **Screening.** At the commencement of the environmental studies, screening of the transmission and the substation/switchyard components was undertaken to confirm the level of due diligence required. Screening entailed: site visits to all project areas to inspect the alignments of all proposed 66kV transmission lines, proposed substation and switchyard sites and a selection of proposed 22kV and low voltage line alignments; discussions with PPL personnel and technical team during site visits regarding scope of works locations and alignments of subproject components; review of project information provided by the PPL and technical consultants.

27. The overall findings of the screening are summarized below:

(i) All of the proposed new 66kV and upgraded 132kV transmission lines are to be located either within or closely following existing road easements or right-of-way corridors where the natural environment is highly disturbed by human activities.

(ii) 66kV/132kV lines will be located wherever feasible on poles rather than towers.
(iii) All proposed new substations/switchyards are located in highly disturbed natural environments and close or adjacent to existing road corridors.
(iv) All 22kV lines are located along existing road easements.
(v) None of the sites or proposed project assets is within any protected areas or culturally sensitive areas.
(vi) There will be minimal civil works required for the project consisting primarily of vegetation clearance, excavation (removal of topsoil), grading, platform preparation and building foundations (substation sites up to 1ha) and pole/tower footing excavation (manual).
(vii) Based on site observation and discussions with PPL and the technical team the overall project is likely to give rise to relatively minor temporary environmental impacts that can be easily mitigated by good engineering practice.

28. **Categorization.** Following the SPS, ADB classifies projects into categories A, B, C, and FI according to the significance of likely impacts. The categorization criteria include: (i) category A projects have the potential to create significant adverse, unprecedented, or irreversible environmental impacts: An EIA is required to address significant impacts; (ii) category B projects have potential to create some adverse impacts, but of lesser degree and/or significance and impacts can be more readily mitigated than category A projects. An IEE is required to determine whether or not significant environmental impacts warranting an EIA are likely. If an EIA is not needed, the IEE is regarded as the final environmental assessment report; and (iii) category C. projects are unlikely to have adverse impacts. No EIA or IEE required, although environmental implications are still reviewed.

29. The project was classified for biodiversity and natural resources following SPS habitat classification criteria on modified, natural and critical habitats whereby modified habitats are defined as natural habitats that have been altered significantly and whereby project activities identify opportunities to enhance, protect and conserve biodiversity. Natural habitats are those where biological communities have not been disturbed by human activity with no loss of the area's primary ecological functions. Critical habitats are those that are of high biodiversity value. Habitat classification also adhered to IFC's 5 thresholds for the determination of critical habitat which are triggered by the; (i) identification of critically endangered (CR) or endangered (EN) species; (ii) identification of habitats of importance to endemic or restricted range species; (iii) identification of migratory or congregatory species; (iv) identification of highly threatened and/or unique ecosystems; and (v) identification of landscape level features that can influence key evolutionary processes.

30. The PSDP (based on the most environmentally sensitive subproject) is categorized as Category B for environment since potential adverse environmental impacts are site-specific, largely created during the construction stage and temporary in nature. Overall few project impacts are irreversible, and in most if not all cases mitigation measures can be designed readily. The examination of the subprojects in the Gazelle system (East New Britain); the Ramu system (Lae-Madang); and the Port Moresby system (Gomore and Motukea) indicate that the potential environmental impacts are largely restricted to the construction phase of the subproject components. The civil construction disturbances such dust, noise, traffic disruptions, erosion, and sedimentation, public and worker safety, as well as potential impacts on the natural environment can be managed effectively with standard construction practices.

III. DESCRIPTION OF THE SUBPROJECT COMPONENTS

31. Electricity demand is growing rapidly in PNG and is forecast to increase from 801 GWh in 2009 to 1,140 GWh by 2018 which is equivalent to an average growth rate of 4.13% per annum. About 90% of the population live in rural areas of which only a very small percentage have access to an electricity supply. Electrification of these areas is hampered by the rugged terrain and the limited ability of the large number of diverse cultural groups that make up the rural population to pay for the service. Provision of rural electrification is included as a pre-requisite in the government's long-term development plans for the development of rural economies and social dynamism.

A. Technical Description

32. The scope of work under the PSDP project comprises three groups of subprojects: (i) construction of new 66kV transmission lines; (ii) upgrade of existing 66 kV transmission lines to 132kV; (iii) construction or upgrade of substations and switchyards; and (iv) construction of distribution lines (22kV, LV) and household connections. All four categories of subprojects are proposed for the three geographically separated grid systems across PNG which are shown in Figures 3 to 6.

Figure 3: Location of Gazelle Subproject Activities

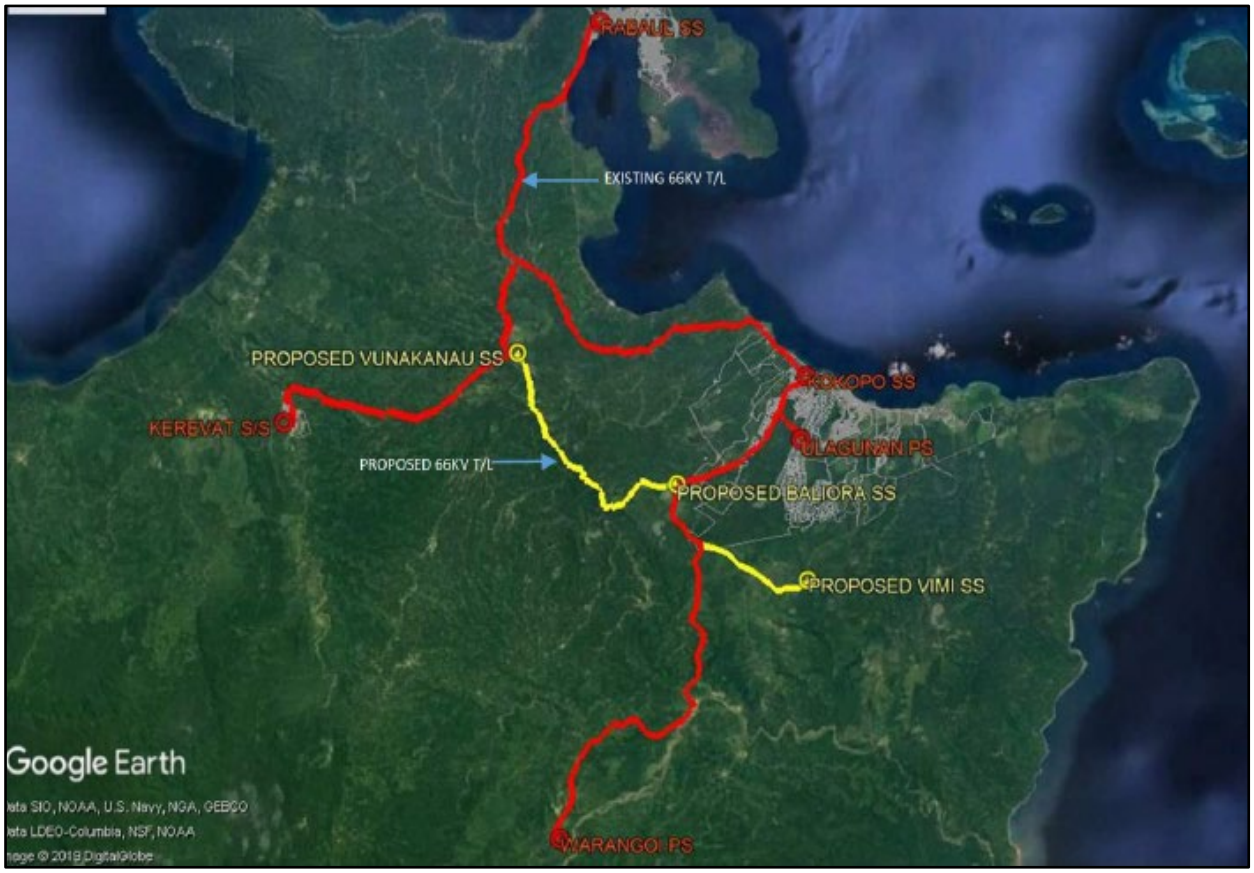


Figure 4: Location of Ramu-Madang Subproject Activities

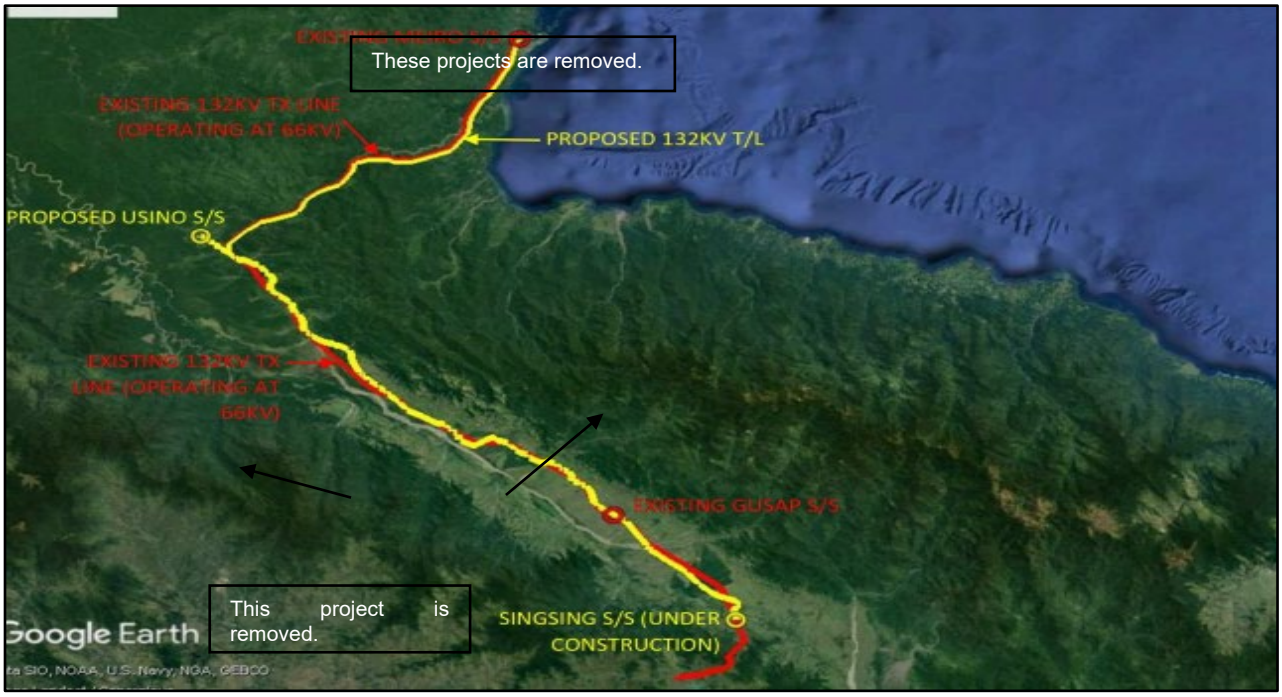


Figure 5: Location of Lae City Subproject Activities

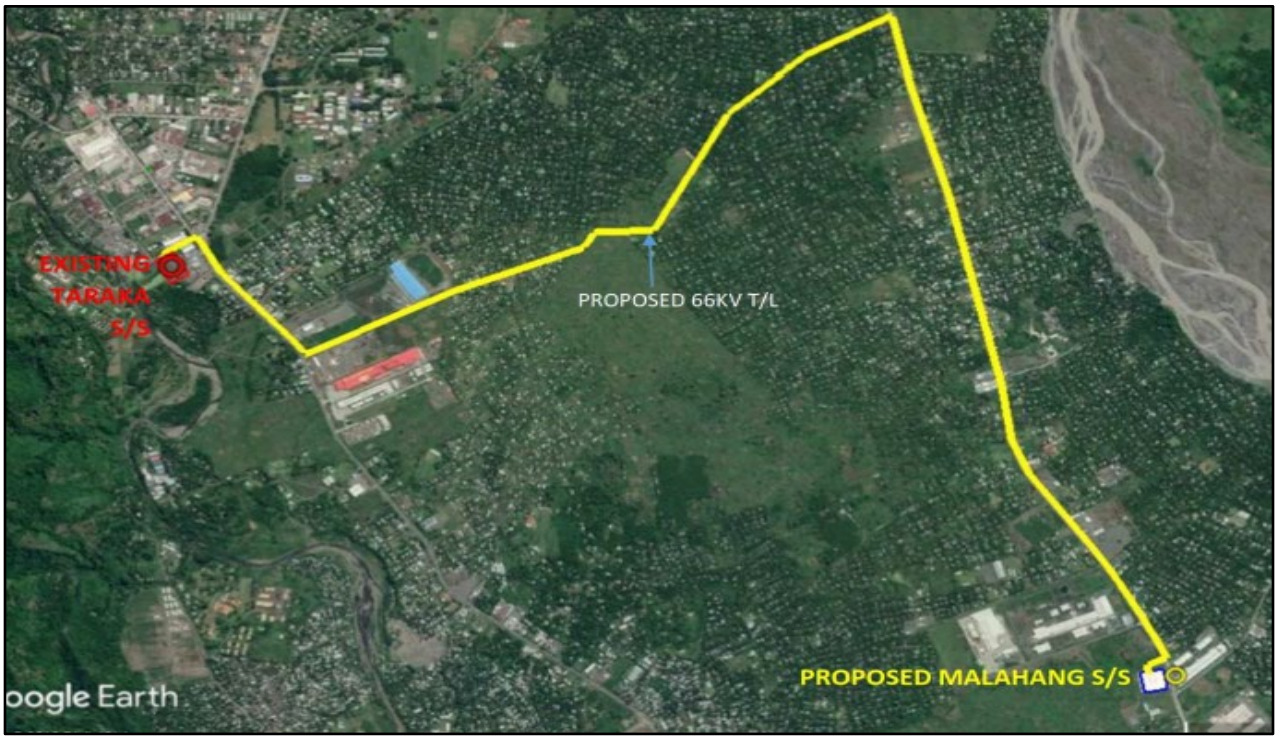
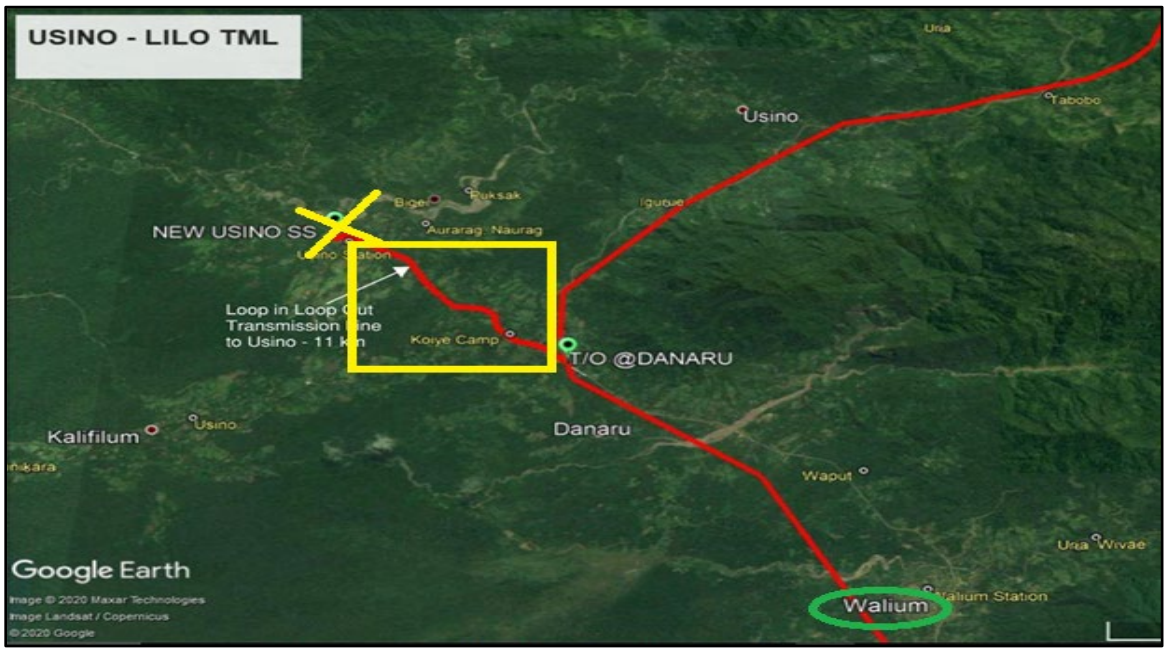


Figure 6: Location of Port Moresby Subproject Activities

33. It is noted that after further due diligence, the proposed Motukea substation for Port Moresby has been removed from the scope of works as shown in Figure 6. In a similar fashion, proposed subproject activities for Ramu-Madang were revised to no longer include the construction of a new substation in Usino but to upgrade the existing Walium substation instead as indicated in Figure 7 below.

Figure 7: Walium Substation



34. Table 2 provides a summary of the physical specifications for each Subproject across four activity areas: (i) construction of new 66kV transmission lines; (ii) upgrade of existing 66kV transmission lines to 132kV; (iii) construction or upgrade of substations/switchyards; and (iv) the construction of distribution lines (22kV, 11 kV, LV), including the new mini grid in WNB based on system modeling undertaken by SMEC and guidance from PPL.

Table 2: Technical Scope of Subproject Activities

SUBPROJECT	TRANSMISSION LINES				DISTRIBUTION LINES			
	No. S/S	No. SW YD	Km SC TML	Km DC TML	KmMV	No. TX	Km LV	No. HH&B
GAZELLE – 66KV TML, S/S, SWYDS, SCADA	1+1+1	2	12	5.7	148	458	268	17,191
RAMU MADANG 132KV (UPGRADE)	1+1+1+ 1		14		88	129	98	4,846
RAMU LAE CITY 132KV OR 66KV (NEW & UPGRADE)	1+1		15		53	591	205	22,152
POM KWIKILA 66KV TML, S/S, SWYDS	1+1	1	71	5.0	281	100	46	2,951
WNB DISTRIBUTION					615	307	472	9,773

S/S = Substation; TML = Transmission Line; SWYDS = Switchyards; SC = Single Circuit; DC = Double Circuit | MV + Medium Voltage | TX = Transformer | LV = Low Voltage | HH&B = Household & Business connections.

35. According to the procurement plan it is anticipated that procurement of transmission and substation components will be through two bid packages with seven lots (five lots for distribution in Ramu, Lae, Madang, POM and Gazelle plus the low voltage connection to households) and four lots for transmission (Lae, Madang, POM, and Gazelle).

36. The transmission lines will be carried alongside the road and be erected wholly within the existing road easements. Eleven new (or upgraded) substations and switchyards will be required but step-down transformers will be provided on the poles for domestic supplies. Clearing of the transmission line easement will be necessary, and compensation will need to be paid for losses of oil palm trees and any other economic crops that may have been planted in the easement area. Clearing will be undertaken by a labor-based community employment project.

IV. DESCRIPTION OF THE ENVIRONMENT

37. The description of the environment presented below was taken from secondary information and generously used with minimal editing where appropriate to the observed conditions in the field during field inspections.

A. Physical Environment

1. Topography, Geology, and Soils

38. **Gazelle.** The Gazelle Peninsula occupies an area of around 6,000km^2 and may be divided into four physiographic units: (i) north Baining Mountains; (ii) central and south Baining Mountains, 3) northeast lowland and 4) Wide Bay – Open Bay Isthmus (McNab 1970). The project area is located in the northeast lowland, which is of relatively low relief developed on Pleistocene and recent ash from the Rabaul eruptive center. It is bounded to the west and south by the lower

Keravat and Warangoi rivers and in the east and north by St. Georges Channel. The lowland topography of Rabaul and Gazelle is dominated by predominantly pyroclastic deposits which are both consolidated and unconsolidated and comprise weathered material from upper lands prone to high rates of erosion. The regional geology is built almost entirely by volcanic activity which comprises, three or four main rock units including, Plio-Quaternary volcanics (and volcanoes); Plio-Quaternary volcanogenic sediments; Miocene limestone (gently dipping) and Eocene-Oligocene basement volcanics (with intrusive rocks, e.g., diorite). Rocks are usually strongly jointed and faulted in New Britain and New Ireland. The general faulting trend is north-north-west (NNW) and associated with complex jointing (Dr J. Banda, Geology Department, University of PNG). The coastal stretch of the project area from Tokua through Kokopo to Rabaul is characterized by alluvium and beach sand while the Gazelle area is characterized by undifferentiated Plio-Quaternary volcanogenic sediments.

39. Soils in the Gazelle, Kokopo and Rabaul areas are dominated by volcanic humus soils subject to minor erosion at slope angle 6-7^{o} and have very high suitability for agricultural purposes (arable crops, tree crops and improved pasture). This type of soil extends to slope angles between 17–30^{o} which are subjected to strong erosion. Land subject to strong erosion is moderately rocky and extends from the Dages Range to Rawlei Range into Mt Sinivit and Mt Biririnia with slope angles greater than 30^{o}. The soil within the Rabaul caldera is dominated by volcanic ash, pyroclasts, and tephra.

40. The older soil is consolidated in contrast to younger unconsolidated soil from recent eruptions. Large parts of the pyroclastic record have been removed or modified and unrecognizable differences of what are inferred to be the same units occur at different locations. This complicates identification of sources of soil forming rocks locally (Dr. J. Banda, Geology Department, University of PNG).

41. **Madang Morobe.** This subproject consists of transmission line within Lae from the current Taraka substation to a new substation at Malahang.

42. The Madang subproject will comprise upgrading of existing 66kV transmission line upgrade along the Ramu Highway between the current Meiro substation near Madang.

43. The Ramu Valley is a wide north-west oriented grassland depression that continues without any visually discernible topographical separation from its directly opposite trending Markham Valley. Inter-valley drainage is divided via a relief differential at Watarais (junction of Ramu Highway and Highlands Highway) with the Markham valley draining south-eastward to the Solomon Sea south-west of Lae and Ramu Valley carrying runoff north-westward to the Bismarck Sea. Ramu Valley consists of lowland plains and dissected alluvial fans. Various levels of terraces occur on the northern Finisterre Range side of the valley where large alluvial deposits have consolidated. The Ramu Valley plains have been found to contain Quaternary deposits of sand, boulder gravel and alluvial fan deposits that have emanated from the northern basal mountains of the Finisterre Range. These are described as Pliocene deposits of soft mudstone, sandstone, conglomerate, and limestone.

44. The Finisterre Range consists of rugged terrain rising to 4000m with steep slopes and deeply incised rivers. Landslides are common. The area has extensive northwest trending faults and contains unstable landforms. The road section through the saddle between the Adelbert mountains and Finisterre Range is unstable and is frequently blocked by landslides which isolates Madang. In the Ramu valley streams entering the northern side of the valley frequently wash out

bridges during heavy rain events. This has also resulted in undermining and washing out foundations of 66kV transmission line towers.

45. The geology of the two provinces, Madang and Morobe (Lae) is structurally controlled by the interaction of three different micro plates within an overall Paleogene island arc setting. The three plates are represented by i) New Guinea Highlands Deformation zone, ii) South Bismarck Plate and iii) Woodlark Plate. Within the two provinces there are major subduction fault zones called Ramu Markham Fault and Owen Stanley strike-slip fault zone trending roughly southeast to northwest of the regional strike which makes this stretch a very seismically active zone. The region experiences frequent earthquakes of varying strengths.

46. The Ramu Markham Fault divides the Finisterre – Saruwaged ranges towards the east and the Adelbert Range with rapid depressions in the Sepik planes in the northeast. On the opposite side of the Ramu – Markham Fault is the Bismarck Range associated with high mountain elevations and comprising Collisional Zone rock types. The Ramu-Markham Fault generally indicates a regional south-east to north-west strike and north dipping thrust (Dr J. Banda, Geology Dept., University of PNG). Madang area is within Zone 2 of seismic activity and building code which is a high-risk area.

47. The soils that have developed on the Ramu valley are young and mainly consist of coarse sandy loams. These soils are well drained and being developed under grassland are moderately high in organic matter. Depending on their location many of the soils are shallow and overlie deep deposits of alluvially washed gravels and boulders. The valley soils mainly remain under grassland and due to their low slope angle are relatively stable. However, with the removal of vegetative cover these soils are prone to rainfall erosivity.

48. The hill soils within the Finisterre ranges and the low hills that flank the Ramu valley are older and depending on the underlying parent material and stability of the landscape in which the soil has formed, show greater clay formation and profile development. Many of the soils are shallow and have been affected by surface wash and mass movement of denuded hill slopes. Deeper soils with limited clay and profile development occur in more stable situations. Most of the mountain and hill soils have moderately well drained profiles and possibly inclusions of rock fragments within their profiles. Under this high rainfall situation, soils that are situated on soft rocks with critical slopes are frequently prone to naturally occurring landslides. Landslides can be easily triggered when these slopes have been cleared for roadworks and the Ramu road formation exhibits significant areas of subsidence and slips.

49. The infrastructure for the Morobe subproject will be installed within the north-eastern zone of Lae city. The city of Lae is situated at the eastern end of the Markham Valley, a large intra-montane basin separating the Bismarck Range, part of the Central Ranges, as well as the Finisterre Range and Sarawaged Range which are part of the northern coastal ranges. The city is located on a coastal plain formed by alluvial fan deposits and a series of uplifted terraces that are a continuation of the NW-SE trending Atzera Range, (Buleka et al, 1999). Mount Lunaman, a prominent feature in the city, is an anomaly sitting on top of the uplifted terrace overlooking the Huon Gulf.

50. The city is low - lying with an average elevation of 20masl, and a gradient of 5 meters per kilometer from the 30m contour to the shoreline, except for the Central Business District and Mount Lunaman. Several depositional surfaces interspersed with small benches, occur within the city area. These include terraces at 35m, 30m, and 20m, the 8 – 15m surface in the Didiman fan at the former Lae airstrip, and the 3 – 5m terrace at Stewart Park (Crook and Liu, 1993).

Geologically, Lae is underlain by alluvial fan deposits with mixed and undifferentiated sedimentary, metamorphic, and volcanic rocks (PNGRIS, 1999).

51. The Morobe Province Resource Database (1997) points out that most of the soils within the city area are alluvial, swampy alluvial/organic, brown forest/lithosols, acid brown forest, and humic brown. This variation in soil type is deemed to have been influenced to a large extent by the successive deposition of eroded material via the Markham, Bumbu, and Busu rivers throughout the geological history of the area.

52. **Port Moresby to Kwikila.** The Port Moresby area as well as the subproject area from the city to Kwikila is generally characterized by a series of hills and ridges interspersed with valleys and plains of varying sizes. Elevation within the subproject area ranges from 0 to 250masl along the coast and 200 to 400masl in the inland areas while slope varies from 0-35^{o} near the coast and 35-65 ^{o} inland. The project area is geologically complicated and contains both metamorphosed sedimentary rocks of Cretaceous and Jurassic age, and numerous pockets of basic igneous Tertiary rocks. The metamorphosed sedimentary rocks which predominate in the eastern parts of Kwikila include greywacke, siltstone and marine volcanics. The basic igneous Tertiary rocks which comprise mainly the western parts of Kwikila and eastern parts of Port Moresby include intrusives, granodiorite, diorite, and gabbro (Loffler, 1979).

53. Kwikila and Port Moresby are characterized by undifferentiated soils with seasonal moisture stress. The ridges and hills have brown clay soils of the suborder Tropepts and order inceptisols. They are relatively shallow soils and are typical of areas of low rainfall with a pronounced dry season typified by a vegetation of eucalypt savanna. The flood plains and gullies have colluvial soils comprised of black, dark grey or grayish brown, sandy loam to clay. According to Bleeker (1983, CISRO) Port Moresby and Kwikila areas are inundated lands subject to slight drought risks and with imperfectly to poorly drained, acid to strongly acid soils. In terms of land suitability, the two areas are not suitable for arable crops, tree crops, pasture improvement or flooded rice.

2. Natural Hazards

54. PNG is particularly prone to natural disasters including earthquakes, volcanic eruptions, tsunamis, cyclones, river and coastal flooding, landslides, and droughts. PNG ranks in the top six countries for the highest percentage of population exposed to earthquake hazards. Figure 8 highlights the levels of seismic hazard for PNG.

55. The country regularly experiences earthquakes between magnitude 5 and 7. Recent earthquakes have caused severe devastation and loss of human life and property. Accompanying events such as tsunamis, landslides, and floods also result as consequences of these tectonic events. Based on the Seismic Hazard Map shown in Figure 8, it is evident that:

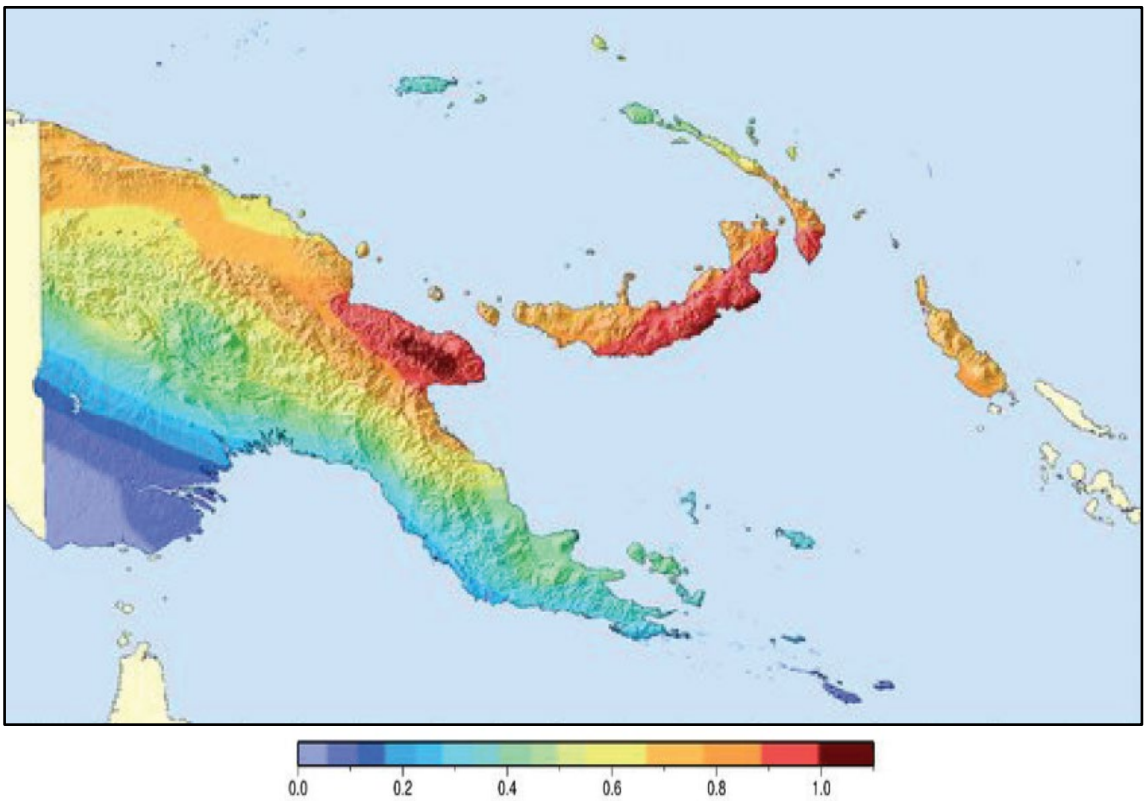
(i) The lowland Rabaul, Kokopo and Gazelle areas, including Tokua, are within areas of high seismic activity. These areas are within Zone 1 of the seismic building code which is a very high-risk area.

(ii) Madang and Marobe provinces are located in a high-risk earthquake zone associated with the Ramu-Markaham fault and Owen Stanley strike-slip fault zones.

(iii) Port Moresby and Kwikila are located within a zone with relatively low risk of earthquakes. However, it is noted that whenever earthquakes of large magnitude occur within active earthquake prone areas such as the Owen Stanley Range, this

may trigger earthquakes with significant magnitude that could affect the project area (Dr J. Banda, Geology Dept., University of PNG).

Figure 8: Seismic Hazard Map of Papua New Guinea



Source: GEM Foundation 2015.

56. **Volcanoes.** There are 16 active volcanoes in PNG; 6 of the volcanoes are classified as high risk. A relatively high percentage of the population is exposed to volcanic eruption. The Geoscience Australia report names the Madang and Morobe provinces as highly vulnerable to volcanic tsunami and lists New Britain as the highest concentration of calderas in the Asia-Pacific region reflecting the long-term hazards faced by this region.

57. **Floods and landslides.** As previously mentioned, PNG is highly vulnerable to the impacts of extreme events including, flooding, landslides, and mudflows, usually due to heavy rainfall. Flooding in PNG causes significant damage to buildings and critical infrastructure such as roads, bridges etc., primarily from landslides. PNG's susceptibility to landslides is due to a combination of factors including steep terrain, earthquakes, deforestation and extreme rainfall events and flash flooding.

58. The Ramu to Madang Subproject is susceptible to localized flash flooding but the risk of landslide is low. For Madang and Lae, the risk of coastal flooding is considered to be medium to low and nil for landslides, and for the East New Britain and Port Moresby to Kwikila subproject areas the risk of flash flooding is high, and the risk of landslide being low to nil respectively.

3. Climate

59. **Overview.** PNG has a monsoonal climate characterized by high temperatures and humidity throughout the year. Two monsoonal seasons are recognized: the northwest monsoons, which occur from December to March, and the southwest Monsoons, which occur from May to October. Indeed, the country is home to one of the wettest climates of the world and rainfall in many areas of the country exceeds 2,500 mm, with the heaviest events occurring in the highlands. Temperatures are relatively steady across the country, and a mean temperature range from 26°C to 28°C.

60. Figure 9 shows mean historical monthly temperature and rainfall for PNG during the time period 1901-2016. The dataset was produced by the Climatic Research Unit (CRU) of University of East Anglia (UEA).

61. The climate is characterized by high rainfall and humidity and high temperatures which remain generally uniform throughout the year. However, there are significant differences in climatic conditions across subproject locations:

(i) Kokopo climate is tropical and has an average annual temperature of 27°C. Rainfall averages 1987 mm/yr. The driest month is May with 124 mm rain and the wettest month is December with 217mm. The warmest month is November averaging 27.4°C and the coolest month July averaging 26.5°C.

(ii) Madang's climate is classified as tropical and it has significant rainfall throughout the year, even in the driest months. The temperature here averages 26.6 °C. About 3378 mm of precipitation falls annually with the variation between the driest and wettest months being 292mm.

(iii) Lae's climate is classified as tropical and it has high rainfall with about 4313 mm annually. The temperature averages 26.4 °C. February is the hottest month of the year and July has the lowest average temperature. Rainfall is lowest in February, with an average of 246 mm. The greatest amount of rain occurs in July, with an average of 484 mm.

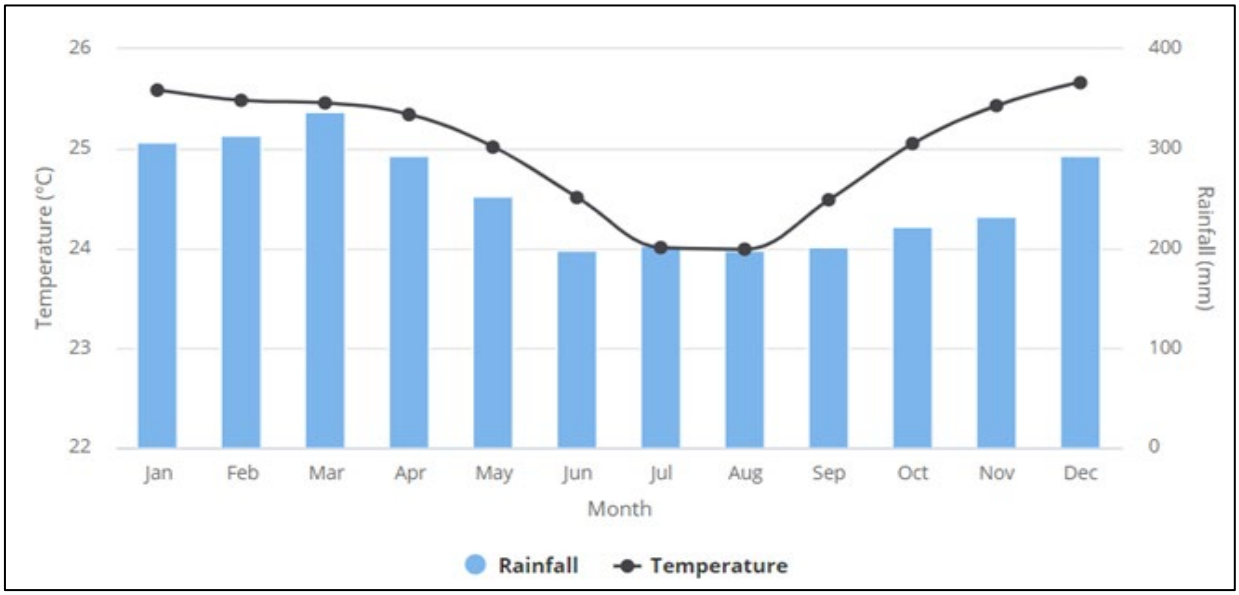
(iv) Kwikila and Port Moresby areas are characterized by a dry sub-humid climate. Average temperature of these areas ranges from 22^{o}C to 31^{o}C with little variation throughout the year. Temperatures are influenced by daily sea-breeze effects, causing some suppression of the heat. Humidity is usually (70-80%) during wet periods and in dry season humidity is usually very low at about 40-50%. The two areas lie in a rain shadow with an average annual rainfall of just over 1000 mm. Most rainfall occurs between December and April with February usually being the wettest month.

62. PNG also experiences severe tropical cyclones during the summer months of December to February and is also vulnerable to anomalously long dry spells associated with warm phase of the El Nino-Southern Oscillation (ENSO) phenomenon.

63. While PNG lies just outside of the main Tropical Cyclone belt for the Southwest Pacific region, on average tropical cyclones hit the country at the rate of about one cyclone per year.

64. The impacts of extreme events including, flooding, landslides and mudflows associated with extreme rainfall events are felt right across the nation's economic, social, and environmental systems, thus making future changes in climate, including extreme events, an issue of great concern nationally. Drought is a common occurrence in the highlands and has significant impact on the incidence of wildfires in the region.

Figure 9: Mean Historical Monthly Temperature and Rainfall for PNG 1901-2016



Source: World Bank Group - Climate Change Knowledge Portal.

65. **Climate change observations and trends.** PNG's Initial Communication to the United Nations Framework Convention on Climate Change (UNFCCC) (2000) highlighted the key historical climate trends for PNG, based on observed climate changes between 1960–1999 which indicate increasing vulnerability to climate change:

(i) Both temperature and precipitation trends in PNG resemble global and regional trends of high rainfall intensity events and prolonged droughts.

(ii) Increases in the mean near surface temperatures, especially over the last 25 years, appear to be above the global mean.

(iii) The increase in mean minimum temperatures has been greater than that of the mean maximum temperatures since 1970.

(iv) Dry season patterns exhibit weakening La Nina impacts during the dry season, and this weakening is influencing the weak dry conditions, implying longer decadal phases of dry conditions.

66. Over the last 40 years, the mean annual daily temperature for PNG has increased by around 0.5°C, which is consistent with both the global and tropical Asian trend. Mean temperatures across the South Pacific have increased by 1°C since 1970 (0.3°C per decade), and the number of hot days and hot nights have also increased significantly across the Pacific.

67. With regard to rainfall, the monthly mean historical rainfall trend for PNG resembles the global and regional trends of high rainfall intensity events and prolonged droughts. However, the trends in annual rainfall are not statistically significant at the 5% level and show little change over the period 1960 to 1999.

68. **Future climate change projections.** Building on the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, the CSIRO Climate Change in the Pacific (2011) country report prepared for PNG indicated that:

(i) Surface air temperature and sea-surface temperature are projected to continue to increase (very high confidence);

(ii) Annual and seasonal mean rainfall is projected to increase (high confidence);
(iii) Intensity and frequency of days of extreme heat are projected to increase (very high confidence);
(iv) Intensity and frequency of days of extreme rainfall are projected to increase (high confidence);
(v) Incidence of drought is projected to decrease (moderate confidence); and
(vi) Tropical cyclone numbers are projected to decline in the southwestern Pacific Ocean basin (0–40ºsouth, 130ºeast–170ºeast) (moderate confidence).

69. Based on the Coupled Model Intercomparison Project, Phase 5 (CMIP5) models used by the World Bank to simulate projected changes in temperature, the majority of climate change projections for PNG indicate that: (i) temperatures in the Pacific are projected to increase between 1.4 and 3.1°C against the baseline period (1960-1990); and (ii) increased surface air temperature between 1.0°C - 4.17°C in the northern Pacific by 2070, resulting in increases in sea surface temperature of 1.0 °C - 3.0°C.

70. With regard to extreme temperatures, all the CMIP5 models agree on an increase in the frequency and intensity of extremely hot days and a decrease in the frequency and intensity of cool days. Based on the analysis of daily temperature data from a subset of CMIP5 models, the frequency of extremely hot days is expected to increase by about the same amount as average temperature. The temperature of the 1-in-20-year hot day is projected to increase by approximately 0.6°C by 2030 under RCP2.6 and by 0.8°C under RCP8.5. By 2090, the projected temperature of the 1-in-20-year hot day is expected to decrease by 0.8°C for RCP2.6 and increase by 3°C for RCP8.5.

71. The CMIP5 projections also indicate increasing rainfall in the wet season, as well as increased variability and extremes, which may result in more severe rainfall and floods and more prolonged and intense droughts. This conclusion is based on analysis of daily rainfall data from a subset of CMIP5 models using a similar method to that described in Australian Bureau of Meteorology and CSIRO (2011).

4. Water Resources

72. **Gazelle system.** As noted above, the project area is primarily located in the northeast lowland whose water resources and drainage pattern are dominated by the lower Keravat River basin to the west and the Warangoi River basin to the south. A dissected southwest-facing escarpment trends southeast from Rembarr Range toward the Warangoi River mouth and forms a watershed between north and south drainage; the height of the escarpment decreases eastward, and the watershed is poorly defined north of the lower Warangoi River. Southwest of the escarpment is a broad depression containing the lower Keravat and Warangoi rivers. The lower Keravat River turns northwest and drains into Atalilklicun Bay.

73. The Warangoi River rises in the mountains south of Kokopo, treks northward for some 40km where it meets the Nengmulha River below Warangoi village, thence turns east and flows into the Bismarck Sea at St Georges Channel (between New Britain and New Ireland). The catchment could be described as a medium to low mountain catchment, descending from the ridge tops through well-defined incised channels, concentrating in the mid-section to a well-defined main channel with only minor tributaries. The Warangoi catchment in the upper reaches is densely forested with old growth vegetation with the mid-reaches now having some increased land development with logging as well as oil palm agriculture. The lower catchment is under semi-subsistence and cash crop cultivation. These include coconut and cocoa plantations some of

which have been converted to oil palm plantations. While the upper reaches are well contained within gorges and terraces, the mid to lower sections have large flood channels bounded within high terraces with substantial sand, gravels, and large boulders. Catchment erosion, bed load and sediment transport are ongoing due to the steeper slopes, slope instability and regular rainfall at higher altitudes. The lower section of the river migrates within its broad and braided flood-induced channels.

74. The Warangoi hydropower plant is located in the Warangoi River, 30 km south of Kokopo township. It is a run-of-the river scheme and has an installed capacity of 10 MW.

75. **Ramu system.** The subproject area traverses the Ramu and Markham river systems, the much smaller Gogol River catchment as well as the alluvial plain between the Bumbu and Busu rivers in Lae.

76. The Ramu River has a relatively small catchment area and flows for about 720 km in a north-westerly direction before and discharging into the Bismarck Sea through a flat, swampy floodplain to the east of the mouth of Sepik River. The water resources of the Ramu valley are derived from fast flowing rivers and streams that drain from the Finisterre and Bismarck Ranges.

77. The drainage system of the Finisterre Ranges is a complex pattern of dendritic water courses that arise within the steep rugged terrain. The southern side of the Finisterre Range drains to the Ramu River. All of the watercourses have very steep gradients that change to moderate gradients as the channels emerge from areas of steep terrain. Where the channels emerge from the steep sided valleys the river gradient decreases and bed load accumulates in the lower valleys. Here the rivers flow over the accumulated deposits and become slightly braided with pronounced meander patterns limited by the narrow width of the valleys.

78. The Markham River, to the east of Ramu valley originates in the Finistere Ranges and forms long wide-braided channels flowing south-eastward over a distance of about 170 km and discharges into Huon Gulf to the south of Lae city. The Gogol River drains the south-western flank of the Adelbert Range west of Madang. Tributaries from the north-western side of the Finisterre Range drain into the Gogol River which discharges into Astrolabe Bay.

79. Three major rivers flow within the Lae City area. These are the Markham River in the western part of the city and the Bumbu and Busu Rivers in the eastern side. These rivers collectively discharge a substantial volume of water, gravel and sediment into the Huon Gulf annually forming larges mud plumes stretching offshore from the city's waterfront. These rivers flood regularly and in so doing cause considerable damage to the city's residences, transport, social and utility infrastructure as well as nearby settlement dwellings and subsistence food gardens. The source of water for Lae is groundwater bores whereas Madang's water supply is sourced from a river. Water supply and sanitation infrastructure in both towns are owned and run by Water PNG which is a national government enterprise.

80. **Port Moresby to Kwikila.** The terrain in the subproject area drains south to southeast into the Coral Sea. There are several permanent surface watercourses whose flow is drastically reduced during the dry season. This is when flow is dependent on rainfall in the mountainous hinterland and groundwater base-flow. These watercourses are prone to heavy flooding during the rainy season from November to April and some of the rainfall is captured in depression swamps scattered throughout the subproject area. The largest surface watercourse is the Kemp Welch River which originates north-east of Kwikila in the Owen Stanley Range, flows south-eastward and discharges into the Coral Sea near Kalo Village.

81. Water supply for Port Moresby is derived from the Sirinumu Dam located adjacent to the Owen Stanley Range at Sogeri in the Central Province. The water supply and sewerage system for Port Moresby is owned and operated by Eda Ranu which is another state-owned enterprise. Most of the communities along the Port Moresby to Kwikila subproject area depend on shallow groundwater wells for domestic consumption and other uses.

5. Ambient Air Quality

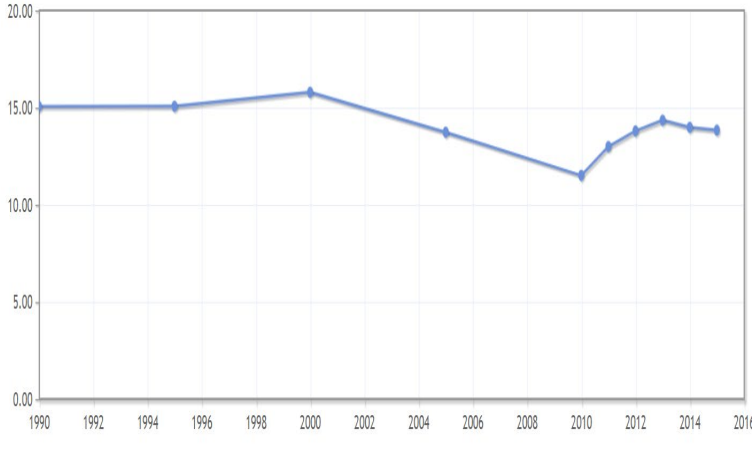
82. While the ambient air quality in PNG is generally considered to be good, PNG has the highest rating for mean annual exposure to air pollution per head of population. The value for PM2.5 air pollution, mean annual exposure (micrograms per cubic meter) for PNG in 2015 was 13.86 as of 2015. The population-weighted exposure to ambient PM2.5 air pollution, mean annual exposure (micrograms per cubic meter) which is defined as the average level of exposure of a nation's population to concentrations of suspended particles measuring less than 2.5 microns in aerodynamic diameter, which are capable of penetrating deep into the respiratory tract and causing severe health damage. Exposure is calculated by weighting mean annual concentrations of PM2.5 by population in both urban and rural areas (Brauer, M. et al. 2016, for the Global Burden of Disease Study 2015).

83. Figure 10 shows the World Health Organization ranking for PM2.5 mean annual exposure for air pollution for each country in Oceania, as well the PM2.5 air pollution, mean annual exposure (micrograms per cubic meter) levels from 1990 through to 2015. Currently, the global average of fine particle pollution is 20µg/m3 (PM2.5). PNG is the country with the highest value in the Oceania is PNG, with a value of 13.86, and is Kiribati is the lowest with a value of 3.45.

84. Ambient air quality conditions in PNG are sensitive to local conditions, and vary substantially between urban, peri-urban, and rural sites. The graph in Figure 10 also shows, over the past 25 years this indicator reached a maximum value of 15.81 in 2000, which is below the World Health Organization's 35µg (PM2.5) uppermost safety set by the World Health Organization (WHO) for PM2.5 (WHO, 2006).

Figure 10: Oceania Country Rankings PM2.5 Air Pollution (Mean Annual Exposure Micrograms/m^3)

No	Country	Value
1	Papua New Guinea	13.86
2	Vanuatu	8.52
3	Fiji	7.78
4	Solomon Islands	
5	Australia	
6	New Zealand	
7	Tonga	
8	Samoa	3.81
9	Kiribati	3.45



Source: World Health Organization 2015.

85. While there are no on-site monitoring data for any of the subproject locations, the main causes of air pollution in the subproject locations are smoke from fires, dust from unsealed roads during dry periods as well as emissions from power generators, vehicles, and machinery. In the rural and semi-rural areas, the main source of localized and short-duration air pollution is smoke from cooking fires and the burning of cleared vegetation for subsistence gardens. Apart from the subproject sites within the urban areas of Lae, Madang, and Port Moresby, the majority of the other subproject areas are in semi-rural and rural locations.

B. Biological Environment

1. Overview

86. PNG has extremely high biodiversity. The total number of different plants and animals in PNG is not accurately known but almost certainly exceeds 200,000 species. It includes 39 Centres of Plant Diversity and Endemism as defined by the WWF and IUCN and includes 12 of the globally important Endemic Bird Areas recognised by Birdlife International (Mittermeier et al, 1998).

87. PNG's forests provide habitat for around 250 species of mammals, 20,000 species of plants, 1,500 species of trees and 750 species of birds, half of which are unique to the island:

(i) Plant diversity is particularly concentrated with an estimated 15,000 to 21,000 higher plants and at least 2,000 pteridophytes and more than 3,000 species of orchids. Plant endemism is high at 10,500 to 16,000 species (Mittermeier et al, 1998).

(ii) PNG's mammal diversity includes 242 species of which 57 species are endemic but does not include primates, squirrels, cats, viverrids or ungulates. Introduced species include deer, pigs, dogs and cats. Placental mammals include rodents and bats of which there are 92 species and 32 are endemic. Marsupial diversity is second only to Australia. Bird diversity is particularly high with 762 species of which 85 species are endemic. Reptiles include 305 species with at least 93 snakes, 190 lizards, 14 turtles and two crocodiles. Amphibians include 200 species of which 134 are endemic. PNG has 329 freshwater fish species (excluding the Bismarck Archipelago) of which 149 are endemic (Mittermeier et al, 1998).

(iii) Scientists estimate that more than half the plants and animals found in PNG have yet to be scientifically named.

88. Despite this, PNG biodiversity continues to face growing threats from a wide range of activities, including illegal and/or unsustainable logging, subsistence exploitation, monoculture palm oil, commercial mining, road construction, invasive and/or exotic species and unsustainable fisheries. These environmental threats are exacerbated by global climate change and increasing weather variability, which is increasing the incidence of fires within forests and savannas, flood events, erosion, and seawater incursion into coastal regions (UNDP 2017).

89. The primary threats to terrestrial biodiversity in PNG are deforestation and degradation (from logging and subsistence agriculture), mining (including pollution and waste runoff) and agricultural conversion (for oil palm). The main drivers of deforestation and degradation in PNG are logging (48.2%) and subsistence agriculture (gardening) (45.6%) (UNDP 2017). Other pressures on forest ecosystems include subsistence harvesting of non-timber forest products (eaglewood resin) and hunting and fishing. Subsistence harvesting is generally linked to the need for cash, while hunting and artisanal fishing are generally for personal consumption or local sale. Traditional hunting is the major threat to mammals such as the now endangered Tree Kangaroos

often putting localized pressure on fauna. The need for cash and food protein are pressures that are closely correlated with the high population growth in rural and peri-urban areas. The full list of critically endangered (CR) and endangered (EN) species and the potential identification of critical habitats to be found within each of the 3 separate areas of interest are summarized in Appendix 2. The risk screening exercise was conducted based on the IFC performance Standard 6 (PS6).

2. Vegetation

90. Primary rainforest covers around 75% of the country.[6] These forests are characterised by very high species diversity when compared to other tropical forests around the world, reflecting the wide range of climatic, geographical, and geological conditions that occur in the country. Plant diversity is particularly concentrated with an estimated 15,000 to 21,000 higher plants and at least 2,000 pteridophytes and more than 3,000 species of orchids. Plant endemism is high at 10,500 to 16,000 species.

91. The site-specific vegetation for each subproject is summarised in Table 3 and described more fully in the sections that follow. The vegetation in the subproject rights-of-way and substations mainly consists of grasses and secondary regrowth.

92. **Gazelle system subproject area.** The risk screening exercise carried out for this project site noted that within the 50km buffer zone, there was the potential for the occurrence of 6 endangered (EN) and 1 critically endangered (CR) plant species. The former are flowering plants (*Magnoliopsida)* and the latter is known as *Orya schlechteri* is from the Lily family (*Liliopsida*). This is a creeping stoloniferous plant, which grows on the bank of rivers in partial or complete shade with primary forest cover. The subproject area however between Kokopo District and Rabaul District is highly disturbed by anthropogenic activities such that the dominant natural vegetation types are secondary regrowth forest patches, cash crops [cocoa (*Theobroma cacao*), coconut (*Cocos nucifera*), oil palm (*Elaeis guineensis*), balsa (*Ochroma pyramidale*)] plantations and subsistence garden patches [dominated by coconut, banana (*Musa spp*), cassava (*Manihot esculenta*), mango (*Mangifera indica*), pawpaw (*Carica papaya*) and taro (*Colocasia esculenta*). The shoreline is dominated by various pandanus and various mangrove plant species. The Rabaul to Matupit areas have also been affected by recent volcanic activities therefore plant succession and regeneration has been slow with dominant plants being mostly local pioneer grasses and shrubby plants. Based on the information available, the area affected by this subproject can be considered as Modified Habitat based on ADB's SPS definition.

Table 3: Description of Vegetation within Subproject Areas

Subproject Site	Description of Vegetation	
	Transmission Line	Substation/Switchyard
Lae	Ornamental plants and fruit trees beside residences	Grasses and lowland shrubs
Madang	Ornamental plants and fruit trees beside residences	No vegetation - existing Meiro Substation
Gazelle	Grasses and secondary regrowth of lowland alluvial plant species Ornamental plants and fruit trees beside residences	Grasses and secondary regrowth of lowland alluvial plant species

[6] UNDP/GEF 2017 Papua New Guinea's Fifth National Report to the Convention on Biological Diversity. Much of the information presented in the overview was sourced from this report.

Subproject Site	Description of Vegetation	
	Transmission Line	Substation/Switchyard
Port Moresby	Grasses and secondary regrowth of Eucalypt Savannah species	Grasses and secondary regrowth of Eucalypt Savannah species
Bautama to Gomore/Kwikila	Grasses and secondary regrowth of Eucalypt Savannah species Ornamental plants and fruit trees beside residences	Grasses and secondary regrowth of Eucalypt Savannah species plus rain trees

93. Local residents who moved back to Rabaul and Matupit after the 1994 volcanic eruptions have managed to replant mango, banana, cassava and some decorative plants. The Gazelle District is also highly disturbed from anthropogenic activities with small remnant patches of primary forest vegetation. The grass vegetation is dominated by kunai grass (*Imperata cylindrica*) and pitpit (*Saccharum edule*).

Site reconnaissance confirmed that all proposed project components including substation, switchyards 66kV and 22kV alignments for Gazelle are located in highly disturbed environments. All transmission lines and distribution lines will be in road easements, and substations /switchyards on land immediately adjacent to roads. Surrounding land is largely plantation and gardens, with roadside area comprising scattered residences community facilities (schools etc.) and small roadside businesses. Local trees dominant in the three district areas are typical of the lowland tropical rainforest vegetation category of PNG and include *Canarium vitiense, Canarium indicum, Instia bijuga* (Teak), *Eucalyptus deglupta, Terminalia megalocarpa and Pometia pinnata*.

94. **Madang Morobe subproject area.** The risk screening exercise carried out for this subproject area noted that within the 50km buffer zone, there was the potential for the occurrence of 4 CR and 34 EN plant species. The former are all flowering plants from the family *Magnoliaciae* and 2 of the latter are from the *Liliopsida* family. It is important to note however that the onsite description of biological resources in the Madang Morobe subproject area along the transmission line alignments up to a 1km buffer zone and covering mainly the Madang and Lae urban areas for power distribution up to a 10km buffer zone, are described as follows with minimal impacts envisaged from implementation of the subproject:

(i) The vegetation in the Madang urban area reflects this where 80-90% of the vegetation is secondary regrowth. There are patches of coastal mangroves, commercial plantations (cocoa and coconut) on the outskirts and subsistence gardens in periphery of Madang Town. Dominant plants are coconut, cocoa, banana, mango, pitpits, breadfruit and kunai grass.

(ii) Similar to Madang the Lae urban area is dominated by domesticated plants of various species. Secondary regrowth areas are dominated by local pioneering plants and subsistence gardens in the peripheral areas of Lae. Dominant plants in Lae Urban area include rain tree, breadfruit, domesticated ornamental plants, coconut, banana, mango, guava, cassava and pitpits. Kunai grass are common in fallow garden areas and along the Lae urban section of Highlands Highway.

95. **Port Moresby to Kwikila subproject area.** Risk screening conducted for this subproject area noted that within the 50km buffer zone, there was the potential for occurrence of 9 CR and 22 EN plant species. Along the subproject main transmission line alignment however to a buffer zone of 1km in the Port Moresby and Kwikila areas, it is categorized as savannah grassland with occasional gully forests and mangroves. Approximately 80% of the project area is lowland savannah grassland with kunai grass, kangaroo grass (Thermada australis), eucalypt tree species and cycads being dominant plants. The lowland gully forests are composed of some lowland tree

species that reach maximum height of about 5m. Most of the gully forests discontinue and show a reduction in plant diversity upstream with reduced water volume, drainage width and increased slope. The remaining 20% of the subproject works are focused on the Port Moresby urban area distribution line rehabilitation component which are located along existing alignments which will have very minimal impact on the terrestrial vegetation.

3. Wildlife

96. PNG's warm-blooded fauna included 813 species of birds and 298 species of mammals. 76 bird species are endemic to PNG as are approximately 50 species of mammals. Birds are the best-known animal group in PNG, while mammals are far less known due to their nocturnal lifestyle. Placental mammals include rodents and bats of which there are 92 species and 32 are endemic. Marsupial diversity is second only to Australia.

97. Cold-blooded vertebrates include approximately 785 species: 314 species of freshwater fishes, and 687 species of amphibians and reptiles. At least 46 % of these species are endemic to PNG. Bird diversity is particularly high with 762 species of which 85 species are endemic. Reptiles include 305 species with at least 93 snakes, 190 lizards, 14 turtles and two crocodiles. Amphibians include 200 species of which 134 are endemic. PNG has 329 freshwater fish species (excluding the Bismarck Archipelago) of which 149 are endemic.

98. **East New Britain Subproject Area**: In the East New Britain subproject area, the risk screening exercise provided a preliminary list of priority species that could potentially occur within the 50km buffer zone of the project site. It is noted that of the 34 species identified, 9 are classified as CR and 25 are EN; with 8 of the former and 32 of the latter listed as occurring in adjacent marine areas of the highly marine biodiverse Bismarck Archipelago which although adjacent to the project site, will not be affected by the subproject components. The only 2 reptiles listed as endangered are both sea turtles, the green turtle (C*helonia mydas*) and the hawksbill turtle (E*retmochelys imbricata*). The majority on the EN and CR list are fish, snails, gastropods and bivalve species. The only bird species listed as critically endangered is the Beck's Petrel (*Pseudobulweria becki*) which ranges over both land and sea. The occurrence of terrestrial fauna in this subproject area is very low due to the intensive anthropogenic activities in the project area. There was no sighting of mammalian fauna during the field visit, however bandicoot, Bismarck Bare-backed Fruit Bat (*Dobsonia praedatrix*) and Polynesian Rat (*Rattus cf. exulans*) are known to be present. From verbal communication with local people the following reptiles and amphibians are present in the project area: Brown Tree Snake (*Boiga irregularis*), grass snakes (python), various lizard species, green frog and canetode frog. Common birds known to present in the area include Green-fronted hanging Parrot (*Loriculus tener*), Red-Chinned Lorikeet (*Charmosyna rubrigularis*), Bismarck Kingfisher (*Alcedo websteri*), Black-Tailed Monarch (*Monarcha verticalis*), Red-banded Flowerpecker (*Dicaeum eximium*), Velvet Flycatcher (*Myiagra eichhorni*), Knob-billed Fruit- Dove (*Ptilinopus insolitus*), Red-knobbed Imperial Pigeon (*Ducala rubricera*), Yellow-tinted Imperial Pigeon (*Ducala rubricera*), Pied Cockatoo-Dove (*Reinwardtoena browni*), Singing Parrot (*Geoffroyus heteroclitus*), Dull Flycatcher (*Myiagra hebetior*), Variable Dwarf Kingfisher (*Ceyx lepidus*) and Black-headed White-eye (*Zosterops hypoxanthus*). Based on the information available, the area affected by this subproject can be considered as Modified Habitat based on ADB's SPS definition.

99. **Madang Morobe Subproject Area:** Risk screening conducted for this site determined that within the 50km buffer zone, there was the potential for occurrence of 11 species as CR and 32 species as EN. 32 of these species however occur in adjacent marine waters. The 2 endangered birds are the Far Eastern Curlew (*Numenius madagascariensis*) and the Great Knot

(*Calidris tenuirostris*) which ranges over both land and sea. Fauna present within uncultivated grassland and disturbed forest gardens areas along the 1km buffer zone of the transmission alignment between Singsing and Walium consist mainly of common PNG fauna such as feral pigs, bats, reptiles including lizards, carpet snakes and death adders, amphibians (including frogs and the introduced cane toad). Within the patches of lowland forest common wildlife includes cuscus, feral pig and flying foxes and bats. Reptiles and amphibians include the same species as already described while avian wildlife includes sulphur crested cockatoo, heron, hawks, crows, starlings, wood pigeon and wild ducks. There is the potential however for occurrence within the 10km buffer zone of the subproject transmission alignment with 2 endangered species of Pademelon otherwise known as small marsupials known as Calaby's pademelon (*Thylogale calabi*) and the Mountain pademelon (*Thylogale lanatus*) likely to occur. They are accompanied by also a pair of endangered tree kangaroos known as the Goodfellow's Tree Kangaroo (*Dendrolagus goodfellowi*) and the Huon Tree Kangaroo (*Dendrolagus matschiei*). Based on the information available, the area affected by this subproject will be considered as Critical Habitat based on ADB's SPS definition. As such, an additional survey and impact assessment is recommended as a validation exercise during the pre-construction stage. If the area is confirmed to host the presence of CR and EN species, a Biodiversity Action Plan will be prepared and included in the updated IEE and EMP to confirm compliance with the SPS and ensure no net loss of biodiversity.

100. Aquatic fauna is rare as there are no all-year-round streams in the area, except Gusap River, which supports little aquatic life due to its very frequent floods that are associated with high volume of gravel and boulder loads. Rats, mice, and fruit bats are common mammalian fauna known to occur in Madang peri-urban area. Bandicoots are restricted to urban peripheral grassland but population there is declining due to increased human activities. Green frog and cane toad are common within the town. Fresh water fishes known in the area include Mosquito fish (*Gambusia affinis*), Guppy (*Poecilia reticulate*) and eels.

101. Common mammalian fauna known to occur in Lae peri-urban areas include rats, mice and fruit bats. Bandicoots are restricted to urban peripheral grassland, but their population is declining due to increased human activities. Green frog and cane toad are common within the town. Python snake is very common in Lae due to high humidity associated with high rainfall. Fresh water fishes known in the area are Mosquito fish (*Gambusia affinis*), tilapia, Guppy (*Poecilia reticulate*) and eels. Common birds of the area are Pigeon, Green Parrot (*Loriculus tener*), Red-Chinned Lorikeet (*Charmosyna rubrigularis*) and Red-banded Flowerpecker (*Dicaeum eximium*).

102. **Port Moresby to Kwikila subproject area:** Risk screening conducted for this site determined that within the 50km buffer zone, there was the potential for occurrence of 3 species as CR and 27 species as EN. 24 of these species however occur in adjacent marine waters. The 2 endangered birds are the far Eastern Curlew (*Numenius madagascariensis*) and the Great Knot (*Calidris tenuirostris*) who range over both land and sea. The endangered Giant Bandicot (*Peroryctes broadbenti*) and the Spectacled Flying Fox (*Pteropus conspicillatus*) are known to be within the 10km buffer zone in addition to Goodfellow's Tree Kangaroo (*Dendrolagus goodfellowi*). Along the 1km buffer zone of the existing alignment however only terrestrial wallabies, bandicoots, rats and python snakes are common fauna known to be occurring in abundance in savannah grasslands of Central Province (Kwikila) and hinterlands of Port Moresby. The wallaby population around the project sites has declined over the years as a direct result of human pressure through hunting, agriculture, and other human settlement activities. The all-year-round creeks in the project area host only Mosquito fish, Guppy, and eels. Green frogs and the introduced Cane toads are common in the project area. Based on the information available, the area affected by this subproject will be considered as Critical Habitat based on ADB's SPS definition. As such, an

additional survey and impact assessment is recommended as a validation exercise during the pre-construction stage. If the area is confirmed to host the presence of CR and EN species, a Biodiversity Action Plan will be prepared and included in the updated IEE and EMP to confirm compliance with the SPS and ensure no net loss of biodiversity.

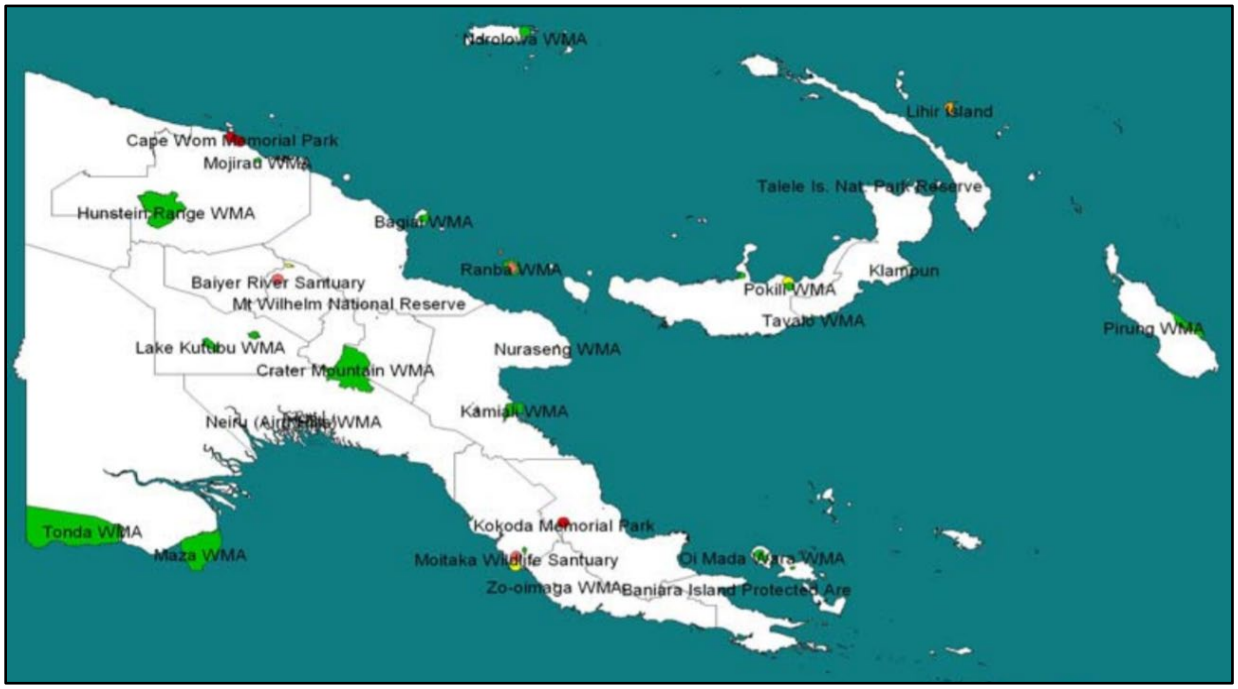
4. Protected Areas

103. According to the data provided by the World Database on Protected Areas, in PNG there are 15 forma National Parks, 9 Provincial Parks, one Recreation Park, one Wildlife Provincial Park, one Nature Reserve, one Historical Reserve, and a range of other protected areas like sanctuaries and locally managed reserves covering less than 2.7 % of the country's land area (which is extremely low). Figure 11 shows the location of all the gazetted Protected Areas in PNG larger than 10,000 hectares.

104. The Balek WMA was established to conserve a unique geothermal limestone cave system, as well as its diverse flora and fauna (which includes tree kangaroos and Hornbills) is located about 24km south-east of Madang Town beside the Ramu Highway in the Madang Morobe subproject area, as shown in Figure 12.

105. The closest protected areas in Central Province are Variarata National Park (1,063 ha), located about 20kms northeast of Port Moresby and Zo-oimaga Wildlife Management Area (1,510 ha) located approximately 90km northwest of Kwikila Station.

Figure 11: Protected Areas in PNG Larger than 10,000 Hectares



Source: UNEP Website.

Figure 12: Balek Wildlife Sanctuary Adjacent to Ramu Highway and Transmission Line Right-of-Way

5. Endangered Species

106. According to the IUCN Red List (2014), a total of 448 species were listed as Threatened in PNG. Of these 39 were terrestrial mammals, 39 birds, 11 amphibians, 11 reptiles,49 fishes, 2 molluscs, 149 invertebrates and 151 plants. Eleven species are listed as Critically Endangered (CR) and include a monotreme, *Zaglossus bartoni*, 6 species of marsupials; *Spilocuscus rufoniger, Phalanger matanim, Petaurus abidi, Dorcopsis atrata, Dendrolagus scottae* and *D. pulcherrimus*, a murid, *Solomys ponceleti*, and three species of bats, *Pharotis Imogene, Aproteles bulmerae* and *Pteralopex flanneryi* (IUCN 2014).

107. The Endangered (EN) mammals include 9 species of marsupials; *Thylogale lanatus, T. calabyi, Phalanger lullulae, Echymipera davidi, Peroryctes broadbenti, Dendrolagus notatus, D. matschiei, D. goodfellowi and Dactylopsila tatei* and four species of rodents; *Paramelomys gressitti, Paraleptomys rufilatus, Melomys matambuai, Solomys salebrosus*, and the Bougainville monkey-faced bat (*Pteralopex anceps*) (IUCN 2014). The remaining 14 species of mammals listed as Vulnerable (VU) on the IUCN Red List are a mix of relatively widespread but uncommon species and narrow-range endemics.

108. A total of 39 species of birds are also listed as Threatened in PNG, of which 34 are considered as Vulnerable, four as Endangered and one as Critically Endangered. The single critically endangered species is a seabird, *Pseudobulweria becki* known from PNG-Solomon Islands area, now locally common in the sea between New Britain and New Ireland (Allison and Tallowin,2015). Four species considered to be endangered include *Otidiphaps insularis, Pitta superba, Actenoides bougainvillei and Aplonis brunneicapillus* (IUCN 2014.2).

109. For the project specific subproject areas, a total of 29 plant species are classified as critically endangered and 72 are endangered. The onsite description of fauna along the existing

transmission line alignments up to a 1km buffer zone are that they are highly modified environments with the dominant natural vegetation types being of secondary regrowth forest with intermittent patches of subsistence and cash crops. In addition, for power distribution, they are located in mainly the urban and peri-urban areas of Madang, Lae and Port Moresby. On wildlife fauna, a total of 8 species are identified during the screening exercise as critically endangered with 84 classified as endangered. Important to note that a vast majority of these are marine mammals, fish, gastropods and bivalve species occur in the adjacent marine environment in the 50km buffer zone and will not be directly impacted by implementation of the project. The full risk screening report summary is attached as Appendix 2.

C. Socioeconomic and Cultural Conditions

1. National Context

110. PNG includes the eastern half of New Guinea, the islands of New Britain, Manus, New Ireland and Bougainville, and hundreds of small islands. The land area is approximately 463,000 km^2, and comprised of over 600 islands, 27% of which are inhabited. PNG is a young nation and one of the world's most diverse with respect to biodiversity, ethnicity, and linguistics (over 850 languages are spoken). The country is also rich in natural resources (forestry, agriculture, fisheries, and minerals) and is characterized by rugged terrain, including dense rainforest, swamps, and unstable volcanoes, which continue to pose challenges for the extension of infrastructure and provision of social services. Since forest covers over 70%of PNG's land, approximately 70% of the total land area has between low and very low potential for most food or cash crops, while 7% has high to very high potential. PNG is the supplier of 3% of the world's gold, 2% of its copper, 3% of its coffee and 1% of its palm oil.

2. Socioeconomic Development

111. The essential economic performance of a country is reflected by the gross domestic product. Worldwide gross domestic product in 2018 was at about 11,038 US Dollar per capita. The GDP in PNG reached 2,723 US Dollar per capita in 2018, and the gross national product has been at 2,530 US Dollar per capita (WorldData.info 2019). The economic performance of PNG has steadily improved over the past decade due to a significant resources boom, mainly in the extractive minerals and hydro-carbon sector. Gross domestic product (GDP) increased from 5.5% in 2009 to 7% in 2010. The construction of a major liquefied natural gas pipeline (PNG-LNG) from the Southern Highlands will be the single largest investment in the country's history (140% of GDP). LNG exports, which will start late in 2014, will increase GDP by 150% and could triple the country's export revenue by 2020.

112. With this boost in GDP, public finances will be under pressure to ensure increased revenues translate into sustained equitable gains for all Papua New Guineans. Unfortunately, PNG did not achieve any of the Millennium Development Goals by 2015, due in part to structural inequalities; lack of investments in sustainable initiatives; limited capacity of government systems to deliver basic social services; and elevated levels of violence, among other factors. Despite increasing national wealth, human development outcomes continue to lag behind: PNG currently ranks 156 out of 187 countries on the Human Development Index (HDI). Key HDI indicators for PNG include:

(i) Life expectancy is 63 years, 25% of children are unable to attend school, and adult literacy is around 50%.

(ii) Only 7% of the population has access to the electric grid and a reticulated water system, and two-fifths of health/sub-health centers and rural health posts have no electricity or essential medical equipment.

(iii) While food security is normally not a serious problem, poverty and social inequality are persistent, with an estimated 40% of the population living on less than US$1.25/day.

(iv) The health system has struggled for decades to provide universal access to quality services. Health indicators have declined in recent years due to the closure of many peripheral health facilities. By 2006, infant mortality had reached 57 per 1000 live births (64 in the year 2000) and maternal mortality was 733 per 100,000 live births (370 in 1996). The challenges of distance, isolation, lack of transport and an extreme shortage of skilled birth attendants, highlight the hazards of childbirth in PNG.

(v) The rate of malnutrition is unacceptably high and remains a significant underlying factor for morbidity and mortality particularly for children under 5 years. Almost half of the children aged 6–59 months are stunted and about a third of women of child-bearing age are anemic.

(vi) Gender equality is a significant challenge and systemic violations of women's rights exist throughout the country. PNG ranks in the bottom ten countries of the Gender Inequality Index. Women and girls have substantially less access to health care and education services than men and boys.

(vii) Violence against children and women and gender-based violence is unacceptably high, experienced by an estimated two-thirds of women. Women are vastly under-represented at all levels of government (less than 3% in the National Parliament), limiting their power to influence public policy at all levels.

113. The government is addressing service delivery through public sector reforms and capacity building of the civil service. The National Education Plan (2005-2014) envisages the incremental introduction of free primary education to increase enrolments in basic education from 957,000 (2005) to 1.3 million by 2014. Similarly, the National Health Plan (2010-2020) aims to tackle the very high infant and maternal mortality rate.

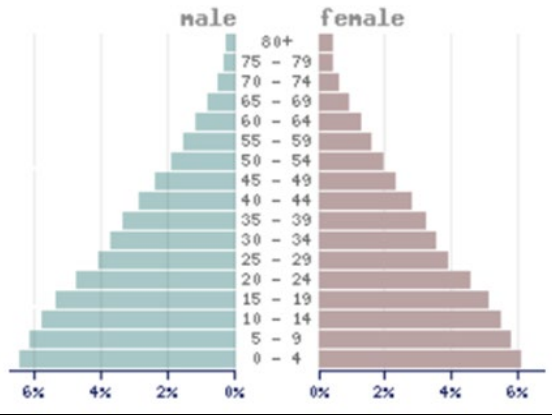
3. Population

114. PNG is one of the least densely populated countries in the world. Using the 2017 population of 8.25 million, the population density of PNG is 17.8 people per square kilometer, which ranks 167th in the world. The population of PNG is relatively young. Around 50% of the 8.6 million people inhabiting the country in 2018 were younger than 19 years of age as illustrated in the population pyramid in Figure 13. The annual growth for the PNG has increased steadily from 2.2 % in 1980 and currently stands at 3.1%. The United Nations Population Fund estimates a population growth of around 160,000 people a year: estimated new births are around 240,000 per year, and estimated deaths around 80,000 annually. This rate of population growth has significant impacts in the provision of public services and basic infrastructure, such as housing, availability of water and sanitation, and access to health and education.

Figure 13: PNGs Population Demographics and Structure 2018

Population	
Population:	8,606,000
Population per km^2:	18.59
Life expectancy males:	63.3 years
Life expectancy females:	68.3 years
Birthrate:	27.3%
Death rate:	7.1%
Males/Females:	50.9% : 49.1%

Population Pyramid



Source: WorldData.info.

115. Around 85% of the population of PNG lives in rural areas. Rural areas also host 80% of the country's poor, which partially explains the substantial migration from rural to urban areas. Of the 22 provinces in PNG, Morobe Province alone contains almost 9.3% of the country's total population, reporting a total population count of 674,810 persons in 2011 Census (WorldData.info 2018). East New Britain has a population of 328,369 people with an average 21.5 persons per square kilometer, which is higher that both Morobe and Central. Increasing population growth in cities is creating new challenges, such as higher levels of unemployment, informal settlements with poor infrastructure and housing, increasing strain on service provision and high rates of crime. Port Moresby has a population of 283,733 people, Lae 76,255, Madang 27,419 and Kokopo 26,273 according to the 2011 Census (WorldData.info 2018).

4. Language and Culture

116. PNG is one of the most diverse countries in the world with 848 different languages spoken (12% of the world's languages), of which 12 have no living speakers remaining. Most languages have fewer than 1,000 speakers. There are hundreds of ethnic groups indigenous to Papua New Guinea, although the largest is the Papuans, whose ancestors arrived in the area tens of thousands of years ago. Before the arrival of Christianity in the final quarter of the 1800s, the tribes observed the existence of protective and malevolent spirits who were believed to control aspects such as weather, garden harvest, fish catch, fertility and diseases. Certain rituals had to be done to enhance the favour of compassionate spirits and avert the wrath of evil spirits. These beings were believed to dwell in certain geographical features such as swamps, rock outcrops, caves and thick forest within tribal territories. In almost all cases entry to these sites was strictly prohibited while in some locations only certain tribal members with magical powers had access. Although most citizens are now Christians, national legislation protects such places in order to preserve the country's cultural heritage.

5. Land Use

117. The land use classification for each subproject is given in Table 4 below.

Table 4: Land Use Classification for Each Subproject

Subproject site	Type of area
Lae	Urban area
Madang	Urban
Gazelle	Rural
Port Moresby	Urban
Bautama to Gomore/Kwikila	Semi-rural then rural

6. Gazelle System Subproject Area

118. **Human population and settlement**. The subprojects will increase electricity connectivity within the Gazelle, Rabaul and Kokopo Districts of East New Britain. Aside from connections to users within the respective district centers, namely Kerevat, Rabaul, and Kokopo; residents of villages, settlements and institutions within the distribution system may be able to access the available electricity supply. Table 5 provides a summary of the human development indicators for East New Britain from the World Data Atlas for PNG in 2018. The main ethnic groups include Tolai and other PNG ethnicities and languages spoken in the area include Tok Pisin, Hiri Motu, and English.

Table 5: East New Britain Human Development Indicators

Indicator	No./Rate	Data year
Population	271,250	2011
Population Density (persons/km^2)	17.76	2011
Total Literacy rate (%)	81.6	2000
Primary School (number)	133	2007
Secondary Schools	7	2007
Life Expectancy (years)	57.1	2000
Infant Mortality (deaths/1000 births)	54	2000

Source: WorldData.info.

119. The district populations recorded in the 2011 National Population census were Gazelle 89,776 Kokopo 58,345 and Rabaul 27,064. The corresponding areas in km^2 for these districts are Gazelle 3,700, Kokopo 408 and Rabaul 95.

120. **Social infrastructure and services**. This part of the Gazelle Peninsula has a well laid-out road network. A large proportion of the main roads were initially built during the German Colonial era from 1884 to 1914. The roads were then used to haul cocoa and copra from the plantations in the region to the Rabaul wharf. Severe flooding from heavy rainfall during the recent 2018-2019 wet season damaged roads, bridges and other infrastructure. The region has relatively better coverage of education and health services compared to other parts of PNG. The townships of Rabaul and Kokopo have reticulated water supplies and sewage disposal systems. Most of the small government stations and institutions as well as villages obtain water from nearby streams, groundwater wells and roof catchment tanks. Human waste disposal in these communities is via septic toilets or pit latrines.

121. **Land use and economic activity**. The key land uses within the region are human habitation in villages, institutions and urban centers, a range of commercial activities as well as subsistence farming and cash crop agriculture mainly cocoa and coconut. Oil palm agriculture started in the region almost a decade ago. Most of the local villagers are involved in cocoa and

copra production as well as market gardening of food crops. A large proportion of the unused areas are covered with grass, secondary regrowth and mature forest. The subproject infrastructure will be located on disturbed land and along existing road easements.

122. The Warangoi catchment in the upper reaches is densely forested with old growth vegetation with the mid-reaches now having some increased land development with logging incursion and oil palm agriculture. Land use in the lower catchment is predominantly farming and older plantations of coconut and cocoa, the latter in some cases being overtaken by oil palm. While the upper reaches are well contained within gorges and terraces, the mid to lower sections have large wide flood prone channels contained within high terraces with substantial sand, gravels and large boulders. Catchment erosion, bed load and sediment transport are ongoing due to the steeper slopes, slope instability and regular rainfalls at the higher altitudes. The river tends to migrate within its flood plain following broad and braided channels.

123. **Cultural resources**. There are no graves, archaeological or culturally significant sites within the subproject areas. The infrastructure is also unlikely to disrupt current cultural practices.

7. Ramu Grid Subproject Area

124. **Human population and settlement**. Spread over 22km^2 and with a population of 119, 178 recorded in 2011, Lae is the second largest urban center PNG (NSO, 2012). The city consists of planned suburbs and ad-hoc settlements mostly occupied by migrants from the highlands and other parts of northern PNG. The main center between the Singsing substation and Gusap Substation is Gusap Town which is run by the New Britain Palm Oil Limited (NBPOL). The next main center along the Ramu Highway towards Madang is Walium, the district headquarters for Usino Bundi District of Madang Province. The next major settlement heading north-eastward along the Ramu Highway is the township of Madang, capital of Madang Province.

125. There are 173 regional languages spoken in Madang some of them being extremely different from the others. There is a large number of very small language groups, many with fewer than 1,000 people. The languages include Lukep, Gedaged, Manam, and Bilbil. Inland, non-Austronesian Papuan languages like Katiati, Hinihon, and Saki predominate. The Ramu river languages include Gamei, Giri, Tangu, Romkun, and Igana, and the Rai Coast languages include Somau Garia and Usino. The population of Morobe speak over 100 languages, representing 27 language families. Kâte is spoken in the mountainous hinterlands, where Papuan languages are spoken, and Yabem in coastal and lowland areas, particularly along the coast and in the Markham Valley, where speakers of the Austronesian family of languages predominate. Today, English, and especially Pidgin English, are the common urban languages in Lae.

126. Located between these major centers are hamlets and villages either alongside the highway or some distance off it. Table 6 provides a summary of the human development indicators for Madang and Morobe.

Table 6: Madang and Morobe Human Development Indicators

Indicator	No./Rate		Data year
	Madang	Morobe	
Population	487,460	646,876	2011
Population Density (persons/km^2)	16.88	19.19	2011
Total Literacy rate (%)	55.2	63.6	2000
Primary School (number)	178	222	2007

Indicator	No./Rate		Data year
	Madang	Morobe	
Secondary Schools	4	7	2007
Life Expectancy (years)	57.1	57.7	2000
Infant Mortality (deaths/1000 births)	78	80	2000

Source: WorldData.info.

127. **Social infrastructure and services**. The residents in the main centers and their immediate environs enjoy better quality social infrastructure and services such as education and healthcare. The status of social infrastructure and accessibility to social services declines with distance from the main centers and Ramu Highway.

128. **Land use and economic activity**. Land use within Lae includes residential, commercial, road transportation, institutional and social infrastructure and public spaces. Lae is the manufacturing hub of PNG and hosts the country's biggest and busiest seaport. Gusap is the main center for NBPOL's sugar, oil palm and beef cattle operation in the Markham and Ramu valleys. Madang is almost one-third the size of Lae and has similar land uses but on a relatively lower scale.

129. **Cultural resources**. There are no known graves, archaeological or culturally significant sites within the sub-project areas. Although the infrastructure is unlikely to directly harm cultural activities it is worth pointing out that one of the primary reasons for the setting up of Balek Wildlife Sanctuary was to protect its cultural significance. The sanctuary shares 4km of its eastern boundary with Ramu Highway.

8. Port Moresby to Kwikila

130. **Human population and settlements.** Up to seven communities are located alongside the Magi Highway between the Rouna tee-off to the new substation site at Gomore. Some residences are located close to the highway and may need to be relocated. Another three communities are located off the highway. The combined population along the highway and around Gomore Village is estimated to be around 12,000. Table 7 provides a summary of the human development indicators for the Port Moresby Kwikila subproject area from the World Data Atlas for PNG in 2018. There are a number of population centers within the subproject area including: Port Moresby (Motukea Substation); Gereka, Bautama, Gwarumemase, Sebore, Tubusereia, Barakau, Gaire, Manugoro, Deugolo, Gomore, Saroa, Kwalimurubu and Kwikila (Bautama to Kwikila transmission line); and Gomore (Gomore Substation). The main languages: spoken include Tok Pisin, English. Hiri Motu, Koiari, and Hula.

Table 7: Port Moresby Kwikila Human Development Indicators

Indicator	No./Rate	Data year
Population	318,128	2011
Population Density (persons/km^2)	1,325	2011
Total Literacy rate (%)	90.7	2000
Primary School (number)	420	2007
Secondary Schools	11	2007
Life Expectancy (years)	59.2	2000
Infant Mortality (deaths/1000 births)	22	2000

Source: WorldData.info.

131. **Social infrastructure and services**. Most of the communities have schools and health clinics to cater for their population. The residents at Gomore and nearby villages have the option of accessing schools and a health center at Kwikila Station which is the administration headquarters for the Rigo District of Central Province. Persons requiring further medical attention are transported to clinics and hospitals within Port Moresby.

132. At Gomore and the villages within the subproject area, the residents get their water for drinking, cooking and washing from nearby streams, groundwater wells and roof catchment tanks. Human waste is mainly discharged into pit latrines.

133. **Land use and economic activity**. Along the Magi Highway the main land use is human habitation, subsistence, and market gardening. The main sources of revenue for the villagers are sale of fresh food crops, marine fish, freshwater prawns, and wallaby meat. These items are sold in markets along the highway, in the villages and Port Moresby city markets. The villagers have recently been encouraged to grow corn and sell it as feed for cows at the Ilimo Dairy Farm which is located at Laloki an agricultural area just outside Port Moresby.

134. **Cultural resources**. There are no known graves, archaeological or culturally significant sites within the sub-project areas.

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

135. The following section provides an assessment of the likely impacts of the PSDP transmission lines and substations components on physical, biological, socioeconomic, and physical cultural resources, and identifies mitigation measures to ensure all such environmental impacts will be avoided or managed/reduced to acceptable levels. The criteria for assessment are in line with SPS. Where PNG has no set standard or guideline, the standards given in World Bank's EHSG are used. The EMP (Section VII) provides a matrix of mitigation and monitoring measures to prevent or minimize the impacts.

A. Impacts Associated with the Project

136. As described previously, the scope of works proposed under the project includes various transmission line and substation/switchyard components which for the purpose of this IEE have been grouped into two project types (i) 66kV transmission lines and ii) substations and switchyards. It is anticipated that procurement of transmission and substation components will be in one contract package with two lots, one lot comprising all transmission components and one lot comprising all substation/switchyard components. Detailed designs and bills of quantities (BOQ) will be provided to the bidders.

137. **Screening**: Various components of the two project types are located in three separate grid systems in PNG. At the commencement of the environmental study screening of the proposed transmission and substation/switchyard components was undertaken to confirm the level of due diligence required. Screening entailed: site visits to all project areas to inspect the alignments of all proposed 66kV/132kV transmission lines, all proposed substation and switchyard sites and a selection of proposed 22kV and low voltage line alignments; Discussions with PPL personnel and technical team during site visits regarding scope of works locations and alignments of subproject components; a review of project information provided by the PPL and technical consultants; and confirmation of Environment Category B designation for subproject components.

138. The overall findings of the screening and due diligence review are briefly summarized below:

(i) All of the proposed new 66kV and upgraded 132kV transmission lines are to be located either within or closely following existing road easements or right-of-way corridors where the natural environment is highly disturbed by human activities;
(ii) The 66kV lines will be located wherever feasible on poles rather than towers;
(iii) All proposed new substations/switchyards are located in highly disturbed natural environments and close or adjacent to existing road corridors;
(iv) All 22kV lines are located along existing road easements;
(v) None of the sites or proposed project assets are within any protected areas or culturally sensitive areas;
(vi) There will be minimal civil works required for the project consisting primarily of vegetation clearance, excavation (removal of topsoil), grading, platform preparation and building foundations (substation sites up to 1ha) and pole/tower footing excavation (manual); and
(vii) Based on site observation and discussions with PPL and the technical team the overall project is likely to give rise to relatively minor temporary environmental impacts that can be easily mitigated by good engineering practice.

139. **Audit of existing facilities**. An audit of existing operations was undertaken in respect of substations that will be upgraded under the project scope of works namely Meiro (Madang), Milford and Taraka (Lae) substations. While environmental impacts of the upgraded substations are assessed in the IEE in line with ADB's Safeguards Policy Statement, the focus of the audit is on the environment of the existing facilities in which the subproject will operate and if the facilities management is generally consistent with ADB's safeguards and objectives as defined in the SPS.

140. The audit also identifies any mitigation measures that are needed (corrective actions) to bring the facility's environmental management in to line with ADB's safeguard objectives and requirements. The DDR has concluded that the environmental impacts from the existing activities at Meiro, Milford and Taraka substations are localized and by and large not significant. However, lessons have been learned from the audit and some matters require attention in order that existing operations comply with the SPS. Potential impacts are manageable if the mitigation measures mentioned below are implemented thoroughly. The key mitigation measures/actions required to ensure existing facilities conform with the SPS are summarized below:

(i) Minimize impacts from incorrect storage and disposal of hazardous substances in line with CEPA environmental code of practice for Vehicle/Machinery Workshops and Petroleum Storage/Resale/Usage is followed.
(ii) Stockpile used waste oil and other toxic and hazardous materials off-site at the PPL Yonki maintenance area stockpile, to await bulk disposal by PPL.
(iii) PPL to urgently arrange for bulk disposal of waste oil from its Hohola storage facility. Offshore options to an international treatment facility to be explored.
(iv) Prevent flooding and protect work crews from hazards associated with heavy rainfall by maintaining existing drains so that the outfalls of the surface run-off are diverted appropriately away from the sensitive receivers.
(v) It is recommended that upgrading of the existing transformer bays to internationally recognized standards with respect to oil containment facilities including oil separator at drainage outlet be included as part of the refurbishment works.
(vi) Government to enforce a rule in line with ADB guidelines on environmentally responsible procurement that new equipment is supplied free of PCB and

certified to be PCB free. No new equipment shall be supplied with PCB contamination.

(vii) Government to enforce a rule that no new equipment supplied under the subprojects can be serviced with reconditioned dielectric oil.

(viii) PPL to ensure that the new equipment is only serviced with new PCB free transformer oil.

141. With these measures in place, the environmental impacts of existing operations at Meiro, Milford and Taraka substations can meet the objectives of SPS and will not result in any residual impacts which are above accepted environmental standards. Through due diligence, review, and supervision ADB ensures that borrowers comply with the SPS requirements during project preparation and implementation. The process outlined in the SPS notes that, over time, safeguards may require the updating of existing operations to enhance environmental effectiveness, respond to changing needs, and reflect evolving best practices.

B. Pre-Construction Phase

142. **Overview**. The proposed subproject involves design, construction and operation of a new substation and transmission line and earthworks to provide foundations for these components. The preliminary designs for the Project have been completed but there are certain detailed design tasks that will be completed by the CSC and the contractors and some potential impact will need to be mitigated in the preconstruction and construction phases. There are a number of mitigation measures that will need to be carried out by the CSC in to avoid construction impacts and by good environmental management to minimize impacts.

143. The CSC will be engaged by the PMU. Detailed design of subproject components will be required and the IEE and EMP will updated at that time.

144. In line with ADB policy on environmentally responsible procurement opportunities to provide environmental enhancements will also be identified in the detailed design as well as routine matters such as professional trimming of trees and avoiding unnecessary removal of trees.

145. **Detailed design measures**. The CSC as part of the PMU will supervise the contractor's preparation of the detailed designs and detailed management plans to address the requirements below including, but not necessarily limited to the following design requirements, and all items identified in the EMP/s:

(i) Consultations undertaken as per the Project's consultation and communications plan (CCP).

(ii) Land acquisition, resettlement and environmental impacts will be avoided or minimized by basing the detailed designs within the substation transmission and feeder line areas as proposed in the preliminary designs.

(iii) Arrangements will be made to facilitate the timely supply of cement and rock-based materials for construction and to avoid impacts by stockpiling within or near the subproject area.

(iv) Improvements and construction and new drainage culverts in and around the subproject area and the adjacent road will be designed to account for increased rain due to a once in 100-year return storm event.

(v) Drainage impacts during construction will be minimized by including in the detailed design the early phasing of collection and diversion of incoming surface runoff from surrounding drains and ditches, culverts, and other infrastructure around the subproject area.

(vi) Disruption to current power supply will be avoided and movement of power lines will be planned well in advance. Temporary power distribution circuitry will be re-provisioned before construction as far as practicable works commence; provisions will be made to preserve the operation of current facilities for power supply in sufficient quantity in agreement with the local power supply company.

(vii) Temporary facilities will utilize the existing PPL area for a contractor's yard. If additional areas are required, acquisition of land will be minimized by selecting locations for additional lay down areas or construction yards on marginal land and agree terms with local community.

146. The final detailed designs will be disclosed and CEPA under the requirements of the Environment Act 2000 and EPAR as well as to the wider public under ADB's Access to Information Policy (2018). A check will be made at the detailed design stage that the subproject has been designed as planned to avoid and mitigate impacts in line with the disclosure to CEPA and in line with any application for environmental permit required by CEPA.

147. The IEE and EMP shall be updated by the PMU and DSC and resubmitted to ADB for approval incorporating the results and recommendations of this IEE and any recommendations and requirements from the CEPA. Further, if during detailed design there are any unexpected changes to subproject design (such as change in layout or footprint) that would result to environmental impacts or risks that are not within the scope of this IEE and EMP, the PMU assisted by CSC during the detailed design phase shall further update the EMP or prepare a new environmental assessment report for submission to ADB. Prior to preparation of the updated or new environmental assessment report, the proposed Project change(s) shall be screened by PMU and confirmed by ADB for potential environmental impacts and risks to determine the appropriate extent and type of environmental assessment to be undertaken. PMU will also establish the grievance redress mechanism (GRM) before site works commence.

148. **Environmental capacity development of PPL**. PPL will make sure that a PMU is set up, trained and prepared by CSC to ensure that contractors are trained as required to provide compliance with EMP and other management plans. PPL has indicated that there are few staff in PPL who have any post-graduate qualifications in environmental management and that the one existing Environment Officer (EO) is currently not designated to project work but is fully committed on environmental management for existing installations.

149. The Country Safeguard System review was recently completed, and this provides a detailed assessment of PPL capacity and record of implementation of environmental safeguards on previous projects. As PPL does not have existing resources to undertake the required environmental management for the Project, sufficient resources will be provided through the PMU. The DSC will engage an international environment specialist (IES) and PPL will provide a national environment specialist (NES) to support the PMU. As set out in the terms of reference safeguards staff will have qualifications and experience in environmental management.

150. In conjunction with ongoing dialogue with PPL, the IES will also develop a strengthening plan for environmental management and provide training to the EO and senior management to increase awareness of environmental management and safeguards issues.

Details of the proposed environmental capacity building are provided in the EMPs in Tables 8 and 9.

151. **Updating of the EMP and bid documents.** Based on detailed design, the IEE and EMP will be updated and form inputs to the tender documentation and bid evaluation. Terms of reference will be prepared for the environmental specialists to be included in the supervision consultant and contractor teams and will be included in the project administration manual. The updated IEE and EMP, along with additional DFAT requirements and any national conditions of environmental permit as required, will be incorporated into technical specifications and bid documents. Following contract award, the contractor(s), with support as required from the PMU and CSC, will prepare their construction EMP (CEMP) responding to the updated EMP contained in the bid and contract documents and providing the construction program, site-specific drawings, work method statements, and construction methodologies (including specifics around material sourcing as necessary, earthworks, spoil disposal and health and safety).

152. **Equipment procurement**. The equipment to be procured and installed by the project will comply with international standards for noise as well as escape of polluting materials. Where possible the project will use compact and preassembled systems to minimize the impacts. Any materials (including food and beverage for foreign workers) or equipment imported will be screened and cleaned to comply with biosecurity and quarantine requirements and to avoid introduction of invasive or alien species. This may require issue of phytosanitary certificates from National Agriculture and Quarantine Inspection Authority (NAQIA).

153. **Prohibited activities**. The contractor is to be aware of the activities shown in Appendix 5 of the of SPS, Prohibited Investment Activities List that became effective in January 2010. Any activity listed in Appendix 5 are prohibited and ADB funds must not be used to finance any activity included in the list. The contractor will be made aware of the Appendix 5 requirements through inclusion in the contract and that none of these activities will be sanctioned during construction.

154. **Preparation of construction EMP**. The PMU will include the updated EMP and relevant provisions from the IEE (and EP conditions as required) in the bidding documentation and provide training on environmental management to contractors as to ensure the contractors are ready to implement the necessary environmental management measures. This is required to ensure compliance with the national law and environmental management measures in the SPS. Prior to signing of contracts, the CSC will produce a series of method statements to be approved by PMU for inclusion in the contract.

155. The contractor(s) will subsequently update the method statements (assisted by the CSC) for approval by PMU. The broad content of the draft work method statements is included in the construction mitigation section of this IEE. The subsequent CEMPs will demonstrate the manner (location, responsibilities, schedule, timeframe, budget, etc.) in which the contractor will implement the mitigation measures specified in the EMP and other management plans.

156. The project will comply with the World Bank Group's EHSG.[7] Amongst other things, the EHSG require that workers be provided with a safe and healthy working environment, considering inherent risks, any hazards in the work areas, including physical, chemical, biological, and radiological hazards. In addition, the implementing agency will be required to take steps to prevent accidents, injury, and diseases arising from, associated with, or occurring during the work. The contractor's CEMP will include a health and safety plan. The CEMP will be reviewed and cleared by the PMU (after receiving comments from ADB).

[7] World Bank Group. 2007. *Environmental, Health, and Safety General Guidelines.* Washington, DC.

157. Once works commence, the contractor's environmental and safety officer (ESO) will conduct monitoring of compliance of activities with the approved CEMP and the DSC and PMU will undertake inspections and audits of the effectiveness of the contractor's implementation of the approved CEMP. The CSC will devise the checklist to be used for the inspections and audits and will consolidate the inspection/audit findings along with summaries of the contractor's monthly reporting. ADB will undertake review missions which will report on, inter alia, overall implementation of environmental safeguard requirements.

158. As early as practicable after commencement, the project will establish the GRM to address concerns and resolve complaints and issues raised on any aspect of Project and subproject implementation. Safeguards concerns will be addressed through the GRM. The CEMP will outline how the contractor will implement the relevant elements of the GRM and how and when they will provide information about construction activities and timing to the community. The contractor will be expected to provide information about the works, impacts and mitigation/control measures to the community in a timely and effective manner. The contractor's liaison and communication with the community, managed by the community liaison officer (CLO), will be guided by the Project's CCP.

159. Based on the EMP, the following method statements shall be drafted by the CSC in the preconstruction/detailed design stage for updating by the contractor (assisted by CSC) before construction commences:

(i) Waste management plan (WMP) - for handling, storage, treatment, transport and disposal of solid and liquid wastes, hazardous materials, hazardous wastes, and excavation of spoil from the power / substation earthworks;
(ii) Materials and spoil management plan (MSMP) - detailing arrangements to be made to facilitate the timely supply of construction materials to avoid impacts due to unnecessary stockpiling inside and near the subproject site area;
(iii) Noise and dust control plan (NDCP) - to minimize impacts to sensitive receptors (educational establishments, hospitals, residential areas, etc.) due to construction works, sourcing and transport of construction materials, and other project-related activities;
(iv) Drainage management plan (DMP) - to ensure that works will not cause blockages to existing drainage or ponding/flooding within the subproject areas, or the residential and commercial areas adjacent to the subproject areas;
(v) Health and safety plan (HSP) - to identify interfaces between the works and public and ensure worker and public safety, prevent accidents due to the construction works and report all accidents due to the Project activities; and
(vi) Excavation protection and runoff control plan (ERCP) - to ensure that construction works are protected and will not cause excessive runoff and siltation of the adjacent road, ensure stabilization of exposed soils, minimize flooding and uncontrolled runoff to adjacent areas and to protect the works under construction.
(vii) If required, a local biodiversity action plan to link and connect existing habitats and landscape features which could potentially be of major importance for wildlife - enhancing their intrinsic quality and also their ability to support migration, dispersal and genetic exchange. It will also include rehabilitation of degraded habitats or the creation of new habitats within and adjacent to project sites.

160. **Key Biodiversity Area Impacts.** The risk screening exercise noted that for all subproject areas there needs to be a more detailed assessment after detailed design with regards to (i) proximity to identified nationally declared protected areas and (ii) key biodiversity areas. On the former, the key priority is the Balek wildlife sanctuary which borders a section of the Ramu-

Madang existing transmission alignment within its 1km buffer zone. On key biodiversity areas (KBAs) that need to be further assessed for critical habitat within the 1km buffer zone for power transmission is the Kerevat KBA in Gazelle, the Adjum and Usino KBAs identified in Ramu-Madang and the Hiri and Variarata KBAs along the existing Port Moresby power transmission alignment. It is noted that although these protected areas are not likely to be affected by the power grid project, a more detailed assessment and survey needs to be carried out at pre-construction stage to confirm that no significant impact will result because of the project. If impacts are confirmed, the IEE and EMP will be updated with a local biodiversity action plan as necessary.

161. **Avifauna Impacts.** Avian mortality due to collisions with power lines and electrocution can also be quite a high risk especially in a highly biodiverse country such as PNG which is home to 746 species of birds, 114 of which are endemic. There are 5 Important Bird Areas (IBAs) in PNG and fortunately none of them will be directly affected by the project. In this context, it is noted that a majority of the works will involve replacing existing power lines in areas that are already disturbed. An opportunity here is provided to improve the existing power line configuration to make it safer for birds. It is recommended that once the detailed designs are complete with the preferred routes chosen, a field survey will be required to provide up to date information on bird distribution and activity, to assess the risk to birds and to inform any required mitigation. This survey work will be required in some cases on priority sections of the proposed line, such as along the Ramu-Madang subproject adjacent to the Balek wildlife sanctuary, for example:

(i) To enable further detailed assessment of impacts of birds on, or connected to protected areas,
(ii) In areas where bird sensitivity is expected or has been shown to be high, and
(iii) Where land use changes may have implications for the use birds make of the landscape.

162. **COVID 19 Response**. The project has the potential to transmit COVID 19 to project workers and residents in the project areas. The contractor in this context shall be required to prepare a COVID 19 Response Plan. The COVID 19 Response Plan will be approved by the PMU, CSC and ADB prior to the mobilisation of any workers to PNG or within PNG. Guidelines for the management of COVID 19 in the workplace and on construction sites have been released by the World Health Organisation[8] and Canadian Construction Association[9]. The COVID 19 Response Plan shall at a minimum:

(i) Describe how the contractor will comply with all COVID 19 related requirements of the Government of the PNG in force at the time of the preparation of the plan.
(ii) Identify measures to prevent exposure of workers and the public to COVID 19 (e.g., communication and training of workers in COVID prevention, hygiene measures, site cleaning, worksite access, maintenance of distancing at the work site etc).
(iii) Identify measures to detect COVID 19 infection amongst workers (e.g., screening prior to mobilisation to PNG for international workers, worksite screening etc).
(iv) Identify response measures should a possible case of COVID 19 be detected (e.g., self-isolation away from the worksite, compliance with PNG directions etc).
(v) Describe how the plan will be monitored and updated to respond to changes in PNG Government policy.

[8] https://www.who.int/publications-detail/considerations-for-public-health-and-social-measures-in-the-workplace-in-the-context-of-covid-19;
[9] https://www.cca-acc.com/wp-content/uploads/2020/04/CCA-COVID-19-Standardized-Protocols-for-All-Canadian-Construction-Sites-04-16-20.pdf

163. **Environmentally responsible procurement**. PPL will establish a PMU that will be supported by a DSC and include an IES and NES. The IES will provide training to NES, existing environment officer and other PPL staff as required to implement CEMP and other plans and start to build capacity within PPL. All the above plans will be agreed in advance by PMU and will be included in contract documentation.

164. The requirements in the contract will include full implementation of the EMP including all the above plans to ensure contractors are fully aware in advance of their environmental responsibilities and obligations. The PMU shall also ensure that any activities carried out in-house will be subject to environmental management practices and therefore the IES will help establish some the environmental management guidelines (EMGs) for work packages. Such EMGs can later be incorporated into environmental management systems established within PPL for tracking the steps and actions required for both contractor and in-house implemented civil works.

165. The PMU shall require the contractor to engage capable and trained site agents to take responsibility for the environmental management at the working level and to audit the effectiveness of the contractor's CEMP and review mitigation measures as the project proceeds. Effective implementation of the CEMP will be audited as part of the loan conditions and the executing agency will be prepared for this.

166. **Materials sourcing**. Should any materials be sourced locally (i.e., sand, or aggregate), the contractor must seek approval (including obtaining the requisite permits) and agreement from, including payment of royalties to, the land/resource owner. Any sand or aggregate extraction required for the project will only be undertaken in accordance with the permit conditions and an extraction plan reviewed and cleared by the PMU and CSC. Vehicles transporting loose materials, from an extraction area to the subproject site, will be covered and secured with tarpaulin to prevent dust or spillage.

167. **Electro-magnetic Fields.** Electric and magnetic fields are important factors to be considered in design and construction of transmission lines. All countries set their own national standards for exposure to EMFs. However, the majority of these national standards draw on the guidelines set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP).[10] The design of the project will adhere to these standards to reduce the risk of exposure to the public. Currently most of the planned power transmission activities are on existing alignments far from interaction with the public. In addition, the proposed lower voltage distribution grid in urban areas will follow ROWs and also poses no significant risks to the public. The proposed substations and switchyards however are notable where the voltages used with transmission lines are stepped down to lower voltages used with distribution lines. Electric and magnetic fields produced by substation equipment are generally not appreciable beyond the substation boundaries, but the fields can be somewhat stronger near them than in other parts of the neighborhood, because the power lines converge at the substation and might be closer to the ground as they go in and out of the substation. In this context, it is critical that provisions are made in detailed design to reduce the EMF risk to workers and the public where possible with transmission line and substation contractors to adhere to international best practice standards.[11]

[10] https://www.icnirp.org/en/activities/news/news-article/rf-guidelines-2020-published.html
[11] https://www.who.int/peh-emf/standards/EMF_standards_framework%5B1%5D.pdf

C. Construction Phase Impacts and Mitigation Measures

168. The source of the construction impacts will include (i) small scale excavation and associated earthworks, slope stabilization and drainage to construct the substation and foundation pads for the poles and towers, (ii) delivery and installation of the capacitor banks, (iii) ensuring drainage and access near adjacent access road other adjacent areas is unimpaired by construction, (iv) managing of supply for construction materials and (v) waste disposal. For purposes of this assessment, it is assumed that the DSC will cover Implementation and the system design. Detailed design of the small engineering works such as foundations will be completed by the contractor in the pre-construction phase.

1. Impacts on the Physical Environment

a. Erosion and loss of topsoil

169. **66kV transmission lines**. These subprojects will not include activities that will cause significant erosion or loss of topsoil. The lines will be largely constructed on poles within road reserve. The diameter of the poles for the transmission lines is approximately 500 mm and 300 mm for distribution lines respectively and will require either a hand dug or auger driven holes of approximately 0.5 m^2 including the concrete pad/footing every 125 m or every 250 m depending on which length of span is selected during detailed design. Spoil from the holes can be re-used for residential and/or community purposes as required. There will be no need for construction of any new access roads during construction due to construction within road easements or along existing transmission line corridors.

170. The existing 66kV line (to be upgraded to 132kV) roughly follows the Ramu Highway road corridor but in many places cuts across country because of steep terrain.

171. Constructing tower foundations in steep terrain along with associated vegetation clearance to widen the existing right-of-way by approximately 20m to accommodate the new line, could give rise to minor localized erosion if not carefully managed. Good engineering practice for minimizing erosion will be applied including soil stabilization measures through seeding, netting, vegetation binders, drainage ditches and diversion structures where necessary. These requirements will be incorporated into contract documents.

172. **Substations and switchyards**. New substation sites at Vimi, (East New Britain), Malahang (Lae) Gomore and Motukea (Port Moresby) and new switchyards at Baliora and Vunakanau will each require site clearance, grubbing, minor excavation and grading including removal of topsoil over a small footprint (generally less than 0.5 ha). Stockpiling of excavated material and disposal of excess soil will be required. These activities could give rise to minor localized erosion and loss of topsoil.

173. These impacts can be avoided or minimized through recognized good engineering design and construction practices incorporating the following mitigation measures which will be incorporated into contract documents:

(i) minimizing removal of existing vegetation and topsoil;
(ii) storage and seeding of topsoil for later reuse/site restoration;
(iii) re-surface any areas where excavation works are completed;
(iv) where storm water drainage is likely to discharge sediment into neighboring water courses sediment traps are to be used; and

(v) infertile and rocky material will be dumped at designated dumping areas or where applicable, used as fill material.

b. Sedimentation of natural drainage pathways

174. **66kV transmission lines**. There is little potential for even localized and short-term water contamination from runoff of suspended sediment as the pole and tower foundations will create nil or negligible exposed surfaces or slopes. As noted above excavation for the poles and towers will be small. Scheduling the excavations in the drier months (May - Oct) will further reduce risk of sediment laden run-off.

175. **Substations and switchyards**. Platform preparation activities for the new substations and switchyards as noted above will give rise to exposed surfaces of relatively small extent (0.25 – 1 Ha). Thus, there is some potential for sediment laden runoff from exposed surfaces during construction that could impact nearby natural drainage systems. These impacts can be avoided or minimized through recognized good engineering design and construction practices incorporating the mitigation measures listed below which will be incorporated into contract documents:

(i) minimizing the vegetation clearance of the footprint for all components;
(ii) re-vegetating and/or stabilizing exposed surfaces and excavated materials;
(iii) implementing effective construction site drainage such that runoff is directed to sediment traps before discharge to the natural drainage pathways;
(iv) use of cut-off drains above excavated areas on slopes to reduce erosion;
(v) close construction supervision to ensure the above measures are implemented; and
(vi) scheduling the construction in the drier months (May - Oct).

176. Effective implementation of the above mitigation measures will ensure that the potential short-term impacts of sediment laden runoff due to construction of the substations and switchyards will be insignificant.

c. Materials and Spoil Management

177. Small to moderate amounts of sand and cement and other equipment and materials will be required for construction of pole and tower footings, transformer and switchyard foundations/platforms and for foundations and structures for substation/switchyard buildings. It is envisaged that dedicated borrow pits/quarries will not be required for the subprojects and that aggregates could be obtained from existing sources. Excavation activities will be limited with a corresponding limited volume of excess spoil needing to be disposed of.

178. The contractor for each contract Lot will be required to prepare and implement a materials and spoil management plan (MSMP) to cover all components of the respective lot to minimize the use of non-renewable resources and provide for safe disposal of any excess spoil. As a first priority, where surplus materials arise from the removal of the existing surfaces these will be used elsewhere on the project for fill (if suitable and feasible) before additional rock, gravel or sand extraction is considered. The MSMP will include as a minimum consideration of the following:

(i) required materials, potential sources, and estimated quantities available;
(ii) impacts related to identified sources and availability;
(iii) excavated material for reuse and recycling methods to be employed;
(iv) excess spoil to be disposed of and methods proposed for disposal;

(v) endorsement from local authority and local landowners for use of sources and disposal of excess spoil; and
(vi) methods of transportation to minimize interference with normal traffic.

179. The contractor will be responsible for (i) identifying suitable sources and obtaining all agreements associated with the sources and preparing a MSMP; (ii) balancing cut and fill requirements to minimize need for aggregates from other sources; (iii) managing topsoil, overburden, and low-quality materials so they are properly removed, stockpiled near the site, and preserved for reuse; and, (iv) arranging for the safe disposal of any excess spoil including provision for stabilization, erosion control, drainage and re-vegetation provisions at the disposal site.

180. Effective implementation of the MSMP by the contractor as outlined above will ensure that potential environmental impacts associated with the management and disposal of construction materials will be negligible.

d. Waste Management

181. Uncontrolled waste disposal during construction (including contractor's camp and work sites/yard) and operation activities can cause significant impacts including water and land pollution and public safety. Mitigation measures for the waste arising from the project will seek to reduce, recycle and reuse waste as far as practicable and dispose of residual waste in an environmentally sustainable way.

182. As part of the CEMP waste management measures will be included in a waste management plan (WMP) to cover all matters related to solid and liquid waste disposal arising from construction related activities (including storage, disposal, and accidental spills). The WMP will cover the following issues:

(i) expected types of waste and volumes of waste arising;
(ii) waste reduction, reuse and recycling methods to be employed;
(iii) agreed reuse and recycling options and locations for disposal/endorsement from local authorities;
(iv) methods for treatment and disposal of all solid and liquid wastes;
(v) establishment of regular disposal schedule and constraints for hazardous waste;
(vi) program for disposal of general waste and chain of custody for hazardous waste;
(vii) designation of waste disposal areas agreed with local authorities;
(viii) segregation of wastes to be observed. Organic (biodegradable - such as tree trimmings) shall be collected, stockpiled and given to the local community (no burning is allowed on site);
(ix) recyclables to be recovered and sold to recyclers;
(x) residual waste to be disposed of in disposal sites approved by local authorities and not located within 500m of rivers or streams;
(xi) camp, construction offices/facilities and work's yard to be provided with garbage bins;
(xii) burning of construction and domestic wastes to be prohibited;
(xiii) disposal of solid wastes into drainage ditches, rivers, other watercourses, agricultural fields, and public areas shall be prohibited; and
(xiv) all solid waste will be collected and removed from work camps and disposed in designated local waste disposal sites.

183. The contractor's WMP, as part of the CEMP, will need to be approved in writing by PPL prior to start of construction.

e. Hazardous materials and hazardous waste disposal

184. Use of hazardous substances during construction, such as oils, lubricants and corrosion protection paint can cause significant impacts if uncontrolled or if waste is not disposed correctly. Mitigation measures will aim to control access to and the use of hazardous substances such as oils, lubricants and corrosion protection paints and control waste disposal.

185. The contractor's mitigation measures in the hazardous materials section of the WMP will include but not necessarily be limited to the following measures:

(i) ensure that safe storage of fuel, other hazardous substances and bulk materials are agreed by PPL and follow internationally recognized good practice;
(ii) hydrocarbon and toxic material will be stored in adequately protected sites consistent with the Environmental Code of Practice for Vehicle/Machinery Workshops and Petroleum, Storage Resale and Usage Sites (DEC 1997) to prevent soil and water contamination;
(iii) segregate hazardous wastes (oily wastes, used batteries, fuel drums) and ensure that storage, transport and disposal shall not cause pollution and shall be undertaken consistent with the Environmental Code of Practice;
(iv) ensure all storage containers are in good condition with proper labelling;
(v) regularly check containers for leakage and undertake necessary repair or replacement;
(vi) store hazardous materials above possible flood level;
(vii) discharge of oil contaminated water shall be prohibited;
(viii) used oil and other toxic and hazardous materials shall be disposed of off-site at a facility authorized by PPL;
(ix) adequate precautions will be taken to prevent oil/lubricant/ hydrocarbon contamination of drainage channel beds;
(x) spill clean-up materials will be made available before works commence (e.g., absorbent pads, etc.) specifically designed for petroleum products and other hazardous substances where such materials are being stored; and
(xi) spillage, if any, will be immediately cleared with utmost caution to leave no traces.

186. All areas intended for storage of hazardous materials will be quarantined and provided with adequate facilities to combat emergency situations complying with all the applicable statutory stipulations.

187. Provided the WMP is prepared, approved, and implemented in accordance with the above recommendations the environmental impacts associated with waste management are expected to be negligible.

f. Asbestos

188. For the substations and switchyards project components, there is potential for discovery of asbestos which, if disturbed, may pose a safety risk to workers and residents in the vicinity of the works site. A site assessment for asbestos will have to be undertaken prior to the commencement of onsite works. If found, the contractor will prepare and Asbestos Management Plan for safe removal and disposal.

g. Water quality impacts

189. During construction wastewater will arise from domestic sewage from site workers, contamination due to spillage of oil and other lubricants, contamination due to disposal of construction wastes and wastewater from washing of construction equipment and vehicles. Such wastewater if not properly controlled has the potential to pollute nearby water bodies.

190. The contractor will be required to implement measures to prevent wastewater produced during construction from entering directly into any adjacent drainage channels Such measures shall include:

(i) provision of adequate on-site sanitation facilities including portable toilets or alternative sanitary facilities that do not allow untreated disposal of sewage to adjacent water bodies;
(ii) provision of an appropriate domestic solid waste and construction waste collection and disposal system;
(iii) provision of hard standing areas for equipment servicing, refueling and wash down where drainage is directed through oil and grease interceptors before being discharged into a settling pond prior to discharge into offsite drainage channels;
(iv) implementation of good operation and maintenance practices for construction equipment; and
(v) preparation of an oil spill response plan.

191. Proper implementation of the above measures will ensure that the potential water quality impacts during construction will be insignificant.

2. Impacts on the Biological Environment

a. Transmission lines

192. Depending on the design and routing, power transmission lines can create electrocution and collision risks to certain bird species. Ensuring that various mitigation measures exist that will help to reduce the impacts of transmission lines on birds will be essential. Guidelines are provided by Birdlife International[12] and as per international good practice.[13] Proposed mitigation measures as such must be commensurate to potential impacts and will be informed by any additional survey work carried out at the pre-construction stage. These include but are not limited to:

(i) route planning to avoid areas of high bird use;
(ii) using bird-friendly power line designs to protect birds by deterring perching and nesting, and by using insulted components and/or large air gaps with configurations with fewer layers of cables vertically, and without an earth wire;
(iii) installing line markers on earth wires and/or conductors as appropriate to reduce collision; and
(iv) carrying out construction and maintenance activities outside of breeding season.

193. It is noted that the use of predominantly manual labour and poles in preference to towers will also reduce the impacts on bird mortality and in addition will reduce the risk of excessive vegetation clearance as these can influence species through changes in habitats. All proposed 66kV lines (ENB and POM Kwikila and Lae) will be constructed on poles within or close to existing road reserve in which the natural environment has been highly modified by human activities.

[12] http://datazone.birdlife.org/sowb/casestudy/reducing-the-impacts-of-power-lines-on-birds
[13] https://www.unep-aewa.org/sites/default/files/publication/ts50_electr_guidelines_03122014.pdf

194. **Gazelle.** The proposed 66kV alignments (12 km S/C with 22kV u/b Vunakanau to Baliora SWYDs and 5.7km D/C with 22kV u/b ABC Vimi SS to #4 Malekuna junction) are both located within existing road reserve. Surrounding land is largely plantation and gardens, with roadside area comprising scattered residences community facilities (schools etc.) and small roadside businesses and occasional large rain trees. Encroachment into the road reserve of various structures and gardens is common. The careful placement of poles can minimise the impact on trees. The contractor will be required to select a line route and location for poles within the road corridor that minimizes the need for tree cutting and removal as much as possible. Where cutting or trimming of trees is necessary, trimming will be minimized in accordance with internationally recognized minimum clearance requirements.

195. Implementing the above measures will ensure that the resultant impact on biodiversity associated with trimming and or cutting of trees for the transmission line will be negligible.

196. The contractor will be required to select a line route and location for poles within the road corridor that minimizes the need for tree cutting and removal as much as possible. Where cutting or trimming of trees is necessary, trimming will be minimized in accordance with internationally recognized minimum clearance requirements.

197. Implementing the above measures will ensure that the resultant impact on biodiversity associated with trimming and or cutting of trees for the transmission line will be negligible.

198. **Lae**. The transmission line within this sub-project will be located within an urban environment so the biological impact will be insignificant. Where required, cutting or trimming of trees will be minimized in accordance with internationally recognized minimum clearance requirements.

199. **Central POM/Kwikila.** The proposed 66kV 56km SC Rouna 535 switching station tee to Gomore on poles is located primarily in road reserve within an overall dry and highly disturbed terrestrial environment comprising mainly grasses with scattered trees as described in Section III above.

200. From the Rouna tee off to Bautama the alignment follows a gravel road along which there are scattered houses, an abandoned farm, operational quarry, small roadside businesses, and a number of side roads leading in different directions. An existing 22kV line runs alongside most of the road.

201. From Bautama the alignment follows the Magi highway to Gomore substation. Near Bautama the Magi Highway skirts a mangrove swamp forest and the transmission line alignment will need to be located in the easement on the landward side of the road to avoid the mangroves. From there to Gomore substation the road reserve and adjacent environment comprises grasses with scattered trees with large rain trees located close to the roadside communities.

202. The natural vegetation has been regularly subject to fires over many years such that a large proportion of the natural vegetation beside the highway is secondary and of low habitat value. The potential impact of the transmission line alignment on biological resources will consequently be insignificant. The contractor will be required to select a line route and location for poles within the road corridor that minimizes the need for tree cutting and removal as much as possible. Where cutting or trimming of trees is necessary, trimming will be minimized in accordance with internationally recognized minimum clearance requirements.

203. Implementing the above measures will ensure that the resultant impact on biodiversity associated with trimming and or cutting of trees for the transmission line will be negligible.

204. Workers will be prohibited from poaching or hunting birds or wildlife from within the project corridor and wider catchment.

b. Substations and switchyards

205. **Gazelle system.** The proposed sites for Vimi substation, Baliora and Vunakanau switchyards in ENB are all on highly disturbed sites comprising grasses and trees and adjacent to roadways. There are no significant ecologically sensitive areas or historical/cultural monuments nearby the substation such that there will be no significant ecological impacts associated with this site.

206. Any compensation relating to resettlement of the informal residence and their assets will be provided for in accordance with the resettlement plan.

207. Substation upgrading works at Meiro, Milford and Taraka substations involve very minor if any, civil works within existing substation sites. There will be no significant ecological impacts associated with substation upgrading works.

208. **Central Port Moresby – Kwikila**. Motukea substation is located within the city of Port Moresby and this development will have no impact on ecological resources.

209. **Gomore substation.** The proposed site for the substation is at one corner of a T-junction (Magi Highway, Gabagaba feeder road and Hula road) and consists of grasses, rain trees and secondary regrowth. It has been subject to successive subsistence gardening after fallow 5 to 8-year fallow periods. The variety of fauna is comparatively low. Compensation may be required for the removal of food gardens and fruit trees. The net impact on the local biological environment will be unnoticeable.

3. Impacts on the Socioeconomic Environment

a. Dust, Gaseous Emissions and Noise

210. Potential nuisance to nearby properties during construction of both transmission lines and substations/switchyards includes:

(i) Noise and vibration from heavy vehicles transporting materials to site and construction activities.
(ii) Dust arising during substation/switchyard platform preparation and transport of materials to site.
(iii) Air pollution due to exhaust gases from construction plant (crane) and heavy transport vehicles.
(iv) Gaseous emissions from welding.

211. The construction activities for substations, switchyards and transmission lines will involve periodic use of powered mechanical equipment such as excavator, augur and mobile crane and generator. The main noise and dust generating activities will be associated with periodic transport of materials and equipment to the sites. The potential impact of noise, dust nuisance and air pollution on nearby communities from these activities will be relatively minor, and sporadic in

nature. However, good construction practice to minimize these impacts shall be specified in contract documents.

212. Mitigation measures for noise shall include:
- (i) scheduling noisy activities during daytime working hours and providing advance notice to sensitive receptors for particularly noisy activities;
- (ii) maintenance of machinery and vehicles to be enhanced to keep noise at a minimum;
- (iii) location of equipment to minimize nuisances; and
- (iv) installation of acoustic insulation or use of portable noise barriers where practicable to limit noise at sensitive receivers.

213. Mitigation measures for dust/air pollution shall include:
- (i) water to be sprayed on unpaved roads and construction areas to suppress dust in the vicinity of communities through which transportation of construction materials passes;
- (ii) vehicles equipment or cement and sand and other construction materials will be covered with tarpaulin sheets to avoid impact from dust;
- (iii) fuel-efficient and well-maintained haulage trucks will be employed to minimize exhaust emissions. Smoke belching vehicles and equipment shall not be allowed and shall be removed from the project; and
- (iv) if works have given rise to complaints over dust, the contractor shall investigate the cause and report it to the PMU.

b. Social impacts related to construction workers

214. For the transmission lines construction, the workforce is expected to be in the order of 12 (line stringing crew, auger operators, people directing/managing traffic, and supervisor). It is expected that separate work crews will be deployed in each of the regions such that construction of all of the transmission lines will be undertaken roughly simultaneously over a period of 1 year.

215. For substation and switchyards, similar sized work crews as for transmission lines are likely to be deployed in each of the three project areas with work undertaken roughly simultaneously. There will be no need for a dedicated or large-scale accommodation at any of the sites. There could be the need for a works offices and storage/maintenance areas to be established, these would be undertaken through consultation with local landowners and the local District Administration/PPL.

216. The contractors for each lot (transmission and substations/switchyards) will be required to adopt good management practices to ensure that both physical impacts and social impacts associated with the office/yard are minimized. Any fuel and construction debris associated with the site office and storage/maintenance area will be stored safely and disposed of according to the approved WMP.

217. Social impacts include: (i) potential for conflict between workers from outside and local residents, and communities; and (ii) minor risk of spread of communicable diseases including STIs and HIV.

218. The proposed measures to mitigate the risks include:
- (i) location of site office and facilities to be agreed with local community including landowners) with facilities approved by the DSC/PMU and managed to minimize

impacts and any negotiation or lease arrangements to follow established procedure as per the resettlement plan;

(ii) induction of workers on requirements of the project's CCP[14] and GRM[15] and protocols established for any contact between local communities and contractor/workers;

(iii) the contractor will be required to engage an approved service provider to deliver a communicable diseases awareness and prevention program targeting risk of spread of STIs and HIV;

(iv) the contractor will agree a code of conduct with community leaders. The code of conduct will cover worker behaviour, prohibit consumption of drugs and alcohol and the like. The code of conduct will be included in workers' contracts;

(v) the contractor will put up notice boards regarding the scope and schedule of construction activities, as well as any disruptions or access restrictions;

(vi) the site office/yard will be fenced and sign-posted and unauthorized access or entry by general public will be prohibited;

(vii) standing and open water (including puddles, ponds, drains etc.) within the office/yard shall not be permitted to reduce possible disease vectors;

(viii) to reduce risk of contamination of local water sources, wastewater effluent from workshop (if any) will be passed through gravel/sand beds or an oil separator and all oil/grease contaminants will be removed before discharging it into natural water courses. Fuel, oil and grease residues if generated, shall be stored, handled and disposed of as per the hazardous materials section of the WMP included in the CEMP;

(ix) the contractor's facilities area will be cleaned up to the satisfaction of the PMU and local community after use; and

(x) post-construction the area shall be fully rehabilitated, and all waste materials shall be removed and taken to disposal sites approved by local authorities.

219. Effective implementation of the above measures will ensure that potential social impacts associated with the contractor's work crew and site office/yard will be negligible.

c. Occupational Health and Safety

220. Worker occupational health and safety is generally governed by the PNG Employment Act 1978. A health and safety plan (HSP) will be submitted by the contractor(s) in the CEMPs to establish routine safety measures to cover the main Project areas and any other associated sites or construction yards. The HSP will meet the requirements of good engineering practice, the Employment Act 1978 and the EHSG as well as to provide first aid facilities.

221. Mitigation measures to be implemented by contractors to ensure health and safety of workers are as follows:

(i) At least 1 month before construction commences the contractor will demonstrate to PMU that the HSP will be properly resourced and a qualified safety officer will be identified by the contractor as shown in their bid and the safety plan will be approved by PMU and CSC before construction commences.

(ii) Before construction commences the contractor will conduct of training for all workers on environmental, safety and environmental hygiene. The contractor will

[14] A framework CCP has been prepared for the project. The CCP will be further developed during the initial stage of project implementation.

[15] Elaborated in Section VI.

instruct workers in health and safety matters as required by law and by good engineering practice and provide first aid facilities.

(iii) The contractor will instruct and induct all workers in health and safety matters (induction course) before they start work and site agents/foremen will follow up with toolbox talks on a weekly basis. Workforce training for all workers starting on site will include environment, safety and hygiene.

(iv) Workers shall be provided (before they start work) with of appropriate personnel safety equipment suitable for electrical work such as safety boots, helmets, gloves, protective clothes, goggles, and ear protection at no cost to the workers. Site agents/foremen will follow up to see that the safety equipment is used and not sold on.

(v) Fencing shall be installed on all areas of excavation greater than 1m deep and at sides of temporary works.

(vi) Audible reversing signals shall be installed on all construction vehicles.

222. The contractor will include provisions in the worker safety section of the HSP in the CEMP for:

(i) instruction of all workers in health and safety matters;

(ii) provision of potable water supply in all work locations;

(iii) establishment of safety measures as required by law and by good engineering practice and provision of first aid facilities;

(iv) providing to all workers appropriate personal protective equipment (PPE) such as safety shoes, hard hats, safety glasses, ear plugs, gloves, etc.;

(v) scheduling of regular (e.g., weekly toolbox talks) to orient the workers on health and safety issues related to their activities as well as on proper use of PPE;

(vi) where worker exposure to transport cannot be completely eliminated, protective barriers shall be provided to shield workers from transport vehicles. Alternatively, another measure is to install channelling devices (e.g., transport cones and barrels) to delineate the work zone;

(vii) fencing shall be installed beside excavation sites, borrow pits and temporary bridges;

(viii) the substation yard is provided with toilets/sanitation facilities in accordance with local regulations and these will be used by the contractors to prevent any hazard to public health or contamination of land, surface or groundwater. These facilities shall be cleaned daily and well maintained to allow effective operation.

223. Facilities for workers and public safety, construction site offices and canteen will also be regulated in line with the Employment Act 1978. Complaints will be monitored and investigated, and mitigation measures will be revised, and the CEMP will be updated as necessary if unexpected impacts occur. All measures related to workers' safety and health protection shall be free of charge to workers. The worker occupational health and safety plan in addition to the COVID 19 response plan will be submitted by the contractor before construction commences and in tandem can be extended to cover public safety and approved by PMU/DSC.

d. Community Health and Safety

224. Public safety, particularly of pedestrians and children can be threatened by works in public areas. The contractor will provide warning signs at the periphery of work sites warning the public not to enter and define this in the CEMP. The contractor will restrict the speed of project vehicles gaining access to the work sites and also control traffic within and around works sites providing flag men and warning signs at either side/end of the works areas if existing traveling lanes need

to be temporarily reduced to facilitate the works. The safety measures for the public in the HSP will include:

(i) barriers (e.g., fence) and signboards shall be installed around the construction areas to deter pedestrian access to the site;
(ii) the general public/local residents shall not be allowed in the sites which is a high-risk area, e.g., installation sites and areas where heavy equipment is in operation and all access points to the sites will have a watchman at the entrance to keep public out as far as is reasonably practicable;
(iii) provide signs at the periphery of the work sites warning the public not to enter, beware of heavy machinery and define this in the CEMP;
(iv) provisions for site security, trench barriers and hole covers and any other safety measures as necessary;
(v) speed restrictions shall be imposed on Project vehicles and equipment traveling within 50m of sensitive receivers (e.g., residential etc.);
(vi) strict imposition of speed limits along access through residential areas and where other sensitive receptors such as schools, hospitals, and other populated areas are located;
(vii) educate drivers on safe driving practices to minimize accidents and to prevent spill of load and other construction materials during transport; and
(viii) communication to the public through local officials, radio and mass media and notice boards regarding the scope and schedule of construction, as well as certain construction activities causing disruptions or access restrictions.

225. The contractor will provide information boards near the work sites to inform and instruct the public on how to conduct themselves and to be aware of their surroundings if they must approach the works. The notice board will provide contact numbers. The public safety section of the HSP will include but not necessarily be limited to the following:

(i) statement of contractor's safety policy for workers and public;
(ii) legal requirements;
(iii) works safety issues and public safety issues;
(iv) training the workforce and informing the public on works safety issues;
(v) establishment and monitoring of acceptable working practices to protect safety;
(vi) overlap with traffic and road safety (e.g., traffic flow/delay requirements);
(vii) discussion of the DSC /PMU inspection/monitoring role;
(viii) establishment of complaints management system for duration of the works;
(ix) agreement on publicity/public consultation requirements;
(x) reporting of accidents; and
(xi) complaints management through the GRM.

226. **Physical cultural resources.** Consultations with the local communities confirmed that there are no known physical cultural resources (including tambu sites) within the corridors of the transmission line routes and substation/switchyard sites. However, during excavation for the poles, and platform preparation for substations and switchyards accepted "chance find" procedures will be followed for any accidental discovery of burial sites or archaeological artefacts, so that such artefacts are properly recorded and preserved and where re-siting is unavoidable, local re-burial protocols are strictly followed.

D. Operations Phase Potential Impacts and Mitigation Measures

227. There will be no adverse operational impacts from the transmission line and substation subprojects provided the design of the facilities has been in accordance with internationally recognised good practice.

228. Installation of new transmission and substation infrastructure will reinforce the transmission and distribution systems in ENB, Madang/Morobe and Central provinces and thereby facilitate on-grid connectivity of new customers under the objective of achieving 70% household connectivity by 2030.

229. Matters of existing operations identified during the audit will be incorporated into the EMP and undertaken as corrective actions. In order to ensure compliance with ADB requirements the following provisions are recommended to be included into the loan and project agreements.

(i) Government to enforce a rule in line with ADB guidelines on environmentally responsible procurement that new equipment is supplied free of PCB and certified to be PCB free. No new equipment shall be supplied with PCB contamination;
(ii) Government to enforce a rule that no new equipment supplied under the subprojects can be serviced with reconditioned dielectric oil;
(iii) PPL to ensure that the new equipment is only serviced with new PCB free transformer oil.

VI. PUBLIC CONSULTATION, DISCLOSURE, AND GRIEVANCE REDRESS

A. Stakeholder Consultation

230. For this IEE, the stakeholder consultation process was undertaken in accordance with the ADB requirements SPS and the Access to Information Policy 2018. During the preparation of IEE public stakeholder consultations and meetings on environmental issues for the project were held at the national, provincial and community level. The projects stakeholder consultation team included the DSC IES and NES together with the international and national social/resettlement specialists.

231. Meetings were conducted in villages where the substations are situated, and transmission and distribution lines components are planned. Formal and informal discussions were held, and participants were informed about details of the project.

232. The objective of the stakeholder consultation process was to disseminate information on the subprojects and the expected impact, long-term as well as short-term, among primary and secondary stakeholders and to gather information on relevant issues so that the feedback received could be used to address these issues at early stages of project design. Another important objective was to determine the extent of the concerns amongst the community, to address these in the project implementation and to suggest appropriate mitigation measures.

233. For the purposes of this IEE, key stakeholders consulted included community and landholder groups and affected persons from the subproject locations, together with government representatives and officials from local, provincial national administrations. Provincial and local consultations in respect of both environmental and social issues were undertaken for all subproject sites: East New Britain: 12-16 November 2018; Madang/Lae: 19-24 November 2018; and Port Moresby Kwikila on the 27 November 2018.This included consultations with provincial and district government officials Kokopo, Madang, Walium, Lae and initial consultations with some

of the potentially affected communities. Table 8 provides a summary of the consultations with potentially affected communities undertaken by the TA consultants in the subproject locations and a record of consultations already undertaken are in Appendix 1.

234. These stakeholders were considered to be generally representative of the community and potentially affected persons associated with the subproject locations. The stakeholders consulted included village clan chiefs, locally affected residents and business owners and other groups with an interest in where the subproject will be implemented. These individuals were informed about the project (and the respective sub-components) and were invited to comment on their environmental concerns for their respective areas.

Table 8: Stakeholder Consultation Summary

Activity	Date	PSDP members	Stakeholder consulted	Issues raised
Port Moresby – all subprojects				
Consultation with national agencies	Ongoing	• Allan Sewell - IES • Francis Iwainde -NES	• CEPA	• Scope of subprojects as well as environment assessment and permitting requirement as per Environment Act 2000.
East New Britain				
Initial consultation and assessment	12 to 16 November 2018	• Francis Uratun – PPL HQ • Peni Diave – PPL HQ • Richard Murray-SMEC-transmission line • Alan Sewell – IES • Francis Iwainde – NES • Velepat Tuaru – NSGS • Kingsley Philip-Engineer • Joseph Auo – NTD Engineer	• PPL East New Britain Staff • Nakikus Konga – Governor ENB • Donald Kunai – EO to Governor • Wilson Matava – Provincial Administrator • Provincial Community Development Officer • Provincial Environment Officer	• ENB needs adequate and reliable electricity to improve living standards and foster socio-economic development. • Possible safety risks and adverse environmental impacts of power infrastructure installation and electricity reticulation must be minimised.
Socio-economic survey	04 to 07 Juyl 2019	• Velepat Tuaru - NSGS • Iru Raga – Project Assistant	• X number of households	• Potential impacts on the health and safety of local residents. • Impact on water quality of surface and groundwater resources. • Compensation for removal of gardens, residences, and other property. • Cost of electricity connection and usage.
Ramu to Madang				
Initial consultation and assessment	20 and 21 Nov 2018	Richard Murray – SMEC – TL Alan Sewell - IES Velepat Tuaru - NSGS Francis Uratun - PPL HQ	Leo Savingu (Acting Provincial Asset Manager Ramu at Madang) Harry Morea (Manager Substations - Ramu)	Provincial administration is keen on assisting PPL to expand provision of reliable power supply within Madang and its immediate environs. Encroachment by villagers and settlers on road easements

Activity	Date	PSDP members	Stakeholder consulted	Issues raised
			John Bivi (Provincial Administrator) Steven Biko (District Administrator Walium) PPL Madang personnel	appears to be rising and will most likely result in increased compensation claims for damages. Need to carry out awareness on the project at the village level.
Socio-economic survey	20 – 22 July 2019	Velepat Tuaru – NSGS Iru Raga – Project Assistant	X number of households	Survey in progress.
Lae				
Initial consultation and assessment	22 – 24 Nov 2018	Richard Murray – SMEC –transmission line Alan Sewell - IES Velepat Tuaru - NSGS Francis Uratun - PPL HQ	Albert Nanako - Regional Manager Ramu Grid PPL Engineering Team Lae Bart Ipambonj – Morobe Provincial Administrator Morobe Provincial Environment Officer Morobe Provincial Community Development Officer PPL Lae personnel	Provincial government will support PPL expand and improve availability of reliable electricity to Lae and its surrounding area. Potential negative impacts of power infrastructure installation and electricity reticulation must be minimized.
Socio-economic survey	17 -19 July 2019	Velepat Tuaru – NSGS Iru Raga – Project Assistant	X number of households	Survey just completed.
POM to Kwikila				
Initial assessment of sub-project area	13 Oct 2018	Richard Murray - transmission line Cheng Lee – ITD Joseph Auo – NTD Tekri Sialot - Driver		N/A
Socio-economic survey	20 June 2019 and 26 June 2019	Iru Raga – Project Assistant Damien Sonny – PPL HQ Wari Kowali – PPL HQ	X number of households	Potential impacts on the health and safety of nearby residents. Impact on water quality of surface and groundwater resources. Compensation for removal of gardens, residences, and other properties. Cost of electricity connection and usage.

CEPA = Conservation and Environment Protection Authority; ENB = East New Britain; EO = Executive Officer; IES = International Environment Specialist; NES = National Environment Specialist; NSGS = National Social and Gender Specialist; NTD = National Transmission and Distribution Engineer; PPL HQ = PNG Power Ltd. Headquarters; TL = Team Leader.

235. Stakeholder consultation at the local level focused on the location of substations and the alignment of transmission and distribution lines proposed for each subproject location. Information was provided on the potential environmental and social impacts and benefits arising from the project, and a preliminary assessment of the significance of such impacts and likely mitigation measures required to ensure impacts are minimized and acceptable. This information, together with comments and issues raised by key stakeholders and affected has been integrated into the IEE where appropriate.

236. The key findings from the stakeholder consultations can be summarized as follows:

(i) No significant operational phase impacts were identified and the community near the subprojects generally indicated they would fully support the Project and saw the Project as beneficial overall.

(ii) While the majority of respondents identified potential benefits in terms of better power supply better life standard and quality of environment, there were also concerns relating to the impact on garden plants, trees and subsistence crops near the proposed transmission lines, increased noise and dust during construction and water supply and sanitation associated with work camps, and an increase in traffic congestion.

(iii) Concern was also expressed about the risk of electrification associated with the transmission and distribution lines and PPL was requested to conduct a public information campaign to discourage adults from allowing children from playing near the power poles.

237. Based these findings, it appears that the project will have minimal environmental and social impacts. The main issues raised are addressed in the environmental management plan, as far as is reasonably practicable at this stage. Concerns with respect to safety, water and sewerage have been passed to the PPL Team.

238. Concerns with respect to temporary increased pollution, increases in traffic congestion, environmental awareness of the implementing agency and planning environmental controls have been addressed in the EMP.

B. Information Disclosure

239. Initial disclosure of the project to local communities and key government stakeholders was undertaken during the stakeholder consultation and participation process. This included a description of the project using maps and diagrams, and its potential social and environmental impacts and proposed mitigation measures.

240. The environmental assessment process under the SPS requires the disclosure of the IEE in an accessible place and language to the public during the completion of the IEE, also in line with ADB's Access to Information Policy 2018 which requires full disclosure of all project documents.

241. This IEE will be updated based on detailed design and PPL will provide summary of the IEE in local language (Tok Pisin) at public places i.e., for display at the district and ward headquarters and in PPL premises during the period when the IEE is disclosed on the ADB website, in accordance with the Project's CCP, ADB Access to Information Policy 2018, and government requirements as per EIA Regulations Order No. 175 of 2011. The CCP prepared for the Project will guide PPL and PMU in ongoing consultations.

242. After Project implementation commences, all environmental reporting submitted by PPL will also be available on the ADB web site. PPL will disclose the Project construction works in advance and it will be necessary also to disclose the complaints monitoring and GRM.

243. The GRM will provide further opportunities for consultation and can assist in public participation. The disclosure of subproject works in advance and subsequent consultation with stakeholders has advantages in the environmental assessment and mitigation of impacts. Public

consultation can also provide a conduit for the improvement of project implementation to better serve the stakeholders.

C. Grievance Redress Mechanism

244. In order to receive and facilitate the resolution of affected peoples' concerns, complaints, and grievances about the project's environmental performance a GRM will be established for the project. The GRM is intended for addressing environment related grievances as well as social issues (including land acquisition/resettlement issues) in relation to construction activities.

245. The GRM will be used for addressing any complaints that arise during the implementation of the project. The GRM will include a proactive component whereby prior to commencement of construction a meeting will be convened by PPL's PMU and the implementation team (CSC, EPC contractor) to formally advise the community of project implementation details (designs, activity schedule, access constraints etc.), so that all necessary project information is communicated effectively to the community and their immediate concerns can be addressed. This will include explaining to the community how the GRM will work. If required, following comments and agreement with the community at this meeting, the GRM may be amended and updated by the PMU.

246. The GRM will address affected people's concerns and complaints proactively and promptly, using an understandable and transparent process that is gender responsive, culturally appropriate, and readily accessible to all segments of the affected people at no costs and without retribution. The mechanism will be consistent with the government administrative and judicial processes.

247. **Type of grievances covered.** The GRM will cover any complaints or concerns made by stakeholders or affected communities and will include:

(i) negative impacts on a person or a community (e.g., financial loss/loss of subsistence resources, physical harm, nuisance, impacts on social infrastructure, damage to property outside designated site boundary);
(ii) dangers to health and safety or the environment;
(iii) failure to comply with mitigation measures, standards or legal obligations;
(iv) harassment of any nature;
(v) criminal activity;
(vi) improper conduct or unethical behavior;
(vii) financial malpractice or impropriety or fraud; and
(viii) improper disclosure or attempts to conceal any of the above.

248. **GRM procedure.** The GRM will be established in the preconstruction phase and well before construction commences. Under this GRM process, any disputes relating to the environmental performance of subproject activities under the project are first taken to the clan leader and problems are resolved via Ward Councilor, and ward committees up to the district level and then through the provincial office responsible for Environment and Conservation matters and back to the agency that implements a project (in this case PPL). Table 9 provides an outline of the process to be used where a grievance cannot be resolved at the sub-project level in consultations with the Ward Councilor.

Table 9: GRM Process for the Project

Project Stage	Procedures
Construction:	Most complaints arising during construction are expected to be minor complaints concerning dust or noise that should be able to be resolved quite easily and acted upon immediately at the sub-project level by the Project Engineer (PE). Where the complaint is of a more serious nature the PE will has up to 2 days to resolve the compliant.
	Complainants discuss their complaint directly with the Ward Councilor in their village. If the Ward Councilor supports the complaint both persons take the complaint to the on-site PE who will review the complaint within 2 days. All complaints arriving at the Site Office are to be entered in a Register that is kept at site by; date, name, contact address and reason for the complaint. A duplicate copy of the entry is given to the complainant for their record at the time of registering the complaint. The Register will show who has been directed to deal with the complaint and the date when this was made together with the date when the complainant was informed of the decision and how the decision was conveyed to the complainant. The Register is then signed off by the person who is responsible for the decision and dated. The Register is to be kept at the front desk of the Site Office and is a public document. The duplicate copy given to the complainant will also show the procedure that will be followed in assessing the complaint, together with a statement affirming the rights of the complainant to make a complaint. For anybody making a complaint no costs will be charged to the complainant. The Project Engineer (PE) will consider the complaint and within a maximum of 2 days will convey a decision to the complainant. The complainant and the Ward Councilor may if so desired discuss the complaint directly with the PE or his representative. If the complaint is dismissed the complainant will be informed of their rights in taking it to the next step. A copy of the decision is to be sent to the Project Manager at the PMU. Should the complainant not be satisfied, the complainant may take the complaint to the Director-Environment[16] and continue the grievance in accordance with Section 87 of the Environment Act 2000. Procedure for dealing with compensation claims for environmental impacts. The procedure is shown in the following steps. The complainant meets with EP-holder (PH) to formally register concern over impact and seek redress. A copy of the alleged impact is submitted to the Director-Environment. The PH has to determine whether the impact has occurred due to its activities. If the PH accepts responsibility for the impact, it can negotiate a mutually acceptable settlement with complainant within 90 days. If the PH rejects responsibility for the impact, complainant can request Director-Environment to carry out a verification investigation. If Director-Environment confirms that the impact has occurred, he/she will advise the PH and complainant to negotiate a settlement within 90 days. If a negotiated settlement is not reached, the PH or complainant can request Director-Environment to formulate a determination. Once this request is made, Director-Environment will have 90 days to reach a determination. If either party is dissatisfied with the determination, they can appeal to the national court.
Operation:	The same procedure is followed except that the complaint is now directed to PPL to rectify. During operation the same conditions apply; i.e., there are no fees attached to the complainant for making a complaint, the complainant is free to make the complaint which

[16] This is the legal title in the Environment Act 2000 that is assigned to the Managing Director of CEPA.

Project Stage	Procedures
	will be treated in a transparent manner and the complainant will not be subject to retribution for making the complaint.

249. It should be noted that this procedure is only for addressing environmental issues under the project, and any grievances dealing with land and related compensation issues are to be directed to the Department of Lands who have established procedures for dealing with these issues.

250. The PMU will provide the support and guidance in grievance redress matters. Investigation of grievances will involve site visits and consultations with relevant parties (e.g., complainant, contractors, local police, etc.).

251. PPL shall instruct the PMU and DSC to make the public aware of the GRM through public awareness campaigns and a project information brochure. The PMU will also raise the level of awareness of local leaders with regard to the GRM and different ways available for aggrieved parties to resolve their disputes. The contact phone number of the PMU will serve as a hotline for complaints and shall be publicized through the media and placed on notice boards outside the PMU offices and at the construction sites and project sites at site entrances and at the entrance to the contractor's maintenance yard(s).

252. The project information brochure will include information on the GRM and shall be widely disseminated to the stakeholders in the areas surrounding the subproject areas by the PMU. Grievances can be submitted verbally to leaders, in writing or by phone with any member of the PMU or PPL, construction sites and other key public offices, all of which will maintain an open-door policy to accept complaints. \

253. Grievances will be documented and personal details (name, address, date of complaint, etc.) will be included unless anonymity is requested. A tracking number shall be assigned for each grievance, including the following elements:

(i) Initial grievance sheet (including the description of the grievance), with an acknowledgement of receipt handed back to the complainant when the complaint is registered;
(ii) Grievance monitoring sheet, mentioning actions taken (investigation, corrective measures);
(iii) Closure sheet, one copy of which will be handed to the complainant after he/she has agreed to the resolution and signed-off.

254. The updated register of grievances and complaints will be available to the public at the PMU office, construction sites and other key public offices around the project area (offices of the LLG and District authority).

255. A grievance redress committee (GRC) shall be established by PPL/PMU before commencement of site works, shall be chaired by Project Manager PMU and shall have members from ward committees and district or municipal authority committees, relevant government departments, a local NGO, and a women's organization. The contractor(s) will have observer status on the committee.

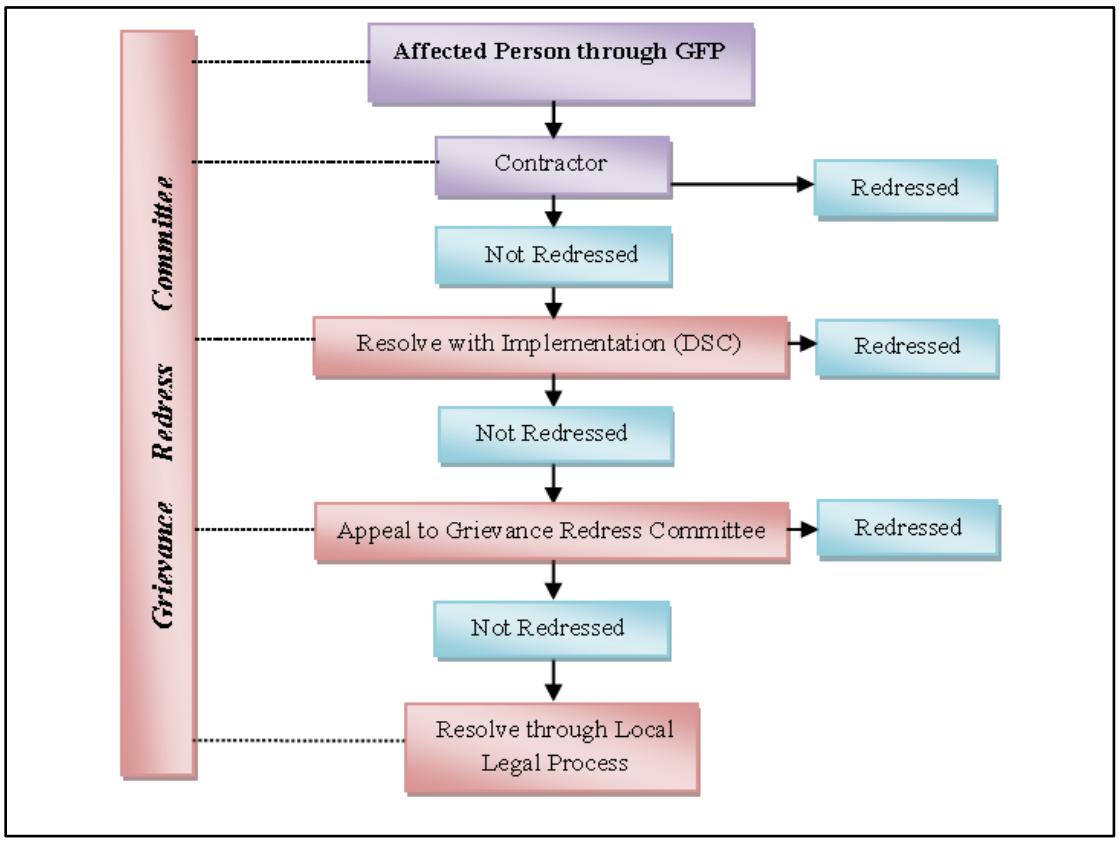
256. The functions of the local GRC are as follows:

(i) Resolve problems and provide support to affected persons arising from various environmental issues and including dust, noise, utilities, power and water supply, waste disposal, traffic interference and public safety as well as social issues such as land acquisition (temporary or permanent); asset acquisition; and eligibility for entitlements, compensation and assistance;
(ii) Reconfirm grievances of displaced persons, categorize, and prioritize them and aim to provide solutions within a month; and
(iii) Report to the aggrieved parties about developments regarding their grievances and decisions of the GRC.

257. The PMU officers will be responsible for processing and placing all papers before the GRC, maintaining database of complaints, recording decisions, issuing minutes of the meetings and monitoring to see that formal orders are issued, and the decisions carried out.

258. The monitoring reports of the EMP and resettlement plan (RP) implementation shall include the following aspects pertaining to progress on grievances: (i) number of cases registered with the GRC, level of jurisdiction (first, second ,and third tiers), number of hearings held, decisions made, and the status of pending cases; and (ii) lists of cases in process and already decided upon may be prepared with details such as name, ID with unique serial number, date of notice, date of application, date of hearing, decisions, remarks, actions taken to resolve issues, and status of grievance (i.e., open, closed, pending).

Figure 14: Grievance Redress Mechanism for the Project



VII. ENVIRONMENTAL MANAGEMENT PLAN

A. Introduction

259. This section identifies mitigation and management measures to avoid, reduce, mitigate or compensate for adverse environmental impacts that have already been identified in the previous sections. The EMP is a management tool and the issues are accordingly addressed with regard to the sequence of operations, i.e., those activities that apply to, pre-construction, construction and operation. The environmental assessment of the subproject has determined that it will have relatively minor and site-specific impacts on the local environment. Environmental mitigation measures have been proposed to avoid or minimize environmental impacts to acceptable levels.

260. International best practice requires the EMP contained in the approved IEE be updated based on detailed design and then the contractor prepare the CEMP detailing the methods they will use. These plans will be approved by PMU/DSC, CEPA and ADB prior to implementation. The roles and responsibilities for various environmental management tasks as well as the overall institutional arrangements are discussed below.

261. An EMP for the project is presented below and complies with government and ADB requirements. The EMP includes the following information:

(i) Implementation arrangements for the EMP including: (i) institutional roles and responsibilities for EMP implementation throughout all stages of the project (procurement, design, construction, operation); (ii) capacity building requirements for implementing agency to ensure environmental management requirements are properly understood and fully implemented; and (iii) linkages to the grievance redress mechanism;

(ii) Environmental mitigation and monitoring matrices including: (i) potential environmental impacts that could occur during each stage of the project (pre-construction/design, construction, operation); (ii) proposed mitigation measures to address each impact identified; (iii) agency responsible for implementing each mitigation measure; (iv) monitoring tasks to ensure mitigation measures have been implemented effectively during each stage of the project; and (v) schedule and responsibility for monitoring;

(iii) Costs associated with implementation of all aspects of the EMP.

262. Prior to construction commencing, the project's EMP will be updated, included in the bid and contract documents, and developed into a detailed CEMP by the contractor. The PMU set up within PPL which will be supported by the CSC, will be responsible for supervision of approved CEMP implementation through regular observation and spot checks of construction-related activities. PPL, with CEPA's endorsement, will ensure that the CEMP will be adequately prepared and consistent with the EMP matrix. PPL will ensure that adequate and timely remedial actions are taken by the contractor. The local community will have access to the supervising engineer to report and have resolved any project-related concerns or problems. Any construction-related problems, along with follow-up actions undertaken, will be reported by the supervising engineer to appropriate parties regarding the previously established and agreed-upon GRM.

B. Implementation Arrangements

1. Institutional Arrangements

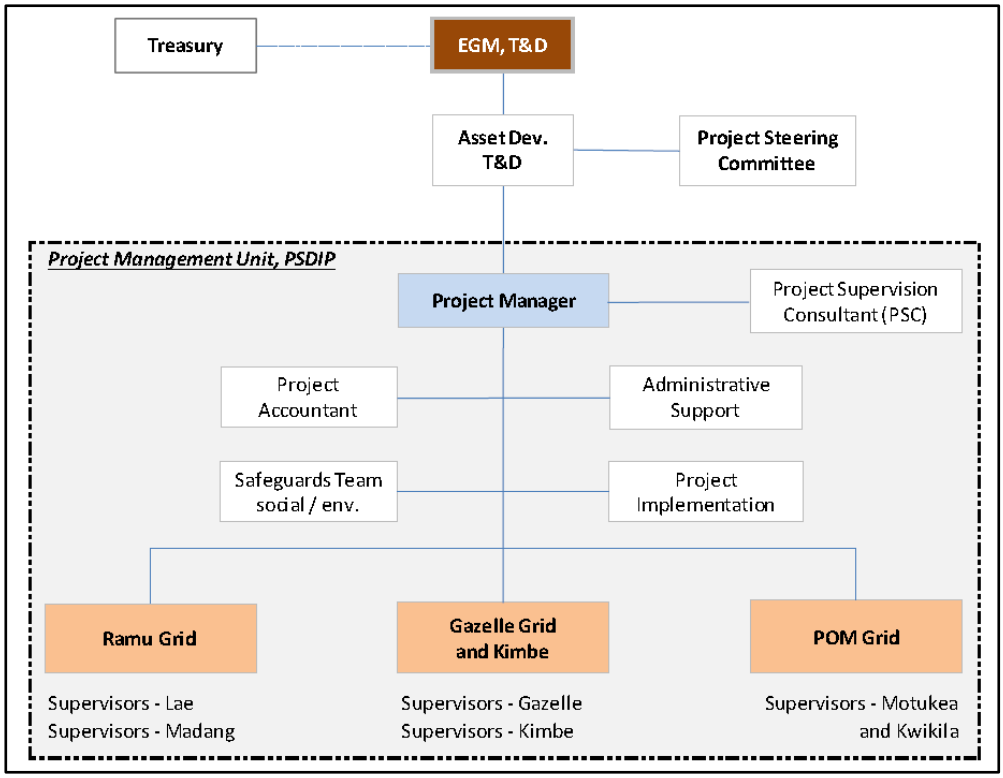
263. The key implementation organizations involved in delivering the Project include the Department of Petroleum and Energy (DPE), PPL and the Department of Treasury. The DPE, as the executing Agency, will provide oversight of the project, while PPL, as implementing agency, will manage the day-to-day execution of the works.

264. PPL's implementation of these projects is managed by the PMU, supported by DSC recruited for implementation of specific projects. The DSC comprises international and national specialists in relevant disciplines. In this context, PPL will have overall responsibility for implementing the EMP. Other organizations involved in implementing the EMP include.

(i) Government agencies such as CEPA who will be responsible for environmental approval and compliance monitoring;
(ii) The Department of Lands and Physical Planning who will be responsible for assessing land ownership and damages claims and facilitating compensation.
(iii) The contractor who will be responsible for developing the plan to mitigate and manage the impacts of the activities they undertake and reporting on environmental activities during construction.

265. **Project Management Unit**. PPL has established a PMU; Figure 15: shows the organization chart for PMU and its role in implementing the Project.

Figure 15: PPL PMU Organization Structure for the Project



266. The PMU will be managed by a Project Manager (PM) and will include engineering, social and environmental personnel. During construction on-site supervision of the construction program will be managed by the Project Engineer (PE). Included as part of the PMU team, will be three staff - an Environmental Officer (EO), a Social Development Specialist (SDS) and a Community Development Specialist (CDS). The EO will be responsible for environmental related matters, the

SDS will be responsible for compensation and resettlement issues and the CDS will be responsible for arranging consultation and awareness meetings with the affected communities.

267. **Conservation and Environment Protection Authority.** The Conservation and Environment Protection Authority is responsible for the administration and enforcement of the Environment Act 2000 and its regulations. CEPA has advised PPL that transmission line development is assessed as a level 2B activity requiring PPL to submit an EP application which is in a similar format to the IEE. Following approval CEPA will issue an EP for level 2B projects. No work can commence until the EP is issued. The CEPA may also undertake monitoring work as required.

268. **The Department of Lands.** The Department of Lands and Physical Planning will be responsible for assessing land related claims and facilitating compensation where appropriate.

2. Roles and Responsibilities

269. The PPL's environment officer, with the support and oversight of the IES and NES, will be responsible for: (i) ensuring that all environmental safeguard requirements of ADB and government are complied with; (ii) monitor implementation of subproject' CEMPs; and (iii) prepare compliance reports for PMU.

270. The IES will also be responsible for ensuring that environmental management of the Project is incorporated during detailed design, bidding process, contract process, construction, and implementation. The specific responsibilities of the PMU include:

(i) Obtaining necessary permits and/or clearance, as required, from CEPA and other relevant government agencies, before commencing any civil work;
(ii) Submitting the IEE, EMP and monitoring reports and other documents to ADB;
(iii) Ensuring that any EMP mitigation measures needing to be incorporated during the construction stage by the contractor are included in the bidding documents;
(iv) Ensuring that the contractors have access to the IEE and EMP reports of the projects;
(v) Ensuring that contractors understand their responsibilities to mitigate environmental problems associated with their construction activities and train their staff in implementation of the EMP;
(vi) Ensure and monitor that the EMP including an environmental monitoring plan will be properly implemented including spot check noise monitoring during construction to verify contractual compliance;
(vii) Ensure that the contractors submit monthly environmental management reports to the PMC (these reports will be included as part of the contractors' monthly progress reports);
(viii) Ensure that the PMC reviews and submits biannual environmental monitoring reports to the PMU;
(ix) Submit bi-annual environmental monitoring report to ADB; and
(x) In case unpredicted environmental impacts occur during the project implementation stage, prepare and implement as necessary a corrective action plan in consultation with ADB, CEPA and any other relevant government agencies.

271. **The contractor**: Each contractor will develop and submit their CEMP for approval by PPL and ADB on the mitigation measures that it will take in the implementation of a project. The CEMP will be approved and used in the submission of regular reports to PPL who will submit to ADB for perusal and approval. Implementation of these EMPs should begin with the following:

(i) Incorporation of these EMPs into CEMP by contractor to ensure consistency.
(ii) PMU environmental officer conduct environmental induction or training to contractor's Environmental Officer and management, specifically on implementation of EMPs/CEMP.
(iii) PMU ensures the contractor's environmental officer is qualified and experienced to implement the EMPs/CEMP.
(iv) PMU ensures these EMPs are recognized, adopted and implemented together with CEMP through clauses in the contract with contractor.
(v) Cost of implementation of these EMPs and CEMP during construction phase should be included in the BOQ for the subprojects.

272. While the contractor's site engineer will undertake day-to-day supervision of the approved CEMP, the Project Engineer (DSC) will be assisted by the IES and NES and will have overall site supervision responsibilities for ensuring that the contractor is meeting the CEMP requirements.

273. **Conservation and Environment Protection Authority**. The CEPA is responsible for: (i) Determining the notice to proceed/EP requirements for each subproject; (ii) Reviewing and approving environmental assessment reports required by the Government; iii) Undertaking monitoring of the project's environmental performance based on the CEPA mandate and environmental assessment; and iv) Advising the appropriate authority should any physical cultural resource of significance be reported during the works.

274. **ADB responsibilities.** ADB through its PNG Resident Mission will provide guidance as to the submission of periodic monitoring reports from PPL that would meet ADB's standards and guidelines before these are uploaded onto ADB website for public viewing or consumption. ADB will also have its own scheduled missions in PNG who will oversee the monitoring and progress of the projects as per loan covenant. ADB is responsible for: (i) review and clearance of the IEE, updated IEE and environmental monitoring reports; (ii) undertaking periodic monitoring of CEMP implementation and due diligence as part of an overall project review mission; and (iii) If required, provide advice to PPL in carrying out its responsibilities to implement the EMP for the Project.

C. Mitigation and Management Plans

275. Environmental impacts identified during construction are limited in area, are site specific, and largely temporary in nature. The activities can be mitigated and managed through implementation of recognized as good international industry practice. Some operational environmental impacts are anticipated, including waste, wastewater, noise, fugitive dust, community and occupational health, safety; and inadequate handling of waste. These environmental impacts are anticipated to be minor and will be addressed through conventional operation and maintenance practices, health and safety codes and measures; and waste management system included in the operations aspects of the EMP.

276. Two EMPs have been prepared, one for substations and switching yards (Table 10) and the other for transmission and distribution lines (Table 10) covering the four geogrid upgrades for the Grid Gazelle, Ramu-Madang, Ramu-Lae and Port Moresby Grid systems. Each EMP includes information on: (i) the potential environmental impacts that could occur during each stage of the project (pre-construction/design, construction, operation); (ii) proposed mitigation measures to address each impact identified; (iii) the institutional responsibility for implementing each mitigation measure; and (iv) the monitoring requirements and responsibilities relevant to the design/pre-construction, construction, and operation phases of the project.

277. **Budget for EMP implementation**. The cost of all compensation and rehabilitation works will be an integrated part of the overall subproject cost, which will be borne by the project. The costs associated with mitigation and monitoring of construction-stage impacts are included as part of the civil works contract. The ongoing operations budget of PPL PMU for monitoring will be included in the DSC services contract.

Table 10: Environmental Management and Monitoring Matrix – Transmission and Distribution Lines

Project Activity	IMPACT MITIGATION				IMPACT MONITORING			
	Potential Environmental Impact	Proposed Mitigation Measure	Implementing Responsibility	Mitigation Cost	Parameter to be Monitored	Frequency and Verification	Monitoring Responsibility	Monitoring Cost
PRE-CONSTRUCTION ACTIVITIES								
Equipment specifications and design parameters	Release of toxic pollutants chemicals and gases in receptors (air, water, land) PCBs will not be used in substation transformers and other project facilities or equipment.	Processes, equipment and systems not to use chlorofluorocarbons (CFCs), including halon, and their use, if any, in exiting processes and systems should be phased out and to be disposed of in a manner consistent with the requirements of GoPNG.	PMU Environment Officer and Design and Supervision Consultant	Cost included in PMU and DSC staffing.	Preconstruction Complete check of equipment specifications and design parameters	Once verify inclusion in specification and design	PPL/PMU	Cost met by PMU/PMU project staffing
Design and layout of equipment	Exposure to noise Interference with other utilities and traffic Encroachment into farmland	1. Design of equipment to comply with noise regulations and World Bank EHS guidelines. 2. Obtain necessary clearances from other utilities that could be affected by the project. 3. For any proposed new 66kV lines to and from green field 66kV substations, lines will be sited to as much as possible avoid productive land. In the event that encroachment is necessary farmers will be compensated accordingly	PMU/Environment Officer & Design Consultant	Cost included in PMU and DSC staffing.	Preconstruction Complete check of items 1 to 3	Once verify inclusion in specification and design	PPL/PMU	Cost met by PMU/PMU project staffing
Hazardous/Toxic Substances Use Risks	Unsafe handling, use, waste disposal of hazardous or toxic chemicals/substances or greenhouse gas (GHG) substances can pollute/impact local environment and human.	1. All hazardous/toxic substance procurement specifications shall follow international standards and best practices to avoid use of substances that cause greenhouse gas (GHG) emissions or impact upon humans. 2, All equipment procured under the investment program shall be free from polychlorinated biphenyl (PCBs)	PMU/Environment Officer & Design Consultant	Cost included in PMU and DSC staffing.	Preconstruction Complete check of items 1 to 2	Once verify inclusion in specification and design	PPL/PMU	Cost met by PMU/PMU project staffing
Interference with drainage patterns/Irrigation channels	Flooding, erosion and sedimentation hazards	Appropriate siting of facilities and drainage design to avoid channel interference and off-site flooding.	PMU/Environment Officer & Design Consultant	Cost included in PMU and DSC staffing.	Preconstruction Complete check of drainage/flooding hazard	As needed before tendering	PPL/PMU	Cost met by PMU/PMU project staffing

Project Activity	IMPACT MITIGATION				IMPACT MONITORING			
	Potential Environmental Impact	Proposed Mitigation Measure	Implementing Responsibility	Mitigation Cost	Parameter to be Monitored	Frequency and Verification	Monitoring Responsibility	Monitoring Cost
Vegetation clearing impacts/issues	Nil	Undertake impact assessments of transmission line/DL construction and determine and document potential environmental issues.	PMU/Environment Officer & Design Consultant	Cost included in PMU and DSC staffing.	Preconstruction Complete check of vegetation clearing	As needed before tendering	PPL/PMU	Cost met by PMU/PMU project staffing
Avifauna Impacts from Transmission Lines	Bird mortality and modification to habitat	Undertake additional surveys to determine impact in most environment sensitive subproject sections	PMU/Environment Officer & Design Consultant	Cost included in PMU and DSC staffing.	Preconstruction Complete bird assessment	As needed before tendering	PPL/PMU	Cost met by PMU/PMU project staffing
Encroachment into protected and cultural heritage areas/sites	Nil	Identify protected and cultural heritage areas near project area and map it out for avoidance.	PMU/Environment Officer & Design Consultant	Cost included in PMU and DSC staffing.	Preconstruction Complete check for encroachment	As needed before tendering	PPL/PMU	Cost met by PMU/PMU project staffing
CONSTRUCTION STAGE								
Planning for construction environmental management	EMP not effectively implemented	1.Prior to mobilization the Contractor shall prepare and submit a site-specific environmental management plan (SSEMP) for approval. The SSEMP will include any corrective measures relating to the existing environmental risks associated with wastes exiting at the facilities prior to the new project. 2. SSEMP to provide details on how contractor plans to implement the construction mitigation measures specified in this EMP including COVID 19 response plan and any additional measures identified in the impact assessment surveys for potentially affected flora and fauna	PMU Contractor	Cost included in contractor fees	Check implementation of items 1-2	As needed before start of site works. Monthly during construction.	Contractor/PMU (DSC & Environmental Specialist)	Contractor's monitoring costs met by contractor. DSC & ES costs met by PMU.
Mechanized construction including vehicles transporting materials to site	Noise and vibration	1. Schedule activities during daytime working hours Construction equipment to be well maintained. 2. Noise levels due to construction activities at sensitive receptors shall not exceed 50dB(A) during daytime hours (0700-2300hrs) or 40 dB(A) during night-time hours (2300-0700hrs) 3. Provide noise Personal Protection Equipment (PPE) to workers.	PMU Contractor	Cost included in contractor fees	Check implementation of items 1-2	Weekly or as required until site has been established. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.

Project Activity	IMPACT MITIGATION				IMPACT MONITORING			
	Potential Environmental Impact	Proposed Mitigation Measure	Implementing Responsibility	Mitigation Cost	Parameter to be Monitored	Frequency and Verification	Monitoring Responsibility	Monitoring Cost
		4. Community awareness at first instance on potential of producing noise.						
	Dust/air pollution	1.Water to be sprayed on unpaved roads to suppress dust in the vicinity of communities through which transportation of construction materials passes. 2. Vehicles delivering construction materials shall be covered. 3. Vehicles and construction equipment shall be regularly serviced and well maintained. 4. Vehicles and construction equipment shall comply with statutory emission standards		Cost included in contractor fees	Check implementation of items 1-4	Weekly or as required until site has been completed. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.
Interference with utilities and blockage of access ways	Disruption of community access to amenities and services	Ensure existing access to public and private amenities are maintained throughout construction period	PMU Contractor	Cost included in contractor fees	Check maintenance of access provisions	Weekly or as required until site has been completed. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.
Equipment servicing	Contamination of receptors (land, water, air)	Provision of hard standing areas for equipment servicing, refueling and wash down with drainage directed through oil and grease interceptors	PMU Contractor	Cost included in contractor fees	Check provisions of equipment servicing	Weekly or as required until completed. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.
Storage of chemicals and materials	Contamination of receptors (land, water, air)	1. Fuel and other hazardous materials securely stored above high flood level in hard standing area undercover surrounded by containment bunds. 2. Store petrochemicals and other toxic substances inside a bunded shed. 3. Regular servicing of machinery to prevent petrochemical leaks.	PMU Contractor	Cost included in contractor fees	Check implementation of items 1-3	Weekly or as required until completed. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.

Project Activity	IMPACT MITIGATION				IMPACT MONITORING			
	Potential Environmental Impact	Proposed Mitigation Measure	Implementing Responsibility	Mitigation Cost	Parameter to be Monitored	Frequency and Verification	Monitoring Responsibility	Monitoring Cost
	Unsafe handling, use, waste disposal of hazardous or toxic chemicals/substances or greenhouse gas (GHG) substances can pollute/impact local environment and human	1. Regular servicing of machinery to prevent petrochemical leaks. 2. Safety inductions on hazardous/toxic substances to employees. 3. Equipment/facilities specifications shall follow international standards and best practices to avoid use of substances that cause greenhouse gas (GHG) emissions or impact upon humans. 4. All equipment procured under the investment program shall be free from polychlorinated biphenyl (PCBs). 5. Handle, use, storage and disposal that is consistent with international best practices to prevent soil/water contamination and human impact.		Cost included in contractor fees	Check implementation of items 1-5	Weekly or as required until completed. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.
Provision of facilities for construction workers	Contamination of receptors (land, water, air)	Construction workforce facilities to include proper sanitation, water supply and waste disposal facilities.	PMU Contractor	Cost included in contractor fees	Check Provision of facilities for construction workers	Weekly or as required until completed. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.
Health and safety	Injury and sickness of workers and members of the public Employees will be exposed to work related hazards, injuries, diseases and sickness.	1. Contractor to comply with WB EHS requirements or equivalent for worker and public safety related to electric power infrastructure including WHO guidelines on COVID 19 in the workplace and construction sites. 2. Contractor to prepare and implement a worker health and safety plan and COVID 19 response plan prior to commencement of construction.	PMU Contractor	Cost included in contractor fees	Check implementation of items 1-3	Weekly or as required until completed. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.

Project Activity	IMPACT MITIGATION				IMPACT MONITORING			
	Potential Environmental Impact	Proposed Mitigation Measure	Implementing Responsibility	Mitigation Cost	Parameter to be Monitored	Frequency and Verification	Monitoring Responsibility	Monitoring Cost
		3. Contractor to arrange for health and safety training sessions for workers						
Inadequate construction stage monitoring	Likely to maximize damages	1. Implementation of effective environmental monitoring and reporting system using checklist of all contractual environmental requirements. 2. Appropriate contact clauses to ensure satisfactory implementation of contractual environmental mitigation measures.	PMU Contractor	Cost included in contractor fees	Check implementation of items 1-2	Weekly or as required until completed. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.
Encroachment into garden/farmland and interference with private property	Damage to assets and loss of production	1. Use existing maintenance access roads wherever possible. Provide compensation for temporary loss of production if necessary. 2. Reinstate existing facilities fully after construction completion.	PMU Contractor	Cost included in contractor fees	Check implementation of items 1-2	Weekly or as required until completed. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.
Erosion and loss of topsoil	Soil loss, downstream siltation; Spoil soils erosion can contaminate downstream creeks and streams, including drinking water sources. Spoil earth material washout by storm can cause sedimentation/siltation in streams/creeks (water quality) and affect migration and feeding of aquatic life	1. Minimize removal of vegetation and topsoil. 2. Limit site clearing to work areas. 3, Topsoil disturbed during site development to be used to restore the surface of excavated areas (where applicable) 4. Regeneration of vegetation to stabilize works areas on completion (where applicable) 6. Water courses protected from siltation through use of bunds and sediment ponds. 7. Use appropriate slope stabilization, bunding, sedimentation ponds and other drainage management measures as necessary 8. Install cut-off drains above excavated areas on steep slopes.	PMU Contractor	Cost included in contractor fees	Check implementation of items 1-10	Weekly or as required until completed. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.

Project Activity	IMPACT MITIGATION				IMPACT MONITORING			
	Potential Environmental Impact	Proposed Mitigation Measure	Implementing Responsibility	Mitigation Cost	Parameter to be Monitored	Frequency and Verification	Monitoring Responsibility	Monitoring Cost
		9. Water courses protected from siltation through use of bunds and sediment ponds. 10. Stockpile topsoil away from storm water drains for later use in landscaping.						
Vegetation destruction and loss of birds/animal habitat	Loss of commercially valuable plants. Loss of cultural significant plants. Loss of birds and wildlife feeding, breeding and nesting plants/area. Permanent loss of domesticated food plants (if any) along transmission and distribution line corridors.	1, Consult locals (if any) on their uses and values of the area and plants. 2. Avoid passing through any sanctuaries, protected areas, national parks, etc. 3. Avoid clearing of domesticated or valuable plants near villages or seek approval from local owner first. 4. Avoid felling nesting plants of Bird of Paradise and other protected bird species. 5. Minimize damage to natural forest resources by restricting vegetation clearing to access road, transmission line and distribution line corridors.	PMU Contractor	Cost included in contractor fees	Check implementation of items 1-5	Weekly or as required until completed. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.
OPERATION STAGE								
Inadequate provision of staff/workers health and safety during operations	Injury and sickness of staff /workers Employees will be exposed to work related hazards, injuries, diseases and sickness.	1. Careful design using appropriate technologies to minimize hazards. 2. Safety awareness raising for staff. 3. Preparation of fire emergency action plan and training given to staff on implementing action plan. 4. Provide adequate sanitation and water supply facilities. 5. Environmental/Safety Officer of PPL to conduct safety inductions to all employees prior to commencement of work. 6. PPL to provide PPE to all its employees.	PNG Power Environmental or Safety Officer. Operations Manager.	PNG Power operating cost	Monito items 1-6	Biannual Check completion of items 1-6	PNG Power Environmental or Safety Officer	PNG Power cost

Project Activity	IMPACT MITIGATION				IMPACT MONITORING			
	Potential Environmental Impact	Proposed Mitigation Measure	Implementing Responsibility	Mitigation Cost	Parameter to be Monitored	Frequency and Verification	Monitoring Responsibility	Monitoring Cost
Operations and maintenance staff skills less than acceptable	Unnecessary environmental losses of various types	1. Adequate training in O&M to all relevant staff of facility maintenance crews. 2. Preparation and training in the use of O&M manuals and standard operating practices.	PNG Power Environmental or Safety Officer. Operations Manager.	PNG Power operating cost	Monitor items 1-2	Biannual Check completion of items 1-2	PNG Power Environmental or Safety Officer	PNG Power cost
Inadequate periodic environmental monitoring.	Diminished ecological and social values.	O&M staff to receive training in environmental monitoring of project operations and maintenance activities	PNG Power Environmental or Safety Officer. Operations Manager.	PNG Power operating cost	Monitor the incidence of inadequate monitoring	Biannual Check completion of items 1-2	PNG Power Environmental or Safety Officer	PNG Power cost
Risks of people' encroachment into transmission line/DL corridor or right of way (RoW).	Injury/mortality to staff and public	1. Careful design using appropriate technologies to minimize hazards. 2. Security fences around facilities 3. Appropriate warning signs on facilities 4. Electricity safety awareness raising in project areas. 5. Prevent people from doing gardening, settling and business activities within transmission line/DL corridor or RoW. 6. Control vegetation growth near and under transmission line/DL to prevent electrocution of people	PNG Power Environmental or Safety Officer. Operations Manager	PNG Power operating cost	Monitor items 1-6	Biannual Check completion of items 1-6	PNG Power Environmental or Safety Officer	PNG Power cost
DL transformer leakage risks and water contamination.	Impact on water quality. Impact on aquatic life. Impact on people	1. Service or replace leaking transformers. 2. Proper handling, use and storage of used or damaged transformers.	PNG Power Environmental or Safety Officer. Operations Manager.	PNG Power operating cost	Monitor items 1-4	Biannual Check completion of items 1-4	PNG Power Environmental or Safety Officer	PNG Power cost

Table 11: Environmental Management Plan - Substations and Switching Yards

Project Activity	IMPACT MITIGATION				IMPACT MONITORING			
	Potential Environmental Impact	Proposed Mitigation Measure	Implementing Responsibility	Mitigation Cost	Parameter to be Monitored	Frequency & and Means of Verification	Monitoring Responsibility	Monitoring Cost
PRE-CONSTRUCTION ACTIVITIES								
Equipment specifications and design parameters	Release of toxic pollutants chemicals and gases in receptors (air, water, land)	1. PCBs will not be used in substation transformers and other project facilities or equipment. 2. Processes, equipment and systems not to use chlorofluorocarbons (CFCs), including halon, and their use, if any, in exiting processes and systems should be phased out and to be disposed of in a manner consistent with the requirements of GoPNG.	PMU Environment Officer and Design and Supervision Consultant	Cost included in PMU and DSC staffing.	Preconstruction Complete check of equipment specifications and design parameters	Once verify inclusion in specification and design	PPL/PMU	Cost met by PMU/PMU project staffing
Design and layout of equipment	Exposure to noise Interference with other utilities and traffic	1. Design of equipment to comply with noise regulations and World Bank EHS guidelines. 2. Obtain necessary clearances from other utilities that could be affected by the project	PMU/Environment Officer & Design Consultant	Cost included in PMU and DSC staffing.	Preconstruction Complete check of items 1 to 2	Once verify inclusion in specification and design	PPL/PMU	Cost met by PMU/PMU project staffing
Interference with drainage patterns/Irrigation channels	Flooding, erosion and sedimentation hazards	Appropriate siting of facilities and drainage design to avoid channel interference and avoid off-site flooding.	PMU/Environment Officer & Design Consultant	Cost included in PMU and DSC staffing.	Preconstruction Complete check of drainage/flooding hazard	As needed before tendering	PPL/PMU	Cost met by PMU/PMU project staffing

Project Activity	IMPACT MITIGATION				IMPACT MONITORING			
	Potential Environmental Impact	Proposed Mitigation Measure	Implementing Responsibility	Mitigation Cost	Parameter to be Monitored	Frequency & and Means of Verification	Monitoring Responsibility	Monitoring Cost
Escape of polluting materials	Environmental pollution Risks of dielectric fluids (Polychlorinated Biphenyls (PCBs))	1. Equipment designed with oil spill containment systems, and purpose-built oil, lubricant and fuel storage system, complete with spill cleanup equipment. 2. Enforce a rule in line with ADB guidelines on environmentally responsible procurement that new transformer is supplied free of PCB and certified to be PCB free. 3. Enforce a rule that no new equipment supplied under the subproject can be serviced with reconditioned dielectric oil. 4. Ensure that the new equipment is only serviced with new PCB free transformer oil.	PMU/Environment Officer & Design Consultant	Cost included in PMU and DSC staffing.	Preconstruction Complete check of items 1 to 4	Once verify inclusion in specification and design	PPL/PMU	Cost met by PMU/PMU project staffing
	Potential exposure of workers and residents to Asbestos	1. Site assessment for asbestos (including sampling) undertaken prior to the commencement of works. 2. If found, the contractor will be required to prepare an Asbestos management plan.	PMU/Environment Officer & Design Consultant	Cost included in PMU and DSC staffing	Preconstruction complete check of items 1 and 2	Once verify inclusion in specification and design	PPL/PMU	Cost met by PMU/PMU project staffing
Explosions/Fire	Hazards to life	1, Design of facilities to include modern fire control systems/firewalls. 2. Provision of fire-fighting equipment to be located close to transformers	PMU/Environment Officer & Design Consultant	Cost included in PMU and DSC staffing.	Preconstruction Complete check of items 1 to 2	Once verify inclusion in specification and design	PPL/PMU	Cost met by PMU/PMU project staffing
Vegetation clearing impacts/issues	Nil	Undertake impact assessments of SS/SWYA construction and determine and document potential environmental issues.	PMU/Environment Officer & Design Consultant	Cost included in PMU and DSC staffing.	Preconstruction Complete check of vegetation clearing	As needed before tendering	PPL/PMU	Cost met by PMU/PMU project staffing
Encroachment into protected and cultural heritage areas/sites.	Nil	Identify protected and cultural heritage areas near project area and map it out for avoidance.	PMU/Environment Officer & Design Consultant	Cost included in PMU and DSC staffing.	Preconstruction Complete check for encroachment	As needed before tendering	PPL/PMU	Cost met by PMU/PMU project staffing.

Project Activity	IMPACT MITIGATION				IMPACT MONITORING			
	Potential Environmental Impact	Proposed Mitigation Measure	Implementing Responsibility	Mitigation Cost	Parameter to be Monitored	Frequency & and Means of Verification	Monitoring Responsibility	Monitoring Cost
CONSTRUCTION STAGE								
Planning for construction environmental management	EMP not effectively properly implemented	1. Prior to mobilization the Contractor required to prepare and submit a site-specific environmental management plan (SSEMP) for approval. The SSEMP will include any corrective measures relating to the existing environmental risks associated with wastes exiting at the facilities prior to the new project. 2. SSEMP to provide details on how contractor plans to implement the construction mitigation measures specified in this EMP including COVID 19 response plan.	PMU Contractor	Cost included in contractor fees	Check implementation of items 1-2	As needed before start of site works. Monthly during construction.	Contractor/PMU (DSC & Environmental Specialist)	Contractor's monitoring costs met by contractor. DSC & ES costs met by PMU.
Disposal of hazardous waste (PCB oils) due to decommissioning and disposal of old transformers	Water and soil pollution, hazard to human health	1. Oil from all transformers to be replaced will be tested to determine the chlorine content. If the chlorine content of oil exceeds 50 ppm the oil from that transformer will be properly tested for PCBs. 2. Retired transformers awaiting testing and disposal will be stored in a designated storage area in compliance with international requirements for storage of hazardous chemicals. 3. Temporarily store equipment/parts safely within a shed on site and safely transport to PPL designated or approved storage yards. 4. Store unwanted (used) transformers safely in upright positions to prevent leakage of transformer oils or PCBs.	PMU Contractor	Cost included in contractor fees	Check implementation of items 1-4	Weekly or as required until completed. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.
	Exposure of workers and residents to asbestos	1. Should initial assessment discover asbestos is present. An asbestos management	PMU Contractor	Cost included in contractor fees	Check implementation of items 1 & 2	Weekly or as required until	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor.

Project Activity	IMPACT MITIGATION				IMPACT MONITORING			
	Potential Environmental Impact	Proposed Mitigation Measure	Implementing Responsibility	Mitigation Cost	Parameter to be Monitored	Frequency & and Means of Verification	Monitoring Responsibility	Monitoring Cost
		plan is to be prepared by the contractor. 2. Plan will outline safe handling, storage and disposal of asbestos material.				task has been completed.		ES costs met by PMU.
Mechanized construction including vehicles transporting materials to site	Noise and vibration	1. Schedule activities during daytime working hours Construction equipment to be well maintained. 2. Noise levels due to construction activities at sensitive receptors shall not exceed 50dB(A) during daytime hours (0700-2300hrs) or 40 dB(A) during night-time hours (2300-0700hrs)	PMU Contractor	Cost included in contractor fees	Check implementation of items 1-4	Weekly or as required until site has been established. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.
	Dust/air pollution Dust and noise pollution (to local communities and workers) are likely to be produced during clearing and grubbing works, machinery /vehicle use of access road and SS/SWYA construction activities. Noise likely to be generated transformers	1. Water to be sprayed on unpaved roads to suppress dust in the vicinity of communities through which transportation of construction materials passes. 2. Vehicles delivering construction materials shall be covered. 3. Vehicles and construction equipment shall comply with statutory emission standards. 4. Community awareness at first instance on potential of producing noise and dust. Provide noise and dust Personal Protection Equipment (PPE) to workers. 5. Monitor and investigate complaints and propose alternative mitigation measures. 6. Locate transformer(s) reasonable distance away from nearest receptor; walls, fencing, and/or greenbelt to provide partial sound barrier from transformer(s).	PMU Contractor	Cost included in contractor fees	Check implementation of items 1-6	Weekly or as required until site has been completed. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.

Project Activity	IMPACT MITIGATION				IMPACT MONITORING			
	Potential Environmental Impact	Proposed Mitigation Measure	Implementing Responsibility	Mitigation Cost	Parameter to be Monitored	Frequency & and Means of Verification	Monitoring Responsibility	Monitoring Cost
Interference with utilities and blockage of access ways	Disruption of community access to amenities and services	Ensure existing access to public and private amenities are maintained throughout construction period	PMU Contractor	Cost included in contractor fees	Check maintenance of access provisions	Weekly or as required until completed. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.
Equipment servicing	Contamination of receptors (land, water, air)	Provision of hard standing areas for equipment servicing, refueling and wash down with drainage directed through oil and grease interceptors	PMU Contractor	Cost included in contractor fees	Check provisions of equipment servicing	Weekly or as required until completed. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.
Storage of chemicals and materials	Contamination of receptors (land, water, air)	Fuel and other hazardous materials securely stored above high flood level in hard standing area undercover surrounded by containment bunds	PMU Contractor	Cost included in contractor fees	Check storage of chemicals and materials	Weekly or as required until completed. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.
Provision of facilities for construction workers	Contamination of receptors (land, water, air)	Construction workforce facilities to include proper sanitation, water supply and waste disposal facilities.	PMU Contractor	Cost included in contractor fees	Check Provision of facilities for construction workers	Weekly or as required until completed. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.
Health and safety	Injury and sickness of workers and members of the public	1. Contractor to comply with WB EHS requirements or equivalent for worker and public safety related to electric power infrastructure including WHO guidelines on COVID 19 in the workplace and construction sites. 2. Contractor to prepare and implement a worker health and safety plan and COVID 19 response plan prior to commencement of construction. 3. Contractor to arrange for health and safety training sessions for workers.	PMU Contractor	Cost included in contractor fees	Check implementation of items 1-3	Weekly or as required until completed. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.

Project Activity	IMPACT MITIGATION				IMPACT MONITORING			
	Potential Environmental Impact	Proposed Mitigation Measure	Implementing Responsibility	Mitigation Cost	Parameter to be Monitored	Frequency & and Means of Verification	Monitoring Responsibility	Monitoring Cost
		Contractor to provide PPE to all its employees.						
Inadequate construction stage monitoring	Likely to maximize damages	1. Implementation of effective environmental monitoring and reporting system using checklist of all contractual environmental requirements. 2. Appropriate contact clauses to ensure satisfactory implementation of contractual environmental mitigation measures.	PMU Contractor	Cost included in contractor fees	Check implementation of items 1-2	Weekly or as required until completed. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.
Vegetation destruction and loss of birds/animal habitat	Loss of domesticated and valuable plants. Loss of food plants. Loss of birds feeding & nesting plants. Disruption of animal breeding area.	1. Consult locals (if any) on their uses and values of plants. 2. Avoid clearing of domesticated or valuable plants. 3. Avoid felling of birds nesting plants. 4. Locate SS/SWYA on disturbed areas away from food gardens. 5, Restrict/minimize plant clearing to access road corridor and SS/SWYA area only.	PMU Contractor	Cost included in contractor fees	Check implementation of items 1-5	Weekly or as required until completed. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.
Petro-chemical spills and water quality impacts	Petrochemical spills from machinery can be washed out by storm water resulting in pollution of streams and impacts of aquatic life.	Do regular servicing of machinery to prevent petrochemical leaks. Store petrochemicals and other toxic substances inside a bunded shed.	PMU Contractor	Cost included in contractor fees	Check petro-chemical spills and water quality impacts	Weekly or as required until completed. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.
Uncontrolled erosion/silt runoff	Soil loss, downstream siltation Spoil soils erosion can contaminate downstream creeks and streams, including drinking water sources. Spoil earth material washout by storm can cause sedimentation/siltation in streams/creeks	1. Minimize/restrict vegetation clearing. 2. Install cut-off drains above excavated areas on steep slopes. 3. Stockpile topsoil away from storm water drains for later use in landscaping or made available to local community for use.	PMU Contractor	Cost included in contractor fees	Check implementation of items 1-5	Weekly or as required until completed. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.

Project Activity	IMPACT MITIGATION				IMPACT MONITORING			
	Potential Environmental Impact	Proposed Mitigation Measure	Implementing Responsibility	Mitigation Cost	Parameter to be Monitored	Frequency & and Means of Verification	Monitoring Responsibility	Monitoring Cost
	(water quality) and affect migration and feeding of aquatic life.	4. Regeneration of vegetation to stabilize works areas on completion (where applicable) 5. Water courses protected from siltation through use of bunds and sediment ponds.						
Sedimentation in streams/creeks & water quality	Foundation excavation for SS/SWYA and access road works will produce earth spoils that can runoff and cause sedimentation of streams/creeks downstream resulting in impairing of water quality and restricting migration/mobility of aquatic life.	1. Schedule excavation works to dry days. 2. Stockpile excavated materials in stable flat areas away from storm water drains. 3. Install riprap traps in sloppy (high gradient) area to prevent erosion of loss spoils.	PMU Contractor	Cost included in contractor fees	Check implementation of items 1-3	Weekly or as required until completed. Verify that contractor/s meet EMP requirements.	Contractor/PMU (Environmental Specialist)	Contractor's monitoring costs met by contractor. ES costs met by PMU.
OPERATION STAGE								
Inadequate provision of staff/workers health and safety during operations	Injury and sickness of staff /workers	1. Careful design using appropriate technologies to minimize hazards. 2. Preparation of fire emergency action plan and training given to staff on implementing action plan. 3. Environmental/Safety Officers of PMU and Contractor to conduct safety inductions to all employees prior to commencement of work. 4, Periodic safety inductions to be conducted by contractor's environmental officer. 5. Contractor to provide PPE to all its employees. 6. Implement approved contractors' Occupational Health and Safety Plan	PNG Power Environmental or Safety Officer SS/SWYA Operation Manager	PNG Power operating cost	Monito items 1-6	Biannual Check completion of items 1-6	PNG Power Environmental or Safety Officer	PNG Power cost
Electric Shock Hazards	Injury/mortality to staff and public	1. Careful design using appropriate technologies to minimize hazards. 2. Security fences around facilities	PNG Power Environmental or Safety Officer SS/SWYA Operation Manager	PNG operating cost	Monito items 1-4	Biannual Check completion of items 1-4	PNG Power Environmental or Safety Officer	PNG Power cost

Project Activity	IMPACT MITIGATION				IMPACT MONITORING			
	Potential Environmental Impact	Proposed Mitigation Measure	Implementing Responsibility	Mitigation Cost	Parameter to be Monitored	Frequency & and Means of Verification	Monitoring Responsibility	Monitoring Cost
		3. Appropriate warning signs on facilities 4. Electricity safety awareness raising in project areas						
Operations and maintenance staff skills less than acceptable	Unnecessary environmental losses of various types	1. Adequate training in O&M to all relevant staff of facility maintenance crews. 2. Preparation and training in the use of O&M manuals and standard operating practices.	PNG Power Environmental or Safety Officer SS/SWYA Operation Manager	PNG operating cost	Monitor items 1-2	Biannual Check completion of items 1-2	PNG Power Environmental or Safety Officer	PNG Power cost
Inadequate periodic environmental monitoring.	Diminished ecological and social values.	O&M staff to receive training in environmental monitoring of project operations and maintenance activities.	PNG Power Environmental or Safety Officer SS/SWYA Operation Manager	PNG Power operating cost	Monitor the incidence of inadequate monitoring	Biannual Check completion of items 1-2	PNG Power Environmental or Safety Officer	PNG Power cost
Oil spillage	Contamination of land/nearby water bodies	1. Oil storage facilities and substation transformers located within secure and impervious bunded areas with a storage capacity of at least 120% of the capacity of tank and oil capacity of transformers. 2. Safe handling and disposal of phased out equipment	PNG Power Environmental or Safety Officer SS/SWYA Operation Manager	PNG Power operating cost	Monitor items 1-2	Biannual Check completion of items 1-2	PNG Power Environmental or Safety Officer	PNG Power cost
Disposal of old/replaced conductors, transformers, switchgear	Abandonment of old/replaced conductors, transformers and switchgear products on site may create unsightly ugly scene. Leakages of transformer oil and polychlorinated biphenyl (PCBs) may impact water sources, aquatic life and human.	1, Temporarily store equipment/parts safely within a shed on site and safely transport to PPL designated or approved storage yards. 2. Store unwanted (used) transformers safely in upright positions to prevent leakage of transformer oils or PCBs.	PNG Power Environmental or Safety Officer SS/SWYA Operation Manager	PNG Power operating cost	Monitor items 1-2	Biannual Check completion of items 1-2	PNG Power Environmental or Safety Officer	PNG Power cost
Hazardous/Toxic Substances Use Risks	Unsafe handling, use, waste disposal of hazardous or toxic chemicals/substances or greenhouse gas (GHG) substances can pollute/impact local	1. Do safety inductions on hazardous/toxic substances to employees. 2. New equipment/facilities specifications shall follow international standards and best practices to avoid use of	PNG Power Environmental or Safety Officer SS/SWYA Operation Manager	PNG Power operating cost	Monitor items 1-4	Biannual Check completion of items 1-4	PNG Power Environmental or Safety Officer	PNG Power cost

Project Activity	IMPACT MITIGATION				IMPACT MONITORING			
	Potential Environmental Impact	Proposed Mitigation Measure	Implementing Responsibility	Mitigation Cost	Parameter to be Monitored	Frequency & and Means of Verification	Monitoring Responsibility	Monitoring Cost
	environment and human.	substances that cause greenhouse gas (GHG) emissions or impact upon humans. 3. All equipment procured under the investment program shall be free from polychlorinated biphenyl (PCBs). 4. Handle, use, storage and disposal that is consistent with international best practices to prevent soil/water contamination and human impact						

D. Monitoring and Reporting

278. **Monitoring**. Environmental monitoring is required across all phases of subproject implementation. The monitoring meets two objectives to ensure: (i) that mitigation measures are effective in reducing/managing impacts and identify corrective actions as required; and (ii) that safeguard requirements are being complied with by the contractor and the implementing agency (on behalf of government). The PMU will have overall responsibility for the management, monitoring and reporting of project implementation. The provincial administrations will receive training and capacity development from the PMU and CSC. The PMU and CSC will be responsible for liaising with the contractor and providing training, advice and assistance in the preparation of the CEMP and its implementation as well as assisting in any baseline and follow-up monitoring required as well as conducting inspections and reporting on implementation of the CEMP (compliance).

279. Throughout implementation of the Project, the government and ADB will monitor the implementation of the approved CEMP as applicable to each subproject. In consultation with PPL and ADB, the PMU will establish a system for preparing semi-annual monitoring reports on environmental performance, issues resolution, and corrective action plans. The extent of monitoring activities, including their scope and periodicity, will be commensurate with the project's risks and impacts. PPL is required to implement safeguard measures and relevant safeguard plans, as provided in the loan agreement. At a minimum, ADB will require PPL to:

(i) Ensure that relevant sections of the EMP are included in the various contract packages' bidding document;
(ii) Establish and maintain procedures to monitor the progress of implementation of the EMP for all contract packages;
(iii) Verify the compliance with environmental measures and their progress toward intended outcomes;
(iv) Document monitoring results and identify necessary corrective and preventive actions in the periodic monitoring reports;
(v) Follow up on these actions to ensure progress toward the desired outcomes; and
(vi) Submit semi-annual environmental monitoring reports on compliance with the approved CEMPs.

280. Environmental monitoring including monitoring/auditing implementation of EMP/CEMP is necessary to determine impacts of the subproject and non-compliances of project's EMP/CEMP. Where impacts or potential issues relating to project are identified through the monitoring process corrective or mitigation actions will be recommended or taken. The semi-annual environmental monitoring reports are part of the overall project monitoring and supervision and will be implemented by the respective contractor under the supervision of the DSC with oversight from the PMU. The PMU is responsible for ensuring that all the environmental monitoring and reporting requirements are met for the project. PPL's environmental officer, the IES and NES will undertake the subproject environmental monitoring and reporting for PPL, and the PPL will submit the environmental assessment reports, monitoring reports and other environmental documents to ADB for review.

281. Monitoring will relate to compliance with construction contract (including EMP measures and provisions), the state and health of the nearby environmental resources and sensitive receptors, and the effectiveness of mitigation measures and complaints.

282. Monthly progress reporting by the contractor will include a summary of the ESO reports (and their site diary notes including corrective action requests and results). The ESO will report

to the PMU on the monitoring parameters contained in Tables 8 and 11, and the PMU will consolidate these reports for submission to ADB.

283. **Pre-construction monitoring**. During the pre-construction phase any gaps in the baseline will be filled. It is in the pre-construction phase where requirements for environmental monitoring in the construction phase can be legally required by placing specific provisions on environmental monitoring in the: (i) subproject specifications, (ii) bidding documents, and (iii) construction contracts. In particular, the CEMP requirement is inserted during the bid documents preparations. Design consultants will prepare the design and tender documents during the pre-construction phase. Relevant aspects of each subproject's EMP shall be incorporated in these documents. The PMU shall verify if these aspects are incorporated in the said documents first during submission of the draft documents and later during submission of the draft final documents.

284. **Construction monitoring**. Contractors are expected to implement the relevant aspects of each subproject's EMP as per their approved CEMP during execution of the construction activities as stipulated in their contracts. The contractors' CEMP will detail the monitoring plan (based on the subproject EMP) with details on staff, resources, implementation schedules, and monitoring procedures (parameters, frequency etc.). Compliance with the approved CEMP will be the basis for inspections and audits by PMU, CSC and ADB. The bid and contract documents will include provisions requiring the contractor to submit their CEMP which will include a section on monitoring which should be linked to allocation of budget and staff for implementation.

285. Inspections and audits will be conducted during construction by Project Engineer, PPL, and PMU/CSC environment personnel. They will be filing reports concerning quality of work, adherence to schedule, potential issues to be addressed. They more often will be recording the inspection with photos. Some inspections will be weekly because of the pace of work and the nature of the item for inspection, sedimentation, for example and other inspections may be monthly, habitat disturbance, for example. Some inspections may increase to daily should there be a need for the change due to environmental conditions—sedimentation control, water quality sampling, for example.

286. **Operation monitoring**. Potential performance indicators include:

(i) number of environmental protective works completed on time and with high quality control;
(ii) no accidents to workers that are protected (goal);
(iii) no complaints from residents regarding noise and dust (goal);
(iv) no accidents with persons falling into excavated areas (goal);
(v) no spillage of liquids, chemicals, materials into water bodies (goal).

287. **Reporting**. Overall, the project will establish a system of reporting. The contractor will prepare monthly reports which will include a section on compliance with the approved CEMP, corrective actions, training, and the like. This will also record any grievances lodged, and project communications undertaken by the contractor. The PMU will review and consolidate information from the monthly reports of all subprojects. The quarterly progress report (QPR) prepared by the PMU will include a section on safeguards implementation summarizing the monthly reports (including training and capacity development activities).

288. A semi-annual safeguards monitoring report will be submitted to ADB. This report will be based on the QPR and will include the environmental performance of each subproject/component.
289. The reporting will be as per the following schedule:

(i) A monthly report prepared by the contractor during construction reporting on progress of CEMP activities, issues and corrective actions;
(ii) A QPR prepared by the PMU. The QPR will include a section on safeguards activities and CEMP compliance for subproject and will summarize the monthly reports submitted by the contractor and any actions or citations made by the Resident Engineer;
(iii) A semi-annual safeguards monitoring report (prepared every 6 months) by Water PNG, submitted to DNPM and ADB and disclosed; and
(iv) The project completion report will include a section on safeguards implementation and make recommendations as required for modifications to the processes set out in the EMP based on the review undertaken at the end of the project. The safeguards section will be prepared by the PMU 3 months prior to the end of the project.

290. Tables 8 and 11 provide the environmental monitoring plan outlining parameters and frequency of monitoring.

VIII. CONCLUSIONS

291. This IEE concludes that the potential environmental impacts arising from design, construction, operation and maintenance of the project will be minor, localized and acceptable provided that the mitigation measures set out in the EMP are incorporated into the design and implemented properly. Key findings from the IEE are summarized as follows:

(i) The examination of the subprojects under this project indicate that the potential environmental impacts are largely minor and restricted to the construction phase of the subproject components. Stakeholder consultations were carried out at all subproject locations to document any issues/concerns and to ensure that such concerns are addressed in the project design. No significant environmental concerns were raised during consultations and the local communities were generally very supportive of the proposed project activities.
(ii) Any potential impacts arising from the design, construction and operation can be mitigated to standard levels without difficulty through proper engineering design and the incorporation or application of recommended mitigation measures and procedures set out in the EMPs and monitoring plans under this IEE.
(iii) Impacts associated with construction disturbances such as dust, noise, traffic disruptions, erosion and sedimentation, and public and worker safety can be managed effectively with standard construction practices and the EHSG.
(iv) EMPs have been prepared for each group of subprojects (transmission and distribution lines and substations and switchyards which describe required actions, responsibilities, procedures, and specific environmental mitigation measures to be applied to each subproject.
(v) The subprojects will be mostly undertaken in highly disturbed locations. Upgrades will be undertaken on some existing substations, as well as new substations and yards constructed on disturbed or secondary regrowth vegetative areas. No substations or switchyards will be located in ecologically or a culturally significant sites or protected area.
(vi) Transmission line subprojects will be mostly undertaken in existing transmission line right-of-way of PPL and over highly disturbed or secondary regrowth vegetation areas. Anticipated environmental impact is low and manageable using best practice standards and controls. None of the transmission line subproject are

to be undertaken within ecologically or culturally sensitive areas or protected area. Lines will be installed along existing roads.

(vii) In general, the subprojects will have negligible to low impacts on the environment. The few potential medium ranked impacts listed in the EMP are manageable or can be reduced through proper induction of project employees and implementing of EMP and CEMP.

(viii) The EMP for the subprojects will provide guide in the implementation of the subprojects. The EMPs identify potential environmental impacts arising from the project along with a corresponding schedule of recommended mitigation measures that will be implemented at each stage of subproject implementation to ensure potential impacts are maintained at insignificant levels and that international best practice is applied.

(ix) Environmental monitoring of each subproject will consist of routine systematic checking that the environmental management measures adopted in the EMP and approved CEMP are implemented effectively during each stage of the project.

292. In conclusion, this IEE and the respective EMPs covering substations, transmission, and distribution line subprojects (and their subsequent updates) are considered sufficient to meet both the SPS and CSS requirements (Schedule 2 EPAR and Environment Act 2000 [as amended]). The IEE will be made available at public locations in the project areas and will be disclosed to a wider audience via the ADB website. The consultation process will be extended through to project implementation to ensure that stakeholders are fully engaged in the project and have the opportunity to participate in its development and implementation.

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APPENDIX 1 – CONSULTATION RECORDS

I. INTRODUCTION

1. A site visit was arranged by the Project Team of SMEC and PPL to review the Grid Strengthening Subprojects of the Gazelle Grid with the proposed Transmission, Substations and Distribution Systems.

2. The purpose is to visit the site locations of these subprojects to verify the areas of the proposed substations of the grid strengthening and upgrade program for the Gazelle Grid System and also inform and consult with the Provincial Government officials.

3. Selected sample subproject areas were visited on the 15 November 2018 for each District/LLG areas for community awareness and assess any environmental impacts of the subproject's areas could have on the communities. The site visit was made on the 12 to 16 November 17 by SMEC & PPL Project Team listed:

(i) **PPL Team –HO & Kokopo Centre Staff**
   (a) Francis Uratun- Manager IP- PPL HO
   (b) Peni Diave- PPL Asset Manager T&D- PPL Kokopo Centre staff
   (c) PPL T&D Kokopo Centre Staff

(ii) **SMEC TEAM**
   (a) Richard Murray- SMEC-TL (International)
   (b) Alan Sewell- Environmental Specialist-(International)
   (c) Velepat Tuaru – Social & Gender (National)
   (d) Francis Iwainde – Environmentalist (National)
   (e) Kingsley Philip- Renewable Energy Engineer (National)
   (f) Joseph Auo – T & D Engineer (National)

4. This report covers the observations, data collected, and discussions held with the various resource PPL officers available during and after the site visit to the existing and new subproject transmission lines, substations, and distribution lines. The Reference drawings used for the site investigation are:

(i) SLD – Gazelle Transmission System Operating Diagram – Drawing No. SOD-Revision dated 2011; and
(ii) Google Earth Maps of the Transmission, Substations and Distribution Subprojects Sites.

II. MEETINGS AND CONSULTATIONS

5. Meetings and Discussions were held with the Governor and the Provincial Government staff and then later with the PPL Senior Centre Staff on Monday 12 November 2018. Separate MoM (RM) attached to the report for the record.

6. The photograph below with the Team and Hon. Nakikus Konga after the meeting.

7. Consultations and dialogue with PPL Senior substations and the line staff and the Provincial Social and Environmental staff were also held during the site visit. Below photograph show the Team.

Meeting with Senior PPL Kokopo Team

Meeting with Social & Environmental Team

8. In the meeting with the Senior PPL staff FM & PD from PPL requested the corporation of staff for the projects to be developed.

9. RM explained the proposed Gazelle Grid subprojects and the connection of the HH.

1. Gazelle Grid Subprojects

10. The following subprojects in Tranche#1 as shown in below table were visited and separately commented in the following sections of the report:

TABLE 1: GAZELLE GRID SUBPROJECTS TRANCH#1 (REF: INCEPTION REPORT)

SP	Description	Location
G1A	66kV TML SC /with 22KV ub	Vandidir to Baliora Switchyard
G1B	66KV Switchyards: 3CB mesh bus with space for future Tx	Vundidir and Baliora
G1B	66kV/22kV Vimmi SS 1x15/20MVA	Vimmi
G1B	Extend Kokopo Substation upgrade Txs	Kokopo
G1B	Consider Rabaul GIS SS	Rabaul
G2A	Backbone 22kV heavy Reinforcement	Gazelle System
G3A	ENB Districts: MV Spur Lines, Tx's, LV and HH connections (NGEP)	Gazelle System

11. The subproject sites listed above were visited including existing Kokopo, Ulangunan and Rabaul (RM & AS) Substations as described below with photographs of the sites.

2. Kokopo Substation

12. Kokopo Substation Transformer technical details are shown in the table below:

No.	Transformer/ Year of Manuf.	Operational Status	No of Windings	Vin/Vout1/ Vout2	Rated Capacity	Vector Group
1	Crompton Greeves-2006	Operational	2	66kV/22kV	15/20MVA	Dyn11

13. The existing substation equipment has been in use for over 30 years and requires upgrading for additional future loads to be connected. The existing transformer purchased in 2006 is still in operational condition. The photographs below show the Kokopo substation Equipment.

14. The photograph shows the 22kV Bus section at Kokopo Sub.

15. The photograph below shows the outgoing feeder poles.

3. Existing Ulangunan Substation

16. The existing 22kV lines runs along the road for approximately 4 km from Kokopo along some sections of winding road to the existing Ulangunan Power Station and Substation with tropical vegetation/secondary growth (banana, coconut, and trees) along the route.

17. Ulangunan Substation Transformer technical details are shown in the table below:

No.	Transforme/ Year of Manuf.	Operational Status	No of Windings	Vin/Vout1/ Vout2	Rated Capacity	Vector Group
1	QRE-2006	Operational	2	66kV/22kV	15MVA	YNd11
2	Crompton Greeves-2006	Spare	2	66kV/22kV	15/20MVA	Dyn11

18. The Photographs below show the Ulangunan Transformer and the Incomer 66kV Line Tee off from the Kokopo- Warangoi 66kV Line.

19. The photo below shows the 15MVA, 66kV/22kV substation.

20. The photo below shows the Incomer 66kV Line.

4. New Proposed Vimmi Substation

21. From Ulangunan Power Station to the new proposed Vimmi substation site is approximately 12kms. The 22kV line route to Gunumur Cocoa Depot located approximately 3km from Ulangunan with isolated villages inland from the road and the vegetation is similar to the route to Ulangunan with balsa trees along the route.

22. The new proposed Vimmi substation site (GPS Location coordinates 04˚24' 41.1''South, 152˚15'10.9''E, Elevation: 172metres ASL- near Tobera village) is located at the junction road approximately 13km from Kokopo.

23. The above photo shows the proposed Vimmi substation site west of the road junction. PPL advise that it is state land and therefore there should be no issues with land. The 22kV distribution line route from Vimmi continues another 6km to the Warangoi tee- junction road. The vegetation along the route is generally secondary growth with sections of balsa trees. The photograph below shows the 22Kv line route with the general vegetation to Warangoi T-junction and fairly flat in elevation.

25. The Warangoi road T-junction has a 90-degree angle steel lattice pole from which the 66kV pole line can be tapped off to the Vimmi proposed substation site. The Total distance is approximately 19km from Kokopo Road junction.

26. The photo below shows the 66kV structure at Warangoi- Vunamami- Vimmi Road Junction.

27. The photo below shows the Warangoi T- junction from Vimmi Substation Site

28. The 66kV and 22kV line routes from the Warangoi T junction road run in parallel to the Vunami Vocational School then to the Baliora junction. The distance to Baliora is approximately 3kms and routes through secondary growth vegetation and is fairly flat in elevation.

29. The photo below shows the 66kV Line and 22kV line.

5. New Proposed Baliora Switchyard

30. The new proposed Baliora switchyard is located on State Land and is on the western side of the Road junction from Warangoi (near Vunamami Vocational School). The below photo shows the proposed site option 1 (Location coordinates: 4˚22’43.7 South, 152˚11’59.7’’ East).

31. The Option 2 site for Baliora switchyard is located approximately 20-50metres away from the existing 66kV Steel lattice Pole. The land is owned by AG Mark Ltd and is on a coconut plantation. This site may require further investigation for suitability.

32. The below photo shows the option 2 site left of the steel lattice pole.

33. The switchyard of the Option 1 site is recommended as the 66kV Line runs in front of the proposed site and can be turned in and out easily with the details to be investigated further.

34. The proposed 66KV SC Transmission Line route from the Baliora proposed switchyard to the proposed Vunadidir (Toma) would generally follow the road easement. However, there are winding sections of the road where the poles would have to be positioned in locations to provide an acceptable line route. The line route at the top of the crest then descends down to the Toma junction however the corridor is narrow and would require selective location of pole sites to maximize the span lengths.

35. The vegetation is generally secondary growth to semi forest in some locations.

36. The below photos show the road easement and line corridor to Vundidir (Toma)

6. New Proposed Vunadidir Toma Swtichyard

37. The proposed option for the Vundidir site is located on customary land and is approximately 500metres from the Toma Road T junction.

38. The new 66kV Line route corridor from the Toma junction would follow the road easement to the proposed new switchyard site which is approximately 500metres from the Toma road junction.

39. Other switchyard sites were also looked at to see if other suitable locations were available. One such site is the location near the Takelkel village which is approximately 2km from the Toma junction.

40. The other site was the location at the Toma Road T junction on the RHS coming from the Toma Hill. See photo below however this site will be the subject of further investigation to confirm the possibility of this site being a switchyard location.

41. Further site visit was made on the Rabaul Kerevat 66kV Transmission line and the section from the Takelkel village (near Tomaringa Police Barracks) then off road thru a track to the Nappapur

villages' then out onto the road crossing to the road to Kerevat town.

7. ENB MV Spur Lines to Villages

42. Site visits of the selected ENB distribution spur lines from the NGEP were selected for site visit and were divided into Districts and agreed with PPL, Velepat- Social, F. Iwainde-Environmental and the SMEC Distribution Team (JA/KP). The object being to get the indication of the people's views to the project of the power lines and the connectivity to the villagers.

43. A project/s were selected for each District and LLG to get a representation of the areas covered in the ENBP under the electrification program in Tranches #1 subprojects selected.

44. The following were the Districts and the LLG areas of the spur lines covered. As is common with all the distribution lines, the spurs followed the road for easement and access requirements and for consultation with the villagers.

(i) Gazelle District (Central Gazelle LLG)-
  (a) The areas covered were the villages of Rakunai, Vunalaka, and Kuraip
  (b) Tinganagalip
(ii) Gazelle District (Toma- Vunadidir LLG)
  (a) Tomanarik
  (b) Takubar
(iii) Kokopo District (Bitapaka LLG)
  (a) Malakuna
  (b) Mukurapau
(iv) Kokopo District (Raluana LLG)
  (a) Ranguna
(v) Rabaul District
  (a) Matupit,1,2,3 &4
  (b) Sikut Settlement

45. Consultation and awareness are important in the process of Project Implementation and therefore the visits were made to the above listed villages with the Provincial Coordinators for the Social and Gender and the Environmental

46. Generally, overall, the people were very receptive of the consultations and welcomed the news of power to eventually reach the villages. Some of the cases not everyone in the village was present as adequate notice was not provided to all the villages for community gathering.

47. Most of the councillors were available and were on the contact list for future notification and would communicate the messages to the community. The Provincial Social and Gender Coordinator-Geraldine Tail Wampo will do interviews with her team in the villages and communicate with SMEC's Velepat Tuaru.

48. The below photograph shows the consultations at each of the villagers.

1. Kokopo District - Bitapaka LLG

	
Makurupau Village	Malakuna Village

	
Rabaul District	Gazelle District

2. Matupit 2- with Councillor Rakunai Village

Kokopo District- Raluana LLG	Gazelle District- Toma LLG
	
Raguna Village	Takubar Village

49. A point of note was a particular village at Takubar that had the road washed away and the river crossing subject to flooding.

50. Photograph to show the access condition of the road and the river crossing flood at Takubar Village Toma LLG.

Meeting:	MOM#1-Gazelle		
Meeting Title:	**ADB TA9428-PNG: Power Sector Development Investment Program**	**Date:**	Monday 12 Nov 2018
Subject:	Meeting TA9428: Provincial Governor and Administrator	**Time:**	13:30
Location:	Governor's Office, Provincial Government Building, Kokopo, ENBP, PNG		
Copies:	File: 5036255-04-MOM; Attendees as below; CC: Bruce Corbet (BC)		
Attendees:	ENBP Govt: Hon. Nakikus Konga MP Governor, (NK), Donald Kunai, Executive Officer (of the Governor), Wilson Matava – Provincial Administrator PPL: Francis Uratun (FU) - Manager Planning, Peni Diave Manager T&D Kokopo Team (PD) SMEC – Richard Murray (RM - T/L), Joseph Auo (JA – T&D Engineer), Alan Sewell (AS-Environmental Specialist), Francis Iwande (FI-Environmental), Kingsley Philipp (KP-Engineer) Attendance registers appended. NONE		
Apologies:	Dr Velepat Tuaru (SMEC Social and Gender Expert – to arrive Tuesday)		

Agenda/Minutes:

Item	Item Details	Actions (by whom & date)
0.0	The meeting purpose was to introduce the Governor to the proposed ADB funded works and for PPL to update current status	
1.0	Welcome, Introduction of Attendees, Apologies & Meeting Agenda	
	1. The Governor welcomed everyone. 2. FU Responded 3. R Murray introduced SMEC team, and brief outline of purpose of visit	
2.0	Discussion	
	4. The Governor outlined his vision for growth in ENBP: ○ Key was adequacy and reliability of power supply. ○ Urgency on new generation, new hydro and rehabilitation of Wairongoi critical. ○ Governor advised he had parties interested in provided expanded generation. 5. RM briefed the governor on proposed funding streams for meeting objectives of NEROP. ○ WB/IFC/IPP partners for generation, ADB for backbone transmission and distribution and donor agencies for household connections including LV. ○ Confirmed ADB loans over three-tranches total USD800m potentially was agreed with Govt of PNG and SMEC were in the process of due diligence. ○ In ENB focus was on reliability and capacity expansion for growth and driving of economic benefits to ENBP. ○ That bidding for works would be on competitive basis.	
	6. FU advise Governor that new generation would also be bid on competitive basis with program in process with IFC for Independent Power Producers (IPP's) to provide the short-mid-term needs for energy and studies for longer term prospects for generation followed up soon. 7. FU Advised the meeting the contract for rehabilitation of	
7.0	Meeting Close: **Time: 1430**	

Meeting:	MOM# 2-Gazelle		
Meeting Title:	**ADB TA9428-PNG: Power Sector Development Investment Program**	**Date:**	Monday 12 Nov 2018
Subject:	Meeting TA9428: Provincial Senior PPL Staff	**Time:**	3:15pm
Location:	Kokopo Hotel, Conference Room, Kokopo, ENBP, PNG		
Copies:	File: 5036255-04-MOM; Attendees as below; CC: Mairawesi Pulayasi (MP)		
Attendees:	PPL: Francis Uratun (FU) - Manager Planning, Peni Diave Manager T&D Kokopo Team (PD), Senior PPL Staff – Kokop. SMEC – Richard Murray (RM - T/L), Joseph Auo (JA – T&D Engineer), Alan Sewell (AS-Environmental Specialist), Francis Iwande (FI-Environmental), Kingsley Philipp (KP-Engineer) Attendance registers appended: PPL Senior Staff –Kokopo		
Apologies:	Dr Velepat Tuaru (SMEC Social and Gender Expert – to arrive Tuesday)		

Agenda/Minutes:

Item	Item Details	Actions (by whom & date)
0.0	The meeting purpose was to introduce to the Senior PPL staff the proposed ADB funded works in ENB Province and for PPL staff to assist the Team in the Study and Implementation.	
1.0	Welcome, Introduction of Attendees, Apologies & Meeting Agenda	
	1. FU & PD welcomed everyone. 2. PD introduced his senior Staff and their roles briefly. 3. R Murray responded & introduced SMEC team, and brief outline of purpose of visit. 4. PD advised his staff to cooperate with the Team while in ENB on the Teams visit.	
2.0	Discussion	
	5. RM briefed the PPL Team on the proposed funding streams for meeting objectives of NEROP ○ WB/IFC/IPP partners for generation, ADB for backbone transmission and distribution and donor agencies for household connections including LV. ○ Confirmed ADB loans over three-tranches total USD800m potentially was agreed with Govt of PNG and SMEC were in the process of due diligence. ○ In ENB focus was on reliability and capacity expansion for growth and driving of economic benefits to ENBP. ○ That bidding for works would be on competitive basis. 6. FU advised that new generation would also be bid on competitive basis with program in process with IFC for Independent Power Producers (IPP's) to provide the short-mid-term needs for energy and studies for longer term prospects for generation followed up soon.	
	7. FU and PD further advised if there were any queries during the Teams visit the respective PPL Kokopo Team would be requested to assist.	
3.0	Meeting Closed: **Time: 4:15pm**	

Meeting:	MOM# 2-Gazelle		
Meeting Title:	**ADB TA9428-PNG: Power Sector Development Investment Program**	**Date:**	Mon 12 Nov 2018
Subject:	Meeting TA9428: Provincial Senior PPL Staff	**Time:**	3:00pm
Location:	Kokopo Hotel, Conference Room, Kokopo, ENBP, PNG		

Attendance Register: PPL Senior Staff Kokopo

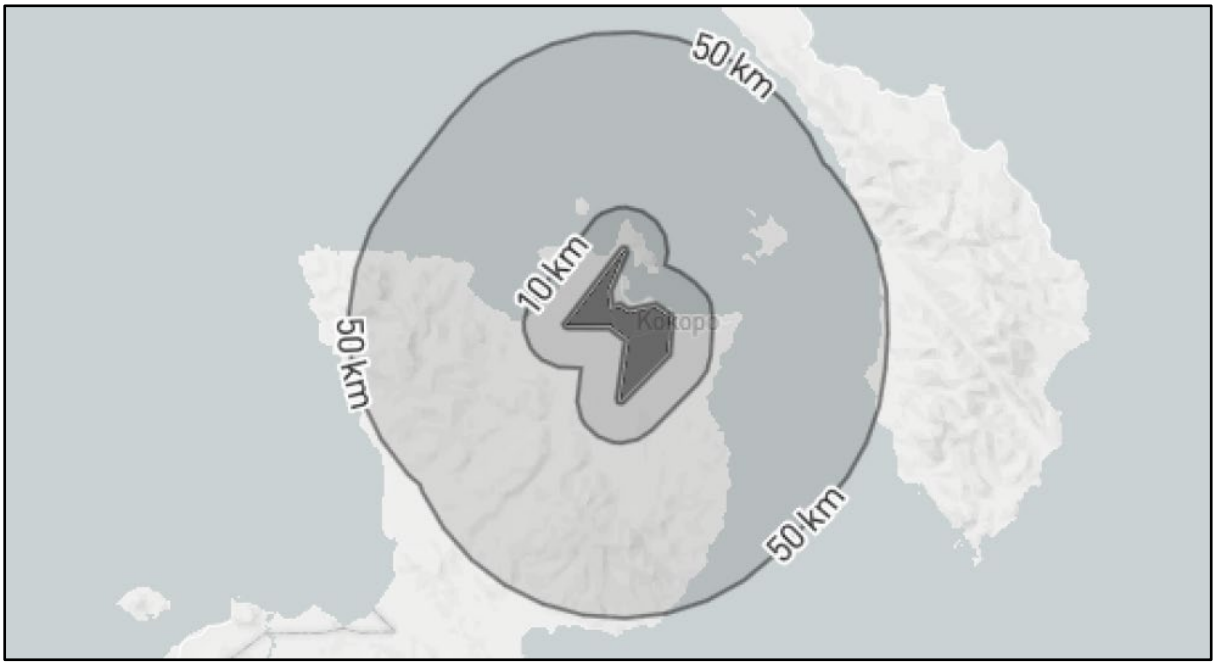
Name	Position	Contact-email
Ronnie Hollies	Transmission Maintenance Coordinator	rhollies@pngpower.com
Joseph Koiri	Team Leader Customer Services	jkoiri@pngpower.com
Peni Diave	Manager Transmission & Distribution	pdiave@pngpower.com
Ilato Fitonoga	Hydro Specialist – Warangoi Hydro	ifitonoga@pngpower.com
David Karigal	Substation Maintenance Coordinator	dkarigal@pngpower.com
Sylvester Goarea	Team Leader Substations	SGoarea@pngpower.com
Russell Choi	Team Leader Gazelle Network	RChoi@pngpower.com

APPENDIX 2 – SUBPROJECT BIODIVERSITY RISK SCREENING SUMMARY

Integrated Biodiversity Assessment Tool

1. GAZELLE

Protected Areas	50 km: **0**	10 km: **0**	1 km: **0**	**0**
World Heritage (WH)	50 km: **0**	10 km: **0**	1 km: **0**	**0**
Key Biodiversity Areas	50 km: **1**	10 km: **1**	1 km: **1**	**3**
Alliance for Zero Extinction (AZE)	50 km: **0**	10 km: **0**	1 km: **0**	**0**
IUCN Red List				42
Critical Habitat				Likely



IUCN Red List of Threatened Species - CR & EN
The following species are potentially found within 50km of the area of interest.

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Eretmochelys imbricata	Hawksbill Turtle	REPTILIA	CR	Decreasing	Terrestrial, Marine

Carcharhinus longimanus	Oceanic Whitetip Shark	CHONDRICHTHYES	CR	Decreasing	Marine
Pristis zijsron	Green Sawfish	CHONDRICHTHYES	CR	Decreasing	Marine
Rhina ancylostoma	Bowmouth Guitarfish	CHONDRICHTHYES	CR	Decreasing	Marine
Rhynchobatus australiae	Bottlenose Wedgefish	CHONDRICHTHYES	CR	Decreasing	Marine
Pristis pristis	Largetooth Sawfish	CHONDRICHTHYES	CR	Decreasing	Marine, Freshwater
Pseudobulweria becki	Beck's Petrel	AVES	CR	Decreasing	Terrestrial, Marine
Glaucostegus typus	Giant Guitarfish	CHONDRICHTHYES	CR	Decreasing	Marine
Beilschmiedia pullenii		MAGNOLIOPSIDA	CR	Unknown	Terrestrial
Lepetodrilus schrolli	Schroll's Dimorphic Limpet	GASTROPODA	CR	Unknown	Marine
Balaenoptera borealis	Sei Whale	MAMMALIA	EN	Increasing	Marine
Balaenoptera musculus	Blue Whale	MAMMALIA	EN	Increasing	Marine
Chelonia mydas	Green Turtle	REPTILIA	EN	Decreasing	Terrestrial, Marine
Oryza schlechteri		LILIOPSIDA	EN	Unknown	Terrestrial
Cryptocarya cordata		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Ficus sciaphila		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial

Stegostoma tigrinum	Zebra Shark	CHONDRICHTHYES	EN	Decreasing	Marine
Mobula tarapacana	Sicklefin Devilray	CHONDRICHTHYES	EN	Decreasing	Marine
Rhincodon typus	Whale Shark	CHONDRICHTHYES	EN	Decreasing	Marine
Horsfieldia ralunensis	Nutmeg	MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Diospyros insularis		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Isurus oxyrinchus	Shortfin Mako	CHONDRICHTHYES	EN	Decreasing	Marine
Carcharhinus amblyrhynchos	Grey Reef Shark	CHONDRICHTHYES	EN	Decreasing	Marine
Anoxypristis cuspidata	Narrow Sawfish	CHONDRICHTHYES	EN	Decreasing	Marine
Pristis clavata	Dwarf Sawfish	CHONDRICHTHYES	EN	Decreasing	Marine
Holothuria scabra	Golden Sandfish	HOLOTHUROIDEA	EN	Decreasing	Marine
Holothuria lessoni	Golden Sandfish	HOLOTHUROIDEA	EN	Decreasing	Marine
Holothuria whitmaei	Black Teatfish	HOLOTHUROIDEA	EN		Marine
Thelenota ananas	Prickly Redfish	HOLOTHUROIDEA	EN	Decreasing	Marine
Mobula birostris	Giant Manta Ray	CHONDRICHTHYES	EN	Decreasing	Marine
Bathymodiolus manusensis	Manus Basin Vent Mussel	BIVALVIA	EN	Unknown	Marine
Mobula mobular	Spinetail Devil Ray	CHONDRICHTHYES	EN	Decreasing	Marine

Mobula thurstoni	Bentfin Devilray	CHONDRICHTHYES	EN	Decreasing	Marine
Isurus paucus	Longfin Mako	CHONDRICHTHYES	EN	Decreasing	Marine
Cantharellus noumeae		ANTHOZOA	EN	Unknown	Marine
Alopias pelagicus	Pelagic Thresher	CHONDRICHTHYES	EN	Decreasing	Marine
Macaranga hartleyana		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Psychotria stevensiana		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Alviniconcha boucheti	Bouchet's Punk-rock Snail	GASTROPODA	EN	Unknown	Marine
Alviniconcha kojimai	Kojima's Punk-rock Snail	GASTROPODA	EN	Unknown	Marine
Ifremeria nautilei	Warty-foot Snail	GASTROPODA	EN	Unknown	Marine
Centrophorus granulosus	Gulper Shark	CHONDRICHTHYES	EN	Decreasing	Marine

Biodiversity features which are likely to trigger Critical Habitat.

Protected Areas

There are no protected areas to show for this report.

Key Biodiversity Areas

The following key biodiversity areas are found within 1 km and 10 km and 50 km of the area of interest.

Area name	Distance	IBA	AZE	Recommendation
Kerevat-Toma	1 km	No	No	Assess for critical habitat
Baining Mountains	10 km	No	No	Assess for critical habitat
Bismarck Sea	50 km	Yes	No	Assess for critical habitat

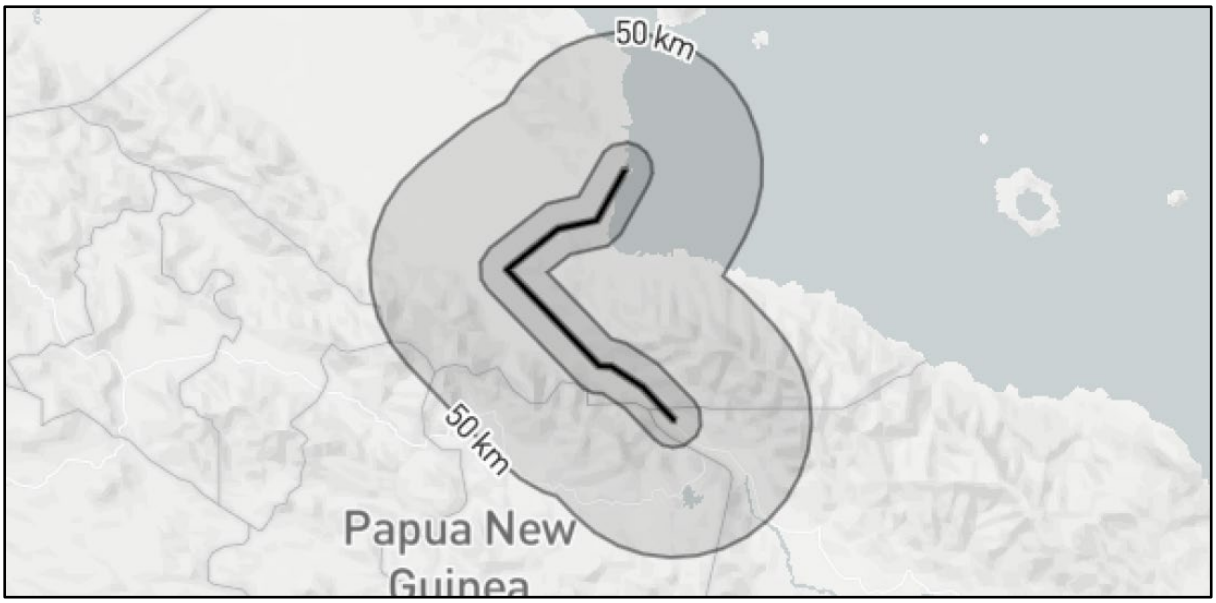
Species with potential to occur

Area Taxonomic group	Total assessed species	Total (CR, EN & VU)	CR	EN	VU	NT	LC	DD
REPTILIA	30	5	1	1	3	0	24	1
CHONDRICHTHYES	46	31	6	13	12	8	5	2
AVES	209	14	1	0	13	20	174	1
MAGNOLIOPSIDA	114	9	1	6	2	1	102	2
GASTROPODA	138	4	1	3	0	0	131	3
MAMMALIA	84	6	0	2	4	5	68	5

ANTHOZOA	492	135	0	1	134	135	202	20
HOLOTHUROIDEA	49	9	0	4	5	0	23	17
BIVALVIA	4	1	0	1	0	0	1	2
LILIOPSIDA	31	2	0	1	1	1	28	0
ACTINOPTERYGII	1520	11	0	0	11	9	1446	54
AMPHIBIA	20	2	0	0	2	1	15	2
INSECTA	58	0	0	0	0	1	48	9
HYDROZOA	6	0	0	0	0	1	5	0
MALACOSTRACA	25	0	0	0	0	0	20	5
POLYPODIOPSIDA	1	0	0	0	0	0	1	0
ARACHNIDA	4	0	0	0	0	0	3	1

2. RAMU-MADANG

Protected Areas	50 km: **2**	10 km: **7**	1 km: **1**	**10**
World Heritage (WH)	50 km: **0**	10 km: **0**	1 km: **0**	**0**
Key Biodiversity Areas	50 km: **7**	10 km: **1**	1 km: **2**	**10**
Alliance for Zero Extinction (AZE)	50 km: **0**	10 km: **0**	1 km: **0**	**0**
IUCN Red List				**82**
Critical Habitat				Likely



IUCN Red List of Threatened Species - CR & EN
The following species are potentially found within 50km of the area of interest.

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Eretmochelys imbricata	Hawksbill Turtle	REPTILIA	CR	Decreasing	Terrestrial, Marine
Spilocuscus rufoniger	Black-spotted Cuscus	MAMMALIA	CR	Decreasing	Terrestrial
Carcharhinus hemiodon	Pondicherry Shark	CHONDRICHTHYES	CR	Unknown	Marine
Carcharhinus longimanus	Oceanic Whitetip Shark	CHONDRICHTHYES	CR	Decreasing	Marine
Sphyrna mokarran	Great Hammerhead	CHONDRICHTHYES	CR	Decreasing	Marine
Pristis zijsron	Green Sawfish	CHONDRICHTHYES	CR	Decreasing	Marine
Rhina ancylostoma	Bowmouth Guitarfish	CHONDRICHTHYES	CR	Decreasing	Marine
Rhynchobatus australiae	Bottlenose Wedgefish	CHONDRICHTHYES	CR	Decreasing	Marine

Centrophorus atromarginatus	Dwarf Gulper Shark	CHONDRICHTHYES	CR	Decreasing	Marine
Pristis pristis	Largetooth Sawfish	CHONDRICHTHYES	CR	Decreasing	Marine, Freshwater
Glaucostegus typus	Giant Guitarfish	CHONDRICHTHYES	CR	Decreasing	Marine
Actinodaphne ledermannii		MAGNOLIOPSIDA	CR	Unknown	Terrestrial
Antiaropsis uniflora		MAGNOLIOPSIDA	CR	Decreasing	Terrestrial
Barringtonia serenae		MAGNOLIOPSIDA	CR	Decreasing	Terrestrial
Mischarytera bullata		MAGNOLIOPSIDA	CR	Unknown	Terrestrial
Balaenoptera borealis	Sei Whale	MAMMALIA	EN	Increasing	Marine
Balaenoptera musculus	Blue Whale	MAMMALIA	EN	Increasing	Marine
Chelonia mydas	Green Turtle	REPTILIA	EN	Decreasing	Terrestrial, Marine
Dendrolagus goodfellowi	Goodfellow's Tree Kangaroo	MAMMALIA	EN	Decreasing	Terrestrial
Dendrolagus matschiei	Huon Tree Kangaroo	MAMMALIA	EN	Decreasing	Terrestrial
Glossolepis maculosus	Spotted Rainbowfish	ACTINOPTERYGII	EN	Unknown	Freshwater
Pteropus conspicillatus	Spectacled Flying Fox	MAMMALIA	EN	Decreasing	Terrestrial

Rhincodon typus	Whale Shark	CHONDRICHTHYES	EN	Decreasing	Marine
Thylogale calabyi	Calaby's Pademelon	MAMMALIA	EN	Decreasing	Terrestrial
Pterocarpus indicus	Burmese Rosewood	MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Isurus oxyrinchus	Shortfin Mako	CHONDRICHTHYES	EN	Decreasing	Marine
Carcharhinus amblyrhynchos	Grey Reef Shark	CHONDRICHTHYES	EN	Decreasing	Marine
Anoxypristis cuspidata	Narrow Sawfish	CHONDRICHTHYES	EN	Decreasing	Marine
Pristis clavata	Dwarf Sawfish	CHONDRICHTHYES	EN	Decreasing	Marine
Centrophorus uyato	Little Gulper Shark	CHONDRICHTHYES	EN	Decreasing	Marine
Stegostoma tigrinum	Zebra Shark	CHONDRICHTHYES	EN	Decreasing	Marine
Choerophryne gudrunae		AMPHIBIA	EN	Decreasing	Terrestrial
Mobula tarapacana	Sicklefin Devilray	CHONDRICHTHYES	EN	Decreasing	Marine
Mobula thurstoni	Bentfin Devilray	CHONDRICHTHYES	EN	Decreasing	Marine
Isurus paucus	Longfin Mako	CHONDRICHTHYES	EN	Decreasing	Marine
Cantharellus noumeae		ANTHOZOA	EN	Unknown	Marine

Thylogale lanatus	Mountain Pademelon	MAMMALIA	EN	Decreasing	Terrestrial
Dendrolagus notatus		MAMMALIA	EN	Decreasing	Terrestrial
Alopias pelagicus	Pelagic Thresher	CHONDRICHTHYES	EN	Decreasing	Marine
Holothuria scabra	Golden Sandfish	HOLOTHUROIDEA	EN	Decreasing	Marine
Holothuria lessoni	Golden Sandfish	HOLOTHUROIDEA	EN	Decreasing	Marine
Holothuria whitmaei	Black Teatfish	HOLOTHUROIDEA	EN		Marine
Thelenota ananas	Prickly Redfish	HOLOTHUROIDEA	EN	Decreasing	Marine
Mobula birostris	Giant Manta Ray	CHONDRICHTHYES	EN	Decreasing	Marine
Numenius madagascariensis	Far Eastern Curlew	AVES	EN	Decreasing	Terrestrial, Marine, Freshwater
Calidris tenuirostris	Great Knot	AVES	EN	Decreasing	Terrestrial, Marine
Oreophryne cameroni		AMPHIBIA	EN	Decreasing	Terrestrial
Mobula mobular	Spinetail Devil Ray	CHONDRICHTHYES	EN	Decreasing	Marine
Oryza schlechteri		LILIOPSIDA	EN	Unknown	Terrestrial
Etlingera grandiflora		LILIOPSIDA	EN	Stable	Terrestrial

Calostoma insigne		AGARICOMYCETES	EN	Decreasing	Terrestrial
Erythrina merrilliana		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Rhododendron multinervium		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Aidia waugia		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Aporosa reticulata		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Barringtonia tagala		MAGNOLIOPSIDA	EN	Stable	Terrestrial
Beilschmiedia podagrica		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Canarium macadamii		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Carpodetus montanus		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Claoxylon porphyrostemon		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Croton pilophorus		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Crudia katikii		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Cryptocarya apamifolia		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Cryptocarya hartleyi		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Cryptocarya magnifolia		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Cryptocarya nothofagetorum		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Cryptocarya splendens		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Cynometra katikii		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial

Dillenia fagifolia		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Discocalyx brassii		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Eleutherostylis renistipulata		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Endiandra carrii		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Endiandra engleriana		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Endiandra sleumeri		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Fontainea borealis		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Psychotria chonantha		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Psychotria kelelensis		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Psychotria marafungaensis		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Psychotria phaeochlamysioides		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Litsea trichophylla		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Astronia arborea		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Astronia grandiflora		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial

Biodiversity features which are likely to trigger Critical Habitat

Protected Areas

The following protected areas are found within 1 km and 10 km and 50 km of the area of interest.

Area name	Distance	IUCN Category	Status	Designation	Recommendation
Balek	1 km	Not Reported	Designated	Wildlife Sanctuary	Assess for biodiversity risk
Laugum	10 km	Not Reported	Proposed	Wildlife Management Area	Assess for biodiversity risk
Laugum Marine	10 km	Not Reported	Designated	Locally Managed Marine Area	Assess for biodiversity risk
Sinub	10 km	III	Proposed	Wildlife Management Area	Assess for biodiversity risk
Sinub Island Marine	10 km	Not Reported	Designated	Locally Managed Marine Area	Assess for biodiversity risk
Tab Island	10 km	Not Reported	Designated	Locally Managed Marine Area	Assess for biodiversity risk
Tabad Island	10 km	Not Reported	Designated	Wildlife Management Area	Assess for biodiversity risk
Tabad Island Marine	10 km	Not Reported	Designated	Locally Managed Marine Area	Assess for biodiversity risk
Mt Gahavisuka	50 km	Not Reported	Designated	Provincial Park	Assess for biodiversity risk
Mt Wilhelm	50 km	Not Reported	Designated	National Park	Assess for biodiversity risk

Key Biodiversity Areas

The following key biodiversity areas are found within 1 km and 10 km and 50 km of the area of interest.

Area name	Distance	IBA	AZE	Recommendation
Adjum	1 km	No	No	Assess for critical habitat
Usino	1 km	No	No	Assess for critical habitat
Huon Peninsula	10 km	No	No	Assess for critical habitat
Galisakan	50 km	No	No	Assess for biodiversity risk
Mendi	50 km	No	No	Assess for critical habitat
Mount Otto	50 km	No	No	Assess for biodiversity risk
Mount Wilhelm	50 km	No	No	Assess for critical habitat
Okapa	50 km	No	No	Assess for critical habitat
Pundibasa	50 km	No	No	Assess for critical habitat
Waffa	50 km	No	No	Assess for critical habitat

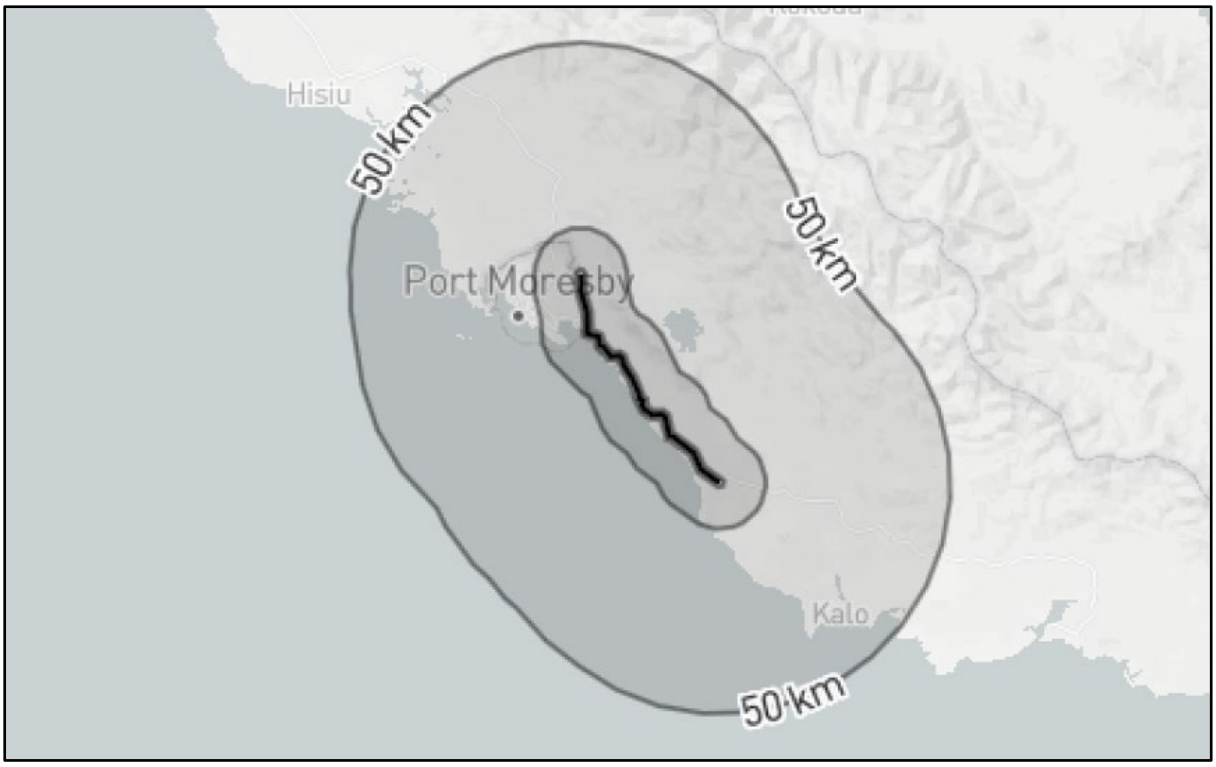
Species with potential to occur

Area Taxonomic group	Total assessed species	Total (CR, EN & VU)	CR	EN	VU	NT	LC	DD
REPTILIA	45	6	1	1	4	0	38	1
MAMMALIA	156	13	1	8	4	6	130	7
CHONDRICHTHYES	63	39	9	13	17	12	11	1
MAGNOLIOPSIDA	482	61	4	32	25	11	396	14
ACTINOPTERYGII	1609	13	0	1	12	7	1517	72
AMPHIBIA	73	2	0	2	0	1	67	3

POLYPODIOPSIDA	2	0	0	0	0	0	2	0
ANTHOZOA	463	118	0	1	117	128	198	19
HOLOTHUROIDEA	50	9	0	4	5	0	24	17
AVES	465	9	0	2	7	16	438	2
LILIOPSIDA	59	3	0	2	1	0	54	2
AGARICOMYCETES	1	1	0	1	0	0	0	0
INSECTA	93	0	0	0	0	2	80	11
HYDROZOA	6	0	0	0	0	1	5	0
MALACOSTRACA	30	0	0	0	0	0	24	6
GASTROPODA	145	0	0	0	0	0	140	5
BIVALVIA	4	0	0	0	0	0	1	3
JUNGERMANNIOPSIDA	1	0	0	0	0	0	1	0
ARACHNIDA	3	0	0	0	0	0	3	0
MYXINI	1	0	0	0	0	0	0	1

2. PORT MORESBY

Protected Areas	50 km: **0**	10 km: **4**	1 km: **0**	**4**
World Heritage (WH)	50 km: **0**	10 km: **0**	1 km: **0**	**0**
Key Biodiversity Areas	50 km: **2**	10 km: **3**	1 km: **2**	**7**
Alliance for Zero Extinction (AZE)	50 km: **0**	10 km: **1**	1 km: **0**	**1**
IUCN Red List				70
Critical Habitat				Likely



IUCN Red List of Threatened Species - CR & EN
The following species are potentially found within 50km of the area of interest.

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Eretmochelys imbricata	Hawksbill Turtle	REPTILIA	CR	Decreasing	Terrestrial, Marine
Pharotis imogene	Thomas's Big-eared Bat	MAMMALIA	CR	Stable	Terrestrial

Carcharhinus hemiodon	Pondicherry Shark	CHONDRICHTHYES	CR	Unknown	Marine
Carcharhinus longimanus	Oceanic Whitetip Shark	CHONDRICHTHYES	CR	Decreasing	Marine
Sphyrna lewini	Scalloped Hammerhead	CHONDRICHTHYES	CR	Decreasing	Marine
Sphyrna mokarran	Great Hammerhead	CHONDRICHTHYES	CR	Decreasing	Marine
Pristis zijsron	Green Sawfish	CHONDRICHTHYES	CR	Decreasing	Marine
Rhina ancylostoma	Bowmouth Guitarfish	CHONDRICHTHYES	CR	Decreasing	Marine
Rhynchobatus australiae	Bottlenose Wedgefish	CHONDRICHTHYES	CR	Decreasing	Marine
Bruguiera hainesii		MAGNOLIOPSIDA	CR	Decreasing	Terrestrial, Marine
Pristis pristis	Largetooth Sawfish	CHONDRICHTHYES	CR	Decreasing	Marine, Freshwater
Glaucostegus typus	Giant Guitarfish	CHONDRICHTHYES	CR	Decreasing	Marine
Psychotria lolokiensis		MAGNOLIOPSIDA	CR	Unknown	Terrestrial
Bridelia triplocarya		MAGNOLIOPSIDA	CR	Decreasing	Terrestrial
Endiandra archboldiana		MAGNOLIOPSIDA	CR	Unknown	Terrestrial
Endiandra faceta		MAGNOLIOPSIDA	CR	Unknown	Terrestrial
Endiandra macrostemon		MAGNOLIOPSIDA	CR	Unknown	Terrestrial

Fontainea subpapuana		MAGNOLIOPSIDA	CR	Decreasing	Terrestrial
Litsea perlucida		MAGNOLIOPSIDA	CR	Unknown	Terrestrial
Litsea mafuluensis		MAGNOLIOPSIDA	CR	Unknown	Terrestrial
Balaenoptera borealis	Sei Whale	MAMMALIA	EN	Increasing	Marine
Balaenoptera musculus	Blue Whale	MAMMALIA	EN	Increasing	Marine
Chelonia mydas	Green Turtle	REPTILIA	EN	Decreasing	Terrestrial, Marine
Dendrolagus goodfellowi	Goodfellow's Tree Kangaroo	MAMMALIA	EN	Decreasing	Terrestrial
Ornithoptera alexandrae	Queen Alexandra's Birdwing	INSECTA	EN	Unknown	Terrestrial
Peroryctes broadbenti	Giant Bandicoot	MAMMALIA	EN	Decreasing	Terrestrial
Pteropus conspicillatus	Spectacled Flying Fox	MAMMALIA	EN	Decreasing	Terrestrial
Rhincodon typus	Whale Shark	CHONDRICHTHYES	EN	Decreasing	Marine
Pterocarpus indicus	Burmese Rosewood	MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Isurus oxyrinchus	Shortfin Mako	CHONDRICHTHYES	EN	Decreasing	Marine
Carcharhinus amblyrhynchos	Grey Reef Shark	CHONDRICHTHYES	EN	Decreasing	Marine
Anoxypristis cuspidata	Narrow Sawfish	CHONDRICHTHYES	EN	Decreasing	Marine

Pristis clavata	Dwarf Sawfish	CHONDRICHTHYES	EN	Decreasing	Marine
Eusphyra blochii	Winghead Shark	CHONDRICHTHYES	EN	Decreasing	Marine
Stegostoma tigrinum	Zebra Shark	CHONDRICHTHYES	EN	Decreasing	Marine
Mobula tarapacana	Sicklefin Devilray	CHONDRICHTHYES	EN	Decreasing	Marine
Mobula thurstoni	Bentfin Devilray	CHONDRICHTHYES	EN	Decreasing	Marine
Isurus paucus	Longfin Mako	CHONDRICHTHYES	EN	Decreasing	Marine
Cantharellus noumeae		ANTHOZOA	EN	Unknown	Marine
Alopias pelagicus	Pelagic Thresher	CHONDRICHTHYES	EN	Decreasing	Marine
Holothuria scabra	Golden Sandfish	HOLOTHUROIDEA	EN	Decreasing	Marine
Holothuria lessoni	Golden Sandfish	HOLOTHUROIDEA	EN	Decreasing	Marine
Holothuria whitmaei	Black Teatfish	HOLOTHUROIDEA	EN		Marine
Thelenota ananas	Prickly Redfish	HOLOTHUROIDEA	EN	Decreasing	Marine
Mobula birostris	Giant Manta Ray	CHONDRICHTHYES	EN	Decreasing	Marine
Numenius madagascariensis	Far Eastern Curlew	AVES	EN	Decreasing	Terrestrial, Marine, Freshwater
Calidris tenuirostris	Great Knot	AVES	EN	Decreasing	Terrestrial, Marine
Mobula mobular	Spinetail Devil Ray	CHONDRICHTHYES	EN	Decreasing	Marine

Oryza schlechteri		LILIOPSIDA	EN	Unknown	Terrestrial
Calostoma insigne		AGARICOMYCETES	EN	Decreasing	Terrestrial
Planchonella suboppositifolia		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Aidia waugia		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Aporosa reticulata		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Archidendron glandulosum		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Cryptocarya fluminensis		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Cryptocarya globosa		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Cryptocarya parallelinervia		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Cryptocarya subbullata		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Elaeocarpus hartleyi		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Endiandra invasiorum		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Ficus rigo		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Koilodepas homaliifolium		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Macaranga hartleyana		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Cynometra fortuna-tironis		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Psychotria mafuluensis		MAGNOLIOPSIDA	EN	Unknown	Terrestrial

Psychotria sphaerothyrsa		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Rhadinopus kurivana		MAGNOLIOPSIDA	EN	Decreasing	Terrestrial
Astronia arborea		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Litsea crenata		MAGNOLIOPSIDA	EN	Unknown	Terrestrial
Phoebe clemensii		MAGNOLIOPSIDA	EN	Unknown	Terrestrial

Biodiversity features which are likely to trigger Critical Habitat.

Protected Areas

The following protected areas are found within 1 km and 10 km and 50 km of the area of interest.

Area name	Distance	IUCN Category	Status	Designation	Recommendation
Iomare	10 km	Not Reported	Designated	Wildlife Management Area	Assess for biodiversity risk
Namanatabu	10 km	Not Reported	Designated	Reserve	Assess for biodiversity risk
Varirata	10 km	Not Reported	Designated	National Park	Assess for biodiversity risk
Zo-oimaga	10 km	Not Reported	Designated	Wildlife Management Area	Assess for biodiversity risk

Key Biodiversity Areas

The following key biodiversity areas are found within 1 km and 10 km and 50 km of the area of interest.

Area name	Distance	IBA	AZE	Recommendation
Hiri	1 km	No	No	Assess for critical habitat
Variarata	1 km	No	No	Assess for critical habitat
Goubia	10 km	No	No	Assess for critical habitat
Kemp Welch River	10 km	No	Yes	Highest risk. Seek expert help
Zo-oimaga WMA	10 km	No	No	Assess for critical habitat
Iomare WMA	50 km	No	No	Assess for critical habitat
Vanapa River	50 km	No	No	Assess for critical habitat

Species with potential to occur:

Area Taxonomic group	Total assessed species	Total (CR, EN & VU)	CR	EN	VU	NT	LC	DD
REPTILIA	67	7	1	1	5	1	55	4
MAMMALIA	153	13	1	5	7	8	125	7
CHONDRICHTHYES	68	44	9	13	22	13	10	1
MAGNOLIOPSIDA	383	47	9	21	17	7	322	7
INSECTA	58	1	0	1	0	2	50	5
ANTHOZOA	405	88	0	1	87	117	188	12
HOLOTHUROIDEA	50	9	0	4	5	0	24	17
AVES	492	9	0	2	7	13	469	1
LILIOPSIDA	54	1	0	1	0	1	51	1
AGARICOMYCETES	1	1	0	1	0	0	0	0

ACTINOPTERYGII	1529	11	0	0	11	10	1452	56
HYDROZOA	6	0	0	0	0	1	5	0
MALACOSTRACA	30	0	0	0	0	0	23	7
AMPHIBIA	42	0	0	0	0	0	40	2
GASTROPODA	143	0	0	0	0	0	140	3
POLYPODIOPSIDA	2	0	0	0	0	0	2	0
BIVALVIA	5	0	0	0	0	0	2	3
ARACHNIDA	3	0	0	0	0	0	3	0