CHAPTER ONE:

INTRODUCTION

CHAPTER ONE

INTRODUCTION

1.1 Background Information

The Nigeria Federal Executive Council approved the Power Sector Reform Program (PSRP) on March 22, 2017. One of the PSRP initiatives is the Nigeria Electrification Project (NEP) which seeks to increase electricity access to households, public institutions, micro, small and medium enterprises (MSMEs) and to provide clean, safe, reliable and affordable electricity to unserved and underserved rural communities through mini-grid/off-grid renewable power solutions. The NEP is being implemented by the Rural Electrification Agency (REA), on behalf of the Federal Government of Nigeria (FGN), and co-financed by the World Bank.

One of the key components of the NEP is Energizing Education Programme (EEP). The objective of the EEP is to provide dedicated, clean and reliable power supply to 37 Federal Universities and 7 affiliated University Teaching Hospitals across the country. The scope of the EEP includes provision of off-grid, dedicated and independent power plant, rehabilitation of existing electricity distribution infrastructure, and provision of street lighting (for illumination and improved security) as well as a world class renewable energy training centre for each of the beneficiary Universities.

The EEP is being implemented in phases. The first phase (Phase I) covers 9 Universities and 1 affiliated Teaching Hospital and it is currently ongoing, while the second phase (Phase II), to be funded by the World Bank loan under the NEP, covers 7 Universities and 2 affiliated Teaching Hospitals.

One of the beneficiary universities under the EEP Phase II is the Federal University Gashua (FUGA) in Yobe State, Northeast region of Nigeria. The University was founded in 2011 and took off in 2013. The FUGA campus is situated on approximately 2,000 hectares (ha) of land and the University population as at April 2019 stood at 4,493 persons (REA Energy Audit Report, 2019).

Based on the energy demand audit conducted by REA in conjunction with the National Universities Commission (NUC), a 2.5 megawatt (MW) power plant is proposed for FUGA. This is in addition to other associated infrastructure under the EEP. The proposed power plant will be solar-hybrid technology.

In compliance with the relevant requirements of the Federal Ministry of Environment (FMEnv.) and other relevant regulatory agencies in Nigeria, as well as the applicable requirements of the World Bank Safeguard Policies, an Environmental

and Social Impact Assessment (ESIA[1]) of the proposed solar-hybrid power plant and associated infrastructure in FUGA, Yobe State (the "Project") has been conducted. The ESIA study is also in fulfilment of commitments documented in the Environmental and Social Management Framework (ESMF) for NEP.

The ESIA study covers the entire life cycle of the proposed Project (i.e. pre-construction, construction, commissioning, operation, decommissioning and closure).

1.2 Objectives of the ESIA Study

The overall objective of the ESIA is to identify and assess the potential and associated impacts of the proposed Project throughout its life cycle and to put in place appropriate environmental and social measures to eliminate or mitigate the identified adverse impacts and enhance the associated benefits. This is aimed at ensuring that the proposed Project is developed and operated in an environmentally and socially sustainable manner.

The specific objectives of the ESIA study are to:

- Establish and document the existing environmental and social conditions of the Project's Area of Influence[2] prior to construction, including any cultural resources and sensitive components of the environment.
- Assist Project design and planning by identifying those aspects of location, construction, operation and decommissioning which may cause adverse environmental and social impacts, including occupational and community health and safety issues.
- Develop appropriate and practicable mitigation measures and environmental and social management plan (ESMP)[3] including monitoring programme, responsible parties, timeframe and cost estimates required to address the identified adverse impacts and enhance the associated Project benefits (e.g. positive climate impact).
- Identify, where required, the need for development and implementation of a Resettlement Action Plan (RAP) / Livelihood Restoration Plan (LRP).

[1] The proposed project is being co-financed by the World Bank. If reference is made to the FMEnv procedure, the term "EIA" is used, while if reference is made to the project's broader perspective, the term "ESIA" is used. Both ESIA and EIA are synonymous.

[2] Based on the consideration of potential environmental and social aspects/footprints of the proposed Project, the Area of Influence (AoI) for the Project covers the Project site (approximately 12.5 hectares of land within the University campus) and its surrounding environment up to 2 km radius from the centre of the site (as discussed in details in Chapter 4). This also includes the areas where the cumulative impacts of the Project may be experienced, as well as the transport route.

[3] The term "ESMP" is used in this ESIA report to ensure consistency with the World Bank requirements. The term is, however, synonymous with Environmental Management Plan (EMP) adopted by the FMEnv.

- Conduct stakeholder consultations to capture the concerns of the various stakeholders (e.g. relevant government institutions, potentially affected persons, etc.) about the Project including gender-based violence (GBV) risks.
- Prepare a detailed report presenting clear and concise information on the findings of the ESIA study.
- Obtain FMEnv-approval for the proposed Project.

1.3 Scope of the ESIA Study

The scope of the ESIA study covers the following:

- Review of applicable local and international laws, regulations, standards and industry codes that apply to the proposed Project.
- Description of all actions/activities that will be carried out in the course of the Project development and implementation.
- Desktop review of relevant documents pertaining to the Project and the environment where the Project would be located. These documents include the NEP ESMF, amongst others.
- Field data gathering covering biophysical and socio-economic components of the Project's Area of Influence.
- Consultations with relevant stakeholders including government institutions, project affected persons, University management representatives, etc. Detailed information on stakeholder consultations conducted as part of the ESIA study for the proposed Project is documented in Chapter 4 of this report.
- Laboratory analysis of field samples, and data analysis.
- Impacts identification and evaluation, and development of appropriate and practicable mitigation measures and ESMP.
- Perimeter survey of the Project site, including development of survey maps.
- Report preparation and disclosure.

1.4 ESIA Study Approach / Methodology

The ESIA of the proposed Project has been carried out in line with the FMEnv-approved EIA process for mini-grid / off-grid projects being implemented under NEP. It also takes into consideration the requirements of relevant international standards and guidelines, such as the World Bank Environmental and Social (E&S) Safeguard Policies.

The illustration of general methodology adopted for the ESIA study is provided in Figure 1.1. Detailed information on each of the activities is provided in the subsequent chapters of this report.

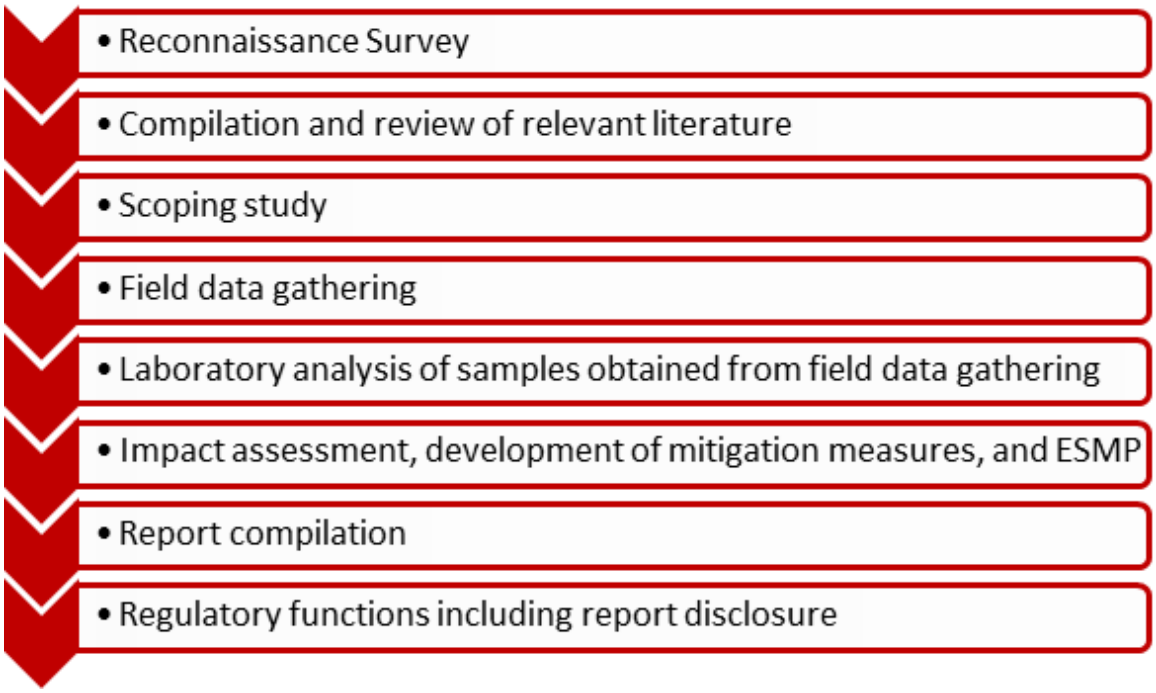


Figure 1.1: Schematic presentation of the general methodology for the ESIA

1.5 Limitations of the ESIA Study

The ESIA study has been carried out in line with the relevant local and international guidelines and regulations to identify and assess the potential environmental and social impacts of the proposed Project, and also to put in place appropriate mitigation measures to address the identified impacts. However, the inherent limitations in the ESIA process require that a few assumptions have to be made. Hence, there may be some degree of uncertainty as to the exact nature and magnitude of the environmental impacts. These uncertainties could arise from issues such as the level of available information on the proposed development at the time of the environmental assessment and limitations of the impact assessment prediction process. In view of these limitations, a robust ESMP has been put in place to ensure that the environmental and social performance of the project is monitored throughout the project's life cycle.

1.6 Legal and Administrative Framework

The proposed Project is part of the FGN's EEP, a component of NEP. Several laws and regulations apply to the energy sector in Nigeria. In addition, a number of laws, policies and instruments have been established to support environmental management and the EIA process in Nigeria.

In this section, an overview of the relevant statutory regulations, legislations and guidelines to the proposed Project and the ESIA study is provided. The Project shall ensure compliance with the applicable local and international regulations and standards throughout its life cycle.

1.6.1 National Policy, Guidelines and Regulations

1.6.1.1 Federal Ministry of Environment (FMEnv.)

The FMEnv is the primary authority for the regulation and enforcement of environmental laws in Nigeria. The Act establishing the Ministry places on it the responsibilities of ensuring that all development and industry activity, operations and emissions are within the limits prescribed in the national guidelines and standards, and comply with relevant regulations for environmental pollution management in Nigeria as may be released by the Ministry.

In furtherance of her mandate, the FMEnv developed laws, guidelines and regulations on various sectors of the national economy. The specific policies, acts, guidelines enforced by FMEnv that apply to the proposed Project are summarized in the following paragraphs:

- *National Policy on the Environment, 1989 (revised in 1999 and 2017)*

The National Policy on the Environment, 1989 (revised 1999 and 2017) provides for a viable national mechanism for cooperation, coordination and regular consultation, as well as harmonious management of the policy formulation and implementation process which requires the establishment of effective institutions and linkages within and among the various tiers of government.

The objective of the policy is to achieve sustainable development in Nigeria and in particular to:

- Secure a quality environment adequate for good health and wellbeing;
- Conserve the environment and natural resources for the benefit of present and future generations;
- Raise public awareness and promoting understanding of the essential linkages between the environmental resources and developments and encouraging individual and community participations in environmental improvement efforts;
- Maintain and enhance the ecosystems and ecological processes essential for the functioning of the biosphere to preserve biological diversity;
- Co-operate with other countries, international organizations and agencies to achieve optimal use and effective prevention or abatement of trans-boundary environmental degradation.

- *The National Guidelines and Standards for Environmental Pollution Control in Nigeria*

This was launched on March 12th, 1991 and represents the basic instrument for monitoring and controlling industrial and urban pollution.

- *S.I. 9 National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations, 1991*

This Statutory Instrument imposes restrictions on the release of toxic substances into the environment and stipulates requirements for pollution monitoring, machinery for combating pollution, contingency plan, and safety for workers.

- *S.I. 15 National Environmental Protection (Management of Solid and Hazardous Wastes) Regulations, 1991*

This Statutory Instrument regulates the collection, treatment and disposal of solid and hazardous wastes from municipal and industrial sources.

- *EIA Act No. 86 of 1992 (now codified as the EIA Act Cap E12 LFN 2004)*

The EIA Act is the primary Act governing the environmental and social assessment of developmental project or activity in Nigeria. Section 2(2) of the Act requires that where the extent, nature or location of a proposed project or activity is such that it is likely to significantly affect the environment, an EIA must be undertaken in accordance with the provisions of the Act.

- *National Environmental Impact Assessment Procedural and Sectoral Guidelines*

In response to the promulgation of the EIA Act, the FMEnv developed National EIA Procedural Guidelines and other set of guidelines on various sectors of the National economy. Applicable to the proposed Project is the EIA Guidelines for Power Sector, 2013. However, in line with the request by REA, an abridged EIA process has been approved by the FMEnv for proposed mini-grid/off-grid projects to be implemented under NEP. This ESIA study ensures compliance with the approved EIA process.

1.6.1.2 National Environmental Standards and Regulation Enforcement Agency

The National Environmental Standards and Regulations Enforcement Agency (NESREA) was established in 2007 by the FGN as a parastatal of the FMEnv. The Agency is charged with the responsibility of enforcing the environmental laws, guidelines, standards and regulations in Nigeria, specifically during the operational phase of developmental projects. The applicable NESREA's regulations to the proposed Project include:

- *S.I. 28 National Environmental (Sanitation and Wastes Control) Regulations, 2009*

The purpose of this regulation is the adoption of sustainable and environment friendly practices in environmental sanitation and waste management to minimize

pollution.

- *S.I. 35 National Environmental (Noise Standards and Control) Regulations, 2009*

This regulation highlights the permissible noise levels to which a person may be exposed, control and mitigation of noise, permits for noise emissions in excess of permissible levels, and enforcement.

- *S.I. 22 National Environmental (Surface and Groundwater Quality Control) Regulations, 2010*

The purpose of this regulation is to enhance and preserve the physical, chemical and biological integrity of the groundwater and surface water resources.

- *S.I. 63 National Environmental (Energy Sector) Regulations, 2014*

The purpose of this regulation is to prevent or minimize pollution and encourage energy efficiency in all operations and ancillary activities of the energy sector in achieving sustainable economic development in Nigeria.

Other NESREA regulations relevant to the proposed Project are:

- *National Environmental (Ozone Layer Protection) Regulations, 2009, S.I.32*: The provisions of this regulation seek to prohibit the importation, manufacture, sale and the use of ozone-depleting substances.
- *National Environmental (Control of Bush/Forest Fire and Open Burning) Regulations, 2011, S.I.15*: The principal thrust of this regulation is to prevent and minimize the destruction of ecosystem through fire outbreak and burning of any materials that may affect the health of the ecosystem through the emission of hazardous air pollutants.
- *National Environmental (Electrical/Electronic Sector) Regulations, 2011, S.I.23*: The main purpose of this regulation is to ensure that best practices are applied and maintained in the operation of electrical and electronic equipment in order to safeguard the Nigerian environment against pollution hazards.
- *National Environmental (Soil Erosion and Flood Control) Regulations 2011, S. I. 12*: The overall objective of this regulation is to regulate all earthing-disturbing activities, practices or developments for non-agricultural, commercial, industrial and residential purposes.
- *National Environmental (Protection of Endangered Species in International Trade) Regulations, S. I. 11, 2011*: The major objective of this regulation is to protect species of endangered wildlife from extinction through the prohibition of trade, importation, etc.
- *National Environmental (Control of Alien and Invasive Species) Regulations, S. I. 32, 2013*: This regulation seeks to prevent the decline, minimize the

modification and destruction of ecosystem, and human health caused by alien and invasive species.

- *National Environmental (Air Quality Control) Regulations, S. I. 64, 2013*: The objective of this regulation is to ensure the control of air pollutants that may affect the ambient environment.

1.6.1.3 Federal Ministry of Power

The Federal Ministry of Power is the policy making arm of the Federal Government with the responsibility for the provision of power in the country. The Ministry is guided by the provisions of the Electricity Act No 28 of 1988, the National Electric Power Policy, 2001, the Electric Power Sector Reform Act, 2005, the Roadmap for Power Sector Reform, 2010, the National Energy Policy, 2013 and the National Energy Efficiency Action Plans, 2015.

1.6.1.4 Nigerian Electricity Regulatory Commission (NERC)

The Nigerian Electricity Regulatory Commission (NERC) is an independent regulatory agency inaugurated on October 31, 2005. The Commission is mandated to carry out the following, amongst others: i) monitor and regulate the activities of the electricity industry in Nigeria; ii) issue licenses to market participants; iii) ensure compliance with market rules and operating guidelines.

1.6.1.5 Endangered Species Act 1985

The FGN enacted the Endangered Species (Control of International Trade and Traffic) Act 11, 1985 which makes, amongst others, the provisions for the conservation, management and protection of the country's endangered species. Section 1 of the Act prohibits the hunting, capture and trade of endangered species.

1.6.1.6 Harmful Waste (Special Criminal Provisions) Act CAP H1 LFN 2004

The Harmful Waste (Special Criminal Provisions) Act CAP H1 LFN 2004 prohibits and declares unlawful all activities relating to the purchase, sale, importation, transit, transportation, deposit, storage of harmful wastes. Appropriate penalties for contravention are prescribed.

1.6.1.7 Nigerian Urban and Regional Planning Act CAP N138 LFN, 2004

This Act establishes a Development Control Department (DCD) charged with the responsibility for matters relating to development control and implementation of physical development plans at Federal, State and Local Government levels within their respective jurisdiction.

1.6.1.8 Penal Code (Northern States) Federal Provisions Act, CAP P3 LFN 2004

The Act contains the basic criminal law offences relating to endangering the life of people from various activities in the Northern region of Nigeria. These include offences relating the public health and safety, amongst others.

1.6.1.9 Labour Act CAP L1, LFN 2004

The Labour Act is the primary law protecting the employment rights of individual workers. The Act covers protection of wages, contracts, employment terms and conditions, and recruitment; and classifies types of workers and special workers.

1.6.1.10 National Policy on Occupational Safety and Health

Section 17(3c) of the constitution of the Federal Republic of Nigeria (1999) stipulates that the health, safety and welfare of all persons in employment must be safeguarded and not endangered or abused.

1.6.1.11 Land Use Act CAP L5 LFN 2004

Section 1 of the Act vests the entire land in any state in the Governor of the State. The Act also stipulates the procedures the State must follow to clear the land, and define the compensatory measures the State must implement in order to compensate any affected person. The proposed solar-hybrid power plant and associated infrastructure will be sited within the land property owned by FUGA. No additional land outside the University campus will be expropriated for the proposed Project.

1.6.1.12 Violence Against Persons (Prohibition) Act, 2015

The Violence Against Persons (Prohibition) Act (VAPP) was passed into law in May, 2015. The Act was necessitated as a result of agitations for protection of persons against different forms of violence. The Act has strengthened advocacy against rape, female genital mutilation, partner battery, stalking, harmful widowhood practices while prohibiting all forms of violence, including physical, sexual, psychological, domestic, harmful traditional practices and discrimination against persons. It also provides maximum protection and effective remedies for victims and punishment of offenders. The Act is a key instrument for addressing GBV in Nigeria.

1.6.2 State and Local Government Environmental Authorities

In Nigeria, States and local government councils are empowered under the law to set up their own environmental protection bodies for the purpose of maintaining good environmental quality in the areas of related pollutants under their control.

The proposed Project will be located within FUGA campus in Bade Local Government Area (LGA) of Yobe State. The key State and local government administrative authorities with statutory functions related to the Project are briefly described below:

- *Yobe State Ministry of Environment*

The Ministry is responsible for the management and protection of the environment in Yobe State. It works with other relevant agencies and authorities to ensure a conducive and sustainable development of the environment in the State.

❖ *Yobe State Environmental Protection Agency (YOSEPA)*

The Agency is charged with the responsibility of overseeing waste (solid and liquid) management in Yobe State. Other functions of the Agency, amongst others, are to: control industrial waste (liquid emission) and air pollution, and cooperate with federal and state ministries, local government council's statutory bodies, research and educational institutions on matters related to environmental protection.

❖ *Bade Local Government Council*

The Local Government Council has an Environmental Health Department which ensures compliance with environmental sanitation policy of 2005, which includes maintaining good housekeeping and proper management of waste, amongst others.

1.6.3 International Guidelines, Conventions and Industry Codes

An overview of international guidelines, conventions and industry codes that are relevant to the proposed Project is provided in the sub-sections below:

1.6.3.1 International Guidelines and Standards

❖ *The World Bank Safeguard Policies*

The environmental and social safeguard policies of the World Bank are the fulcrum of its support towards sustainable poverty reduction, particularly in developing countries. The policies aimed at preventing and mitigating undue harm to the people and the environment in the development process. As indicated in Table 1.1, there are a total of ten (10) environmental and social safeguard policies of the World Bank, of which only Operational Policy (OP) 4.01 – Environmental Assessment- is triggered by the proposed Project, and its requirements have been taken into consideration in the ESIA study.

Table 1.1: Applicability of the World Bank Safeguard Policies to the proposed Project

S/N	World Bank Safeguard Policies	Scope/ Requirement	Safeguard triggered by the proposed Project	Justification	Sections of the ESIA report that address the requirements
1.	Environmental Assessment (OP/BP 4.01)	The World Bank requires Environmental Assessment (EA) of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable, and thus to improve decision making.	Yes	The proposed Project in FUGA under the FGN's EEP Phase II has associated environmental and social aspects which may affect the environment. Thus, this ESIA study has been conducted to ensure that the potential environmental	Chapter 3 – Project Description Chapter 4 – Description of the Environment Chapter 5 – Potential and Associated Impact Chapter 6 – Mitigation Measures Chapter 7 – Environmental and Social Management

S/N	World Bank Safeguard Policies	Scope/ Requirement	Safeguard triggered by the proposed Project	Justification	Sections of the ESIA report that address the requirements
				and social impacts/ risks of the proposed Project are identified and managed appropriately.	Plan
2.	Forests (OP/BP 4.36)	Operational Policy on Forests (OP 4.36) is proactive in both identifying and protecting critical forest conservation areas and in supporting improved forest management in production forests outside these areas. The Forests Policy covers all projects that affect natural or planted forests, whether positively or negatively	No	There are no natural or planted forests within the Project site and its immediate surroundings environment that would be affected by the proposed Project.	-
3.	Involuntary Resettlement (OP/BP 4.12)	The Involuntary Resettlement Policy (OP/BP 4.12) applies to projects involving either (i) the involuntary taking of land for project purposes that leads to physical relocation, loss of assets, or loss of income sources or livelihoods for the affected persons; or (ii) the involuntary restriction of access to legally designated protected areas that leads to adverse impacts on the livelihoods of the affected persons. To address these impacts, the policy requires the preparation of (i) either a Resettlement Plan or Resettlement Policy Framework in the case of involuntary land taking; and (ii) a Process Framework in the case of involuntary restriction of access to the natural resources within parks and protected areas.	No	The proposed solar-hybrid power plant and associated infrastructure will be sited within the land property owned by FUGA. No additional land outside the University campus will be expropriated for the Project. In addition, as at the time of site visits, there were no farming or livelihood activities on the Project site. The preferred site for the Project (as further described in Chapter 3) will not lead to physical and/or economic displacement.	-
4.	Indigenous Peoples	The Indigenous Peoples Policy (OP/BP 4.10)	No	The people in the Project's	-

S/N	World Bank Safeguard Policies	Scope/ Requirement	Safeguard triggered by the proposed Project	Justification	Sections of the ESIA report that address the requirements
	(OP/BP 4.10)	specifies how Indigenous Peoples need to be consulted and involved in the design of projects that may affect them (positively or negatively). Key requirements of OP 4.10 are social assessment; free, prior, and informed consultations leading to broad community support to the project; and development and disclosure of an Indigenous Peoples Plan or Planning Framework.		area of influence are not considered as Indigenous Peoples as defined by the World Bank.	
5.	Safety of Dams (OP/BP 4.37)	This policy (OP 4.37) applies to projects that construct, rehabilitate, or substantially depend upon large or high-hazard dams, whether these dams are for hydropower, water supply, or other functions (including mine tailings containment). The Bank requires that such projects adopt and implement certain dam safety measures.	No	The proposed Project is not in any way linked to any known dam.	-
6.	Pest Management (OP 4.09)	The Pest Management Policy (OP 4.09) applies to projects that (i) involve (through World Bank or counterpart funds) the procurement of pesticides or pesticide application equipment; (ii) would lead to substantially increased pesticide use; or (iii) would maintain or expand pest management practices that are unsustainable or risky from an environmental or health standpoint. In Bank-financed projects, the borrower is required to address pest management issues in the context of the project's	No	The development and operation of the proposed Project will not involve substantial use of pesticides.	-

S/N	World Bank Safeguard Policies	Scope/ Requirement	Safeguard triggered by the proposed Project	Justification	Sections of the ESIA report that address the requirements
		environmental assessment			
7.	Physical Cultural Resources (OP/BP 4.11)	This policy applies to projects that might affect sites and objects of archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance. It is required that the physical cultural resources component of the EA includes an investigation and inventory of physical cultural resources likely to be affected by the project; documentation of the significance of such physical cultural resources; and assessment of the nature and extent of potential impacts on these resources.	No	Based on field observations, documents review and interviews, there are no cultural sites within and around the Project site.	-
8.	Natural Habitats (OP/BP 4.04)	The Natural Habitats Policy (OP/BP 4.04) covers projects that affect natural forests or other non-forest natural ecosystems, with special focus on those projects that might lead to significant loss or degradation of natural habitats. The Bank supports, and expects such projects to apply, a precautionary approach to natural resource management to ensure opportunities for environmentally sustainable development	No	The Project site is characterized by secondary vegetation, dominated by grasses (refer to Chapter 3 of this report for sample photographs of the Project site).	-
9.	Projects in Disputed Areas (OP/BP 7.60)	This policy prescribes special consultation and due diligence procedures for any projects proposed in geographic areas that are disputed between two or more countries.	No	The Project site does not fall in a disputed location.	-
10.	Projects on International Waterways (OP 7.50)	This policy (OP 7.50) covers projects that could appreciably affect international	No	There are no known international waterways	-

S/N	World Bank Safeguard Policies	Scope/ Requirement	Safeguard triggered by the proposed Project	Justification	Sections of the ESIA report that address the requirements
		waterways, or the quantity or quality of water in more than one country.		within the Project's Area of Influence that could be affected by the proposed Project.	

❖ *World Bank Group Environmental, Health and Safety (EHS) Guidelines*

The World Bank Group EHS Guidelines are technical reference documents that include the World Bank Group expectations regarding industrial pollution management performance. The EHS Guidelines are designed to assist managers and decision makers with relevant industry background and technical information. This information supports actions aimed at avoiding, reducing, and controlling potential EHS impacts during the construction, operation, and decommissioning phase of a project. The EHS Guidelines serve as a technical reference source to support the implementation of the World Bank policies and procedures, particularly in those aspects related to pollution prevention and occupational and community health and safety.

The World Bank EHS Guidelines relevant to the proposed Project are:

- The World Bank Group EHS General Guidelines; and
- The World Bank Group EHS Guidelines for Electric Power Transmission and Distribution

The General EHS Guidelines provide guidance to users on common EHS issues potentially applicable to all industry sectors. It contains management measures for the following EHS issues associated with a project under the following headings:

- Air emissions
- Noise
- Ambient water quality
- Water conservation
- Energy conservation
- Hazardous materials management
- Waste management
- Occupational health and safety
- Community health and safety
- Construction and decommissioning.

The EHS Guideline for Electric Power Transmission and Distribution provides guidance applicable to the power project facilities that will involve power transmission and distribution.

The E&S management measures documented in the relevant World Bank EHS Guideline form part of the recommended mitigation measures to address the identified impacts of the proposed Project, as detailed in Chapters 6 and 7.

1.6.3.2 International Conventions

The Nigerian Government is an important player in the international support for the protection of the environment. As such, the country is a signatory to some international laws and conventions, which are targeted towards conservation and protection of the environment in order to ensure sustainable development. The international conventions (ratified by Nigeria) and regulations that are relevant to the proposed Project include:

- *African Convention on the Conservation of Nature and Natural Resources*

The African Convention on the Conservation of Nature and Natural Resources was adopted in Algiers, Algeria, on September 15, 1968 and entered into force on June 16, 1969. The Convention stipulates that the contracting States shall undertake to adopt the measures necessary to ensure conservation, utilization and development of soil, water, flora and fauna resources in accordance with scientific principles and with due regard to the best interest of the people.

- *Basel Convention on the Control of Trans-boundary Movement of Hazardous Wastes and their Disposal*

The Convention was adopted on March 22, 1989 and entered into force on May, 1989. It focuses attention on the hazards of the generation and disposal of hazardous wastes. The Convention defines the wastes to be regulated and controlled in order to protect human and environmental health against their adverse effects.

- *The United Nations Convention on Biological Diversity*

The Convention was adopted in 1994. The objectives of the Convention include the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of benefits arising out of the utilization of genetic resources.

- *The United Nations Framework Convention on Climate Change*

The Convention on Climate Change was adopted in 1992 during the Rio Earth Summit in Rio De Janeiro, Brazil, and entered into force in 1994 to limit Greenhouse Gas (GHG) emissions.

- *The Minamata Convention on Mercury*

The Minamata Convention on Mercury is a global treaty to protect human health and the environment from the adverse effects of mercury. The Minamata Convention was adopted in 2013 and entered into force in 2017. The international treaty is designed to protect human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds by member countries.

- *Protocol to the African Charter on Human and Peoples' Rights on the Rights of Women in Africa (Maputo Protocol)*

This calls on states to protect rights of women and girls, such as property rights, rights to a consensual marriage, protection against child marriage, widows' rights, inheritance rights, and protection against all forms of violence. Nigeria ratified this protocol in 2004 to address the historical discrimination and marginalization of women and girls, including GBV.

- *International Health Regulations (2005)*

The International Health Regulations (IHR) is an international legal instrument that is binding on 196 countries across the globe, including all the member states of World Health Organisation (WHO). This binding instrument of international law entered into force on 15 June 2007. The purpose and scope is "to prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks and which avoid unnecessary interference with international traffic and trade".

- *Declaration of the United Nations Conference on Human Environment*

The principles of this Declaration relevant to the proposed Project are summarized below:

Principle 2: The natural resources of the earth, including the air, water, land, flora and fauna especially representative samples of natural ecosystems, must be safeguarded for the benefit of present and future generations through careful planning or management, as appropriate.

Principle 3: The capacity of the earth to produce vital renewable resources must be maintained and, wherever practicable, restored or improved.

Principle 4: Nature conservation, including wildlife, must receive importance in planning for economic development.

Principle 15: Planning must be applied to human settlements and urbanization with a view to avoiding adverse effects on the environment and obtaining maximum social, economic and environmental benefits for all.

Principle 18: Science and technology, as part of their contribution to economic and social development, must be applied to the identification, avoidance and control of environmental risks and the solution of environmental problems and for the common good of mankind.

- *International Labour Organisation (ILO): ILO-OSH 2001 – Guidelines on Occupational Safety and Health (OSH) Management Systems*

These guidelines call for coherent policies to protect workers from occupational hazards and risks while improving productivity. The guidelines present practical approaches and tools for assisting organizations, competent national institutions, employers, workers and other social partners in establishing, implementing and improving occupational safety and health management systems, with the aim of reducing work-related injuries, ill health, diseases, incidents and deaths. Nigeria ratified the guidelines in 2001.

1.6.3.3 Industry Codes and Standards

- *International Electrochemical Commission (IEC)*

The IEC Technical Specification 62257 series contains recommendations for small renewable energy and hybrid systems for rural electrification projects. It outlines international best practice solutions to support energy access in developing countries across a range of technologies. The purpose of this series is to assist renewable energy project managers, engineers and system designers as well as operators to choose the right system for the right place and to design, operate and maintain the system.

1.7 Institutional Arrangements for Environmental and Social Management

The proposed Project is under the FGN's EEP Phase II, being implemented by REA. REA was set up by Section 88 of the Electric Power Sector Reform Act 2005, and its Board and Management were inaugurated on March 16, 2006.

REA will lead the design, installation, operation, and maintenance of the Project while FUGA, through its Department of Works and Physical Planning, is responsible for land allocation for the Project. REA is responsible for selecting Engineering, Procurement and Construction (EPC) contractor (through competitive process) to build, operate and maintain the proposed power plant, and also build and equip the associated training center. The selected EPC will also be considered for a ten-year operation and maintenance (O&M) contract for the power plant. In the long run, the University will be responsible for operating and maintaining the Project.

REA has established a Project Management Unit (PMU) which includes experienced Environmental and Social Safeguard Specialists. The REA-PMU will provide oversight functions for the management of potential environmental and social issues associated with the Project throughout its life cycle. The PMU, in conjunction with

the University's Department of Works and Physical Planning, will monitor the hired contractor's E&S performance.

The implementation of mitigation measures for potential environmental and social impacts associated with the Project (at various stages) will also be monitored by FMEnv, NESREA, Yobe State Ministry of Environment and other relevant regulatory agencies, as part of their statutory responsibilities.

In addition, the World Bank will provide overall supervision, facilitation and co-ordination of the Project, and monitor Project performance indicators.

Further information on E&S risk management process for the Project is provided in Chapter 7 of this report.

1.8 Report Structure

In line with the FMEnv guidelines, this report is structured as follows:

- **Preliminary Sections:** containing table of contents, lists of ESIA preparers, Executive Summary, amongst others.

- **Chapter One**: Introduction containing an overview of the proposed Project, the ESIA objectives and study approach and applicable legal and administrative framework.

- **Chapter Two**: Project Justification containing a rationale for the proposed Project as well as the analysis of Project alternatives and development options.

- **Chapter Three**: Project Description containing the technical elements of the Project. It concisely describes the proposed Project and its geographic and temporal context, including the Project's associated infrastructure.

- **Chapter Four**: Description of the Environment. It details the baseline data that is relevant to decisions about the Project location, design, development and operation.

- **Chapter Five**: Potential and Associated Impacts. This takes into account all relevant environmental and social risks and impacts of the proposed Project, including cumulative impacts.

- **Chapter Six**: Mitigation measures for the identified negative environmental and social impacts, as well as the enhancement measures for the identified positive impacts.

- **Chapter Seven**: is the ESMP. It summarizes the key environmental and social measures and actions and the timeframe including responsibility for the implementation of the recommended measures.

- **Chapter Eight**: presents an overview of remediation / decommissioning plan after Project closure.

- **Chapter Nine**: describes the stakeholder engagement activities carried out during the ESIA and an overview of the grievance redress mechanism for the Project.

- **Chapter Ten**: Conclusion and Recommendations

The report also includes references and appendices.

CHAPTER TWO:

PROJECT JUSTIFICATION

CHAPTER TWO

PROJECT JUSTIFICATION

This chapter presents the justification for the proposed 2.5 MW solar-hybrid power plant and associated infrastructure in Federal University Gashua (FUGA), Yobe State, as part of the Federal Government of Nigeria (FGN) Energizing Education Programme (EEP) Phase II. It also includes the description of alternatives and development options considered for the proposed Project.

2.1 Need for the Project

The Federal Universities in Nigeria remain the top choice for a large percentage of students seeking admission into tertiary institutions in the country. However, inadequate power supply from the grid is a major challenge facing many of these universities (for example, the energy demand audit conducted by REA and NUC at FUGA in 2019 reveals that the University receives an average of 2 hours of grid supplied power a day). To cope with the situation, most of the universities rely on diesel-fuelled generators for power generation, with significant economic and environmental implications.

Part of the FGN's initiatives to address inadequate power supply in the country is the Nigeria Electrification Project (NEP). NEP is an innovative programme that seeks to provide electricity access to off-grid communities across the country through renewable power sources. It is being implemented by REA and co-financed by the World Bank.

One of the components of the NEP is EEP, with the objective of providing dedicated, clean and reliable power supply to Federal Universities and affiliated University Teaching Hospitals across the country. However, the current phase covers 7 universities and 2 affiliated teaching hospitals. Also, the EEP is part of measures in ensuring that Nigeria achieves its carbon emission targets (20 % - 30 % carbon emission reduction by the year 2030) as contained in its Nationally Determined Contributions (NDC), under the Paris Agreement.

The proposed Project in FUGA is part of the FGN's EEP Phase II, under NEP. The Project will help to significantly address the power supply challenges currently facing the University, which will also lead to many positive spill-over effects. The associated infrastructure such as the training centre to be provided as part of the Project would enhance learning in renewable energy leading to certification, while the street lighting will improve security within the campus as a result of proper illumination.

2.2 Value of the Project

NEP is being co-financed by the World Bank through a $350 million loan. However, $105 million has been allocated for the implementation of EEP as a component of NEP. The finance required for the proposed Project in FUGA will be obtained from the $105 million.

2.3 Project Benefits

The proposed Project is envisaged to have a range of associated benefits, since the importance of gaining access to reliable and steady power supply cannot be over-emphasized. Some of the benefits are a function of the objectives of the Project, while others are a function of the way in which the Project is designed to meet its objectives.

The potential benefits of the proposed Project include but are not necessarily limited to the following:

- Stimulation of academic and research activities within the University as a result of access to constant and reliable power supply, thereby promoting educational advancement.
- Reduction in fossil fuel consumption by the University, thereby leading to reduction in carbon emissions and improvement in eco-balance. The University's average monthly diesel consumption is 4,749 litres (REA Energy Audit Report, 2019).
- Significant reduction in the cost of power generation by the University through diesel-fuelled generators. The University has 9 generators and spends ₦1,163,505 on diesel monthly to self-generate 684 kW of power 14 hours daily (REA Energy Audit Report, 2019). Such savings would be used for other undertakings that will benefit the University.
- Increase in social interactions within the University. There will be enhanced security in the University as a result of more streetlights for illumination which would help keep off opportunistic crimes and gender-based violence.
- Enhancement of learning in renewable energy leading to certification as a result of training centre to be provided as part of the Project.
- Improvement in livelihood enhancing activities within the University.
- Direct and indirect employment opportunities during Project development and operation. The employment opportunities will lead to acquisition of new skills and introduction of all manners of income generating spill-over effects.
- Increase in local and regional economy through award of contracts and purchase of supplies for Project development.

- Increase in financial and technical collaborations between the FGN, the University, REA, World Bank and other relevant Ministries, Departments and Agencies (MDAs).
- Contributing to the Nigeria's NDC to cut carbon emission by 20 % to 30 % by the year 2030, under the Paris Agreement.

2.4 Envisaged Sustainability

2.4.1 Technical Sustainability

The Project development shall be handled by qualified and experienced EPC contractor (to be selected by REA through a competitive process) according to pre-established standards and procedures. The design and construction phase of the Project shall be overseen by qualified engineers from REA and the Department of Works and Physical Planning in FUGA. In addition, standard operating manuals and appropriate documentation regarding the operation and maintenance of the Project shall be developed and put in place by the EPC contractor. These documents will be used as the basis for providing facility-specific training to relevant personnel prior to start-up to further ensure technical sustainability of the Project.

Upon completion of the construction phase, an O&M contractor will be engaged to operate and maintain the Project, in conjunction with the team from FUGA's Works and Physical Planning Department. In addition, adequate capacity building shall be provided to the University personnel that will work with the O&M Contractor for the day-to-day operations of the Project in the long run.

2.4.2 Environmental Sustainability

The environmental sustainability measures for the Project include the use of renewable source of energy (solar) for electricity generation (with negligible greenhouse gas (GHG) emissions compared to fossil fuel-burning power plants). In addition, the establishment of REA-PMU (which includes experienced Environmental and Social Safeguards Specialists) to oversee the implementation of the Project will contribute to environmental sustainability of the Project. More so, this ESIA study undertaken at the early stage of the Project development phase (and the commitment to implement the recommended mitigation measures and the ESMP developed as part of the ESIA) is geared towards ensuring the environmental sustainability of the Project.

2.4.3 Economic Sustainability

The proposed Project is part of the FGN's EEP initiative, a component of NEP. NEP is being funded by the World Bank with Three Hundred and Fifty Million US Dollars ($350,000,000) loan, of which One Hundred and Five Million US Dollars ($105,000,000) is allocated for projects under the EEP. The proposed Project in FUGA, as part of the EEP Phase II, will be financed from the NEP fund. Upon

completion, the Project will significantly reduce the use of diesel generators in the University thereby saving costs on diesel fuel and generator maintenance, amongst others. Also, the monthly payment to distribution company (Yola Electricity Distribution Company) for power consumption through the grid would stop (the University consumes an average of 3,541kWh monthly from the grid). Part of such savings will be used for the maintenance of the Project facilities in the long run.

A cost-reflective service charge (to be determined based on consultation with University management and users) shall be implemented for all facilities within the University campus. Private business establishments within the University campus shall be allowed to connect to the power Project and metered for billing to generate additional revenue to the University. The generated funds shall be used to sustain the operational costs of the project as well as for the procurement of project components that may be replaced (e.g. spent batteries, panels, etc.) in the future. Additionally, the Project will enhance the University's Internally Generated Revenue (IGR) for other development activities and minimize dependency on allocation from the Federal Government.

2.4.4 Social Sustainability

Stakeholder consultation has been carried out as part of the ESIA process in ensuring that all relevant stakeholders are presented with the opportunity to provide input into the Project at the early stage. This has also assisted in laying a good foundation for building relationship with the stakeholders. In addition, initial stakeholder engagement activities carried out during the ESIA have been presented in the report. A Stakeholder Engagement Plan (SEP) shall be developed to ensure continuous engagement with relevant stakeholders throughout the Project life cycle. In addition, a grievance redress mechanism (GRM) has been developed by REA for the Project. The GRM provides the communication channel to receive any complaints from stakeholders on the proposed Project and ensures that they are timely and adequately addressed. Details on stakeholder consultations carried out till date on the proposed Project are provided in Chapter 9 of this report.

2.5 Project Alternatives

2.5.1 Site Alternatives

An approximately 12.5 hectares of land within the FUGA campus has been allocated by the University authority for the proposed Project. The preferred site is located about 100 m from the University's Administrative building. The Project site has been selected based on a number of considerations including: i) absence of any rocky outcrops on the site that could pose constraints to the solar panels to be installed; ii) absence of any ecologically sensitive areas and/or cultural resources within and around the Project site; iii) accessibility - the Project site can easily be accessed

through the existing road network within the campus; iv) direct link to the existing switch yard can easily be achieved; and v) security reasons.
Other candidate sites considered within the University campus for the proposed Project were rejected due to some factors such as: i) presence of physical structure and agricultural crops which could trigger displacement and relocation; ii) far distance from the existing switch yard; iii) poor accessibility; iv) technical considerations for installation of solar panels, for example, topography.

2.5.2 Alternatives Considered within the Context of the proposed Solar-Hybrid Power Plant

The power plant to be provided as part of proposed Project in FUGA has been conceptualized to be a renewable energy source (solar technology) since that is part of the objectives of the EEP initiative (i.e. carbon emission reduction). Thus, this section specifically focuses on the alternatives considered within the proposed solar-hybrid power plant and eliminates discussion on other possible sources of power generation in Nigeria such as the use of natural gas fired power plant, coal-fired plant, oil-fuelled plant, etc.

2.5.2.1 Overview

Solar power generation is currently one of the fastest growing areas in renewable energy. Beyond panel production, it does not emit any significant GHGs. Compared to alternative renewable generation technologies such as wind turbines or biofuel generators, solar energy is produced by converting the sun's radiation – a process void of any smoke, gas, or other chemical by-product, which makes this technology to meet the clean development mechanism of the Kyoto Protocol. This is the main driving force behind all green energy technology, as nations attempt to meet climate change obligations in curbing emissions.

The use of solar energy for the proposed power plant in FUGA will significantly avoid the generation of GHG emissions associated with fossil-fuelled power plants. Thus, the proposed Project will help contribute to Nigeria's NDC on climate change. In addition, the high solar irradiation in Yobe State (as indicated in Figure 2.1) will be able to support the proposed power plant.

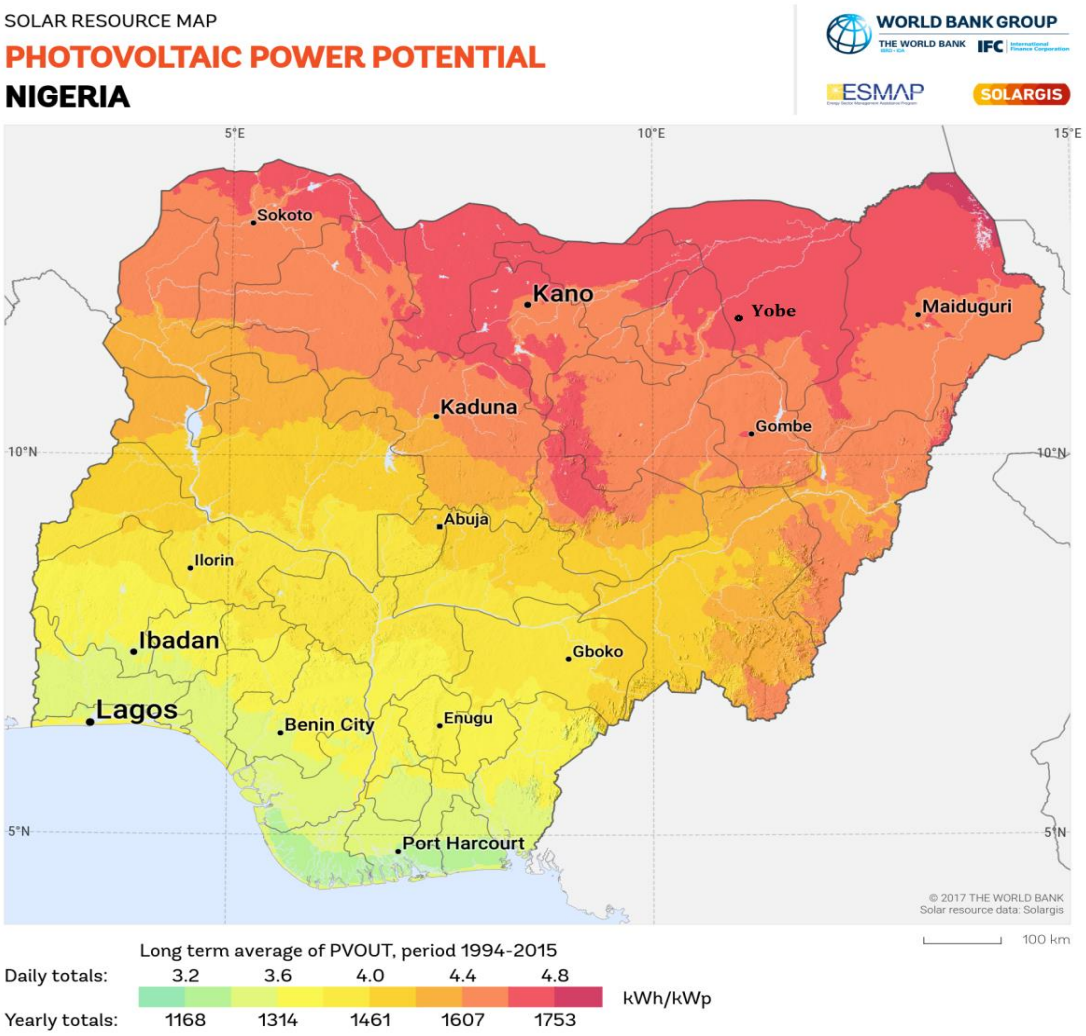


Figure 2.1: Photovoltaic power potential of Nigeria
Source: © 2017 The World Bank, Solar resource data: Solargis

2.5.2.2 Solar Power Technology Alternatives

The solar technologies considered for the proposed power plant in FUGA are:

- Concentrated Solar Power (CSP) Systems
- Photovoltaic (PV) Solar Panels

However, the preferred option for the proposed power plant is the use of PV Solar Panel, since it is highly flexible and requires low installation and maintenance cost in comparison to CSP technology. Water requirement for PV system is also low when compared to CSP system.

The comparison between CPS and PV Solar technologies considered for the Project is summarized in Table 2.1.

Table 2.1: Comparison between CSP and PV Solar Technology

Features	CSP Technology	PV Technology
Description	CSP technology uses concentrated radiation from the sun, to heat a liquid substance which is used to generate steam which in turn passes through a steam-turbine to generate electricity. CSP Technology produces electricity through indirect means. Energy output with CSP technology is of AC type.	PV technology uses sunlight through the 'photovoltaic effect' to generate direct electric current (DC). PV Technology produces electricity through direct means. Energy output with PV technology is of DC type but commonly converted to AC through an inverter.
Applications/Scale	CSP is used for utility scale power generation, mostly for Grid Connections, and also supporting conventional thermal power and desalination plants.	PV technology is suitable for off grid small and medium-sized applications, and for utility scale applications
Land requirement	CSP technology is best suited for areas of high direct normal solar radiation. CSP technology requires about 4 hectares of land per MW of capacity	PV technology has a wider geographical area of application. PV technology requires about 2 hectares of land per MW of capacity
Cost	CSP technology has an high installation and maintenance cost compared to PV	PV technology has a low installation and maintenance cost in comparison to CSP
Construction Time	CSP plant construction is technical more complex than PV	Utility scale PV plants are easier to install and require less time than CSP for Plant construction
Water Requirement	Water requirement is variable depending on the CSP technology option adopted. CSP may utilize wet, dry, and hybrid cooling techniques	Typically requires less water than CSP technology. Water is occasionally required for cleaning of dust from the panels.
Design Options	Less flexible in comparison to PV technology. Can be hybridized with fossil fuels like natural gas.	Highly flexible and adaptable to the project specific requirement
Average life span	25 years	25 years
Efficiency	Power production efficiency of CSP technology are as high as 45%	Power production fluctuates with the sunlight's intensity. For practical use this usually requires conversion to certain desired voltages or AC, through the use of inverters.
Environmental Risks	CSP systems have been recorded to pose environmental risks to bird species, which may be killed by the intense heat generated by the concentrated solar radiation which is reflected off the mirrors.	PV systems are considered to be generally benign.

Culled from different online sources

2.5.2.3 PV Panel Alternatives

Solar PV panel is an assembly of photovoltaic cells, also known as solar cells. It is an essential component of a PV system that converts sunlight directly into direct current (DC) electricity. To achieve a required voltage and current, a group of PV panels (also called PV modules) are wired into large array that called PV array. PV panels can be wired together in series and/or parallel to deliver voltage and current in a particular system requires.

The types of solar cells that are commonly used in PV technology are: i) mono-crystalline silicon; ii) poly-crystalline silicon; and iii) thin film. The typical appearance of each of these PV panels is shown in Figures 2.2 to 2.4.

Based on the consideration of cost and efficiency, polycrystalline silicon PV panels are envisaged to be used for the proposed Project.

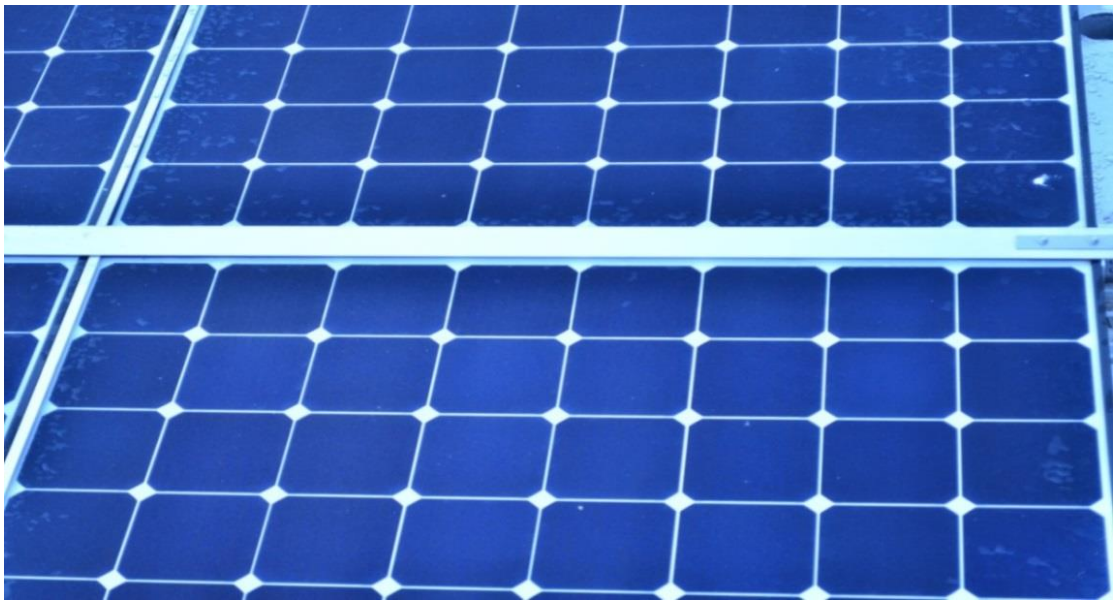


Figure 2.2: Typical appearance of mono-crystalline silicon PV panels

Figure 2.3: Typical Appearance of Polycrystalline Silicon PV panels

Figure 2.4: Typical appearance of Thin-Film CdTe panels

2.5.3 Battery Types Alternative

The proposed solar-hybrid power plant in FUGA is an off-grid system, which will involve the storage of power. Storage allows the PV array to continue providing power even when the demand is down, instead of having to disconnect and refrain from generating power. The batteries for the proposed power plant would be required to meet the demands of heavy cycling (charging and discharging) and irregular full recharging. There are a variety of battery types fitted for these requirements; however, four (4) of these batteries are the best available technology for solar power plants. These are: lead-acid, lithium-ion, flow, and nickel-cadmium batteries.

Following the careful consideration of factors such as safety, charging cycles, depth of discharge and life span, lithium-ion batteries are envisioned to be used as the preferred battery for the proposed solar power plant.

An overview of the battery types considered for the Project is provided below:

- ***Lead-Acid Batteries***

These are the oldest and cheapest form of batteries used in solar systems. They are widely used in Solar PV installations due to their wide availability and ability to work in a wide range of conditions. They internally convert hydrogen and oxygen into water and do not require maintenance (Zhang *et al.,* 2016). However, proper disposal of end-of-life lead-acid batteries is important. The lead-acid battery life is typically 3-10 years (Sun *et al.,* 2017).

❖ ***Lithium-Ion Batteries***

Lithium-ion batteries can deliver more cycles in their lifetime than lead-acid. They can be lighter and more self-contained than lead-acid batteries. They are solid, and do not require refills or maintenance. The most important benefit lithium-ion provides for solar is its high charge and discharge efficiencies, which help harvest more energy. Lithium-ion batteries also lose less capacity when idle, which is useful in solar installations where energy is only used occasionally. Lithium ion batteries usually have longer lifespan when compared to the lead-acid batteries, average of 5 years.

❖ ***Flow Batteries***

The vanadium redox flow battery (VRFB) is the most common technology in this type of batteries. In VRFB, the vanadium electrolyte does not degrade over time, so they can last much longer than other technologies. With other technologies, adding more batteries is the only way to increase hours of storage; however, adding more electrolyte (vanadium) can increase battery size in VRFB (Whitehead *et al.,* 2017).

The VRFB has no cycling limitations, and batteries can be charged and discharged completely without impact on their lifespan. They can last up to 20 years. The recycled vanadium in flow batteries is not toxic and can be reused repeatedly for other purposes, such as in making steel (Whitehead *et al.,* 2017). However, the high cost of vanadium and ion selective membrane within the cell will lead to significant cost implications for the Project.

❖ ***Nickel-cadmium Batteries***

Nickel cadmium or NiCd batteries are as old as the lead-acid batteries. Though they may not have the energy density (the power) of other technologies, they provide long life and reliability without complex management systems. They are also as cheap as lead-acid batteries (Shukla and Hariprakash, 2009).

NiCd batteries are rugged batteries with a high life span of up to 20 years (Shukla and Hariprakash, 2009). However, the major disadvantage of NiCd batteries is the relatively low energy density and susceptibility to self-discharge. Thus, making NiCd batteries an unreliable alternative for the proposed Project

2.6 Project Options

2.6.1 No Project Option

One of the reasons for the proposed Project in FUGA is that the current demand for electricity in the University significantly exceeds generation/supply and, that the current power supply through the grid is unreliable and suffers interruptions. If the Project does not go ahead, access to reliable, safe and cheaper power supply may be

difficult to realize. In addition, the potential benefits associated with the Project would not be realized. Furthermore, the no project option would mean that the University will continue to significantly rely on diesel-fuelled generators for self-generation of power considering the current situation of electricity supply to the University through the grid. This has serious economic implications to the University and would not also be in line the FGN's efforts in achieving its carbon emission targets. Thus, the No Project option is not considered a viable option to adopt.

2.6.2 Delayed Option

This option implies that the planned Project will be delayed until a much later date. Such option is usually taken when conditions are unfavourable to project implementation such as in war situation, or where the stakeholders are deeply resentful of the Project. Also, if the prevailing economic climate is not quite favourable to the Project, then delayed project option may be feasible. But none of these conditions is applicable.

Indeed, both the economic and the political environments are most favourably disposed towards the Project. The implication of delayed project option will mean that all the preliminary work and associated efforts/costs incurred would have come to nothing. Also, because of inflationary trends, such a delay may result in unanticipated increases in project costs, which may affect the final profit accruable from the Project. The delayed option is considered unviable for the Project.

2.6.3 Go Ahead Option

The inherent benefits of allowing the Project to go ahead as planned are multifarious. The quality of education, capacity for research and innovation, training opportunities, improved security within the University campus, job opportunities for Nigerian professionals, skilled and semi-skilled craftsmen will increase. Thus, the option to go ahead as planned does outweigh the other options as clearly highlighted above.

CHAPTER THREE:

PROJECT DESCRIPTION

CHAPTER THREE

PROJECT DESCRIPTION

3.1 Introduction

This chapter presents the technical description of the proposed Project including the Project location, associated components, power generation and evacuation approach, and development activities. Waste streams associated with the proposed Project over its life cycle, and the proposed handling techniques are also discussed.

3.2 Project Location

3.2.1 About FUGA

FUGA is a Federal Government-owned tertiary institution, with its campus situated on approximately 2,248 hectares (ha) of land in Bade Local Government Area of Yobe State, Northeast geo-political region of Nigeria (Figures 3.1 to 3.4).

In pursuance of its drive to transform the Education Sector in Nigeria, the Federal Government had, in 2010, approved the establishment of 12 new universities in the six geopolitical zones of the country. This was intended to open access to tertiary education for the teeming Nigerian youths. As part of the effective planning, the Federal Government set up an Implementation Committee which comprised of the National Universities Commission (NUC), the Tertiary Education Trust Fund (TETFUND) and other relevant stakeholders. Following a wide consultation by the Committee and the submission of its report, the implementation of the first phase of the proposal commenced in February, 2011, with the establishment of 9 universities, while the second phase involving the remaining 3 universities including FUGA commenced on February 18, 2013.

Currently, FUGA has 4 faculties namely: Faculty of Education, Faculty of Agriculture, Faculty of Science, and Faculty of Art, Management and Social Science, offering about 23 programmes. As at April 2019, the population of FUGA stood at 4,493 persons, consisting of 3,500 undergraduate and postgraduate students and 993 administrative staff (both academic and non-academic).

3.2.2 Description of the Project Site

An approximately 12.5 ha of land within the FUGA campus has been allocated for the proposed solar-hybrid power plant and the training centre. The Project site lies geographically within Latitude 12.88172°N - 12.87680°N and Longitude 11.01232°E - 11.01727°E, and its boundary is bordered to the north (about 100 m) by the University's Administrative building. Other existing infrastructure in the immediate

surroundings of the Project site include newly constructed male and female hostels (to the west of the site), the University's Information and Communications Technology (ICT) centre and the FUGA water factory unit (to the east), as indicated in Figure 3.5.

The proposed Project site is one of the undeveloped land areas within the University campus that are reserved for future development projects. The topography of the site is relatively flat and there is a rainwater harvesting trench at the southern part of the Project site. The trench is one of the rainwater harvesting points within the campus for irrigation demonstration to some of the University students in the Faculty of Agriculture as part of their coursework.

As shown in Plate 3.1, the vegetation on the site is composed of grasses and a few trees. The site is not known to fall within any gazetted grazing reserves, breeding areas, or animal migratory routes. However, during site visit, some grazing activities were observed at the proposed site. Interviews with the University representative from the Department of Works and Physical Planning revealed that the grazing activities were free range due to the presence of grasses on the site, and not exclusively limited to the site.

In addition, there is no local community encroachment (i.e. farms, residential buildings, and firewood / fruit gathering) within the site. Also, as at the time of site visit, the Project site was not being used for farming or any livelihood activities. The nearest community to the Project site is Low-Cost community situated about 1.2 km away from the University. Detailed information on the local community is provided in Chapter 4 of this report.

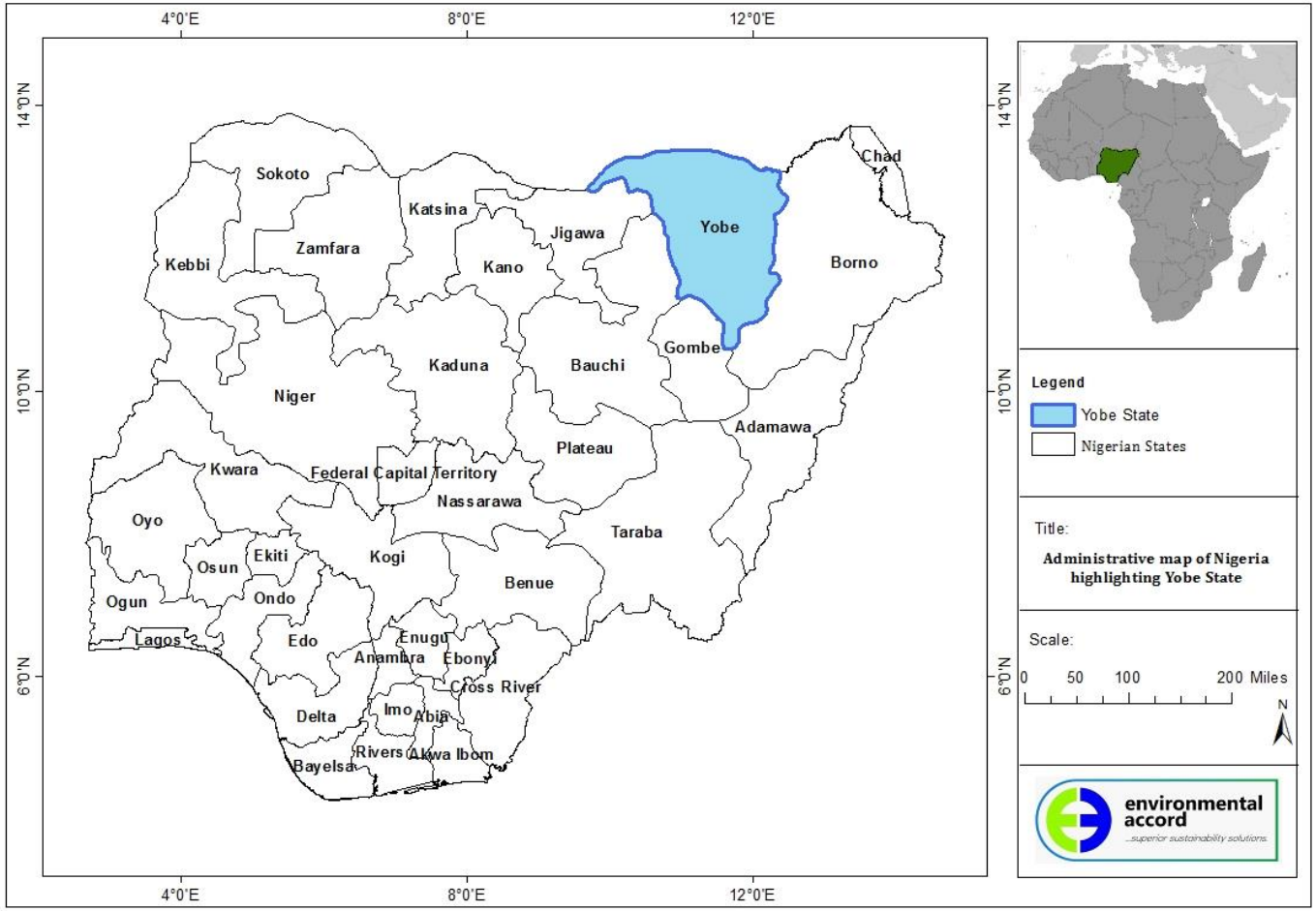


Figure 3.1: Administrative Map of Nigeria highlighting Yobe State
(Source: EnvAccord GIS, 2019)

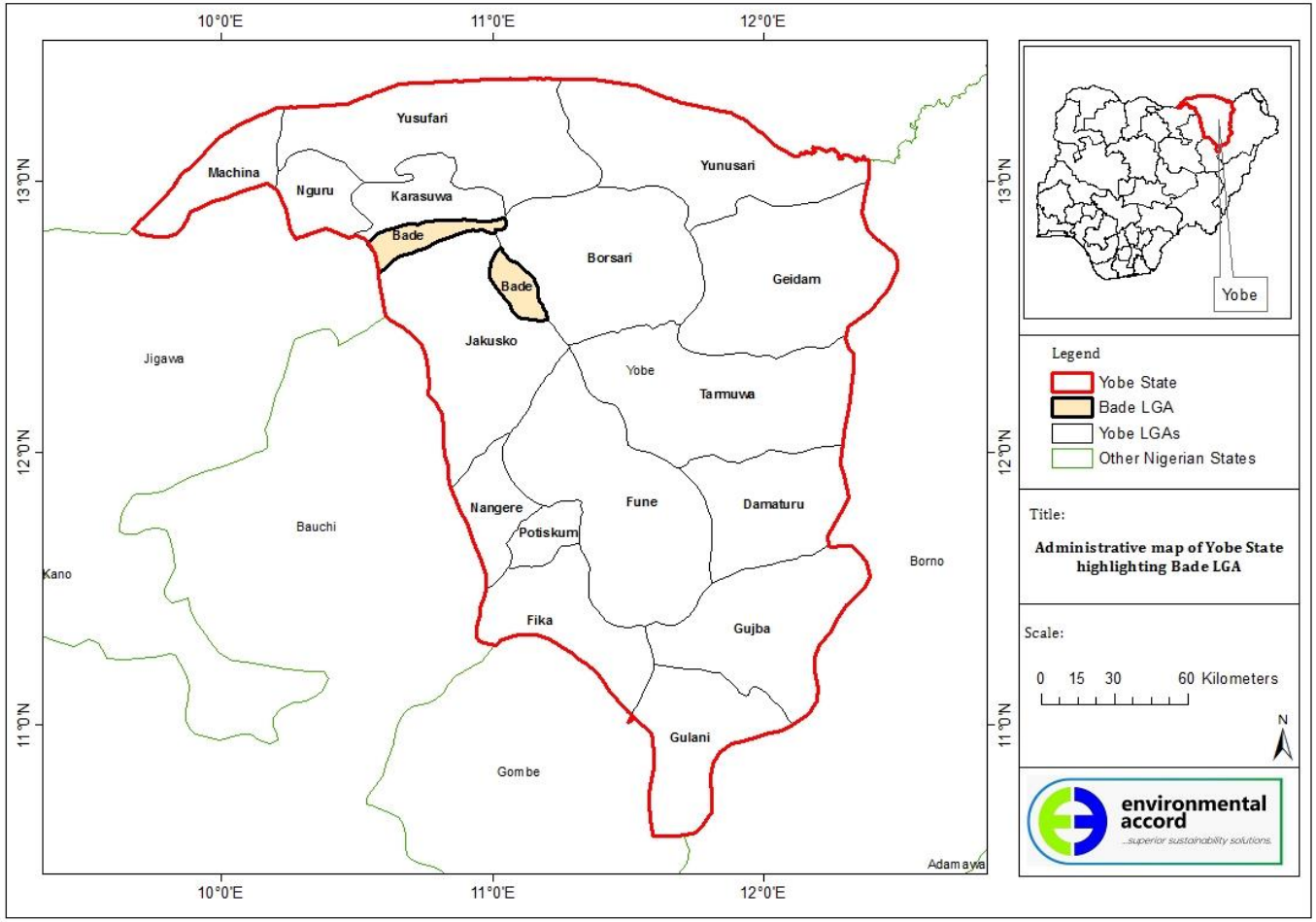


Figure 3.2: Administrative Map of Yobe State highlighting Bade Local Government Area
(Source: EnvAccord GIS, 2019)

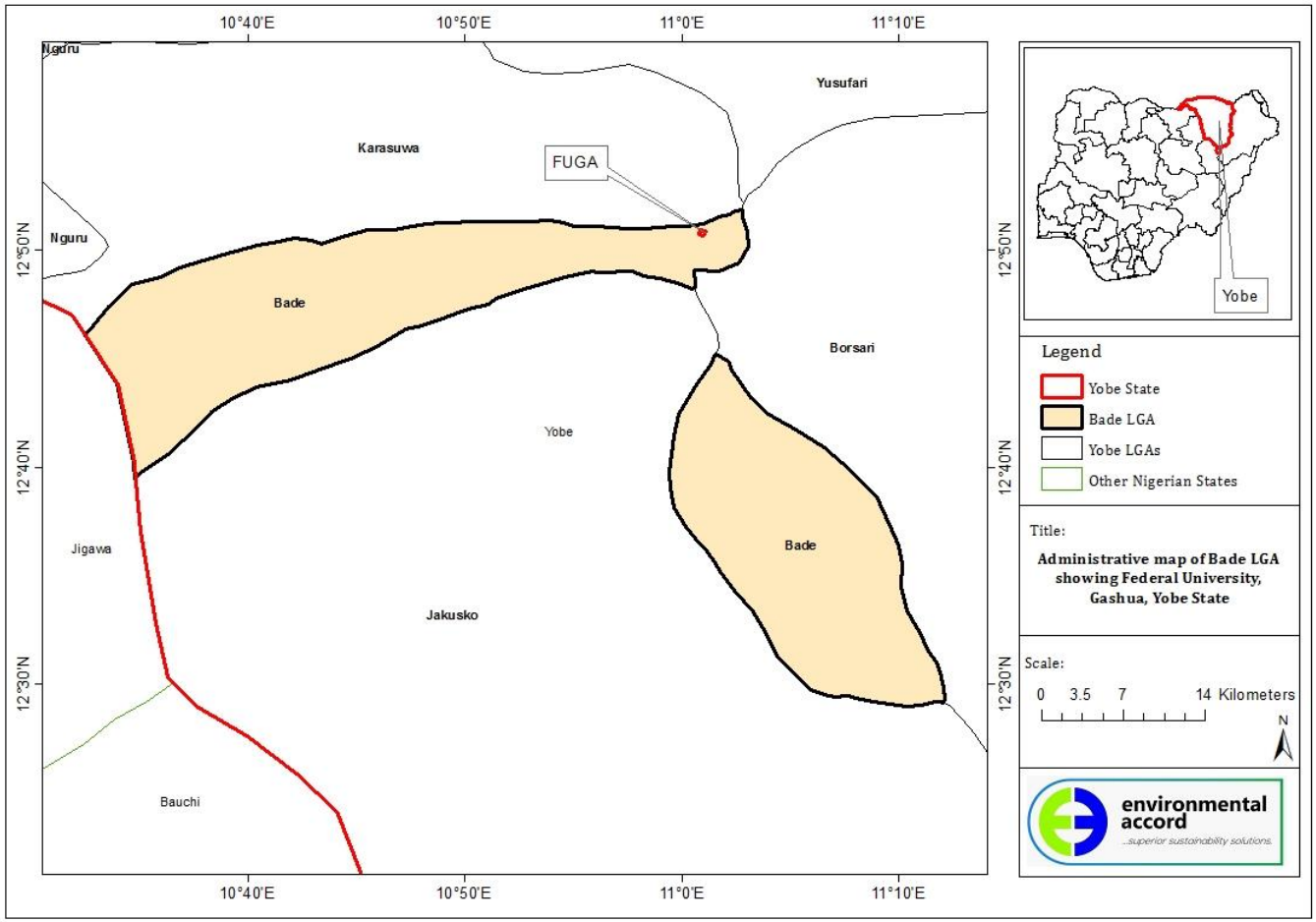


Figure 3.3: The Location of FUGA campus in Bade Local Government Area
(Source: EnvAccord GIS, 2019)

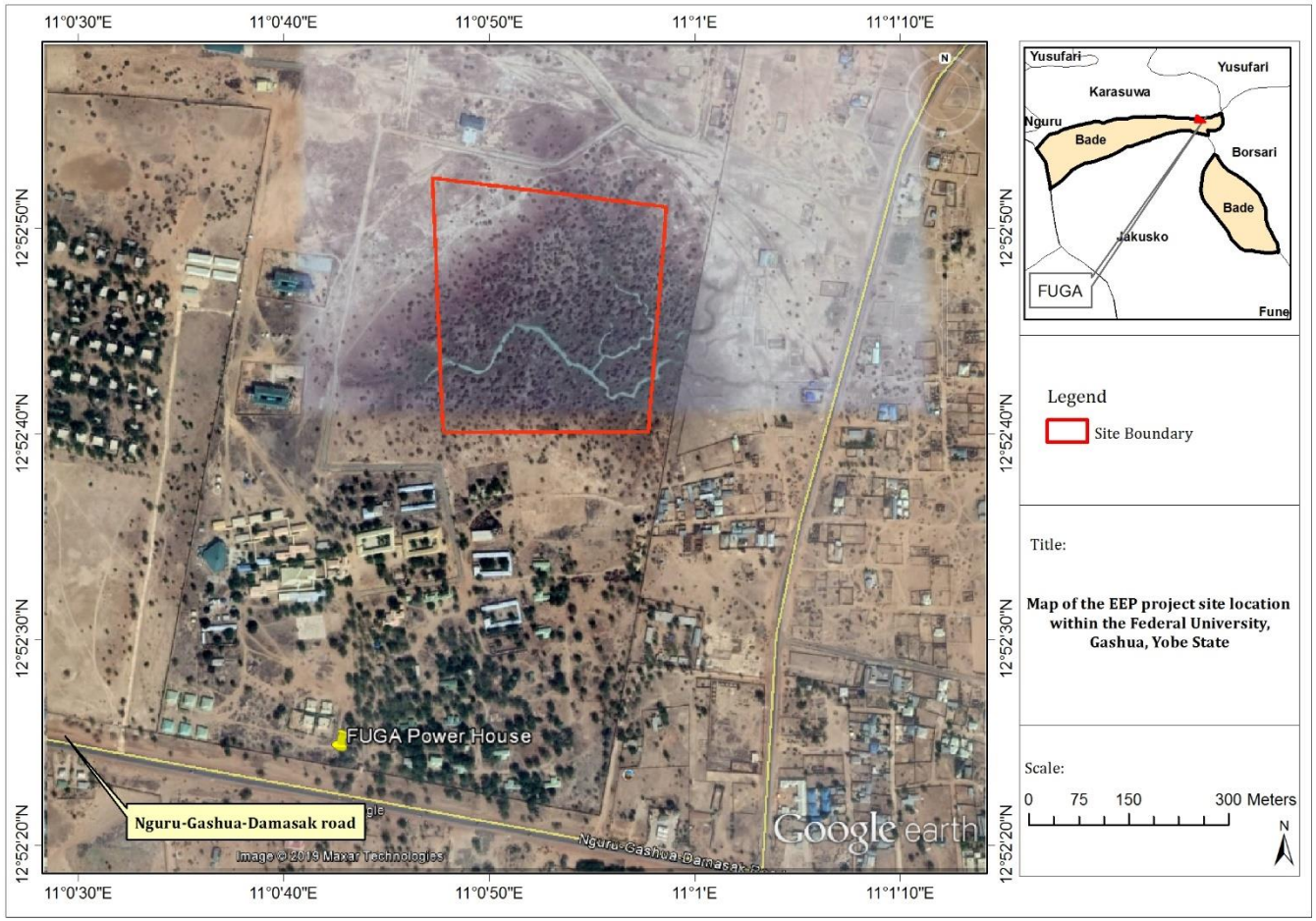
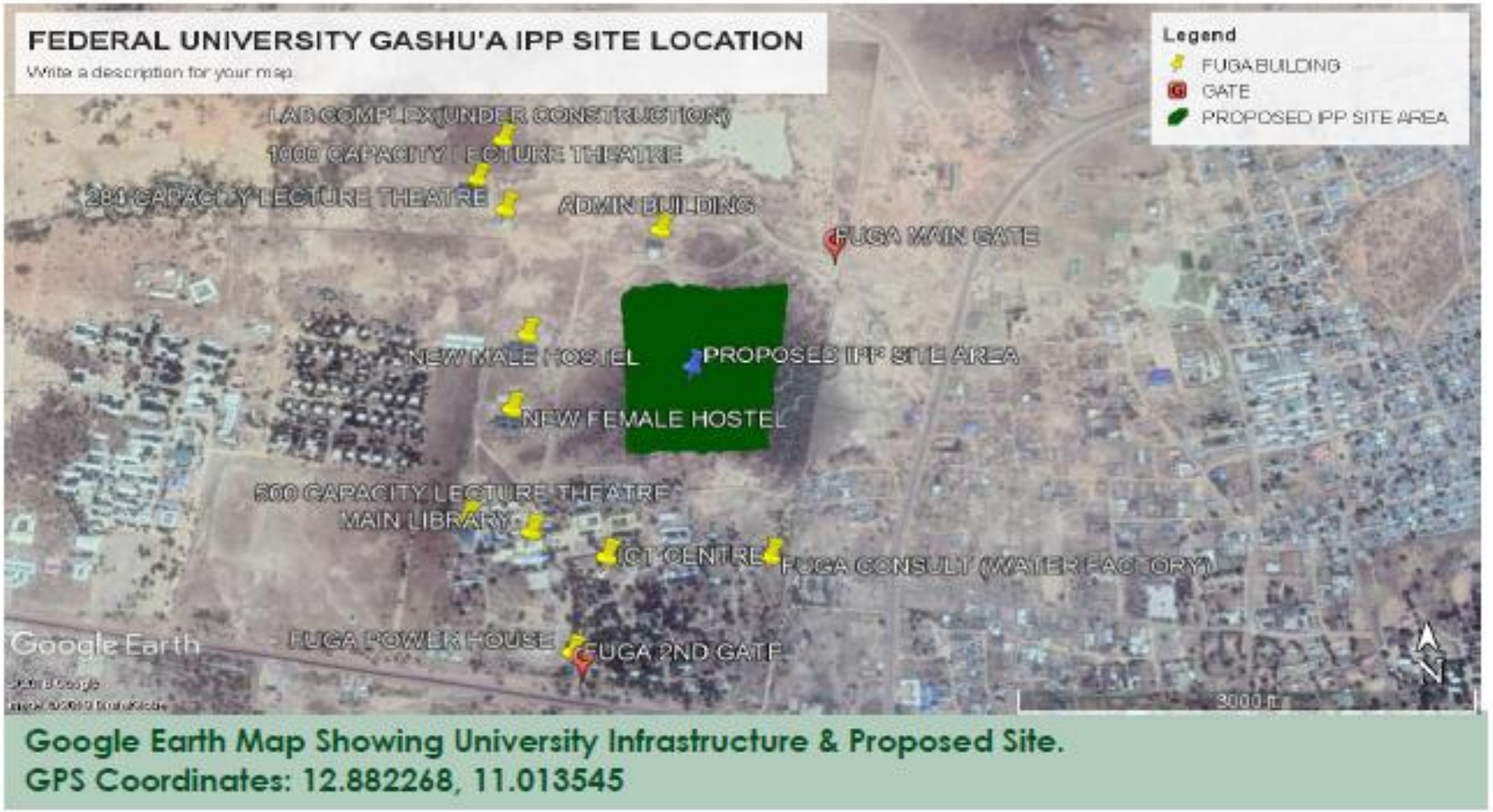


Figure 3.4: Map of the Project site within the FUGA campus
(Source: Google Earth, 2019)



Google Earth Map Showing University Infrastructure & Proposed Site.
GPS Coordinates: 12.882268, 11.013545

Figure 3.5: Aerial imagery of the Project site and the surrounding infrastructure within FUGA campus
(Source: REA energy audit report, 2019)

Plate 3.1: Cross-sectional view of the Project Site within FUGA campus (during the rainy season)
(Source: EnvAccord fieldwork, 2019)

3.3 Project Components

As previously stated, the scope of the EEP includes provision of independent power plant, rehabilitation of existing electricity distribution infrastructure, provision of street lighting as well as a renewable energy training centre. Each of these components as relate to FUGA is discussed below.

3.3.1 Proposed Solar-Hybrid Power Plant

As part of the initial activities, an energy demand audit of FUGA was carried out in April 2019, by REA in conjunction with the NUC. The summary of the audit findings is provided in Table 3.1.

Table 3.1: Summary of Energy Demand Audit for FUGA, April 2019

S/N	Item	Value	Duration/ Remarks
1.	Daily Energy Consumption (Measured) (kWh)	710.36	1 day
2.	Daily Energy Inductive Consumption (Measured) (kVARH, kilovolts amperes reactive hours)	0.04	
3.	Daily Capacitive Energy Consumption (Measured) (kVARH)	0.00	
4.	Daily Peak Power Demand (Measured) (kW)	110.46	10:00am to 12:00pm
5.	Daily Off-Peak Power Demand (Measured) (kW)	13.76	
6.	Daily Energy Consumption (Historical Data) (kWh)	118.03	
7.	Total energy consumed per month from grid supply (kWh)	3,541	
8.	Total capacity of self- generation (kW)	684.00	
9.	Total Number of Diesel Generating (DG) Sets	9	
10.	Estimated hours of grid supply per day (h)	2	
11.	Yearly Energy Consumption (Historical Data) (kWh)	42,490	
12.	Displacement Power Factor (DPF) (%)	0.98	Average from 2 Nos. DG sets of 250kVA (power house) and 100kVA (lecture theatre) powering different sections of the University
13.	Power Factor Total (PFT) (%)	0.98	
14.	Total Harmonic Distortion (THD) (V-N)	1.81	This is an average of the 3 phases from both DG sets
15.	Total Harmonic Distortion (THD) (V-phase)	1.66	
16.	Total Harmonic Distortion (THD) (I-phase)	13.08	
17.	Total Harmonic Distortion (THD) (I-N)	61.78	Average from 2Nos. DG sets of 250kVA (power house) and 100kVA (lecture theatre) powering different sections of the University
18.	Measured Power Demand (kW)	110.46	Same as peak load

S/N	Item	Value	Duration/ Remarks
19.	Estimated Annual Power Demand Growth (%)	-395.03	
20.	Planned Expansion Load for New Building, Hostels etc. (kW)	1,382	
21.	Not connected load that are considered critical with plans for re-activation (kW)	336	
22.	Estimated Power Demand Forecast in 5 Years	1,828	

Source: REA Energy Demand Audit report for FUGA, 2019

Based on the findings of the energy audit, a 2.5 MW solar-hybrid power plant is proposed for FUGA. The proposed power plant will involve the use of PV technology for power generation.

PV technology is a method of generating electricity through the use of solar panels which are composed of a number of solar cells. Such cells convert solar energy (radiation from the sun) into electricity using semiconductors such as silicon. One of the properties of semiconductors that makes them most useful is that their conductivity may be easily modified through the introduction of foreign materials into their crystal lattice, which in turn can lead to improved energy generation.

PV technology is basically comprised of:

PV Cell: This is the basic photovoltaic device which generates electricity when exposed to solar radiation due to its photo-electric effect. The absorbed solar energy excites electrons inside the cells into a higher state of energy, producing electrical energy. PV cells are commonly constructed from mono- or polycrystalline silicon or thin film technology. A number of solar (PV) cells electrically connected to each other and mounted in a single support structure or frame is called a PV panel.

PV panel or module: This is the smallest assembly of interconnected PV cells sold commercially. In the case of crystalline silicon cells, following testing and sorting to match the current and voltage, the cells are interconnected in series and encapsulated between a transparent, anti-reflective front, and a backing material to provide environmental protection to the cells. The panel is then typically mounted in an aluminium frame to provide mechanical strength to the assembly. PV panels are usually designed to supply electricity at a certain voltage, such as a 12 V system. The current produced is directly dependent on the intensity of light reaching the panel. Several PV panels can be wired together to form an array. PV panels and arrays produce Direct Current (DC) electricity.

The most likely PV panels to be used for the proposed power plant in FUGA are of poly-crystalline silicon as discussed in Chapter 2. However, the exact number of the panels is yet to be finalized. Based on the review of similar solar power projects,

about 6,600 PV panels (for example, JKM340PP-72H-V) would be required to generate a power capacity of 2.5 MW.

The PV panels to be installed will have following characteristics:

- All PV panels within a PV string will have equivalent Voc (voltage at open circuit) and Vmpp (voltage at maximum power point) values and will be of same type, with same design, from the same manufacturer.
- All PV strings within a PV sub-array connected in parallel will have similar rated electrical characteristics of open circuit voltage and maximum power voltage, and temperature coefficients.
- All PV panels that are electrically in the same string will have the same orientation (azimuth and tilt angle).
- PV structural components will be corrosion resistant.

Aside the PV panels, the power plant will typically consist of the following associated components:

Mounting structure: The PV panels will be secured on a fixed structure, made up of galvanized steel or aluminium. The majority of leg structures for the frames will be fixed into the earth. Driven piles and/or screwed system will be used and the depth of driven piles is 2 m.

Inverter: An inverter converts the variable DC output of a PV panel into a utility frequency alternating current (AC) that can be used by a local, off-grid electrical network or fed into a commercial electrical grid. Solar inverters are usually designed to have in-built safety features required by PV cells as well as special functions adapted for use with PV arrays, including string current monitoring and anti-islanding protection. The number and specification of inverters to be installed as part of the proposed solar-hybrid power plant is yet to be finalized. The inverters shall however be acquired from the internationally recognized manufacturers such as WSTech, Ingeteam, Gamesa, Jema, Power Electronics, GPTech, and Helios Systems.

Battery: The number and capacity of lithium-ion batteries to be installed as part of the power plant is yet to be finalized. The batteries would be stored and operated under optimum conditions as specified by the manufacturers.

Backup Generators: Diesel-fuelled generating sets (2 – 3 Nos) would be installed at the Project site for recharging the batteries during unfavourable weather conditions (e.g. at the peak of raining season). The capacity of the proposed generators is yet to be finalized. A diesel-storage tank with appropriate bund wall on a concertized floor will also be provided on site.

Power distribution cabinet and synchronization panel: Power from the inverters will be synchronized before it is evacuated to injection station (power house in the University). During plant operation, more than one inverter will be used to convert DC from the PV panels to AC, hence the need for synchronization. Synchronization is the process of matching the speed and frequency of all the operating inverters before the generated power is evacuated. The power from the inverters will be inefficient unless they are running at the same frequency. Therefore, a synchronization panel will be used for matching the speed and frequency of all the inverters installed for the power plant.

Underground cable for power evacuation: The power generated from the proposed plant would be evacuated to the existing power house in the University through an 11 kV underground armoured cable. The distance between the Project site and the existing power house is approximately 600 m. Information on the size of the evacuation cable is not available yet.

Low and medium voltage switchgear cabinets: Power generation and distribution during plant operation involves the use of various types of circuit breakers and surge protectors, which will be enclosed in low and medium voltage switchgear cabinets. The switch gear cabinets to be installed at the plant site will contain a combination of electrical disconnect switches, fuses and circuit breakers. These components will be used to control, protect and isolate power generation and distribution activities during operation. A typical low voltage switchgear cabinet is shown in Plate 3.2.

Plate 3.2: A typical low voltage switchgear cabinet
Source: bowerselec.co.uk/low-voltage-switchgear, 2018

3.3.2 Rehabilitation of Existing Distribution Infrastructure

The energy audit conducted at FUGA indicates that the major power equipment in the University such as transformers, distribution network are in good condition. In addition, there are high level interconnection substations in place with installed distribution capacity of 3,750 kW. Where required, the existing distribution network will be upgraded to accommodate the generated power from the proposed solar-hybrid power plant.

3.3.3 Provision of Street Lighting

Information obtained from the report of energy demand audit conducted in FUGA in April 2019 reveals that the University has 106 streetlights (solar and conventional) covering 8 major roads within the campus. Sample photographs of the streetlights are shown in Plate 3.3. As part of proposed Project, new and additional streetlights will be installed (where required) to ensure that different areas within the University campus are well illuminated.

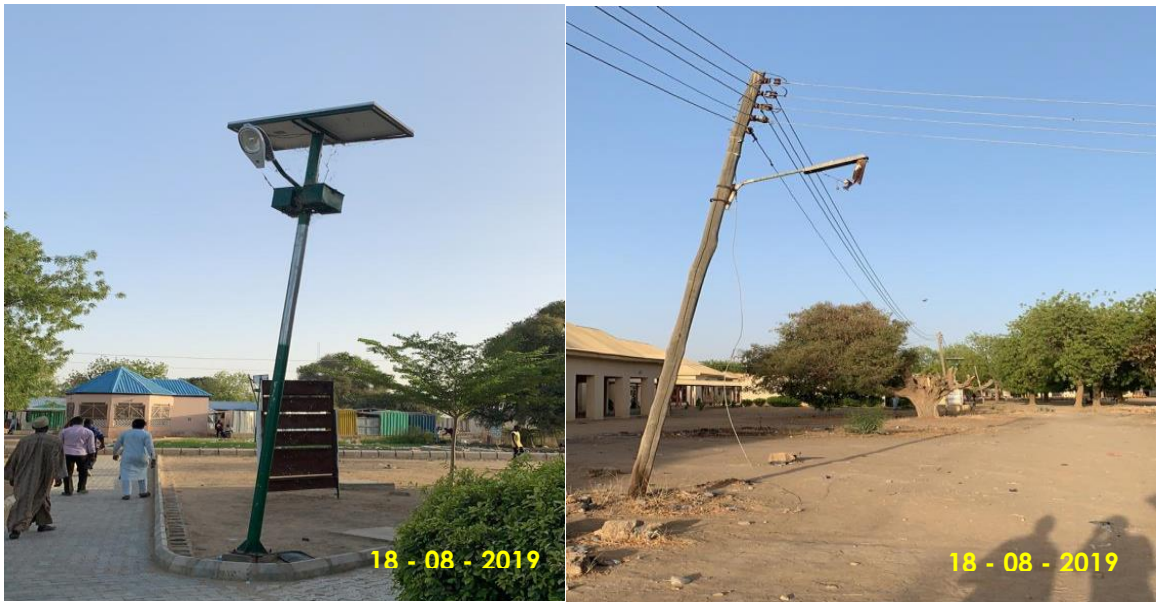


Plate 3.3: Sample of stand-alone and pole-mounted streetlights in FUGA campus

3.3.4 Renewable Energy Training Centre

Students from the University will be allowed to access the Project site for learning and training purposes. Therefore, a renewable energy training centre will be constructed within the 12.5 ha of land earmarked for the entire Project. The training centre will also include storage room, workshop and toilet facilities.

3.4 Engineering Codes and Standards

The Project components shall be designed and installed in compliance with the relevant codes and standards of the British Standard- Europe Norms (BS–EN), the International Electrotechnical Commission (IEC), International Organization for Standardization (ISO) and the Standard Organization of Nigeria (SON). Examples of the relevant codes and standards include ISO 15673:2005 "Guidelines for the simplified design of structural reinforced concrete for buildings" and BS EN 60529:2013 "Degree of Protection by Enclosures (IP Code)", amongst others.

3.5 Project Implementation Phase

3.5.1 Pre-construction Phase Activities

Following the completion of engineering design for the Project and receipt of relevant approvals, the major activities during this phase include site clearing and preparation, and mobilization of equipment, materials and personnel to site. Clearing will involve removal of existing vegetation from the site and preparing a level working surface in readiness for construction activities.

3.5.2 Construction Phase Activities

The construction phase of the Project will include civil, mechanical and electrical works; installation of PV panels and associated plant facilities; construction of a training centre; installation of streetlights as well as underground armoured cable for power evacuation. Also, where required, an upgrade of some of the existing power distribution infrastructure within the University will be carried out.

It is envisaged that approximately 3,000 people would be required for construction activities. These are divided into low skilled workers (e.g. construction labour who will make up the majority of workers), semi-skilled workers (drivers, technicians, etc.), and skilled personnel (e.g. engineers and expatriates). Most of the unskilled and semi-skilled workers would be drawn from the nearby local community (located outside the University campus) to enhance the job opportunities associated with the proposed Project. Moderate level of migrant workers may also be associated with the construction phase activities (potential impacts associated with the migrant workers as well as the proffered mitigation measures are covered in Chapters 5 and 6). No workers camp is planned to be established onsite during construction.

3.5.3 Commissioning Phase Activities

The commissioning phase of the proposed Project will include testing and checking individual equipment /system, as well as the associated infrastructure to ensure they have been installed correctly and can be handed over for use.

3.5.4 Operational Phase Activities

The operational phase of the Project will involve power generation and distribution to various sections of the University as well as the preventative, corrective and predictive maintenance of the power plant and associated facilities. In addition, the training centre will be put into use to enhance learning in renewable energy.

The EPC contractor shall develop standard operating procedures (SOPs) for the operation and maintenance of the solar panels, inverters, batteries, and other associated components of the Project. If need be, the SOPs shall be further reviewed and updated by the O&M contractor during operation. The day-to-day operations of the plant will involve both regular preventive and corrective maintenance carried out by the O&M Contractor in order to keep the power plant in optimal working condition throughout its operating life. The preventive maintenance follows a routine service schedule aimed at preventing faults from occurring and keeping the power plant operating at its optimum level. The frequency of the preventive maintenance would depend on a number of factors such as the technology selected, environmental conditions of the site, warranty terms and seasonal variances. It contains, for example,

activities like PV panel cleaning, inverter servicing, and checks on structural integrity of the mounting structure.

Corrective maintenance will be carried out in response to failures, for example, the repair / exchange of damaged or faulty equipment. Maintenance will consist mostly of panel / battery replacement and other mechanical and electrical infrastructure repairs. Faulty components will be replaced as soon as the problems are identified.

The average life span of the PV power plant is 25 years which can be extended through regular maintenance. Even after the 25 years, the PV panels can still generate up to 90% of the design capacity.

Chapter 8 of this report contains detailed information on the activities associated with the decommissioning of the proposed solar-hybrid power plant and its ancillary facilities (in the event of final decommissioning), including the environmental and social measures to be implemented to address potential impacts of the decommissioning activities.

3.6 Water Use and Supply

One of the key benefits of the power plant (to be provided as part of the proposed Project) in terms of resource use is the generation of electricity using freely available solar energy to produce electricity, reducing the dependence on fossil fuels; thus, reducing carbon emission.

The use of water for construction activities will be minimal because construction works requiring cement mixing will be few on site. Water is required majorly during the operational phase of the power plant for periodic cleaning of PV panels to prevent dust build-up (especially during the dry season), since dust can affect their performance by inhibiting the amount of irradiation that reaches the solar cells. The rate of build-up of dust on the PV panels is dependent on a number of factors including soil type, local wind speed and the mounting structure used for the panels.

Manual cleaning of the PV panels with water shall be regulated as much as practicable. During the periods of rainy season (usually from May to October in Yobe State), direct cleaning of the PV panels is estimated to occur not more than three times. However, during the dry season (November to April), the frequency of cleaning will depend on the rate of dust accumulation, and it is envisaged to be more than three times due to high dust generation usually experienced in the Northern part of the country.

Based on the review of similar solar power projects, each PV panel would require approximately 5 litres of water per cleaning cycle. The water required for the cleaning purpose would be obtained from the borehole that will be installed within the Project site. Based on observations noted during the field survey and the estimated quantity of water required for occasional cleaning of the PV panels, water abstraction for the Project is not envisaged to have significant effect on the existing groundwater aquifer of the Project area as well as the local water use. The recharge of the existing boreholes in the study area is largely due to direct precipitation. During the rainy season, the water reserve of the aquifer in the study area increases; thus hand dug wells and boreholes yields improve significantly.

3.7 Health and Safety

The EPC Contractor shall engage dedicated personnel competent on the basis of appropriate education, training, and experience to manage and oversee the Health, Safety and Environment (HSE) aspects of the Project. The HSE personnel shall ensure that the Project and subcontractors operate in accordance with the applicable regulatory HSE requirements and plans; and also monitor implementation of environmental and social protection measures.

Occupational health and safety (OHS) plans shall be developed and maintained by all contractors involved in the implementation of the proposed Project. The contractors shall provide OHS training that may include hazard awareness, safe work practices and emergency preparedness to their workers to ensure they are appraised to project sites rules of work, personal protection and preventing injury to fellow workers. Worker activities will be managed through appropriate planning and the application of Permit-to-Work system, Job Hazard/Safety Analysis, Personal Protective Equipment (PPE) requirements and other safety based protocols.

Also, all contractors, as a component of their contracts, will implement HSE plans which will outline procedures for avoiding health and safety incidents and for emergency medical treatment. Contractors will be required to carry our regular safety inspections to ensure measures to manage potential OHS hazards are implemented.

For example, during the construction phase, a Health and Safety (H&S) risk assessment based approach will be taken to manage H&S risks to workers. This would involve assessing all the various risks that are involved in each aspect of the job and educating workers on how to manage these risks. The people working around the Project area shall also be warned of the risk involved i.e. warning signs shall be erected for people to see clearly. In addition, First aid equipment and PPEs for workforce will be provided onsite throughout the construction activities.

All staff, workmen, supplier and sub-contractor working on site shall be informed on the need to ensure their safety and the safety of the people working around them. Every worker will be instructed to always put on PPE whilst on site. Appropriate warning signs will be erected and checked each day. Daily health and safety tool-box meetings among workforce will be ensured. The safety briefings will be led by the onsite HSE officers. Smoking, use of alcohol or hard drugs will be strictly forbidden.

3.8 Waste Management

This section discusses the waste streams associated with the proposed Project and the intended management plan.

3.8.1 Overview

It is the goal of REA that the proposed Project is designed, developed and operated in a sustainable manner. Thus, effective waste management practices that comply with the relevant local requirements and international best practices shall be implemented during all phases of the proposed Project. To achieve this, all contractors engaged during the lifecycle of the Project will put in place and comply with a site waste management plan.

Waste management principles shall be based on an integrated approach which involves a combination of techniques and programs to manage waste. Source reduction is at the top of the approach, followed by reuse and recycling as preferred options to disposal.

Generally, wastes associated with the proposed Project shall be managed using the following prioritized program:

- **Reduction at Source** – The elimination or minimization of waste generation through equipment modifications and installation of pollution abatement equipment.
- **Reuse** – Using an item for its original purpose, or similar purpose, in its original form. Wastes generated from one operation shall be put to use in other operations where they are found useful without compromising standards and safety.
- **Recycling** – conversion of waste materials into reusable objects. This will involve using FMEnv/NESREA approved companies involved in recycling business using best available technology that meet international standards.
- **Residue Disposal** – disposal of wastes in a Government-approved dumpsite.

3.8.2 Associated Waste Streams

The waste streams associated with the proposed Project are discussed as follows:

Pre-construction Phase

The waste streams associated with the pre-construction phase of the Project include cleared vegetation (during site preparation), food waste, and general rubbish. The cleared vegetation (mostly grasses) will be removed from the site and allow to biodegrade at a portion of the site while wood from felled trees will be made available to the local community. The general rubbish will be collected within the Project site and disposed of at a government-approved dumpsite through a third party waste contractor accredited by the Yobe State Environmental Protection Agency (YOSEPA).

Construction Phase

The planned activities during the construction phase include civil, mechanical and electrical works and installation of PV panels and associated components which will be carried out by a number of construction workers. The waste streams associated with the construction activities include excavated soil, general refuse, garbage, inert construction materials, metal scraps, concrete waste, food waste, and used packaging materials. In line with the NEP ESMF, the EPC Contractor shall put in place and comply with a site waste management plan. The plan shall be developed to address all waste streams associated with the construction activities and comply with relevant regulations. The contractor shall comply with the national requirements and building rules on storage of construction materials.

Furthermore, all concrete mixing will be undertaken on impermeable plastic lining to prevent contamination of the surrounding areas. Scrap metals generated during the construction phase will be collected for recycling in blue coloured waste receptacles for non-hazardous wastes. Excavated soil generated during the foundation work will be arranged according to the various soil layers for reuse as backfill during landscaping and site rehabilitation.

All electronic equipment shall be supplied by credible manufacturers to reduce the risk of generating wastes from faulty equipment. All damaged PV panels generated during the installation activities shall be collected in a dedicated container and returned to the manufacturer outside the country for proper recycling since there is currently no recycling facility in Nigeria that handles PV panels.

Litter collection facilities shall be provided and all solid waste materials that are not identified for reuse or recycling will be placed in appropriate on-site storage containers (black-coloured waste receptacles for food waste, blue-coded bins for paper, and yellow-coded bins for general rubbish) and periodically disposed of (at least once a

week throughout the construction period or on the need basis depending on the volume of the waste) at a government-approved dumpsite through a third party waste contractor approved by YOSEPA. It is estimated that approximately 0.225 m^3 of construction debris will be produced per week.

Hazardous wastes that could be generated during the construction activities include used oil rags, and spent filters from onsite diesel generator for power source during construction. Hazardous wastes shall be stored in a manner that prevents the commingling or contact between incompatible wastes, and stored in properly labelled, closed containers prior to evacuation by a third party waste contractor approved by YOSEPA for treatment and disposal.

Operational Phase

Solid wastes generated during the operational phase of the Project will be incorporated into the existing FUGA waste management approach (there is a dedicated site within the University environment where solid wastes are collected for disposal). Approximately 2.25 cm^3 of solid waste (e.g. paper waste, food packaging, etc.) is estimated to be generated per week during the operational phase.

In line with NEP ESMF, the University shall be encouraged to prepare e-waste management plans that account for safe end-of-life disposal of equipment from the solar-hybrid power plant. The Extended Producer Responsibility program (EPR) will be implemented for solar panels, inverters, batteries and other electrical components to be installed for the Project. Damaged or discarded PV panels and inverters will be collected and sent to the manufacturer for recycling in line with the EPR model. Spent, damaged or expired batteries will also be returned to the manufacturer for recycling. Alternatively, the spent batteries will be recycled by local and accredited battery recycling companies in Nigeria. These batteries shall be stored in red coloured waste receptacles before they are transported to the accredited battery recycling companies. The quantity of waste batteries generated typically depends on a number of factors such as type, capacity and number of batteries installed and depth of discharge.

Storm water will be managed through a combination of open trenches and ditches. Storm water shall drain away to the natural environment via gravity. Paved and concreted areas will be sloped to allow for proper drainage.

Sanitary wastes (sewage) generated during the facility operation shall be channelled to a septic tank to be installed onsite. The septic tank shall be of reinforced concrete and will be located away from any groundwater source. As at when due, the contents of the septic shall be evacuated by an accredited waste contractor for treatment at a sewage treatment plant approved by YOSEPA.

Decommissioning

The waste streams associated with the decommissioning phase of the Project would be similar to the construction waste. These will include refuse, e-waste, general rubbish and demolition debris. The University shall also be encouraged to prepare e-waste management plan that account for safe end-of-life disposal of equipment from solar installations. Wastes will be segregated onsite, and non-reusable / recyclable wastes will be disposed of through an accredited third party waste contractor.

The summary of wastes stream associated with the Project is provided in Table 3.2.

Table 3.2: Summary of Wastes Stream associated with the proposed Project and Handling Techniques

Waste Stream	Sources	Waste Generation Phase Construction (C), Operation (O), Decommissioning (D)	Handling Techniques
General rubbish, refuse, and putrescible wastes (food wastes)	Wood splinter, domestic waste, food packs, used bottles	C, O, D	On-site waste segregation; disposal of non-reusable waste through a third party waste contractor approved by Yobe State Environmental Protection Agency (YOSEPA).
Cleared vegetation	During site clearing and preparation	C	Composting, collection for biomass fuel
Scrap metals	Used tubular and casings, used iron rods	C, O, D	Scrap metals will be collected for recycling
Excavated materials	Foundation works	C, D	Excavated materials generated during foundation works will be used for back-filling. Excess excavated spoil will be stockpiled and reused as part of materials for construction of plant buildings.
Damaged/expired PV panels	PV modules	C, O, D	Return to the manufacturer for recycling using the EPR model
Expired inverters	Electrical installation	O, D	Return to the manufacturer for recycling using the EPR model
Damaged/expired Batteries	Power generation	O, D	Return to the manufacturer for recycling using the EPR model
Sanitary waste	Training centre	C, O, D	Periodic evacuation of content of the septic tank by YOSEPA accredited third party waste contractor.

3.9 Project Schedule

The proposed Project is planned to be operational by the fourth quarter (Q4) of 2021. The tentative Project schedule is provided in Table 3.3.

Table 3.3: Tentative Project Schedule

Project Schedule	Timeline											
	2019				2020				2021			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Site allocation												
Energy demand audit												
Front-End Engineering Design												
ESIA study and Approval												
Selection of EPC Contractor and contract signing												
Civil, electrical, and mechanical design												
Procurement (manufacturing and transportation)												
Preconstruction and construction Phase Activities												
Commissioning												
Commencement of operation												

CHAPTER FOUR:

DESCRIPTION OF THE ENVIRONMENT

CHAPTER FOUR

DESCRIPTION OF THE ENVIRONMENT

4.1 Introduction

This chapter provides a description of the existing environmental and socio-economic conditions of the Project's area of influence, which covers the Project site and its surrounding environment up to 2 km, including the area where the cumulative impacts of the Project may be experienced.

Data and information for the environmental description of the Project area were based on field data gathering (primary data) as well as review of relevant literature (secondary data).

The field sampling was carried out from August 15 to 17, 2019 (wet season) by different specialists. Based on the consideration of the potential environmental and social footprints of the proposed Project, the observations noted during the preliminary visit to the Project site as well as the need to ensure that all the sensitive receptors that could be potentially affected by the proposed Project have been captured, a 1 km radius from the centre of the Project site was selected as the spatial boundary for biophysical sampling while the socio-economic survey was extended to approximately 2 km radius from the centre of the Project site, as illustrated in Figure 4.1.

The environmental components of the Project area described in this chapter cover the following:

- Climate and meteorology;
- Geology and hydrogeology;
- Air quality and noise;
- Groundwater;
- Surface water;
- Soil;
- Terrestrial flora;
- Terrestrial fauna;
- Land use;
- Socio-economic and health.

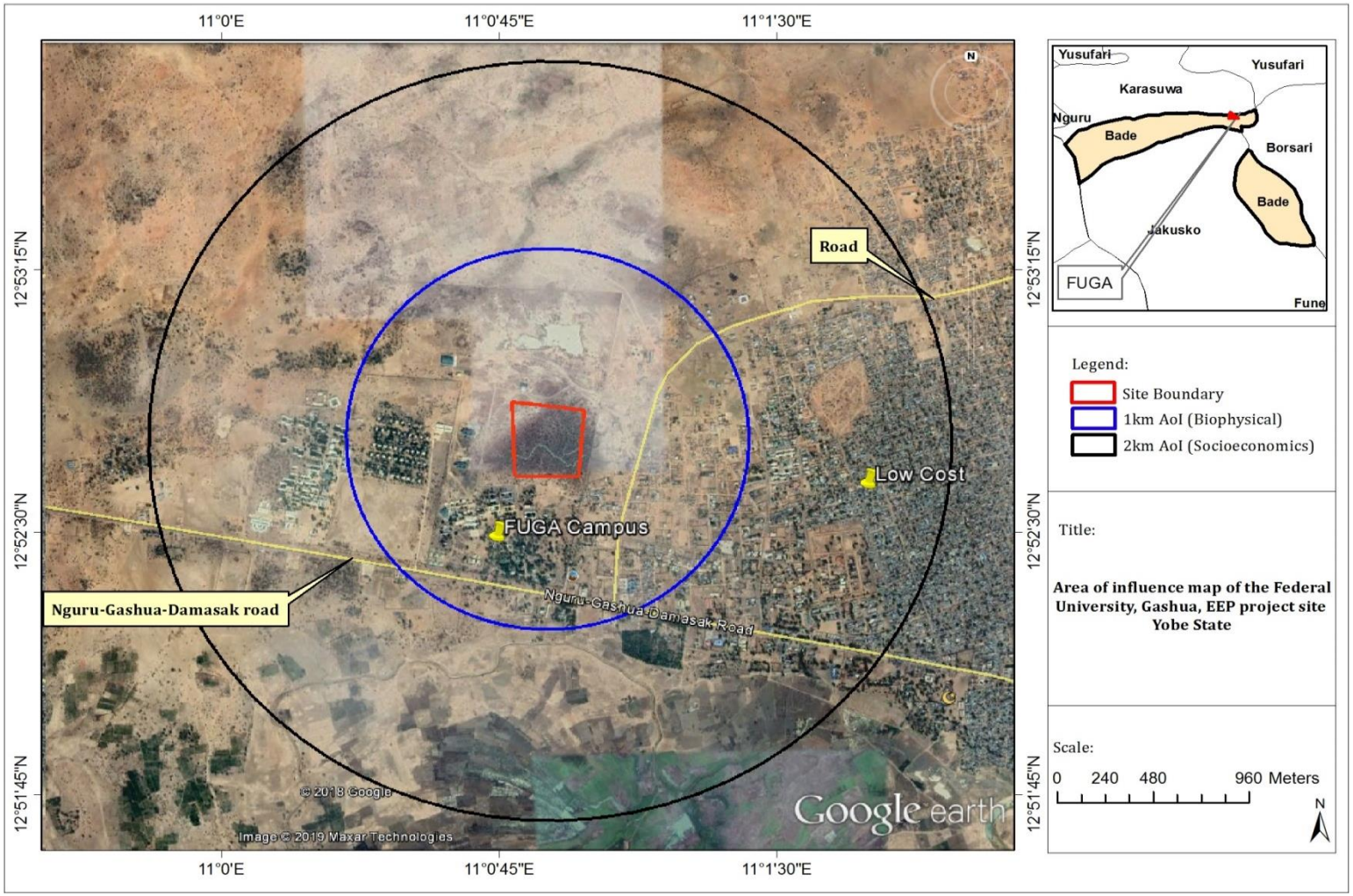


Figure 4.1: Aerial imagery of the Project's Area of Influence for biophysical and socio-economic survey
Source: EnvAccord Field Survey, 2019

4.2 Baseline Data Collection

Baseline data acquisition exercise involved a multi-disciplinary approach and was executed within the framework of Quality Health, Safety, and Environment (QHSE) management system. This approach assured that the required data and samples were collected in accordance with the approved scientific and regulatory requirements using appropriate equipment, materials and personnel.

The study approach includes the following:

- Desktop review of existing materials relevant to the Project environment;
- Designing and development of field sampling strategies to meet the scope of the ESIA study and regulatory requirements;
- Pre-mobilization activities (including calibration/pre-testing of field equipment, review of work plan with team members);
- Mobilization to site for fieldwork sampling (sample collection, in-situ measurements, sample handling, documentation, and storage);
- Demobilization from field; and
- Transfer of field samples to the laboratory for analysis.

4.2.1 Desktop Studies/Literature Review

Desktop studies involved the acquisition of relevant background information on the biophysical and socio-economic environment of the Project area. Information was sourced from the relevant government authorities including the Nigerian Meteorological Agency (NiMet), the National Bureau of Statistics (NBS) and the Federal Ministry of Environment (FMEnv). Other sources of information employed include online publications, textbooks, articles etc.

4.2.2 Field Sampling and Laboratory Analysis

4.2.2.1 Field Sampling

In order to effectively characterise the environment of the Project area, field sampling was conducted from August 15 to 17, 2019. The objective of the field survey was to obtain the baseline data of the Project's area of influence and describe its environmental and social context. Sampling locations were identified using recent satellite imagery of the Project area. The basis of the sampling design was informed by a preliminary characterization of the Project area through desktop research and nearby sensitive receptors.

Sampling locations for biophysical components were randomly selected to cover as much as possible the land area for the proposed Project as well as the surrounding environment, while the socio-economic survey focused on the potentially affected community (Low-Cost Community) identified within the Project's area of influence. All sampling locations were geo-referenced using Garmin Map-62 series Global Positioning System (GPS) handsets.

Plate 4.1 shows sample photographs of field sampling activities in the Project's AoI.

Plate 4.1: Sample Photographs of Field Sampling Activities in the Project's Area of Influence: A- Noise/Air sampling, B- Soil sampling, C- Focus Group Discussion with male youths at Low-Cost Community, D- Groundwater sampling, E- Surface water sampling **Source: EnvAccord Field Survey, 2019**

Quality assurance and quality control measures consistent with the relevant local and international guidelines and standards were implemented during the field sampling. These measures include, amongst others:

- In-situ measurements of parameters with short holding time in water samples immediately after collection.
- Proper calibration of all portable meters used for in-situ measurements.
- Separate samples were collected for parameters requiring different treatment/preservation before analysis.
- Field samples were adequately preserved and labelled.
- The chemical reagents used for sample preservation were adequately labelled to avoid mix-up.

The summary of sample management program put in place to safeguard the integrity of the field samples collected during the baseline data gathering is provided in Figure 4.2.

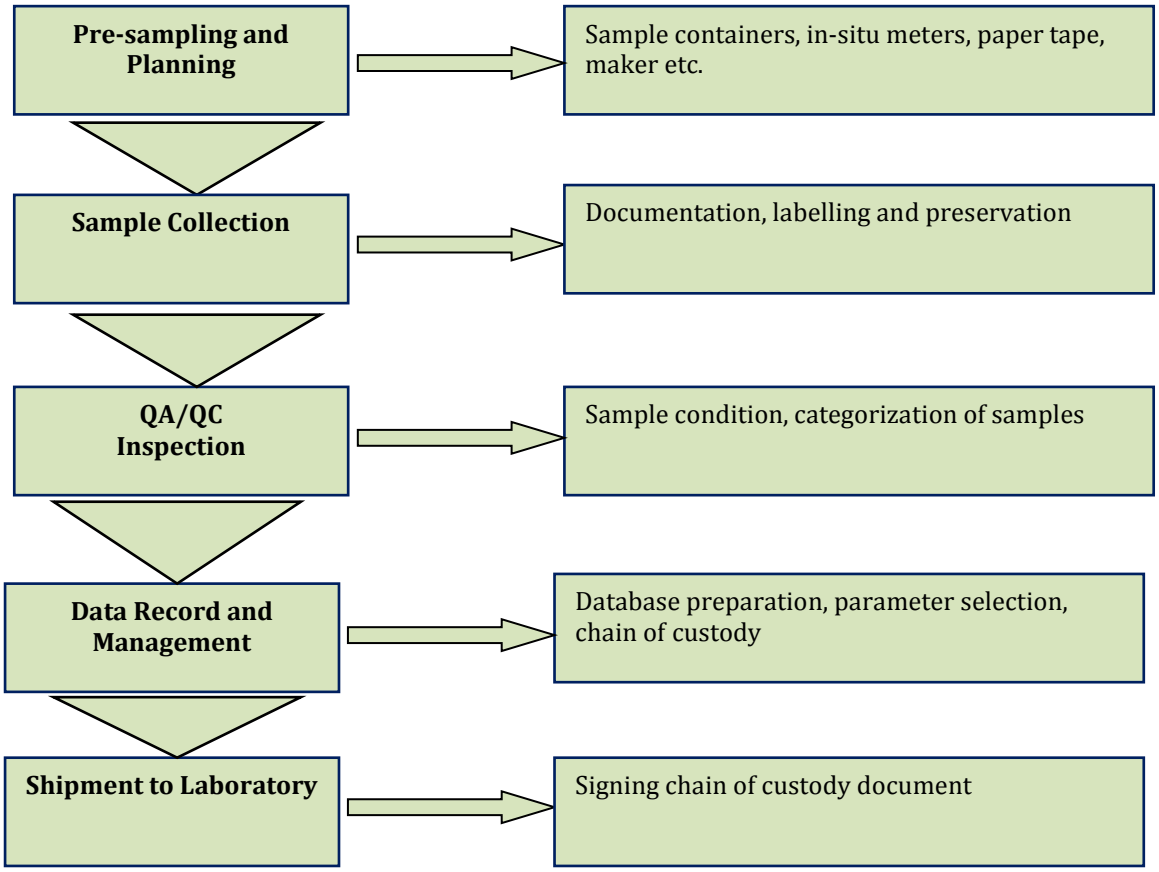


Figure 4.2: Management program employed for field sampling
Source: EnvAccord Field Survey, 2019

4.2.2.2 Laboratory Analysis of Field Samples

Field samples collected during the baseline survey were conveyed to the laboratory for analysis, along with the completed chain of custody forms. The samples were preserved with appropriate reagents (such as nitric acid and sulphuric acid), and the recommended temperature of 4^0C for the samples was maintained in-transit with the use of ice-chest and ice chips in different insulating containers.

The field samples were analysed for physico-chemical and microbial parameters at EnvAccord Laboratory located at 13 Alabi Street off Oguntona Crescent Gbagada Phase 1, Lagos. The Laboratory is accredited by the FMEnvand other relevant regulatory agencies.

The laboratory analyses were undertaken in consistent with the approved standard methodologies such as those recommended by the American Society for Testing and Materials (ASTM) International, the American Public Health Association (APHA) and the FMEnv. The summary of analytical methods employed is presented in Table 4.1.

Table 4.1: Analytical methods employed for field sample analysis

S/N	Parameters	Analytical Methods	Units	
			Water sample	Soil sample
1.	Total Suspended Solids	Gravimetric method	mg/l	-
2.	Biological Oxygen Demand	Dilution method	mg/l	-
3.	Chemical Oxygen Demand	Closed Reflux dichromate method	mg/l	-
4.	Oil and Grease	N-Hexane Extraction Method	mg/l	mg/kg
5.	Alkalinity	Titration method	mg/l	-
6.	Total Hardness	EDTA/Titration method	mg/l	-
7.	Nitrate	Spectrophotometric method	mg/l	mg/kg
8.	Sulphate	Spectrophotometric method	mg/l	mg/kg
9.	Phosphate	Spectrophotometric method	mg/l	mg/kg
10.	Nitrite	UV/VIS Spectrophotometry	mg/l	mg/kg
11.	Sodium	Flame photometric method	mg/l	mg/kg
12.	Potassium	Flame photometric method	mg/l	mg/kg
13.	Calcium	Titration with ethylenediamine tetra-acetic acid method	mg/l	mg/kg
14.	Magnesium	Titration with EDTA method	mg/l	mg/kg
15.	Lead	Atomic Absorption Spectrophotometry	mg/l	mg/kg
16.	Nickel	Atomic Absorption Spectrophotometry	mg/l	mg/kg
17.	Cadmium	Atomic Absorption Spectrophotometry	mg/l	mg/kg
18.	Zinc	Atomic Absorption Spectrophotometry	mg/l	mg/kg
19.	Copper	Atomic Absorption Spectrophotometry	mg/l	mg/kg
20.	Chromium	Atomic Absorption Spectrophotometry	mg/l	mg/kg
21.	Manganese	Atomic Absorption Spectrophotometry	mg/l	mg/kg
22.	Total Iron	Atomic Absorption Spectrophotometry	mg/l	mg/kg
23.	Mercury	Cold Vapour Atomic Absorption Spectrophotometry	mg/l	mg/kg

Source: EnvAccord Field Survey, 2019

4.3 Description of Biophysical Environment of the Study Area

4.3.1 Climate and Meteorology

Yobe State is located in the hot, dry tropical climate zone of North-east, Nigeria. The climate in the area is tropical with alternating wet and dry seasons and it is strongly influenced by Inter-Tropical Convergence Zone (ITCZ) weather patterns. Maritime tropical air masses, characterized by warm, humid south-westerly winds and the continental air mass, characterized by hot, dry north-easterly winds, converge in the

ITCZ. The alternating wet season and dry season phenomenon is determined by the north-south oscillation of air masses in the ITCZ.

Movement of these air masses results in two (2) main seasons; a wet season from May to October, and a dry season from November to April. During the dry season, there are periods when the harmattan (a period characterized by dry dusty winds and relatively low temperatures) is experienced.

In this section of the report, the dominant climatic elements and factors within the regional Project area are discussed. These include rainfall, ambient temperature, relative humidity, sunshine, wind speed and wind direction. Information on the climatic data of the Project area is sourced from the Nigerian Meteorological Agency (NiMet) and it spans from 1991 to 2017.

Table 4.2 summarizes the monthly mean climatic characteristics of the Project area from 1991 to 2017.

Table 4.2: Monthly Mean Climatic Characteristics of the Project Area (1991-2017)

Month	Temperature (^{0}C)		Rainfall (mm)	Humidity (%)		Sunshine Hours	Wind Speed (m/s)
	Min.	Max.	Mean	09:00Hr	15:00Hr		
January	29.29	14.25	0	24.41	16.56	7.92	8.87
February	32.57	16.93	0.3	19.89	14.26	7.93	9.74
March	36.57	21.10	0.17	22.63	17.11	7.20	9.38
April	39.22	24.35	37.63	36.93	24.59	7.52	9.66
May	38.04	24.74	75.1	52.41	37.11	8.10	10.16
June	34.67	23.34	176.91	66.22	49.78	8.01	10.58
July	31.68	21.80	299.30	76.19	60.19	6.95	9.44
August	30.46	22.97	358.1	79.67	63.37	6.95	8.40
September	32.13	21.61	164.49	71.37	52.85	7.38	7.90
October	34.02	20.91	16.21	48.22	33.33	7.77	7.04
November	33.18	16.88	0.03	26.19	19.48	8.59	6.97
December	29.18	14.11	0	26.44	19.52	8.03	8.56
Total			1128.24				
Min	33.42	20.25	94.02	45.88	34.01	7.70	8.89
Max.	29.18	14.11	0	19.89	14.26	6.95	6.97
Mean	39.22	24.74	358.1	79.67	63.37	8.59	10.58

Source: NiMet, 2018

i) Rainfall

Overall, a total of about 1128.24mm of rain is recorded annually as shown in Table 4.2. This gives an average of 94.02mm per month. The minimum rainfall amount (0 mm) is received in the months of January and December while the maximum rainfall amount (358.1mm) is received in the month of August (Figure 4.3).

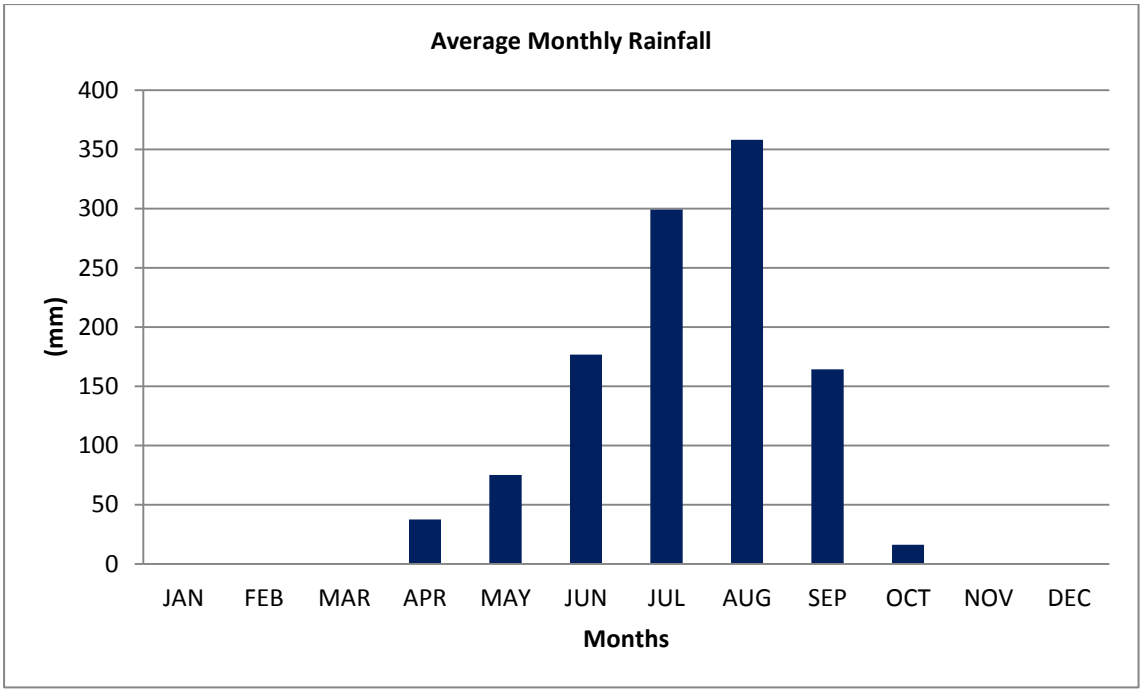


Figure 4.3: Average rainfall characteristics of the Project area (1991- 2017)
Source: NiMet, 2018

ii) Ambient Temperature

Temperature of the Project area is relatively high and stable all over the year. The overall annual average daily temperature is 33.42 ^{O}C (Table 4.2). Figure 4.4 shows the temperature characteristics of the Project area.

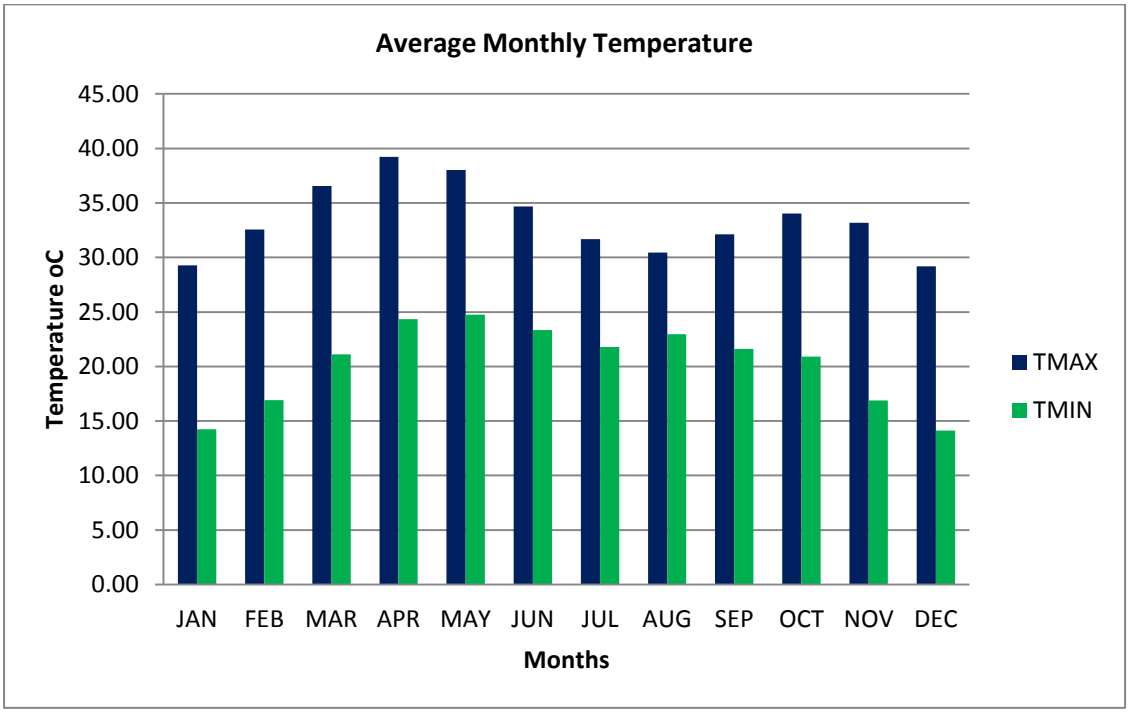


Figure 4.4: Monthly Mean Temperature Characteristics of the Project Area (1991-2017) **Source: NiMet, 2018**

iii) Relative Humidity

The Project area is characterized by very low relative humidity as a result of the prevailing dry north-east trade winds blowing over the area almost all the year round. Overall, the month of February recorded values of 19.89 % and 14.26 % which were the lowest relative humidity recorded over 9:00 hrs and 15:00 hrs period while 79.67 % and 63.37 % were the highest values recorded over the 9:00 hrs and 15:00 hrs period respectively in the month of August (Figure 4.5).

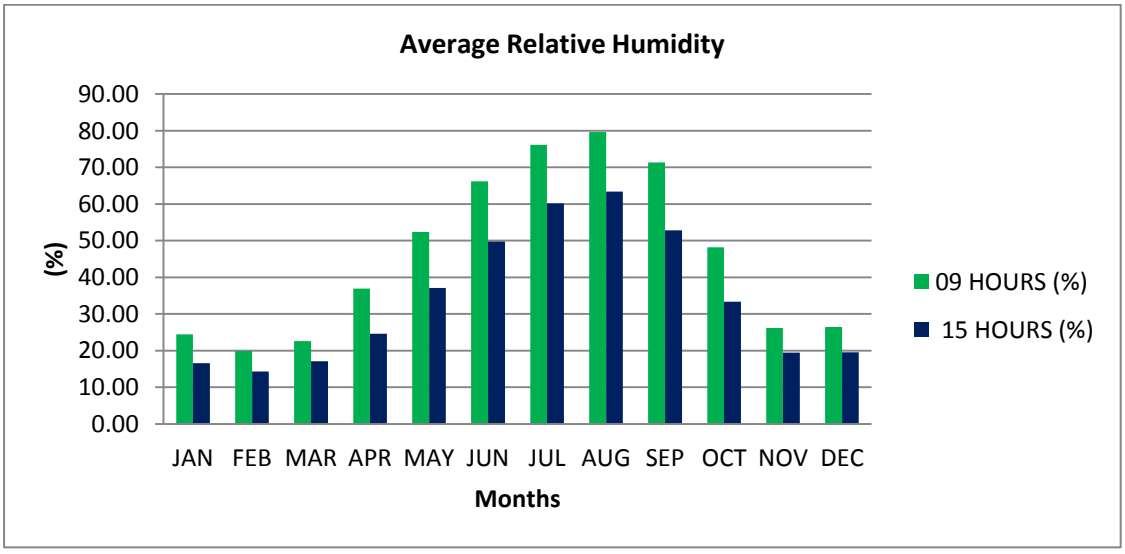


Figure 4.5: Monthly Relative Humidity Characteristics of the Project Area (1991-2017) **Source: NiMet, 2018**

iv) Wind Speed

Seasonal observations revealed appreciable variability. Wind speed variability is more pronounced from May to June when speeds could exceed an average of 10.16 m/s. The intensity is lowest in November with 6.97 m/s (Figure 4.6).

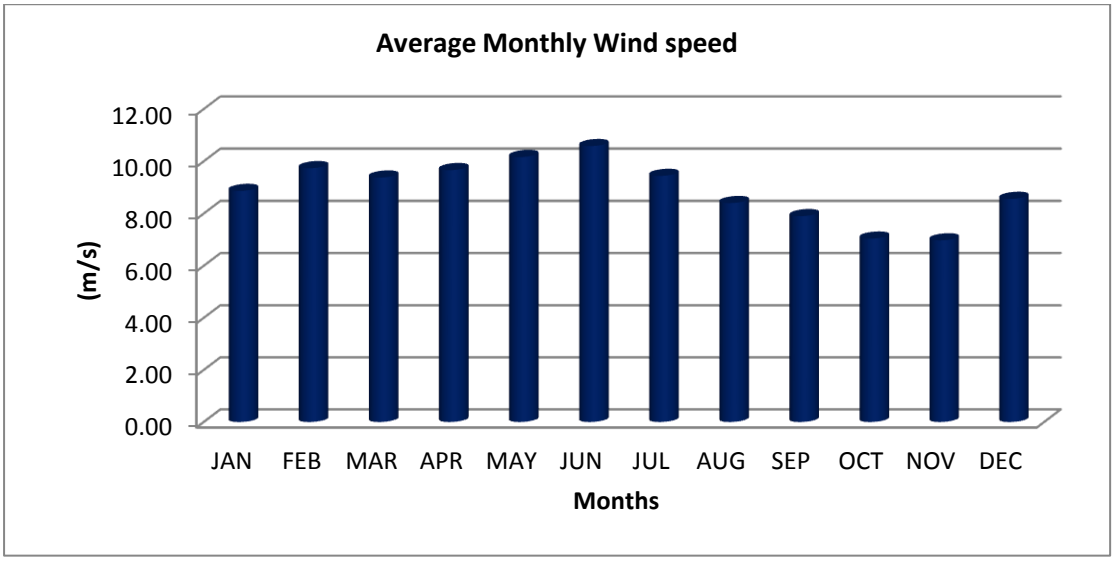


Figure 4.6: Monthly Average Wind Speeds of the Project Area (1991- 2017)
Source: NiMet, 2018

v) Sunshine Hours

An assessment of the sunshine hours of the Project area revealed that the mean monthly sunshine hour in the area is approximately 7.70 hours, while the brightest months occur in November (Figure 4.7).

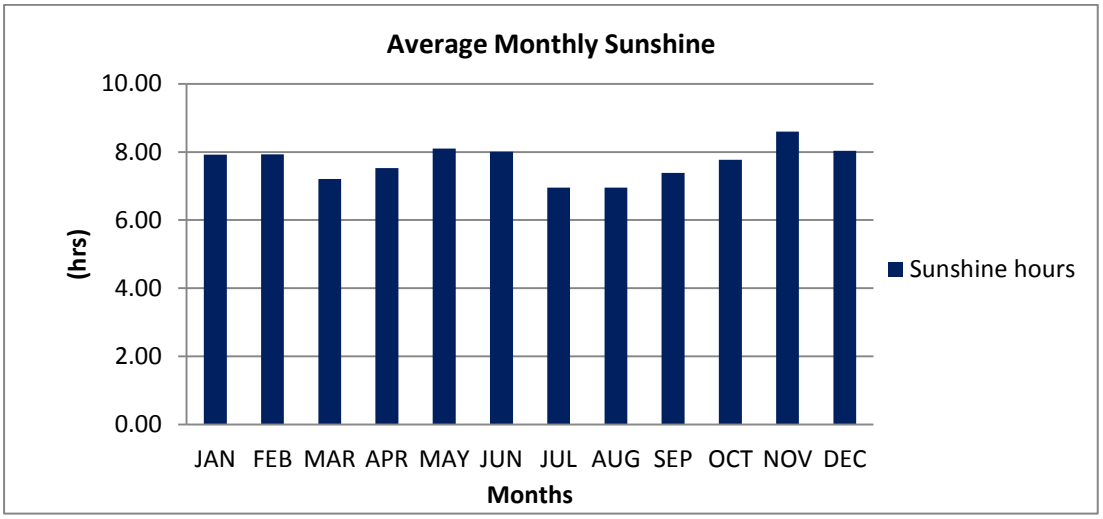


Figure 4.7: Monthly Average of Sunshine Hours for the Project Area (1991-2017)
Source: NiMet, 2018

vi) Wind Direction

The dominant wind directions in the Project area are the South-West (SW) and South South-West (SSW) winds (Figure 4.8).

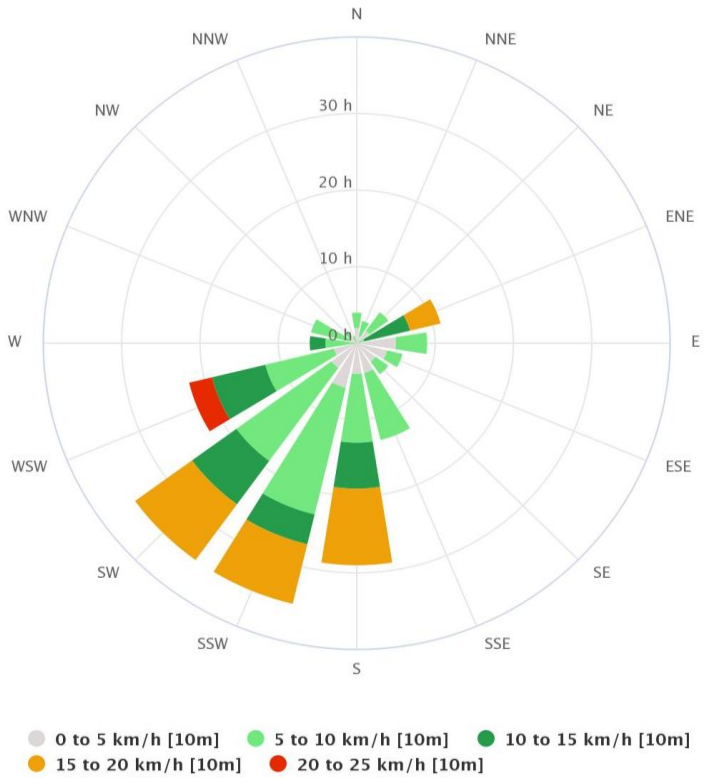


Figure 4.8: Wind rose for the Project Area in Yobe State
Source: Meteoblue, 2019

4.3.2 Geology and Hydrogeology

4.3.2.1 Geology

The geology of Yobe State principally comprises crystalline and sedimentary rocks, underlain by basement complex rocks. The crystalline rocks are represented by older granites found in pockets of places in the southern part of the State. Another crystalline rock formation of younger age is located in the northwestern tip of the state in the Machina area (Figure 4.9).

The older granite is Precambrian in origin consisting of metamorphic structures of gneiss and amphibolites. The sedimentary rocks that are found in most parts of the State were uncomfortably deposited on the basement crystalline rocks (Kwaya *et al.*, 2017).

In the southern fringe of the State, the sedimentary deposits are made up of the cretaceous Bima, Pindiga, Fika and Gombe formations. The Karekare formation is also found in this part of the State. However, in the greater part of Yobe, these sedimentary formations are overlaid by a large expanse of Quaternary Chad formation that stretches into Jigawa and Borno States.

The Biu basalts found in the southern end of the State are believed to have been extruded during the Tertiary/Quaternary periods as lava flows. However, the influence of climatic fluctuations is reflected in the superficial deposits overlaying most of Yobe State. This, for instance, has led to the deposition of series of longitudinal and traverse dunes around Yunusari, Yusufari, Machina, Geidam and Bade local government areas (Usman *et al.*, 2018).

4.3.2.2 Hydrogeology

The hydrogeology of the study area is dominated by the Chad formation. Exploitable aquifers occur at depths of up to 650 m and comprise the upper, middle and lower zones which correspond to the phreatic, lower pliocene and terminal continental aquifers described by the Lake Chad Basin Commission (LCBC) for the entire basin.

Potential deep aquifers at depths greater than 700 m are unlikely ever to become economically feasible in the area or elsewhere in the basin. For all practical purposes the development of groundwater resources is limited to the currently exploited aquifers to depths of about 650 m. The upper zone is termed the upper aquifer system because it is a heterogeneous body comprising more than one aquifer intercalated with less permeable beds. The middle and lower zones are termed separate aquifers since each is sufficiently isotropic as to be considered an individual hydrogeological unit (Zaji M., 1999).

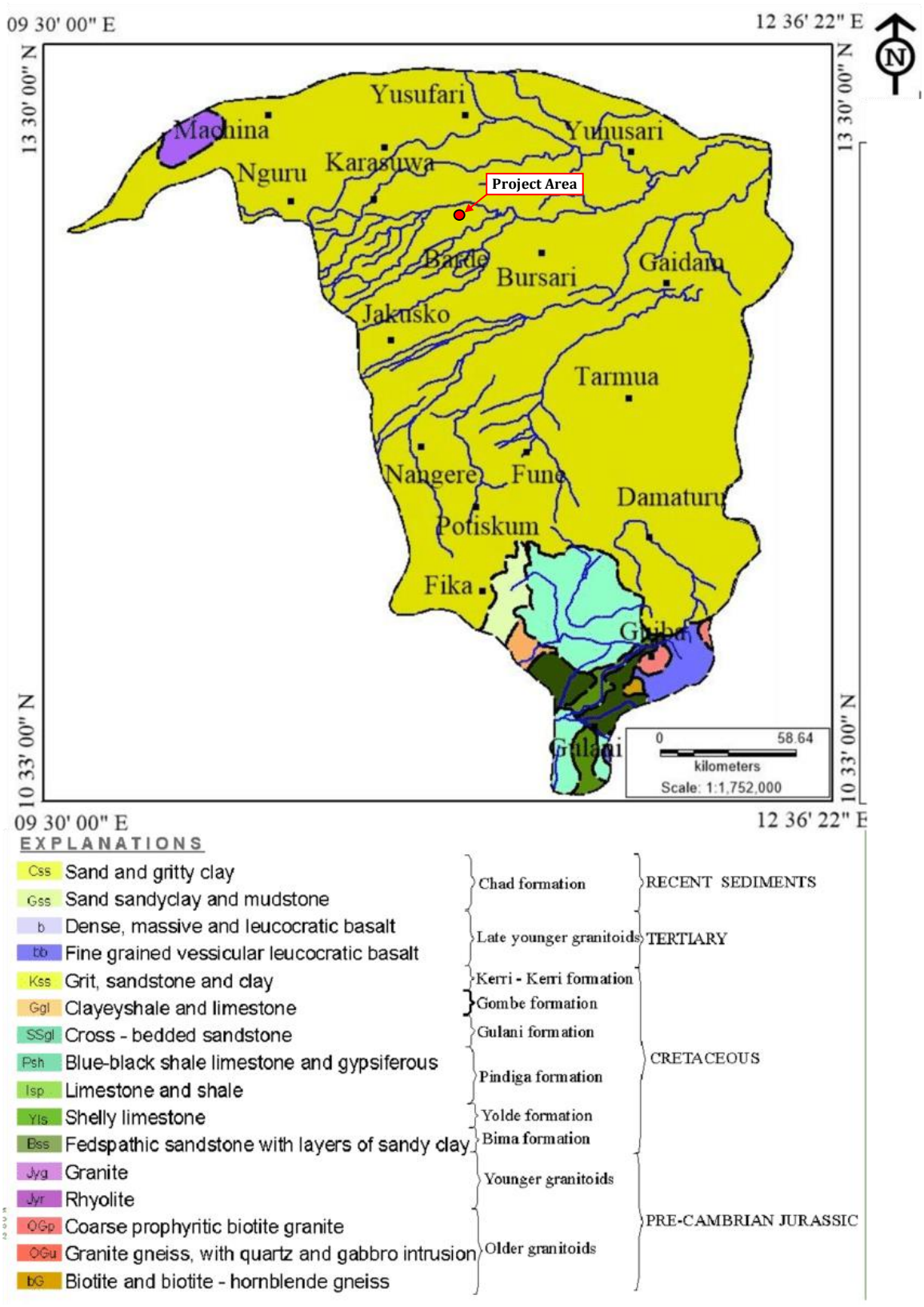


Figure 4.9: Geologic map of Yobe State indicating the Project area
Source: Kwaya *et al.*, 2017

4.3.3 Ambient Air Quality and Noise

In-situ air quality measurements were conducted in the Project's area of influence with the use of pre-calibrated digital hand-held monitoring equipment (Aeroqual series 500; Aerocet 531; Graywolf particle counter) for the following parameters: Sulphur (IV) Oxide (SO_2), Nitrogen (IV) Oxide (NO_2), Methane (CH_4), Carbon Monoxide (CO), Carbon (IV) Oxide (CO_2), Volatile Organic Compounds (VOC), Hydrogen Sulphide (H_2S) and Total Suspended Particulate (TSP).

Ambient noise levels were measured using an Extech Integrated Sound Level Meter with a detection range of 30 dB(A) to 130 dB(A). Noise Level measurements were taken at a height of approximately 2m above ground level and the response time was set to slow and read on the 'A' frequency weighting scale in unit decibels.

A total of eight (8) sampling locations (4 within the Project site, 2 within 1km radius, and 2 at control/buffer points) were established for ambient air quality and noise study. The air quality and noise sampling location map is presented in Figure 4.10.

4.3.3.1 Air Quality Standards

The concentrations of air quality parameters recorded at the Project area were compared to the Nigerian Ambient Air Quality Standards (NAAQS), World Health Organization (WHO) Air Quality Guidelines, and World Bank noise level guidelines. The summary of these limits is provided in Tables 4.3 to 4.5.

Table 4.3: Ambient Air Quality Standards

Parameter	Averaging Period	Nigeria Standards FMEnv Limit ($\mu g/m^3$)	WHO Ambient Air Quality Guideline values ($\mu g/m^3$)
CO	1-hour	11, 400	-
NO_2	1-hour	75 - 113	200
SO_2	1-hour	260	500 (10-minutes)
TSP	1-hour	250	-

Source: FMEnv, 1991; and World Bank General EHS 2007

Table 4.4: Noise Exposure Limits for Nigeria

Duration per Day, Hour	Permissible Exposure Limit dB(A)
8	90
6	92
1	105
0.5	110
0.25	115

Source: Guidelines and Standards for Environmental Pollution Control in Nigeria (FEPA {now FMEnv}, 1991)

Table 4.5: Noise Level Guidelines adopted by the World Bank

Receptor	One Hour Leq (dBA)	
	Daytime	Night time
Residential; institutional educational	55	45
Industrial; commercial	70	70

Source: The World Bank General EHS Guidelines, 2007

4.3.3.2 Air Quality of the Project Area

The geographical coordinates of the air sampling locations established in the Project area are presented in Table 4.6.

Table 4.6: Geographical coordinates of Air quality sampling locations in the Project Area

Sampling Code	Latitude (N)	Longitude (E)
Within the Project site		
A1	11.01195	12.87941
A2	11.01241	12.88066
A3	11.01338	12.88057
A4	11.01258	12.87961
Within 1km AoI (area of influence) radius		
A5	11.01464	12.88345
A6	11.01297	12.87423
Control/buffer points		
A7	12.87637	11.99474
A8	12.87465	11.02474

Source: EnvAccord Field Survey, 2019

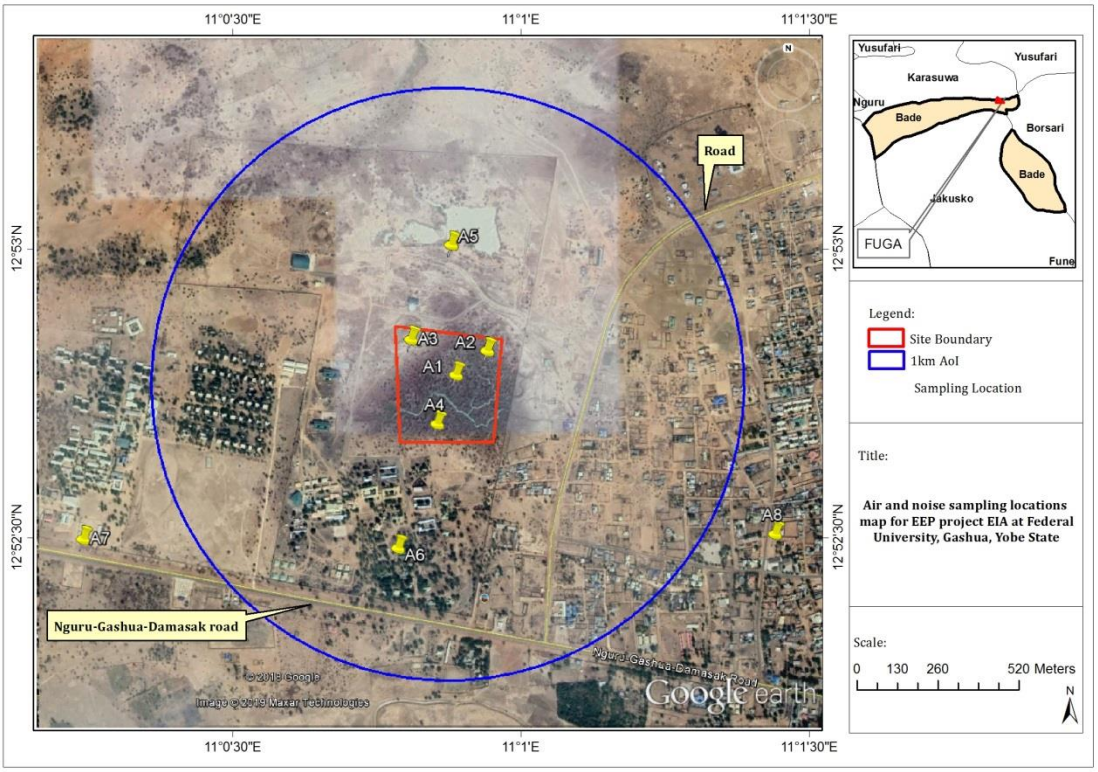


Figure 4.10: Air quality/ Noise sampling locations map

Source: EnvAccord Field Survey, 2019

The results of air quality and noise level measurements are presented in Table 4.7.

Table 4.7: Results of ambient air quality and noise levels measured in the Project area

Parameters	Within the Project site			Within 1km AoI (area of influence) radius			Control/Buffer points		
	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
TSP (mg/m³)	0.072	0.082	0.064	0.062	0.063	0.062	0.079	0.099	0.059
NO_2 (mg/m³)	0.026	0.062	0.005	0.033	0.047	0.019	0.048	0.071	0.025
SO_2 (mg/m³)	0.0025	0.003	0.001	0.004	0.005	0.004	0.003	0.004	0.002
VOC (mg/m³)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
CO_2 (mg/m³)	1580.5	1892	1134	1499	1797	1201	1370.5	1412	1329
CO (mg/m³)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
CH_4 (mg/m³)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
H_2S (mg/m³)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Noise dB(A)	45.4	47.1	43.5	49.05	49.9	48.2	50.5	51.7	49.3

Source: EnvAccord Field Survey, 2019. BDL= Below Detection Limit (VOC = 0.1; CH_4, = 0.01; CO = 0.01; H_2S = 0.01)

Total Suspended Particulate (TSP): Within the Project site, the measured TSP values ranged from 0.064 mg/m³ to 0.082 mg/m³ with a mean value of 0.072 mg/m³ which is below the FMEnv 1hr averaging time limit of 0.25 mg/m³ for TSP in ambient air. This implies that the ambient air of the Project site in terms of TSP could be considered to be unpolluted.

Also, the TSP values recorded at locations established outside the Project site including the control/buffer points showed a similar trend as the values recorded fell below the FMEnv limit of 0.25 mg/m³.

Nitrogen dioxide (NO_2): NO_2 values recorded within the Project site ranged from 0.005 mg/m³ to 0.062 mg/m³ with an average value of 0.026 mg/m³ which complies with the FMEnv recommended threshold limit of 0.113 mg/m³ and the WHO guideline value of 0.2 mg/m³ respectively for 1hr averaging time of NO_2 in ambient air. Comparably, the results of NO_2 measurements conducted within 1km area of influence of the Project site as well as the control/buffer points fell below the FMEnv and WHO maximum permissible limits. This indicates the ambient air of the Project area is not polluted.

Sulphur dioxide (SO_2): At the time of field sampling, the concentrations of SO_2 recorded at four (4) different locations established within the Project site ranged from 0.001 mg/m³ to 0.003 mg/m³ with an average concentration of 0.0025 mg/m³. The SO_2 values recorded in all the sampling locations, including the control/buffer points were below the FMEnv recommended threshold limit (1-hour averaging time) of 0.026 mg/m³ for SO_2 in ambient air. The measured SO_2 values were also lower than the WHO guideline value of 0.5 mg/m³ for SO_2 in ambient air (10-minutes averaging period).

Ambient Noise Level: Within the Project site, the average noise level recorded ranged from 43.5 dB(A) to 46.3 dB(A) with an average value of 50.5 dB(A), which is

lower than the World Bank limit of 55 dB(A) (1-hour Leq day time) for educational institution. In addition, the noise levels (by extrapolation) were also below the FMEnv limit of 90 dB(A) for 8-hour occupational exposure. The noise levels recorded at the sampling locations within 1 km radius of the Project site, including the control/buffer points were also below the regulatory limit.

4.3.4 Soil Quality

Soil is an important component of the ecosystem that serves as a footprint of impacts. The critical properties of soil that usually form the basis for impact evaluation include physical properties, fertility indices, and chemical composition.

4.3.4.1 Soil Sampling

A total of eight (8) soil sampling stations (4 within the Project site, 2 within 1 km radius, and 2 at control/buffer points) were established. At each of the sampling station, both top soil (0-15cm) and sub-soil (15-30cm) were collected.

Soil sampling was carried out using a stainless steel auger. The soil samples collected were homogenized in plastic bucket lined with aluminum foil sheet, and from the homogenized soil samples, sub samples were taken for physico-chemical analysis. All samples collected were preserved and transported to the laboratory for analysis. The geographical coordinates of the soil sampling locations are presented in Table 4.8 while the soil sampling location map is depicted in Figure 4.11.

Table 4.8: Geographical coordinates of Soil Sampling Locations in the Project Area

Sampling Code	Latitude (N)	Longitude (E)
Within the Project site		
S1	11.01195	12.87941
S2	11.01241	12.88066
S3	11.01338	12.88057
S4	11.01258	12.87961
Within 1 km AoI (area of influence) radius		
S5	11.01464	12.88345
S6	11.01297	12.87423
Control/buffer points		
S7	12.87637	11.99474
S8	12.87465	11.02474

Source: EnvAccord Field Survey, 2019

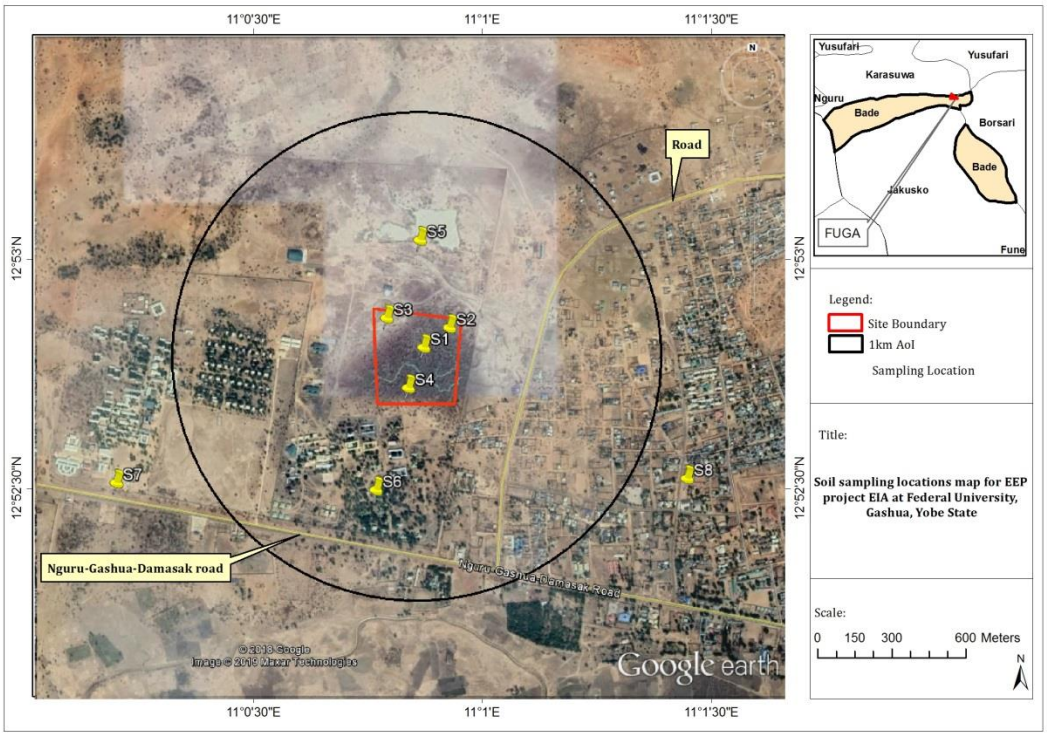


Figure 4.11: Soil Sampling Locations Map
Source: EnvAccord Field Survey, 2019

The physico-chemical and microbial analysis results of the soil samples are provided in Tables 4.9 to 4.10.

Table 4.9: Physico-chemical and microbial properties of top soils (0 – 15cm) from the Project area

Sample ID	Within the project site			Within 1km AoI radius		Control/Buffer area		Limits - Alloway (1991); Allen *et al* (1974)
	Min	Max	Mean	Min	Max	Min	Max	
pH	6.56	7.5	6.94	6.45	6.55	6.55	7.06	-
Conductivity µS/cm	101	220	140.5	107.00	121.00	98.00	121.00	-
TOC %	1.18	2.34	1.67	0.99	1.87	1.47	2.15	-
Moisture Content %	2.42	3.44	2.82	3.66	4.09	3.68	5.21	-
Chloride mg/Kg	7.493	18.74	12.99	14.49	14.99	14.74	16.24	-
Nitrate mg/Kg	0.035	0.126	0.0795	0.15	0.15	0.104	0.153	-
Sulphate mg/Kg	21.993	30.775	25.506	23.01	25.89	17.399	19.553	-
Phosphate mg/Kg	0.09	0.41	0.2725	0.00	0.12	0	0.16	-
Carbonate mg/Kg	2.2	4.1	3.235	3.40	4.00	3	3.33	-
Cu mg/Kg	BDL	BDL	-	BDL	BDL	BDL	BDL	5-500
Pb mg/Kg	BDL	BDL	-	BDL	BDL	BDL	BDL	2-20
Zn mg/Kg	0.143	2.37	0.947	0.10	0.40	0.089	0.101	10-50
Cd mg/Kg	BDL	BDL	-	BDL	BDL	BDL	BDL	0.03-0.30
Hg mg/Kg	BDL	BDL	-	BDL	BDL	BDL	BDL	-
Cr mg/Kg	BDL	BDL	-	BDL	BDL	BDL	BDL	-
Ni mg/Kg	BDL	BDL	-	BDL	BDL	BDL	BDL	5-500
Fe mg/Kg	76.11	118.2	104.42	75.61	117.38	89.4	128.47	NS
Ca mg/Kg	17.75	43.4	31.705	31.22	42.71	11.2	32.05	-
Mg mg/Kg	1.06	3.63	2.24	1.15	2.45	2.51	2.88	-
Na mg/Kg	115.6	149.41	133.352	85.66	120.56	107.94	108.15	-
K mg/Kg	13.06	26.07	19.582	13.59	13.69	9.71	16.09	-
Sand %	14.68	23.17	19.22	17.59	23.51	14.96	18.54	-
Silt %	13.15	14.81	13.8875	12.36	12.52	16.95	18.74	-
Clay %	62.02	72.15	66.895	63.97	70.05	64.5	66.3	-
Oil and Grease, mg/Kg	BDL	BDL	-	BDL	BDL	BDL	BDL	-
Total Heterotrophic Bacteria cfu/g	4.0×10^5	2.0×10^7	1.1×10^7	3.0×10^6	4.0×10^7	4.0×10^6	4.4×10^5	-
Total Heterotrophic Fungi cfu/g	4.0×10^3	2.0×10^6	5.5×10^5	2.20×10^5	5.0×10^3	3.0×10^5	4.0×10^4	-
Total Coliform cfu/g	2.4×10^4	2.1×10^5	7.7×10^5	2.0×10^3	3.0×10^3	1.0×10^5	2.0×10^5	
Hydrocarbon Utilizing Bacteria cfu/g	3.0×10^1	6.8×10^2	2.7×10^3	1.8×10^2	6.8×10^2	2.80×10^1	3.0×10^2	-
Hydrocarbon Utilizing Fungi cfu/g	2.0×10^1	2.0×10^3	5.6×10^2	2.0×10^1	2.0×10^1	2.0×10^1	2.0×10^1	-
% HUB	0.0012	0.0075	0.0047	0.00	0.01	0.0006	0.0075	

Source: EnvAccord Field Survey, 2019

BDL= Below Detection Limit. Equipment Detection Limit = Cu, 0.005; Pb, 0.04; Ni, 0.05; Hg, 0.001; Cd, 0.01; Cr, 0.04; oil and grease, 0.001

Table 4.10: Physico-chemical and microbial properties of sub soils (15 – 30 cm) from the Project area

Sample ID	Within the Project site			Within 1km AoI radius		Control/Buffer area		Limits - Alloway (1991); Allen *et al* (1974)
	Min	Max	Mean	Min	Max	Min	Max	
pH	6.74	7.43	6.94	6.6	6.84	6.64	7.41	-
Conductivity µS/cm	116	195	137.5	110.00	113.00	102.00	109.00	-
TOC %	1.22	2.11	1.52	1.18	1.65	1.19	1.68	-
Moisture Content %	3.62	4.23	4.02	3.44	4.58	4.53	4.61	-
Chloride mg/Kg	14.493	19.99	16.62	15.742	16.242	14.993	17.491	-
Nitrate mg/Kg	0.079	0.188	0.145	0.126	0.135	0.014	0.141	-
Sulphate mg/Kg	25.061	45.711	31.563	21.692	22.795	16.188	26.398	-
Phosphate mg/Kg	0.1	0.4	0.30	0	0.23	0	0.23	-
Carbonate mg/Kg	3.15	4.07	3.62	2.19	4.24	2.74	3.5	-
Cu mg/Kg	BDL	BDL	-	BDL	BDL	BDL	BDL	5-500
Pb mg/Kg	BDL	BDL	-	BDL	BDL	BDL	BDL	2-20
Zn mg/Kg	0.012	2.538	0.693	0.113	0.144	0.073	0.086	10-50
Cd mg/Kg	BDL	BDL	-	BDL	BDL	BDL	BDL	0.03-0.30
Hg mg/Kg	BDL	BDL	-	BDL	BDL	BDL	BDL	-
Cr mg/Kg	BDL	BDL	-	BDL	BDL	BDL	BDL	-
Ni mg/Kg	BDL	BDL	-	BDL	BDL	BDL	BDL	5-500
Fe mg/Kg	83.42	144.88	114.21	90.09	122.19	95.11	121.51	NS
Ca mg/Kg	20.76	48.1	37.88	39.79	40.74	31.38	38.44	-
Mg mg/Kg	1.13	2.65	2.03	1.04	2.7	2.16	2.72	-
Na mg/Kg	115.85	124.93	120.98	99.11	128.85	107.06	119.31	-
K mg/Kg	16.08	23.37	18.525	12.27	14.61	9.57	12.22	-
Sand %	16.15	23.91	19.21	15.48	16.53	11.22	16.3	-
Silt %	12.02	15.48	13.525	15.27	19.52	16.09	19.09	-
Clay %	64.07	68.53	67.26	65	68.19	67.6	69.69	-
Oil and Grease, mg/Kg	BDL	BDL	-	BDL	BDL	BDL	BDL	-
Total Heterotrophic Bacteria cfu/g	4.0×10^5	5.4×10^6	3.05×10^6	3.0×10^6	4.0×10^6	3.0×10^6	6.6×10^6	-
Total Heterotrophic Fungi cfu/g	2.0×10^3	3.0×10^5	1.28×10^5	1.0×10^5	4.0×10^3	1.0×10^6	2.0×10^6	-
Total Coliform cfu/g	2.6×10^3	1.4×10^4	6.00×10^3	2.0×10^3	3.0×10^4	1.0×10^3	2.0×10^3	
Hydrocarbon Utilizing Bacteria cfu/g	2.0×10^2	3.0×10^2	2.55×10^2	1.8×10^1	3.5×10^2	6.8×10^2	6.80×10^1	-
Hydrocarbon Utilizing Fungi cfu/g	1.0×10^1	5.0×10^1	2.50×10^1	1.90×10^1	3.0×10^1	3.0×10^2	5.0×10^3	-
% HUB	0.0005	0.0085	0.0055	0.006	0.0087	0.001	0.0023	

Source: EnvAccord Field Survey, 2019

BDL= Below Detection Limit. Equipment Detection Limit = Cu, 0.005; Pb, 0.04; Ni, 0.05; Hg, 0.001; Cd, 0.01; Cr, 0.04; oil and grease, 0.001

The discussion of the soil quality results is provided in the following paragraphs:

Soil Physical properties (Sand, Clay, and Silt): The soil texture is determined by the balance of clay, silt and sand particles. The soil environment of the Project site can be classified as of clay texture going by their particle size distribution when evaluated using the soil texture triangle (Figure 4.12). The laboratory analysis of soil samples from the Project site indicate that in the top soil, sand particles ranged from 14.68 % to 23.17 %, silt ranged from 13.15 % to 14.81 % while the percentage of clay particles ranged from 62.20 % to 72.15 %. In the sub soil, sand particles ranged from 16.15 % to 23.91 %, silt ranged from 12.02 % to 15.48 % while clay ranged from 64.04 % to 68.53 %. Generally, sand, sandy loam and loam textured soils tend to be less eroded than silt, very fine sand, and clay textured soils. Soil samples from the Project area of influence as well as the buffer points showed a similar composition.

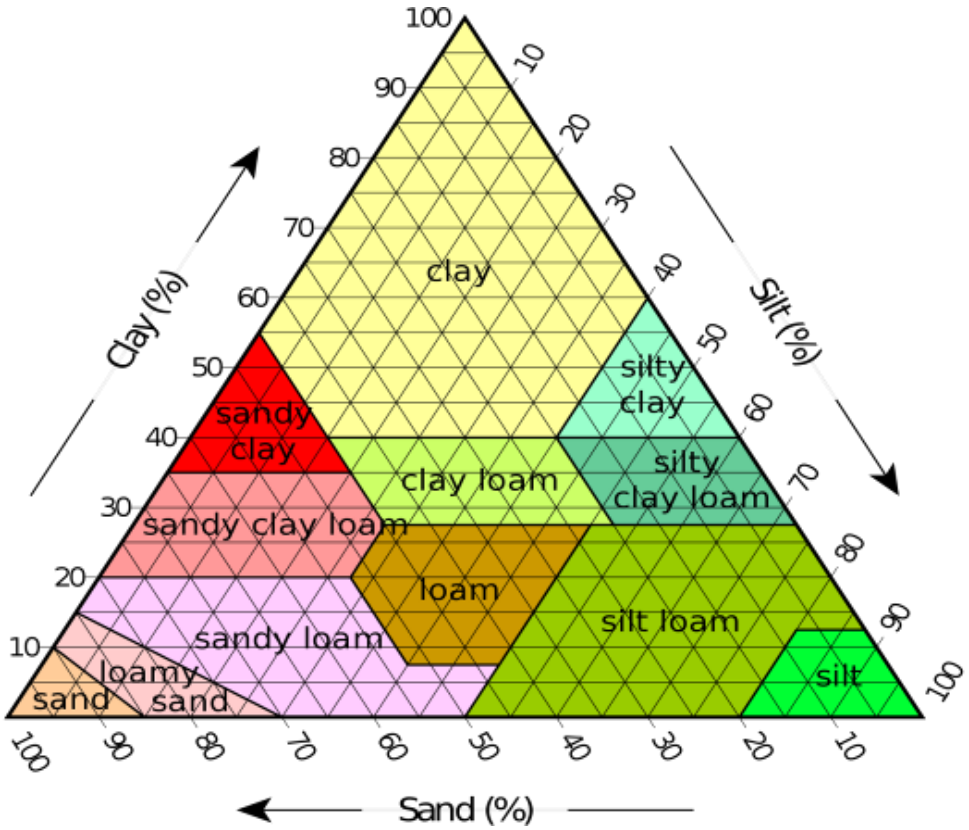


Figure 4.12: Soil texture triangle
Source: https://www.nrcs.usda.gov

Soil pH (soil reaction): The pH of soil samples from the Project site ranged from 6.56 to 7.50 (slightly acidic to neutral) for top soil and a range of 6.74 to 7.43 (slightly acidic to neutral) was obtained for the sub soil. This indicates that the soil environment of the Project site is not corrosive and can easily support the mounting structure for the solar PV panels to be installed on site. Similarly, within the 1 km

area of influence, the pH values ranged from 6.45 to 6.55 while at the control points, a range of 6.55 to 7.06 was recorded.

Soil Anions: The concentrations of anions measured in the soil from the Project site were generally within the prescribed limits for tropical soil. Among the anions, sulphate had the highest concentrations in the soil samples with a range of 21.93 mg/kg – 45.71 mg/kg while phosphate had the least concentration with a range of from 0.00 to 0.41 mg/kg. As indicated in Tables 4.9 and 4.10, the nitrate concentration in the soil samples from the Project site was also low indicating relative low nutrient. This could be expected since the Project site is dominated by grasses and it is not currently used for farming. This inference could also be supported by low percentage of total organic carbon recorded in soil samples from the Project site.

Soil Cations: The concentrations of Sodium (Na), Calcium (Ca), Potassium (K) and Magnesium (Mg) recorded in soil samples from the Project area fall within natural occurrence levels for tropical soils as prescribed by Alloway (1991). Within the Project site, Na recorded the highest concentration among the anion analyzed. In the top soil, the Na concentrations ranged from 115.60 mg/kg to 149.41 mg/kg while in the sub-soil, the measured Na values ranged from 115.85 mg/kg to 124.93 mg/kg. Similar trends were obtained in the soil samples collected within the 1 km radius of the Project site as well as the control/buffer points.

Heavy Metals: Heavy metals occur naturally in the environment at low concentrations (Table 4.11); however, elevated levels of these metals in the environment may be experienced due to anthropogenic activities. The presence of heavy metals in soil at the level within the naturally occurring concentration is, therefore, not indicative of contamination. The concentration of metals in uncontaminated soil is primarily related to the geology of the parent material from which the soil was formed (McLean and Bledsoe, 1992).

Table 4.11: Naturally Occurring Heavy Metal Concentrations

Metals	Limits (mg/kg)
Cadmium	0.03-0.3
Nickel	5-500
Lead	2-20
Zinc	10-50
Copper	5-500
Iron	NS

Source: Alloway (1991); Allen *et al* (1974) NS = Not Specified

Based on the results of laboratory analysis conducted on soil samples from the Project site and its surrounding environment, no heavy pollution was recorded in the soil samples from the Project area. Copper (Cu), Lead (Pb), Mercury (Hg),

Cadmium (Cd), Chromium (Cr) and Nickel (Ni) were below the detection limits of 0.005m/kg, 0.04mg/kg, 0.001mg/kg, 0.01mg/kg, 0.04mg/kg and 0.05mg/kg respectively. The concentrations of Zinc (Zn) recorded in the soil samples from the Project site, had a range of 0.143mg/kg – 2.370mg/kg, in the top soil while in the subsoil, a range of 0.012 mg/kg – 2.538 mg/kg was recorded. The measured Zn values in all the soil samples collected from the Project site were within the naturally occurring levels. The concentrations of Iron (Fe) in the soil samples obtained from the Project site ranged from 76.11 mg/kg to 118.2 mg/kg in the topsoil and 83.42 mg/kg to 144.88 mg/kg in subsoil. Due to the geological nature of the Project area, Iron (Fe) recorded the highest concentrations amongst the heavy metals recorded in the soil samples as indicated in Tables 4.9 and 4.10 above. This also reflected in the Fe concentration recorded in the groundwater samples from the area.

Soil Microbiology: Microorganisms are one of the major components of soil. Microbial community in soil make important contributions to biogeochemical cycling and the carbon, nitrogen, sulfur, iron and manganese cycle. The population counts of Total Heterotrophic Bacteria (THB) and Total Heterotrophic Fungi (THF) in the soil samples from the Project site ranged from 2.40×10^6 to 6.60×10^6 cfu/gm and 1.0×10^5 to 6.8×10^3 cfu/gm respectively. The percentage of hydrocarbon utilizing bacteria (HUB) recorded was less than 1 % of the total heterotrophic bacteria, indicating that the soil environment is not polluted with hydrocarbon compounds that could serve as substrates for the HUB to thrive well. Predominant species of microorganisms isolated includes *Bacillus* spp., *Corynebacterium* spp., *Nocardia* spp., *Aspergillus flavus*, *Fusarium* spp., and *Penicillium* spp.

4.3.5 Groundwater Quality

Groundwater quality refers to the state of water that is located beneath Earth's surface. Naturally, groundwater contains mineral ions. Microbial matter is also a natural constituent of groundwater (Harter 2003).

In order to assess the quality of existing groundwater in the Project area, water samples were collected from existing groundwater resources in the Project area and analyzed. The results of the physico-chemical and microbial characteristics of the groundwater samples were compared with the WHO standards (highest desirable level and maximum permissible limits for substances and characteristics affecting the acceptability of water for domestic use) as well as the FMEnv prescribed limits for drinking water as highlighted in the National Guidelines and Standards for Water Quality in Nigeria, 1999.

4.3.5.1 Groundwater Sampling

Groundwater samples were collected from two (2) different boreholes in the Project area during the field sampling; one close to the Project site and one from the nearby

local community. At each sampling location, groundwater samples were collected into a 2-litre polyethylene bottle for general physico-chemical analysis, while samples for oil & grease determination were collected in 1-litre glass bottle and preserved with concentrated sulphuric acid. Samples for heavy metals were fixed with concentrated nitric acid. Pre-sterilized 50 ml McCartney bottles were used for samples meant for microbial analysis. In-situ measurements of pH, Electrical Conductivity, Total Dissolved Solids (TDS), Temperature, and Dissolved Oxygen (DO) were taken at each location using Extech Digital DO700 meter. Table 4.12 shows the coordinates of the groundwater sampling points while Figure 4.13 shows the sampling location map.

Table 4.12: Geographical coordinates of Groundwater sampling locations in the Project Area

Sampling Code	Latitude (N)	Longitude (E)
GW 01	11.01075	12.88015
GW 02	11.02452	12.87141

Source: EnvAccord Field Survey, 2019

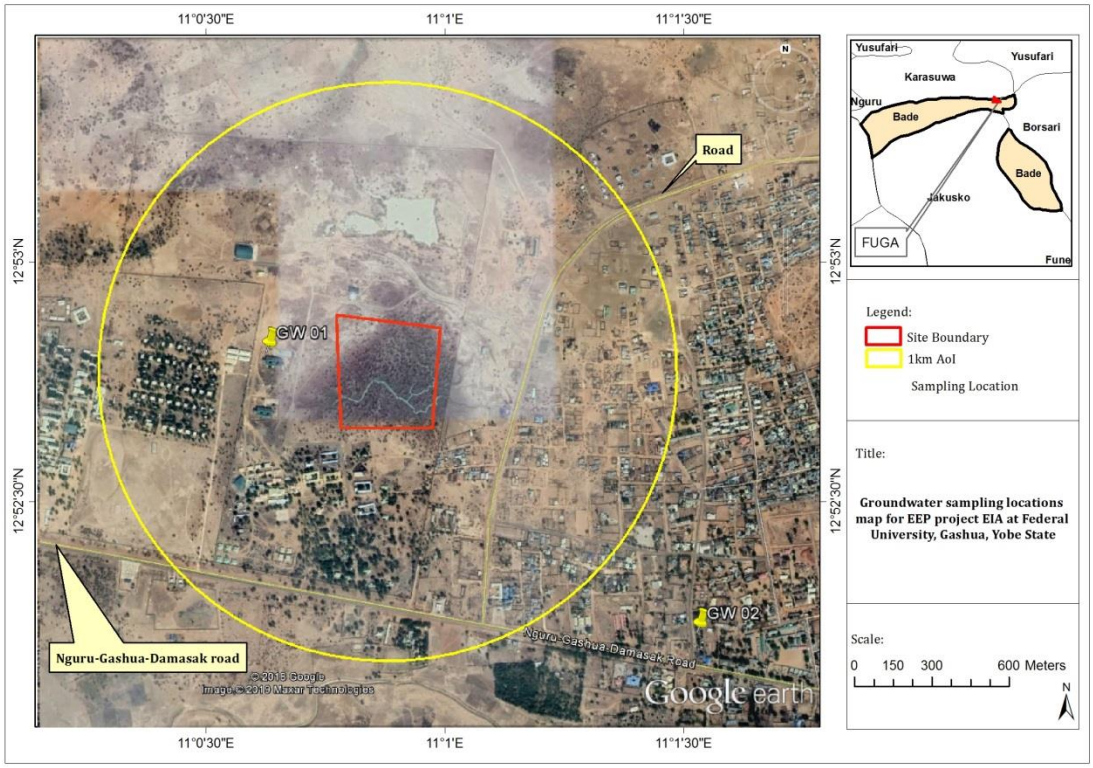


Figure 4.13: Map of Groundwater Sampling Locations in the Project Area
Source: EnvAccord Field Survey, 2019

4.3.5.2 Physico-chemical and Microbial Characteristics of Groundwater Samples

The results of physico-chemical and microbial analyses conducted on groundwater samples from the Project area are presented in Table 4.13.

Table 4.13: Physico-chemical and microbial characteristics of groundwater samples from the Project area

Parameter / Unit	GW 01	GW 02	WHO Limits		FMEnv. Limits
			Highest Desirable Level	Max. Permissible Level	
pH	7.24	7.56	7.0-8.5	6.5-9.2	6.5-8.5
Temperature ^{0}C	27.10	27.80	NS	NS	<40
Conductivity µS/cm	176.0	179.0	NS	1000	-
TDS mg/L	88.0	90.0	200	500	500
Appearance	Clear	Clear	NS	NS	NS
TSS mg/L	0.00	0.00	NS	NS	NS
Turbidity, NTU	0.40	0.42	NS	NS	1
Dissolved Oxygen, mg/L	3.00	3.20	NS	NS	7.5
BOD mg/L	0.30	0.20	NS	NS	0
COD mg/L	41.72	47.65	NS	NS	NS
Salinity ppt	0.11	0.11	NS	NS	NS
Total Hardness mg/l	50.40	60.00	100	500	200
Carbonate mg/L	1.09	2.00	NS	NS	NS
Chloride mg/L	19.99	16.59	-	-	250
Nitrate mg/L	0.00	0.00	NS	NS	10
Sulphate mg/L	0.00	0.00	200	400	500
Phosphate, mg/L	3.21	0.98	NS	NS	5
Hg mg/L	BDL	BDL	NS	NS	NS
Cu mg/L	BDL	BDL	0.05	1.5	1.0
Pb mg/L	BDL	BDL	NS	NS	0.05
Fe mg/L	1.034	1.323	NS	NS	1.0
Zn mg/L	0.037	0.016	5.0	15.0	5.0
Cd mg/L	BDL	BDL	NS	NS	0.05
Cr mg/L	BDL	BDL	NS	NS	<1.0
Ni mg/L	BDL	BDL	NS	NS	NS
Na mg/L	37.928	40.083	NS	NS	NS
Ca mg/L	12.633	10.832	75	200	NS
Mg mg/L	5.822	4.637	30	150	NS
K mg/L	4.730	3.821	NS	NS	NS
Oil/Grease mg/L	BDL	BDL	NS	NS	0.05
Total Heterotrophic Bacteria cfu/g	3.0 x 10^4	5.0 x 10^3	-	-	-
Total Heterotrophic Fungi cfu/g	1.0 x 10^2	2.0 x 10^2	-	-	-
Total coliform	Nil	Nil	-	-	-

Source: EnvAccord Field survey, 2019, NS = Not Specified BDL= Below Detection Limit. Equipment Detection Limits are as follows: Cu, 0.005; Pb, 0.04; Ni, 0.05; Cd, 0.01; Cr, 0.04; Mn, 0.03; Hg, 0.001; oil and grease, 0.001.

The pH of the groundwater samples ranged from 7.24 to 7.56 (*i.e.* slightly alkaline) while the in-situ water temperature ranged between 27.1 ^{0}C and 27.8 ^{0}C. The measured pH and temperature values in the groundwater samples fall within the FMEnv recommended limits of 6.5 – 8.5 and 40 ^{0}C for pH and temperature respectively for potable water.

Electrical conductivity which is a measure of the ability of water to pass an electrical current, ranged from 176.00 µS/cm to 179.00 µS/cm. The conductivity values

obtained in the groundwater samples were within the WHO limit of 1000 µS/cm. Similarly, the Total Dissolved Solids (TDS) values ranged from 88.00mg/l to 90.00mg/l which fall below the WHO and FMEnv limits of 500 mg/l for potable water. Both conductivity and TDS are indicators of how much ions are dissolved in the water samples. Salinity of the groundwater samples was very low (below 1ppm) indicating a fresh water environment, and did not indicate any salt intrusion to the groundwater aquifers. The groundwater resources in the Project are largely recharged through direct precipitation (rainfall).

Heavy metals in the groundwater samples were recorded in trace concentrations, below the regulatory limits. Copper (Cu), Lead (Pb), Cadmium (Cd), Nickel (Ni), Mercury (Hg), and Chromium (Cr) were not detected in the groundwater samples while Zinc (Zn) ranged from 0.016 mg/l to 0.037 mg/l, below the FMEnv limit of 5.0mg/l. The Iron (Fe) concentrations (1.034 mg/l to 1.323 mg/l) recorded in the groundwater samples were slightly above the FMEnv limit of 1.0mg/l. This could be attributed to the geological formation of the Project area, which principally comprises crystalline and sedimentary rocks, underlain by basement complex rocks. Generally, no heavy metal pollution was recorded in the groundwater samples from the Project area.

Similarly, the concentrations of oil and grease measured in the groundwater samples were below the detection limit of 0.001mg/l, indicating that the groundwater samples are not polluted with hydrocarbons.

The population counts of Total Heterotrophic Bacteria (THB) and Total Heterotrophic Fungi (THF) recorded in the groundwater samples ranged from 5.0 x 10^3 to 3.0 x 10^4 cfu/gm and 1.0 x 10^2 to 2.0 x 10^2 cfu/gm respectively. The percentage of hydrocarbon utilizing bacteria (HUB) recorded was less than 1 % of the total heterotrophic bacteria, indicating that the groundwater is not polluted with hydrocarbon compounds that could serve as substrates for the HUB to thrive well. Microbes are naturally found in groundwater resources. Predominant species of microorganisms isolated in the groundwater samples from the Project area are *Bacillus* spp., *Mucor* spp. and *Aspergillus niger*.

4.3.6 Surface water Quality

There is an existing rainwater harvesting trench owned by the University at the southern part of the Project site. As part of the field sampling, water samples from the trench was collected from two different locations (indicated in Figure 4.14) and analyzed. The geographical coordinates of the water sampling locations are presented in Table 4.14.

.

Table 4.14: Surface water sampling locations

Sampling Code	Latitude	Longitude
SW 1	11.01169	12.87859
SW 2	11.01636	12.87878

Source: EnvAccord Field Survey, 2019

The results of the physico-chemical and microbial analyses of the water samples are provided in Table 4.15. The results were compared with the FMEnv limits for aquatic life as well as the surface water quality criteria for fisheries and recreation quality as enshrined in the National Environmental (Surface and Groundwater Quality Control) Regulations, 2011.

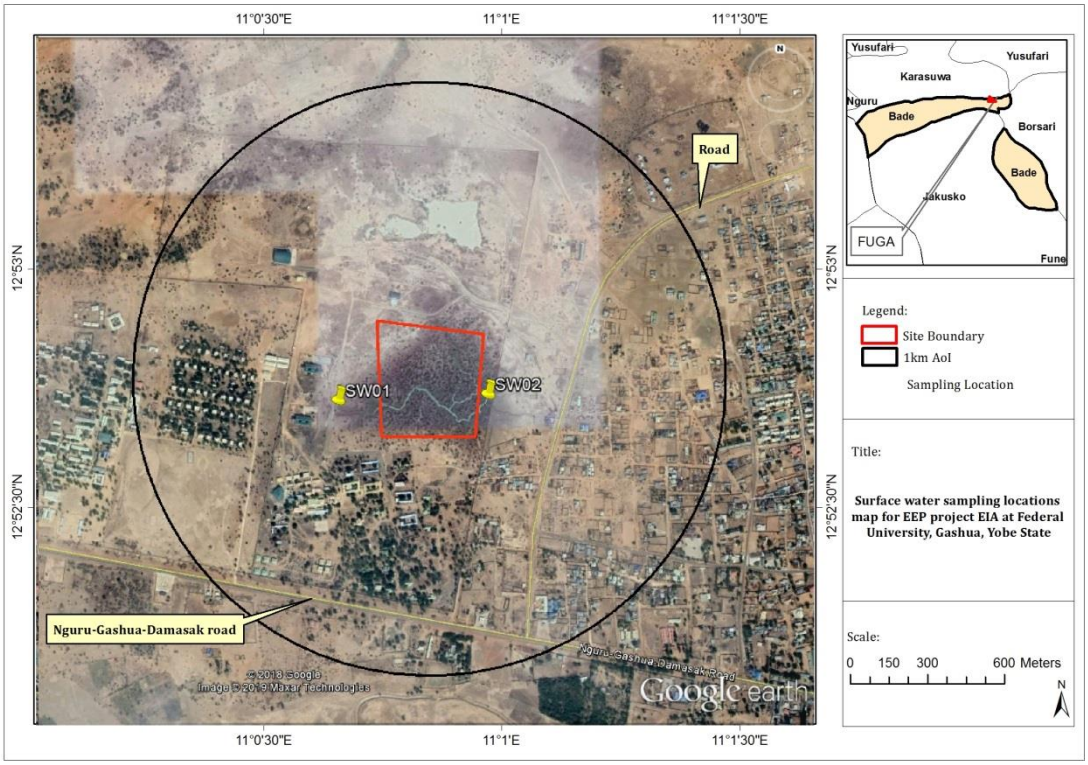


Figure 4.14: Map of Surface water Sampling Locations at the study area
Source: EnvAccord Field Survey, 2019

Table 4.15: Physico-chemical and microbial characteristics of surface water samples from the Project area

Parameter / Unit	SW 01	SW 02	*NESREA Limit	FMEnv. Limits (Aquatic Life)
pH	6.84	6.72	6.5-8.5	6.0-9.0
Temperature ^{0}C	28.4	28.3	NS	20-33
Conductivity µS/cm	172.00	168.00	NS	1000
TDS mg/L	87.00	84.00	NS	500
Appearance	Brownish	Brownish	NS	NS
TSS mg/L	2.12	1.835	NS	NS
Turbidity NTU	4.05	4.13	NS	NS
Dissolved Oxygen mg/L	2.70	3.60	6	6.8
BOD mg/L	0.40	0.60	3	4.0

Parameter / Unit	SW 01	SW 02	*NESREA Limit	FMEnv. Limits (Aquatic Life)
COD mg/L	31.82	30.72	30	NS
Salinity ppt	0.11	0.10	0.25	NS
Total Hardness mg/l	130.20	108.00	NS	NS
Carbonate mg/L	1.70	1.80	NS	NS
Chloride mg/L	13.993	11.994	300	NS
Nitrate mg/L	0.450	0.600	9.1	NS
Sulphate mg/L	41.036	15.219	0.001	NS
Phosphate	0.320	0.000	0.01	NS
Hg	BDL	BDL	NS	NS
Cu mg/L	BDL	BDL	0.001	2.4
Pb mg/L	BDL	BDL	0.01	1.7
Fe mg/L	2.436	1.426	NS	NS
Zn mg/L	1.009	0.829	0.005	0.2-1.8
Cd mg/L	BDL	BDL	0.001	0.02-2.0
Cr mg/L	BDL	BDL	300	NS
Ni mg/L	BDL	BDL	0.01	25-150
Na mg/L	32.734	39.622	120	NS
Ca mg/L	9.836	8.637	180	NS
Mg mg/L	8.057	7.228	40	NS
K mg/l	4.523	6.341	50	NS
Oil/Grease mg/L	BDL	BDL	0.01	NS
Total Heterotrophic Bacteria cfu/g	2.0×10^3	1.6×10^4	-	-
Total Heterotrophic Fungi cfu/g	3.0×10^4	4.0×10^4	-	-
Total coliform	0.00	1.0×10^2	-	-

Source: EnvAccord Field survey, 2019, NS = Not Specified
BDL= Below Detection Limit. Equipment Detection Limits are as follows: Cu, 0.005; Pb, 0.04; Ni, 0.05; Cd, 0.01; Cr, 0.04; Mn, 0.03; Hg, 0.001; oil and grease, 0.001.
***NESREA Limit (for Surface water for Fisheries and recreation quality criteria standards)**

The pH of the water samples ranged from 6.72 to 6.84 (*i.e.* slightly acidic) while the in-situ water temperature ranged between 28.3 ^{0}C and 28.4 ^{0}C. The temperature values fall within the FMEnv recommended limit of <40 ^{0}C for potable water.

Electrical conductivity, a measure of the ability of the water to pass an electrical current, ranged from 168.00 µS/cm to 172.00 µS/cm. The conductivity values obtained in the water samples were within the WHO limit of 1000 µS/cm. Similarly, the Total Dissolved Solids (TDS) values ranged from 84.00 mg/l to 87.00 mg/l which fall below the WHO and FMEnv limits of 500 mg/l. Both conductivity and TDS are indicators of how much ions are dissolved in the water samples.

Heavy metals in the water samples were analysed using Atomic Absorption Spectrophotometer (AAS). Copper, Lead, Cadmium, Nickel and Chromium were not detected in the samples. Zinc ranged from 0.829 mg/l to 1.009 mg/l while Iron ranged from 1.426 mg/l to 2.436 mg/l. Generally, no heavy metal pollution was recorded in the surface water samples. Similarly, no hydrocarbon contamination was recorded in the water sample. The measured values of oil and grease in the water sample were below 0.001 mg/l.

The population counts of Total Heterotrophic Bacteria (THB) and Total Heterotrophic Fungi (THF) in the water samples ranged from 2.0 x 10^3 to 1.6 x 10^4 cfu/gm and 3.0 x 10^4 to 4.0 x 10^4 cfu/gm respectively. The percentage of hydrocarbon utilizing bacteria (HUB) recorded was less than 1 % of the total heterotrophic bacteria, indicating that the water is not polluted with hydrocarbon compounds.

4.3.6 Terrestrial Flora and Fauna

4.3.6.1 Terrestrial Flora

Flora refers to all plant life forms that are found within a specific region at a particular period of time. Plants provide valuable information about site environmental conditions. By their occurrence and relative abundance, certain plant species serve as environmental indicators, through which inferences can be drawn about the state of the environment in that area. Thus, the physiological state and ecological response of plants provide evidence of changes in the environmental conditions of a project site. The array of information derived from the flora composition and vegetation structure of a site is of importance for understanding the nature of the site, potential human health and ecological risk, and the feasibility of different mitigation approaches.

The field assessment of the Project site and surrounding area was done via direct observations. The identification of flora specimen was done both in situ (field) and ex situ using appropriate manuals and monographs. Photographs were taken during survey to record relevant plant species, habitat characteristics and other features.

The results of the vegetation assessment are presented as follows:

- Habitat characterization
- Physiognomy, Floristic composition, and Biodiversity status

Habitat characterization

The vegetation zone of Yobe State is divided into two; Sahel Savanna to the north and Sudan Savanna to the south. Gashua falls within the Northern zone therefore the vegetation zone is Sahel (Wakawa *et al.*, 2017). The natural vegetation of the Project area was observed to have been modified over the years as a result of human interference; mainly development activities within the University. The vegetation within the Project site is dominated by shrubs, grasses and a few trees (Plate 4.2).

Plate 4.2: Some of the flora species observed in the Project site
Source: EnvAccord Field Survey, 2019

Physiognomy, Floristic composition, and Biodiversity assessment

Species composition, distribution and structure of the vegetation of Project site as well as the physiognomic view show few trees, shrubs, and grasses.

In terms of biodiversity assessment, the IUCN (International Union of Conservation of Nature) Red List of Threatened Species was employed. The IUCN Red List of Threatened Species provides taxonomic, conservation status and distribution information on plants, fungi and animals that have been globally evaluated using the IUCN Red List Categories and Criteria. This system is designed to determine the relative risk of extinction, and the main purpose of the IUCN Red List is to catalogue and highlight those plants and animals that are facing a higher risk of global extinction (i.e. those listed as Critically Endangered, Endangered and Vulnerable).

The IUCN Red List also includes information on plants, fungi and animals that are categorized as Extinct or Extinct in the Wild; on taxa that cannot be evaluated because of insufficient information (i.e., are Data Deficient); and on plants, fungi and animals that are either close to meeting the threatened thresholds or that would be

threatened were it not for an ongoing taxon-specific conservation programme (i.e., are Near Threatened).

None of the plant species observed within the Project site belongs to the endangered status. In addition, there are no known protected species on the Project site under the Nigerian legislation. The IUCN status of the plant species encountered in the Project area is highlighted in Table 4.16.

Table 4.16: Plant inventory and Conservation Status

Species Encountered	Family Name	Common Name (Local name)	Plant Forms	IUCN Status
Acacia seyel	Fabaceae	Red acacia	Tree	NE
Balanite aegyptiaca	Zygophyllaceae	Desert date	Tree	NE
Faidherbia albida	Fabaceae	White acacia	Tree	NE
Adansonia digitata	Malvaceae	Baobab	Tree	NE
Azadirachta indica	Meliaceae	Neem tree	Tree	NE
Cenchrus biflorus	Poaceae	K 'arangiya	Grass	NE
Pennisetum pedicellatum	Poaceae		Grass	NE
Setaria pallide fusca	Poaceae	Geron darli	Grass	NE
Schoenefeldia gracilis	Poaceae		Grass	NE
Paspalum conjugatum	Poaceae		Grass	NE

Source: EnvAccord Field Survey, 2019; NE= Not Evaluated
IUCN – International Union for Conservation of Nature

4.3.6.2 Fauna Species

The methodology used in identifying the terrestrial fauna species within the Project site includes direct sighting, sound, nest type, and footprints. The fauna species observed at the Project site were generally few and restricted to small invertebrates such as earthworms, insects, grasshoppers, butterflies, spiders. Also, vertebrates such as Lizards (*Agama agama*), birds and grazing animals were sighted in the surrounding environment of the Project site. Although, grazing activities were observed on the Project site during the field activities, the site is not known to fall within any gazetted grazing reserves or grazing routes. The livestock grazing noted during the field data gathering was free ranging. Table 4.17 presents a list of fauna species encountered in the Project's area of influence, while sample pictures of the fauna species are shown in Plate 4.3.

Table 4.17: List of Fauna Species Encountered in the Project's Area of Influence

Common (Local) Names	Species	Family	Group	IUCN status
Blue naped mousebird	*Urocolius macrourus*	Coliidae	Aves	LC
Sun lark	*Galerida modesta*	Coliidae	Aves	LC
Black Kite	*Muluus migrans*	Accipitridae	Aves	LC
Yellow fronted bird	*Pogoniulus scolopaceus*	Lybiidae	Aves	LC
Common bulbul	*Pycnonotus barbatus*	Pycnonotidae	Aves	LC
African silverbill	*Euodice cantans*	Estrildidae	Aves	LC
Black ant	*Lasius niger*	Formicidae	Insecta	NE
Earthworm	*Lumbricus terrestris*	Acanthodrilidae	Annelida	NE

Common (Local) Names	Species	Family	Group	IUCN status
Giant African mantis	*Sphodromantis viridis*	Mantidae	Insecta	NE
Green fruit Pigeon	*Treron australis*	Columbidae	Aves	LC
Lizard	*Varanus albigularis*	Varanidae	Reptilia	NE
Butterfly	*Chlosyne rosita*	Nymphalidae	Insecta	NE
Soldier ant	*Strongylognathus alboini*	Formicidae	Insecta	NE
Cattle egret	*Bubulcus ibis*	Ardeidae	Aves	LC
Cattle (cows)	*Bos Taurus*	Bovidae	Mammalia	LC
Sheep	*Ovis aries*	Bovidae	Mammalia	LC
Housefly	*Musca domestica*	Muscidae	Insecta	NE
Red headed Malimbe	*Malimbus rubricollis*	Ploceidae	Aves	LC

IUCN – International Union for Conservation of Nature
Source: EnvAccord Field Survey, 2019; NE= Not Evaluated; LC = Least Concern

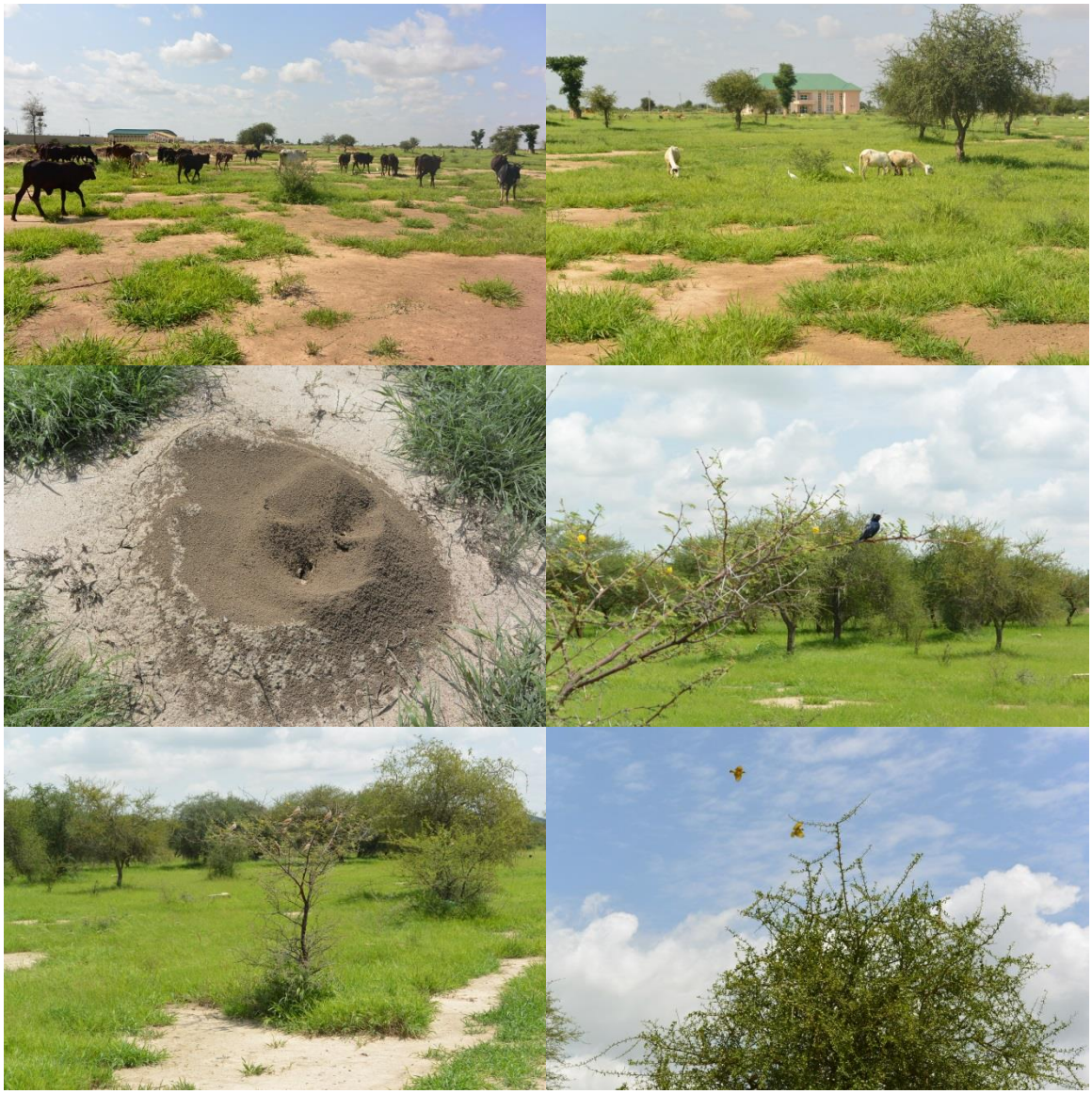


Plate 4.3: Some of the fauna species observed in the Project's Area of Influence
Source: EnvAccord Field Survey, 2019

4.3.7 Land Use/Land Cover

This section discusses the existing land use / land cover type in the Project area. The land use map (Figure 4.15) was produced from a combination of ground truthing, aerial imagery (LandSat ETM+) and topographical maps covering the Project area. The study covers the land use within the Project site boundary and the wider area area (1 km from the Project site).

The land use composition of the proposed Project site was observed to be bare land reserved for future development projects (characterized by trees, grasses and a rainwater harvesting trench used for irrigation demonstration activities by the University students. At the time of the baseline study, there were no academic, residential or business structures on the proposed site. Also, there are no farming, fruit gathering, or wood gathering activities on the proposed site.

The wider area (AoI) can be categorized in three classes, namely; built-up area, dry land and waterbody (Figure 4.16). The estimated area covered by each of the land use types is presented in Table 4.18.

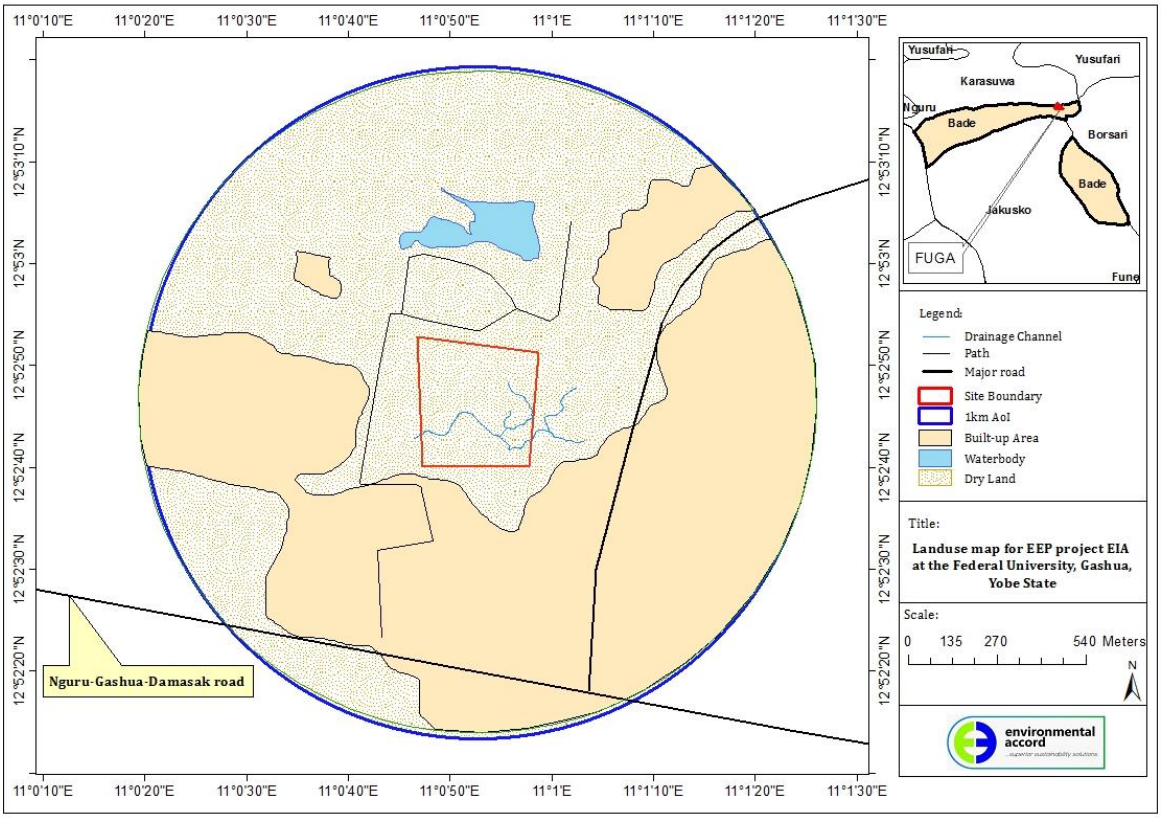


Figure 4.15: Land use map of the Project site and area of Influence

Source: EnvAccord GIS. 2019

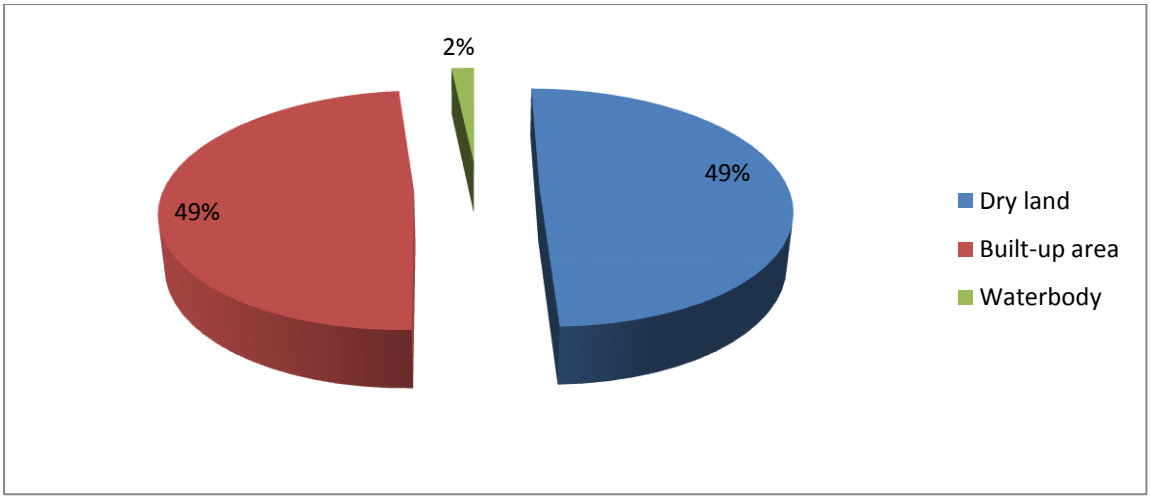


Figure 4.16: Land use composition within the Project's area of Influence
Source: EnvAccord Field Survey, 2019

Table 4.18: Existing Land Use within the wider area (outside the Project site)

S/N	Land use/ Land cover	Area (ha)	Percentage (%)
1	Bare land	156.69	49.53
2	Built-up area	154.21	48.75
3	Waterbody	5.44	1.72
	Total	**316.34**	**100**

Source: EnvAccord Field Survey, 2019

- **Bare land**

This class covers about 50% of the wider area. It entails bare soil and dry vegetal cover. The bare lands within FUGA campus are mostly undeveloped lands that have been reserved for future projects by the University. The proposed Project site falls into this category.

- **Built-up area**

This is a general name used to classify building structures within an environment. The major constituents of this class are the buildings in FUGA and the host community. This covers over 150ha of the entire wider study area. There are no built up structures (temporary or permanent) within the proposed project site.

- **Waterbody**

The waterbodies observed during the field survey are rainwater harvesting trench (owned by the University) at a section of the Project site and an artificial pond in the wider area (located about 1 km away from the Project site). This amounts to about 6 ha of the entire area under study.

4.3.8 Traffic Survey

Traffic survey was conducted as part of the ESIA study to understand the traffic nature of the Project's area of influence, including the type of vehicles plying the

area, in order to put in place appropriate mitigation measures during the Project development and operation.

4.3.8.1 Survey Methodology and Analysis

There are two (2) sampling techniques for conducting traffic surveys in order to account for the number, movements, and classifications of vehicles at a given location over a period of time. The techniques are manual and automatic counts.

A manual count method was adopted for this survey. Owing to the socio-economic nature of the environment, the peak periods identified for the survey were from 7:30am to 9:00am, 12:00noon to 2:00pm, and 4:30pm to 6:00pm. The survey was carried out on 9th August, 2019.

4.3.8.2 Selection of Screen Lines

The screen lines for the traffic survey were selected based on the direction of movements that may be impacted during the phases of the Project. As presented in Figure 4.17, two (2) screen lines which were principal routes leading to the Project site, were identified and surveyed.

- *Screen Line 1 (SL 1):* to capture the traffic flow along Nguru-Gashua expressway from Nguru to Gashua.
- *Screen Line 2 (SL 2):* to capture the traffic flow along Nguru-Gashua expressway from Gashua to Nguru.

Figure 4.17: Aerial Imagery of the project site showing the screen lines

Source: EnvAccord Field Survey, 2019

The data collected by the traffic survey team (Plate 4.4) were recorded on a traffic survey designed sheets using tally system, while a stopwatch was used to monitor the count intervals. The vehicle classification schemes used for this survey are presented in Table 4.19.

Table 4.19: Vehicle Classification Scheme used for the traffic survey

S/N	Vehicle Classification	Vehicle Types
1.	Trucks/Lorries,	Tankers
		Trucks
		Pick-ups
		Trailers and Heavy duty vehicles
2.	Buses,	Private buses
		Commercial buses
		Coaster buses
		Mini buses
		Vans
3.	Cars and Sport Utility Vehicles (SUVs),	Cars
		Jeeps
		Space buses
4.	Cycles	Motorcycles
		Bicycles
5.	Tricycles	Three wheeled vehicles

Plate 4.5 shows some of the vehicle types observed during the survey.

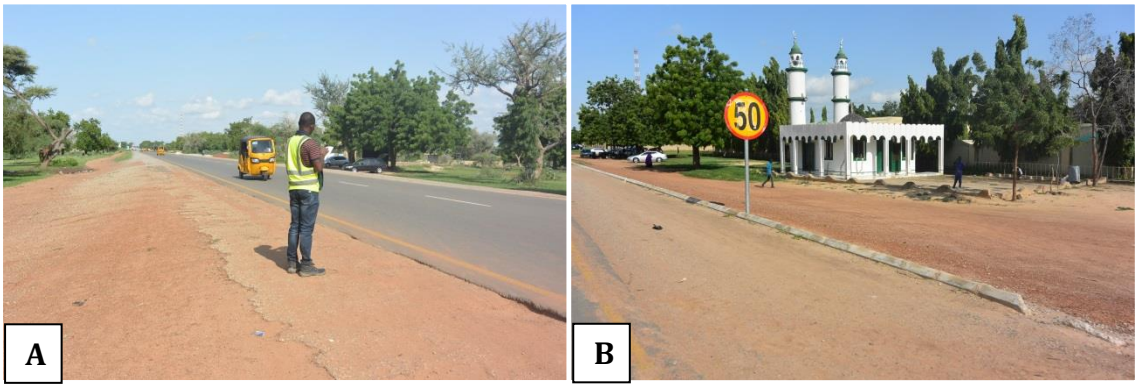


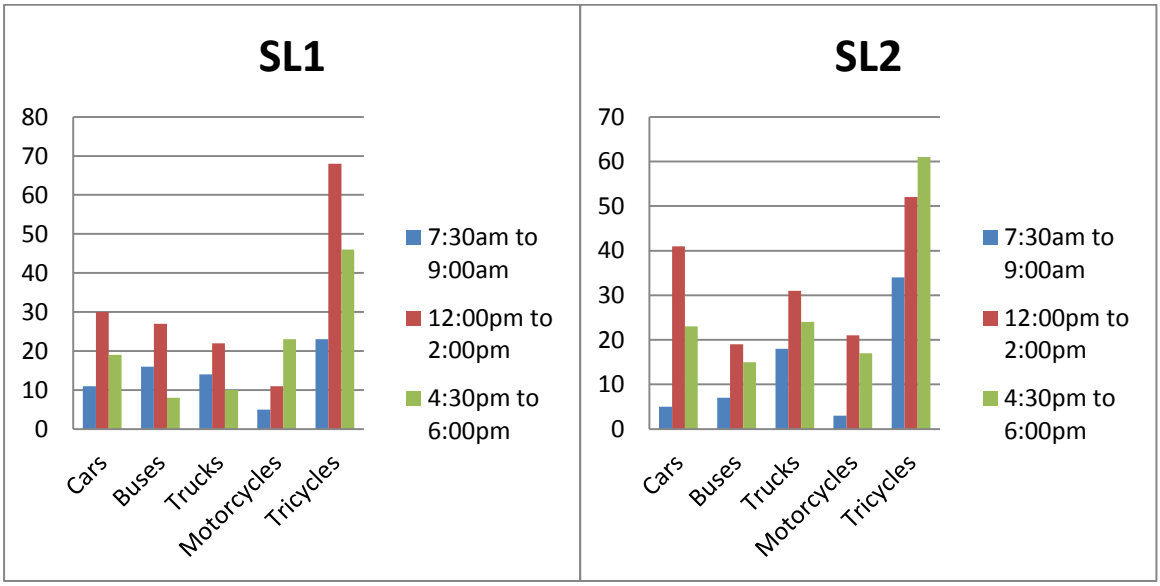
Plate 4.4: (A) Traffic count by field observers in the Project area (B) Traffic signs in the Project area **Source: EnvAccord Field Survey 2018**

Plate 4.5: Vehicle types observed during the survey
Source: EnvAccord Field Survey 2018

4.3.8.3 Results and Discussion

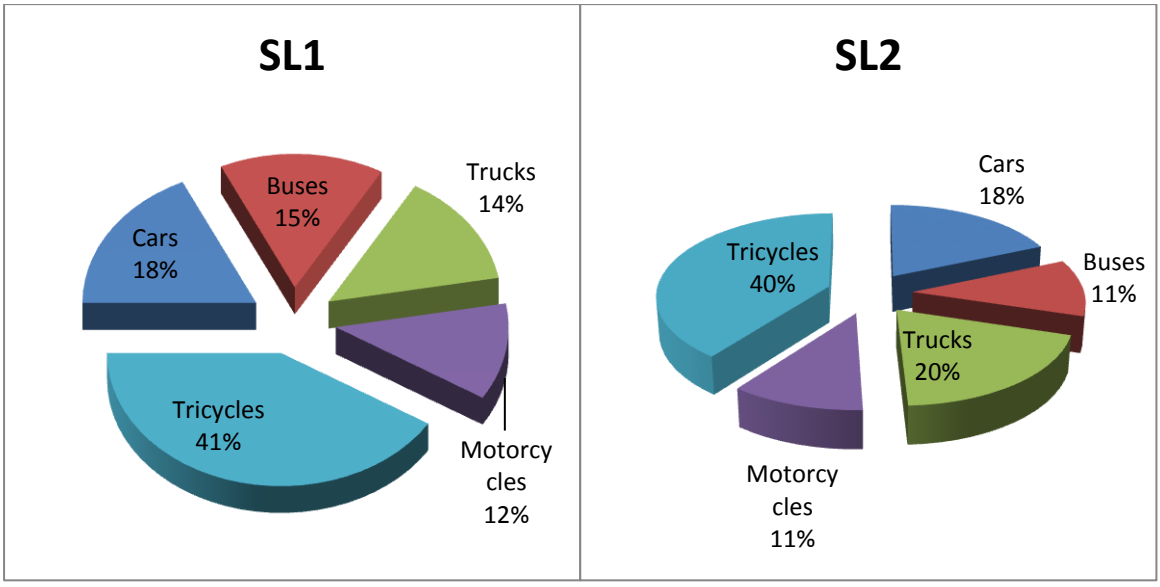
Based on field observations, the prominent means of transportation in the Project area are tricycles, cars and motorcycles. A few heavy duty trucks carrying farm produce, sand, gravel and livestock were also observed during the survey.

The results from the average count at the screen lines are presented in Figure 4.18 while the percentage composition of vehicles is presented in Figure 4.19.



Source: EnvAccord Field Survey, 2018

Figure 4.18: Average traffic flow result for the screen lines (SL1 & SL2)



Source: EnvAccord Field Survey, 2018

Figure 4.19: Percentage composition of vehicles for the screen lines (SL1 & SL2)

Road traffic in the Project area can be described as relatively light as Gashua town is a developing area. Based on the survey, the peak traffic periods are afternoons for both screen lines. There are a few traffic signs as well as security checkpoints along

the expressway. Additional traffic which might result from the Project activities is therefore envisaged to have minimal impact on the traffic situation in the Project area as further discussed in Chapter 5.

4.4 Description of Socio-economic Environment of the Project Area

4.4.1 Introduction

The proposed Project will be sited within the FUGA campus in Gashua, Bade Local Government Area of Yobe State. There is no local community presence within the Project site. However, the identified community within the 2km radius of the Project site is Low-Cost Community, Gashua. This section thus provides baseline information on the socio-economic and health survey conducted in the community.

4.4.2 Study Approach and Methodology

4.4.2.1 Study Area

The socio-economic survey was conducted in Low Cost Community, situated about 1.2km from the Project site in FUGA, Yobe State. With an estimated population of 2,000 residents (as observed by survey enumerators and corroborated by the community leaders), Low Cost community is located in Bade LGA of Yobe State. According to the 2006 National Population Census (NPC), the LGA has a population of 139,804 persons. Going by Nigeria's annual population growth rate of 3.2% (NBS, 2018) the LGA is estimated to now have a projected population of 256,627 persons.

Low Cost Community was built between 1979 and 1983 by the government of Sheu Shagari, who initiated the Federal Government mass housing programme. Low Cost community has a leader who reports directly to the District Head who also reports to the Emir of Gashua.

4.4.2.2 Study Population

The target populations for the study are the community residents who are above the age of 18 years. This study also considered community heads (often referred to as ward head), healthcare practitioners, youths and women.

4.4.2.3 Study Design

The study employed a sequential mixed methods research design using quantitative and qualitative methods of data gathering, analysis, and reporting. Information obtained during the study was investigated to separate perception from reality and to check for information consistency, reliability, and validity. The study was carried out from August 15 to 17, 2019. The study employed questionnaire administration for quantitative data gathering, while Key Informant Interview (KII), Focus Group Discussions (FGD) and stakeholders' consultation were used for the qualitative data gathering.

4.4.2.4 Sample Size and Sampling Techniques

The study population is largely homogenous with respect to ethnicity and language. The community does not have a large population. The sample size was calculated using the Cochran Formula.

$$n = \frac{Z^2 pq}{e^2}$$

Where n is the sample size

p is the estimate of the proportion of interest (i.e. 0.29)

q is 1 – p (i.e. 0.71)

e is the desired level of precision (i.e. 0.07)

Hence, n = 1.96^2 (0.29) (0.71) / 0.07

n = 180

A 10% non-response rate was added as a standard practice with the speculation that some respondents within the study area may refuse to participate or some may withdraw at the middle of the interview. Thus, the selected samples size was 200. The systematic sampling technique employed ensures a fair representation of both males and females among the respondents (Plate 4.6).

For the qualitative data, Focus Group Discussions (FGDs) were conducted (2 male groups, both men and youths, 1 female group) making a total of 3 FGDs. Each FGD includes a minimum of 6 and maximum of 15 participants. Different categories of respondents including youths, adults, males, females, people living with disabilities, educated and non-educated etc. were included in each FGD session. Key informant interview (KII) was held with the community leader. In-depth interview was held with healthcare practitioner of Federal University Gashua, Yobe State (Plate 4.7). Samples of the socio-economic data gathering tools are provided in Appendix 4.1.

Questionnaire Administration in Low-Cost community

Questionnaire Administration in Low Cost community

Plate 4.6: Sample Pictures of survey activities in the Project area

Plate 4.7: Sample Pictures of survey activities in the Project area

Source: EnvAccord Field Survey 2018

4.4.2.5 Data Collection, Analysis and Reporting

During data gathering, this study made use of Computer Assisted Personal Interviewing (CAPI), a SurveyCTO Software using smartphone and assisted by competent survey enumerators.

4.4.3 The Socio-Economic Baseline Report Structure

This study adopted the Social Framework Model for reporting its findings. In line with the social framework developed by Smyth and Vanclay in 2017, the socio-economic baseline report is structured as follows:

- Overview of key socio-economic indicators
- Demographic Profile;
- Administrative and socio-cultural institutions
- Livelihood Assets and Activities
- Infrastructure and Services
- Housing Structures/Settlement pattern
- Land Acquisition
- Project Affected Persons (PAPs)
- Health Profile
- Gender Assessment
- Community Concerns and Perceptions

4.4.3.1 Demographic Profile of the Study Area

- *Population Distribution*

The proposed Project will be located in FUGA campus within Bade LGA of Yobe State. Yobe State is located in Northeast Nigeria and was created on August 27, 1991. The State is bordered by Bauchi, Borno, Gombe, and Jigawa States. It also shares boundary to the north with the Republic of Niger. The State lies mainly in the dry savanna belt and the weather conditions are hot and dry for most of the year. The State occupies a total land mass of 45,502 km^2 and is ranked 6^{th} by land mass among the 36 States in Nigeria.

Using the NPC 2006 Census data and a growth rate of 3.2 % (NBS, 2018), Yobe State has a 2019 population projection estimate of approximately 3.3 million people of which 51.9 % are male and 48.1 % are female. The bulk of the State population is skewed towards people who are economically active, with the age group of 15-64 years owning approximately 50.5 % of the total population; 46.7 % of the population are within the age group of 0-14 years and 2.8 % of the population are 65 years and above.

Bade LGA occupies a land size of 772 km^2 and has a population density of 257 km^2 (NBS, 2016). Using the Nigeria population growth rate of 3.2 % per annual, the local government has 2019 population projection estimate of 256, 627.

- *Culture, Ethnicity and Religion*

The ethnic composition of Gashua is rich and diverse, with interesting historical and cultural heritage. The study area has five major ethnic groups which include the Kanuri, Fulani, Karekare, Bade and Hausa. The people of Gashua, just like many people in Yobe State are well known for their Durbar; rich culture and traditions arising from their historical connection with North Africa and Eastern Arabia. The Durbar provides illuminating perspective to the display of horses, regalia and spectacular horsemanship to bring about colour, pump and pageantry to the joy of

spectators. Islam stands as the largest religion, with 98% estimate of the total population in Bade LGA while Christianity has 2 % of the population.

The language of the identified community is predominantly Bade, which has been estimated to be spoken by over 344,000 people in Nigeria (Georg Ziegelmeyer, 2015). Analysis of the data obtained from the baseline survey showed that 92%, representing one hundred and eighty-four (184) respondents are Muslims while 8% representing sixteen (16) respondents are Christians. Despite religious differences, it was gathered that there is a cordial relationship among the people.

- *Migration Status and Patterns*

During the survey, it was revealed that most residents within the community are natives of the community, who settled in the area generations ago. However, some people have emigrated from the community to other towns or state for varying reasons such as security, social and economic opportunities.

- *Crime, Security and Safety*

During the interview with the community leader, it was stated that the community is peaceful, although there are many people who are concerned about the security issue in the town as Yobe State is one of the states affected by the Boko Haram insurgency. For safety purposes, the community leader (ward head), along with the District Heads and Emir manage the affair of the town by supporting vigilante groups and Joint Task Force. The community also has a good relationship with the local police command (Plate 4.8).

Plate 4.8: Police station in the community
Source: EnvAccord Field Survey 2018

- *Vulnerable or Marginalized Groups*

Vulnerability is the diminished capacity of an individual or group to anticipate, cope with, resist and recover from the impact of a natural or man-made hazard (IFC, 2012). In the context of this report, vulnerable groups are groups who by virtue of gender, ethnicity, age, physical or mental disability, economic disadvantage or social status may be more adversely affected by a Project than others. They may include people who are limited in their ability to take advantage of a project's development benefits.

Vulnerable groups within the community were observed to be the physically challenged, elderly women and men. This classification is by virtue of their economic vulnerability based on dependency. The elderly women depend on their husbands, who often are not economically buoyant while the elderly men are often farmers with depleting strength, many of whom also depend on the remittances from their children to survive. The people living with disability within the community often resort to begging for alms or engaging in menial jobs to support themselves. However, none of the vulnerable groups identified during study have direct links or derive benefits from the proposed Project site.

Host Community Profile

The community overview is summarized below in Box 1.1.

Box 1.1: Overview of the Project AoI – Demographic Profile

- **Low Cost community is relatively homogenous in terms of ethnicity and language.**
- **Islam is the most prevalent religion in the community.**
- **The housing pattern in the community is nucleated and are built with cement blocks and aluminum roofing sheets**
- **Lands are owned by individual and can be sold, leased, shared and gifted.**
- **Trading and seasonal agricultural activities are the common livelihood activities in the community**

During the baseline survey, 52.50 % of the respondents in the community were male while 47.50 % were female representing 105 males and 95 females among the respondents.

Further analysis of the baseline data showed the age distribution among the gender, 33.33 % of respondents within the age group of 18-30 years are male, 54.74 % are female. The male respondents within the age group of 31-45 years are 46.67 % while 37.89 % are female. As shown in the Table 4.21, there are 7.37 % of female respondents within the age group of 46-65 years and 20 % of male respondents.

Table 4.21: Age-group distribution between the two genders

Gender	18-30	31-45	46-65
Female	52 (54.74%)	36 (37.89%)	7 (7.37%)
Male	35(33.33%)	49 (46.67%)	21 (20%)
Total	87 (43.50%)	85 (42.50%)	28 (14%)

According to the data collected during the KII and baseline survey, the community is majorly occupied by Hausa, Fulani and Bade tribes. The survey data shows the distribution of respondent's ethnicity, a large percentage are Hausa (93 %), Fulani tribe are 3.50 % of the sampled respondents, 3.50 % are Bade. Among the respondents, there are Muslims (98 %) and Christians (2 %). Figure 4.20 shows the graphical distribution of respondent's religion in the study area.

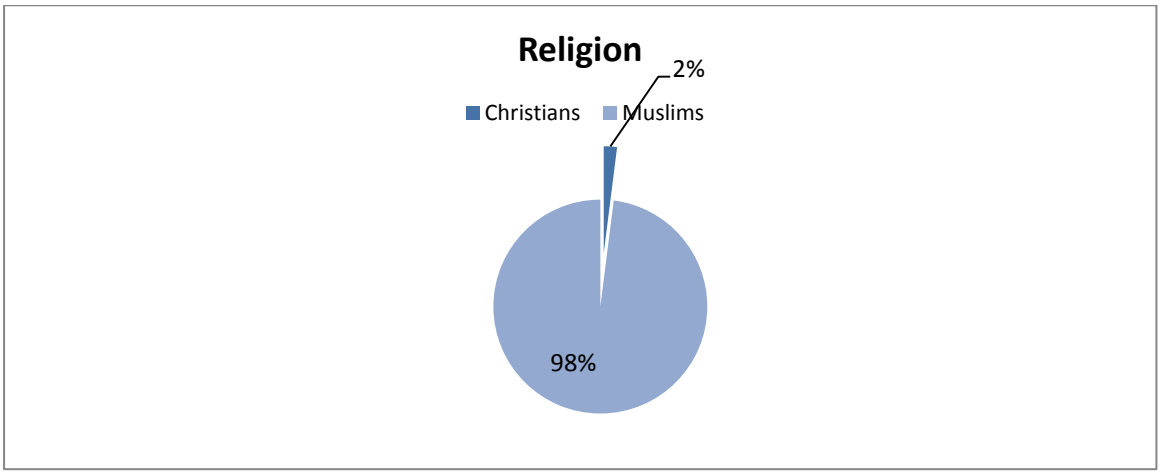


Figure 4.20: Distribution of religion among the respondents

The baseline survey results show that the average household size in the study area is 7.8 persons, with males averaging about 5.1 per household compared to females who average 2.9 per household. The community has an economically active and youthful population in which 43.50 % are between the age group of 18 – 30 years; 42.50 % are between the age group of 31 – 45 years and 14 % are between the age group of 46 – 65 years. With regard to education, 10.50 % of the respondents have attained secondary school level of education; 31.50 % have attained tertiary education and 58 % had no formal education.

As at the time of the survey, about 54 % of the respondents reported to be self-employed and many of them were engaged in trading of goods and services; 3.50 % are unemployed; 21 % employed; 14.50 % are farmers and 7 % are students.

50 % of the respondents had lived in the community for more fifteen years; 25 % had been living in the community for about 11-15 years and 25 % of the respondents had been living in the community for about 6-10 years. This suggests that a large percentage of respondents have a good knowledge of the community.

- *Marital Status*

The survey data revealed that about 75.50 % of respondents within the community are married; among these married people, 75.50 % are into monogamous family while 24.50 % are into polygamous family. The polygamy is supported by their religion and culture. 14 % of sampled respondents stated that they were single or soon to be married while 10 % are divorced (Figure 4.21).

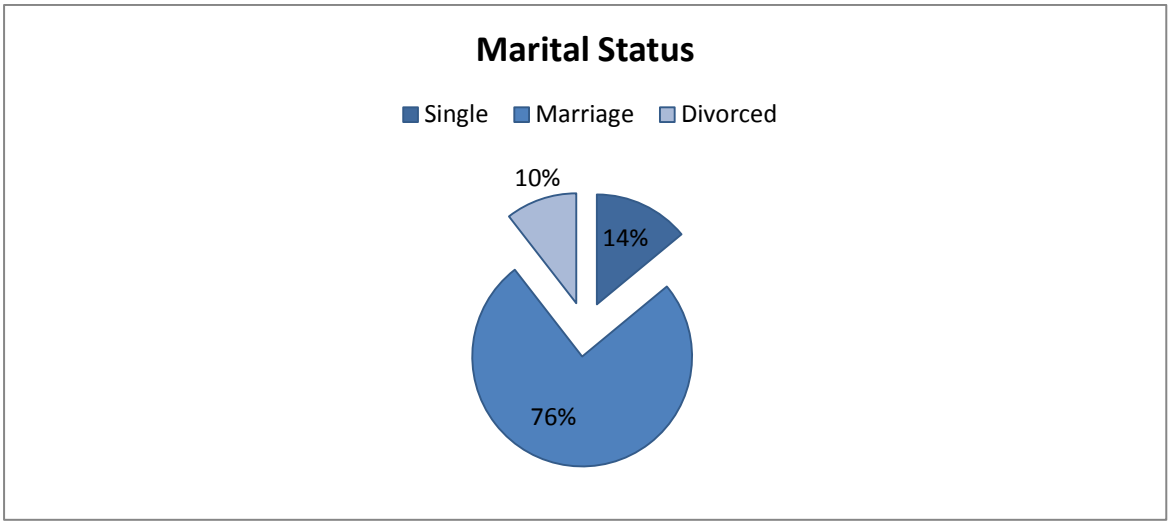


Figure 4.21: Marital status among respondents in the community

4.4.3.3 Administrative and Socio-Cultural Institutions

- *Government Institutions*

Nigeria is made up of 36 states and one Federal Capital Territory (FCT). Each of the states is subdivided into smaller administrative units called Local Government Areas (LGAs). There is a total of 774 LGAs in Nigeria. It has a mixed legal system of English Common law, Islamic law and traditional law.

Yobe state, which has its capital in Damaturu, comprises of 17 LGAs. The proposed Project site within the FUGA campus is situated in Bade LGA. The relevant government ministries in the State that have been consulted in respect of this Project at the State level include: Yobe State Ministry of Environment, Yobe State Environmental Protection Agency, Yobe State Ministry of Women Affairs and Yobe State Ministry of Youth, Sport and Social Development, as further discussed in Section 5 of this chapter.

- *Traditional Leadership Patterns and Representations*

Traditional leadership remains a strong and respected structure in Yobe State, just like many other states in Nigeria. The powers of traditional leaders are still much relevant in modern times, the respect and ceremony that surround these positions remain strong, and also these leaders retain significant influence over their people.

The community is governed by traditional rulers, ranging from constitutional monarchs to ceremonial ones. The Emir is an example of the constitutional monarch, while the districts heads play a supporting role and work with the Emir in the progression of the community. The power structure thus begins from the Emir to the District head, then to the ward heads (community heads). Low Cost community has a leader who reports directly to the District Head who also reports to the Emir of Gashua.

- *Community-based Organizations and Other Local Institutions*

Community groups are an important source of social capital in Nigeria, providing social, livelihood, financial and religious support. Most communities in the country typically have a variety of associations, including livelihood-based groups, saving groups, religious groups and other community-based organizations that play an important role in the management of the community. There is open membership opportunity in most of these groups, and there is the possibility of people belonging to more than one group. However, groups such as Elders Forums and Traditional Cultural Groups have restricted participation.

During the KII, the community leader stated there are several associations in the area such as Vegetable Marketer Associations and Farmers Association. Also, there are informal savings and credit groups within the community and its neighbouring wards.

- *Social Conflict*

During the data gathering survey, the survey enumerators were informed that there have been no major conflicts in the community within the last 5 years. The ward head resolves domestic and minor conflicts within his jurisdiction. However, whenever the disputes escalate, the case will be transferred to the District Head, then referred to the Emir, if necessary. The Emir has the authority to make final verdict for conflict resolution.

4.4.3.4 Livelihood Assets and Activities (Economics, Livelihoods, and Employment)

Box 4.2: Overview of the Project AoI – Livelihood Assets and Activities

- **The principal economic activity in the Project area is agriculture and trading.**
- **There is a central market close to the community**
- **Traders mostly sell goods such as farm produce, manufactured products and offering of services.**
- **Self-employment is the common livelihood activities in the community**

Yobe State economy is driven largely by agriculture with more than 80% of the citizens engaged in small scale subsistence farming. Food crops such as millet, sorghum, beans, and maize are grown by small-scale farmers to generate household

income. Cash crops are commonly grown by farmers in the state such as groundnut, sesame seed, cotton and Benny seed. The State has some of the largest livestock markets in West Africa. It supplies meat, hides and skin to other parts of the country particularly to the south (Yobe State Government's Fiscal Strategy Paper, 2013).

The major occupations reported in the Low Cost Community are:

- Agriculture; and
- Trading.

- *Agriculture*

Farming is one of primary occupation of most residents in the community. The farming is done mostly by men along with their family members. Their farmlands are averagely large in size and farming equipment are crude with many farmers making use of cutlasses and hoes. The farmers practiced shifting cultivation and mixed cropping. Farming activities are mostly done during the rainy season. The farmers either sell their farm produce or consume them with their family members as opined by the community leader.

- *Trading*

There are no major trading activities within the community. Members of the community who are into trading activities do have their shop outlets in the main market, which is situated outside the community (Plate 4.9). Those who are into trading activities leave the community very early in the morning and return late in the evening. Some common products being sold by the members of the community are vegetables, fish, rice, beans, meats, peppers and other food supplements, clothes and electronics. Some of them are also into services like tailoring, barbing and computer services. From the survey data, there are 42.50 % of the respondents who are traders.

Plate 4.9: Trading activities found close to the community

Source: EnvAccord Field Survey 2018

- *Income Levels and Poverty*

During the household survey, the respondents gave an estimate of their monthly income, 25 % of the respondents stated that they earn less than 10,000 naira per month; 75 % earn between 10,000 and 50,000 naira. It is believed that poverty levels have increased over time with reference to factors such as reduction in number of people who come to community market to buy farm products, and shortage of formal employment opportunities. The cost of living in the community is low. However, food prices vary considerably according to seasons. During the rainy season, the cost of food is usually cheaper than the dry season.

4.4.3.5 Infrastructure and Services

Box 4.3: Overview of the Project AoI – Infrastructure and Services

- **The internal roads networks are smooth and well tarred.**
- **There are government hospital, private hospital, and pharmaceutical outlets.**
- **The community has existing market accessible for members and non-members.**

- *Access to Electricity*

The community is connected to national grid for electricity supply. The consistency of the electric supply is not very encouraging as reported by the respondents. During the baseline survey, 88 % of all the respondents affirmed that they have access to electricity while only 12 % did not have access to electricity. There is no communally owned generator, but a few residents have privately owned generators to provide back-up electricity for their business activities and houses. It was also observed that some residents installed solar panels in their home as alternative power supply. Some electrical infrastructure seen within the community are shown in Plate 4.10.

Plate 4.10: Electricity infrastructure observed in Low Cost Community

Source: EnvAccord Field Survey 2018

- *Access to Water*

Tap water and boreholes were found in the community. High proportion of people have access to water, however most residents in the community make use of public water supply while some buy water from water vendors, as shown in Plate 4.11. The survey data revealed that 79 % make use to public water supply and 21 % make use of private borehole.

Plate 4.12: Water supply facilities within the community
Source: EnvAccord Field Survey 2018

- *Telecommunication, Transportation and Road Infrastructure*

The community has access to all the available mobile telecommunications networks in Nigeria such as MTN, Airtel, Glo and 9mobile. This makes it quite easy to communicate socially and also carry out business transactions within any part of the community. The common forms of transportation in the community are cars, motorcycles, tricycles and bicycles (Plate 4.12). The road networks within the community are good and traffic within the community is usually light.

Plate 4.12: Road infrastructure within the community
Source: EnvAccord Field Survey 2018

- *Access to Education*

Literacy level within the community is average when compared with other States in Nigeria. Large percentages (58 %) of the respondents do not have formal education, 10.50 % of the respondents have attained secondary school level of education and 31.50 % have attained tertiary education (Figure 4.22). Further analysis of education and gender revealed that female education is not a big priority among the respondents; 75.86% of those who have no education are female while 24.14 % are male. 66.67 % of respondents who have attained the secondary school level of education are male while 33.33 % were female. None of the respondents who had attained tertiary education were female. However, there are educational facilities within the community such as primary schools, Islamic schools, and secondary schools as shown in Plate 4.13.

Plate 4.13: Educational facilities observed within the community
Source: EnvAccord Field Survey 2018

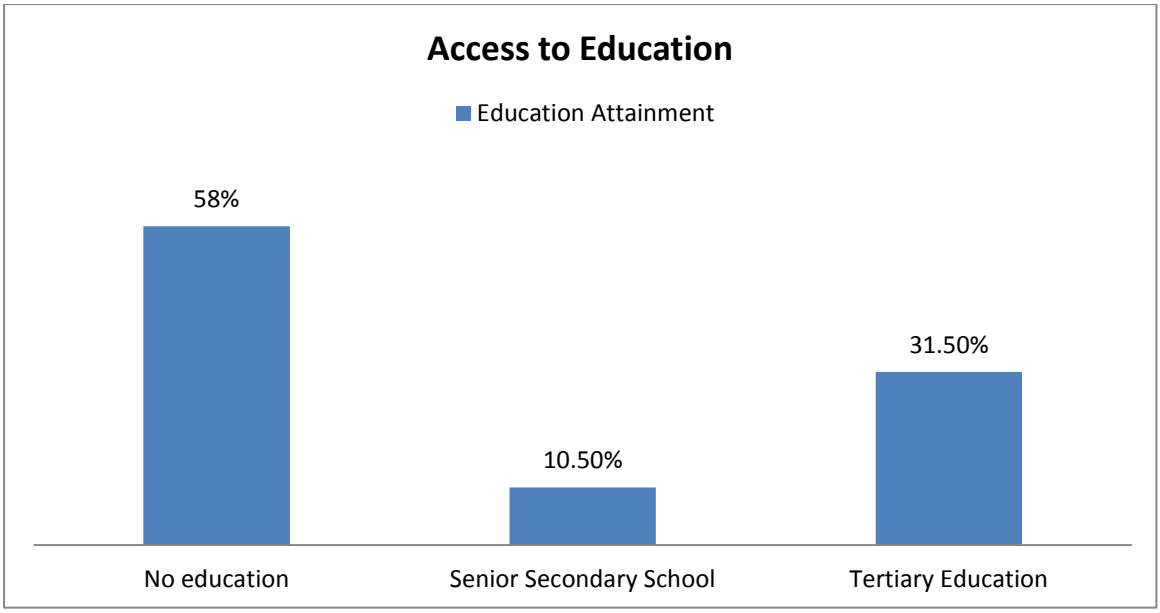


Figure 4.22: Education level among respondents in Low Cost Community

- *Recreation*

The community is conservative. The survey enumerators observed that the community has designated playground for playing football.

- *Settlement patterns, Housing and Business Structures*

The houses in the community are arranged in nucleated and linear settlement patterns. The houses are built with fences to allow for privacy for their women and girls. Results from the household survey indicated that about 89.50 % of the houses are block of flats; 7 % are tenement houses and 3.50 % are bungalows. Some of the houses and business structures observed in the community are shown in Plate 4.14. Most houses have water system (74 %), pit toilets (16 %) and those with pail system are 10 % of the houses. Materials used in construction of the houses in the community are cement blocks and corrugated iron sheets for roofing.

Plate 4.14: Housing and business structures within the community
Source: EnvAccord Field Survey 2018

The plastering materials of most houses in these settlements are cement. Overall, about 46.67 % of the houses in the community were plastered with cement. Cement block houses are generally solid and durable; majority of the houses in the community are built with cement blocks.

4.4.3.6 Land Acquisition

During the KII with the community leader, it was gathered that the land within the community originally belong to the Federal Government, but the land properties have been sold to private individuals after the government abandoned the housing intervention programme. Individuals, including indigenes and non-indigenes of the community can own a piece of land and put it to any use of their choice as long as they are able to fulfil the transaction obligations with the rightful owner.

The proposed Project site (12.5 ha) is within FUGA permanent site in Gashua. The University has a total land area covering 2,248 hectares in Bade LGA which was allocated by the Federal Government. The site for the proposed Project was authorized by the University management.

4.4.3.7 Project Affected Persons (PAPs)

Project affected persons are the people whose activities may be directly or indirectly affected by the proposed Project. Such people include farmers that may temporarily

cultivate on the Project site or those who navigate the access road beside the Project site leading to their farmland. During the FGD sessions with men and women in the communities, it was discovered that no member of the community engage in farming activities on the proposed Project site as their means of livelihood. Also, there are no benefits (in terms of ecosystem services) that the local community derives from the site. In addition, none of the University staff uses the Project for livelihood activities such as farming or fishing.

4.4.3.8 Health Profile

Box 4.4: Highlight of the Community Health Profile

- **Household survey data indicate that majority of the residents have access to good medical health care.**
- **Most of the residents in the community make use of public health facilities and pharmaceutical outlets**
- **Income of the residents is a deciding factor on choice of healthcare facilities to use.**

During the socio-economic survey, it was gathered that the community have adequate access to a well-equipped healthcare facility. There are also pharmaceutical shop outlets in the community. These pharmacists' shops serve as a place for buying drugs to cure minor ailments such as headache, malaria, fever, among others. However, in the case of serious medical attention, the community residents go to the General Hospital in Gashua for medical attention (Plate 4.15).

The KII held with the healthcare practitioners in FUGA revealed that malaria, typhoid, ulcer and fever are the most reported health cases by the students. The doctor-patient ration is 1/50, meaning that there is only one (1) doctor for fifty (50) patients, rather than the acceptable standard of 1/10. The University health clinic facilities are not adequate as there are only four (4) beds in the hospital.

The baseline survey further revealed that 86 % of the respondents prefer to visit the General Hospital in Gashua while 14 % opt for pharmaceutical shop outlets to buy drugs. All respondents rated their health status as good during the survey. Figure 4.23 shows the preference of healthcare facilities by the respondents.

Plate 4.15: Healthcare facilities observed in the community

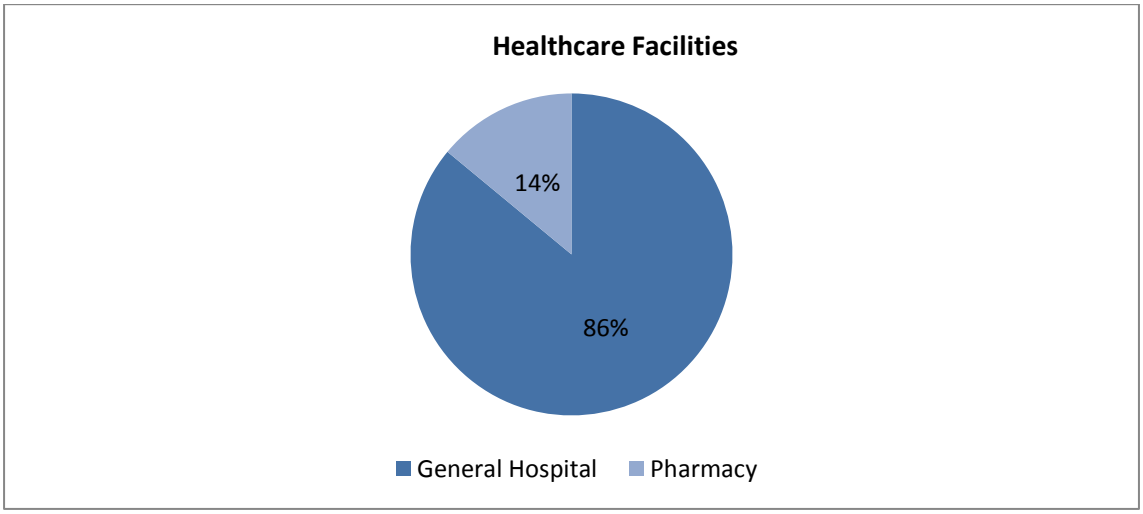


Figure 4.23: Preference of healthcare facilities of the respondents

4.4.3.9 Gender Assessment

Gender equality is crucial to poverty reduction and it is one of the Sustainable Development Goals (SDGs), which have been commonly accepted as a framework for measuring development progress.

- *Role of Women Within the Community*

Women are saddled with the responsibility of educating the children and also are the main house keepers within the community. Some of them also engage in petty trading to support the family.

- *Major Health, Social And Environmental Challenges Faced By Women*

There was no reported health, social and environmental challenges facing the women as at the time of the study.

- *Women Representation In Leadership*

The discussion held with women within the community revealed that many of them are not permitted to take up leadership roles. There was no measure in place to

integrate women in the community leadership structure. The women also pointed out that there is one women association within the community named "Women Initiative" but the association is not well structured and also not functioning.

- *Autonomy for Decision Making*

Women within Low-Cost community do not have the autonomy for decision making except for their personal decision relating to themselves and the family. Even at the family level, consultation has to be made with their husbands. As evident from the discussion held with women in the community, they are not allowed to inherit property within the community. Neither are they permitted to own landed properties.

- *Major Grievances from The Women*

The main grievance reported by the women is the need for financial empowerment for their business. The dressing pattern of women in the community is mostly influenced by their culture. Women must not dress outside the cultural standard of "all covered cloth" and must use hijab within the community. Women's movement is restricted as they are not permitted to move around the community in the evening from 8:00p.m and above.

- *Gender Based Violence (GBV)*

According to Nigeria Demographic and Health Survey, the percentage of women who have experienced physical, sexual, or emotional violence committed by their current or most recent husband/partner in Yobe State was 28.0% which is low compared to some other states in Nigeria (Nigeria DHS, 2018).

During the data gathering, it was observed that the marginalization of women is prevalent within the community. This may be attributed to the patriarchal culture, customs, religious beliefs, and social norms that are characteristic of the region. This limits the participation of women in the various household, economic activities, and community life. It was also observed that most of the women stay indoors.

GBV cases are usually reported to the community heads or police depending on the severity. Civil Society Organizations and Non-Governmental Organizations collaborate with Yobe State Ministry of Women Affairs and Social Development to provide GBV services in Yobe State. The closest service provider identified within the area was located at the General Hospital Gashua.

4.4.3.10 Community Concerns and Perception

The survey data revealed that none of the respondents were aware of the proposed Project until the survey team explained the Project in detail to the community leader and members. During the discussion with the men, youths and women, the Project components and associated impacts were carefully explained. The reaction was

positive as the participants believe that there is an impending economic advantage for them in terms of temporary jobs on site during construction.

CHAPTER FIVE:

ASSOCIATED AND POTENTIAL IMPACTS

CHAPTER FIVE

ASSOCIATED AND POTENTIAL IMPACTS

5.1 Introduction

This chapter presents the potential environmental and social (E&S) impacts and risks associated with the proposed 2.5 MW solar-hybrid power plant and associated infrastructure in the Federal University Gashua (FUGA), Yobe State, under the Federal Government's Energizing Education Programme (EEP), a component of the Nigeria Electrification Project (NEP). It also includes the methodology employed to assess the significance of the E&S impacts and risks.

5.2 Impact Assessment Overview

The potential for an E&S impact exists where an environmental aspect has been identified i.e. where a project activity has been determined to have the potential to interact with the biophysical and socio-economic environment. The significance of each impact is then determined. Figure 5.1 illustrates the general overview of the impact assessment process employed for this ESIA.

The primary objectives of the impact assessment process are to:

- Establish the significance of identified potential impacts that may occur as a result of the proposed Project activities;
- Differentiate between those impacts that are insignificant and those that are significant (; and
- Apply mitigation hierarchy measures for the identified significant impacts and assess residual impacts, including periodic monitoring of the effectiveness of the proffered mitigation measures through the entire life cycle of the Project.

The assessment of impact significance is both in qualitative and quantitative terms. Qualitatively, the impact significance is ranked on four (4) widely accepted levels: **Major**, **Moderate**, **Minor** and **Negligible.**

The impact assessment covers the entire life cycle of the Project. i.e.: pre-construction; construction; commissioning; operation; and decommissioning. However, environmental and social issues including mitigation and management plans related to decommissioning activities are discussed in Chapter 8.

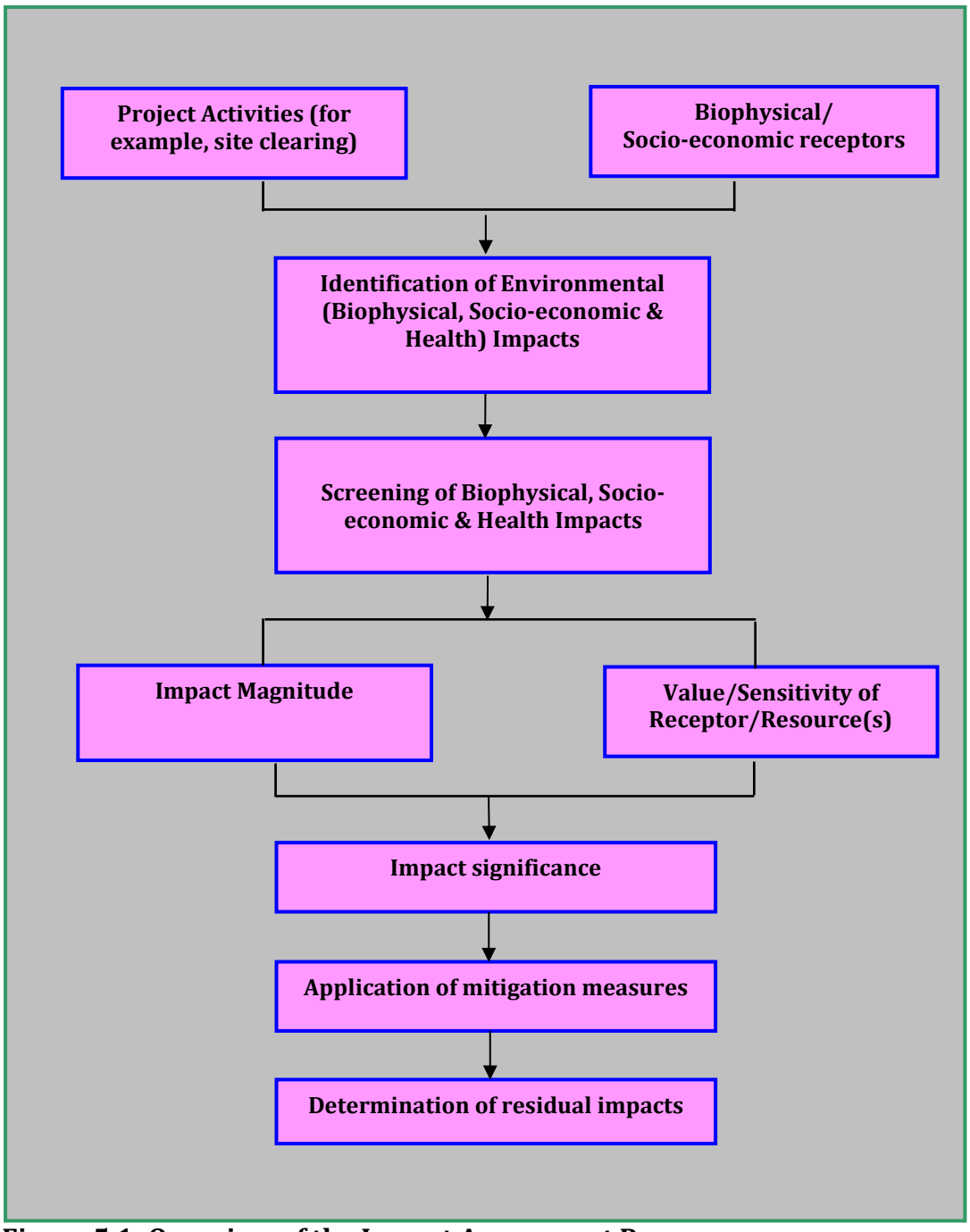


Figure 5.1: Overview of the Impact Assessment Process

5.3 Identification of Environmental and Socio-economic Aspects and Impacts

5.3.1 Defining Environmental and Socio-economic Aspects and Impacts

The International Organization for Standardization's Environmental Management Systems (EMS), ISO 14001, defines an environmental aspect as: *"An element of an organization's activities, products or services that can interact with the environment." while an* environmental impact is defined as: *"Any change to*

the environment, whether adverse or beneficial, wholly or partially resulting from an organization's activities, products or services."

To identify environmental and social aspects of the Project, the proposed Project activities were considered in terms of their direct or indirect potential to:

- Interact with the existing natural environment including its physical and biological elements;
- Interact with the existing socio-economic environment; and
- Breach relevant policy, legal and administrative frameworks including national legislation, relevant international legislation/conventions, standards and guidelines, and corporate environmental policy and management systems.

Activities assessed covered planned and non-planned events.

Table 5.1 illustrates the links between project activity, environmental aspect and potential impact.

Table 5.1: Example of a Link between Activities, Environmental Aspects and Impacts

Project Activity	Environmental Aspect	Potential Impact
Site clearing and grading	Removal of vegetation	Loss of biodiversity
Installation of PV panels	Soil excavation	Soil erosion and degradation
	Noise generation	Disturbance to surrounding environment and/or sensitive receptors

5.3.3 Potential Impact Characteristics

The following characteristics were also used to define potential impacts that may be associated with the proposed Project:

i. *Negative:* An impact that is considered to represent an adverse change from the baseline or to introduce a new undesirable factor.

ii. *Positive:* An impact that is considered to represent an improvement to the baseline or to introduce a new desirable factor.

iii. *Direct*: Impacts that result from the direct interaction between a planned project activity and the receiving bio-physical and socio-cultural environment.

iv. *Indirect:* Impacts that result from other activities that are encouraged to happen as a consequence of the project.

v. *Temporary:* Temporary impacts are predicted to be of short duration, reversible and intermittent/occasional in nature

vi. *Short-term:* Short term impacts are predicted to last only for a limited period but will cease on completion of the activity, or as a result of mitigation measures and natural recovery

vii. *Long-term:* Impacts that will continue for the life of the project, but cease when the project stops operating.

viii. *Permanent:* Potential impacts that may occur during the development of the project and cause a permanent change in the affected receptor or resource that endures substantially beyond the project lifetime

ix. *On-site:* Impact that is limited to the project site.

x. *Local:* Impacts that affect locally important environmental resources or are restricted to a single (local) administrative area or a single community.

xi. *Regional:* Impacts that affect regionally important environmental resources or are experienced at a regional scale as determined by administrative boundaries.

xii. *National:* Impacts that affect nationally important environmental resources; affect an area that is nationally protected; or have macro-economic consequences

xiii. *Reversible:* An impact that the environment can return to its natural state

xiv. *Irreversible:* An impact that the environment cannot return to its original state, e.g. the extinction of an animal or plant species

xv. *Cumulative/Synergistic*: Potential impacts that may result from incremental changes caused by other past, present or reasonably foreseeable actions together with the project. This also includes synergy with other projects/infrastructure in the project area

xvi. *Residual:* Both environmental and social impacts that will remain after the application of mitigation measures to project impacts during each of the project phases.

5.4 Screening and Scoping for Potential Impacts

A modified version of the Leopold Interaction-matrix technique was employed to screen and scope for the potential impacts of the proposed Project on the environment. The basis for the screening was derived from the following:

- Knowledge of the Project activities as summarized in Table 5.2.
- Detailed information on the environmental and socio-economic setting of the Project's area of influence as documented in Chapter 4. The potential environmental and social receptors/resources that could be affected by the proposed Project are summarized in Table 5.3.
- Consultation with relevant stakeholders.
- Review of other ESIA reports on similar projects/environments.
- Series of experts group discussions, meetings and experience on similar projects.

Table 5.2: Summary of the proposed Project Activities

S/N	Project Phase	Associated Activities
1.	Pre-Construction	Site selection
		Site clearing and preparation
		Mobilization of construction equipment and materials to site
2.	Construction/ Installation	Civil work activities including excavation, trenching, cable laying, foundation, construction of building (e.g. training centre)
		Installation of power plant facilities such as PV panels, mounting structures, inverters, power storage batteries; upgrade of existing distribution infrastructure; installation of streetlights
		Waste generation and disposal
3.	Commissioning	Testing of power plant and associated infrastructure
4.	Operation	Power generation (through PV panels) and distribution; provision of training on renewable energy
		Routine maintenance including occasional cleaning of PV panels; waste generation

Note: Activities related to decommissioning are discussed in Chapter 8

Table 5.3: Resource/Receptors and Impacts Indicators Considered

Environmental Receptor/Medium	Comment	Impact Indicators
Physical		
Air	Ambient air quality within the Project's area of influence.	Increase in concentration of gaseous and particulate pollutants.
Noise	Ambient noise level within the Project's area of influence.	Increase in ambient noise level; day and night-time disturbance; communication impairment, etc.
Soil	Soil environment the Project's area of influence.	Changes in physical, chemical and biological properties of the soil; loss of soil ecology and fertility; soil erosion, etc.
Groundwater/ aquifers	Underground water resources in the Project's area of influence.	Decrease in underground water/aquifer reservoir level; groundwater contamination.
Surface water	Surface water body in the Project's area of influence	Surface water contamination.
Landscape/	The geomorphological land	Alteration in drainage pattern;

Environmental Receptor/Medium	Comment	Impact Indicators
topography	forms and terrain of the Project site and its surrounding environment.	changes in landscape.
Biological		
Terrestrial flora and habitats	Plant species (vegetation) in the Project's area of influence.	Loss of terrestrial flora; introduction of new species.
Terrestrial fauna	Terrestrial fauna in the Project's area of influence.	Loss of terrestrial fauna; involuntary migration.
Socio-economic Environment		
Land use	Existing land use within the Project site and its surrounding environment.	Loss of existing land use.
Visual prominence	The aesthetic quality of the proposed Project on the surrounding visual catchment.	The compatibility of the Project with the character of the locality; visual nuisance through reflection of panels.
Demography	Demography of community in the Project's area of influence.	Changes in demography, gender ratio, age distribution, socio-economic structure, etc. of the local community
Utilities	The existing utilities (e.g. power supply, water, sewer services, etc.) in the Project's area of influence.	Changes in existing utilities; potential damage to public utilities.
Infrastructure	The existing infrastructure such as road, waste handling facilities, etc. within the Project's area of influence.	Potential damage to road infrastructure; road traffic and accidents; increased pressure on waste management facilities.
Employment/income	The employment situation in the Project's area of influence.	Opportunities for local employment; changes in income level.
Gender	Gender and disproportionate gender impacts	Potential for gender-based violence (GBV); marginalization of women; gender pay gaps; discrimination, etc.
Other (Health and Safety)		
Construction workers	Health and safety of construction workers.	Accident, injury, fatality, exposure to nuisance (dust, noise), fire, etc.
Workplace health and safety	Health and safety of employees involved in the operational phase of the Project operation.	Accident, injury, fire, explosion, etc.
General public	Health and safety of the general public	Accident, fire, explosion, etc.

Identified Project activities, biophysical and socio-economic receptors were integrated into a matrix. The Project activities are on the y-axis while the biophysical and socio-economic receptors are on the x-axis. The matrix was completed for each of the Project elements. The Leopold's Interaction matrix was subsequently assessed to identify every possible case of activity-receptor interaction. Where it was considered that an activity-receptor interaction was possible, the cell was marked denoting an identified environmental aspect (denoted as "X" in Table 5.4).

Table 5.4: Activity-Receptor Interaction for Impact Screening

Summary of Project Activities at various Phases	Receptors																
	Physical						Biological		Socio-economic						Others (Health and Safety)		
	Air Quality	Ambient Noise	Soil	Groundwater and Aquifers	Surface Water	Landscape/ Topography	Terrestrial Flora	Terrestrial Fauna	Land Use	Population	Utilities	Infrastructure	Employment/ Income	Gender	Construction workers	Workplace health and safety	General Public
Pre-construction Phase																	
Site selection									X								
Site clearing and preparation	X	X	X			X	X	X					X		X		
Mobilization of construction equipment and materials to site	X	X										X	X				X
Construction Phase																	
Civil work activities including excavation, trenching, cable laying, foundation, construction of building (e.g. training centre)	X	X	X	X	X					X			X	X	X		X
Installation of power plant facilities, upgrade of existing distribution infrastructure, installation of streetlights	X	X	X											X	X		
Waste generation and disposal			X	X								X	X		X		X
Commissioning Phase																	
Testing of power plant and associated infrastructure		X								X		X			X		X
Operational Phase																	
Power generation and distribution and provision of training on renewable energy		X											X	X		X	X
Routine maintenance; waste generation and disposal	X		X	X		X					X	X	X	X		X	X

Note: Decommissioning is separately covered in Chapter 8

5.5 Determination of Impact Significance

Once all environmental aspects (and interactions between a receptor/resource and Project activity) were identified, the levels of impacts that may result from the proposed Project activities were assessed. Three (3) stages were utilized to establish significance of impacts as follows:

- **Impact Magnitude** which is a function of the combination of the following impact characteristics: extent, duration, scale and frequency;
- **Value/Sensitivity/Fragility and importance of the relevant Receptor**;
- **Identification of the impact significance,** which is the "product" of a combination of the above two (2) key variables.

The magnitude of an effect is often quantifiable such as the extent of land take or predicted change in noise levels while the sensitivity, importance or value of the affected resource or receptor is derived from:

- Legislative controls;
- Designated status within the land use planning system;
- Number of affected individual receptors;
- An empirical assessment based on characteristics such as rarity or condition;
- Ability of the resource or receptor to absorb change; and
- Public perception about the criticality or sensitivity of the receptors.

The determination of significance also includes consideration of performance against environmental quality standards or other relevant pollution control thresholds, and compatibility with environmental policies.

Further details on the criteria used for determining the impacts significance are provided in the sub-sections below:

5.5.1 Impact Magnitude

The magnitude designations employed for potential negative impacts are: **Negligible**; **Low**; **Medium**; and **High**. In the case of a positive impact, it is considered sufficient for the purpose of the impact assessment to indicate that the Project is expected to result in a positive impact, thus no magnitude designation is assigned.

The magnitude of an impact takes into account the various dimensions of a particular impact in order to make a determination as to where the impact falls

on the spectrum from Negligible to High. These criteria are discussed further as follows:

5.5.1.1 Determining Magnitude for Biophysical Impacts

For biophysical impacts, the quantitative definitions for the spatial and temporal dimension of the magnitude of impacts used are summarized in the following paragraphs:

A **High Magnitude Impact** is considered to affect an entire area, system (physical), or species (biological) and at sufficient magnitude to cause a significant measureable numerical increase in measured concentrations when compared with national or international limits s specific to the receptors) or a decline in species abundance beyond which natural process would not return that population or species, to its former level within several generations.

A **Medium Magnitude Impact** affects a portion of an area, system, aspect (physical), population or species (biological) and at sufficient magnitude to cause a measurable numerical increase in measured concentrations or levels (when compared with national or international limits and standards specific to the receptors) and may bring about a change in species abundance, but does not threaten the integrity of that population or any population dependent on it.

A **Low Magnitude Impact** affects a specific area, system, aspect (physical), group of localized individuals within a population (biological) and at sufficient magnitude to result in a small increase in measured concentrations or levels (when compared with national or international limits and standards specific to the receptors) over a short time period, but does not affect other trophic levels or the population itself, and localized area.

A Negligible Magnitude Impact: Some impacts will result in changes to the environment that may be immeasurable, undetectable or within the range of normal natural variation. Such changes can be regarded as essentially having no impact, and are characterized as having a very low or negligible magnitude.

5.5.1.2 Determining Magnitude for Socio-economic Impacts

For socio-economic impacts, the magnitude considers the perspective of those affected by taking into account the likely perceived importance of the impact, the ability of people to manage and adapt to change and the extent to which a human receptor gains or loses access to, or control over socio-economic resources resulting in a positive or negative effect on their well-being. The quantitative elements are included into the assessment through the designation and consideration of scale and extent of the impact. Table 5.5 below presents the impact magnitude criteria for socio-economic and health impacts.

Table 5.5: Impact Magnitude Criteria for Socio-economic Impacts

Category	Ranking	Definition
High	4	▪ Major impacts on human health (e.g. serious injury). ▪ Significant impact on the livelihoods of individuals (i.e. access to income source restricted over lengthy period of time). ▪ Serious impact on access to community facilities and utilities ▪ Breach of economy social policy and/or regulation.
Medium	3	▪ Modest impact on human health and well-being. ▪ Moderate impact on individual livelihoods (e.g. restricted access to income source). ▪ Medium impact on access to community facilities and utilities (e.g. access to utilities restricted for long periods (weeks) of time). ▪ Potential breach of company social policy and/or legislation.
Low	2	▪ Limited impact on human health and well-being (e.g. occasional dust, odour, traffic noise). ▪ Some impact on the livelihoods of individuals (e.g. isolated incidents related to ethnic tensions and some restrictions on access to income source). ▪ Some impact on access to community facilities and utilities (e.g. access to cultural centers restricted to a limited extent, i.e. (days).
Negligible	1	▪ Possible nuisance to human health and well-being (e.g. occasional unpleasant odours) ▪ Inconvenience experienced in accessing community facilities and utilities (e.g. electricity supply disruption for short (hours) period of time). ▪ No impact on livelihood, community facilities and human health.
Positive	+	▪ Beneficial improvement to human health. ▪ Benefits to individual livelihoods (e.g. additional employment opportunities). ▪ Improvements to community facilities/utilities. ▪ Increased economy (e.g. local procurement, sourcing of supplies).

5.5.2 Determining Receptor Sensitivity

In addition to characterizing the magnitude of impact, the other principal variable necessary to assign significance for a given impact is the value, and sensitivity/fragility of the receptor. This refers to economic, social, and/or environmental/ecological importance of the receptor, including reliance on the receptor by people for sustenance, livelihood, or economic activity, and to the importance of direct impacts to persons associated with the resource.

Impacts that directly affect people or vital natural resources are deemed to be more important than impacts that indirectly affect people or vital resources. The sensitivity of the receptor criterion also refers to potential impacts to Environmentally Sensitive Areas (ESAs) and impacts to species, including loss of endangered species, effects of introduction of invasive species, and similar

environmental/ecological impacts as well as the public perception about the criticality or sensitivity of the receptors.

There are a range of factors to be taken into account when defining the sensitivity of the receptor, which may be physical, biological, cultural or human:

- Where the receptor is physical (for example, soil environment) its current quality, sensitivity to change, and importance (on a local, national and international scale) are considered.
- Where the receptor is biological (for example, the aquatic environment), its importance (for example, its local, regional, national or international importance) and its sensitivity to the specific type of impact are considered.
- Where the receptor is human, the vulnerability of the individual, community or wider societal group is considered.

The receptors-sensitivity designations employed in this impact assessment process are **Low**, **Medium** and **High** which are universally acceptable.

The sensitivity/fragility/value/importance criteria for biophysical and socio-economic receptors are defined in Table 5.6.

Table 5.6: Bio-physical and Socio-economic Receptor-Sensitivity/ Fragility/ Value Criteria

Category	Ranking	Definition
Physical (for example, air quality)		
High	3	All ambient conditions/concentrations exceed guideline limits and are indicative of the resource being impacted or polluted. There is no (or very little) assimilation capacity for increased concentrations/ change in conditions.
Medium	2	Some ambient conditions/concentrations exceed guideline limits while others fall within the limits. There is some small assimilation capacity for increased concentrations/ change in conditions. Resource use does affect other users
Low	1	All ambient conditions/concentrations are significantly lower than guideline limits and there is capacity for assimilation for additional concentrations/ change in conditions. Resource use does not significantly affect other users.
Biological (for example, terrestrial ecology)		
High	3	Specifically protected under Nigerian legislation and/or international conventions such as International Union for Conservation of Nature (IUCN); considered to be of critical importance to the local use; and totally dependent on for livelihood or means of survival.
Medium	2	Not protected or listed but may be a species common globally but rare in Nigeria with little resilience to ecosystem changes, important to ecosystem functions, or one under threat or population decline; considered to be of moderate importance to the local use; and partially dependent on for livelihood or means of survival.

Category	Ranking	Definition
Physical (for example, air quality)		
Low	1	Not protected or listed as common / abundant; or not critical to other ecosystem functions; considered to be of minor importance to the local use; and local communities do not depend on the resources for livelihood.
Socio-economic and Health		
High	3	Those affected will not be able to adapt to changes and continue to maintain pre-impact status.
Medium	2	Able to adapt with some difficulty and maintain pre-impact status but only with a degree of support.
Low	1	Those affected are able to adapt with relative ease and maintain pre-impact status.

5.5.3 Significance

The significance of the impact is determined by calculating the "product" of impact magnitude and severity/fragility/value/importance of the relevant receptor(s). Figure 5.2 illustrates the process for combining the impact magnitude with the receptor sensitivity.

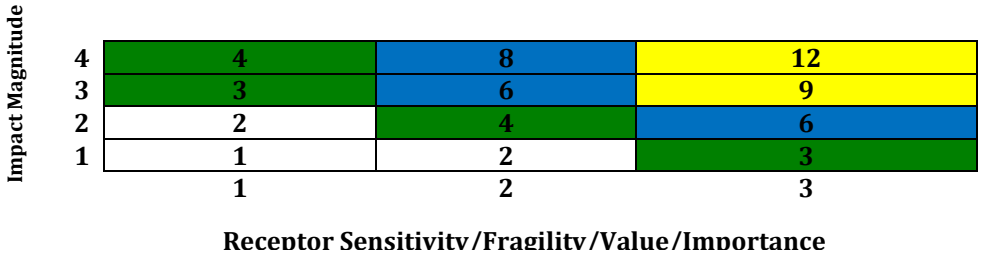


Figure 5.2: Impact Magnitude-Receptor Sensitivity Product Results

Based on its impact magnitude-receptor sensitivity/fragility/value score, each impact was again ranked into four (4) categories of significance as illustrated in Table 5.7 below.

Table 5.7: Environmental Impact Significance Rankings

Ranking (Impact Magnitude x Sensitivity of Receptor)	Significance
9 - 12	**Major**
6 - 8	**Moderate**
3 - 5	**Minor**
1 - 2	**Negligible**

Negligible Significant impacts are where a resource or receptor will not be affected in any way by a particular activity or the predicted effect is deemed to be 'negligible' or 'imperceptible' or is indistinguishable from natural background variations.

An impact of minor significance is one where an effect will be experienced, but the impact severity is sufficiently low (with or without mitigation) and well within accepted standards, and/or the receptor is of low sensitivity/value.

An impact of moderate significance is one within accepted limits and standards. Moderate impacts may cover a broad range, from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP).

An impact of major significant is one where an accepted limit or standards may be exceeded, or high magnitude impact occurs to highly valued/sensitive receptors/resources.

5.5.3.1 Determining the Significance of Potentials Impacts of the Project

To assist in calculating the overall significance of each of the identified potential impacts, expert discussions were constituted. They employed extensive use of screening matrices and predefined criteria for impact magnitude and sensitivity/fragility/value/importance of resources/receptors. The significance was then developed as seen in Table 5.8.

Table 5.8: Leopold's Activity-Receptor Interaction Matrix (Impact Significance Matrix)

Summary of Project Activities at various Phases	Receptors																
	Physical						Biological		Socio-economic						Others (Health and Safety)		
	Air Quality	Ambient Noise	Soil	Groundwater and Aquifers	Surface Water	Landscape/ Topography	Terrestrial Flora	Terrestrial Fauna	Land Use	Population	Utilities	Infrastructure	Employment/ Income	Gender issues	Construction workers	Workplace health and safety	General Public
Pre-construction Phase																	
Site selection									2(1)								
Site clearing and preparation	2(2)	2(2)	2(2)			2(1)	3(1)	3(1)					+		2(2)		
Mobilization of construction equipment and materials to site	2(2)	2(2)										2(2)	+				2(2)
Construction Phase																	
Civil work activities including excavation, trenching, cable laying, foundation, construction of building (e.g. training centre)	2(2)	2(2)	3(1)	2(2)	2(2)					3(2)			++	2(3)	2(3)		2(3)
Installation of power plant facilities, power storage batteries, upgrade of existing distribution infrastructure, installation of streetlights	2(2)	2(2)	3(1)											2(3)	2(3)		
Waste generation and disposal			2(2)	2(2)								2(1)	+		2(2)		2(2)
Commissioning Phase																	
Testing of power plant and associated infrastructure		2(1)								1(1)		1(1)			2(3)		2(2)
Operational Phase																	
Power generation and distribution and provision of training on renewable energy		2(1)											++	2(3)		2(3)	2(3)
Routine maintenance; waste generation and disposal	2(2)		2(2)	2(2)		2(2)					2(1)	1(2)	+	2(1)		2(2)	2(2)

Note: Decommissioning is separately covered in Chapter 8

The value assigned to each cell in the matrix is in the form "x (y)": where "x" denotes the impact magnitude and "y" the sensitivity/fragility/importance of receptor

Impact magnitude ranking: 1 = Negligible; 2 = Low; 3 = Medium; 4 = High.

Impact sensitivity raking: 1 = Low; 2 = Medium; 3 = High.

5.6 Impacts Discussion

5.6.1 Potential Positive Impacts

The proposed Project seeks to provide independent and reliable power supply to Federal University Gashua (FUGA) through a renewable (solar) energy source and thus, enhance learning and institutional operations. It also forms part of the measures in ensuring that Nigeria achieves its carbon emission reduction targets (20 % - 30 % carbon emission reduction by the year 2030) as contained in Nigeria's Nationally Determined Contributions (NDC) on climate change. In line with the Federal Government's plans for Power Sector reform, the Project will assist to promote stronger relationship and collaboration between the Federal Government of Nigeria (FGN), Nigerian Universities, REA, and other relevant regulatory bodies.

Another component of the proposed Project is the construction of a world-class renewable energy workshop/training centre within the Project site. The facility will enhance learning in renewable energy in the University thus leading to certification. Also, the installation of streetlights as part of the proposed Project will boost safety and security within the University.

In addition, the Project will improve social economic activities within the University and help to enhance internally generated revenue. Furthermore, there are employment opportunities associated with the proposed Project for skilled, semi-skilled and unskilled workforce. The employment opportunities will lead to acquisition of new skills and introduction of all manners of income generating spill-over effects. For example, during the construction phase, about 3000 workers would be engaged. The larger portion (60 %) of the workforce (especially semi-skilled and unskilled craftsmen) would be drawn from the Project area.

Other potential benefits of the proposed Project include increase in local and regional economy through award of contracts and purchase of supplies for Project development as well as waste management.

5.6.2 Potential Negative Impacts

The potential negative impacts associated with the proposed Project are discussed under the following headings:

- Potential impact of the proposed 2.5 MW solar-hybrid power plant and associated infrastructure
- Potential cumulative impacts

It is important to note that the significance of potential environmental and social impacts discussed in this section is without mitigation measures except those

already built into the Project design. Implementation of additional mitigation measures (presented in Chapter 6 of this report) are expected to further reduce the impact rating as low as reasonably practicable.

5.6.2.1 Potential Impacts of the proposed Project

5.5.2.1.1 Pre-Construction Phase Activities

The pre-construction phase of the proposed Project includes the following activities:

- Site selection
- Site clearing and preparation
- Mobilization of equipment and materials to site

❖ ***Site Selection***

Approximately 12.5 ha of land within the FUGA campus has been allocated by the University management for the proposed 2.5 MW solar-hybrid power plant and the training center. No additional land either from private or public property outside the University will be expropriated for the Project. The Project site is an undeveloped area within the University and it is characterized by vegetation which includes grasses and a few trees. There is no community presence within the Project site, and as at the time of site visit there was no farming or livelihood activity on site. The Project site is also not known to fall within any designated grazing reserves or grazing routes. Thus, the impact significance of the proposed Project on the existing land use within the Project site is **negligible**. However, in a situation where the Project site is temporarily put into use for farming activities by the University staff prior to commencement of the Project, such persons will be allowed to harvest their crops before construction activities begin.

❖ ***Site Clearing and Preparation***

The Project site will be cleared of vegetation prior to construction activities. The site clearing activities would likely involve the use of earth moving equipment such as tractor. The potential impacts associated with the site clearing activities are discussed as follows:

Potential Impact on Terrestrial Flora and Fauna

Site clearing activities associated with the proposed Project will lead to loss of terrestrial flora on the Project site. The potential impact on the terrestrial flora is considered to be negative, direct, site specific and largely irreversible. The impact magnitude is considered to be medium considering that not all the land area (12.5 ha) will be cleared for the Project. However, the sensitivity/importance of the receptor is regarded as low since the Project site is a modified habitat, and none of the plant species identified within the Project site during the baseline survey was found to be endangered or threatened based on the International Union for

Conservation of Nature (IUCN)-2018 classification scheme. Also, the local community has no direct or indirect ecosystem services that they benefit from the site. Furthermore, there are no protected/conservation areas within the site. The significance of the potential impact of site clearing on the existing terrestrial flora species of the Project site is therefore regarded as **minor.**

While the plant species are unable to avoid the point of impact, most fauna species may be able to migrate away from unfavourable areas. Animals are generally mobile and, in most cases, can move away from a potential threat. The tolerance levels of some animal species are of such a nature that surrounding areas will suffice in habitat requirements of species forced to move from areas of impact.

With regard to the clearing of the Project site for construction purpose, the potential impact on terrestrial fauna species may include loss of individual or localized population of fauna species or disturbance to avifauna species. This is unlikely to lead to a change in conservation status of the species since none of the fauna species (including avi-fauna) encountered or reported in the Project site belongs to the IUCN classification of threatened animal species which include those classified as critically endangered, endangered or vulnerable. The major fauna species observed on the site were mostly the birds nesting on some of the trees within the site. However, the site is not a designated bird nesting area. The sensitivity of the fauna species recorded on the Project site is thus regarded as low. The impact magnitude is considered to be medium given that the site clearing activities would not cover all of the approximately 12.5 ha of land allocated for the Project. The impact significance is thus considered **minor.**

Potential Impact on Soil

The proposed site clearing and preparation activities could potentially impact the soil environment of the Project site. The potential effects on soil include degradation due to site preparation e.g. compaction of soil as a result of the movement of earth moving equipment. Soil degradation is the removal, alteration, or damage to soil and associated soil forming processes, usually related to human activities. The stripping of vegetation or disturbance to the natural ground level over disturbance areas will negatively affect soil formation, moisture levels, soil density, soil chemistry, and biological activity. Uncontrolled site clearance of vegetation could lead to direct surface soil exposure and hence erosion of soil which could be significant.

The impact magnitude is considered as medium as the extent of soil erosion could be high, especially if the site clearing activities are carried out in the wet season. However, based on the results of laboratory analysis conducted on soil samples from the Project area, the Project site is not considered to be significantly prone to land-based erosion. The soil texture analysis of soil samples collected at the Project site

and its surrounding environment showed high percentage of clay followed by sand and then silt. For example, at the Project site, sand particles ranged from 14.68 % to 23.17 %, silt ranged from 13.15 % to 14.81 % while the percentage of clay particles ranged from 62.20 % to 72.15% in the top soil, while in the sub soil, sand particles ranged from 16.15 % to 23.91 %, silt ranged from 12.02 % to 15.48 % while clay ranged from 64.04 to 68.53 %. This revealed that the near-surface ground of the area was formed of compacted fine-grained sediments, such as clays and silts and a conglomerate with lateritic matrix. In addition, the no heavy metal pollution was recorded in the soil samples from the Project site and it surrounding environment. Copper (Cu), Lead (Pb), Cadmium (Cd), Chromium (Cr) and Nickel (Ni) were below the detection limits of 0.005 mg/kg, 0.04 mg/kg, 0.01 mg/kg, 0.04 mg/kg and 0.05mg/kg respectively while the concentrations of Zinc (Zn) recorded in the soil samples from the Project site, the 1km area of influence and the control/buffer points had a range of 0.143 mg/kg – 2.370 mg/kg, 0.102 mg/kg – 0.396 mg/kg, 0.089 mg/kg – 0.101 mg/kg respectively in the top soil and a range of 0.012 mg/kg – 2.538 mg/kg, 0.073 mg/kg – 0.144 mg/kg, 0.073 mg/kg – 0.086 mg/kg respectively was recorded in the sub soil. The measured Zn values in all the soil samples from the Project area were below the recommended limit of 50 mg/kg. Thus, the impact significance of site clearing on soil environment of the study area is considered **minor**.

Potential Impact on Air Quality and Ambient Noise

The pollutants which could impair air quality during site clearing activities are particulate matter in form of dust, and NOx, CO, Total Suspended Particulates (TSP), SOx from combustion engines of the earth moving equipment that will be used for clearing. Intermittent noise emissions could also occur from the operation of the machinery. The impact magnitude is considered to be low since the activities will be short-termed, intermittent, localized and reversible. The site clearing activities will take less than 1 week. The sensitivity of the air shed of the Project area is also regarded as low based on the results of air quality measurements conducted in the area during the field data gathering. No elevated concentrations of air pollutant criteria beyond the FMEnv, WHO, and the World Bank Ambient Air Emission Limits were recorded in the Project site and its surrounding environment. For example, within the Project site, the measured TSP values ranged from 0.064 mg/m^3 to 0.082 mg/m^3 while the TSP values recorded at locations established outside the Project site but within its 1km radius ranged from 0.062 mg/m^3 to 0.063 mg/m^3. At the control/buffer points, the measured TSP values ranged from 0.059 mg/m^3 to 0.099 mg/m^3. The TSP values recorded in all the sampling locations were below the FMEnv 1hr averaging time limit of 0.25 mg/m^3 for TSP in ambient air. The impact significance of site clearing on the ambient air environment of the Project site is considered to be **minor**.

Potential Impact on Workers Safety

Site clearing and preparation are potentially hazardous activities. Accidents may occur especially when those involved are unskilled. Such accidents may result in loss of man-hours which may ultimately affect the schedule date of completion of the Project development especially if the man-hour losses are high. The site clearing activities will take less than 1 week and the number of workers required would be less than five (5). The impact significance is considered to be **minor**.

- ***Mobilization of Construction Equipment and Materials to Site***

Potential Impact on Air Quality and Ambient Noise

Construction equipment and materials will be moved to the Project site prior to commencement of main construction activities. The potential biophysical impacts associated with the mobilization activities include decrease in ambient air quality of the Project area as a result of emissions from vehicles that will convey materials and equipment to site.

It is anticipated that the potential impacts will be similar to those experienced during site clearing activities. The capacity for assimilation of vehicular emissions and dust associated with the mobilization activities in the Project's area of influence is considered to be high. The overall impact significance of mobilization activities on the ambient air quality and noise of the Project area is rated **minor**.

Potential Impact on Infrastructure (Road)

Regarding community health and safety, the mobilization activities during the pre-construction phase of the Project could increase the traffic volume in the Project area (and potential for road accident) as a result of movement of vehicles in and out of the Project site. The social aspects of these activities could lead to accident, traffic congestion and annoyance from other road users in the area. The magnitude of the impact is considered low since the mobilization activities would be less than 1 week. The sensitivity of the receptors is adjudged as medium given that the existing vehicular movement in the University environment is high. The prominent means of transportation are cars, tricycles, and motorcycles while buses/trucks are rare. The impact significance is considered to be **minor**.

Potential Impact on Workers Safety

Mobilization of construction materials will involve off-loading of heavy consumables such as cement, gravel, etc. Injuries and accidents may occur especially when those involved are unskilled. It is expected that the potential impacts will be similar to those experienced during site clearing and preparation activities. The impact significance is considered to be **minor**.

❖ ***Summary of Potential Negative Impacts Associated with Pre-Construction Phase***

Table 5.9 below summarizes the potential impacts associated with the pre-construction phase of the proposed Project.

Table 5.9: Summary of Potential Negative Impacts Associated with the Pre-Construction Phase of the proposed Project

Activity	Receptor	Associated Impact	Significance
Site Selection	Existing land use of the Project site	• Restriction on the use of the Project site by third party	Negligible
Site clearing and preparation	Terrestrial flora and fauna	• Vegetation loss • Direct impacts on vegetation and soil-dwelling organisms; indirect impacts on fauna species in the immediate surroundings of the Project site	Minor
	Soil	• Loss of top soil • Soil compaction and degradation • Increased erosion potential • Reduction in structural stability and percolative ability of soil	Minor
	Air Quality and Noise	• Air quality impacts due to emission from site clearing equipment • Increase in ambient noise levels	Minor
	Workers Safety	• Injuries and accidents to workers during site clearing and preparation.	Minor
Mobilization of construction equipment and materials to site	Air Quality and Noise	• Air quality impacts from vehicular emissions (TSP, NO_x, CO, SO_x) • Increase in noise levels	Minor
	Infrastructure (road)	• Increase in vehicular movement and traffic including potential for road accident	Minor
	Workers Safety	• Injuries and accidents to workers during loading and offloading of construction materials.	Minor

5.6.2.1.2 Construction Phase

The construction phase of the proposed Project will include activities such as civil and electrical works (excavation, trenching, concrete mixing, etc.), installation of PV panels and associated components; construction of training centre; installation of streetlights, upgrade of existing electricity distribution infrastructure; and waste waste generation and disposal.

The potential environmental and social impacts associated with the construction phase of the proposed Project are assessed and discussed as follows:

- ***Civil and Electrical Works, and Installation of Plant Facilities and Associated Infrastructure***

Potential Impact on Air Quality

Air quality could be impacted due to dust generation from earth moving equipment and emissions (like SO_2, TSP, CO, NO_x, VOC) from internal combustion of construction equipment. Dust is also likely to be generated during extraction and removal of overlying materials as well as a windblown dust generated from cleared land and exposed materials stockpiles.

It is proposed that the construction phase of the Project would take up to approximately 6 months (less than 1 year). Although emissions from the construction equipment and operations of construction vehicles could increase the existing concentrations of gaseous pollutants in the ambient air of the Project site beyond the permissible limit, the potential impact is considered to be short term, infrequent, localized and reversible. The impact magnitude is considered to be medium. The sensitivity of the air shed of the Project site and its surrounding environment is considered to be low judging by the results of in situ measurements obtained during the baseline data gathering. There are no heavy industrial activities in the Project area. The impact significance of construction activities on ambient air quality of the Project site and its surrounding environment is rated **minor**.

Potential Impact on Noise Levels

The planned activities during the construction phase of the Project have the potential to increase the ambient noise levels at the Project site and its surroundings. Based on in situ measurements conducted as part of field survey in August 2019, the day-time noise level recorded in the Project site ranged from 43.5 dB(A) to 46.3 dB(A); at the 1km, it ranged from 48.2 dB(A) to 49.9 dB(A) while at the control/buffer points, a range of 49.3 dB(A) to 51.7 dB(A) was obtained. The measured noise levels at the Project site and its surrounding environment were within the World Bank noise limit of 55 dB(A) (1hour Leq day time) for educational institution. In addition, the noise levels (by extrapolation) were also below the FMEnv limit of 90 dB(A) for 8-hour occupational exposure.

The potential source of noise during the construction phase of the Project includes civil work and installation activities, vehicular movement and operation of construction equipment may lead to elevated noise levels beyond the baseline concentration. The noise levels from construction activities would be intermittent and localized and are not envisaged to result in a maximum increase in background levels of 3 dB(A) at the nearest receptor location offsite. The sensitivity of the receptor is regarded as medium. Aside the existing University facilities such as Administrative building, FUGA water factory and new male and female hostels within 500 m radius of the Project site, the identified local community in the Project

area – Low Cost Community – is situated about 1.2 km away from the Project site. The potential impact magnitude is regarded as medium considering that the construction activities may take up to about 6 months. The impact significance prior to mitigation is rated **moderate.**

Potential Impact on Soil

The proposed construction activities will include excavation, loosening of soil, stockpiling, mixing, filling, etc. These activities can directly impact soil environment negatively contributing to soil degradation and possibly accelerated erosion.

Soil environment of the Project site could be impacted in terms of removal of topsoil and soil compaction, reduction in structural stability and percolative ability of soil, loss of soil dwelling organisms resulting from compaction during excavation and installation activities. These activities also have the potential to increase siltation as a result of accelerated erosion. The impact magnitude is considered to be medium considering that foundation works would only be required for the proposed training centre while the trenching for the underground power evacuation cable to be installed would be minimal. The sensitivity of the soil environment of the Project area is considered to be low based on the laboratory results. No evidence of heavy metal and/or hydrocarbon pollution was recorded in soil samples from the Project area. Thus, the impact significance is considered to be **minor**.

Potential Impact on Surface water

The surface water body noticed around the Project site at the time field sampling was a rain harvesting trench constructed by the University. The waterbody is therefore man-made Rainwater from the trench is often used for irrigation demonstration to students of agriculture in the University. During the peak of rainy season, water from the trough flows to the immediate surroundings.

The quality of water in the trough could be impacted due to increased sediment load a result of accelerated erosion from the Project site during construction. Also, any contaminated run-off from the construction site as well as improper handling of construction wastes could pose adverse impact on the quality of the water. The potential impact on the man-made water body would be localized, indirect and reversible. The impact magnitude is considered to be medium. In terms of receptor sensitivity/importance, the results of laboratory analysis conducted on the water sample did not indicate heavy metals and hydrocarbon loads. This implies that although there may be some minor effect on the ecological balance of the water body, it will not impact the overall integrity of the ecosystem. Thus, the impact significance is rated **minor**.

Potential Impact on Terrestrial Flora and Fauna

The construction activities may potentially cause disturbance to flora and fauna species as a result of increase in human activity, noise level, creation of areas of bare soil, etc. which may alter the composition and diversity of plant species around the Project site and drive many fauna species away from the area. In addition, the potential for plant species invasion is likely to increase as a result of increase in areas of bare soil around the Project site.

Also the disturbance associated with noise and movement of construction equipment and personnel at the Project site may deter bird species from the area and disrupt the breeding of avifauna. It may also lead to increased risk to species such as snakes, rodents and mammals. The sensitivity of the receptor is adjudged to be low. The Project area is not known as a migratory route for avifauna species based on desktop reviews and field observation. The impact significance is regarded as **minor**.

Potential Impact on Hydrogeology and Groundwater Quality

The construction activities could lead to potential impacts on hydrogeology of the Project area. These include increased sediment load in the drainage channels as a result of erosion; increased storm water runoff from a decrease in infiltration; and increased runoff from hardstanding areas.

Groundwater may be impacted as a result of infiltration of contaminants associated with spills or leaks of fuels, oils and lubricants from construction vehicles and/or storage containers. Currently, there are no boreholes within the Project site and the nearest borehole to the Project is over 150m away. The results of laboratory analysis conducted on groundwater samples from existing boreholes in the Project area did not reflect any heavy metal and hydrocarbon pollution. It is not anticipated that construction activities will have any direct impacts on the underground aquifer in the project area. Therefore, the potential for groundwater contamination as result of construction activities is rated **minor**

The potential impact on the existing underground aquifer (water reserve) of the Project area as a result of water abstraction for construction activities such as concrete mixing and washing of construction equipment is considered to be **negligible** since the use of water for construction activities would be minimal. There are several boreholes within the University campus as noted during the site visit. The recharge of the existing boreholes in the Project area is largely due to direct precipitation. During the rainy season, the water reserve of the aquifer in the study area increases; thus hand dug wells and boreholes yields improve significantly.

Potential impact on Gender

Construction activities in Nigeria are typically dominated by males which presents a major challenge for equal opportunities for women. Generally, the Nigerian construction sector has a particularly low participation rate for women, both in industry and academia. Key Informant Interviews (KII) and Focus Group Discussions (FGD) conducted within the local community revealed that although women are allowed to work and trade freely; they are underrepresented in leadership positions.

During construction activities, women may experience discrimination as most employment and training opportunities will be provided to men, while women will be left with menial jobs. This may result in marginalization thereby reinforcing gender stereotypes and gender pay gaps. Furthermore, there is the possibility that the proposed Project may increase the risk of GBV, as a result of shifting existing power dynamics and financial relationships. However, this is considered a moderate risk as a few women in the community are engaged in economic activities.

The women in the local community also revealed that GBV incidents have been reported within the community. Such incidents are either addressed internally by the traditional community leaders or reported to the police. Furthermore, Yobe State ministry of Women affairs and NGOs are available in the case to handle such incidents. During the study, GBV service providers were identified at FUGA health center and Gashua general hospital. FUGA management expressed their commitment to providing a safe and conducive environment for all women within the institution. The sensitivity of gender impacts is rated high due to cultural and religious doctrine that is deeply rooted in the belief and customs of an average Nigerian therefore; the impact significance is regarded as **moderate**.

Potential Impact on Socio-economic and Health

Impacts associated with the construction phase of a project are usually of a short to medium term in nature, but could have long term effects on the surrounding environment. During construction, the proposed Project has the potential to affect the nearby community.

With regards to the influx of workers to the community for the construction phase, the manner in which the workers conduct themselves can affect the local community in terms of disruption of existing family structures and demography. The potential behaviour of workers, most especially male construction workers, may lead to an increase in levels of crime and drug and alcohol abuse, and an increase in incidence of casual sexual relations, which may result in increase in sexually transmitted disease (such as HIV/AIDS infections) and unwanted pregnancies. Additional pressure may also be placed on existing social infrastructure. Considering that the proposed number of workers (approximately

3,000) for the construction phase of the Project is relatively high, the potential risk to local family structures is regarded as high. However, Given that the majority of the construction workers, especially unskilled labour force would be drawn from the local community, the impact significance is considered to be **moderate**.

Potential Impact on Infrastructure (Road)

Regarding road infrastructure, the movement of construction vehicles in and out of the Project site during construction has the potential to increase road traffic and accidents. The impact magnitude is considered as low due to the minimal (about 2-3 daily) number of Project vehicles and trucks to be used during the construction phase. Also, traffic survey conducted at the screen lines leading to the University indicated that the existing road traffic in the Project area can be described as relatively light as Gashua town is a developing area. Therefore, the impact significance is considered **minor**.

Potential Impact on Construction Workers Safety

Construction sites are potentially hazardous place. Occupational accidents may occur especially when those involved are unskilled. Such occupational accidents may result in loss of man-hours which may ultimately affect the schedule date of completion of the Project development especially if the man-hour losses are high. Potential impacts to construction workers include increase in noise level and air emissions from construction activities, injuries, electrical shocks, accident, and denial of rights. The impact significance is considered **moderate**.

- ***Waste Generation and Disposal***

Potential Impact on Soil

Construction activities are associated with waste generation. The potential wastes to be generated during the construction phase of the Project include scrap metals, electrical cables, spent oils, damaged batteries, wood/planks, paper waste, food remnants, leftover sand and gravel, etc. The waste streams if not properly handled, could contaminate the soil environment within the Project site and its surrounding environment. The impact sensitivity of the soil environment of the Project area is low judging by the results of laboratory analysis conducted on the soil samples. The impact significance is considered to be **minor**.

Potential Impact on Groundwater

Groundwater may be impacted as a result of infiltration of contaminants associated with liquid wastes especially from damaged batteries and spent oils. The impact magnitude is considered low; the nearest existing groundwater source to the Project site is over 150 m away. The results of laboratory analysis conducted on groundwater samples from existing boreholes in the Project area did not reflect any

heavy metal and hydrocarbon pollution. The potential for groundwater contamination as result of waste disposal is rated **minor**.

Potential Impact on Infrastructure (Waste Management Facility)

Construction wastes can potentially have impact on the existing waste management facility of the Project area. However, as part of the Project design, construction wastes such as scrap electrical components, batteries, damaged/defective PV panels are planned to be returned to the manufacturers based on a take-back scheme or local recycling companies (approved by regulatory authorities) for proper recycling. The quantity of domestic wastes to be disposed of would be minimal. It is estimated that approximately 0.225 m^3 of construction debris will be produced per week. Thus, the impact of construction wastes disposal on the waste management facility of the Project area is considered **negligible**.

- ***Summary of Potential Negative Impacts Associated with Construction Phase***

Table 5.10 summarizes the potential negative impacts associated with the construction phase of the proposed Project.

Table 5.10: Summary of Potential Negative Impacts Associated with the Construction Phase of the proposed Project

Activity	Receptor	Associated Impact	Significance
Civil and Electrical Works/ Installation Activities	Air Quality	• Air quality impacts due to emission from construction equipment (SPM, NOx, CO, SO_x) • Increase in dust from cleared land and windblown stockpiles	Minor
	Ambient Nosie	• Increase in noise level due to construction activities	Moderate
	Soil	• Increased erosion potential as a result of construction activities such as excavation • Reduction in structural stability and percolative ability of soil resulting from compaction during civil works and installation activities	Minor
	Terrestrial Flora and Fauna	• Loss of plant species as a result of introduction of alien plants which may prevent the natural recovery of the natural vegetation on the site and power evacuation route. • Loss of fauna as a result of increased human activity and associated noise.	Minor
	Hydrogeology and Groundwater	• Decrease in groundwater aquifer as a result of groundwater abstraction for construction activities e.g. concrete mixing, equipment washing, etc. • Groundwater contamination	Minor
	Surface water	• Surface water contamination	Minor

Activity	Receptor	Associated Impact	Significance
	Gender	• Discrimination of women during employment • GBV	Moderate
	Socio-economic and health	• Influx of migrant workers, increase in sexual transmitted diseases.	Moderate
	Infrastructure (road)	• Road damage, traffic and safety impacts.	Minor
	Construction workers safety	• Injury to construction workers during construction activities.	Moderate
Waste Generation and Disposal	Soil	• Decrease in soil quality	Minor
	Groundwater	• Groundwater contamination	Minor
	Infrastructure (waste management facility)	• Disposal of construction wastes to existing waste management facility in the Project area.	Negligible

5.6.2.1.3 Commissioning Phase

Once the construction phase of the proposed Project is completed, the power plant and associated infrastructure will be tested to ensure that they have been installed according to the pre-design and operational requirements. During the commissioning, there could be increase in noise level due to humming noise emission from the plant components (inverters and batteries), vehicular movement (transportation of commissioning officials), crowd noise, and other ceremonial activities. The ambient noise levels recorded in the area during baseline data gathering were generally below the FMEnv and World Bank recommended limits. Also, considering that the commissioning activities would be short-termed and localized, the impact significance is rated **minor**.

Also, there is potential for occupational hazards during the facility testing as a result of any wrong electrical connection. The impact significance is considered to be **moderate** on the workers' health and safety.

The commissioning phase will lead to an influx of guest and officials which will have an impact on the existing population and infrastructure (road) of the Project area. Due to the short duration of the commissioning activities, the impacts are considered to be **negligible**.

Table 5.11 summarizes the potential negative impacts associated with the commissioning phase of the proposed Project.

Table 5.11: Summary of Potential Impact Associated with the Commissioning Phase of the proposed Project

Activity	Receptor	Associated Impact	Significance
Plant testing	Ambient noise	• Increase in ambient noise level	Minor
	Workers	• Occupational health and safety hazards (e.g. injuries, electrocution,	Moderate

Activity	Receptor	Associated Impact	Significance
		etc.) as a result of any wrong electrical connection.	
	Population influx	• Increase in population during commissioning	Negligible
	Infrastructure (road)	• Road traffic and risk of accidents	Negligible

5.6.2.1.4 Operational Phase

❖ ***Power Generation and Distribution***

Potential Impact on Noise

The potential sources of noise during the power plant operations are inverters and batteries. Typically, the designed noise level from an inverter is approximately 30-35 dB(A) while that of a battery is 15-20 dB(A). The associated noise levels from the inverters an batteries are not envisaged to result in a maximum increase in background levels of 3 dB(A) at the nearest receptor location offsite (e.g. female hostel located about 300 m away). The impact significance is considered to be **negligible**.

Potential Impact on Gender

Women have conventionally been under-represented in the energy sector; they are often marginalized from many power sector employment and training opportunities. There is a potential that this situation may come to play during the operations phase of the Project as women may experience discrimination during employment and training opportunities. Also GBV related issues such as sexual harassment, intimate partner violence, assault (physical and psychological), could potentially occur during operation. Although the number of personnel working at the Project site would be minimal, the likelihood of gender-based impacts predicted during the construction phase may exists. Therefore, the impact significance is regarded as **moderate**

Potential Impact on Socio-economic and Health

The potential negative impacts on the socio-economic environment (community health and safety) during the operational phase of the Project are related to visual impact and the generation of electromagnetic field (EMF) radiation.

For visual impact, the Project site is not known to be a tourist route or to have any special scenic characteristics, hence it has a limited potential for visual impacts on the receiving environment. However, the facility (primarily the PV panels) will be visible during operation. The impact significance is considered **negligible**.

Regarding EMF radiations, Solar PV panels, inverters, batteries, and other components that make up solar PV arrays produce extremely low frequency EMF when generating and transmitting electricity. To protect the general public from

health effects from short-term high level magnetic fields, the International Commission on Non-Ionizing Radiation Protection (ICNIRP, 2010) advised an exposure limit for extremely low frequency magnetic fields at 2000 mG (milligauss – the unit used to measure magnetic field strength).

Solar PV panels produce low levels of extremely low frequency (ELF) EMF, with measured field strengths of less than one mG. The measured EMF level decreases as the distance from the PV panel increases (Chang and Jennings, 1994).

Research has not been able to prove that the ELF-EMF radiations generated from PV arrays or transmission line have an adverse impact on human health, as most studies show a weak association between magnetic field and adverse health effects. The World Health Organization (WHO) has designated ELF-EMF as a possible carcinogen (WHO, 2007). The use of the label "possible carcinogen" indicates that there is not enough evidence to designate ELF-EMF as a "probable carcinogen "or "human carcinogen," the two indicators of higher potential for being carcinogenic in humans. Thus, the potential impact of EMF radiation from the proposed Solar-hybrid Power Plant on community health and safety is considered to be **negligible**.

Potential Impact on Occupational Health, Safety and Welfare of Workers

During the Plant operation, workers may be exposed to occupational health and safety issues (e.g. electrical and field exposure, shock hazards and mechanical injuries) including work related issues such as discrimination, denial of rights, unfair treatment, poor working conditions etc. The impact significance is considered to be **moderate** primarily due to the low number of staff (approximately 10) required for operation.

- ***Routine Maintenance, Waste Generation and Disposal***

Potential Impact on Soil

Routine maintenance of the Project facilities has the potentially for waste generation. Such wastes if not handled properly could lead to soil contamination. The major waste stream will be e-waste generated from spent/damaged components of the Project such as batteries, inverters and PV panels. These wastes will be stored within the Project site according to the manufacturer's instructions. All components to be used for the Project will have buy back agreements with the manufacturers as specified in the Extended Producer Responsibility (EPR) Program. The impact significance is considered to be **minor**.

Potential Impact on Groundwater

Potential impacts may include decrease in amount of groundwater reservoir as a result of water abstraction for cleaning of the PV panels. Cleaning of the PV panels is

envisaged to be carried out at three (3) times during the raining reason and this would be more than three times during the dry season.

Based on previous experience, each panel would require approximately 5 litres of water per cleaning cycle. With an estimated number of 6,600 panels for 2.5MW generation, it is envisaged that the proposed Project would consume approximately 16,500 litres of water per cleaning cycle. The water required for the cleaning purpose would be obtained from a new borehole to be installed on the project site. Based on observations noted during the field survey and the estimated quantity of water required for occasional cleaning of the PV panels, water abstraction for the Project is not envisaged to have serious effect on the existing groundwater aquifer of the Project area as well as the local water use. Thus, the impact significance is considered **minor**.

Potential Impact on Occupational Health, and Safety of Workers

During routine maintenance, workers may be exposed to occupational health and safety issues (e.g. electrical and field exposure, shock hazards and mechanical injuries). The impact significance is considered to be **minor** primarily due to the low number of staff (approximately) required for maintenance activities and low frequency of maintenance.

❖ ***Summary of Potential Negative Impacts Associated with Operation Phase***

Table 5.12 below summarizes the potential negative impacts associated with the operational phase of the proposed Project.

Table 5.12: Summary of Potential Negative Impacts Associated with Operational Phase of the proposed Project

Activity	Receptor	Associated Impact	Significance
Power Generation and distribution	Noise	• Noise from batteries and inverters during power generation and evacuation	Negligible
	Gender	• Discrimination of women during employment • GBV (sexual harassment, assault and poor working condition)	Moderate
	Socio-economic (visual prominence)	• Landscape alterations resulting in unpleasant changes in the visual character of the area	Negligible
	Socio-economic (health issues)	• Community health and safety impact due to electromagnetic field (EMF) radiation from the Solar-hybrid Power Plant	Negligible
	Health, safety and welfare of staff during Plant operation	• Electric shock, injuries to personnel associated with the Power Plant operations, • Work related issues such as discrimination, denial of rights, unfair treatment, poor working	Moderate

Activity	Receptor	Associated Impact	Significance
		conditions	
Routine Maintenance, Waste Generation and Disposal	Soil	• Soil contamination from spent batteries and inverters	Minor
	Groundwater	• Groundwater abstraction from cleaning of PV panels	Minor
		• Groundwater and soil contamination	Negligible
	Health, safety and welfare of staff during maintenance	• Electric shock, injuries to personnel during maintenance	Minor

5.6.2.2 Potential Cumulative Impacts

Cumulative impacts are those impacts resulting from the combined effects of past, present or reasonably foreseeable actions owing to the project aspects and activities outside the project (GSI, 2003). The concept of cumulative effects is an important one. It holds that, while impacts may be small individually, the overall impact of all environmental changes affecting the receptors taken together can be significant. When a resource is nearing its tolerance threshold, a small change can push it over.

The major existing developments around the Project area are the University facilities such as Administrative building, FUGA water factory, and male and female hostels. Given the nature of the activities associated with the proposed Project and the existing activities around the project area, the potential cumulative impacts of the Project on road traffic, ambient noise levels and groundwater availability is considered **low**.

5.7 Risk and Hazard Assessment

5.7.1 Overview

Risk assessment is the determination of quantitative or qualitative estimate of *risk* related to a concrete situation and a recognized threat (also called hazard). The assessment of the risks and hazards associated with the proposed Project involves the following steps:

- Identification of hazards/risks
- Likelihood of occurrence
- Consequence/severity of the hazards

The risk assessment matrix is then developed as presented in Figure 5.3.

0 – 5 = Low Risk 6 – 10 = Moderate Risk 11 – 15 = High Risk 16 – 25 = extremely high unacceptable risk		Severity of the potential injury/damage				
		Insignificant damage to Property, Equipment or Minor Injury 1	Non-Reportable Injury, minor loss of Process or slight damage to Property 2	Reportable Injury moderate loss of Process or limited damage to Property 3	Major Injury, Single Fatality critical loss of Process/damage to Property 4	Multiple Fatalities Catastrophic Loss of Business 5
Likelihood of the hazard happening	Almost Certain 5	5	10	15	20	25
	Will probably occur 4	4	8	12	16	20
	Possible occur 3	3	6	9	12	15
	Remote possibility 2	2	4	6	8	10
	Extremely Unlikely 1	1	2	3	4	5

Figure 5.3: Risk Assessment Matrix

5.7.2 Project Specific Risks and Hazards

The potential risks and hazards associated with the proposed Project are described below:

5.7.2.1 Fire and Explosion

The major risk associated with the operational phase of the Project is fire and explosion. PV systems are subject to electrical faults like any other electrical installation such as short circuits, ground faults and reverse currents. These faults and other failures of the system, including cable insulation breakdowns, rupture of a module, and faulty connections, can result in hot spots that can ignite combustible material in their vicinity. Wrongly installed or defect DC/AC inverters have been the reason of several photovoltaic fires as well.

Fire could possibly occur during operation of the power plant. Overcharging, high temperatures and physical stress to Lithium ion battery cells can cause thermal runaway, which commonly leads to the destruction of the battery, fire and even explosions. In addition deep discharging can also cause battery fires. Any outbreak of uncontrolled fire in the area can escalate to dangerous dimensions which could be critical. The hazard is classified as **high risk**.

5.7.2.2 Electrocution

Electrocution from direct contact with high-voltage electricity or from contact with tools, vehicles, ladders, or other devices that are in contact with high-voltage electricity could occur during the Plant operation. The likelihood of the hazard happening is remotely possible and its severity if occurs may result into marginal consequence. The hazard is classified as **moderate risk**.

5.7.2.3 Occupational Hazards

Workers may be exposed to occupational hazards when working at elevation during construction. Also, there could be electrical hazards to workers. Common electrical accidents result in shocks and/or burns, muscle contractions, and traumatic injuries associated with falls after the shock. The likelihood of the hazards occurring is considered to be possible while its severity is considered to be marginal. The hazard is classified as **moderate risk**.

5.8 Summary

In summary, the key potential impacts and risks associated with the proposed Project have been evaluated in this chapter. From such, the significance of the identified negative impacts/risks will be minimized to as low as reasonably practicable with the implementation of appropriate mitigation measures presented in the next chapter of this report. Enhancement measures for the identified positive impacts are also contained in the chapter.

CHAPTER SIX:

MITIGATION MEASURES

CHAPTER SIX

MITIGATION MEASURES

6.1 Introduction

Following the detailed description of the associated and potential impacts of the proposed Project in Chapter 5, the recommended mitigation measures for the identified negative impacts are presented in this chapter as well as the enhancement measures for the potential positive impacts. The implementation of the mitigation measures shall be overseen by the Rural Electrification Agency's Project Management Unit (REA-PMU).

6.2 Mitigation Measures Approach

Mitigation refers to measures or interventions necessary to avoid, minimize, reduce or offset adverse impacts. Approach for selecting appropriate mitigation measures followed the framework stated by the World Bank (2018):

- Anticipate and avoid risks and impacts;
- Where avoidance is not possible, minimize or reduce risks and impacts to acceptable levels;
- Once risks and impacts have been minimized or reduced, mitigate;
- Where significant residual impacts remain, compensate or offset them, where technically and financially feasible.

In proffering mitigation measures for the various negative impacts identified in the previous chapter, preference was given to avoidance or prevention of adverse impacts and where not feasible, measures which are practicable and cost-effective using best available technology were suggested to reduce and/or minimize the impacts while rehabilitation, restoration or compensation was considered as the last resort.

6.3 Mitigation Measures for the Identified Significant Negative Impacts

The recommended mitigation measures for the identified negative impacts associated with the proposed Project are highlighted in Table 6.1. The recommended mitigation measures are considered adequate to address the adverse impacts identified in the Chapter 5 of this report. There are no potential long-term impacts associated with the Project that cannot be mitigated to acceptable levels of residual impact. The residual impacts of the proposed Project, following the

implementation of the proffered mitigation measures highlighted in Table 6.1, are of negligible to minor significance.

6.4 Mitigation Measures for the Identified Project Risks and Hazards

The mitigation measures for the identified Project risks and hazards are highlighted below:

Fire and Explosion

- Only PV modules which comply with international and local standards for electrical performance and safety shall be used.
- Only solar cables suitable for outdoor applications and severe weather conditions shall be used
- Inverters shall not be mounted on combustible walls such as wood panels or combustible sandwich panels
- Inverters shall be easily accessible and protected from severe weather conditions.
- The local fire department shall be informed of and familiarized with the photovoltaic installation.
- PV systems shall only be installed by qualified contractors.
- PV systems shall be inspected regularly by qualified professionals.
- PV systems shall be regularly checked for damage from rodents and other pests, which could compromise wiring or insulation.
- Batteries installed for the power plant shall be monitored regularly to prevent overcharging and deep discharging during operations
- Protection devices (e.g. Current interrupt devices (CIDs), positive temperature coefficient (PTC) thermistors, current-limiting fuses, diodes, battery management systems (BMSs), etc.) shall be installed to protect the batteries
- The batteries shall be housed in well ventilated, dust free containers under optimal conditions.
- Emergency response plan shall be developed and implemented.
- Fire extinguishers, fire notices, warning signs) shall be installed at different locations within the Plant site.

Electrocution

- Use of signs, barriers and public outreach to prevent public contact with distribution cables shall be employed.
- Grounding conducting objects (e.g. fences or other metallic structures) shall be installed where required to prevent shock.

Occupational Hazards

- Provision of an adequate work-positioning device system for workers shall be ensured.
- Hoisting and lifting equipment shall be rated and maintained and operators trained in their use.
- Appropriate Personal Protective Equipment shall be worn.
- Electrical installation shall be carried out by trained personnel in line with the approved procedures.

6.5 Enhancement Measures for Identified Positive Impacts

6.5.1 Reduction in Carbon Emissions

The Project will enhance Nigeria's intention of reducing its carbon emissions by 20 % in the year 2030 as contained in its NDC on climate change. To enhance this impact, the following measures shall be implemented:

- In cases where the power generated (2.5 MW) is insufficient to meet the power demands of the University in the next 10 to 20 years (due to expansion), power shall be distributed to high priority areas so as to reduce/eliminate the use of diesel-powered generators. In addition, The Project will be designed and constructed to allow for further expansion in power generation and distribution capacity to meet the University's demands.
- The University shall implement energy conservation measures such as encouraging switching off appliances, use of energy-saving bulbs, purchase of low-energy appliances such as printers, computers, refrigerators, etc.

6.5.2 Enhancement of Learning

The Project will help to overcome the barrier on research and learning posed by epileptic power supply to the University. To enhance this impact, the following measures shall be implemented:

- Power distribution priority shall be given to all classrooms, lecture theatres, research centers, libraries, laboratories, and other academic buildings especially during learning hours.
- Research centres, laboratories, and libraries shall have 24-hour power supply.

6.5.3 Direct Employment and Training

The Project will give rise to direct employment opportunities across different skill levels, from unskilled to highly skilled labour. It is estimated that during

construction phase, at least 3,000 job opportunities would be created. Training for local people from skilled technicians shall also be carried out.

The following measures shall be implemented to ensure that direct employment and training opportunities are maximized:

- A Labour and Employment Management Plan (LEMP) shall be developed prior to construction, detailing percentages and numbers of the workforce to be sourced from the local area and various demographics as well as influx management. The plan shall follow local and international employment guidelines.
- The EPC contractor shall provide notification to different groups in the community on specific jobs and skills required for the project, prior to the commencement of construction. Subsequently, the group leaders shall notify the local population prior to the commencement of construction of job opportunities and relevant skills/qualifications required to be employable on the Project. .
- A Gender Management Plan (GMP) shall be developed and implemented to ensure that the Project does not increase women's burden and that women not only contribute, but also benefit from it.
- The EPC contractor shall initiate training and skills development programmes prior to the commencement of construction, as a means of ensuring that members of the local workforce are up-skilled and can be employed on the Project.

During the operational phase of the Project, job opportunities will also be created. About 15 people shall be employed. This will be a mixture of skilled labour (such as electrical and mechanical technicians) and unskilled labour (such as PV module cleaners and security personnel). Periodic capacity building will be offered to the workforce.

6.5.4 Procurement and Indirect Employment

The construction and operation of the proposed Project will create opportunities for the supply of goods and services to the Project and in turn, indirect employment will be created in the supply chain. Other opportunities for local companies to provide catering, waste / recycling and landscaping facilities, etc. will also be created. Local and regional procurement targets shall be included in the Project's LEMP to enhance this potential opportunity.

Table 6.1: Mitigation Measures for the Potential Negative Impacts of the proposed Project

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
Pre-construction Phase					
Site Selection	Land Use	• Loss of access to land	Negligible	▪ To prevent any encroachment on the Project site, perimeter fencing and signposts shall be erected around the site ▪ Where new encroaching activities (e.g. farming) are observed, the affected persons shall be given adequate time to harvest their crops before commencement of construction activities.	Negligible
Site clearing and preparation	Terrestrial flora and fauna	• Vegetation loss • Direct impacts on vegetation and soil-dwelling organisms; indirect impacts on fauna species in the immediate surroundings of the Project site	Minor	▪ To avoid the direct impacts of Vegetation loss, site clearing shall be limited to the areas within the site needed for the Project. ▪ The extent of vegetation to be cleared shall be clearly identified and appropriately demarcated. Clearing exceeding the approved working corridor shall be prohibited. ▪ Bush burning shall be avoided. ▪ Use of herbicides for site clearing shall be avoided. ▪ Any cleared areas which are not used will be re-vegetated using plants or seeds of locally occurring species. ▪ Hunting or deliberate killing of animals by workers shall be prohibited and monitored. Workers shall be sensitized on ecological protection.	Negligible
	Soil	• Removal of top soil and soil compaction associated with site clearing	Minor	▪ Removal of vegetation and soil cover shall be restricted to the areas required for the Project. Soil conservation measures shall be implemented such as stockpiling topsoil or for	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
		• Loss of top soil • Increased erosion potential • Reduction in structural stability and percolative ability of soil		the remediation of disturbed areas. ▪ Disturbed areas will be rehabilitated as soon as possible to prevent erosion. ▪ The extent of vegetation to be cleared shall be clearly identified and appropriately demarcated. Clearing exceeding the approved working corridor shall be prohibited. ▪ Use of silt traps or similar systems to reduce discharge of silt shall be ensured.	
	Air quality and noise	• Air quality impacts due to emission from site clearing equipment • Increase in ambient noise levels	Minor	▪ Site clearing equipment / machinery shall be operated and maintained under optimum fuel efficient conditions. ▪ Site clearing activities shall be carried out only during the daytime (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr) ▪ Equipment/machinery with lower sound power levels shall be selected and used for site clearing. ▪ A procedure for receiving and addressing noise complaints shall be developed and implemented	Negligible
	Workers Safety	• Injuries and accidents to workers during site clearing and preparation.	Minor	▪ Site clearing shall be limited to the day time as much as possible. ▪ Unregistered labourers and touts shall not be engaged for off-loading materials ▪ Provision of adequate personal protective equipment (PPE) such as nose masks shall be ensured. All employees will be required to wear the appropriate PPE whilst performing their duties.	Negligible
Mobilization of	Air quality and	• Air quality impacts	Minor	▪ Construction vehicles with efficient engine	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
personnel, materials and equipment to site	noise	from vehicular emissions • Increase in ambient noise levels		performance and with minimal noise and air emissions shall be selected and used. This can be achieved through regular servicing and maintenance. ▪ All materials with potential to result in dust emissions shall be covered during transport. ▪ Onsite vehicle speed on unhardened roads and surfaces shall be limited to about 15 – 20km/h so as to reduce dust generation.	
	Infrastructure (road)	• Increase in vehicular movement and traffic around the project site; • Potential for road accident.	Minor	▪ A traffic management plan (TMP) shall be developed by the EPC contractor and implemented. ▪ Appropriate signage and safety measures (barrier, formalized crossing points) to reduce the risk of accidents in the Project area shall be provided. ▪ The local community shall be sensitized about the Project activities and the need to comply with the traffic management plan put in place. ▪ Project related vehicles shall be regularly serviced and maintained. ▪ Drivers' competency shall be assessed and where required, appropriate training shall be provided. This will include training on safe driving measures such as adherence to speed limits (of less than 10 km/h) in the Project area. ▪ A procedure for recording traffic incidents/accidents associated with the Project shall be developed and implemented. This will include date/time, location, reason	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				for accident, corrective measures, etc.	
	Workers Safety	• Injuries and accidents to workers during loading and off-loading construction materials.	Minor	▪ Mobilization of materials shall be limited to the day time as much as possible (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr) ▪ Provision of adequate PPE especially gloves and hard hats to workers shall be ensured. All employees will be required to wear the appropriate PPE whilst performing their duties. ▪ Unregistered labourers and touts shall not be patronised for off-loading materials. ▪ The site shall be secured with perimeter fencing and/or security. ▪ Separate sanitary amenities and potable water facilities for men and women shall be provided	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
Construction Phase					
Civil and Electrical Works/ Installation Activities	Soil	• Increased erosion potential as a result of construction activities such as excavation • Reduction in structural stability and percolative ability of soil resulting from compaction during civil works and installation activities	Minor	▪ Excavation works shall not be executed under aggressive weather conditions. ▪ Stockpiles shall be appropriately covered to reduce soil loss as a result of wind or water erosion. ▪ Disturbed areas shall be rehabilitated with erosion control plants (using native plant species) as soon as possible to prevent erosion. ▪ Work areas shall be clearly defined and where necessary demarcated to avoid unnecessary disturbance of areas outside the development footprint.	Negligible
	Air Quality	• Air quality impacts due to emission from construction equipment • Increase in dust from cleared land and windblown stockpiles	Minor	▪ Regular maintenance and servicing of construction equipment /machinery shall be ensured. ▪ Only modern and well maintained equipment and machinery shall be used for construction activities. ▪ Routine water sprinkling shall be carried out to minimize dust generation during construction.	Negligible
	Ambient Noise	• Increase in noise level due to construction activities; • Disturbance to neighbouring community and local	Moderate	▪ Noise suppression equipment (e.g. mufflers) shall be fitted on construction machinery. ▪ Construction activities shall be limited to day-time (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr). In the event that noisy activities are undertaken outside of	Minor

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
		ecology		the specified working hours, all noise receptors in the Project area shall be informed of such activities in advance. ▪ Construction machinery shall be turned off when not in use. ▪ Machinery/equipment to be used for construction work shall meet industry best standard in relation to noise attenuation. ▪ Construction equipment shall be properly maintained and serviced. ▪ Major construction activities shall be limited to a particular area within the site. ▪ Construction-related vehicles shall be limited to access areas. ▪ Noise complaints related to the construction activities shall be assessed and appropriately addressed. ▪ Noise monitoring at locations with persistent noise complaints shall be maintained.	
	Infrastructure (road)	• Road damage, traffic and safety impacts.	Minor	▪ A TMP shall be developed by the EPC contractor and implemented. ▪ Speed limits for all construction-related vehicles shall be established and enforced. ▪ Construction related vehicles shall be regularly serviced and maintained. ▪ Appropriate barriers and signage shall be provided to demarcate areas in which construction traffic is active. ▪ Drivers' competency shall be assessed and where required training shall be provided. ▪ A procedure for recording all construction	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				related traffic incidents/accidents shall be developed and implemented. This will include date/time, location, reason for accident, corrective measures, etc. ▪ The NEP Grievance Redress Mechanism (GRM) shall be implemented for receiving complaints arising from damage to infrastructure and private property during construction activities. The EPC contractor shall receive the complaints and repair damage as quickly as possible.	
	Groundwater and surface water	• Groundwater and surface water contamination	Minor	▪ Training shall be provided for workers on safe storage and handling practices and rapid spill response and clean-up techniques during induction. ▪ Spill control and response plans to respond to spills and leaks shall be implemented. ▪ Waste receptacles shall be provided within a secured area within the project site for collection of solid waste. ▪ General wastes that cannot be reused shall be periodically evacuated by the government accredited waste contractor	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	Terrestrial Flora and Fauna	• Loss of plant species as a result of introduction of alien plants which may prevent the natural recovery of the natural vegetation on the site. • Loss of fauna as a result of increased human activity and associated noise.	Minor	▪ Construction workers shall be provided with appropriate training on ecological awareness, as appropriate to their work activities. ▪ All construction equipment shall be cleaned (mud and soil removed) at source before being brought to site to minimise introduction of alien species. ▪ If sand or other natural materials for building are required and brought onto site, the stored heaps will be monitored for the growth and germination of alien species and will be regularly cleared during construction. ▪ Regular monitoring shall be undertaken to ensure that alien plants are not increasing as a result of the disturbance that has taken place. ▪ Hunting or deliberate killing of animals by construction workers shall be prohibited and monitored. ▪ In order to reduce collision of vehicles with fauna, a 10 km/hr speed limit by construction-related vehicles shall be enforced in the Project area.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	Gender	• Discrimination during employment and training opportunities • GBV (sexual harassment, intimate partner violence, poor working)	Moderate	▪ Equal treatment of workers shall be ensured. ▪ The GBV Action Plan for EEP shall be implemented for the Project ▪ All workers on the project shall be required sign a code of conduct to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse (GBV/ SEA) ▪ GBV sensitive channels for reporting in GRM shall be implemented for the Project ▪ The EPC Contractor shall be required to hire a Gender/GBV officer. ▪ Collaboration with appropriate government institutions or GBV service providers on potential GBV case management shall be ensured. ▪ All workers shall be required to undergo regular training and refreshers on GBV ▪ The EPC Contractor shall provide separate facilities for men and women and add GBV-free signage at the project site. ▪ All gender-based violence incidents shall be reported and dealt with as per the law.	Minor
	Construction workers safety	• Injury to construction workers during construction activities.	Moderate	▪ Health and Safety Plan shall be developed and implemented. The plan shall provide for recording, reporting, and investigating accidents and near misses, and developing measures to prevent recurrence. ▪ Construction workers shall be sensitized and monitored on the need to be safety conscious. ▪ Daily toolbox talks prior to commencement of work activities shall be carried out.	Minor

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				▪ Construction activities shall be limited to daytime as much as possible. ▪ Onsite safety officer shall be engaged to monitor the compliance of workers to safety rules. ▪ Proper safety signs and signage shall be placed at strategic locations within the site. ▪ PPE such as safety boot, coverall, eye google, safety helmets, reflective vests, etc. shall be provided to construction workers and the level of PPE compliance shall be monitored. ▪ Safety training focused on safe working practices, information on specific hazards, first aid and fire-fighting shall be included in the induction programme for workers. ▪ A mechanism procedure for receiving and addressing the concerns of workers shall be put in place and implemented. ▪ The site shall be secured with perimeter fencing and/or security. ▪ Sanitary amenities and potable water shall be provided.	
	Socio-economic and health	• Influx of people, increase in sexual transmitted diseases.	Moderate	▪ Construction workers (e.g. semi-skilled and unskilled craftsmen) shall be drawn from the local community as much as possible. ▪ No person under the age of 18 shall be engaged to work on the project. The EPC Contractor shall ensure that children and minors are not employed directly or indirectly on the project ▪ Any child dropout should be reported to the	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				relevant government agency ▪ The local community shall be informed of the Project activities prior to commencement of work. ▪ An induction and sensitization programme, including a Code of Conduct, for all construction workers shall be carried out prior to construction activities. This will increase sensitivity to local norms and customs, provide awareness to construction workers of appropriate and acceptable behaviours, and will govern worker interactions with the local community. ▪ Awareness education about GBV/SEA/HIV/AIDS and other sexually transmitted diseases shall be created among the workforce and extended to the local community. ▪ The CoC shall include provisions to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse by workers within the local community. ▪ Public access shall be restricted to construction area via security fencing and appropriate signage. ▪ Substance abuse prevention and management programs shall be implemented for workers. ▪ Sanctions (e.g., suspension and dismissal) shall be introduced for workers involved in criminal activities ▪ Procedure for receiving and addressing	

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				community concerns shall be developed and implemented.	
Waste Disposal and Generation	Infrastructure (waste management facility)	• E-waste generation • Disposal of construction wastes to existing waste management facility in the Project area.	Minor	▪ A Waste Management Plan shall be developed and implemented ▪ Training shall be provided for workers on safe storage, use and handling of e-waste on site. ▪ E-wastes generated shall be stored in appropriate locations prior to recycling and/or disposal ▪ Waste receptacles shall be provided within a secured area for collection of solid waste. ▪ Construction vehicles and equipment shall be serviced regularly.	Negligible
	Soil	• Soil contamination from solid and liquid construction waste streams.	Minor	▪ Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate locations with impervious hardstanding and adequate secondary containment. ▪ Portable spill containment and clean-up kits shall be available onsite. ▪ Construction workers shall be provided with adequate training on use, storage and handling of hazardous substances.	Negligible
	Groundwater	• Groundwater contamination of liquid construction waste streams.	Minor	▪ Training shall be provided for workers on safe storage, use and handling of hazardous materials (e.g. fuel, lubricating oil) on site. ▪ Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate locations with impervious hardstanding and adequate secondary containment.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				▪ Portable spill containment and clean-up kits shall be available onsite. ▪ Waste management plan (WMP) shall be developed by the EPC Contractor and implemented. ▪ Waste bins shall be provided at designated locations on site for temporary storage of different waste streams. ▪ Construction waste, as much as practicable, shall be reused or recycled. ▪ Waste that cannot be reused or recycled shall be disposed of at an approved dumpsite.	
Commissioning Phase					
Plant Testing	Ambient noise	• Increase in ambient noise level	Minor	▪ The Power Plant components shall be installed in line with the pre-established standards and as per manufacturer recommendations. ▪ Strict compliance to the Standard Operating Procedures shall be ensured. ▪ The inverters and batteries to be used for the Project shall meet industry best standard in relation to noise attenuation.	Negligible
	Workers	• Occupational health and safety hazards (e.g. injuries, electrocution, etc.) as a result of any wrong electrical connection.	Moderate	▪ Plant testing shall be carried out by experienced personnel. ▪ Adequate PPE shall be worn. ▪ The Project components shall be installed in line with the pre-established standards and as per manufacturer recommendations. ▪ The EPC contractor shall develop Standard Operating Procedures (SOPs) for the operational phase of the Project.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				▪ Strict compliance to the Standard Operating Procedures (SOPs) shall be ensured.Prior to the Plant commissioning, appropriate emergency equipment (such as first aid box, fire extinguishers) shall be provided onsite. ▪ Plant testing shall be restricted to the daytime. ▪ The site shall be secured with perimeter fencing and/or security ▪ Sanitary amenities and potable water shall be provided	
Operational Phase					
Power Generation and Evacuation	Socio-economic (visual prominence)	• Landscape alterations resulting in unpleasant changes in the visual character of the area	Minor	▪ All lighting will be kept to a minimum within the requirements of safety and efficiency. Where such lighting is deemed necessary, low-level lighting, which is shielded and directed downward, to reduce light spillage will be used.	Negligible
	Health, safety and welfare of staff during Plant operation	• Electric shock, injuries to personnel associated with the Power Plant operations, • Work related issues such as discrimination, denial of rights, unfair treatment, poor working conditions	Moderate	▪ Appropriate PPE shall be provided for workers. ▪ Training shall be provided to employees on emergency preparedness and responses. ▪ Provision of medical insurance scheme for employees shall be ensured. ▪ Appropriate safety signage shall be placed at strategic locations within the site. ▪ Strict compliance to the SOPs/code of conduct shall be ensured. ▪ A grievance mechanism procedure for receiving and addressing the concerns of employee shall be put in place and	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				implemented.	
	Gender	• Discrimination during employment and training opportunities • GBV (sexual harassment, intimate partner violence, poor working)	Minor	▪ Equal treatment of workers shall be ensured. ▪ Continuous implementation of the GBV Action Plan for EEP shall be sustained for the Project ▪ All workers on the project shall be required sign a code of conduct to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse (GBV/ SEA) ▪ GBV sensitive channels for reporting in GRM shall be implemented for the Project ▪ The O&M Contractor shall be required to hire a Gender/GBV officer. ▪ Collaboration with appropriate government institutions or GBV service providers on potential GBV case management shall be sustained. ▪ All workers shall be required to undergo regular training and refreshers on GBV ▪ The O&M Contractor shall provide separate facilities for men and women and add GBV-free signage at the project site. ▪ All gender-based violence incidents shall be reported and dealt with as per the law.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
Routine Maintenance, Waste Generation and Disposal	Soil	• Soil contamination from spent batteries and inverters	Minor	▪ General housekeeping to ensure the site is not overgrown with grasses shall be maintained ▪ Waste bins shall be provided at designated locations on site for temporary storage of different waste streams. ▪ General waste that cannot be reused or recycled shall be disposed of at an approved dumpsite. ▪ WMP shall be implemented. ▪ Burning of waste shall be prohibited. ▪ Damaged/expired Lithium ion batteries, solar panels, inverters and electric components shall be returned to the manufacturer based on the Extended Producer Responsibility (EPR) model. Prior to returning them to the manufacturers, they will be stored on impermeable surfaces within the site.	Negligible
	Health, safety and welfare of staff during maintenance	• Electric shock, injuries to personnel during maintenance	Minor	▪ Appropriate PPE shall be provided for workers. ▪ Maintenance workers shall imbibe the workplace safety rules via proper sensitization procedures. ▪ Strict compliance to the SOPs shall be ensured.	Negligible
	Groundwater	• Groundwater abstraction from cleaning of PV panels	Minor	▪ Water conservation plan shall be implemented ▪ Manual cleaning of the PV panels with water shall be regulated as much as practicable. The frequency of cleaning of PV panels with water is dependent on the rainfall pattern in the project area. During rainy season, cleaning is estimated to occur not more than thrice;	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				however during dry season the interval shall depend on the rate of dust accumulation. ▪ Periodic monitoring of groundwater resources in the Project's area of influence shall be implemented.	

CHAPTER SEVEN:

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

CHAPTER SEVEN

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

7.1 Introduction

The potential and associated impacts of the proposed 2.5 MW solar-hybrid power plant and associated infrastructure in the Federal University Gashua (FUGA), Yobe State, as part of the Federal Government's Energizing Education Programme, have been analyzed and documented in Chapter 5 of this report. The results show that if the recommended mitigation measures (presented in Chapter 6) are implemented, the identified impacts of the Project are not severe and can be reduced to as low as reasonably practicable. It is thus important that those recommended mitigation measures be translated into practical management actions, which can be adequately resourced and integrated into the Project phases.

Hence, this chapter presents the management measures and actions required to address the potential environmental and social impacts of the proposed Project. It also includes monitoring programme as well as performance indicators, responsible parties, timeframe and cost estimates for the implementation of recommended measures to address the associated impacts of the project throughout its life cycle. In addition, the framework for the contents of additional management plans to be developed and implemented as part of this ESMP is provided.

7.2 Objectives of the ESMP

The ESMP is essential for successfully implementing the Project's environmental and social performance throughout the life of the Project. Having this framework in place ensures a systematic approach to bringing environmental and social considerations into decision-making and day-to-day operations. It establishes a framework for tracking, evaluating and communicating environmental and social performance and helps ensure that environmental risks and liabilities are identified, minimized and managed including roles, responsibilities, and budget.

The ESMP will be a living document and will continue to develop during the design and construction phases to enable continuous improvement of the Project's environmental performance.

The specific objectives of the ESMP are to:

- Promote environmental and social management and communicate the

aims and goals of the ESMP;

- Ensure that all workers, subcontractors and others involved in the Project meet legal and regulatory requirements with regard to environmental management including financial implications;
- Incorporate environmental and social management into Project design and operating procedures;
- Serve as an action plan for environmental and social management for the Project;
- Provide a framework for implementing Project environmental and social commitments (i.e. mitigation measures identified in the ESIA);
- Prepare and maintain records of Project environmental and social performance (i.e. monitoring, audits and non-compliance tracking).

7.3 Environmental and Social Management Measures

Tables 7.1 to 7.4 present the recommended environmental and social management measures required to mitigate the identified impacts of the Project development and operation. Environmental and social measures for the decommissioning are documented in Chapter 8.

Table 7.1a: Environmental Management Measures for Pre-construction Phase of the proposed Project

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Site Clearing and Preparation							
Vegetation loss; direct impacts on vegetation and soil-dwelling organisms; indirect impacts on fauna species	Vegetation clearing shall be limited to the areas within the site needed for the Project. Use of herbicides for clearing shall be avoided. Site clearing and preparation shall be done mechanically.	Inspection	Daily	Adherence to measures	EPC Contractor	REA (PMU) FUGA (Site Engineer)	500
	Bush burning shall be avoided.	Inspection	Daily	Adherence to measures			
	Any cleared areas which are not used will be re-vegetated using plants or seeds of locally occurring species.	Inspection	Monthly after the site clearing phase	Re-vegetated land			
	The extent of vegetation to be cleared shall be clearly identified and appropriately demarcated. Clearing exceeding the approved working corridor shall be prohibited.	Inspection	Monthly before the site clearing activities	Adherence to measures			
	Hunting or deliberate killing of animals by workers shall be prohibited and monitored. Workers shall be sensitized on ecological protection	Inspection	Daily before the site clearing activities	Adherence to measures			
Removal of top soil and soil compaction; loss of top soil; increased erosion potential; reduction in structural stability and percolative ability of soil	Removal of vegetation and soil cover shall be restricted to the areas required for the Project. Soil conservation measures shall be implemented such as stockpiling topsoil or for the remediation of disturbed areas.	Inspection	Daily	Re-vegetated land			
	Use of silt traps or similar systems to reduce discharge of silt shall be ensured.	Inspection	Monthly before the site clearing activities	Re-vegetated land			
Air quality impacts due to	Site clearing equipment /	Maintenance	Daily	Adherence to			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
emission from site clearing equipment; increase in ambient noise levels	machinery shall be operated and maintained under optimum fuel efficient conditions.	records; Fuel consumption records		measures			
	Site clearing activities shall be carried out only during the daytime (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr)	Inspection	Daily	Adherence to measures			
Mobilization of Materials and Equipment to Site							
Air quality impacts from vehicular emissions; Increase in ambient noise levels	Project vehicles with efficient engine performance and with minimal noise and air emissions shall be selected and used. This can be achieved through regular servicing and maintenance	Inspection; Maintenance records	Once before vehicle commences journey	Adherence to measures	EPC Contractor	REA (PMU) FUGA (Site Engineer)	2000
	All materials with potential to result in dust emissions shall be covered during transport.	Inspection	Once before vehicle commences journey	Adherence to measures	EPC Contractor		
	Onsite vehicle speed on unhardened roads and surfaces shall be limited to about 15 – 20km/h so as to reduce dust generation.	Inspection	Daily	Adherence to measures	EPC Contractor		
	Unnecessary engine idling shall be avoided.	Inspection	Daily	Adherence to measures	EPC Contractor		
	Site roads shall be sprinkled as needed to prevent dust entrainment.	Inspection	Daily	Adherence to measures	EPC Contractor		

Table 7.2a: Environmental Management Measures for Construction Phase of the proposed Project

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Civil and Electrical Works/ Installation Activities							
Air quality impacts due to emission from construction equipment; Increase in dust from cleared land and windblown stockpiles	Regular maintenance and servicing of construction equipment /machinery shall be ensured.	Maintenance records	Monthly during construction phase	Adherence to measures	EPC Contractor	REA-PMU FUGA (Site Engineer) FMEnv Yobe State Ministry of Environment	1000
	Routine water sprinkling shall be carried out to minimize dust generation during construction.	Inspection	Daily during civil work activities	Adherence to measures	EPC Contractor		
	Only modern and well maintained equipment and machinery shall be used for construction activities.	Inspection	Daily during civil work activities	Adherence to measures	EPC Contractor		
Increase in noise level	Noise suppression equipment (e.g. mufflers) shall be fitted on construction machinery.	Inspection	Daily during construction phase	Adherence to measures	EPC Contractor	REA-PMU FUGA (Site Engineer) FMEnv Yobe State Ministry of Environment	500
	Construction activities shall be limited to day-time (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr).	Inspection	Daily during construction phase	Adherence to measures	EPC Contractor		
	Construction machinery shall be turned off when not in use.	Inspection	Daily during construction phase	Adherence to measures	EPC Contractor		
	Construction equipment shall be properly maintained and serviced.	Maintenance records	Monthly during construction phase	Adherence to measures	EPC Contractor		
	Noise complaints related to the construction activities shall be assessed and appropriately addressed.	Complaint records	Weekly during construction phase	World Bank Good Practice Note on Addressing Grievances	EPC Contractor		
	Noise monitoring at locations with persistent noise complaints shall be maintained.	Noise monitoring records	Monthly during construction phase	FMEnv Noise limit World Bank Noise Limit	EPC Contractor		
	Machinery/equipment to be used for construction work shall meet industry best standard in relation to	Inspection	Before commencement of construction	Adherence to measures	EPC Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	noise attenuation		phase				
Increased soil erosion potential; reduction in structural stability and percolative ability of soil	Excavation works shall not be executed under aggressive weather conditions.	Inspection	Daily during excavation activities	Adherence to measures	EPC Contractor	REA-PMU FUGA (Site Engineer) FMEnv Yobe State Ministry of Environment	-
	Stockpiles shall be appropriately covered to reduce soil loss as a result of wind or water erosion.	Inspection	Daily during civil work activities	Adherence to measures	EPC Contractor		
Loss of plant species as a result of introduction of alien plants; loss of fauna as a result of increased human activity and associated noise.	Construction workers shall be provided with appropriate training on ecological awareness, as appropriate to their work activities.	Training records	Once before start of construction phase	Certificates of Training	EPC Contractor	REA-PMU FUGA (Site Engineer) FMEnv Yobe State Ministry of Environment	-
	All construction equipment shall be cleaned (mud and soil removed) at source before being brought to site to minimise introduction of alien species. If sand or other natural materials for building are required and brought onto site, the stored heaps will be monitored for the growth and germination of alien species and will be regularly cleared during construction.	Inspection	Daily during construction phase	Adherence to measures	EPC Contractor		
	Regular monitoring shall be undertaken to ensure that alien plants are not increasing as a result of the disturbance that has taken place.	Monitoring records	Monthly during construction phase	Adherence to measures	EPC Contractor		
Road damage, traffic and safety impacts	TMP shall be developed by the EPC Contractor and implemented.	TMP implementation records	Daily during construction phase	Benchmarks stated in the TMP	EPC Contractor	REA-PMU FUGA (Site Engineer) FMEnv	500
	Speed limits for all construction-related vehicles shall be established and enforced.	Inspection	Daily during construction phase	Adherence to measures	EPC Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	Appropriate barriers and signage shall be provided to demarcate areas in which construction traffic is active.	Safety signs and barriers	Once before commencement of construction	Adherence to measures	EPC Contractor	Yobe State Ministry of Environment	
	Drivers' competency shall be assessed and where required training shall be provided.	Drivers' competency assessments; training records	Once before commencement of construction	Passing of competency assessment or training completion certificates	EPC Contractor		
	A procedure for recording all construction related traffic incidents/accidents shall be developed and implemented.	Incident forms	Daily during construction phase	Completed incident forms	EPC Contractor		
	The EPC contractor shall promptly repair damage to public infrastructure and repair or compensate for damage to private property.	Incident forms, GRM	Daily during construction phase	Completed incident forms	EPC Contractor		
Waste Disposal and Generation							
E-waste generation	A Waste Management Plan shall be developed and implemented	Waste Management records	Weekly during construction phase	Adherence to measures	EPC Contractor	REA-PMU FUGA (Site Engineer) FMEnv Yobe State Ministry of Environment	2000
	Training shall be provided for workers on safe storage, use and handling of e-waste on site.	Training records	Once before commencement of construction	Certificates of completion of trainings	EPC Contractor		
	E-wastes generated shall be stored in appropriate locations at the Project site prior to recycling.	Waste consignment notes, waste receptacles on site	Weekly during construction phase	Adherence to measures	EPC Contractor		
Soil contamination from solid and liquid construction waste streams.	Hazardous substances and materials shall be stored in appropriate locations with impervious hardstanding and adequate secondary containment. Portable spill containment and clean-up kits shall be available onsite.	Inspection	Daily during construction phase	Adherence to measures World Bank General EHS Guidelines	EPC Contractor	REA-PMU FUGA (Site Engineer) FMEnv	200

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	Construction workers shall be provided with adequate training on use, storage and handling of hazardous substances.	Training records	Once before commencement of construction	Certificates of completion of trainings	EPC Contractor	Yobe State Ministry of Environment	
Groundwater contamination of liquid construction waste streams.	Training shall be provided for workers on safe storage, use and handling of hazardous materials (e.g. fuel, lubricating oil) on site.	Training records	Once before commencement of construction	Certificates of completion of trainings	EPC Contractor	REA-PMU FUGA (Site Engineer) FMEnv Yobe State Ministry of Environment	500
	Hazardous substances and materials shall be stored in appropriate locations with impervious hardstanding and adequate secondary containment. Portable spill containment and clean-up kits shall be available onsite.	Inspection	Daily during construction phase	Adherence to measures World Bank General EHS Guidelines	EPC Contractor		

Table 7.2b: Social Management Measures for Construction Phase of the proposed Project

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Civil and Electrical Works/ Installation Activities							
Discrimination during employment and training opportunities	Employment of workers for construction activities shall be open and fair. However, no person under the age of 18 shall be engaged on the project sites.	Employment records	Once before start of construction	Adherence to measures	EPC Contractor	REA-PMU FUGA (Site Engineer) FMEnv Yobe State Ministry of Environment	-
GBV (sexual harassment, intimate partner violence, poor working)	The EEP GBV Action Plan shall be implemented for the Project	Implementation by the EPC Contractor	Once before start of construction	Evidence to show implementation of EEP GBV action plan	EPC Contractor	REA-PMU FUGA (Site Engineer)	2500

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	All workers shall be required to undergo regular training and refreshers on GBV	Organize regular onsite training and refreshers	Monthly during construction phase	Records of regular training and attendance	EPC Contractor	FMEnv Yobe State Ministry of Environment Yobe State Ministry of Women Affairs and Social Development GBV/SEA service providers	
	All workers on the project shall be required sign a code of conduct (CoC) to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse (GBV/ SEA)	Develop CoC forms for workers	Once before start of construction	Signed CoC forms	EPC Contractor		
	GBV sensitive channels for reporting in GRM shall be implemented for the Project	Establish accessible GRM reporting channels	Monthly during construction	GRM records	EPC Contractor		
	The EPC Contractor shall be required to hire a Gender/GBV officer	Employ GRM Officer	Once before start of construction	Employment records and job description	EPC Contractor		
	Collaboration with appropriate government institutions or GBV service providers on potential GBV case management shall be ensured	Engagement of GBV service provider	Once before start of construction	Records of ongoing engagement and consultation with GBV service providers	EPC Contractor		
	The EPC Contractor shall provide separate facilities for men and women and add GBV-free signage at the project site	Erection of separate convenience facilities and display of GBV signage	Once before start of construction	Inspection of facilities to ensure adequacy	EPC Contractor		
Influx of people, increase in sexual transmitted diseases.	Construction workers (e.g. semi-skilled and unskilled craftsmen) shall be drawn from the local community as much as possible.	Employment records and prepare a labour management plan	Once before start of construction	Adherence to measures	EPC Contractor	REA-PMU FUGA (Site Engineer) FMEnv Yobe State Ministry of Environment Yobe State Ministry of	3000
	An induction and sensitization programme, including a Code of Conduct, for all construction workers shall be carried out prior to construction activities. This will increase sensitivity to local norms and customs, provide awareness to construction workers of appropriate	Induction records and training on the code of conduct	Once before start of construction	Adherence to measures	EPC Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	and acceptable behaviours, and will govern worker interactions / fraternization with the local community.					women affairs and Social Development	
	Awareness education about GBV/SEA/HIV/AIDS and other sexually transmitted diseases shall be created among the workforce and extended to the local community	Training records	Once before start of construction	Adherence to measures	EPC Contractor	GBV/SEA service providers	
	Public access shall be restricted to construction area via security fencing and appropriate signage	Inspection	Daily during construction phase	Adherence to measures	EPC Contractor		
	All workers on the project shall be required to sign a code of conduct that prohibits any form of Gender Based Violence/Sexual Exploitation and Abuse	Signed code of conduct records	Once before start of construction	Adherence to measures	EPC Contractor		
	The NEP Grievance redress mechanism procedures for receiving and addressing community concerns shall be developed and implemented.	Consultations and grievance records	Weekly during construction phase	World Bank Good Practice Note on Addressing Grievances	EPC Contractor		
Injury to construction workers during construction activities	Health and Safety Plan shall be developed and implemented.	Health and Safety plan implementation records	Daily during construction phase	Benchmarks stated in Health and Safety Plan	EPC Contractor	REA-PMU FUGA (Site Engineer) FMEnv Yobe State Ministry of Environment,	4000
	Construction workers, including hire local workers, shall be sensitized and monitored on the need to be safety conscious. Daily toolbox talks prior to commencement of work activities shall be carried out for all workers.	Daily toolbox records	Daily during construction phase for workers and monthly for communities as part of engagement	Benchmarks stated in Health and Safety Plan	EPC Contractor		
	Onsite safety officer shall be engaged to monitor the compliance of	Qualified and dedicated safety officer	Once before commencement	Adherence to measures	EPC Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	workers to safety rules.		of construction				
	PPE such as safety boot, coverall, eye google, safety helmets, reflective vests, etc. shall be provided to construction workers and the level of PPE compliance shall be monitored.	Availability of PPE	Daily during construction phase	PPE compliance	EPC Contractor		
	Safety training focused on safe working practices, information on specific hazards, first aid and fire-fighting shall be included in the induction programme for workers.	Training records	before commencement of construction and weekly	Certificates of completion of trainings	EPC Contractor		
	A mechanism procedure for receiving and addressing the concerns of workers shall be put in place and implemented.	Completed grievance forms	Weekly during construction phase	Adherence to measures	EPC Contractor		
	Hazardous substances and materials shall be stored in appropriate locations with impervious hardstanding and adequate secondary containment. Portable spill containment and clean-up kits shall be available onsite.	Inspection	Daily during construction phase	Adherence to measures World Bank General EHS Guidelines	EPC Contractor		
	Waste management plan (WMP) shall be developed and implemented.	WMP implementation records	Daily during construction phase	Benchmarks stated in WMP World Bank General EHS Guidelines	EPC Contractor		

Table 7.3a: Environmental Management Measures for Commissioning Phase

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Plant testing							
Increase in ambient noise level due to Plant testing	Strict compliance to the Standard Operating Procedures (SOPs) shall be ensured.	SOPs	Once before commissioning	Adherence to measures	EPC Contractor	REA-PMU FUGA (Site Engineer) FMEnv Yobe State Ministry of Environment	500
	The EPC contractor shall develop Standard Operating Procedures (SOPs) for the operational phase of the Project	SOPs	Once before commissioning	Adherence to measures	EPC Contractor		
	The Power Plant components shall be installed in line with the pre-established standards and as per manufacturer recommendations	SOPs	Once before commissioning	Adherence to measures	EPC Contractor		

Table 7.3b: Social Management Measures for Commissioning Phase

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Plant testing							
Occupational health and safety hazards (e.g. injuries, electrocution, etc.) as a result of any wrong electrical connection.	Plant testing shall be carried out by experienced personnel.	Qualified and dedicated Engineer	Once before commissioning	Adherence to measures	EPC Contractor	REA-PMU FUGA (Site Engineer) FMEnv Yobe State Ministry of Environment	200
	Adequate PPE shall be worn	Availability of PPE	Once before commissioning	Adherence to measures			
	Prior to the Plant commissioning, appropriate emergency equipment shall be installed at the Project site.	Availability of emergency response equipment	Once before commissioning	Adherence to measures			
Wrong electrical connection leading to explosion/fire	Plant testing shall be carried out by experienced personnel.	Qualified and dedicated Engineer	Once before commissioning	Adherence to measures	EPC Contractor	REA-PMU FUGA (Site Engineer)	-

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
						FMEnv Yobe State Ministry of Environment	

Table 7.4a: Environmental Management Measures for Operational Phase

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Power Generation and Evacuation							
Landscape alterations resulting in unpleasant changes in the visual character of the area	All lighting will be kept to a minimum within the requirements of safety and efficiency. Where such lighting is deemed necessary, low-level lighting, which is shielded and directed downward, to reduce light spillage will be used.	Inspection	Monthly during operations	Adherence to measures	O&M Contractor	REA-PMU FUGA (Site Engineer) FMEnv Yobe State Ministry of Environment	-
Routine Maintenance, Waste Generation and Disposal							
E-waste generation and disposal	Training shall be provided for workers on safe storage, use and handling of e-waste on site.	Training records	At induction of new staff , and in annual refresher training	Certificates of completion of trainings	O&M Contractor	REA-PMU FUGA (Site Engineer) FMEnv Yobe State Ministry of Environment	2000
	E-wastes generated shall be stored in appropriate locations prior to recycling; consignment notes will be maintained	Waste consignment notes, waste receptacles on site	Continuous during operations	Adherence to measures	O&M Contractor		
	Waste receptacles shall be provided within a secured area for collection of solid waste.	Waste consignment notes, waste	continuous during operations	Adherence to measures	O&M Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
		receptacles on site					
Soil contamination from spent batteries and inverters	Waste that cannot be reused or recycled shall be disposed of at an approved dumpsite. Spent batteries and inverters shall be sent to manufacturers in line with the Extended Producer Responsibility (EPR) policy.	Consignment notes for spent batteries to manufacturers for recycling	Yearly	World Bank General EHS Guidelines	O&M Contractor	REA-PMU FUGA (Site Engineer) FMEnv Yobe State Ministry of Environment	1000
	WMP shall be implemented.	WMP implementation records	Quarterly during operation phase	Benchmarks stated in WMP World Bank General EHS Guidelines	O&M Contractor		
Groundwater abstraction from cleaning of PV panels	Water management / conservation plan and measures shall be implemented	Implementation records of water management plan	Quarterly during operations	Benchmarks in water conservation plan World Bank General EHS Guidelines	O&M Contractor	REA-PMU FUGA (Site Engineer) FMEnv Yobe State Ministry of Environment	500

Table 7.4b: Social Management Measures for Operational Phase

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Power Generation and Evacuation							
GBV (sexual harassment, intimate partner violence, poor working)	The EEP GBV Action Plan shall be implemented during operations	Implementation by the O&M Contractor	Continuously during operations	Evidence to show implementation of EEP GBV action plan	O&M Contractor	REA-PMU FUGA (Site Engineer)	2500
	All workers shall be required to undergo regular training and	Organize regular onsite training and	Monthly during operation phase	Records of attendance			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	refreshers on GBV	refreshers				FMEnv Yobe State Ministry of Environment	
	All workers on the project shall be required sign a code of conduct to prohibit any form of Gender Based Violence/Sexual Exploitation and Abuse (GBV/ SEA)	Develop CoC forms for workers	Once before start of operations	Signed CoC forms			
	GBV sensitive channels for reporting in GRM shall be implemented for the Project	Establish GRM reporting channels	Once before start of operations	GRM records			
	The EPC Contractor shall be required to hire a Gender/GBV officer	Hire GRM Officer	Once before start of operations	Employment records and job description			
	Collaboration with appropriate government institutions or GBV service providers on potential GBV case management shall be ensured	Engagement of GBV service provider	Once before start of operations	Records of ongoing engagement and consultation with GBV service providers			
	The EPC Contractor shall provide separate facilities for men and women and add GBV-free signage at the project site	Erection of separate convenience facilities and display of GBV signage	Once before start of operations	Inspection of facilities to ensure adequacy			
Health, safety and welfare of staff during Plant operation	Provision of medical insurance scheme for employees shall be ensured.	Employment forms of employees	Quarterly during operations	Adherence to measures	O&M Contractor	REA-PMU FUGA (Site Engineer) FMEnv Yobe State Ministry of Environment	3000
	Appropriate safety signage shall be placed at strategic locations within the site.	Safety signs	Quarterly during operations	Adherence to measures			
	Strict compliance to the SOPs shall be ensured.	SOPs	Quarterly during operations	Adherence to measures			
	A grievance mechanism procedure for receiving and addressing the concerns of employee shall be put in place and implemented.	Completed grievance forms	Monthly during operations	Adherence to measures			
Routine Maintenance, Waste Generation and Disposal							
Electric shock, injuries to	Appropriate PPE shall be provided for workers.	Availability of PPE	Quarterly during operations	Adherence to measures	O&M Contractor	REA-PMU	500

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
personnel during maintenance	Strict compliance to the SOPs shall be ensured.	SOPs	Quarterly during operations	Adherence to measures		FUGA (Site Engineer) FMEnv Yobe State Ministry of Environment	

7.4 Roles, Responsibilities and Accountabilities

The main responsibility for overseeing the implementation of the ESMP lies with the REA PMU throughout the project life span. However, conformance with the specific environmental measures detailed in Chapter Six of this report will be ensured by the EPC contractor during the construction phase and Operations and Maintenance (O&M) contractor at the operational phase of the Project.

7.4.1 Pre-construction Phase

The key personnel and institutions with major roles in the implementation of the ESMP during pre-construction phase are:

FUGA Director of Physical Planning

- Select the land for the proposed Project
- Appoint a Site Engineer
- Arrange and ensure adequate training is carried out for the Site Engineer
- Review the ESMP from the consultant
- Ensure the University's commitment to the ESMP implementation

REA-PMU

- Provide technical support to the University in selecting sufficient and suitable land for construction of power plant and training center
- Appoint an EPC contractor
- Supervise the activities of the EPC contractor
- Review the ESMP from the consultant
- Ensure REA's commitment to the ESMP implementation

FUGA Site Engineer

- Attend adequate training on ESMP implementation
- Supervise the activities of the EPC contractor and ensure compliance ESMP with mitigation measures
- Report to FUGA Director of Physical Planning on ESMP compliance and non-compliance issues

EPC Contractor

- Familiarize with ESMP requirements
- Ensure that all personnel are made aware of the management measures/plans that are to be implemented
- Report to the REA-PMU and FUGA Site Engineer on ESMP compliance and non-compliance issues
- Implement ESMP requirements relevant to work being undertaken

7.4.2 Construction Phase

The key personnel and institutions with major roles in the implementation of the ESMP during construction phase are:

FUGA Director of Physical Planning

- Supervise the activities of the Site Engineer by reviewing reports on ESMP issues
- Suggest ESMP improvements to REA-PMU to address non-compliance and upcoming issues

REA-PMU

- Supervise the activities of the EPC contractor by reviewing reports on ESMP issues
- Discuss ESMP improvements with FUGA Director of Physical Planning to address non-compliance and upcoming issues.
- Monitors the implementation of the ESMP

FUGA Site Engineer

- Supervise the activities of the EPC contractor and ensure compliance ESMP with mitigation measures
- Report to FUGA Director of Physical Planning on ESMP compliance and non-compliance issues

EPC Contractor

- Implement ESMP requirements relevant to work being undertaken
- Hire a Gender/GBV officer
- Report to the REA-PMU and FUGA Site Engineer on ESMP compliance and non-compliance issues

FMEnv Representatives

- Monitor the implementation of ESMP requirements (impact mitigation monitoring) relevant to work being undertaken
- Discuss ESMP improvements with FUGA Director of Physical Planning and REA-PMU to address non-compliance and upcoming issues

Yobe State Ministry of Women Affairs and Social Development; and GBV/SEA Service Provider

- Monitor the implementation of Gender mitigation measures relevant to work being undertaken
- Discuss ESMP improvements with the Gender/GBV officer, FUGA Director of Physical Planning, and REA-PMU to address non-compliance and upcoming issues

Yobe State Ministry of Environment Representatives

- Monitor the implementation of ESMP requirements (impact-mitigation monitoring) relevant to work being undertaken
- Discuss ESMP improvements with FUGA Director of Physical Planning and REA-PMU to address non-compliance and upcoming issues

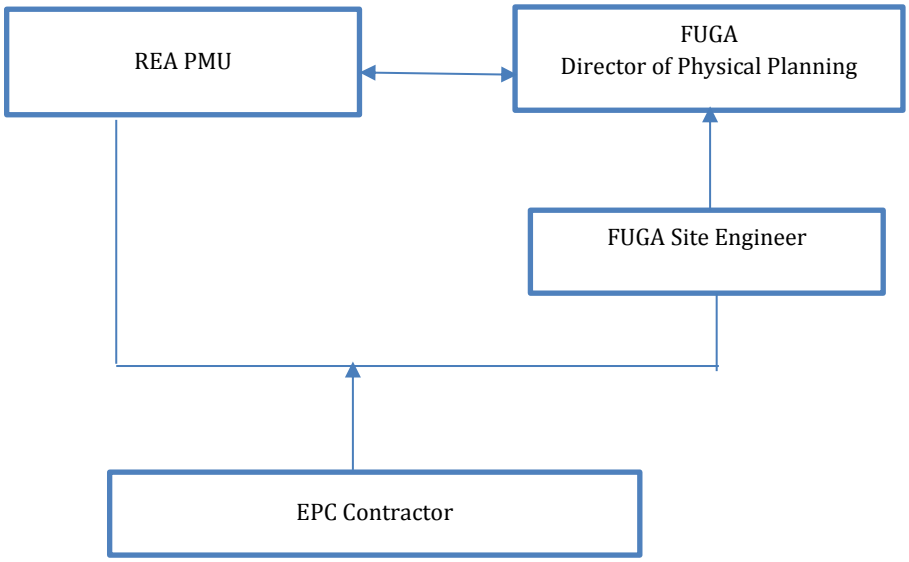


Figure 7.1: Roles and Responsibilities for the Pre-Construction and Construction Phase

7.4.3 Operational Phase

FUGA Director of Physical Planning

- Supervise the activities of the Site Engineer by reviewing reports on ESMP issues
- Suggest ESMP improvements to O&M Contractor and REA-PMU to address non-compliance and upcoming issues

REA-PMU

- Appoint an O&M Contractor
- Supervise the activities of the O&M Contractor by reviewing reports on ESMP issues
- Discuss ESMP improvements with FUGA Director of Physical Planning to address non-compliance and upcoming issues

FUGA Site Engineer

- Supervise the activities of the O&M Contractor and ensure compliance ESMP with mitigation measures
- Report to FUGA Director of Physical Planning on ESMP compliance and non-compliance issues

O&M Contractor

- Implement ESMP requirements relevant to work being undertaken
- Report to the REA-PMU and FUGA Site Engineer on ESMP compliance and non-compliance issues

FMEnv Representatives

- Monitor the implementation of ESMP requirements (environmental compliance monitoring) relevant to work being undertaken
- Discuss ESMP improvements with O&M Contractor, FUGA Director of Physical Planning and REA-PMU to address non-compliance and upcoming issues

NESREA Representatives

- Monitor the implementation of ESMP requirements (environmental compliance monitoring) relevant to work being undertaken
- Discuss ESMP improvements with FUGA Director of Physical Planning and REA-PMU to address non-compliance and upcoming issues

Yobe State Ministry of Women Affairs and Social Development; and GBV/SEA Service Provider

- Monitor the implementation of Gender mitigation measures relevant to work being undertaken
- Discuss ESMP improvements with the Gender/GBV officer, FUGA Director of Physical Planning, and REA-PMU to address non-compliance and upcoming issues

Yobe State Ministry of Environment Representatives

- Monitor the implementation of ESMP requirements (environmental compliance monitoring) relevant to work being undertaken
- Discuss ESMP improvements with O&M Contractor, FUGA Director of Physical Planning and REA-PMU to address non-compliance and upcoming issues

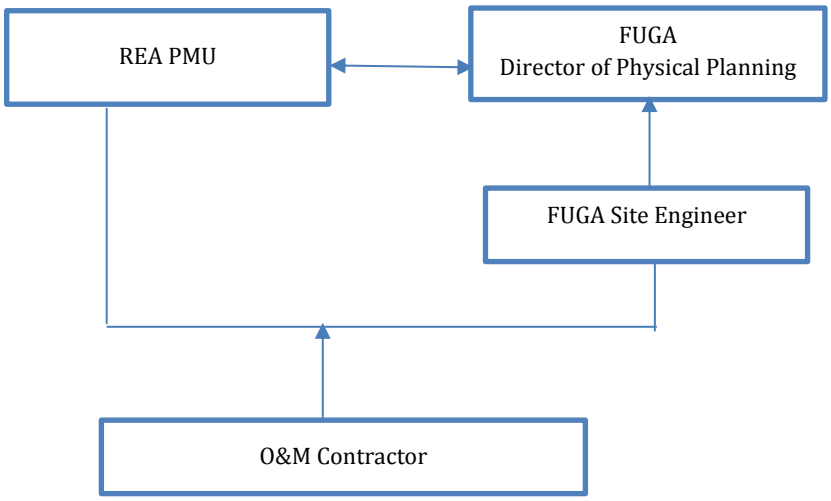


Figure 7.2: Roles and Responsibilities for the Operational Phase

7.5 Additional Management Plans

This section provides a framework for the contents of additional management plans to be developed and implemented, in support of this ESMP, for the proposed Project. As the Project progresses, the management plans will be expanded to include specific procedures to guide implementation by the relevant Project personnel including contractor and subcontractors.

The documents will be prepared strictly in line with the requirements set out in the relevant international standards and guidelines such as the World Bank General EHS Guidelines as well as other applicable national and local regulations and guidelines.

7.5.1 Stakeholder Engagement Plan

A Stakeholder Engagement Plan (SEP) shall be developed and implemented throughout the lifecycle of the proposed Project. The objectives of developing SEP for the proposed Project include the following:

- Ensuring stakeholder inclusion and involvement across the various phases of the project;
- Ensuring clarity and understanding through an open, inclusive and transparent process of culturally appropriate engagement and communication undertaken to ensure that stakeholders are well informed about the proposed Project;
- Building and maintaining productive relationship between REA and its various stakeholders through supporting open dialogue;
- Engaging vulnerable groups through an open and inclusive approach to consultation, thereby increasing the opportunity for stakeholders to provide comment and voice their concerns on the proposed Project;

- Managing expectations to ensure that the proposed Project does not create or allow unrealistic expectations to develop amongst stakeholders about proposed Project benefits. The engagement process will serve as a mechanism for understanding and managing stakeholder and community expectations, where the latter will be achieved by disseminating accurate information in an accessible way.
- Ensuring compliance with both local regulatory requirements and international best practice.
- Ensuring stakeholders are free of external manipulation or coercion.

REA is committed to implementing stakeholder management as part of its operations. As such REA will ensure that the responsibility for implementing the SEP is duly assigned and all components of the plan are well-defined within its organizational processes. REA shall also commit to providing the necessary support to implement the SEP.

In line with the Environmental and Social Management framework (ESMF) for NEP, an effective SEP should:

- ❖ Describe regulatory, lender, company, and/or other requirements for consultation and disclosure.
- ❖ Identify and prioritize key stakeholder groups, focusing on Affected Communities.
- ❖ Provide a strategy and timetable for sharing information and consulting with each of these groups.
- ❖ Describe resources and responsibilities for implementing stakeholder engagement activities.
- ❖ Describe how stakeholder engagement activities will be incorporated into a company's management system.

A sample SEP is outlined in the Environmental and Social Management framework (ESMF) for NEP (NEP ESMF, 2019).

7.5.1.1 Grievance Redress Mechanism

A Grievance Redress Mechanism (GRM) has been developed for NEP. The proposed solar-hybrid power plant and associated infrastructure in FUGA is part of the NEP. The GRM provides a framework for addressing Project-related complaints, including logging, tracking, and grievances resolution. The GRM will be communicated to all stakeholders in the course of Project development and implementation and will make publicly available a record documenting the responses to all grievances received. The GRM shall be maintained throughout the project life cycle.

7.5.2 Emergency Preparedness and Response Plan (EPRP)

An Emergency Preparedness and Response Plan (EPRP) shall be developed and implemented for the proposed Power Plant. As part of the EPRP, the fire protection system for the Project will be designed to meet the requirements of the local fire codes under the National Fire Protection Association. In addition, the grounding and lightning protection systems for the Project shall be installed in a manner that will limit the effect of ground potential gradients to such voltage and current levels that will not endanger the safety of people or equipment under normal and fault conditions.

The EPRP shall include procedures for addressing all reasonably foreseeable and possible emergencies such as: fire, spill or release of hazardous wastes, medical and weather-related emergencies. It shall address the following aspects, amongst others:

- Identification of the emergency scenarios and the development of appropriate and specific emergency response procedures for each scenario;
- Training of emergency response teams on the appropriate procedures and the use of emergency response equipment;
- Identification of emergency contacts and support services and the development of effective communication systems / protocols;
- Emergency equipment and facilities must be provided (e.g., first aid stations, fire-fighting equipment, personal protective equipment);
- Development of decontamination / clean-up procedures and identify critical remedial measures to contain, limit and reduce pollution;
- Identification of potential risk relating the uncontrolled release of hazardous materials and the preparation of a spill prevention, control, and response plans including:
    - Training of operators on spill prevention.
    - Implementation of inspection programmes to confirm the integrity of secondary containment structures and equipment.
    - Development of standard operating procedures for filling containers or equipment and the transfer of hazardous materials.
    - Identification and availability of the appropriate personal protective equipment and equipment.

7.5.3 Traffic Management Plan (TMP)

The purpose of this plan is to adopt best transport safety practices across all the aspects of the Project (especially at the construction phase) with the goal of preventing traffic accidents and minimizing injuries suffered by Project personnel and the public. The measures to be included in the TMP should include the following, amongst others:

- Emphasizing safety aspects among drivers;
- Improving driving skills and requiring licensing of drivers;
- Adopting limits for trip duration and arranging driver rosters to avoid overtiredness;
- Avoiding dangerous routes and times of day to reduce the risk of accidents;

7.5.4 Waste Management Plan (WMP)

The primary purpose of the WMP is to ensure that wastes (hazardous/non-hazardous) are avoided or minimized, and any wastes that are generated are properly managed and disposed in an environmentally sound manner. The waste management hierarchy is expressed as follows:

- Prevention: avoid waste generation;
- Reduction at source - minimization of waste generation through installation of pollution abatement equipment;
- Reuse - Using an item for its original purpose, or similar purpose, in its original form;
- Recycling – conversion of waste materials into reusable objects;
- Disposal - disposal of wastes in an environmentally sound manner.

7.5.5 Occupational Health and Safety (OHS) Plan

The OHS plan must include the following elements, amongst others:

- Identification of potential hazards and development of responses to eliminate sources of risk or minimize workers' exposure to hazards;
- Provision of Personal Protective Equipment (PPE) to workers at no cost;
- Provision of training to all workers on all relevant aspects of occupational health and safety issues associated with their daily work, including emergency arrangements;
- Third parties (visitors and external service providers) must be briefed on the relevant aspects of health and safety and emergency response when accessing the site premises;

7.5.6 Local and Employment Management Plan (LEMP)

The LEMP should aim to promote employment opportunities and training for local people in the Project's area of influence and include, amongst others:

- Targets for employing local labour;
- Targets for work experience opportunities;
- Notification of all employment and training opportunities prior to them being advertised elsewhere;

- Measures to provide verifiable monitoring information regarding training and employment. The training status for all workers must be recorded;

7.5.7 Erosion Control Management Plan

This Plan should aim to control soil erosion in the Project area. The timing of works and the installation of control measures has a major influence on the management of storm water. The Plan should include the following measures, amongst others:

- Clearing of only those areas necessary for construction works shall be ensured.
- Slopes of all cut and fill areas shall be rigorously controlled and will at no time be allowed to be greater than the slope established in the final design;
- Piles of soil or other materials shall be allowed for short periods of time and will be located only in flat areas and away from any storm water courses;
- Temporary protection of exposed soil surfaces with measures such as plastic film, bio-membranes or other means, will be implemented whenever necessary;

7.5.8 Water Conservation Plan

The Plan will address the appropriateness of water conservation, and efficient use of groundwater for construction activities and cleaning of PV panels during the operational phase of the Project.

7.5.9 EEP Gender-Based Violence (GBV) Action Plan

The EEP GBV action plan shall be implemented throughout the project lifecycle. The components of the plan include:

- A GBV risk assessment; which has been conducted as part of the ESIA.
- Integration of GBV risk management in the ESMP.
- REA-PMU shall define GBV requirements in the contractor bid documents including the hiring of a Gender/GBV officer.
- REA-PMU shall evaluate GBV response protocol of the contractors before finalizing engagement contract.
- Contractors shall ensure that there are GBV-sensitive channels for reporting in GRM.
- Contractors shall inform Project affected communities about GBV risks.
- Contractors shall ensure code of conducts (CoC) forms are signed and understood by all workers. Workers shall be trained on CoC including regular training and refreshers

- Contractors shall ensure separate facilities for men and women and install GBV-free signage at the Project site.

Timely implementation of the EEP GBV action plan shall reduce GBV/SEA risks that may arise during Project development and operation.

7.5.10 Summary of Additional Management Plans

Table 7.5 summarizes the additional management plans required for the Project, including the cost estimate for developing each of the plans.

Table 7.5: Additional Management Plans and Timing for Development

S/N	Plan	Timing for Development	Cost Estimates (US Dollars)
1.	Emergency Preparedness and Response Plan	Pre-construction	2000
2.	Traffic Management Plan	Pre-construction	2000
3.	Waste Management Plan	Pre-construction	3000
4.	Occupational Health and Safety	Pre-construction	2000
5.	Local and Employment Management Plan	Pre-construction	1500
6.	Erosion and Sediment Control Plan	Pre-construction	2000
7.	Water Conservation Plan	Pre-construction	1000
8.	EEP Gender Action Plan	Pre-construction	2,000
Total			15,500

7.6 Environmental Monitoring Programme

Monitoring shall be conducted to ensure compliance with regulatory requirements as well as to evaluate the effectiveness of operational controls and other measures intended to mitigate potential impacts. Table 7.6 summarizes the environmental monitoring programme for the Project.

Table 7.6: Environmental Monitoring Programme for the proposed Project

Environmental Components/ Matrix	Sampling Locations	Sampling Method	Environmental/ Social Parameters to be monitored	Compliance Requirement	Frequency of Monitoring	Responsible Party	Project Development Phase	Estimated Cost (US Dollars)
Atmosphere (Air Quality & Noise)	• Project Site • Power evacuation route	• Air Quality Monitoring Equipment • Sound level meter	TSP, CO, NO_x, SO_x, Noise Level (dBA)	FMEnv/ WHO/ World Bank	Monthly monitoring; Monthly reporting	EPC Contractor	• Construction Phase	1000
Groundwater Quality	Borehole within the University	Thermometer, Water sampler, Turbidity meter, pH meter, AAS etc.	Temperature, pH, salinity, TDS, conductivity, DO, BOD, TOC, COD, NO_3, PO_4, Chloride, sulphate, Microbiology, Heavy metals, TSS and Turbidity	FMEnv/ WHO	Quarterly monitoring and reporting	EPC Contractor REA Project Manager	• Construction Phase • Operations Phase	4000
Soil	Unpaved sections of the Plant	Composite soil samples collection for laboratory analysis.	pH, Moisture, TOC, THC, TPH, NO_3, PO_4, Chloride, sulphate, Microbiology, Heavy metals.	NESREA/ World Bank	Quarterly monitoring and reporting	EPC Contractor REA Project Manager	• Construction Phase • Operations Phase	4000
Solid Waste	Operational areas	Monitor the handling and disposal of solid wastes generated onsite; waste tracking documentation.	Operational solid wastes including used packaging waste.	FMEnv/NESREA/ World Bank	Monthly monitoring; Quarterly reporting	EPC Contractor REA Project Manager	• Construction Phase • Operations Phase	2000
Health and Safety	Workers and Operational areas	Observe compliance to PPE and unsafe working conditions	Health and Safety Plan	FMEnv/NESREA/ World Bank	Daily monitoring; Quarterly reporting	EPC Contractor REA Project Manager	• Construction Phase • Operations Phase	2000
Training	Workers	Observe compliance with existing training plan	Training plan and records	FMEnv/NESREA/ World Bank	Quarterly monitoring and reporting	EPC Contractor REA Project Manager	• Construction Phase • Operations Phase	2000
General Housekeeping	Construction sheds and operational areas	Observe cleanliness and aesthetics of Plant	Cleanliness and aesthetics of Plant	FMEnv/NESREA/ World Bank	Daily monitoring; Quarterly reporting	EPC Contractor REA Project Manager	• Construction Phase • Operations Phase	2000
Stakeholder Engagement	• Local community • Regulatory agencies	Observe evidence of stakeholder consultations	Stakeholder Engagement Plan	FMEnv/NESREA/ World Bank	Quarterly monitoring and reporting	EPC Contractor REA Project Manager	• Construction Phase • Operations Phase	2000

7.7 Training, Awareness and Capacity Building

REA shall identify, plan, monitor, and record training needs for personnel whose work may have a significant adverse impact upon the environmental or social conditions. The Project recognizes that it is important that employees at each relevant phase of the Project are aware of the potential impacts of their activities; and roles and responsibilities in achieving conformance with the management measures documented in this ESMP. This will be achieved through a formal training process.

In addition, training for local community on general environmental awareness and ESMP mitigation measures pertaining to community health, safety and security shall as be provided as indicated in Table 7.7.

Table 7.7: Institutional Capacity Strengthening Plan

Target Audience	Training Overview	Cost Estimates (US Dollars)
Site Engineer, REA-Project Manager, EPC contractor and their sub-contractors, O&M contractor	In-depth understanding of the mitigation measures proffered by the EMP. Training on implementation of all emergency response procedures; training on Health, Environment, Safety, and Security Management Plan	2000
Local community	General environmental awareness and mitigation measures proffered by the ESMP pertaining to community health, safety and security.	1000
Total		**3000**

7.8 Implementation Schedule and Reporting

The implementation of the ESMP will take place from the planning stages to ensure quality equipment and support services is sourced, through construction, commissioning, operation to decommissioning phases. Once monitoring of the ESMP begins the officers responsible will report all issues identified to respective authorities in REA and corrective/ remedial actions taken without delay to ensure optimal performance of the Project while promoting environmental sustainability.

Also, REA shall keep the regulatory authorities (FMEnv, NESREA, Yobe State Ministry of Environment) informed of the Project performance with respect to E&S related matters through reports that will be made available to the regulators when required. REA will provide appropriate documentation of HSE related activities, including internal inspection records, training records, and reports to the relevant

authorities.

7.9 ESMP Costing

Table 7.8 provides the summary of cost estimate required to effective and efficiently implement the recommended mitigation measures and management plans required to address the potential and associated impacts of the proposed Project.

Table 7.8: ESMP Costing

S/N	Fundamental ESMP Activities	Cost Estimates (US Dollars)
1.	Pre-construction phase E&S management activities	2,500
	Construction phase E&S management activities	14,200
	Commissioning phase E&S management activities	700
	Operational phase E&S management activities	9,500
2.	Preparation of additional management plans	15,500
3.	Institutional Capacity Strengthening Plan	3,000
4.	Monitoring and Evaluation Programme	19,000
Total		**64,400**

CHAPTER EIGHT:

REMEDIATION PLAN AFTER DECOMMISSIONING / CLOSURE

CHAPTER EIGHT

REMEDIATION PLAN AFTER DECOMMISSIONING / CLOSURE

8.1 Introduction

This chapter discusses the activities associated with the decommissioning of the proposed Project, including the potential impacts associated with the decommissioning activities as well as the environmental and social measures to address the issues. In addition, the overview of remediation plan after the decommissioning/closure of the Project is provided.

8.2 Decommissioning Activities

Decommissioning refers to the process of removing all the operating assets of a project after completion of its life cycle. The average life span of the solar-hybrid Photovoltaic (PV) power plant to be provided as part of the proposed Project is 25 years (which can be extended through regular maintenance) while the training centre can last for 40 years or more. Even after the 25 years, the PV panels can still generate up to 90 % of the design capacity.

The decommissioning activities will typically include the following:

- Dismantling and removal of PV panels and associated infrastructure (mounting structure, power evacuation cable, inverters, transformers, batteries, etc.);
- Removal of any sub-surface installations (e.g. underground cables);
- Waste generation and management;
- Rehabilitation of any impacted environmental component (e.g. soil).

8.3 Management of Decommissioning Activities

In the event of decommissioning, REA, in conjunction with the leadership of FUGA, shall ensure that the Project site is left in a safe and environmentally acceptable condition. A standard decommissioning, abandonment and closure programme shall be invoked. The tasks will include, amongst others:

- Evacuation of the dismantled PV panels and other related items (such as inverters, and control devices) to the manufacturers for recycling.
- Transportation of spent batteries to recycling facilities;
- Restoration of the Project site to baseline conditions (as much as practicable) in line with legislative and regulatory requirements.
- Assessing the residual impact, if any, the project has on the environment.

- Monitoring the abandoned project environment as necessary.

Decommissioning activities will only begin after due consultation with the relevant stakeholders including the regulatory authorities. The decommissioning activities shall be carried out in line with the relevant provisions of the National Guidelines for Decommissioning of Facilities in Nigeria (2017) issued by the FMEnv.

Typically, the following actions shall be undertaken for decommissioning:

- An updated plan which takes into account the most cost-effective and best practicable methods, legal requirements and industry practices at that time for the facility decommissioning shall be developed and submitted to the FMEnv and other relevant regulatory authorities for approval. The plan shall include, but not limited to the following:
    - Description of the site and components to be decommissioned.
    - Description of the decommissioning scope, objectives, end state and strategy;
    - Activities to be performed during the decommissioning;
    - Schedule of decommissioning activities;
    - Estimate of the decommissioning cost;
    - Estimated inventory of waste streams to be generated during the decommissioning and handling techniques;
    - Decommissioning team (qualifications, roles and responsibilities)
- To ensure that due consideration is given to all options a detailed evaluation of facility decommissioning options shall be carried out. The options will include facility mothballing, partial facility decommissioning or complete site decommissioning. The evaluation will consider environmental issues in conjunction with technical, safety and cost implications to establish the best practicable environment friendly options for the Project decommissioning.
- A risk assessment shall be conducted to ensure that nothing, which could be constituted as a hazard for other users of the site or for the environment in general, will be left at the site. The Project site shall be left in a safe and environmentally acceptable condition.
- Hazard identification and analysis shall be conducted to determine special safety concerns to be addressed.
- An appropriate Health, Safety and Environment (HSE) plan shall be implemented to ensure that the decommissioning activities are carried out in an environmentally sound manner and in conformity with relevant laws and regulations guiding such operations
- Third party notifications shall be carried out before any demolition and shall be conducted in a phased sequence.

- Socio-economic considerations of facility decommissioning shall be carried out. These will include assessment of potential effects associated with termination of employment (at the end of operational phase) and the measures to minimize the effects by:
    - Ensuring that employees are fully informed about the decommissioning and how it will affect them before the project finally closes.
    - Building community capacity to manage opportunities and impacts arising from the decommissioning and post-decommissioning phase of the Project.
    - Providing training to build local skills tailored to project decommissioning and post-decommissioning activities (e.g. equipment dismantling, rehabilitation activities, monitoring, etc.).
    - Providing training to transfer project-learned skills to alternative and secondary industries tailored to respond to market economy.
- An effective waste management plan shall be developed for the decommissioning activities. The decommissioning options for redundant structures and equipment will include: the complete dismantling of structures and equipment and the return of all components to the equipment manufacturer for recycling. A detailed record of all suitable recycling materials shall be maintained.

The environmental and social management measures for the identified potential impacts of the decommissioning activities are presented in Table 8.1.

8.3.1 Used Battery Management at Decommissioning Phase

Lithium-ion batteries that have reached the end of their life spans are classified as hazardous waste. The used batteries decommissioned from the power plant shall be packed separately from other materials. Damaged batteries in a critical stage, in particular, require special expertise in handling, as they can be flammable. Currently, Lithium-ion battery recycling in Nigeria is at the infancy stage as most local recycling companies specialize in recycling lead-acid batteries. This presents a challenge to the recycling of used batteries locally. Therefore, the Extended Producer Responsibility (EPR) policy shall be adopted for the project. It includes the take-back, recycling and final disposal of the product including its packaging. The manufacturers / suppliers of the batteries shall be responsible for the recycling and safe disposal of the used batteries. The costs of recycling and disposal will be internalized in the price of the batteries or take-back agreements will be provided. During decommissioning activities, the batteries shall be removed, discharged, and packaged according to the manufacturer / supplier's instructions before transportation to the endpoint.

Conversely, the University shall be encouraged to develop end-of-life management plans for the batteries and other electrical components. The plan shall include the development of procedures for safe handling, storage, and transport of the used batteries generated during Project operations. Also, procedures for identification and engagement of NESREA-certified battery recycling companies based in Nigeria shall be developed and implemented for the Project.

8.4 Abandonment Plan

Prior to site abandonment, REA shall establish a standard procedure for incorporating the following practices:

- Identification of the components of the Project that will be abandoned and/or removed;
- The proposed methods for abandonment or re-use of the Project equipment/material applicable;
- Processes put in place to mitigate potential environmental impacts associated with the abandonment process; and
- Appropriate site rehabilitation programs (including re-vegetation of the site with native plant species) to return the Project site to its original status (as much as possible).

The decommissioning, abandonment and/or closure programme shall generally be managed by a team of competent personnel from REA-Project Management Unit, the Department of Works and Physical Planning in FUGA, the Federal Ministry of Environment and the Yobe State Ministry of Environment. A close out report shall be prepared and archived for future reference.

8.5 Roles, Responsibilities and Accountabilities for Decommissioning Phase

The key personnel and institutions with major roles in the implementation and monitoring of environmental and social measures for the Project decommissioning/closure are as follows:

<u>Contractor(s) Engaged for Decommissioning Activities</u>

- Implement environmental and social measures and management actions put in place for the decommissioning activities.

<u>REA-PMU</u>

- Supervise the activities of the contractor(s) engaged for decommissioning purpose by ensuring that the recommended environmental and social measures and management actions are implemented.

- Discuss environmental and social management plan improvements with the Director of Works and Physical Planning Department in FUGA to address non-compliance and upcoming issues.

FUGA Site Engineer/Manager

- Directly monitor the activities of the contractor(s) engaged for decommissioning and ensure compliance to the implementation of environmental and social measures and management actions put in place to address potential impacts and risks associated with the decommissioning activities.
- Report to the Director of Works and Physical Planning Department in FUGA on contractor's performance regarding the implementation of environmental and social measures.

Director of Works and Physical Planning Department in FUGA

- Jointly supervise the activities of the contractor(s) engaged for decommissioning
- Suggest environmental and social management plan improvements to REA-PMU to address non-compliance issues and upcoming issues.

FMEnv/Yobe State Ministry of Environment Representatives

- Approve the decommissioning plan for the Project.
- Monitor the implementation of environmental and social measures and management actions documented in the decommissioning plan.
- Discuss environmental and social management plan improvements to REA-PMU to address non-compliance issues and upcoming issues.

Table 8.1: Environmental and Social Management Measures for Decommissioning Phase

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
Removal of PV panels, batteries and inverters; demolition of buildings and associated facilities							
Soil contamination due to waste generation; soil compaction;	Excavation works shall not be executed under aggressive weather conditions.	Inspection	Daily	Adherence to measures	Contractor(s) engaged for facility decommissioning	REA-PMU FUGA (Site Manager and Director of Works and Physical Planning) FMEnv Yobe State Ministry of Environment	5000
	Stockpiles shall be appropriately covered to reduce soil loss as a result of wind or water erosion	Inspection	Daily	Adherence to measures			
	Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate locations with impervious hardstanding and adequate secondary containment (bund wall). Portable spill containment and clean-up kits shall be available onsite.	Inspection	Daily	Adherence to measures World Bank General EHS Guidelines			
	PV panels, batteries and inverters shall be collected and returned to the manufacturer for recycling. The take-back scheme shall be based on the EPR model.	Consignment notes for batteries to recycling plants	Daily	World Bank General EHS Guidelines			
	All impacted soil area	Inspection	Daily	Re-vegetated land			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	shall be re-vegetated with native plant species						
	A decommissioning plan approved by the relevant regulatory authorities shall be developed and implemented.	Implementation records of decommissioning plan	Daily	Benchmarks in decommissioning plan			
Air quality impact; increase in dust level.	Dust suppression measures shall be implemented.	Inspection	Daily	Adherence to measures	Contractor(s) engaged for facility decommissioning	REA-PMU FUGA (Site Manager and Director of Works and Physical Planning) FMEnv Yobe State Ministry of Environment	1000
	Decommissioning equipment shall be properly serviced and maintained.	Inspection; Maintenance records	Before commencement of decommissioning activities	Adherence to measures			
Discomforting noise from decommission-ing equipment and related activities	Noise suppression equipment (e.g. mufflers) shall be fitted on decommissioning equipment / machinery.	Inspection	Daily	Adherence to measures	Contractor(s) engaged for facility decommissioning	REA-PMU FUGA (Site Manager and Director of Works and Physical Planning) FMEnv	2000
	Decommissioning activities shall be limited to day-time (08.00hr to 17.00hr during weekdays; and	Inspection	Daily	Adherence to measures			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	weekends 09.00hr-13.00hr).					Yobe State Ministry of Environment	
	Equipment shall be turned off when not in use.	Inspection	Daily	Adherence to measures			
	Equipment shall be properly maintained and serviced.	Inspection; Maintenance records	Once before commencement	Adherence to measures			
	Noise complaints related to the construction activities shall be assessed and appropriately addressed.	Complaint records	Weekly	World Bank Good Practice Note on Addressing Grievances			
	Noise monitoring at locations with persistent noise complaints shall be maintained.	Noise monitoring records	Monthly	FMEnv Noise limit World Bank Noise Limit			
Groundwater and surface water contamination due to waste generation	Training shall be provided for workers on safe storage, use and handling of hazardous materials (e.g. fuel, lubricating oil) on site.	Training records	Once before commencement	Certificates of completion of trainings	Contractor(s) engaged for facility decommissioning	REA-PMU FUGA (Site Manager and Director of Works and Physical Planning) FMEnv Yobe State Ministry of Environment	1500
	Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate locations with impervious hardstanding and adequate secondary	Inspection	Daily	Adherence to measures World Bank General EHS Guidelines			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	containment. Portable spill containment and clean-up kits shall be available onsite.						
	Waste Management Plan shall be implemented.	WMP implementation records	Daily	Benchmarks stated in WMP World Bank General EHS Guidelines			
Traffic due to transportation of dismantled equipment and materials from site including wastes	TMP shall be implemented.	TMP implementation records	Daily	Benchmarks stated in the TMP	Contractor(s) engaged for facility decommissioning	REA-PMU FUGA (Site Manager and Director of Works and Physical Planning) FMEnv Yobe State Ministry of Environment	2500
	Appropriate barriers and signage shall be provided to demarcate areas in which traffic is active.	Safety signs and barriers	Once before commencement	Adherence to measures			
	Drivers' competency shall be assessed and where required training shall be provided.	Drivers' competency assessments; training records	Once before commencement	Passing of competency assessment or training completion certificates			
	A procedure for recording all decommissioning related traffic incidents/accidents shall be developed and implemented. This will	Incident forms	Daily	Completed incident forms			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	include date/time, location, reason for accident, corrective measures, etc.						
	The EPC contractor shall promptly repair damage to public infrastructure and repair or compensate for damage to private property.	Incident forms, GRM	Daily during decommissioning phase	Completed incident forms	EPC Contractor		
Exposure to injuries, electrical shock, slip, trip and fall	All workers involved in the decommissioning activities shall be sensitized and monitored on the need to be safety conscious. Daily toolbox talks prior to commencement of work activities shall be carried out.	Daily toolbox records	Daily	Benchmarks stated in Health and Safety Plan	Contractor(s) engaged for facility decommissioning	REA-PMU FUGA (Site Manager and Director of Works and Physical Planning) FMEnv Yobe State Ministry of Environment	2500
	Appropriate PPE shall be provided for workers.	Availability of PPE	Daily	PPE compliance			
	Onsite safety officer shall be engaged to monitor the compliance of workers to safety rules.	Qualified and dedicated safety officer	Once before commencement	Adherence to measures			
	Health and safety plans shall be implemented.	Health and Safety plan implementation records	Daily during construction phase	Benchmarks stated in Health and Safety Plan			

CHAPTER NINE:

STAKEHOLDER ENGAGEMENT AND GRIEVANCE REDRESS MECHANISM

CHAPTER NINE

STAKEHOLDER ENGAGEMENT AND GRIEVANCE REDRESS MECHANISM

This chapter describes the Stakeholder engagement activities as well as the grievance mechanism to be implemented for the proposed 2.5 megawatts (MW) solar-hybrid power plant and associated infrastructure in the Federal University Gashua (FUGA), under the Federal Government's Energizing Education Programme.

9.1 Stakeholder Engagement

Stakeholder engagement is an ongoing process of sharing Project information, understanding stakeholder concerns, and building relationships based on collaboration. Stakeholder consultation is a key element of engagement and essential for effective Project delivery. Disclosure of information is equally as vital and must focus on informed consultation and participation with the local community and relevant stakeholders. If there are risks or adverse impacts from a Project, consultation must be inclusive and culturally appropriate and provide stakeholders with opportunities to express their views. In line with current guidance from the World Bank, consultation should ensure "*that appropriate project information on environmental and social risks and impacts is disclosed to stakeholders in a timely, understandable, accessible and appropriate manner and format*" In other words, effective consultation requires the prior disclosure of relevant and adequate Project information to enable stakeholders to understand the risks, impacts, and opportunities. The Project's consultation program was intended to ensure that stakeholder concerns are considered, addressed and incorporated in the development process, especially during the ESIA.

9.2 Legal and Administrative Framework Guiding Stakeholder Engagement

The stakeholder engagement was carried out to ensure compliance with both Nigerian legislative requirements, as well as international standards (as defined in the World Bank's Safeguard Policy – Operational Policy 4.01, Environmental Assessment). This section presents the relevant standards and legislation that relate directly to the public participation and stakeholder engagement requirements for the proposed Project.

9.2.1 Nigerian Legislative Requirements

9.2.1.1 EIA Act No. 86 of 1992 (as amended by the EIA Cap E12 LFN 2004)

The EIA Act is the primary Act governing the environmental and social assessment of developmental projects or activities in Nigeria. Section 2(2) of the Act requires that where the extent, nature or location of a proposed project or activity is such

that it is likely to significantly affect the environment, an EIA must be undertaken in accordance with the provisions of the Act.

Section 55 of the EIA Act provides for the maintenance of a Public Registry to facilitate public access to records relating to environmental assessments. Public hearings to which interested members of the public are invited are a key part of the approval process for EIA reports by the Federal Ministry of Environment (FMEnv). However, this project shall not be subject to a public hearing but rather an in-house review to be conducted by the FMEnv. This arrangement was adopted based on the abridged EIA process for the Nigeria Electrification Projects (NEP), which has been approved by the FMEnv.

9.2.2 International Requirements

9.2.2.1 World Bank requirements for Stakeholder Engagement and Information Disclosure

The project will endeavour to meet standards and requirements set out by the World Bank safeguard policies as defined below:

- *World Bank OP 4.01 - Environmental Assessment*

If there are risks or adverse impacts from the Project, engagement must be inclusive and culturally appropriate and provide stakeholders with opportunities to express their views. Engagement should ensure 'free, prior and informed engagement of the affected communities (1).' The World Bank Operational Policy (OP) 4.01 requires at least one round of engagement early in the Environmental and Social Impact Assessment (ESIA) process, and again one on the draft ESIA report before decision-making. In other words, effective engagement requires the prior disclosure of relevant and adequate project information to enable stakeholders to understand the risks, impacts, and opportunities.

9.3 Objectives of Stakeholder Engagement

The stakeholder engagement process was designed to conform to the Nigerian EIA Act and international standards. For this Project, the key objectives for stakeholder engagement are:

- inform and educate stakeholders about the proposed Project;
- gather local knowledge to improve the understanding of the environmental and social context;
- better understand the locally-important issues;
- provide a means for stakeholders to have input into the Project planning process;

- take into account the views of stakeholders in the development of effective mitigation measures and management plans; and
- lay the foundation for future stakeholder engagement.

9.4 Stakeholder Identification and Analysis

Stakeholders are persons or groups who are directly or indirectly affected by a project, as well as those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively (IFC, 2007). Stakeholders may include locally affected communities or individuals and their formal and informal representatives, national or local government authorities, politicians, religious leaders, civil society organizations and groups with special interests, the academic community, or other businesses.

Proper stakeholder identification forms the basis on which the stakeholder engagement was conducted for the Project as well as the development of the stakeholder engagement plan. It is necessary to determine who the stakeholders of a project are and understand their priorities and objectives. In addition it is also essential that stakeholders are classified based on their position, influence, capacity and interests in order to develop a functional Stakeholder Engagement Plan (SEP) that is tailored to meet the individual and group needs of the identified stakeholders.

The EPC Contractor shall develop and implement an effective SEP which shall be maintained throughout the lifecycle of the project. A sample format for the SEP is outlined in the Environmental and Social Management framework (ESMF) for NEP.

A list of identified stakeholders for the Project is shown in Table 9.1. This consists of individuals, groups, and organizations that may be affected by or may influence project development positively or negatively. The list was developed using international guidance and considered the following groups: national and local governments; Local community leaders; community members including potentially vulnerable sub-groups such as women, youth and elderly; international, national and local environmental and social Non-Government Organizations (NGOs); Potential contractors and service suppliers; and local businesses/cooperatives and associations.

Table 9.1: Identified stakeholders associated with the Project

Stakeholder Group and Interest in the proposed project	Stakeholder Name	Stakeholder Level				Connection to the Proposed Project
		International	National	State	Local	
Project Sponsor	World Bank	✓				Provide financial and technical support to Project development and operation
Regulatory Authorities	Federal Ministry of Environment (FMEnv)		✓			Has the responsibility for overseeing EIA process for the proposed Solar Projects and ensuring compliance to relevant environmental laws and regulations
	National Environmental Standards and Regulations Enforcement Agency (NESREA)		✓			Has the responsibility of enforcing the environmental laws, guidelines, standards and regulations in Nigeria, specifically during the operational phase of developmental projects.
	Federal Ministry of Power (Department of Renewable Energy)		✓	✓		The Department of the Renewable Energy and Rural Power Access of the Federal Ministry of Power, Works and Housing is charged with the responsibility to coordinate all issues relating to renewable energy and energy efficiency
	Nigerian Electricity Regulatory Commission (NERC)		✓	✓		Responsible for granting operating licences for the Solar Projects
	Yobe State Ministry of Environment			✓		The Ministry oversees the protection of environment in Yobe State
	Yobe State Environmental Protection Agency			✓		Responsible for waste management in Yobe State
	Yobe State Ministry of Women Affairs and Social Development			✓		Promotes the development of women with equal rights and corresponding responsibilities including gender inclusion
	Yobe State Ministry of Sports and youth development			✓		Responsible for the inclusion of youths in Nigeria's development as well as the coordination of sports and recreational activities in the state
	Bade Local Government Authority			✓		

Stakeholder Group and Interest in the proposed project	Stakeholder Name	Stakeholder Level				Connection to the Proposed Project
		International	National	State	Local	
Communities	Low Cost Community				✓	Households, communities and groups that may be directly or indirectly affected by the proposed Project and its activities.
University Representatives	Management of FUGA				✓	Direct Project beneficiaries.
	Physical Planning Office				✓	
	FUGA Student Union Body				✓	

9.4.1 Stakeholder Register

The project shall maintain a stakeholder engagement register for recording stakeholder information such as contact details, dates of engagement with comments and follow up requirements. A sample stakeholder engagement register is provided Appendix 9.1.

9.4.2 Stakeholder Engagement Process

REA shall adopt a proactive approach towards building and maintaining mutually beneficial relationships with all relevant stakeholders, throughout its operations. The engagement program shall be implemented to comply with national and international standards. The stakeholder engagement will be free of manipulation, interference, coercion, and intimidation. It shall be conducted on the basis of timely, relevant, understandable and accessible information.

Effective stakeholder engagement depends on mutual trust, respect and transparent communication between the Project and its stakeholders. It thereby improves REA's decision-making and performance by:

- **Managing costs:** Effective engagement can help project REA avoid costs, in terms of money and reputation;
- **Managing risk:** Engagement helps project REA and communities to identify, prevent, and mitigate environmental and social impacts that can threaten project viability;
- **Enhancing reputation:** By publicly recognising human rights and committing to environmental protection, REA and financial institutions (World Bank) involved in financing the project can boost their credibility and minimise risks;
- **Avoiding conflict:** Understanding current and potential issues such as land rights and proposed project activities;

- **Improving corporate policy:** Obtaining perceptions about a project, which can act as a catalyst for changes and improvements in REA corporate practices and policies;
- **Identifying, monitoring and reporting on impacts:** Understanding a project's impact on stakeholders, evaluating and reporting back on mechanisms to address these impacts; and
- **Managing stakeholder expectations:** Consultation also provides the opportunity for REA to become aware of and manage stakeholder attitudes and expectations.

Table 9.2 presents elements of the stakeholder engagement program to be implemented by REA.

Table 9.2: Stakeholder Engagement Process

Stakeholder Engagement Activity	Approach
Stakeholder Identification and Analysis	An initial stakeholder identification and analysis has been conducted as part of this ESIA. REA shall maintain a register of identified stakeholders and undertake periodic review on a need basis.
Information Disclosure	REA shall ensure that information is provided to relevant stakeholders on an on-going basis over the course of the Project lifecycle. REA shall maintain regular communication with its stakeholders throughout the project lifecycle.
Stakeholder Consultation	REA shall consult with its various stakeholders on mutual concerns to fulfil its compliance obligations in line with industry best practice. REA shall maintain records of its consultation with its various stakeholders.
Negotiation and Partnerships	REA shall adopt a stakeholder management process that fosters the mutual interest of all parties and adds value to its operation.
Grievance Management	REA shall provide appropriate channels for stakeholders to raise their concerns and grievances about its operations
Stakeholder Involvement	This entails procedures that allow the direct involvement of stakeholders in project related functions in order to foster transparency and credibility.
Reporting to Stakeholders	REA shall establish reporting procedure that allows information disclosure to stakeholders about the environmental social and economic performance of its operations.
Management Functions	REA shall build and maintain management capacity within the company to manage the process of stakeholder engagement, track commitments and report on progress.

9.4.3 Stakeholder Engagement Tool and Communication

REA recognizes the need to tailor its stakeholder engagement approach and information disclosure to suit the needs of each of its stakeholder. REA shall adopt a variety of communication and engagement methods to ensure continuous engagement, dialogue and feedback is established during its engagement activities. Table 9.3 presents various tools and methods to be adopted by REA during its stakeholder engagement process.

Table 9.3: Stakeholder Engagement Tools and Communication

Medium	Most Appropriate Application
Stakeholder meetings	
One-on-one consultations	REA shall on a need basis hold consultation meetings with its individual stakeholders. These meetings will be held to: • Solicit views and opinions; • Discuss freely and confidently about stakeholder concerns and provide feedback etc.; • Build personal relations with stakeholders.
Focus group discussions	REA shall on a need basis hold focus group discussions (FGDs) to pull together a small group of people with the same interest into a single meeting to engage them on common issues. FGDs would have specific objective and be aligned with the expectations and interest of the stakeholders present.
Workshops	REA shall on a need basis hold workshops with its various stakeholders. Workshops are ad-hoc outcomes based meetings that seek to find solutions for specific issues facing the environment and social aspects. When conducting a workshop, REA shall use participatory exercises to facilitate group discussions, brainstorm issues, analyse information, and develop recommendations strategies.
Forum	REA shall on a need basis use forums to engage with various stakeholders. Participatory tools and methodologies such as workshops, town hall meetings, and FGDs will continue to be utilized, as they are more likely to increase stakeholder involvement in the process and elicit alternative responses, especially if there is controversy or complexity, or a need to build a consensus around possible solutions.
❖ Written / visual/electronic communication	
	REA shall use a variety of communication methods to disseminate information to its stakeholders. The approach adopted shall be based on the nature of the issue and the concerned stakeholder. External communications will include: ○ Project newsletters ○ Emails ○ Meetings ○ Executive Summary of the Environmental Impact Assessment ○ Mass Media, newspapers print etc. ○ Surveys

Table 9.4 presents a stakeholder analysis with respect to appropriate levels of consultation for each of the major stakeholder groups. REA shall determine the frequency of these interactions.

Table 9.4: Stakeholder Group Consultation Methods

STAKEHOLDER GROUP	CONSULTATION METHOD
Government and Regulators	• Email exchanges and letters • One-on-one consultations • Formal meetings • Print media • Compliance reporting • Performance report (Audits)
Project beneficiaries (FUGA Management, Physical Planning, Students)	• Formal meetings • One-on-one consultations • Print media • Strategic collaboration • Information Centre

STAKEHOLDER GROUP	CONSULTATION METHOD
Employees	• Phone / email / text messaging/ WhatsApp • Print media • Workshops • Focus group meetings • Surveys • Management/departmental meetings • Performance appraisal • Trainings
NGO's	• Phone / email • One-on-one interviews • Town hall meetings • Focus group meetings • Information Centre

9.4.4 Principles for Effective Stakeholder Engagement

Stakeholder engagement is usually informed by a set of principles defining core values underpinning interactions with stakeholders. Common principles based on International Best Practice include the following:

- **Commitment** is demonstrated when the need to understand, engage and identify the key stakeholders is recognized and acted upon;
- **Integrity** occurs when engagement is conducted in a manner that fosters mutual respect and trust;
- **Respect** is created when the rights, values and interests of stakeholders and neighbors are recognized;
- **Transparency** is demonstrated when stakeholder concerns are responded to in a timely, open and effective manner;
- **Inclusiveness** is achieved when broad participation is encouraged and supported by appropriate participation opportunities; and
- **Trust** is achieved through open and meaningful dialogue that respects stakeholder's values and opinions.

9.4.5 Summary of Previous Stakeholder Engagement Activities

This section describes the initial Stakeholder engagement activities carried out during the ESIA

The initial consultations were carried out from August 9 to 17, 2019 with the following:

- Yobe State Ministry of Environment
- Yobe State Environmental Protection Agency
- Yobe State Ministry of Women Affairs and Social Development
- Yobe State Ministry of Youth and Sports
- FUGA Vice Chancellor
- FUGA Director of Works
- FUGA Student Union Government President

- Bade Local Government
- Ward Leader of Low Cost community

The consultations served to provide stakeholders with information about the proposed Project and to gather information important to the ESIA. The objective was to identify any key concerns or high level issues that the stakeholders had at this early stage. Prior to the consultation, notification letters and Background Information Documents (BID) were sent to the stakeholders to provide high level information about the proposed Project. The notification letters and BID are provided in Appendix 9.2. Plate 9.1 shows some sample photographs of the stakeholder consultation exercise carried out during the ESIA.

Plate 9.1: Sample pictures taken during Stakeholder Consultations

Records (attendance sheets) of consultation meetings are also provided in Appendix 9.2 while Table 9.5 below summarizes the findings of the stakeholder consultation meetings.

Table 9.5: Initial Stakeholder Consultation Findings

Stakeholder	Priority Issues	Quotes/Comments during stakeholder consultation	How the comments have been addressed in the ESIA report
Yobe State Ministry of Environment	ESIA process and stakeholder consultation	– The ESIA should be carried out in line with best practice – All the relevant laws and regulations should be considered in the ESIA – The Project should make considerations for the local community by providing employment – A waste management plan should be developed and incorporated into the for the Project design	– The ESIA study has been carried out in line with the FMEnv ESIA process as well as the relevant requirements of the World Bank Safeguards Policies, especially OP 4.01 (Environmental Assessment) triggered by the proposed Project. – Relevant laws, regulations and international guidelines are considered and documented in the ESIA report (refer to chapter 1) – Labour would be drawn from local communities during the Project development and operation. – Different waste streams associated with the Project have been identified and appropriate waste management practices that comply with the relevant local and international standards and guidelines shall be adopted.
FUGA Vice Chancellor	Stakeholder consultation, Sustainability of the Project,	– The Project is a welcome development that will enhance the quality of education, research, and living conditions within the University. – The University is ready to provide the necessary support to ensure the sustainability of the Project – Female students of the University would be	– Measures to enhance the positive impacts of the Project are documented in the ESIA report (refer to chapter 6).

Stakeholder	Priority Issues	Quotes/Comments during stakeholder consultation	How the comments have been addressed in the ESIA report
		allowed to benefit from the Project	
FUGA Director of works	Stakeholder consultation	– The land selected for the Project site has been approved by the University. – The are no security issues within the University that could threaten the Project – There are no Land issues associated with the Proposed site – The local community do not farm on the proposed site or derive any benefits from the land. – The Department is ready to provide support to ensure the successful completion of the Project	– Roles and responsibilities of the Department of Works and Physical Planning with regard to environmental, technical and social sustainability of the Project are documented in the ESIA report.
President of FUGA Students Union Government	ESIA process and stakeholder consultation	– The power situation in FUGA is poor but the School management is working on it – Security within the school is satisfactory but can be improved with the installation of streetlights – The Project is a welcome development that will benefit the students. – The student union is willing to participate wherever necessary	– Measures to enhance the positive impacts of the Project are documented in the ESIA report (refer to chapter 6).
Bade Local Government	ESIA process and stakeholder consultation	– The Project is a welcome development – Indigenes from the host community should be employed to work at the Project site	– A percentage of the workforce for the Project will be drawn from the host community
Ward leader of Low Cost community	ESIA process and stakeholder consultation	– The Project is a welcome development. – They would appreciate it if youths from the communities can be given employment – Local from the community do not farm on the site	– A percentage of the workforce for the Project will be drawn from the host community

Consultation with the identified stakeholders (including regulators and potentially affected communities) showed general acceptance of the proposed Project. Regulators such as the Yobe State Ministry of Environment made suggestions relating to the proposed Project which have been addressed in the ESIA study as indicated in Table 9.5 above. Community members also showed enthusiasm about the Project and shared their expectations from the Project including provision of jobs for the youth, skill acquisition opportunities for women and children, etc.

9.5 Management Function and Grievance Mechanism

9.5.1 Management Commitment

REA is committed to implementing stakeholder management as part of its operations. As such REA will ensure that the responsibility for implementing the SEP is duly assigned and all components of the plan are well-defined within its organizational processes. REA shall also commit to providing the necessary support to implement the SEP. The management structure for the SEP shall include the following elements.

Systems: REA will pursue its Stakeholder engagement activities as scheduled in a systematic manner that creates predictability in the eyes of the stakeholder in order to support and foster a relationship that is based on trust.

Structure: REA will establish a Stakeholder focused-structure within its organizational processes to provide the needed decision-making authority to enable quicker turnaround time on Stakeholder engagement activities and grievance feedback.

Skills: REA will ensure that the required internal capacity for effective Stakeholder engagement is provided for the implementation of the stakeholder engagement plan.

9.5.2 Roles and Responsibilities

REA shall assign the responsibilities of conducting and organizing stakeholder consultation and involvement to competent individuals. The individuals shall be qualified professionals with relevant skills and experience. The REA Project Management Unit shall have the overall responsibility of overseeing the implementation of the SEP. The role of managing stakeholder engagement shall be given to the University's Community Liaison Officer (CLO). The CLO shall monitor the implementation of the Project's stakeholder engagement program and report findings to the REA Project Management Unit.

9.5.3 Grievance Redress Mechanism (GRM)

A grievance redress mechanism (GRM) has been developed by REA which is applicable to all components of the NEP; including the EEP Projects (Available in Appendix 9.3). The NEP GRM was developed to provide project affected persons (including interest groups) directly affected by its development activities with access to mechanisms for them to present their grievances and find solutions through avenues that are legitimate, reliable, transparent, cost-effective and easily accessible at the lowest level, without allowing them to escalate into unmanageable levels. This access will be all inclusive with consideration for people living with disabilities and vulnerable groups.

With respect to the EEP component of the NEP, the GRM has identified potentials for grievance associated with the proposed project. The GRM also outlines the following:

- Identification of core institutional blocks for the EEP;
- Provision of grievance uptake points, including a description of communication channels, actions, and timeframe;
- Composition of the Project Management Unit (PMU) Grievance redress committee, with details about their activities;
- Composition of the community based Grievance redress committee; and
- GRM structure to be implemented for the EEP Projects.

CHAPTER TEN:

CONCLUSION AND RECOMMENDATIONS

CHAPTER TEN

CONCLUSION AND RECOMMENDATIONS

10.1 Conclusion

The ESIA of the proposed 2.5 MW solar-hybrid power plant and associated infrastructure in FUGA, under the EEP Phase II, has been conducted in accordance with the relevant requirements of the FMEnv guidelines and the applicable World Bank Safeguard Policies, specifically the Operational Policy 4.01 triggered by the proposed Project.

The ESIA study consists of a number of key steps including: desktop review, scoping, consultations with relevant stakeholders including relevant government authorities and potentially affected community in the Project's area of influence, field data gathering, laboratory analysis of field samples, potential impact identification and evaluation, development of mitigation measures and environmental management plan, report writing and disclosure.

The essence of the ESIA process is aimed at ensuring informed decision-making and environmental accountability, and to assist in achieving environmentally sound operation and social acceptance throughout the life cycle of the proposed Project.

Consistent with the regulatory standards, the assessment of the environmental status and the socio-economic aspects of the proposed Project's area of influence have been carefully carried out using accepted scientific methodology. Evaluation of associated and potential impacts of the proposed Project identified both positive and negative interactions with the receiving biophysical and socio-economic environment.

The positive impacts associated with the Project include:

- Stimulation of academic and research activities within the University as a result of access to constant and reliable power supply, thereby promoting educational advancement.
- Reduction in fossil fuel consumption by the University thereby leading to reduction in carbon emissions and improvement in eco-balance.
- Significant reduction in the cost of power generation by the University through diesel-fuelled generators. Such savings would be used for other undertakings that will benefit the University.
- Increase in social interactions within the University. There will be enhanced security in the University as a result of more streetlights for illumination which would help keep off opportunistic crimes and gender-based violence.

- Enhancement of learning in renewable energy leading to certification as a result of training centre to be provided as part of the Project.
- Improvement in livelihood enhancing activities within the University.
- Direct and indirect employment opportunities during Project development and operation. The employment opportunities will lead to acquisition of new skills and introduction of all manners of income generating spill-over effects.
- Increase in local and regional economy through award of contracts and purchase of supplies for Project development.
- Increase in financial and technical collaborations between the FGN, the University, REA, World Bank and other relevant Ministries, Departments and Agencies (MDAs).
- Contribution to the Nigeria's NDC to cut carbon emission by 20 % to 30 % by the year 2030, under the Paris Agreement.

The identified negative impacts of the proposed Project were mostly of minor to moderate significance, and they are largely site-specific and localized. The preferred site for the proposed Project within the University campus does not trigger any physical and economic displacement and relocation. In addition, there are no cultural resources within and around the Project site that would be affected during the Project development and operation. The identified potential negative impacts include:

- Decreased in ambient air quality due to construction and decommissioning activities.
- Increase in ambient noise level due to construction and decommissioning activities.
- Decrease in soil quality due to improper management of generated wastes during construction, operation and decommissioning.
- Minimal loss of terrestrial flora species (largely grasses) during site preparation for construction activities.
- Environmental nuisance due to improper disposal of e-waste including spent/damaged batteries.
- Influx of potential job seekers during construction which could pose indirect impacts on the nearby local community.
- Occupational health and safety issues during construction, operation and decommissioning.

Based on the nature and extent of the proposed Project and the findings of the ESIA study, it is believed that the potential negative impacts associated with the proposed Project can be mitigated to as low as reasonably practicable through the implementation of the proffered mitigation measures documented in Chapter 6 of this report, while the positive impacts can also be enhanced. In addition, an ESMP

has been established (refer to Chapter 7 of this report) to assess the efficiency and effectiveness of the recommended mitigation measures and ensure long-term monitoring of the Project.

10.2 Recommendations

The ESIA study recommends the following:

1 The REA, through its Project Management Unit (PMU), as well as the leadership of FUGA, through its Department of Works and Physical Planning, shall ensure that the proposed Project is developed and operated in an environmentally sustainable manner by properly managing the processes / activities that may bring about disturbances to the environment through the implementation of the recommended mitigation measures and the ESMP.
2 Continuous monitoring of environmental and social performance of the Project shall be ensured, including periodic consultation with the relevant regulatory authorities, the potentially affected community, and other relevant stakeholders throughout the Project life cycle.
3 Implementation of the Project's Stakeholder Engagement Plan (including grievance redress mechanism) shall be maintained.