Environmental Assessment Document

PPTA Number: 8285-VAN

Vanuatu: Energy Access Project
Brenwe Hydropower Project –
Malekula Island, Malampa Province

Initial Environmental Examination

Prepared by the Department of Energy, Republic of Vanuatu

ABBREVIATIONS

ADB	-	Asian Development Bank
CAC	-	Community Advisory Committee
CPP	-	Consultation and Participation Plan
DEPC	-	Department of Environmental Protection and Conservation
DGMWR	-	Department of Geology Mines and Water Resources
DOE	-	Department of Energy
DSC	-	Design and Supervision Consultant
EIA	-	Environmental impact assessment
EIS	-	Environmental impact statement
EMP	-	Environmental Management Plan
EPC	-	Engineer, Procure and Construct
GRC	-	Grievance Redress Committee
GRM	-	Grievance Redress Mechanism
HSP	-	Health and Safety Plan
IEE	-	Initial environmental examination
IES	-	International environmental specialist
IUCN	-	International Union for the Conservation of Nature
kW	-	kilowatt
l/s	-	Litres per second
MAQFF	-	Ministry of Agriculture, Quarantine, Forestry and Fisheries
MOCC	-	Ministry of Climate Change, Adaptation, Meteorology & Geohazards, Energy, Environment and Natural Disaster Management
MPC	-	Malampa Provincial Council
MSMP	-	Materials and Spoils Management Plan
NES	-	National environmental specialist
PEA	-	Preliminary Environment Assessment
PPE	-	Personal protective equipment
SEMP	-	Site-specific Environmental Management Plan
SPS	-	Safeguard Policy Statement (of ADB, June 2009)
STI	-	Sexually Transmitted Infections
UNDP	-	United Nations Development Programme
UNELCO	-	Union Electrique du Vanuatu Limited
VPMU	-	Vanuatu Project Management Unit
VUI	-	Vanuatu Utilities and Infrastructure Limited
WMP	-	Waste Management Plan

CONTENTS

EXECUTIVE SUMMARY

1. **Background**. The Asian Development Bank (ADB) is supporting the government of Vanuatu (government) through the Department of Energy (DOE) to develop reliable and sustainable supply of electricity in the provinces of Sanma and Malampa to assist economic growth and increase the capacity to support greater access to electricity for local residents, businesses and industry.

2. A project preparatory technical assistance has been undertaken and completed a feasibility study of a small run-of-river hydropower scheme located at Brenwe on Malekula Island, Malampa Province. The feasibility study includes this initial environmental examination (IEE). This report is the IEE for the design construction and operation of the proposed Brenwe River hydropower scheme and associated transmission grid under the Vanuatu Energy Access Project (the Project). The IEE is intended to meet the requirements of the ADB for Category B projects as described in the Safeguard Policy Statement 2009 (SPS) as well as comply with the requirements of an environmental impact statement (EIS) as required under the environmental assessment requirements of the government.

3. The objectives of the IEE are to: (i) assess the existing environmental conditions; (ii) identify potential environmental impacts; (iii) evaluate and determine the significance of the impacts; (iv) develop an environmental management plan (EMP) detailing mitigation measures, monitoring activities, reporting requirements, institutional responsibilities and cost estimates to address adverse environmental impacts; and (v) carry-out public consultations to document any issues/concerns and to ensure that such concerns are addressed in the project design. The IEE is based on field inspection including fish and aquatic resources surveys, discussions with key government agencies, information gathered during stakeholder consultations and data compiled from secondary sources. This IEE is submitted to ADB by the borrower and the final IEE report will be disclosed to the public by the government's executing agency and uploaded to ADB's website.

4. **Project Description.** The proposed Brenwe River hydropower scheme is located in northwest Malekula Island, Malampa Province approximately 20 km WNW of Lakatoro the provincial administrative centre. The Project will harness the flow of the Brenwe River to generate hydro-electric power. The layout follows the footprint of the partially constructed Brenwe hydropower project which was abandoned in the mid-90s.

5. The intake of the run-of-river scheme is located at 160 m above sea level about 5 km north-west of Unmet village and comprises a low weir with a single gated sluice on the left side. Water is diverted into a side intake and sand trap on the left bank before being conveyed along a south trending headrace canal for approximately 1 km. Along the gorge the river drops nearly 100 m over less than 1 km. The canal discharges into a forebay (16 m x 4 m). A 150 m steel penstock conveys water from the head pond west to the powerhouse (15 m x 8 m) located on the left bank of the Brenwe River at elevation 80 m above sea level which will provide an output of up to 600 kilowatt (kW) with a design flow of 0.66 m^3/s.

6. Access to the site from Lakatoro is via the northwest Malekula Road which crosses the Brenwe River about 400 m upstream of the intake site. Previous access roads from the public road to the intake, powerhouse and forebay sites will be used as a priority for this project. The existing roads are degraded and will have to cleared and rehabilitated. Construction of new access roads will be minimal. An approximately 23 km long 20 kV transmission line will be constructed from the powerhouse to Lakatoro where it will connect to the existing grid currently operated under a concession arrangement by Union Electrique du Vanuatu Limited (UNELCO). The line route will be within the corridor of the powerhouse access road and the northwest Malekula public road to Lakatoro.

7. **Categorization** The subproject is classified as Category B in accordance with ADB's SPS, as the project's potential adverse environmental impacts are site-specific, few if any of

them are irreversible, and in most cases mitigation measures can be designed readily. The IEE was carried out in March and May 2014 and the results of this IEE and the environmental management plan (EMP) will be updated if necessary at the detailed design / tender preparation stage by the implementing agency.

8. **Implementation Arrangements.** The executing agency for the project is the Ministry of Finance and Economic Management (MFEM) and the implementing agency is DOE within the Ministry of Climate Change, Adaptation, Meteorology & Geohazards, Energy, Environment and Natural Disaster Management (MOCC) supported by the Vanuatu Project Management Unit (VPMU) established within the Prime Minister's Office. The VPMU manage the project on behalf of MOCC-DOE and will lead design and implementation of the project. The VPMU will be supported by a design and supervision consultant (DSC). The DSC will include international specialists who will provide capacity building to MOCC-DOE and VPMU staff. The DSC will assist the VPMU in procurement (preparation of tender documents, tender evaluation) and supervision of construction. It is most likely that the project will be implemented under an engineer, procure and construct (EPC) contract and under such an arrangement the EPC contractor will be responsible for the final design and construction of the project. The VPMU and DSC will include an international environmental specialist to assist the government meet all its obligations with respect to the clearances and EMP for the project as well as provide training to VPMU and MOCC-DOE in monitoring the contractor's compliance with the EMP and safeguard requirements. The facilities are likely to be operated by a private company under a concession arrangement.

9. **Policy, Legal and Administrative Framework**. The project shall comply with requirements of the Environmental Management and Conservation Act 2010 and the Environmental Impact Assessment Regulations 2011 which require that for development of hydropower projects an EIS must be undertaken by the project proponent and clearance obtained from the Department of Environmental Protection and Conservation (DEPC). The project will also comply with the requirements of SPS. Government environmental clearance and development consent (and other permits) must be obtained before any works commence.

10. **Environmental Management Plan**. Mitigation measures, environmental monitoring, and capacity development are required to minimize the environmental impacts in the pre-construction, construction and operation phases. The DSC and contractor will be tasked with finalizing the detailed design and compilation of updated EMP and the contractor will be responsible for implementing the EMP.

11. The main environmental issues relate to ensuring that the design of the project: i) allows for a minimum environmental flow release of 80 litres/second (l/s) into the Brenwe River at the intake point at all times; and ii) incorporate design criteria that are based on available climate change modelling data used to develop extreme event data or, in the absence of such data, design criteria should be demonstrably conservative.

12. Implementation of internationally recognized good construction environmental practices form the basis of the EMP which covers issues such as erosion and sedimentation control, materials sourcing and spoil management, waste management, minimization of habitat disturbance, and worker and community health and safety. The EMP will form part of the construction contract documents and the contractor will be required to prepare a site-specific environmental management plan (SEMP) based on the contract EMP. The contractor will submit the SEMP to VPMU for approval prior to commencement of works.

13. The operation of the project should have beneficial effects on the environment overall through more efficient provision of electrical power from renewable resources and improved environmental management within government.

14. **Information Disclosure and Consultation.** The stakeholder consultation process disseminated information to the general public, project affected communities and key environmental stakeholders. Information was provided on the scale and scope of the project and the expected impacts and the proposed mitigation measures through consultation with government departments, local authorities and the general public in meetings. The process also gathered information on relevant concerns of the local community for the Project so as to address these in the project design and implementation stages. No significant environmental concerns were raised during consultations and the local communities expressed a strong desire for the project to go ahead so that they could benefit from the electricity generated.

15. The IEE will be disclosed according to the provisions of ADB Public Communications Policy 2011 and requirements of the laws of Vanuatu

16. **Grievance Redress Mechanism.** A grievance redress mechanism (GRM) will be established to receive, evaluate and facilitate the resolution of affected people's concerns, complaints and grievances about the environmental and social performance of the project. The GRM is based on accepted practices in Vanuatu and provides an accessible, time-bound and transparent mechanism for the affected persons to voice and resolve social and environmental concerns linked to the Project.

17. **Conclusion and Recommendations**. The potential environmental impacts arising from design, construction, operation and maintenance of the project will be relatively minor, localized and acceptable provided that the mitigation measures set out in the EMP are implemented properly. Key findings are summarized below:

- The project is a small run-of river hydropower project that does not involve a dam or reservoir. It has a small footprint that will be constructed within the same footprint of a previously partially constructed and abandoned hydropower project;
- The 1 km stretch of channel to be affected by reduced water flow due to the project includes a 30 m high waterfall and two other cascades > 3 m high. These falls are significant natural barriers to most fish other than species such as goboids which have natural adaptations enabling them to climb waterfalls. The waterfalls are significantly higher than the proposed weir such that a 3 m high weir is unlikely to be a barrier to goboids after scaling the waterfalls. The critical factor is to ensure a continuous flow of water is crossing the weir and thereby also ensuring continuous flow over the waterfalls between the weir and the powerhouse.
- The weir and intake structure will be designed and operated to ensure that a minimum flow of 80 l/s will be released into the Brenwe River at all times. This flow will be supplemented by natural inflows to the channel from springs and surface water flows over the 1 km river section between the weir and powerhouse. To ensure constant environmental flow the design will include a pipe of diameter 150mm – 200mm through the weir with a fixed orifice at the downstream end. The orifice constricts and expands when the water pressure on it changes to keep the outflow constant.
- The proposed minimum flow is considered sufficient to ensure the sustainability of the existing downstream ecosystem along the 1 km affected stretch No significant impacts are expected on the fish and aquatic resources of the Brenwe River as a result of the project.
- The potential loss of up to 4 ha of highly modified successional vegetation of low biodiversity value due to the project is of minor significance. The natural environment of the project area is highly modified due primarily to the fact that the project will be constructed on the same footprint as a previously partially

constructed and abandoned hydropower project. Loss of habitat can be further minimized by reducing the clearance corridors;

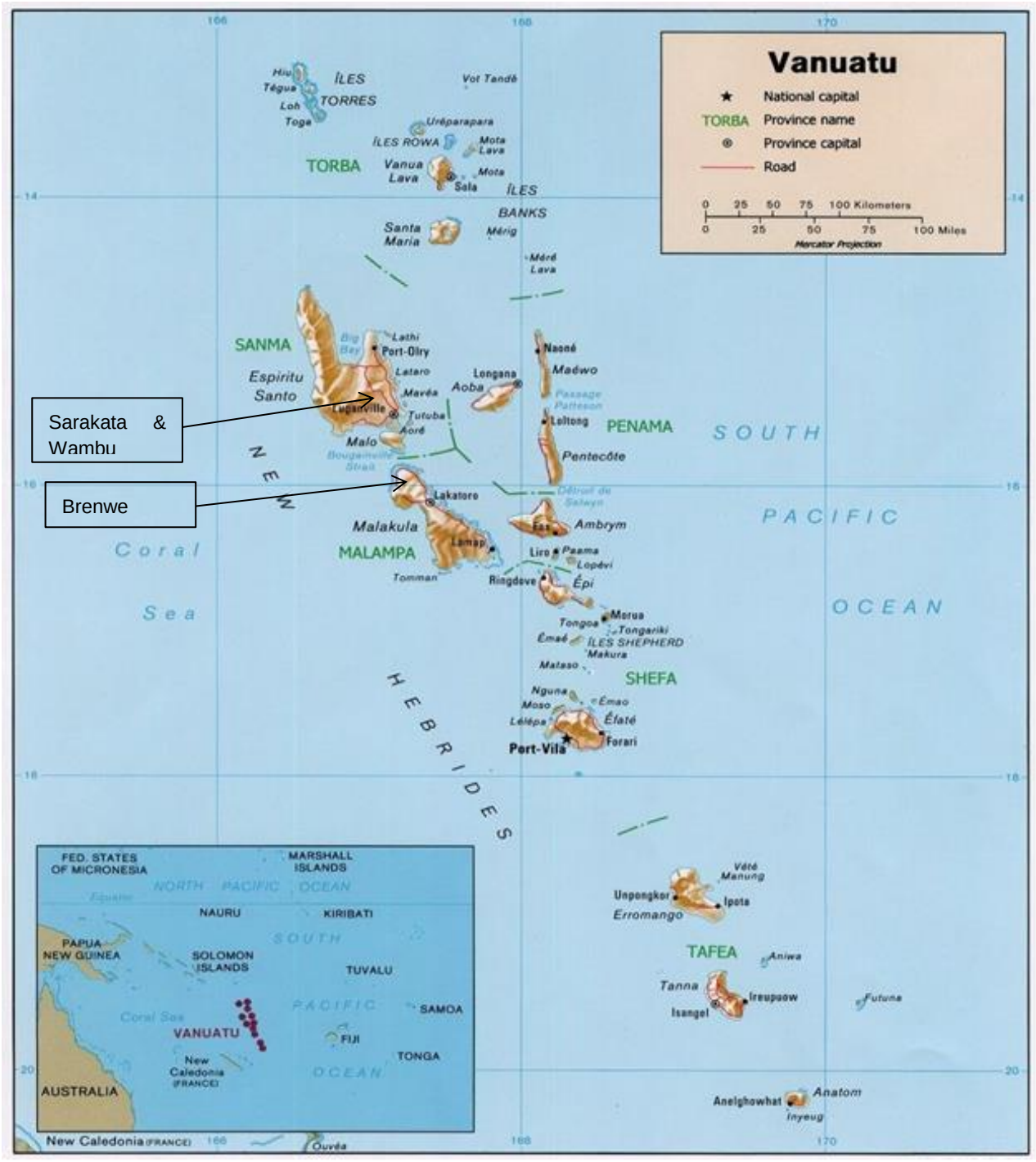
- The potential impact on terrestrial wildlife including rare and / or endangered species is considered to be insignificant and the project does not impinge upon any national or locally recognized protected areas;
- Nearby communities consulted are keen for the project to be implemented and expressed their desire to benefit from both electricity generated and employment opportunities during construction and operation; and
- Appropriate climate change adaptation and resilience needs to be incorporated into the design of structures including: i) suitable erosion protection to prevent scour around the intake weir's training walls, and ii) powerhouse - level of powerhouse discharge outlet needs to be sufficiently high so as to prevent any flood induced backflow resulting in flooding of the powerhouse and damage to electromechanical equipment.

18. This IEE, including the EMP is considered sufficient to meet government and ADB environmental safeguard requirements in respect of the Brenwe River Project. No further or additional impact assessment is considered necessary at this stage.

I. INTRODUCTION

1. Vanuatu comprises around 80 islands with a total land area of 12,300 square kilometres spread over some 1,300 kilometres in a north to south direction, between latitudes 12° to 23° south and longitudes 166° to 173° east (Figure 1.1). The current population is estimated to be 215,000, of which 80 percent live in rural villages on the seven main islands of Efate, Espiritu Santo, Tanna, Malekula, Pentecost, Ambae, and Ambrym.

Figure 1.1 - Republic of Vanuatu



Source: Vanuatu Statistics Office

2. Since 1994, the country has been divided into six provinces:

- TORBA (Torres and Banks)
- SANMA (Santo and Malo)
- PENAMA (Pentecost, Ambae and Maewo)
- MALAMPA (Malekula, Ambrym and Paama)
- SHEFA (Shepherds and Efate)
- TAFEA (Tanna, Aniwa, Futuna, Erromango and Aneityum)

3. Each province hosts a provincial government that delivers services to the inhabitants.

4. Electricity in Port Vila and two provincial administrative centres of Lakatoro (Malekula, Malampa Province) and Lenakel (Tanna,Tafea Province) is provided by Union Electrique du Vanuatu Limited (UNELCO) and in Luganville (Santo, Sanma Province) it is provided by Vanuatu Utilities and Infrastructure Limited (VUI). UNELCO operates mainly diesel power station and VUI operates a hydropower station at Fanafo and diesel generator in Luganville.

5. There are also several micro-hydropower stations operated by rural communities, on Maewo and Epi. The government through the Department of Energy (DOE) has requested support from Asian Development Bank (ADB) to develop reliable and sustainable supply of electricity in the provinces of Sanma and Malampa to assist economic growth and increase the capacity to support greater access to electricity for local residents, businesses and industry.

6. A project preparatory technical assistance has been undertaken and completed a feasibility study of a small run-of-river hydropower scheme located at Brenwe on Malekula Island, Malampa Province. The feasibility study includes this initial environmental examination (IEE) which also serves as environmental impact statement (EIS) as required under Vanuatu law.

II. POLICY AND LEGAL FRAMEWORK

7. The implementation of the project will be governed by the environmental laws and regulations of the Republic of Vanuatu and the safeguard policies of the ADB.

A. Government of Vanuatu

1. Constitution and Environmental Sector Policy

8. Environmental management is enshrined in the 1980 Constitution which provides the overarching administrative and legal mandate for the protection of all Vanuatu lands and other associated environmental resources such that:

- “All land in the Republic of Vanuatu belongs to the indigenous custom owners and their descendants.” (Article 73)
- “Every person has the following fundamental duties to himself and his descendants and to others to protect Vanuatu and to safe guard the national wealth, resources and environment in the interest of present and of future generations” (Article 7(d))

9. The protection of land and all associated environmental resources, for future generations is therefore a fundamental responsibility for all people of Vanuatu mandated by the Constitution.

10. Following on from this the sustainable use and management of land in Vanuatu is addressed within existing Vanuatu national laws and policies that supports economic development. The government's policy on environment and conservation is to provide an affordable framework of environmental protection and compliance within Vanuatu. This policy has been materialized through the enactment of the Environmental Management and Conservation Act N°12 of 2002. As of March 2003, this represents the only legislation governing environmental protection of all natural resources in Vanuatu. The Act was amended in 2010.

11. A number of important sectoral policies, strategies and aspirational documents that support the environmental management commitments of the Vanuatu Constitution and/or are relevant to the project are listed below. Relevant aspects of these documents are summarized in Annex 1A. They include:

- The National Biodiversity Strategy and Action Plan 1999
- National Energy Policy Framework 2007
- National Rural Electrification Policy 2000
- National Energy Road Map (2013-2020) 2013
- Priorities and Action Agenda of Government of Vanuatu 2006
- Productive Sector Policy (2012-2017)
- National Forest Policy 1997

2. Environmental Legislation

12. **Environmental Management and Conservation Act.** The defining national environmental legislation is the Environmental Management and Conservation Act which was amended to Environmental Protection and Conservation Act in 2010 (the Act). The amended Act resulted in the establishment of the Department of Environment and Conservation (DEPC). The Act establishes the protection of the environment within Vanuatu and makes provision for the conservation, sustainable development and management of the environment and the regulation of related activities. This includes land, air and water. Specifically the Act introduces the requirement for environmental assessment and provides for the conservation of biodiversity and the establishment of protected areas in Vanuatu.

13. The Act is administered by the DEPC. In Vanuatu all development other than residential buildings or custom structures requires an environmental clearance before construction can commence. This includes hydro-power schemes. Furthermore, any development on the coast requires the written consent of the Minister for Lands. The Act is supported by the accompanying regulatory instrument, the Environment Impact Assessment Regulations (Amendment) Order N° 105 of 2013.

14. **Environmental Impact Assessment Regulations.** The Regulations (amended in 2012) establishes the procedures for undertaking the environmental assessment of Prescribed Activities. [1] The developer is required to first submit a development consent application following which the DEPC will conduct a preliminary environment assessment (PEA) which determines whether (i) no further assessment is required, (ii) no further assessment is required but an environmental management and monitoring plan is required, or (iii) where major projects are considered such as logging, large agricultural developments, mining and other prescribed activities as noted above, an EIS is required. The DEPC prepares a terms of reference for the EIS which would include technical, economic, environmental and social investigations. The EIS also requires public consultation.

[1] The Environment Impact Assessment Regulations (Amendment) Order N° 102 2012 replaced the original Environmental Impact Assessment Regulations Order N° 175 of 2011.

15. A steering committee reviews the EIS and recommends to the Director of the DEPC for approval, refusal or for more information. The Director can approve a prescribed activity with or without conditions.

16. Importantly, no development can commence without an approval from the DEPC. The Director of the DEPC may issue a notice to stop or restrict the activity if the approval conditions are not being met.

17. Environmental standards are not provided in the Regulations as Vanuatu currently does not have national environmental standards. However, the DEPC requires World Health Organization standards to be used. The Regulations do provide guidelines for licenses to discharge waste or emissions but without clearly defined national standards the enforcement of these is difficult.

18. This IEE will be submitted to DEPC for approval (as an EIS) under the procedures outlined above. The Director of DEPC advised the consultant that the ADB approved IEE for the Brenwe hydropower project will be accepted by DEPC as meeting the requirements for the project under the Act.[2] On this basis a development consent shall be issued.

19. However, should any additional/supplementary assessment be required by DEPC to obtain approval under the Act and its regulations, this will be undertaken during the pre-construction phase of project implementation.

3. Other Legislation Relevant to the Project

20. The government has enacted a series of laws across multiple sectors that contain provisions that apply to the management of the environment and natural resources. These laws including the government institutions responsible for their implementation are listed below. A summary of the sections these laws that address environmental management issues including their relevance to the project, is provided in Annex 1B.

- Public Health Act 22 1994 - Department of Health
- Water Resources Management Act 2002 - Department of Geology Mines and Water Resources (DGMWR)
- Pollution Control Act 2013 - DEPC
- Draft Waste Management Bill3 2012 - DEPC
- Forest Act 2001 - Department of Forests
- Quarry Act 2013 - DGMWR
- Control of Nocturnal Noise Act 1965 - DEPC
- National Parks and Nature Reserves Act 1993 - National Parks Board
- Preservation of Sites and Artefacts Act 1965 - Vanuatu Cultural Centre
- Wild Bird Protection Act 1989 - DEPC
- National Disaster Act 2000 - National Disaster Management Office
- Pesticides Control Act 1998 Department of Agriculture

21. While these laws provide a basic legal framework for environmental management, the system has several significant weaknesses.

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[2] This advice was provided to the Consultant during a meeting with the Director of DEPC 15 May 2014. (See Annex 5 Table A5.1.)

[3] This Bill is scheduled to go before Parliament in 2014.

22. Firstly, there are instances where conflicts occur due to inconsistencies between various national laws, or where the national laws are not in tune with local laws and policies especially the by-laws and policies of the provincial councils.[4]

23. Another significant weakness is the fact that, while environmental legislation has been enacted into law, apart from the EIA Regulations Amendment Order N° 102 of 2013, there are no rules and regulations to require and guide the enforcement of the laws. For example, the Pollution Control Act was enacted by Parliament in 2013 but with no regulations there is no formal legal basis for enforcement. Similarly, there are no regulations for waste management under the Waste Management Act or for conservation under the National Parks and Conservation Act and until such regulations are enacted, there is no formal legal basis for enforcement.

24. Institutionally, there is lack of coordination between and among the government departments and other institutions at various levels that handle environmental concerns and management responsibilities. This results in legal and procedural overlaps, gaps and conflicts.

25. Based on a review of the legislation relevant to the project, a summary of the national consents and permits required for the Project, including supporting documentation, is presented in Table 2.1.[5]

Table 2.1 - Permitting Requirements for the Project

Permit Required	Agency Responsible	Documentation
Development Consent	DEPC	Development Application as per the Environmental Impact Assessment Regulations Order N° 175, 2011 (amended in 2012)
Water Use Right (as per Water Resources Management Act 2002)	DGMWR	Application to Director of Water Resources (no prescribed form[6])
Right to construct, operate and maintain works associated with resources that do not comply with customary rights and rights of occupiers as specified in Part 2 Division 1 Section 4 of the Water Resources Management Act.	DGMWR	As above
Permit for any discharge of pollution (as per Pollution Control Act 2014)	DEPC	Application to Director of DEPC (no prescribed form)[7]
Building Materials Permit (as per Quarry Act N° 9 2013)	DGMWR	Application to Director of DGMWR. (No prescribed form)[8]

Source: Distilled from review of existing legislation

4. International Treaties and Agreements

26. Vanuatu is a signatory to a number of international conventions, treaties and agreements with environmental and conservation implications as well as for the protection, promotion and safeguarding of cultural heritage and traditional knowledge. These are presented in Annex 1C.

[4] It is noted that there are no specific by-laws for Malampa or Sanma Provinces which would be in conflict with the hydropower projects proposed under the project.

[5] It is noted that the Draft Waste Management Bill is expected to be passed by parliament into law in 2014 and if so, a waste disposal permit will be required from the Director of DEPC.

[6] There are currently no Regulations for the Act

[7] Regulations for the Act are currently in draft form.

[8] Regulations for the Quarry Act are currently in draft form.

B. ADB Safeguards Policy

27. The ADB Safeguard Policy Statement 2009 (SPS) has the objectives to (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. The environment safeguard requires due diligence which entails addressing environmental concerns, if any, of a proposed activity in the initial stages of project preparation.

28. 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 project is categorized as environment Category B because potential adverse environmental impacts are site-specific, few if any of them are irreversible, and in most cases mitigation measures can be designed readily. Accordingly this IEE has been prepared as the requisite level of assessment to address the potential impacts in line with the SPS.

III. DESCRIPTION OF THE PROJECT

A. Project Components and Location

29. The project is located at Brenwe in northwest Malekula Island, Malampa Province, Republic of Vanuatu approximately 20 km WNW of Lakatoro the provincial administrative centre. The project will harness the flow of the Brenwe River to generate hydro-electric power. The location and general layout of the proposed Brenwe River hydropower project is shown in Figure 3.1. The layout follows the footprint of the partially constructed Brenwe hydropower project which was abandoned in the mid-90s.

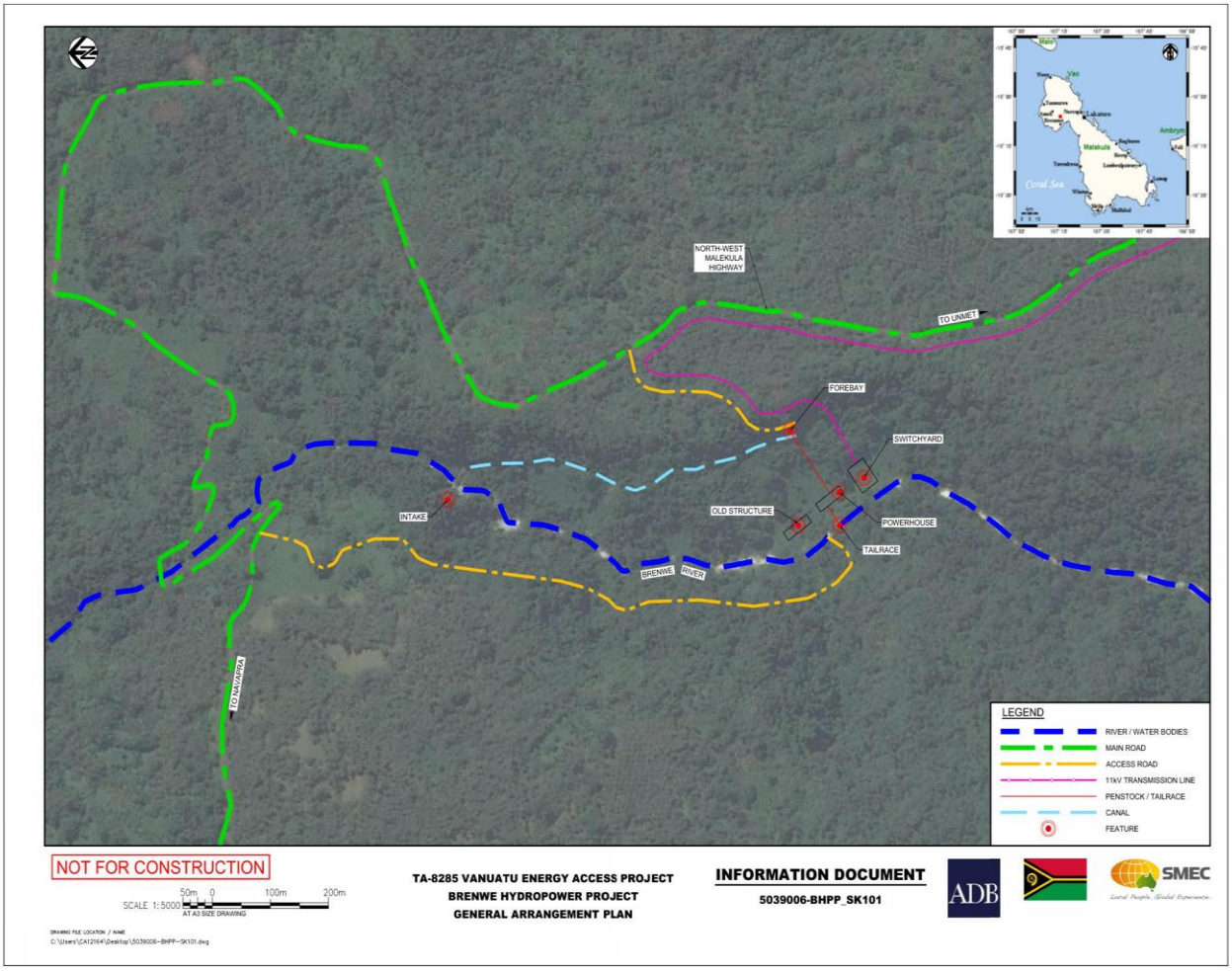
30. The intake of the run-of-river scheme is located at 160 m above sea level about 5 km north-west of Unmet village and comprises a low weir with a single gated sluice on the left side. Water is diverted into a side intake and sand trap on the left bank before being conveyed along a south trending headrace canal for approximately 1 km. The headrace canal passes alongside a gorge where it is cut into a steep to sub vertical slope. Along the gorge the river drops nearly 100 m over less than 1 km. The canal discharges into a forebay (16 m x 4 m). A 150 m steel penstock conveys water from the head pond west to the powerhouse (15 m x 8 m) located on the left bank of the Brenwe River at elevation 80 m above sea level which will provide an output of up to 600 kilowatt (kW) with a design flow of 0.66 m^3/sec.

31. Access to the site from Lakatoro is via the northwest Malekula Road which crosses the Brenwe River about 400 m upstream of the intake site. Previous access roads from the public road to the intake, powerhouse and forebay sites will be used as a priority for this project. The existing roads are dilapidated and overgrown with vegetation and will have to cleared and rehabilitated. Construction of new access roads will be minimal.

32. An approximately 23 km long 20 kV transmission line will be constructed from the powerhouse to Lakatoro where it will connect to UNELCO's existing grid. [9] The line route will be within the corridor of the powerhouse access road and the northwest Malekula public road to Lakatoro.

[9] 2 0kV is a distribution voltage and is mounted on poles and aligned along existing road corridors. It does not require a clearance corridor typical of high voltage transmission lines. However, for the purposes of this project the 20 kV line performs a transmission function and is therefore referred to throughout this report as a transmission line.

Figure 3.1 - Location and General Layout of Brenwe River Hydropower Project



B. Construction Activities

33. Construction of the Brenwe River hydropower scheme will involve small-scale construction activities consisting of largely manual labour under the supervision of trained personnel. The site is easily accessible by access road and transportation of construction material is not an issue. Civil works will be simple and straightforward requiring limited need for specific skills and abilities by the workers. Construction of the project will provide the opportunity for capacity building for future maintenance. The use of prefabricated equipment, reinforced concrete and masonry, minimizes the quantities of building materials that need to be transported to the site. It is estimated that temporary employment for 50 to 80 workers (60% skilled) will be required for the Project over the construction period, estimated to be about 24 months.

34. **Main Civil Works.** The existing access roads to headworks,[10] forebay and powerhouse sites will be cleared of overgrown vegetation and rehabilitated / graded as necessary. This will be followed by demolition and removal of the existing facilities, namely the abandoned weir, forebay and powerhouse structures. As much as possible waste materials (concrete, masonry etc.) will be reused as construction materials.

[10] Headworks refer to the weir and intake structures.

35. At the head works site a temporary coffer dam and channel diversion will be constructed to allow for construction of the intake works. This will be followed by largely manual excavation of soil rock and boulders to form the head works. As much as possible excavated material will be used as backfill with surplus material disposed of as required. The intake structure will be manually constructed with reinforced concrete.

36. Vegetation clearance and excavation of the headrace canal, head pond and penstock route will be followed by construction of the stone masonry or concrete canal and forebay pond structures and concrete support piers and anchor blocks for the penstock.

37. Powerhouse and tailrace construction will commence with site clearance followed by excavation of discharge pit and concrete slab foundation for the powerhouse.

38. River bank protection works adjacent to the tailrace will involve placement and filling of gabion baskets.

39. **Transmission Line**. Construction of the 23 km long 20 kV transmission line will require i) vegetation trimming along the road corridors to ensure adequate safety clearances for the power lines (up to 5 m from the centreline of the overhead line); ii) transporting 12 m steel or concrete poles to the road side; iii) erection of poles; iv) stringing of conductors; and v) installation of transformers where required. These sequential activities are primarily manual activities involving a small team with minimal use of mechanical equipment. No excavation is required other than manual digging for the pole footing. Concrete foundations will be provided for the pole footings.

C. Operation and Maintenance

40. Operation of the hydropower scheme will require one operator to be continuously present to check proper operation of machinery and hydraulic structures (intake) and in case of failures (tripping of circuit breaker) will have to put the scheme back into operation after removing the fault. [11]

41. Maintenance requirements of the hydro scheme are low and include: greasing of movable parts on machinery and intake gates, sediment removal from sand trap, cleaning and repairs at intake area after floods, repainting of gates and powerhouse super structure, and cutting grass, bushes and shrubs along the scheme components.

IV. DESCRIPTION OF ENVIRONMENT (BASELINE DATA)

A. Physical Resources

1. Climate, Air Quality and Noise

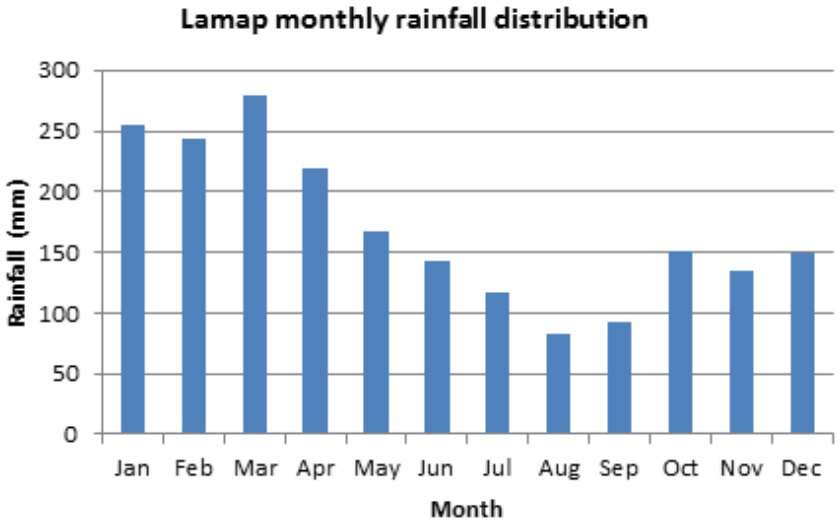
42. Malekula, situated in the northern part of the Vanuatu archipelago experiences a wet tropical climate. Average temperatures range from between 21°C and 27°C and average humidity ranges between 75% and 80%. Temperatures vary slightly between the dry season (from June to October) and the wet season (from November to April). The warmest months are January-March and the coolest are July to September. The mean annual rainfall at Lakatoro (Lamap Gauging Station) over the 53 year period 1961 - 2013 is 2,022 mm per year. However, the range of annual rainfall maxima over that period shows significant variability, from 1,305 mm (1992) to 3,693 mm (1963).[12]

[11] Assumes a shift system of about four operators coming to and from Lakatoro.
[12] Data obtained from Vanuatu Meteorological Service

43. Indications are that Brenwe rainfalls are slightly less than those of Lamap due to the Northwest rain shadow compared with the Lamap south easterly exposure to the wet season weather systems.[13]

44. Rainfall is associated with the monsoon winds, which change direction due to the movement of the inter-tropical convergence zone in winter and summer. In the summer (wet season) months of October to April, north-easterly wind conditions bring warm humid airstreams, and associated cyclonic disturbances. During this period about 68% of the annual recorded rainfall occurs. From May to September (dry season) south-easterly trade winds affect the country. The driest month as recorded at the Lamap gauging station is August where mean monthly rainfall of 83 mm has been recorded as shown in Figure 4.2.

Figure 4.2 - Mean Monthly Rainfall at Lamap Station (1961-2013)



Source Vanuatu Meteorological Service

45. While no air quality measurements are available for Vanuatu air quality is good due to the remoteness of the archipelago, a small population and good exposure which promotes reliable air movement. Fires for disposing of rubbish and vehicle emissions particularly in Port Vila provide localized areas of poor air quality. CO_2 emissions are considered to be 0.4 mt/capita which is very low in comparison to the East Asia and the Pacific Region at 2.1 mt/capita.[14]

2. Topography and Soils

46. Malekula Island is the second largest island in the Vanuatu archipelago encompassing approximately 2000 km^2 in area. Similar to Espiritu Santo it has two main geomorphic features comprising a deeply dissected central volcanic area rising to 863m, surrounded by an elevated limestone plateau, and at the coast, by narrow 'ribbons' of alluvium bordering the major rivers draining the interior.

47. The limestones are overlain by thick clay soils and only locally by small amounts of river and coastal alluvium. Soil cover on the limestones is derived from ancient air fall ash from nearby volcanoes. The soils are mature and comprise light brown clays showing relict tuffaceous texture with thickness increasing with altitude of the limestone.[15]

[13] As reported in the Feasibility Study Hydrology Report.
[14] IEE for Litzlitz Wharf, Interisland Shipping Support Project, November 2011
[15] Loan,C and Lum, J. 1997. Soil Geochemistry Mobile Metal Ion Survey Vanuatu. SOPAC Technical Report No. 253. Department of Geology Mines and Water Resources Vanuatu.

48. The volcanic mountains of Malekula are overlain by shallow, less mature, but generally fertile, volcanic soils.[16] Soils developed on alluvium are immature but fertile and low in potassium.

49. The Brenwe project area is located within the limestone plateau where up to six terraces sloping to the southwest have been identified from aerial photography.[17] The Brenwe River flows across the limestone terraces with varying indentation along its course and exhibits steep drops between terraces.

3. Geology, Seismicity and Natural Hazards

a. Geology

50. The islands of Vanuatu along with the Santa Cruz group to the north collectively form the subaerial expression of the New Hebrides Arc. The New Hebrides Arc is part of a narrow chain of Tertiary to Holocene volcanic island arcs extending from Papua New Guinea and the Solomon Islands through Fiji, Tonga and the Kermadec islands in the north to the islands of Matthew and Hunter in the south, and is a partly emerged ridge of around 200km in width. The ridge is underlain by an east dipping subduction zone where the India Australia tectonic plate to the west is being consumed by the Pacific plate to the east.

51. The geology of Malekula and Espiritu Santo reflects a dynamic geological history controlled by evolving plate boundary tectonism that has occurred from Late Oligocene to the present. This has included associated phases of volcanic activity, uplift and submergence in an overall island arc setting. Such a geological history and setting has given rise to a complex assemblage of Late Oligocene to Early Pliocene marine and sub-aerial volcanic and volcaniclastic sedimentary rocks intercalated with reef carbonates. Typical rock types include tuffs, breccias, turbidites sandstones, reef limestones, mudstones and pelagic sediments. These have been intruded by occasional stocks of gabbro, andesite and diorite. This assemblage is represented by the rocks that form the central and western mountain ranges of Malekula and Espiritu Santo and has undergone extensive dissection due to uplift and erosion during the Quaternary period.[18]

52. Late Pliocene to recent reef limestone terraces abut the eastern margin and fringe the southern edge of the western mountain range and thereby reflects the interplay between tectonic uplift and sea level changes that have occurred in the area during the Quaternary period. The indented gorge through which the Brenwe River flows (mainly in a north-south direction) is controlled by structural features such as bedding, joints/faults and lithological contacts (limestone/basalt). Rocks within the Brenwe project area comprise uplifted limestones interbedded with conglomeratic limestone and occasional basaltic/andesitic volcanic rocks.

b. Seismicity and Natural Hazards

53. Vanuatu is exposed to a wide range of geological, hydrological and climatic hazards. The United Nations Office for Coordination of Humanitarian Affairs assesses that Vanuatu is one of the most natural disaster prone countries in the world and is highly vulnerable to the impacts of natural disasters.[19] This is reflected in the World Risk Report 2012 which ranks Vanuatu as the world's most at risk country in respect to exposure and vulnerability to natural disasters.[20]

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[16] Mueller-Dombois, D and Fosberg, F. 1998. *Vegetation of the Tropical Pacific Islands*. Springer Verlag, New York

[17] ADB. 2012. *Promoting Access to Renewable Energy in the Pacific* (Vanuatu Component) Pre-Final Report (TA 7329-REG)

[18] Brief overview distilled from McFarlane, A and Carney J, op.cit.

[19] United Nations Office for the Coordination of Humanitarian Affairs. 2011. *Vanuatu: Natural Hazard Risks*

[20] United Nations University Institute for Environment and Human Security and Alliance Development Works. (2012) World Risk Report 2012.

54. Between 1980 and 2010 the country experienced 31 major disaster events, costing over US$205 million. Of these events there were nine earthquakes, fourteen tropical cyclones, and five volcanic eruptions directly impacting over 200,000 people with over 200 deaths. Climate-related events, including floods, landslides and storms, comprised approximately half the disaster events, but were markedly predominant in terms of the number of people affected and damage and losses experienced. For example, the percentage of reported people affected by climate related disasters was 88% compared with 12% affected by earthquakes and volcanoes.[21]

55. Vanuatu lies in a seismically active region, located just to the east of the boundary between the Australian and Pacific tectonic plates. This means that earthquakes and tsunamis are likely to affect the area and therefore the relative sea level.

56. The Pacific Catastrophic Risk Assessment and Financing Initiative notes that Vanuatu has a 40% chance in the next 50 years of experiencing, at least once, very strong to severe levels of shaking resulting in moderate to heavy damage to well-engineered buildings.[22] More severe damage is expected to structures built with less stringent criteria.

4. Water Resources

57. Water resources are a crucial factor in the location of villages in Vanuatu. The Brenwe catchment provides abundant water resources. The flow of the Brenwe River varies according to the wet and dry season. However communities report the River never dries up even during very dry seasons.

58. Two relatively large villages of Unmet and Brenwe are located on either side of the Brenwe River adjacent to the coastline where the river discharges into the sea. There are no communities living along the banks of the Brenwe River between the proposed intake and powerhouse and no communities living in the upper river catchment. These communities depend on the Brenwe River for washing and bathing. For drinking water, communities use lateral streams and rainwater collection tanks. On occasions the Brenwe River is used for food in the form of eels, fish and prawns as part of their subsistence livelihood but is not a significant or critical source of food supply. The catchment area above the intake is not permanently populated but is used increasingly for subsistence agriculture as the population of Brenwe and Unmet villages expands.

a. Brenwe River Hydrology

59. The Brenwe River is a small river located in the north west of Malekula Island. It rises in the low mountain lands central to the northern part of the island at around 450 m falling gently at around 1.5% gradient in a general southerly direction over 19 km reaching the ocean at Unmet.[23] The catchment of 21.9 km^2 has moderate to heavy forest cover interspersed with grass clearings and subsistence garden plots. The catchment has three main stream threads which join some 5 km above the Brenwe water fall. The proposed weir and intake is located immediately upstream of the waterfall at an altitude of 175 m. The dominant limestone geology of the catchment complicates the hydrology in that it does not respond like a surface water catchment due to its karstic nature. Flood peaks are sharp and storm runoff declines rapidly as surface runoff appears to infiltrate into subterranean storage for slow release during the dry season. The river appears to take some months to attain a base flow condition.

60. Figure 4.3 shows the catchment topography and stream threads to the water level station.

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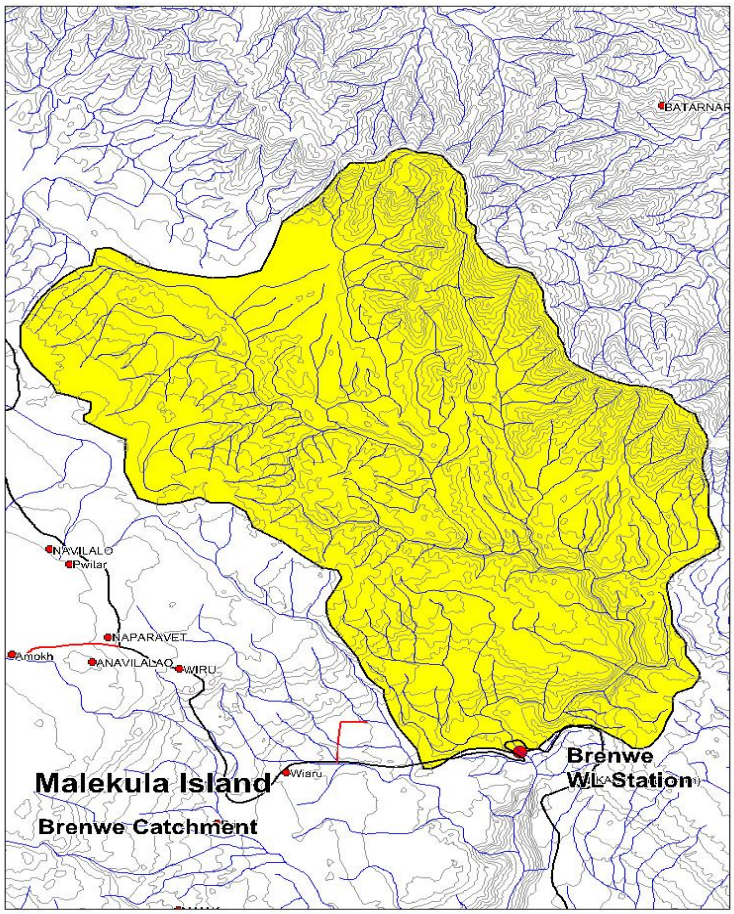
[21] Disaster Statistics Vanuatu. www.preventionweb.net

[22] SOPAC, ADB, WB,JICA, GFDRR, AirWorldwide, GNS Science; Pacific Catastrophe Risk Assessment and Financing Initiative, Vanuatu (2011)

[23] Description of hydrology is summarized from the Feasibility Study hydrology report.

Figure 4.3 - Brenwe River Catchment



Source: Project Feasibility Study (2014)

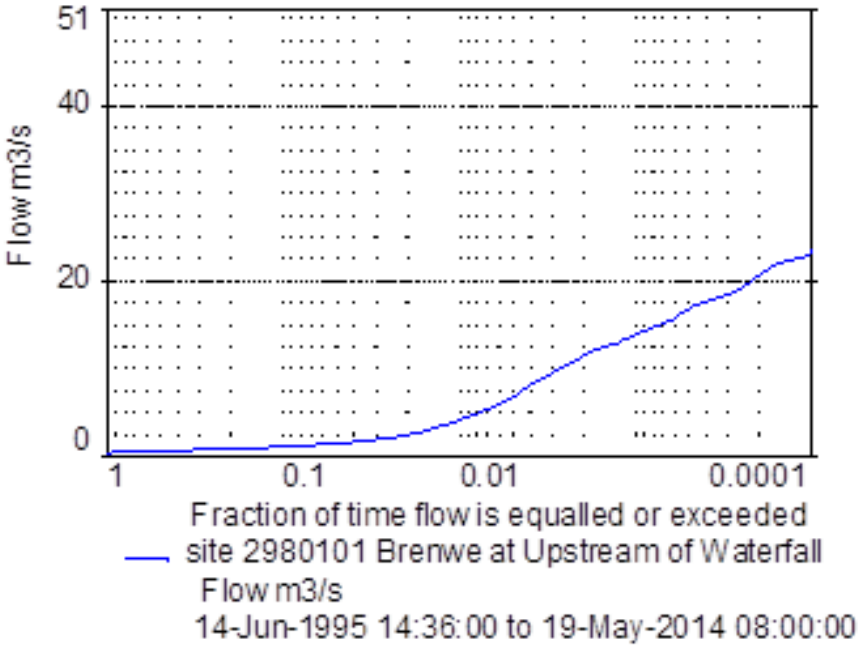
61. The hydrology report for the feasibility study developed flow duration statistics based on three years of available data. This is a very short dataset on which to design and size power plant and given the shortfall in actual catchment rainfalls data, it is not possible to model catchment flows, especially dry season flows which have more importance for a run-of-river scheme. Likewise, as measured (gauged) flows have only been possible at flows less than 1.2 m^3/s and with no intensity frequency duration data, detailed flood modelling has not been possible. This also extends to rating curve development and above gauged flows the extrapolation has been based on cross section survey and parabolic extension.

62. ORSTOM developed some provisional design rainfall intensities for Santo Island, located 75 km to the north.[24] This data has been utilized using a regional flood estimation model, to develop flood estimates for 10, 20, 50 and 100 year recurrence intervals. Measured data to date (1995-97/2013-14) shows a rated minimum flow of 0.41 m^3/s and a maximum flow of 41.8 m^3/s. Historic ORSTOM flows gauged in 1983 show a flow of 0.25 m^3/s and in 1993, 0.28 m^3/s, these are the only two spot measurements available.

63. The flow duration curve based on the available data was developed and is presented below in Figure 4.4 and Table 4.1.

[24] ORSTOM is a French Government Agency that has undertaken hydrological studies in Vanuatu since 1981.

Figure 4.4 - Flow Duration Curve for Brenwe River



Source: Project Feasibility Study (2014)

Table 4.1 - Flow Duration Curve Data for Brenwe River

% Flow Exceedance	River Flow (m^3/s)
0	41.8
5	1.46
10	1.15
15	0.96
20	0.90
25	0.84
30	0.76
35	0.71
40	0.68
45	0.65
50	0.64
55	0.62
60	0.60
65	0.58
70	0.57
75	0.55
80	0.52
85	0.50
90	0.48
95	0.45
100	0.15

Source: Project Feasibility Study (2014)

B. Biological Resources

1. Terrestrial Habitats

64. **General.** The regional terrestrial ecosystems of Vanuatu vary with altitude, major substrate type windward versus leeward position and human influences. Mueller-Dombois and Fosberg summarizes the ecosystems in landscape[25] terms as follows: [26]

- Lowland rain forest (with six variations)
- Mountain cloud forest and related vegetation
- Seasonal forest scrub and grassland (with three variations)
- Vegetation on new volcanic surfaces
- Coastal vegetation including mangroves
- Secondary and cultivated woody vegetation

65. The terrestrial biodiversity in Vanuatu is significantly less rich than its neighbouring countries such as New Caledonia, the Solomon Islands, Fiji and Papua New Guinea. Overall biodiversity richness and endemism in Vanuatu range from low to moderate. This is largely because the islands of Vanuatu are geologically younger and smaller in size and are isolated from large land masses. Generally, larger and older islands support a greater diversity of terrestrial ecosystems, plants and animals. However, both the sea that separates the islands and the rugged interiors separating catchments and lowland habitats are barriers to many species providing conditions that have favoured relatively rapid sub-speciation and speciation. Frequent disturbance due to tropical cyclones or volcanic activity has also had a significant effect on the distribution of species especially on smaller islands. Consequently there is a considerable distribution variation of species within and between islands, and Vanuatu's biodiversity is of particular interest for its ongoing processes of immigration, range extension and contraction and sub-speciation.

66. Vanuatu's flora is thought to be more closely allied with that of the Solomon Islands to the north with some elements from Fiji and very few from Australia or New Caledonia. Similarly the fauna demonstrates closer affinities with Solomon Islands. Internally there is a biogeographic divide with islands to the north of Efate demonstrating significant differences to the islands in the south.

67. Overall, Vanuatu's biodiversity remains poorly known with detailed studies of only a few genera and few studies of the biota of the smaller or less accessible islands. Available information suggests that Vanuatu's biodiversity is relatively intact and possibly better preserved than in most Pacific Island countries. A few plants and animals that have been studied in detail (orchids, palms, lizards and flying foxes) show that a significant number of endemic species are found on some islands.

68. A review on studies on the flora and fauna for the Vanuatu Biodiversity Strategy and Action Plan noted the presence of more than 1100 plant species, 297 coral species, 80 species of insect, 13 mammal species and more than 469 shallow fish species. However, many species are in decline.

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[25] *Landscape* is the geographical equivalent of the term *ecosystem*. However, while the term *ecosystem* is often interpreted as an interactive system involving the functional relations of primary producers, consumers and decomposers by energy transfer and nutrient dynamics the term *landscape* is more generally understood as a larger land segment with its built-on component. The functional relationships in a landscape are seen as an interaction of climate geology, geomorphology, soils and disturbance regimes with the prevailing built-on component.

[26] Mueller-Dombois, D and Fosberg, F. 1998. *Vegetation of the Tropical Pacific Islands*. Springer Verlag, New York

69. The only terrestrial mammal species in Vanuatu are bats including four pteropodids (fruit bats) and eight microchiroptera. Six of these species are endemic or near endemic. About 121 bird species have been recorded in Vanuatu comprising 32 seabirds, 15 shorebirds and 74 land and freshwater birds.[27] Of the 74 land and freshwater birds, 56 bird species are considered resident breeding species; ten introduced, one is a non-breeding visitor and seven have been recorded less than five times.[28] Isolation has led to the development of nine endemic species in Vanuatu and one the Buff-bellied Monarch, *Neolalage banksiana* belongs to an endemic genus.

70. **Threats to Vanuatu's biodiversity.** Over-exploitation of plants and animal resources is the most likely cause for the reported decline in the abundance and distribution of many species. Examples include the coconut crab (*Birgus latro*), green snail (*Turbo marmoratus*). Plants such as kava (*Piper methysticum*) sandalwood (*Santalum austrocaledonicum*) white wood (*Endospernum medullosum*) and the melektree (*Antiarus toxicana*) are also in decline.

71. Degradation of habitats mainly through the destruction of rainforest for subsistence agriculture is considered a significant factor affecting Vanuatu's biodiversity. Along with this new development practices coupled with declining respect for traditional resource management systems and traditional authority structures contribute to the degradation of habitat. Degradation of freshwater habitats through over exploitation of freshwater species and clearing of catchment vegetation on some islands has resulted in much reduced aquatic diversity.

72. Introduction of invasive species imported in the past such as Mile a minute (*Mikania sp*) and American rope (*Meremia sp*) are suppressing regrowth of tree forests and can cause loss of wildlife. Other invasive species of concern include: water hyacinth (*Eichhornia sp*), rats and feral pigs, the fire ant (*Wasmania auropunctata*), African snail (*Euglandina fulica*) and the Indian Mynah Bird (*Acridothera tritis*).

73. **Project Area.** Lowland rainforest is recognized as the natural vegetation on all islands of Vanuatu on their south-eastern windward sides inland of the coastal zone up to about 500-600 m elevation. This is the characteristic landscape type and setting of the three hydropower project sites considered for the project. In particular the project areas correspond with lowland rainforest sub-category C complex forest scrub densely covered with lianas. This complex vine forest and scrub is the most widely distributed lowland rain forest type on Malekula. It is in various stages of recovery following disturbances by cyclones and human activities. It is interpreted as secondary successional vegetation in different stages of adjustment to the prevailing rainforest climate.

74. Distinguishing features of this lowland forest sub-category include its floral heterogeneity often made up of forest islands. *Meremia* and *Mucuna* species are dominant among the lianas or vine genera. Principal canopy tree species include *Kleinhovia hospita*, *Intsia bijuga* and *Gyrocarpus americanus*. The subcanopy typically includes *Diospyros acris*, *Syzygium sp, Garcinia pancheri, Myristica fatua, Terminalia, Tieghemopanax* and (endemic) *Veitchia* palms. The undergrowth is rich in ferns (*Tectaria, Asplenium* and *Selaginella).*

75. Other tree species characteristic of northwest Malekula as identified by the Department of Forestry include *Pterocarpus indicus* (Rosewood), *Garuga floribunda* (Namalaus), *Dracontomelon vitiensis* (Nakatambol), *Pisonia umbellifera, Antiaris toxicaria* (Melek tri), *Premna corymbosa, Odrosia oppositifolia, Hernandia peltata.*[29]

76. Within the Brenwe River project area, this complex forest scrub subcategory is now largely confined to the steep slopes of the narrow riparian area which is unsuitable for subsistence agriculture, or in the upper reaches of the catchment.

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[27] Parr, J. 2007. Important Bird Areas in Vanuatu. Birdlife International, Fiji
[28] Ibid.
[29] Species list provided by Department of Forestry during stakeholder consultations

77. Beyond the immediate riparian area, the natural vegetation has been highly modified by human activity in the form of plantations and subsistence garden plots used by the nearby population of Unmet and Brenwe Villages.

78. Vegetable gardens typically include taro, yams, bananas, manioc, sweet potatoes and coconuts. Plantations include mixed coconut (copra), kava, cocoa pawpaw mango and citrus trees. From community consultations it is evident that the population of Unment and Brenwe has increased significantly over recent years and as a result villagers have to go deeper into the Brenwe catchment area where forest is cleared for the establishment of vegetable gardens and plantations. Birds, wild pigs and giant fruit bats are occasionally hunted for their meat. Overall the natural habitat of the project area is classified according to the SPS definition as a modified to highly modified habitat.

79. The DEPC and Department of Forestry advised that there had been no commercial logging in the Brenwe catchment. This was also confirmed during community consultations at Unmet. Clearance of forest is related to the establishment of gardens and plantations to meet the needs of the expanding local population.

2. Terrestrial Fauna

80. Whilst a range of wildlife was reported during community consultations as being present in the catchment including birds, frogs, lizards and aquatic fauna, the modified to highly modified habitat is considered generally poor in terms of wildlife for village hunting purposes. Wild pig populations are low and occasionally hunted.

3. Fish and Aquatic Resources

81. A fish and aquatic resources (FAR) survey was undertaken in the project area to establish a baseline inventory of fish and aquatic resources through a rapid biodiversity survey methodology.[30] The FAR report for the Project is presented in Annex 2. Information was gathered through direct observations and informant interviews. The survey involved walking along the length of the project affected river channel from the proposed powerhouse site to above the intake site and making observations at 5 sampling locations. Observations included: i) type and quality of riverine and riparian habitats; ii) fish species present in the various habitats including relative abundance, conservation status, endemism, rarity etc.; and, iii) assessing the fish and aquatic resource usage of the project area through informant interviews. The FAR report notes that there were limitations to the survey undertaken including limited time to undertake field work and heavy rain encountered which made conditions along the river bank hazardous. The key findings of the FAR Survey Report are summarized below.

82. Aquatic habitats identified and sampled along the surveyed river stretch included pools, riffles, runs and boulders. Fish live mainly in pools and under boulders and cobbles. Seventeen fish species and five species of crustacean were sighted in the Brenwe River during the field survey. Sampling stations 1 to 3 were located in the stretch of river between the proposed weir and powerhouse and below a 30 m high waterfall. Stations 4 and 5 were located upstream of the proposed weir location.

83. The relative abundance of aquatic biota (fish and crustaceans) sighted during the survey is presented in Table 4.2.

[30] The survey was conducted for the IEE by a university degree qualified and experienced freshwater ecologist from Pacific Horizons Consulting Group, Honiara, Solomon Islands.

Table 4.2 - Relative Abundance of Aquatic Species in Brenwe River

Species	Brenwe Stations					Vanuatu Endemic	IUCN Status	Level of Exploitation	Migratory behaviour
	1	2	3	4	5				
Freshwater Fish, Class: *Osteichthyes*									
Awaous ocellaris	3	2	4			No	LC	Low	Yes
Awaous gaumensis	2	1	1			No	LC	Low	Yes
Cestraeus goldei	5					No	DD	Medium	Yes
Cestraeus plicatilis	3					No	DD	Medium	Yes
Eleotris melanosoma	2					No	LC	Low	Yes
Eleotris fusca	1					No	LC	Medium	Yes
Khulia marginata	2	3	2			No	LC	High	Yes
Khulia rupestris	4	3	5			No	LC	High	Yes
Sicyopterus lagocephalus	1	2	2	1	3	No	LC	Low	Yes
Sicycopterus aiensis	1		1		1	Yes	NT	High	Yes
Sicyopus zosterophorum				1		No	LC	Low	Yes
Sicyopus (Smilosicyopus) chloe					1	No	LC	High	Yes
Mesopristes cancellutus	3					No	LC	High	Yes
Ryacicthys guilberti	1	1				No	NA	Medium	Yes
Stiphodon atratus	1	1	1			No	LC	High	Yes
Stiphodon mele				4	3	No	DD	Medium	Yes
Stiphodon rutilaureus	1					No	LC	Medium	Yes
Crustaceans, Subphylum: *Crustacea*									
Macobranchium lar	6	5	5	7	8	No	LC	High	Yes
Macrobrachium bariense			3	3	2	No	LC	Low	Yes
Utica gracilipes	1					No	NE	Medium	No
Atyoida pillipes			1	1		No	LC	Medium	No
Caridina typus			3	1		No	LC	Medium	Yes

Key: LC-Least Concern, NA-Not Assessed, NE-Not Evaluated, NT-Near Threaten, DD-Data Deficient.
Source: FAR survey report (2014)

84. The dominant element of the fauna consists of goboid fishes (*Stiphodon, Sicyopterus, Sicyopus, Awaous*) which is typical of clear rocky streams in the interior of Vanuatu islands, the Solomon Islands and PNG.[31][32] Freshwater fish species inhabiting these islands are forms that possess a pelagic larval stage, hence are widely dispersed. Many species have distributions that encompass most of Melanesia or range beyond this into Australia and Indonesia. Pelagic goboid larvae enter the island streams at periodic intervals in prodigious numbers and are likely to play an important role in the food web and overall stream ecology. However, there is little reliable information about the details of such larval migrations in the Vanuatu.

85. The stretch of Brenwe River surveyed is characterized by predominantly riparian areas of complex forest scrub with aquatic substrates of cobbles and pebbles along with detritus of leaves and wood debris. One approximately 30 m high waterfall and two other waterfalls >3m high were encountered between the proposed weir and powerhouse sites. The three sampling stations within this stretch had a natural milkiness of water due to precipitation of calcite. Abundant springs emanating from the steep river banks of limestone were noted as providing additional water to the river system in the gorge area. Apart from the waterfalls and deep pools beneath them (3 -10 m deep), shallow riffles with running flow of 2-5 m/s were noted.

86. Apart from the endemic *Sicyopterus aiensis* which is listed as near threatened in the International Union for Conservation of Nature (IUCN) Red Book all other species sighted are classified as least concern status or unlisted in the IUCN Red Book.

[31] Keith, P, Marquet, G, Lord, C, Kalfatak, D, Vigneux, E. 2010. *Vanuatu Freshwater Fish and Crustaceans*. Societe Francaise d'Ichtyologie, Paris.

[32] Polhemus D, Englund R, Allen G, Bosetto D & Polhemus J. 2008. *Freshwater Biotas of the Solomon Islands Analysis of Richness, Endemism and Threats*, Bishop Museum Technical Report N° 45, Honolulu, Hawaii

87. *Sicyopterus aiensis* is reported by local informants to be rare in the Brenwe River. This is possibly due to high levels of exploitation by Unmet and Brenwe communities at the river mouth.[33] It is noted that this species was sighted at three of the five sampling stations on the Brenwe River during the FAR survey including stations both above and below a series of waterfalls, one of which was 30 m high. This is not unexpected as *Sicyopterus aiensis* and other goboids are known to be able to climb over waterfalls by using alternately their pelvic suction cup and lips.[34] Furthermore, this species was sighted at all sampling stations surveyed in the Sarakata and Wambu Rivers (Espiritu Santo) during the FAR Survey for the project. Keith et al (2010) note that, *Sicyopterus aiensis* is reported to be present in rivers on six islands in Vanuatu including Malekula, Espiritu Santo, Pentecost, Maewo, Efate and Tanna.

88. The following key facts are noted regarding the freshwater ecosystems in respect of natural fish fauna.[35]

- The main type of lifecycle for freshwater fish species in Vanuatu is amphidromic;[36]
- Vanuatu's distinctive river habitats are oligotrophic[37] rivers subject to extreme climatic and hydrological seasonal variation (including floods and droughts). These river systems are colonized by fish (*Gobiidae, Eleotridae*…) and crustaceans (*Palaemonidae, Atyidae*…) with a lifecycle adapted to these distinctive habitats;
- The first major waterfall acts as a barrier for species not adapted to climbing waterfalls and is a barrier against predators for goboids; and
- Freshwater flow (floods) in estuaries seems to trigger migration inland for amphidromous species.

4. Rare and Endangered Species

89. The IUCN Red Book lists 17 endemic species in Vanuatu for which Red Book categories have been assigned. Four species of bird are categorized as vulnerable and one species of bird is categorized as near threatened. A further four endemic birds are least concern. The remaining listed species include three reptile species of which two are least concern and one is data deficient and four freshwater fish species of which one is near threatened, two are least concern and two are data deficient.

90. Details are provided in Table 4.2.

[33] Keith et al (op.cit.) report that at certain times of the year the biomass of goboid fish larvae migrating upstream is so great they become a major source of food for local populations in Vanuatu.
[34] Ibid p18,20.
[35] Ibid pp18-22
[36] Amphidromous species spawn in freshwater, the free embryos drift downstream to the sea where they undergo a planktonic phase, before returning to rivers to reproduce.
[37] Oligotrophic rivers are relatively low in plant nutrients and contain abundant oxygen

Table 4.2 - IUCN Red List of Endemic Vanuatu Fauna

Species Group	Name	Red List Category	Habitat
Birds	Vanuatu Imperial Pigeon *Ducula bakeri*	VU	Forest
	Vanuatu Kingfisher *Todiramphus farquhari*	NT	Forest
	Vanuatu Scrub Fowl *Megapodius layardi*	VU	Forest
	Vanuatu Starling *Aplonis santovestris*	VU	Forest
	Royal Parrot Finch *Erythrura regia*	VU	Forest
	Tanna Fruit Dove *Ptilinopus tannensis*	LC	Forest
	New Hebrides Honey Eater *Phylidonyris notabilis*	LC	Forest
	Buff-bellied Monarch *Neolalage banksiana*	LC	Forest
	Yellow fronted White Eye *Zosterops flavifrons*	LC	Forest, plantations, gardens
Reptiles	*Lepidodactylus vanuatuensis*	LC	Scrubland
	Vanuatu Silver Vineskink *Emoia nigromarginata*	LC	Forest
	Vanuatu Sawtailed Gecko *Perochirus guentheri*	DD	Marine coastal
Fish	*Akihito vanuatu*	LC	Rivers (Ambae, Pentecost)
	Schismatogobius vanuatuensis	LC	Rivers (common in Santo, rare elsewhere)
	Sicyopterus aiensis	NT	Rivers (Malekula, Santo, Maeo, Efate,Tanna)
	Stiphondon astilbos	DD	Rivers (Santo, Pentecost, Efate)
	Stiphondon kalfatak	DD	Rivers (Santo)

Source: IUCN website: www.iucnredlist.org

5. Protected Areas and Areas of Conservation Value

91. Malekula does not have any formalized terrestrial protected area. The only legally recognized protected area is the Amal Crab Bay Marine Conservation Area in central east Malekula. There are some locally initiated marine conservation areas around Malekula but these are traditionally managed by the community or a family or tribe.

92. One such area is the Nabi Protected Area located in Wiawi northwest Malekula. It was declared a protected area in 1994 by the kastom landowners. The Nabi Protected area comprises around 1000 hectares of forest and coastline. The vegetation at Wiawi is diverse including savannah, thickets, semi-deciduous forests and, at higher elevations, rainforests. More than 35 bird species have been recorded in the area. Wiawi also has a long white sand beach where sea turtles come ashore to lay their eggs, during September to March each year. Tagging of sea turtles here is an ongoing activity.

93. DEPC and the Department of Forestry in consultation with the Wiawi community have initiated a proposal to legally recognize the Wiawi conservation area. This area is located more than 10km northwest of the project area and will not be affected by the project.

6. Persistent Organic Pollutants

94. There is no legislation governing the intentional production and use of persistent organic pollutants in Vanuatu. The Global Environment Fund Evaluation Report noted that DDT was used for the control of malaria carrying mosquitoes until 1989, and some of the used stocks of transformers in Vanuatu contained polychlorobyphenals.[38] The main sources of dioxin and furan releases in Vanuatu are from the incineration of quarantine and medical waste and uncontrolled burning, including landfills and backyard rubbish fires. Vanuatu lacks the capacity to record control or monitor releases of dioxins and furans. The knowledge and application of best available techniques and best environmental practices for new or existing sources in Vanuatu is very limited or non-existent.

C. Socioeconomic and Cultural Resources

1. Population and Communities

95. Malekula Island is the second largest island of Vanuatu. The 2009 census shows that the total population of Malekula was 22,528 composed of 4,928 households. The ratio of male to female was 51:49 while average household size was 4.3, which was much lower than the national average of 4.9. The province including its capital Lakatoro is considered primarily rural. The population is predominantly Ni Vanuatu Melanesian.

96. The 2009 census data show that the island has lost people due to internal migration to the urban centres of Luganville and Port Vila. There are 553 households in the wider Northwest area of Malekula with Brenwe and Unmet collectively having 147 households. With an average of 4.5 persons per household, the total population of Brenwe/Unmet would be around 662 people. For the whole of the north-west area, the total population would be around 2,500.

97. Lakatoro is the main provincial and government administrative centre for Malampa Province. Lakatoro receives an influx of people from the other areas of Malekula for short periods mainly for the purpose of access to banking facilities, hospital, shops, airport, and markets to sell their produce. According to the 2009 census, the annual urban growth rate is 1.9 % compared with the national average of 4.1%.

2. Health and Education

98. According to UNDPs Human Development Report, Vanuatu's human development index of 0.626 ranks Vanuatu 124th out of 187 countries. This value is below the average of 0.64 for countries in the medium human development group and below the average of 0.68 for countries in East Asia and the Pacific and indicates an overall relatively low level of development (based on health, education and income).

99. Amongst infectious diseases, malaria and tuberculosis are major public health concerns. Also the incidence of sexually transmitted infections (STIs), acute respiratory tract infections, diarrhoea, and viral hepatitis is significant.

100. Urbanization and population growth are two major factors that places pressure on the government to continue providing communities with good health services. Remoteness and vastly dispersed communities are a challenge in providing proper healthcare especially to the rural population, where due to lack of medical infrastructure, preventable diseases are prominent. However, nationally, with half the population aged less than 20 and an increased life expectancy, disease patterns and demands on the health system are changing.

101. Malekula has two referral hospitals located at Norsup in the northeast and one at Lamap in the south of the island.

[38] Global Environment Facility. 2014. GEF Vanuatu and SPREP Portfolio Evaluation (1991-2012) Volume I: Evaluation Report

102. In the northwest there are four dispensaries, one Health Centre and 11 Aid-posts. Two dispensaries (Unmet and Leviam) are located near the project site, each having a registered nurse. There are also 11 Village Health Workers scattered throughout the northwest area of the island where they take care of the aid-posts at the village level.

103. Norsup hospital is the referral hospital for Malampa Province. It receives patients from rural health facilities throughout the province including Ambrym and Paama Islands. For more serious illnesses, these are referred to the Vila Central Hospital or the Northern Provincial Hospital located in Luganville, Santo. Norsup hospital has 64 staff of which 36 are permanent and 11 are on contract. There are currently 17 unfilled positions.

104. The distance between Unmet/Brenwe and the Norsup Hospital is around 20 km by road using four-wheel drive vehicles

105. In 2009, of the population 15 years and older in Malekula, 27% was reported to have completed primary education; another 22% had some primary education, 10% had trio certificate and 7% senior secondary. Approximately 15% had no schooling at all while almost 3% and 2% had some college degree and completed bachelor's degree respectively. A minority either had post graduate or vocational degrees. The literacy rate of the province was reported to be about 94.3% with the women (95.6%) having higher literacy rate than male (93%) population.

106. There are six schools in northwest Malekula with a total of 663 students from year 1 - year 8. A new junior secondary school provided by the government near Brenwe will commence year 9 and year 10 classes in 2015 and 2016 respectively. Currently students passing year 8 exams have to move to other schools in the central/northeast side of the island and/or travel to schools in other provinces. There are three different education providers in the vicinity of the project area (Unmet/Brenwe). They include the Anglican church, Catholic church, and the government. The Malampa Provincial Education Authority is the overall agency responsible for educational programs, direction and policy development in Malekula.

3. Cultural Heritage

107. Vanuatu has a rich history, and Ni-Vanuatu people adhere closely with many ancient traditional practices, even up to the present day. The concept of kastom relates to cultural, historical and religious traditions. It is most intimately tied to the land, natural resources and revenue for the spiritual forces of nature. While there are many sites that are preserved by their custom owners, sites that are officially designated as having cultural and historical significance are limited in numbers.

108. Vanuatu is rich in settlement sites from these ancient times, but many of the sites have disappeared and have not been relocated.

109. Within the proposed project sites, no significant cultural or archaeological discoveries have been reported. Consultations with the communities of Unmet and Brenwe have indicated that there are no areas of historical significance or tambu sites within the project area. However, the forest and bush areas contain traditional herbal medicines and food. According to the landowners, these important plants and food sources are also in abundance in other areas outside of the Project area.

4. Land use, Livelihoods and Employment

110. The main use of land by majority of rural Ni-Vanuatu (>80%) is subsistence farming. Due to population growth, pressure has been placed on the land and the forest mainly for new gardens. Almost every household in rural Vanuatu owns a small patch of garden as the main source of food. The main crops grown are coconut, cocoa, root crops such as cassava, taro, yam, sweet potato, banana, and recently kava for which demand has increased significantly.

111. After land clearance, lands are normally cultivated for one to three years followed by a longer fallow period ranging from 1 to 5 years however due to decreasing amount of space fallow periods are becoming shorter.

112. Coconut and copra are the major cash earning activities in the provinces. The level of smallholder copra and livestock production is increasing although there are fluctuations in the world price year to year. The production for cocoa on the other hand is also increasing over the years because of the high world price and the increased number of buying points in the provinces.

113. The Northwest area of Malekula is a significant producer of agricultural products including copra, kava, timber, fish, sandalwood, cocoa, vanilla, livestock and garden crops for both domestic and export markets. Malekula alone exports 3,000 metric tonnes of copra from Litzlitz wharf direct to the Philippines once every three to six months and approximately 2- 3 tons of kava from northwest Malekula are shipped to Luganville and Vila weekly. Malekula is also a significant producer of livestock.

114. During community consultations the community confirmed that no-one actually lived within or close to the project footprint and no one relied on the fish and aquatic resources in the stretch of river that would have reduced flows between the weir and the powerhouse. Fishing is undertaken in the lower course of the Brenwe River on an occasional basis but not relied upon as part of the community's subsistence livelihood.

5. Infrastructure

115. **Water Supply**. From the 2009 Census data, about 35% of Malekula households have a shared pipe system, 16% a shared village tank, 13% obtain water from river/spring or lake, household tank for 10% and protected well for 9%. But some 10% reported having their own private pipe system. The rest source their drinking water either from village stand pipe, unprotected well, bottled water or other unspecified sources. Community consultations in Unmet indicated that most villages source their water from small streams near to their village or in the lower stretches of the Brenwe River downstream of the proposed project site.

116. **Sanitation.** In terms of toilet facility, the majority (68%) of Malekula households use a pit latrine (either individual or shared). Only about 16% reported the use of water sealed toilet wither individual or shared while less than 1% of households use the flush type toilet. Likewise less than one percent reported having no toilet at all.

117. **Energy.** According to the 2009 Census data, only about 10% of households on Malekula are reported to use the electricity grid with the majority (71%) using kerosene lamp as the main source of lighting. The rest either use solar, torch, candle, wood, gas or coleman lamp as source of light. A few reported petrol generators as their source of light also. UNELCO the power concessioner in the area supplies electricity within the Lakatoro - Norsup grid where only about 526 customers are connected, i.e., only 21% of the potential customers within the service area of the UNELCO power plant are connected to grid power.

118. Nationally, only 15% of Vanuatu's population is connected to the local grids in Port Vila, Luganville and Lakatoro/Norsup where electricity is generated by diesel and/or hydropower.

119. **Waste Management.** There is no organized waste management system in any rural areas of Vanuatu. The six provincial councils have adhoc waste disposal sites with no proper management systems in place. From the 2009 Census data, about 32% of all households dispose of their waste by burning.

120. **Transport**. Private transport services, including buses and taxis, are common in the islands. In northwest Malekula the main form of transport for rural dwellers to and from the provincial centre at Lakatoro and airfield at Norsup is four-wheel drive vehicles which ply the roads transporting people and agricultural products on a semi-informal basis.

121. Coastal ships also periodically anchor offshore from Brenwe/Unmet and load up agricultural products for local and international markets.

122. Road conditions are generally poor such that during the wet season some more isolated roads are impassable. The Public Works Department in Lakatoro advised that the northwest Malekula Road between Lakatoro and Brenwe is typically maintained on an annual basis through grading and re-graveling to ensure the road remains passable at all times.

6. Industries

123. Vanuatu has a small industrial sector. The manufacturing sector, located mainly in Port Vila and Luganville (Santo) is mostly food processing and is actually declining. There are no major processing industries in the project areas or in other parts of islands. However, Malekula and Santo are major contributors to the national economy through, copra, cocoa and kava commodities. Handicrafts are also produced by small home or village enterprises and incomes are not regular.

7. Tourism

124. Tourism is the most significant contributor to the national economy, and accounts for about 75% of the foreign exchange, 20% to the gross domestic product and an estimated 5,000 jobs. Most tourism activities in Vanuatu are closely linked to the coastal and marine areas. Fundamental among these are the relatively clean, pristine and scenic shorelines and coastal waters where most of the tourist resorts are located.

125. Malekula and Santo receive a large number of tourists annually due to reliability of sea and air transport, accommodation and the pristine and scenic shorelines. The strong, unique and diverse culture and the undisturbed way of life in some parts of the islands are also the main attraction which contributes significantly to the increase in the number of tourist arrivals to Vanuatu.

126. Tourism is becoming the most important sector in Vanuatu, with visitor numbers growing each year along with the increase in cruise ship visitors (who have a short onshore visit and return to the ship). Vanuatu is also a popular destination for the yachting fraternity. Most tourism activity has been in the vicinity of the capital, Port Vila, but the recent opening of new airports and airline routes is beginning to spread tourism to the other islands.

127. In 2011 there was a 5% increase in the total number of visitors to Vanuatu compared to 2010, mostly from the buoyant cruise ship industry. In 2011 tourism arrivals numbered 248,898.

128. Eco-tourism activities and forest conservation have been encouraged, notably through the establishments of community conservation areas and marine protected areas by the local communities.

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Screening of Potential Impacts

129. The ADB rapid environmental appraisal checklist for hydropower projects and climate risk screening checklist were used to screen for potential impacts. The checklists were prepared during the project inception stage following review of previous studies and finalized following field inspection and community consultations in Brenwe in March 2014. The completed checklists are presented in Annex 3. The checklists confirm the project is Category B for environment, and indicate moderate risk primarily due to potential impact of climate change on rainfall patterns.

130. 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.

131. 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.

B. Impacts on the Physical Environment

1. Erosion and Loss of Top Soil

132. Erosion could occur during rehabilitation of the access road, and construction of headrace canal, especially where they cross steep slopes, and in the river channel adjacent to the intake/sand trap and tailrace. Erosion could also occur in these areas during operation of the facility. Erosion could result in i) loss of top soil and the forest it supports due to landslides, and ii) increased siltation/sedimentation of the Brenwe River. Such impacts can be avoided or minimized through recognized good engineering design and construction practices incorporating the following mitigation measures:

- Minimizing the vegetation clearance corridor for all components;
- Installing cut-off drains when excavating on steep slopes;
- Ensuring slope cuts are appropriately designed and engineered for the prevailing conditions (geotechnical, climate etc.);
- Cut slopes to be re-vegetated as soon as practicable to minimize the exposure of bare surfaces;
- Re-vegetation of cut slopes to incorporate appropriate bioengineering practices utilizing local native species as much as possible;
- Masonry or gabion basket bank protection in the river channel adjacent to the weir/intake and sand trap, and adjacent to the tail race; and
- Scheduling the construction in the dry season (Jun - Oct).

133. The scale of the construction activities and limited footprint of the project means there will be limited direct loss of top soil. However, indirect loss of topsoil could occur through erosion as described above. Nevertheless, following site clearance top soil will be stockpiled for later use in landscaping or made available to the local community for their use.

134. The relatively small scale nature of the project coupled with local labour intensive approach and rigorous implementation of the above mitigation measures will ensure that the potential impact of erosion and loss of topsoil due to the project will be minimized to acceptable levels.

2. Sedimentation / Water Quality

135. There is potential for localized and short term water contamination from runoff of suspended sediment from exposed surfaces, slope erosion and concrete residues into the Brenwe River during various construction activities as outlined below:

- Vegetation clearance along project corridor and stockpiling of excavated materials;
- Demolition of existing weir, powerhouse and penstock facilities
- Excavation works associated with rehabilitation/construction of:
    - access road
    - intake structures, (weir, intake sandtrap) and associated riverbank protection works
    - 1 km long headrace canal and 150 m penstock
    - powerhouse foundations

- tailrace and associated riverbank protection works
- Spoil disposal from demolition and excavation works.

136. Construction activities will involve some use of powered mechanical equipment especially for rehabilitation of the access roads and some sections of the headrace canal however it is envisaged that the majority of the construction activities will be undertaken using manual labour. This should help in minimizing the potential for erosion and sediment runoff into the Brenwe River.

137. A range of proven mitigation measures normally associated with good construction practice will be implemented during construction of the facilities to avoid or minimize sedimentation impacts on the Brenwe River. As a minimum these mitigation measures will include:

- Minimizing the vegetation clearance corridor or footprint for all components;
- Re-vegetate and/or cover/stabilize exposed surfaces and excavated materials
- Implementing effective construction site drainage such that runoff is directed to sediment traps before discharge to water courses;
- Use of cut-off drains above excavated areas on steep slopes to reduce erosion;
- Close construction supervision to ensure the above measures are implemented; and
- Scheduling the construction in the drier months (Jun - Oct).

138. Effective implementation of the above mitigation measures will ensure that the potential short term impacts on water quality due to construction of the Project will be of relatively minor significance.

139. Operation of the project will not give rise to any significant impact on water quality.

3. Water Composition/Profile

140. The high calcium content (water hardness) of the Brenwe River is a natural phenomenon related to the river catchment characteristics as a whole. The natural seasonal/daily variation in flow of the Brenwe River reflects the rainfall and runoff characteristics of the catchment. Whilst the Brenwe weir will result in a reduced flow in the 1km section of natural channel between the weir and the powerhouse, the seasonal/daily variation in flows due to rainfall/climatic factors will still be reflected in the stretch of river subject to reduced flows. This is because the weir (as opposed to a dam) is designed to allow continuous flow over it such that the amount of water spilling over the weir will be related to the natural flow variations in the catchment.

141. Mean annual rainfall maxima recorded near Brenwe (Lakatoro) over a 53 year period shows significant variability (1,305 mm to 3,693 mm). Thus under natural conditions there are significant flow variations in the channel throughout the year according to seasonal/climatic variations in rainfall. Natural variations in the relative volume of surface water and discharge of springs within the river channel and therefore changes in water profile/composition (if any) would also be expected. In other words during periods of drought the relative volume of surface water and flow from springs in a given stretch would be higher than in periods of high rainfall and/or floods. The aquatic ecology will be adapted to such natural variations in flows and water chemistry (if any). The imposition of the weir will not significantly alter this range of natural variation.

142. On the basis of the above, it is considered that the operation of the Brenwe hydropower scheme will not result in a significant change in water profile/composition between the weir and the power house over and above the current level of natural variation and therefore is unlikely to affect the existing flora and fauna.

4. Dust and Noise

143. Owing to the limited scope of works, largely manual construction methods and distance away from residential communities, the impact of dust and noise generation will be negligible. The largest impact of dust and noise will likely be from construction site traffic transporting materials and equipment to the site along northwest Malekula Road from Lakatoro. This will be temporary and sporadic over a 24 month period. Implementation of good practice construction methods such as watering of access roads adjacent to residential areas during dry spells and using well maintained powered mechanical equipment equipped with silencers will ensure impacts are minimized and acceptable.

5. Materials and Spoil Management

144. Moderate amounts of sand and cement and other equipment and materials will be required for construction. It is envisaged that a dedicated borrow pit /quarry will not be required for the Project and that aggregates could be obtained from existing sources in either Malekula or other nearby islands. Materials sources will be identified by the contractor and will be detailed in Materials and Spoil Management Plan (MSMP). Excavation activities will be limited with a corresponding limited volume of excess spoil needing to be disposed of.

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

- Required materials, potential sources and estimated quantities available;
- Impacts related to identified sources and availability;
- Excavated material for reuse and recycling methods to be employed;
- Excess spoil to be disposed of and methods proposed for disposal;
- Endorsement from Malampa Provincial Council (MPC) and local landowners for use of sources and disposal of excess spoil; and
- Methods of transportation to minimize interference with normal traffic.

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

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

6. Waste Management

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

149. As part of the site-specific EMP (SEMP) prepared by the contractor waste management measures will be included in a waste management plan (WMP) to cover all matters related to solid and liquid waste disposal arising from construction related activities (including storage, disposal and accidental spills). The WMP will cover the following issues:

- Expected types of waste and volumes of waste arising;
- Waste reduction, reuse and recycling methods to be employed;
- Agreed reuse and recycling options and locations for disposal/endorsement from MPC;
- Methods for treatment and disposal of all solid and liquid wastes;
- Establishment of regular disposal schedule and constraints for hazardous waste;
- Program for disposal of general waste / chain of custody for hazardous waste;
- Designation of waste disposal areas agreed with local authorities;
- Segregation of wastes to be observed. Organic (biodegradable - such as tree trimmings) shall be collected, stockpiled and given to the local community (no burning is allowed on site);
- Recyclables to be recovered and sold to recyclers;
- Residual waste to be disposed of in disposal sites approved by local authorities and not located within 500 m of rivers or streams;
- Camp, construction offices/facilities and work's yard to be provided with garbage bins;
- Burning of construction and domestic wastes to be prohibited;
- Disposal of solid wastes into drainage ditches, rivers, other watercourses, agricultural fields and public areas shall be prohibited; and
- All solid waste will be collected and removed from work camps and disposed in designated local waste disposal sites.

150. The contractor's WMP, as part of the SEMP, will need to be approved in writing by the VPMU prior to start of construction.

151. **Hazardous Materials and Hazardous Waste Disposal.** Use of hazardous substances during construction, such as oils and lubricants can cause significant impacts if uncontrolled or if waste is not disposed correctly. Mitigation measures will aim to control access to and the use of hazardous substances such as oils and lubricants and control waste disposal.

152. The contractor's mitigation measures in the hazardous materials section of the WMP will include but not necessarily be limited to the following measures. The contractor shall ensure implementation of such measures.

- Ensure that safe storage of fuel, other hazardous substances and bulk materials are agreed by VPMU and follow internationally recognized good practice;
- Hydrocarbon and toxic material will be stored in adequately protected sites consistent with national and local regulations and codes of practice to prevent soil and water contamination;
- Segregate hazardous wastes (oily wastes, used batteries, fuel drums) and ensure that storage, transport and disposal shall not cause pollution and shall be undertaken consistent with national regulations and code of practice;
- Ensure all storage containers are in good condition with proper labelling;
- Regularly check containers for leakage and undertake necessary repair or replacement;
- Store hazardous materials above possible flood level;
- Discharge of oil contaminated water shall be prohibited;
- Used oil and other toxic and hazardous materials shall be disposed of off-site at a facility authorized by the VPMU;
- Adequate precautions will be taken to prevent oil/lubricant/ hydrocarbon contamination of drainage channel beds;

- Spill clean-up materials will be made available before works commence (e.g., absorbent pads, etc.) specifically designed for petroleum products and other hazardous substances where such materials are being stored; and
- Spillage, if any, will be immediately cleared with utmost caution to leave no traces.

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

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

C. Impacts on the Biological Environment

1. Impact on Aquatic Ecosystem

155. Information gathered in the FAR survey indicates an aquatic ecosystem that has been disturbed by introduction of exotic species *Oreochromis mossambicus* and *Gambusia affinis* and forest degradation due to invasive vines and clearance for subsistence gardening and cattle farming. Despite this disturbance the aquatic biodiversity appears somewhat intact with a diversity of goboid species and others, typical of the rivers and streams of Vanuatu.

156. Construction stage impacts on the aquatic ecosystem include erosion, pollution, sedimentation and effects from run-off which have been described above. Effects of dewatering and requirement for environmental flows are discussed under operational impacts.

2. Impacts on Terrestrial Habitat and Biodiversity

157. The project will involve clearance of about 4 ha of vegetation, comprising degraded successional vegetation that has colonized the previously excavated and abandoned Brenwe hydropower facilities since the mid-90s. A breakdown of the estimated vegetation clearance area by project components is provided below.

- Access road to head works and powerhouse 3 ha (15 m x 2000 m);
- Settling basin and headrace canal 0.765 ha (15 m x 30 m + 8 m x 900 m);
- Penstock 0.08 ha (100 m x 8 m);
- Forebay 0.045 ha (15 m x 30 m); and
- Power house, tailrace and accommodation facilities 0.24 ha (20 m x 90 m + 20 m x 30 m).

158. The successional vegetation habitat to be removed is considered to be of low biodiversity value especially when considered that the immediately surrounding vegetation has been highly modified by coconut, kava, cocoa and fruit tree plantations and subsistence gardening.

159. Taking into account the overall disturbed natural environment of the project area, the potential loss of habitat due to the Project is considered to be of minor significance. The potential impact on terrestrial wildlife is considered minor and insignificant, given the existing degree of natural habitat modification and human interference.

160. The transmission line route will be within the access road corridor and the existing public road to Lakatoro. The careful placement of power poles 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.

161. 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.

162. The proposed use of predominantly manual labour over mechanical equipment during construction will also reduce the risk of excessive vegetation clearance. The proposed use of predominantly manual labour over mechanical equipment during construction will also reduce the risk of excessive vegetation clearance. However, this will require close construction supervision to ensure clearance corridors are minimized. Such provisions shall be included in the EMP.

163. Workers will be prohibited from poaching or hunting any birds or wildlife from within the Project area or adjacent catchment.

D. Impacts on the Socio-economic Environment

1. Construction Camp/Site Office Impacts

164. The workforce is expected to be in the order of 50-80, with 40% being unskilled labour which can be recruited locally from Unmet, Brenwe and surrounding settlements and 60% skilled labour which will likely come from outside the area and can be accommodated in Lakatoro town therefore it is unlikely that there will be need for large-scale accommodation at the site. However, a site office and storage/maintenance area is likely to be established for the duration of the construction period.

165. The contractor will be required to adopt good management practices to ensure that both physical impacts and social impacts associated with a camp and/or office/yard are minimized. As noted previously fuels and chemicals, raw sewage, wastewater effluent, and construction debris associated with the construction site office and storage maintenance area is disposed of appropriately. As part of implementation of the WMP waste will be disposed of under controlled conditions to reduce impacts (refer to section B.5).

166. The contractor will be required to negotiate a lease for land for a camp and/or office/yard from local land owners and this process will be required to follow the process established in the resettlement plan.

167. Social impacts include i) potential for conflict between workers from outside and local residents and communities; ii) risk of spread of communicable diseases including STIs and HIV; and iii) risk of contamination of local water sources.

168. The proposed measures to mitigate the above risks and impacts include:

- Induction of workers on requirements of the project's consultation and participation plan (CPP) [39] and grievance redress mechanism (GRM) [40] and protocols established for any contact between local communities and contractor/workers;
- Implementation of a communicable disease awareness and prevention program targeting risk of spread of STIs and HIV as outlined in the project's poverty and social assessment and gender action plan;
- Location of site office and facilities to be agreed with local community including land owners) with facilities approved by the VPMU and managed to minimize impacts and any negotiation or lease arrangements to follow established procedure as per the resettlement plan;
- The facilities (camp and yard) will be fenced and sign-posted and unauthorized access or entry by general public will be prohibited;

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

[40] See Section VII. 4.

- The contractor will put up notice boards regarding the scope and schedule of construction, as well as certain construction activities causing disruptions or access restrictions;
- 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. 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 Separate toilets shall be provided for male and female workers;
- For unskilled activities and labour, as many local people (including women) as possible will be recruited and trained;
- Standing and open water (including puddles, ponds, drains etc) within the camp or office/yard shall not be permitted to reduce possible disease vectors;
- To reduce risk of contamination of local water sources, wastewater effluent from contractors' workshops (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. Oil and grease residues shall be stored, handled and disposed of as per the agreed WMP;
- The contractors facilities area will be cleaned up to the satisfaction of VPMU 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.

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

2. Occupational Health and Safety

170. A health and safety plan (HSP) will be submitted by the contractor to establish routine safety measures and reduce risk of accidents during construction. The HSP will cover both occupational health and safety (workers) and community health and safety. The HSP will be appropriate to the nature and scope of construction activities and as much as reasonably possible meet the requirements of good engineering practice and World Bank's Environmental Health and Safety Guidelines.

171. The HSP 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.

172. 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;
- 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;
- The camp and/or office/yard will be equipped with first aid facilities including first aid kits in construction vehicles. A suitable vehicle will be available for transport to the nearest town for medial or emergency treatment if required;

- Provision of potable water supply in all work locations;
- The camp and/or office/yard will be securely fenced and warning signs erected. Unauthorized people shall not be permitted within the cam and work sites/yards; and
- Fencing shall be installed on all areas of excavation greater than 1 m deep and at sides of temporary works.

173. All measures related to workers' safety and health protection shall be free of charge to workers. The worker occupational health and safety plan to be submitted by the contractor before construction commences and in tandem can be extended to cover public safety and approved by VPMU.

3. Community Health and Safety

174. Community safety can be threatened by works in public areas. General measures and requirements of the HSP which apply equally to community and workers have been discussed above. The HSP will cover 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 camp and construction areas to deter access to or through the sites;
- The general public/local residents shall not be allowed in the sites which are high-risk areas;
- 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.

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

4. Physical Cultural Resources

176. Consultations with the local communities confirmed that there are no known physical cultural resources (including tambu sites) within the area of influence of the project. However, during earthworks and excavation, 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.

E. Operation Impacts

177. **Access and maintenance**. Access roads to the project facilities including maintenance corridor alongside the headrace canal, could become de facto walking tracks for local communities and gives rise to the potential for people swimming, using (eg washing) or falling into the canal (especially children). Security fencing will be required to ensure there is no public access to the canal and forebay.

178. **Health and safety**. Provided the project includes the necessary safety fencing described above there will be negligible effect on community health and safety. Worker health and safety will be protected by implementation of EMP measures including safety briefings, access to first aid kit at the power house, and provision of PPE appropriate to roles and activities undertaken by facility operator staff.

179. **Environmental flows**. The project involves placement of a low weir (up to 3 m high) with a single gated sluice on the left side. The weir and intake structure will result in a portion of the natural river flow being diverted for use in hydropower generation before being discharged back into the river channel via the powerhouse tailrace approximately 1 km downstream.

180. The main effect on the aquatic ecosystem arises from a reduction in the natural flow regime of the Brenwe River between the intake structure and the powerhouse tailrace. This could have a negative impact on the existing aquatic ecosystem including fish and aquatic resources along the 1 km stretch. The project has a design flow of 0.66 m^3/second and the estimated mean flow of the Brenwe River at the intake site is 0.8 m^3/second.

181. The estimated flow duration curve indicates that for about 45% of the time the design flow would be exceeded at the intake such that under full capacity operating conditions of the project there would be surplus flow spilling over the weir and into the river channel at the intake.

182. The 1 km stretch of channel to be affected by reduced water flow due to the project represents a small proportion of the entire river length and includes a 30 m high waterfall and two other cascades > 3 m high. These falls are significant natural barriers to most fish other than species such as goboids which have natural adaptations (pelvic suction cup and lips) enabling them to climb waterfalls. This is the case with the Brenwe River where four goboid species were sighted at survey stations upstream of the waterfalls (and weir site).

183. The waterfalls are significantly higher than the proposed weir such that it would be expected that a 3 m high weir would not be a problem for goboids to climb after scaling the waterfalls. The critical factor is to ensure that a continuous flow is maintained across the weir and thereby also ensuring continuous flow over the waterfalls between the weir and the powerhouse.

184. It was noted in the FAR survey report that along the 1 km stretch of river between the weir and powerhouse sites there are significant inflows to the channel from springs and surface waters emanating from the porous limestone banks. These inflows will not be affected by the project to any significant extent. It is also important to note that the aquatic ecosystem of the Brenwe River, like all rivers in the islands of Vanuatu, is subject to extreme hydrological seasonal variation (including floods and droughts). A run-of-river hydropower project such as Brenwe will still allow for these natural hydrological seasonal variations between the weir and powerhouse.

To ensure that amphidromous species in the Brenwe River are able to freely circulate between upstream and downstream reaches in the river a minimum environmental flow equivalent to 10% of the mean annual flow (at the intake) will be released across the weir at all times. Thus, the intake structure will be designed to ensure that a minimum flow of 80 l/s will be released into the Brenwe River at all times. This flow will be supplemented by the natural inflows to the channel from springs and surface water flows over the 1 km river section between the weir and powerhouse. To ensure constant environmental flow the design will include be a pipe of diameter 150mm – 200mm through the weir with a fixed orifice at the downstream end. The orifice constricts and expands when the water pressure on it changes to keep the outflow constant. The proposed minimum flow is considered sufficient to ensure the sustainability of the existing downstream ecosystem along the 1 km affected stretch.

185. It is important to note that Vanuatu has no statutory requirements for minimum environmental releases for hydropower projects. The only relevant requirements other than a Development Consent is the need for the project proponent to obtain a water use right and right to construct, operate and maintain works associated with resources that do not comply with customary rights and rights of occupiers as specified in Part 2 Division 1 Section 4 of the Water Resources Management Act 2002.

186. A study on freshwater biota of the Solomon Islands which analysed richness, endemism and threats to freshwater biota concluded the following in respect to the impacts of dams: *Given the short, discrete nature of many Solomon Islands drainage basins, and the sharp topographical divides separating them, the environmental changes caused by any one dam, although locally dramatic, would have little overall effect on the aquatic biota of a given island, and would not serve to endanger any endemic species in a global sense*.[41] Given the similarity of Vanuatu's freshwater ecosystems to those of the Solomon Islands it is reasonable to assume this statement would equally apply to Vanuatu.

187. Such a statement provides a certain confidence that given the Brenwe scheme is a run-of river and not a dam and given the proposed mitigation measures for a minimum environmental flow release of 80 l/s to sustain the existing aquatic ecosystem of the Brenwe River between the intake and the powerhouse, the impact of the project on the overall aquatic biota of Brenwe River and Vanuatu's biodiversity as a whole is likely to be insignificant.

188. Based on the information provided above it is considered that maintenance of a minimum environmental flow release of 80 l/s into the natural channel at the weir will ensure that the potential impact of the project on fish migration in the Brenwe River will be insignificant.

F. Climate Change Effects and Adaptation Requirements

189. The following paragraphs rely primarily on review of available information on climate risks in Vanuatu with a view to proposing practical measures for integrating adaptive measures into project design. Unless where referenced otherwise, information has been gleaned from the following reports.

- Profile of risks from climate change and geo-hazards in Vanuatu: Draft Report (2013);
- National Climate Change Adaptation Strategy for Land-based Resources 2012-2022 (Second Draft July 2011);
- Vanuatu National Adaptation Program for Action (2007);
- Australian Bureau of Meteorology and CSIRO. Climate Change in the Pacific: Scientific Assessment and New Research. Volume 2: Country Reports (2011).
- ADB's Climate Risk and Adaptation in the Power Sector (2012).

190. Climate change is concerned with long term changes in weather patterns often averaged over 30 years. These include things like increases in average temperatures, changes to average rainfall and changes to the intensity and frequency of extreme events, such as cyclones. Climate change risk management approaches focus on predicting how these changes could impact on natural systems including hydrologic, geological processes, agricultural systems, ecological equilibrium and the built environment, and building resilience in these systems through adaptive interventions.

191. Based on the available information, an assessment of climate risks is presented and recommendations made for resilience building adaptive measures into the project.

[41] Polhemus et.al. 2008. *Freshwater Biota of the Solomon Islands Analysis of Richness, Endemism and Threats*, Bishop Museum Technical Report N° 45, (p. 146), Honolulu, Hawaii

1. Review of Relevant information

192. Fairly clear projections exist which suggest that temperature has been steadily rising and is expected to increase by 0.4 - 1.0°C by 2030 in Vanuatu. Projections in terms of rainfall changes are less consistent and climate change models are unable to resolve many of the physical processes involved in producing extreme rainfall.[42] However, increases in extreme rainfall days are expected in terms of both frequency and duration. For design of most infrastructure, peak rainfall is more important than annual average rainfall.

193. Sea level has risen near Vanuatu by about 6 mm per year since 1993 which may or may not be due to climate change, yet is nevertheless an issue that needs to be considered in long-term infrastructure development. Sea-level changes across the country will vary but is assumed to increase in general, along with its associated storm surges and wind strength.

194. Sea-surface temperatures have also gradually risen around Vanuatu since the 1950s and ocean acidification has increased which puts the health of coral reefs at risk. These are important because coral reefs protect the shoreline from impacts from storms and support the tourism and fishing industries, which are important to the country.

2. Exposure of Small Hydropower Infrastructure

195. Key civil infrastructure components associated with the small hydropower projects of the project including intake structure, canal, penstock, powerhouse and access road are located away from the coast in hilly areas.

196. These components are somewhat less exposed to climate driven extremes than most of the other infrastructure for which power will be supplied through distribution lines. Distribution lines and their receiving infrastructure including schools, clinics, airstrips and community households are located mainly on the coast and are thus more exposed to extremes such as intense storms, tropical cyclones and flash floods including storm surges.

197. Vanuatu is expected to incur on average, US$ 47.9 million per year in losses due to earthquakes and tropical cyclones and in the next 50 years Vanuatu has a 40% chance of experiencing one or more events in a calendar year that will cause casualties exceeding 900 people.[43]

198. A Natural Hazard Risk Mapping prepared by the United Nations Office for the Coordination of Humanitarian Affairs identified that there is a 10% probability that Malekula and Espiritu Santo will experience a Category 4 tropical storm (wind speed 210-249 km/hr) in the next 10 years.[44] There is also a 20% chance of these islands experiencing the highest category of earthquake intensity within the next 50 years.

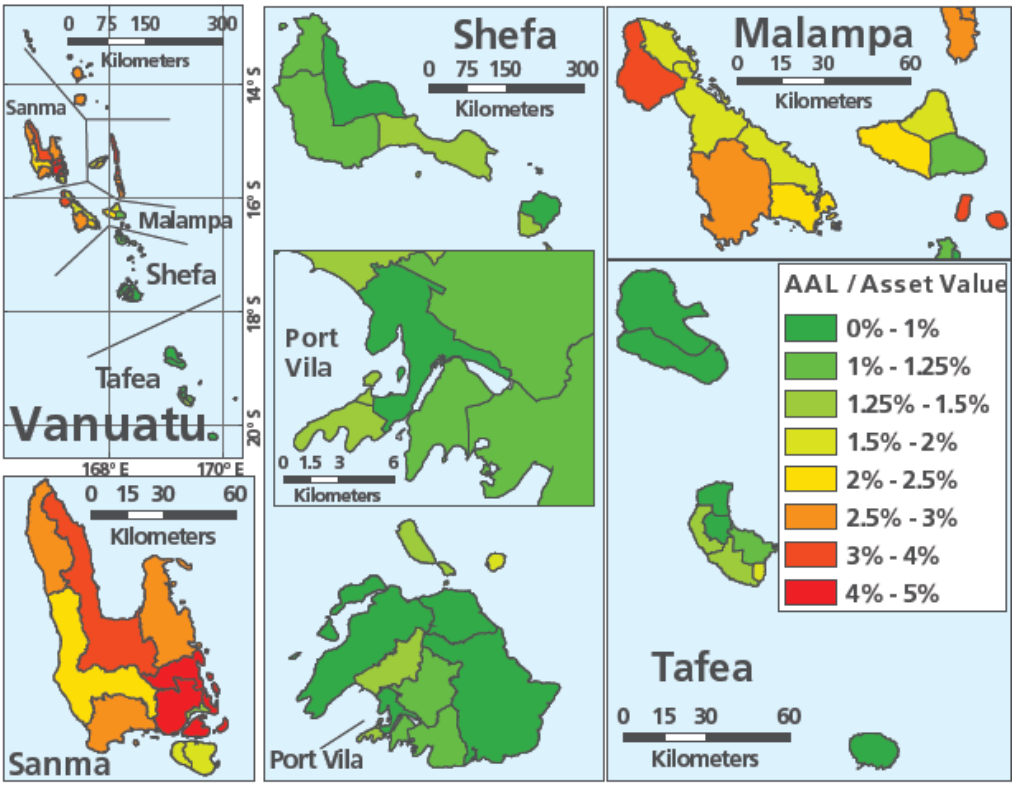
199. Figure 5.1 below illustrates the highest risk areas in the country for tropical cyclones and earthquake (ground shaking and tsunami), in terms of average relative annual losses. North-west Malekula and southern Sanma are cited as being among the highest risk areas of the country.

[42] Government of Vanuatu & Australian Bureau of Meteorology. 2011. Pacific Climate Change Science Program: Current and Future Climate of Vanuatu

[43] SOPAC, ADB, WB,JICA, GFDRR, AirWorldwide, GNS Science. 2011. Pacific Catastrophe Risk Assessment and Financing Initiative

[44] United Nations Office for the Coordination of Humanitarian Affairs. 2011. Vanuatu Natural Hazard Risks

Figure 5.1 - Loss/Value from Earthquake and Tsunami Damage by Ward



Source: Pacific Catastrophe Risk Assessment and Financing Initiative (2011)

200. Climate change is expected to change the patterns for tropical storms. Generally there is a projected decrease in the number of events but an increase in their intensity or severity (i.e. category 4 and 5 being the highest). Windstorms, including cyclones, tidal surges and storms are already the leading hazard cause of losses of life and assets across the Pacific.[45] Earthquakes are the most important hazard for building damage.

201. It should be noted that the above assessment does not include risks from sea-level rise and associated storms, increased temperatures and land based flooding. This type of hazard assessment does not exist on a country scale. It should be noted however that overall Vanuatu has high exposure to tropical storms and earthquake risks. Sea level rise will increase exposure where elevations are lower and floods may increase in more mountainous areas.

202. Some of the identified risks posed by climate change and natural hazards in the Pacific, specific to the energy sector are described in Table 5.1. This table is adapted from the ADB Climate Risks and Adaptation in the Power Sector. It includes various adaptation options that could be considered for the risks identified in respect of the small run-of-river type hydropower projects proposed under the project.

203. Energy production, utilization, conversion and transportation have and will be affected by most natural weather phenomena such as cyclones, floods, droughts and storm surge.

[45] World Bank. 2006. *Not if But When: Adapting to Natural Hazards in the Pacific Islands Region*. Policy Note

Table 5.1 - Summary of Impacts and Adaptations on Hydroelectricity Infrastructure

Climate change/hazard	Potential Impact	Potential Resilience Measure	Complementary Measures
Sea-level rise	Most hydro is located inland and not directly affected by sea-level rise, possibly increased rate of deterioration of concrete structures due to increased salinity from sea-level penetration upstream	Materials substitution for less corrosive materials	Coastal zone protection to protect estuaries and watersheds
Increase/decrease in rainfall	Energy from hydropower relies on rainfall and reduced river flow over a period of time could reduce or disrupt entirely energy generation.	Where flow is expected to increase, modify the number and type of turbines that are better suited for expected water flow rates, reduce expected turbine lifetime due to higher suspended sediment loads, modify canals to better handle changes in water flows, modify spillway capacities	Develop improved hydrological forecasting techniques and adaptive management operating rules; develop basin-wide management strategies that take into account the full range of downstream environmental and human water uses; restore and better manage upstream land including afforestation to reduce floods, erosion, silting, and mudslides. Improved watershed modelling to inform better management
Cyclones/hurricanes and frequent strong storms	Flooding of riverbanks could adversely affect stream flow particularly where hydropower is generated. Transmission/distribution lines and poles are damaged.	Design more robust infrastructure for heavier flooding and extreme events	
Increased temperatures	Higher evaporation rates, reduced turbine efficiency	Water cooling systems in turbines	
Earthquakes	Damage to infrastructure, oil spills and fire hazards.	Use design standards applicable to high earthquake risk areas.	

Source: ADB (2012)

3. Recommendations for Integrating Climate Change Adaptation Measures into the Project Design

204. Integrating climate change adaptation measures into the design of the hydropower scheme needs to be based on the economic considerations associated with the relatively small-scale nature of the scheme. The expected increase in extreme rainfall days in terms of both frequency and duration is the prime climate change issue in respect to the design of small run-of-river hydro projects in Vanuatu. Therefore design criteria in respect of peak flood size and levels need to take account of the potential effects of climate change.

205. Critical structures that need to be considered for possibly increased peak floods include: (i) intake weir - suitable erosion protection to prevent scour around the intake weir's training walls; and (ii) powerhouse - Level of powerhouse discharge outlet needs to be sufficiently high so as to prevent any flood induced backflow resulting in flooding of the powerhouse and damage to electromechanical equipment.

206. Appropriate climate change adaptation and resilience needs to be incorporated into the design of structures including: i) suitable erosion protection to prevent scour around the intake weir's training walls, and ii) powerhouse - level of powerhouse discharge outlet needs to be sufficiently high so as to prevent any flood induced backflow resulting in flooding of the powerhouse and damage to electromechanical equipment.

207. Design criteria need to be established for these structures that take account of future climate change induced peak flood size and levels during the design life of the plant. In practical terms this could mean increasing the maximum design flood level for each of the above structures and/or increasing the level of design flood freeboard. If possible, the establishment of design criteria needs to be based on available climate change modelling data to develop synthetic extreme event data. In the absence of climate change modelling data the design criteria should be demonstrably conservative. Design criteria for the hydropower projects will be established by the consultant responsible for preparation of the tender documents.

208. Other measures to mitigate the effect of an increase in intensity and frequency of extreme rainfall and consequent floods on the project components centre on enhanced erosion protection. Such measures could include: (i) additional river bank protection / rock armour placed around the intake structures and powerhouse tailrace; and (ii) enhanced slope protection works along steep sections of the headrace canal routes (benching, cut off drains, masonry etc.).

209. The extent to which such climate change adaptive measures are employed for erosion protection needs to be balanced against the marginal economics of small scale hydropower projects. For example, for project components that are repairable and any resulting outage not significant, normal best practice design criteria should apply. Any additional erosion protection measures such as benching of headrace canal slopes (over and above normal design criteria for such works), can be implemented during project operation if required. On the other hand if there is a plentiful supply of nearby rock material able to be utilized for erosion protection it might be that a small incremental cost for enhanced erosion protection for climate change adaptation purposes during construction may have a significant economic benefit.

210. In principle, it is suggested that the project only makes climate change design decisions on structures that cannot be practically modified or adapted later during the project's operational life. This includes the critical structures that need to be protected against peak flood size and levels as indicated above. However, if the incremental cost of providing enhanced river bank and/or slope protection as a climate change adaptation measure is low, this should also be incorporated into the project design otherwise such measures can be implemented as needed during the operational life of the project.

VI. INFORMATION DISCLOSURE AND CONSULTATION

211. Stakeholder consultations on environmental issues for the project were undertaken at both the national, provincial and community level.

A. National Level Consultation

212. Consultations at the national level were undertaken on a one on one basis with relevant agencies. Key institutions and their responsible personnel were identified by the environmental safeguards team and meetings arranged accordingly. The purpose of the consultations was to i) briefly outline the key features of the project (sub-project location, indicative lay out/footprint etc) ii) ascertain key stakeholders' views and concerns in relation to the proposed developments and iii) obtain information from the stakeholders on environmental and social characteristics of the sites that would assist in the preparation of the IEEs including any constraints that need to be addressed.

213. A list of key national stakeholders consulted including summary of information obtained and significant comments made is provided in Annex 4 Table A4.1. Relevant information obtained and comments made during the consultations have been integrated into the IEE where appropriate. No significant environmental constraints on the proposed project were identified through the national level consultations with all those consulted being supportive of the project. The most significant comment came from DEPC's Biodiversity Officer who expressed the importance of ensuring that aquatic biodiversity of project areas was surveyed so that adequate mitigations can be implemented as necessary to protect any vulnerable species that might be present.

B. Provincial and Community Consultation

214. Provincial and community consultations in respect of both environmental and social issues were undertaken in Lakatoro township and Unmet village on 19 March 2014. The project consultation personnel included the consultant's international environment specialist (IES) and international and national social/resettlement specialists. Local logistical support was provided by the Malampa Provincial Assistant Planner. Key activities during the consultation visit included:

- Introductory meeting with MPC
- Consultation meeting with project affected land owners, interested stakeholders and community members at Unmet

215. The purpose of the provincial and community consultation was to disseminate basic project information and obtain the views and concerns of communities with respect to environmental issues related to the project with a view to addressing these issues in the project design and implementation. The consultations also provided the opportunity to gather relevant site specific information from the stakeholder's perspective on the physical biological and social environments of the project area.

216. **Malampa Provincial Council**. An initial meeting was held with the MPC to introduce the safeguards team, explain the purpose of the visit and consultation process within the context of the overall TA objectives including government and ADB safeguards requirements, obtain information relating to the community's readiness for the project including any issues of concern they might have, and to request the MPC's assistance in supporting the consultation process. Twelve members of the provincial council attended the meeting. A list of the attendees is provided in Annex 4, Table A4.2.

217. A power point presentation delivered by the IES provided the opportunity to inform the MPC of what the proposed Brenwe hydropower project entailed. The presentation included sketches of the key project components, a summary of potential environmental and social impacts and benefits arising from the project, and a preliminary assessment of the significance of such impacts and likely mitigation measures required to ensure impacts are minimized and acceptable.

218. The MPC were familiar with the key components of the hydropower project through their previous experience with the partially constructed and abandoned Brenwe hydropower project during the 1990s. The provincial council expressed overall support for the project. In respect of environmental issues one member queried the potential impact on downstream water quality in the Brenwe River and loss of water between the intake and powerhouse due to the project. These issues were clarified during discussions with the council. In particular they were advised that significant impacts on water quality downstream of the project were unlikely and any impacts associated with reduction of water between the intake and powerhouse will be investigated as part of the IEE with necessary mitigation measures proposed to ensure impacts are minimized and acceptable.

219. Other issues raised included questions on the proposed alignment of the transmission line; whether or not the transmission line will be routed to Lakatoro; whether or not the project would result in lower cost of electricity; and whether or not the partially completed and abandoned hydropower sites and facilities would be used.

220. Details regarding land acquisition issues discussed with the MPC are reported separately in the resettlement plan.

221. **Community consultation/information dissemination.** An outdoor meeting was held in Unmet Village and involved the participation of approximately one hundred community members including community leaders, affected landowners, school teachers and interested people. A significant proportion of the participants were women and youth.

222. The meeting commenced with introduction of the consultant team by the international social/resettlement specialist and outline of the teams proposed activities during the visit and the overall purpose of the stakeholder consultation process. This was followed by a brief description of the project by the IES and identification of the potential environmental and social impacts and benefits associated with the project.

223. Following the presentation, participants were asked to express any and every concern they might have regarding the project. Most of the queries and discussion centred around the proposed alignment of the transmission line including the need to consult closely with the community regarding the alignment as well as ensuring appropriate compensation to land owners. The community was also keen to ensure that their community would benefit from the electricity generated. The community's experience of the previous Brenwe hydropower project abandoned during construction in the 1990s due to conflicts over land and the transmission line alignment was foremost in their minds.

224. When specifically asked if anyone had any concerns over environmental issues associated with the project the response was "no". The community reported that there were no tambu sites in the vicinity of the project area, no-one actually lived within or close to the project footprint and no one relied on the water resources in the stretch of river that would have reduced flows between the weir and the powerhouse.

225. The communities clearly understood the concept of hydropower and were very familiar with what the project involved due to the previous project and they expressed a strong desire for the project to go ahead. Various comments were made regarding the community's need for electricity to enhance the existing and flourishing economic activity and population growth in the area including school facilities for the growing population. It was mentioned by a retired school teacher that this area of Malekula produces the most kava and cocoa of any region in Vanuatu and that cargo ships periodically anchor offshore of Unmet to load up these commodities.

226. **Disclosure**. Initial disclosure of the project to local communities and key government stakeholders was undertaken during the community consultation and participation process. This included a description of the project using maps and diagrams, and its potential social and environmental impacts and proposed mitigation measures. The communities were advised that the finalised IEE would be made available to the communities as well as being posted on the ADB website.

227. The IEE will be disclosed appropriately to the communities in accordance with the CPP, the ADB Public Communications Policy 2011, and government requirements as per EIA Regulations Order No. 175 (2011).

VII. ENVIRONMENTAL MANAGEMENT PLAN

A. Introduction

228. The environmental assessment of the construction, operation, and maintenance of project has determined that the project will have a relatively minor impact on the local environment. Environmental mitigation measures have been proposed to avoid or minimize environmental impacts to acceptable levels. The proposed environmental mitigation measures are proven technologies normally associated with internationally recognized good engineering practice.

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

- Implementation arrangements for the EMP including:
  - institutional roles and responsibilities for EMP implementation throughout all stages of the project (procurement, design, construction, operation)
  - capacity building requirements for executing agency to ensure environmental management requirements are properly understood and fully implemented
  - Grievance redress mechanism
- Environmental mitigation and monitoring matrices including:
  - potential environmental impacts that could occur during each stage of the project (pre-construction/design, construction, operation)
  - proposed mitigation measures to address each impact identified
  - agency responsible for implementing each mitigation measure
  - monitoring tasks to ensure mitigation measures have been implemented effectively during each stage of the project
  - schedule and responsibility for monitoring
- Costs associated with implementation of all aspects of the EMP.

B. Implementation Arrangements

230. **General**. It is likely that the project will be implemented under an engineer, procure and construct (EPC) contract and design and supervision consultant (DSC). Under such an arrangement the EPC contractor will be responsible for the final design of the project based on the feasibility study design, project construction, project commissioning, and training of the operator. Currently Vanuatu's generation and distribution facilities are operated under concession agreements by two operators, UNELCO (Efate, Malekula and Tanna) and VUI (Espiritu Santo).

C. Institutional Roles and Responsibilities

231. **Department of Energy**. The DOE (within MOCC) is the implementing agency for the project. The DOE will be responsible for ensuring that sufficient resources are in place to undertake its environmental safeguards responsibilities.

232. **Environmental management responsibilities.** The VPMU will implement the project on behalf of MOCC-DOE. The VPMU will be responsible for overall implementation including procurement, construction, and commissioning. The VPMU will be supported by the DSC which will include an international environmental specialist (IES) to support the existing environment officer (EO) in the VPMU and to ensure environmental safeguards are implemented in accordance with government and ADB requirements.

233. The VPMU will be responsible for ensuring that the environmental assessment is submitted to DEPC for issue of environmental permit and confirming whether a water resources permit is required, the EMP is updated, cleared and then implemented during each stage of the project (procurement, construction and operation), that the EPC contractor prepares and submits a suitable SEMP, and monitoring compliance with the approved SEMP. This includes ensuring that all government and ADB requirements and procedures relating to environmental safeguards are complied with. The VPMU will be supported by a DSC during all aspects of project implementation. In respect of environmental management and safeguards application the IES will support the VPMU in the following tasks:

- Preparation of the EPC tender documents including integration of the EMP from the approved IEE and draft method statements for various aspects of the EMP such as HSP, MSMP and WMP;
- Consult with DEPC to check whether the IEE meets the EIA requirements of the EMC Act and Environment Regulations Order 2013, re-format/upgrade the IEE as necessary, make the application for development consent on behalf of the DOE and obtain a development consent as required;
- Ensure that VPMU and the EPC contractor are aware of any consent conditions and implications those might have for project implementation;
- Consult with DGMWR with regard to application requirements and process for obtaining water resource permit and building permit;
- Work with the VPMU's social specialists in respect of implementation of the CPP and GRM;
- Supporting tender evaluation with respect to contractors' environmental management capability and proposed EMP provisions;
- Providing training/induction on EMP updating (based on detailed design) and requirements to successful contractor;
- Review and approval of contractor's SEMP;
- Monitoring compliance of the contractor with the approved SEMP and other provisions of the EPC contract;
- Review of contractor's monthly reports on safeguards application;
- Providing inputs to quarterly progress reports and safeguards monitoring reports to be submitted to VPMU and ADB; and
- Capacity building of government in environmental management and supervision aspects of project implementation.

234. The IES will oversee that EMP design and construction requirements are fully integrated into the tender documents and assist government meet all its obligations for EMP and safeguards implementation as outlined above. A key aspect of the IES's role will be training and capacity building of the VPMU's in-house environment officer and other staff (including management) in implementation of its obligations under government law and regulations. Given that the existing VPMU is already responsible for coordinating safeguard issues for three large projects, it is recommended that an additional environment officer be recruited.

235. A terms of reference for the IES has been prepared. To meet the TOR it is recommended that three person months of IES time is required intermittently over the procurement and construction period.

236. **EPC contractor.** The EPC contractor will be responsible for ensuring that all environmental design and construction environmental mitigation requirements specified in the EPC contract are included in the design and properly implemented during construction.

237. The EPC contractor will include staff to be specifically responsible for preparation and implementation of the SEMP. Based on the detailed design of the project, the EPC contractor will be required to prepare the SEMP which describes the contactor's construction methodology and measures and plans for implementing the SEMP (including method statements for WMP, HSP and MSMP) as specified in the EPC contract. This includes maintaining a site diary and a grievance registry (as per the GRM). The SEMP shall be approved by the VPMU prior to the EPC contractor's mobilization to the site. The EPC contractor will be required to report on the implementation status of the SEMP.

238. **Department of Environmental Protection and Conservation**. The DEPC is responsible for the administration and enforcement of the Act and EIA Regulations 2011. As such the DEPC is responsible for i) issuing a development consent for the project by way of review and approval of the IEE (as EIS) and ii) monitoring and enforcing compliance of the project with the conditions of the development consent.

239. **Department of Geology Mines and Water Resources.** The DGMWR has overall responsibility for water resources management in Vanuatu as per the Water Resources Act. The Act requires that if a land lease grants the right to use any water the lessee must apply to the Director of Water Resources for the right to use the water for any purpose other than the customary rights or for domestic purposes.

240. The Act also requires that the project owner obtains a building permit, namely "the right to construct, operate and maintain works associated with resources that do not comply with customary rights and rights of occupiers as specified in Part 2 Division 1 Section 4 of the Water Resources Management Act. VPMU will therefore be required to apply for and obtain both a water use right and a building permit from the Director of Water Resources during the detailed design / pre-construction stage.

D. Capacity Building Requirements

241. **DEPC.** The DEPC operates at the national level from its office in Port Vila. However, certain environmental management and monitoring functions can be delegated to provincial administrations if and when they have the resources and capacity to conduct these activities. Currently Sanma Province is the only province that has a full time resident Environmental Officer.

242. DEPC currently has 17 staff, 10 of which are permanent, seven on contract and two volunteers who make up four divisions: i) Biodiversity Conservation Division, ii) Environmental Protection Division, iii) Environmental Assessment and Planning Division (one EIA officer and one compliance officer) and iv) Support Services Division. Within the current structure there are skill gaps across all levels. The Environmental Assessment and Planning Division has the mandate for overall coordination and effective implementation of the EIA process and procedures, as well as implementation and enforcement of the Act.

243. A number of institutional constraints to effective implementation of the Act have been identified by others in previous reviews. These include:

- Lack of capacity and funding for carrying out the DEPC's functions under the Act;
- Environmental officers are uncertain about their powers to enter land in the course of their duties;
- Many rural subdivisions around Vanuatu, particularly for Efate, Malekula and Santo have not complied with the Act; and
- Complications associated with the fact that various Ministerial responsibilities are in potential conflict. For example the DEPC was part of the Ministry of Lands, which also has functions of promoting development, while the subject of foreshore development lies within the responsibility of the Ministry of Internal Affairs.

244. ADB has recently commenced institutional support to DEPC through *Technical Assistance for Strengthening and Use of Country Safeguard Systems* (RETA 7566-REG), which aims to address the above constraints. Key components of the technical assistance include:

- Capacity assessment and review of DEPC's track record in implementing the Environment Act and EIA regulations;
- Diagnostic of environmental related laws and regulations;
- Preparation of an action plan based on i) recommendations of capacity assessment and legal diagnostic study, and ii) consultation with key government agencies, development partners and NGOs; and
- Strengthening procedures through development of tools for DEPC to improve capacity in implementing the Environment Act and EIA regulations. This will involve, interalia, preparation of manuals and development and delivery of training materials.

245. **VPMU.** The VPMU currently has five staff comprising Director, Project Management Advisor, Civil Engineer, Environment (Safeguards) Specialist and Financial Specialist. Three additional staff are expected to join the VPMU later in 2014. They include a Communications and Public Relations Officer, Monitoring and Evaluation Officer and Executive Secretary.

246. The VPMU is currently the implementing agency for three major government infrastructure projects including the Port Vila Urban Development Project, Vanuatu Interisland Shipping Support Project and Lapetasi International Multi-purpose Wharf Development Project. It is understood that additional projects may be added to VPMU's current portfolio over the next year and if so further staff will be required. All of the projects are supported by international technical consultants which include international and national specialists responsible for supporting the VPMU in undertaking its environmental responsibilities (as described above for project).

247. VPMU's environment specialist has more than six years' experience supervising and coordinating environmental and social/resettlement requirements for infrastructure projects and as such has benefitted from significant on-the-job training and mentoring from international environmental consultants. That being said, additional resources will be required as additional projects are added to the VPMU's portfolio. Whilst support is provided through consultants, currently there is only one experienced national environmental consultant specialist in Vanuatu and that person is working on all three of VPMU's projects. Thus it is recommended that VPMU recruits an additional NES to support implementation of the project.

248. It is recommended that the terms of reference of the DSC's IES under the project include a significant component for training of graduate national environmental specialists. Such training could involve a series of modules ranging from preparation of EIAs and EMPs to implementing, monitoring and reporting of EMP implementation including the various EMP activities required through the project procurement and implementation process.

E. Grievance Redress Mechanism

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

250. The GRM will be used for addressing any complaints that arise during the implementation of the project. The GRM will include a proactive component whereby prior to commencement of construction a meeting will be convened by government's VPMU and the implementation team (DSC, EPC contractor) to formally advise the community of project

implementation details (designs, activity schedule, access constraints etc.), so that all necessary project information is communicated effectively to the community and their immediate concerns can be addressed. This will include explaining to the community how the GRM will work. If required, following comments and agreement with the community at this meeting, the GRM may be amended and updated by the VPMU.

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

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

- Negative impacts on a person or a community (e.g. financial loss/loss of subsistence resources, physical harm, nuisance, impacts on social infrastructure, damage to property outside designated site boundary);
- Dangers to health and safety or the environment;
- Failure to comply with mitigation measures, standards or legal obligations;
- Harassment of any nature;
- Criminal activity;
- Improper conduct or unethical behaviour;
- Financial malpractice or impropriety or fraud; and
- Improper disclosure or attempts to conceal any of the above.

253. **GRM Establishment and Procedure.** During the EPC tender process, VPMU with support from the MPC will assist the affected communities/villages establish a community advisory committee (CAC) made up of affected persons representatives, community representatives and representatives of the customary land owners. The CAC will be chaired by the Village chief. In the event that the village chief is a "customary owner" the chair of the CAC may be represented by the community religious leader. The community will be advised that the CAC will be the first point of contact for any person with a grievance in regard to the project. The chair of the CAC will be responsible for communicating community members' grievances to the EPC contractor or to the VPMU. The chair of the CAC will form part of the grievance redress committee (GRC) which will be made up of the CAC chair, contractor's representative, MPC representative and VPMU. Prior to the selected contractor's mobilization, the VPMU will convene a public consultation meeting in Unmet. The meeting will be attended by the EPC contractor, VPMU/DSC, MPC and any other interested community members. The objectives of the meeting will be as follows:

- Describe the disclosure requirements and process for the project as per the provisions of the CPP;
- Introduction of key personnel of each stakeholder including roles and responsibilities;
- Presentation of project information to the communities by the EPC contractor (timing and location of specific construction activities, design issues, access constraints etc.) This will include a brief summary of the EMP - its purpose and implementation arrangements;
- Establishment and clarification of the GRM to be implemented during project implementation including communications activities to ensure communities are continually advised of project progress;
- Identification and confirmation of CAC for affected communities and membership of the GRC; and

- Elicit and address any immediate concerns of the community based on information provided above.

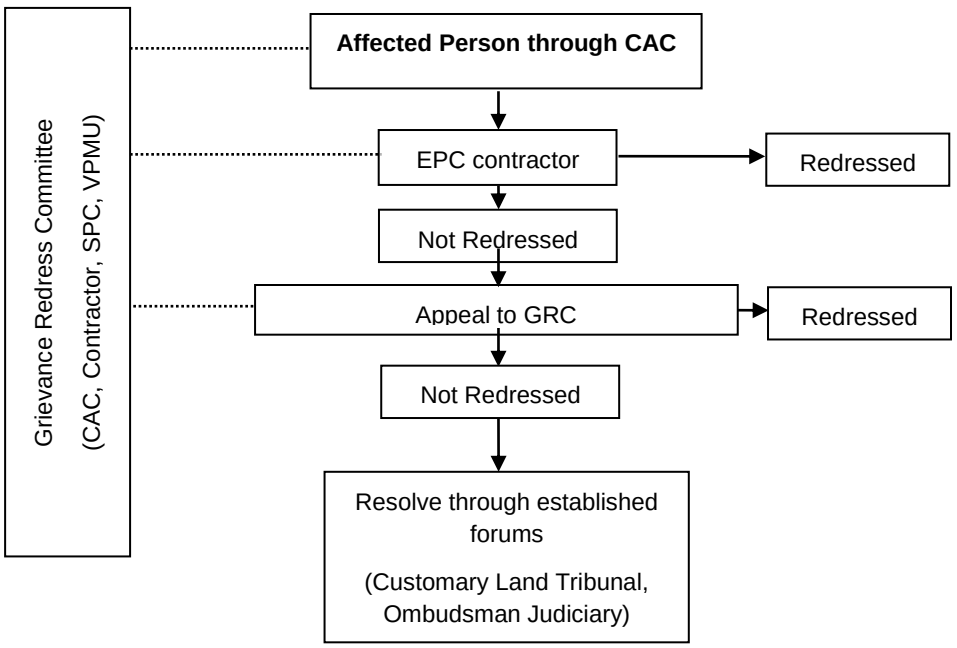
254. Following the pre-mobilization public consultation meeting, complaints associated with the construction activity or other Project related matters will be routinely handled through the GRM as explained below and shown schematically in Figure 7.1. The GRM will be updated if necessary as per any agreement reached during the pre-mobilization public meeting.

255. **Step one**. Individuals will lodge their environmental complaint/grievance with the CAC. The CAC will discuss the complaint and either resolve it with the complainant or where this is not possible or the complainant is not satisfied with the CAC's solution the chair of the CAC will bring the individual's complaint to the attention of the EPC contractor's environmental engineer. He/she will record the complaint in the onsite environmental complaints register. The Environmental Engineer will discuss and resolve the complaint with the chair of the CAC.

256. **Step two**. If the complaint is not resolved within one week, then the chair of the CAC will bring the complaint to the attention of the GRC. The GRC will meet to resolve the issue. The GRC is expected to resolve the complaint within a period of 2 weeks. The resolved complaint will then be communicated back to the complainant via the chair of the CAC. The EPC contractor's environmental engineer will then record the complaint as resolved and closed in the environmental complaints register.

257. **Step three**. Should the complaint not be resolved through the GRC, the issue will be adjudicated through established forums including the Customary Land Tribunal, the Ombudsman and the Judiciary depending on the nature of the complaint. DOE will keep track of the status of all complaints through the EPC contractor's monthly report and QPR and will ensure that they are resolved in a timely manner. All GRM matters will be subject to monitoring and disclosure.

Figure 7.1 - Grievance Redress Mechanism



F. Environmental Mitigation and Monitoring Matrix

258. The EMP matrix for the project is provided in Table 7.1 and identifies the following:

- Potential environmental impacts that could occur during each stage of the project;
- Proposed mitigation measures to address each impact;
- Agency responsible for implementing mitigation measures;
- Monitoring tasks to ensure mitigation measures have been implemented effectively during each stage of the project; and
- Schedule and responsibility for monitoring.

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	1. Submit ADB-approved IEE to DEPC for approval using applicable form and obtain a Development Consent as per the EIA Act. 2. Obtain Water Use Right from DGMWR and Right to construct, operate and maintain works associated with resources that do not comply with customary rights and rights of occupiers as specified in Part 2 Division 1 Section 4 of the Water Resources Management 3. Ensure DEPC approved EMP and any conditions of Development Consent are included in EPC tender documents including i) requirement for EPC contractor to seek DEPC approval and update EMP in the case of significant changes to FS design ii) requirement for EPC contractor to prepare a SEMP (based on EMP) for approval of VPMU/DSC before commencement of construction. The SEMP 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 DEPC Development Consent. 4. Implement plan for Grievance Redress Mechanism as described in the IEE 5. EPC contractor's design to adhere to all design related mitigation measures in SEMP or in updated EMP as approved under DEPC Development Consent	1 to 4: VPMU/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 VPMU/DSC staffing 5: Cost included in EPC contract	Environmental approval for the Project obtained from DEPC. Complete check of items 1 to 5.	Prior to signing of EPC contract and start of site works. Once.	VPMU	Cost included in VPMU budget for additional NES to support project procurement and impl. Estimate is USD 40,000 per year.
Environmental capacity development	1. Government to commit to provide sufficient resources for project duration to oversee EMP implementation. 2. DSC to train VPMU in implementation of EMP as well as general safeguards requirements to raise awareness and build capacity t. A mix of workshops and on-the-job training to be used. 3. Conduct contractor / workers' orientation on EMP provisions.	1: VPMU 2: DSC 3: EPC contractor	Initiate during procurement period and continue throughout project construction	1: & 2: IES and NES cost included as part of VPMU (project) costs 3: Included in EPC contract cost	1.ADB loan covenants 2.IES TOR, DSC progress reports 3. EPC Tender documents and check during construction.	Prior to start of site works and throughout construction phase.	VPMU	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**
Disclosure of CPP and GRM and establishment of procedures	1: Project documents disclosed and made available 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	VPMU	Before EPC contractor mobilization	Included in bid cost	EPC tender document; Grievance registry, monthly reports	Monthly Grievance registry, monthly reports	EPC contractor, VPMU	EPC contractor-included in project cost VPMU - as above.
Workers and public safety	Prepare a Health and Safety Plan (HSP) 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	VPMU/IES & NES	VPMU – as above. IES & NES – included in DSC staffing
Environmentally responsible procurement	1. EMP included in EPC tender documents to ensure mitigation measures are budgeted, prepare the contractor for environmental responsibilities. 2. Specify in tender document that contractor shall engage appropriately qualified and experienced staff to be responsible for environmental management and safety issues and monitor the effectiveness and review mitigation measures as project proceeds. 3. EPC contractor to submit site specific environmental management plan (SEMP) based on contractual EMP for approval by DSC (i.e., site clearance, site drainage, 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.	1 & 2: DSC for VPMU 3: Preparation of SEMP - EPC contractor, Approval of SEMP-DSC 4: EPC contractor	1 & 2: Bid preparation 3 & 4: Before start of civil works	Included in bid cost	1 & 2: Inclusion in bid docs 3 & 4: Check compliance	Bid preparation stage. Before start of site works	VPMU/IES & NES	VPMU – as above. IES & NES – included in DSC staffing
Environmental design for maintenance of aquatic ecosystem and resources	Design for project to include provision for a continuous minimum environmental flow release into Brenwe River at intake point of 80 l/second	VPMU/DSC	EPC tender document preparation	Included in overall project cost	Hydraulic design specifications in tender doc. EPC con. detailed hydraulic design	Prior to signing of EPC contract and start of site works. Once.	VPMU/DSC (IES & NES)	VPMU – as above. IES & NES – included in DSC staffing

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
Climate change adaptation measures to be properly considered and incorporated into design as necessary	Design criteria in respect of peak flood size and levels need to take account of the potential effects of climate change. Critical structures that need to be considered for possibly increased peak flows include: 1 Intake weir - level of the training walls need to be sufficiently high to prevent overtopping, stilling basin design to address energy dissipation requirements; 2. Intake structures isolation facilities - level of intake deck sufficient to ensure gate is available at all times to deal with any need to close down operation of the hydropower scheme; and 3. Powerhouse - Level of powerhouse discharge outlet needs to be sufficiently high so as to prevent any flood induced backflow resulting in flooding of the powerhouse and damage to electromechanical equipment. There are many examples in the past of powerhouse flooding due to extreme flood events. Appropriate design criteria to be established based on available climate change modelling data to develop extreme event data. In the absence of such data, design criteria to be demonstrably conservative.	VPMU/DSC	EPC tender document preparation	Included in overall project cost	Civil design specifications in tender document EPC contractor's detailed civil design	Prior to signing of EPC contract and start of site works. Once.	VPMU/DSC (IES & NES)	VPMU – as above. IES & NES – included in DSC staffing
Grievance Redress Mechanism established	Establishment and implementation of GRM confirmed by VPMU.	VPMU	Before start of civil works	Cost met by VPMU/ project staffing	GRM confirmed and agreed with community.	Before start of civil works	Government	Included in VPMU 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	VPMU	Included in VPMU budget for additional NES
Construction permits	Obtain Permit for any discharge of pollution (DEPC) and Building Materials permit (DGMWR) if required.	EPC contractor	Before start of construction	Cost included in contract	Documents	Once before start of construction	VPMU	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
CONSTRUCTION STAGE								
Physical Impacts								
Erosion and loss of topsoil	1. Schedule excavation activities in the drier months (Jun - Oct) 2. Minimize vegetation clearance corridor or footprint of components 3. Ensure slope cuts are properly engineered and re-vegetated immediately after cutting 4. Install cut-off drains above excavated areas on steep slopes 5 Install river bank protection measures (Masonry, gabion baskets etc) in river channel adjacent to headworks structures and powerhouse tailrace 6. Stockpile topsoil for later use in landscaping or made available to local community for their use 7. As far as possible ensure cut to fill balance	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)	Included in DSC staffing
Water Quality impact due to site runoff	1. Schedule excavation activities in the drier months (Jun - Oct) 2. Install check-dam in dry channel immediately above river diversion discharge point to contain sediment build-up from construction runoff within dry channel at headworks. Following completion of intake structures and prior to removal of coffer dam and decommissioning of diversion channel, remove sediment build-up and check-dam and dispose of in a designated location. 3. Minimize width of vegetation clearance corridor for i) access road ii) headrace canal iii) penstock route 4 Immediately re-vegetate and/or stabilize exposed surfaces and stockpiles of excavated material 5. Implement effective construction site drainage such that runoff is directed to sediment traps before discharge to water course 6. Install cut-off drains above excavated areas on steep slopes to reduce erosion 7. 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

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
Noise and dust nuisances	1. Construction equipment and vehicles will be maintained to a good standard and shall be provided with muffler silencers. 2. Ensure watering of access road adjacent to residential areas 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
Materials and Spoil Management	1. Prepare and implement MATERIALS AND SPOIL MANAGEMENT PLAN (MSMP) one month before construction commences to cover all aspects of materials management and spoil disposal. Contractor to implement MSMP provisions. 2. Balance cut and fill requirements to minimize need for aggregates from other sources 3. Topsoil, overburden, and low quality materials shall be properly removed, stockpiled near the site, and stored for reuse. 4. Areas for disposal to be agreed with land owner and MPC and recorded by the VPMU/DSC and monitored 5. Spoil will not be disposed of in rivers and streams or other natural drainage path. 6. Spoil will not be disposed of on fragile slopes, flood ways, wetland, farmland, forest, religious or other culturally sensitive areas or areas where a livelihood is derived. 7. 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. 8. Disposed spoil will be spread in 15 cm layers and compacted to optimum moisture content, covered with topsoil, landscaped and provided with drainage and vegetation to prevent erosion in line with best practice. 9. Spoil disposal shall not cause sedimentation and obstruction of flow of watercourses, damage to agricultural land and densely vegetated areas.	1: EPC contractor to prepare MSMP, VPMU/DSC to assist and approve 2 to 10: EPC contractor	1: One month before start of site works 2 to 10: Throughout construction phase	Cost included in contracts	Check implementation of items 1-10 and MSMP provisions	1: Before construction 2 - 10 Implementation of MSMP 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
	10. Spoil disposal sites shall be located at least 50 m from surface water courses and shall be protected from erosion by avoiding formation of steep slopes and grassing.							
Waste Management	1. Prepare and implement WASTE MANAGEMENT PLAN (based on draft method statements) as part of SEMP before construction to cover all aspects of waste storage disposal and accidental spills s to be approved in writing by VPMU/DSC one month prior to starting works. Contractor to implement WMP provisions. 2. Areas for disposal to be agreed with land owner and MPEC and checked, recorded and monitored by the VPMU/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 disposal sites approved by local authorities and not located within 500m of rivers or streams. 6 Construction offices and facilities 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 MPC.	1: EPC contractor to prepare WMP, VPMU/DSC /ES 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 - 9 Implementation of WMP provisions: Monthly	DSC (IES/NES)	As above
Use of hazardous substances and hazardous waste disposal	1. Hydrocarbon, toxic material will be stored in adequately protected sites consistent with international best practices to prevent soil and water contamination. 2. All areas intended for storage of hazardous materials will be quarantined and provided with adequate facilities to combat emergency situations. 3. Segregate hazardous wastes (oily wastes, used	EPC contractor	Throughout construction phase	Cost included in contracts	Check implementation of all items	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
	batteries, fuel drums) and ensure that storage, transport and disposal shall not cause pollution and shall be undertaken consistent with international best practice. 4. Ensure all storage containers are in good condition with proper labelling. 5. Regularly check containers for leakage and undertake necessary repair or replacement. 6 Store hazardous materials above possible flood level 7. Discharge of oil contaminated water shall be prohibited. 8. Used oil and other toxic and hazardous materials shall be disposed of off-site at a facility authorized by the VPMU/DSC. 9. Ensure availability of spill clean-up materials (e.g., absorbent pads, etc.) specifically designed for petroleum products and other hazardous substances where such materials are being stored. 10. Spillage, if any, will be immediately cleared with utmost caution to leave no traces.							
Biological Impacts								
Fish and Aquatic resources	1. Intake and weir structures constructed to ensure continuous environmental flow release of 80L/s. 2. Implementation of all proposed mitigation measures for i) erosion & loss of top soil and ii) water quality impacts, as identified above to be rigorously applied.	EPC contractor	Throughout construction	Cost included in contract	Check implementation of all items	Twice a month as part of routine construction monitoring	DSC (IES & NES)	As above
Loss of Forest Habitat and impacts on fauna	1. Minimize width of vegetation clearance corridor for i) access road ii) headrace canal and iii) penstock route 2. Mark boundary of clearance corridors with high visibility tape to ensure construction workers are aware of clearance boundaries. 3. Workers prohibited from poaching or hunting birds and wildlife (sanctions to be imposed)	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	1: Before start of site works 2: Within one week of start of construction	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
Socioeconomic Impacts								
Operation of contractor camp / Site offices	1. Location of site office and facilities to be agreed with local community with facilities approved by government VPMU/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 water courses. Oil and grease residues shall be stored in drums awaiting disposal in line with an agreed WMP. 7. The Contractors facilities area will be cleaned up to the satisfaction of VPMU and local community after use. 8 All waste materials shall be removed and disposed to disposal sites approved by local authorities	1:EPC contractor with VPMU/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
Occupational Health and Safety	1. Contractor to prepare a HEALTH AND SAFETY PLAN (HSP) instructing workers in health and safety matters. Plan to be approved in writing by VPMU/DSC one month prior to starting works. Contractor to implement HSP provisions. 2. Before construction commences the contractor will conduct of training for all workers on environmental, safety and environmental hygiene. The contractor will	1:EPC contractor with VPMU/DSC approval 2-5: EPC contractor	1: One month before start of site works 2 to 5: Throughout construction phase	Cost included in contracts	Check implementation of items 1-5	1: Before construction 2 - 5: 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
	instruct workers in health and safety matters as required by good engineering practice and provide first aid facilities. 3. Workers shall be provided (before they start work) with appropriate 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. 4. Fencing shall be installed on all areas of excavation greater than 1m deep and at sides of temporary works. 5. Provision of potable water supply in all work locations.							
Community Health and Safety	1. Include in HSP for barriers (e.g., temporary fence), shall be installed at construction areas to deter pedestrian access except at designated crossing points. 2. The general public/local residents shall not be allowed in high-risk areas, 3. Provide warning signs at periphery of site warning public not to enter 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 5. Communication to the public through public consultation, MPC and notice boards regarding the scope and schedule of construction as well as certain construction activities causing disruptions and access restrictions. 6. Implementation of communicable diseases (incl. STIs and HIV) awareness and prevention measures	EPC contractor	At all times throughout construction phase	Cost included in contracts Cost for item 6 included in PSA	Check implementation of items 1-6	Monthly	DSC (IES/NES)	As above.
OPERATION STAGE								
Maintenance of aquatic ecosystem and resources in	Ensure a continuous minimum environmental flow release into Brenwe River at intake point of 80 L/s.	Concessionaire /Facility Operator	Operation phase	Included in overall project cost	Brenwe River flow immediately	Periodically during dry periods	Concessionaire/ Facility Operator	Included in Concessionaire /

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
Brenwe River between intake and powerhouse					downstream of intake		reporting to MPC	Operator's O&M costs
Public safety around project facilities	Security fencing to be provided to ensure no public access to the headrace canal and fore-bay especially where facilities are adjacent to access road.	Concessionaire /Facility Operator	Operation phase	Included in overall project cost	Security fencing intact and effective	Periodically during routine maintenance activities	Concessionaire/Facility Operator	Included in Concessionaire /Facility Operator's O&M costs

VIII. CONCLUSION AND RECOMMENDATION

259. The IEE concludes that the potential environmental impacts arising from design, construction, operation and maintenance of the project will be relatively 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 is a small run-of river hydropower project that does not involve a dam or reservoir. It has a small footprint that will be constructed within the same footprint of a previously partially constructed and abandoned hydropower project and;
- The 1 km stretch of channel to be affected by reduced water flow due to the project includes a 30 m high waterfall and two other cascades > 3 m high. These falls are significant natural barriers to most fish other than species such as goboids which have natural adaptations enabling them to climb waterfalls. The waterfalls are significantly higher than the proposed weir such that a 3 m high weir is unlikely to be a barrier to goboids after scaling the waterfalls. The critical factor is to ensure a continuous flow of water is crossing the weir and thereby also ensuring continuous flow over the waterfalls between the weir and the powerhouse.
- The weir and intake structure will be designed and operated to ensure that a minimum flow of 80 l/s will be released into the Brenwe River at all times. This flow will be supplemented by natural inflows to the channel from springs and surface water flows over the 1 km river section between the weir and powerhouse. The proposed minimum flow is considered sufficient to ensure the sustainability of the existing downstream ecosystem along the 1 km affected stretch No significant impacts are expected on the fish and aquatic resources of the Brenwe River as a result of the project.
- The potential loss of up to 4 ha of highly modified successional vegetation of low biodiversity value due to the project is of minor significance. The natural environment of the project area is highly modified due primarily to the fact that the project will be constructed on the same footprint as a previously partially constructed and abandoned hydropower project. Loss of habitat can be further minimized by reducing the clearance corridors;
- The potential impact on terrestrial wildlife including rare and / or endangered species is considered to be insignificant and the project does not impinge upon any national or locally recognized protected areas;
- Nearby communities consulted are keen for the project to be implemented and expressed their desire to benefit from both electricity generated and employment opportunities during construction and operation; and
- Appropriate climate change adaptation and resilience needs to be incorporated into the design of structures including: i) suitable erosion protection to prevent scour around the intake weir's training walls, and ii) powerhouse - level of powerhouse discharge outlet needs to be sufficiently high so as to prevent any flood induced backflow resulting in flooding of the powerhouse and damage to electromechanical equipment.

260. An EMP has been prepared and will be implemented during all phases of project implementation. 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.

261. This IEE, including the EMP is considered sufficient to meet ADB and government environmental safeguard requirements in respect of the Brenwe River project. No further or additional impact assessment is considered necessary at this stage.

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ANNEX 1 - POLICY, LEGAL, AND ADMINISTRATIVE DOCUMENTS

ANNEX 1A - SECTORAL POLICIES, STRATEGIES AND ADMINISTRATIVE DOCUMENTS

National Biodiversity Strategy Action Plan 1999. Vanuatu completed its National Biodiversity Conservation Strategy in 1999. The strategy highlights six key objectives for effective management of biological resources: (a) Ensure sustainable management and conservation of Vanuatu's biodiversity; (b) Develop appropriate policy, planning and legal mechanisms for the management of biodiversity; (c) Improve knowledge about biodiversity in Vanuatu; (d) Improve the capacity of national, provincial, NGO and community organizations to manage biodiversity; (e) Increase local awareness of the importance and value of biodiversity; (f) Foster community participation in the management and conservation of biodiversity. The strategy identified 20 priority actions to meet the objectives mentioned above[1].

National Energy Policy Framework. The Vanuatu National Energy Policy Framework is focused in areas such as the promotion of energy efficiency and conservation, promotion of renewable energy sources and the provision of electricity to rural and remote areas.

The ultimate goal of the policy is to provide a long term development plan for the energy sector and the provision of reliable and affordable energy services to all people in Vanuatu.

National Rural Electrification Policy 2000. The National Rural Electrification Policy of Vanuatu is to provide electricity to all rural people in Vanuatu. Specifically the National Rural Electrification Policy has the following objectives:

- To address the electricity needs of the consumers in the rural areas both for social and economic development;
- Ensure the provision of electricity to rural consumers while clearly defining the overall level of Government subsidy;
- Incorporate the Government Station, medical institutions such as health centre/clinic/aid posts and education institutions such as secondary schools, primary schools and rural training centres within the rural electrification network;
- Be consistent with Government Policies.[2]

National Energy Road Map (2013-2020). The Government has developed a National Energy Road Map to put the sector on the path to achieving objectives shared by the Government, members of the public, development partners, and private energy sector operators. The Road Map provides a consistent basis for tracking energy sector challenges, recognizing that streamlining government policy, legislation, and investment is needed to enable Vanuatu to achieve its development objectives.

The vision for the National Energy Road Map is: "*To energize Vanuatu's growth and development through the provision of secure, affordable, widely accessible, high quality, clean energy services for an Educated, Healthy, and Wealthy nation*."[3]

The investments presented in the Road Map are expected to provide net environmental and social benefits. For example, investing in renewable energy sources will reduce local noise and air pollution near existing diesel generation plants, and will reduce Vanuatu's emission of greenhouse gases. Similarly, improving the petroleum supply chain between islands will reduce the incidences of small spills. The Road Map identifies ways to ensure that environmental impacts are mitigated.

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1 National Biodiversity Strategy Action Plan,1999
2 Government of Vanuatu. Revised Rural Electrification Policy, Port Vila, December 2000
3 Government of the Republic of Vanuatu, Vanuatu National Energy Road Map, 2013-2020, Port Vila, March 2013

Special consideration has also been given to groups with specific vulnerabilities, women and the poor, and to incorporate an element of equity. It also includes the provision of sustainable, affordable electricity supply that meets the needs of the poor and those living in remote areas.[4]

Priorities and Action Agenda of Government of Vanuatu (PAA) 2006. The Priorities and Action Agenda of the Government of Vanuatu published in 2006 introduced a long- term national vision - 'an educated, healthy and wealthy Vanuatu'. A recent review of the PAA of 2010 to 2012 identified the necessity to address Governance issues as a means to improve effectiveness and efficiency of the Public Sector.

The primary policy objective and strategies in the PAA 2006 have been re-organized to make policy directions clear and more focused on key issues facing the sector.

Strategies covering the Environment have been strengthened to include strengthening of the Department of Environmental Protection and Conservation (DEPC). New strategies have been introduced covering the Biodiversity Advisory Council, protected areas and pollution control measures and the Environmental Impact Assessment Regulation.

The Government of Vanuatu clearly states its objectives in the PAA (2003) as follows: *"The general objective of the Government is to contribute towards achieving balanced and mutual supportive policies in the economic, social and environmental dimensions of sustainable development. Specific objectives to achieve this goal are*:

- *To develop appropriate legal framework for the conservation and management of the environment;*
- *To promote sound and sustainable environmental management practices;*
- *To ensure ecosystems must be managed in an integrated manner and at appropriate scale;*
- *To ensure sustainable management and conservation of Vanuatu's biodiversity;*
- *To implement the Environmental Management and Conservation Act N°12 of 2002 and as amended in 2010 and the regulations of related activities, e.g. EIA Regulation; and*
- *To ensure that biodiversity must become an ever greater priority, with resources pooled and political will mobilised behind winning strategies to protect it."*

Productive Sector Policy (2012-2017). Under the Government's Overarching Productive Sector Policy (2012-2017), supporting policy statements on environment include the need to:

- enhance capacities to utilise natural resources in a sustainable manner; and
- Assess and take into consideration the competing demands on the environment and differentiated impacts in climate change when formulating strategies to address the development challenges that the productive sector faces.[5]

National Forest Policy 1997. One of the important sectorial policies is the national forest policy (NFP) of 1997, which sets minimum standards, which will allow selected forest areas in Vanuatu to be harvested with minimum adverse impacts. It balances the need for protection of environmental values with safety and commercial consideration. The objectives of the national forest policy include:

- Forest management objectives such as timber production, conservation and conversion and conserving ecosystems,

[4] Government of the Republic of Vanuatu. Vanuatu National Energy Road Map, 2013-2020, Port Vila, March 2013

[5] Government of Vanuatu ,Overarching Productive sector Policy (2012-2017)

- Environment and conservation which deals with protection and conservation for the current and future generations, establishment and management of conservation areas with landowners.[6]

ANNEX 1B - LAWS

Public Health Act 1994. Under the Public Health Act, the Ministry of Health retains an important responsibility for many waste management activities. The Ministry acknowledges the need for minimum standards in the areas of Environmental Health: clinical waste, food, water, solid waste management, housing, pollution, and sanitation and port health. The Ministry recognizes that there are special stresses/ problems faced by the urban environment including: collection and disposal of large quantities of rubbish, sub-standard housing, water quality, water supply not keeping up with population growth, unhygienic conditions of food for sale, industrial pollution, and lack of proper drainage system.

With respect to the water sector, there is a chapter of the Act for the Provision and Protection of Water Supply. Other aspects relating to the water sector as defined by the Act are as follows:

- The administrative powers of the Minister (of Health) of supervision and inspection over local authorities in all matters relating to maintenance and promotion of public health;
- Obligation of provision of proper and sufficient supply of wholesome water to all buildings and premises and all inhabitants of the rural area within local government council Powers of Environmental Health Officers to enter any premises, land at all times for the purpose of, water sampling for examination of the source of water supply, and to inspect the appropriateness and adequacy of sanitation system Obligation of maintaining clean conditions and protection from contamination of any storage of water.
- Powers of local authorities to examine sanitation and water supply apparatus and facilities
- The right of the Minister to make regulations prescribing all matters that by the Act are required or convenient to be prescribed for giving effect to the Act, as the standard, quality and adequacy of water for domestic purposes and as — for the control and maintenance of general Environmental Health quality in matters such as to prevent soil, water, noise and air pollution. The Minister allocates responsibility to the relevant local authorities to take all lawful, necessary and practicable measures to maintain its respective areas free from nuisance. Nuisance is defined to include any…. River, stream, spring or other sources of water supply….which is likely to be used for human drinking or domestic purposes…which in the opinion of the environmental health officer polluted…[7]

In Vanuatu, both ground and surface water resources are utilised for domestic purposes. In rural areas, there are various sources of water such as wells, springs, rivers and rainwater are used. Water supply systems in rural areas vary from good to poor and some do not exist. Throughout Vanuatu no provincial government is responsible for the operation and maintenance of rural water supply systems.

Relevance for the project - No permit required. Project must comply with requirements of Act during all phases of project

[6] Vanuatu National Forest Policy, 1997
[7] Public Health Act 1994, section 24(c)

Water Resources Management Act 2002. The Water Resources Management Act (2002) provides for the protection, management and use of water resources in Vanuatu. The Act is administered by the Minister of Lands and Natural Resources. In addition, the Public Health Act provides for general public health in Vanuatu including prohibition of pollution of water resources and the regulation of adequate sanitary systems. Vanuatu has not developed its own water quality standards to date and relies on the World Health Organization (WHO) standards as a reference.

The overall responsibilities for water resources management rest with the Department of Geology Mines and Water Resources (DGMWR) under the Ministry of Lands and Natural Resources. The Water Resources Act gives the Director of the DGMWR overall power to establish groundwater protection zones among other powers vested by the Act. The Act defines the following aspects:

- The rights and general rules in respect to the utilisation and protection of water resources
- Administrative aspects and the formation of a National Water Resources Advisory Committee
- Water resources planning, management and development plans, designation of water protection zones
- Access over adjoining lands
- Water utilities (formation of water utility board to facilitate the management, control and regulation of water utilities involved in water supply services)
- Water quality guidelines and criteria

Relevance for the project: The Act requires that if a land lease grants the right to use any water the lessee must apply to the Director of Water Resources for the right to use the water for any other purpose other than the customary rights or for domestic purposes. The Act also stipulates that works and uses undertaken prior to the commencement of the Act are lawful. In this respect the Sarakata hydropower project does not need to apply for the right to use the water. However, Wambu, Brenwe and Sarakata 2 projects are required to apply for and obtain water use rights from the Director of Water Resources.

Pollution Control Act 2013. The objectives of this Act are to minimize and manage the discharge and emission of pollution and encourage all levels of government to work together to control the discharge and emission of pollution.

Clause 8 imposes a requirement on owners and occupiers of premises to comply with prescribed standards for the discharge of pollution, wastewater and the emission of noise, odour or electromagnetic radiation and Clause 9 establishes a permit scheme for the discharge or emission of pollutants and creates offences for the discharge or emission of pollutants without a permit.

Clause 11 confers power on the Director to revoke or suspend a permit if a permit condition has been breached or if the discharge or emission of pollution is likely to endanger human health or cause excessive harm or damage to the environment.

If it appears to the Director that: (a) a pollutant is being or is likely to be discharged or emitted from the premises into the environment; or (b) a pollutant or matter is being discharged or emitted which does not comply with a prescribed standard; or (c) a pollutant, is causing or likely to cause pollution, he or she may serve a pollution abatement notice to the owner or occupier of the premises. Such a notice is to be issued in writing and is to: a).state the grounds upon which the notice is issued; and (b) require the person identified in the notice to take any measure that the Director considers necessary to prevent, control or reduce the discharge or emission of pollutants, in the manner specified in the notice.

The Director may in writing, vary or revoke a notice.

The Act does not have a regulation to enforce the provisions of the Act, including standards for waste water disposal from an operation or premises.

Relevance for the project: A permit is required from the Director of the Department of Environment Protection and Conservation (DEPC) for any discharge of pollution, wastewater and emission of noise or odour resulting from the project.

Draft Waste Management Bill 2012. Scheduled to go before parliament in 2014, this Bill provides for the protection of the environment through encouragement of effective waste services and operations. Once passed into law the Director of the DEPC will be responsible for the evelopment, coordination and, where appropriate, implementation of the Government's waste and litter minimization policies and programmes. In carrying out the functions, the director must carry out the following:

- administer the system the waste management system,
- in the absence of relevant regulations, prepare guidelines and standards for the purpose of giving effect to the Act;
- undertake environmental assessment, monitoring, and inspection generally; and
- undertake such other duties and responsibilities as may lawfully be required.

The Director may also assist the Provincial Government Councils to ensure that each Provincial Government Council develop a Waste Management Strategy. The Director will be responsible for the implementation of the Act.

The Bill covers local, regional and international waste issues under Vanuatu's commitments, for example, the Stockholm Convention and Montreal Protocol on Substances that Deplete Ozone Layer. The Director will be responsible for developing regulations under the Act.

At the national level the government has developed and endorsed its first ever-national waste management policy in 2001, which embraces the importance of managing waste at the national provincial and community level. The overall goal of the national waste policy is "prevent, protect and control the adverse effects of waste on human health, environment and the economy of the country"[8]

Relevance for the project: Once passed into law, any waste disposal on the project sites will require the approval of Director of DEPC.

Forestry Act 2001 The Forestry Act of 2001 provides for the protection, development and sustainable management of forests and the forest industry. The Act is administered by the Department of Forests under the Ministry of Agriculture, Quarantine, Forestry and Fisheries (MAQFF). The Forestry Act also establishes the Forests Board of Vanuatu whose main task is to supervise negotiations for timber rights agreements and advise the Minister on matters relating to forestry policy and administration.

The Forestry Act 2001 repealed the previous Act, but it kept in force the Regulations and Orders made under that Act, adapted as necessary. Licences, permits, etc., made under the previous Act were continued in force as if they were made under the new Act. The main features of the new Act are to establish structures and processes for administration, planning, resource access, environmental protection, and reforestation.

Relevance for the project: The project will involve removal of some secondary vegetation for various components of the hydropower projects. Such vegetation removal is not expected to involve tree species which have significance for timber

[8] National Waste Management Policy, 2001

Quarry Act 2013. This Act provides for the regulation of quarries and for related purposes. A holder of a Quarry Permit granted by the Commissioner of Mines has the right to prospect for and extract building materials, which are defined as "mineral substances and rocks commonly used for building, road making or agricultural purposes." The Quarry Act N° 9 of 2013 has the following classes of quarry permits: (i) commercial permit; (ii) landscaping permit;(iii) public works department permit; and (iv) occasional permit.

The quarry permit is ranked into three categories as large, medium and small. For a large quarry, a permit issued must not exceed a period of 10 years and is renewable. The volume of materials extracted per annum may exceed 50,000 m^3 and the quarry operations must not exceed 100 hectares. A quarry permit issued for medium quarry operations must not exceed a period of 10 years and renewable with a volume of materials extracted per annum ranges from 20,000 to 49,999 m^3 and an operations area must not exceed 10 hectares. A quarry permit issued for small quarry operations must not exceed a period of 3 years and is renewable. The volume of materials extracted for small quarry operations ranges from 501 to 19,999 cubic metres and the area must not exceed 5 hectares.

Relevance for the project: If any construction material is sourced from quarries such quarries are required to have a Quarry Permit under the Act. Whilst legal responsibility for a Quarry Permit rests with the owner/operator of the quarry, as part of general duty of care it is necessary for the contractor to ensure that all suppliers have the necessary legal permits and approvals.

Control of Nocturnal Noise Act 1965. This Act prohibits excessive noise between 9pm and 5am particularly in the urban areas. This is mainly for the urban areas, but where noise is an issue in rural areas, the Act can also be applied.

Relevance for the project: No permit required. Unlikely to be an issue since night time construction work is most unlikely and noise during operation will not be a problem due to distance of powerhouse from nearby communities.

National Parks and Nature Reserves Act 1993. The National Parks and Nature Reserves Act N° 07 of 1993 provides for the declaration of national parks and nature reserves; for the protection and preservation of such areas and all related matters. The Minister responsible for environment and conservation regulates the provisions of this Act upon the advice of the National Parks Board. Legal declaration of national parks and nature reserves under the Act involves a set of community consultation procedures along within development of a park or reserves Management Plan that is approved by the Minister.

Currently there are six legally registered protected areas in Vanuatu along with a further four areas either in the process of being legalised or under consideration for legal designation. However, the focus of much present work in country is on resource use and management systems that are both applicable and practical at a local level and that are compatible with in-situ conservation of biodiversity. This has led to the development of a number of community based protected areas. All in all there are 28 protected areas 14 of which have a terrestrial component. Existing community based protected areas include Loru protected area, Vathhe Conservation Area, Ringhi te Suh (Maskelynes), Hideaway Island (Efate), Narong marine reserve (Uri Island), Mystery Island Reef (Aneityum), Nguna-Pele marine protected area, Epi, Central Pentecost, Lelepa marine protected area, Mangaliliu marine protected area, Spuaki conservation area (Nguna), and Wiawi (Malekula). Community based management practices and taboo areas are also widespread. One of the few efforts by the Government to create a publicly owned protected area, the Erromango Kauri Protected Area, has now lapsed as government funding of the lease could not be sustained.

Relevance for the project: Community consultations conducted during preparation of the IEE along with desk study on designated protected areas in Vanuatu indicates that no protected areas (legally protected or community based initiatives) will be affected by the project.

A full list and breakdown of the of protected areas in Vanuatu is given in Table A.1

Table A.1 - Vanuatu Conservation Areas

Name	Location	Island	Terrestrial Marine/	Govt/NGO Community Initiative	Supporting Partners (NGOs or Govt	Size	Traditional Management	Management Plan	Proposed for Legal	Legally Recognised
Lake Letas CA	Top of island at foot of Mt. Garet	Gaua	Terrestrial	Govt in consultation with communities	DEPC & Dept. of Forestry	-	Yes	-	Will be developed through FPAM	EMC Act & FPAM site
Mondoro CA	Mondoro Village	SE Gaua	Marine	Community Initiative	Dept.of Fisheries	-	Yes	Draft Management Plan	-	Draft Management Plan developed for legal registration
Vathe CA	Matantas	NE Santo	Both	Govt in consultation with communities	DEPC.SPREP, Lands Dept & Royal Forest & Bird Society of NZ	2,740 ha	-	Yes, currently updated and will be launched in June 2014	-	Legally recognised as of 2004
Loru Protected ea	Khole	East Santo	Both	NGO/VPAI/Live & Learn	VPAI/Live & Learn/DEPC	-	Yes	-	Yes	Legally registered in 2011
Panora CA	Panora Village	NW Santo	Terrestrial	Community initiative with government strengthening from	DEPC/LCIP	2,500 ha	-	-	Yes	Legally registered in 2011
Guyon Reef Marine CA	Melcoffee, Luganville	Santo	Marine	Community Initiative	DEPC/Department of Fisheries	-	-	-	-	Under consideration
Million Dollar Point	South	Santo	Marine	Government	Dept. of Fisheries	-	-	Yes	-	Legally recognised under the Fisheries Act and Maritime Zone
President Coolidge	South	Santo	Marine	Government	Dept. of Fisheries	-	-	-	-	Legally recognised under the Fisheries Act and Maritime Zone
Butmas CA	South	Santo	Terrestrial	Government in consultation with communities	DGMWR, DEPC, SOPAC	-	-	Yes	Draft Man. Plan	In the process of being legalised
Nabauk CA	South	Santo	Terrestrial	Govt in consultation with communities	DGMWR, DEPC, SOPAC	-	-	Yes	Draft Man. Plan	In the process of being legalised

Name	Location	Island	Terrestrial Marine/	Govt/NGO Community Initiative	Supporting Partners (NGOs or Govt	Size	Traditional Management	Management Plan	Proposed for Legal	Legally Recognised
Edenhope Forest Reserve	West	Santo	Terrestrial	Lessor in consultation with the communities	DGMWR,DEPC, Dept. of Forestry	700 ha	-	Yes	In process	In process
Amal/Krab Bay Tabu Area	Northeast	Malekula	Marine and mangrove	Community Initiative	DEPC, Dept. of Fisheries, IUCN,SPREP	-	-	Yes	-	Legally registered under the EMC Act
Naron/Uri Marine Conservation Area	Northeast	Malekula	Marine	Community initiative	DEPC, Dept. of Fisheries	-	Yes	-	-	-
Wiawi CA	Northwest	Malekula	Both	Government in consultation with community	DEPC, Dept. of Forestry	-	Yes	-	-	-
Ringi Te Suh Maine Protece Area	South Malekula	Pelonk, Maskelye Island	Marine	Community Initiative	Dept. of Fisheries, FSP	-	Yes	-	-	-
Avok II Island CA	South Malekula	Avok Island	Marine	Community Initiative	DEPC	-	Yes	-	Explore the process for legal reg. under the Act	-
Duviara	North	Ambae	Terrestrial	Community Initiative	-	-	Yes	-	-	-
Manaro Tourist CA	West	Ambae	Terrestrial	Community Initiative	-	Yes	-	Requested DEPC to assist with the Development of the Management Plan	-	-
Ranputor CA	South	Pentecost	Both	Community initiative with funding support from ADB-CTI	Live & Learn, ADB-CTI, DEPC, Dept of Fisheries	-	YES	DEPC will assist with drafting of Management Plan	-	-
Homo Bay	South	Pentecost	Terrestrial	Government in consultation with FPAM Project, FAO	-	-	Will draft management Plan during the phase of FPAM Project	-	-	-
Proposed Marine Protected Areas	Around Island	Epi	Marine	Community Initiative	DEPC	-	Yes	-	Approved by DEPC for legal -registration	-
Nguna/Pele Marine PA	North Efate	Nguna & Pele	Marine	Community Initiative	Pearce Corp,GTZ-CCA Project with support from DEPC and Dept of Fisheries	-	Yes	-	Approved by DEPC for legal registration	-

Name	Location	Island	Terrestrial Marine/	Govt/NGO Community Initiative	Supporting Partners (NGOs or Govt	Size	Traditional Management	Management Plan	Proposed for Legal	Legally Recognised
Mere-Sauwia Conservation Area	Northeast Efate	Nguna	Both	Community Initiated	DEPC, Dept of Forests, UNDP Small Grant	-	Yes	Management Plan	-	-
Unakapa MPA	South Efate	Nguna	Marine	Community Initiated	Peace Corp and AYA	-	Yes	-	-	-
Epau Conservation Area	East Efate	Efate	Both	Community Initiated	DEPC	-	Yes	-	Draft Management Plan	-
Efate Land Management Area (ELMA)	Central Efate	Efate	Terrestrial	Community initiated through SHEFA province	SHEFA, DEPC & Dept of Forests	-	-	Provincial Bi-Law	-	Explore possibility of legal registration through EPC Act
Hide Away Island Sanctuary	Southwest Efate	Hide Away Island	Marine	Hideaway Island Resort Initiative	Dept. of Fisheries	-	-	Hide Away Island Resort Management	Hide Away Island Resort Management	-
Eruiti Marine Protected Area	South Efate	Eruiti	Marine	Lessor Initiated	DEPC	-	-	-	-	-
Lelepa Island Tours MPA	Northwest Efate	Lelepa Island	Marine	Community Initiative	DEPC	-	-	Draft Management Plan	-	-

Source: Donna Kalfatak, Biodiversity Officer, DEPC, March 2014

Preservation of Sites and Artefacts Act 1965. The Act provides for the preservation of sites and objects of historical, ethnological or artistic interest. The Minister responsible for Culture must inform the owners of the site classified and allow three months for representations to be made by the owners. Once a site is classified, the owner is obligated under the Act to prevent modification or deterioration of the site and must inform the Minister of the likelihood of modification or deterioration of the site.

Relevance for project: No sites or objects of historical, ethnological or artistic interest have been declared or classified in the vicinity of the project sites. In the event that any suspected items are found during construction, this shall be reported to the Vanuatu Cultural Centre with immediate effect and physical activity on the site shall cease until assessment is done.

Wild Bird (Protection) Act 1989. which prohibits the destruction of certain bird species (which may occur through clearing of site vegetation) without a permit; Other major regulations that concern ecosystems and biodiversity conservation are: International Trade (Fauna and Flora) Act of 1989, Convention on Biological Diversity (Ratification) Act (1992), and the Animal Importation and Quarantine Act (1988) which regulates the control of animal importation including the importation of animal products and biological products.

Relevance for project: Vegetation required to be cleared for the projects is relatively small in scale and involves removal of mainly secondary vegetation in areas that are currently modified by human activities. Such disturbance is most unlikely to result in any significant impact on protected or endangered bird species.

National Disaster Act 2000. The Department of Disaster under the Ministry of Climate Change and Natural Disaster is mandated to develop strategies for the prevention of, preparation for, response to and recover from natural disaster, ensure that strategies are implemented to counter the effect of natural disaster.

A National Disaster Plan has been developed to operationalise the national plan. The Plan has been very useful as it identifies the major risk that any health facility in Vanuatu is faced with such as earthquakes, droughts, tropical cyclones and it also identifies climate change and sea level rise.

The Government is promoting a Comprehensive Hazard And Risk Management (CHARM), Disaster Risk Reduction (DRR) and Disaster Management (DM) through the National Disaster Management Office (NDMO) with the overall objective that communities at all levels are aware of the hazards that exist to a vulnerable group as well as identifying adaptive or mitigation measures to reduce the impact lives, property and socio-economic development.

Pesticides Control) Act 1998. The Pesticides Control Act makes provision for the regulation and control of the importation, manufacture, sale, distribution and use of pesticides, including persistent organic pollutants. The Act provides for the (i) registration of all pesticides for import, manufacture, packaging or export purposes maintained by the Registrar of Pesticides, and (ii) setting out minimum standards when dealing with pesticides in Vanuatu.

Relevance for project: Any use of pesticides during project implementation will be undertaken in accordance with the Act.

Annex 1C - International Treaties and Agreements

Multilateral environmental agreements supported by Vanuatu are listed in Table A.2 below.

Table A.2 Multilateral Environment Agreements Supported by Vanuatu Government

International Treaties	Status
United Nations Convention on Biological Diversity (UNCBD)	Ratified 1993
United Nations Convention to Combat Desertification (UNCCD)	Ratified 1999
United Nations Convention on Law of the Sea (UNCLOS)	Ratified 1999
United Nations Framework Convention on Climate Change (UNFCCC)	Ratified 1992
Kyoto Protocol to the UNFCCC	Acceded 2001
Montreal Protocol on Substances that Deplete the Ozone Layer	Acceded 1994
Vienna Convention for Protection of the Ozone Layer	Acceded 1994
London Amendment	Ratified 1994
Copenhagen Amendment	Ratified 1994
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	Ratified 1989
International Convention on the Establishment of an International Fund for the Compensation for Oil Pollution Damage	Ratified 1989
International Convention on Civil Liability for Oil Pollution Damage	Ratified 1983
International Convention for the Prevention of Pollution of the Sea by Oil	Ratified 1983
Treaty on the Non-Proliferation of Nuclear Weapons	Ratified 1995
Plant Protection Agreement for South East Asia and the Pacific	Ratified 1997
Agreement on the International Dolphin Conservation Programme	Ratified 2003
Millennium Development Goals	Adopted 2000
Stockholm Convention of Persistent Organic Pollutants (POPs)	Adopted 2010
Protocol of 1978 Relating to the International Convention for the Prevention of Pollution from Ships	Ratified 1989
Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal	Acceded 2002
Nagoya Protocol on Access to Genetic Resources and Benefit Sharing	In progress for accession
Bio-Safeti Cartagena Protocol	In progress for accession

ANNEX 2 - FISH AND AQUATIC RESOURCES SURVEY REPORT

1 SUMMARY

A survey trip was made to the proposed area for the hydropower site on the Brenwe River, Malekula Island on 28 April 2014. A rapid survey was conducted along the river to collect baseline data on the fish biodiversity, riparian flora and fauna and the aquatic resources of the proposed project affected area. Information gathered through direct observation indicates a relatively healthy aquatic ecosystem with minimal anthropogenic influences. However the dominant presence of the invasive vine *Merremia peltata* provides cause for concern.

There is one migratory aquatic species *Sicyopterus aiensis* endemic to Vanuatu and listed as having “near threatened” status on the IUCN red list. It is not endemic to the river or island, but has been identified as inhabiting four islands of the country. Based on site observations and available information it is clear this species and other goboid and crustacean species are able to migrate across high waterfalls. Thus, the proposed weir (up to 3 m high) is unlikely to be a barrier to migration of such species provided that the design and operation of the weir provides for a continuous flow of water across the weir.

2 SURVEY ACTIVITIES

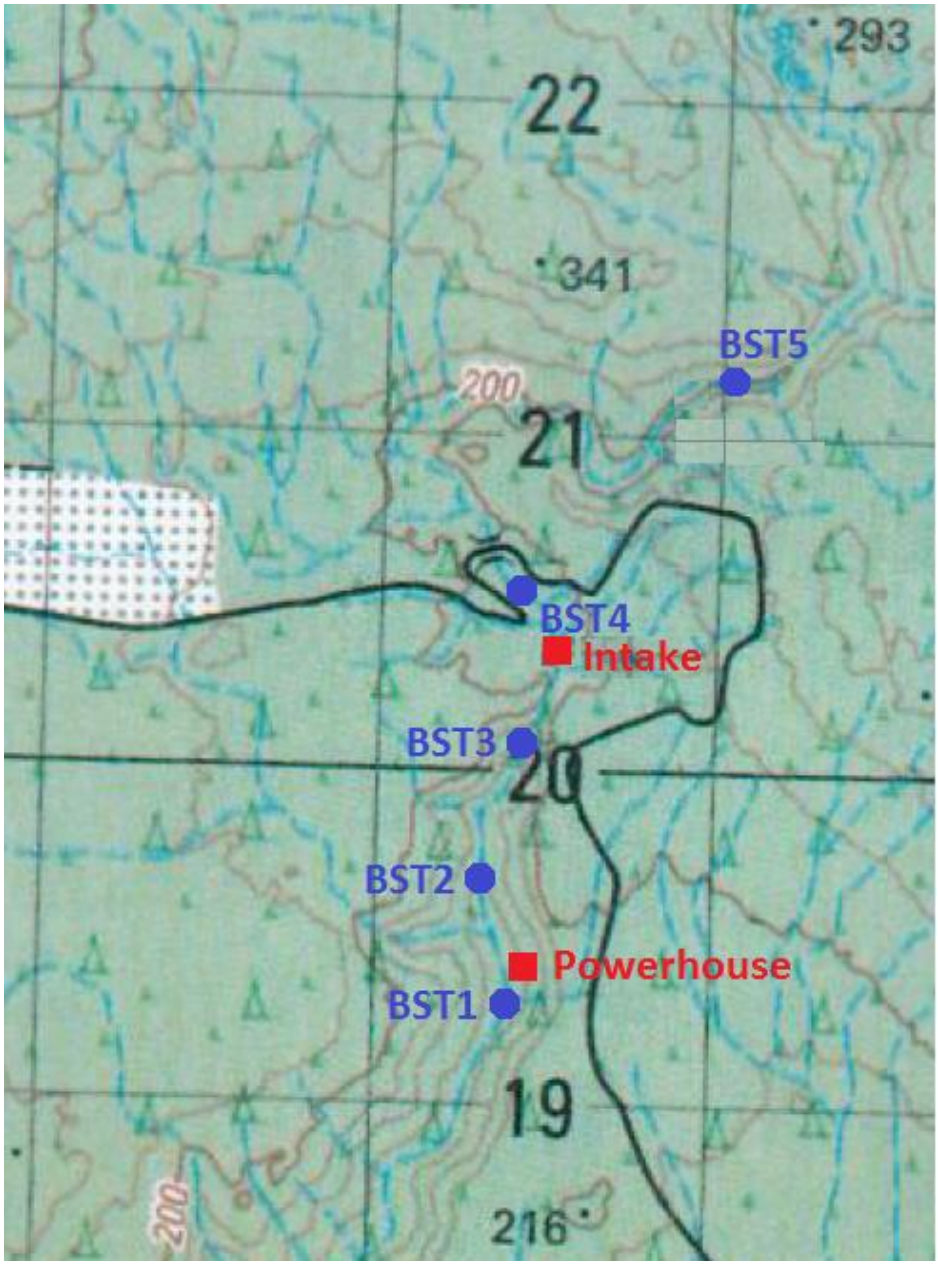
The survey covered the area of the old Chinese hydro scheme from the power station up past the existing weir (which will be replaced with a new weir and intake structure) to a previously proposed intake site approximately 1.2 km upstream of the existing weir. Methods included GPS logging, photographic documenting and visual encounter observations on species of interest and observations on general habitat ecology.

The team descended from the road to the first station (BST1) a distance of around 200 m with a drop of about 60 m. The team then followed the river upstream to each of the following stations, spending roughly 30 mins at each site. After the third station (BST3) the team were not able to proceed up the river due to a large (30 m) waterfall and a detour was taken to reach BST4 located at the SMEC rain and flow gauging station. To reach the fifth and final station (BST5) a detour was also taken along the road before descending to the site.

Chief Walter who is also the paramount chief of the surrounding areas was the team’s tour guide and participated in unstructured interviews regarding the study site and aquatic resources, he also participated in diving.

The locations of the study sites are shown in Figure 1.

Figure 1 – Study Sites for FAR Survey – Brenwe River



3 SURVEY FINDINGS AND RESULTS

A description of ecology and habitat found at each of study sites shown in Figure 1 is provided in Appendix 1.

Terrestrial biota. The general topography surrounding the Brenwe River is of narrow gorges with steep cliffs, indicative of a geologically young river. A large waterfall of approximately 30 m was also present. Dominant riparian vegetation included thick undergrowth of ferns and ginger plants with medium to large trees present where slope permits. Vines dominated by the invasive *Meremia peltata* were present. Table 1 (below) lists the species observed in the field and additional information regarding endemicity to Vanuatu, IUCN status and are migratory behaviour based on literature, observations and local knowledge

Table 1 - Dominant terrestrial biota of riparian habitats

Species	Brenwe Stations					Vanuatu Endemic	IUCN Status	Level of Exploitation	Migratory behaviour
	1	2	3	4	5				
Birds, Class: *Aves*									
Collocalia esculenta	2		3			No	LC	Low	No
Aerodramus spodiopygius				1		No	LC	Low	No
Ptilinopus tannensis					2	Yes	LC	Low	No
Ptilinopus greyii					1	No	LC	Low	No
Ducula pacifica		1				No	LC	Low	No
Reptiles, Class: *Reptilia*									
Emoia caeruleocauda	1		3			No	LC	Low	No
Emoia cyanura				1		No	LC	Low	No
Plants, Kingdom: *Plantae*									
Calamus vanuatuensis				1		Yes	NA	Low	Na
Cyathea spp.		1	2			No	NA	Low	Na
Inocarpus fagifer	1					No	LC	Medium	Na
Veitchia spp.	2		2			Yes	NA	Low	Na
Pometia pinnata		1		1		No	NA	High	Na
Calophullum spp		1				No	NA	High	Na
Potamogeton spp.					X	No	NA	Low	Na
Merremia peltata	X	X	X	X	X	No	LC	Low	Na

Key: LC-Least Concern, NA-Not Assessed

Aquatic biota. The aquatic environment was defined in a 10 metres radius from the station surveyed. The bed rock is mainly precipitated limestone. The first three stations (BST1, BST2 and BST3) included three cascade falls of at least 3 m height with one waterfall of 30m at BST3. The water at these stations had a natural milky (calcite) appearance due to the precipitation of calcite.

The slopes were from 40 to 60%. Springs and surface waters from the cast limestone flow into the river which adds more water into the riverine system of the area. The canopy partially covers the stations. In addition the depth ranges from 0.5-10 metres in the areas of cascade and waterfall with cross-sectional width of river 5-10 metres per seconds.

The species and their status according to IUCN Red Book list is provided in Table 2.

Table 2 - Dominant aquatic biota of river habitats

Species	Brenwe Stations					Vanuatu Endemic	IUCN Status	Level of Exploitation	Migratory behaviour
	1	2	3	4	5				
Freshwater Fish, Class: *Osteichthyes*									
Awaous ocellaris	3	2	4			No	LC	Low	Yes
Awaous gaumensis	2	1	1			No	LC	Low	Yes
Cestraeus goldei	5					No	DD	Medium	Yes
Cestraeus plicatilis	3					No	DD	Medium	Yes
Eleotris melanosoma	2					No	LC	Low	Yes
Eleotris fusca	1					No	LC	Medium	Yes
Khulia marginata	2	3	2			No	LC	High	Yes
Khulia rupestris	4	3	5			No	LC	High	Yes
Sicyopterus lagocephalus	1	2	2	1	3	No	LC	Low	Yes
Sicycopterus aiensis	1		1		1	Yes	NT	High	Yes
Sicyopus zosterophorum				1		No	LC	Low	Yes
Sicyopus (Smilosicyopus) chloe					1	No	LC	High	Yes
Mesopristes cancellutus	3					No	LC	High	Yes
Ryacicthys guilberti	1	1				No	NA	Medium	Yes
Stiphodon atratus	1	1	1			No	LC	High	Yes
Stiphodon mele				4	3	No	DD	Medium	Yes
Stiphodon rutilaureus	1					No	LC	Medium	Yes
Crustaceans, Subphylum: *Crustacea*									
Macobranchium lar	6	5	5	7	8	No	LC	High	Yes
Macrobrachium bariense			3	3	2	No	LC	Low	Yes
Utica gracilipes	1					No	NE	Medium	No
Atyoida pillipes			1	1		No	LC	Medium	No
Caridina typus			3	1		No	LC	Medium	Yes

Key: LC-Least Concern, NA-Not Assessed, NE-Not Evaluated, NT-Near Threaten, DD-Data Deficient.

Sicyopterus aiensis is the only species endemic to Vanuatu that is at elevated risk under IUCN classification. It is endemic to the islands of Santo, Malekula, Epi, Pentecost, Maewo, Efate and Tanna.

The results of the FAR surveys (species observed) according to habitat type are presented in Table 3.

Table 3 - Survey Results of Species According to Habitats

Types of Habitats	Description	Species
Pools	Pools are areas at bends which had an approximate depth of 4-5 metres. Main habitats are under the rocks and boulders	*Awaous gaumensis* *Khuliarupestris* *Mesopristescancellatus* *Macrobrachium lar* *Atyoida pillipes*
Riffle	Here the river is flowing at an average of 0.2-0.5 m/s at a depth of 2-3 metres. Main habitats are under rocks and boulders. Such areas were represented before and after long stretches.	*Caridina typus* *Awaous ocellaris* *Awaous gaumensis* *Stiphodon rutilaureus* *Sycyopterus lagocephalus*
Run	This habitat is an area in which the river is running clear over a stretch. The velocity is between 1-2m/s. The depth is approximately 1-2 metres	*Awaous ocellaris* *Awaous gaumensis* *Stiphodon atratus* *Stiphodon mele*
Boulders, cobble, gravel, sand, silt and clay areas	These are areas where >80% of the banks and the physical stretch of the substrate is of mentioned. Such areas are present in the other 3 habitats mentioned above.	*Awaous ocellaris* *Awaous gaumensis* *Cestraeus goldei* *Cestraeus plicatilis* *Eleotris melanosoma* *Eleotris fusca* *Khulia marginata* *Khulia rupestris* *Sicyopterus lagocephalus* *Sicyopterus aiensis* *Sicyopus zosterophorum* *Sicyopus (Smilosicyopus) chloe* *Mesopristes cancellutus* *Ryacicthys guilberti* *Stiphodon atratus* *Stiphodon mele* *Stiphodon rutilaureus* *Macrobranchium lar* *Atyoida pillipes* *Caridina typus*
Below altitude of 90 metres	These areas are in lower altitudes which were under more pressure of population and villages. Most of the habitats (mentioned) are exposed due to access from people. Most of the area is of boulders, cobble, gravel, sand, and silt and clay areas.	*Awaous ocellaris* *Awaous gaumensis* *Cestraeus goldei* *Cestraeus plicatilis* *Eleotris melanosoma* *Eleotris fusca* *Khulia marginata* *Khulia rupestris* *Sycopterus lagocephalus* *Sycopterus aiensis* *Sicyopus zosterophorum* *Sicyopus (Smilosicyopus) chloe* *Mesopristes cancellutus* *Ryacicthys guilberti* *Stiphodon atratus* *Stiphodon mele* *Stiphodon rutilaureus* *Macrobranchium lar*

4 IMPACTS AND MITIGATIONS

4.1 Description of the Upper Brenwe Watershed

The upper watershed of Brenwe was defined to be intact, with challenges of surviving the invasive vine *Merremia peltata*. This has caused the Brenwe watershed to have a mixture of primary and secondary vegetation from human activities.

People access the watershed areas only occasionally, during special events and the need for wild protein. From BST1 to BST5, there was no evidence of gardening or major disturbance from humans, only the invasive vine indicated evidence of a change in the natural vegetation. The invasive vine had clearly invaded the areas previously cleared for the abandoned Brenwe hydropower scheme.

There were two representatives of Vanuatu's endemic flora that were present in the area from BST1 to BST5 (*Veitcha spp* and *Calamus vanuatuensis*). They were on the ridge tops and the slopes (40% to 60% slope) to the river. There were other commercial trees (*Pometia pinnata* and *Calophyllum sp*) which were present but were all covered by the invasive vine.

Brenwe was accessed through Unmet. The communities surrounding the area only use the river for fishing, recreation and sometimes water collection. There were no communities living within the project area. During moderate to heavy rain the river was evident to be very dangerous to cross or walk up stream in. This is since the river may increase its velocity 1-3 metres per seconds as the sides were narrow of about 5-15 metres. The sides have slopes of 60% to vertical with existing gullies which bring runoff from the terrestrial environment.

The upper watershed is likely to be significant to most gobiidae fish for spawning. They go through a post-larval stage (pelagic phase) before drifting to shore and migrating upstream.

Aquatic ecology (freshwater ecosystem). Surface water flows along the areas observed support a high diversity of fauna, characterized by diverse range of aquatic habitats, intact riparian vegetation and limited erosion. The value of these ecosystems is relatively high, having healthy flow and clean water, allowing movement of organisms along waterways.

Some 22 aquatic species were observed in this expedition. Nine of the species were known to be in the gobiidae family, and are commonly found in most reaches from lowland to the higher elevations, and are adapted to obstructed environments such as waterfalls and to extreme climatic and hydrological seasonal variation (including floods and droughts). Five species of crustaceans were common in the lowland areas, restricted to areas of rock and debris (leafs and woods) and secondary riparian vegetation. All of these crustaceans were regarded as sources of protein by local populations. At certain locations there is elevated fishery pressure via pole line and spear methods. This is primarily in the lower reaches below the waterfall where mullet (*Cestraeus sp.*) and Jungle Perch (*Khulia sp.*) are caught. The waterfall acts as a natural up-stream barrier to these species unlike for goboids which are able to climb waterfalls due to special adaptations.

A significant ecological threat to the aquatic system arises from sedimentation which appears to be increasing due to changes in the forest composition in the vicinity of the river. Large swathes of vegetation are under threat of the invasive species *Merremia pintata* which climbs emergent flora and closes off the canopy from light, driving a change in the understory composition. The predominance of shrubs that results appears to permit increased runoff to be dominant in the riverine slopes, so that with heavy rain falls runoff has direct effects on the natural condition of the river course.

4.2 Impacts in the Project Area

The potential Impacts of the project in the aquatic ecology (freshwater ecosystem) include;

1. Increased turbidity and subsequent sedimentation in the freshwater systems due to road construction, vegetation clearing and earthworks and construction of weir and headrace canal.
2. Loss of freshwater habitats due to vegetation clearing and earthworks and construction of weir.
3. Spillage of hydrocarbons and other potential contaminants from vehicle operation, heavy machineries, transport or handlings of materials/substances into the freshwater ecosystem.
4. Introduction of freshwater pests from substances/materials transported or excavated.

5. Introduction of litter and waste into rivers, surface flow rivers and streams contributing to degradation of water quality affecting the freshwater biota.
6. Increased vulnerability for migratory fish especially goboids.

Potential impacts on fish migration. Migration was one of the main issues to consider in studying fish and aquatic resources. The fish species observed in this report were important to the ecosystem due to their availability over time in the freshwater systems of Malekula. The natives inhabiting the islands expressed that the river resources were their source of life. They occasionally accessed the areas proposed for hydro for hunting pigs, recreation and fishing. Their understanding however, was limited regarding the fish migration patterns.

According to the fish species observed during this survey, two types of migratory behaviour are represented, (1) Catadromous and (2) Amphidromous. Catadramous refers to fish species such as *Khulia sp,* and *Cestraeus sp,* Amphidromous refers to the majority of fish species present in this river under the family gobiidae. Amphidromous fish that are born in the estuary or freshwater system, and then drift into the ocean as larvae before migrating back to the freshwater system to grow into adults and spawn. Catadromous fish are born in the ocean/saltwater and migrate into freshwater systems as juveniles to grow into adults before migrating back to the ocean to spawn.

Local evidence and literature suggests that the lunar cycle plays a major role in fish migration, together with high rainfall events and the flowering of higher plants (Manicop, 1953). For most gobiidae species presented in this report, maturing, mating and spawning occurs in the upper catchment before floating downstream to drift in the ocean for several months before migrating upstream as post-larvae. The fish juveniles migrate from the lower reaches of river habitats to the habitats they will occupy as adults. As a rule the first major waterfall is a crucial factor for species' distribution along a river.

Predatory species of the genus Khulia are abundant in the lower reaches below the first waterfall, but are absent above it (as observed in this survey). This limitation in the movements of predators of the genus Khulia affects the distribution of other organisms. Gobies and Palaemonid crustaceans such as *Macrobrachium sp* or Atyid shrimps are often more abundant in areas above cascades where predators are less numerous.

Mitigation and management measures. Mitigation of the potential impacts above includes taking practical measures to minimize short and long term soil erosion and adverse effects of sediment transport by creating temporary sumps and sediment traps during construction of roads, weir and waterways.

Fuel, oil and chemical storage design will need to ensure containment of spillages and proper plans for remediation to avoid impacts on the rivers and streams.

Weir design for the Brenwe hydropower scheme needs to facilitate migration of species that have the ability to climb the 30 m high waterfall that exists in the natural channel downstream of the weir site.

As noted above, and is clear from the species sighted in the survey above the waterfall, gobies have specialised adaptations enabling them to climb waterfalls, whereas *Khulia sp.* (Jungle Perch) and *Cestraeus sp* (Mullet) cannot pass across major waterfalls. Whilst the proposed weir height (up to 3m high) is unlikely to be a significant barrier to aquatic species (goboids and crustaceans) able to scale a 30 m high waterfall. The key issue will be to ensure that as far as possible there is a continuous flow of water over the weir and over the waterfall during operation, thereby enabling fish migration both upstream and downstream across the stretch of river affected by the project.

The extent of abstraction from the main river channel into the power system needs to be considered from the perspective of habitat modification in the dewatered reach of the river.

4.3 Terrestrial Ecology

Flora. In an overview, 60% of the areas observed were covered with old growth forest. Some areas were currently used by local village communities for cropping, hunting for birds and pigs and fishing. There were two environments observed in this expedition;

The highlands which includes slopes and above cascade areas of the riverine, dominated by endemic palms of the Vanuatu and lowlands indicated by vascular plants of ferns and ginger trees (*Alpania sp*).

There were two plants identified to be endemic to the Vanuatu,*Calamus vanuatiensis* and *Vetchia sp*. The two species are not declared in the IUCN Red List. The two species were common around thick riparian vegetation along slopes and near rivers.

Fauna. There were diverse birds endemic to the Vanuatu, however with unfavourable weather condition only two species were observed in the areas that could e impacted by the project. They include *Zosterops flavirons* and *Ptilinopus tannensis*. and were common in the areas observed.

As also observed were reptiles which were active only during morning sunshine, around 0730 am to 9 am. During the trips the weather was cloudy, humid, cold and dull so that fauna observation was not performed as expected.

Potential impacts. There were several possible impacts to the terrestrial ecology that would be considered;

1. Habitat removal by vegetation clearing and excavation, resulting in habitat transformation
2. Habitat fragmentation, leading to overcrowding and increase competition among individuals and species
3. Edge effects, such as microclimatic changes that can cause ecological shifts creating ecology patches
4. Pollution of local habitats (example, landfill, waste, sludge and discharge from water and sewage) that will increase invasive species or tolerant species to survive in the area

Mitigation and management measures. To reduce the impacts on the terrestrial ecology the following measures are recommended.

1. Minimize habitat removal, modification and fragmentation;
2. Minimize indirect impacts from construction and operational activities
3. After vegetation losses rehabilitation needs to be conducted to minimize land degradation.
4. All areas for road access should have proper drainage that directs runoff to sediment traps before release into the river.

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Appendix 1 – Study and Station Description Summaries

Station	Type of sampling	Ecology and site description
BST1	Riverine sampling of the aquatic and terrestrial biota (flora and fauna) and GPS and photographic recording	The aquatic terrain was of pools depth of 3-5 metres with flow rates from 2-5 metres per seconds (m/s) and substrate mainly of precipitated calcite and detritus of leaves and wood debris in addition to cobbles and pebbles.
BST2	Riverine sampling of the aquatic and terrestrial biota (flora and fauna) and GPS and photographic recording	The aquatic terrain was of pools depth of 3-5 metres with flow rates from 2-5 metres per seconds (m/s) and substrate mainly of precipitated calcite and detritus of leaves and wood debris in addition to cobbles and pebbles.
BST3	Riverine sampling of the aquatic and terrestrial biota (flora and fauna) and GPS and photographic recording	A major pool of 30 m diameter as a result of the 30 m water fall with flow rates from 2-5 metres per seconds (m/s) and substrates mainly of precipitated calcite and detritus of leaves and wood debris in addition to cobbles and pebbles. Depth was estimated to be more than 10 metres.
BST4	Riverine sampling of the aquatic and terrestrial biota (flora and fauna) and GPS and photographic recording	1 metre on the either side of this station is a growing limestone bed above the main stream; the river travels under creating a habitat of low light habitat for most for *gobiidae*, crustacean and eels even though canopy cover was only partial The water clarity was 95% clear with substrates of 10% coarse detritus of leaves and dead branches 90% is of pebbles and coarse sands with some areas of bed rock visible. The width of the river was about 2.5 metres and the velocity was about 0.5 metres per seconds. The slope on the either sides was about 40% on the left bank and about 70% on the right bank and dominated by fragmented sedimentary rocks
BST5	Riverine sampling of the aquatic and terrestrial biota (flora and fauna) and GPS and photographic recording	The aquatic terrain was of pools depth of 3-5 metres with flow rates from 2-5 metres per seconds (m/s) and substrate mainly of detritus of leaves and wood debris in addition to cobbles and pebbles.

ANNEX 3 - RAPID ENVIRONMENTAL APPRAISAL CHECKLIST

Country/Project Title: TA 8285: Vanuatu Energy Access Project - Brenwe hydropower project

Sector Division: PATE/PARD

A. Basic Project Design Data

1. Dam height, m = weir approx. 2 m
2. Surface area of reservoir, (ha) = no reservoir
3. Estimated number of people to be displaced = nil
4. Rated power output, = 400 - 600 kW

Other Considerations:

1. Water storage type: run of river
2. River diversion scheme: in-stream flow regulation
3. Type of power demand to address: base load, possible daily peaking

SCREENING QUESTIONS	Yes	No	REMARKS
B. Project Location Is the dam and/or project facilities adjacent to or within any of the following areas?			
▪ Unregulated river	X		Natural river that has been disturbed by previous construction of weir. It is envisaged that the existing weir will be refurbished for the current project or new weir nearby slightly above existing
▪ Undammed river tributaries below the proposed dam		X	
▪ Unique or aesthetically valuable land or water form		X	Highly disturbed riparian area due to previous construction of abandoned Hydropower scheme. Terraces above river channel are used extensively for plantations (copra, cocoa, kava, pawpaw, oranges etc) and vegetable gardens.
▪ Special area for protecting biodiversity		X	No known area in the catchment
▪ Protected Area		X	No known area in the catchment
▪ Buffer zone of protected area		X	None known
▪ Primary forest		X	Catchment appears not to have been commercially logged but is used extensively by local population for plantations and garden activity
▪ Range of endangered or threatened animals		X	Not known
▪ Area used by indigenous peoples		X	For traditional building materials and garden activity
▪ Cultural heritage site		X	None within vicinity of project impact area.
▪ Wetland		X	None reported
▪ Mangrove		X	None reported
▪ Estuary		X	None reported

SCREENING QUESTIONS	Yes	No	REMARKS
C. Potential Environmental Impacts - will the project cause…			
▪ short-term construction impacts such as soil erosion, deterioration of water and air quality, noise and vibration from construction equipment?	X		Soil erosion on steep slopes as a result of road re-construction and clearance of the penstock and canal corridors. Water quality will be impacted.
▪ disturbance of large areas due to material quarrying?		X	No quarrying required. Existing quarries for road surface material are located along the Lakatoro to Brenwe Road.
▪ disposal of large quantities of construction spoils?		X	Small - moderate amount of construction spoil from access road rehabilitation and headrace canal will be required.
▪ clearing of large forested area for ancillary facilities and access road?		X	Previously constructed access roads will be rehabilitated for this project.
▪ impounding of a long river stretch?		X	No dam or reservoir
▪ dryness (less than 50% of dry season mean flow) over a long downstream river stretch?		X	None expected with other perennial flows below intake structure
▪ construction of permanent access road near or through forests?		X	Previously constructed access roads to abandoned hydropower site will be rehabilitated for this project
▪ creation of barriers for migratory land animals		X	No risk
▪ loss of precious ecological values due to flooding of agricultural/forest areas, and wild lands and wildlife habitat; destruction of fish spawning/breeding and nursery grounds?		X	No flooding of lands. Insignificant loss of wildlife habitat due to small scale activity.
▪ deterioration of downstream water quality due to anoxic water from the reservoir and sediments due to soil erosion?		X	No dam or reservoir
▪ significant diversion of water from one basin to another?		X	Water used returned to same river system
▪ alternating dry and wet downstream conditions due to peaking operation of powerhouse?		X	Water used returned to same river system
▪ significant modification of annual flood cycle affecting downstream ecosystem, people's sustenance and livelihoods?		X	Flood flows result of high short duration peak discharges and will not be modified. Bed load material will not be impacted.
▪ loss or destruction of unique or aesthetically valuable land or water forms?		X	The river system is not unique to Malekula.
▪ proliferation of aquatic weeds in reservoir and downstream impairing dam discharge, irrigation systems, navigation and fisheries, and increasing water loss through transpiration?		X	No dam or reservoir
▪ scouring of riverbed below dam?		X	No dam
▪ downstream erosion of recipient river in trans-basin diversion?		X	No trans-basin diversion
▪ increased flooding risk of recipient river in trans-basin diversion?		X	No trans-basin diversion
▪ decreased groundwater recharge of downstream areas?		X	No risk
▪ draining of downstream wetlands and riparian areas?		X	No risk
▪ decline or change in fisheries below the dam due to reduced peak flows and floods, submersion of river stretches and resultant destruction of fish breeding and nursery grounds, and water quality changes?		X	No dam or reservoir. No breeding areas impacted
▪ loss of migratory fish species due to barrier imposed by the dam?		X	Insignificant impact since waterfalls between intake and powerhouse present significantly greater natural barriers to fish migration than the proposed weir
▪ formation of sediment deposits at reservoir entrance, creating backwater effect and flooding and waterlogging upstream?		X	No reservoir
▪ significant disruption of river sediment transport downstream due to trapping in reservoir?		X	No reservoir

SCREENING QUESTIONS	Yes	No	REMARKS
▪ environmental risk due to potential toxicity of sediments trapped behind the dams?		X	No dam
▪ increased saltwater intrusion in estuary and low lands due to reduced river flows?		X	Water is returned to the river several kilometres upstream of river mouth..
▪ significant induced seismicity due to large reservoir size and potential environmental hazard from catastrophic failure of the dam?		X	No reservoir or dam
▪ cumulative effects due to its role as part of a cascade of dams/ reservoirs?		X	No dam in river system.
▪ depletion of dissolved oxygen by large quantities of decaying plant material, fish mortality due to reduced dissolved oxygen content in water, algal blooms causing successive and temporary eutrophication, growth and proliferation of aquatic weeds?		X	No reservoir or dam
▪ risks and vulnerabilities related to occupational health and safety due to physical, chemical, biological, and radiological hazards during project construction and operation?	X		Physical hazards associated with machine operation and construction activities on steep slopes can be mitigated with appropriate HSE Plan
▪ large population influx during project construction and operation that causes increased burden on social infrastructure and services (such as water supply and sanitation systems)?		X	Small-scale construction using local labour where possible
▪ creation of community slums following construction of the hydropower plant and its facilities?		X	Small-scale project with no large work force.
• social conflicts if workers from other regions or countries are hired?		X	GoV committed to socially responsible working conditions
▪ uncontrolled human migration into the area, made possible by access roads and transmission lines?		X	Not anticipated in this customary land
▪ disproportionate impacts on the poor, women, children or other vulnerable groups?		X	No negative impacts expected. Project will have positive impacts on these groups by providing improved access to electricity as well as providing improved road access to remote villages.
▪ community health and safety risks due to the transport, storage, and use and/or disposal of materials likely to create physical, chemical and biological hazards?		X	No negative impacts expected
• risks to community safety due to both accidental and natural hazards, especially where the structural elements or components of the project (e.g.,dams) are accessible to members of the affected community or where their failure could result in injury to the community throughout project construction, operation and decommissioning?		X	Potential for accidental falls into headrace canal and forebay increased due to presence of villages and possible use of canal corridor for access. Awareness campaign required.

Checklist for Preliminary Climate Risk Screening

Country/Project Title: TA 8285: Vanuatu Energy Access Project - Brenwe Hydropower project

Sector: Energy

Subsector: Renewable

Division/Department: PATE/PARD

Screening Questions		Score	Remarks[1]
Location and Design of project	Is siting and/or routing of the project (or its components) likely to be affected by climate conditions including extreme weather related events such as floods, droughts, storms, landslides?	1	hydropower project components likely to be subject to increased extreme flood events
	Would the project design (e.g. the clearance for bridges) need to consider any hydro-meteorological parameters (e.g., sea-level, peak river flow, reliable water level, peak wind speed etc.)?	1	hydropower project components need to be designed to take account of likely extreme flood events
Materials and Maintenance	Would weather, current and likely future climate conditions (e.g. prevailing humidity level, temperature contrast between hot summer days and cold winter days, exposure to wind and humidity hydro-meteorological parameters likely affect the selection of project inputs over the life of project outputs (e.g. construction material)?	1	Potential increased extreme floods, increased rainfall intensity and potential increased frequency and intensity of cyclones needs to be considered in selection of construction materials.
	Would weather, current and likely future climate conditions, and related extreme events likely affect the maintenance (scheduling and cost) of project output(s) ?	1	Potential increased extreme floods, increased rainfall intensity and potential increased frequency and intensity of cyclones needs could result in increased maintenance costs including scheduling of routine maintenance
Performance of project outputs	Would weather/climate conditions, and related extreme events likely affect the performance (e.g. annual power production) of project output(s) (e.g. hydro-power generation facilities) throughout their design life time?	0	Possible decreased generation potential in dry season offset by increased generation potential in wet seasons

Options for answers and corresponding score are provided below:

Response	Score
Not Likely	0
Likely	1
Very Likely	2

Responses when added that provide a score of 0 will be considered low risk. If adding all responses will result to a score of 1-4 and that no score of 2 was given to any single response, the project will be assigned a medium risk category. A total score of 5 or more (which include providing a score of 1 in all responses) or a 2 in any single response will be categorized as high risk project.

Result of Initial Screening (Low, Medium, High): MEDIUM

Other Comments: NA

[1] If possible, provide details on the sensitivity of project components to climate conditions, such as how climate parameters are considered in design standards for infrastructure components, how changes in key climate parameters and sea level might affect the siting/routing of project, the selection of construction material and/or scheduling, performances and/or the maintenance cost/scheduling of project outputs.

ANNEX 4 - STAKEHOLDER CONSULTATIONS

Annex 4a - Key National Environmental Stakeholders Consulted during PPTA

Consultations at the national level were undertaken on a one on one basis. Key relevant institutions and their responsible personnel were identified by the environmental safeguards team and meetings arranged accordingly. The main purpose of the meetings was to:

- Briefly outline the key features of the project projects (location, indicative lay out/footprint etc)
- Ascertain key stakeholders views and concerns in relation to the proposed developments and
- Obtain information from the stakeholders on environmental and social characteristics of the sites that would assist in the preparation of the IEEs including any constraints that need to be addressed.

A list of key national stakeholders consulted including summary of information obtained and significant comments made is provided in Table A4.1.

Table A4.1 - Key National Stakeholders Consulted during PPTA

Agency	Name & Position	Date (2014)	Information Obtained / Comments made
DEPC	Albert Williams Director of Environment, DEPC and Acting Director General of MOCC.	15 May	• General discussion on institutional set up, function and capacity of DEPC. • Provided copy of DEPC Annual Report 2013. • Advised that ADB approved IEE for the project shall be deemed as meeting EIA requirements of EA Act and shall therefore be the basis for issuing a Development Consent.
DEPC	Donna Kalfatak Biodiversity Officer	18 Mar 24 Mar	• Inventory of protected areas in Santo and Malekula • Recent research and publications on Freshwater fauna of Vanuatu provided. • Commented on need to ensure aquatic biodiversity of project areas surveyed and adequate mitigations implemented as necessary to protect any vulnerable species. • Provided list of conservation areas in Vanuatu
DEPC	Trinison Tari Environment Education & Information Officer (EEIO)	28 Mar 14 Apr	• Provided information about the structure for the DEPC. Concern that there was not enough staff for the department to enforce the laws with new project initiatives • Advised that the Waste Management Bill for Vanuatu is not yet law. • Also advised that Pollution Control Act is enforced but without a Regulation. A draft Regulation was prepared but it has not yet been approved.
DOF	Hanington Tate Director Phyllis Berry GIS Mapping Officer	18 Mar	• Provided latest vegetation maps of Malekula and Santo • Provided species lists of trees that are known to be found in project areas • Identified history of passed logging activities (or not) in project areas.
Sanma Provincial Government	Anaclet Philip Environment Extension Officer	27 Mar	• Advised there were two community based protected areas in Santo including Nambauk and Butmas. Both areas are outside proposed project areas in Santo • Community awareness activities undertaken at Fanafo on need for watershed protection above existing Sarakata HP scheme, namely to avoid tree cutting and limit fishing activities.

Agency	Name & Position	Date (2014)	Information Obtained / Comments made
			• Advised that Sarakata catchment was logged during 1990s along with some parts of Wambu catchment. Most large trees were taken. • Had no concerns about endangered or endemic species in Sarakata or Wambu project areas.
Ministry of Lands, Sanma Province	Benuel Tabi Officer in Charge	27 Mar	• Provided advice on water use rights in respect of existing Sarakata hydropower project
DOE	Leo Moli Officer Manager	24 Mar	• Provided structure of the DOE as approved by the Public Service Commission • Also provided vegetation study report for the Sarakata Hydropower • Provided information on the Energy Roadmap for Vanuatu
DOE	Chris Simelum Power Off-grid Officer	24 Mar	• General information on energy issues and needs in Vanuatu. Also referred to the Energy Roadmap
DGMWR	Brooks Rakau Geologist	7 Apr	• Provided information on the new Quarry Act. Advised that the Regulation has not yet been approved and confirmed that the Director can approve a Quarry Application in writing in the absence of a Quarry Permit Application Form
DGMWR	Benjamin Titus Geologist Christopher Ioan Director	17 Mar 9 Apr	• Provided geological maps and associated geology reports of the project areas • Advised that due to the absence of a Regulation for the Water Resources Management Act to grant approval for Right of Use of Water, the Director has powers to approve in writing.
Malampa Provincial Council	Palen Arthur Planner	11 Apr	• General information on the project and the Provincial commitment to support the project. Information on Provincial By-Law was lacking for the province in environmental issues
DOMG	Brian Philips Manager	16 Apr	• Provided information on the role of the National Advisory Board (NAB) on Climate Change and Disaster Risk Reduction
VUI	Jun Fernandez Operations Supervisor Sarakata Hydropower Scheme	25 Mar	• Provided information on VUI's current environmental health and safety procedures and protocols in respect of the auit undertaken for Sarakata Hydropower Scheme
VPMU	Tony Telford Project Management Advisor	28 May	• Provided information on VPMU's current portfolio, staffing and capacity.

A list of attendees at the meeting with Malampa Provincial Council on 19 March is provided in Table A4.2

Table A4.2 - List of Attendees at Consultation Meeting with Malampa Provincial Council Lakatoro

Name	Responsibility	Summary of Comments made
Lapi Kalmet	Assistant Planner	• MPC familiar with the key components of the hydropower project through their previous experience of Brenwe hydropower project during the 1990s. • expressed support for the project. • one member queried the potential impact on downstream water quality in the Brenwe River and loss of water between the intake and powerhouse due to the project. These issues were clarified. MPC were advised that significant impacts on water quality downstream of the project were unlikely and any impacts associated with reduction of water between the intake and powerhouse will be investigated as part of the IEE with necessary mitigation measures proposed to ensure impacts are minimized and acceptable. • Other issues raised included questions on the proposed alignment of the transmission line; whether or not the transmission line will be routed to Lakatoro; whether or not the project would result in lower cost of electricity; and whether or not the partially completed and abandoned hydropower sites and facilities would be used.
Edna Paolo	Tourism Officer	
Melteras Salavina	Cultural Centre	
John Bongnaim	Customary Lands Tribunal	
Kevin Enrol	Malampa Province	
Toufau Kalsakau	Forestry Officer	
George Tusai	Agriculture Officer	
Samson M	Correctional Services	
Noel Nathan	Health Department	
Renjo Samuel	Education Officer	
Palen Ata	Provincial Planner	
Joanna Lingi	Women's Affairs	