

Initial Environmental Examination

March 2014

Solomon Islands: Provincial Renewable Energy Project

Fiu River Hydropower Project – Malaita Province

Prepared by the Ministry of Mines, Energy and Rural Electrification for the Asian Development Bank.

CURRENCY EQUIVALENTS

(as of 1 March 2014)

Currency unit – Solomon Islands dollar (SI\$)

SI\$1.00 = \$0.14

\$1.00 = SI\$7.30

ABBREVIATIONS

ADB	Asian Development Bank
AMNH	American Museum of Natural History
BMP	building material permit
CBSI	Central Bank of Solomon Islands
CDM	clean development mechanism
CITES	Convention on International Trade in Endangered Species
DSC	design and supervision consultant
EA	executing agency
ECD	Environment and Conservation Division (of MECDM)
EBRD	European Bank for Reconstruction and Development
EIS	Environmental Impact Statement
EHSG	Environmental Health and Safety Guidelines (of World Bank Group)
EMP	Environmental Management Plan
EPC	engineer procure and construct
ESP	Environmental Sector Policy
FRI	National Forest Resources Inventory
GDP	gross domestic product
GFP	grievance focal point
GNI	gross national income
GRM	Grievance Redress Mechanism
HDPE	high density polyethylene
HDR	Human Development Report
HSP	Health and Safety Plan
IEE	initial environmental examination
IES	international environmental specialist

IMR	infant mortality rate
ITCZ	inter-tropical convergence zone
IUCN	International Union for the Conservation of Nature
kW	kilowatt
L/s	liter per second
MECDM	Ministry of Environment, Climate Change and Disaster Management
MMERE	Ministry of Mines, Energy and Rural Electrification
MSMP	Materials and Spoils Management Plan
NES	national environmental specialist
NGO	non-governmental organization
NTFP	non-timber forest products
PCCSP	Pacific Climate Change Science Program
PCRAFI	Pacific Catastrophic Risk Assessment and Financing Initiative
PER	Public Environmental Report
PMU	Project Management Unit (in SIEA)
PPE	personal protective equipment
PPTA	project preparatory technical assistance
PREP	Provincial Renewable Energy Project
PTID	Policy Translation and Implementation Document
REA	Rapid Environmental Appraisal
SEMP	Site-specific Environmental Management Plan
SICCP	Solomon Islands Community Conservation Program
SIEA	Solomon Islands Electricity Authority
SIG	Solomon Islands Government
SPS	Safeguard Policy Statement (of ADB, June 2009)
SINIIP	Solomon Islands National Infrastructure Investment Plan
UNDP	United Nations Development Program
UNESCO	United Nations Education and Scientific Cooperation Organization
UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank
WHO	World Health Organization
WMP	Waste Management Plan

NOTES

In this report, "\$" refers to US dollars unless otherwise stated.

This Initial Environmental Examination is a document of the borrower. The views expressed herein do not necessarily represent those of ADB's Board of Directors, Management or staff, and may be preliminary in nature. Your attention is directed to the "terms of use" section of this website.

In preparing any country program or strategy, financing any project, or by making any designation of or reference to a particular territory or geographic area in this document, the Asian Development Bank does not intend to make any judgments as to the legal or other status of any territory or area.

CONTENTS

EXECUTIVE SUMMARY	I
I. INTRODUCTION	1
II. POLICY AND LEGAL FRAMEWORK	2
A. Government of Solomon Islands	2
B. ADB Safeguards Policy	8
III. DESCRIPTION OF THE PROJECT	8
A. Project Components and Location	8
B. Alternatives Considered	10
C. Construction Activities	10
D. Operation and Maintenance	11
IV. DESCRIPTION OF ENVIRONMENT (BASELINE DATA)	12
A. Physical Resources	12
B. Biological Resources	19
C. Socioeconomic and Cultural Resources	23
V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES	28
A. Screening of Potential Impacts	28
B. Impacts on the Physical Environment	28
C. Impacts on the Biological Environment	32
D. Impacts on the Socio-economic Environment	35
E. Operation Impacts	37
F. Climate Change Effects and Adaptation Requirements	37
VI. INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION	43
A. Introduction	43
VII. ENVIRONMENTAL MANAGEMENT PLAN	46
A. Introduction	46
B. Implementation Arrangements	46
C. Environmental Mitigation and Monitoring Matrix	51
VIII. CONCLUSION AND RECOMMENDATION	62
IX. BIBLIOGRAPHY	63
ATTACHMENTS	65

EXECUTIVE SUMMARY

1. **Background.** The Asian Development Bank (ADB) is supporting the Solomon Islands Government (SIG) through the Solomon Islands Electricity Authority (SEIA) develop reliable and sustainable supply of electricity in selected provinces 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 (PPTA) has been undertaken and completed a feasibility study of a small run-of-river hydropower scheme located in Malaita Province. The scheme was selected following a screening and prioritization process in which potential projects from a number of provinces were assessed at pre-feasibility level. The feasibility study includes this initial environmental examination (IEE).
3. This report is the IEE for the design construction and operation of the proposed Fiu River hydropower scheme and associated transmission grid under Provincial Renewable Energy Project (the Project). The project has been classified as Category B projects as described in the Safeguard Policy Statement (SPS) June 2009. The IEE satisfies requirements of a Public Environmental Report (PER) as required under the key environmental assessment requirements of SIG.
4. 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 SIEA staff, 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 SIEA and uploaded to ADB's website.
5. **Project Description.** The proposed Fiu River hydropower scheme is located in Malaita Province approximately 8 km east of Auki town (the provincial capital). The Project would harness the flow of the Fiu River to generate hydro-electric power. The run-of-river scheme comprises a low weir with a single gated sluice and fish pass structure. Water will be diverted into a side intake and sand trap on the left bank before being conveyed along a 1.55 km long concrete headrace canal to a head pond. A 250 m steel penstock will convey water from the head pond to the powerhouse located on the left bank of the Fiu River before being discharged back into the river. The Project infrastructure is designed for 750 kilowatt (kW) with initial installed generation capacity of 500kW.
6. Access to the site from Auki is via Fulisango Road which ends at the Fiu River about 1.25 km northwest of the powerhouse site. From near that point an access road will be constructed to the powerhouse, forebay and headworks (total length about 3.5 km). The new access road will be aligned essentially along existing walking tracks currently used by the local community to access the village of Kwainoa. Thus, the access road to the intake provides a significant additional project benefit through improved road access to remote rural communities.

7. An 8.6 km long 11 kV transmission line will be constructed from the powerhouse to the 11kV bus-bar at the existing SIEA diesel power station at Auki town. The transmission line route will be within the corridor of the proposed access road to the powerhouse for 1.3 km before joining the existing public road to Auki (7.3km).

8. **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 April and May 2013 and results of this IEE and the environmental management plan (EMP) will be updated if necessary at the detailed design / tender preparation stage by the project management unit (PMU) to be established for the Project within SIEA.

9. **Implementation Arrangements.** The executing agency (EA) for the Project is the Ministry of Mines, Energy and Rural Electrification (MMERE) and the implementing agency (IA) is SIEA. SIEA will establish a PMU to lead design and implementation of the Project. The PMU will be supported by a design and supervision consultant (DSC). The DSC will include international specialists who will train SIEA and PMU staff. The DSC will assist PMU in procurement (preparation of tender documents, tender evaluation) and supervision of construction as well as capacity building of the PMU. 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 PMU will include an international environmental specialist and national environmental specialist to assist SIEA meet all its obligations with respect to the EMP for the Project as well as provide training to SIEA/PMU in monitoring the contractor's compliance with the EMP and safeguard requirements. The facilities will be operated by SIEA.

10. **Policy, Legal and Administrative Framework.** The Project shall comply with requirements of the Environment Act 1998 and the Environment Regulations 2008 which require that for development of hydropower projects, as a prescribed activity, a development consent must be obtained from the Ministry of Environment Climate Change and Disaster Management (MECDM). A development consent application must include an environmental assessment which complies with Environment Act and Environment Regulations requirements. The Project will also comply with the requirements of ADB's SPS. SIG environmental clearance and development consent (and other permits) must be obtained before any works commence.

11. **Environmental Management Plan.** Mitigation measures, environmental monitoring, and capacity development are required to minimize the environmental impacts in the pre-construction and 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.

12. The main environmental issues relate to ensuring that the design of the Project: i) allows for a minimum environmental flow release of 280 liters/second (L/s) into the Fiu River at the intake point at all times; and ii) incorporate design criteria that are based on available climate change modeling data used to develop extreme event data or, in the absence of such data, design criteria should be demonstrably conservative.

13. Implementation of internationally recognized good construction environmental practices forms 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 PMU for approval prior to commencement of works.

14. 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 SIEA.

15. **Information Disclosure, Consultation and Participation.** 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.

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 Solomon Islands including previous experience on ADB projects 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 run-of river hydropower scheme with a small footprint and it does not involve a dam or reservoir;
- The existing aquatic habitat of the Fiu River between the intake and powerhouse has a relatively low habitat quality compared with upstream of the intake, due to current human disturbance from nearby communities (forest clearance, river crossings usage of river for domestic washing). No significant impacts are expected on the existing fish and aquatic resources of the Fiu River as a result of the project provided that a minimum environmental flow of 280 L/s is released into the river at the intake point at all times;
- A fish pass structure will be built into the design of the weir. The weir is therefore unlikely to be a significant barrier to current fish migration patterns;
- The potential loss of modified forest habitat due to the Project is of relatively minor significance due to the overall disturbed natural environment of the project area and this 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 local protected areas; 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

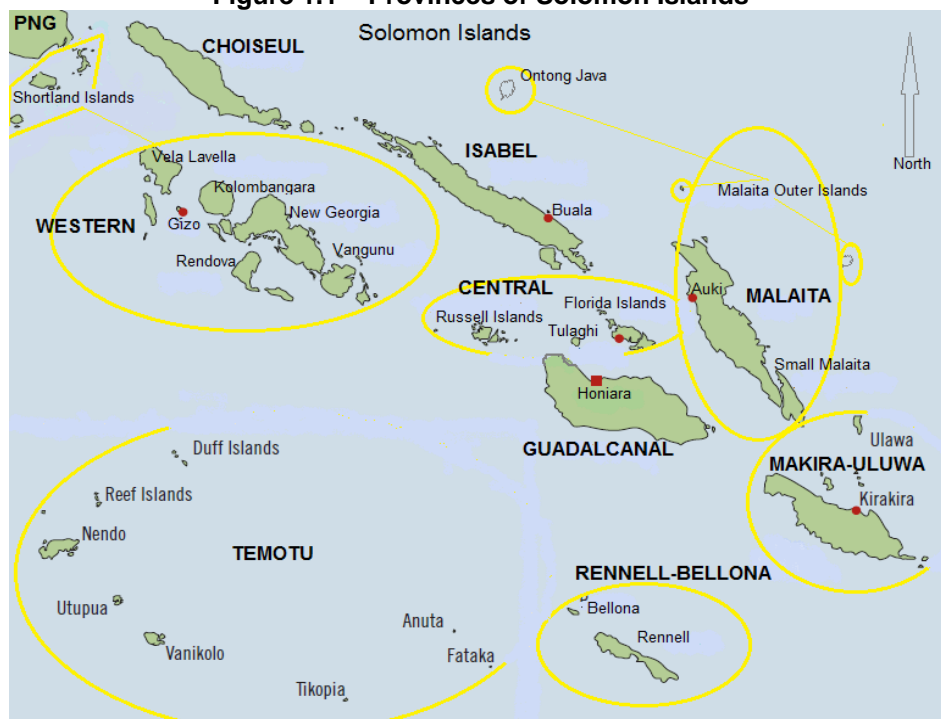
backflow resulting in flooding of the powerhouse and damage to electromechanical equipment.

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

I. INTRODUCTION

19. The Solomon Islands is a country of nearly 1,000 islands spread about 600 km between Bougainville (Papua New Guinea) to the North and Vanuatu to the South. The Solomon Islands are divided into nine provinces Malaita, Makira-Ulawa; Isabel, Western, Central, Temotu, Choiseul, Guadalcanal, and Rennell and Bellona Provinces (Figure 1.1).

Figure 1.1 – Provinces of Solomon Islands



Source: SIRIP – North Malaita Road IEE (2011)

20. Approximately 80% of the population is based in rural areas in these provinces. The Solomon Islands Electricity Authority (SIEA) operates in seven provincial centers (excluding Choiseul and Rennell and Bellona) and three other stations namely Noro, Munda in Western Province, Malu'u in Malaita Province and Buala in Isabel Province. SIEA operates mainly diesel power station. SIEA has historically operated hydropower stations at Malu'u and Buala but both are currently non-operational due to land disputes and technical problems respectively. There are several micro-hydropower stations operated by rural communities, mostly in Malaita and Western Provinces. The Solomon Islands Government (SIG) through the SEIA has requested support from Asian Development Bank (ADB) to develop reliable and sustainable supply of electricity in selected provinces to assist economic growth and increase the capacity to support greater access to electricity for local residents, businesses and industry.

21. A project preparatory technical assistance (PPTA) has been undertaken and completed a feasibility study of a small run-of-river hydropower scheme located in Malaita Province. The scheme was selected following a screening and prioritization process in which potential projects

from a number of provinces were assessed at pre-feasibility level. The feasibility study includes this initial environmental examination (IEE).

II. POLICY AND LEGAL FRAMEWORK

22. The implementation of the Project will be governed by the environmental laws and regulations of the Solomon Islands and the safeguard policies of the ADB.

A. Government of Solomon Islands

1. Environmental Sector Policy

23. The SIG has formulated the Policy Translation and Implementation Document 2010 (PTID) which contains the sector policies and strategies of the government. The policies are to be implemented over the four year period 2010 to 2014. The Environmental Sector Policy (ESP) is amongst these sets of policies. The ESP has a strong emphasis on promoting sustainable developments, conserving natural resources and reducing climate change.

24. The goal of the ESP is to enhance the knowledge and awareness on principles of adaptation and mitigation, guided by a national policy platform duly supported by the government and contributing to increased capacity to adapt to the effects and mitigate the causes of climate change.¹

25. Key ESP principles include:

- Policy No 5.1.8 (a) - increasing awareness on principles of adaptation and mitigation on climate change;
- Policy No 5.1.8 (b) - promote carbon trading in the country;
- Policy No 5.1.8 (c) - increase awareness to rural communities on importance of conserving resources;
- Policy No 5.1.8 (d) - devise appropriate control mechanisms to control, reduce and monitor adverse effects of climate change;
- Policy No 5.1.9 (f) - prioritizing sustainable management of the country's environment;
- Policy No 5.1.8(g) - integration of environmental issues into other sectors to build awareness of others;
- Policy No 5.1.8 (h) - introduce legislation to protect and manage the country's biodiversity; and
- Policy No 5.1.8 (i) - strengthen capacity of National Disaster Management Office to improve disaster preparedness and risk management plans in the country.

2. Environmental Legislation

26. Environmental protection through a system of impact assessment and management in the Solomon Islands is provided for under the Environment Act 1998 and the accompanying regulatory instrument, the Environment Regulations 2008. The Act and Regulations are administered by the Ministry of Environment, Climate Change and Disaster Management (MECDM).

¹ SIG: Policy and Transition Implementation Document 2010 – 2014, Honiara, Solomon Islands (2010), page 91

27. **Environment Act.** The Environment Act 1998 consists of four parts which provides for an integrated system of development control, environmental assessment, pollution control and giving effect to regional and international conventions and obligations.

28. Part I Article 4.1 vests the Act with considerable power which states that in the event of conflict between the provision of Environment Act and other legislation, the Environment Act shall prevail. Part II establishes and defines the powers and role of the Environment and Conservation Division (ECD) - which has since been re-established within the Ministry of Environment, Climate Change and Disaster Management (MECDM). Part III establishes the requirements for environmental assessment, review and monitoring. Under the Act environmental assessment can consist of either a Public Environmental Report (PER) or if the development is shown to be of such a nature as to cause more serious impacts then an Environmental Impact Statement (EIS) is required. Activities that require assessment are listed as Prescribed Activities in the Second Schedule of the Act. Prescribed Activities that will apply to the Project include:

- Activity 3 Non-metallic industries
 - (d) Extraction of aggregates stones or shingles
- Activity 9 Public Works Sector
 - (b) infrastructure developments
 - (e) hydropower schemes

29. Part IV details requirements for control of pollution and emissions (noise, odor and electromagnetic radiation) and requirements to permits for the discharge of waste. Noise and interference with antipollution devices are covered under Article 50 (1) while restrictions and emitting unreasonable noise are covered in Article 51(1).

30. **Environment Regulations 2008.** The Regulations establish the procedures for undertaking the environmental assessment of Prescribed Activities. The developer is required to first submit a development consent application following which the MECDM determines whether (i) no further assessment is required, (ii) a PER, 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. EIS should include technical, economic, environmental and social investigations. Both the PER and EIS require public consultation. Following approval by the MECDM, a development consent can be issued with or without conditions.

31. The Director of ECD was consulted on the 8 April 2013, on whether the IEE would also suffice as either PER or EIS as part of the development consent application for the scheme. MECDM advised that the IEE will need to be reviewed before deciding whether it can be formally submitted as part of the application.

32. Solomon Islands currently does not have emission or water quality standards. While environmental standards are not provided in the Regulations, the MECDM requires World Health Organization (WHO) standards to be used. The Regulations do provide guidelines for licenses to discharge waste or emissions but without defined standards the enforcement of these would appear to be difficult.

3. Other Legislation Relevant to the Project

33. **Rivers and Waters Act 1964.** The stated purpose of the Rivers and Waters Act is to establish control of river waters for equitable and beneficial use. Schedule 5 of the Act requires a developer to obtain a permit and comply with its conditions for the following activities;

- By means of a ditch, drain, channel, pipe or any other means whatsoever, diverts any water from a river;
- Fells any tree so that it falls into a river or river bed;
- In any manner obstructs or interferes with a river or river bed;
- Builds any bridge, jetty or landing stage over or beside any river;
- Damages or interferes with the banks of any river; or
- Contravenes any order made under section 4 of this Act

34. Schedule 7 outlines the steps to obtain permits to carry out activities in river waters. The Application of the Act applies only to a limited number of rivers declared in the schedules of the Act. The Fiu River is not included in the schedules. Consultations held with Director of Water Resources, MMERE confirmed that Fiu River is not a scheduled river and there is therefore no requirement for a water permit for the Project.

35. **Mines and Minerals (Amendment) Act 2008.** Part VIII of this Act will need to be complied with in regard to mining and extraction of aggregate from rivers.

- Article 64 requires that Building Material Permits (BMP) be issued for the extraction of building materials.²
- Articles 65-67: Outlines the format for a BMP application and rights of a BMP holder to enter and extract building materials.
- Article 68: Sets out the obligations on a BMP holder which includes; payment of fees and royalties; operate using good mining practices; report to the Director on the amount removed and sales details; and, at closure of the mining area, make the area safe.
- Article 69 exempts government departments, provincial or local authorities from these requirements if they own the area where the mining is being undertaken.

36. MECDM advised that extraction of materials – as a Prescribed Activity - requires a PER to be prepared even though the Mining Act does not specify this as a requirement for a BMP. Approvals of BMPs are via a Board that is convened four times a year for this purpose. The Director of ECD is a member of the Board.

37. Table 2.1 provides a summary of the consents and permits required for the Project and the supporting documentation.

² The Mines and Mineral Act defines “building material” as; clay, gravel, sand and stone used for buildings, roads or other construction purposes.

Table 2.1 – Permitting Requirements for the Project

Permit Required	Agency Responsible	Documentation
Development Consent	MECDM	Development Application as per Form 2 of Schedule 2 of Environment Regulation 2008 including Environmental Impact Statement (EIS) in accordance with guidelines for EIS as per Form 1 of Schedule 2
Building Materials Permit	MECDM	Public Environmental Report (PER)

Source: SIG Environment Act 1998 and Environment Regulations 2008

38. **Protected Areas Act 2010.** This Act together with the Protected Areas Regulation 2012 establishes procedures for the establishment and management of protected areas and to conserve and regulate biological diversity. Part 3 of the Act outlines criteria necessary to qualify as protected areas. Part 5 of the Act prohibits any unauthorized bio-prospecting research in these areas except if given permission by the Advisory Committee. Part 6 provides for the appointment of inspectors to enforce the provision of the Act. There are sections throughout the Act that highlight fines for breaches of the Act. Whilst there are a number of proposed protected areas in the Solomon Islands, as outlined in Table 2.2, to date no areas have been formally gazetted as national protected areas under the Act.

Table 2.2 - Formal and Informal Protected Areas in Solomon Islands

No.	Name	Description	Area (ha)
Existing Forest Protected Area with Formal Protection			
1	Queen Elizabeth National Park	Mt Austen (Honiara) currently overrun by squatter settlement and highly degraded	1,093
2	Lake Tengano, Rennell Island	Lake Tengano World Heritage Listed	37,000
Existing Forest Protected Area with informal Protection			
1	Tetepare Conservation Area	Tetepare Complex – marine and terrestrial area, Western Province	11,000
2	Makira Conservation Area	Bauro Highlands, Makira Island	63,000
3	Simbo Conservation Area	Megapods Hatcheries – Western Province	725
4	Komarindi Catchment Area	Established by DFEC in early 1990s, Guadalcanal	19,300
5	Arnavon Marine Conservation Area	Mostly marine, but 500m buffer of terrestrial area, Isabel Province	0.5
6	Kolombaranga Conservation Area	Four Catchment Reserve as wildlife corridors and marine protected areas	20,000

Source: SIG Protected Areas Act 2010

39. **Wildlife Protection and Management Act, 1998.** This Act frames the Convention on International Trade in Endangered Species (CITES) agreement and together with the Wildlife Protection and Management Regulations 2008 establishes procedures for the import and export of wildlife and plants. The Act provides a schedule of wildlife that are prohibited for export and a second schedule of wildlife that can be exported subject to notification under the Act.

40. Other relevant Acts include the Town and Country Planning Act 1979 and the Provincial Government Act 1997 both of which are summarized in Attachment 1. Enacted Provincial Ordinances relevant to the Project are also included in Attachment 1.

41. **Labor Act 1978.** This Act deals with protections for workers. Part IX Care of Workers, requires the employer to: provide workers with rations (Article 65); protect workers and dependents from malaria (Article 66); provide workers with an accessible supply of clean, non-polluted water for drinking, washing and for other domestic purposes (Article 67); make sufficient and proper sanitary arrangements for workers (Article 68); provide accommodation for the worker and his family if they are not conveniently located to the work place (Article 69).

42. Article 70 requires the employer to provide medical care at the workplace including: (i) treatment facilities, medicines, first aid equipment and transportation facilities; (ii) responsibility to move workers as quickly as possible either to the employer's treatment facilities or to the nearest medical facilities; (iii) treatment for workers or hospitalization; and (iv) should a worker die the employer is obliged to pay for funeral costs. Article 71 states that the employer may be required to provide medical facilities and services of a medical practitioner. Where the employer is required to provide these facilities the employer is to maintain a register of workers treated.

43. **Safety at Work Act 1996.** This Act consists of four parts. Under Part II Article 4 states that it is the duty of every employer to ensure the health and safety at work of his employees, Article 6 states that it is the duty of the employer to provide a safe workplace for persons other than his employees. Articles 7 and 8 require manufacturers, suppliers of tools and equipment and suppliers of chemicals and other hazardous substances to ensure that these are safe and without health risks. Article 12 states that any employer who operates unsafe machinery or substances and is injured will be responsible for the damages.

44. Under Part III Article 15 requires the employer to protect people from dust, fumes etc. Article 16 provides for limits of exposure to dust and fumes. Articles 17, 18, 19 and 20 require employers to comply with the operating requirements for: (i) pressure and vacuum systems; (ii) machinery; (iii) dangerous machinery; and (v) electrical installations. Articles 21 and 22 require workplaces to have fire protection and to provide sufficient precautions against explosions.

45. The **Safety at Work (Pesticide Regulations) 1983** is included as a component within the Safety at Work Act and deals with the following:

- Article 3 requires the formation of a Pesticides Registration Advisory Committee.
- Article 4 requires a Register of Pesticides to be maintained.
- Article 13 shows that all pesticide containers are to be labeled with a number of details including: The trade name of the pesticide; the net weight and ISO approved name of the active ingredient, together with its formulation; directions for use and what the pesticide is to be used for; hazard label regarding storage, and handling and safety equipment required for application; minimum withholding periods prior to harvest; first aid treatment; and name of manufacturer and registration number of the pesticide.
- Article 15 requires that no unlabelled pesticides can be imported, while Article 16 states that pesticides cannot be sold, supplied or used other than in the original container.
-

46. The First Schedule classifies pesticides into 4 hazard levels depending on their oral or dermal toxicity as follows; 1a - extremely hazardous; 1b - highly hazardous; II - moderately hazardous; and III - slightly hazardous.

47. **Preservation of Cultural Sites** At present, there is no national legislation or regulation dedicated to protect and preserve cultural artefacts, or what to do in situations where they may be unearthed or “discovered” by construction activities.

48. However, the Protected Areas Act 2010, while emphasizing biodiversity conservation also provides a basis for the protection of physical sites of cultural significance within the definition of ‘Protected Area’. In Part 3 of the Act a protected area is defined as an area that;

- Possesses significant genetic, cultural, geological or biological resources;
- Constitutes the habitat of species of wild fauna and flora of unique national or international importance;
- Merits protection under the Convention Concerning the Protection of World Cultural and Natural Heritage; or
- Requires special measures to be taken to conserve biological diversity.

49. The National Museum under the Ministry of Culture and Tourism has several archaeologists on its staff and should a site be suspected of having cultural or historic value, the following procedure is recommended:

- Review the IEE to see if any mention is made in the IEE of any sites.
- Some sites have been registered by the Provincial Governments - these registers should be checked.
- Discuss the site with the local communities and verify whether they know of any taboo sites.
- Where there are possible risks of discovery, ask the National Museum to evaluate the site.
- Include a “chance finds” in the EMP. If a discovery is made, stop work at the affected site and ask the National Museum to evaluate the discovery.

50. Each province also has various ordinances for the preservation and protection of cultural sites and objects (Attachment 1).

4. Other Relevant Legislation

51. Other legislation that has implications for resource development and management is shown in Table 2.3.

Table 2.3 – Legislation Pertinent to the Project

Act	Date	Main Objective
National Park	1978	Establishes National Parks; establishes restrictions within national parks and provide for appoints for park rangers
Wild Birds	1978	List scheduled birds for protection. Establishes bird sanctuaries and strict hunting season for several birds.
Lands and Titles	1988	Covers the management of land; defines “customary land” and sets out procedures for land acquisition. This Act is currently under review
Forest Resources and Timber Utilisation	1991	Governs licensing of felling of trees and sawmills; timber agreements on customary land. Establishes State Forest and Forest Reserves and management systems.
Fisheries	1998	Framework for fisheries management and development, including licensing of fishing vessels and processing plants. Lists prohibited fishing methods, provides for establishment of Marine Protected Areas (MPAs) and coastal management plans.

5. International Treaties and Agreements

52. Solomon Islands 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 Attachment 1.

B. ADB Safeguards Policy

53. The ADB's Safeguard Policy Statement (SPS) 2009 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.

54. 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.

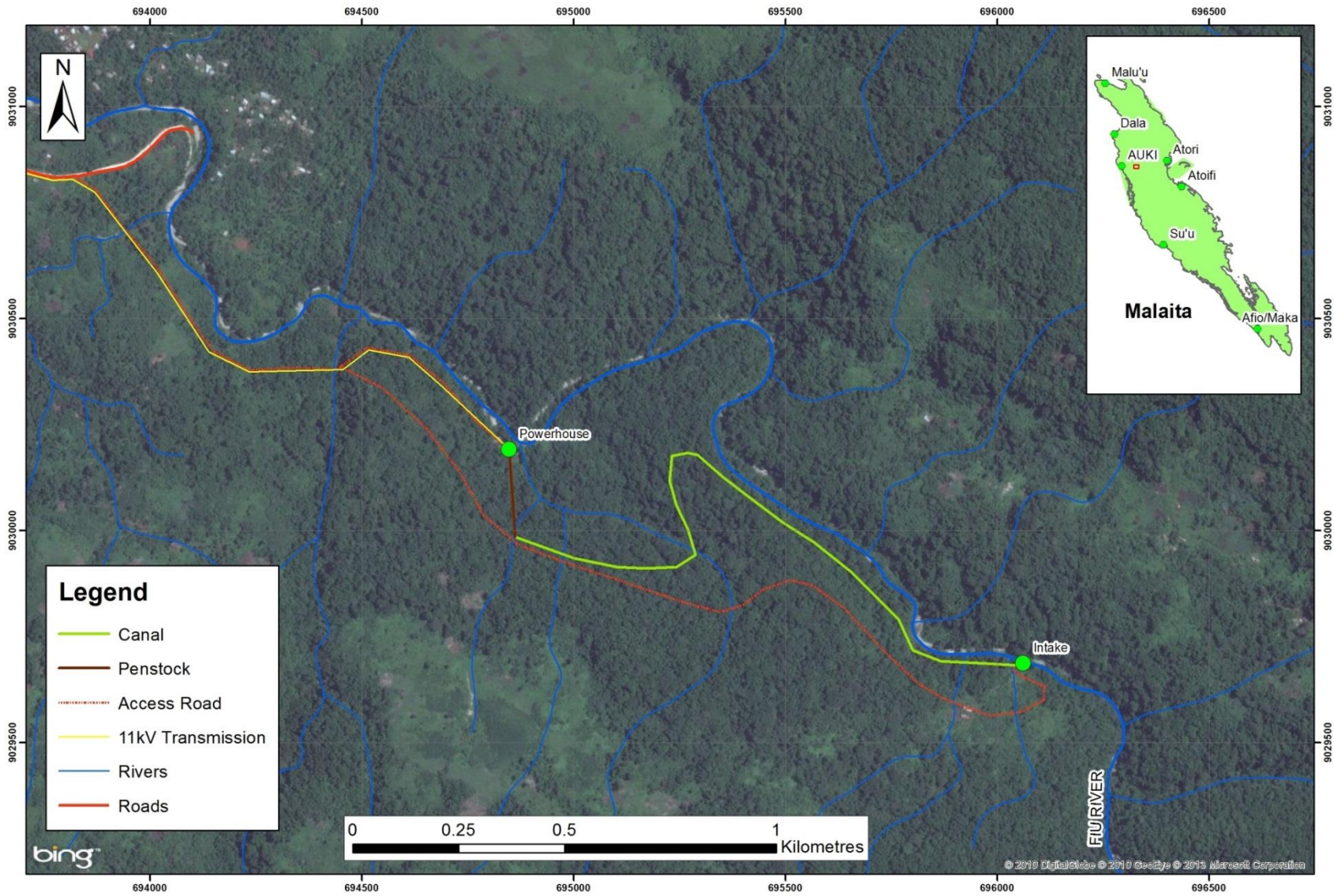
III. DESCRIPTION OF THE PROJECT

A. Project Components and Location

55. The Project is located in Malaita Province of Solomon Islands, approximately 8 km east of Auki the provincial capital. Auki is located on the western side of Malaita. The Project will harness the flow of the Fiu River to generate hydro-electric power. The location and general layout of the proposed Fiu River hydropower scheme is shown in Figure 3.1.

56. The intake of the run-of-river scheme is located at 125 m above sea level about 500 m southwest of the small village of Kwainoa and comprises a low weir with a single gated sluice on the left side and fish pass structure on the right side. Water is diverted into a side intake and sand trap on the left bank before being conveyed along a northwest trending 1.55 km long concrete headrace canal. The headrace canal initially follows the river along the left bank before turning sharply south away from the river and through a low saddle before turning west to discharge into a head pond and settling basin (15 m x 4 m x 3.7 m). A 250 m steel penstock conveys water from the head pond north to the powerhouse (10m x 5 m) located on the left bank of the Fiu River at elevation 65 m above sea level which will provide an output of up to 750 kilowatt (kW) with a design flow of 1.8 m³/sec.

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



57. Access to the site from Auki is via Fulisango Road which ends at the Fiu River about 1.25 km northwest of the powerhouse site. From near that point an access road will be constructed to the powerhouse, head pond and head works³ (total length about 3.5 km). The new access road will be aligned essentially along an existing walking track currently used by the local community to access the village of Kwainoa. The access road will be developed on a ridge which is relatively flat, to reach the water intake facilities, with a short branch to the powerhouse. The access road to the intake provides a significant additional project benefit through improved road access to remote rural communities.

58. An 8.6 km long 11 kV transmission line⁴ will be constructed from the powerhouse to the 11kV busbar at the existing SIEA diesel power station at Auki town. The line route will be within the corridor of the proposed powerhouse access road for 1.3 km before joining the existing public road to Auki (7.3 km).

59. The scheme components will be constructed for 750 kW capacity, however, initially only 500 kW will be installed (2 x 250 kW turbines) under this project. Installation of a third turbine (250 kW) including commissioning of a branch penstock (constructed under this project) will occur in future, according to demand.

60. The scale of the scheme and projected future use of the catchment is such that a detailed catchment management plan is not required.

B. Alternatives Considered

61. Technical alternatives for the project were considered during the development of the recommended interventions. The main considerations with environmental consequences were as follows:

- The choice of Fiu River over other potential hydro sites in Malaita due to proximity to the load centre (Auki), ease of access (reduces requirement for new road construction in steep and forested terrain) and capacity to meet load demand.
- The choice of the current project layout in the Fiu River which involves all components (access road, intake, headrace canal, penstock and powerhouse) located in relatively disturbed riparian and aquatic habitats compared with an alternative layout involving an upper Fiu River catchment layout. The latter would have involved significantly greater earthworks for access road intake and canal construction in relatively undisturbed riparian and aquatic habitats.
- Decision to design the project so as to provide for an environmental flow release at the intake equivalent to 10% of the mean annual river flow (at the intake) to ensure the sustainability of the aquatic ecosystem between the intake and the powerhouse. This decision was made at the expense of foregoing between 5% and 10% of potential energy generation if 10% environmental flow was not provided.

C. Construction Activities

³ The headworks refers to the various components at the water intake point (weir, gated sluice, intake box, sandtrap, fish pass etc.)

⁴ 11kV is strictly speaking distribution voltage and as such is able to be 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 11kV line performs a transmission function and is therefore referred to throughout this report as a transmission line.

62. Construction of the Fiu 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 80 to 100 workers (60% skilled) will be required for the Project over the construction period, estimated to be about 21 months.

63. **Main Civil Works.** A 3.5 km long (5 m wide) access road will be initially constructed from the existing public road to the head works including short branch road to the powerhouse. This will involve vegetation clearance, soil stripping and grading activities. 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 headworks. As much as possible excavated material will be used as backfill with some surplus material disposed of as required. The intake structure will be manually constructed with reinforced concrete.

64. Vegetation clearance and excavation of the headrace canal, head pond and penstock route will be followed by construction of the stone masonry canal and head pond structures and stone masonry piers for the penstock.

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

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

67. **Transmission Line.** Construction of the 8.6 km long 11kV transmission line will require i) vegetation trimming along the road corridors (if required) to ensure adequate safety clearances for the power lines (up to 5 m from the centerline of the overhead line); ii) transporting 11 m Oclyte steel 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.

D. Operation and Maintenance

68. Operation of the hydropower scheme will require one operator to check proper operation of machinery and hydraulic structures (intake) twice a day and in case of failures (tripping of circuit breaker) will have to put the scheme back into operation after removing the fault.

69. 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.

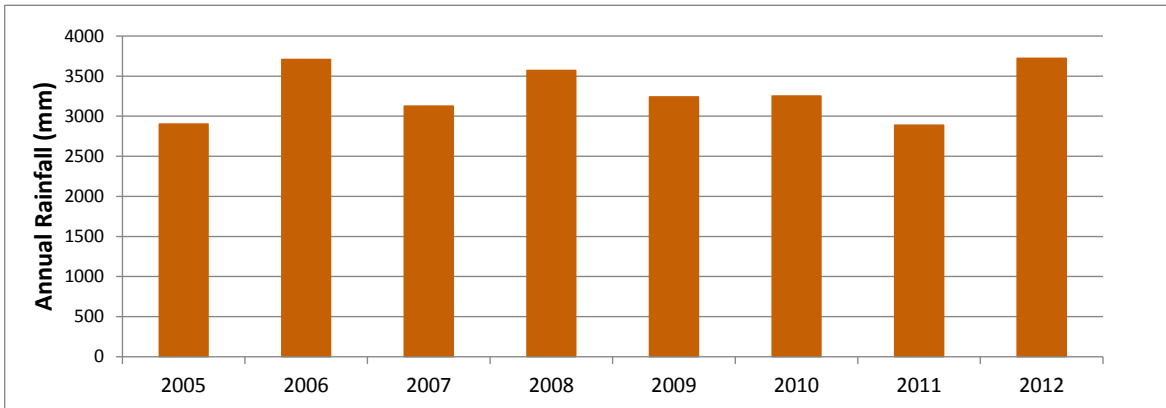
IV. DESCRIPTION OF ENVIRONMENT (BASELINE DATA)

A. Physical Resources

1. Climate, Air Quality and Noise

70. Malaita, situated between latitudes 8-10° south experiences a tropical climate with high humidity and temperature in the mid-20°s to low-30°s throughout the year. The mean annual rainfall at Auki is 3,300 mm, and fairly consistent year-to-year (Figure 4.1)

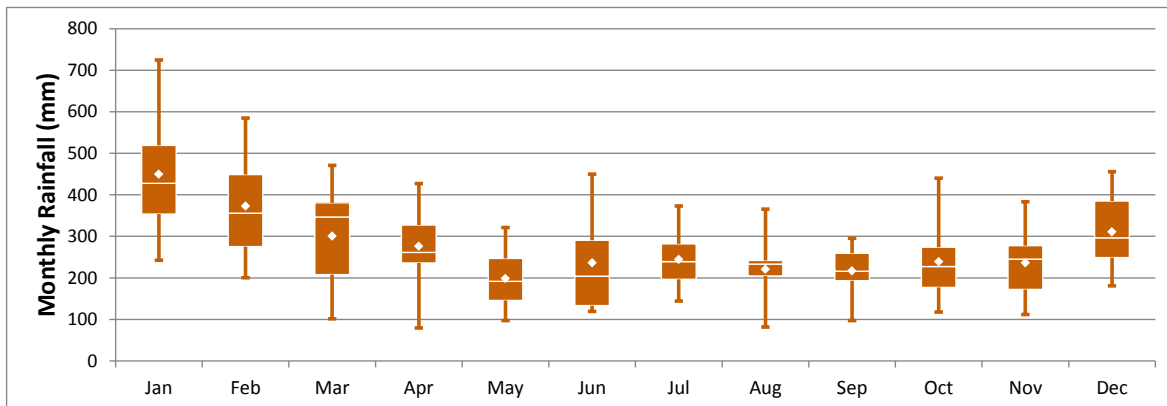
Figure 4.1 - Annual Rainfall at Auki Station, 2005-2012.



Source: MECDM (2012)

71. Rainfall is associated with the monsoon winds, which change direction due to the movement of the Inter-tropical Convergence Zone (ITCZ) in winter and summer. In the summer months of December to March, north-easterly conditions bring warm humid airstreams, and associated cyclonic disturbances. From April to November, the ITCZ moves north and south-easterly winds affect the country. During this period the Auki region experiences lower rainfall due to the rain-shadow effect of the high terrain in the centre of the island. The seasonal rainfall pattern at Auki has a wet season from December to March and dry season May to November. Figure 4.2 shows monthly mean, minimum and maximum (for 25%, 50% and 75% exceedance).

Figure 4.2 - Monthly Rainfall at Auki Station 2005-2012



Source: MECDM (2012)

72. Air quality in Solomon Islands is very good, largely as a result of there being very few industries and a relatively small vehicle fleet generating emissions. This is true for the study area. The same can be said with respect to noise, which is typically only a consideration in urban centres such as Honiara.

73. There are no air quality or emissions standards in Solomon Islands and no monitoring is undertaken.

2. Topography and Soils

74. The project area is in a valley on the Western side of the mountain range that runs in a North West – South East direction along the length of the Malaita Island, east of Auki town. The project area is located in the northern ridges physiographic region⁵ of Malaita which contains a compact block of narrow volcanic ridges with uneven summits and steep, narrow valleys. Bands of limestone rocks surround this volcanic core forming karst topography on long rocky ridges and conical hills.

75. It is generally steep terrain with slopes in excess of 35 – 40 degrees arising from the river near the intake site (125 m asl) and rising some 120 m in altitude within 300 m of the river channel on the right bank. Numerous ephemeral gullies enter the river system characterized by large boulders and blocks of limestone, on both sides of the valley.

76. There are 27 soil groups in Solomon Islands. The soils are generally rich in nitrogen, phosphorous and organic carbon, but poor in potassium. Deep freely drained yellowish brown to yellowish red clays developed on calcareous sandstones and siltstones are the predominant soil type in the moderate to steep slopes of the low hills and ridges of the Fiu River project area.

77. Generally, stable sites with low relief, where soil weathering has proceeded for longer periods have deep soils with acid sub-soils and low fertility levels. Under tropical forest nutrient recycling is important in maintaining fertility in these soils. Freely drained brown loams and clays formed on basalt or other basic rocks are younger, less weathered and more fertile soils and are preferred for subsistence agriculture. These form on relatively steep slopes where rates of natural erosion are higher.

3. Geology, Seismicity and Natural Hazards

a. Geology

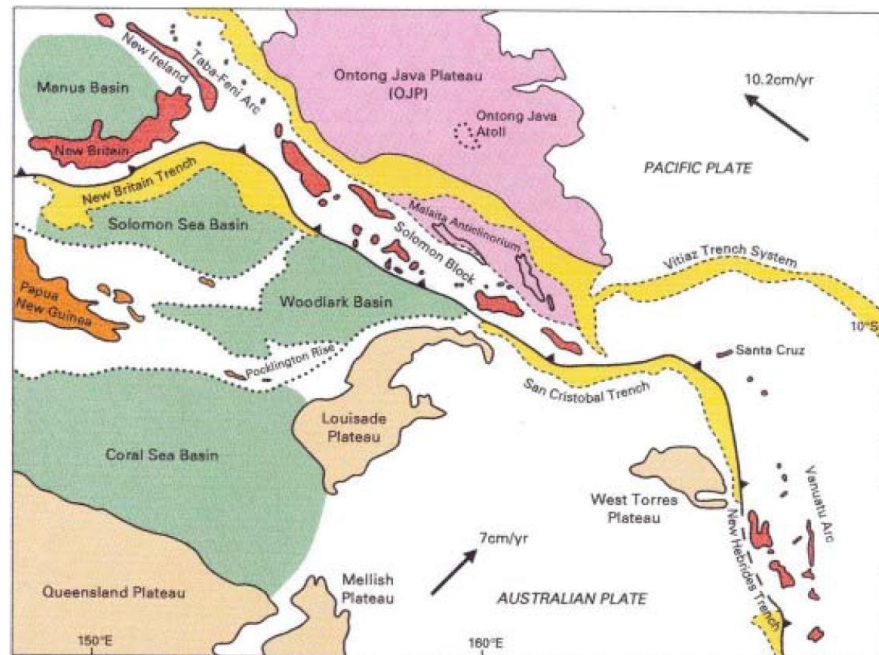
78. The Solomon Islands form part of the Pacific Ring of Fire and lies at the boundary of the Pacific and Australian tectonic plates. The uplift of the plates along with intermittent volcanic and seismic activity has contributed to the island masses which now form the Solomon Islands. The islands are, geologically speaking relatively young, and the larger islands are almost entirely volcanic in origin and consist of lava and basalt and surrounded by uplifted coral terraces.

⁵ SIG Ministry of Natural Resources; Australian International Development Assistance Bureau (1994). Solomon Islands National Forest Resources Inventory Volume 3 - Malaita Province,

79. The regional tectonic setting of the Solomon Islands is shown in Figure 4.3. It comprises two uplifted Island-arc chains of larger islands which form the bulk of the land mass of the Solomon Islands archipelago (Pettersen et.al, 2009)⁶

80. Solomon Islands is an uplifted block bounded to the northeast by the Vitiaz (locally north Solomon Islands) trench and to the southwest by the South Solomon (New Britain- San Cristobal) trench. The Solomon Islands comprise series of complex terrains dominated by thick ocean plateau crust of the Ontong Java Plateau terrain.

Figure 4.3 - Regional Tectonic Setting of Solomon Islands



Source: Peterson et al, SOPAC Technical Bulletin (2009)

81. The geology of Malaita reflects its position as an obducted part of the Ontong Java Plateau. It comprises a Cretaceous basalt basement sequence up to 3-4km thick (Malaita Volcanic Group) conformably overlain by a 1-2 km thick Cretaceous – Pliocene pelagic sedimentary cover sequence. This sequence was punctuated by basalt volcanism during the Eocene and by subsequent intrusions during the Oligocene. Basement and cover sequences were both deformed by an intense, middle Pliocene event. A number of localized Upper Pliocene-Pleistocene shallow marine and subaerial formations (calcsilites, reef limestone, conglomerates and sandstones) overlie the middle Pliocene unconformity surface.

b. Seismicity and Natural Hazards

82. The Solomon Islands are exposed to a wide range of geological, hydrological and climatic hazards. Between 1980 and 2009, for example, the country experienced 17 major

⁶ Pettersen M.G., Magu R., Mason A., Mahoa H., Tolia D., Neal C.R., and Mahoney J.J. (2009) A first geological map of Makira, Solomon Islands: Stratigraphy, structure and tectonic implications. In: Pacific Minerals in the New Millennium – The Jackson Lum Volume. SOPAC Tech. Bull. 11, 145-161

disaster events, costing over USD20 million and affecting almost 300,000 people. Of these events there were six major natural disasters – two earthquakes and four tropical cyclones, and associated floods and storms, directly impacting over 100,000 people with over 100 deaths. Climate-related events, including floods, landslides and storms, dominated the disaster events, both in terms of the number of incidents as well as the number of people affected and damage and losses experienced.

83. The Solomon Islands lies in a seismically active region, located just to the north of the fault 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.

84. The Pacific Catastrophic Risk Assessment and Financing Initiative⁷ notes that the Solomon Islands 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. More severe damage is expected to structures built with less stringent criteria.

85. Such risk was dramatically illustrated during the TA study when on 6 February 2013 a magnitude 8 earthquake struck off the Santa Cruz Islands leading to a tsunami which generated a peak sea level change of 0.9 - 1m in Temotu Province. Ten people were killed. Almost 600 houses were destroyed, affecting 3,329 people. In the aftermath thirteen camps were established to shelter almost 2,500 people. The supply of drinking, cooking and washing water became critically scarce as wells were contaminated or sources and piping were damaged. In addition at least five major landslides were reported on the north and eastern side of Santa Cruz. These could pose a threat to damming upstream and consequently pose a threat to communities downstream.

4. Water Resources

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

87. A number of small scattered communities are located along both sides of the Fiu River between the intake and powerhouse, mainly away from the river and above its steep banks at around 150m above sea level. These communities depend on the Fiu River daily for washing and bathing. For drinking water, communities use lateral streams and rainwater collection tanks. On occasions the Fiu River is used for food in the form of eels, fish and prawns as part of their subsistence livelihood although it is noted that these are now rare in the catchment due to past fishing pressure. The catchment area above the intake is very sparsely populated due to the rugged nature of the area and distance from social infrastructure.

a. Fiu River Hydrology

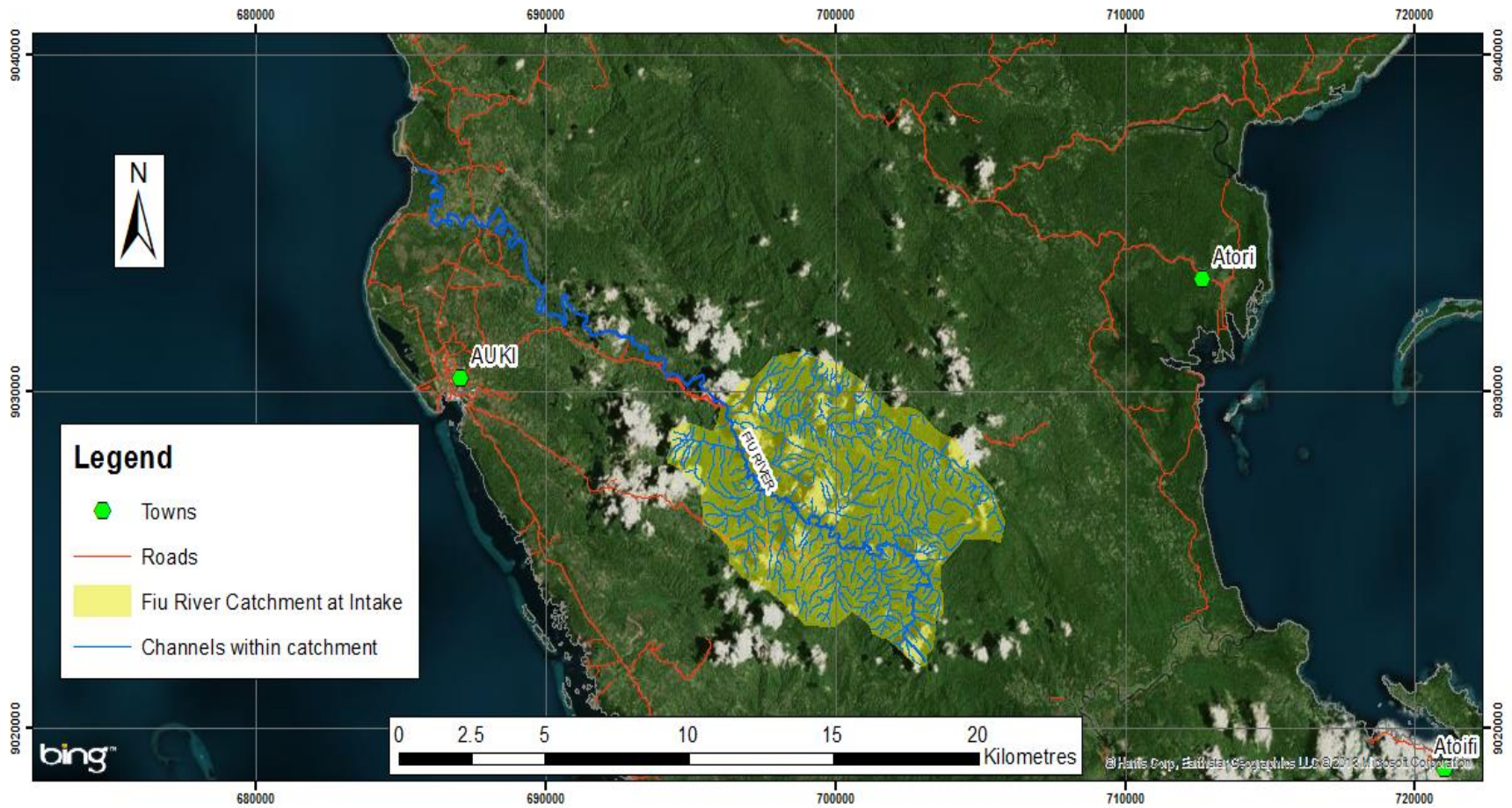
88. The Fiu River emerges at an altitude of about 600 m above sea level, draining a catchment in the hills of the Kwarai area in central Malaita (around 10 km east of Auki township), and flows north-west to meet the coast 6 km north of Auki. The location of the catchment at the

⁷ SOPAC, ADB, WB, JICA, GFDRR, AirWorldwide, GNS Science; Pacific Catastrophe Risk Assessment and Financing Initiative, Solomon Islands (2011)07

proposed intake site is shown in Figure 4.4. The catchment has an area of 62 km², at an average elevation of 455 m above sea level.

89. Using the water balance method the hydrology report for the feasibility study estimates an average annual discharge at the proposed hydropower intake of 7.5 m³/second assuming average annual rainfall across the catchment of 5,000 mm. This is equivalent to 120 L/s per km². However, using limited available water-level data from a recording station at the intake a mean flow of 2.8 m³/second is calculated. With a catchment at the recorder of 62 km², this corresponds to a specific discharge of 45 L/s per km², significantly lower than the 120 L/s per km² estimated using a water balance approach.

Figure 4.4 - Fiu River Catchment at Proposed Intake Site

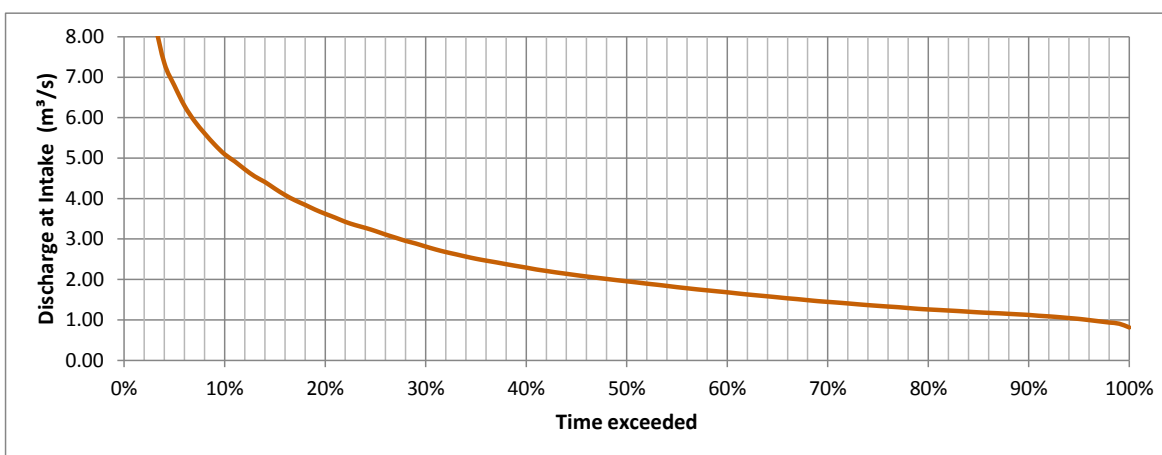


Source: PREP Feasibility Study (2013)

90. The low specific discharge calculated at the water-level recorder is believed to be due to the loss of flow from the catchment through the karstic land form. As an example, a tributary to the Fiu, known as the Nangananga, has a significant catchment area of 17 km² based on topography, but has essentially no surface discharge, flowing on the surface only during periods of high rainfall. Locals have identified a number of sinkholes on the mainstream of the Fiu River below the Fiu River Gorge.⁸

91. Given the presence of significant sinkholes within the catchment, verifiable flow estimates can only be made at the site of flow and water level recording. The water balance approach to estimating flows is therefore considered not suitable for this site. Flow duration statistics for the flow series derived from the Fiu River level recorder (April – December 2012) are presented in Figure 4.5.

Figure 4.5 - Flow Duration Curve for Fiu River



Source: PREP Feasibility Study (2013)

92. The estimated flow duration curve and tabulated statistics are given below in Table 4.1.

Table 4.1 - Estimated Flow Duration Statistics at Fiu River Intake

Parameter	Discharge (m³/s)
Maximum	70
Mean	2.80
Minimum	0.81
20% exceedance	3.62
50% exceedance	1.95
80% exceedance	1.26

Source: PREP Feasibility Study (2013)

93. These flow duration statistics are based on a short period of record, which does not include a full wet season, so may be expected to be biased low. Additionally, flow rate at the maximum recorded river level is subject to significant uncertainty due to extrapolation of the rating curve.

⁸ SIEA; Small Hydropower Scheme Pre-feasibility Study - Fiu River, Honiara, Solomon Islands (July 1996)

B. Biological Resources

1. Terrestrial Habitats

94. **General.** The terrestrial ecosystems of Solomon Islands include tropical moist forests, montane forest and secondary vegetation, grassland and savanna, lowland rainforest, and cropland. The Solomon Island forests are one of the 200 most important “ecoregions” in the world and one of the 10 most threatened forest ecoregions (SOE 2008⁹). A range of forest types are found across the Solomon Islands, many of them unique to this region. The Solomon Island forests with 4500 species of plants are recognised as one of the world’s great Centres of Plant Diversity, rich in unique palms, orchids and climbing pandanus. Currently about 25 tree species are threatened.

95. While diversity is high, endemism is low, with no endemic families and only three endemic genera. Endemism of species is not accurately known but is thought to range from ten per cent of fern species to 80% of pandan species. The islands with the highest rate of endemism are Santa Cruz (Temotu) and Guadalcanal. The main groups of flora include 20 species of pandans, 33 species of palms, 277 species of orchids, seven species of ngali nuts, 19 species of other nuts (cut nut and alite nut), 11 species of shrubs, 14 species of *Eleocarpaceae* trees and 340 species of ferns.

96. It is considered by some that there is greater animal diversity in Solomon Islands than anywhere in the Pacific.¹⁰ There are approximately 223 species of birds, 53 species of native mammals (mostly bats, rats and possums), 80 species of reptiles and 21 species of frogs. A large proportion of the fauna are endemic including 82% of birds, 50% of mammals, 41% of reptiles and 41% of frogs. Many of these unique species occur on only one or two islands and thus their populations are quite vulnerable. However, in general there is limited data on distribution, status, ecology and habitat requirements of the fauna.

97. **Project Area.** The natural vegetation cover of the catchment area (above the intake) is rainforest. Secondary forest growth is predominant, with primary forest remaining along the riparian and steeper, less accessible areas which make it unattractive for commercial logging.

98. The National Forest Resources Inventor¹¹ describes the general forest type and condition of the Fiu River catchment and project affected area based on aerial photographs taken during the mid 1990s. Much of the catchment is classified as degraded hills rainforest. Degraded is defined as canopy disturbances, resulting from human activities (clearing, cultivation, logging) or natural events such as cyclones.

99. Hills rainforest typically comprises mixed species¹² including: *Pometia pinnata*, *Gmelina moluccana*, *Calophyllum spp*, *Pterocarpus indicus*, *Elaeocarpus sphaericus*, *Camptosperma brevipetiolata*, *Dillenia salomonensis*, *Endospermum medullosum*, *Parinari salomonensis*,

⁹ SIG MECM; Solomon Islands State of Environment Report, Honiara, Solomon Islands (2008)

¹⁰ Berdach J T & Llegu M; Solomon Islands Country Environmental Analysis. Honiara, Solomon Islands, ADB TA 6204 (2007)

¹¹ SIG Ministry of Natural Resources & Australian International Development Assistance Bureau; Solomon Islands National Forest Resources Inventory Volume 3 - Malaita Province, Solomon Islands (1994)

¹² Classification as per the Solomon Islands National Forest Resources Inventory Volume 3 Malaita Province (see footnote 11). This list is supplemented by direct observation of tree species during the Fiu River FAR Survey.

Terminalia brassii, *Schizomeria serrata*, *Maranthes corymbosa*, and *Vitex cofasus*. Fruit tree species such as *Canarium spp.*, *Gnetum gnemon* and *Artocarpus altilis* are also present.

100. The habitat and vegetation pattern of the project affected area between the intake and the powerhouse comprises degraded hills rainforest interspersed with cleared areas for village gardens. The degradation of the rainforest is largely the result of the close proximity of small village communities utilising the surrounding forest resources for i) housing, furniture and medicinal plants (trees, bark and leaves, sago palms, canes, various plants and shrubs); ii) vegetation clearance/shifting cultivation for agricultural plots; and iii) access tracks connecting the various communities from the road head and iv) access tracks to the river for washing and bathing. These activities over many years have diminished the quality of the forest habitat in the project area. It is unclear from discussions with community members whether the project area had been subject to commercial logging in the distant past. However, observations made during the Fish and Aquatic Resources (FAR) survey (Attachment 2) confirm that habitat intactness both aquatic and forest decreases rapidly from immediately above the proposed intake site to the power house. The status of the forest within the project area is currently a highly modified habitat and a catchment management plan is not required.

2. Terrestrial Fauna

101. Whilst a range of wildlife was reported during community consultations as being present in the catchment including birds, opossums, frogs, lizards and aquatic fauna, the forest is considered generally poor in terms of wildlife for village hunting purposes. Wild pig populations are very low and not hunted. Bird life was previously hunted for food particularly Kurukuru (pigeon) but this ceased following confiscation of firearms ten years ago as a result of civil tensions within the country. Locals have previously reported that there are no large fish species in the catchment due to extensive trapping and netting in the lower reaches which resulted in the loss of fish population some ten years ago.¹³ Smaller fish species are plentiful in the river but are not fished by local communities.

3. Fish and Aquatic Resources

102. A FAR survey was undertaken in the project area to establish a baseline inventory of fish and aquatic resources through a rapid biodiversity survey methodology.¹⁴ The full FAR report for the Project is presented in Attachment 2. Information was gathered through direct observations and informant interviews. The survey involved walking along the length of the project affected river channel from above the intake site to below the powerhouse site and making observations (with the use of snorkel as needed) on: 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. In addition, the survey included a nocturnal observation in the river channel. The key findings of the FAR Survey Report are summarized below.

103. 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. Twenty two fish species were sighted in the Fiu River during the field survey with a further five species reported present by informants. All species sighted are classified as Least Concern status or unlisted in the IUCN Red List. The relative abundance of species sighted is presented in Table 4.2.

¹³ ADB; RETA 7329 Mini-hydro Pre-feasibility Studies, Honiara, Solomon Islands (2012)

¹⁴ 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 Fiu River

Dominant species	Common species	Occasional species
<i>Stiphodon semoni</i> <i>Stiphodon birdsong</i> <i>Stiphodon rutilaureus</i> ** <i>Awaous spp</i> <i>Sicyopterus lagocephalus</i> <i>Ophieleotris hoedti</i>	<i>Sicyopus dicodinnis</i> <i>Lentipes spp</i> * <i>Mesopristes agents</i> <i>Sicyopus mystax</i> <i>Eleotris fusca</i> <i>Butis amboinensis</i> <i>Stenogobius hoesei</i> <i>Mesopristes cancellatus</i> <i>Macrobrachium lar</i>	<i>Anguilla marmorata</i> ** <i>Stiphodon atratus (female)</i> <i>Khulia rupestris</i> <i>Liza vaigiensis (juveniles)</i> <i>Ophieleotris marmoritaccea</i> <i>Glossogobius spp</i> <i>Schismatogobius marmoratus</i> <i>Belobranchus belobranchus</i> <i>Ambassis miops</i>

Source: Fiu River FAR Survey, Pacific Horizons Group (2013)

Notes: *Endemic to Solomon Islands **Locally rare due to fishing pressure

104. The dominant element of the fauna consists of goboid fishes (*Stiphodon*, *Sicyopterus*, *Sicyopus*, *Awaous*, *Lentipes*) which is typical of clear rocky streams in the interior of the Solomon Islands.¹⁵ According to Polhemus et al freshwater fish species inhabiting the Solomon 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. It is understood that the pelagic goboid larvae enter Solomon 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 almost no reliable information about the details of such larval migrations in the Solomon Islands.¹⁶

105. Upstream of the intake site the Fiu River aquatic habitat is characterized by predominantly riparian areas of primary forest with aquatic substrates of sand and cobbles and clear to very clear water interspersed with stretches showing disturbance due to landslides and human activities giving rise to localized sedimentation runoff and algae.

106. Aquatic habitat along the approximately 2 km stretch of river to be affected by the project (intake to powerhouse) shows a rapid reduction in natural quality compared to the aquatic habitat upstream from the intake site. As can be seen in Figure 3.1 and confirmed through field observations and informant interviews, this is largely the result of human activities from nearby communities (forest clearance and disturbance, river crossings, usage of the river for washing, bathing, fishing and recreation). The change in habitat quality is evident through a significant increase in soil and organic debris, algal growth and reduction in water clarity, the result of localized runoff and effects of human accessibility.

4. Rare and Endangered Species

107. Solomon Islands has over 25 threatened tree species, including ebony, rosewood, rattan and some palms. Ebony (*Diospyros insularis*) is listed as endangered. No proper assessments have been carried out for rare or endangered plant species in Solomon Islands.

108. The International Union for Conservation of Nature & Natural Resources (IUCN) undertakes a global assessment to classify species at varying risk of global extinction.

¹⁵ Polhemus DA, Englund RA, Allen GR, Bosetto D & Polhemus JT; Freshwater Biotas of the Solomon Islands Analysis of Richness, Endemism and Threats, Bishop Museum Technical Report No. 45, Honolulu, Hawaii (2008)

¹⁶ Ibid

109. Excluding species of 'least concern' which are common and widespread species that are not dependent on conservation efforts and do not qualify for near threatened or threatened status, the 2006 Red List identifies 65 species of fauna in Solomon Islands which are endangered or threatened, including 35 of 44 bat species and all eight of the rat species. The definition for each category, as defined in the Red List, is provided in Attachment 3a.

110. Malaita has three endemic bird species including the Malaita fantail (*Rhipidura malaitae*) classified as 'vulnerable', the Malaita honey eater (*Myzomela malaitae*) classified as 'near threatened' and the Malaita white eye (*Zosterops malaitae*) classified as 'least concern'. An additional 15 species have unique subspecies on Malaita.¹⁷ The documented ranges of these species are above the altitudes most threatened by logging and clearance, however little is known about extant distributions or population size. Eighteen indigenous mammal species including bats and rats have also been recorded in Malaita.

111. As on other islands in the country, habitat loss as a consequence of population growth and industrial scale logging are the major threats to biodiversity.

112. No endemic or endangered species were observed during the field investigations.

5. Protected Areas and Areas of Conservation Value

113. Malaita Province does not have any formalized protected area and there appear to be no formal conservation initiatives on the island. Local landowners do not report any locally protected area within the Fiu River catchment. However, two major areas of forest on Malaita have previously been proposed as protection areas against commercial exploitation. More recently these same areas have been identified as proposed Important Bird Areas (IBAs).¹⁸ They include the Central Malaitan Highlands and the Maramasike - Are-Are Lagoon area in southern Malaita. Both areas are located outside the Fiu River catchment area.

114. **The Central Malaitan Highlands.** The proposed area encompasses the highest peak of Malaita (Mount Kolovrat, 1300m) and the surrounding montane and lowland forest. The area is representative of the landscape of the mountainous heart of the island and would protect habitat and fauna that is endemic to the mountains of Malaita such as the Malaitan fantail. The boundary extends downslope to include lowland forest adjacent to the Wairaha River, providing a complete transition from extreme highland to low altitude.

115. **Maramasike - Are-Are.** The boundaries include the very southeastern end of Malaita, the very narrow Maramasike passage and the northwestern side of Maramasike Island. Included in this site is the Are-Are Lagoon, the least disturbed of Malaita's distinctive lagoon communities. The catchments of the Maramasike passage support some of the most extensive remaining tracts of forest on low hill and alluvial surfaces in the Solomon Islands. The lowland forest provides an ideal habitat for all elements of Malaita's lowland bird community including many of its restricted range species.

¹⁷ Filardi Catherine E, Boseto D, Filardi Christopher E; A Preliminary Desk Study Identifying Important Bird Areas in the Solomon Islands, SPREP, Samoa (2007)

¹⁸ Ibid

C. Socioeconomic and Cultural Resources

1. Population and Communities

116. The total population of Malaita is 137,596 with 50.3% being male and 49.7% is female. Malaita is the most densely populated province and accounts for more than a quarter of the national population. Malaita has 24,421 households with an average size of 5.6 persons per household. The province is divided into 33 wards and the Project site is located within Kwaimala/Radefasu Ward (Ward 29). From the last census in 2009, there are 9,634 persons in Ward 29 making it the second largest ward in Malaita.

117. Auki town is the capital of Malaita province. Auki Ward (Ward 1) receives an influx of people from the other wards 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 11.6 % compared with the national average of 4.7%. The urban population of Malaita comprises 4% of the total populace of Malaita.

118. The population of the Project area is dominated by people from more than 30 tribes. The tribes are predominantly of Melanesian ethnicity. Melanesians make up more than 92% of the population of Malaita while other minority ethnic groups including Polynesian, Micronesian (Gilbertise), European, Asian and others, make up the remainder.

2. Health and Education

119. According to the Solomon Islands Health Service Delivery Profile 2012 by WHO and the Ministry of Health, the Human Development Index (HDI) of 0.51 ranks Solomon Islands 142 out of 187 countries. This indicates an overall low level of development (based on health, education and income). Urbanization and population growth are two major factors that places pressure on the government to continue providing the communities with good health services. Remoteness and vastly dispersed communities are a challenge in providing proper healthcare to the population resulting in some communities receiving less or no services at all compared to others that are more accessible by transportation. Access to improved sanitation is very low (18%) with a large difference between urban households (77%) and rural households (5%).

120. Malaria continues to be a leading cause of mortality and morbidity, especially among children and infants. In 2007 clinical malaria and fever accounted for 28% of acute care attendances. At the same time, non-communicable disease (NCD) risk is rising with a recent SIG and WHO study reporting 46% of the study population at high risk for NCDs; 67% overweight; and 33% diabetic.

121. The total number of health facilities in the Solomon Islands is 335. The ratio of population to a facility is 1,540 persons per facility. This however is not a true representation of current access to these by remote communities. The top three facilities only provide basic services. Those with acute illnesses have to go to the provincial hospitals or patients requiring major operation have to travel to the national referral hospital. The communities in the Fiu River Project area live far from the provincial hospital and have no direct road access. They have to walk at least 2 km in bush tracks and cross Fiu River to reach the access road leading to Auki.

122. Malaita has a literacy rate of 70.4% with female (62.4%) much lower than male (78.8%). Based on the 2009 census, approximately 27% of the population 12 years and older had no schooling and about 55% of the population had attained only primary education. School

enrolment rate in 2009 among 6-12 years old was 75.3% which is much lower than the national average of 83.3%.

3. Cultural Heritage

123. Many Malaitans still adhere strictly to their traditional beliefs and practices. Special, sacred or restricted sites or “tambu” areas represent the history, lineage and society of different clans and lines. It is known that bush and forest areas are important for traditional resources (including medicines). Cultural centers have been established in the province including one at East Kwaio; the Kwaio Fandanga Centre at Ngainasuru. There are also others at Are’Are district and in South Malaita. There is also the recent arts festival cultural village at Auki that displays the different cultures of Malaita Province.

124. Consultations with the Fiu Project Area landowners have indicated that there are no areas of historical significance immediately within the Project site. 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 site.

4. Land use, Livelihoods and Employment

125. The main use of land by majority of rural Malaitans (>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 Malaita owns a small patch of garden as the main source of food. The main crops grown are coconut, cassava, taro, yam, sweet potato, banana, ngalinut and various fruit. 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.

126. Whilst the total area of Malaita stands at 4,225 km², only 536 km² is regarded as an agricultural opportunity area according to the Rural Development Report 2001. The primary barrier to agricultural potential is steep topography and land disputes. Coconut and copra are the major cash earning activities in the province. The level of smallholder copra 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 province.

127. Logging activities have removed significant stands of natural forest and contributed to the degradation of soil in Malaita province and many parts of the Solomon Islands. According to the Central Bank of the Solomon Islands (CBSI) 1.9 million cubic meters of timber was produced nationally and 7% of that came from Malaita Province.¹⁹ That is about 130,000 cubic meters or about 44,333 trees that were logged in 2011 from Malaita (based on 3 cubic meters of timber extracted from one tree).

128. The 2009 census indicated that labour force participation rate in Malaita is 66.7% and the employment to population ratio is at 16% with the rate among females significantly lower (9.9%) than males (22.1%). The majority of those in the labour force are in the informal sector

¹⁹ CBSI; Annual Report, Honiara, Solomon Islands (2011)

mainly in subsistence agriculture and fisheries and exploitation of forest products. Unemployment rate for Malaita was recorded as 0.8% in the last national census.

129. Logging and saw milling have been carried out on Malaita for many years and the sawn products are often used locally or sold through markets. Income generated from this activity goes mainly to land owners who have trees and sawmilling equipment.

130. For the people in the immediate project area, living conditions are relatively poor. More than 95% of the dwellings in the project area are made from traditional materials except for the flooring where most households use locally sourced timber. The people from the Fiu watershed live in a mountainous region (inland) and subsistence farming and hunting predominates.

131. Attitudes toward marketing and selling have changed over the years with households increasingly growing produce and catching fish to sell at markets for daily cash income. Women also have developed skills in crafts and food making, and will daily bring their produce to the market or road side to sell. None of the homes in the Project area are connected to the electricity grid which is 6-9 km away in Auki.

132. Pig rearing is traditional and valuable to many communities in the province. Traditionally pigs have been used for payment of compensation, bride price, gifts and for feasting. Nowadays, pigs are also reared for commercial purposes mainly by individual households or families.

5. Infrastructure

133. **Water Supply.** From the 2009 Census data, 46% of the population of Malaita relies on communal standpipes as the main source for drinking water, while 33% relied on lateral streams and rivers. Household and communal rainwater tanks are also an important drinking water source in the province. The communities within the watershed of Fiu River rely on household water tanks, lateral streams and communal piped water for drinking.

134. Some 38% of households depend on rivers and streams for washing and bathing while 31% of the households use communal standpipes for washing. The Outer Islanders of Malaita use only water from dugout wells for washing. Other households in Malaita use communal tanks and the sea for washing.

135. **Sanitation.** Almost half of the households (47%) in Malaita, mostly in the rural areas, do not have access to flush/pour toilets or pit latrines but use either a closet over sea or water or an "open" toilet (beach, river, or forest). Just above a quarter of the households use pit latrines either shared or privately owned. Only 4% of households have access to flush toilets, most of these households are located in Auki town.

136. **Energy.** In Malaita 3% of households rely on the SIEA diesel based electricity grid mostly located in Auki town for lighting and other purposes. More than three quarters (79%) of households use kerosene lamps as their main source of lighting while 12.2% use solar systems. Other sources of lighting for households in Malaita include wood fire, small hydropower, portable generator and gas. For cooking, the majority (98.3%) of households use wood while the rest rely on gas, kerosene and other forms.

137. **Waste Management.** There is no organized waste management system in Malaita, similar to most parts of the Solomon Islands. In Auki, the Provincial Government provides

waste collection services for town residents only. Some 92% of households dispose of their rubbish in the sea or rivers, burn it or bury it in their backyards.

138. **Transport.** Malaita has the longest road system in the whole of Solomon Islands. The North Road is 112.4 km long, South Road is 61.49 km long, East Road is 37.3 km long and feeders roads total 44 km. All these roads connect Auki Town to the different parts of the Province. Malaita has also received heavy investment in the recent years to maintain and connect these roads including construction and maintenance of fords and small bridges across streams and rivers.

139. The roads have provided communities with better access to Auki for medical services, banking facilities, markets and ports. The roads have also facilitated expansion of telecommunication services into rural areas.

140. The main sea port in Malaita Province is in Auki. There are two wharves in Auki including one that was financed by JICA and recently completed in 2012. Ferry services between Auki and Honiara are on a daily basis.

141. Other wharves in the province include 11 in the south and three in the east. The shipping service to the other parts of Malaita ranges between once and three times per week. Compared to the other provinces, shipping services to Malaita are far more regular due to large movements of people going to and from Honiara.

142. There are five airfields in the province. The Gwaunaru'u Airfield in Central Kwara'ae about 20 minutes drive from Auki, was formerly one of the busiest airfields in the country but due to better shipping services to Malaita, there are now only three flights from Honiara to Auki a week. The other airfields are Atoifi in the Eastern Region, Parasi, Southern Region, Afutara, Central Region and Ontong Java, Malaita Outer Islands.

6. Industries

143. There are no major processing industries in Malaita Province except for small timber processing yards in Auki and other parts of Malaita serving local markets and small-scale coconut oil processing plants in the north. Malaita is a major contributor to the national economy through forestry, copra and cocoa commodities. As noted previously according to CBSI Malaita contributed 7% of the total national timber production in 2011.

144. Solomon Islands produced 35,565 tons of copra in 2011 a 40% increase over 2010, Guadalcanal contributed the largest share of the output at 27%. In the same year copra production on Malaita declined to less than 17% due to either low local buying price or fewer buying centres.

145. For Malaita outer Islands of Lord Howe and Sikaiana, marine resources especially sea cucumbers are the primary source of income. This income source stopped for more than three years due to a national ban on the harvest of sea cucumber, due to a significant decline in their numbers. The ban was lifted in early 2013.

146. Handicrafts are also produced mainly by individual businesses and incomes are not regular.

7. Tourism

147. Malaita receives a large number of tourists annually due to reliability of transport and accommodation. The strong culture and the undisturbed way of life in certain parts of Malaita are the main attraction. The series of artificial islands on the north of Malaita also brings visitors to the province.

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Screening of Potential Impacts

148. The ADB checklist for hydropower projects was used to screen for any potential environmental impacts. The checklist was prepared during the project inception stage following review of previous studies and finalized following field inspection and community consultations in Auki in March 2013. The completed REA checklist is presented in Attachment 4 and confirms the Project is Category B.

149. 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.

150. 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

151. Erosion could occur during construction of the access road, and 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 Fiu River and its tributaries. Such impacts can be avoided or minimized through recognized good engineering design and construction practices incorporating the following mitigation measures:

- As much as practicable, aligning the intake access road adjacent to the headrace canal so as to avoid the need for separate excavation corridors;
- 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 bank protection in the river channel adjacent to the weir/intake and sandtrap, and adjacent to the tail race; and
- Scheduling the construction in the dry season (Nov - May).

152. 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.

153. The relatively small scale nature of the Project coupled with local labor 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

154. 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 Fiu River during various construction activities as outlined below:

- Vegetation clearance along project corridor and stockpiling of excavated materials;
- Excavation works associated with construction of:
 - approximately 3.5 km of access road
 - intake structures, (weir, intake sandtrap) and associated riverbank protection works
 - 1.55 km long headrace canal and 250 m penstock
 - powerhouse foundations
 - tailrace and associated riverbank protection works
- Spoil disposal from excavation works.

155. Construction activities will involve some use of powered mechanical equipment especially for excavation works for 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 labor. This should help in minimizing the potential for erosion and sediment runoff into the Fiu River.

156. 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 Fiu River and its tributaries. As a minimum these mitigation measures will include:

- As much as practicable, aligning the intake access road adjacent to the headrace canal so as to avoid the need for separate excavation corridors thereby minimizing the excavation footprint;
- 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 (Nov - May).

157. 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.

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

3. Dust and Noise.

159. 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 Fulisango Road from Auki. This will be temporary and sporadic over a 21 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.

4. Materials and Spoil Management

160. 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 Honiara as has been the case for other recent infrastructure projects. 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. The aim of access road design will be to balance cut and fill as much as possible to reduce requirements for import of material.

161. 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 Malaita Provincial Executive Committee (MPEC) and local landowners for use of sources and disposal of excess spoil; and
- Methods of transportation to minimize interference with normal traffic.

162. 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

163. 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.

5. Waste Management

164. 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.

165. As part of the EMP 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 MPEC;
- 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 500m 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.

166. The contractor's WMP, as part of the EMP, will need to be approved in writing by the SIEA's project management unit (PMU) prior to start of construction.

167. **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.

168. 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 PMU 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 labeling;
- 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 PMU;
- Adequate precautions will be taken to prevent oil/lubricant/ hydrocarbon contamination of drainage channel beds;
- Spill cleanup 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.

169. 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.

170. 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

171. The Project involves placement of a low weir (less than 1m high) with a single gated sluice on the left side and fish pass on the right side of the river. 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 2 km downstream. The main effect on the aquatic ecosystem arises from a reduction in the natural flow regime of the Fiu 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 2 km stretch. The Project has a design flow of 1.8 m³/second and the estimated mean flow of the Fiu River at the intake site is 2.80 m³/second. The estimated flow duration curve indicates that for about 51% 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.

172. The 2 km stretch of channel to be affected by reduced water flow due to the project represents a relatively small proportion of the entire river length and has a relatively low aquatic habitat quality due to human disturbance. Moreover, along this 2 km stretch there are a number of inflows to the channel from tributaries on both sides of the river (see Figure 3.1). In addition, ground water inflows to the channel would also be expected. These factors coupled with the fact that the area receives fairly high rainfall (mean 3,300 mm/yr), would likely ensure maintenance of a continuous flow in the 2 km affected stretch throughout the year without any purposely designed environmental flow release. Nevertheless, a minimum environmental flow equivalent to 10% of the mean annual flow (at the intake) will be released into the natural channel at the intake at all times. Thus the intake structure will be designed to ensure that a minimum environmental flow of 280 L/s will be released into the Fiu River at all times. This minimum flow, coupled with a proposed fish pass on the right bank of the channel is considered sufficient to ensure the sustainability of the existing downstream ecosystem along the 2 km affected stretch.

173. The FAR survey revealed that the aquatic habitat within the 2 km section to be affected by the project shows a significantly reduced natural quality (increased soil and debris, algal growth, reduced water clarity) compared with the river upstream of the intake. The degraded quality along the stretch is considered to be the result of human activities from nearby communities (namely forest clearance, river crossings, usage of the river for washing).²⁰ In spite of this a variety of small, common and predominantly goboid fish species were identified in this stretch. Such small species are not used for food.

174. A 2008 study on freshwater biota of the Solomon Islands which analyzed richness, endemism and threats to Solomon Islands' 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.*²¹ Such a statement provides a certain confidence that the scheme is a run-of river and not a dam and given the proposed mitigation measures for a minimum environmental flow release of 280 L/s to sustain the existing aquatic ecosystem of the Fiu River between the intake and the powerhouse, the impact of the Project on the overall aquatic biota of Fiu River and Solomon Islands biodiversity as a whole is likely to be insignificant.

175. **Fish migration.** As noted above the proposed weir for diverting water to the hydropower scheme will include a fish pass structure on the left bank. The fish pass will be suitable for goboids because they possess a "sucking disk" (a modification formed by the fused pelvic fins) which is used for clinging to rocks in fast flowing streams.²² This coupled with the fact that i) the existing river comprises lots of rapids and jumps which the goboids already negotiate and ii) there will be a significant environmental flow suggests that the weir with a properly designed fish pass will not be a barrier to upstream migrating goboids. This in combination with a minimum environmental release as recommended above will ensure that the potential impact of the weir on fish migration in the Fiu River is likely to be insignificant.

²⁰ The 2 km stretch including both upstream and downstream is occasionally used for fishing for eels, larger fish species and prawns, although these are now rare in the catchment due to past fishing pressure.

²¹ Polhemus et.al; Freshwater Biota of the Solomon Islands Analysis of Richness, Endemism and Threats, Bishop Museum Technical Report No. 45, (p. 146), Honolulu, Hawaii (2008)

²² Ibid, p. 25

2. Impacts on Terrestrial Habitat and Biodiversity

176. The Project will involve clearance of about 3.5 ha of vegetation, comprising mostly degraded secondary hills rainforest with interspersed areas previously cleared for subsistence gardens. A breakdown of the estimated vegetation clearance area by project components is provided below.

- Access road to head works and powerhouse 1.75 ha (3.5 km x 5 m);
- Headrace corridor and head pond 1.55 ha (1.55 km x 10 m);
- Penstock 0.125 ha (250 m x 5 m);
- Head pond fore-bay 200 sq m (20 m x 10 m); and
- Power house and tailrace 400 sq m (20 m x 20 m).

177. It should be noted that the access road will utilize the alignment of existing walking tracks to a significant extent and this will reduce the need for forest clearance. The forest to be cleared comprises degraded secondary hills rainforest habitat which according to the SPS is classified as modified habitat.

178. The modified forest habitat is considered to be of relatively low value due to the past and ongoing exploitation of trees and other forest resources by nearby communities for housing, furniture and other subsistence requirements. Loss of forest habitat can also be minimized by reducing the width of the clearance corridors for the access roads, headrace canal and penstock route and adjusting the alignments to minimize the need to remove large trees wherever possible. Compensation to land owners for loss of trees will be provided in accordance with the resettlement plan (RP) prepared for the Project.

179. Taking into account the overall disturbed natural environment of the Project area, the potential loss of modified forest 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.

180. The transmission line route will be within the access road corridor and the existing public road to Auki. 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 corridors 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 SIEA's minimum clearance requirements. Any compensation to local residents for loss of trees will be provided in accordance with the RP. 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.

181. The proposed use of predominantly manual labor 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 clearly marked and adhered to by construction workers.

182. 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

183. The workforce is expected to be in the order of 100, with 40% being unskilled labor which can be recruited locally from Auki and surrounding settlements and 60% skilled labor which will likely come from outside the area can be accommodated in Auki 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.

184. 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).

185. 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 RP.

186. 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.

187. 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) and grievance redress mechanism (GRM) 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 (PSA) and gender action plan (GAP);
- As per CPP requirements 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;
- Location of site office and facilities to be agreed with local community (including land owners) with facilities approved by the PMU and managed to minimize impacts and any negotiation or lease arrangements to follow established procedure as per the RP;
- The facilities (camp and yard) will be fenced and sign-posted and unauthorized access or entry by general public will be prohibited;
- 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 labor, 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 PMU and local community after use; and
- Post-construction the area shall be fully rehabilitated and all waste materials shall be removed and disposed to disposal sites approved by local authorities.

188. 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

189. 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 (ESHG).

190. 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.

191. 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 ESHG;
- 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 Auki town for medial or emergency treatment if required;
- Provision of potable water supply in all work locations; and
- Fencing shall be installed on all areas of excavation greater than 1m deep and at sides of temporary works.

192. 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 PMU.

3. Community Health and Safety

193. 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.

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

E. Operation Impacts

195. The project access road will provide a significant indirect benefit to the communities located above and within the vicinity of the Project intake site by providing improved road access for remote communities to markets and social services (health, education etc). Currently people living in these communities have to walk several kilometers along bush tracks to the nearest road.

196. The access road to the intake site will pass alongside the head pond and be partially aligned adjacent to the headrace canal. This gives rise to the potential for children to play in, or fall in the canal. Similarly, where the canal is aligned away from the road the maintenance corridor could also become a de facto walking track for local communities. Security fencing will be required to ensure there is no public access to the canal and head pond.

197. Provided the Project includes the necessary safety fencing described above and is designed and operated such that a minimum environmental flow of 280 L/s is maintained in the river at the intake, there will be no significant environmental impacts associated with operation of the Project.

F. Climate Change Effects and Adaptation Requirements

198. The following paragraphs rely primarily on review of available information on climate risks in the Solomon Islands with a view to proposing practical measures for integrating adaptive measures into Project design. Information has been gleaned from the Infrastructure, Climate Change and Disaster Risk Management section of the Draft Solomon Island National

Infrastructure Investment Plan (SINIIP) 2012; Solomon Islands National Adaptation Program for Action (NAPA) 2008; and ADB's Climate Risk and Adaptation in the Electric Power Sector, 2012.

199. 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.

200. Limited information exists in Solomon Islands related to climate change risks. Some detailed assessments have been done for Honiara and Malaita but are scarce for the rest of the country. Based on the available information, an assessment of climate risks is presented and recommendations made for resilience building adaptive measures into the project.

1. Review of Relevant information

201. 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 Solomon Islands. 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.²³ However, increases in extreme rainfall days are expected in terms of both frequency and duration.²⁴ Changes to drought incidence are also uncertain but may decrease. For most infrastructure peak rainfall is more important than annual average rainfall. Acceptable assumptions based on risk tolerance often need to be made at the project level.

202. Sea level rise has risen near the Solomon Islands by about 8mm 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.

203. Sea-surface temperatures have also gradually risen around the Solomon Islands 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

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

205. 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

²³ SIG & Australian Bureau of Meteorology; Pacific Climate Change Science Program: Current and Future Climate of the Solomon Islands (2011)

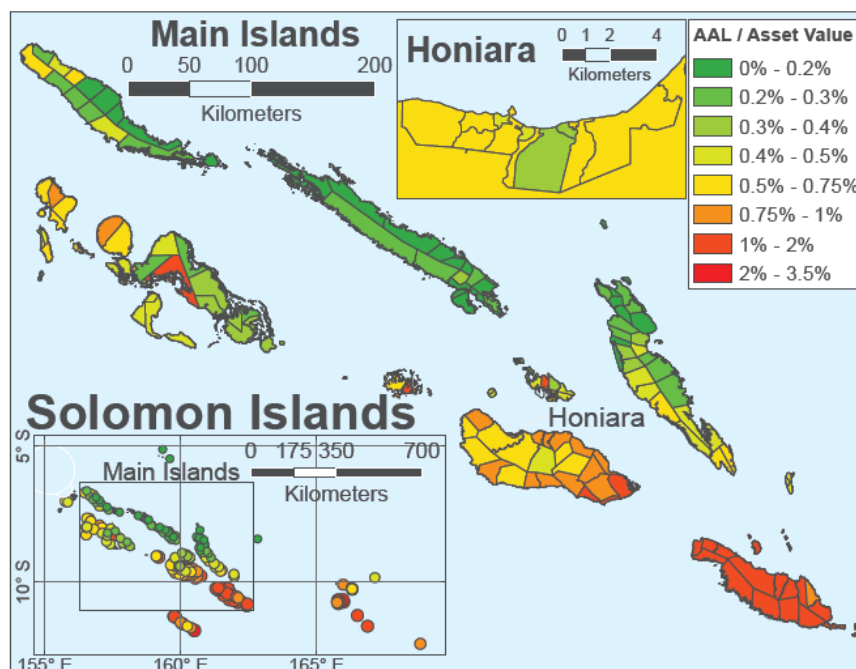
²⁴ SIG MECDM; National Climate Change Policy, Honiara, Solomon Islands (2012)

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.

206. The Solomon Islands are expected to incur on average, US\$20.5 million per year in losses due to earthquakes and tropical cyclones. In the next 50 years the Solomon Islands have a 50% chance of experiencing a loss exceeding US\$240 million and casualties larger than 1,650 people, and a 10% chance of experiencing a loss exceeding US\$527 million and casualties larger than 4,600 people.²⁵

207. A 2011 Natural Hazard Risk Mapping prepared by the United Nations Office for the Coordination of Humanitarian Affairs (OCHA)²⁶ identified the southern part of the country as being more exposed to tropical storms, with Rennell and Santa Cruz (Temotu) Islands being at highest risk, followed by Guadalcanal, Makira and Southern Malaita. The highest risk areas of the country in terms of climate change are a coincident of the existence of infrastructure and the exposure of those regions to hazards events. 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. Northwest Malaita (Project area) is cited as being among the lowest risk areas of the country.

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



Source: PCRAFI (2011)

208. 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.

²⁵ SOPAC, ADB, WB, JICA, GFDRR, AirWorldwide, GNS Science; Pacific Catastrophe Risk Assessment and Financing Initiative (2011)

²⁶ United Nations Office for the Coordination of Humanitarian Affairs (OCHA); Solomon Islands Natural Hazard Risks (2011)

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.²⁷ Earthquakes are the most important hazard for building damage.

209. 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 though detailed studies have been undertaken for Honiara and north Malaita which support concerns over climate change. The Draft SINIIP identifies some of the challenges to the population and economy. It should be noted that the southern facing part of the country has greater exposure to tropical storms as well as earthquake risks. Sea level rise will increase exposure where elevations are lower and floods may increase in more mountainous areas.

210. The SINIIP concludes that Southern Malaita is exposed to strong winds, storm surges and cyclones, experiences high losses of infrastructure due to cyclones and earthquakes, though the population and buildings are concentrated in the northern end of the island. Cash crops such as copra, cocoa and palm oil expansions will increase water demand, the supply of which may become increasingly variable and soil salinity may reduce productivity. These challenges should be considered in the design of the Projects.

211. 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 Draft SINIIP and ADB's report *Climate Risks and Adaptation in the Power Sector (2012)*. 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.

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

²⁷ World Bank; *Not if But When: Adapting to Natural Hazards in the Pacific Islands Region*, World Bank Policy Note, (2006)

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 modeling 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.	

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

213. 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 the Solomon Islands. Therefore design criteria in respect of peak flood size and levels need to take account of the potential effects of climate change.

214. Critical structures that need to be considered for possibly increased peak floods include:

- Intake weir - suitable erosion protection to prevent scour around the intake weir's training walls; and
- 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.
- 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.

215. 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 modeling data to develop synthetic extreme event data. In the absence of climate change modeling 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.

216. 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 armor 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).

217. 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.

218. 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, CONSULTATION AND PARTICIPATION

A. Introduction

219. Stakeholder consultations on environmental issues for the Project were undertaken at both the national and provincial/community level.

220. **National level consultation.** This was undertaken in Honiara with key environmental stakeholders during the inception stage to i) brief them on the project including all potential sites being considered along with the screening and prioritization process; ii) explain the key features of run-of-river small hydro projects and generic potential environmental impacts; iii) ascertain their views and concerns in respect of all the proposed project sites with particular emphasis on identifying key areas of biodiversity significance; and, iv) obtain information from stakeholders to assist in the screening process.

221. A list of invitees, participants, pre-meeting background information provided, power point presentation and views and comments of the participants is provided in Attachment 5a.

222. **Provincial/community consultation/information dissemination.** In respect of both environmental and social issues were undertaken 25-26 March 2013. The project consultation personnel included the Consultant's national environmental specialist and international and national social/resettlement specialists along with the project's SIEA counterpart staff member. Local logistical support was provided by SIEA's provincial out-station Manager. Key activities during the consultation visit included:

- Introductory meeting with MPEC;
- Consultation meeting with project affected land owners interested stakeholders and key community members; and
- Training of social survey team for household surveys and focus group discussions.

223. The MPEC provided strong support to the consultation team by encouraging landowners, key community members and other stakeholders to participate fully in the consultation activities and providing transport and guides for the team's visit to the site.

224. The purpose of the community consultation was to disseminate basic project information, obtain the views and concerns of communities and other local stakeholders with respect to environmental issues 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.

225. **Malaita Provincial Executive Committee.** An initial meeting was held with the MPEC to introduce the PPTA team, explain the purpose of the visit and consultation process within the context of the overall TA objectives including ADB's 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 MPEC's assistance in supporting the consultation process.

226. The MPEC expressed their and the community's strong support for the Project and stated that the provincial government and the local communities have been looking forward to the construction and the operation of the project and the benefits it will bring to everyone. The

Malaita Provincial Secretary has specifically asked when the construction work would begin and how long it would take before the community could enjoy the electricity provided by the proposed hydropower project.

227. MPEC also expressed their appreciation for the process SMEC was undertaking by conducting awareness to the local communities and resource owners on the nature of the project and the potential social and environmental impacts associated with the project. MPEC emphasized that importance for the landowners to be well informed and ready for the process of land acquisition. The MPEC specifically asked for ADB's guidelines on land acquisition and resettlement.

228. MPEC stressed the need for the Project to have ongoing communications with the Province with valid and up to date information on timeframes and requirements for the project, which will enable the province to carry out their part to ensure that the project runs smoothly.

229. It was noted during the meeting with MPEC that all of the land within the proposed project site is customary owned and acquisition of the land is required. The MPEC advised that they had been in discussion with the customary owners about the project and noted that the customary owners were supportive of the project and in their words "committed to achieving a workable arrangement with regard to the land acquisition" required for the project. The MPEC noted that they will work closely with landowners to facilitate the project's land requirements.

230. Details regarding land acquisition issues discussed with the MPEC are reported separately in the RP.

231. **Community consultation/information dissemination.** Meetings were convened in Auki with project affected land owners, key community members and other interested stakeholders. The total number of participants was 26 and consisted of all project affected landowners, key community members (teacher, parish priest, Rural Electrification Officer, youth leaser, landowner committee task force) and other interested community members including the social survey team. There was a small representation of women at the meeting (about 15%).

232. 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 power point presentation by the national environmental specialist providing key information including: i) objectives of consultation meeting within the context of ADB's safeguard requirements; ii) background to the Project including selection and prioritization process for selection of schemes for feasibility study; iii) description of the proposed layout and project components including what the scheme would look like in terms of size and scope, and how it would work (using illustrations and map); iv) identification of the potential environmental and social impacts and benefits associated with the project including types of mitigation measures to minimize impacts; and, v) preliminary assessment of the significance of potential environmental and social impacts of the project. The national social/resettlement specialists presented the information pertaining to their component. The power point presentation used including list of participants is provided in Attachment 5b.

233. Throughout the presentation participants were asked if they had any queries or required clarification, and this was provided by the team on various occasions. Following the power point presentation the participants were asked to express any and every concern they might have regarding the project and were advised that these concerns would be addressed in the design

and implementation of the project. Following the discussion the participants were asked a series of questions to obtain local environmental information pertaining to the communities' knowledge and usage of the project area.

234. A proforma outlining the purpose and methodology of environmental consultations including answers obtained from guidance questions is presented in Attachment 5b.

235. Environmental issues raised by the participants are summarized below. Not many environmental issues were raised by the participants. The few that were raised are summarized below.

Table 6.1 – Concerns Raised During Consultation and Project Responses

Concern/Comment	Response
Concern over contamination of water discharging from the power station back into the Fiu River	This was raised by one of the local community members of Fiu River. It was explained that the purpose of the water was only to mechanically turn the turbine within the powerhouse and no chemicals were added into the water. It was further explained that short term sedimentation in the rivers will occur during the construction phase but will be minimized through proper mitigation measures
Will there be water still running through Fiu River after the project has been constructed especially between the intake and the powerhouse?	The explanation given was that there will be some reduction in the Fiu River flow between the intake and the powerhouse. However, the project will ensure that there will be a minimum continuous flow in the river between the intake and the powerhouse that meets the communities' needs throughout the operational period. This provision is consistent with international best practice in design and operation of hydropower projects and will be implemented in this project. Furthermore, there are a number of tributary streams that join the Fiu River between the intake and the powerhouse and these will be unaffected by the project and add to the reduced Fiu River flow volume between the intake and the powerhouse.
Will the cost of electricity be cheaper with hydro since SIEA will have more revenue due to more customers?	The response to this comment was that whilst the cost of producing electricity from hydropower is significantly lower than diesel, the capital cost for building a hydro scheme is high and that this would be taken into consideration by SIEA in deciding their tariff structure for hydro.
As part of acquisition of land for the project, who will be involved and who will receive compensation for the loss of resources from the proposed project area?	The response to this comment was that everyone within the watershed will be involved in the acquisition process, both above the intake point and below the proposed power house including site for the access way.

Source: PREP Feasibility Study - consultations conducted during PPTA (March 2013)

236. From the consultation it was obvious that the land resource owners at that point were unaware of the actual proposed location of the project components. Understandably the landowners noted that only when physical markers are placed on the ground for the different components of the project will they be able to confidently decide on whose land the proposed project will encroach upon. They expressed that physical markers on the ground would also help the local landowners committee and provincial bodies in the land acquisition process.

237. The Chairman from the representative customary land owners of the project advised that they supported the project and would work closely with the provincial government to facilitate

the project. However, he continued to stress the need to conduct proper and thorough groundwork to ensure that all resource owners are considered during the acquisition process.

238. All participants expressed their strong desire for the project to proceed and a number asked when it was likely the project would be implemented. The team explained briefly the ADB procedures involved in securing a loan with the government and indicative timing associated with procurement should a loan be approved.

VII. ENVIRONMENTAL MANAGEMENT PLAN

A. Introduction

239. 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.

240. An EMP for the project is presented below and complies with ADB's requirements as specified in SPS 2009. 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 ADB's 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

1. General

241. It is most likely that the Project will be implemented under an Engineer, Procure and Construct (EPC) contract and design and supervision consultancy (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 SIEA staff in operating the plant following completion of construction.

242. The DSC will include an international environmental specialist (IES) to ensure environmental safeguards are implemented in accordance with SIG and ADB SPS requirements and to provide training to the national environmental specialist (NES).

2. Institutional Roles and Responsibilities

243. The MMERE is the executing agency for the Project and SIEA is the implementing agency. As such SIEA will be responsible for overall implementation of the Project. It is proposed that SIEA will form a PMU responsible for implementation including procurement, construction and commissioning. SIEA's PMU will be supported by the DSC. SIEA through the PMU will be responsible for ensuring, on a day-to-day basis, that the EMP is implemented during each stage of the project (procurement, construction and operation). This includes ensuring that all SIG and ADB requirements and procedures relating to environmental safeguards are complied with.

244. **SIEA and PMU environmental management responsibilities.** SIEA will be responsible for ensuring that sufficient resources are in place to undertake SIEA's environmental safeguards responsibilities. The PMU will be supported by an DSC during all aspects of project implementation, in respect of environmental management and safeguards application the IES and NES will support the PMU in the following tasks:

- Preparation of the EPC tender documents including integration of the EMP form the approved IEE and draft method statements for various aspects of the EMP such as HSP, MSMP and WMP;
- Consult with ECD to check whether the IEE is suitable as PER or IES under Environment Act or re-format as necessary, make the application for development consent on behalf of SIEA and obtaining consent and permits (BMP) as required;
- Ensuring that SIEA, PMU and contractor are aware of any consent conditions and implications those might have for Project implementation;
- Work with the PMU's social specialists in respect of implementation of the CPP and GRM;
- Supporting SIEA in 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 site-specific EMP (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 (QPR) and safeguards monitoring reports to be submitted to SIEA and ADB; and
- Capacity building of SIEA in environmental management and supervision aspects of project implementation.

245. The DSC will include an IES to oversee that EMP design and construction requirements are fully integrated into the tender documents and assist SIEA meet all its obligations for EMP and safeguards implementation as outlined above. A key aspect of the ES's role will be training and capacity building of the NES and other SIEA staff (including management) in implementation of its obligations under SIG law and regulations as well as general training in safeguards to raise the awareness and build capacity of environmental management in SIEA's operations.

246. A proposed terms of reference (TOR) for the IES has been prepared and is included in the Project Administration Manual. To meet the TOR it is recommended that three person months of IES time is required intermittently over the procurement and construction period.

247. **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. 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 contractor's construction methodology and measures and plans for implementing the EMP (including draft method statements for WMP, HSP and MSMP) as specified in the EPC contract. This includes maintaining a site diary and a grievance registry. The SEMP shall be approved by the PMU prior to the EPC contractor's mobilization to the site. The EPC contractor will be required to report on the implementation status of the EMP to SIEA.

248. **Ministry of Environment, Climate Change, Disaster Management and Meteorology.** The MECDM is responsible for the administration and enforcement of the Environment Act 1998 and its regulations. The department consists of one corporate division and four technical divisions: (i) Environment and Conservation, 13 staff; (ii) Climate Change, 6 staff; (iii) Disaster Management 18 staff and; (iv) Meteorology which has more than 60 staff.

249. The MECDM operates at the national level from its office in Honiara. Personnel from the Meteorology are in some provinces. 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.

250. MECDM is a key stakeholder in the Project and will provide environmental clearance of the Project by review of the IEE (or PER) and issuing development consent.

3. Capacity Building Requirements

251. SIEA currently does not have staff responsible for environmental matters and according to SIEA's General Manager, very little capacity and experience in environmental management aspects in implementation of capital works. There is no capacity within SIEA to prepare, check or monitor the implementation of environmental assessments and EMPs. SIEA currently has no plans to appoint a designated environmental officer and the General Manager advised that there are no financial resources available for such a position.²⁸

²⁸ The General Manager noted that approximately one year ago SIEA signed a new contract with its diesel supplier for all its diesel generating plant whereby responsibility for compliance with all national environmental requirements in respect of SIEA's diesel handling operations was delegated to the diesel supplier. This includes transport, storage, removal of drums and ensuring environmental cleanliness of the sites.

252. Given that SIEA has no plans or financial resources for such a position, the structure of the PMU (to be funded under the Project) will include a NES for 14 months and the DSC team will include an IES for three months to provide inputs on an intermittent basis. An environmental safeguard capacity building program for SIEA staff (including management) and the NES will be designed and implemented by the IES as per the TOR.

4. Grievance Redress Mechanism

253. In order to receive and facilitate the resolution of affected peoples' concerns, complaints, and grievances about the project's environmental performance a grievance redress mechanism (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.

254. 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 SIEA's PMU and the implementation team (PMU/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 SIEA PMU.

255. 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 not impede access to the Solomon Island's judicial or administrative remedies.

256. **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 (e.g. transport of equipment to site, construction traffic);
- Failure to comply with mitigation measures, standards or legal obligations;
- Harassment of any nature;
- Criminal activity;
- Improper conduct or unethical behavior;
- Financial malpractice or impropriety or fraud; and
- Improper disclosure or attempts to conceal any of the above.

257. **GRM Establishment and Procedure.** During the EPC tender process, SIEA with support from the MPEC will assist the affected communities/villages identify local representatives to act as Grievance Focal Points (GFP) for community constituents during project implementation. GFPs will be designated personnel from within the community (trustee / tribal chief / family head) who will be responsible for representing their constituent group in

communicating community members' grievances and concerns to the EPC Contractor or to the PMU. Collectively the nominated GFPs will form part of the Grievance Redress Committee (GRC) which will be made up of the GFPs, contractor's representative and SIEA.

258. Prior to the selected contractor's mobilization, the PMU will convene a public consultation meeting in Auki. The meeting will be attended by the EPC Contractor, PMU/DSC, MPEC landowners/trustees and any other interested community members. The objectives of the meeting will be as follows:

- Describe the disclosure requirements and process for the Project including engagement with the community as per the provisions of the CPP;
- Introduction of key personnel of each stakeholder including roles and responsibilities;
- Presentation of project information of immediate concern 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 routine (proactive) public relations activities proposed by the project team (EPC contractor, PMU, MPEC) to ensure communities are continually advised of project progress and associated constraints throughout project implementation;
- Identification and confirmation of GFPs for affected communities and membership of the GRC; and
- Elicit and address any immediate concerns of the community based on information provided above.

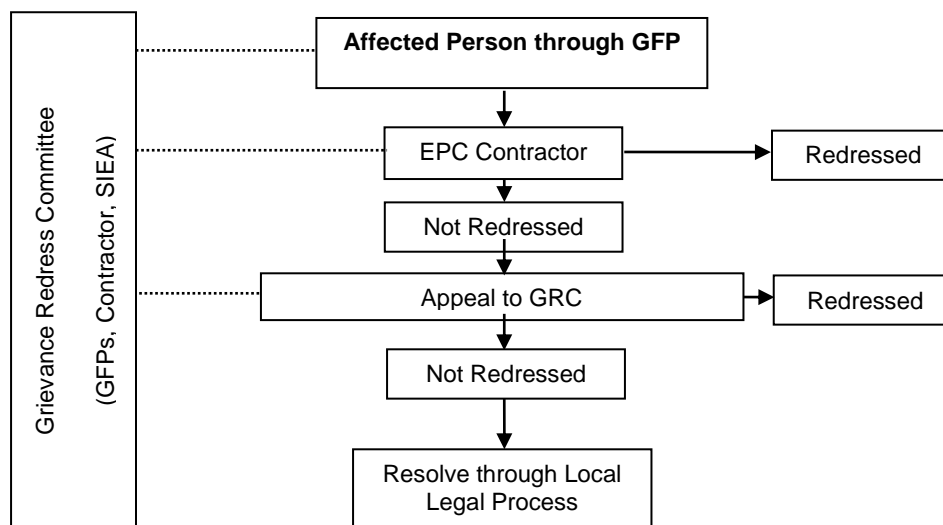
259. Following the pre-mobilization public consultation meeting, complaints associated with the construction activity or other Project related matters will be routinely handled through the GRM as explained below and shown schematically in Figure 7.1. The GRM will be updated if necessary as per any agreement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

260. **Step one.** Individuals will lodge their environmental complaint/grievance with a nominated GFP. The GFP 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 GFP.

261. **Step two.** If the complaint is not resolved within one week, then the GFP 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 community via the GFP. The EPC contractor's Environmental Engineer will then record the complaint as resolved and closed in the Environmental Complaints Register.

262. **Step three.** Should the complaint not be resolved through the GRC, the issue will be adjudicated through local legal processes. SIEA 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 matter will be subject to monitoring and disclosure.

Figure 7.1 - Grievance Redress Mechanism



C. Environmental Mitigation and Monitoring Matrix

263. 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	<p>1. Consult MECDM, submit IEE or re-format as PEZR or EIS as required) and make development consent application under statutory environmental assessment process</p> <p>2. Ensure MECDM approved EMP and any conditions of development consent are included in EPC tender documents including i) requirement for EPC contractor to seek MECDM 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 PMU/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 MECDM Environmental Permit.</p> <p>3. Implement plan for Grievance Redress Mechanism as described in the IEE</p> <p>4. EPC contractor's project design to adhere to all design related mitigation measures in FS EMP or in updated EMP as approved under MECDM Environmental Permit.</p>	<p>1 to 3: PMU/DSC</p> <p>4 EPC contractor</p>	<p>1 & 2: Immediate.</p> <p>Start of preconstruction</p> <p>3: Before start of civil works</p> <p>4:EPC detailed design phase</p>	<p>1 to 3: Cost included in PMU/DSC staffing</p> <p>4: cost included in EPC contract</p>	<p>Environmental approval for the Project obtained from MECDM.</p> <p>Complete check of items 1 to 4.</p>	<p>Prior to signing of EPC contract and start of site works. Once.</p>	<p>PMU</p>	<p>Cost met by PMU/ PMU/DSC staffing</p>
Environmental capacity development	<p>1. SIEA to commit to provide sufficient resources for project duration to oversee EMP implementation.</p> <p>2. PMU/DSC to train PMU/EO in implementation of EMP as well as general training in ADB safeguards requirements to raise awareness and build capacity of environmental management in SIEAs . A mix of workshops and on-the-job training to be used.</p> <p>3. Conduct contractor / workers' orientation on EMP provisions.</p>	<p>1: SIEA, PMU/NES</p> <p>2: DSC</p> <p>3: EPC contractor</p>	<p>Initiate during procurement period and continue throughout project construction</p>	<p>1: & 2: IES and NES cost included as part of PMU (project) costs</p> <p>3:Included in EPC contract cost</p>	<p>1.ADB loan covenants</p> <p>2.IES TOR, DSC progress reports to SIEA/ADB</p> <p>3. EPC Tender documents and check during construction.</p>	<p>Prior to start of site works and throughout construction phase.</p>	<p>PMU</p>	<p>Cost met by PMU project staffing</p>

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	SIEA, PMU	Before EPC contractor mobilization	Included in bid cost	EPC tender document; Grievance registry, monthly reports	Monthly Grievance registry, monthly reports	EPC contractor, PMU	Cost met by Project and EPC contract
Workers and public safety	Prepare a Workers and Public Safety Plan (WPSP) to identify interfaces between the works and the public, formulate measures to ensure safety of workers and the public, and prevent accidents due to the construction works.	EPC contractor in preconstruction	Before start of civil works	Cost included in EPC contract.	EPC tender document. Check at preconstruction.	During EPC tender preparation and again before start of works	PMU/IES & NES	Cost met by PMU project staffing
Environmentally responsible procurement	1. EMP is included in EPC tender documents to ensure that mitigation measures are budgeted and to prepare the contractor for environmental responsibilities. 2. Specify in tender document that contractor shall engage appropriately qualified and experienced staff to take responsibility for the environmental management and safety issues at the working level and to monitor the effectiveness and review mitigation measures as the 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 PMU 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	PMU/IES & NES	Cost met by PMU project staffing
Environmental design for maintenance of aquatic ecosystem and resources	Design for Project to include provision for a continuous minimum environmental flow release into Fiu River at intake point of 280 L/second	PMU/DSC	EPC tender document preparation	Included in overall project cost	Hydraulic design specifications in tender document . EPC contractor's detailed	Prior to signing of EPC contract and start of site works. Once.	PMU/DSC (IES & NES)	Included in overall project cost

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
					hydraulic design			
Climate change adaptation measures to be properly considered and incorporated into design as necessary	<p>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:</p> <p>1 Intake weir - level of the training walls need to be sufficiently high to prevent overtopping, stilling basin design to address energy dissipation requirements;</p> <p>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</p> <p>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.</p> <p>Appropriate design criteria to be established based on available climate change modeling data to develop extreme event data. In the absence of such data, design criteria to be demonstrably conservative.</p>	PMU/DSC	EPC tender document preparation	Included in overall project cost	<p>Civil design specifications in tender document</p> <p>EPC contractor's detailed civil design</p>	Prior to signing of EPC contract and start of site works. Once.	<p>PMU/DSC (IES & NES)</p> <p>PMU/DSC (IES & NES)</p>	Included in overall project cost
Grievance Redress Mechanism established	Establishment and implementation of GRM confirmed by SIEA/PMU.	SIEA/PMU	Before start of civil works	Cost met by PMU/ project staffing	GRM confirmed and agreed with community.	Before start of civil works	SIEA	Cost met by SIEA
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	SEIA/PMU	Cost met by PMU/DSC
CONSTRUCTION STAGE								
Physical Impacts								
Erosion and loss of topsoil	<p>1. Schedule excavation activities in the drier months (Nov-May)</p> <p>2. As much as practicable, align the intake access road adjacent to the headrace canal so as to avoid the need</p>	EPC Contractor	Throughout construction phase	Cost included in contract	Check implementation of all items	Twice a month as part of routine construction monitoring	PMU / DSC	Cost met by PMU/DSC project 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
	for separate excavation corridors. 3. Minimize vegetation clearance corridor or footprint of components 4. Ensure slope cuts are properly engineered and re-vegetated immediately after cutting 5. Install cut-off drains above excavated areas on steep slopes 6. Install river bank protection measures (Masonry, gabion baskets etc) in river channel adjacent to headworks structures and powerhouse tailrace 7. Stockpile topsoil for later use in landscaping or made available to local community for their use 8. As far as possible ensure cut to fill balance							
Water Quality impact due to site runoff	1. Schedule excavation activities in the drier months (May-Nov) 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. As much as practicable, align the intake access road adjacent to the headrace canal so as to avoid the need for separate excavation corridors. 4. Minimize width of vegetation clearance corridor for i) access road ii) headrace canal iii) penstock route 5. Immediately re-vegetate and/or stabilize exposed surfaces and stockpiles of excavated material 6. Implement effective construction site drainage such that runoff is directed to sediment traps before discharge to water course 7. Install cut-off drains above excavated	EPC Contractor	Throughout construction phase	Cost included in contract	Check implementation of all items	Twice a month as part of routine construction monitoring	PMU	Cost met by PMU/DSC & PMU project 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
	areas on steep slopes to reduce erosion 8. Effective construction supervision to ensure above measures implemented							
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	PMU	Cost met by PMU/DSC & project staffing
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 MPEC and recorded by the PMU/DSC and monitored 5. Spoil will not be disposed of in rivers and streams or other natural drainage path. 6. 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 15cm layers and compacted to optimum moisture content, covered with topsoil, landscaped and provided with drainage and vegetation to prevent erosion in line	1: EPC Contractor to prepare MSMP, PMU/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	PMU	Cost met by PMU/DSC & project 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
	with best practice. 9. Spoil disposal shall not cause sedimentation and obstruction of flow of watercourses, damage to agricultural land and densely vegetated areas. 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	<p>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 to be approved in writing by PMU/DSC one month prior to starting works. Contractor to implement WMP provisions.</p> <p>2. Areas for disposal to be agreed with land owner and MPEC and checked, recorded and monitored by the PMU/DSC.</p> <p>3. Segregation of wastes shall be observed.</p> <p>4. Recyclables shall be recovered and sold to recyclers.</p> <p>5. Residual wastes shall be disposed of in disposal sites approved by local authorities and not located within 500m of rivers or streams.</p> <p>6 Construction offices and facilities shall be provided with garbage bins</p> <p>7. Burning of construction and domestic wastes shall be prohibited.</p> <p>8. Disposal of solid wastes into drainage ditches and public areas shall be prohibited.</p> <p>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 MPEC.</p>	1: EPC Contractor to prepare WMP, PMU/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	PMU / DSC	Cost met by PMU/DSC & project staffing
Use of hazardous substances and hazardous waste disposal	1. Hydrocarbon, toxic material will be stored in adequately protected sites consistent with international best	EPC Contractor	Throughout construction phase	Cost included in contracts	Check implementation of all items	Monthly	PMU	Cost met by PMU/DSC

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	<p>practices to prevent soil and water contamination.</p> <p>2. All areas intended for storage of hazardous materials will be quarantined and provided with adequate facilities to combat emergency situations.</p> <p>3. 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 international best practice.</p> <p>4. Ensure all storage containers are in good condition with proper labeling.</p> <p>5. Regularly check containers for leakage and undertake necessary repair or replacement.</p> <p>6 Store hazardous materials above possible flood level</p> <p>7. Discharge of oil contaminated water shall be prohibited.</p> <p>8. Used oil and other toxic and hazardous materials shall be disposed of off-site at a facility authorized by the PMU/DSC.</p> <p>9. Ensure availability of spill cleanup materials (e.g., absorbent pads, etc.) specifically designed for petroleum products and other hazardous substances where such materials are being stored.</p> <p>10. Spillage, if any, will be immediately cleared with utmost caution to leave no traces.</p>							& PMU project staffing
Biological Impacts								
Fish and Aquatic resources	<p>1. Intake and weir structures constructed to ensure continuous environmental flow release of 280L/s.</p> <p>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.</p> <p>3. Design and construction of fish pass</p>	EPC Contractor	Throughout construction	Cost included in contract	Check implementation of all items	Twice a month as part of routine construction monitoring	PMU/DSC (IES & NES)	Cost met by PMU/DSC & PMU project staffing
Loss of Forest Habitat and impacts on fauna	<p>1. Adjust alignment of access road, headrace canal, penstock and transmission line route to minimize need</p>	EPC Contractor	Site surveying and vegetation clearance.	Cost included in contract	Visual observation of surveyed	1: Before start of site works 2: Within one	PMU/DSC (IES & NES)	Cost met by PMU/DSC

Environmental Issue/Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
	<p>for removing large trees.</p> <p>2. Minimize width of vegetation clearance corridor for i) access road ii) headrace canal and iii) penstock route</p> <p>3. Mark boundary of clearance corridors with high visibility tape to ensure construction workers are aware of clearance boundaries.</p> <p>4. Workers prohibited from poaching or hunting birds and wildlife (sanctions to be imposed)</p>				penstock alignment route Sanctions imposed on workers not adhering to item 4	week of start of construction		& PMU project staffing
Socioeconomic Impacts								
Operation of contractor camp / Site offices	<p>1. Location of site office and facilities to be agreed with local community with facilities approved by SIEA PMU/DSC and managed to minimize impacts; Protocols established as per CPP and GRM</p> <p>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.</p> <p>3. Separate toilets shall be provided for male and female workers.</p> <p>4. As many local workers as possible will be hired and trained.</p> <p>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.</p> <p>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.</p> <p>7. The Contractors facilities area will be cleaned up to the satisfaction of PMU and local community after use.</p> <p>8 All waste materials shall be removed and disposed to disposal sites approved</p>	<p>1:EPC Contractor with PMU/DSC approval</p> <p>2-8: EPC Contractor</p>	<p>1: One month before start of site works</p> <p>2 to 8: Throughout construction phase</p>	Cost included in contracts	Check implementation of items 1-8	<p>1: Before construction</p> <p>2 - 8: Monthly</p>	PMU/DSC	Cost met by PMU/DSC and PMU project 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
	by local authorities							
Occupational Health and Safety	<p>1. Contractor to prepare a HEALTH AND SAFETY PLAN (HSP) instructing workers in health and safety matters. Plan to be approved in writing by PMU/DSC one month prior to starting works. Contractor to implement HSP provisions.</p> <p>2. Before construction commences the contractor will conduct of training for all workers on environmental, safety and environmental hygiene. The contractor will instruct workers in health and safety matters as required by good engineering practice and provide first aid facilities.</p> <p>3. Workers shall be provided (before they start work) with appropriate PPE 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.</p> <p>4. Fencing shall be installed on all areas of excavation greater than 1m deep and at sides of temporary works. .</p> <p>5. Provision of potable water supply in all work locations.</p>	1:EPC Contractor with PMU/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	PMU/DSC	Cost met by PMU/DSC and PMU project staffing
Community Health and Safety	<p>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.</p> <p>2. The general public/local residents shall not be allowed in high-risk areas,</p> <p>3. Provide warning signs at periphery of site warning public not to enter</p> <p>4. Strict imposition of speed limits along access through residential areas and where other sensitive receptors such as schools, hospitals and other populated area are located</p> <p>5. Communication to the public through public consultation, MPEC and notice boards regarding the scope and schedule of construction as well as certain construction activities causing disruptions and access restrictions.</p>	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	PMU/DSC Approved service provider	Cost met by PMU/DSC & PMU project 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
	6. Implementation of communicable diseases (incl. STIs and HIV) awareness and prevention measures							
OPERATION STAGE								
Maintenance of aquatic ecosystem and resources in Fiu River between intake and powerhouse	Ensure a continuous minimum environmental flow release into Fiu River at intake point of 280 L/s.	SIEA	Operation phase	Included in overall project cost	Fiu River flow immediately downstream of intake	Periodically during dry periods	SIEA reporting to MPEC	Included in SIEA Operation and maintenance 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.	SIEA	Operation phase	Included in overall project cost	Security fencing intact and effective	Periodically during routine maintenance activities	SIEA	Included in SIEA Operation and maintenance costs
The need for watershed protection to ensure long term sustainability of the project	Protection of the Fiu watershed from future commercial logging and any other significant land use changes that could result in increased sedimentation in the river leading to a reduction in the efficiency and operational life of the project. It is recommended that SIEA makes a formal request to the SIG to designate the Fiu River catchment as reserved for hydropower development and protected against commercial logging and other significant land use changes that could affect the sustainability of the Project.	SIEA / Ministry of Forestry	Prior to EPC contract signing	Included in overall project cost	Government Gazette (MOF declarations)	Once prior to loan effectiveness	SIEA	Included in SIEA Operation and maintenance costs

VIII. CONCLUSION AND RECOMMENDATION

264. 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 run-of river hydropower project with a small footprint and it does not involve a dam or reservoir;
- The existing aquatic habitat of the Fiu River between the intake and powerhouse has a relatively low habitat quality compared with upstream of the intake, due to current human disturbance from nearby communities (forest clearance, river crossings usage of river for domestic washing). No significant impacts are expected on the existing fish and aquatic resources of the Fiu River as a result of the project provided that a minimum environmental flow of 280L/s is released into the river at the intake point at all times;
- A fish pass structure will be included in the design of the weir. The weir is therefore unlikely to be a significant barrier to current fish migration patterns;
- The potential loss of forest habitat due to the project is of relatively minor significance due to the overall disturbed natural environment of the project area and this 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; 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.

265. 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.

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

IX. BIBLIOGRAPHY

ADB (2012), Climate Risks and Adaptation in the Power Sector

Berdach J T and Liegu M (2007) Solomon Islands Country Environmental Analysis. ADB TA 6204

Filardi Catherine E, Boseto D, Filardi Christopher E, (2007) A Preliminary Desk Study Identifying Important Bird Areas (IBAs) in the Solomon Islands. SPREP

GTZ (1996) Solomon Islands Rural Electrification Policy Draft

JICA, (2001) Masterplan Study of Power Development in Solomon Islands

Pauku RL, (2009) Solomon Islands Forestry Outlook Study. Asia-Pacific Forestry Sector Outlook Study II Working Paper No. APFSOS II/WP/2009/31 FAO, Bangkok

Petterson M.G (2004) The Geology of North and Central Malaita, Solomon Islands: the thickest and most accessible part of the world's largest (Ontong Java) ocean plateau. Geological Society of London , Special Publications V.229 p63-81.

Petterson M.G., Magu R., Mason A., Mahoa H., Tolia D., Neal C.R., and Mahoney J.J. (2009) A first geological map of Makira, Solomon Islands: Stratigraphy, structure and tectonic implications. In: Pacific Minerals in the New Millennium – The Jackson Lum Volume. SOPAC Tech. Bull. 11, 145-161

Polhemus DA, Englund RA, Allen GR, Bosetto D and Polhemus JT (2008) Freshwater Biotas of the Solomon Islands Analysis of Richness, Endemism and Threats. Bishop Museum Technical Report 45, Honolulu.

SIEA, Huro, Kirakira – Minihydropower Scheme 1996

SIG Ministry of Natural Resources; Australian International Development Assistance Bureau (1994). Solomon Islands National Forest Resources Inventory Volume 3 - Malaita Province, Volume 6 - Western Province, Volume 7- Makira-Ulawa Province, Volume 8 – Temotu Province

SIG Ministry of Infrastructure Development (2012), Draft Solomon Islands National Infrastructure Investment Plan (SINIIP)

SIG Ministry of Infrastructure Development (2012), Transport Sector Development Project (TSDP), Feasibility Study for Naro Hill-Lambi Road Project, Guadalcanal Province. Climate Change Risk and Adaptation Assessment

SIG Ministry of Infrastructure Development (2008), Road Improvement Sector Project Feasibility Study for Wainuri-Kirakira & Kirakira-Warihito Makira Province. Initial Environmental Examination

SIG MECDM, (2012), National Climate Change Policy

SIG MECM (2008) Solomon Islands State of Environment Report

SIG, Ministry of Meteorological Service Australian Bureau of Meteorology, (2011), Pacific Climate Change Science Program: Current and Future Climate of the Solomon Islands (PCCSP)

SIG Ministry of Environment, Climate Change and Disaster Management (MECDM) (2008), National Adaptation Program for Action (NAPA)

SOPAC, ADB, WB, JICA, GFDRR, AirWorldwide, GNS Science (2011), Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI)

United Nations Office for the Coordination of Humanitarian Affairs (OCHA), (2011), Solomon Islands Natural Hazard Risks.

World Bank Policy Note (2006), Not if But When: Adapting to Natural Hazards in the Pacific Islands Region

ATTACHMENTS

Attachment 1 – Summary of Selected SIG Policy, Legal and Administration Documents

1A – National Laws and Policy

Town and Country Planning Act 1979. The Town and Country Act of 1977 applies to urban areas (Honiara and provincial centers), covers the management of land including government-owned land; specifies urban and rural management and planning functions including development controls. The objective of the Act is to ensure that land is developed and used in accordance with proper policies and consideration of peoples' welfare. The Act is limited in that it applies only to non-customary land and any physical planning officer can only give advice regarding customary land. Otherwise customary land owners are not required to follow the mechanisms of the Act.

Provincial Government Act, 1997. The Provincial Government Act of 1997 gives power to the provinces to make their own legislation including environment and conservation. Schedule 3 of the Act provides a list of activities for which the provinces have responsibility to pass ordinances.

- Trade and Industry - local licensing of professions, trades and businesses and markets.
- Cultural and Environment - protection of wildlife, coastal and lagoon shipping.
- Agriculture and Fishing - protection, improvement and maintenance of freshwater and reef fisheries.
- Land and Land Use - codification and amendment of existing customary laws about land. Registration of customary rights in respect of land including customary fishing rights. Physical planning except within a local planning area.
- Local matters - waste disposal.
- Rivers and Water - control and use of river waters, water pollution.
- Corporate or Statutory Bodies - establishment of corporate or statutory bodies for provincial services including those for economic activities.

The State of the Environment Report (2008) shows that eight provincial ordinances have been passed as outlined in Table 9.2 and include: one environmental protection ordinance, six wildlife and wildlife management and conservation area ordinances, and one marine and freshwater ordinance.

There are also provincial ordinances and regulations that preserve and protect cultural sites and objects. So far only five provinces-Guadalcanal, Makira, Malaita, Temotu and Western, have enacted ordinances regarding this which is also included in Table 2.2

Table A1.1. List of Provincial Ordinances

No	Province	Name of Ordinance
Environmental Ordinances		
1	Temotu Province	Temotu Province Environmental Protection Ordinance 1994 (TPEPO)
2	Malaita Province	Malaita Province Wildlife Management and Licensing Ordinance 1995 (MalPVMLO)
3	Malaita Province	Malaita Province Management Area Ordinance 1990
4	Isabel Province	Isabel Province Conservation Areas Ordinance 1993 (IPCAO)
5	Isabel Province	Isabel Province Wildlife Sanctuary Ordinance 1995(IPWSO)
6	Isabel Province	Isabel Province Marine and Freshwater Areas Ordinance 1993 (IPMFAO)
7	Guadalcanal Province	Guadalcanal Province Wildlife Management Area Ordinance 1990 (GPWMAO)
8	Makira Province	Makira Province Preservation of Culture and Wildlife Ordinance 1984
9	Makira Province	The Makira Ulawa Province Preservation of Culture and Wildlife Ordinance 2012
Cultural Ordinances		
1	Guadalcanal Province	Guadalcanal Province Protection of Historical Places Ordinance 1985
2	Western Province	Western Province Preservation of Cultural Ordinance 1989
3	Malaita Province	Malaita Province Preservation of Culture Ordinance 1995
4	Makira Province	Makira Ulawa Council Prevention of Sale of Traditional Artefacts Bylaws 1977
5	Makira Province	The Makira Ulawa Province Preservation of Culture and Wildlife Ordinance 2012
6	Temotu Province	Temotu Province Preservation of Culture Ordinance 1993

1B – International Agreements

Solomon Islands is a signatory to a number of regional and international agreements with environmental and conservation implications as well as for the protection, promotion and safeguarding of cultural heritage and traditional knowledge. These are listed below.

Regional

- Pollution Protocol for Dumping. Ratified 1998. Prevention of pollution of the South Pacific region by dumping.
- Pollution Protocol for Emergencies. Ratified 1998. Co-operation in combating pollution emergencies in the South Pacific region.
- Natural Resources & Environment of South Pacific Region (SPREP Convention). Ratified 1998.
- Waigani Convention on Hazardous & Radioactive Wastes 1995. Ratified 1998. Bans the importation and the trans-boundary movement and management of hazardous wastes within the South Pacific region.

International - Chemicals, Wastes and Pollution

- Liability for Oil Pollution Damage. Ratified. Liability of ship owner for pollution damage.

- (Marine Pollution Convention (London). Ratified. Prevention of marine pollution by dumping of wastes.
- POPs Convention (Stockholm). 2004. Bans use of persistent organic pollutants.

International - Biodiversity

- CITES, ratified 1998. Regulates trade in wild animals and plants
- (World Heritage Convention. Acceded 1992. Protection of sites of Outstanding Universal Values. (East Rennelle Island is listed as a World Heritage site).
- Convention on Biological Diversity (UNCBD). Ratified 1995.
- Desertification (UNCCD). Acceded 1999. Agreement to combat desertification and drought.
- Cartagena Protocol on Biosafety. Acceded 2004. Protection of human health and the environment from possible adverse effects of modern biotechnology.

International - Climate

- Montreal Protocol. Acceded 1993. Phase out of substances that deplete the ozone layer.
- Ozone Layer Convention (Vienna). Acceded 1993. Protection of the ozone layer.
- Climate Change (UNFCCC). Ratified 1994.
- Kyoto Protocol. Ratified 2003. Reduce greenhouse gases especially CO₂ by an average of 5.2% by 2012.

International - Cultural

- World Heritage Convention. Acceded 1992. Protection of sites of Outstanding Universal Values. (East Rennelle Island is listed as a World Heritage site).
- The Convention for the Safeguarding of the Intangible Cultural Heritage 2003
- The Convention of the Protection and Promotion of the Diversity of Cultural Expressions 2005

Attachment 2 - Fish and Aquatic Resources Survey Report

Summary Field Report – Fish and Aquatic Resource Survey of Fiu River

Contents

1. Report Summary.....	69
2. Survey Activities	69
2.1. Fiu summary of movement.....	69
2.1.1. Fiu River Survey	70
2.2. Nangnang summary of movement	Error! Bookmark not defined.
2.2.1. Nangnang tributary mobilisation.....	70
3. Results.....	71
3.1. Habitat findings	71
3.1.1. Terrestrial Biota	71
3.1.2. Aquatic Biota.....	73
4. Overview.....	77
4.1. Upper Fiu Watershed.....	77
4.2. Project affected area (from intake to powerhouse)	77

1. Summary

There were two separate survey trips made to the proposed area for the hydropower site covering alternative locations and layouts. The first survey was conducted in 24th April, 2013 to 27th April, 2013. The first survey involved surveying the main Fiu River channel. On this occasion the FAR survey team went through Busurata road and were dropped off at Adma village. The team walked about 200 meters before arriving to what was perceived to be the proposed project intake site. In fact this site was the location of the intake under a previously studied scheme and not the currently studied scheme.

The second trip was made during 2nd to 4th May 2013 during which the Nangnang Tributary was surveyed, since at that time the Nangnang tributary was under consideration as the intake site for the Project. In fact the Nangnang tributary turned out to be largely a waterfall emanating from an underground source and not suitable as an intake site for hydropower.

A rapid survey was conducted along both stream courses. However, it became apparent during the Nangnang tributary survey that above the waterfall (close to the confluence with the Fiu River) there were no surface flows in the Nangnang, therefore the Nangnang tributary was discarded as the intake site for the Project, and no aquatic sampling was undertaken.

The following report refers primarily to data collected during the first trip which covered both the upper catchment area of the proposed Project as well as the project affected area between the newly proposed intake close to Kwainoa Village and the powerhouse some 1.7 km downstream of the intake.

Information gathered from direct observations and informants indicates a relatively high level of aquatic habitat intactness in the upper catchment area (Stations 1–7) which decreases downstream (Stations 8 - 10) and is related to increasing human influence. Fish and aquatic species observed and reported indicate healthy biodiversity and limited livelihood pressure in the upstream region, although full presence of checklist species was not established. Similarly, the riparian area above the proposed intake site (Stations 1-7) shows a relatively high level of forest habitat intactness which also decreases significantly from the intake site downstream (Stations 8-10) due to human activities such as clearing for gardens and the use of a variety of forest resources for daily requirements.

2. Survey Activities

The following table provides a summary of the activities undertaken for the survey.

Table A2.1 - Fiu River Survey Activities

Date	Activities
24 th April	Departure for Auki and overnight stay prior to mobilisation to field sites.
25 th April	Departure to Fiu location, beginning of field survey. Arrival at old intake location, , observations at stations 1-7 and overnight observations between stations 7 and 8.
26 th April	Observations at stations 8 – 10, pick up at Fiu for Auki.Overnight at Auki.
27 th April	Depart Auki to Honiara.
2 nd May	Departure for Auki and team went to Bola land to camp
3 rd May	Field work and observing the Nangnang Tributary and overnight at Auki

4th May

Depart for Honiara at 1300h

2.1.1. Fiu River Survey

The survey was conducted for the area of the earlier proposed intake, canal and penstock locations.¹ SIEA staff dropped off the team at the nearest road location to the intake. The team descended some 2 km to the Fiu River along the indicated track. The team began the survey at the perceived intake area and travelled down to the power house area, where they spent the night at Tahubala village. During the night, nocturnal visits were done to assess the biota; amphibians, reptiles and mammals in the area. The results are presented below.

Several informant interviews were held with residents of Tahubala Village to gather local knowledge of the area, both current and historical. This assisted the team to relate the livelihood of the people with the Fiu River.

It was evident that almost all animals in the area were used for food including frogs, skinks and fish. Near to the river area, ferns and bamboo are used as cooking tools and for water storage, and trees and lawyer canes are used for building houses. This traditional livelihood practice continues today. An important local custom is the “drying of the water” in the river channel. This occurs on special occasions, whereby a leader sacrifices taro to their ancestors in a number of the sinkholes into which the river flows.

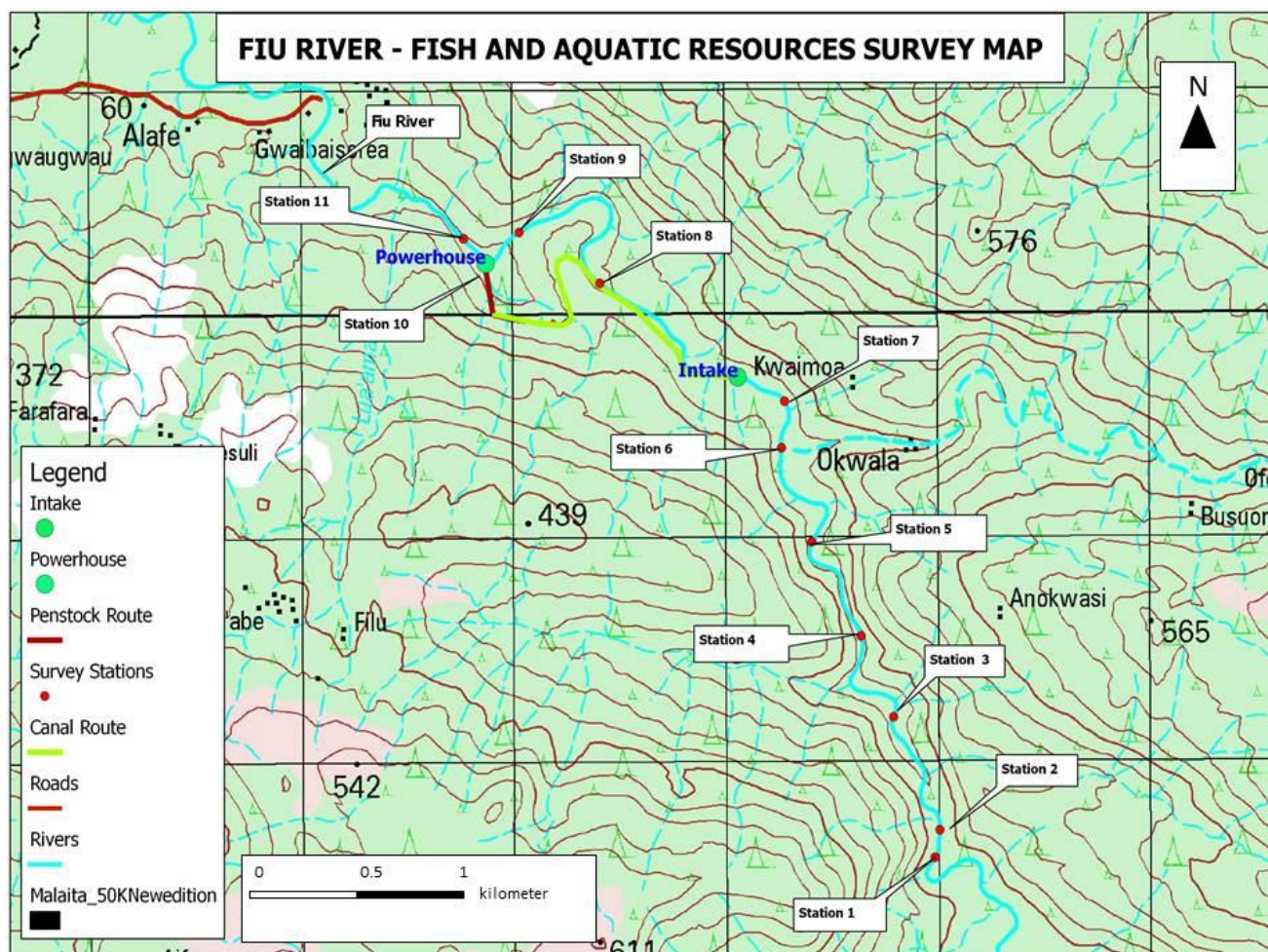
2.1.2. Nangnang Tributary Survey

The second field survey was to Nangnang tributary to the site of SMEC’s originally proposed Project intake site. The team walked for about an hour before arriving at the confluence of the Nangnang tributary and the Fiu River. At the confluence the Nangnang discharges into the Fiu via a waterfall. The team climbed the gorge around the waterfall and discovered that at about 50 m up the waterfall, water was gushing out from under a rock outcrop. At an elevation of about 260 m the team came to a cave which according to villagers is a shrine and represents the source of the Nangnang tributary. Inside the cave water gushes out from cracks in the limestone rocks before disappearing again underground. During heavy rain water travels across the surface of the channel but typically after about a day flow again goes mainly underground. Some *Macrobrachium spp* were found in the cave.

According to locals the Nangnang is the name of the waterfall (Station 6) but it does not originate from regular surface flows, but rather subsurface streams. It was strongly contested by local informants that there are regular surface flows at the original location proposed for the intake of the scheme. As a result of this visit a new layout for the Project was proposed with the intake about 250 m downstream from Station 7 and the powerhouse a further 1.7 km downstream.

¹ As noted above the first survey assumed the layout of an earlier scheme not currently studied for feasibility under the PREP. Hence, the survey includes Stations 1-7 which are all above the currently proposed Project intake site. However, these stations provide good information in relation to the habitats of the upper catchment of the proposed Project. Stations 8-10 are located within the project affected area (between intake and powerhouse).

Figure A2.1 - Survey Map



3. Results

3.1. Habitat findings

3.1.1. Terrestrial Biota

The Fiu and Nangnang upper watersheds have a diverse vertebrate fauna due to the generally intact and undisturbed nature of the forests and the surrounding watershed system. There is overlapping of primary and secondary rainforest along the ridgelines of the Fiu due to milling of timber primarily for housing requirements. Vegetation types are a mixture of exotic and native plants. Higher in the watershed area the secondary nature of the forest segues into more primary forests. It is here in the upper watershed that the vertebrate assemblage is relatively rich. In summary the Fiu watershed is dominated by at least five species of frogs and reptiles, more than 10 species of birds, and some mammals represented by bat species. Table A2.2 and A2.3 provide data on flora and fauna observed during the surveys.

Table A2.2 - Dominant Flora found in the Fiu Watershed Area

Timber	Palms	Bamboo	Orchids
<i>Vitex cofassus</i> (Vasa)	<i>Areca macrocalyx</i>	<i>Bambusa blumeana</i>	<i>Liparis condylobulbon</i>
<i>Terminalia brassii</i> (Dafo)	<i>Licuala lauterbachii</i>	<i>Schizostachyum tessellatum</i> Bamboo	<i>Liparis gibossa</i>
<i>Pterocarpus indicus</i> (Lingi)	<i>Calamus hollrungii</i>	<i>Nastus racemosa</i> Climbing bamboo	<i>Spathoglotti splicata</i>
<i>Calophyllum peekellii</i> (Koilo)	<i>Ptychosperma latius</i>	<i>Nastus obtusus</i>	<i>Appendicula polystachya</i> Epiphytic orchid
<i>Calophyllum vitiense</i> (Koilo)	<i>Calamus vestitus</i>		<i>Macodes cominsii</i> Macodes, Ground Orchid
<i>Pometia pinnata</i> (Kovahi)	<i>Ptychosperma salomonense</i> Ptychosperma palm		
<i>Gmelina moluccana</i> (Arokoko) Gmelina, Canoe tree	<i>Ptychosperma latius</i> Ptychosperma palm		
<i>Terminalia brassii</i> (Dafo) Swamp or Brown Terminalia			

Table A2.3 – Fauna Observed during the Fiu and Nangnang Surveys

Frogs	IUCN Status	Birds	IUCN Status	Mammals	IUCN Status	Reptiles	IUCN Status
<i>Discodeles malukuna</i>	U	<i>Anassu percilliosa</i>	LC	<i>Pteropus rayneri</i>	LC	<i>Emoia cyanura</i>	LC
<i>Discodeles guppyi</i>	LC	<i>Ducula rubricerarufigila</i>	LC	<i>Pteropus admiraltatum</i>	LC	<i>Emoia nigra</i>	LC
<i>Litoria lutea</i>	V	<i>Chalcopsitta cardinalis</i>	LC			<i>Emoia cyanogaster</i>	LC
<i>Platymantis weberi</i>	LC	<i>Megapodius eremita</i> Melanesian scrub fowl	LC				
<i>Platymantis guppyi</i>	LC	<i>Ducula rubricera rufigila</i>	LC				
		<i>Macropygmackin layarossi</i>	LC				
		<i>Chalcopsitta cardinalis</i>	LC				

		<i>Cacatua ducorpsi</i>	LC				
		<i>Rhipidura leucophrys</i>	LC				

The Fiu watershed has a rich invertebrate fauna, some possibly unknown to science. Common insects included, *Orthodera* sp (Mantodea: Mantidae), *Gryllacridid* sp (Orthoptera: Gryllacrididae), and Katydid (Tettigoniidae). A number of butterfly species were also observed such as the large *Ornithoptera victoriae victoriae*, *Graphium* sp.

3.1.2. Aquatic Biota

Table A2.4 provides the aquatic biota encountered during the survey and Table A2.5 is a list of species presence based on established checklists.²

Table A2.4 - Description of Aquatic Biota by Station in Fiu River³

Station	Type of sampling	Ecology Description	Fish present
1	Riverine sampling of the aquatic biota (flora and fauna) and GPS recording	The area is fully covered with primary forest. The channel width is about 3m. The banks have large boulders and substrate dominated with cobbles. There is also a heavy presence of leaf detritus. Maximum depth of river 1.5m with running velocity of 1m/s. The water is very clear.	<i>Stiphodon atratus</i> <i>Stiphodon rutilaureus</i> <i>Sicopus mystax</i> <i>Sicyopterus lagocephalus</i> <i>Sicyopus discodinnis</i>
2	Riverine sampling of the aquatic biota (flora and fauna) and GPS recording	The environs of the station are primarily covered with banks of large boulders and substrates of sand and cobbles. The width of the river is 3m. The depth of river is 1.5 m, with running velocity of 1.5m/s. Leaf debris features significantly.	<i>Awaous spp</i> <i>Lentipes spp</i> <i>Stiphodon birdsong</i> <i>Stiphodon semoni</i>
3	Riverine sampling and aquatic biota assessment and GPS recording	The station is partly shaded due to landslide from large rainfall last 7 days. The area is full of debris of leaves with boulders and gravels and top soils. The depth is about 3m and the width is 3.5m with running velocity of 0.8m/s. Algae are present indicating localized pollution from top soil and runoffs.	<i>Redigobius leptochilus</i> <i>Stenogobius hoesei</i> <i>Mesopristes cancellatus</i> <i>Hypostomus plecostomus</i> <i>Macrobrachium lar</i>
4	Riverine sampling and aquatic biota assessment and GPS recording	The station is fully shaded due to primary rainforest and it is between gorges of 60 m. The area is full of debris of leaves with boulders and gravels and top soils. The depth is about 2.5m with riffle velocity of 0.5m/s	<i>Khulia rupestris</i> <i>Liza vaigenis (juvi)</i> <i>Mesopristes cancellatus</i> <i>Hypostomus plecostomus</i>
5	Riverine sampling and aquatic biota assessment and GPS recording	The station is fully shaded due to primary rainforest. The area is full of debris of leaves with boulders and gravels and top soils. The depth is about 1m with running velocity of 1.5m/s. The water is clear.	<i>Stiphodon rutilaureus</i> <i>Sycoptus mystax</i> <i>Sicyopterus lagocephalus</i> <i>Sycyoptus discodinnis</i> <i>Ophieoeleotris hoedti (male)</i> <i>Ophieoeleotris hoedti (female)</i> <i>Khulia rupestris</i>

² Summarizes the fish species present in the area surveyed relative to the Malaita, Fiu River checklist compiled from Polhemus et al. (2008) and Jenkins and Boseto (2007)

³ The Nangnang tributary was not surveyed due to the absence of surface flowing water.

Station	Type of sampling	Ecology Description	Fish present
			<i>Liza vaigenisis</i>
6	Riverine sampling and aquatic biota assessment and GPS recording	The station is fully shaded due to primary rainforest. The area is covered with dead leaves with boulders on the bank and cobbles on the river bed. The depth is about 1m with running velocity of 1.5m/s. The water is clear.	<i>Awaous spp</i> <i>Lentipes spp</i> <i>Stiphodon birdsong</i> <i>Stiphodon semoni</i> <i>Stiphodon atratus</i> <i>Stiphodon rutilaureus</i>
7	Riverine sampling and aquatic biota assessment and GPS recording	The station is located in a gorge of approximately 60m depth with primary rainforest with shrubs and ferns on the bank of sands and cobble. Substrates are of sands and cobble. Depth is 3.4m making a pool. The clarity is very clear.	<i>Ambassis miops</i> <i>Schismatogobius marmoratus</i> <i>Glossogobius spp</i> <i>Sicyopus spp</i> <i>Ophieleotris marmaritaccea</i> <i>Eleotris fusca</i>
8	Riverine sampling and aquatic biota assessment and GPS recording	The station is covered with partial canopy, accessed by the local population for a crossing point and recreation. The banks are covered with cobble and gravel. Large boulders are present on the sides stacking on to a 40 m gorge. The substrate is of sand and soil and debris of woods and leaves. The depth of the river at this point area is 1m-4m with riffle velocity of 1m/s. The area displays some algae from localized runoff and human accessibility. The water is slightly clear.	<i>Awaous spp</i> <i>Lentipesspp</i> <i>Anguilla marmorata</i> <i>Belobranchus belobranchus</i> <i>Schismatogobius marmoratus</i> <i>Glossogobius spp</i> <i>Sicyopus spp</i>
9	Riverine sampling and aquatic biota assessment and GPS recording	The area is of secondary rainforest with banks of boulders, cobbles, sands plus shrubs and ferns. The river width is about 4m and depth with 2.5m. The substrates are covered with dead leaves from runoff with debris of woods and large logs. Localized pollution is visible because of algae. The clarity is partially clear. The area is running 1.5m/s	<i>Sicyopterus lagocephalus</i> <i>Sycyoptus discodinnis</i> <i>Ophieoeleotris hoedti</i> (<i>Khulia rupestris</i> <i>Liza vaigenisis (juv)</i>
10	Riverine sampling and aquatic biota assessment and GPS recording	The area is of secondary rainforest with banks of boulders, cobbles, sands plus shrubs and ferns. The river width is about 4m and depth with 2.5m. The substrates are covered with dead leaves from runoff with debris of wood and large logs. Localized pollution is visible because of algae. The clarity is partially clear. The area is running 1.5m/s	<i>Sicyopterus lagocephalus</i> <i>Sycyoptus discodinnis</i> <i>Ophieoeleotris hoedti</i> <i>Khulia rupestris</i> <i>Liza vaigenisis (juvi)</i> <i>Mesopristes cancellatus</i> <i>Hypostomus plecostomus</i> <i>Macrobrachium lar</i>

Table A2.5 - Species Presence Relative to Established Checklists⁴

Sighted in the field survey	Reported present but not sighted	Not reported nor sighted
<i>Awaous spp</i> <i>Lentipes spp*</i> <i>Stiphodon birdsong</i> <i>Stiphodon semoni</i> <i>Stiphodon atratus</i> <i>Stiphodon rutilaureus**</i> <i>Sycoptus mystax</i> <i>Sicyopteru slagocephalus</i> <i>Khulia rupestris</i> <i>Liza vaigenisis (juvi)</i> <i>Anguilla marmorata**</i> <i>Belobranchus belobrachus</i> <i>Butis amboinensis</i> <i>Ambassis miops</i> <i>Schismatogobius marmoratus</i> <i>Glossogobius spp</i> <i>Sicyopus spp</i> <i>Ophieleotris marmaritaccea</i> <i>Eleotris fusca</i> <i>Redigobius leptochilus</i> <i>Stenogobius hoesei</i> <i>Mesopristes cancellatus</i> <i>Hypostomus plecostomus**</i> <i>Macrobrachium lar (juvi)</i>	<i>Khulia marginate</i> <i>Lutjanus fuscescens</i> <i>Apogon spp</i> <i>Gymnothorax polyurandon</i>	<i>Zenarchchopterus dispar</i> <i>Scatophagus argus</i> <i>Rhyacichthys aspro</i> <i>Ambassis interrupta</i> <i>Toxotes jaculatrix</i> <i>Terapon theraps</i>

*Endemic to Solomon Islands (Boseto D and Jenkins P, 2010)

**Rare species due to fisheries pressure from population (Information from local community)

All are "least concern" status or unlisted in the IUCN Red List.

All are confirmed edible

⁴ Summarizes the fish species present in the area surveyed, relative to the Malaita, Fiu river checklist compiled from Polhemus et al. (2008) and Jenkins and Boseto (2007)

Table A2.6 establishes the relative abundance of species aggregating data from the survey sites. Table A2.7 provides a description of species by habitat type.

Table A2.6 - Relative Abundance of Species in Sites Surveyed

Dominant species	Common species	Occasionally
<i>Stiphodon semoni</i> <i>Stiphodon birdsong</i> <i>Stiphodon rutilaureus</i> <i>Awaous spp</i> <i>Sicyopterus lagocephalus</i> <i>Ophioeleotris hoedti (male)</i>	<i>Sicyopus dicodinnis</i> <i>Lentipes spp</i> <i>Mesopristes agents</i> <i>Sicyopus mystax</i> <i>Electro fusca</i> <i>Buti samboinensis</i> <i>Stenogobius hoesei</i> <i>Mesopristes cancellatus</i> <i>Macrobrachium lar</i>	<i>Anguilla marmorata</i> <i>Stiphodon atratus (female)</i> <i>Ophioeleotris hoedti</i> <i>Khulia rupestris</i> <i>Liza vaigiensis (juveniles)</i> <i>Ophioeleotris marmoritacea</i> <i>Glossogobius spp</i> <i>Schismatogobius marmoratus</i> <i>Sicyopus discodinnis</i> <i>Belobranchus belobranchus</i> <i>Ambassis miops</i>

Table A2.7 - Species by Habitat Type

Habitat	Description	Species
Pools	In description the pools are areas at bends which had an approximated depth of 4-5 meters. At the substrates there were habitats under the rocks and boulders	<i>Anguilla marmorata</i> <i>Glossogobius spp</i> <i>Khulia rupestris</i> <i>Mesopristes agents</i> <i>Mesopristes cancellatus</i> <i>Macrobrachium lar</i> <i>Hypostomus plecostomus</i> <i>Schismatogobius marmoratus</i> <i>Lentipes spp</i> <i>Liza vaigiensis</i>
Riffle	In this the river is flowing at an average of 0.2-0.5 m/s at a depth of 2-3 meters. At the substrates there were habitats under the rocks and boulders.	<i>Lentipes spp</i> <i>Stiphodon semoni</i> <i>Stiphodon birdsong</i> <i>Liza vaigiensis</i> <i>Stiphodon rutilaureus</i> <i>Awaous spp</i> <i>Sicyopterus lagocephalus</i> <i>Ophioeleotris hoedti</i> <i>Sicyopus dicodinnis</i>
Run	This habitat area in which the river is running clear over a stretch. The velocity is between 1-2m/s. The depth is approximately 1-2 meters	<i>Lentipes spp</i> <i>Stiphodon semoni</i> <i>Stiphodon birdsong</i> <i>Stiphodon rutilaureus</i> <i>Awaous spp</i> <i>Sicyopterus lagocephalus</i> <i>Ophioeleotris hoedti</i> <i>Sicyopus dicodinnis</i>

Habitat	Description	Species
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.	<i>Mesopristes agents</i> <i>Sicyopus mystax</i> <i>Electro fusca</i> <i>Buti samboinensis</i> <i>Stenogobius hoesei</i> <i>Mesopristes cancellatus</i> <i>Macrobrachium lar</i>
Below altitude of 69 meters	These areas are below altitudes which were more pressure of population and villages are present. Most of the habitats (mentioned) are exposed due to access from people. Most area is of boulders, cobble, gravel, sand, silt and clay areas.	<i>Belobranchus belobranchus</i> <i>Buti samboinensis</i> <i>Ambassis miops</i> <i>Schismatogobius marmoratus</i> <i>Glossogobius spp</i> <i>Sicyopus spp</i> <i>Lentipes spp</i> <i>Mesopristes agents</i> <i>Sicyopus mystax</i> <i>Khulia marginate</i> <i>Lutjanus fuscescens</i> <i>Apogon spp</i> <i>Gymnothorax polyurandon</i>

4. Overview

4.1. Upper Fiu Watershed

The Fiu watershed area above the Project intake site has relatively intact primary forest interspersed with areas of secondary forest due to milling and gathering of forest materials for building materials and firewood. The primary forest areas form the habitats of some important plants and vertebrate species. The ridgelines are a mixture of old growth forest and montane forests, with overlapping lowland forests on the slopes and valleys.

There is evidence of invasive species in the area, such as the cane toad (*Bufo marinus*). Diversity of birds is dominated by the parrots, and other forest birds. With low hunting pressure there was relatively high abundance of birds in the area. Two bats were observed in the study area also. The herpetofauna of the Fiu basin is quite rich, compared to other sites in the Solomon Islands. It is dominated mostly by forest dependent species. Ground frogs include the many *Platymantis* species whilst canopy dwellers include *Platymantis guppyi*,

The community living around the area have strong historical linkages to the Fiu River. The people depend on the river and the rainforest for their livelihood including food, fuel, medicine, house materials access and security.

4.2. Project Affected Area

The immediate or direct project affected area comprises the area between the intake and the powerhouse and consists of modified terrestrial habitats and secondary forest due to its relatively accessible location and proximity to local settlements. These factors have supported intensified human impact and relatively frequent access. There is ample evidence of foraging (for edible ferns), hunting (primarily edible frogs) and the harvest of non-timber forest products from habitats on both banks of the river.

The river channel and banks are used frequently at a number of points for recreation and crossings. Local informants also indicate the use of the area for fishing.

The secondary forest has not been industrially exploited for commercial timber but experiences ongoing access due to the gathering of building materials from inhabitants of the Bola and Tahubala villages. At the lower extreme of the area of influence there are sizable sago palm plantings which are an actively managed livelihood resource.

The river is used regularly for fetching water, recreation, bathing, washing and as a meeting area. There are several crossings regularly used by the nearby population.

Preliminary indigenous terrain analysis of the area of influence for the new proposed locations indicates that there are landowning tribes forming part of the Bola and Tahubala villages although these settlements are composed of multiple moieties, as is normally the case in Solomon Islands villages. Disturbance and modification of the area for the proposed scheme will need to involve early understanding of the affected groups (in terms of land users, land owners and others with rights to the areas impacted) so that an integrated approach to building sustainable social license is implemented. Biotic and livelihood aspects will be an important but not exclusive component of these considerations.

Attachment 3a – Categories in IUCN Red List

Category	Definition
Least concern	Common and widespread species not dependent on conservation efforts and not assessed to be near threatened or threatened.
Low risk	A species is dependent on conservation efforts to prevent it becoming threatened with extinction.
Near threatened	A species does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying or is likely to qualify for a threatened category in the near future.
Vulnerable	Same definition as previous category of "threatened". Species is likely to become endangered unless circumstances threatening its survival are improved or a species is considered to be facing a high risk of extinction in the wild.
Endangered	A species with few in number or its habitat is threatened and evidence indicates that the species is considered to be facing a very high risk of extinction in the wild.
Critically endangered	A species is considered to be facing an extremely high risk of extinction in the wild.
Extinct in the wild	When it is known that a species can only survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range.
Extinct	When there is no reasonable doubt that the last individual has died. A species is presumed extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), and through out its historic range have failed to record an individual.
Data deficient	When there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A species in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat but does not discount that the habitat of a species could be threatened; investigation and assessment is required.

Attachment 4 – Rapid Environmental Appraisal Checklist

Instructions:

- (i) The project team completes this checklist to support the environmental classification of a project. It is to be attached to the environmental categorization form and submitted to the Environment and Safeguards Division (RSES) for endorsement by Director, RSES and for approval by the Chief Compliance Officer.
- (ii) This checklist focuses on environmental issues and concerns. To ensure that social dimensions are adequately considered, refer also to ADB's (a) checklists on involuntary resettlement and Indigenous Peoples; (b) poverty reduction handbook; (c) staff guide to consultation and participation; and (d) gender checklists.
- (iii) Answer the questions assuming the "without mitigation" case. The purpose is to identify potential impacts. Use the "remarks" section to discuss any anticipated mitigation measures.

Country/Project Title: TA-8130 SOL Provincial Renewable Energy Project

Sector Division:

A. Basic Project Design Data

- 1. Dam height, m = weir approx. 1m
- 2. Surface area of reservoir, (ha) = no reservoir
- 3. Estimated number of people to be displaced = nil
- 4. Rated power output, = 750 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
---------------------	-----	----	---------

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 with no other activity
▪ Undammed river tributaries below the proposed dam	X		Numerous streams enter along the Fiu River including many ephemeral waterways where groundwater discharge enters the river channel at the waters edge.
▪ Unique or aesthetically valuable land or water form		X	Natural forest and garden activity in the upper catchment is similar to nearby catchments
▪ 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 for local village consumption and cleared for 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 with vicinity of project impact area.
▪ Wetland		X	None reported
▪ Mangrove		X	None reported
▪ Estuary		X	None reported
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 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 quarry for road surface material is located on road out of Auki.
▪ disposal of large quantities of construction spoils?		X	Moderate amount of construction spoil from access road and headrace canal will be required.
▪ clearing of large forested area for ancillary facilities and access road?		X	Clearing of forest/garden for some 3km of new access road (mostly along existing walking tracks), 1.7 km headrace canal 250m penstock and powerhouse/tailrace.
▪ 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		Clearing of disturbed forest/garden for some 3km of new access road to powerhouse and intake. (mostly along existing walking tracks. Reduce clearance of undisturbed forest where possible.

SCREENING QUESTIONS	Yes	No	REMARKS
▪ 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 Malaita.
▪ 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	Low weir with fish passage structure therefore no significant barrier to migrating fish.
▪ 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
▪ 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, no significant reduction in flow due to other perennial stream flows.
▪ 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

SCREENING QUESTIONS	Yes	No	REMARKS
<ul style="list-style-type: none"> ▪ 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
<ul style="list-style-type: none"> ▪ 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
<ul style="list-style-type: none"> ▪ creation of community slums following construction of the hydropower plant and its facilities? 		X	Small-scale project with no large work force.
<ul style="list-style-type: none"> • social conflicts if workers from other regions or countries are hired? 		X	SIEA is committed to socially responsible working conditions
<ul style="list-style-type: none"> ▪ uncontrolled human migration into the area, made possible by access roads and transmission lines? 		X	Not anticipated in this customary land
<ul style="list-style-type: none"> ▪ 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.
<ul style="list-style-type: none"> ▪ 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
<ul style="list-style-type: none"> • 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 use of canal corridor for access. Awareness campaign required.

Attachment 5 - Stakeholder Consultations

Attachment 5a - Environmental Stakeholder Meeting, Project Office, Honiara – 5 February, 2013

Key Environmental stakeholders were invited to attend a meeting at the OIREP office in Honiara for the following purpose:

- To briefly outline the key features of the proposed projects (location, indicative lay out/footprint etc)
- ascertain key stakeholders views and concerns in relation to the proposed developments (focusing particularly on the environmental issues associated with the Ringgi site) and
- obtain any information stakeholders may have on the environmental and social characteristics of the sites that would assist in the screening and overall decision making process regarding the proposed projects.

Background information was provided to the invited participants in advance. The following environmental stakeholders were invited:

- Ministry of Environment Conservation and Meteorology (MECM)
- WWF
- Solomon Island Community Conservation Program (SICCP) / American Museum of Natural History (AMNH) / Kolombangara Island Biodiversity Conservation Association (KIBCA) - one national representative covers all three
- The Nature Conservancy
- Live & Learn
- Solomon Island National Commission (SINC) for UNESCO
- Coral Triangle Pacific (CTI)
- Mangrove Ecosystem Services Climate Adaptation Livelihoods (MESCAL)
- Australian Volunteers
- Foundations of the Peoples of the South Pacific (FSSP)

Meeting Participants

SMEC

- Tilak Battherai, Team Leader
- Alan Sewell, Intl Environmental Specialist
- Marista Kapini, Ntl Environmental Specialist
- Miguel de Lopez, Int Social/Gender Specialist
- Dougal Clunie, Hydrologist

Key Environmental Stakeholders who attended

- Rosemary Apa, Chief Environment Officer, MECDM
- Agnetha Vave, Chief Conservation Officer, MECDM

- Watson Puiahi, Director, Ilukim Sustainability Solomon Islands
- Michelle Papaol, Operation Manager, SICCP/AMNH
- Wilson David, Live and Learn Environmental Education
- Peter Ramohia, Coral Triangle Pacific

Minutes of Meeting

Alan Sewell delivered a brief power point presentation covering

- the key features of the proposed project, (objectives, screening etc indicative locations and layout of project components),
- purpose of consultation – obtain views and concerns of key environmental stakeholders including any additional information (sources of data etc)
- summary of REA findings of prefeasibility studies
- key environmental issues identified

Following the presentation participants were asked for their comments and queries on environmental issues associated with the projects and especially the significant issues identified at Ringi site. The following table provides details of the comments queries and discussion.

Name/Organisation	Comments/Discussion
Michelle Papaol SICCP	<p>Michelle asked if the penstock and the canal will be above the ground or buried. Dougal Clunie responded in saying that the penstock will be above ground but the canal can be either above or buried if it is a pipe.</p> <p>Michelle also asked about the actual location of the hydro power site. Alan responded with the aid of a google map in the prefeasibility study report that there are 2 proposed sites. The highest site is at where Imbu Rano lodge is and the lower site further downstream. He mentioned that the lower site won't be able to produce enough power to supply Noro/Munda. The higher site is more feasible and if there should be a hydro power site at Ringi, it should be at the higher site.</p> <p>Michelle also requested if a biologist is needed to carry out an independent study on the biodiversity at Ringi. Alan agreed but added that only if Ringi is screened to be a priority site for the project, that ADB would require an extensive biodiversity study be carried out.</p> <p>Michelle also wanted to know if the surrounding coastal villages at Ringi will benefit from the proposed hydro power at Vila to which Alan responded that it is likely that local coastal area of Ringi will benefit but at this stage cannot say for the other communities.</p>
Wilson David Live and Learn(LL)	<p>Wilson David contributed that LL is working closely with KIBCA to discourage logging from Kolombangara. They are concerned about any development at Ringi due the fact that it is a conservation site. He then asked if Mase would be able to provide enough power for the nearest growth centres such as Noro and Munda. Tilak responded in saying that the proposed installed capacity for Mase is 3400KW and the current requirement for Noro/Munda is only 1500KW therefore Mase will definitely be able to cater for the towns' requirement. The 20 years projection for the centres power need is 4300 KW. Wilson then recommended that Mase could be a better site for the proposed hydro power from live & learn's perspective and not Ringi.</p>

	Wilson also commented on the growing need to shift from the heavy dependency on diesel for energy to other forms of renewable energy.
Agnetha Vave-Karamui Chief Conservation Officer MECDM	<p>Agnetha asked about the time frame to complete the hydro power setup. Tilak responded that it will roughly take 1.5 years from road construction to the building of the actual hydropower set. She mentioned that from MECDM point of view, there is no formal (gazetted) protected area in the Solomon Islands, Ringi included. However, the Ministry has recognised the initiative that KIBCA has taken to protect their areas. She mentioned that MECDM has already received a proposal (application) from KIBCA to formalise their protected area and are in the process of formalising it. This initiative by KIBCA has been fully supported by local coastal communities around Ringi. She also mentioned that Kolombangara would become a flag ship for protected areas in the Solomon Islands as far as MECDM is concerned and have fully supported KIBCA's Ridges to Reef Protected/conservation area initiative program.</p> <p>Agnetha also asked about how many communities will be affected or benefit by the proposed hydropower development. Alan Sewel responded in saying that two major growth centres including Noro and Munda will be supplied from the Vila site by submarine cables from Ringi to the main land.</p> <p>She also expresses the serious concern the Ministry has on the impacts that the proposed project will have on the protected area. However, she advises that SMEC must consult KIBCA on this project for their views.</p> <p>In response to Alan's inquiry on any other known protected areas or heritage sites, Agnetha mentioned that even though Kolombangara, Tetepare and Marovo have been proposed as world heritage sites, only East Rennel has been formally recognised as World Heritage.</p>
Rosemary Apa Chief Environment Officer MECDM	Rosemary expresses concern about the submarine cables to Noro should the hydropower will be situated at Ringi. She mentioned that there are a number of marine protected areas around where the submarine cables are proposed to be at. The areas include Nusa Tupe and Vona Vona. Alan responded that only if the proposed hydropower site is at the top site (Imbu Rano) then the submarine cables into Noro will be necessary.
Watson Puiahi ISSI	In response to Miguel's inquiry on land issues in the Solomon Islands and the suitable approach to take in dealing with the land issues, Watson suggested that it is always good to consult directly with the right person or the actual owners. He mentioned that sometimes it is complicated by the fact that owners are not working together. However, he stresses that it is good to go down and talk with the people at the community level and share with them the benefits of such projects to convince them or help them to understand the project and its purpose.
Data and Reports	
Agnetha Vave-Karamui & Rosemary Apa	<p>The suggested places to get up to date data and information are; MECDM Ministry of Provincial Government The Nature Conservancy Census document from the Ministry of Finance.</p> <p>They also mentioned that when doing site visits to collect information/data, it is always beneficial to also involve MECDM. They have more experience in dealing and talking with people and have better methods of collecting data on environmental parameters.</p>
END OF MEETING	

Attachment 5b – Community Consultation Meeting, Auki – 25 March 2013

Introduction

The purpose of the community consultations is to disseminate basic project information and obtain the views and concerns of communities and other local stakeholders with respect to environmental issues. The consultations also provide the opportunity to gather relevant site specific information from the stakeholder's perspective on the physical biological and social environments of the project area.

Methodology

Relevant environmental Information during the public consultations will be obtained through:

- field observations including aquatic surveys,
- meetings with potentially affected communities (namely villagers and district officials)
- meetings with local government agencies and NGOs

The Environmental team will participate in community and provincial level consultations in conjunction with the social/gender and resettlement consultations. In addition, the environmental team will consult with relevant agencies of the Ministry of Environment Climate Change and Disaster Management (MECDM) and other ministries as required as well as environmental NGOs at the central/provincial levels as appropriate.¹

Project information will be disclosed in an appropriate manner such that the views and concerns of the various stakeholders can be obtained, documented, properly considered and where appropriate incorporated into the project

In addition the following set of questions will be used as a guide for obtaining relevant environmental information during discussions. The results of these informal discussions and field observations will be summarised and integrated into the IEEs for each sub project along with data obtained through desk study and literature review.

Community Consultation Responses 25/3/2013 (in italics)

All answers from the community consultation are based on the local's fair understanding of where the project area would be located. The locals advised that physical markers on the proposed project site would help them to know the actual locations of the project site and therefore provide a more accurate account for the proposed project area.

1. Are there any locally protected areas in the vicinity of the project? Describe how far from the project components. (approx km).
No. According to the local knowledge of the local community and the landowners, there is no protected area within the vicinity of the proposed project.
2. Are there any culturally significant areas or Tambu sites in the vicinity of the project components? Describe site and identify location. (ie Will the project impact on any such areas).

¹ The environmental consultations with government agencies and NGOs will be undertaken separately from the Resettlement consultations.

None as far as they are aware.

3. What wildlife has been reported/seen in the area within and or around the project site and nearby area in recent years? Has there been a change in recent years (ie more or less wildlife than previously) *All kinds of birds, snakes, opossum, frogs, lizards, and aquatic flora such as fish, eels and prawns.*

4. What is the status of forest resources within the vicinity of the project components? (eg natural (undisturbed), previously logged, highly disturbed etc).

While some of the community members claimed that forests within the project area and the watershed have already been previously logged there are others from other communities who said that the forest within the vicinity of the project site is undisturbed. From observation carried out during site visit has indicated that forest within the catchment is secondary forests with patches of primary forest in inaccessible areas. Also areas within the water shed are continuously cleared for local gardening. There is on-going tree felling within the watershed for house timbers and other building materials. This was confirmed also during site visit.

5. What forest resources do the local communities make use of in the vicinity of the project components?

Trees for local housing needs - bark branches and leaves of trees felled all used for housing and furniture. Sago palms for house roofs and walling, canes for houses flooring and walling. A variety of plants are used for medicinal purposes. All of these resources are in abundance and community not concerned over any losses due to the project

6. What use do the local communities make of the river resources, particularly in the area between the proposed intake site and power house (irrigation, drinking/washing, food (fish, aquatic plants etc)? Try and get an idea of how much water is used in this area so that we can determine what the impact of the project would be in reducing the flow between intake and power house.

Small scattered communities in the project area on both sides of the river between the intake and powerhouse use the river for washing and bathing. The 2 km stretch of river between the intake and powerhouse including both upstream and downstream is occasionally used for fishing for eels, larger fish species and prawns, although these are now rare in the catchment due to past fishing pressure. These are not for commercial purposes but for food.

The flow of the Fiu River does vary during wet and dry season. Wet season results in very high and fast flowing water while in dry season the level of water is lower. However communities have claimed that the Fiu River never dries up even during very dry seasons. Some discussions with the local community members revealed that there are sinkholes within the Fiu River that were blocked by many years back to allow subsurface flow. It was a practice in the olden days (that's no longer practised) that for certain celebrations, men would remove the plugs from the sink hole to dry up certain portions of the Fiu River to enable them to collect fish, eels, prawns and other aquatic fauna from the dry river beds for feasting.

7. Where do the communities source their drinking water supply?

Mainly from tributaries flowing into Fiu River along with rainwater collection.

8. What are the main crops/plantations in the project area?

Coconut, sweet potato, cassava, bananas, various vegetables

9. What are the main local industries in the project area?

There are no industries within the project area. However there is occasional tree felling for timbers to sell. Local farmers normally bring their garden produce to sell at the local market at Auki. People are also making money from small pig farms.

10. What communication facilities are available?

Bemobile mobile network locally available in parts of the project area.

11. What percentage of villages have electricity within and around the provincial centre?

SIEA noted that about 90% of households within the Auki town area are connected to the local diesel generated grid. The connection currently does not extend more than 6km from Auki.

12. What other development projects are currently being implemented or planned in the nearby area?

There are road networks already established in Malaita extending out from Auki. The central road which runs 6km from Auki ends about 1-2.5 km short of where the powerhouse and intake point would be. Communities along the Fiu River can only be accessed by foot through bush tracks that are often steep and very slippery during wet times. The condition of the existing road itself is bad and will need upgrade work. Various schools are already established along the existing road but have no electricity. The proposed hydropower project will be the first major development in the area which will help communities within the project area in terms of better accessibility to school, markets, transportations, electricity and more.