Initial Environmental Examination

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SOL: Solar Power Development Project

ABBREVIATIONS

ADB	Asian Development Bank
CAA	Civil Aviation Authority
ECD	Environment and Conservation Division (of MECDM)
IEE	Initial Environmental Examination
kW	kilowatts
kWh	kilowatt hours
MECDM	Ministry of Environment, Climate Change, and Disaster Management
MMERE	Ministry of Mines, Energy and Rural Electrification
PER	Public Environment Report
SIBC	Solomon Islands Broadcasting Corporation
SIEA	Solomon Islands Electricity Authority (now Solomon Power)
SIG	Solomon Islands Government
SPS	ADB Safeguard Policy Statement

CONTENTS

EXECUTIVE SUMMARY

1. Solomon Power with assistance of Asian Development Bank (ADB) proposes to develop and operate grid connected solar-diesel-battery hybrid power stations in five provincial centres in the Solomon Islands, which will largely substitute for existing diesel generation. The proposed project will provide a total solar generation capacity of 2MW at the provincial centres of Kirakira 320 kW, Lata 290 kW, Malu'u 140 kW, Munda 1,000kW and Tulagi 250 kW. Kirakira will include 1.5km 11 kV pole mounted power line to connect to the town grid. Munda will require a connection to the grid a short distance from the site.

2. The Project has been classified by ADB as Environmental Category B. An initial environmental examination (IEE) has been prepared in accordance with ADB Safeguard Policy Statement (SPS, 2009) requirements and the environmental assessment requirements of the Solomon Islands Government (SIG). The IEE has been undertaken in conjunction with the technical feasibility, social, economic and financial studies under ADB project preparatory technical assistance (PPTA). The IEE includes an environmental management plan which specifies the mitigation measures required during pre-construction, construction and operation stages and allocates responsibility for their implementation. The IEE has found that with the mitigation measures proposed the identified impacts will be able to be adequately managed and that there are no significant issues which would prevent the project proceeding.

3. The main potential impacts and mitigation measures identified were for vegetation on two of the sites, noise from backup diesel generators, waste from disused or damaged solar panels, batteries and other equipment, management of existing diesel power stations after relocation to the new solar hybrid sites and soil erosion during construction.

4. Munda and Tulagi will require clearing of approximately 2 ha of secondary regrowth forest and scrub. An ecological study has been carried out by a local specialist which found that there are no significant ecological values identified on the site that would be impacted by the project.

5. It is predicted that noise from diesel generators at sensitive receptors at some sites may exceed the World Bank Environmental Health and Safety Guidelines and mitigation measures are proposed to address this.

6. Reduction in CO_2 emissions are estimated at 72% or 55,000 T CO_2 over a 25 year life compared with 100% diesel generation. This is based on modelling for the design of the hybrid system, and indicative lifecycle emissions for solar PV allowing for emissions in manufacture, transport, construction and operation, and due to land clearing. A medium exposure to risk of tsunami was identified for two of the sites and low at the others. A high exposure to cyclone risk was identified at one site and medium at the other sites. Climate change risk and adaption measures have been identified in the IEE.

7. The implementing agency will be Solomon Power. The project will be managed by a project management unit within Solomon Power, including ensuring that the environmental requirements are met. A national environment specialist is proposed for a total of 6 person-months to support the activities of the PMU. A contractor will be appointed though a competitive tendering process for the design, procurement and construction of the project.

8. Consultations have been carried out with provincial representatives, local organisations and community representatives in all of the communities proposed for the project as well as relevant agencies, international projects and NGOs in Honiara. Further consultation and participation will continue through the design phase and into construction and operation. Project

documents will be published on the ADB website. Environmental assessment documents will be made available to the public as part of the Solomon Islands approval process.

9. A grievance redress mechanism (GRM) will be established by the Project Management Unit for receiving and resolving grievances including complaints and concerns from affected people and stakeholders about environmental and socioeconomic issues in relation to the project.

10. The project will have a net benefit due to the provision of a sustainable energy supply, reduction in greenhouse gas emissions, reduced reliance on imported diesel fuel and long term reduction in the cost of generation. Potential negative impacts are predicted to be minor and able to be managed with the mitigation measures proposed in the IEE.

I. INTRODUCTION

11. Solomon Power (formerly Solomon Islands Electricity Authority (SIEA)) with assistance of Asian Development Bank (ADB) proposes to develop and operate grid connected solar-diesel-battery hybrid power stations in several provincial centres in the Solomon Islands.

12. This document is an initial environmental examination (IEE) prepared in accordance with ADB requirements and the environmental assessment requirements of the Solomon Islands Government (the government).

13. The project has been classified by ADB as category B for environment following the Safeguard Policy Statement 2009 (SPS). The IEE has been prepared in accordance with SPS.

14. Solomon Islands is a nation in the south-west Pacific Ocean, of approximately 990 islands with a land area of 28,000 km^2 and over 1.3 million km^2 of ocean. The population of approximately 500,000 lives mainly on the coastal strip of the islands, with about 80 per cent living in rural areas with a largely subsistence economy.

15. Solomon Power is the government owned power utility for the Solomon Islands and includes generation, distribution and retail of power. Solomon Power provides electricity via grids in Honiara in Guadalcanal Province, Gizo, Noro and Munda in Western Province, Auki and Malu'u in Malaita Province, Tulagi in Central Province, Kirakira in Makira-Ulawa Province, Lata in Temotu Province, Buala in Isabel Province.

16. The project sites are located in the provincial towns of Kirakira in Makira-Ulawa Province, Lata in Temotu Province, Malu'u in Malaita Province, Munda in Western Province and Tulagi in Central Province.

II. POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

17. The project will be subject to both the laws and regulations of Solomon Islands and the requirements of the SPS.

A. Solomon Islands Policy and Legal Requirements

18. Legal and policy instruments in Solomon Islands include the Constitution, Customary law, Acts of the National Parliament and Ordinances made by Provincial Governments.

19. Customary law is valid under the constitution and relevant to land ownership in relation to developments on customary land. Customary law can be overriden by the Constitution or Acts of Parliament.

20. The following Solomon Islands laws relate to environmental management:

- Environment Act 1998
- Town and Country Planning Act
- Land and Titles Act
- Protected Areas Act 2010
- Wildlife Protection and Management Act 1998
- Forest Resources and Timber Utilisation Act
- Mines and Minerals Act
- Fisheries Act 1998
- Environmental Health Act
- National Parks Act
- River Waters Act
- Wild Birds Protection Act.

1. Solomon Islands Environmental Assessment and Approvals Process

21. The *Environment Act 1998* governs environmental protection and is administered by the Environment and Conservation Division (ECD) of the Ministry for Environment, Climate Change, Disaster Management and Meteorology (MECDM). The *Environment Act* requires Development Consent to be obtained from the ECD prior to development. The Act governs pollution control and waste discharge.

22. The process for proposal applications and environmental assessment under the Environment Act is described in the document "Format of the Proposal Application" and the flowchart "EIA Procedural Steps". The first step is for the proponent to submit a Proposal Application. The level of environmental assessment called for by ECD would be determined within 15 working days after receiving the initial Proposal Application. This would be either a Public Environmental Report (PER) or a (higher level) Environmental Impact Assessment (EIA). Once submitted, ECD would take a minimum of 60 working days to review a PER and 120 working days to assess an EIA.

23. It is envisaged that the Proposal Application would be submitted by Solomon Power to ECD / MECDM after the ADB approval of the loan / grant. The ADB Initial Environmental Examination (IEE) has been prepared to also meet the above requirements of the ECD for a PER.

2. Proposed Amendments to National Environmental Safeguards System

24. Since 2012, ADB has been providing support to the government to strengthen the country safeguard system (CSS). Working with Ministry of Infrastructure Development (MID), Ministry of Lands, Housing and Survey (MLHS) and Ministry of Environment, Climate Change, Disaster Management and Meteorology (MECDM), the technical assistance (TA) first undertook a detailed diagnostic of the legal framework for CSS and an institutional capacity assessment of three main agencies (MID, MLHS, and MECDM) implementing various elements of the CSS. The second TA focused on preparing draft amendments to the Lands and Titles Act and Environment Act to address the gaps and weaknesses identified and piloting the proposed modified procedures for development consent and land acquisition.[1]

25. Consultations with the Chief Environmental Officer and Senior Environmental Officer of ECD of MECDM indicated that proposed amendments to the Environment Regulations including proposed modified procedures for development consent have been developed with ADB Technical Assistance. The amended regulations are expected to come into force in 2016. ECD expect the proponent to submit a Proposal Application for assessment under the new regulation. ECD noted that the application by Solomon Power for the Honiara solar project was prepared under the former existing regulation.

B. International Conventions

26. Solomon Islands is party to the following international conventions (LASLU, 2015):

- International Convention on the Regulation of Whaling 1946
- Convention on Fishing and Conservation of the Living Resources of the High Seas 1958
- Convention Concerning the Protection of the World Cultural and Natural Heritage 1972
- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972
- Convention on International Trade in Endangered Species of Wild Fauna and Flora 1975
- Vienna Convention for the Protection of the Ozone Layer 1985
- United Nations Convention on the Law of the Sea 1982
- Nauru Agreement Concerning Cooperation in the Management of Fisheries of Common Interest 1982
- Convention for the Protection of the Natural Resources and Environment of the South Pacific Region 1986
- South Pacific Forum Fisheries Agency Convention 1987
- Convention for the Prohibition of Fishing with Long Driftnets in the South Pacific 1989
- United Nations Convention on Biological Diversity 1992
- UN Framework Convention on Climate Change 1992
- Agreement Establishing the South Pacific Regional Environment Program 1993

[1] ADB. *Technical Assistance to the Solomon Islands for Strengthening Country Safeguard Systems in the Transport Sector.* Manila (TA 8217-SOL, $600,000, approved on 16 November 2012, financed by the Japan Fund for Poverty Reduction), and *Technical Assistance for Supporting Good Governance through Safeguards.* (TA 8737-SOL, $300,000, approved on 08 October 2014, financed by the TASF-IV).

- United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification particularly in Africa 1994
- Convention to Ban the Importation into Forum Island Countries of Hazardous and Radioactive Wastes and to Control the Transboundary Movement and Management of Hazardous Wastes within the South Pacific Region (Waigani Convention) 1995
- Kyoto Protocol to the United Nations Framework Convention on Climate Change 1997
- Stockholm Convention on Persistent Organic Pollutants 2004.

1. Conventions in relation to international movements of hazardous wastes

27. Solomon Islands is not signatory to a signatory to the Basel Convention for controlling transboundary movements of hazardous wastes and their disposal.

28. Solomon Islands is a signatory to the Waigani Convention (Convention to Ban the Importation into Forum Island Countries of Hazardous and Radioactive Wastes and to Control the Transboundary Movement and Management of Hazardous Wastes within the South Pacific Region). The Waigani Convention bans import of hazardous and radioactive wastes into South Pacific Forum Island Countries. The Convention enables Australia to receive hazardous wastes exported from Solomon Islands and other South Pacific Forum Island countries that are not Parties to the Basel Convention.

C. ADB Policy Requirements

1. ADB Safeguard Policy

29. The ADB Safeguards Policy Statement (SPS) 2009 sets out policy principles and outlines the delivery process for ADBs safeguard policy in relation to environmental and social safeguards. The ADB has adopted a set of specific safeguard requirements that borrowers/clients are required to meet in addressing environmental and social impacts and risks. ADB ensures that borrowers/clients comply with these requirements during project preparation and implementation.

30. All projects funded by ADB must comply with SPS 2009 to ensure that projects undertaken as part of programs funded under ADB loans are environmentally sound, are designed to operate in compliance with applicable regulatory requirements, and are not likely to cause significant environmental, health, safety hazards. The policy promotes international good practice as reflect in internationally recognized standards such as the World Bank's Environmental Health and Safety Guidelines.

31. The SPS environmental policy principles are summarised as follows:

- Project screening
- Impact assessment
- Examine project alternatives
- Minimise adverse impacts and prepare an environmental management plan (EMP)
- Carry out meaningful consultations and establish a grievance redress mechanism
- Disclose a draft environmental assessment
- Implement the EMP and monitor its effectiveness
- Biodiversity protection
- Pollution prevention and control

- Provide safe and healthy working conditions
- Conserve physical cultural resources.

III. PROJECT DESCRIPTION

A. Overall Project Description

32. The proposed project is to install and operate solar PV/battery/diesel hybrid generation power plants at the provincial centres of Kirakira, Lata, Malu'u, Munda and Tulagi.

33. The proposed solar PV and battery capacities for each site are shown in the table below.

Table 1 Proposed Solar PV and Battery Capacity per Site

Site	Proposed Solar Capacity kW	Proposed Battery Capacity kWh
Kirakira	320	1,950
Lata	290	1,800
Malu'u	140	900
Munda	1,000	6,300
Tulagi	250	1,950

B. Construction

34. Each Site will be developed as follows:

- Clearing of vegetation, site preparation and drainage works
- Fencing, access, security, fencing, staff amenities, office
- Water supply
- Cabling to connect solar panels
- Solar PV panels on steel frames and suitable footings (screw or driven piles are envisaged which will reduce earthworks, concrete use and construction time)
- Inverters to convert DC power from the solar panels to AC
- Battery banks with suitable shelter
- Diesel generator with suitable shelter
- 415V/11kV AC Power Systems
- 48V DC Power Systems
- Other electrical, SCADA and communications
- Connection to the existing town grid
- Diesel fuel unloading and storage
- Generators, transformers and fuel storage, handling and pumping area to have spill containment in the form of impervious base and bund walls and oil water separation on outlets. Bunding in accordance with latest version of Australian Standard *AS1940 The Storage and Handling of Flammable and Combustible Liquids.* The containment volume required is the volume of the largest container, tank or drum, plus 10 per cent.

C. Operation

35. Operation of the PV/battery/diesel hybrid system is proposed as follows:

- suitably sized string inverters will generate AC power directly from the PV modules. The AC power output of the inverters is directly useable by the load, without the requirement for storage or further conversions that would increase system losses.
- suitably sized battery inverters will generate AC power from the batteries while there is a deficit of electricity supply on the local grid and will recharge the battery during periods of excess electricity, such as when the load requirement is less than what is available from the string inverters.
- the hybrid generation system will be sized to matche with the load requirements, that is both the generator kVA rating and the battery inverters kW ratings are determined by the load requirements.
- Battery capacity ratings will be sized to requirement only and not be oversized, as battery storage is the most expensive part of the system.
- The diesel generator will run mostly be during the day when the required load exceeds the maximum capacity of the battery inverters, or when battery state of charge requires the diesel generator to run.
- Whenever the sun is available, DC power is generated by the PV strings and 400V AC is delivered directly into the local grid, which means that the solar energy is made directly available to the load and the diesel consumption by the diesel generator reduces proportionally. The balance of the energy will be supplied by the diesel generator during sunshine hours of the day.
- When excess energy is available from the string inverters (marked by an increased local grid voltage), the battery inverters will act as battery chargers to recharge the batteries proportional to the amount of excess energy that is available. The diesel generator may even be turned off dependant on the magnitude of the excess and the duration of the excess. If the charging capacity of the battery inverters are however exceeded or the battery charge increases to a state where the batteries require less charging, the string inverters will reduce their AC output by spilling some of the generated DC power.
- The battery would sufficiently charge during daylight hours to allow the diesel generator to be switched off during low consumption periods, which normally occur during the early morning hours of the night. During this period, the whole grid would be supplied by the battery inverters.
- During cloudy days or during days of exceptional power consumption, the diesel generators will run for longer periods.
- Diesel savings are therefore proportional to the amount of solar energy generated during daylight hours.
- The diesel generator is automatically started and stopped by the battery controller. The diesel generator will run within an optimal efficiency range.
- Maintenance of the diesel generation would be scheduled for times when the generator would be turned off.

D. Decommissioning

36. Should the project be decommissioned in the future, all equipment would be removed from the site, subject to the future use of the site and relevant approvals. Suitable materials would be

taken away for recycling where feasible. The site would be rehabilitated and stabilised to a condition suitable for the next land use.

E. Equipment Components

1. Solar Panels

37. Solar panels are to be poly or mono crystalline cells (thin film or amorphous silicon is not preferred) and mounted on frames of marine grade anodised aluminium or stainless steel.

2. Batteries

38. Batteries are to be either lead-acid or advanced types such as lithium ion/polymer variants and have sufficient capacity to provide for 24-36 hours energy requirements.

3. Diesel Generators

39. The following table identifies the diesel generators proposed at each site along with the existing generators currently in use in those communities.

Table 2 - Diesel Generators

Site	Preferred / Proposed DGS	Existing or planned DGSs
Kirakira	Kohler KD130 (96kW) or KD165 (120kW). An enclosed Kohler unit is not available. 1x Cummins unenclosed unit shall be transferred from existing DPP site. Compliant noise mitigation may be required.	2x unenclosed Cummins 6BTAA5.9G2 (109kW-Solomon Power rated 104kW) complete with Stamford UCi274E alternators installed 2013.
Lata	Kohler KD165 (120kW): surplus KD165 enclosed unit ex Tulagi to be relocated.	2x unenclosed Cummins 6CTAA8.3G2 (183kW – Solomon Power rated 146kW) complete with Stamford UCi274G(or J?) alternators installed one each 2011 and 2012.
Malu'u	Kohler KD66 (48kW): An enclosed unit is not available ex Malu'u. Initially operation will commence with a Cummins unit. Compliant noise mitigation may be required; unless an alternative Kipor KDE75SS3 (56kW) unit ex Tulagi is made available.	2x unenclosed Cummins 4BTA3.9 – G2 (48kW) complete with Stamford UCi224E alternators installed 2013
Munda	Kohler KD220W (163kW) or KV350C2 (235kW): the new KV350C2 may be transferred from the old DPP pre solar plant commissioning provided 11kV supply from Noro available.	1x Kohler KV350C2 to be installed in 2016
Tulagi	Kohler KD130 (96kW) or KD165 (120kW): 1 of the new KD165 units from SISL DPP to be transferred to solar plant: the other to be transferred to Lata post commissioning. Kipor transferred Malu'u	2x Kohler KD165 to be installed in 2016 An enclosed Kipor KDE75SS3 (56kW) and KFS70 alternator unit installed 2012

40. Kohler KD66, KD165 and KV350C2 are Solomon Power standard diesel generators. They are enclosed and soundproofed to 75dBA at 1 meter. They are suitable for outdoor operation, however a cover portal shall be provided for maintenance during wet weather. (http://www.kohlerpower.com.sg).

41. The Kipor unit at Tulagi is 56kW and is an ultra-quiet unit rated at 51dBA at 7m. It is understood the Kipor unit is suitable for outdoor operation however a cover portal shall be provided. (http://www.kipor.com/product/xiangxi.aspx?classid=144681445154095104&id=174#).

42. At Kirakira and possibly Malu'u Cummins un-enclosed generators may be provided.

4. Grid connection

43. Grid connection requires a short section of power line at some sites.

44. Kirakira requires approximately 1.5 km line on poles to connect to the existing 415 V town grid, proposed to be an 11 kV pole mounted line running along the road side to a transformer outside the hospital.

45. Lata and Tulagi will connect to the existing grid immediately adjacent to the site.

46. Malu'u will connect to the existing grid about 50 m south from the south-western corner of the site via a short section of pole mounted line running along the west side of the telecommunications tower yard.

47. Munda will connect to the grid a short distance to the west of the site or may need to connect on the other side of the runway approximately 600 m to the north. This would require undergrounding of the line where it passes around the western end of the runway.

5. Service life

48. Project components would be expected to have a service life without major repair as listed below. The design will also allow for potential future decommissioning of the plant and environmental reinstatement.

- 25 years for the PV System (excluding the inverters and instrumentation)
- 15 years for the inverters
- 10 to 15 years for battery banks
- 15 years for instrumentation
- 25 years for the civil work/frames
- 25 years for LV/MV power systems including cables.

F. Existing Power Systems

49. The existing power systems in the communities proposed to be served by the solar project are diesel generators with town grids distributing the electricity within the town. In the case of Munda, while the town has an existing diesel generator, the town is mainly served from the larger diesel power station at Noro via an underground transmission line.

50. These existing power stations have diesel delivered in 200 L drums by sea and then transferred to the power station and the drums pumped into storage tanks. In the case of Noro power station (serving Munda), fuel is delivered in bulk and pumped into a holding tank. All the sites have wharves for receiving fuel deliveries, except Kirakira whose wharf is not functioning and here 200 L drums are floated ashore guided by people swimming.

G. Other Projects

1. Power Line Extensions

51. Solomon Power is planning to extend the grid in some of the communities in order to connect more customers to electrical supply. The solar power project is not dependent on these extensions, and so they are outside the scope of this assessment. The partial exception is Kirakira where a 1.5 km 11 kV line to be built will allow power from the solar site to be delivered to the town grid in order to prevent it being a “stranded asset”.

2. Existing Diesel Power Stations

52. Existing power generation at all the communities proposed to be served by the Solar Power Project is by diesel powered generators. These power stations and associated fuel delivery and storage have existing local impacts in noise, air emissions, soil and water contamination by fuel and oil, other site contamination and waste generation. In addition there is a relatively small contribution to greenhouse gasses.

53. The existing diesel power stations to be replaced by the solar-diesel-battery hybrid systems will need to be decommissioned including clean-up and rehabilitation or management of existing contamination on the sites. This includes land, soil and potentially groundwater contaminated with oil, diesel fuel and possibly other chemicals, and asbestos in structures, equipment and in asbestos-cement (fibro) fragments on the site.

Fuel and oil management

54. Diesel fuel is generally delivered to the power stations in 200 L drums. These are brought in by ship and then transferred to the power station by truck. Drums are unloaded in the power station yard and fuel pumped into holding tanks which feed the generators. The empty drums are stored in the yard, sometimes in large numbers. Fuel is reported in some cases to be delivered on a 3 monthly basis with around 200 drums each delivery. This means that large numbers of drums are in the yard at any time, exceeding the practical ability to store them all in a bunded area.

55. Risks arise from spills and leaks of fuels and oils during the above activities, leading to contamination of soil, groundwater and surface drainage. Good practice includes sealing and bunding of storage and handling areas in accordance with a standard such as Australian Standard *AS1940 The Storage and Handling of Flammable and Combustible Liquids*. The containment volume required is the volume of the largest container, tank or drum, plus 10 per cent. Drainage outlets from the bunded area should have oil-water separation. Oil and fuel spill kits should be provided on site. Operators should be provided with environmental training in the operation and maintenance of the facilities. Generators and power station oil-filled transformers should also be provided with similar oil containment.

56. The sites generally had bunded areas for containing spills from some areas of fuel handling and storage. However there were areas where fuel had spilled outside of bunded areas including where drums have been stored or fuel pumped from drums, and where outlets of bunded areas had been left open allowing fuel and fuel-contaminated rainfall to flow out. The sites showed varied levels of staining indicating spillage or seepage of fuel and/or oil with consequent contamination of soil, groundwater and surface water and potential risk to human health if contact is made with contaminated material. Due to the use of the site it should be assumed that all sites have some level of contamination even where visual evidence is not observed.

57. Noise from existing power stations exceeds World Bank EHS Guideline levels at sensitive receptors at Kirakira and Lata, where houses and offices are in close proximity and complaints have been made in this respect, and possibly at Malu'u where the power station is near a church and some houses. Munda and Tulagi power stations are distant from sensitive receptors, and Munda is infrequently used.

58. No evidence was observed that air emissions from generators have a significant impact.

59. Waste was evident at sites including disused equipment, old oil filters, containers and in some cases asbestos cement (fibro) fragments on the site. It was reported that waste oil is given away for termite protection on wood and for chain saw use and old batteries used by fishermen to extract lead for sinkers. There was also a report of waste oil being disposed of by spreading on the ground. General waste was also burned on site. Infrastructure is not generally available in these communities for proper management of waste. Waste disposal sites are generally poor with designated sites generally uncontrolled. The small scale and cost of transport means that most recycling is not feasible. All this means that waste management is a challenge in these communities.

60. Fencing was poor at some sites.

61. Safety training is reported to be provided to operators in Honiara on an annual basis, but no training in environmental awareness.

Kirakira

62. Kirakira's existing power station is located in the commercial and administrative area of the town close to the port area. Nearby buildings experience high noise levels due to the close proximity of the power station. These include local offices as close as 10 m away and other businesses nearby. The open air fish and produce market area by the sea front about 50 m away and a well-used sport field about 30 m are also nearby. It is understood that complaints have been received about noise, the provincial government has asked for the station to be moved and that Solomon Power is motivated to relocate the power station to outside of town.

63. Kirakira's fuel use is reported by operators as 160,000 L/year, with approximately 200 drums of 200 L delivered each three months. In addition at Kirakira as the wharf is damaged and unusable, fuel drums are thrown off the cargo ship offshore and floated in by people swimming and pushing the drums. It is reported that some drums have been damaged and spilled diesel when hitting the shore. There was evidence of fuel/oil staining on the ground and in drains around the site.

64. Kirakira's fencing is poor and should be improved to prevent access by members of the public especially children.

Lata

65. Lata existing power station is located in the town area and has houses close by with relatively new Police housing 40 to 50 m to the south-east and east, and numbers of traditional houses to the north and north-east as close as 50 m. It is reported that complaints have been received about noise.

66. There is an elevated fuel tank at Lata power station that is reported to be no longer in use. The generators have an inbuilt fuel tank under each generator with internal spill containment. These new generators were reportedly installed in 2011. One of the old generators remains on site outside the power station building, with other disused items.

67. There is significant staining of the ground by fuel/oil. It was reported that leaking fuel (or possibly waste oil) had previously been drained away to the north-east of the power station

building, so contamination in this area may be expected. There were reportedly complaints made to the local Ministry of Health about waste oil being spread on the ground. It was advised that 60 L oil is changed each two weeks with the waste oil given away for termite control and chainsaw use.

68. The area downslope to the north, where there a number of traditional houses, was inspected from the site to the airport runway, including a number of wells. The water in the wells is used by residents here for washing. The water appeared clear and visibly good quality, with no sign of visible hydrocarbons sheen or odour.

69. There is a small building at the rear (north) of the site made of asbestos-cement (fibro) sheeting in poor condition with broken asbestos-cement walls and fragments scattered about.

70. The operator advised that he had safety training in Honiara on an annual basis, but no training in environmental awareness.

71. The designated public rubbish dump in Lata is at the north-eastern corner of the airport runway. Rubbish is dumped in a gully close to the sea. Rubbish is spilling out downstream and spreading on the coast, and contaminating drainage from the gully.

72. The Lata site is relatively secure with a high fence in reasonable condition.

Malu'u

73. Malu'u existing power station is located about 2 km west of the town in a rural area and about 200 m from the coast.

74. Malu'u power station appears to be relatively well maintained with no visible evidence of contamination by diesel observed. However due to the nature of the site use it should be assumed for the future management of the site that there is hydrocarbon contamination present on the site.

75. The nearest sensitive receptor is a church about 30 m south, and a building about 35 m south-east. No reports of complained were advised.

76. The power station is close to a stream in which people were seen to be swimming and washing. The water appears good quality as it flows out the mountain forest behind the site. There is also a 35 kW hydro station here that is meant to be driven by water diverted from this stream, however is out of operation due to a landowner dispute.

77. The proximity of the stream presents a risk of pollution from the power station. However this station appears to be relatively well kept and no evidence of significant pollution was observed.

78. Malu'u power station is relatively secure with a high fence in good condition.

Munda

79. Munda power station is used infrequently as the electrical supply comes primarily from Noro and the Munda station is retained as backup. The site appears in reasonable condition and is securely fenced. However due to the nature of the site use it should be assumed for the future management of the site that there is hydrocarbon contamination present on the site.

Tulagi

80. Tulagi existing power station is located on the north side of the island in the shipyard area, and SE of the proposed solar site. It is well shielded for noise from most residents, being on the other side of the island from most of the town and separated by a ridge.

81. Fuel is pumped by hand pump from drums to an elevated tank inside the building, reported by the operator as 260 gallons (980 L). This tank is not bunded. There is a bunded tank outside but this appears to be out of use. There is visible evidence of hydrocarbon staining indicating contamination. The site is on the sea front and there is a drain immediately adjacent and it is likely that hydrocarbons have entered the sea here. The water quality here is also likely impacted by the other activities in the adjacent shipyard.

82. It was reported that waste such as rags, oil and oil filters is disposed of at the designated waste disposal area at the north of the island. This was inspected and it appears that rubbish is dumped somewhat indiscriminately in a swampy area along the roadside. It was also advised that dirty diesel is disposed of to the sea. The operator advised that he had had no training in environmental management.

83. The Tulagi site is relatively secure being in the shipyard compound with secure fencing and controlled access through a manned gate.

Mitigation Measures

84. Where power stations are to continue operation, the following are recommended:

- Environmental awareness training to be provided to power station operation staff and other staff such as engineers who visit the stations
- Prepare operational environmental management plans for each station
- Regular reviews and inspections by visiting professional staff to support ongoing improvement.
- Establish a protocol for communication with neighbours and other stakeholders and receiving, recording and responding to complaints.
- Fuel and oil storage including drums, generators and power station oil-filled transformers to be in impervious bunded area in accordance with Australian Standard *AS1940 The Storage and Handling of Flammable and Combustible Liquids*. The containment volume required is the volume of the largest container, tank or drum, plus 10 per cent. Drainage outlets from the bunded area should have oil-water separation.
- Consideration to reducing the size of individual fuel deliveries in order to reduce the space needed for storing fuel drums.
- Oil and fuel spill kits should be provided on site, and training provided in their use.
- Secure fencing to prevent public access
- Noise from generators be reviewed to achieve World Bank EHS Guidelines at sensitive receptors. All generators should have acoustic shielding and exhaust mufflers as a minimum and regular maintenance to minimise noise and air emissions. Additional noise shielding should be considered where sensitive receptors are close by or repeated complaints are received.
- Remove asbestos from the site. Establish and follow a plan based on best international practice to protect workers and public health. This should include personal protective equipment, wetting down broken fibro structures and removing without creating or liberating dust, collecting scattered fragments, securely bagging and transporting to an appropriate facility for safe disposal.
- Liaise with reputable contractors to take wastes for recycling or disposal for which local waste facilities are not sustainable, including waste oil, asbestos, batteries, and

if feasible, metal and disused equipment that can be recycled. Environmental management plans should include waste planning and establishing a system to record and verify where waste is disposed of or sent for recycling.

85. Where power stations are to be shut down and replaced by solar-diesel-battery hybrid at a new site, the following is recommended for the existing site:

- Prepare contamination management plans for each site for the long term management or clean up of the site. This will depend on the ultimate use of the site, identification of public health and environmental risk pathways and other factors.
- Without prejudicing the above plans, in the short term the site should be made secure and stable and minimise immediate health and environmental risk. This could include the following actions.
- The site should be made secure against public access.
- Establish a protocol for communication with neighbours and other stakeholders to keep them informed about plans and emphasise the importance of preventing public access.
- The site should be made stable to prevent runoff or dust carrying contaminants from the site. This could include establishing a stable ground cover vegetation, and if necessary divert upslope runoff around the site by installing a low bank along the contour.
- Ensure that the site and any soil from the site is not used for any gardening or food growing.
- Remove asbestos from the site. Establish and follow a plan based on best international practice to protect workers and public health. This should include personal protective equipment, wetting down broken fibro structures and removing without creating or liberating dust, collecting scattered fragments, securely bagging and transporting to an appropriate facility for safe disposal.
- Liaise with reputable contractors to take wastes for recycling or disposal for which local waste facilities are not sustainable, including waste oil, asbestos, batteries, and if feasible, disused equipment that can be recycled. Environmental management plans should include waste planning and establishing a system to record and verify where waste is disposed of or sent for recycling.

H. Project Alternatives and Justification

86. The proposed project is considered the best approach to economically, environmentally and socially sustainable energy supply for the proposed communities. Alternatives to the proposed solar-battery-diesel hybrid systems include the following:

- continuation with existing diesel generation: this would be to not take the opportunity for a more sustainable long term electricity generation, with long term cost savings and reduced exposure to future rises in diesel prices, reduced environmental risk associated with fuel transport, handling and storage, and reduced local noise and air pollution and reduced greenhouse gas emissions

- full solar or other combinations of solar-battery-diesel hybrid with greater or lesser solar component: this would be economically sub-optimal as the project has been designed to optimise these components
- other renewable energy: wind or geothermal resources are not suitable or generally available for these locations, or are less feasible than the proposed solar power project. There may be opportunities for mini or micro hydro at some locations, however this is less feasible than solar and customary landowner issues create a significant risk for the investment. For example, at Malu'u there is an existing small hydro station but a landowner dispute has led to damage to the diversion weir that has put the scheme out of operation for some years
- alternative sites in the selected communities: the proposed sites have been selected based on solar energy resource, relatively flat, lack of shading, low flood risk, proximity to connect to the grid, and importantly security of land tenure and low risk of customary landowner dispute.

87. Other communities at Gizo and Noro were also considered but were ruled out. At Gizo the grounds of the existing power station were assessed but found to have insufficient area of land as much of the site was excessively steep. Other investigations did not identify a suitable secure site. At Noro the nominated site in the grounds of the existing power station was found to be insufficient given the need of the area for uses associated with the existing power station. Given that Noro and Munda are connected by a transmission line, it was considered more effective to use the Munda site.

I. Sub-projects Descriptions

1. Kirakira

a. Existing Generation

88. The existing diesel power station at Kirakira is located in the centre of the commercial area of the town and has a significant noise impact on surrounding land use. The existing generators are two unenclosed Cummins 6BTAA5.9G2 (109kW- Solomon Power rated 104kW) with Stamford UCi274E alternators installed 2013.

89. Due to the wharf being damaged and out of use, diesel fuel is delivered by dropping 200 L drums off a ship and floating them to the shore guided by people swimming with the drum. It is reported that there have been instances of drums being damaged and diesel spilt into the sea. The existing power station is seen to have fuel/oil staining on the ground indicating soil contamination. The power station is not fully fenced and secure against unauthorised access.

b. Kirakira Site Description

90. Land has been acquired by Solomon Power about 1.5 km west of Kirakira town on the road to the airport. This is adjacent to the proposed 11 kV power line between the airport and the existing 415 V grid at the hospital. This site is bounded by the Huro River on the east and south-east, and a high ridge on the west running SSE to NNW. The road to the airport passes the northern part of the site.

91. The land is mostly flat, with steep banks running down to the Huro River on the east and south-east side of Lot 9, and the east and north-east side of Lot 8 (on the north side of the road). The high ridge on the western side may shade part of the western side late in the afternoon. The

ridge is highest at the road end of the site. The height of the ridge is shown on the contour plan as about 40 m. The treetops at the top of the ridge are estimated to be up to about 80 m above the site level.

92. The rear or south-south-west end of the site, furthest from the road (Lot 10, 4,898 m^2) narrows between the high ridge and the steep river bank and is forested, including large trees that appear to be old growth, and for this reason is unlikely to be suitable.

93. The cadastral plan shows an access corridor connecting Lot 10 to the road. This divides the site down the centre. Solomon Power is seeking to acquire this corridor and relocate access to the western part of the site.

94. The site includes land identified as Lot 8, to the north-north-east of, and on the opposite side of the road from the main part of the site. This is bounded by the Huro River bank on east and north-east where the river enters the sea behind sand dunes. The northern end of Lot 8 is a narrow strip along the road. A small waste incinerator and waste burial pit reportedly used by the hospital is located here.

95. The land use of the site is vegetable gardens, scattered fruit trees, and areas of grass and low regrowth. Numbers of fruit trees were estimated during the inspection. The soil appears quite fertile being adjacent to the river.

96. Local anecdotal advice indicates that the site is not flood prone and the bridge has never flooded. However, this does not rule out the possibility of flooding.

97. Views of the site are shown in the photographs below.

Figure 1 View from bridge (NE corner of Lot 9) looking west to high ridge at western side of site

Figure 2 View of ridge from road at Lot 15

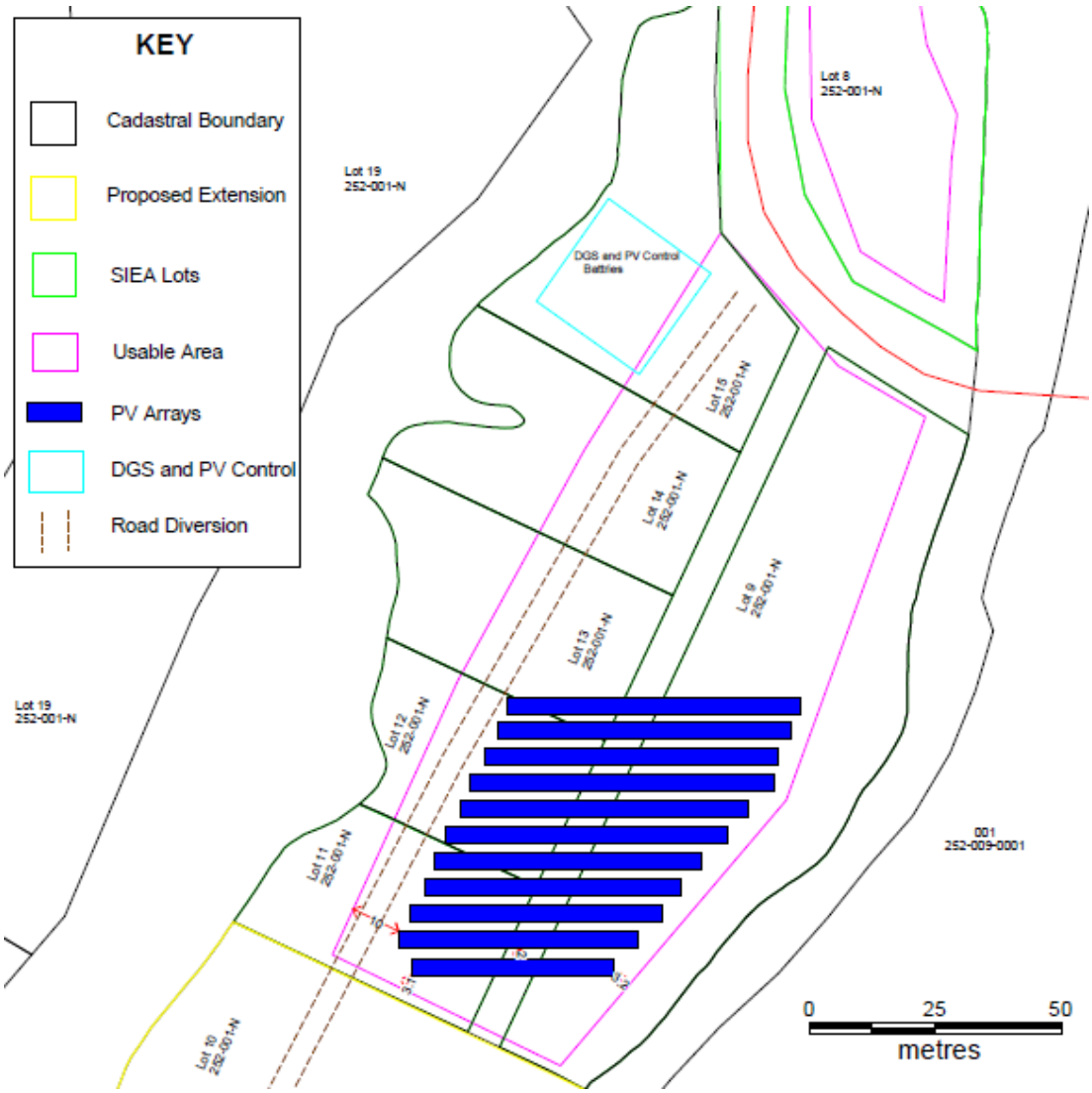
Figure 3 View of Lot 8 from the bridge

c. Kirakira Project Description

98. The proposed site layout is shown on the plan below.

Figure 4 – Kirakira Site Location

Figure 5 Kirakira Site Area and Sketch of Proposed Layout



99. The proposed solar PV capacity at Kirakira is 320 kW requiring a land area of 3,700 m^2 plus 500 m^2 for equipment housing and controls. This provides a solar fraction of 84%, which is the proportion of energy that will be provided by the solar panels.

100. The proposed generator is Kohler KD130 (96kW) or KD165 (120kW). An enclosed Kohler unit is not available. One Cummins unenclosed unit shall be transferred from the existing DPP site.

101. Solomon Power plan to install an 11 kV powerline from the town past the solar site to supply the police housing to the west of the site. The 1.5 km section of this line from the solar site to the town is required for the solar project. This will be built along the roadside.

d. Alternatives and Justification

102. An alternative to the proposed project would be to retain the existing diesel power station in the town with the existing high noise impacts. Siting the solar at the existing site would not be suitable due to space constraints. It would also result in continuation of the existing noise impact in the town.

2. Lata

a. Existing Generation

103. The existing diesel power station at Lata is located in the urban area. The existing generators are two unenclosed Cummins 6CTAA8.3G2 (183kW – Solomon Power rated 146kW) installed in 2011 and 2012. These have a noise impact on nearby houses and complaints have been reported.

b. Lata Site Description

104. The proposed Lata site is land currently owned by SIBC. It is currently empty apart from SIBC towers in the centre of the site, and clear of vegetation. The site is gently sloping with an area of 0.7 ha and has a piece excised from the centre for the SIBC towers. The site is shown in the map below.

Figure 6 – Lata Site Location

Figure 7 – Lata Site Photos

105. The adjacent areas of the site have changed since the date of the photo. Buildings to the NW of the site have been replaced with a number of new houses, the coconut trees on the west side have been removed, while a thick grove of trees have grown up to the NE of the site. There is also a newer building near the SW corner of the site.

c. Lata Project Description

106. The proposed site layout is shown on the plan below.

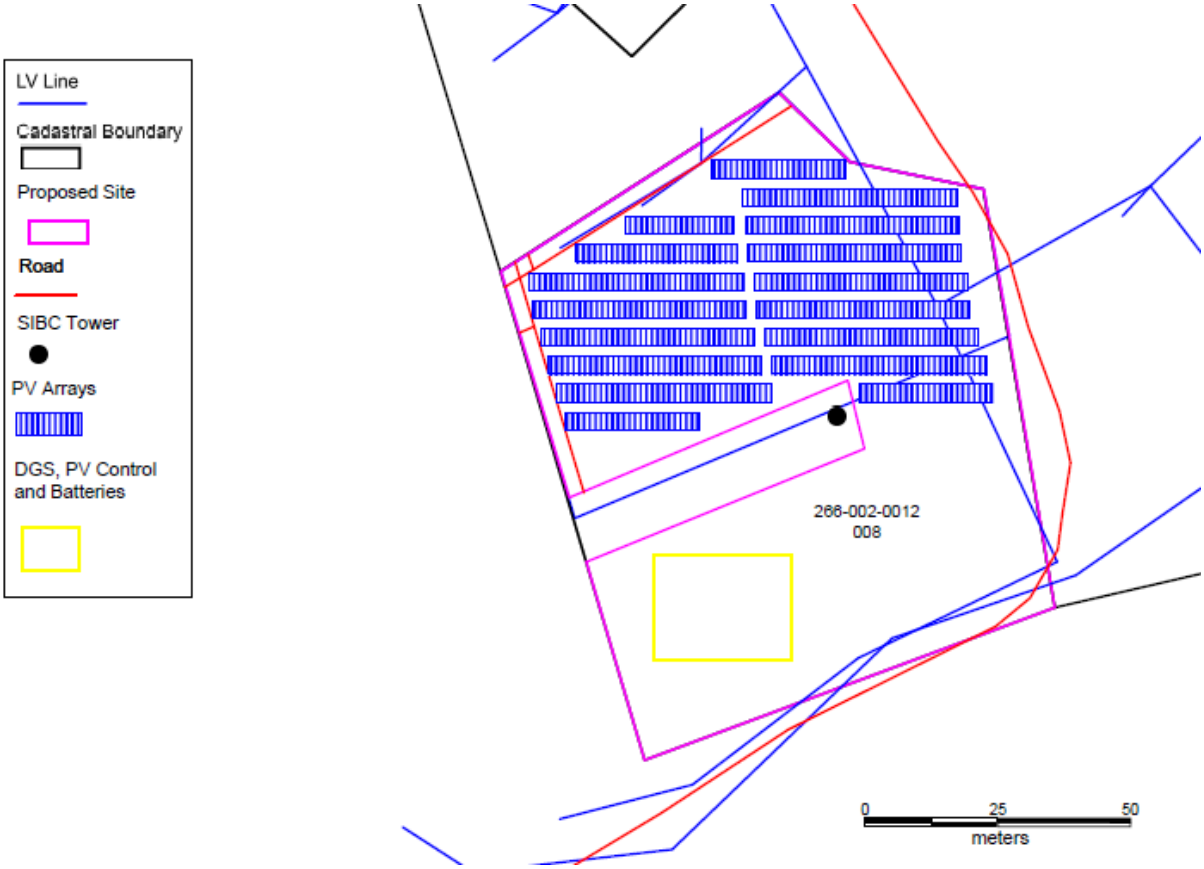
107. The proposed solar PV capacity at Lata is 290 kW requiring a land area of 3,300 m^2 plus 500 m^2 for equipment housing for diesel generators, battery, control room, diesel drum storage and tank, loading area and parking space. This provides a solar fraction of 86%, which is the proportion of energy that will be provided by the solar panels.

108. The proposed generator is Kohler KD165 (120kW) enclosed unit to be relocated from Tulagi.

d. Alternatives and Justification

109. An alternative to the proposed project would be to retain the existing diesel power station with the existing high noise impacts. Siting the solar at the existing site would not be suitable due to space constraints.

Figure 8 Lata site area and sketch of proposed layout



3. Malu'u

a. Existing Generation

110. The existing diesel power station at Malu'u is located outside the town area, and has a moderate noise impact on a nearby church and houses. The existing generators are two unenclosed Cummins 4BTA3.9 – G2 (48kW) complete with Stamford UCi224E alternators installed 2013.

b. Malu'u Site Description

111. The proposed Malu'u solar site is in the urban area, has an area of 2,800 m^2 and is elevated and gently sloping with little vegetation apart from a few isolated trees. The site is shown on the map below outlined in red and in the site photos below.

112. Adjacent land uses are houses to the north across the road, Provincial offices to the west, telecommunications to the south and SE and school sport fields to the east.

Figure 9 Malu'u Solar site location

Figure 10 Malu'u Solar site NW corner

Figure 11 Malu'u Solar site SW corner

Figure 12 Malu'u Solar site looking north

c. Malu'u Project Description

113. The proposed site layout is shown on the plan below.

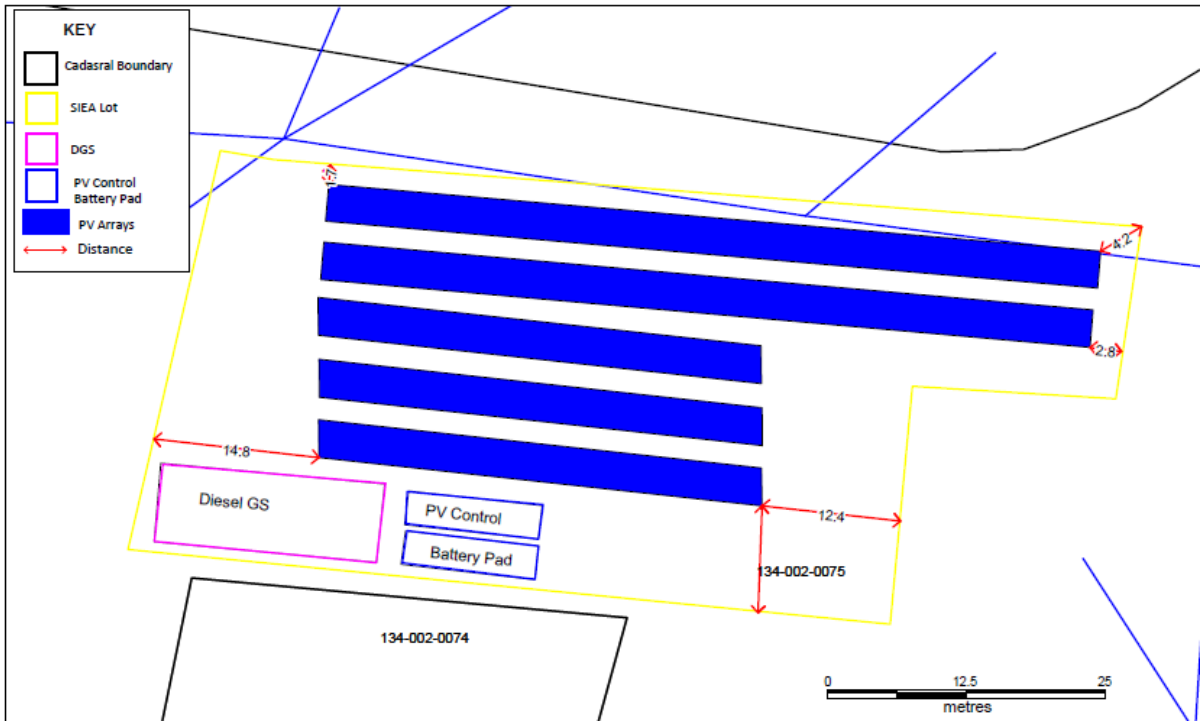
114. The proposed capacity of solar PV plant at Malu'u is 140 kW, for which a minimum land area required is 1,600 m^2. The solar fraction for this system is 88 %.

115. The proposed generator is Kohler KD66 (48kW): An enclosed unit is not available at Malu'u. Initially operation will commence with a Cummins unit. Compliant noise mitigation may be required unless an alternative Kipor KDE75SS3 (56kW) unit from Tulagi is made available.

d. Alternatives and Justification

116. Alternatives considered included locating the diesel generator component near the port, however it is considered more effective for operation to keep the diesel generator with the solar and battery components. The existing diesel power station does not have space for solar. There is a small hydro station beside the existing diesel power station, but this has put out of service by damage to the diversion weir upstream due to a landowner dispute. This could theoretically be brought back into service but the ongoing dispute makes this impracticable and presents an ongoing risk to the project.

Figure 13 Malu'u site area and sketch of proposed layout



4. Munda

a. Existing Generation

117. The existing diesel power station at Munda is located to the north of the eastern end of the airport runway. This is seldom used however and is mainly backup as the main supply comes from Noro power station via an underground 11 kV transmission line. In the absence of the solar project, the generator at Munda is planned to be replaced with a single Kohler KV350C2 in 2016.

b. Munda Site Description

118. The proposed site to the south of the western end of the airport runway. It is flat coastal land mostly vegetated with scrub and trees. The hospital is located to the west. Site location and photographs are shown below.

Figure 14 Munda Site Location (Yellow Rectangle)

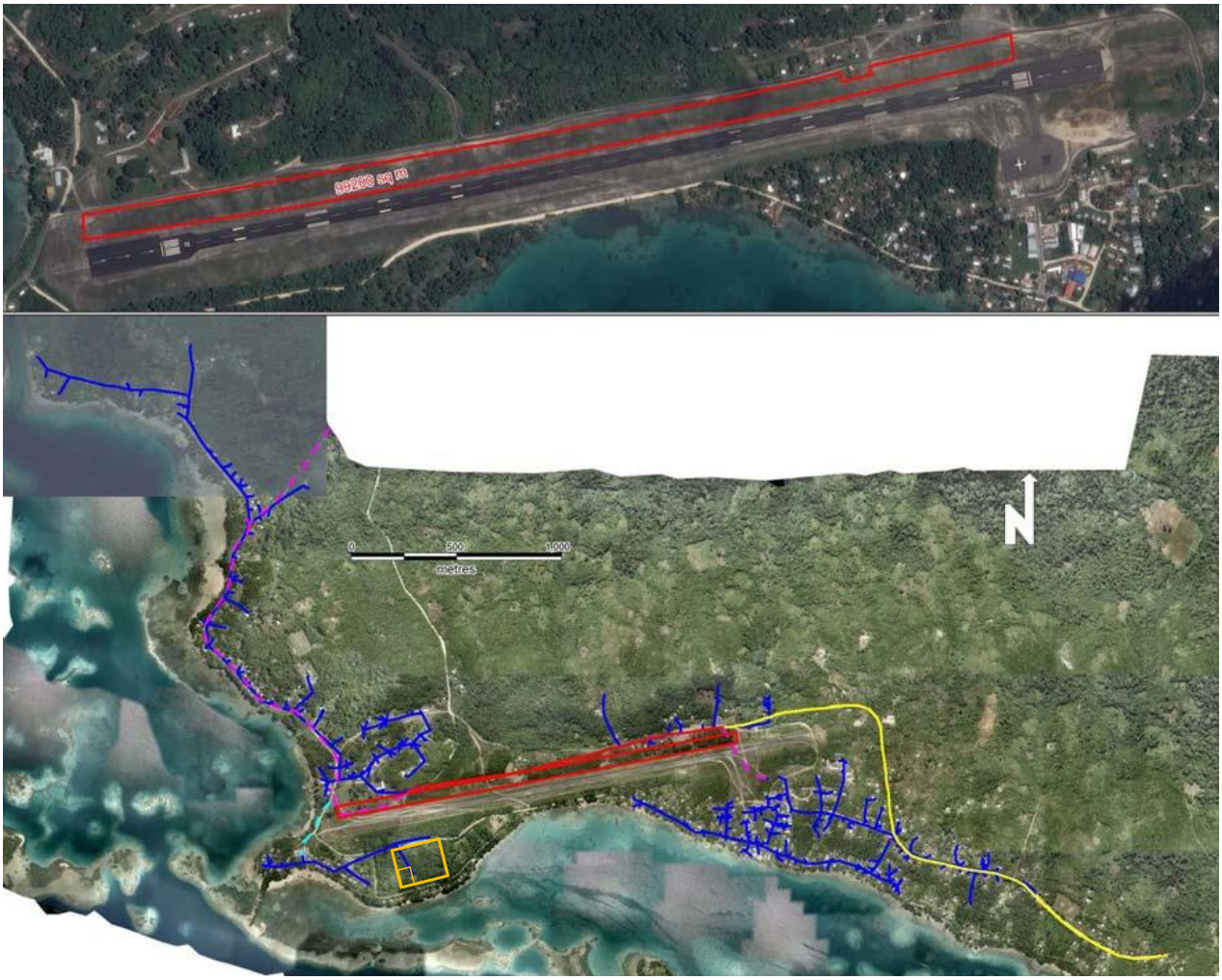


Figure 15 Munda Site Photographs

Photo 1: Site 2B from SIBC mast pan clockwise

Photo 2: Site 2B pan clockwise

Photo 3: Site 2B pan clockwise: red post

Photo 4: Site 2B pan clockwise

Photo 5: Site 2B pan clockwise

Photo 6: Site 2B pan clockwise to SIBC mast

Photo 7: Red boundary post as marked on Photo 3 ~~Photo 5~~ above.

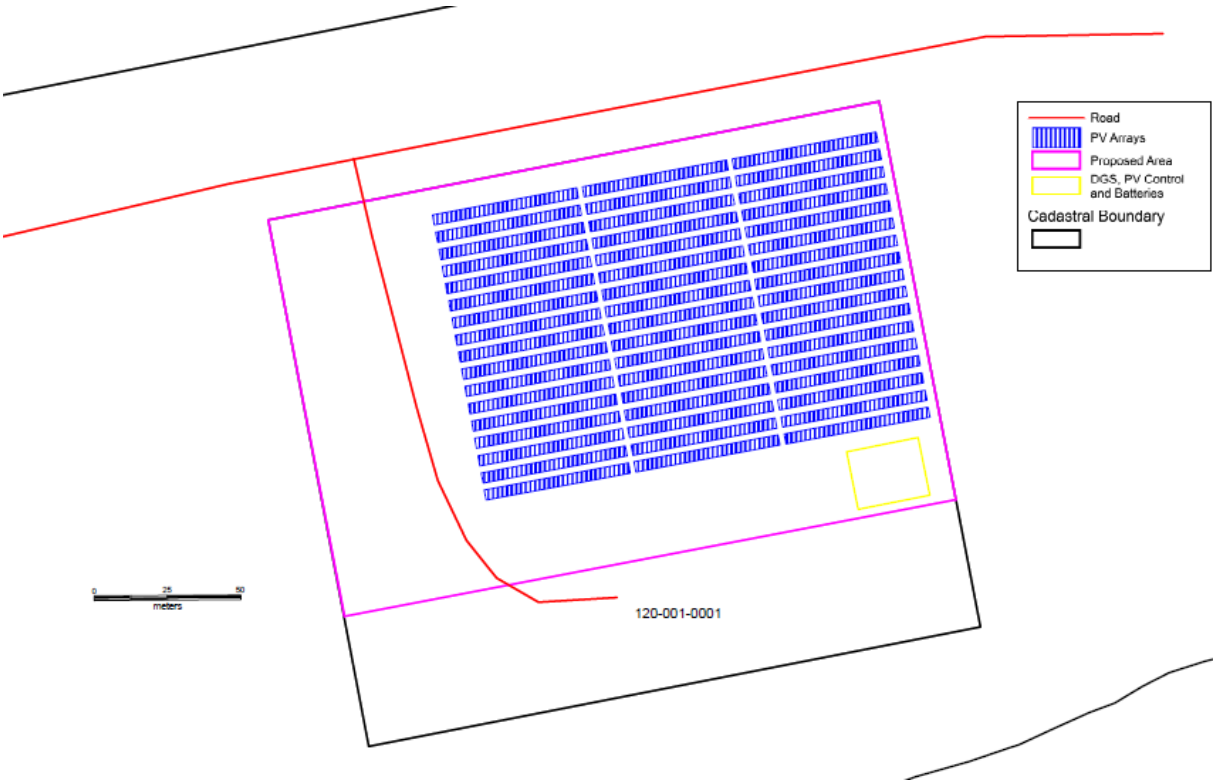
Photo 8: Road side boundary post near existing access road into site.

Figure 16 Munda Site (Yellow Rectangle, "Site Option 2" is the proposed site)

c. Munda Project Description.

119. The proposed solar PV capacity at Munda is 1,000 kW, requiring a land area of 1.15 ha. Proposed concept site layout is shown below.

Figure 17 Munda Solar Site Layout



120. The proposed generator is Kohler KD220W (163kW) or KV350C2 (235kW). The new KV350C2 may be transferred from the existing diesel power station before solar plant commissioning provided 11kV supply from Noro available.

d. Alternatives and Justification

121. The project initially assessed land along the northern side of the runway which has a very large area of open land which would be technically suitable. However the Civil Aviation Authority has declined agreement to this proposal. A further option was a strip also on the south side of the runway, on the north side of the proposed site, which was also rejected by CAA.

5. Tulagi

a. Existing Generation

122. The existing diesel power station at Tulagi is located in the shipyard industrial area on the north side of the island to the east of the proposed solar site. The diesel generators are An enclosed Kipor KDE75SS3 (56kW) and KFS70 alternator unit installed 2012 with two Kohler KD165 to be installed in 2016 in the absnec of the solar project.

123. The existing station is well located with respect to noise disturbance as it is shielded by the hill behind from the main community area.

b. Tulagi Site Description

124. The proposed Tulagi solar site is located on the north side of the island close to the main wharf area. The site is flat coastal land with the road and power line on the eastern boundary.

The site is mainly cleared except for forested swampy ground at the western end. There is a ridge line with tall trees to the north of the site.

Figure 18 – Tulagi Site Photos

Figure 19 – Tulagi Site Location

c. Tulagi Project Description

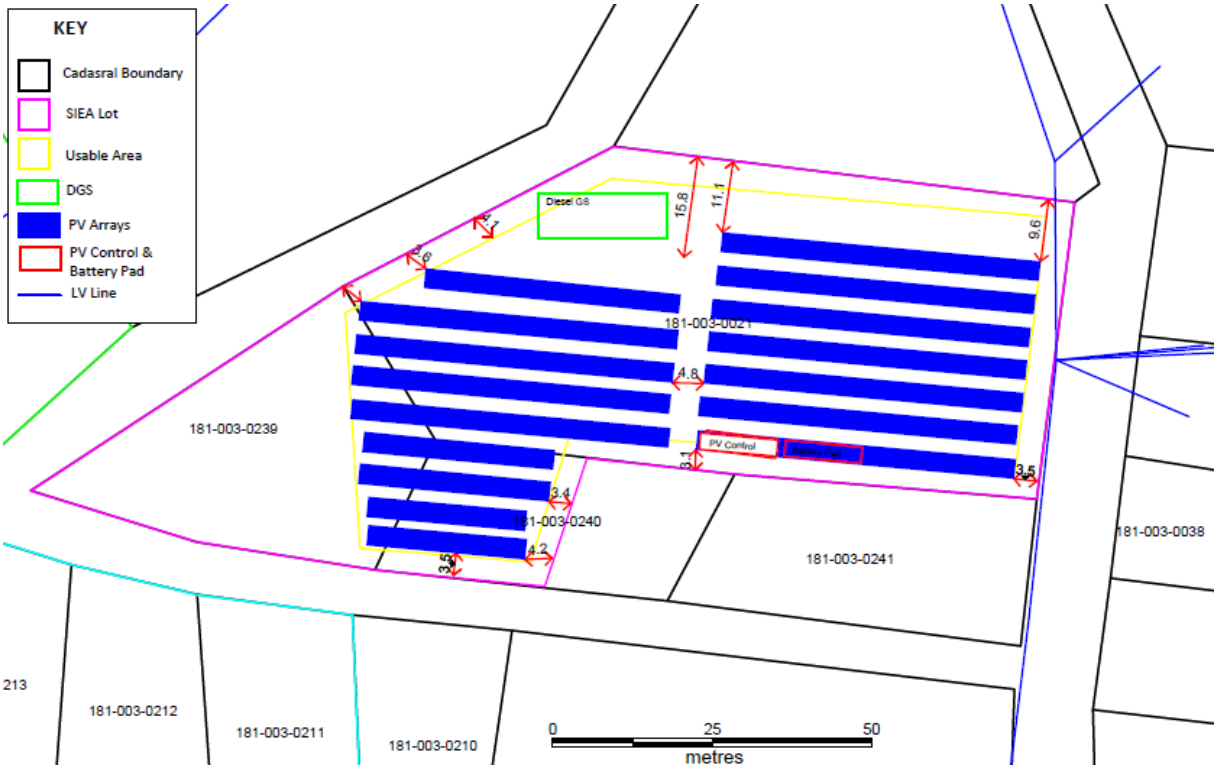
125. A solar capacity of 250 kW is proposed for Tulagi. This requires an area of 2,800 m^2 plus 500 m^2 for equipment housing and controls. The proposed layout is shown below.

126. The proposed diesel generator is Kohler KD130 (96kW) or KD165 (120kW), one of the new KD165 units from the existing diesel power station is to be transferred to the solar plant. (the other to be transferred to Lata once the solar project is operating).

d. Alternatives and Justification

127. Modelling for Tulagi indicates a larger solar capacity could be technically optimal. However the usable site area is limited by shading and swampy ground at the western part of the site including the former power station area at the west of the site and larger suitable sites were not found to be available.

Figure 20 Tulagi Solar Site Layout



IV. DESCRIPTION OF THE ENVIRONMENT

A. General Description

129. This section provides a general description applicable to all sites.

1. Physical Environment

a. Geology, Soils and Topography

130. Solomon Islands consists of about 990 islands with a land area of 28,000 km^2. The topography and geology of the islands is varied with mountainous volcanic islands and coral attols. The project sites are located on the narrow coastal strips of flat to undulating land which occur around much the coast of islands which are otherwise generally hilly to mountainous. The Solomon Islands is subject to earthquakes and tremors.

131. The geology and soils are variously volcanic with fertile soils or limestone derived from old coral reef with calcerous infertile soils.

132. The majority of the solar sites are cleared of vegetation and subject to disturbance by existing vegetable growing, so that the soil is exposed to erosion by rainfall especially on steep slopes.

b. Climate

133. Solomon Islands experiences a tropical climate with an average temperature of 27 degrees C, average rainfall of 3,000 mm and high humidity. The country experiences cyclones on a regular basis with greater frequency in the south-east. Rainfall is seasonably variable with wet and dry seasons, much rain falling in intense storms and areas subject to drought. Water supplies are obtained from streams, springs, wells and roof runoff. The table below shows average monthly and yearly temperature and rainfall conditions.

Table 3 - Weather Conditions

Average	Annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	No of Years
Temperature (C)	26.1	26.8	26.6	26.4	26.5	26.4	26.3	25.8	25.8	25.9	26.4	26.4	26.6	18
High Temperature (C)	29.7	30.3	30.2	30.1	30.2	30.1	29.7	29.1	29.1	29.5	29.8	30.2	30.5	16
Low Temperature (C)	22.7	23.1	23.1	22.9	22.9	22.8	22.7	22.6	22.5	22.5	22.7	22.8	22.9	16
Rainfall (mm)	3,210.3	333.9	340.6	364.9	259.2	239.8	192.5	253.5	247.6	231.3	234.8	226.2	255.8	26

c. Air Quality

134. Background air quality in the vicinity of existing sites is generally good, however is intermittently affected by smoke from burning of rubbish which is a common method of waste disposal in Solomon Islands. Existing diesel power stations have an impact on local air quality however this is not likely to be major.

d. Noise

135. Background noise levels at the proposed sites are generally low. Traffic levels are generally low and the main noise sources are low levels associated with urban and rural activities. In relation to noise the ambient noise environment at Kirakira can be described as

quiet rural environment expected to have a typical indicative background noise around 30 dBA, while the other sites can be described as quiet urban or peri-urban expected to have an indicative background noise around 45 dBA.

136. The solar power sites are separate from the existing diesel power stations so the existing environments at the new sites are less affected by noise from the existing power stations. This currently impacts the surrounding residences at Lata, Kirakira, and an adjacent church at Malu'u. Existing Tulagi power station is in a separate industrial area and has little impact while Munda power station operates infrequently as backup and is currently supplied from Noro.

e. Natural Hazards and Climate Change

137. Based on the analysis below, the risk of earthquake, tsunami and cyclone for each site are summarised in the following table. This is based on records and a low risk does not mean that an event could never occur.

Table 4 Relative Risk of Earthquake, Tsunami and Cyclone

Site	Earthquake	Tsunami	Cyclone
Kirakira	low to medium	medium	high
Lata	medium to high	Low	low
Malu'u	Low	Low	medium
Munda	medium	medium	medium
Tulagi	Low	low	medium

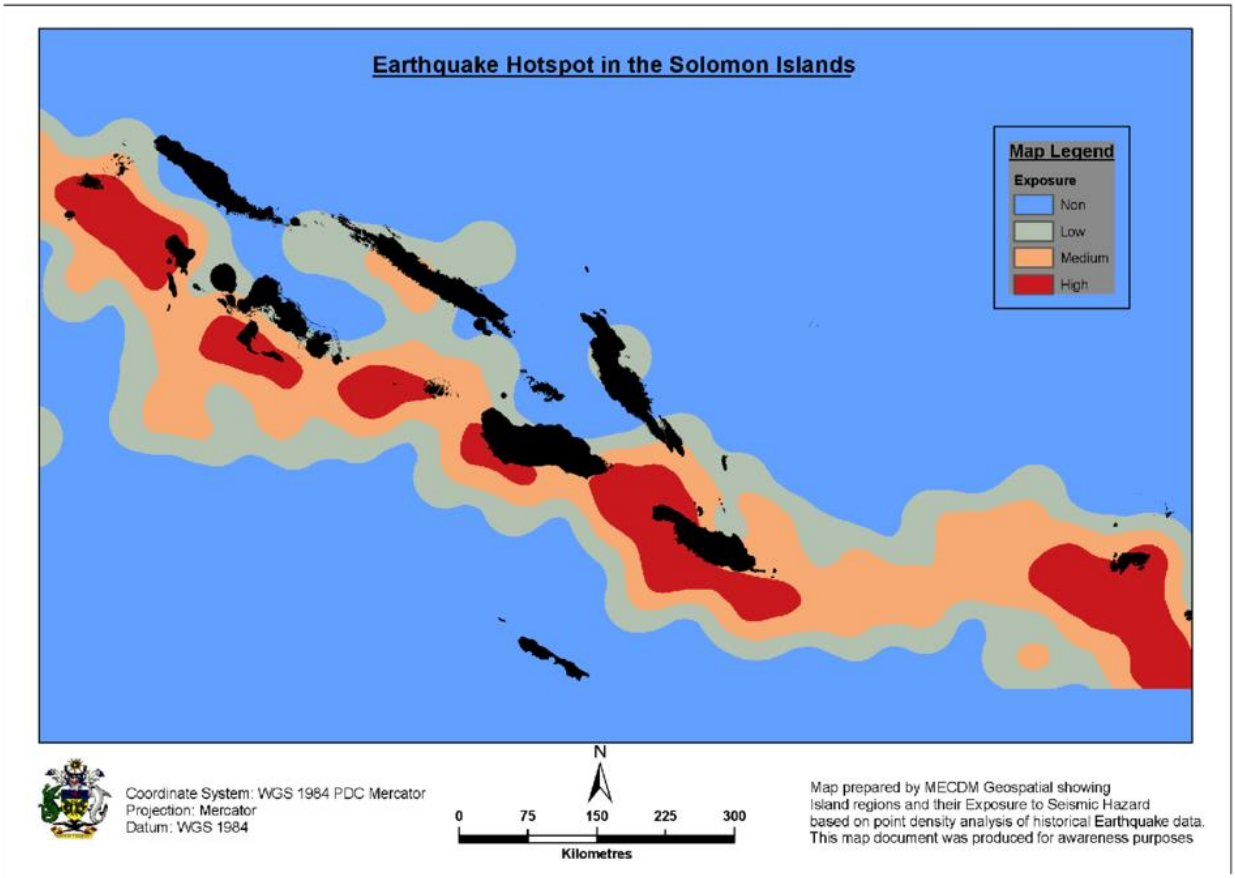
i. Earthquake and Tsunami.

138. The risk of earthquake and tsunami varies across the country, depending on the location with respect to subduction zones. Advice from the Solomon Islands Government Seismology Office, Geology Department indicates that Munda, Kirakira and Lata are considered to have a significant risk while Tulagi and Malu'u are considered to have a lower risk.

139. The map below shows the risk of earthquake across the country, and inferred from this the associated tsunami risk for adjacent coastal locations. This shows that the location at Lata has medium to high exposure risk, Munda has medium exposure, Kikakira low to medium exposure, and Tulagi and Malu'u low exposure.

140. Tsunami exposure is also related to the exposure to the sea, the shelter provided by the coast and the elevation of the site. In this respect Munda is assessed as medium risk of tsunami as it low lying and has medium exposure to earthquake. Kirakira is assessed as medium risk as it has low to medium earthquake exposure and fronts the coast at about 7-10 m elevation; while incoming waves may be funnelled by the Huro River and the ridge to the west. Lata and Malu'u are on elevated sites set back hundreds of metres from the sea giving them a negligible risk. Tulagi is at lower elevation close to the sea but have low risk due to low exposure to earthquake.

Figure 21 Earthquake Hotspots in the Solomon Islands



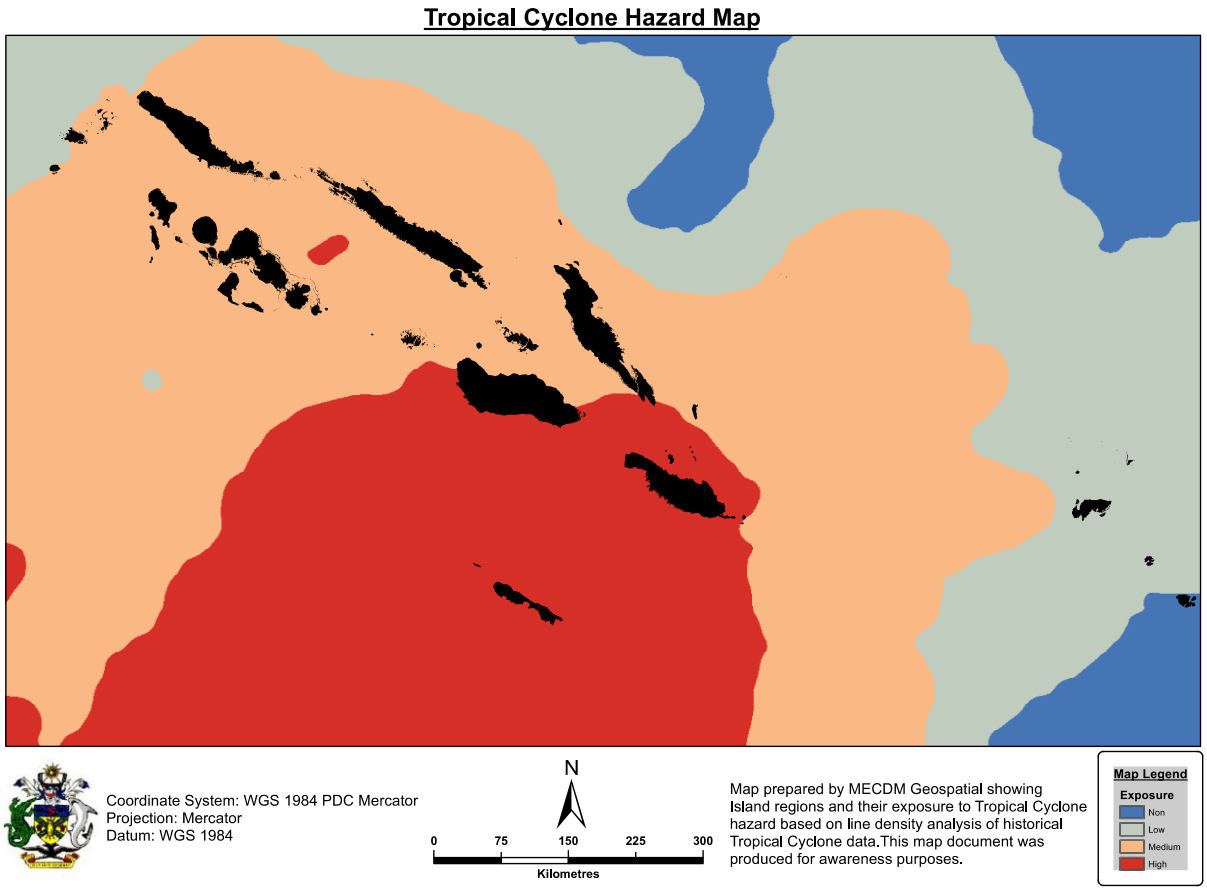
ii. Tropical Cyclone Risk

141. Solomon Islands experiences tropical cyclones with the risk varying across the country. The map below shows the risk of cyclones across the country. This shows that Kikakira has high exposure, Munda, Tulagi and Malu'u have moderate exposure, and Lata has low exposure.

iii. Climate Change

142. Climate change is predicted to lead to storms and dry periods being more frequent and more severe, and sea level to rise. Increased storms and sea level rise are expected to be compounded by climate change. Climate change vulnerability and adaption for the project are discussed in the Impacts and Mitigation section.

Figure 22 Tropical Cyclone Hazard Map



2. Ecological Environment

a. Solomon Islands

143. Solomon Islands is rich in flora and fauna with numerous endemic species developed on the many isolated islands. The country possesses a rich and diverse marine environment including extensive coral reefs and rich fisheries. Numerous plants are identified across the country as having uses for timber, food, medicinal, handicraft, traditional and other uses. Sixteen species of plants are identified as threatened under the IUCN Red List.

144. Bird life in Solomon Islands exhibits a high level of species diversity and endemism. Solomon Islands has the highest number of birds of unique restricted range and unique species by area on earth. Larger islands have their own endemic species and/or subspecies (the New Georgia group has 10 endemic species, Malaita 3, Guadalcanal 3, Makira 13, Kolombangara 2, Vella Lavella 1, Ranongga 1, Ghizo 1, Rennell 5, Santa Cruz 3). In total, the Solomon Islands (including Rennell, Bellona and the Santa Cruz Islands) have 94 bird species with a Restricted Range, 16 of which are classified as threatened.[2]

[2] Ministry of Environment Conservation and Meteorology (2008). Solomon Islands State of the Environment Report July 2008

145. Solomon Islands has more mammal species than most Pacific island countries with 53 known species of mammals, mostly bats, rats and possums, of which 20 are endemic (including several Macrochiropterans such as the Pteralopex spp. complex) and 20 are identified as threatened[3].

146. Approximately 80 reptiles are recorded in Solomon Island which include marine species with over one third endemic and 5 identified as threatened species. There are a 21 reported frog species in Solomon Islands, of which two species are endemic[4].

147. Solomon Islands has an 14,511 described insect species and 46,015 insect species. At least 130 species of butterflies occur in Solomon Islands, of which 35 are endemic and 25 recognised endemic snail species[5].

b. Project Sites

148. All sites with the exception of Tulagi and Munda are on land largely or entirely clear of significant natural vegetation or fauna habitat. Tulagi and Munda have had specialist field assessment by a local ecologist finding that the sites are regrowth without significant conservation value.

149. There are no listed, rare, endangered, vulnerable or threatened species of flora or fauna or communities potentially affected by the project. This includes the IUCN Red List.

150. There are no “Critical Habitats” potentially affected by the project, as defined in Asian Development Bank Safeguards Policy Statement, 2009: "Critical Habitat: A subset of both natural and modified habitat that deserves particular attention. Critical habitat includes areas with high biodiversity value, including habitat required for the survival of critically endangered or endangered species; areas having special significance for endemic or restricted-range species; sites that are critical for the survival of migratory species; areas supporting globally significant concentrations or numbers of individuals of congregatory species; areas with unique assemblages of species or that are associated with key evolutionary processes or provide key ecosystem services; and areas having biodiversity of significant social, economic, or cultural importance to local communities."

151. There are none of the following ecological components that may be affected by the project as identified in proposed Solomon Islands “Screening Guide Criteria for Determining if Prescribed Development will require a PER or EIS” (MECDM): wetlands, mangroves, corals, fisheries, protected area and national parks, wildlife especially any rare endangered or vulnerable species or habitats, forests or coastal resources.

3. Social Environment

a. Population

152. The population of the Solomon Islands at the last census in 2009 was 515,870, living in 92,241 households, with a growth rate in the ten years prior of 2.3%. The population is relatively

[3] Ministry of Environment Conservation and Meteorology (2008). Solomon Islands State of the Environment Report July 2008
[4] Ministry of Environment Conservation and Meteorology (2008). Solomon Islands State of the Environment Report July 2008
[5] Ministry of Environment Conservation and Meteorology (2008). Solomon Islands State of the Environment Report July 2008

young with a median age of 19.7 years. Life expectancy in 2009 was 67 years. The population density is relatively low at 20 persons per km^2. [6]

153. The country's GDP in 2009 was US$592M. About 82 per cent live in rural areas with a largely subsistence economy. Melanesians make up 93%, Polynesians 4% and other ethnic groups 3%.

154. Solomon Islands has a low level of development in terms of health, education and income indicated by a Human Development Index of 0.51[7].

b. Land use

155. Aerial photos of each of the project areas are given in the Project Description section. All of the project sites are within the provincial towns they are to serve, except for Kirakira which is in the rural area 1.5 km west of the town. The towns are small with low density and generally have a mixture of land use with residential, schools, clinics, small shops, produce markets, government, administrative, communications, airport, seaport, town services, playing fields as well as small scale vegetable and fruit growing, pigs and chicken raising and areas of bush. The coastal areas surrounding these towns have dispersed villages, small scale vegetable and fruit growing, including shifting cultivation, pigs and chicken raising, timber and areas of bush. The agricultural activities form important subsistence livelihoods along with fishing.

c. Sensitive Receptors

156. The neighbouring buildings to each of the solar sites that are identified as the nearest sensitive receptors are identified in the table below. This can be used to identify potential impacts including noise.

Table 5 - Sensitive Receptors - Buildings

Site	Nearest Sensitive Receptor	Distance & direction from site boundary	Location of new diesel generator area within site	Distance & direction from new diesel generator area
Kirakira	Houses	100 m S	NW	200 m S
Kirakira	Police houses	200 m W	NW	250 m W
Lata	Houses	25 m, N, E & SW	SW	40 m, SW
Malu'u	Houses	10 m N	SW	40 m N
Malu'u	Provincial offices	10 m W	SW	20 m NW
Malu'u	Police Station	20 m SE	SW	40 m SE
Munda	House	20 m W	SW	160 m W
Munda	House	40 m S	SW	70 m S
Tulagi	House	30 m N	N	40 m NE
Tulagi	House	5 m S	N	40 m S

Distances are indicative estimates.

[6] Solomon Islands Government. 2009 Population & Housing Census National Report.
[7] World Health Organisation. 2012. Solomon Islands Health Service Delivery Profile.

d. Energy use

157. The predominant fuel used by 89% of the population is wood, or 95% for areas outside Honiara. This provides more than 61% of gross national energy production[8].

158. Grid electricity is supplied by Solomon Power predominately from diesel powered generators. There are a number of hydro and solar schemes in planning or development in the country. Private operators such as hotels and resorts often have their own power supply, frequently diesel with some solar. Solar panels are also in use in villages for household use.

159. A small hydro scheme was established at Malu'u but has been damaged and is not currently in operation due to a landowner dispute.

B. Existing Environment at Sub-Project Sites

160. Site descriptions including maps and photographs are provided in the Project Description section.

1. Kirakira

a. Physical Environment

161. The Kirakira site is located on flat coastal land bounded by the Huro River on the east and on the north where the river enters the sea, a steep forested ridge on the west, and on the south where the site converges as a narrow forested strip between the river and the ridge. The site is physically constrained by this topography.

162. The soil is sandy and likely derived from alluvial material from the river.

163. The air quality of the site is good and noise levels low given the rural environment.

164. The route of the proposed transmission line along the road to the town is flat to gently undulating coastal land with a number of small creek crossings.

165. Kirakira has low to medium earthquake exposure (refer to maps in Section IV.A.1.e Natural Hazards and Climate Change) and is assessed as medium tsunami risk as it has low to medium earthquake exposure and fronts the coast at about 7-10 m elevation; while incoming waves may be funnelled by the Huro River and the ridge to the west. Tropical cyclone risk is high (refer to Section IV.A.1.e Natural Hazards and Climate Change). Climate change presents a risk to the project in combination with the existing tsunami and cyclone risk.

b. Ecological Environment

166. The Kirakira site is mainly vegetable gardens and some fruit trees. Other parts of the site that are not expected to be used for the project include a steep slope down to the river which is also planted with vegetables; steep land on the west side which is forested; and the rear section of the site which forms a narrowing strip of forest between the river and the steep land on the west.

167. There are no ecological values on the cleared flat area of the site to be developed that would prevent the project. The areas of the site that are considered potentially sensitive are those areas not included on the area to be developed, as identified above.

[8] Ministry of Environment Conservation and Meteorology (2008). Solomon Islands State of the Environment Report July 2008

c. Social Environment

168. Kirakira is located at 10°27′S 161°55′E on the north coast of Makira, and is the capital of the Makira-Ulawa Province. The population in 2013 was 2,461. The town is served by primary and secondary schools, hospital, churches, airport, guest houses mobile phone and sport field. The Kirakira wharf is in a state of disrepair so that goods need to ferried to shore by small boats from the larger cargo boats.

169. The area surrounding the solar site is rural. The site is used for vegetable growing and fruit trees. There are in the vicinity of 20 houses to the south of the site, the closest about 250 m from the bridge over the Huro River, or about 100 m from the back of the site. There is a police housing area about 300 m north-west of the site, and the airport beyond this at about 600 m from the site. There is extensive coconut plantation to the east along the road to town.

170. The neighbouring buildings that are identified as the nearest sensitive receptors are identified in the table below. This can be used to identify potential impacts including noise.

Table 6 - Kirakira Sensitive Receptors - Buildings

Site	Nearest Sensitive Receptor	Distance & direction from site boundary	Location of new diesel generator area within site	Distance & direction from new diesel generator area
Kirakira	Houses	100 m S	NW	200m S
Kirakira	Police houses	200 m W	NW	250 m w

Distances are indicative estimates.

171. There are reportedly minihydro schemes with a total capacity of approximately 0.5 MW under consideration for the Huro river.

2. Lata

a. Physical Environment

172. The Lata site is located on the edge of the urban area in an elevated position about 450 m away from the coast. The site is flat to gently sloping and clear of vegetation.

173. Air quality is good and noise levels low on the site with very few motor vehicles in use in the area.

174. Lata solar site has a medium to high earthquake risk but the site has no tsunami risk due to its elevated position (in the order of 30 m) and 450 m away from the coast. Although cyclones have occured in Lata including in March 2015, Lata has a statistically low exposure to cyclone risk (refer to Section IV.A.1.e Natural Hazards and Climate Change).

b. Ecological Environment

175. The site is cleared of vegetation in association with its current use for broadcasting towers. There are no significant ecological values identified on the site that would be impacted by the project. This is judged from aerial photos as the Lata SIBC site was identified after the visit to Lata by ADB Consultant Environmental Specialist.

c. Social Environment

176. Lata is located at 10°43′S 165°50′E is the capital of Temotu Province and has a population of about 553 (in 2007). The town has a hospital and a prison as well as several churches, shops, market, post office, mobile phone, guest houses, school and playing fields, airport and wharf.

177. The project site is owned by SIBC and a small area is used for broadcasting towers.

178. The surrounding area is residential with vegetable gardens, fruit trees and plantation. There are houses close to the east, north-west and at the south-west corner of the site.

179. The neighbouring buildings that are identified as the nearest sensitive receptors are identified in the table below. This can be used to identify potential impacts including noise.

Table 7 - Sensitive Receptors - Buildings

Site	Nearest Sensitive Receptor	Distance & direction from site boundary	Location of new diesel generator area within site	Distance & direction from new diesel generator area
Lata	Houses	25 m, N, E & SW	SW	40 m, SW

Distances are indicative estimates.

3. Malu'u

a. Physical Environment

180. The Malu'u site is located in the urban area in an elevated position in the order of 30 m about 260 m from the coast. The site is flat to gently sloping and clear of natural vegetation.

181. Air quality is good and noise levels low on the site.

182. Malu'u has a low exposure to earthquake risk or to tsunami risk due to its elevated position away from the coast. Malu'u has a statistically low exposure to cyclone risk (refer to Section IV.A.1.e Natural Hazards and Climate Change).

b. Ecological Environment

183. The Malu'u site is on cleared land in the urban area vegetated with grasses, some vegetable plantings and a few trees. There are no significant ecological values identified on the site that would be impacted by the project.

c. Social Environment

184. Malu'u is in the north of the island of Malaita and is reached by a four hour drive on an unsealed 82 km road from the Malaita provincial capital of Auki. The town is served by schools, clinic, churches, market, small shops, wharf, mobile phone communications and sport field.

185. The surrounding area is residential to the north across the road, with provincial government offices to the west, communications towers to the south and playing fields and school to the east.

186. The neighbouring buildings that are identified as the nearest sensitive receptors are identified in the table below. This can be used to identify potential impacts including noise.

Table 8 - Sensitive Receptors - Buildings

Site	Nearest Sensitive Receptor	Distance & direction from site boundary	Location of new diesel generator area within site	Distance & direction from new diesel generator area
Malu'u	Houses	10 m N	SW	40 m N
Malu'u	Provincial offices	10 m W	SW	20 m NW
Malu'u	Building	20 m SE	SW	40 m SE

Distances are indicative estimates.

187. A small hydropower station outside the town is disused due to damage arising from a landowner dispute.

4. Munda

a. Physical Environment

188. The site is located on flat low lying land, estimated at about 5 m, with the coast about 100 m to the south.

189. Air quality is good and noise levels low on the site.

190. Munda has statistically medium level of exposure to exposure to earthquake, tsunami and cyclone risk (refer to Section IV.A.1.e Natural Hazards and Climate Change). Its flat low lying nature makes it potentially more vulnerable to storm surge and tsunami, while fringing reefs offshore may provide some protection.

b. Ecological Environment

191. The Munda site is vegetated with trees and scrub over most of the site, with a large cleared area in the SW part of the site. A specialised ecological assessment by an experienced local ecologist has been carried out. Advice from the assessment is that the vegetation is mainly secondary forest regrowth. The area was heavily impacted during the second world war when the airstrip was first constructed. Following that, there was heavy fighting in this area during the war and then activities of the hospital establishment caused some impacts. The site is affected by settlement around the surrounding boundaries. As such, the earmarked site is mainly comprised of secondary forest flora with overlaps of coastal or beach strand vegetation that is heavily impacted due to successive human activities and there is no ecological issue to the project establishment.

c. Social Environment

192. Munda is located at 8°20′S 157°16′E in Western Province at the western end of New Georgia island. The town is served by schools, hospital, churches, airport, guest houses, wharf, mobile phone and sport field.

193. The site has houses to the south and west and the hospital further to the west. The site is located adjacent to the southern side of the Munda airport runway.

194. The neighbouring buildings that are identified as the nearest sensitive receptors are identified in the table below. This can be used to identify potential impacts including noise.

Table 9 - Sensitive Receptors - Buildings

Site	Nearest Sensitive Receptor	Distance & direction from site boundary	Location of new diesel generator area within site	Distance & direction from new diesel generator area
Munda	House	20 m W	SW	160 m W
Munda	House	40 m S	SW	70 m S

Distances are indicative estimates.

5. Tulagi

a. Physical Environment

195. The site is located on flat low lying land, estimated at about 5 m, with the coast about 100 m to the south.

196. Air quality is good and noise levels low on the site.

197. Tulagi has statistically low risk of earthquake or tsunami and medium risk of cyclone (refer to Section IV.A.1.e Natural Hazards and Climate Change). Although the site is flat, low lying and close to the sea, this north side of the island is protected by the large island of Nggela which it faces some 2 km to the north.

b. Ecological Environment

198. The Tulagi site is cleared of vegetation in the front (eastern) part closest to the road with vegetable plantings, a house and outbuildings, while the western part of the site is forested and poorly drained. A flora and fauna field study was undertaken for the Tulagi site by a local ecologist with extensive experience in undertaking such assessments. The study found the forest is regrowth with no significant ecological values which would be impacted by the clearing of the site for the project. The report is attached as an Appendix.

c. Social Environment

199. Tulagi is the capital of Central Province and historically was the capital of the British Solomon Islands. The town of Tulagi is located at 9°06′S 160°09′E, on the small island also called Tulagi. The population is 1,750. Tulagi can be reached by ferry or small boat from Honiara. The town is served by schools, clinic, churches, airport, guest houses, mobile phone and sport field.

200. The site has houses to the south and east sides of the western part of the site and other buildings to the east across the road which appear to be disused. The neighbouring buildings that are identified as the nearest sensitive receptors are identified in the table below. This can be used to identify potential impacts including noise.

Table 10 - Sensitive Receptors - Buildings

Site	Nearest Sensitive Receptor	Distance & direction from site boundary	Location of new diesel generator area within site	Distance & direction from new diesel generator area
Tulagi	House	30 m N	N	40 m NE
Tulagi	House	5 m S	N	40 m S

Distances are indicative estimates.

V. ANTICIPATED IMPACTS AND MITIGATION MEASURES

201. Potential impacts and mitigation measures are described here in terms of pre-construction/design stage impacts; construction impacts; and operations impacts, with each looking at impacts on physical, biological and socio-economic environments. Mitigation measures have been compiled in the environmental management and monitoring plan matrix in Section VII.

A. Pre-Construction/Design Stage Impacts

202. Impacts arise from the decisions and actions taken during the design / preconstruction stage. While the impacts may be experienced in the construction or operation stages, there are mitigation measures that should be implemented in the planning of the project. Refer also to the sections covering construction and operation stages.

203. Mitigation measures during design / preconstruction stage include planning the project so as to implement the mitigation measures specified for the construction and operation stages. This includes: ensure all approvals and permits in place; Ensure environmental requirements are incorporated in contract documents; contractor to prepare a construction environmental management plan (CEMP) describing how the contractor will ensure the work complies with the environmental requirements and this reviewed and approved by Solomon Power PMU; selection and design location of equipment including diesel generators and noise shielding so as to comply with noise guidelines at sensitive receptors; Community consultation and project disclosure; establish grievance redress mechanism (GRM); design structures to withstand cyclone loading; appoint environmental officer; Contractors prepare CEMP will separate or sub-plans as required such as occupational health and safety plans; Plan the project so as to maximise local labour and business participation.

a. Climate Change and Adaption

204. Natural hazards and climate change risks are discussed in Section IV.A.1.e Natural Hazards and Climate Change.

i. Benefits in Carbon Emission Reductions

205. The project will bring reduction in carbon emissions due to the reduced emission of fossil fuels by diesel generators. The solar-diesel-battery hybrid system was modelled using the "Homer" computer model to optimise the design of the system. The modelling found that the hybrid system would reduce diesel consumption and associated CO_2 emissions by 78%. Estimation of diesel saving and greenhouse gas reduction is shown below per year and over a nominal 25 year life.

Table 11 - Indicative Reduction in Greenhouse Gas Emissions from Diesel Generators

	Diesel '000 L/year average	**CO_2 T/year @2.63 kg/L**	**%**	**CO_2 emissions over 25 year life (Tonnes)**
100% Diesel (no solar)	1,182	3,109	100%	77,715
Solar-diesel hybrid	261	686	22%	17,140
Saving	921	2,423	78%	60,575

Derived from Homer computer modelling

206. Further emissions occur in the manufacture and transport of the solar panels and other equipment and in the construction, operation and decommissioning of the project. Greenhouse gas emissions over the lifecycle of a "typical" solar PV project have been published by IPCC as 46 g CO_2 per kWh of electricity produced. From this the indicative CO_2 emissions over the lifecycle of the solar PV is 3,583 T, or 6% of the savings from avoided diesel based generation.

Table 12 – Indicative Lifecycle Emissions of Solar PV

Power from PV MWh/ year	CO_2 kg/kWh [9] [10]	CO_2 T/year	CO_2 emissions over 25 year life (Tonnes)
3,116	0.046	143	3,583

207. Greenhouse gas emissions from clearing of about 2 ha forest for construction at Munda and Tulagi are estimated as 1,468 T CO_2. This is 2.4% of the saving on diesel consumption of 60,575 T CO_2 over a nominal 25 year life.

Table 13 – Indicative CO_2 Emission from Land Clearing

Forest clearing ha	Carbon (C) T/ha[11] (indicative)	CO_2 T/ha (see note)	CO_2 T
2	200	734	1,468

Note: Multiply by 3.67=(16*2+12)/12 to convert from T Carbon to T CO_2

208. The total greenhouse gas reductions as a result of the project including the above is estimated as 55,000 T, or 72% of the alternative case of 100% diesel generation, as shown in the table below. Further savings in greenhouse gas emissions that have not been included in this are those that occur due to the extraction and refining of oil to make diesel and lubricating oils, storage and transport of oil and diesel from point of extraction to refining including pipeline, road and sea transport.

Table 14 – Indicative Total CO_2 Emissions over 25 Year Life

	CO_2 emissions over 25 year life (Tonnes)
100% Diesel (no solar) base case	77,715
Saving on diesel by Solar	-60,575
Lifecycle Emissions of Solar PV	3,583
Emissions due to land clearing	1,468
Total Saving over 25 year life	-55,524
Saving as % of 100% diesel base case	72%

[9] Moomaw, W., P. Burgherr, G. Heath, M. Lenzen, J. Nyboer, A. Verbruggen, 2011: Annex II: Methodology. In IPCC: Special Report on Renewable Energy Sources and Climate Change Mitigation (ref. page 10)

[10] National Renewable Energy Laboratory. November 2012. Life Cycle Greenhouse Gas Emissions from Solar Photovoltaics. http://www.nrel.gov/docs/fy13osti/56487.pdf

[11] Gibbs, HK, S Brown, JO Niles and JA Foley. Monitoring and estimating tropical forest carbon stocks: making REDD a reality. (https://unfccc.int/files/land_use_and_climate_change/redd/submissions/application/pdf/redd_20081022_tfg.pdf)

ii. Climate Change Risk to the Project

209. Climate change is predicted to lead to storms and dry periods being more frequent and more severe, and sea level to rise. Increased storms and sea level rise are expected to be compounded by climate change. The main risks to the project are as a result of extreme wind events, and increased storm surge generating extreme waves on the coastline. Other factors considered in climate change assessment include temperature rise, corrosion, flooding, landslide, reduced solar power generation due to increased cloud cover, damage by lightning, reduced capacity of power lines, increased losses in transformers.[12]

210. Solomon Islands already experiences tropical cyclones with the risk varying across the country. The Tropical Cyclone Hazard Map (refer to Existing Environment section) indicates that Kikakira has high exposure, Munda, Tulagi and Malu'u have moderate exposure, and Lata has low exposure.

211. Kirakira is located close to the coastline adjacent to a river, in the order of ten metres above sea level and potentially exposed to extreme storm waves, erosion of the sea front or river bank. It is also in an area identified as having an existing high cyclone risk (refer Existing Environment section). The river bank area facing the sea front is heavily vegetated with trees and undergrowth which would provide some protection to the bank fronting the site. Local advice is that the site has never flooded, but this does not mean that it will never flood.

212. Kirakira has a proposed 1.5 km power line which would connect the solar station to the town grid. This power line would follow the road which is on low lying coastal land as close as 40 to 50 m from the sea and with one significant river crossing close to the town, and passes through coconut plantation and other trees. This power line is also exposed to damage from high winds and tree fall.

213. Lata is located on an elevated site hundreds of metres from the sea. It is subject to wind damage but not sea storm waves.

214. Malu'u located on an elevated site hundreds of metres from the sea. It is exposed to extreme wind but not sea storm waves.

215. Munda is located on low lying land at approximately 3 m elevation approximately 100 m from the sea. It is potentially at risk from extreme storm waves as well as extreme wind. However some protection from high waves is provided by coral reefs offshore and dense tree growth between the site and the sea.

216. Tulagi is located on low lying land close to the sea. It is potentially at risk from extreme storm waves as well as extreme wind. However Tulagi is protected from large seas by the larger islands to the north. For this reason Tulagi hosts shipyards which are located here due to the sheltered waters.

217. Tsunami risk is not climate related and is discussed in the Existing Environment section.

iii. Climate Change Adaptation – Mitigation Measures

218. Climate change adaptation benefits will accrue from the reduced reliance on transported fuel the supply of which can be cut off locally if transport is interrupted during extended stormy weather.

219. The project, the solar panels and connecting power lines in particular, are exposed to potential cyclonic storm damage. As an adaption, all structures will be designed and installed

[12] ADB (2013). Guidelines for Climate Proofing Investment in the Energy Sector.

with appropriate cyclone rating. This includes the foundations, solar panel support frames and fixings, walls, roofs, fences.

220. As adaption for new powerlines to be built as part of the project connecting solar station to the grid, poles and foundations will be designed to withstand cyclonic winds, conductors will be of high strength. Solomon Power has local capability to repair storm damaged lines quickly and will have appropriate skills, parts and equipment locally available to enable rapid emergency response. At Kirakira where the solar site is 1.5 km from the town, the risk of interruption due to damage to the powerline is to be mitigated by keeping on of the diesel generators at the existing power station in town, which can operate in such an event.

221. As adaption for where solar panels are put out of service by storm damage, or where electrical generation is reduced by cloud cover, high temperature or losses increased, this is mitigated by the use of the back up diesel generators which, in conjunction with the expanded battery banks, will be able to maintain electrical supply.

222. Adaption for storm surge (and tsunami risk) is achieved at some of the sites (Lata, Malu'u) by their location on elevated positions set back from the coast. At other low lying coastal locations however the availability of alternative suitable sites is limited where the communities are in such locations.

223. Adaption in the project design for high temperatures, high humidity and corrosive coastal atmosphere includes using solar modules with a high temperature coefficient, string inverters which cool relatively easily, panels mounted on frames allowing cooling air flow, and corrosion resistant materials.

B. Construction Stage Impacts

1. Impacts on the Physical Environment

a. Soil and Water

224. During construction there are likely to be impacts due to disturbance of soil and associated risk of soil erosion and sediment pollution, and risk of soil and water contamination due to spills of fuels and oils. Soil erosion risk is relatively low on flat sites with porous soils.

225. For those sites that are already cleared of vegetation and subject to ongoing soil disturbance by existing vegetable growing, it is likely that soil erosion will be reduced over the medium to long term as the site is stabilised as part of the development.

226. Mitigation measures will be employed which are seen as standard good practice. These include minimising the area of vegetation clearing and ground disturbance, installing upslope drains on steep areas to divert runoff, protecting steep slopes from erosion including minimising vegetation clearing, stabilising access ways, restricting vehicles to designated routes, revegetating or stabilising disturbed areas as soon as practical, keeping stockpiles and soil disturbance out of drainage and flood areas.

i. Kirakira

227. Soil erosion and water impacts are moderate risk due to proximity to the river and sea. There is a higher risk associated with any work on or near the steep slope to the river. Mitigation measures include maintaining a fenced setback from the top of the slope to the river and seafront from which all site development activity and any access for personnel, vehicles, equipment or materials is prevented.

228. This strip and the slope to the river should have vegetation protected and maintained to protect the bank from erosion and filter runoff. All materials and activities that could cause water pollution, including fuel, oils and stockpiles should as far as practicable be kept as far as possible from the river.

ii. Lata

229. Soil erosion or water pollution are low risk as the site is gently sloping with no creeks or streams and set back from the sea.

iii. Malu'u

230. Soil erosion or water pollution are low risk as the site is gently sloping with no creeks or streams and set back from the sea.

iv. Munda

231. Soil erosion and water pollution are low risk as the site is flat with no creeks or streams and set back from the sea.

v. Tulagi

232. Soil erosion is low risk due to the flat terrain. Water pollution is moderate risk due to the proximity to drains that flow to the sea. Generic mitigation measures apply with extra diligence with regular visual monitoring to detect and prevent any pollution or leakage.

b. Air quality

233. During construction short term and intermittent air quality impacts may arise due to dust generated by disturbance of soil, materials handling and other site activities and smoke due to equipment operation and burning of waste.

234. During construction mitigation measures will be taken to minimise impacts by dust or smoke on neighbouring land uses or sensitive receptors. Dust will be minimised by minimising the area of vegetation clearing and ground disturbance, stabilising access ways, restricting vehicles to designated routes, revegetating or stabilising disturbed areas as soon as practical, covering dusty loads during transport, modifying work if neighbours affected especially during dry windy conditions, cover stockpiles and wet dusty areas where practical. Smoke nuisance from equipment operation will be minimised by ensuring mechanical equipment is maintained and fitted with appropriate exhaust systems. There shall be no burning of waste on the site.

i. Lata

235. Air quality may be an issue if the communications and broadcasting equipment on the site is sensitive to dust. SIBC should be consulted about mitigation measures in this regard.

ii. Malu'u

236. Air quality impacts by dust and smoke may affect surrounding houses and provincial government offices, communications facilities, school and sport fields due to their being close to the site. Mitigation measures should therefore be carefully applied and monitored for this site.

iii. Munda

237. Air quality is generally good. Development of the site will require clearing of trees and scrub which cover most of the site. Local short term impacts may arise from dust during

construction and smoke if burning is carried out. This impact would be greater if smoke and dust affect the hospital area to the west of the site, or blows across the runway when planes are landing or taking off. It is recommended that burning be minimised. However if this is not practicable then as a mitigation measure burning should only occur under favourable conditions when wind is from the north, so that smoke will blow away from the hospital, the main town area to the east and away from the runway.

iv. Tulagi

238. Although most of the site is cleared, development of the site will require clearing of vegetation. Local short term impacts may arise from dust during construction and smoke if burning is carried out. It is recommended that burning be minimised. However if this is not practicable then as a mitigation measure burning should only occur under favourable conditions when wind is favourable to disperse smoke.

c. Noise

239. Noise will occur during construction due to use of vehicles, plant and equipment, movement of materials and various construction activities.

240. During construction a range of standard noise mitigation measures will be applied with the aim to meet the noise level guidelines at sensitive receptors (refer operations impacts section for noise objectives). Mitigation measures include the following; Application of the World Bank Group's Environmental Health and Safety Guidelines (EHSG); workers are to be trained in being sensitive to noise impacts on the neighbouring community including antisocial behaviour; consult and inform neighbours and local community of construction activities in relation to noise generating activity. If valid complaints are received, modify methods if possible to reduce impact. Do not undertake activities outside of scheduled daytime hours. Noise from equipment will be mitigated by ensuring that all equipment is in reasonable condition and regularly maintained and fitted with exhaust silencers in accordance with manufacturers recommendations; and turning off or throttle down plant and machinery when not use.

d. Waste Management

241. Waste management has been identified as a key issue for the project in consultations with ECD for the Project Preparation. Waste management has been identified by ADB as one of eight highest priority environmental challenges (ADB *Pacific Region Environmental Strategy 2005–2009*, in Solomon Islands Country Environmental Analysis 2007). ADB further identifies inadequate collection and management of solid waste as a Priority Concern in relation to the Sustainable Development Objectives of service delivery and institutional strengthening (ADB Country Environmental Analysis).

242. The current system of waste management in the towns where the project sites are located is generally poor. Waste disposal sites are generally ad hoc, designated waste disposal sites are poorly managed and open burning of waste is common. Where there are designated waste disposal sites these are generally uncontrolled and waste spreads such as on road size areas and in gullies.

243. Waste during construction will include the range of wastes typical of construction projects, including cleared vegetation, earth and rock, relatively small amounts of timber and metal excess, waste oil and paint, waste concrete, packaging (cardboard, wood, plastic, polystyrene), general office waste, wastewater and human waste.

244. During installation and commissioning waste may be generated by failure of and possibly damage to solar PV panels and other equipment. For example, industry advice in Australia is

that it is reported that typically up to two percent of solar panels may fail and need to be replaced during installation and commissioning.

245. In order to prevent the uncontrolled dumping and / or burning of waste the following mitigation measures are proposed. Waste shall be managed according to the waste management hierarchy of reduce waste generated, reuse waste materials where possible, recycle materials and finally safe disposal of residual waste material. The remote locations and lack of recycling and waste management infrastructure and capacity limit the implementation of recycling.

246. Waste materials such as cleared vegetation, wood and clean metal offcuts that require disposal shall be made available to the local community provided it is safe to do so. Recyclable materials should preferably be removed for recycling where this is safe and practicable. Non-hazardous non-toxic waste that is not recycled shall be disposed of at an appropriate licenced facility after approval from the local authority.

247. Waste oil shall not be disposed of to land or waters. Small quantities of waste oil may be made available for local reuse. Larger quantities should be removed to a recycling facility. Oil and fuel spill kits will be provided on site during construction and operation.

248. Any solar panels, batteries and other electrical equipment that are rejected during installation and commissioning due to damage or failure shall be removed from the site and returned to the supplier for recycling or disposal at a suitably licenced facility.

249. Human waste will be disposed of via appropriate toilet and wastewater facilities to protect public health and prevent water pollution. During construction toilet and washing facilities will be built for workers, likely pit toilets or septic / absorption systems. Toilets will be fitted with lids to exclude insects. Septic / absorption and site drainage will constructed and managed to ensure that mosquito or other insects cannot breed.

250. General solid waste will be disposed of at a facility approved by the local government (not including solar panels, batteries and electrical equipment as described above). Food waste will be disposed of so as to prevent access by vermin. There shall be no burning of waste on the site.

251. **Tulagi** site has existing asbestos-cement (fibro) structures and fragments of fibro scattered around site. This represents a public health and occupational health and hazard. Asbestos dust is carcinogenic if breathed into the airways. Mitigation measures are to establish and follow a plan based on best international practice to protect workers and public health. All care must be taken to prevent asbestos becoming dust, for dust to be disturbed and for humans to come into contact with the dust. This should include personal protective equipment, wetting down broken fibro structures and removing without creating or liberating dust, collecting scattered fragments, securely bagging and transporting to an appropriate facility for safe disposal.

2. Impacts on the Biological Environment

252. Construction of the project will require significant clearing of vegetation at two sites, Munda and Tulagi, while other sites are largely or entirely clear of significant natural vegetation or fauna habitat. To assess the impact at Munda and Tulagi, specialist field assessments have been carried out by a local ecologist. This found that these sites are regrowth without significant conservation value. Therefore there will be no significant impacts on flora or fauna as a result of the project.

253. There will be no impacts on listed, rare, endangered, vulnerable or threatened species of flora or fauna or communities as there are none potentially affected by the project. This includes the IUCN Red List.

254. None of the sites are, or include areas of, critical habitats defined in the SPS as: *: A subset of both natural and modified habitat that deserves particular attention. Critical habitat includes areas with high biodiversity value, including habitat required for the survival of critically endangered or endangered species; areas having special significance for endemic or restricted-range species; sites that are critical for the survival of migratory species; areas supporting globally significant concentrations or numbers of individuals of congregatory species; areas with unique assemblages of species or that are associated with key evolutionary processes or provide key ecosystem services; and areas having biodiversity of significant social, economic, or cultural importance to local communities.*"

255. There will be no impacts on the following ecological components as identified in proposed Solomon Islands "*Screening Guide Criteria for Determining if Prescribed Development will require a PER or EIS*" (MECDM): wetlands, mangroves, corals, fisheries, protected area and national parks, wildlife especially any rare endangered or vulnerable species or habitats, forests or coastal resources.

256. As mitigation measure for ecological impacts construction activities will be managed so as to minimize the area of clearing and ground disturbance to that reused for the project. This includes access to people, vehicles and equipment and stockpiling and storage of materials and equipment.

i. Kirakira

257. Ecological impacts are low risk for the already cleared part of the site to be developed. However this is based on natural vegetation around the perimeter of the site being excluded from the project development, as the surrounding areas are potentially more sensitive than the site itself. As a mitigation measure all natural vegetation around the perimeter of the site should be protected and access for personnel, vehicles, equipment or materials prohibited by educating workers, fencing and signage. This includes the river bank and sea front as described above, the trees and bush adjacent to this, along the western ridge and at the rear southern end of the site.

ii. Munda

258. The project will have the impact of clearing the vegetation from the site. This will have minor ecological impact as the site has been assessed by the local ecological specialist consultant as regrowth forest having low ecological value. Refer to the Existing Environment section for further detail.

iii. Tulagi

259. The project will have the impact of clearing the vegetation from the site. The Tulagi site is mostly cleared except for the western inland end of the site and a strip along the northern boundary. The site has been assessed including a specialist field assessment by a local ecologist. The study found the forest is regrowth with no significant ecological values which would be impacted by the clearing of the site for the project. The report is attached as an Appendix.

3. Impacts on the Socioeconomic Environment

260. Construction stage impacts on the socioeconomic environment include both positive (beneficial) and negative impacts.

261. Positive impacts include the employment, business and economic benefits arising from the purchase of goods and services. While most of the larger cost items will be imported, there will

be national and local content in their transport and handling, and in local labour, contractors, equipment suppliers and local people and businesses providing support to workers such as accommodation, food and other services. People, businesses and Solomon Power itself will benefit from the capacity building and experience gained from involvement with the projects.

262. During construction there will be potential negative social impacts from the disruption and inconvenience from influx of outside workers, potential for disease transmission, public safety, construction noise, dust and air emissions and waste disposal. The numbers of outside workers involved in each project will be relatively small so the related impact will be manageable.

263. Mitigation measures in relation to influx of outside workers include establishing a protocol for community relations, educating workers on this, the grievance redress mechanism and communicable disease prevention. Further measures outlined in the social assessment for the project should also be implemented.

264. Mitigation measures for any temporary use of land or restriction of access required for the construction period will be agreed with the provincial / town administration and landowners and subject to consultation with affected people.

265. Public health and safety mitigation measures include public information and signage, fencing of the site and access control, supervision of equipment movement outside the site, managing noise, air emissions and waste (refer Physical Environment section), prevent mosquito breeding on site by preventing water ponding, install and properly manage toilet and washing facilities for workers.

266. Occupational Health and Safety mitigation measures will include requiring that Solomon Power's safety requirements are fully implemented and complied with. The contractor will be required to prepare a health and safety plan describing how safety will be managed for the project. Health and safety mitigation will include but necessarily be limited to training and induction of workers, ongoing identification, prevention and management of risks and hazards, safe working method statements, incident response, compliance, protective equipment and first aid and medical facilities.

C. Operation Stage Impacts

1. Impacts on the Physical Environment

a. Soil and Water

267. During operation there is a risk of soil and water contamination due to spills or leaks of fuels and oils from the backup diesel generators and associated fuel handling and storage as well as from oil filled transformers and other electrical equipment.

268. Mitigation measures for this include sealing and bunding of areas where spills and leaks could occur, including containing fuel and oil storage and handling areas, and equipment such as generators and fuel pumps; oil separation on drainage outlets and sumps and training of operators. Oil and fuel spill kits will be provided on site during construction and operation. Generators, transformers and fuel storage, handling and pumping area to have spill containment in the form of impervious base and bund walls and oil water separation on outlets. Bunding in accordance with latest version of Australian Standard *AS1940 The Storage and Handling of Flammable and Combustible Liquids.* The containment volume required is the volume of the largest container, tank or drum, plus 10 per cent.

269. Where the backup diesel generators are to be on the same site as the existing diesel power station ("brownfield site"), any existing contamination can be improved with the development of the project and the smaller quantities of fuel and the more up to date equipment.

270. Where the backup diesel generators are to be on a new site separate from the existing power station ("greenfield site"), the former power station that will be left will generally have soil contamination and waste materials which will need to be managed or remediated to ensure no contaminants leave the site to protect public and environmental health.

271. Water may be required on occasions for washing panels. This is expected to be a rare occurrence as the panels are installed with a tilt to allow self-cleaning during rainfall. Water runoff from panels during washing will infiltrate and evaporate and not generate wastewater.

b. Air Quality

272. During operation existing localised air pollution from the existing diesel power stations will be reduced as a result of the solar project through the replacement of diesel with solar PV, the newer and more efficient backup generators which are expected to have lower emissions of particulates and other air pollutants, and the more efficient operation of the diesel generators. Where the diesel generators as part of the solar-diesel hybrid are located at the new site, then the emissions at the new site will be greater than previously, while at the existing site emissions will be removed.

273. During operation mitigation measures for air impacts will include ensuring that diesel generators are fitted with standard emissions controls as specified by the manufacturer and generators are serviced and maintained in accordance with manufacturers specifications.

a. Noise

i. Noise objectives

274. **Community Noise**. With respect to noise and other pollution, the SPS requires that project performance meets the World Bank Group's EHSG. The EHSG Noise Level Guidelines are as follows:

Table 15: World Bank EHSG Noise Level Guidelines[13]

	One Hour LAeq (dBA)	
Receptor	**Daytime 07:00 - 22:00**	**Nighttime 22:00 - 07:00**
Residential; institutional; educational*	55	45
Industrial; commercial	70	70
Noise impacts should not exceed the levels above, or result in a **maximum increase in background levels of 3 dB** at the nearest receptor location off-site For acceptable indoor noise levels for residential, institutional, and educational settings refer to WHO (1999)[14]		

275. Application to the project of EHSG including that "noise impacts should not exceed the levels above, or result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site" is given in the table below.

[13] World Bank / IFC (2007). Environmental, Health, and Safety (EHS) Guidelines. General EHS Guidelines: Environmental. 30 April 2007.
[14] World Health Organisation (1999). Guidelines for Community Noise (http://www.who.int/docstore/peh/noise/guidelines2.html)

Figure 23 Background Noise +3 dBA

Site	Ambient Noise Environment	Indicative background noise dBA	Target "Background +3 dBA", EHS Guidelines
Kirakira	Quiet rural	30	**33**
Lata	Quiet urban	45	**48**
Malu'u	Quiet urban	45	**48**
Munda	Quiet urban	45	**48**
Tulagi	Quiet urban	45	**48**

276. **Occupational Noise**. The EHSG state that no employee should be exposed to noise level greater than 85 dB(A) for more than eight hours per day without hearing protection, for heavy industry where there is no demand for oral communication.

ii. Noise impacts

277. Noise will occur during operation due to vehicles, materials loading and unloading and workers on site. These impacts will be minor and intermittent.

278. Noise will be emitted due to the operation of diesel generators. In comparison to the existing diesel power station operation the noise impacts will be significantly reduced. The generators will operate intermittently to charge the associated batteries in periods of overcast weather and as backup if required. Nevertheless, in the absence of appropriate mitigation measures, the noise levels from the diesel generators may at some sites exceed the EHSG given above.

279. The noise impact will depend on the selection of generators, operation and maintenance regime and the use of mitigation measures. It will also depend on the nature of each specific site and the affected sensitive receptors and their proximity to the noise source, such as residences, schools, offices, churches, businesses, institutions, community facilities, recreation areas, etc.

280. Noise is decreased by dissipation in the atmosphere by 6 dBA for every doubling of distance. Some further reduction occurs by absorption into the ground, physical barriers and to a minor degree vegetation while the landform can also reflect and concentrate noise.

281. The proposed **new enclosed generators** are specified by the manufacturer to be no greater than 75 dBA at 1m distance. Considering dissipation over distance alone the noise levels are predicted to be as follows at distances from the source. Thus the daytime noise guideline level of 55 dBA will be achieved at approximately 10 to 11 m distance from the new generator while the nighttime guideline of 45 dBA will be achieved at about 32 m.

Table 16: Noise Levels from New Enclosed Generators with Dissipation Over Distance

Distance from New Generator (m)	Noise Level dBA	Note
1	75	Specified by manufacturer
2	69	
4	63	
8	57	Daytime guideline 55 dBA
16	51	
32	45	Nighttime guideline 45 dBA

64	39
128	33
256	27

282. Where existing or other old generators are to be reused, a similar estimate is provided below for noise at a distance from the generator. The following unenclosed generators are to reused at Malu'u and Kirakira

- Malu'u: unenclosed Cummins 4BTA3.9 – G2 (48kW) complete with Stamford UCi224E alternators installed 2013. Also called Cummins 60kVA/48kW DGS model GMS60C.
- Kirakira: unenclosed Cummins 6BTAA5.9G2 (109kW) complete with Stamford UCi274E alternators installed 2013. Also called Cummins QSM130C 130kVA (104kW).

283. The noise level at source from the existing generators has been obtained from contact with Cummins and dbacoustics (supplier of acoustic shielding and referred to by Cummins). For the 48 kW generator at Malu'u noise level at source of 90 dBA at 1m has been used. For the 109 kW generator at Malu'u noise level at source of 100 dBA at 1m has been used. Thus the daytime noise guideline level of 55 dBA at Malu'u will be achieved at approximately 60 m distance from the generator while the nighttime level of 45 dBA will be achieved at an indicative distance of 190 m. At Kirakira the daytime noise guideline level of 55 dBA at Malu'u will be achieved at approximately 190 m distance from the generator while the nighttime level of 45 dBA will be achieved at an indicative distance of over 500 m.

Table 17: Noise Levels from Old Generators with Dissipation Over Distance

Distance from New Generator (m)	Noise Level dBA enclosed generator	Noise Level dBA 48 kW unenclosed generator at Malu'u	Noise Level dBA 109 kW unenclosed generator at Kirakira	Note
1	75	90	100	from manufacturer
2	69	84	94	
4	63	78	88	
8	57	72	82	
16	51	66	76	daytime guideline =
32	45	60	70	55 dBA
64	39	54	64	
128	33	48	58	nighttime guideline =
256	27	42	52	45 dBA
512	21	36	46	

284. The existing units to be relocated will require noise mitigation such as enclosure and baffles to comply. All are urban sites except Kirakira. Kirakira and Malu'u will get unenclosed

generators and possibly Lata initially but within 3 months of commissioning will be changed to a sound proofed type.

285. The table below gives estimates of noise levels from proposed generators at sensitive receptors and identifies whether this meets the EHS noise criteria for day, night (where relevant) and background + 3dBA. Where an unenclosed generator is proposed and EHS noise criterion is not met or is marginal, alternative generators are also assessed.

286. This shows that for Kirakira with the proposed unenclosed Cummins 109 kW generator the EHS criteria will be exceeded for night time noise and background +3 dBA, but with an enclosed Kohler generator the criteria would be met.

287. For Lata, the proposed Kohler KD165 enclosed unit would result in marginal compliance with night time noise targets at the nearest house which is close to the generator location in the south-west corner of the site.

288. For Malu'u with the proposed unenclosed Cummins generator, all noise levels are exceeded at the Provincial Government Office Building to the west and the closest houses. For comparison, the Kohler enclosed generator would achieve daytime target but would be marginal for night time levels at houses nearby. The alternative Kipor KDE75SS3 (56kW) if available would meet all criteria.

289. At Munda, all noise targets would be met with the enclosed Kohler generator.

290. At Tulagi with the enclosed Kohler generator would result in marginal compliance with night time noise targets at the nearest houses.

Table 18 - Noise estimates at sensitive receptors and assessment against the EHSG

Site	Nearest Sensitive Receptor	Location of new diesel generator area in site	Distance & direction from new diesel generator area	Proposed Generator	Noise at 1 m dBA (see note below)	Estimate noise at sensitive receptor (dissipation over distance)	Meets EHS Targets?
Kirakira	Houses	NW	200m S	Cummins unenclosed unit be transferred from existing power station	100	54	Day: Marginal Night: No Background +3 dBA: NO
				For Comparison, Kohler enclosed	75	30	YES
Kirakira	Police houses	NW	250 m W	Cummins unenclosed	100	50	Day: Yes Night: No Background +3 dBA: NO

Site	Nearest Sensitive Receptor	Location of new diesel generator area in site	Distance & direction from new diesel generator area	Proposed Generator	Noise at 1 m dBA (see note below)	Estimate noise at sensitive receptor (dissipation over distance)	Meets EHS Targets?
				For Comparison, Kohler enclosed	75	27	YES
Lata	House	SW	40 m, SW	Kohler KD165 enclosed unit ex Tulagi	75	43	Day: Yes Night: Marginal
Lata	Houses	SW	80 m N 80 m E		75	37	YES
Malu'u	Houses Building	SW	40 m N 40 m SE	Proposed: unenclosed Cummins 4BTA3.9 – G2	90	58	NO
Malu'u	Houses Building	SW	40 m N 40 m SE	Alternative Kipor KDE75SS3 (56kW) ex Tulagi if available	51 @7m	34	YES
Malu'u	Houses Building	SW	40 m N 40 m SE	For Comparison, Kohler enclosed	75	43	Day: Yes Night: Marginal
Malu'u	Provincial offices	SW	20 m NW	Initially: unenclosed Cummins 4BTA3.9 – G2	90	64	NO
Malu'u	Provincial offices	SW	20 m NW	Alternative Kipor KDE75SS3 (56kW) ex Tulagi if available	51 @7m	43	YES
Malu'u	Provincial offices	SW	20 m NW	For Comparison, Kohler enclosed	75	49	YES (Day only applicable)
Munda	House	SW	160 m W	Kohler enclosed	75	30	YES
Munda	House	SW	70 m S	Kohler enclosed	75	39	YES

Site	Nearest Sensitive Receptor	Location of new diesel generator area in site	Distance & direction from new diesel generator area	Proposed Generator	Noise at 1 m dBA (see note below)	Estimate noise at sensitive receptor (dissipation over distance)	Meets EHS Targets?
Tulagi	House	N	40 m NE	Kohler enclosed	75	43	Day: Yes Night: Marginal
Tulagi	House	N	40 m S	Kohler enclosed	75	43	Day: Yes Night: Marginal

iii. Noise mitigation

291. Mitigation measures should be adopted where necessary to achieve the World Bank EHS Noise Level Guidelines given above. For each site the noise from the generators at the sensitive receptors is to be calculated including dissipation. If the predicted noise level is greater than the guideline level, then additional mitigation measures shall be incorporated as described below.

292. From the estimates above it is likely that additional noise mitigation measures will be required to achieve EHSG noise level guidelines, especially in case of reuse of old generators. The EHSG state that the preferred method for controlling noise from stationary sources is to implement noise control measures at the source, and give a number of options including the following that are potentially relevant to this project. These are listed in the table below with their application as related noise mitigation measures for the project, the relevant stage of the project and whether it contributes to occupational health and safety (OHS) noise control.

Figure 24 Diesel Generator Noise Mitigation

EHSG Mitigation Measure *	Noise mitigation measures for this project	Project Stage	Contributes to OHS?
Select generators and other equipment with lower sound power levels	Include lower sound power levels as a key selection criteria for diesel generators. Include requirement in Contract Specifications to meet EHS Noise Level Guidelines at sensitive receptors.	Planning & Design	Yes
Install silencers for fans	If relevant	Planning & Design / Operation	Yes
Install suitable mufflers on engine exhausts and compressor components	Include requirement in Contract Specifications for mufflers if necessary to meet EHS Noise Level Guidelines at sensitive receptors. Mufflers / exhausts to be installed so that exhaust noise is directed away from sensitive receptors as far as practicable.	Planning & Design / Operation	Yes
Install acoustic	Include requirement in Contract	Planning &	Yes

EHSG Mitigation Measure *	Noise mitigation measures for this project	Project Stage	Contributes to OHS?
enclosures for acoustic equipment radiating noise	Specifications for Acoustic enclosure of diesel generators if necessary to meet EHS Noise Level Guidelines at sensitive receptors, where high noise exceedance. Relatively expensive to retrofit and may not be be cost effective for marginal exceedance.	Design / Operation	
Improve the acoustic performance of constructed buildings, apply sound insulation	Cost effective but may not be suitable due to need for ventilation in tropical climate.	Planning & Design / Operation	No
Install acoustic barriers close to the source without gaps and with a continuous minimum surface density of 10 kg/m^2	A cost effective measure to reduce noise by up to about 10dBA.	Planning & Design / Operation	No
Limit hours of operation for specific equipment	Guideline levels are more stringent for night time. Avoid operation of diesel generators at sensitive times, including night time where sleep may be affected. Consult neighbours / sensitive receptors about other sensitive times.	Operation	No
Relocate noise sources to less sensitive areas	Within the site, seek to locate diesel generators as far as practicable from sensitive receptors.	Planning & Design	No
Site permanent facilities away from community areas	Within the site, seek to locate diesel generators as far as practicable from sensitive receptors.	Planning & Design	No
Use natural features as noise buffer during design	Use natural features where available such as siting diesel generators where some shielding from sensitive receptors is provided by site features.	Planning & Design	No
Develop a mechanism to record and respond to complaints.	Complaints procedure will be included in Grievance Redress Mechanism. Consult affected people in regard to noise mitigation measures.	Planning & Design + Operation	No

World Bank Group: *Environmental, Health, and Safety Guidelines (2007).*

293. The following mitigation measures are recommended for diesel generator noise based on the impacts predicted in the previous section. (Achievement of night time noise levels could be achieved by restricting operation to day time but this is considered impractical and unenforceable.)

Figure 25 Mitigation measures recommended for diesel generator noise for each site

Site	Impact	Mitigation options
Kirakira	Cummins **unenclosed** 109 kW generator predicted to exceed night time noise target and background +3 dBA	Use acoustic enclosure on generators or Sound barrier close to SSW side of generators plus high performance exhaust silencer
Lata	Kohler KD165 enclosed generator is marginal for night time target.	Use a quieter generator / additional shielding or High performance exhaust silencer
Malu'u	**Unenclosed** Cummins 48 kW generator exceeds all targets. Enclosed generator is marginal for night time target	Use quieter generator / acoustic enclosure on generators plus higher high performance exhaust silencer.
Munda	Kohler enclosed meets all targets	
Tulagi	Kohler enclosed generator is marginal for night time target	Use a quieter generator / additional shielding or High performance exhaust silencer
ALL SITES		Complaints procedure. Consultation. Noise measurements as required eg to respond to complaints.

i. Kirakira

294. Noise for Kirakira with the proposed unenclosed diesel generators is predicted to exceed the EHS criteria, but with the enclosed Kohler generator the criteria would be met. The night time exceedance is predicted to be 9 dBA.

295. As a mitigation measure to achieve the night time target of 45 dBA it is recommended to use a solid barrier close to the generator on the SW side (facing the houses at back of the site) in conjunction with a higher performance exhaust silencer directed toward the NW (into the hill). The barrier should be perpendicular to a straight line path from the noise source to the receiver (i.e. the houses). A cost effective option for the barrier would be a solid timber hardwood fence up to the height of the generator shed, 40 mm thick and with no gaps (including at the ground). Alternatives include an earth/rock mound or a solid wall or a combination of the above. An acoustic enclosure was considered but the cost of retrofitting this is high and would achieve a level of reduction exceeding that required for only a few houses potentially affected. For analysis of noise impacts, and generic mitigation measures, refer Section V.C.1.a Noise.

296. In the case of the Police houses to the NW of the site, adequate mitigation is provided by the location of the generators in the NW part of the site on the south side of the road, with shielding by the high ridge on the NW side of the site

ii. Lata

297. Noise for Lata, with the proposed Kohler KD165 enclosed unit would result in marginal compliance with night time EHS noise targets at the nearest house which is close to the generator location in the south-west corner of the site.

298. As mitigation measures, it is recommended that a higher performance exhaust silencer be installed and directed away from the nearest houses.. For analysis of noise impacts, and generic mitigation measures, refer Section V.C.1.a Noise.

iii. Malu'u

299. Noise levels for Malu'u with the proposed unenclosed Cummins generator, may exceed the EHS criteria at the Provincial Government Office Building to the west and at the closest houses. For comparison, the Kohler enclosed generator would achieve daytime target but would be marginal for night time levels at houses nearby. The alternative Kipor KDE75SS3 (56kW) if available would meet all criteria.

300. As mitigation measures, it is recommended to use acoustic enclosure on the generator to achieve a sound level of 75 dBA at 1 m plus a higher performance exhaust silencer, or use a quieter generator. For analysis of noise impacts, and generic mitigation measures, refer Section V.C.1.a Noise.

iv. Munda

301. Noise levels at Munda, with the proposed Kohler enclosed generator would meet noise targets. For analysis of noise impacts, and generic mitigation measures, refer Section V.C.1.a Noise.

302. Mitigation measure is to confirm the generator installed is the proposed Kohler enclosed generator with acoustic shielding.

v. Tulagi

303. Noise levels at Tulagi with the enclosed Kohler generator would result in marginal compliance with night time noise targets at the nearest houses.

304. As a mitigation measure, it is recommended that a higher performance exhaust silencer be installed and directed away from the nearest houses. For analysis of noise impacts, and generic mitigation measures, refer Section V.C.1.a Noise.

a. Waste Management

i. Impacts

305. Waste management has been identified as a key issue for the project in consultations with ECD for the Project Preparation. Waste management has been identified by ADB as one of eight highest priority environmental challenges (ADB *Pacific Region Environmental Strategy 2005–2009*). ADB further identifies inadequate collection and management of solid waste as a Priority Concern in relation to the Sustainable Development Objectives of service delivery and institutional strengthening (ADB Country Environmental Analysis).

306. The current system of waste management in the towns where the project sites are located is generally poor. Waste disposal sites are generally ad hoc, and open burning of waste is common. Where there are designated waste disposal sites these are generally uncontrolled and waste is spread such as on road size areas and in gullies.

307. The project will generate a range of wastes during operation and at decommissioning.

308. During operation panels may fail or be damaged by storms or vandalism. Panels and other equipment will become waste at the end of their service or at decommissioning when they will be removed.

309. Solar PV panels may have a service life of twenty or more years. However inverters are usually replaced at around ten years so panels are often replaced at this frequency if found to be feasible. Batteries are usually replaced at similar or greater frequency. Other equipment

requiring disposal at the end of its service life includes inverters, transformers, and 11kV switchgear.

310. Approximately 8,000 solar panels with a weight 160 T will become waste at the end of their service life across all the Project sites. Subject to final selection of panels, this is for a total solar project of 2 MW, an indicative panel capacity of 0.25 kW, and an indicative panel weight of 20 kg.

311. Solar panels, batteries and some other electrical equipment contain quantities of heavy metals and other toxic compounds in the materials. In the case of solar panels these are in small quantities and are embedded in the panel materials, but may contaminate soil and water if dumped without controls or air if burned. In the case of batteries lead acid batteries contain significant quantities of lead, a toxic heavy metal, and acid, while other battery types contain toxic materials, which can similarly cause environmental contamination and potential health impacts. Lead from batteries is commonly recycled by local people to produce fishing sinkers, however the uncontrolled disposal of acid and battery casings and the health effects of exposure to lead while processing have potential impacts.

ii. Waste Management Mitigation Measures

312. In order to prevent the uncontrolled dumping and / or burning of waste the following mitigation measures are proposed. Waste shall be managed according to the waste management hierarchy of reduce waste generated, reuse waste materials where possible, recycle materials and finally safe disposal of residual waste material. The remote locations and lack of recycling and waste management infrastructure and capacity limit the implementation of recycling.

313. Waste materials such as cleared vegetation, wood and clean metal offcuts that require disposal shall be made available to the local community provided it is safe to do so. Recyclable materials should preferably be removed for recycling where this is safe and practicable. Non-hazardous non-toxic waste that is not recycled shall be disposed of at an appropriate licenced facility after approval from the local authority.

314. Waste oil shall not be disposed of to land or waters. Small quantities of waste oil may be made available for local reuse. Larger quantities should be removed to a recycling facility. Oil and fuel spill kits will be provided on site during construction and operation.

315. At the end of their service life, or in the event of damage to panels such as due to storms or vandalism, panels will be taken away for recycling or appropriate disposal, which could be by the Contractor in conjunction with the future supply of replacements.

316. Recycling of solar panels is a growing practice and is considered best practice. Examples include Canadian Solar Australia[15], Suntech Australia[16], Yingli Green Energy Australia[17] and Reclaim PV Recycling[18]. At the end of the service life of the panels, in approximately 20 years, the solar energy industry is expected to significantly larger and more advanced than at present, and with the maturing of the market, developments in infrastructure and improvements in technology it can be expected to be feasible at that time.

317. Human waste will be disposed of via appropriate toilet and wastewater facilities to protect public health and prevent water pollution. Toilet and washing facilities will be built for workers, likely pit toilets or septic / absorption systems. Toilets will be fitted with lids to exclude insects.

[15] http://www.utilitymagazine.com.au/taking-the-initiative-to-recycle-solar-cells/
[16] http://bradmanrecruitment.com/suntech-partners-with-reclaim-pv-recycling-to-recycle-solar-panels/ http://www.energymatters.com.au/renewable-news/em433/
[17] http://electricalconnection.com.au/yingli-solar-reclaims-solar-waste-through-partnership-with-reclaim-pv-recycling/
[18] http://reclaimpv.com/reclaimpv/

Septic / absorption and site drainage will constructed and managed to ensure that mosquito or other insects cannot breed.

318. General solid waste will be disposed of at a facility approved by the local government (not including solar panels, batteries and electrical equipment as described above).

2. Impacts on the Biological Environment

319. There will be no significant ecological impacts as a result of the operation of the project.

320. As a mitigation measure, no access will be allowed for workers to vegetated areas outside designated project area, no cutting of trees and undergrowth except as required for the maintenance. At Kirakira, especially protect vegetation on riverbank and sea front slopes adjacent to the site.

321. Glare from solar panels has been identified as a potential issue in relation to birds. Cases of glare effect on birds found are related to migratory/water birds in deserts mistaking the solar farm for a lake and trying to land on it and being injured[19]; given the sites are next to the sea this is considered unlikely to occur.

3. Impacts on the Socioeconomic Environment

322. Operation stage impacts on the socioeconomic environment include both positive (beneficial) and negative impacts.

323. Positive social and economic benefits arise from the reduced reliance on the use of diesel for electricity generation and reduced exposure to the financial impacts of future diesel price rises, reduced long-term cost of electricity generation and the possible opportunity for electricity prices to come down in the long run. There will also be a social benefit from the reduced noise, air emissions and soil and water contamination from diesel use, particularly from stakeholders close to the current power stations.

324. Negative social impacts arise from the backup diesel generators noise and air emissions. While this will be significantly lower than from the current power stations, where the new facility is on a new site, the impact will be greater at the new site.

325. During operation negative social impacts arise from loss of the land used for the project, and the visual effect of the solar panels. Negative impacts arise to the businesses currently supplying diesel and related services to the current power stations, and to the government in the reduced taxes levied on diesel use.

326. Glare from solar panels during operation has been identified as a potential issue in relation to aircraft. Solar panels are designed to absorb light and have anti-reflective coatings for this so reflection is minimal. Consultation with senior pilots from Solomon Airlines indicated that this would not be significant as there is already similar glare from tin roofs and the sea near airfields.

327. Mitigation measures during operation for noise and air emissions are discussed in the Physical Environment section. Use of land is unavoidable but the power stations are considered an appropriate use of land for the public benefit.

[19] Clarke, Chris. 2013. Water Birds Turning Up Dead at Solar Projects in the Desert. http://www.kcet.org/news/redefine/rewire/solar/water-birds-turning-up-dead-at-solar-projects-in-desert.html

VI. INFORMATION DISCLOSURE, CONSULTATION, AND PARTICIPATION

328. Information Disclosure, Consultation, and Participation are requirements of the ADB SPS and of the Solomon Islands environmental assessment and approval procedures.

329. Solomon Power works closely on an ongoing basis with province and national agencies on a regular basis. Through the province level Solomon Power local personnel and head office staff communicate regularly with provincial officials and local communities.

330. The ADB project team and Solomon Power planning staff met with provincial representatives, local organisations and community representatives in all of the communities proposed for the project as well as relevant agencies, international projects and NGOs in Honiara. This included identification of suitable alternative sites, land ownership and other local issues.

331. Further consultation and participation will continue through the design phase and into construction and operation. This includes keeping local communities and stakeholders informed of the project and establishing a grievance Redress Mechanism to receive and address complaints and concerns.

332. Information Disclosure. The project documents will be published on the ADB website. Environmental assessment documents will be made available to the public as part of the Solomon Islands approval process.

A. Consultation undertaken

333. Stakeholders consultations / meetings were held with the following organisations as part of the PPTA, with relevant comments noted:

- Western Province, Gizo, Provincial Secretary Office (with PPTA team and Solomon Power). Hon Mr Billy Veo, Minister for Housing Lands and Physical Planning; Mr Maloney Lopoto, Mines Energy and Natural Resources; Adrian Toni, Provincial Secretary. Responded that the project idea is very good. Indicated that local permit needed for structures and for land clearing. Liaise with Province pre-construction.
- Western Province, Gizo. Requested Cadastral plan, not available.
- Western Province, Gizo, Division of Environment, Environment Officer Ms Julie Kalamara. No specific comments, focus on public health.
- WWF, Western Province, Gizo. Met Ms Minny and Ms Salome. Advised that WWF focus on marine issues, no specific comments.
- Western Province, Gizo, Natural Resource Development Foundation. Focus on forestry.
- Western Province, Munda, (at Solomon Power office) Mr Donald Beasley aka Maepio Bisili. Identified himself as a customary owner and Tribe Chairman, Voramali.
- Malaita Province, Auki, Meeting at Premier's office (with PPTA team and Solomon Power). Mr Peter Channen, Premier; staff: Mr George Hoadamauri, Lands Officer; Mr Jackson Gigi, project coordinator; Mr David Dauta, Energy Officer. Supportive. Advice on land title and landowner issues. Land alienated. Security, recommend awareness program.
- Malaita Province, Malu'u. Meeting stakeholders at community meeting house (with PPTA team and Solomon Power). Mr David Rara, Province Senior Admin Officer for

Malu'u region; David Dauta, Province Energy Officer; Selisu Koma, community leader; John, Director Nursing Education; Alfred, Police office; Warren, farmer; Andreson, looks after school; Richard, Area Health Centre; James Terami, Mandewai? Community; Paterson, OIC Solomon Power; Joshua, Manger Outstations Solomon Power; Philip Solomon Power. Supportive. Hospital has solar but not working. Identified need for training on O&M for solar. Only small boats can access. Solar panels common but only lasting 6 months. Concern about high tariff.

- Lata, Temotu Province. Meeting at Province office (with PPTA team and Solomon Power). Hon Stanley, Deputy Premier Province; Mr Bruno, Chief Planning Officer; Mr Alan, Senior Admin Officer Physical Planning; Mr Lonsdale, Principal Planner; Albert Wilson; Mr Simon, Province Minister Infrstructure Lands and Housing. Discussed alternative sites to the proposed site near water source 7km south: broadcasting tower land, next to existing power station, hill opposite airport terminal. Identified plan to upgrade airport
- Lata. Disaster Management Office, MECDM. Working with CRISP and UNDP-PRRP on adaption and resilience. Identified cyclone cutting off roads and power lines as risks.
- Lata. Innie Vaike, Environmental Health Officer, Environmental Health Division, Minstry of Health. Involved in OHS, waste management, rural water supply and sanitation. Identifed health issues of lack of electricity due to use of kerosene lights causing eye and respiratory problems. Identified complaints re existing power station noise and spreading waste oil on ground. Identified presence of wells at huts north of power station toward airport.
- Tulagi, Central Province. Meetings at Province office (with PPTA team and Solomon Power). Mr Selwyn Mapuli, Premier; Frank Vohe; Mr Humphrey, Province Minster for Works Transport and Communications; John Bosamata, Speaker; Danny Waneora, Economic Planner; Mr Marvin, Deputy Treasurer; Willy Biru, Chief Tulagi area; Clavis Dagi, OIC Solomon Power. Discussed land issues, vandalism problem. Suggested other land be considered on top of ridge near phone tower, owned by Commissioner of Lands
- Tulagi, Mr Stanley Seni, Environmental Health Officer. Focus on rural water supply, drinking water quality, marine pollution. Identified complaints re diesel and oil from ships including under repair. Referred to old oil being sold for chainsaw use and mixed with sawdust for fire fuel. Local NGOs World Vision, ADRA, Rotary. Referred to stealing and need for security and awareness raising.
- Kirakira, Meeting Province Office (with PPTA team and Solomon Power). Thomas, Premier; Clement, Deputy Premier; Silas, Provincial Secretary; Saul, Minister for Lands; Fred, Minister for Works; Martin, Investment and Tourism; Mr, Minister for Agriculture and Tourism; Ms Cicilia Waokahi, Senior Planning Officer; Eddy Quiroquiro, Provincial Planning Officer; John, Lands Officer; Desmond, A/Personnel Officer. Want existing opwre station moved due to noise in town and hae allocated land to Solomon Power for this. Old coconut plantation privately owned. Need for agreement with landowners to secure land for power line. Risk of damage to power line by trees would cut power to town. No wharf, losing goods, lost 50-100 fuel drums

in one incident. Considered will be okay transporting panels, outside windy months of Nov-March. Proposing new stadium, hospital upgrade

- Kirakira. Mr Mannesh Irofimae, Solomon Islands Water Sector Adaption Project, UNDP/GEF.

Honiara

- Environment Division, MECDM, Honiara. Rosemary Apa, Chief Environmental Officer; Debra Kereseka, Senior Environmental Officer. Environmental assessment requirements and process. Concerned about waste management including panels, batteries including if cyclone and other disaster damage. Reviewing current waste management strategy, advocate Extended Producer/Supplier Responsibility (EPR) whereby supplier takes back waste as part of contract.
- Climate Change Division, MECDM, Honiara. Hudson Kauhiona, Deputy Director. Processes being developed for vulnerability and risk assessment.
- South Pacific Regional Environment Program (SPREP), Honiara. Fred Patison, Solomon Islands Country Manager, Pacific Ecosystem-based Adaptation to Climate Change. Working on climate change adaption and risk resilience.
- The Nature Conservancy, Honiara. Willy Atu, Country Director. Supportive as less air, noise and fuel transport issues. Mostly focus marine, mining.
- Solomon Islands Development Trust (SIDT), Honiara. Mr Longden Manedika, Director. Operate service to other NGOs in capacity building, committees, planning, training, participation. Suggests work closely with province, use existing systems, provide sense of engagement to surrounding communities, educate villages to respect public facilities.
- Community Resilience to Climate and Disaster Risk Project (CRISP). Mary Alalo, Project Manager. Climate Change Adaption Program. Advice that houses below existing Lata power station experience noise and fumes from the power station, but do not have electricity and want it; early 1900s tsunami reached the existing power station site and 2013 just below (other reports indicate a wave of about 1 m in Lata, which would be well below the power station).
- Landowners Advocacy and Legal Support Unit (LALSU), Public Solicitors Office. Ms Martha Manaka. Receive public complaints about developments. Mostly forestry. No complaints about Solomon Power. Recommend giving adequate notice to landusers including informal eg vegetable growing. Noted need for capacity and maintenance.
- Solomon Islands Community Conservation Partnership (SICCP). Ms Seno Mauli. Marine focus, train local partners to run eg marine protected areas.
- Seismological Section, Geology Dept, Ministry of Mines Energy and Rural Electrification. Solomon Parry, Assistant Seismological Officer; Jack Ben Gwali, Geophysics Officer; Belinda Rose Waokahi, Senior Seismological Officer. Advice on distribution of earthquake and tsunami risk: Munda, Lata, Kira significant risk; Tulagi, Malu'u low risk.

VII. GRIEVANCE REDRESS MECHANISM

335. A Grievance Redress Mechanism (GRM) is required by ADB Safeguard Policy. The GRM is a system for receiving and resolving grievances including complaints and concerns from affected people and stakeholders about environmental and socioeconomic issues in relation to the project. Complaints are to be resolved promptly with a process that can readily be understood and accessed by all segments of affected people and is responsive to gender and cultural aspects.

336. The GRM will be established by the Project Management Unit of Solomon Power. The PMU and the Contractor will inform and consult each community about the GRM and how it will work via a community meeting held before construction commences. A sign at the site and notices on community notice boards will give the contact details for lodging complaints.

337. Grievances, complaints and concerns can be lodged with the PMU or the Contractor on site. A GRM Register will be kept on site in which complaints are recorded. The grievance will be assessed by the PMU to confirm that it is related to the project. If it is urgent or can be immediately resolved, action will be taken and this recorded in the GRM Register and the complainant informed. The aim will be for complaints to be acted on within one week. Where this cannot occur, the complainant will be advised within one week of the complaint, what action is to be taken. If a complainant approaches the Contractor directly, the Contractor will receive the information and pass it onto the PMU. The Contractor will take any immediate action necessary to resolve the issue if practical and appropriate. Where there is urgency in terms of safety, damage to property or environment, then this will be acted on urgently.

338. Regular meetings between the Contractor and PMU will review the complaints register as part of regular meetings and reporting. A brief summary of complaints will be given in regular reports and any outstanding grievances identified. The PMU environmental officer will review the GRM Register for complaints and confirm that they are resolved satisfactorily. Any outstanding complaints will be investigated. The PMU and Contractor will work together proactively to ensure grievances are satisfactorily resolved.

339. Where complaints cannot be resolved by the GRM process the complainant will be able to take their complaint to normal legal processes.

340. Training in awareness of the GRM will be provided to PMU and Contractor staff. There will be no fees or charges made in relation to lodging complaints or otherwise accessing the GRM.

341. Typical grievances that may occur in projects of this nature may include (but not limited to) damage to or use of public or private property or communal resources, safety risks or incidents, noise, dust, fumes, water pollution, litter, rubbish dumping, unauthorised land use, unauthorised tree cutting or vegetation removal, hunting, antisocial or criminal behaviour and harassment.

VIII. ENVIRONMENTAL MANAGEMENT PLAN

342. This section describes implementation and institutional arrangements and provides an environmental management plan matrix summarising the actions required to achieve the environmental requirements and how they will be monitored.

A. Institutional Arrangements

343. The implementing agency for the project will be Solomon Power. A project management unit (PMU) within Solomon Power will manage the project. A contractor will be appointed though a competitive tendering process for the design, procurement and construction of the project. An exception is the diesel generators, which will be supplied by Solomon Power to the sites for the contractor to install.

B. Roles and Responsibilities

344. Solomon Power through the PMU is responsible for ensuring that the environmental requirements are achieved through monitoring and control of the Contractor. The PMU is expected to be supported by a design and supervision consultant, and to employ an environmental officer for the project. This will include tender documents, obtain consent from MECDM, ensure IEE and MECDM consent conditions are integrated in project documents, connect with contractors to ensure that contractor's environmental management plan and capability are adequate, review final design compliance with environmental requirements, monitoring contractor compliance with environmental requirements including regular site inspections, reviewing contractor reports and providing input to PMU reports.

20. A national environment specialist is proposed for a total of 6 person-months to support the activities of the PMU. The Environment Specialist will have relevant qualifications in science or engineering and at least 5 years of relevant experience. Specific activities will include:

(i) Undertake consultations as required by the consultation and participation plan (CPP) prepared for the project;
(ii) Update the initial environmental examination (IEE) for the subproject in compliance with ADB Safeguard Policy Statement 2009 (SPS) and the Environment Act 1998;
(iii) Prepare draft method statement/contractor environmental management plan (CEMP), and other management plans as required;
(iv) Assist PMU, in consultation with the Environment and Conservation Division (ECD) of the Ministry for Environment, Climate Change, Disaster Management and Meteorology (MECDM), to ensure that environmental safeguard measures under the Project comply with national safeguard requirements including but not limited to submitting the IEE and application for environmental permits under the Environment Act 1998;
(v) Ensure relevant provisions and text from the updated IEE are included in the tender/contract documentation for the subproject;
(vi) Review the contractor's environment management plan (CEMP), suggest changes or revisions as required, and recommend to PMU that approval of the CEMP may be issued;
(vii) Establish an environmental monitoring and reporting system within the PMU and contribute to quarterly progress reports;
(viii) Monitor the contractor's compliance with CEMP;
(ix) Ensure compliance with all assurances under the project.

(x) The contractor will be required to implement the relevant provisions of the environmental management plan, as part of the design and construction of the project. It is expected that the contractor would employ environmental expertise and training as required to achieve this. The contractor will prepare the contractor's environmental management plan in conjunction with the detailed design and its construction methodology which will show how the IEE and this EMP will be implemented.

C. Institutional Strengthening and Capacity Building

345. Solomon Power currently does not have specialist capability in or staff specifically responsible for environmental management. The PMU should employ an environmental officer (EO) to support the implementation of the project from pre-construction through to commissioning. Throughout the project, the environmental specialist on the supervision consultant team will provide training and capacity building to the EO. .

346. The contractor will designate one of it's staff as environment and safety officer (ESO) to ensure it has sufficient environmental capacity as well as environmental awareness of its workers. The ESO will have the responsibility of implementing the CEMP and reporting on it's implementation to the PMU. The PMU EO will liaise with the contractor to help ensure this.

347. Power station operational staff and other Solomon Power staff should be given environmental awareness training, which can efficiently be provided by the environmental officer in conjunction with the safety training program already provided, and on the job during site visits.

D. EMP Matrix

348. The environmental management plan matrix below compiles the environmental mitigation measures and actions from this IEE and identifies responsibilities, timing and monitoring activities.

Table 19 - Environmental Management Plan Matrix

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
PRE CONSTRUCTION / DESIGN STAGE								
Approvals	Ensure approval from Ministry of Environment, Conservation, Climate Change and Disaster Management (MECDM). Consult MECDM, submit application.	Solomon Power PMU - Environmental Officer	Following ADB approval ASAP	Included in PMU staffing	Check that approval in place	Before work on site commences	PMU	Included in PMU staffing
Contract	Ensure environmental requirements are incorporated in contract documents.	Solomon Power PMU Environmental Officer	Contract preparation	Included in PMU staffing	Check that included	Contract preparation	PMU	Included in PMU staffing
PMU to provide induction and orientation on environmental management provisions	Prior to contractor preparing CEMP, PMU to provide training or orientation	PMU Environmental Officer	Prior to CEMP preparation	Included in PMU staffing	Training record	Prior to CEMP preparation	PMU	Included in PMU staffing
Contractor's CEMP - prepared	Contractor's prepare construction environmental management plans (CEMP) with sub-plans as required specific to each site to be approved by PMU.	Contractor	Before work on site commences, as per contract	Included in contractor's costs	Plan submitted	Before work on site commences	PMU	Included in PMU staffing & contractor costs
Contractor's CEMP - approval	Ensure contractor's CEMP is reviewed and approved and issue clearance.	PMU Environmental Officer	Before work on site commences, as per contract	Included in PMU staffing	Reviewed and approved	Before work on site commences	PMU	Included in PMU staffing & contractor costs
Health and Safety	Contractors prepare occupational health and safety plans. Prepare plans for community and workers health and safety in accordance with Solomon Power requirements.	Contractor, PMU	Before work on site commences	Included in contractor's costs	Contract prepared by contractor, reviewed and approved by PMU.	Before work on site commences	PMU	Included in PMU staffing & contractor costs
Capacity building	Appoint environmental officer to PMU with adequate resources. Training in procedures and ADB requirements. Training for PMU and contractors operational personnel in environmental requirements.	PMU	Following ADB approval	Staff salary. Travel monthly to each site.	Confirm appointment	Before contract signing	PMU	Included in PMU staffing
Update IEEs as PER and the EMP	Prepare the proposal application; Update the IEEs as PER or EIS as	PMU Environmental	On final design and MECDM	Included in PMU staffing	Reviewed and approved	Before work on site commences	PMU	Included in PMU

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
	required and submit development consent application; Update EMP in line with final design and any conditions of approval from MECDM.	Officer	approval					staffing & contractor costs
Community and Project disclosure	Consult and inform Affected Persons and the wider community of the project and their rights including GRM and ensure project documents are available to local communities. inform affected persons including re noise in development and operation.	PMU Environmental Officer + Contractor	Before work on site commences	Included in PMU staffing	Before site works commence and Ongoing.	Before work on site commences	PMU	Included in PMU staffing & contractor costs
Noise	Plan to ensure achieve World Bank EHSG Noise Level Guidelines at sensitive receptors as per IEE. i.e. for Residential, institutional, educational: night time 45dBA, day 55dBA, Background +3dBA. Consult and inform affected persons including re noise in development and operation.	Contractor, Solomon Power	Design	Included in contractor's costs	Confirmation that addressed in design	Design review	PMU	Included in PMU staffing & contractor costs
Noise due to diesel generators	Undertake consultation with neighbours and adjacent users; Review detailed design, site layouts and equipment selection and proposed operation regime to ensure World Bank EHSG Noise Level Guidelines are met at sensitive receptors.	PMU Environmental Officer + Contractor	On detailed design. Before work on site commences	Included in PMU staffing	Ongoing.	Before work on site commences	PMU	Included in PMU staffing
Noise due to diesel generators	Plan for and select high performance exhaust silencers to be fitted to all diesel generators in accordance with manufacturers recommendations. Plan to implement additional noise control measures where necessary to comply with the EHS Noise Level Guidelines at sensitive receptors, such as additional shielding or select quieter generators. Concept analysis indicates that to meet compliance with generators as anticipated in IEE additional measures may be required as below.	PMU	Design	Cost of enclosures	Ongoing.	Before work on site commences	PMU	Included in PMU staffing
Noise – generators- Kirakira.	Acoustic wall to block sound to houses to	Contractor	Design and	Cost of	Check Barrier	Design - once	PMU	Included in

Environmental Issue / Project activity	Mitigation and/or Enhancement Measures				Monitoring Plan			
	Measures and Actions	Responsible to Implement	Timing to Implement	Cost	Parameter to monitor	Frequency & Verification	Responsible to Monitor	Cost
Proposed Cummins 109 kW unenclosed may exceed night target by 9 dBA	SSW, e.g. solid 40 mm thick timber fence or 25 mm marine ply, no gaps, height to height of generator shed, close to generator on south and east sides. Or earth/rock mound or combination. Install higher performance 20dBA exhaust silencer directed toward the NW (into the hill).		Construction	barrier Cost of exhaust silencer	design. Check silencer selection Check installation.	Construction - once		PMU staffing
Lata - generator noise	Higher performance exhaust silencer be installed and directed away from the nearest houses	Contractor	Design and Construction	Cost of exhaust silencer	Check silencer selection Check installation.	Design - once Construction - once	PMU	Included in PMU staffing
Malu'u - generator noise -. Proposed Cummins 48 kW unenclosed may exceed	acoustic enclosure to achieve 75 dBA at 1 m plus a higher performance exhaust silencer	Contractor	Design and Construction	Cost of acoustic enclosure and exhaust silencer	Check acoustic enclosure design. Check installation.	Design - once Construction - once	PMU	Included in PMU staffing
Munda - generator noise	confirm the generator installed is the proposed Kohler enclosed generator with acoustic shielding	Contractor	Design and Construction	-	Check generator and acoustic enclosure installation.	Design - once Construction - once	PMU	Included in PMU staffing
Tulagi - generator noise	higher performance exhaust silencer be installed and directed away from the nearest houses	Contractor	Design and Construction	Cost of exhaust silencer	Check silencer selection Check installation.	Design - once Construction - once	PMU	Included in PMU staffing
Grievance Redress Mechanism	Establish Grievance Redress Mechanism	PMU	Before Construction	Included in PMU staffing	Confirm that PMU pre-construction actions taken	Before Construction	PMU	Included in PMU staffing
Natural disaster	Ensure planning for All structures to be designed with specified cyclone rating.	Contractor	Before Construction	Included in contractor staffing and design costs	Confirm that PMU pre-construction actions taken	Before Construction	PMU	Included in PMU 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
CONSTRUCTION STAGE								
Consultation	Consult and inform affected persons and local community prior to and during construction.	PMU	prior to and during all construction stage	Included in PMU staffing	Confirm that consultation mechanisms in place	Before and during Construction	PMU	Included in PMU staffing
Approvals	Ensure all permits and approvals in place before starting construction or any preliminary site works. See also under Pre-Construction).	PMU	prior to construction commencing.	Included in PMU staffing	Confirm that approvals in place	Before Construction	PMU	Included in PMU staffing
Contractor's environmental plans	Ensure contractors environmental plans have been approved by PMU prior to commencing work on site. See also under Pre-Construction).	PMU + Contractor	prior to construction commencing.	Included in PMU staffing	Confirm that in place	Before Construction	PMU	Included in PMU staffing
Soil and water	Prevent soil erosion and sediment pollution as follows: minimise the area of vegetation clearing and ground disturbance, This includes access to people, vehicles and equipment and stockpiling and storage of materials and equipment. install upslope drains on steep areas to divert runoff, protect steep slopes from erosion including minimising vegetation clearing, stabilise vehicle access ways, restrict vehicles to designated routes, revegetate or stabilise disturbed areas as soon as practical, stockpile and reuse topsoil, keep stockpiles and soil disturbance out of drainage and flood areas. No spoil or other waste to be placed in water bodies including drains, streams, riverbanks, swamps, the sea or flood prone land. Oil and fuel spill kits will be provided on site during construction and operation.	Contractor	During all construction stage	Included in contractor cost	Review contractor's environmental plan to ensure all included. Attend site with Contractor prior to commencement to ensure contractor understanding; Regular inspections to ensure all in place. Total Dissolved Solids	Before Construction and Monthly inspections As above	PMU Environmental Officer PMU Environmental Officer	Included in PMU staffing
KIRAKIRA **Soil erosion** **Water** **Ecology** **:**	maintain a fenced setback from the top of the slope to the river and seafront from which all site development activity and any access for personnel, vehicles, equipment or materials is prevented. This	Contractor	During all construction stage	Included in contractor cost	Review contractor's environmental plan to ensure all included.	Before Construction and Monthly inspections	PMU Environmental Officer	Included in PMU 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**
	strip and the slope to the river should have vegetation protected and maintained to protect the bank from erosion and filter runoff. All materials and activities that could cause water pollution, including fuel, oils and stockpiles should as far as practicable be kept as far as possible from the river. Prevent access to forest and bush along the western ridge and at the rear southern end of the site				Attend site with contractor prior to commencement to ensure contractor understanding; Regular inspections to ensure all in place.			
Air quality	Dust will be minimised by minimising the area of vegetation clearing and ground disturbance, stabilising access ways, restricting vehicles to designated routes, revegetating or stabilising disturbed areas as soon as practical, covering dusty loads during transport, modifying work or wetting down if neighbours affected especially during dry windy conditions, cover stockpiles and wet dusty areas where practical. Smoke nuisance from equipment will be minimised by ensuring mechanical equipment is maintained and fitted with appropriate exhaust systems. There shall be no burning of waste on the site.	Contractor	During all construction stage	Included in contractor cost	Review contractor's environmental plan to ensure all included. Attend site with contractor prior to commencement to ensure contractor understanding; Regular inspections to ensure all in place.	Before Construction and Monthly inspections	PMU Environmental Officer	Included in PMU staffing
Air quality **MUNDA**	Ensure dust and smoke do not impact hospital to the west or airport runway to north and north-east by undertaking activities that may generate only when wind is from the northern quarter.	Contractor	During all construction stage	Included in contractor cost	Review contractor's environmental plan to ensure all included. Regular inspections to ensure all in place.	Before Construction and Monthly inspections	PMU Environmental Officer	Included in PMU staffing
Noise - Construction	Manage construction noise to achieve World Bank EHS Noise Level Guidelines at sensitive receptors as per IEE. i.e. for Residential, institutional, educational: night time 45dBA, day 55dBA, Background +3dBA.	Contractor	During all construction stage	Included in contractor cost	Review contractor's environmental plan to ensure all included. Regular	Before Construction and Monthly inspections	PMU Environmental Officer	Included in PMU 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**
	Consult and inform neighbours and local community of construction activities in relation to noise. If valid complaints are received, modify methods if possible to reduce impact. Do not undertake activities outside of scheduled daytime hours. Ensure that equipment is in good condition and regularly maintained and fitted with exhaust silencers in accordance with manufacturers recommendations. Turn off or throttle down plant and machinery when not use. Workers to be trained in being sensitive to noise impacts on the neighbouring community including antisocial behaviour. Ensure that that no employee is exposed to noise level greater than 85 dB(A) for more than eight hours per day without hearing protection.				inspections to ensure all in place. Check complaints.			
Noise – diesel generators installation	Confirm that diesel generators installed and acoustic enclosure and shielding are in accordance with that planned – See Planning above.	PMU	Before and after installation of diesel generators	Solomon Power	Inspection and verification	Before and after installation of diesel generators	PMU	Included in PMU cost
Waste	Contractor to prepare waste plan, as part of contractor's construction environment management plan, specifying how all wastes are to managed. No uncontrolled dumping and / or burning of waste. Waste to be managed according to the waste management hierarchy of reduce waste generated, reuse waste materials where possible, recycle materials and safe disposal of residual waste material. Waste materials such as cleared vegetation, wood and clean metal offcuts	Contractor	During all construction stage	Included in Contractor's costs	Waste Plan prepared and approved. Documentation showing waste recycling. Inspection of site and approved waste sites.	Monthly inspection	PMU	Included in PMU 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
	that require disposal shall be made available to the local community provided it is safe to do so. Recyclable materials to be removed for recycling where this is safe and practicable. Non-hazardous non-toxic waste that is not recycled shall be disposed of at an appropriate licenced facility after approval from the local authority.							
Waste - oil	Waste oil shall not be disposed of to land or waters. Small quantities of waste oil may be made available for local reuse. Larger quantities to be removed to a recycling facility. Oil and fuel spill kits to be provided on site during construction and operation.	Contractor	During all construction stage	Included in Contractor's costs	Documentation showing waste oil returned for recycling. Inspection of site.	Monthly inspection	PMU	Included in PMU cost
Waste – failed equipment rejected during installation	Any solar panels, batteries and other electrical equipment that are rejected during installation and commissioning due to damage or failure shall be removed from the site and returned to the supplier for recycling or disposal at a suitably licenced facility.	Contractor	During all construction stage	Included in Contractor's costs	Documentation showing return of failed equipment. Inspection of site.	Monthly inspection	PMU	Included in PMU cost
Waste - sanitation	Human waste will be disposed of via appropriate toilet and wastewater facilities to protect public health and prevent water pollution. During construction toilet and washing facilities will be built for workers, likely pit toilets or septic / absorption systems. Toilets will be fitted with lids to exclude insects. Septic / absorption and site drainage will constructed and managed to ensure that mosquito or other insects cannot breed	Contractor	During all construction stage	Included in Contractor's costs	Inspection of site.	Monthly inspection	PMU	Included in PMU cost
Waste – general solid	General solid waste will be disposed of at a facility approved by the local government (not including solar panels, batteries and electrical equipment as described above). Food waste will be disposed of so as to prevent access by vermin. There shall be no burning of	Contractor	During all construction stage	Included in Contractor's costs	Inspection of site.	Monthly inspection	PMU	Included in PMU 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
	waste on the site							
Asbestos on Site - TULAGI	TULAGI site has existing asbestos-cement (fibro) structures that will be demolished and fragments of fibro scattered around site. Establish and follow a plan based on best international practice to protect workers and public health. This should include personal protective equipment, wetting down broken fibro structures and removing without creating or liberating dust, collecting scattered fragments, securely bagging and transporting to an appropriate facility for safe disposal.	Contractor	Early in construction stage	Included in Contractor's costs	Review plan. Environmental officer to observe procedures are followed. Inspection of site.	Once off. Inspection	PMU	Included in PMU cost
Socioeconomic **- Influx of outside workers**	establish a protocol for community relations, educating workers on this, the grievance redress mechanism and communicable disease prevention. Further measures outlined in the social assessment for the project also to be implemented.	PMU Social Officer	Before construction	Included in PMU cost	Measures in place and operating	Monthly review of GRM actions	PMU	Included in PMU cost
Socioeconomic **- Land use, access restriction**	temporary use of land or restriction of access required for the construction period will be agreed with the provincial / town administration and landowners and subject to consultation with affected people	Contractor	During all construction stage	Included in Contractor's costs	Agreements in place	Monthly inspection	PMU	Included in PMU cost
Socioeconomic **- Public health and safety**	public information and signage, fencing of the site and access control, supervision of equipment movement outside the site, managing noise, air emissions and waste (refer Physical Environment section), prevent mosquito breeding on site by preventing water ponding, install and properly manage toilet and washing facilities for workers.	Contractor	During all construction stage	Included in Contractor's costs	Measures in place	Monthly inspection	PMU	Included in PMU cost
Socioeconomic **- Community exposure to project campsite -** Spread of sexually transmitted infections such as HIV or AIDS. Health problems.	Village/community protocols and health awareness to be discussed as part of project and campsite induction Signage and security to be located at the campsite to prohibit access to unauthorised people, especially children	Contractor	During all construction stage	Included in Contractor's costs	Measures in place	Monthly inspection	PMU	Included in PMU 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
	Workers to respect village and landowner boundaries An STI awareness and prevention programme to be implemented for workers and local communities (carried out by NGOs and/or MoH) Contractors to provide a first aid post at campsite and safety equipment for workers							
Socioeconomic **- Increase in disorderly public behaviour or alcohol use - Disagreements between workers and the local community causing social disruption**	The Contractor to ensure that a code of conduct is in place at the camp, which will include a ban on alcohol The Contractor to educate workers to respect village/community protocols and customs Controls to be in place so that if a situation is beyond the capacity of the community leaders, the police will be notified to investigate and mitigate the problem	Contractor	During all construction stage	Included in Contractor's costs	Measures in place	Monthly inspection	PMU	Included in PMU cost
Socioeconomic **- Local community access to solar sites and routes across them prevented by the project** **- Minor disruption to local community traditions and inconvenience in losing access routes** **- Disagreements**	Alternative routes around the perimeter of the sites are available Consultation with community leaders prior and during construction works to communicate the plans and notify them of the access restrictions in place Provincial authorities, communities and schools will be notified in advance. Signs and other safety features will be used to indicate construction works and danger zones.	Contractor	During all construction stage	Included in Contractor's costs	Measures in place	Monthly inspection	PMU	Included in PMU cost
Socioeconomic - Encroachment on to cultural property and/or archaeological sites causing damage or disturbance **- Degradation of cultural landmarks**	The construction of solar panels and diesel power stations are not expected to impact on any cultural and archaeological sites. During clearing of land or earthworks, if any culturally significant artefacts are exposed, clearing will cease immediately and the National Museum will be contacts to review the situation.	Contractor	During all construction stage	Included in Contractor's costs	Measures in place	Monthly inspection	PMU	Included in PMU 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**
Socioeconomic – Increased traffic using local roads to come to and from site affecting communities **- Disruption to local communities** **- Road accidents**	Limit high traffic activities to day light hours and agree work schedules with surrounding community, churches and schools Roads will be kept free of debris, spoil and other material at all times Speed restrictions and signage to be implemented	Contractor	During all construction stage	Included in Contractor's costs	Measures in place	Monthly inspection	PMU	Included in PMU cost
Occupational Health and Safety	Solomon Power's safety requirements are fully implemented and complied with. The contractor will be required to prepare a health and safety plan describing how safety will be managed for the project. Health and Safety mitigation will include but necessarily be limited to training and induction of workers, ongoing identification, prevention and management of risks and hazards, safe working method statements, incident response, compliance, protective equipment and first aid and medical facilities.	Contractor Solomon Power Safety officers	During all construction stage	Included in Contractor's costs	OHS Measures in place	Monthly inspection	PMU	Included in PMU 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
OPERATION								
Consultation	Consult and inform affected persons including re noise in operation	Solomon Power	On commissioning and ongoing as required	Included in Solomon Power operating costs	Consultation records. GRM records.	Once on commissioning	Solomon Power	Included in Solomon Power operating costs
Soil and water contamination	Maintain sealing and bunding of spill containment areas, including fuel and oil storage and handling areas, and equipment such as generators and fuel pumps; oil separation on drainage outlets and sumps. Bunding in accordance with latest version of Australian Standard *AS1940 The Storage and Handling of Flammable and Combustible Liquids.* The containment volume required is the volume of the largest container, tank or drum, plus 10 per cent. Oil and fuel spill kits will be provided on site Provide training to operators in the above.	Solomon Power Officer in Charge	Ongoing	Included in Solomon Power operating costs	Inspect to ensure bunding in place, maintained and operated correctly. Check training register.	Include in general inspections	Solomon Power Officer in Charge Solomon Power management	Included in Solomon Power operating costs
Air quality	Ensure diesel generators have standard emissions controls remaining fitted and generators serviced, maintained and operated in accordance with manufacturers specifications. Provide training to operators in the above.	Solomon Power Officer in Charge	Ongoing	Included in Solomon Power operating costs	Inspect facility and to ensure emissions controls in place, and generators serviced, maintained and operated correctly. Inspect maintenance records. Check training register.	Include in general inspections	Solomon Power Officer in Charge Solomon Power management	Included in Solomon Power operating costs
Noise	Ensure compliance with World Bank EHS Noise Level Guidelines at sensitive receptors as per IEE. i.e. for Residential, institutional, educational: night time 45dBA, day 55dBA, Background +3dBA.	Solomon Power Officer in Charge	Ongoing	Included in Solomon Power operating costs	As below	Include in general inspections	Solomon Power Officer in Charge,	Included in Solomon Power operating costs

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
							Solomon Power management	
Noise due to diesel generators	Ensure all diesel generators remain fitted with exhaust mufflers and acoustic enclosures shielding, and generators serviced, maintained and operated in accordance with manufacturers specifications. Provide training to operators in the above.	Solomon Power Officer in Charge	Ongoing	Included in Solomon Power operating costs	Inspect facility to ensure with exhaust mufflers and acoustic enclosures shielding in place, and generators serviced, maintained and operated correctly. Inspect maintenance records. Check training register.	Include in general inspections	Solomon Power Officer in Charge, Solomon Power management	Included in Solomon Power operating costs
Noise due to diesel generators	Measure noise at sensitive receptors to check compliance with World Bank EHS Noise Level i.e. Residential, institutional, educational: night time 45dBA, day 55dBA, Background +3dBA. Implement additional controls if necessary to comply, e.g. additional shielding, restriction on night time operation.	Solomon Power management	On commissioning, annually and if appropriate in response to complaints. Check complaints record and consult stakeholders.	Included in Solomon Power operating costs	Measure noise at sensitive receptors. Measurement records. Check training register.	On commissioning, annually and if appropriate in response to complaints.	Solomon Power management	Included in Solomon Power operating costs
Noise due to diesel generators - OHS	No employee to be exposed to noise level greater than 85 dB(A) for more than eight hours per day without hearing protection, where there is no demand for oral communication (EHS Guidelines). Provide high quality hearing protection PPE and enforce its use. Provide training in above.	Solomon Power Officer in Charge Solomon Power Safety officers	Ongoing	Included in Solomon Power operating costs	Check training register. Consult workers to ensure their understanding of hearing protection requirements.	Include in general inspections	Solomon Power Officer in Charge Solomon Power management	Included in Solomon Power operating costs

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**
Waste – old or damaged panels	At the end of their service life or in the event of damage to panels such as due to storms or vandalism, used panels and other electrical equipment will taken away for recycling or safe disposal, which could be by the Contractor in conjunction with the supply of replacements	Solomon Power	At end of service life, on replacement or if disaster damage	Future decommissioning or replacement cost	Contracts and receipts	Inspect records as and when required.	Solomon Power	Included in future operating costs
Waste - oil	Waste oil shall not be disposed of to land or waters. Small quantities of waste oil may be made available for local reuse. Larger quantities should be removed to a recycling facility. Oil and fuel spill kits will be provided on site during construction and operation.	Solomon Power	Throughout operation	Included in Solomon Power operating costs	Check records. Check for hydrocarbon staining on site.	Include in general inspections	Solomon Power Officer in Charge, Solomon Power management	Included in Solomon Power operating costs
Waste – human waste	Toilet and washing facilities will be built for workers, likely pit toilets or septic / absorption systems. Toilets will be fitted with lids to exclude insects. Septic / absorption and site drainage will constructed and managed to ensure that mosquito or other insects cannot breed.	Solomon Power	Throughout operation	Included in Solomon Power operating costs	Facilities in place, operating and in reasonable condition	Include in general inspections	Solomon Power Officer in Charge, Solomon Power management Solomon Power Safety/ Environment officers	Included in Solomon Power operating costs
Waste – general solid	General solid waste will be disposed of at a facility approved by the local government (not including solar panels, batteries and electrical equipment as described above).	Solomon Power	Throughout operation	Included in Solomon Power operating costs	Waste records, Site tidy,	Include in general inspections	Solomon Power Officer in Charge, Safety/ Environment officers	Included in Solomon Power operating costs
Ecology – Operation	No access to vegetated areas outside designated project area, no cutting of trees and undergrowth except as required for the maintenance. **Kirakira** – protect vegetation on riverbank and sea front slopes.	Solomon Power	Throughout operation	Included in Solomon Power operating costs	Waste records, Site tidy,	Include in general inspections	Solomon Power Officer in Charge, Safety/ Environment officers	Included in Solomon Power operating costs

IX. REFERENCES

Asian Development Bank (2005). Solomon Islands Country Environmental Analysis: Mainstreaming Environmental Considerations in Economic and Development Planning Processes, Honiara.

Asian Development Bank. Pacific Region Environmental Strategy 2005–2009.

Asian Development Bank (2009). Safeguard Policy Statement (SPS).

Asian Development Bank (2012). ADB Environment Safeguards - A Good Practice Sourcebook. December 2012.

Asian Development Bank (2013). Guidelines for Climate Proofing Investment in the Energy Sector.

Gibbs, HK, S Brown, JO Niles and JA Foley. Monitoring and estimating tropical forest carbon stocks: making REDD a reality. (https://unfccc.int/files/land_use_and_climate_change/redd/submissions/application/pdf/redd_20081022_tfg.pdf)

Ministry of Environment Conservation and Meteorology (2008). Solomon Islands State of the Environment Report July 2008.

Ministry of Environment, Conservation and Meteorology, (2008) Corporate Plan 2008 – 2012, Honiara.

Moomaw, W, P Burgherr, G Heath, M Lenzen, J Nyboer, A Verbruggen, 2011: Annex II: Methodology. In IPCC: Special Report on Renewable Energy Sources and Climate Change Mitigation

National Renewable Energy Laboratory. November 2012. Life Cycle Greenhouse Gas Emissions from Solar Photovoltaics. (http://www.nrel.gov/docs/fy13osti/56487.pdf)

Price S, A Beeson, J Fardin, J Radford (2015). Environmental Law in Solomon Islands. Landowners' Advocacy and Legal Support Unit, Public Solicitors Office Solomon Islands.

Solomon Islands Government. 2009 Population & Housing Census National Report.

World Bank / IFC (2007). Environmental, Health, and Safety (EHS) Guidelines. General EHS Guidelines: Environmental. 30 April 2007.