

Environment Assessment Document

Initial Environmental Examination

Town Electrification Investment Project Tranche 2

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Annex 1 – EMP Matrix

Annex 2 – Environmental Monitoring Plan

ABBREVIATIONS

ABC	–	Aerial bundled conductor
ADB	–	Asian Development Bank
AP	–	Affected person/s
B&C	–	Bid and Contract Document
CEP	–	Contractor's Environmental Plan (prepared by contractor)
DE	–	Design Engineer
CEPA	–	Conservation and Environment Protection Authority
EARF	–	Environmental and Review Framework
EIA	–	Environmental Impact Assessment
EMP	–	Environmental Management Plan
EO	–	Environmental Officer (in PMU)
GRM	–	Grievance Redress Mechanism
HPP	–	Hydropower plant
IEE	–	Initial Environmental Examination
JPRF	–	Japan Poverty Reduction Fund
kW	–	kilowatt
LLG	–	Local Level Government
MFF	–	multi tranche financing facility
MSDS	–	Material safety Data Sheet
MW	–	megawatt
NTU	–	Nephelometric Turbidity Unit
PE	–	Project Engineer (in PMU, responsible for construction supervision)
PM	–	Project Manager
PMU	–	Project Management Unit
PPL	–	PNG Power Ltd
PPTA	–	Project Preparation Technical Assistance
RP	–	Resettlement Plan
ROW	–	right of way
SDS	–	Social Development Specialist
SE	–	Site Engineer (Contractor's representative)
TEIP	–	Town Electrification Investment Project

EXECUTIVE SUMMARY

1. Three initial environmental examinations (IEE) for the Town Electrification Investment Project (TEIP) Tranche 1 covering Divune and Ramazon Hydro Power Projects in Oro (Northern) province and Autonomous Region of Bougainville (ABG) and Bialla – Kimbe Transmission Line have been completed. This IEE covers TEIP Tranche 2 component (referred to as the subproject) which includes (i) upgrading of the Lake Hargy hydropower plant (HPP), and (ii) 2,500 distribution connections to villages along the alignment of the TEIP transmission lines in (i) Northern Province (700 connections), (ii) WNB (1,200 connections), and (iii) ABG (600 connections).
2. The Lake Hargy HPP upgrade involves the upgrading of one generator and supporting equipment within the plant. The 2,500 distribution connections are to villages, vocational and community schools and mission stations along the route of the TEIP Tranche 1 transmission lines.
3. The IEE report has reviewed the environmental impacts associated with the sub-project and has developed an environmental management plan (EMP) to address these activities. Overall there are few impacts associated with the upgrade of the Lake Hargy Hydro Power Plant and the distribution connection to the 2500 clienteles of the TEIP subproject.
4. The Lake Hargy HPP upgrade will involve a governor system upgrade to a modern refitting of equipment and all refitting work will be contained within the premises of the HPP. For the distributor connections, the scope of work will involve installation of 25 – 100kVa transformers, underhung low voltage (LV) hardware, LV Poles, single and three phase LV distributors and 6mm₂ and 10mm₂ consumers connectors.
5. Minimal clearing will be required when LV poles are erected together with transformers and LV lines will be laid along the length of the connection poles to households or infrastructure and the impact on the undergrowth or shrubs will be minimal during the period of the lines laid down. After that impact will be negligible.
6. All other construction impacts if any are addressed by the EMP. During construction the contractor will be initially responsible for monitoring and supervising compliance with the EMP. The Project Engineer (PE) will be assisted by the Environmental Officer (EO) to supervise the contractor while the EO will monitor the work and report any defects to the PE as required. The local community will be encouraged to seek work on the limited erection and lines laying in the subproject and will be advised of opportunities through awareness meetings between PNG Power Limited (PPL) and this will commence during pre-construction.
7. The project will be managed by PPL as the implementing agency. PPL has already established a Project Management Unit (PMU) for TEIP headed by a Project Manager (PM) and includes engineering and social and environmental staff. Three staff responsible for safeguards have already been appointed to the PMU; an Environmental Officer (EO), a Land Acquisition Officer (LAO), and a Community Development Officer (CDO). The EO will be supported by an internationally recruited Environmental Specialist (ES) to provide support in strengthening the linkage of the EMP with the contractual documents as well as supporting the environmental program during pre-construction and construction. Recommendations are made within the EMP for including work requirements in the Statement of Duties for the PM and PE to harmonise their duties with the application of the environmental safeguards.
8. The IEE concludes that the project has few adverse impacts and all can be satisfactorily mitigated and/or managed and that no further assessment is required. The subproject will need to be approved by Conservation and Environment Protection Authority who will issue an environmental permit for the subproject to proceed.

I. INTRODUCTION

1. The Government of Papua New Guinea (the government) has requested the Asian Development Bank (ADB) provide financing for Tranche 2 of the Town Electrification Investment Project (TEIP). Tranche 2 allows for the upgrading of the existing Lake Hargy hydropower plant (HPP) so that it can supply maximum electricity throughput. In addition, the TEIP AF allows for 2,500 distribution connections to villages, schools, mission and other infrastructures along the route of the TEIP Transmission Lines.
2. The executing agency for the TEIP is PNG Power Limited (PPL). It is also the implementing agency through a project management unit (PMU). PNG Power Ltd is a State Owned Enterprise (SOE) through the Independent Public Business Corporation (IPBC) that is responsible for the generation and distribution of electricity throughout PNG.
3. This initial environmental examination (IEE) presents the environmental assessment of the TEIP Tranche 2. The IEE has been carried out in compliance with the ADB Safeguard Policy Statement 2009 (SPS).
4. The main purpose of the IEE is to assess the location and upgrading work of the Lake Hargy HPP and the 2,500 distribution connections to villages, schools, missions along the TEIP transmission lines in the Northern and West New Britain Provinces and the Autonomous Region of Bougainville (Figure 1). The IEE has been submitted to the ADB by PNG Power Ltd. A separate report to meet government environmental requirements in accordance with the Environment Act 2000 and associated regulatory tools will be submitted to the Conservation and Environment Protection Authority (CEPA¹) for evaluation and issuance of relevant environmental permits.

A. Overview

5. Approximately 90% of the population of PNG live in highly dispersed and culturally diverse rural settlements that are isolated from each other by rugged topography. While PNG has adequate hydropower resources the development and distribution of power from these resources is difficult due to the scattered population, low population densities, the rugged topography and low ability to pay. Electricity grids that do exist are isolated and clustered around the main population centres. Small provincial and district centres have traditionally relied on diesel generation. However, with increasing fuel prices and high maintenance costs many of these systems are now in need of replacement. PPL is now considering replacing or reducing reliance on these systems with hydropower generation.

B. Objectives and Scope of the IEE

6. The objectives of the IEE are to:
 - Assess the upgrading work on the Lake Hargy HPP and surrounding environment including the identification of environmentally sensitive areas; also assess the 2,500 distribution connection to villages, schools and missions along the alignment of the TEIP transmission lines.

¹ Formerly the Department of Environment and Conservation. CEPA is in operation from 2015 onwards.

- Assess the proposed location, design, construction and operation activities to identify and evaluate their potential impacts, and determine their significance; and
- Propose appropriate mitigation and monitoring measures that can be incorporated into an environmental management plan (EMP) that will avoid or minimize adverse impacts so that residual impacts are reduced to acceptable levels.

C. Report Structure

7. The report structure follows the format outlined in Annex to Appendix 1 of the SPS. The IEE consists of eleven sections: executive summary; introduction; policy, legal and administrative framework; description of the subproject; description of the environment (baseline conditions); anticipated environmental impacts and mitigation measures; analysis of alternatives; information disclosure, consultation, and participation; grievance redress mechanism; the EMP; and, conclusions and recommendations. The EMP matrix is presented in Annex 1, and the monitoring plan in Annex 2.

9. The Environment Act 2000 caters for the sustainable management of the biological and physical components of the land, air and water resources of the country. Other related legislation administered by CEPA includes; the Fauna (Protection and Control) Act (1966) the Conservation Areas Act (1978), the International (Fauna and Flora) Trade Act (1978), the Crocodile Trade (Protection) Act (1978) and the National Parks Act (1984).

10. The Environment (Prescribed Activities) Regulation 2002 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 sub-categories with sub-category 10 addressing Energy Production. Item 10.1 in this sub-category includes *Operation of hydroelectric plants with a capacity of more than 2 MW*. Sub category 12 also applies to this project and Item 12.6 covers the construction of electricity transmissions lines or pipelines greater than 10 kms in length.

11. Projects that have more adverse environmental impact are designated in Schedule 2 as Level 3 Activities and only apply to major hydropower schemes with reservoirs inundating an area greater than 5km². All hydropower projects that meet any of these requirements are required to prepare a Notification of Preparatory Works which is submitted to the Conservation and Protection Authority (CEPA) who review the Notification and then advise the level of investigation required. A Notification will be prepared for this project and submitted to CEPA for its assessment. At this stage, this development falls into a level 2B activity requiring PPL to submit an Environmental Application which is in a similar format to the IEE. Following approval CEPA issue an Environmental Permit (EP). A project cannot proceed until the EP has been granted.

12. The CEPA is responsible for the administration and enforcement of the Environment Act 2000 and its regulations. As the governments environmental management agency, the mission statement of CEPA is: *To ensure PNG’s natural resources are managed to sustain environmental quality, human well-being and support improved standards of living*². The department consists of three divisions: Environment Protection which is responsible for environmental approvals, Sustainable Environment Management and Policy Coordination and Evaluation. The current organisation structure consists of about 200 positions and about 170 are currently occupied.

13. CEPA has also issued several guidelines including:

- Guideline for submission of an application for an environmental permit to discharge waste. *GL-Env/03/2004*. These include:
 - Noise discharges. *IB-ENV/03/2004*
 - Air discharges. *IB-ENV/02/2004*
 - Water and Land Discharges. *IB-ENV/04/2004*

14. CEPA operates at the national level from its office based in Port Moresby. It does not have offices and personnel in the provinces. As part of the national government’s decentralisation policy, CEPA has to work in close consultation with the various provincial governments through the respective provincial administrations to ensure implementation of environmental legislation at the provincial level. Certain environmental management and monitoring functions are delegated to provincial administrations if and when they have the resources and capacity to conduct these activities.

² DEC Corporate Plan 2009 - 2012.

B. Other PNG Legislation

15. The following legislation will also apply:

- (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) Road development, 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*.

C. ADB Safeguard Policies

16. The SPS promotes the sustainability of project outcomes by protecting the environment and people from potential adverse impacts. The SPS has the following objectives: (i) avoid adverse impacts of projects on the environment and affected people; (ii) where possible; minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible; and (iii) help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks.

17. The Environmental Safeguards of the SPS sets out eleven principles to ensure that the environmental soundness and sustainability of projects are achieved and to support the integration of environmental considerations into the project decision-making process. The SPS categorizes potential projects or activities into categories of impact (A, B or C) to determine the level of environmental assessment required to address the potential impacts. The subproject is classified as Category B for environment which requires an IEE. The IEE has been carried out to ensure that potential adverse environmental impacts are addressed according to the SPS

D. International Agreements

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

- International Plant Protection Convention, Rome 1951
- International Convention for the Prevention of Pollution of the Sea by Oil, London 1954
- Plant Protection Agreement for the South East Asia and Pacific Region, Rome 1956
- International Convention on Civil Liability for Oil Pollution Damage, Brussels 1969
- International Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter, London, Mexico City, Moscow 1972.
- International Convention on International Trade in Endangered Species of Wild Fauna and Flora, Washington 1973 (CITES Treaty)
- Convention on the Conservation of Nature in the South Pacific, Apia 1976
- International Convention on the Prohibition of Military or any other Hostile Use of Environmental Modification Techniques, New York 1976
- 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)
- International Convention on Biological Diversity, Rio de Janeiro 1992.

III. DESCRIPTION OF THE SUBPROJECT

A. Background

19. 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 annum³. The construction of the Ramazon and Divune hydropower subprojects in the Autonomous Region of Bougainville and Oro Province will assist in meeting these demands, In addition, the Bialla – Kimbe Transmission Lines will allow for High Voltage lines from 22kV to 33kV hence ensuring greater distribution of electricity to the general public in West New Britain province. The latter subprojects cover TEIP but to allow for the maximising of electricity efficiency will need hydro power upgrade and distribution connections to the villages and communities aligned with the TEIP transmission lines.

20. Lake Hargy HPP will have its Governor Control System upgraded/replaced so that it can provide for 1500kW, its maximum power output. The 2500 distributor connections will be provided to connect villages and communities to the power grid; 700 in Oro province, 1200 in West New Britain and 600 in the Autonomous Region of Bougainville.

B. Technical Description

i. Generator Rehabilitation

31. The Lake Hargy HPP has generator components which are nearly 30 years old and this has resulted in reduced output over the years. Two turbo generators have a potential of 750 kW each producing a total of 1500kW which will meet electricity demands in Bialla, Kimbe and even allow for future customers along the New Britain Highway from West to East New Britain.

32. A performance engineering assessment by PNG Power Limited (PPL)⁴ noted the inadequacies of the Lake Hargy HPP and recommended that its governor control system (GCS) be replaced to reflect the rapidly changing technology since it is thirty years old and producing only half of its electricity output. The GCS consists of; guide vane hydraulic system, speed signal tachometer and guide vane angle transducer. The old analog GCS will be replaced by a digital version and power house persons will be trained on the use of operating the new GCS.

³ Details in this section are quoted from *National and Provincial Ten Year Power Development Plan 2009-2018*, PNG Power Ltd, 2009.

⁴ James, R. 2014. Lake Hargy HPP Capacity Restoration Technical Proposal, Performance Engineering PNG Power Limited.

ii. Distributor connections

33. Distributor connections to the three sub projects consist of 25 – 100kVa transformers, underhung low voltage (LV) hardware, LV poles, and conductor and consumer connections. These will connect to villages, schools and communities along the TEIP Transmission lines.

- (i) 25 – 100kVa Transformers will be erected on LV poles at designated areas along the 150km from Lake Hargy HPP to Bialla and Kimbe.
- (ii) Likewise it will be for 65 and 25km routes from Divune HPP to Kokoda and Popondetta.
- (iii) Likewise distributor connections will be done along the 40km length of transmission line from Ramazon HPP to Kokopau and Buka in the Autonomous Region of Bougainville. All these connections follow along existing right of way (ROW) and will not require additional land for them. Details of the distributor connections are stated in Table 1.⁵

Table 1: Scope of Distribution Connections in the Sub Projects

Material	Unit	Quantity	Comments
West New Britain Province			
Transformers	kVA	2,620	Based on an estimated initial after diversity maximum demand of 660kW and an assumed initial transformer utilisation of 25%.
Underhung LV hardware	km	85	Assumed to be required over 70% of the route.
LV poles	No	840	Assumed equal to the estimated number of poles supporting LV underhung distribution. Note that all road crossings are likely to require at least one LV pole.
Three phase LV distribution	m	5,500	Assumed 15m per connection for 20% of consumers.
Consumer connections 6mm ²	No	1,100	Used for semi-permanent houses, first aid posts, elementary schools, churches, community centres and small trade stores.
Consumer connections 10mm ²	No	720	Used for all other loads
Oro (Northern) Province			
Transformers	kVA	4,000	Based on an estimated initial after diversity maximum demand of 1.0MW and an assumed initial transformer utilisation of 25%.
Underhung LV hardware	km	32	Assumed to be required over approximately 40% of the route. Unlike West New Britain, houses tend to be clustered into villages, and the population is relatively sparse between the Embara river and Kokoda.
LV poles	No	640	Assumed equal to the twice estimated number of poles supporting LV underhung distribution. The clustering of houses is likely to increase the relative number of LV poles when compared to West New Britain.
Three phase LV distribution	m	10,000	Assumed 15m per connection for 20% of consumers.
Single phase LV distribution	m	40,000	Assumed 15m per connection for 80% of consumers. Single phase distribution will also be used where there are three phase transformers.
Consumer connections 6mm ²	No	2,700	Used for semi-permanent houses, first aid posts, elementary schools, churches, community centres and small trade stores.
Autonomous Region of Bougainville			
Transformers	kVA	3,650	Based on an estimated initial after diversity maximum demand of 915kW and an assumed initial transformer utilisation of 25%.
Underhung LV hardware	km	20	Assumed to be required over 30% of the route.
LV poles	No	200	Assume equal to the estimated number of poles supporting LV underhung distribution. While houses are often three deep the reduced number of road crossings will lessen the requirement.
Three phase LV distribution	m	6,600	Assume 15m per connection for 20% of consumers.
Single phase LV distribution	m	26,400	Assume 15m per connection for 80% of consumers. Single phase distribution will also be used where there are 3-phase transformers.
Consumer connections 6mm ²	No	1,100	Used for village houses, first aid posts, elementary schools, churches, community centres and small trade stores.

⁵ Estimates are from Brown, G, 2015, Distributor Engineers Report – Improved Energy Access for Rural Communities, Project Development Report.

21. The sub-projects will have several benefits including:

- The full capacity of 1500kW of energy generated for the West New Britain province
- The above allows for replacement of diesel generation systems for cheaper and more efficient renewable energy generation systems.
- The erection of the LV poles and distributor connections line will allow connection of rural households living alongside the transmission line at all three sub projects.
- By increasing availability to a reliable and economic supply of electricity the sub-projects will provide a significant social benefit to the communities.
- There will be some employment opportunities created during construction and during operation when vegetation maintenance will be addressed by community labour based contracts.

IV. DESCRIPTION OF THE ENVIRONMENT

22. The project area includes; (i) the generator upgrading that have already been described as well as the distribution connections that will come off from the transmission lines. There will not be a need for a full contractor's facilities (administration offices, workshop, storage areas for materials and fuel and vehicle parking areas) as the scope of work will be minimal and will require local labour and limited heavy equipment.

23. The subproject areas will be in three provinces; West New Britain and Oro (Northern) and the Autonomous Region of Bougainville. Generator rehabilitation will be at the existing Lake Hargy HPP in West New Britain. In addition will be 1200 distribution connections along the TEIP transmission line from Lake Hargy HPP to Bialla and to Kimbe. Up to 700 distribution connections will run off TEIP transmission lines from the Divune HPP to Popondetta in the Northern Province. In the Autonomous Regions of Bougainville will be 600 distribution connections and these will run off TEIP transmission lines from the Ramazon Hydro Power into Wakunai, Tinputz and Buka or to connect into Arawa township

A. Physical Environment⁶

1. Topography Geology and Soils

West New Britain

24. Lake Hargy HPP is situated 5° 21'43.7" E and 151° 8' 25.81" S, at an elevation of 319 metres above sea level (asl), downstream of Lake Hargy, a remnant volcanic caldera of the Hargy volcano. Geology within the lake area consists predominantly of basaltic and andesitic lava, tuffs and breccia and limestone that are typical of the island arc volcanism chain on the island of New Britain. Volcanic fans and plains occur at the base of the Lake Hargy volcano and these consist predominantly of volcanic soils.

25. The transmission line easement is located on old ash deposits and colluvial structures situated on the lower foot-slopes of the Whiteman and Nakanai Ranges which forms the rugged spine of New Britain. This landform consists of numerous volcanoes and intricate drainage

⁶ Material in this section is extracted from (i) *Divune Hydroelectric Project Environmental Plan, PNG Electricity Commission, March 1989*; (ii) *Geology and Mineral Potential of PNG, Dept of Mining 2005*; and (iii) *Divune HPP IEE 2010 (and other sources listed elsewhere)*.

systems that descend the volcanic peaks to drain into Kimbe Bay and the Bismarck Sea. Extensive coastal plains have formed along these lower slopes from volcanic outwash which includes alluvium, pumice and tuff.

26. For its entire length the transmission line follows the main road from Kimbe to Biella and traverses areas of low agriculturally suited topography. From about the Kapiura River onwards to Biella the road generally follows the upper extremity of the agriculturally suited land as defined by the oil palm plantations. After leaving Biella the road rises through slightly steeper topography to reach the Lake Hargy HPP.

27. West New Britain Province in an area of recent volcanism some of which are still active. The volcanoes have built up extensive deep andesitic ash deposits that have covered much of the island and overlie older volcanic and sedimentary rocks. The road mainly traverses volcanic andesitic rocks that are now covered in ash deposits while boulder alluvial deposits mainly of andesite and limestone have been carried into the area from steeply sloping rivers that descend from the mountains.

28. The ash deposits have weathered to form reasonably stable soils that are predominantly composed of silts and fine sands. Due to their good structure and reasonable fertility these soils are now used as the basis for the oil palm industry in PNG and now support extensive plantings within WNB.

29. The site lies in an area of consistent seismic activity. Out of four seismic zones within PNG, the area lies in Zone 1 - which is classified as an area of high seismic risk. It is estimated that in this Zone an earthquake has a return frequency of 1 in 20 years with a severity to cause significant damage to structures built without earthquake resistance incorporated in their design.

30. Volcanoes which have erupted in the area in the past 100 years include Mt Ulawun and Mt Bamus, Mt Pago in the centre and Mt Makalia at the end of the Williaumez Peninsula. Mt Pago which is about 20 km northeast of the transmission line route close to the Hoskins turnoff was active in 2007 and also recorded major eruptions in 2002 and 2003 which blanketed the surrounding area in ash and closed Hoskins airport.

31. Soils along the transmission line route are young and have experienced limited weathering and profile development and are derived from mixtures of alluvium and ash fall deposits. The soils include *Andosols* which are moderately weathered soils with some horizon definition and *Inceptisols* which are slightly weathered soils with no strongly contrasting horizons. Being derived from ash these soils are well drained, are inherently moderately fertile and provide excellent physical properties for plant growth. The soils have good inherent fertility and are slightly acid to neutral.

32. The area is still adjusting to the geological uplift and natural erosion is high which is evidenced by the amount of boulders and gravels constituting the bed load and other debris within the rivers that descend to the coastal plains where they have created out-wash plains. Due to the retention of forest and vegetation, man induced erosion is slight and is limited to scattered gardens that have been developed around the villages on the steeper slopes.

Northern Province

33. The transmission line easement from Divune Hydro Power Plant to Popondetta in the Northern or Oro province runs along the road alignment and will be within the ROW.

34. The geology of the area has been well documented during previous studies and at the site consists of chaotic fan deposits of sand, gravel, breccia and alluvium which were deposited during the Pleistocene era as a result of rapid erosion of uplifted areas on the Owen Stanley escarpment.⁷ Large boulders and blocks of hard schist (up to 10m) are strewn along the stream bed and banks which indicate subsequent erosion of landslide debris during the Pleistocene. The fans of alluvial, colluvial and littoral sediments indicate a period of intense erosion/deposition associated with the rapid uplift of the Owen Stanley fault. Rock outcrops occur upstream of the site and consist of low grade ultra-mafic green schists, quartzite and gneiss of Jurassic and Cretaceous origin.

35. The Divune HPP site is situated just below the active Owen Stanley Fault that extends for approximately 650km from the coast near Wau to Alotau in Milne Bay. The Geological Survey of PNG (1981) shows that moderate seismic activity can be expected at the site. A magnitude 6.2 earthquake occurred in 1972 from movement in the Owen Stanley Fault. However, records show that the area has not been subject to any excessive seismic disturbances.

36. Mount Lamington immediately to the east of the site erupted violently in 1951. While the site is outside the range of volcanic pyroclastic and lahar flows it could be subject to ash fallout which may affect the site and transmission lines.

37. The soils are young and have experienced limited weathering and profile development and are derived from mixtures of alluvium and ash fall deposits. The surface horizon consists of silt which is free draining and overlies gravel beds that may be between 0.7m to 1.5m deep. Fragments of volcanic glass are evident suggesting that silt is derived from weathered ash deposits. This material has high moisture content and is difficult to compact. The soils have good inherent fertility and are slightly acid to neutral. The area is still adjusting to the geological uplift and natural erosion is high which is evidenced by the amount of boulders and gravels constituting the bed load and other debris within the creek. Due to the retention of forest and vegetation, man induced erosion is slight and is limited to scattered gardens that have been developed around the villages on the lower fan structure.

38. The transmission line easement from Ramazon HPP site to Kokopau (about 41 km) and onto Buka in the Autonomous Region of Bougainville (ARB) will follow along the ROW.

39. The geology of Ramazon contains the Emperor Range Volcanic bed, which is composed of Andesite, Basalt Agglomerates and Tuff. The age of the rocks is Pleistocene to recent age. The upper part of the catchment exposes an intrusive body consisting of Microdiorite and Diorite. Both the intake and the powerhouse consist of outcrops of volcanic agglomerate and boulder deposits with agglomerates.

40. Bougainville is located within an area of very high seismicity. The island also contains one active volcano Mt Bagana which in the 1990's was PNG's most continuously active volcano. Two volcanoes that are believed to have been recently active are Mt Balbi immediately south of the site and Mt Loloru in the south of the island.

⁷ Geological Survey of PNG, 1981.

41. The soils are derived from recent andesitic ash falls. The soil belongs to the main class of Inceptisols and includes sub-classes of *eutrandepts*, *tropaquents*. These are young soils that have good inherent fertility and are slightly acid to neutral. The area is still adjusting to the geological uplift and natural erosion is high which is evidenced by the amount of boulders and gravels constituting the bed load within the creek. Due to the retention of forest and vegetation, man induced erosion is slight and is limited to some forestry activities and scattered gardens that have been developed around the villages on the upper slopes.

2. Climate

42. The Lake Hargy and West New Britain province has a typical monsoonal climate with alternation of southeast trade winds and northwest monsoons. From May to October the north coast is relatively sheltered from the effects of the southeast trade winds and during this period the north coast does not receive as much rain. The coastal areas are hot and humid.

43. Climate data for three stations in New Britain are shown in Table 1. The sub-project is located in an area of high annual rainfall with Talasea about 50 km northwest of Kimbe recording 4,069 mm while Hoskins which is 100 km west of Bialla records 4,053 mm. November to April are the months with heaviest rainfall with 75% falling during these months. January is the wettest month which coincides with the northwest monsoon. Rainfall will be higher further inland as the elevation increases.

Table 2: Climate Data

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Rainfall (mm)	738	704	640	460	198	126	113	109	110	166	251	454	4,069
Max temperature (oC)	30.9	30.9	30.7	30.8	31.2	30.9	30.4	30.7	31.4	31.6	31.3	30.9	31
Min temperature (oC)	23.2	23.2	23.3	23.3	23.6	23.3	23.2	23.4	23.3	23.3	23.3	23.3	23
Relative Humidity (%)	85	86	86	86	84	84	83	82	79	81	82	86	84
Mean daily Sunshine hours (hrs)	3.2	2.4	4.2	3.9	5.3	5.0	4.5	5.6	5.1	4.9	5.5	3.4	2,474
Mean Evaporation (mm)	151	164	181	160	170	175	168	216	222	207	176	164	2,154

Source: Source: McAlpine J.R. *et al*, 1975

Rainfall, Talasea; temperature and evaporation, Rabaul, Sunshine, Mosa DPI Stn;

44. No air quality measurements are available for the area and apart from localised areas of smoke from village cooking fires, air quality will be good.

45. Divune HPP and Oro (Northern) province is in an area of high annual rainfall of about 3,600 mm which is reasonably spread throughout the year. Rainfall is higher during October to April which coincides with the northwest monsoon season and is lower from May to September. The elevation of the area makes this location subject to intense tropical storms. On average all months have a moisture surplus. Climate data is shown in Table 3.

Table 3: Climate Data

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Rainfall (mm)	336	333	365	328	259	187	180	224	273	321	407	362	3,596
Max temperature (oC)	32	31	32	32	32	31	31	32	31	32	31	32	31
Min temperature (oC)	22	22	22	22	22	22	22	22	22	22	22	22	22

Source: CSIRO, 1975.

Rainfall for Kokoda 39 years; temperature for Popondetta 39 years.

46. Cyclones are rare in this area with the last one, cyclone Guba occurred in 2007 which dumped large amounts of rain in the area and caused significant flood damage to crops, roads and washed away several bridges on the Popondetta - Kokoda road.

47. The Ramazon and Autonomous Region of Bougainville has a typical monsoonal climate with alternation of southeast trade winds (May to October) and northwest monsoons (November to April). The coastal areas are hot and humid.

48. Climate data for two stations in are shown in Table 4. The sub-project is located in an area of high annual rainfall with Buka about 40 km north of the site recording 2,507 mm. Rainfall is reasonably distributed with all months recording rain, however, November to April are the months with heaviest rainfall with 64% of the annual rainfall occurring during these months. Rainfall is higher further inland as the elevation increases. Thunderstorms are frequent in the late afternoon and evening. Apart from the lower rainfall months all other months have a moisture surplus. Cyclones do not occur in the area.

Table 4: Climate Data

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean rainfall (mm)	327	280	326	234	194	115	147	147	147	165	208	217	2,507
Max temperature oC	30.3	30.2	30.2	30.3	30.7	30.4	30.2	29.8	29.9	30.4	30.7	30.7	30.3
Min temperature oC	23.1	23.1	22.9	23.1	22.7	22.4	21.7	21.9	22.3	22	22.6	23	22.6
Relative Humidity (%)	74	85	86	85	85	86	87	83	83	83	83	84	84
Mean daily Sunshine hours (hrs)	5.9	4.9	5.4	6.4	7.2	5.8	5.8	4.4	6.5	6.3	5.7	5.7	5.8
Mean Evaporation (mm)	142	127	133	155	144	159	146	173	172	166	149	148	1,814

Source: McAlpine J.R. et al, 1975

Rainfall, temperature, RH%, evaporation measured at Buka; sunshine measured at Kieta.

49. No air quality measurements are available for the three sub project areas and apart from localised areas of smoke from village cooking fires air quality is good.

50. PNG is exposed to climate variation⁸ and has regularly experienced extreme weather conditions including; cyclones, landslides, flooding and droughts related to *El Nino* conditions. Evidence shows that since 1977 mean temperature has increased by almost 0.5°C which is also consistent with a similar temperature rise in mean water temperatures. Rainfall shows great variability but there appears to be an increasing trend to drier conditions with decadal rainfall decreasing from 3,000 mm to 2,500 mm. Climate models show that by 2050 temperature may increase by 1.2-1.3°C; rainfall may increase by 2.2% to 8.8%, droughts and floods will be more intense and sea level may increase between 20 - 40cm.

⁸ Office of Climate Change and Environmental Sustainability and World Bank, 2009. *Climate Change in Papua New Guinea: Framework for the National Climate Change Strategy and Action Plan.*

51. For this subproject the main change will be extended periods of drought which will affect hydrology whereby low flows will become smaller and high flows more extreme. Research carried out by the National Agricultural Research Institute has predicted that a major drought will affect PNG in 2012.⁹

3. Water Resources

52. The transmission line route from Lake Hargy Hydro Power Plant crosses numerous water courses which include the Dagi, Kapiura, Tiaru and Lobu Rivers and other smaller unnamed drainage systems that drain to the north to the Bismarck Sea. Unlike the other watercourses the Lobu River rises from Lake Hargy. All of these watercourses have high bed loads and where the rivers meet the alluvial plains outwash plains have formed. During flood events these large watercourses with high bed loads are prone to lateral movement and bank instability. The ash fields have good infiltration characteristics and there would be extensive ground water resources in the area. These also maintain extensive fringing coastal swamps.

53. The Luwini Creek is one of many watercourses that occur in the Divune HPP and has a catchment area of 98 km². The Luwini Creek rises near Mount Kenevi at an elevation of 3,440m and then flows northwards and descends steeply at about 16% through a steep sided gorge to emerge onto the alluvial fan where the sub-project site is located. At the alluvial fan the river gradient falls away to about 5%. The catchment is mostly covered in dense rainforest but some swampy areas occur in the upper area around Mount Kenevi.

54. The Luwini Creek discharges to the Oivi Creek which then drains eastwards to join the Kumusi River which is characterised in its lower section by large wetland areas before it discharges to the north coast of PNG. The Luwini Creek was gauged from 1985 to 1988 and an analysis of the discharges is shown in Table 5. The data set is quite short and while it gives an indication of the actual results for the period it requires a longer period of record to improve the accuracy of the data set. Records ceased at the end of 1988.

Table 5: Mean monthly discharge measurements for Luwini Creek 1985-1988
(m³/s)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	8.97	7.66	9.58	9.68	9.36	7.96	8.18	8.79	9.40	11.99	11.19	6.56
Max	61.87	79.64	87.63	61.87	67.11	93.81	97.00	97.02	93.50	85.00	107.80	98.30
Min	4.16	2.56	2.15	1.93	2.63	2.98	2.89	2.68	2.70	3.44	4.07	3.10

Max and min are instantaneous values

Source: Hydrometric Yearbooks 1995-1988. Bureau of Water Resources.

55. Table 4 shows that the Luwini Creek has a reasonably well maintained flow but can exhibit extremely high discharges at any time of the year. The creek is sustained by well distributed rainfall and some upper swampy areas which will store and release water. Mean discharges are highest during the wet season between October and April which coincides with the rainy season. The greatest instantaneous discharge was 107 m³/s recorded in November 1985, though all months have recorded discharges greater than 60 m³/s. The lowest instantaneous discharge recorded was 1.9 m³/s in April 1988, though all months recorded flows less than 5.0 m³/s.

⁹ As quoted in the *Nation* Friday 7th May 2010.

56. The MacDonald Wagner study (1988) concluded that the sediment load is restricted to flood flows. No sediment estimates were made but due to the uplift that has occurred within the catchment, natural erosion rates will be high which has resulted in the fan deposition being laid down where the creek emerges from the down-cutting gorge. There is a plentiful supply of bedload in the creek bed as demonstrated by the boulder strewn channel and during floods large amounts of boulders, gravels and sand will be moved along the channel. A de-sanding facility is incorporated in the design to remove large suspended particles.

57. The Luwini Creek is little used by the surrounding villagers who prefer to collect water from smaller tributaries closer to their villages. The creek does not flood any villages.

58. The Ramazon River rises at 1970 m in the Emperor Range and flows northwards to the Pacific Ocean. The catchment at the intake has an area of 98 km². The Ramazon River descends steeply at about 8.4% through a steep sided valley to the intake. The upper catchment is mostly covered in rainforest while below the intake this remains in areas of secondary disturbed forest while further up the slopes cocoa and coconut plantations have been developed.

59. A staff gauge was installed on the river in 2009 but no data is available at the time of the report. As no gauging records are available for the Ramazon River the data has been synthesized which shows that the mean flow is 5.0 m³/s and the 90% flow (which is used for the powerhouse design) is 3.0m³/s.

60. Sediment movement will be restricted to flood flows. No sediment estimates are available but due to the youthfulness of the catchment it is expected that natural erosion rates will be high. There is a plentiful supply of bed load in the creek bed as demonstrated by the boulder strewn channel and during floods, boulders; gravels and sand will be moved along the channel.

61. The Ramazon River is not used as a source of water and villagers instead collect water from smaller tributaries closer to their villages or from roof catchments. No water quality measurements are available for the Ramazon River but as it emerges from a basically undisturbed upper catchment, water quality is expected to be very good. Similarly Lumini Creek in the Northern province has good water quality.

B. Biological Environment

62. PNG is an island with high species biodiversity and belongs to the Indonesia-Malaysia region though it also shares similarities to northern Australia. 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.¹⁰

63. 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.

64. 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

¹⁰ This section is extracted from "Megadiversity", Mittermeier et al, 1998.

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.

1. Flora

65. Forest covers 61% of PNG and 74% of West New Britain Province. The transmission line route follows the main road from Biala to Kimbe. All vegetation alongside the road has either been disturbed due to its proximity to the road or has been converted to oil palm blocks. Apart from river crossings including a 5km long area with excessively stony soils 20km west of Bialla, and roadside settlements the coastal side of the road consists totally of oil palm. There is less oil palm on the interior side of the road as in many places the road is located on the boundary between the low sloping topography that is suitable for oil palms and steeper hilly topography. Where this has not been planted to oil palm this side of the road supports disturbed vegetation including some remnant forest.

66. Likewise, forest covers 69% of Oro Province. The vegetation of the project area has been documented by Taylor in Haantjens (1964), and later by Paijmans and Saunders in Blake et al (1973). In the last decade, the forest has suffered from both natural and human-induced activities. The 1997 drought caused a large bush fire that spread across the Owen Stanley Range burning large areas of rainforest. In addition, vegetation clearance for shifting cultivation and cash cropping has altered the vegetation in the locality. The location for the proposed dam and intake area, the power house and switchyard and the access road will be within secondary re-growth, garden and oil palm plantations and abandoned garden sites. There is no primary forest in the area demarcated for the hydro power project.

67. Secondary regrowth of *Macaranga* and *Ficus* are common in old garden areas and disturbed sites. Okari trees (*Terminalia sp.*) are found in a few locations and have been cultivated for their edible nuts. Near the river beds, *Syzygium*, *Terminalia*, *Pometia*, *Ficus*, *Pandanus* and tree ferns *Cyathea spp.* are common. Along parts of the river bank and old garden sites *Piper aduncun* is found in abundance. Gardens with cassava, bananas, sweet potato (kaukau) are cultivated about 10 m from the creek while about 40 m from the creek, oil palm plantations have been developed. In recently abandoned garden sites, grasses and creepers and vines dominates. Riparian vegetation is badly degraded and contains no trees of ecological or economic importance. The edge vegetation includes mostly grasses, primarily *Typha angustata*, *Saccharium spontanarum*, *saccharum munja*, *Tammarix aphylla*, etc.

68. Forests cover 50% of the Autonomous Region of Bougainville Province. Much of the tropical forests have either been converted to cocoa and coconut plantations, or modified by commercial large scale logging which was carried out as selective logging that was carried out about 10 years ago. Closer to the ridge top areas have been cleared for cocoa and coconut plantations and gardens. The lower elevation areas of the Ramazon are characterized by secondary vegetation of anthropogenic origin. The area includes several plantations and these include; Rugen Plantation, Raua Plantation, Dios Plantation and various village cocoa plantation blocks owned by locals.. Shifting cultivation is common in nearby village areas and food gardens are cultivated in small blocks. Although logging activities and vegetation clearance has affected much of lowland areas, the same cannot be said for the intake site. Much of the forests are intact and plant species are diverse. Large trees in the area are an indication of mainly undisturbed forests.

69. The general topography of the area is that it is about c.364 m at high elevations and c.94m at lower land. There are areas of gentle slopes and areas of steep climbs. Mountain streams flow down into the main river and nearby soil formations was observed to be sandy volcanic soil. Much of the riverine vegetation was dominated by the grass *Imperata cylindrical* and *Calamus sp.* (Cane).

2. Freshwater Aquatic system

70. PNG has approximately 330 species of freshwater fish, including a few introduced species. Many of the native species share similarities with Australian fish fauna reflecting the close proximity and past links between these land masses. About 10% of the freshwater fish species found in PNG also occur in Australia. Approximately two thirds of the PNG native fish species spend their entire lives in freshwater and one third are thought to have an estuarine or seawater stage in their lifecycle. (Allen, 1991)

71. Within West New Britain province, various aquatic habitats occur along the water courses and range from slow moving rivers to fast bouldery sections. Riparian vegetation mainly consists of the tall grass *Saccharum sponteum*, pandanus and low water tolerant trees. In slower stream sections aquatic larvae of a range of insects and worm like groups typically dominate the streambed ecosystems. Fish which were sampled in Ru Creek and also in the Lobu River below Lake Hargy showed that neither fish diversity nor numbers were significant in any of the watercourses. Diversity increased as river size increased and diversity was also greater below the waterfall that is situated on the Lobu River below the Lake Hargy powerhouse which allowed some estuarine fish to move into these lower freshwater habitats.

72. In the upper sections of the water courses fish mainly consisted of gobies and gudgeons. All of these fish are commonly found throughout PNG in these water systems and grow to <10cm in length. Freshwater prawns *Macrobrachium sp.* and eels (family *Anguillidae*) also occur in these systems.

73. Within Divune HPP and Oro province, the aquatic habitats of the Luwini Creek consist of riffle and run sections falling at a steep gradient over a boulder bed. Fish species found in the Luwini prefer riffle habitats and rest near boulders, logs and other woody debris. Riparian vegetation is located alongside the creek which provides a degree of shade. Aquatic larvae of a range of insects and worm like groups dominate the streambed ecosystems.

74. Allen (1991) described the fish fauna of Eastern Papua which includes the Oro Province as being relatively impoverished. The limited fish fauna may be in part due to the relative isolation caused by the Owen Stanley Range. Four species of freshwater fish were recorded in the Luwini Creek. These are shown in Table 6.

Table 6: Freshwater fish occurring in Luwini Creek

Common name	Species
Papuan Gudgeon	<i>Mogumda sp.</i>
Kokoda Mogurnda	<i>Mogurnda lineata</i>
Popondetta Blue-eye	<i>Pseudomugli (Popondichthys) connieae</i>
Kokoda Glass Perchlet	<i>Tetracentrum caudovittatus</i>

Source: GHD field survey, 2010

75. All of the fish species are commonly found in the area with the Kokoda Mogurnda caught in Luwini Creek during the field study. The occurrence of the other species was confirmed by discussions with the villagers. All fish species are small with the adults growing to <10 cm. All fish are common in rainforest streams. Gudgeons and the Kokoda Glass Perchelet have defined breeding seasons with Gudgeons spawning in late summer and autumn while the Kokoda Glass Perchelet spawns at the onset of the monsoon.

76. Neither the Kokoda Mogurnda nor the Popondetta Blue-eye have any particular spawning requirements and may breed all year round, though this may peak at the onset of the rainy season. Based on this and their small size (unable to move long distances) there appears to be no strongly related migratory requirements in these fish species. No prawns were found in the water course and it is thought that this may be due to the extensive flooding that occurred in 2007. Eels are also found in the area.

77. Tadpoles from the families *Hylidae* and cane toad tadpoles (*Bufo marinus*) were also observed in the Omare Creek which is located alongside the Luwini Creek. No reptiles were noted to be present in the water bodies.

78. The aquatic habitats of the Ramazon River consist of pools, with riffle and run sections falling at a steep gradient over a boulder bed. Riparian vegetation is located alongside the creek which provides a degree of shade. Aquatic larvae of a range of insects and worm like groups dominate the streambed ecosystems and as invertebrates are primary indicators of habitat and water quality the presence of these indicates that the stream has good water quality and is in good health.

79. Fish species found within Ramazon River prefer riffle habitats that include steep and rapidly flowing streams and resting placed near cover provided by boulders or logs, branches and other woody debris. This habitat is typical of mountain streams and hosts fish species that are widespread throughout the sub-project area and also PNG. The communities that are found in these mainstream habitats generally have a higher potential for recovery or re-colonization should impacts occur.

80. Three freshwater fish species were identified in the Ramazon River. These are shown in Table 7.

Table 7: Freshwater fish occurring in Ramazon River

Common name	Species
Crescent Perch (Grunter)	<i>Terapon jarbua</i>
Island Goby	<i>Glossogobius sp.</i>
Admiralty Goby	<i>Stenogobius sp</i>

Source: GHD field survey, 2010

81. *Terapon jarbua* Grunters are small to medium - sized perch-like fishes that inhabit marine, brackish and freshwater. Several of the brackish water species range a few kilometers upstream into pure freshwater, but many of the species spend their entire life cycle in freshwater. Habitats range from quiet lowland streams to lakes and swift-flowing streams in mountainous terrain. Most of the stream dwelling species prefer deeper, rocky pools, frequently below waterfalls and rapids. The New Guinea species are generally carnivorous, feeding on aquatic and terrestrial insects and their larvae, crustaceans, molluscs, fishes and frogs. Algae and floating fruit, flowers, leaves and seeds of terrestrial plants are also consumed by some species.

82. The Island Goby is an undescribed species known from Waigeo Island off the Western end of the Vogelkop Peninsula and the Solomon Islands at Bougainville. It inhabits clear creeks in rainforest or open situations, usually up to 10 km from the sea. Gobies are bottom dwellers and deposit their eggs on hard surfaces, such as rocks and below ledges. They are carnivorous and feed on small crustaceans, worms and small fish. Spawning takes place repeatedly during the warmer months of the year.

83. Gudgeons belong to the family *Eleotrididae* and are estuarine and freshwater dwellers. Gudgeons are close relatives of Gobies and share a similar appearance and benthic dwelling mode. Spawning may take place repeatedly over several months when the water becomes warmer. Eggs are laid on hard surfaces or vegetation. They are carnivorous.

84. The Admiralty Goby is distributed along habitats within the Admiralty Islands, Bismarck Archipelago and Solomon Islands. It is an undescribed species that generally occurs in small clear creeks flowing through dense terrestrial vegetation, usually 5 kilometres from the sea.

85. All of these fish are commonly found throughout these water systems and grow to <10cm in length. None of these fish have dedicated migratory needs.

86. Freshwater prawns presumably *Macrobrachium sp.* and eels (family *Anguillidae*) are common in the water course. Other aquatic life like tadpoles, freshwater snails, thiarid snails were also found in Ramazon River and other feeder creeks. There were no reptiles found in the Ramazon River as stated by the local communities.

3. Wildlife

87. Avifauna of Papua New Guinea is well studied compared to other animals. The Bismarck Archipelago records 60 bird species that are endemic with about 8 species that are endemic to West New Britain.¹¹ Some bird species found to be common in West New Britain include *Myiagra hebetior*, *Ceyx lepidus*, *Tanisia nigriceps*, *Dicrurus bracteatus*, *Eclectus roratus* and *Rhipidura alblimbata*. Most of these are frugivores, insectivores and nectivores and depend on fruit, flowering plants and insects. The common scrub fowl, *Megapodius eremita* inhabits lowland forests near rivers and creeks and is common in the area. Various species of Kingfishers, Pigeons, Parrots, Lorikeets, Cockatoos and Cassowaries and the Torresian crow are common throughout the site. The Eclectus Parrot (*Eclectus roratus solomonensis*), is widespread and common throughout the mountains and foothills.

88. Marsupial diversity is lower in the island regions than in mainland PNG because they are very poor over-water dispersalists with only three species known to occur in the area.¹² Cuscus and gliders are common marsupials in the area. *Petaurus breviceps* is a common sugar glider found throughout PNG and is expected to be found in the area.

89. The species diversity of Bats in WNB is relatively high¹³ with 17 species of bats. The *Pteropodid* fruit-bats have a high degree of endemism on the New Guinea islands including West New Britain. Bats are hunted for their meat. There are seven species of rodents on West New Britain of which three are endemic and only found in New Britain. The species are *Uromys neobritannicus*, *Hydromys neobritannicus* and *Melomys cf. levipes*.

90. There is low endemism of snakes and frogs in the Bismarck Archipelago which includes West New Britain. *Bufo marinus*, the marine toad is an introduced species. Snakes include the Brown Tree Snake, (*Boiga irregularis*) and the Pacific Tree Boa, (*Candoia Carinata*).

¹¹ Bibby et al. 1992.

¹² Heads, 2002.

¹³ Flannery, 1995.

91. Other reptiles include monitor lizards (*Varanus sp*), which are hunted for food and the skins used for kundu drums.

92. Oro (Northern) Province on the mainland is an area of high biodiversity and has a particularly high diversity of fruit bats, frugivore birds (Parrots and Pigeons) and nectivore birds (Honeyeaters), marsupials (cuscus), Birds of Paradise, Casowaries, snakes and other reptiles such as lizards. The area is also famous for the Queen Alexandra Birdwing Butterfly.

93. Birds noted in the area include the Papua Hawk Owl (*Uroglauz dimorpha*), the Barn Owl (*Tyto alba*) which nests in Oil Palms and trees. Birds of Paradise including *Paradisea apoda*, *Paradisea minor* and *Paradisea rudolphia* occur in heavily forested areas away from the site. The Willie Wagtail (*Rhipidura leucophrys*) occurs around habitation, while Parrots and Lorikeets, honeyeaters and swifts are found near the Luwini Creek. The Cassowary is hunted for food and occurs in areas away from the village. Mammals include feral pigs, cuscus, tree kangaroo and bats. These are hunted and mainly occur at some distance from the villages.

4. Rare and Endangered Species

94. Within West New Britain Province and the Autonomous Region of Bougainville, various bat species from the *Order Chiroptera* are classified as Endangered, Vulnerable and Critically Endangered in accordance to CITES categories of varying threat. The Lesser Bare Back Fruit Bat, *Dobsoni minor*, the Lesser Tube Nosed Bat, *Nyctimene draconilla* the Greater Tube Nosed Bat, *Nyctimene aello* are classified as RARE according to the IUCN threat classifications. Existing threats are clear fell logging of bat habitats and clearing of habitation to make way for new oil palm and cocoa plantations. Bat colonies are located in dense forest areas where fewer disturbances occur. Many travel to garden areas in search for fruit at night.

95. In Divune and Oro province, the Tree Kangaroo, Birds of Paradise and Queen Alexandra's Birdwing Butterfly are listed as protected fauna of PNG under the Fauna (Protection Control) Act 1976 and subsequent amendments. None of these fauna occur in the disturbed areas where the sub-project is located.

5. Conservation Areas

96. Within Hargy Hydropower Plant, there are no Protected Areas within the immediate area. Lake Hargy has been proposed as a conservation area but this has not progressed. There is one Wildlife Management Area (WMA) Pokili which is situated 60 km south west of the transmission line in Talasea District.

97. In Oro province, there is no Conservation Areas (CA) or Protected Areas (PAs) that are close to the sub-project site that would warrant protection or be affected by the proposed development. The only PAs in the Province is the Hombaretta Wildlife Management Area (WMA). The WMA has a total land area of 149 ha, comprising 52 ha of rainforest areas. However, extensive logging has resulted in 52 ha of logged over forest resulting in 100% forest cover change (Shearman et al, 2008).

98. The Conservation Needs Assessment (CNA) undertaken by CEPA in 1992 identified the upper Luwini Catchment as having high priority areas of conservation. The sub-project is located below and outside the area and does not contain any conservation priority areas.

99. In the Autonomous Region of Bougainville, the only existing Wildlife Management Area is Pirung in Arawa which was gazetted on 9th of May 1989. That is more than 100 kms to the south of Ramazon.

6. Invasive Alien Species

100. Biological impacts from introduced species and invasive species can cause a great deal of damage to naturally adapted systems. Invasive or introduced species are species that are non-indigenous and can colonise and out compete local species. Most of these species are a major threat to freshwater ecosystems of Papua New Guinea. Aquatic plants such as *Salvinia* (*Salvinia molesta*) and Water Hyacinth (*Eichhornia crassipes*) have been reported to cause major problems in Sepik river and other major rivers. Introduced species such as Tilapia and Mosquito fish are two examples that threaten natural freshwater fauna in the country. The aquatic plant was not observed in the project site but precautionary measures need to be taken to control the plant species if there is evidence of it occurring. Mosquito fish is not likely to be found in Lobu, Luwini or Ramazon Rivers in the three provinces. This particular fish inhabits slow flowing streams and fast flowing creeks in the three provinces will restrict its colonization. *Tilapia* is another introduced species but it was not found in the three areas.

C. Socio-economic Conditions

101. The population of PNG in 2010 was determined as being 6.9 million and is dispersed widely across the country. Since the 1970s the population has been growing at an average rate of 2.3 %/yr and has increased to 2.8%¹⁴. Accordingly the population has a broad based age-sex structure with about 40% of the population less than 15 years of age. This implies a very high level of youth dependency as well as a high child-woman ratio and a low median age of <20 years. With population doubling every 30 years pressure on available services and natural resources has increased dramatically during the last decade, which will require PNG to invest large resources in social infrastructure.

102. PNG is a culturally diverse country with over 875 different languages of which 87% of the population are still living in rural environments. While this has provided the country with distinctive cultures the isolation of these groups has also created a high dependence on natural resources. Development has not been uniform across the country and the resulting migration to urban areas has created landless people who live in squatter settlements in and around urban areas with accompanying high crime rates.

103. PNG's social environment is based on three key elements; (i) the traditional land tenure system whereby 97% of land is locked away in customary tenure; (ii) the "wantok" system whereby family and clan members support each other, and (iii) service delivery by churches and community groups which now provide around 50% of all health and education services in the rural sector.¹⁵

104. It is considered that despite some gains in the economy the number of people living in poverty has changed little during the last two decades with 30% of the population continuing to

¹⁴ DNPM 2015, National Water, Sanitation and Hygiene (Wash) Policy 2015- 2030, Department of National Planning and Monitoring

¹⁵ United Nations and government, 2004. Millennium Development Goals. Progress Report for Papua New Guinea 2004.

live below the 1996 criteria of K400/yr although the Vision 2050¹⁶ has objectives to improve this standing. Average life expectancy is 54 years. The national literacy rate is 62% which has slightly improved.¹⁷

105. The population of West New Britain Province is about 184,508 persons as stated by National Research Institute 2010 Provincial and District Profile¹⁸. The majority of the population (94%) live in rural areas. Kimbe is the largest town with a population of 8,400 and is the commercial and administrative centre of West New Britain Province. Bialla is a very much smaller district administration town with about 4,000 persons. Including Bialla but excluding Kimbe there are 35,900 persons living alongside the transmission line in 6,800 households which are the potential beneficiaries of the development. Connection to the supply will be dependent on their ability to pay but as they farm cash crops particularly oil palm they have one of the highest farmer incomes in PNG. Oil palm has and continues to attract good prices and is the most profitable enterprise in PNG. West New Britain is also recognised as one of the better off provinces in the country and while information on poverty is dated WNB consistently appears above the national average in various poverty indicators as quoted by the Millennium Development Goals.

125. The estimated rural population of Oro in the year 2010 is 136 065¹⁹. The average population growth rate is 2.7 per cent per year. The highest population densities of 36 persons/km² are on the volcanic plains and fans, inland of Popondetta, and in the upper Mambare Valley around Kokoda. The northern coastal floodplains, the Managalas Plateau and the coastal areas of Collingwood Bay have an average of 25 persons/km². The coastal floodplains, east of Popondetta, and the Waria Valley have 20 persons/km², while the floodplains of the Musa River and the inland valleys around Safia have low densities of 10 persons/km². The floodplains and swamps to the northwest and southeast, and the Owen Stanley Range, are largely unoccupied. Areas around Popondetta have significant in-migration.

126. The population of Autonomous Region of Bougainville is about 175,160²⁰ persons as noted by the NRI provincial and district profile in 2010. Buka is the largest town with a population of 16,250 persons and is the commercial and administrative centre of Autonomous Region of Bougainville Province. The ARB has emerged from a 10 year period of civil unrest which saw the economy largely destroyed. The economy is now recovering and typically with the rest of PNG the ARB has a significant subsistence base that is supported by large areas of copra and cocoa production. Prior to the civil unrest Bougainville had a significant mining sector and log export trade. The formation of an autonomous government has paved the way for development within the province and support from both the national government and foreign assistance is slowly re-establishing services and development within the province.

D. Land Use

106. Most people living along the TEIP transmission line in the three provinces are subsistence farmers. In addition, those in the West New Britain and Northern provinces plant also oil palm and this has created wealth for them. In the Autonomous Region of Bougainville, most are subsistence farmers but also cocoa farmers.

¹⁶ Government, 2010, Vision 2050. National Strategy Plan Task Force.

¹⁷ UN and government 2004, op.cit.

¹⁸ NRI,2010, Papua New Guinea District and Provincial Profile National Research Institute

¹⁹ Ibid

²⁰ Ibid.

E. Cultural Sites

107. In West New Britain province, the distribution connections will feed off the transmission line that will be erected within the existing road easement. There are no known sacred or historical sites of significance within this area. This is also noted in the Ramazon area in the Autonomous Region of Bougainville.

108. Within Divune HPP, there are no sacred or historical sites of significance to the landowners within the project area, except for two burial sites that are more than 50 years old. It is important that the views of the relatives or family members regarding the two burial sites are obtained before construction commences. Landowners upstream of the weir site where the Luwini Creek leaves the gorge support the project but would not want to see that particular section of the Luwini River disturbed by the project as they have reserved this area as a potential tourist attraction.

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

86. The following section provides an assessment of the project's likely impacts on physical, biological, socio-economic and physical cultural resources, and identifies mitigation measures to ensure all such environmental impacts will be avoided or managed/reduced to acceptable levels. The mitigation measures identified below along with other environmental management requirements normally associated with international best practice will be implemented in accordance with the EMP presented in Section VII. The relatively small scale nature of the works coupled with local labour intensive approach and rigorous implementation of the above mitigation measures will ensure that the minor impacts will be managed or minimized to acceptable levels.

A. Impacts on the Physical Environment

1. Erosion and Loss of Top Soil

87. The project will not include activities that will cause erosion or loss of top soil. The diameter of the poles is approximately 300 mm and will require an auger driven hole of approximately 0.5 m² 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.

2. Sedimentation and Water Quality

88. There is little potential for even localized and short term water contamination from runoff of suspended sediment as the project will not create exposed surfaces or slopes. As noted above excavation for the poles will be small. Scheduling the excavations in the drier months (May - September) will further reduce risk of sediment laden run-off. The works can be undertaken within one season (about four months).

3. Dust and Noise

89. Owing to the limited scope of works, largely manual construction methods and small requirement for equipment (i.e. auger on small tip-truck) and poles, conductors, distribution lines and cement and sand hauled on another one or two truck(s), the impact of dust and noise

generation will be negligible. To mitigate the minor effect of sedimentation it is recommended that construction be undertaken in the dry season, this can create potential for some dust nuisance where unsealed roads are disturbed by the trucks. This will be temporary and sporadic. If required by residents, implementation of good practice construction methods such as watering of the roads will ensure impacts are minimized and acceptable. Dry materials (sand and cement) hauled by truck will be covered.

4. Materials, Spoil and Waste Management

90. **Materials and spoil management.** Sand and cement for the concrete footing for the poles will be brought to the site and will be stored under a tarpaulin or similar suitable covering to prevent dispersal/dust generation. Excavation activities will be limited with a corresponding limited volume of excess spoil needing to be disposed of. As a first priority, where excavated materials are not required by the local community, they can be transported to the provincial government works yard to be used elsewhere as fill. If this cannot be achieved and excess material needs to be stockpiled, the location of any stockpiled material will be discussed with the local community. The EMP addresses this through inclusion of the following:

- Sand and cement to be stored on the truck and covered by tarpaulin or similar, trucks will not be permitted to transport dry materials without a suitable cover;
- Excavated material for reuse and recycling methods to be employed;
- Requiring consultation with and endorsement from the Ward Councillors within appropriate Local Level Governments (LLG) and local landowners within Ramazon, Divune and Bialla – Kimbe transmission line route for disposal of excess spoil;
- Stockpiling material within 50m of a waterway will not be permitted;
- Excess spoil to be disposed of only as per the site and method approved by the SPC and local community; and
- Methods of transportation to minimize interference with normal traffic.

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

92. **Waste management.** There will unlikely be much other waste generated by the works. A contractor's camp and dedicated work sites/yard will not be required. Any waste materials such as conductor wrapping, remnant cable/line, cement bags and any other residuals (including minor rubbish generated by contractor's employees) will be collected and disposed of at an approved dump site within the route corridor.

93. The contractor will be expected to address waste management issues and measures in the construction EMP (CEMP) prepared to control the effects and minimise risk from the works. The waste management measures will cover the following issues:

- Identification of expected types and volume of waste arising;
- Waste reduction, reuse and recycling methods to be employed;
- Agreed reuse and recycling options and locations for disposal/endorsement from the PPL – PMU and the Local Level Government;
- Designation of waste disposal areas agreed with local authorities;

- Residual waste to be disposed of in disposal sites approved by local authorities and not located within 500m of rivers or streams;
- Burning of construction wastes to be prohibited; and
- Disposal of solid wastes into drainage ditches, rivers, other watercourses, agricultural fields and public areas shall be prohibited.

94. Provided that waste management is undertaken as per the approved methods and implemented in accordance with the above recommendations, the environmental impacts associated with waste management are expected to be negligible.

B. Impacts on the Biological Environment

95. **Impacts on terrestrial habitat and biodiversity.** The proposed use of predominantly manual labour over mechanical equipment during construction will reduce the risk of excessive vegetation clearance. However, this will require close construction supervision to ensure vegetation clearance is minimized. Such provisions shall be included in the CEMP.

96. The 2500 distribution connections coming off the TEIP transmission lines in West New Britain and Oro provinces and the Autonomous Region of Bougainville will be aligned along the existing road corridor. The careful placement of low voltage poles and use of ABC can minimize impacts 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.

97. Any compensation to local residents for loss of trees will be provided in accordance with the resettlement plan. 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.

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

C. Impacts on the Socio-economic Environment

99. **Social impacts related to construction workers.** The workforce is expected to be in the order of 12 (line stringing crew, auger operators, people directing/managing traffic, and supervisor) for a period of about four months, there will be no need for a dedicated or large-scale accommodation. There could be the need for a works office and storage/maintenance area to be established, this would be undertaken through consultation with local land owners and the Ward Councillors .

100. The contractor 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 waste management measures agreed.

101. 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.

102. The proposed measures to mitigate the risks include:

- Location of site office and facilities to be agreed with local community (including land owners) with facilities approved by PPL and managed to minimize impacts and any negotiation or lease arrangements to follow established procedure as per the resettlement plan;
- Induction of workers on requirements of the project's consultation and participation plan (CPP)²¹ and grievance redress mechanism (GRM)²² and protocols established for any contact between local communities and contractor/workers;
- The project will be required to implement communicable disease awareness and prevention measures targeting risk of spread of STIs and HIV as outlined in the project's poverty and social assessment and gender action plan. This should include the areas proposed for grid extension;
- The contractor will put up notice boards regarding the scope and schedule of construction activities, as well as any disruptions or access restrictions;
- The site office/yard will be fenced and sign-posted and unauthorized access or entry by general public will be prohibited;
- Standing and open water (including puddles, ponds, drains etc) within the office/yard shall not be permitted to reduce possible disease vectors;
- 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. Storage of fuel, and oil and grease residues if generated, shall be stored, handled and disposed of as per the agreed provisions of the CEMP;
- The contractor's facilities area will be cleaned up to the satisfaction of PMU and local community after use; and
- Post-construction the area shall be fully rehabilitated and all waste materials shall be removed and disposed to disposal sites approved by local authorities.

103. 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.

5. Occupational Health and Safety

104. The overall project will be required to reduce risk of accidents during construction activities; the same level of care is required for the Lake Hargy HPP upgrade in West New Britain and the distribution connections in the TEIP provinces. The CEMP will cover both occupational health and safety (workers) and community health and safety. The CEMP will be appropriate to the nature and scope of grid expansion activities and as much as reasonably possible meet the requirements of good engineering practice and World Bank's Environmental Health and Safety Guidelines.

²¹ A framework CPP has been prepared for the project. The CPP will be further developed during the initial stage of project implementation.

²² Elaborated in Section VII.

105. The CEMP will include agreement on consultation requirements (workers and communities) established in the project's CPP, establishment and monitoring of acceptable practices to protect safety, links to the complaints management system for duration of the works (in accordance with agreed GRM), and system for reporting of accidents and incidents.

106. Mitigation measures to be implemented by the contractor to ensure health and safety of workers are as follows:

- Before construction commences the contractor will conduct training for all workers on environmental, safety and environmental hygiene. The contractor will instruct workers in health and safety matters as required by good engineering practice and Environmental Health and Safety Guidelines;
- The site office/yard and construction vehicles will be equipped with first aid facilities including first aid kits. A suitable vehicle will be available for transport to and from the TEIP sites to the main towns for medical or emergency treatment if required;
- Regular meetings will be conducted to maintain awareness levels of health and safety issues and requirements;
- Workers shall be provided (before they start work) with appropriate personnel protective equipment (PPE) suitable for civil 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;
- Provision of potable water supply in all work locations; and
- The site office/yard will be securely fenced and warning signs erected. Unauthorized people shall not be permitted within the camp and work sites/yards.

107. All measures related to workers' safety and health protection shall be free of charge to workers.

6. Community Health and Safety

108. Community safety can be threatened by works in public areas. General measures and requirements of the CEMP which apply equally to community and workers have been discussed above, this will include measures to minimize risk to community safety including:

- Communication to the public through public/community consultation as per the provisions of the CPP including notice boards and meetings etc. regarding the scope and schedule of construction, as well as certain construction activities causing disruptions or access restrictions;
- Barriers (e.g. fence) and signboards shall be installed around the site office/yard and construction areas to deter access to or through the sites;
- Provision of warning signs at the periphery of the site warning the public not to enter; and
- 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.

109. Such measures will manage risk to community health and safety to acceptable levels.

7. Physical Cultural Resources

110. Consultations with the local communities confirmed that there are no known physical cultural resources (including tambu sites) within the corridor of the grid expansion route. However, during excavation for the poles, 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.

D. Operation Impacts

111. The expansion of the low voltage distribution system will not create impacts during operation.

VI. ANALYSIS OF ALTERNATIVES

112. The generator upgrade in the Lake Hargy HPP can only be done at a single location in the station and hence there is no alternative location. Likewise, the Distributor Connections for the three sub projects are aligned at optimum length and direction while allowing for line sag and hence there are no alternative locations for these LV pole alignments.

VII. INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

113. The sub-project details will be posted on PNG Power’s website www.pngpower.com.pg . Following approval of the IEE by the ADB this will also be posted on the website.

114. No consultation was undertaken for this IEE however, consultation at the three sub projects sites in March - April 2010 did indicate overwhelming support from the provincial government, communities and landowners.

115. At all meetings in the three sub projects, the community were very supportive of the project and the UV lines to villages paid for by the project is a positive incentive for the community to have connection to light and TV and then internet. This has been their wish for a long time and will create opportunities for children to read and do their homework at night which is not the case now.

116. Local business saw it as an opportunity to venture into trade stores where perishable items can be stored and offered to customers. Electricity is cheap and reduced their current diesel generator costs. At the Autonomous Region of Bougainville, government officers stated that hydro power reduced carbon emissions from diesel fuels. While there were issues of land, the overall community perception was positive.

VIII. GRIEVANCE REDRESS MECHANISM

117. During the course of the project it is possible that people may have concerns with the project's environmental performance including the implementation of the EMP.²³ Issues may occur during construction and again during operation. Any concerns will need to be addressed quickly and transparently, and without retribution to the AP.

118. The following process is to be used and commences with an attempt to sort out the problem directly at sub-project level. If this cannot be resolved then the grievance moves to the resolution process outlined in Section 87 of the Environment Act 2000. The process is also shown as a flow chart in Figure 2.

1. During construction:

119. 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 have up to two days to resolve the complaint.

- i. Affected people (AP) are in the first place to discuss their complaint directly with the Ward Councillor in their village. If the Ward Councillor 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 AP 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 AP was informed of the decision and how the decision was conveyed to the AP. 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 AP will also show the procedure that will be followed in assessing the complaint, together with a statement affirming the rights of the AP to make a complaint. For anybody making a complaint no costs will be charged to the AP.
- ii. The (PE) will consider the complaint and within a maximum of two days will convey a decision to the AP. The AP and the Ward Councillor may if so desired discuss the complaint directly with the PE or his representative. If the complaint of the AP is dismissed the AP will be informed of their rights in taking it to the next step. A copy of the decision is to be sent to the PM at the PMU.
- iii. Should the AP not be satisfied, then the AP may take the complaint to the Managing Director in the Conservation and Environment Protection Authority. (CEPA) 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.
- iv. Affected party (AP) meets with Environment Permit Holder (PH) to formally register concern over impact and seek redress. A copy of the alleged impact is submitted to the Managing Director of CEPA (MD).

²³ This procedure is for addressing environmental issues. Any grievances dealing with land and compensation issues are to be directed to the Department of Lands who have established procedures for dealing with these issues.

- v. PH has to determine whether the impact has occurred due to its activities.
- vi. If PH accepts responsibility for the impact, it can negotiate a mutually acceptable settlement with AP within 90 days.
- vii. If PH rejects responsibility for the impact, AP can request CEPA to carry out a verification investigation.
- viii. If MD confirms that the impact has occurred, he/she will advise the PH and AP to negotiate a settlement within 90 days.
- ix. If a negotiated settlement is not reached under either Step 3 or 5, the PH or AP can request SDEC to formulate a determination. Once this request is made, MD will have 90 days to reach a determination.
- x. If either party is dissatisfied with the determination, it can appeal to the National Court.
- xi. The Secretary will have four weeks to consider the complaint. The Secretary will arrange for any complaint to be dealt with under the same procedure i.e. there will be no charge made to the AP for making a complaint.
- xii. Should the AP not be satisfied with the ruling of the MD of the CEPA, the AP may at their discretion take the grievance to the PNG judicial system. This will be at the APs cost but if the court shows that the Managing Director, or the administration have been negligent in making their determination the AP will be able to seek costs.

2. During Operation

120. The same procedure is followed except that the complaint is now directed to the HPP manager to rectify. During operation the same conditions apply; i.e. there are no fees attached to the AP for making a complaint, the complainant is free to make the complaint which will be treated in a transparent manner and the AP will not be subject to retribution for making the complaint.

A. Environmental Impacts and Mitigation Measures Needed during the Design/Pre-Construction Phase

121. The design and pre-construction phase will address the environmental mitigation measures that are outlined in this section. The majority of the measures are already established within Best Engineering Design Practices. The pre-construction work concludes with the integration of the EMP conditions into the Bid and Contract Documents and the evaluation and selection of the contractor. The responsibility for carrying out this work is shared by the Design Engineer and the Environmental Specialist. No additional costs have been identified for this work and all work require at this time will be covered by the budget for the pre-construction or design phase for the PMU. The following items are to be addressed during pre-construction.

- Siting of generator upgrade at Lake Hargy Hydro Power Station
- Siting of sub-project facilities - avoiding vegetation losses
- Anti-climbing barriers for wildlife on transmission poles
- Inclusion of Appendix 5 Prohibited Activities in Bid and Contract (B&C) Document
- Review EMP, extract construction section of the EMP and attach to the B&C document
- Bid evaluation and selection of contractor

122. **Siting of generator upgrade at Lake Hargy HPP.** This component of the subproject is the upgrading of the governor system in the Lake Hargy HPP. The siting is within the power

station and the only precautionary measure to take is the containment of equipment so as to avoid the spillage of oil coming out from generator when it is being replaced.

123. Siting of sub-project infrastructure - avoiding vegetation losses: The second main sub-project infrastructure is the LV poles which will be mounted that will contain transformers and LV hardwares for connection to village houses or schools infrastructures. These poles will be sited within areas of scattered regrowth, agriculturally disturbed areas and some tree crops. Hence not much clearing is anticipated unless a tree is in the direct path of where the LV line is coming off the HV transmission line.

124. The Design Engineer will be responsible for including this as a specification within the Bid and Contract Documents.

125. Anti-climbing barriers for wildlife on transmission poles: Cuscus - a marsupial is an avid climber and to avoid outages caused by the animal climbing and shorting the LV poles, anti-climbing barriers consisting of a smooth aluminium sheet about 0.5 m wide is required to encircle each pole about 3m above ground to be clear of vegetation.

126. The Design Engineer will be responsible for including this as a specification within the Bid and Contract Documents.

127. Inclusion of Appendix 5 - Prohibited Investment Activities List - in Bid and Contract Document: It will be necessary to include in the B&C document reference to Appendix 5 - Prohibited Investment Activities List, especially Item (ii) - production or trade in any product or activity deemed illegal under host country laws and regulations or international conventions and agreements or subject to international phase outs or bans, such as (a) pharmaceuticals, pesticides, and herbicides (b) ozone-depleting substances, (c) polychlorinated biphenyls and other hazardous chemicals etc.....

128. The Project Manager and Environmental Officer will be responsible for including reference to Appendix 5 Activities in the B&C document in the section "Special Conditions of Contract".

129. Review EMP, extract construction section of the EMP and attach to the B&C document: Experience shows that inadequate application of the EMP by the contractor may occur due to weak linkages of the EMP with the contract document. The EMP is a part of the work program and as such it must be addressed by the contractor and carried out as required. If the EMP is not satisfactorily addressed then the environmental safeguards and project sustainability will be compromised.

130. In the B&C section "Special Conditions of Contract" list the EO will arrange the following; (i) prior to the tender being called the EO will revise and update the EMP and (ii) extract the construction section of the EMP and together with the PM will attach this to the Bid and Contract Documents in section; Part II - Requirements; Section 6 - Employer's Requirements. In the B&C section "Special Conditions of Contract" list the construction section of the EMP as forming part of the B&C document. The contractor will use this document to cost his compliance with the EMP.

131. This will be the responsibility of the EO and PM as shown above.

132. Bid evaluation and selection of contractor: The contractor will be required to provide a short statement that confirms the following three points. The statement is to be attached to the Bid in the section “Special Conditions of Contract”.

- (i) that the construction section of the EMP conditions have been costed into the bid price,
- (ii) the contractor is to provide prior experience of working with an EMP,
- (iii) the contractor is required to provide the name, details of qualifications and experience of the person on the contractor’s team who will be responsible for the environmental compliance requirements of the EMP.

133. During bid evaluation these strengths will be evaluated in the selection of the contractor. Should the contractor not provide these details, the bid will be judged to be non-compliant and the bid rejected.

134. The PM will be responsible for ensuring that these conditions are included as conditions in the B&C document.

135. Both the PM and Environment Specialist (EO) are to be members of the bid evaluation panel. The EO will evaluate the contractor’s environmental capability to the evaluation panel.

B. Environmental Impacts and Mitigation Measures Needed during Construction

136. Environmental impacts identified during construction are limited in size, are site specific and temporary. The activities would normally be recognised as Best Construction Practices. While the scale of the works for hydropower projects of this size are relatively minor the sub-project will still require the normal range of contractor’s facilities such as site offices, workshops, storage areas and construction camps. The following activities have been identified during construction:

- Contractor prepares CEP
- Induction of contractor to site
- Control of invasive species
- Preparation of site and establishment of contractor’s facilities, quarries, concrete batching areas etc.
- Excavation of pipeline, road-bed, powerhouse and other sites
- Removal and disposal of excavated waste material
- Clearing transmission line
- Storage and handling of construction materials, fuel and lubricants.
- Noise and vibration
- Dust management
- Public access to site
- Community safety from increased vehicle movements
- Use of hazardous materials and Appendix 6 Prohibited Activities
- Workplace health and safety
- Worker issues - hiring of workers
- Worker issues - use of fuelwood
- Worker issues - hunting and sale of wildlife
- Worker issues - clearing of forest for gardens
- Disposal of waste materials
- Chance discovery of archaeological and cultural sites
- Clearance and rehabilitation of construction sites and removal of contractor’s facilities

137. During construction the contractor will work according to the requirements of the Contractor's Environmental Plan (CEP) which has been prepared by the contractor. Supervision and monitoring of the CEP activities will be undertaken as follows:

- (i) The contractor has the initial responsibility for supervising and monitoring of the CEP as already provided for in supervision of the works contract.
- (ii) The Project Supervising Engineer (PE) located within the Project Management Unit (PMU) will direct the contractor with regard to compliance with the CEP. The PE will be supported by the Environmental Officer (EO).
- (iii) The EO will carry out independent monitoring of the work and can issue Defect Notices to the PE who will transmit these to the contractor.
- (iv) The contractor will have his own representative on site – the Site Engineer (SE) who will be responsible for implementing the contract and complying with the CEP.

138. Contractor prepares CEP: following the award of the contract and before commencing work the contractor will be required to prepare a Contractor's Environmental Plan (CEP) that addresses the conditions of the construction EMP that has been attached to the B&C Documents. The CEP will amplify how the contractor will address the activities in the construction section of the EMP. An outline of the CEP will be provided by the EO. The contractor will submit the CEP to the EO for approval. The contractor has 10 days to prepare the CEP and the EO has 5 days to review the CEP.

139. Induction of contractor to site: Following the selection of the contractor and the approval of the CEP, the contractor together with the person on the contractor's staff who will be responsible for supervising the CEP will meet the EO on-site where the CEP conditions will be confirmed with the contractor. When the EO is confident that the contractor understands and can comply with the CEP, the EO will advise the PE that the contractor can now commence work.

140. Control of invasive species: invasive species have the ability to out compete local vegetation and the introduction of these into new areas should be avoided.

- Prior to the contractor mobilising the EO will arrange to review the site and determine whether there is or is not any infestations of invasive species in the area.
- If the area is not infested then the PE will advise the contractor that all earth must be cleaned from machinery before moving to the site.
- The contractor and the EO will be required to observe for any infestations.
- Should infestations occur on construction sites that are due or are not due to the contractor's activities the contractor will be required to control the infestation.
- Control and avoidance of the introduction of invasive species is the contractor's responsibility and this also extends to any sub-contractors that are working under his control.

141. This will be the responsibility of the contractor. The PE and the EO will be responsible for the supervision and monitoring of the contractor.

142. Preparation of site and establishment of contractor's facilities: This applies to all of the contractor's facilities, storage areas, workshops, labour camps, quarries, concrete batching areas etc. The sites are to be selected so that:

- they do not interfere with the welfare of surrounding communities in terms of noise dust and vibration from construction activities and their social wellbeing from their proximity to contractor's labour camps,
- size of contractor's facilities are limited to reduce unnecessary clearing of vegetation,
- sanitary waste and grey water is not to be released untreated into surface water systems.
- sites are to be properly drained. Paved areas, including vehicle parking areas, workshops and fuel storage areas are to drain to an oil and water separator.
- Fuel storage areas are not to be located within 20m of a water course.
- The contractor's facilities are to be contained within an adequate security fence.

143. The location and development of contractor's facilities are to be approved by the PE and the EO.

144. Clearing of sites and removal and disposal of vegetation: this applies to the intake area, the pipeline, powerhouse, the access road and the contractor's site facilities.

- Wherever possible limit area to be cleared and avoid excessive machine disturbance of the topsoil as this is required to be removed and stored.
- Areas of significant vegetation within the cleared area have been identified and have been shown to machinery operators.
- The area to be cleared is defined by a clearly established boundary.
- 10 m wide buffer zones are to be established around watercourses and no clearing is permitted within this area.
- Machinery operators must be shown the boundaries of areas to be cleared.
- Cleared material is to be pushed into manageable sized heaps according to disposal or re-use requirements.
- Waste vegetation should be made available to villagers as fuelwood
- If the material is an impediment to workers it may need to be burnt to clear the area. Wherever possible limit burning and if this is to be done ensure that the wood is dry so as allow a hot clean burn that produces little smoke.

145. This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

146. Excavation of construction sites: this applies to all cleared sites where excavation will be undertaken and includes the intake area, pipeline, powerhouse, access road etc. The contractor is to arrange the following.

- Limit the areas to be excavated to those that can be effectively managed and protected.
- Topsoil is removed and stored in separate heaps that are located in stable areas for later re-use for site rehabilitation.
- Excavated material is sorted and stored as either competent (able to be reused) and incompetent (to be disposed of) materials.

147. This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

148. Prevention of soil erosion on construction site: this applies to all excavated sites. The contractor will be responsible for ensuring that the site is stable and that erosion is contained by appropriate soil conservation protection methods.

- Limit the extent of excavation to reduce soil erosion potential.
- Soil conservation protection methodology is to be applied to susceptible areas to avoid storm water runoff carrying eroded materials either, off-site to susceptible areas or, else onto already finished work areas.
- Where excessive areas are to be opened up, soil protection is unlikely to be effective or storm water drainage is likely to discharge sediment into neighbouring water courses sediment traps are to be used to settle eroded particles.
- Avoid excavating areas and operating machinery in wet ground conditions.
- Excavated areas are to be revegetated as soon as possible at the completion of the site work.

149. This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

150. Removal and disposal of spoil: this applies to all sites where incompetent excavated materials have been produced that need to be disposed of off-site. This includes excavation waste (spoil) from; the weir, pipeline, powerhouse and access road. The contractor will be responsible for selecting sites and disposing of excavated waste at the sites. Sites for spoil dumps will not be approved where there is significant vegetation and at the completion of dumping the sites will need to be reshaped and rehabilitated back to a stable vegetated state. When the sites are opened these areas will require that vegetation be cleared and topsoil removed prior to being used. Once they are being used they must be maintained in a stable manner and soil conservation technology applied as required.

151. This will be the responsibility of the contractor. The PE and the EO will responsible for approving the site selected by the contractor and supervising and monitoring the contractor.

152. Prevention of soil erosion on finished work areas: this applies to all finished sites that have been disturbed by construction activities. The contractor will ensure at the completion of work that all excavated areas are properly stabilized. This includes the rehabilitation of all disturbed areas by the most appropriate and effective method. Re-vegetation requirements are to be discussed with the PM's representative who will advise on the re-vegetation conditions as required for the areas.

153. This will be the responsibility of the contractor. The PE and the EO will be responsible for the supervision and monitoring of the contractor.

154. Clearing of LV poles: the LV poles will be erected as coming off the TEIP transmission line and the LV poles will be erected adjacent to the right of way with connection to residential homes and schools. The poles and lines should be limited to that width that meets conductor safety requirements in terms of sag and side clearance limits. Waste vegetation should be made available to villagers as fuelwood or otherwise it may need to be burnt to clear the area. Wherever possible limit burning and if this is to be done ensure that the wood is dry so as allow a hot clean burn that produces little smoke.

155. This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

156. Storage and handling of construction materials. Fuel and lubricants: Only small amounts of construction materials are likely to be brought to site. These will include sand, gravel and cement for concrete manufacture, reinforcing rods and steel mesh, wood and other construction materials, paint and thinners, fuel and lubricants. Areas will need to be prepared for storing these materials. Fuel and oil will need to be stored in dedicated areas at least 20 m away from a watercourse. Where >5000 litres of fuel is stored on site, the fuel must be stored in sealed tanks that are provided with a concrete base that is bunded to hold 110% of the tank capacity. All spills within the sub project areas are to be reported to CEPA. All waste oil, oil and fuel filters are to be collected and disposed of in secure landfill areas. At the closure of the site all contaminated soil is to be excavated, removed and replaced with fresh topsoil.

157. This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

158. Noise and Vibration: this applies to all machinery, vehicles and construction sites where noise and vibration may affect susceptible receptors. The mounting of the LV poles within communities in the sub project area may affect susceptible receptors. The contractor will be responsible for ensuring that noise and vibration does not affect the surrounding communities. While it is unlikely that noise and vibration will be an issue due to the distance between the activities and the communities the contractor must be prepared to curtail work to daylight hours (0700hrs - 1900hrs) should the community find that any night time operations become a nuisance. Noise is not to exceed 45 dBA at the boundary of residential areas.

159. This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

160. Dust management: this applies to the sites where LV poles are erected and also topsoil and spoil dumps. Work that is carried out during the drier time of the year and especially when wind speeds increase may create localised dusty conditions. During construction when dust (if any) may be generated the contractor is to monitor the worksite conditions and apply dust control measures which includes reducing traffic movements and spraying water on exposed areas. Use of oil for dust control is not allowed. The contractor is to maintain a dust control record that shows where and when dust control practices were carried out. This is to be made available as required when requested by the PE and/or the EO.

161. This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

162. Public access to the site: this applies to the contractor's site and work areas. Access will be controlled to the contractor's facilities since this will be surrounded by a security fence. All visitors will be required to report to a check point before being allowed to enter the site. Other work areas will be demarcated by barrier tape and signs erected as required to warn people that there is no right of entry to these areas.

163. This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

164. Community safety from increased vehicle movements: this applies to all vehicles and in particular haul trucks that have to pass through villages. The contractor is to ensure that all

vehicles that may be required to pass through villages are operated and transport equipment and materials safely without endangering these communities. The contractor is to ensure:

- that trucks and other vehicles are maintained in a safe operating condition,
- all drivers and machinery operators act responsibly,
- all loads are to be secured and all loads with fugitive materials (e.g. excavated soil and sand) are to be covered with tarpaulins,
- the contractor is to immediately remove any drivers that ignore any of the community safety requirements.

165. This will be the responsibility of the contractor. The PE and the EO will be responsible for the supervision and monitoring of the contractor.

166. Use of hazardous materials and Prohibited Activities:

167. **Hazardous Materials:** Care will need to be taken should any hazardous (HAZCHEM) materials be required during construction. It is recommended that the contractor uses the HAZCHEM system which is based on the UN classification system. Details of the classification of dangerous materials can be found on the site <http://www.minerals.csiro.au/safety/dangood.htm>. The contractor will be required to prepare a list of all materials that are proposed to be brought to site together with their HAZCHEM rating. The EO is to verify the HAZCHEM rating and approve the use of any HAZCHEM rated chemicals. The contractor will also be required to display Material Safety Data Sheets (MSDS) in all work areas and to train workers in the safe use of these materials, including the provision of protective equipment for handling these substances.

168. **Prohibited Activities:** The contractor is to be aware of the activities shown in Appendix 5 of the of the ADB's *Safeguard Policy Statement, Prohibited Investment Activities List* that became effective in January 2010. Any listed Appendix 5 activities are prohibited. The PE and ES are to verify that the contractor is aware of the Appendix 5 requirements and that none of these activities will be sanctioned during construction.

169. This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

170. Workplace health and safety: Workplace health and safety is covered by the Employment Act (1978). The contractor may employ up to 100 people at any one time of which all will have to be housed on site. The main workplace safety issues include:

- Hazards from operating and using machinery. Direct hazards to the machine operators and to workers working in the vicinity of the machine
- Hazards from working in the pipeline trench where sides may collapse.
- Hazards to workers exposed from heavy materials being lifted by cranes.
- Refuelling hazards.
- Exposure to HAZCHEM materials.
- Traffic accident hazards

171. Before commencing work in any of these activities (and in any other areas that the contractor identifies), the contractor will be required to prepare a brief Work Statement (WS) that identifies hazards that apply at a particular site together with an outline of the approved work procedure and details of protective safety equipment to be used by any person entering the specified work area. The WS is also to include an emergency response plan to address serious accidents and nominate a person who is to be immediately contacted should an accident occur.

A copy of the WS is to be posted at the site and before commencing work the contractor is required to discuss the WS requirements with the workers. The WS plan is to be submitted to the PE and ES for approval one week prior to starting work in any of these areas.

- The contractor will be required to keep the site free of drugs and alcohol.
- The contractor will be required to appoint a person on his staff who will evaluate workplace safety issues and instruct all workers on workplace hazards and health and safety issues.
- The contractor will be required to provide a safe work environment and provide safety measures and protective equipment for all workers including; hand, head, eye and ear protection and safety footwear.
- The contractor is also to provide first aid facilities on-site and employ a competent person trained in first aid.
- Noise and dust are to be controlled at the workplace.
- Supplies of potable water, toilets and washing water are to be provided for workers.
- A record of accidents and time lost from accidents will be required to be kept by the contractor which will be forwarded each month to the PM's representative for the attention of the ES.

172. The PE or EO will inspect and approve the adequacy of these arrangements.

173. Worker camp establishment/incoming workers: (i) location of camps with regard to social conflicts: A construction site such as this may employ upwards of 100 persons who will be housed and located on-site. There is a potential for conflict to develop with local communities should they be marginalised by the introduction of outside workers who then enjoy an enhanced economic status in comparison the local communities.

- Camps to be located and managed so that social harmony is maintained between workers and local communities.
- Local people should be given priority in labour recruitment.

174. This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

175. Worker camp establishment/incoming workers: (ii) provision of adequate living conditions: Workers will need adequate housing, sanitation and recreational facilities.

176. The contractor will provide acceptable camp facilities with potable water, adequate food rations and recreational facilities to either meet requirements of the Employment Act (1978) or an acceptable international standard whichever is the higher.

177. This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

178. Worker camp establishment/incoming workers: (iii) camp water heating and cooking: To avoid sudden and unsustainable loss of any resources to the detriment of surrounding communities, the contractor will be required to address these issues as follows.

- Locate camp outside significant forest areas.
- Limit collection and use of fuel-wood.
- Contractor provides gas and kerosene for water heating and cooking.

179. This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

180. Worker camp establishment/incoming workers: (iv) hunting and sale of wildlife: To avoid sudden and unsustainable loss of any wildlife resources the contractor will be required to address these issues as follows.

- Labour employment agreement enforced by Contractor that bans hunting and trading in wildlife.
- Provision of adequate camp rations.

181. This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

182. Worker camp establishment/incoming workers: (v) clearing of forest for gardens: workers may want to clear areas for gardens. This will be driven by tradition rather than necessity as the contractor will be required to provide all workers with an adequate ration. While there is adequate land in the area this is owned under traditional systems and should workers want to prepare gardens they must first seek the approval of the Ward Counsellor to avoid social conflict with the surrounding communities. The Ward Counsellor will be advised that workers will not be permitted to clear any forest for garden activities. The contractor is to provide adequate and nutritionally balanced rations for all workers under his control that also incorporates traditional food items that would normally be sourced from markets.

183. This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

184. Disposal of waste materials: All construction waste materials including steel and timber off-cuts, sand and gravel, cement bags etc are to be suitably disposed of. If these cannot be recovered for scrap value these materials are to be taken to an approved landfill sites and dumped there. Operation of landfill sites will be included as an item in the Environmental Permit.

185. This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

186. Chance discovery of archaeological and cultural sites: Archaeological sites are protected under the National Cultural Property (Preservation) Act (1965). There are no known archaeological or cultural sites within the boundaries of the sites. However, it is possible that "chance discoveries" may be made during development of the site. The contractor will be responsible for these finds and is to immediately stop work where the discovery has been made and advise the PE and the EO of the discovery. The EO will arrange to have the site evaluated. Depending on the evaluation of the discovery the contractor will be advised whether or not it is possible to resume work on the site.

187. This will be the responsibility of the contractor. The PE and the EO will responsible for the supervision and monitoring of the contractor.

188. Clearance and rehabilitation of construction sites and removal of contractor's facilities: It is the contractor's responsibility to address site clean-up. This includes the removal all waste materials, machinery and any contaminated soil. All construction sites and work areas are to be rehabilitated so that these can be returned as close as possible to their previous use. This includes the stabilization and landscaping of all of the construction sites. Any borrow pits or

quarries that were operated by the contractor are to be reshaped and closed. Any contaminated soil must be removed from fuel and oil storage areas and the site revegetated. No waste is to remain behind after work is completed that will not naturally and safely decompose. Should waste not be removed the Owner is entitled to withhold payment and arrange the clean-up and deduct the cost of the clean-up from the final payment amount less an additional 10% for arranging the task.

189. The PE is to ensure that all waste is removed and the site restored. The EO will also inspect and approve the clean-up of the site.

C. Environmental Impacts and Mitigation Measures Needed during Operation

190. During operation, there will be issues such as;

- handling of waste materials generated from the powerhouse and
- Human safety – along the UV poles

191. Handling of waste materials from the powerhouse: small quantities of lubricating oil will need to be stored on site for maintenance of the turbines and generation equipment. Risks will mainly arise from storage and handling of lubrication oil and only small quantities (<100 litres) should be stored on site. All waste oil is to be collected and disposed of to recycling facilities. On no account is oil to be disposed of in the waterway. All spills are to be immediately cleaned. Any serious spills are to be reported immediately to CEPA. The powerhouse manager will be responsible for the correct storage and handling of all oil and lubricants and is to be trained in these techniques including procedures to manage any spills. Solid waste such as paper and food wastes from the powerhouse are to be collected and disposed to a landfill area.

192. The area around the powerhouse is to be kept clean and the grass cut on a regular basis. No equipment will be allowed to be discarded within the powerhouse grounds which are to be kept clean and tidy at all times.

193. PNG Power will be responsible for implementing these procedures.

194. The PNG powerhouse staff will be responsible for taking the samples and forwarding them to the Environmental Officer in the PPL office in Port Moresby. The EO will review and evaluate the samples and determine the course of the monitoring program.

195. Human safety - along the UV pole: the poles for the UV line are to carry a sign warning of the dangers of the transformers. While there is no causal link established between electromagnetic radiation and transmission line ideally houses should not be allowed within 15 m of the outer conductor of the transmission line. PNG Power will be responsible for making these arrangements.

196. Maintenance of UV poles: the UV poles will need to be maintained to ensure that vegetation does not compromise conductor safety requirements. It is recommended that the UV poles be cleared under contracts arranged by PNG Power with local communities. PNG Power will be responsible for making these arrangements.

D. Monitoring

197. A matrix summarizing the monitoring that is required for the EMP is attached as Annex 2 which shows the monitoring measures that are required together with the frequency of measurement, the means of verification and who is responsible for monitoring the activity. Monitoring is carried out as follows:

198. Pre-construction: during preconstruction the EO will monitor the tasks identified within the EMP.

199. Construction: During construction monitoring of construction activities is carried out to ensure that construction work complies with the requirements of the EMP. Monitoring responsibilities are arranged as follows.

- The contractor has the initial responsibility for monitoring compliance with the Contractor's Environmental Plan (CEP) which is identical to the contractor's responsibilities for monitoring the construction works.
- The Project Engineer is responsible for monitoring the contractor's compliance with the CEP and the PE will be assisted in this role by the EO. A Monitoring checklist is attached as Annex 2.
- The EO also monitors the work but in more of an auditing role. The EO can issue Defect Notices for non-compliant work and depending on the seriousness of the work may instruct the contractor that this is to be completed by a certain date. The Defect Notice is given to the PE who directs the contractor to undertake the work as shown in the Defect Notice. If the work is not completed by the due date then the PE can arrange for the work to be completed by another contractor and the cost deducted from the contract plus 10% as a management charge.
- Monitoring may also be carried out by a Third Party e.g. CEPA who may make spot checks on the work being undertaken.

200. Operation: During operation monitoring will be undertaken by the PNG Power Environmental Officer. Monitoring tasks are established in Annex 1 and maintenance of safety signage, removal of vegetation from the UV Pole line and waste handling in the Lake Hargy Hydro Power Station.

E. Implementation Arrangements

1. Institutional Arrangements

201. PNG Power will have overall responsibility for implementing the EMP. Other organisations involved in implementing the EMP include.

- (i) **Government agencies** such as CEPA who will be responsible for environmental approval.
- (ii) **The Department of Lands** who will be responsible for assessing and paying compensation.
- (iii) The **contractor** who will be responsible for mitigating and reporting on environmental activities during construction.

202. **Department of the Environment and Conservation (CEPA)**. The Conservation and Environment Protection Authority is responsible for the administration and enforcement of the Environment Act 2000 and its regulations.

203. CEPA have advised the PPL that the small hydropower developments have been assessed as a level 2B activity requiring PPL to submit an Environmental Application which is in a similar format to the IEE. Following approval CEPA will issue an Environmental Permit for level 2 and 3 projects. No work can commence until the Environmental Permit is issued.

204. **The Department of Lands** will be responsible for assessing and paying compensation for loss of land and privately owned assets according to the RAP.

205. **PNG Power Ltd (PPL)**. The lending facility will be a Multi Tranche Finance Facility (MFF) that is planned to last for six years. The first tranche will be drawn down in the first three years of the project; the second tranche will be drawn down over the next three years. For the purposes of this assessment the budget requirements are established only for the first tranche while the environmental safeguards that are required to support the project over all of the tranches are included in the environmental assessment and review framework (EARF).

206. PNG Power (PPL) has already a Project Management Unit (PMU) established within the PPL structure. A Project Manager (PM) manages the PMU and has engineering, social and environmental personnel. During construction the on-site supervision of the construction program will be managed by the Project Engineer (PE). Both the PM and the PE have roles in ensuring that the EMP is actioned which is formalised by attaching the following to their Statement of Duties.

- (i) *The Project Manager will be responsible for ensuring that the environmental safeguards are implemented so as to meet their intended requirements. This includes ensuring that the construction section and tendering conditions for the EMP is attached to the Bid and Contract documents.*
- (ii) *The Project Engineer (PE) will be responsible for supervising the implementation of the EMP during construction. The PE will be assisted by the Environmental Officer (EO) and the Environmental Specialist (ES). The PE will be responsible for conveying any instructions from the EO or the ES to the contractor.*

207. Included as part of the PMU team, are three staff - an Environmental Officer (EO), a Land Acquisition Officer (LAO), and a Community Development Officer (CDO). The EO will be responsible for environmental related matters, the LAO will be responsible for land acquisition and compensation issues and the CDO will be responsible for community development program of the affected communities. These staff will report to the Project Manager (PM) of the PMU. These positions have already been filled for the TEIP and TEIP AF will be effectively managed.

208. During pre-construction the EO will ensure that issues that need to be addressed by the PMU Design Engineers are considered in the design. The EO will prepare a Design Brief containing these requirements for action by the PMU technical design team. The EO will also review and revise the EMP as required and extract the construction section from the EMP so that these may be attached to the Bid and Contract Documents. The EO will arrange public consultation with the LAO to advise affected communities of the scope and scheduling of the sub-project to raise awareness within the communities of the likely phasing of events that will occur within their social boundaries.

209. Prior to construction commencing the EO will also evaluate and approve the Contractor's Environmental Plan (CEP) that will be prepared by the Contractor as a condition of the contract. Following approval of the CEP the EO will arrange to induct the contractor to the construction site whereby the details of the CEP are confirmed with the contractor. When the EO considers

that the contractor is competent to undertake compliance with the CEP the EO advises the PMU Project Supervising Engineer (PE) that the contractor may now commence work.

210. While the Contractor's SE will undertake day-to-day supervision of the CEP, the PE who will be assisted by the EO will have overall site supervision responsibilities for ensuring that the Contractor is meeting the CEP requirements.

211. During operation, the EO will also undertake regular monitoring as required by the EMP. The EO may issue Defect Notices concerning non-compliant work which are channelled to the contractor via the PE.

212. The EO will prepare IEEs and Notification of Preparatory Works for other sub-projects as required to meet the requirements of the MFF lending facility.

213. During the first tranche which will take three years an international Environmental Specialist (ES) will also be appointed to the PMU for a period of 5 months to assist the EO in establishing the environmental program. The ES will be located within the PMU and will directly assist the EO in carrying out his duties. The ES will work with and train contractors to assist them in proactively understanding their contractual requirements. The ES is to be familiar with contract preparation, evaluation and supervision so as to advise the EO in the steps required to carry the environmental safeguards across to the Bid and Contract documents, the evaluation of bids, selection of the contractor and the monitoring of the contractor's work. The ES will need to be recruited prior to tendering so as to ensure that the environmental safeguards are integrated into the contractual documents. The ES will have several intermittent inputs over the two years with the first input of three months scheduled during pre-construction to assist in the formation of the environmental work program and facilitate the integration of the EMP with the contractual document. The remaining two inputs of two months are to be used as two, one month inputs to commence the construction program and the last input is required at the end of the construction period and at the beginning of the operation period. The social and environmental team will use PMU facilities and be supplied with computer facilities, transport and specialised equipment including; a portable water quality meter, and a noise meter.

214. **The Contractor.** The contractor's responsibilities include;

- (i) Prior to construction commencing the contractor will address the construction section of the EMP which has been attached to the Bid and Contract Documents and develop this into a detailed Contractor's Environmental Plan (CEP) that amplifies the conditions established in the EMP. The CEP also identifies persons who will be responsible for undertaking the work within the contractor's team. It will include a basic monitoring plan and a reporting program.
- (ii) The CEP will be submitted to the EO who will approve it and forward a copy to CEPA for their information.
- (iii) Following approval of the CEP the contractor is required to attend a site induction meeting where the CEP is further discussed directly with the contractor to ensure that all compliance conditions are understood.
- (iv) Following this the EO advises the PE that the contractor is now cleared to commence work.

215. The contractor will prepare a quarterly compliance report that will be submitted to the PMU. The report will also contain the Monthly Accident Report. The EO will submit the report to CEPA and include a copy for the ADB in the project's quarterly progress report prepared to meet the ADB loan requirements.

216. Environmental Assessment of Subsequent Projects: the sub-projects are part of a MFF lending facility and additional sub-projects may be added as required. An Environmental and Review Framework (EARF) has been prepared to guide the preparation of subsequent sub-projects.

2. Budget

217. The sub-project will be implemented over years as part of TEIP Tranche 1 implementation. Costs for the social measures are presented in the social development report. As the sub-project will be one of several funded under the MFF facility, the PMU costs for national staff, travel and accommodation and those for the international consultant (the ES) will be common to sub-projects implemented during this tranche.

IX. CONCLUSIONS AND RECOMMENDATIONS

112. The 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 are summarized below:

- The project involves the upgrading of the Governor System in the Lake Hargy Hydropower Station thus increasing power output to a maximum of 1500 kW for West New Britain province.
- The potential loss of less highly modified habitat of low ecological value within the route corridor, and any impact on terrestrial wildlife due to the project will be insignificant. Minor loss of vegetation can be further minimized through selection of pole location (to minimize tree removal) and use of ABC (to minimize need to trim or cut trees) and alignment of LV poles along existing roads to minimise need for removing or trimming trees; and
- Nearby communities consulted are happy for the project to be implemented and expressed their desire to benefit from both electricity generated and employment opportunities during construction and operation.

113. An EMP has been prepared and will be updated based on detailed design and implemented during all phases of the project. The EMP identifies potential environmental impacts arising from the project along with a corresponding schedule of mitigation measures to ensure potential impacts are maintained at insignificant levels and that international best practice is applied. It also includes the institutional arrangements for implementing the EMP to ensure its effectiveness.

114. This IEE, including the EMP is considered sufficient to meet ADB's and government environmental safeguard requirements in respect of the distribution connections to the TEIP sub project areas in West New Britain and Oro province and the Autonomous Region of Bougainville. No further or additional impact assessment is considered necessary at this stage.

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Table 7.1 - EMP Matrix: Environmental Mitigation and Monitoring Plan

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
DESIGN / PRE CONSTRUCTION								
Project disclosure	<p>1. Submit ADB-approved IEE to CEPA for approval using applicable form and obtain a Development Consent as per the EIA Act.</p> <p>2. Ensure CEPA approved EMP and any conditions of Development Consent are included in EPC tender documents including i) requirement for EPC contractor to seek CEPA approval and update EMP in the case of significant changes to FS design ii) requirement for EPC contractor to prepare a construction EMP (CEMP) for approval of PMU/DSC before commencement of construction. The CEMP will demonstrate the manner (location, responsibilities, schedule/ timeframe, budget, etc.) in which the contractor will implement the mitigation measures specified in the EMP approved under CEPA Development Consent.</p> <p>3. Tender document to include upgrading of the existing transformer bay to internationally recognized standards with respect to oil containment facilities including oil separator at drainage outlet.</p> <p>4. Implement plan for Grievance Redress Mechanism as described in the IEE</p> <p>5. EPC contractor's project design to adhere to all design related mitigation measures in FS EMP or in updated EMP as approved under CEPA Development Consent.</p>	1 to 4: PMU/DSC 5: EPC contractor	1 and 2 Immediate. 3: During tender preparation 4: Before start of civil works 5: EPC detailed design phase	1 to 4: Cost included in PMU/DSC staffing 5: Cost included in EPC contract	Environmental approval for the project obtained from CEPA. Complete check of items 1 to 5.	Prior to signing of EPC contract and start of site works. Once.	PMU	Cost included in PMU budget for additional NES to support the project procurement and impl.
Environmental capacity development	<p>1. PMU to commit to provide sufficient resources for project duration.</p> <p>2. DSC to train PMU/EO in implementation of EMP as well as general training in ADB safeguards requirements to raise awareness and build capacity of environmental management in PMU. A mix of workshops and on-the-job training to be used.</p> <p>3. Conduct contractor / workers' orientation on EMP provisions.</p>	1: PMU 2: DSC 3: EPC contractor	Initiate during procurement period and continue throughout project construction	1: & 2: IES and NES cost included as part of PMU (project) costs 3: Included in EPC contract cost	1. ADB loan covenants 2. IES TOR, DSC progress reports to PMU/ADB 3. EPC Tender documents and check during construction.	Prior to start of site works and throughout construction phase.	PMU	As above.
Environmentally responsible procurement	1. EMP is included in EPC tender documents to ensure that mitigation measures are budgeted and to prepare the contractor for environmental	1 & 2: DSC for PMU 3: Preparation	1 & 2: Bid preparation 3 & 4: Before	Included in bid cost	1 & 2: Inclusion in bid docs	Bid preparation stage.	PMU/IES & NES	PMU – as above. IES & NES –

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	responsibilities. 2. Specify in tender document that contractor shall engage appropriately qualified and experienced staff to take responsibility for the environmental management and safety issues and monitor the effectiveness and review mitigation measures as the project proceeds. 3. EPC contractor to submit construction environmental management plan (CEMP) based on contractual EMP for approval by DSC (i.e., waste and materials management, traffic, noise and dust management etc.). 4. Contractor recruit qualified and experienced staff to oversee implementation of environmental and safety measures specified in the EMP.	of SEMP - EPC contractor, Approval of SEMP-DSC 4: EPC contractor	start of civil works		3 & 4: Check compliance	Before start of site works		included in DSC staffing
Disclosure of CPP and GRM and establishment of procedures	1: Project documents disclosed to public and communities in an appropriate form and manner and accessible place 2: Inclusion of appropriate measures from CPP and GRM in tender documents	PMU	Before EPC contractor mobilization	Included in bid cost	EPC tender document; Grievance registry, monthly reports	Monthly Grievance registry, monthly reports	EPC contractor, PMU	Included in project cost PMU - as above.
Workers and public safety	CEMP to include measures covering workers and public safety and to identify interfaces between the works and the public, formulate measures to ensure safety of workers and the public, and prevent accidents due to the construction works.	EPC contractor in preconstruction	Before start of civil works	Cost included in EPC contract.	EPC tender document. Check at preconstruction.	During EPC tender preparation and again before start of works	PMU/IES & NES	PMU - as above. IES & NES - included in DSC staffing
Grievance Redress Mechanism established	Establishment and implementation of GRM confirmed by PMU.	PMU	Before start of civil works	Met by PMU/ project	GRM confirmed and agreed with community.	Before start of civil works	PMU	Incl. in PMU budget for additional NES
Raise awareness of EPC contractor on environmental management matters	Induction safeguards training for EPC contractor	DSC	Before submission of SEMP	Cost included in project and contract	Approved SEMP	Before submission of SEMP	PMU	Included in PMU budget for additional NES
CONSTRUCTION STAGE								
Physical Impacts								
Noise and dust nuisances	1. Construction equipment and vehicles will be maintained to a good standard and provided with muffler silencers. 2. Watering of roads/route corridor during dry periods 3. Monitor and investigate complaints; propose alternative mitigation measures.	EPC contractor	Throughout construction phase	Cost included in contract	Check implementation	Twice a month as part of routine construction monitoring	DSC (IES/NES)	As above
Erosion and loss of	1. Schedule excavation activities in the drier	EPC	Throughout	Cost	Check	Twice a month	DSC	Included in

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
topsoil	months (May - Oct) 2. Minimize vegetation clearance corridor or footprint of components 3. Stockpile topsoil for later use in landscaping or made available to local community for their use	contractor	construction phase	included in contract	implementation of all items	as part of routine construction monitoring	(IES/NES)	DSC staffing
Sedimentation and water quality impact	1. Schedule excavation activities in the drier months (May - Oct); 2. Minimize width of vegetation clearance; 3. Immediately re-vegetate and/or stabilize exposed surfaces and stockpiles of excavated material; 6. Effective construction supervision to ensure above measures implemented	EPC contractor	Throughout construction phase	Cost included in contract	Check implementation of all items	Twice a month as part of routine construction monitoring	DSC (IES/NES)	As above.
Materials and spoil management	1. Identify and implement measures for materials and spoil management as part of CEMP; 2. Topsoil, overburden, and low quality materials shall be properly removed, stockpiled near the site, and stored for reuse. 3. Areas for disposal to be agreed with land owner and SPC and recorded by the PMU/DSC and monitored 5. Spoil will not be disposed of in rivers and streams or other natural drainage path. 6. Surplus spoil will be used where practicable for local repair works to fill eroded gullies and depression areas and degraded land in consultation with local community. 7. Spoil disposal shall not cause sedimentation and obstruction of flow of watercourses, damage to agricultural land and densely vegetated areas. 8. Spoil disposal sites shall be located at least 50 m from surface water courses and shall be protected from erosion.	1: EPC contractor to prepare CEMP and submit PMU/DSC to assist and approve 2 to 8: EPC contractor	1: One month before start of site works 2 to 8: Throughout construction phase	Cost included in contracts	Check implementation of items 1-8 and CEMP provisions	1: Before construction 2 - 8 Implementation of CEMP provisions: Monthly	DSC (IES/NES)	As above
Waste Management	1. Prepare and implement waste management measures of CEMP to cover all aspects of waste storage and disposal (incl. accidental spills if required). 2. Areas for disposal to be agreed with land owner and Local Level Government and checked recorded and monitored by the PMU/DSC. 3. Segregation of wastes shall be observed. 4. Recyclables shall be recovered and sold to recyclers. 5. Residual wastes shall be disposed of in	1: EPC prepare WMP, PMU/DSC IES to assist and approve 2 to 9: EPC contractor	1: One month before start of site works 2 to 9: Throughout construction phase	Cost included in contracts	Check implementation of items 1-9 and WMP provisions	1: Before construction 2 to 9: Implementation of WMP provisions: Monthly	DSC (IES/NES)	As above

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	disposal sites approved by local authorities and not located within 500m of rivers or streams. 6. Site offices and works yard shall be provided with garbage bins 7. Burning of construction and domestic wastes shall be prohibited. 8. Disposal of solid wastes into drainage ditches and public areas shall be prohibited. 9. All general solid waste will be collected and removed from the work areas and disposed in local waste disposal sites as identified by the SPC.							
Biological Impacts								
Loss of Forest Habitat and impacts on fauna	1. Use ABC and adjust alignment of grid expansion route to minimise need for removing or trimming trees. 2. Minimize width of vegetation clearance corridor and removal of large trees – only marked trees to be removed; 3. Mark boundary of clearance corridors with high visibility tape to ensure construction workers are aware of clearance boundaries; 4. Workers prohibited from poaching, hunting or fishing (sanctions to be imposed); 5. No timber or local materials to be cut or used other than specified under 1.	EPC contractor	Site surveying and vegetation clearance.	Cost included in contract	Visual observation of surveyed penstock alignment route Sanctions imposed on workers not adhering to item 3 and 4	1, 3, 4: Before start of site works 2: Within one week of start of construction	DSC (IES & NES)	As above
Socioeconomic Impacts								
Operation of contractor site office and works yard	1. Location of site office/yard to be agreed with local community with facilities approved by PMU/PMU/DSC and managed to minimize impacts; Protocols established as per CPP and GRM 2. Potable water, clean water for showers, hygienic sanitation facilities/toilets with sufficient water supply, worker canteen/rest area and first aid facilities will be provided onsite. 3. Separate toilets shall be provided for male and female workers. 4. As many local workers as possible will be hired and trained. 5. Adequate toilet facilities shall be installed and open defecation shall be prohibited and use of toilets encouraged by keeping toilet facilities clean at all times. 6. Wastewater effluent from contractors' workshops (if any) will be passed through gravel/sand beds and all oil/grease contaminants will be removed before discharging it into natural	1:EPC contractor with PMU/DSC approval 2-8: EPC contractor	1: One month before start of site works 2 to 8: Throughout construction phase	Cost included in contracts	Check implementation of items 1-8	1: Before construction 2 - 8: Monthly	DSC (IES/NES)	As above

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	<p>water courses. Oil and grease residues shall be stored in drums awaiting disposal in line with an agreed WMP.</p> <p>7. The Contractors facilities area will be cleaned up to the satisfaction of PMU and local community after use.</p> <p>8 All waste materials shall be removed and disposed to disposal sites approved by local authorities</p>							
Occupational Health and Safety	<p>1. Contractor to include health and safety provisions in the CEMP and instruct workers in health and safety matters. CEMP to be approved in writing by PMU/DSC one month prior to starting works. Contractor to implement all provisions.</p> <p>2. Before construction commences the contractor will conduct of training for all workers on environmental, safety and environmental hygiene. The contractor will instruct workers in health and safety matters as required by good engineering practice and provide first aid facilities.</p> <p>3. Workers shall be provided (before they start work) with appropriate PPE.</p> <p>4. Fencing shall be installed at sides of temporary works. .</p> <p>5. Provision of potable water supply in all work locations.</p>	<p>1:EPC contractor with PMU/DSC approval 2-5: EPC contractor</p>	<p>1: One month before start of site works 2 to 5: Throughout construction phase</p>	<p>Cost included in contracts</p>	<p>Check implementation of items 1-5</p>	<p>1: Before construction 2 - 5: Monthly</p>	<p>DSC (IES/NES)</p>	<p>As above.</p>
Community Health and Safety	<p>1. Include in CEMP for barriers (e.g., temporary fence), shall be installed at construction areas to deter pedestrian access except at designated crossing points.</p> <p>2. The general public/local residents shall not be allowed in high-risk areas,</p> <p>3. Provide warning signs at periphery of site warning public not to enter</p> <p>4. Strict imposition of speed limits along access through residential areas and where other sensitive receptors such as schools, hospitals and other populated area are located</p> <p>5. Communication to the public through public consultation, SPC and notice boards regarding the scope and schedule of construction as well as certain construction activities causing disruptions and access restrictions.</p> <p>6. Implementation of communicable diseases (incl. STIs and HIV) awareness and prevention measures (under overall project)</p>	<p>EPC contractor</p>	<p>mes throughout construction phase</p>	<p>ncluded in contracts item 6 included in PSA</p>	<p>Check implementation of items 1-6</p>	<p>Monthly</p>	<p>DSC (IES/NES)</p>	<p>As above.</p>

CONCLUSION AND RECOMMENDATION

115. The 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 are summarized below:

- The project involves the upgrading of the Governor System in the Lake Hargy Hydro Power Station thus increasing power output to a maximum of 1500 kW for West New Britain province.
- The potential loss of less highly modified habitat of low ecological value within the route corridor, and any impact on terrestrial wildlife due to the project will be insignificant. Minor loss of vegetation can be further minimized through selection of pole location (to minimize tree removal) and use of ABC (to minimize need to trim or cut trees) and alignment of LV poles along existing roads to minimise need for removing or trimming trees; and
- Nearby communities consulted are happy for the project to be implemented and expressed their desire to benefit from both electricity generated and employment opportunities during construction and operation.

116. An EMP has been prepared and will be updated based on detailed design and implemented during all phases of the project. The EMP identifies potential environmental impacts arising from the project along with a corresponding schedule of mitigation measures to ensure potential impacts are maintained at insignificant levels and that international best practice is applied. It also includes the institutional arrangements for implementing the EMP to ensure its effectiveness.

117. This IEE, including the EMP is considered sufficient to meet ADB's and government environmental safeguard requirements in respect of the distribution connections to the TEIP sub project areas in West New Britain and Oro province and the Autonomous Region of Bougainville. No further or additional impact assessment is considered necessary at this stage.