NIGERIA ELECTRIFICATION PROJECT

RURAL ELECTRIFICATION AGENCY

ENERGY = EMPOWERMENT = EFFICIENCY

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA[1])

OF

THE PROPOSED 10.0 MW SOLAR HYBRID POWER PLANT AND ASSOCIATED INFRASTRUCTURE IN UNIVERSITY OF MAIDUGURI (UNIMAID) AND TEACHING HOSPITAL, MAIDUGURI, BORNO STATE

UNDER THE FEDERAL GOVERNMENT OF NIGERIA (FGN) ENERGIZING EDUCATION PROGRAMME (EEP) PHASE II

(DRAFT REPORT)

SUBMITTED TO

THE FEDERAL MINISTRY OF ENVIRONMENT

MARCH 2020

[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.

DRAFT ESIA REPORT

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TABLE OF CONTENTS

CHAPTER FIVE: ASSOCIATED AND POTENTIAL IMPACTS

CHAPTER SIX: MITIGATION MEASURES

CHAPTER SEVEN: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

CHAPTER EIGHT: REMEDIATION PLAN AFTER DECOMMISSIONING / CLOSURE

CHAPTER NINE: STAKEHOLDER ENGAGEMENT AND GRIEVANCE REDRESS MECHANISM

CHAPTER TEN: CONCLUSION AND RECOMMENDATIONS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF ACRONYMS AND ABBREVIATIONS

AC	-	Alternating Current
ALARP	-	As Low As Reasonably Practicable
AoI	-	Area of Influence
a-S	-	Amorphous silicon
ASTM	-	American Standards for Testing and Materials
BOD	-	Biological Oxygen Demand
BOSEPA	-	Borno State Environmental Protection Agency
B.Sc.	-	Bachelor of Science
Cd	-	Cadmium
CdTe	-	Cadmium telluride
CH_4	-	Methane
CO	-	Carbon monoxide
CoC	-	Code of Conducts
Cr	-	Chromium
CSP	-	Concentrated Solar Power
Cu	-	Copper
DC	-	Direct Current
E&S	-	Environmental and Social
EA	-	Environmental Assessment
EEP	-	Energizing Education Programme
EHS	-	Environmental, Health and Safety
EMF	-	Electromagnetic Field
ESIA	-	Environmental and Social Impact Assessment
ESMP	-	Environmental and Social Management Plan
EnvAccord	-	Environmental Accord Limited
EPC	-	Engineering, Procurement and Construction
ESAs	-	Environmentally Sensitive Areas
Fe	-	Iron
FEC	-	Federal Executive Council
FGD	-	Focus Group Discussion
FGN	-	Federal Government of Nigeria
FMEnv	-	Federal Ministry of Environment
GBV	-	Gender Based Violence
GHG	-	Greenhouse Gas
GPS	-	Global Positioning System
H&S	-	Health and safety
H_2S	-	Hydrogen Sulphide
HSE	-	Health, Safety and Environment
IDI	-	In-depth Interview
IEC	-	International Electrotechnical Commission

IGR	-	Internally Generated Revenue
IHR	-	International Health Regulations
ILO	-	International Labour Organisation
IPAN	-	Institute of Public Analysts of Nigeria
ITCZ	-	Inter-Tropical Convergence Zone
IUCN	-	International Union for Conservation of Nature
KII	-	Key Informant Interview
LEMP	-	Labour and Employment Management Plan
LGA	-	Local Government Area
mono-Si	-	Mono-crystalline silicon
M.Sc.	-	Master of Science
MW	-	Megawatt
NAAQS	-	Nigerian Ambient Air Quality Standards
NBS	-	National Bureau of Statistics
NDC	-	Nationally Determined Contributions
NEPP	-	National Electric Power Policy
NERC	-	Nigerian Electricity Regulatory Commission
NESREA	-	National Environmental Standards and Regulations Enforcement Agency
Ni	-	Nickel
NiCd	-	Nickel cadmium
NiNAS	-	Nigeria National Accreditation Service
NiMet	-	Nigerian Meteorological Agency
NO_2	-	Nitrogen dioxide
NPC	-	National Population Commission
OP	-	Operational Policy
OPC	-	Organic Photovoltaic Cells
OSH	-	Occupational Safety and Health
Pb	-	Lead
PHCN	-	Power Holding Company of Nigeria
PM	-	Particulate Matter
PMT	-	Project Management Team
poly-Si	-	Polycrystalline silicon
PPE	-	Personal Protective Equipment
PV	-	Photovoltaic
QA/QC	-	Quality Assurance and Quality Control
REA	-	Rural Electrification Agency
RH	-	Relative Humidity
SEA	-	Sexual Exploitation and Abuse
SL	-	Screen Line
SMEs	-	Small Medium Enterprises
SO_2	-	Sulphur dioxide

SOP	-	Standard Operating Procedure
TDS	-	Total Dissolved Solids
TFSC	-	Thin-film solar cell
TMP	-	Traffic Management Plan
TOC	-	Total Organic Carbon
TSP	-	Total Suspended Particulate
UNIMAID	-	University of Maiduguri
UMTH	-	University of Maiduguri Teaching Hospital
V	-	Vanadium
VOC	-	Volatile Organic Compounds
VRFB	-	Vanadium Redox Flow Battery
WBG	-	World Bank Group
WHO	-	World Health Organisation
WMP	-	Waste Management Plan
Zn	-	Zinc

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EXECUTIVE SUMMARY

1.0 INTRODUCTION

This report documents the Environmental and Social Impact Assessment (ESIA) study for the proposed 10.0 megawatt (MW) solar-hybrid power plant and associated infrastructure in University of Maiduguri (UNIMAID), Borno State, under the Federal Government's Energizing Education Programme (EEP) Phase II. The power generated from the proposed solar power plant will also be extended to University of Maiduguri Teaching Hospital (UMTH) located about 4.9 km from the Project site.

The EEP is one of the key components of the Nigeria Electrification Project (NEP). NEP is a Federal Government initiative that is private sector driven and seeks to provide electricity access to off grid communities across the country through renewable power sources. NEP is being implemented by the Rural Electrification Agency (REA) in collaboration with the World Bank.

The objective of the EEP is to provide dedicated, clean and reliable power supply to Federal Universities and affiliated 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.

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, the ESIA of the proposed Project in UNIMAID has been conducted.

The ESIA study covers the entire life cycle of the Project (i.e. pre-construction, construction, commissioning, operation, decommissioning, and closure) and it involves key issues identification, baseline environmental and socio-economic data gathering, stakeholder consultation, identification and evaluation of impacts, development of mitigation measures and environmental and social management plan.

The applicable legal and institutional framework to the proposed Project includes, but not necessarily limited to the following:

- EIA Act CAP E12 LFN 2004
- National Policy on the Environment, 1989 (revised in 1999 and 2017)
- World Bank Safeguard Policies on Environmental Assessment

- National Environmental (Energy Sector) Regulations, 2014
- National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations, 1991
- National Environmental Protection (Management of Solid and Hazardous Wastes) Regulations, 1991
- National Environmental (Sanitation and Wastes Control) Regulations, 2009
- National Environmental (Noise Standards and Control) Regulations, 2009
- Borno State Ministry of Environment Laws on Environmental Protection
- Basel Convention on the Control of Trans-boundary Movement of Hazardous Wastes and their Disposal
- The United Nations Framework Convention on Climate Change
- Declaration of the United Nations Conference on Human Environment
- International Labour Organisation (ILO): ILO-OSH 2001 - Guidelines on Occupational Safety and Health (OSH) Management Systems

2.0 PROJECT JUSTIFICATION

Need for the Project and Benefits

The Project is justified primarily based on the need for power for Nigeria's federal universities as an essential element for research and educational development. The EEP is also 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 potential Project benefits include, amongst others:

- Stimulation of academic and research activities within the University as a result of access to constant and reliable power supply, thereby promoting educational advancement.
- Improvement in the provision of healthcare service by the University Teaching Hospital as a result of power supply from the proposed Project.
- Reduction in fossil fuel consumption by the University and the Teaching Hospital 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 and the teaching hospital.
- Increase in social interactions within the University and the Teaching Hospital. There will be enhanced security in the campuses as a result of more streetlights for illumination which would help keep off opportunistic crimes and gender-based violence (GBV).
- 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 and the Teaching Hospital.
- Direct and indirect employment opportunities during Project development and operation.
- 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, the Teaching Hospital, REA, World Bank and other relevant Ministries, Departments and Agencies (MDAs).
- The project will contribute to Nigeria's nationally determined contributions for the Paris agreement to cut carbon emission by 20 % - 30 % by 2030.

Envisaged Sustainability of the Project

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 UNIMAID. 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 UNIMAID's Works and Physical Planning Department.

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 emissions compared to fossil fuelled power plants). In addition, the establishment of REA Project Management Unit (PMU) which includes experienced Environmental and Social Safeguards Specialists to oversee the implementation of the Project will contribute to environmental sustainability of the Project.

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 UNIMAID (with generated power to be extended to UMTH), 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 and the Teaching Hospital, thereby saving costs on diesel fuel and generator maintenance, amongst others. Also, the monthly expenditures to the local power distribution company for power consumption from the national grid would be saved. Part of such savings will be used for the maintenance of the Project facilities in the long run.

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, a Stakeholder Engagement Plan (SEP) has been developed as part of the ESIA study 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.

Project Alternatives

Within the context of the Solar Project, various alternatives were considered based on environmental, economic and operational benefits. These included solar technology types, PV module types, and battery type alternatives. The preferred option is the use of polycrystalline silicon PV panels and Lithium ion batteries for the Project.

3.0 PROJECT DESCRIPTION

An approximately 20.0 hectare (ha) of land has been allocated for the proposed solar power plant and the training centre. The Project site lies geographically within Latitude 11.79372^0N to 11.79564^0N and Longitude 13.30172^0E to 13.20510^0E. The proposed Project site is largely characterized by seasonal vegetation which includes shrubs, grasses, trees and herbs. Some portion of the Project site (about 30 %) is used temporarily for subsistence and low scale commercial farming by relatives of UNIMAID staff. There is no local community presence (e.g. residential buildings, and firewood/fruit-gathering activities, etc.) within the proposed Project site. The nearest community to the Project site is Mairi which is located about 2.2 km away from the University.

The proposed solar power plant will involve the use of PV technology for power generation. PV panels will be installed on the site using piling foundations and the power generated will be evacuated via an 11 kV underground armoured cable to the existing power house (also the switch yard) and distributed within the University and Teaching Hospital. The exact number of the panels is yet to be finalized. However, based on the review of similar solar power projects, about 31,680 PV panels (for example, JKM340PP-72H-V) would be required to generate a power capacity of 12.0 MW.

Storage facilities will be constructed for the batteries and inverters to be installed for the Project. Power distribution within the University will be via the existing power infrastructure (mostly wooden poles and overhead cables), which will be rehabilitated where required. An underground transmission line (approximately 4.9 km) will be installed to transmit power from the Project site to the Teaching

Hospital. Additional streetlights will be installed within the University and the Teaching Hospital while existing streetlights will be retrofitted for energy efficiency purposes and powered by the proposed Project.

The pre-construction phase activities for the Project will include site clearing, and mobilization of equipment and construction materials to site. The construction phase activities will include civil, mechanical and electrical works; installation of PV panels and associated components such as mounting structures, inverters, batteries, and switchgear. The exact number of PV panels, batteries and inverters to be installed is yet to be finalized. Also, the construction of renewable energy training centre as well as installation of additional streetlights will be carried out during the construction phase.

Following the construction phase, the facility will be tested and commissioned before operational phase. Activities during the operational phase will include power generation and distribution, and routine maintenance such as periodic cleaning of the PV panels.

The envisaged life span of the power plant is 25 years which could be extended with proper and regular maintenance. In the event of decommissioning, the PV panels and associated infrastructure will be removed from the Project site and recycled as appropriate. The site will be rehabilitated with native plant species afterwards.

It is estimated that about 6,000 people would be employed during the construction phase. 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 which will include hazard awareness, safe work practices and emergency preparedness. 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.

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.

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 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.

The proposed Project is planned to be commissioned in the fourth quarter (Q4) of 2021.

4.0 DESCRIPTION OF THE ENVIRONMENT

The description of environmental conditions of the Project's area of influence is based on desktop studies and field investigations. Field sampling was conducted from July 31 to August 2, 2019 by a team of environmental and social specialists.

A 1 km radius from the centre of the Project site was selected as the spatial boundary for biophysical sampling while a 3 km radius was selected as the spatial boundary for socio-economic survey. The rationale for the spatial boundary was based on the consideration of potential environmental and social aspects of the proposed Project as well as observations noted during the reconnaissance survey.

The environmental and social condition of the Project's AoI is summarized as follows:

Climate and Meteorology: Borno 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. Maximum rainfall of 187.62 mm is received at the peak of rainy reason (August). The average monthly temperature is 35.32^{o}C while the mean monthly sunshine hour in the study area is approximately 8.26 hrs.

Geology and Hydrogeology: Borno State is underlain by sediments of the Chad Formation. The Chad Formation overlies the Kerri Formation of Tertiary period and it is overlain by recent alluvial deposits.

Air Quality and Noise: A total of 12 locations were sampled (4 locations within the Project site, 4 locations along the transmission route, 2 within the 1 km AoI, and 2 at control/buffer points). The concentrations of air quality parameters recorded at the sampled locations were generally below the National Ambient Air Quality Standards and the World Health Organization (WHO) Air Quality Guidelines. The noise levels recorded within the Project site were also within acceptable limits (World Bank limit of 55 dB(A) for educational institution and FMEnv limit of 90 dB(A). In summary, the ambient air quality and noise within the Project site and the surrounding environment is considered to be satisfactory.

Soil Quality: The dominant soil type within the Project site is clay based on the grain size analysis. No heavy metal and hydrocarbon pollution was recorded in the soil samples collected from the Project site. The concentrations of Zinc (Zn) recorded in the soil samples the Project site and along the transmission cable route ranged from 0.03 mg/kg to 0.190 mg/kg in topsoil and 0.03 mg/kg to 0.16 mg/kg in subsoil while Iron (Fe) ranged from 22.23 mg/kg and 74.59 mg/kg in the topsoil and 29.54 mg/kg to 73.16 mg/kg in the subsoil. Mercury, Chromium, Lead and Nickel were undetected in the soil samples from the Project site and AoI.

Groundwater Quality: Groundwater samples were collected from three (3) different boreholes in the study area. The concentrations of parameters analyzed in the groundwater samples were generally within the FMEnv and WHO limits for substances and characteristics affecting the acceptability of groundwater for domestic use.

Terrestrial Flora: The natural ecosystem of the Project site was observed to have been substantially modified by human activities (mainly development activities within the university). The physiognomy of the entire study area is characterized by open vegetation of thorny shrubs, grasses and trees. Based on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species classification, no endangered species were recorded within the Project site. The plants species noted include *Azadirachta indica, Panicum maximum, Ipomoea involucrate, Adansonia Digitata, Synedrella nodiflora* and *Arachis hypogaea*. Also, the site is not within any designated grazing reserves, breeding areas, or animal migratory routes.

Terrestrial Fauna: 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 (Cattle egret, Black Kite, Green fruit Pigeon etc.) and a few grazing animals (cows and sheep) were sighted outside of the Project site. Based on the IUCN classification, no threatened or endangered fauna species were recorded in the study area.

Socio-economic and Health: the identified local community in the Project's AoI is Mairi community located about 2.2 km away from the University. The socio-economic characteristics of the community based on information gathered through focus group discussions, key informants interviews, direct observations, and surveys are summarized as follows:

- Mairi community is relatively heterogeneous in terms of ethnicity and language.
- Islam is the most prevalent religion in the community.

- The major economic activities in the study area are food processing, handicraft, and commercial transport services.
- The community has access to public electricity supply from the national grid.
- There are government hospital, private hospital and pharmaceutical outlets.
- Public and private boreholes are found within the community.
- Women in the community are limited to domestic roles and they are underrepresented in leadership positions.
- Based on interviews with community leadership and respondents in the community, there are no direct livelihood activities or ecosystem services obtained from the Project site.
- Members of the community were positively disposed to the proposed Project. They believe that the Project will improve the economic values of the communities, impact positively on entrepreneurship and create job opportunity for community members.

5.0 ASSOCIATED AND POTENTIAL RISKS AND IMPACTS

The potential environmental and social (E&S) risks and impacts associated with the proposed Project were identified and ranked across each phase of the Project development. In the pre-construction phase, the significant impacts identified include increase in vehicular movement and traffic including potential for road accident, soil degradation as a result of site clearing and loss of a few farmlands onsite. For construction phase, the potential impacts identified include: soil degradation, temporary disruption of market activities along the transmission route, decrease in ambient air quality, increased noise emission, Gender Based Violence (GBV) risks, community health and safety impacts due to influx of workers and construction activities, and occupational health and safety hazards.

During the commissioning phase, the proposed Project is presumed to have minor noise impact and Occupational Health and Safety (OHS) hazards which may arise from injuries and electrocution. The operational phase will have significant risks such as electric shock and injuries to workers, GBV issues, and work related issues (poor working conditions and discrimination). The decommissioning phase will have significant impacts on the soil and road traffic of the Project area.

Some of the potential positive impacts associated with the proposed Project include: employment opportunity, promotion of clean energy source, reduction of GHG emissions, and skill acquisition and transfer of knowledge through training and retraining.

6.0 MITIGATION MEASURES

Recommended mitigation measures required to complement those incorporated in the Project design for the identified negative impacts were proffered while

enhancement measures for the positive impacts were similarly presented and documented in the ESIA report.

The summary of the recommended mitigation measures for the identified significant negative impacts is provided as follows:

Pre-construction Phase

The proffered mitigation measures for the potential impacts associated with the pre-construction phase of the Project include, amongst others:

- The affected farmers (University staff) on the site shall be identified and allowed to harvest their crops before commencement of construction activities.
- UNIMAID management shall provide alternative land within the University for the affected farmers.
- The commitment for the provision of alternative land for the affected persons shall be documented in a letter signed by the University's Vice Chancellor.
- The Nigerian Military shall be consulted before the trench onsite is filled up and relocated.
- Alternative location for the trench shall be selected and agreed upon by the Nigerian Military and the University before commencement of the Project.
- Consultations shall be held with the leaders of markets along the power evacuation route before commencement of trenching and cable laying.
- The extent of vegetation to be cleared shall be clearly identified and appropriately demarcated. Clearing exceeding the approved working corridor shall be prohibited.
- Soil conservation measures shall be implemented such as stockpiling topsoil or for the remediation of disturbed areas.
- Disturbed areas will be rehabilitated with native plants as soon as possible to prevent erosion.
- 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).
- A traffic management plan (TMP) shall be developed and implemented by the EPC Contractor.
- Appropriate signage and safety measures (barrier, formalized crossing points) to reduce the risk of accidents in the Project area shall be provided.
- 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.

- Provision of adequate PPE especially gloves, safety boots, 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.

Construction Phase

Mitigation measures for the potential impacts associated with the construction phase of the Project include:

- 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.
- Work areas shall be clearly defined and where necessary demarcated to avoid unnecessary disturbance of areas outside the development footprint.
- Construction machinery shall be turned off when not in use.
- 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 minimize introduction of alien species.
- Employment of workers for construction activities shall be open and fair.
- 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.
- 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.

- Daily toolbox talks prior to commencement of work activities shall be carried out.
- 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.
- The NEP Grievance Redress Mechanism (GRM) for receiving complaints arising from damage to infrastructure and private property during construction activities shall be developed.
- Construction workers (e.g. semi-skilled and unskilled craftsmen) shall be drawn from the local community as much as possible.
- Public access shall be restricted to construction area via security fencing and appropriate signage.

Commissioning Phase

Mitigation measures for the potential impacts associated with the commissioning phase of the Project include:

- The Project components shall be installed in line with the pre-established standards and as per manufacturer recommendations.
- The inverters and batteries to be used for the Project shall meet industry best standard in relation to noise attenuation.
- Plant testing shall be carried out by experienced personnel.

Operation Phase

Mitigation measures for the potential impacts associated with the operation phase of the Project include:

- 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.
- 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 shall be ensured.
- A grievance mechanism procedure for receiving and addressing the concerns of employee shall be put in place and implemented.
- 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.
- 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.
- 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.
- 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.
- Burning of waste shall be prohibited.

7.0 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

An Environmental and Social Management Plan (ESMP) has been developed as part of the key elements of the ESIA study to satisfy long term objectives of managing and monitoring the environmental and social impacts of the proposed Project. It covers the entire life cycle of the Project and also includes desired outcomes; performance indicators; monitoring (parameters to be monitored and frequency); timing for actions; responsibilities and cost estimates required for implementation.

REA-PMU is committed to the implementation of the ESMP and shall work with relevant agencies at local, state and national levels to ensure full compliance. REA shall have principal responsibility for all measures outlined in the ESMP, but may delegate responsibility to its contractors, where appropriate and monitor the implementation. The relevant regulatory authorities at Federal, State and Local

Government levels shall also be involved in the monitoring of the ESMP implementation.

An environmental monitoring programme, which outlines specific environmental/social components to be measured, methodology, parameters/requirement, frequency of monitoring, timelines, and estimated budget, has also been developed as part of the ESMP.

Table ES 1 provides the summary of cost estimate required for the implementation of recommended mitigation measures and management plans required to address the potential and associated impacts of the proposed Project.

Table ES 1: Cost Estimate for ESMP Implementation

S/N	Fundamental ESMP Activities	Cost Estimates (US Dollars)
1.	Pre-construction phase E&S management activities	3,700
	Construction phase E&S management activities	16,200
	Commissioning phase E&S management activities	700
	Operational phase E&S management activities	8,000
2.	Preparation of additional management plans	17,500
3.	Institutional Capacity Strengthening Programme	1,500
4.	Monitoring and Evaluation Programme	19,000
Total		**66,600**

8.0 REMEDIATION PLAN AFTER DECOMMISSIONING/CLOSURE

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 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.

In the event of decommissioning, REA, in conjunction with the leadership of UNIMAID, 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.

9.0 STAKEHOLDER ENGAGEMENT AND GRIEVANCE REDRESS MECHANISM

Stakeholder engagement was conducted as part of the ESIA for the proposed project. This included a review of the legal and administrative framework, stakeholder identification and analysis, and initial consultation with stakeholders. Comments and issues raised by relevant stakeholders consulted during the ESIA study were provided in the report. The consultations were conducted from July 31st to August 2nd, 2019 with the following:

- Borno State Ministry of Environment
- Borno State Environmental Protection Agency
- Borno State Ministry of Women Affairs and Social Development
- Borno State Ministry of Youth and Sports
- UNIMAID Vice Chancellor
- UNIMAID Teaching Hospital Chairman of Medical Advisory Committee
- UNIMAID Director of Works, Physical Planning and Development
- UNIMAID Teaching Hospital Director of Works, Physical Planning and Development
- UNIMAID Student Union Government President
- Jere Local Government Representative
- Lawan of Mairi Land (host community)
- Mairi Market Leader/Park Chairman
- Farmers within the Project site

The consultations served to provide stakeholders with information about the proposed Project and to gather information important to the ESIA. Consultation with the identified stakeholders (including regulators and potentially affected communities) showed general acceptance of the proposed Project.

9.0 CONCLUSION AND RECOMMENDATIONS

The ESIA of the proposed Project has been conducted in accordance with the relevant requirements of the FMEnv and other relevant regulatory agencies in Nigeria, as well as the applicable requirements of the World Bank Safeguard Policies, specifically the Operational Policy 4.01 and Involuntary Resettlement Policy 4.12 triggered by 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.

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 to assess the efficiency and effectiveness of the recommended mitigation measures and ensure long-term monitoring of the Project.

The ESIA study recommends the following:

1 The REA, through its PMU, as well as the management of the UNIMAID, 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.

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 University of Maiduguri (UNIMAID) in Borno State, Northeast region of Nigeria. The University was created by the Federal Government in 1975. The UNIMAID main campus is situated along Bama Road and the University population as at November, 2018 stood at 48,000 students in its combined programs, which include a college of medicine and faculties of agriculture, arts, dentistry, education, engineering, law, management science, pharmacy, science, social science, and veterinary medicine (REA Energy Audit Report, 2018).

Based on the energy demand audit conducted by REA in conjunction with the National Universities Commission (NUC), a 10.0 megawatt (MW) power plant is proposed for UNIMAID. The power generated from the Project will be extended to

the University of Maiduguri Teaching Hospital located about 4.5km away. 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 UNIMAID, Borno 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,

[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 20.0 hectares of land within the University campus) and its surrounding environment up to 3km 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 transmission route.

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).
- 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.

[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.

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.

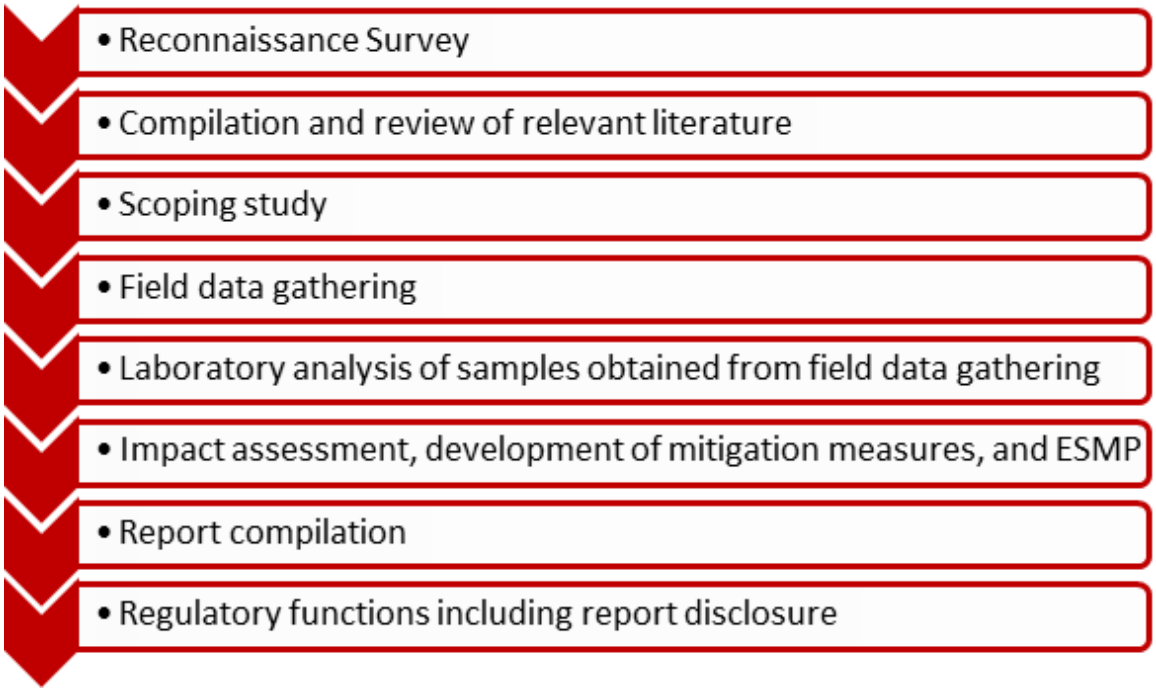

Figure 1.1: Schematic presentation of the general methodology for the EIA

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 ESIA 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 UNIMAID. 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 UNIMAID campus in Jere Local Government Area (LGA) of Borno State. The key State and local government administrative authorities with statutory functions related to the Project are briefly described below:

- *Borno State Ministry of Environment*

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

- *Borno State Environmental Protection Agency*

Borno State Environmental Protection Agency (BOSEPA) is an agency of the Borno State government charged with protecting the environment and waste management matters in the state.

- *Jere 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 <u>International Guidelines and Standards</u>

- *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 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 UNIMAID 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 and social impacts/ risks of the proposed Project are identified and managed appropriately.	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 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	Yes	The Project site (approximately 20.0 hectares) and the proposed power distribution network are within the	Chapter 3 – Project Description Chapter 4 – Description of the Environment Chapter 5 –

S/N	World Bank Safeguard Policies	Scope/ Requirement	Safeguard triggered by the proposed Project	Justification	Sections of the ESIA that address the requirements
		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.		existing land property of UNIMAID. No additional land will be expropriated (either through eminent domain or otherwise) for the Project. Some farmlands were observed on the proposed Project site during site visit which are cultivated by staff of UNIMAID only during wet season. The farmers on the site stated that they have no legal claims to the site and but have obtained permission from the University to use the site for subsistence farming.	Potential and Associated Impact Chapter 6 – Mitigation Measures Chapter 7 – Environmental and Social Management Plan
4.	Indigenous Peoples (OP/BP 4.10)	The Indigenous Peoples Policy (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.	No	The people in the Project's 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	No	The proposed Project is not in any way linked to any known dam.	-

S/N	World Bank Safeguard Policies	Scope/ Requirement	Safeguard triggered by the proposed Project	Justification	Sections of the ESIA that address the requirements
		functions (including mine tailings containment). The Bank requires that such projects adopt and implement certain dam safety measures.			
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 environmental assessment	No	The development and operation of the proposed Project will not involve substantial use of pesticides.	-
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	The Natural Habitats Policy (OP/BP 4.04)	No	The Project site is characterized	-

S/N	World Bank Safeguard Policies	Scope/ Requirement	Safeguard triggered by the proposed Project	Justification	Sections of the ESIA that address the requirements
	(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		by secondary vegetation. Also, it is not likely that the proposed transmission route would impact any natural habitat.	
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 waterways, or the quantity or quality of water in more than one country.	No	There are no known international waterways 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 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.

- *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.

- *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 UNIMAID, 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, Borno 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 10.0 MW solar-hybrid power plant and associated infrastructure in University of Maiduguri, (UNIMAID), Borno State, as part of the Federal Government of Nigeria (FGN) Energizing Education Programme (EEP) Phase II. The power generated from the solar-hybrid plant will also be extended to the University of Maiduguri Teaching Hospital. This chapter 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 UNIMAID in 2018 reveals that the University receives an average of 10 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 UNIMAID 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 UNIMAID 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 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.
- Improvement in the delivery of medical services at UNIMAID Teaching Hospital.
- Reduction in fossil fuel consumption by the University and Teaching Hospital thereby leading to reduction in carbon emissions and improvement in eco-balance. The University's average monthly diesel consumption is 17.870 litres while the Teaching Hospital is 212,400 litres (REA Energy Audit Report, 2018).
- Significant reduction in the cost of power generation by the University through diesel-fueled generators. The University has 71 generators and spends ₦4,378,150 on diesel monthly to self-generate 16,086kW of power 10 hours daily. In the same vein, the Teaching Hospital has 12 generators and spends ₦52,038,000 on diesel monthly to self-generate 4,040kW of power for the same amount of time (REA Energy Audit Report, 2018). Such savings would be used for other undertakings that will benefit the University and the Teaching Hospital.
- 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 as a result of training centre to be provided as part of the Project.
- Improvement in livelihood enhancing activities within the University and the Teaching Hospital.
- 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 UNIMAID. 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, the EPC contractor will be operate and maintain the Project in conjunction with the team from UNIMAID'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 UNIMAID, 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 and Teaching Hospital 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 340,008kWh monthly from the grid while the Teaching Hospital consumes 220,167kWh). 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, a Stakeholder Engagement Plan (SEP) has been developed as part of the ESIA study to ensure continuous engagement with relevant stakeholders throughout the Project life cycle. Also, 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 4 of this report.

2.5 Project Alternatives

2.5.1 Site Location Alternative

An approximately 20.0 hectares of land within the UNIMAID main campus has been allocated by the University authority for the proposed Project. The preferred site is located close to the third gate of the University. The Project site has been selected based on a number of considerations including: i) accessibility - the Project site can easily be accessed through the existing road network leading to the campus; ii) security; iii) absence of any major physical structure on the site that could be affected by the proposed Project except for the temporary military trench that was dug during the insurgency in State (it is currently not in use and would be filled up for the proposed project); iv) absence of any rocky outcrops on the site that could pose constraints to the solar panels to be installed; v) absence of any ecologically sensitive areas and/or cultural resources within and around the Project site.

Other candidate sites considered within the University campus for the proposed Project were rejected due to some factors such as: i) presence of occupied physical structures; ii) poor accessibility; iii) 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 UNIMAID 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 UNIMAID will significantly avoid the generation of GHG emissions associated with fossil-fueled power plants.

Thus, the proposed Project will help contribute to Nigeria's NDC on climate change. In addition, the high solar irradiation in Borno State (as indicated in Figure 2.1) will be able to support the proposed power plant.

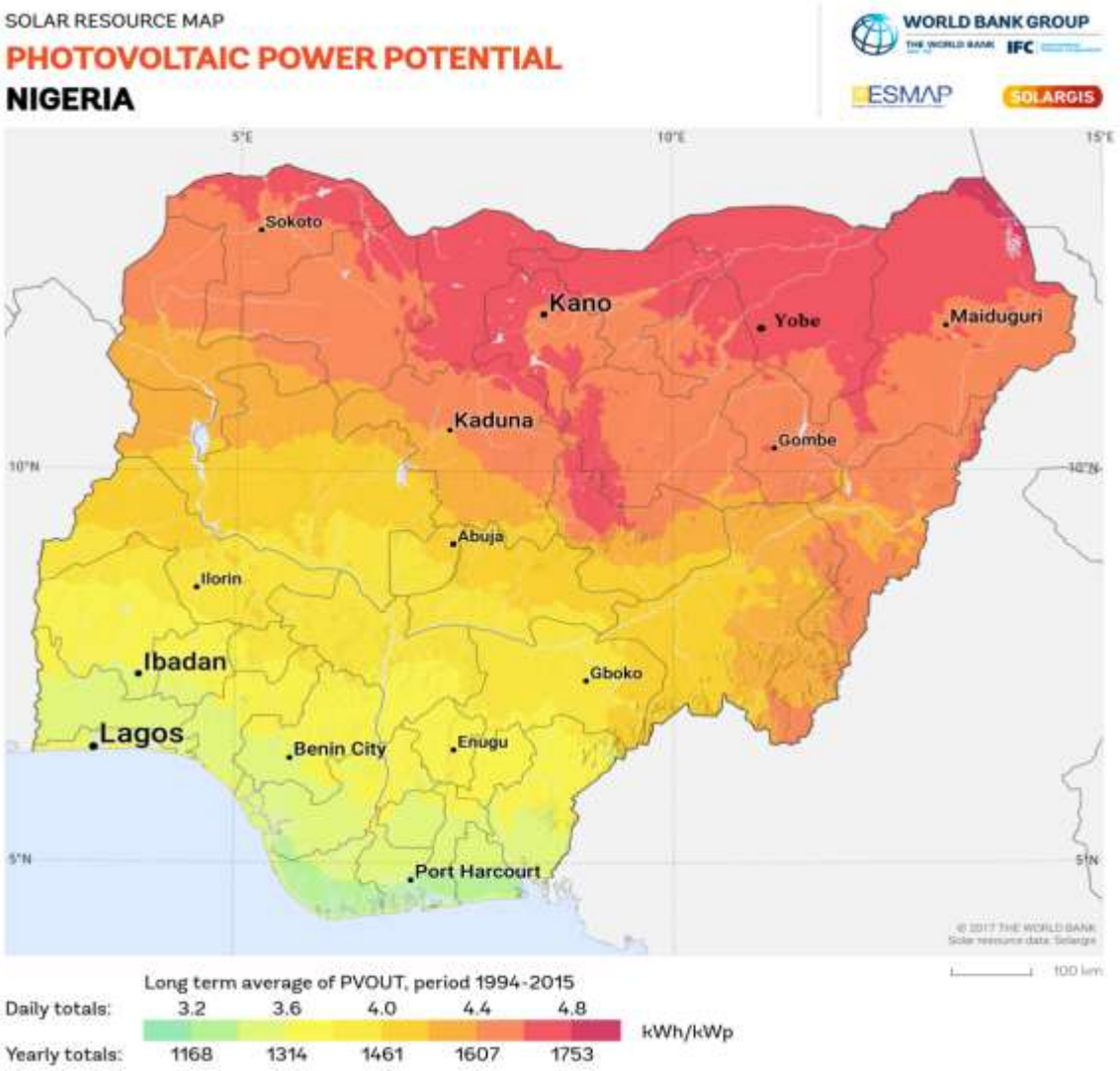

Figure 2.1: Photovoltaic power potential of Nigeria
Source: © 2017 The World Bank, Solar resource data: Solargis

2.5.2.2 Solar Power Technology Alternatives

The solar technologies considered for the proposed power plant in UNIMAID 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.

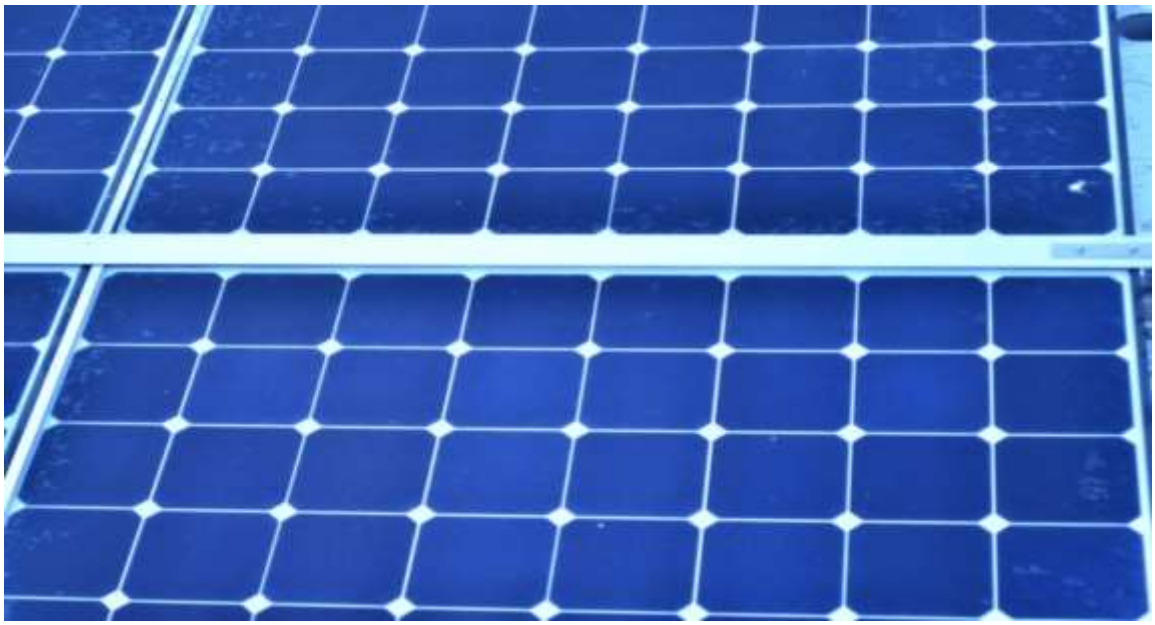

Figure 2.2: Typical appearance of mono-crystalline silicon PV panels

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 UNIMAID 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 UNIMAID 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 UNIMAID and the Teaching Hospital

UNIMAID is a Federal Government-owned tertiary institution, with its campus situated along Bama Road in Jere Local Government Area of Borno State, Northeastern geo-political region of Nigeria (Figures 3.1 to 3.4).

The University of Maiduguri (UNIMAID) was created in 1975 as one of the second-generation Universities, which formed part of the programmes of the Third National Development plan (1975-80) by the then Federal Military Government. At inception, the university did not have physical structures of its own, but in April 1976 it inherited the premises owned by the former North East College of Arts and Science (NECAS). The structures bequeathed to the University by NECAS were adequate in terms of office blocks, classrooms, staff quarters, laboratories and other physical structures requirement by a university of its size. The personnel of NECAS were equally absorbed into the University employment and this made it possible for the institution to commence its academic programmes in October 1976.

The UNIMAID College of Medical Sciences was formally established by the University of Maiduguri act 83 of 1979 comprising four faculties, namely; Basic Medical Sciences, Allied Health Sciences, Clinical Sciences and Dentistry. The UNIMAID Teaching Hospital is used by the College of Medical Sciences for the clinical components of its training. The hospital also serves as a major medical center in Maiduguri and is open to the general public for medical care.

As at October 2018, there are 48,160 students enrolled in its combined programs; which include the college of medical sciences and faculties of agriculture, arts, dentistry, education, engineering, law, management science, pharmacy, science, social science, and veterinary medicine. Also, there are 4,501 Administrative staff which includes the Academic and non-academic staff.

3.2.2 Description of the Project Site

An approximately 20.0 hectare (ha) of land within the UNIMAID campus has been allocated for the proposed solar-hybrid power plant and training centre. The Project site lies geographically within Latitude 11.79372^{0}N to 11.79564^{0}N and Longitude 13.30172^{0}E to 13.20510^{0}E. Its boundary is bordered to the east by Bama road, to the north by a praying ground, and to the east and south by unoccupied lands. An aerial view of the Project site is shown in Plate 3.1 while a cross-sectional view of the Project site is presented in Plate 3.2.

At present, there is an abandoned structure on the Project site owned by the University. Also, there is a temporary military trench (about 1 m deep and 1 m wide) that runs diagonally across the site which was dug by the Nigerian Military during the height of terrorist attacks in Borno State. The topography of the site is relatively flat and there are no rocky outcrops within the site.

The Project site is largely characterized by seasonal vegetation which includes shrubs, grasses, trees and herbs. Some portion of the Project site (about 30 %) is used temporarily for subsistence and low scale commercial farming by relatives of UNIMAID staff. Three (3) farmers were identified within the Project site during the baseline studies; and they were all UNIMAID staff who obtained permission from UNIMAID Farm Manager to use the site during rainy season only.

Although some nomadic herders were observed on the site during site visit; the University representatives stated that they were free range grazing and the site is not within any designated grazing reserves, breeding areas, or animal migratory routes.

There is no local community presence (i.e. farms, residential buildings, and firewood/fruit-gathering activities) within the proposed Project site. The nearest community to the Project site is Mairi which is located about 2.2 km away from the University. Detailed information on the local community is provided in Chapter 4 of this report.

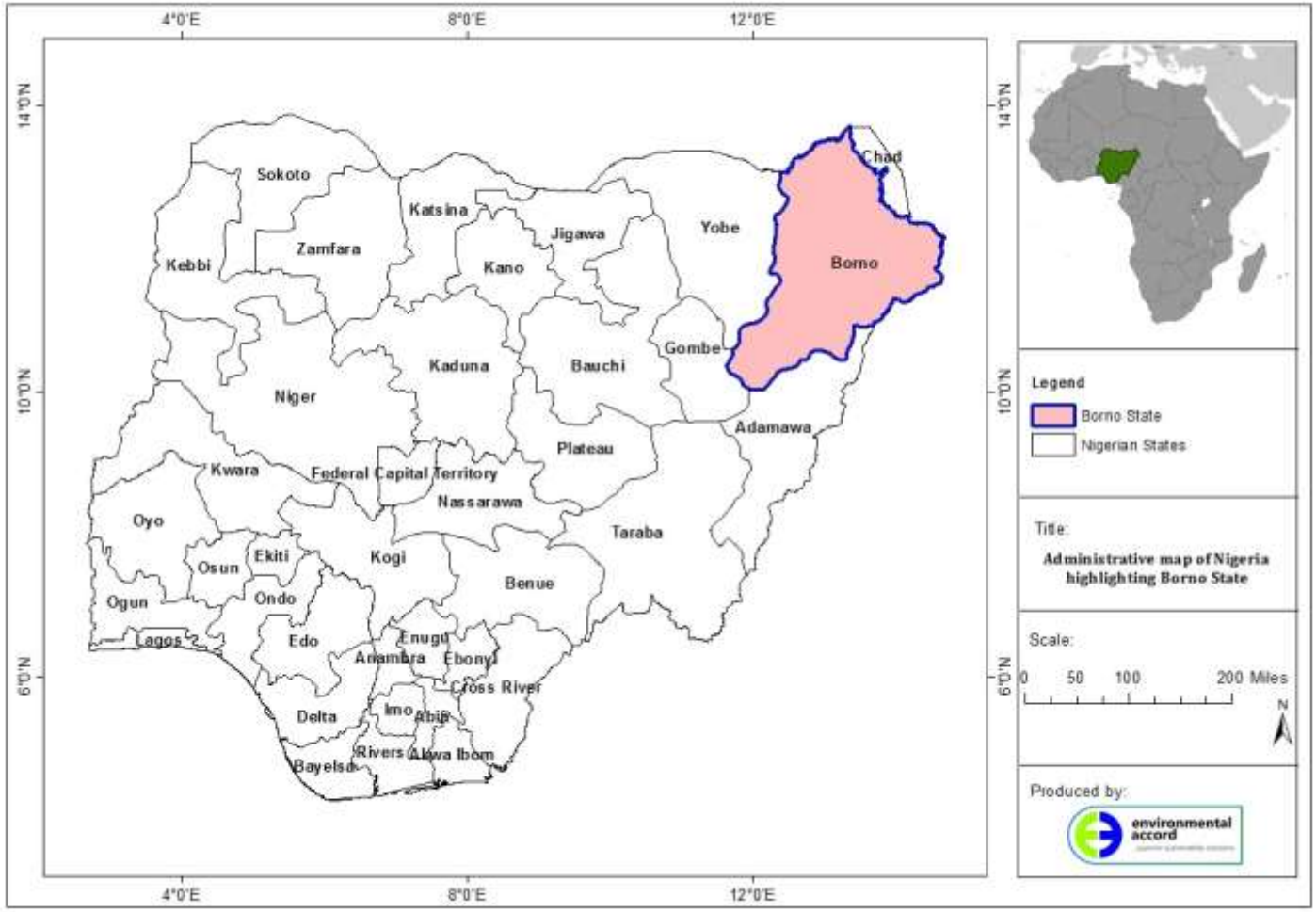

Figure 3.1: Administrative Map of Nigeria highlighting Borno State

Source: EnvAccord Field survey, 2019

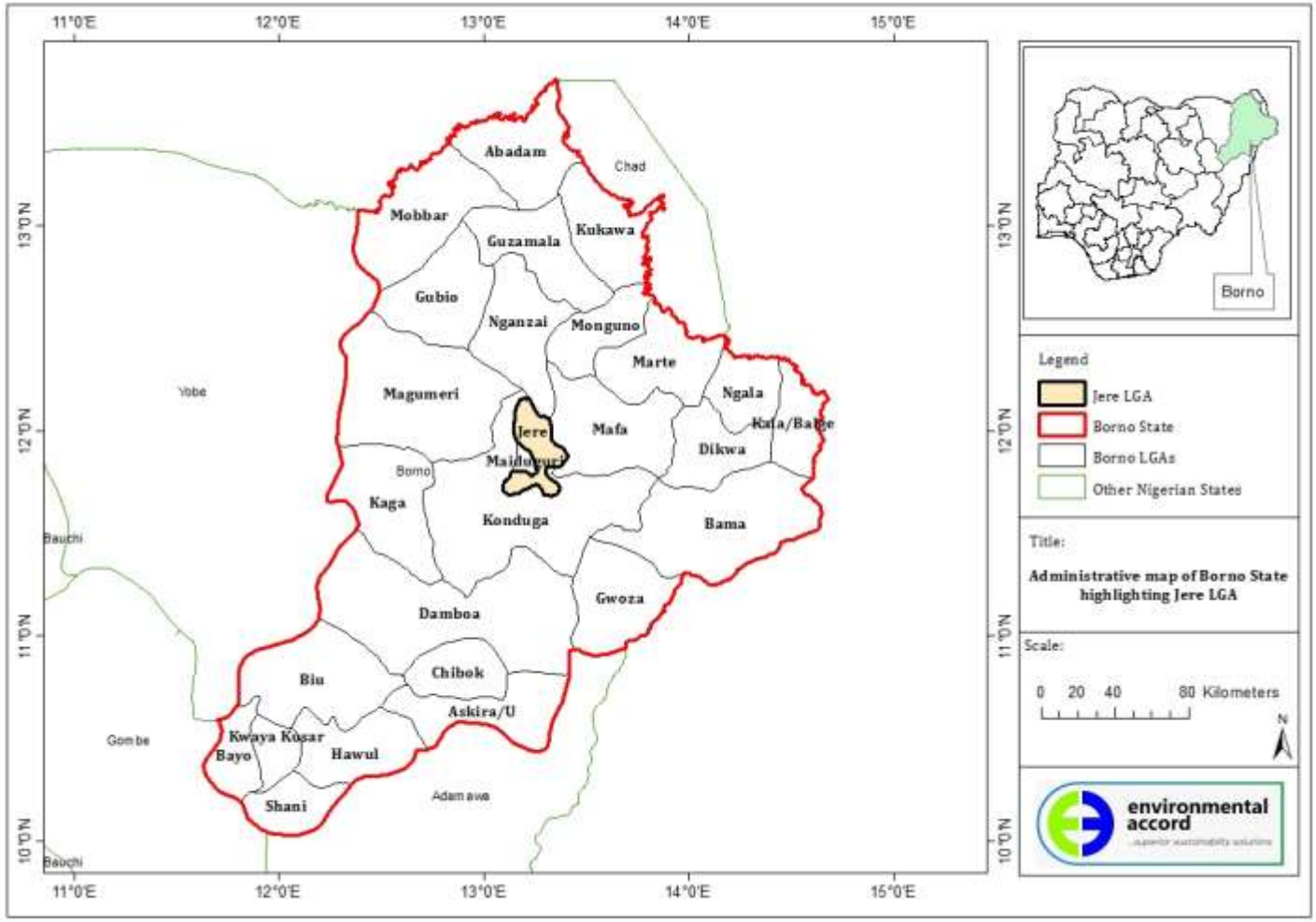

Figure 3.2: Administrative Map of Borno State highlighting Jere Local Government Area

Source: EnvAccord Field survey, 2019

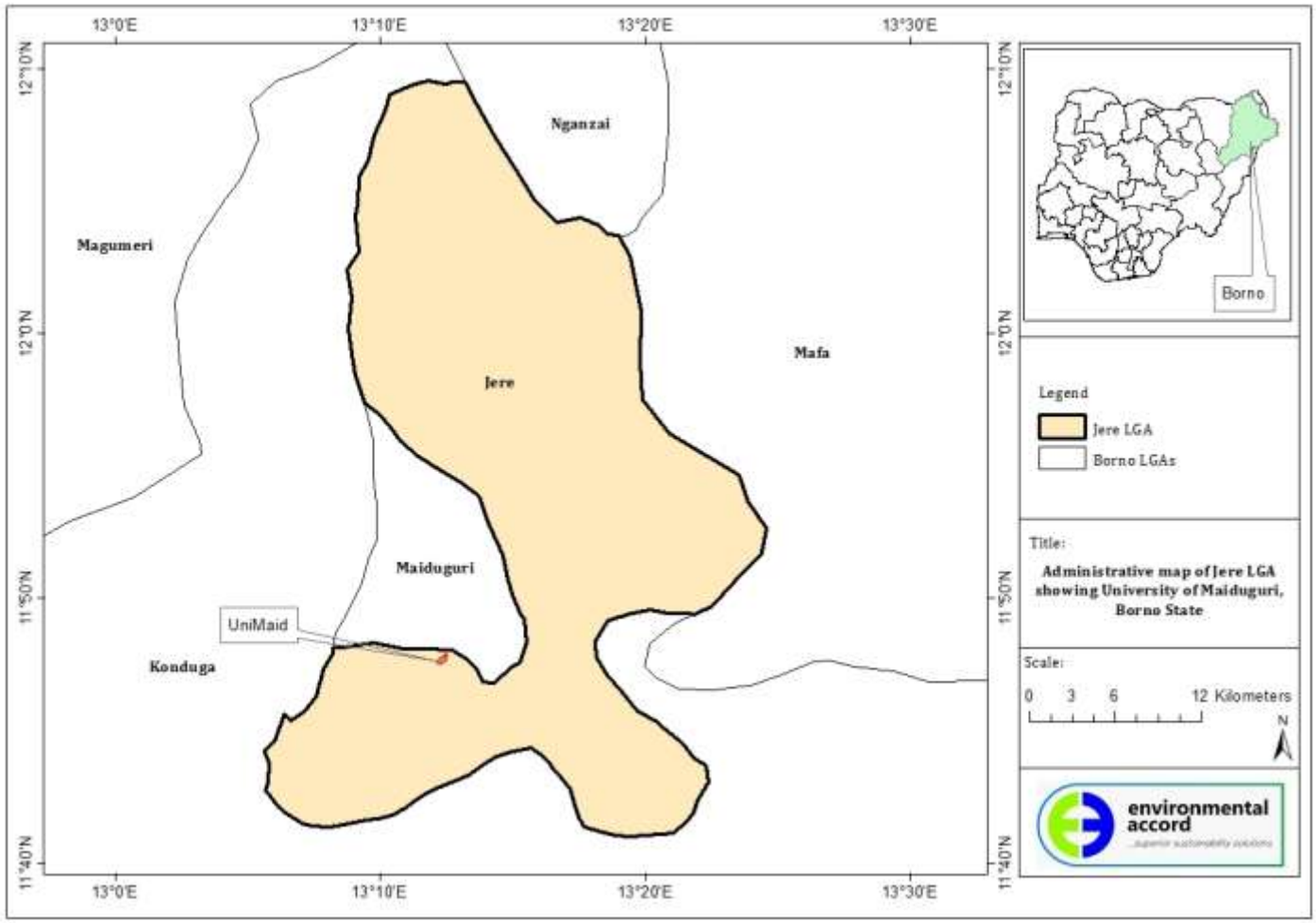

Figure 3.3: Map of Jere Local Government Area highlighting the Project Site within UNIMAID campus
Source: EnvAccord Field survey, 2019

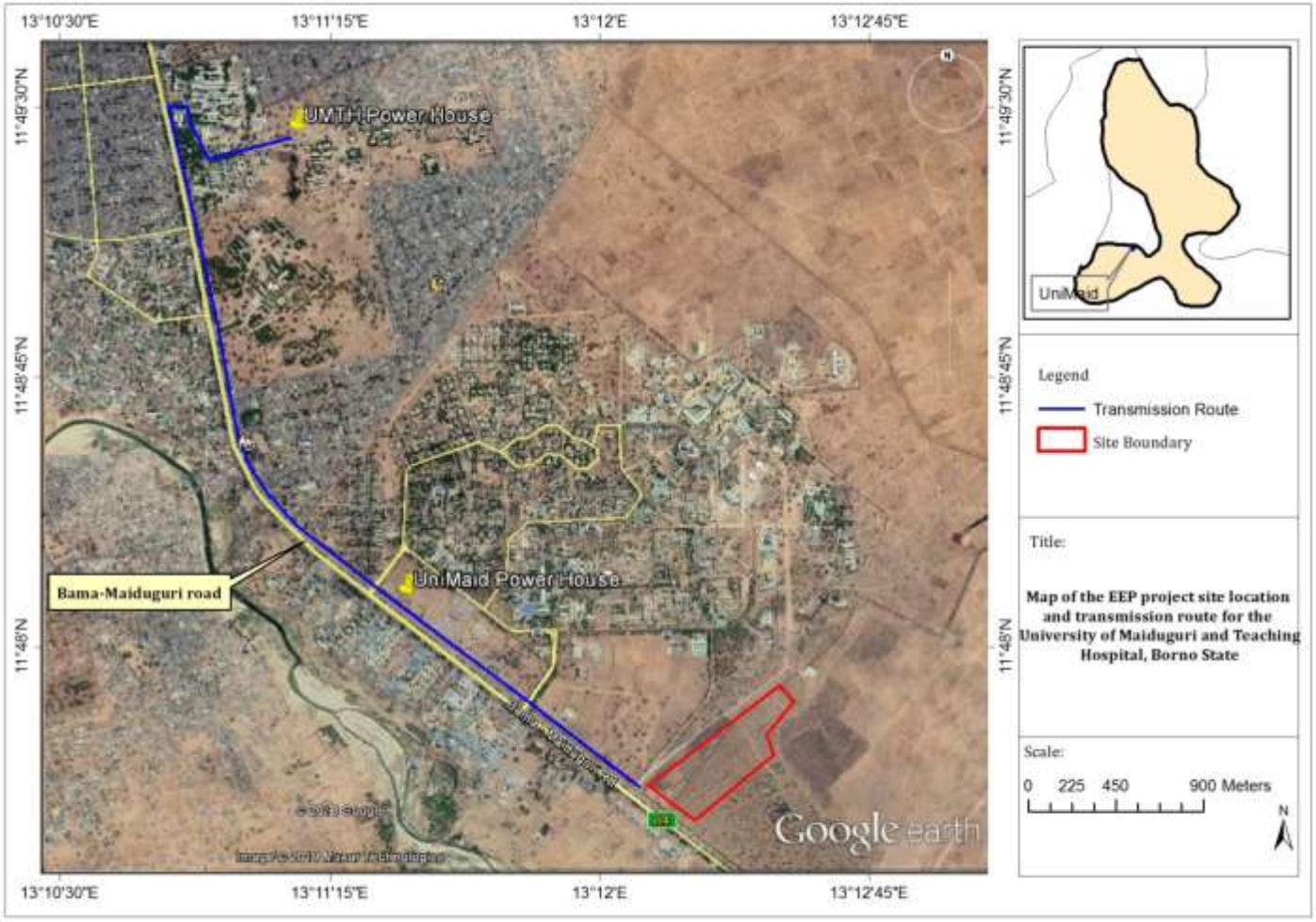

Figure 3.4: Map of the EEP Project Site within UNIMAID campus and proposed transmission line to the Teaching Hospital
Source: EnvAccord Field survey, 2019

Plate 3.1: Aerial view of the proposed Project site

Source: EnvAccord Field survey, 2019

Plate 3.2: Cross-sectional view of the Proposed Project Site showing the military trench
Source: EnvAccord Field survey, 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. The power generated from the Project will be transmitted to UNIMAID Teaching Hospital. Each of these components as it relates to UNIMAID and the Teaching Hospital is discussed below.

3.3.1 Proposed Solar-Hybrid Power Plant

As part of the initial activities, an energy demand audit of UNIMAID and the Teaching Hospital was carried out in October 2018, by REA in conjunction with the NUC. The summary of the audit findings is provided below in Table 3.1.

Table 3.1: Summary of Energy Demand Audit for UNIMAID and Teaching Hospital, October, 2018

S/N	Item	UNIMAID	UNIMAID Teaching Hospital	Duration/ Remarks
1.	Daily Energy Consumption (Measured) (kWh)	40,433.58	17,375.00	1 day
2.	Daily Energy Inductive Consumption (Measured) (kVARH, kilovolts amperes reactive hours)	13,225.97	2057.45	
3.	Daily Capacitive Energy Consumption (Measured) (kVARH)	0.00		
4.	Daily Peak Power Demand (Measured) (kW)	4,038.10	1,922.49	24 hours
5.	Daily Off-Peak Power Demand (Measured) (kW)	560.1	123.6	
6.	Daily Energy Consumption (Historical Data) (kWh)	11,333.59	7,339	
7.	Total energy consumed per month from grid supply (kWh)	340,008	220,167	
8.	Total capacity of self- generation (kW)	16,086	4,040	
9.	Total Number of Diesel Generating (DG) Sets	71	12	
10.	Estimated hours of grid supply per day (h)	10	10	
11.	Yearly Energy Consumption (Historical Data) (kWh)	4,080,093	2,642,000	
12.	Displacement Power Factor (DPF) (%)	0.93	0.99	
13.	Power Factor Total (PFT) (%)	0.947	0.99	
14.	Total Harmonic Distortion (THD) (V-N)	V1-N= 39.28, V2-N= 55.49, V3-N=39.82,	V1-N= 39.28, V2-N= 55.49, V3-N=39.82,	

S/N	Item	UNIMAID	UNIMAID Teaching Hospital	Duration/ Remarks
15.	Total Harmonic Distortion (THD) (V-phase)	V1-2= 49.76, V2-3= 46.86, V3-1=37.82,	V1-2= 37.22, V2-3= 48.50, V3-1=45.30	
16.	Total Harmonic Distortion (THD) (I-phase)	I1= 61.04, I2=69.17, I3=55.19,	1= 29.84, I2=36.78, I3=42.64,	
17.	Total Harmonic Distortion (THD) (I-N)	IN=520.6	IN=255.7,	
18.	Measured Power Demand (kW)	4,038.10	1922.49	
19.	Estimated Power Demand Forecast in 5 Years	2,700		
20.	Planned Expansion Load for New Building, Hostels etc. (kW)	4048		

Source: REA Energy Demand Audit report for UNIMAID and the Teaching Hospital, 2018

Based on the findings of the energy audit, a 10.0 MW solar-hybrid power plant is proposed for UNIMAID and the Teaching Hospital. The proposed solar 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 12V 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 UNIMAID 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 26,400 PV panels (for example, JKM340PP-72H-V) would be required to generate a power capacity of 10.0MW.

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 2m.

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 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 Generator: Diesel-fuelled generating sets (4-6 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 11kV underground armoured cable. The distance between the Project site and the existing power house is approximately 1.8 km. The power will also be evacuated to the existing power house at the Teaching Hospital over a distance of approximately 4.9 km along Bama road. 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 3.3.

Plate 3.3: 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 UNIMAID 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 20,080kW within the University and Teaching Hospital. Where required, the existing distribution network will be upgraded to accommodate the generated power from the proposed solar power plant.

3.3.3 Provision of Street Lighting

Information obtained from the report of energy demand audit conducted in UNIMAID in October 2018 reveals that the University has 327 streetlights (solar and conventional) covering the major roads within the campus. The Teaching Hospital has only 2 streetlights. Sample photographs of the streetlights are shown in Plate 3.4. As part of proposed Project, new and additional streetlights will be installed (where required) to ensure that different areas within the University campus and Teaching Hospital are well illuminated.

Plate 3.4: Sample of stand-alone and pole-mounted streetlights in UNIMAID 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 20.0 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 6,000 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 the workers), semi-skilled workers (drivers, technicians, etc.), and skilled personnel (e.g. engineers and experts). 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 operations. 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 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 June to September in Borno State), direct cleaning of the PV panels is estimated to occur not more than three times. However, during the dry season (October to May), 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 PPE 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.

<u>Waste management in UNIMAID</u>

The University has an Environmental Unit that handles general waste generated within the University. Wastes (mostly office and domestic wastes) from various waste collection points within the University are collected and disposed of at BOSEPA approved dumpsites within Maiduguri. However, incineration of wastes as well as open dumping was observed within UNIMAID main campus (Plate 3.5). Furthermore, there are no clear procedures for handling e-waste in the University.

Plate 3.5: Waste management in UNIMAID (a) Incinerator (b) Open dumping

3.8.2 Associated Waste Streams

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

Pre-construction Phase

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 Borno State Environmental Protection Agency (BOSEPA).

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 the 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 BOSEPA. It is estimated that approximately 1.50 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 BOSEPA for treatment and disposal.

Operational Phase

Solid wastes generated during the operational phase of the Project will be incorporated into the existing UNIMAID waste management approach (solid wastes within the University environment are collected for disposal at approved dumpsites). Approximately 15.0 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 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 channeled 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 BOSEPA.

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 will also be encouraged to prepare e-waste management plans 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 Borno State Environmental Protection Agency (BOSEPA).
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	O, D	Return to the manufacturer for

Waste Stream	Sources	Waste Generation Phase Construction (C), Operation (O), Decommissioning (D)	Handling Techniques
	installation		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 BOSEPA 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												
ESIA study and Approval												
Front-End Engineering Design												
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 3 km, including the area where the cumulative impacts of the Project may be experienced.

Data and information for the environmental description of the study 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 July 31st to August 2nd, 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 1km 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 3 km radius from the centre of the Project site, as illustrated in Figure 4.1.

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

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

Based on the field observation, there is no surface water body within the Project site and its immediate surroundings.

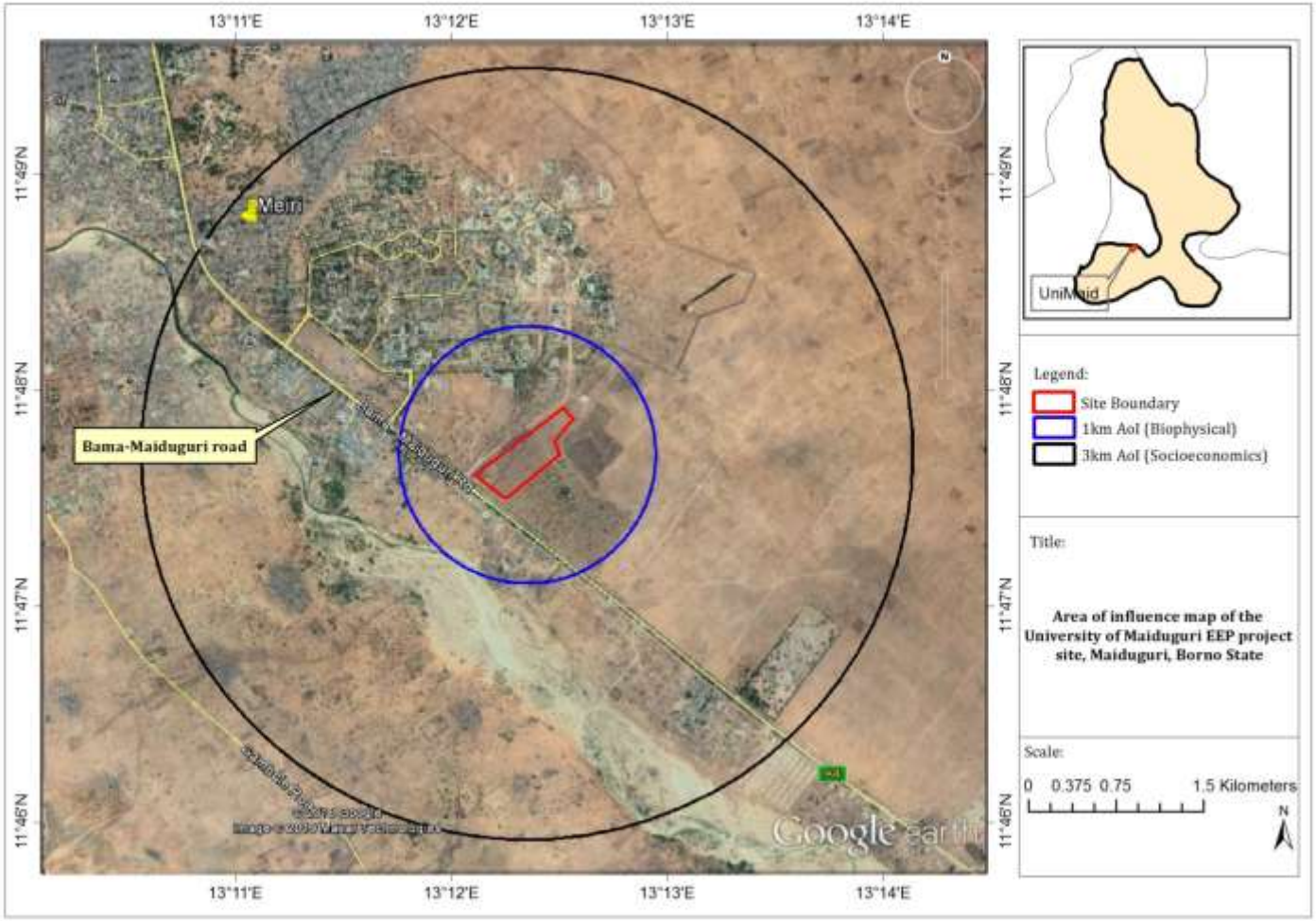

Figure 4.1: Aerial imagery of the Project site showing the 1km and 3km AoI.
Source: EnvAccord Field Survey, 2019

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 study area, field sampling was conducted from July 31st to August 2nd, 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 area.

Plate 4.1: Sample Photographs of Field Sampling Activities at the Study Area: A- Noise/Air sampling, B- Soil sampling, C- Socio-economic survey, D- Groundwater 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.

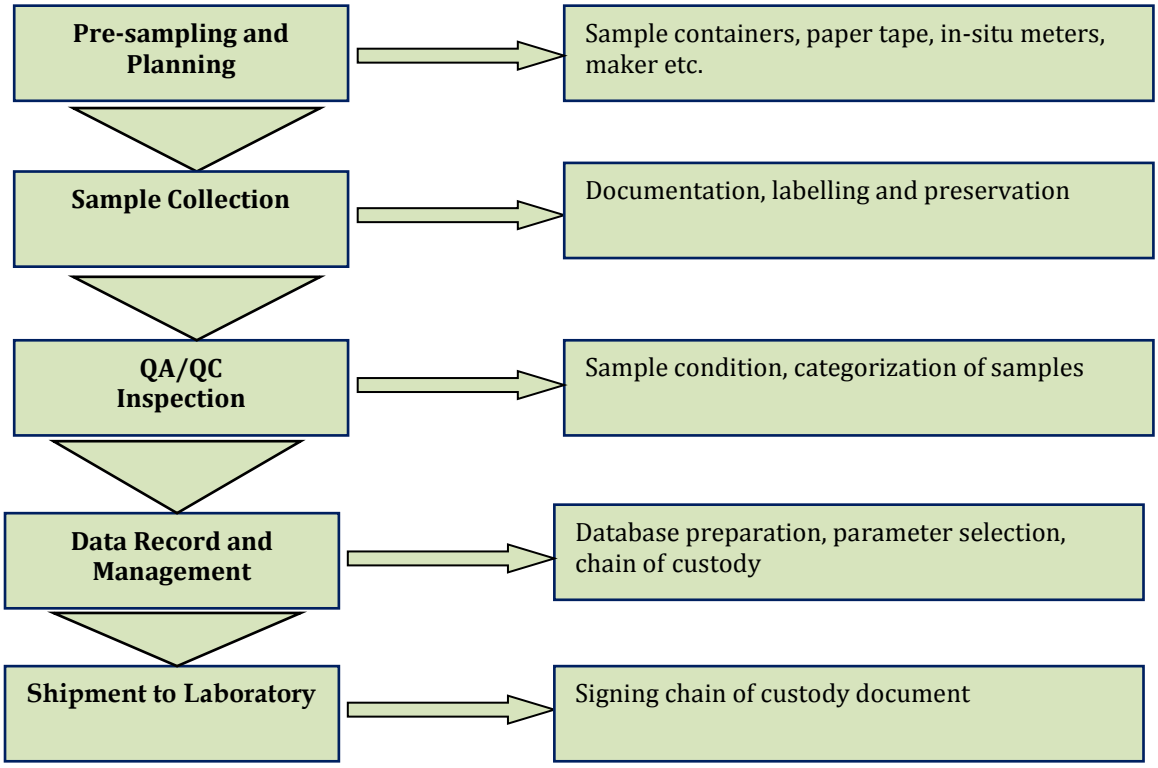

Figure 4.2: Management program employed for field sampling
Source: EnvAccord Field Survey, 2019

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 FMEnv and other relevant regulatory agencies., and 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.	Mercury	Cold Vapour Atomic Absorption Spectrophotometry	mg/l	mg/kg
16.	Lead	Atomic Absorption Spectrophotometry	mg/l	mg/kg
17.	Nickel	Atomic Absorption Spectrophotometry	mg/l	mg/kg
18.	Cadmium	Atomic Absorption Spectrophotometry	mg/l	mg/kg
19.	Zinc	Atomic Absorption Spectrophotometry	mg/l	mg/kg
20.	Copper	Atomic Absorption Spectrophotometry	mg/l	mg/kg
21.	Chromium	Atomic Absorption Spectrophotometry	mg/l	mg/kg
22.	Manganese	Atomic Absorption Spectrophotometry	mg/l	mg/kg
23.	Total Iron	Atomic Absorption Spectrophotometry	mg/l	mg/kg

Source: EnvAccord Field Survey, 2019

4.3 Description of Environmental Characteristics of the Project Area

4.3.1 Climate and Meteorology

Borno 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 June to September, and a dry season from October to May.

In this section of the report, the dominant climatic elements and factors within the study area are discussed. These include rainfall, temperature, relative humidity, sunshine and wind direction and speed. Information on the climatic data of the study area is sourced from the Nigerian Meteorological Agency (NiMet) and it spans from 1988 to 2018 (Table 4.2).

Table 4.2: Climatic Characteristics of the Study Area (1988-2018)

Month	Temperature (oC)		Rainfall (mm)	Relative Humidity (%)		Sunshine hours	Wind speed (m/s)
	Min.	Max.		9:00 hrs	15:00 hrs		
January	12.784	31.416	0	23.516	14.71	8.7194	5.1
February	15.942	34.306	0	17.226	11.387	9.029	6.029
March	20.123	38.339	0.3367	15.452	10.239	8.1355	6.4742
April	24.31	40.709	7.109	25.065	17.742	7.7032	6.0839
May	26.058	39.884	28.403	39.452	25.355	8.4645	6.1774
June	25.103	36.906	71.948	52.677	34.903	8.0742	6.5516
July	23.51	33.158	170.75	66.806	50.613	7.1968	6.1806
August	22.745	31.419	187.62	74.161	61.355	6.3452	4.8258
September	22.919	33.629	97.684	66.161	53.097	7.5032	4.6903
October	21.348	36.289	13.92	44.097	30.452	8.971	4.5194
November	16.235	35.623	0	24.806	17.161	9.5484	4.9226
December	13.177	32.3	0.0806	23.581	15.903	9.4581	5.0613
Total			577.84				
Mean	20.518	35.332	48.15	39.417	28.578	8.2624	5.5513
Min	12.784	31.416	0	15.452	10.239	6.3452	4.5194
Max	26.058	40.709	187.62	74.161	61.355	9.5484	6.5516

Source: NiMet, 2019

(a) Rainfall

Overall, a total of about 577.84mm of rain is recorded annually as shown in Table 4.3. This gives an average of 48.15mm per month. The minimum rainfall amount (0 mm) is received in the months of January, February and December while the maximum rainfall amount (187.62mm) is received in the month of August (Figure 4.3).

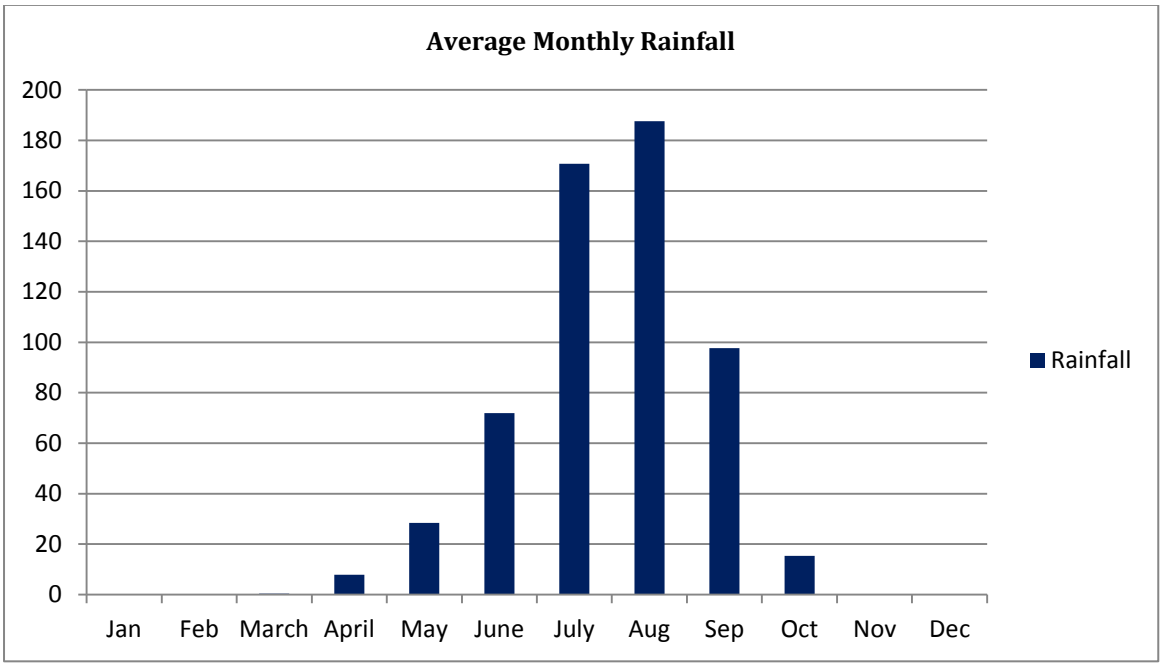

Figure 4.3: Rainfall characteristics of the study area (1988-2018)
Source: NiMet, 2019

(b) Temperature

The temperature of the study area is relatively high and stable all over the year. The overall annual maximum average daily temperature is 35.32°C. Figure 4.4 shows the temperature characteristics of the study area.

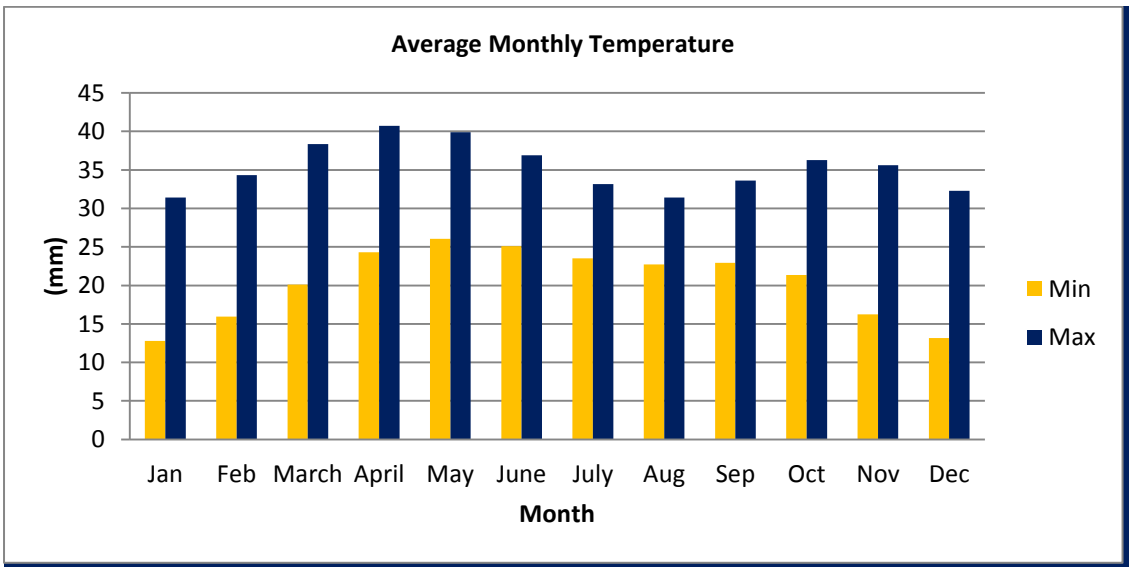

Figure 4.4: Temperature characteristics of the study area (1988-2018)
Source: NiMet, 2019

(c) Relative Humidity (RH)

The study area is characterized by very low RH as a result of the prevailing dry north-east trade winds blowing over the area almost all the year round. Overall, the month of March recorded values of 15.452 and 10.239% which was the lowest relative humidity recorded over 9:00 hrs and 15:00 hrs period respectively while the month of August recorded the highest values of 74.161 and 61.355 over the 9:00 hrs and 15:00 hrs period respectively, (Figure 4.5).

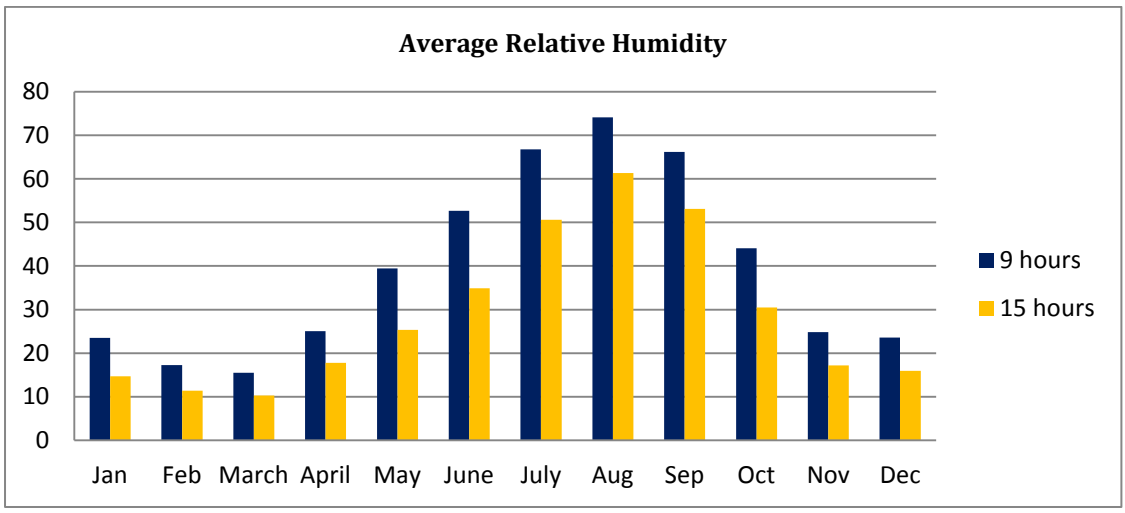

Figure 4.5: Relative humidity of the study area (1988-2018)
Source: NiMet, 2019

(d) Wind Speed

Wind speed recorded the highest value in the month of June with speed of 6.5516 m/s while the speed of wind is lowest in the month of October with 4.5194 m/s as the recorded value (Figure 4.6).

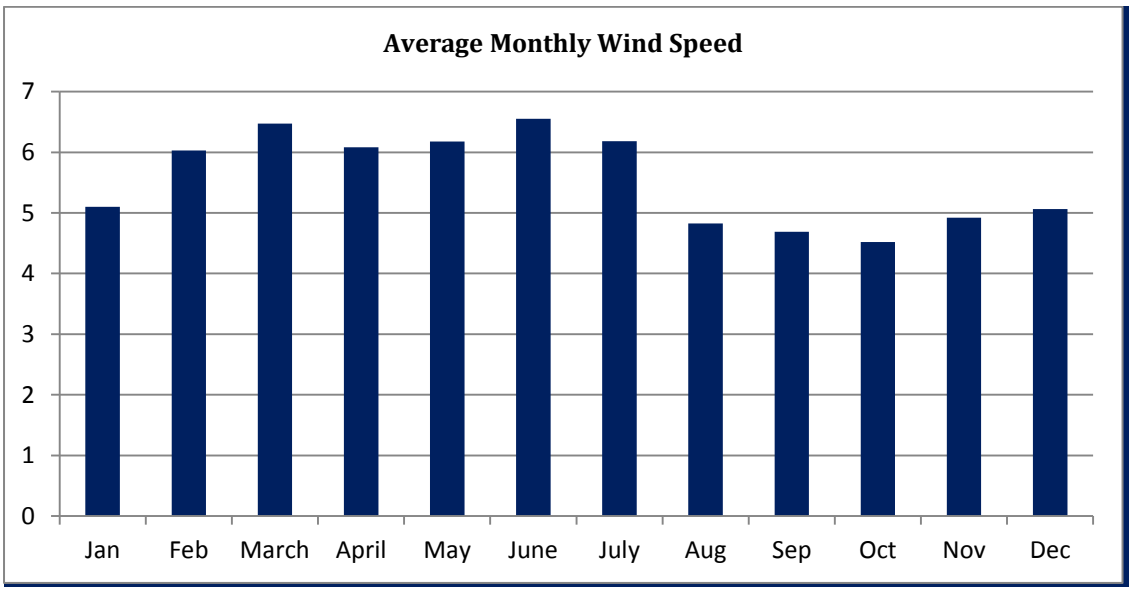

Figure 4.6: Monthly Average Wind Speeds of the Project Area (1988-2018)
Source: NiMet, 2019

(e) Sunshine Hours

The mean monthly sunshine hour in the study area is approximately 8.2624 hrs (Figure 4.7).

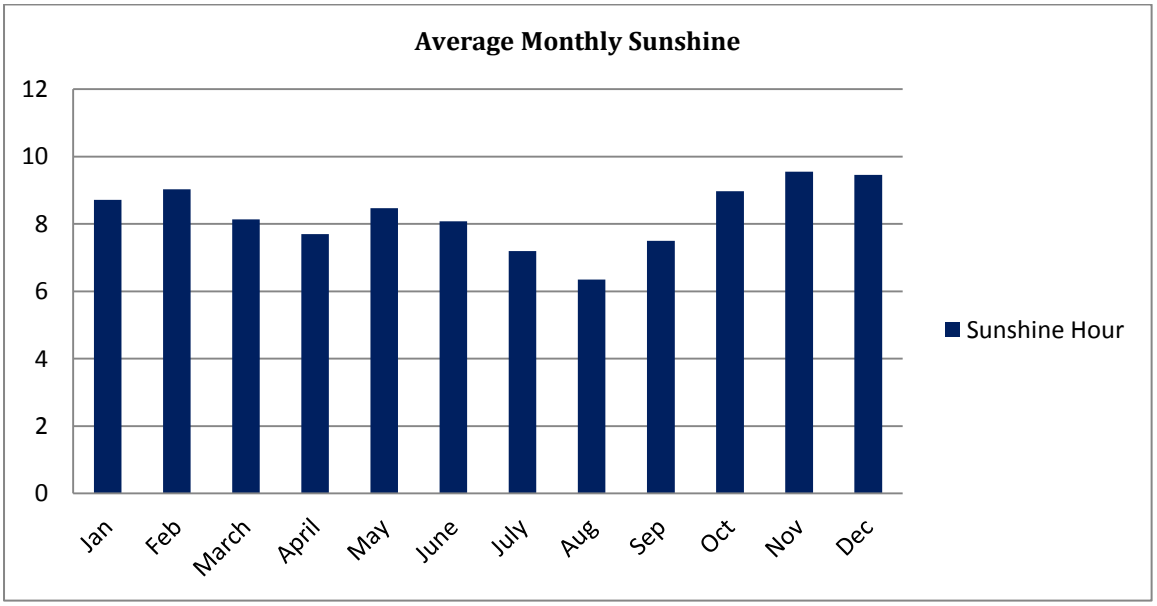

Figure 4.7: Monthly Average of Sunshine Hours in the Project Area (1988-2018)
Source: NiMet, 2019

(f) Wind Rose

As indicated in the Figure 4.8 below, the dominant wind direction in the study area is NNE (North-North-East).

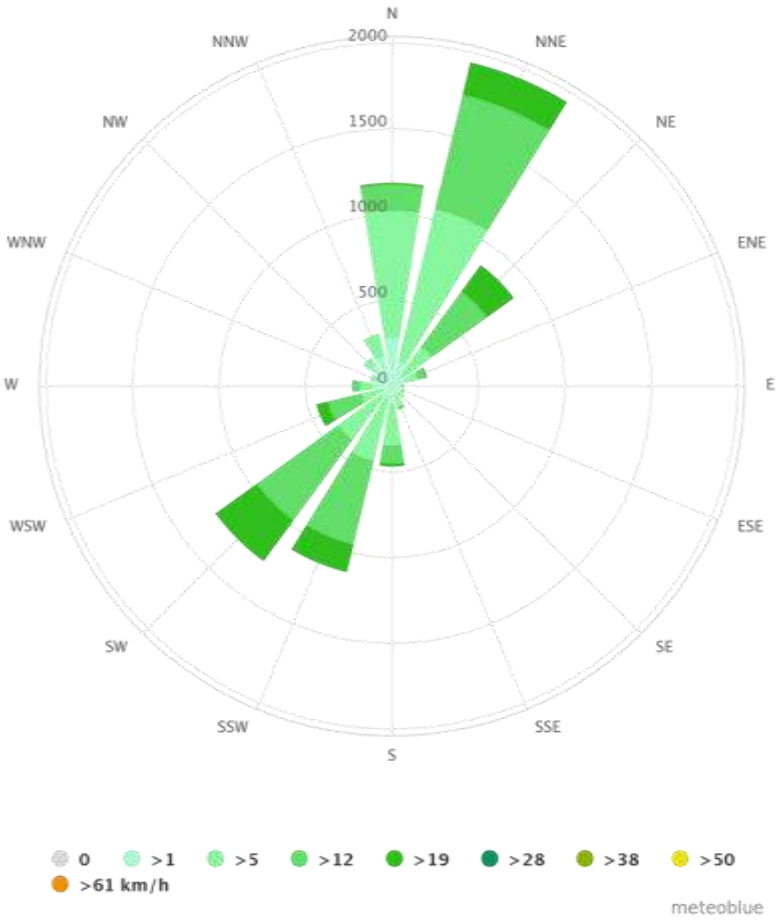

Figure 4.8: Wind direction chart for Borno State
Source: meteoblue.com, 2019

4.3.2 Geology and Hydrogeology

4.3.2.1 Geology

Generally the geology of north eastern Nigeria consists of ancient (Precambrian) crystalline Basement Complex rocks represented mainly by granitic and migmatitic rocks, on which rest nonconformably the sedimentary and volcanic rocks ranging in age from Cretaceous to Quaternary (Carter *et al.,* 1963).

Borno State is underlain by sediments of the Chad Formation (Figure 4.9). The Chad Formation overlies the Kerri Kerri Formation of Tertiary period and it is overlain by recent alluvial deposits (Barber, 1965). These sediments were deposited during the end of the Cretaceous period and the beginning of the Tertiary period. The formation covers an area of about 23,000 km^2 in parts of Bauchi, Borno, Jigawa, Kano, and Yobe States in Nigeria.

The sediments which were deposited by turbulent current are poorly sorted. They vary in grain size and colour; finer grains exhibiting fluviatile depositional patterns were deposited at low velocity.

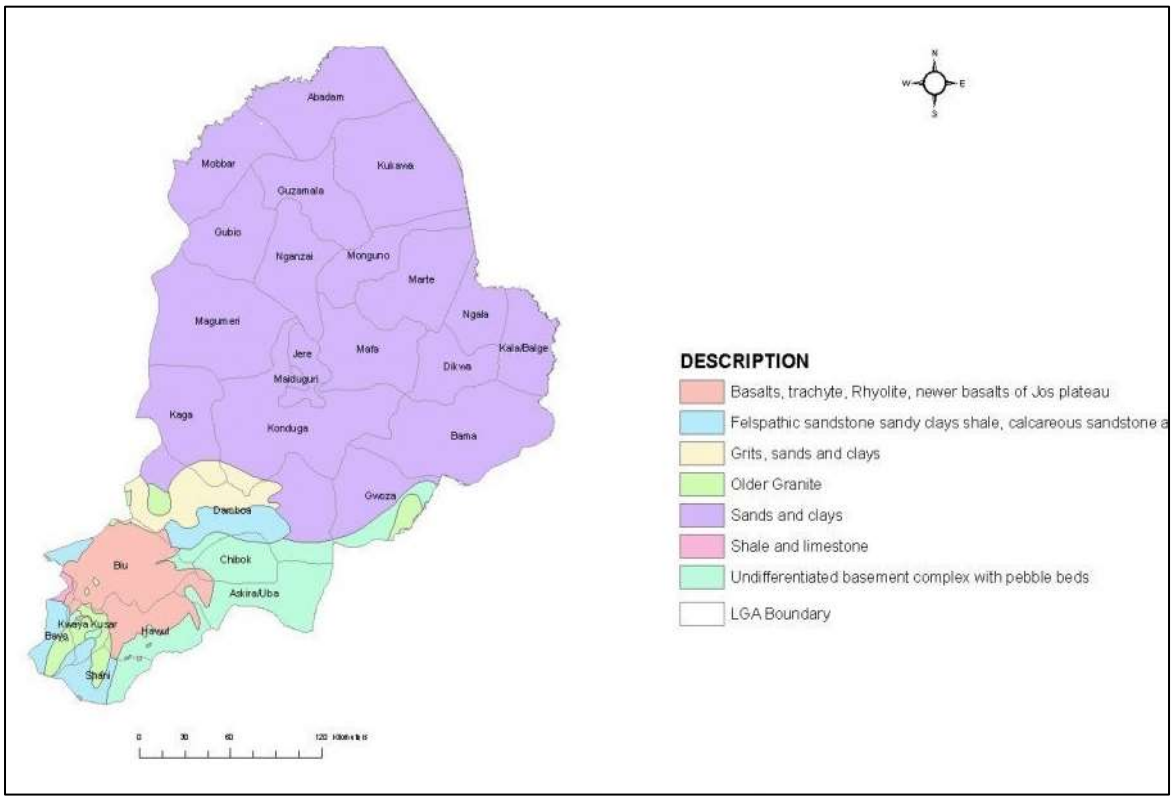

Figure 4.9: Geology map of Borno State
Source: Alkali and Uba, 2014

4.3.2.2 Hydrogeology

Maiduguri lies on the Chad formation. In the Plio-Pleistocene Chad Formation, groundwater occurs under water table condition, in perched condition, in semi-confined and confined conditions. Three well-defined arenaceous horizons within the argillaceous Chad Formation constitute the aquifers, and were named by Barber & Jones (1960) as the Upper, Middle and Lower Aquifers. The Upper Aquifer in most of the Maiduguri is within the superficial deposits, and extends across the entire outcrop of the Chad Formation. It is composed of alluvium and Aeolian sands and gravel deposited during recent times (Adelana *et al.*, 2008).

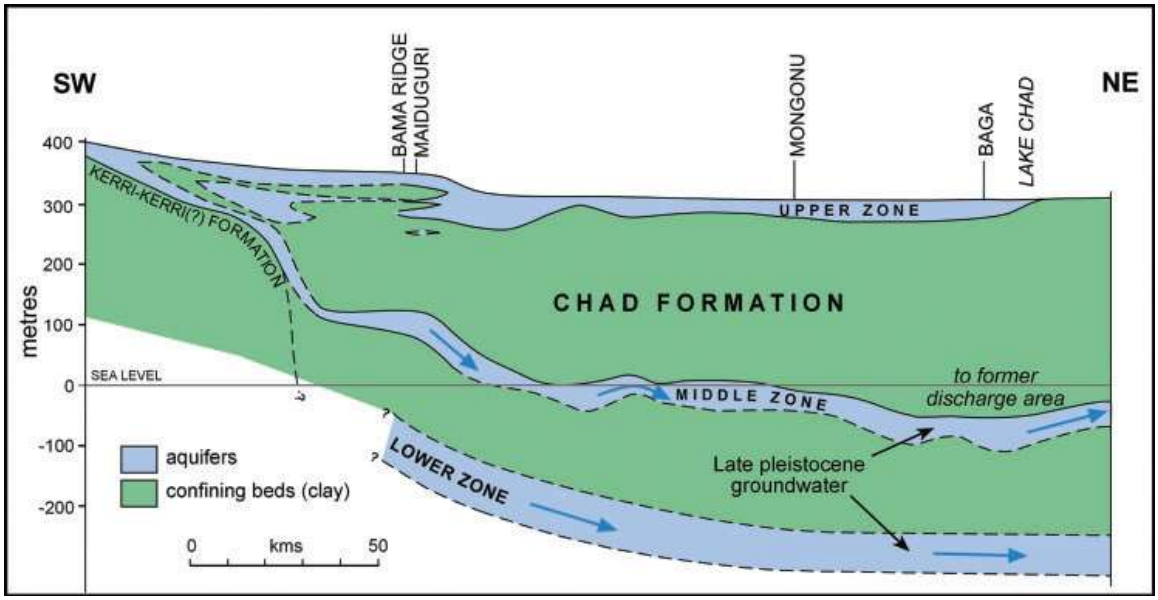

Figure 4.10: Geological cross section showing the aquifers of the Chad Formation

Source: Adelana *et al.*, 2008

Deposition of the Chad Formation occurred after the regression of the sea southwards at the end of Cretaceous time (Barber and Jones, 1960). Wells and boreholes in Maiduguri revealed three distinct zones of sandy sediments separated by clay deposits. Logs from boreholes' sediments vary both laterally and vertically. The sandy sediments were laid as Lake Margin deposits or as alluvial fans and deltas (Alkali and Uba, 2014).

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 number of twelve (12) sampling locations were established for ambient air quality and noise study. The air quality and noise sampling locations map is presented in Figure 4.10.

4.3.3.1 Air Quality Standards

The concentrations of air quality parameters recorded at the study 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 are provided in Tables 4.3 to 4.5.

Table 4.3: Ambient Air Quality Standards

Parameter	Averaging Time	Nigeria Standards FMEnv Limit ($\mu g/m^3$)	WHO Ambient Air Quality Guidelines ($\mu g/m^3$)
CO	1-hour	11, 400	-
NO_2	1-hour	75-113	200
SO_2	1-hour	26	20 (24hr)
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 points studied are presented in Table 4.6 while Figure 4.11 shows the air quality and noise sampling locations map.

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

Sampling Location	Coordinates	
	Latitude (N)	Longitude (E)
Within the Project site		
AQ1	11.79377	13.20211
AQ2	11.79325	13.20302
AQ3	11.79454	13.20419
AQ4	11.79618	13.20464
Within 1km AoI (area of influence) radius		
AQ5	11.79058	13.20464
AQ6	11.79697	13.20106
Along The Transmission Route		
AQ7	11.79826	13.19495
AQ8	11.81499	13.18124

Sampling Location	Coordinates	
	Latitude (N)	Longitude (E)
AQ9	11.82196	13.17961
AQ10	11.82444	13.18496
Control/buffer points		
AQ11	11.80945	13.18392
AQ12	11.73278	13.21914

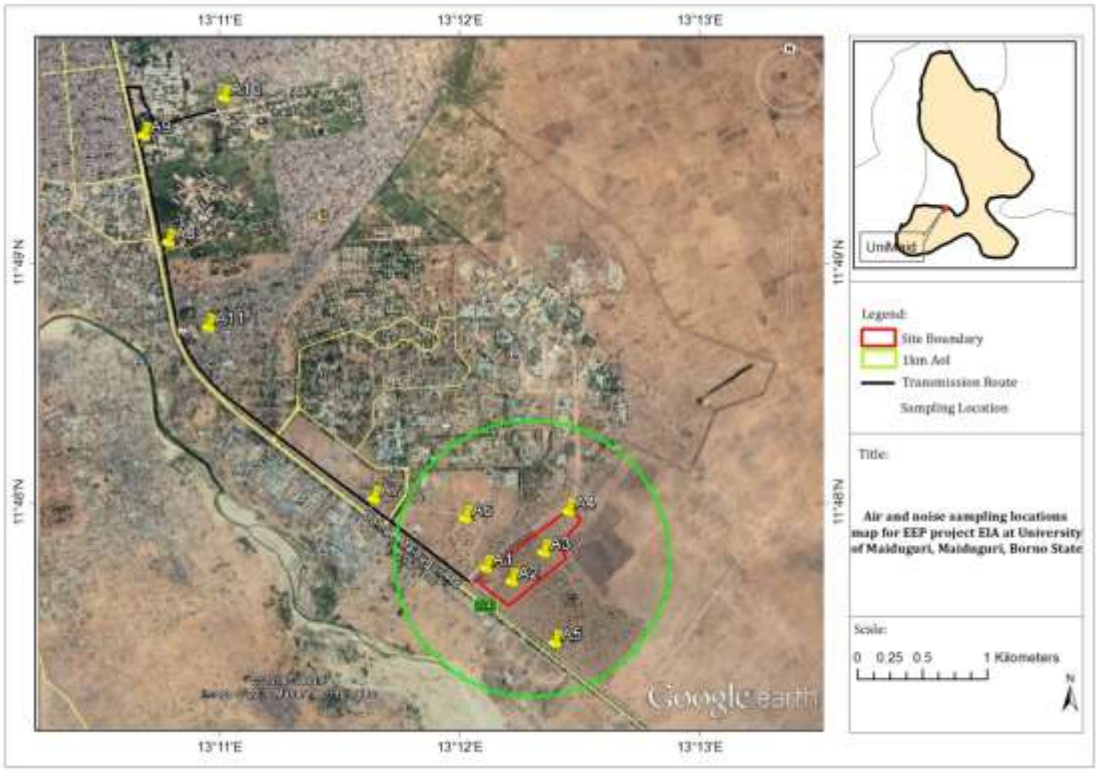

Figure 4.11: Air quality /noise sampling locations map
Source: Google Earth 2019 and EnvAccord Field Survey, 2019

The results of air quality study are presented below in Table 4.7.

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

Sampling Code	TSP	NO_2	SO_2	VOC	CO_2	CO	CH_4	H_2S	Noise (dBA)
	(mg/m³)								
	Within the Project site								
AQ1	0.142	BDL	0.001	0.1	964	0.21	BDL	BDL	52.9
AQ2	0.151	BDL	0.002	0.1	961	0.47	BDL	BDL	50.4
AQ3	0.166	BDL	0.004	0.2	901	0.58	BDL	BDL	51.7
AQ4	0.149	BDL	0.001	0.1	929	0.15	BDL	BDL	50.6
Within 1km AoI (area of influence) radius									
AQ5	0.195	BDL	0.011	2.4	912	0.93	BDL	BDL	67.1
AQ6	0.138	BDL	0.005	0.1	925	0.15	BDL	BDL	55.8
Along the Transmission Route									
AQ7	0.203	BDL	0.012	1.6	903	0.58	BDL	BDL	65.9
AQ8	0.248	BDL	0.014	0.8	961	0.89	BDL	BDL	68.2
AQ9	0.221	BDL	0.016	1.5	927	0.84	BDL	BDL	73.2

Sampling Code	TSP	NO_2	SO_2	VOC	CO_2	CO	CH_4	H_2S	Noise (dBA)
	(mg/m³)								
	Within the Project site								
AQ10	0.174	BDL	0.008	0.2	901	0.24	BDL	BDL	61.5
Control/Buffer Points									
AQ11	0.164	BDL	0.002	0.5	901	0.15	BDL	BDL	61.9
AQ12	0.157	BDL	0.001	0.1	921	0.28	BDL	BDL	51.6

Source: EnvAccord Field Survey, 2019 * BDL= Below Detection Limit (Equipment Detection Limit for the parameters are: NO_2, 0.001; SO_2, 0.01; CH_4, 0.01; H_2S, 0.01; VOC, 0.01; CO, 0.01)

Sulphur dioxide (SO_2): The concentrations of SO_2 ranged from 0.001-0.004 mg/m³ within the Project site; 0.005–0.011 mg/m³ within 1km AoI radius; 0.008-0.016 mg/m³ along the transmission route; and 0.001-0.002 mg/m³ at the control/buffer areas. The values recorded were below the FMEnv ambient air quality standards of 0.026 mg/m³ for 1-hour averaging time as well as the WHO guideline value of 0.5 mg/m³ for 10-minute averaging time.

Nitrogen dioxide (NO_2): The results of air quality measurement conducted in the study area show that the NO_2 values were below detection limit of 0.001 mg/m³. All the values recorded were below the FMEnv threshold limit of 0.113 mg/m³ and WHO guideline value of 0.2 mg/m³ respectively for 1hr averaging time.

Total Suspended Particulate (TSP): The concentrations of TSP recorded in the study area ranged from 0.142- 0.166 mg/m³ within the Project site; 0.138–0.195 mg/m³ within 1km AoI radius; 0.203-0.248 mg/m³ along the transmission route; and 0.157-0.164 mg/m³ at the control/buffer areas. The TSP values recorded in all the sampling locations were below the FMEnv 1hr averaging time limit for TSP concentration (0.25 mg/m³). This implies that the ambient air of the study area in terms of TSP could be considered to be unpolluted. The highest concentrations of TSP were obtained at sampling points that were close to the main road (Bama road), this was as a result of ongoing traffic.

Noise: The measured noise level values ranged from 50.4 to 52.9 dB(A) within the Project site; 55.8 to 67.1dB(A) within 1km AoI radius; 61.5 to 73.2dB(A) along the transmission route; and 51.6 to 61.9 dB(A) at the control/buffer areas. The noise level values were below the FMEnv permissible Noise Exposure Limit of 90 dB(A).

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

Soil samples were collected from twelve (12) different sampling stations (4 within the Project site, 2 within 1km radius, 4 along the transmission route, and 2 at control points). 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 locations map is shown in Figure 4.12.

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

Sampling Location	Coordinates	
	Latitude (N)	Longitude (E)
Project Site		
S01	11.79377	13.20211
S02	11.79325	13.20302
S03	11.79454	13.20419
S04	11.79618	13.20464
AoI		
S05	11.79058	13.20464
S06	11.79697	13.20106
Along The Transmission Route		
S07	11.79826	13.19495
S08	11.81499	13.18124
S09	11.82196	13.17961
S10	11.82444	13.18496
Buffer area/Control Points		
S11	11.80945	13.18392
S12	11.73278	13.21914

Source: EnvAccord Field Survey, 2019

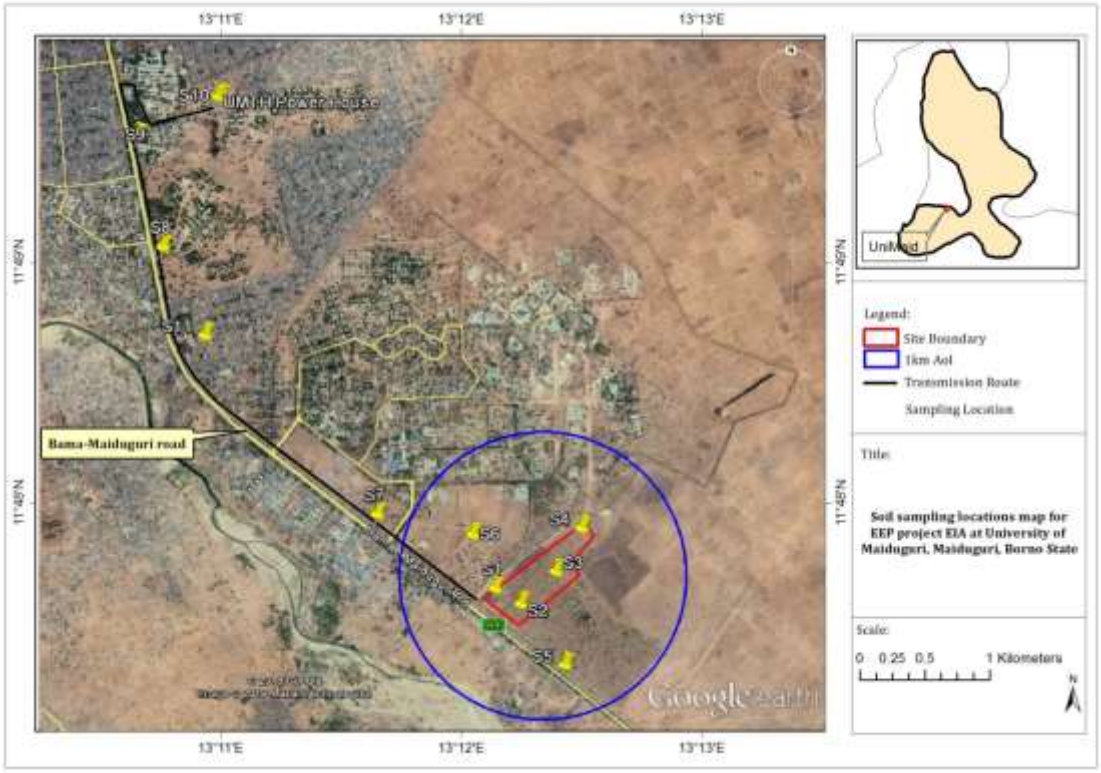

Figure 4.12: Soil Sampling Locations Map
Source: EnvAccord Field Survey, 2019

Table 4.9 below presents the descriptive summary of the results of physicochemical and microbial parameters analysed in soil samples collected from the project site as well as the project Aol. The full results are provided in Appendix 4.1,

Table 4.9: Physico-chemical and microbial properties of soil samples from the Project area

Parameters	Within the Project Site and Transmission cable Route						Within the Project Aol and Buffer						Limits Alloway (1991): Allen *et al* (1974)
	0-15			15-30			0-15			15-30			
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	
pH	7.09	6.68	7.88	6.99	6.33	7.41	6.74	6.39	7.46	6.64	6.02	7.53	-
Conductivity µS/cm	261.25	201	374	256.75	185	392	221.75	168	278	206.00	184	232	-
Moisture Content %	0.90	0.19	1.45	0.98	0.23	1.83	1.11	0.83	1.22	1.13	1.08	1.22	-
TOC %	0.83	0.08	1.35	0.71125	0.06	1.22	1.04	0.86	1.17	0.92	0.71	1.03	-
Carbonate mg/Kg	4.31	3.45	5.4	4.5025	3.48	5.5	4.29	3.5	5.22	4.54	4.06	5.3	-
Chloride mg/Kg	15.21	11.994	17.991	16.6795	14.493	18.491	13.24	11.244	17.741	15.16	12.494	18.991	-
Nitrate mg/Kg	0.25	0.056	1.152	0.1265	0.075	0.179	0.14	0.082	0.211	0.12	0.073	0.182	-
Sulphate mg/Kg	19.16	7.229	33.001	17.04638	5.056	43.601	15.02	10.806	24.082	15.67	12.118	22.521	-
Phosphate mg/Kg	0.53	0.31	0.91	0.4825	0.29	0.86	0.65	0.44	0.95	0.66	0.57	0.73	-
Cu mg/Kg	0.07	0.012	0.211	0.080875	0.018	0.219	0.06	0.004	0.193	0.04	0.027	0.048	5-500
Pb mg/Kg	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2-20
Fe mg/Kg	53.24	22.23	74.59	52.76	29.54	73.16	53.70	21.73	68.92	61.89	57.48	68.31	NS
Zn mg/Kg	0.07	0.03	0.19	0.05875	0.03	0.16	0.05	0.02	0.1	0.06	0.03	0.1	10-50
Ni mg/Kg	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5-500
Cd mg/Kg	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.03-0.30
Cr mg/Kg	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-
Na mg/Kg	65.54	47.64	94.48	60.22375	43.66	80	48.44	30.73	65.63	41.80	34.18	51.58	-
K mg/Kg	6.33	1.04	14.05	5.7425	1.12	12.06	2.97	1.57	5.14	4.10	2.25	5.83	-
Ca mg/Kg	25.42	5.02	40.67	28.60625	5.2	41.92	30.19	21.05	38.13	29.98	19.53	35.85	-
Mg mg/Kg	3.23	1.66	4.34	3.03125	1.73	4.74	2.88	1.75	4.15	3.45	1.64	5.11	-
Hg mg/kg	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
Sand %	16.66	14.01	19.62	16.91	14.11	18.97	16.00	14.85	16.83	17.93	15.27	22.61	-
Silt %	3.67	0.89	8.32	4.58875	0.92	9.75	4.08	1.58	7.18	2.16	1.45	3.27	-
Clay %	79.68	75.27	82.49	78.5	72.36	82.87	79.93	77.03	83.57	79.91	75.62	82.65	-
Oil and Grease	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-
Total Heterotrophic Bacteria cfu/g	-	$1.6x10^7$	$4.6x10^7$	-	$1.1x10^7$	$3.7x10^7$	-	$2.0x10^7$	$4.0x10^7$	-	$1.7x10^7$	$3.1x10^7$	-
Total Heterotrophic Fungi cfu/g	-	$3.7x104^5$	$30.1x10^5$	-	$4.8x104^5$	$28.0x10^5$	-	$8.7x10^5$	$20.1x10^5$	-	$9.9x10^5$	$18.5x10^5$	-
Total Coliform cfu/g	-	0	0	-	0	0	-	0	0	-	0	0	
Hydrocarbon Utilizing Bacteria cfu/g	-	$1.0x10^3$	$3.6x10^3$	-	$0.9x10^3$	$3.2x10^3$	-	$1.1x10^3$	$1.9x10^3$	-	$1.0x10^3$	$1.7x10^3$	-
Hydrocarbon Utilizing	-	$1.5 x10^2$	$7.2 x10^2$	-	$1.0 x10^2$	$6.9 x10^2$	-	2.8	8,8 $x10^2$	-	$2.1x10^2$	$3.9 x10^2$	-

Parameters	Within the Project Site and Transmission cable Route						Within the Project Aol and Buffer						Limits Alloway (1991): Allen *et al* (1974)
	0-15			15-30			0-15			15-30			
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	
Fungi cfu/ml								$x10^2$					
% HUB	0.01	0.0022	0.0163	0.0103	0.0024	0.0192	0.01	0.0039	0.0065	0.01	0.0042	0.0065	

Source: EnvAccord Field Survey, 2019

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

- **Soil Physical Properties (Sand, Clay Silt)**

In general, the soils were mainly clay in both topsoil and subsoil. At the project site and along the transmission cable route, the clay fraction ranged from 75.27 % - 82.49 % within the project area of influence it ranged from 72.36% – 82.87%. The proportions of other soil fractions at the Project site were as follows sand (14.01 – 19.62 %) and silt (0.89 – 8.32 %). The subsoil (15-30cm) profile had a clay fraction varying from (72.36 – 82.87 %) while the proportions of other soil fractions were as follows sand (14.11 – 18.97 %) and silt (0.92 – 9.75 %), as indicated in Tables 4.9 above.

- **Soil pH (soil reaction)**

The pH of top soil samples from the Project site and along the transmission cable route ranged from 6.68 to 7.88 while the pH of subsoil samples ranged from 6.33 to 7.41 which imply that the soils in the study area can be classified as slightly acidic to slightly alkaline.

- **Moisture Content**

The amount of moisture in soil depends on many factors which include soil type, pH, soil organisms, soil organic matter, climatic conditions etc. At the Project site and along the transmission cable route, the moisture contents of top soil samples in the study area ranged from 0.19% to 1.45% while the subsoils ranged from 0.23% to 1.83%.

- **Nutrients (Nitrate, Sulphate and Phosphate)**

At the Project site and along the transmission cable route, Sulphate had the highest concentrations and ranged from 7.229 mg/kg to 33.001 mg/kg in topsoil samples, and 5.056 mg/kg to 43.601 mg/kg in subsoil samples. Nitrate concentrations ranged from 0.056 mg/kg to 1.152 mg/kg for topsoil, and 0.075 mg/kg to 0.179 mg/kg for subsoil. Phosphate concentrations were also low, ranging from 0.310 mg/kg to 0.91 mg/kg in topsoil and 0.290 mg/kg to 0.860 mg/kg in subsoil.

- **Heavy Metals**

Copper (Cu): The concentrations of analyzed copper in the topsoil at the Project site and along the transmission cable route ranged from 0.012 mg/kg to 0.211 mg/kg and subsoil samples from the study area ranged from 0.018 mg/kg to 0.219 mg/kg which fall below the recommended limit (50-100 mg/kg) for tropical arable soils as prescribed by Alloway (1990).

Lead (Pb): Pb concentrations in both topsoil and subsoil samples from at the Project site and along the transmission cable route were below detection limits (<0.04 mg/kg) which was below the limit (2-20 mg/kg) prescribed for unpolluted soils (Alloway, 1990).

Iron (Fe): Iron (Fe) recorded the highest concentration among the heavy metals analyzed in soil samples from the Project site and along the transmission cable route. Its concentrations ranged between 22.23 mg/kg to 74.59 mg/kg in the topsoil and 29.54 mg/kg to 73.16 mg/kg in subsoil.

Zinc (Zn): The concentrations of Zinc obtained in the soil samples from the Project site and along the transmission cable route ranged from 0.03mg/kg to 0.190 mg/kg in topsoil and 0.03 mg/kg to 0.16 mg/kg in subsoil. The values of Zn recorded at the study area were below the limit prescribed for unpolluted soil (10-50 mg/kg) (Alloway, 1990).

Cadmium (Cd), Chromium (Cr), and Nickel (Ni) were below the detection limits of <0.01 mg/kg, <0.04 mg/kg and <0.05 mg/kg respectively in all soil samples.

- **Microbiology**

The population counts of Total Heterotrophic Bacteria (THB) and Total Heterotrophic Fungi (THF) in topsoil samples within the Project site and along the transmission cable route ranged from 1.6 x 10^7 to 4.6 x 10^7cfu/ml and 3.7 x 10^5 to 30.1 x 10^5cfu/gm respectively While in thesubsoil samples, theyranged from 1.11 x 10^7 to 3.7 x 10^7cfu/ml and 4.8 x 10^5 to 28.0 x 10^5cfu/gm respectively. The percentage of hydrocarbon utilizing bacteria (HUB) recorded is less than 1 % of the total heterotrophic bacteria in all samples from the study area indicating that the soil environment is not polluted with hydrocarbon compounds that could serve as substrates for the HUB to thrive well. Furthermore, coliform was undetected in all the soil samples from the study area.

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 ground water in the study area, groundwater samples were collected from existing wells/boreholes in the study area and analyzed. The results of the physico-chemical and microbial characteristics of the analyzed groundwater samples were compared with the World Health Organization (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 three (3) different existing wells/boreholes in close proximity to the Project site and its surrounding environment, inclusive of control point. 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 50ml 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 4.11 shows the geographical coordinates of the groundwater sampling points while Figure 4.13 shows the sampling locations map.

Table 4.11: Geographical coordinates of Groundwater sampling locations in the Project Area

Sampling Code	Latitude (N)	Longitude (E)
Within the Project site		
UNIMAID GW 01	7.23599	3.44022
Within 2km radius of the Project site		
UNIMAID GW 02	7.22825	3.43102
UNIMAID GW 03	7.21875	3.44643

Source: EnvAccord Field Survey, 2019

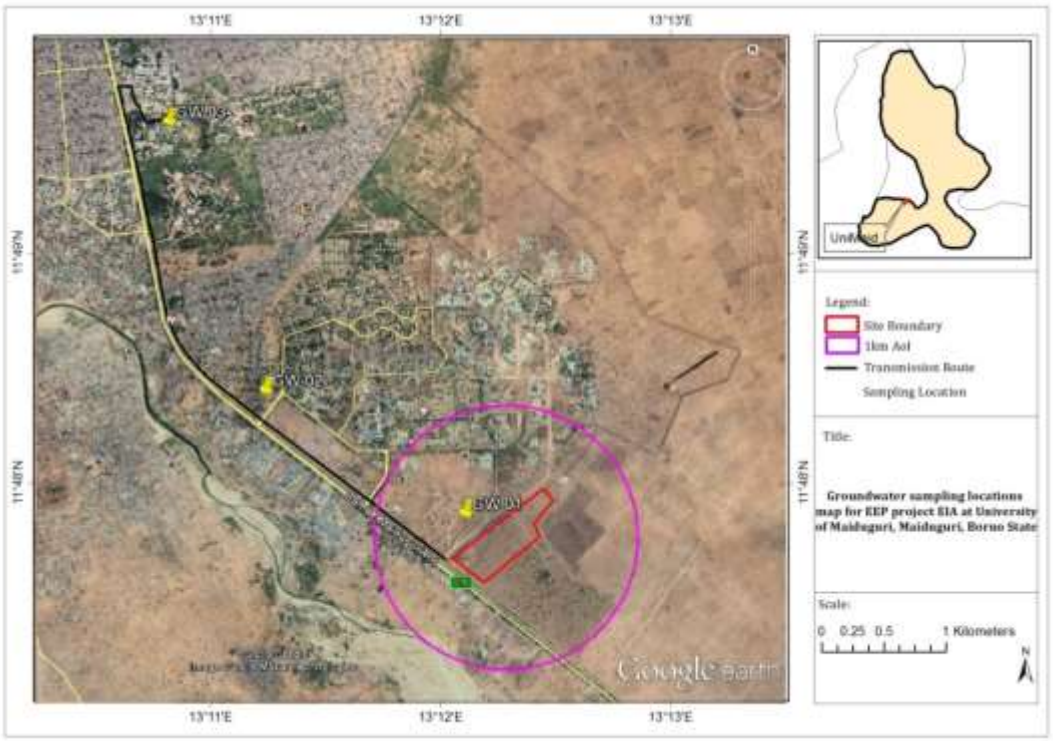

Figure 4.13: Map of Groundwater Sampling Locations at the Project area

Source: EnvAccord Field Survey, 2019

4.3.5.2 Physico-chemical Characteristics of Groundwater Samples

The results of physico-chemical and microbial analyses conducted on groundwater samples collected from the study area are presented in Tables 4.12.

Table 4.12: Results of physico-chemical and microbial parameters analysed in groundwater samples collected from the study area

Parameters	GW 01	GW 02	GW 03	WHO Limits		FMEnv. Limits
				Highest Desirable Level	Max. Permissible Level	
pH	7.44	7.04	7.53	**7.0-8.5**	**6.5-9.2**	**6.5-8.5**
Temperature °C	29.5	28.6	30.3	**NS**	**NS**	**<40**
Conductivity µS/cm	158.00	614.00	210.00	**NS**	**1000**	**NS**
TDS mg/L	79.00	302.00	105.00	**200**	**500**	**500**
Appearance	Clear	Clear	Clear	**NS**	**NS**	**NS**
Total Hardness mg/L	65.20	92.00	84.00	**100**	**500**	**200**
Colour PtCo	2.00	2.00	2.00	**NS**	**NS**	**NS**
Salinity	0.11	0.13	0.11	**NS**	**NS**	**NS**
TSS mg/L	0.00	0.00	0.00	**NS**	**NS**	**NS**
Turbidity NTU	0.29	0.32	0.00	**NS**	**NS**	**1.0**
Dissolved Oxygen mg/L	3.40	3.10	4.00	**NS**	**NS**	**7.5**
BOD mg/L	0.40	1.50	0.90	**NS**	**NS**	**0**
COD mg/L	38.79	40.43	36.83	**NS**	**NS**	**NS**
Chloride mg/L	18.990	28.59	17.99	**NS**	**NS**	**NS**
Nitrate mg/L	0.00	0.00	0.00	**NS**	**NS**	**10.0**
Sulphate mg/L	29.725	6.593	0.00	**200**	**400**	**500**
Phosphate mg/L	0.100	0.00	0.00	**NS**	**NS**	**5.0**
Hg mg/L	BDL	BDL	BDL	**NS**	**NS**	**NS**
Copper mg/L	0.05	0.03	0.02	**0.05**	**1.5**	**1.0**
Lead mg/L	<0.04	<0.04	<0.04	**NS**	**NS**	**0.05**
Iron mg/L	0.04	0.22	1.05	**0.1**	**1.0**	**1.0**
Zinc mg/L	0.11	0.08	0.04	**NS**	**NS**	**NS**
Nickel mg/L	<0.05	<0.05	<0.05	**NS**	**NS**	**NS**
Cd mg/L	<0.01	<0.01	<0.01	**NS**	**NS**	**NS**
Cr mg/L	<0.04	<0.04	<0.04	**NS**	**NS**	**NS**
Na mg/L	21.09	32.08	42.47	**NS**	**NS**	**NS**
K mg/L	1.27	1.06	0.86	**NS**	**NS**	**NS**
Ca mg/L	2.15	1.99	2.41	**NS**	**NS**	**NS**
Mg mg/L	3.78	2.81	4.84	**NS**	**NS**	**NS**
Oil/Grease mg/L	ND	ND	ND	**NS**	**NS**	**0.05**
THB(cfu/ml)	3.6×10^3	4.3×10^3	2.8×10^3			
THF(cfu/ml)	5.7×10^1	4.6×10^1	6.6×10^1			
Total Coliform cfu/ml	0.00	0.00	0.00	**NS**	**NS**	**0**

Source: EnvAccord Field Survey, 2019

The pH of the groundwater samples ranged from 7.04 to 7.53 while the in-situ water temperature ranged between 28.6 ^{0}C and 30.3 ^{0}C. The temperature values fall within the FMEnv recommended limit of <40 ^{0}C for potable water.

Electrical conductivity which is a measure of the ability of the water to pass an electrical current, ranged from 158.00µS/cm to 614.00µS/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 79.00mg/l to 302.00mg/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 (0.11 to 0.13 ppm) indicating a fresh water environment.

Heavy metals in the groundwater samples were analysed using Atomic Absorption Spectrophotometer (AAS). Nickel, Lead, Mercury (Hg), Cadmium and Chromium were not detected in the samples. Zinc ranged from 0.04 mg/l to 0.11 mg/l, Iron ranged from 0.04 mg/l to 0.22 mg/l, while Nickel was below the detection limit of <0.005 mg/l in all the groundwater samples analysed.

The concentrations of Oil & Grease in the groundwater samples were below the detection limit of the analytical instrument. Coliform was also undetected in the groundwater samples.

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 a rapid field biodiversity survey (RFS). The identification of flora specimen was done both in situ (field) and ex situ using appropriate manuals and monographs, photographswere 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 assessment

❖ *Habitat characterization*

The vegetation in Borno State is mainly of the Sudan savanna type, which includes the acacia (a source of gum arabic), baobab, locust bean, shea butter, dum palm, and kapok trees; however, there is a region of Sahel savanna, mostly thorn scrub and with sandy soils, in the north. The natural vegetation within the Project area was

observed to have been modified habitat as a result of human interference; mainly farmlands as shown in Plate 4.2 below and development activities within the University. The dominant vegetation observed on the site can be described as secondary vegetation dominated by grasses, shrubs, and few trees.

Plate 4.2: Some farmlands observed within the proposed Project site
Source: EnvAccord Field Survey, 2019

- *Physiognomy, Floristic composition, and Biodiversity assessment*

Species composition, distribution and structure of the vegetation of Project as well as the physiognomic view show 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).

The plant species encountered in the study area fall under Not Evaluated. None of the recorded plant species in the study area is critically endangered or endangered. 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 study

area is highlighted in Table 4.13 below while Plate 4.3 show some of the common flora species observed in the study area.

Table 4.13: Plant Species observed around proposed site

Dominant Species Encountered	Family Name	Common Name (Local name)	Plant Forms	IUCN Status
Azadirachta indica	Meliaceae	Neem tree	Tree	NA
Panicum maximum	Poaceae	Guinea Grass	Grass	NA
Telfaria occidentalis	Cucurbitaceae	Fluted pumpkin	Herb	NA
Parkia spp	Fabaceae	African locust bean	Tree	NA
Pennisetum spp.	Poaceae	Elephant grass	Grass	NA
Paspalum spp	Poaceae	Crown grass	Grass	NA
Ipomoea involucrata	Convolvulaceae	Morning glory	Vine	NA
Synedrella nodiflora	Asteraceae	Node weed	Shrub	NA
Sorghum bicolor	Poaceae	Sorghum	Vine	NA
Dactyloctenium aegyptium	Poaceae	Cow foot grass	Grass	NA
Arachis hypogaea	Fabaceae	Groundnut	shrub	NA
Adansonia Digitata	Malvaceae	Baobab	Tree	NA
Acacia seyel	Fabaceae	Red acacia	Tree	NE
Balanite aegyptiaca	Zygophyllaceae	Desert date	Tree	NE
Faidherbia albida	Fabaceae	White acacia	Tree	NE

IUCN – International Union for Conservation of Nature; NA – Not Assessed
Source: EnvAccord Field Survey, 2019

Plate 4.3: Some of the flora species observed in the Project area
Source: EnvAccord Field Survey, 2019

4.3.6.2 Fauna Species

The methodology used in identifying the terrestrial fauna species in the study area includes direct sighting, sound, nest type, and foot prints. The fauna characteristics of the Project site and the Project area of influence are discussed in the section below.

The fauna species observed at the site were generally few and mostly small invertebrates such as earthworms, insects, Grasshoppers, Butterflies, spiders. Also, vertebrates such as Lizards, birds and rodents were sighted within the Project site and AoI (Table 4.14 and Plate 4.4). 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. Interviews with a representative of the Department of Works and Physical Planning revealed that livestock grazing noted during the field data gathering was free ranging and not exclusive to the Project site.

Table 4.14: List of Fauna Species Encountered in the Project Site and AoI

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

Common (Local) Names	Species	Family	Group	IUCN status
Black ant	*Lasius niger*	Formicidae	Insecta	NE
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	Least concern

IUCN – International Union for Conservation of Nature;
EnvAccord Field Survey, 2019

Plate 4.4: Some of the animals sighted within the study area
Source: EnvAccord Field Survey, 2019

4.3.7 Land Use/Land Cover

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

The land use composition of the Project site was observed to be plots of bare land with some scattered vegetation and small farms while the wider study area was observed to be categorized in three major classes. The classes are Built-up area, bare land and Scattered trees (Figure 4.14 to 4.15). The estimated area covered by each of the land use types is presented in Table 4.15 below.

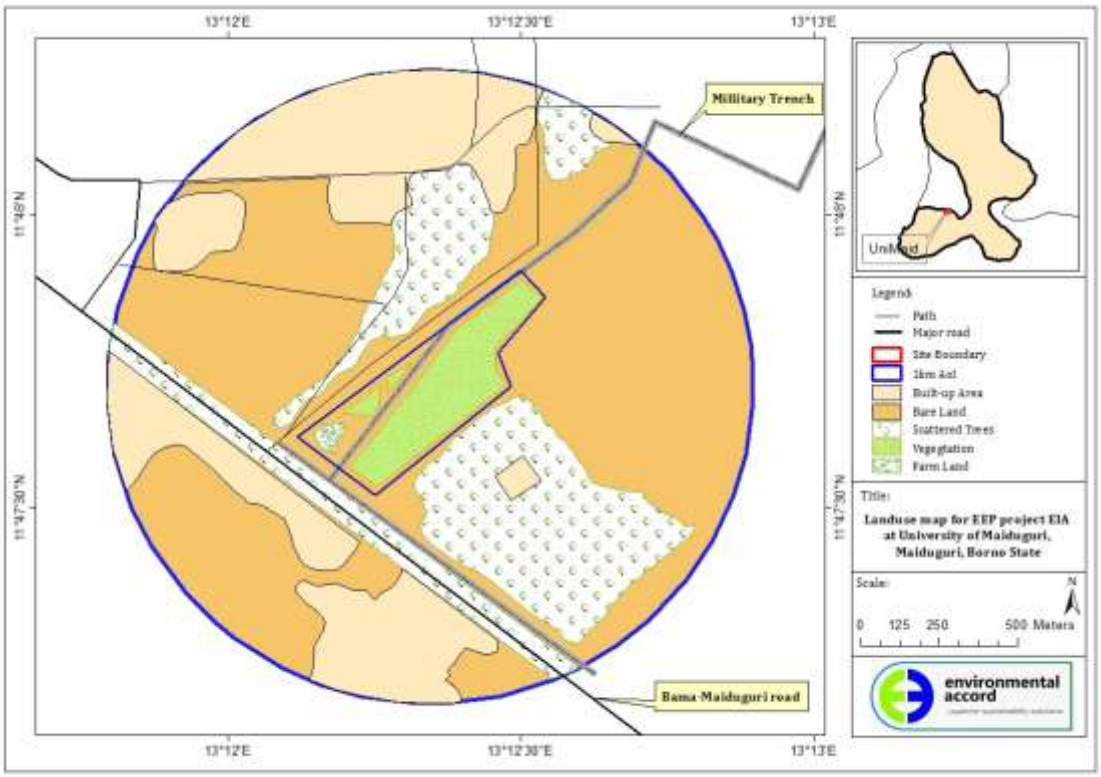

Figure 4.14: Land use map of the study area

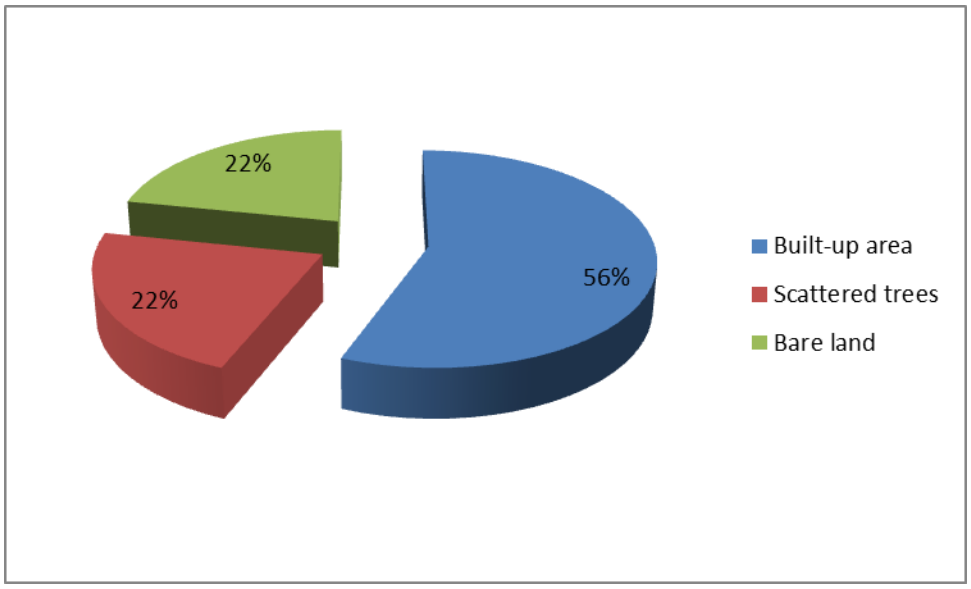

Figure 4.15: Land use composition within the Project site

Table 4.15: Existing Land Use within the wider study area

S/N	Land use/ Land cover	Area (ha)	Percentage (%)
1	Built-up area	176.61	56.05
2	Scattered trees	69.83	22.16
3	Bare land (with scattered vegetation and farms)	68.67	21.79
	Total	**315.11**	**100**

EnvAccord Field Survey (2019)

- **Built-up Area**

The major constituent of this class is part of the UNIMAID structures. The covers over 56 % of the entire wider study area. No residential structures were observed within the Project site and the 1 km wider study area. However, there are a few dilapidated structures within the Project site which according to the University representatives have been abandoned for almost 15 years (Plate 4.5). Also, a temporary military trench runs diagonally across the Project site.

Plate 4.5: (a) Dilapidated structures within the Project site (b) a section of the temporary military trench on the site

- **Scattered Trees**

This is class categorizes the vegetation available within the wider study area. The observed plant species are Red acacia, Desert date, White acacia, Neem, Baobab, vegetables, groundnut, etc. This accounts for about 22 % of the wider study area.

- **Bare Land**

This class describes the occupied plots of land observed during the data gathering. These areas are characterized by small grasses and shrubs. At present small portions of these areas within the Project have been allocated to some staff for subsistence farming during the wet season. It covers 21.79% of the wider study area.

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 socioeconomic 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 August 2, 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 4.15 below, two (2) screen lines were identified and surveyed which the principal routes to the Project site. The survey covered the peak periods of daily traffic which were determined to be from 7:30 am to 9:00 am and 3:30 pm to 5:00 pm. Figure 4.16 below shows the road networks around the Project site and the selected screen lines.

Figure 4.16: Aerial Imagery of the Project site showing the selected screen lines for traffic survey

Source: EnvAccord Field Survey, 2019

- Screen Line 1 (SL1): to capture the traffic flow along Bama road to UNIMAID third gate. This is the direct road to the Project site.
- Screen Line 2 (SL2): to capture the traffic flow along Bama road from UNIMAID third gate.

The data collected by the traffic survey team were recorded on a traffic survey designed sheets using tally system as shown in Plate 4.5. A stopwatch was used to monitor the count intervals. The vehicle classification schemes used for this survey are presented in Table 4.16.

Table 4.16: Vehicle Classification Scheme used for the traffic survey

S/N	Vehicle Classification	Vehicle Types
1.	Trucks/Lorries,	Tankers
		Trucks
		Pick-ups
		Heavy duty vehicles
		Trailers
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

4.3.8.3 Results and Discussion

Bama road is a busy road that connects the Maiduguri town to other neighbouring towns such as Dalori and Bama including Cameroon. Based on field observation, the prominent means of transportation is tricycles, followed by cars, while buses are also relatively abundant. A significant number of heavy-duty trucks were observed on the screen lines during the study as well. The tricycles are mainly used for commercial purposes to commute locals, traders, students, staff and visitors. Buses are owned by both private drivers for mass transit of passengers and goods.

At both screen lines, the traffic count reaches its peak between 12:00 pm and 2:00 pm when the road experiences heavy traffic flow. This was as a result of the movement of traders, suppliers and travelers. Also, due to the security situation in the state, movement at early mornings and late evening is usually restricted.

Plate 4.6 shows sample photographs of traffic survey activities in the study area and UNIMAID third gate while Figures 4.17 to 4.18 show the result of traffic survey for

all screen lines established in the area. Plate 4.7 shows some of the vehicle types observed during the survey.

Plate 4.6: Traffic survey activities in the study area at UNIMAID third gate
Source: EnvAccord Field Survey, 2019

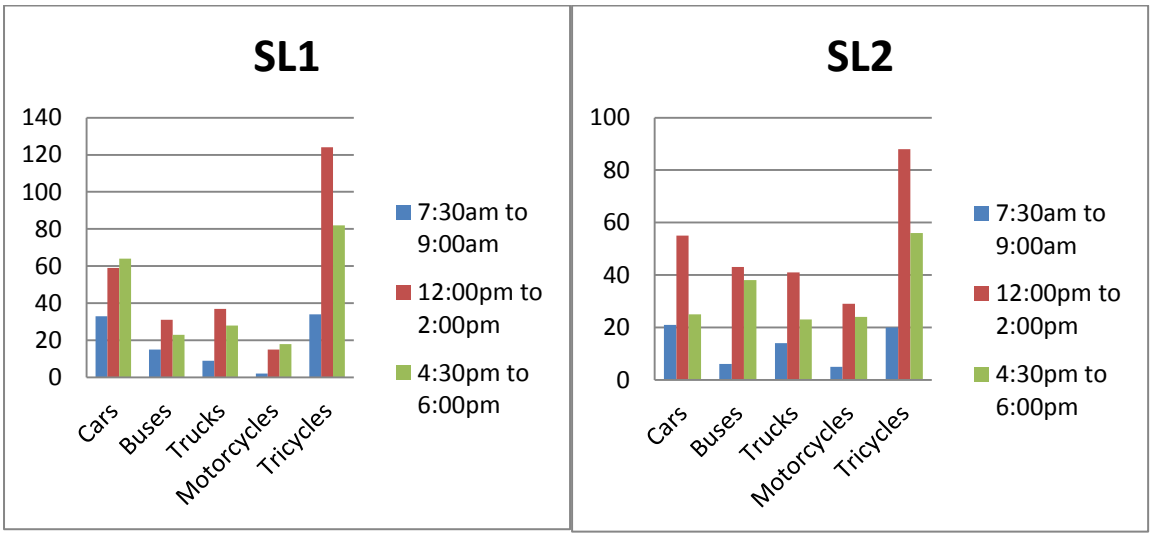

Figure 4.17: Traffic flow result for SL1 and SL2

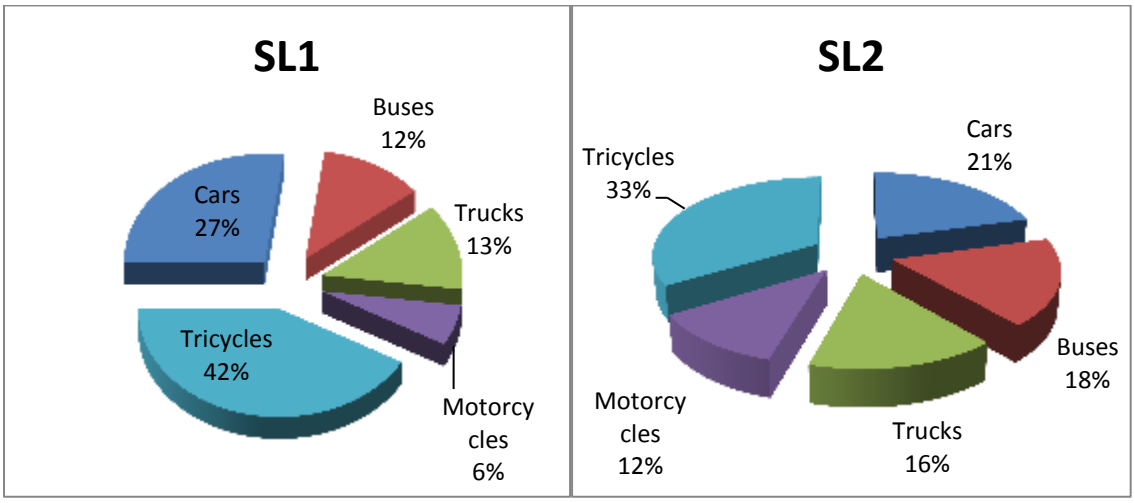

Figure 4.18: Percentage Composition of Vehicles Recorded at SL1 and SL2

Plate 4.7: Sample Pictures of vehicle types observed during the survey

The traffic nature of the studied area is generally high and there were few traffic signs and signals installed along the route to the proposed Project site. The most commonly used transport means are cars and tricycles due to the flexibility of their movement.

4.4 Socio-economic and Health Conditions of the Study Area

4.4.1 Introduction

The proposed project will be sited within UNIMAID campus in Maiduguri, Jere LGA of Borno State. There is no local community presence within the Project site. However, the identified community within the 3km radius of the project site is Mairi community. 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 Mairi community, Jere Local Government area of Borno State. Jere Local Government Area (LGA) is located in the northern part of Borno State with its headquarters in Khaddamari. Jere LGA has an estimated population of 209, 107 (NPC, 2006). Using the national population growth rate of 3.2% (NBS, 2018), the local government has 2019 population projection of 316, 982. Jere LGA shares boundaries with Maiduguri Metropolitan Council (MMC) to the southeast, Magumeri LGA to the west and Mafa LGA to the northeast.

4.4.2.2 Study Population

The study population consists of residents of Mairi village. A sample of the population above 18 years who gave informed consent was studied.

4.4.2.3 Study Design

The study employed sequential mixed methods research design including quantitative and qualitative methods of data gathering, analysis and reporting.

Information obtained during the study was triangulated to separate perception from the reality. The study was carried out in August, 2019. The study made use of questionnaire for quantitative data gathering and Key informant interview, Focus Group Discussions (FGD) and stakeholders' consultation for the qualitative data.

4.4.2.4 Sample Size and Sampling Techniques

The study population is homogeneous with respect to ethnicity and language. However, Mairi community does not have a large population. The sample size would be 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.

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 interviews were held with the local chief i.e. community leaders and in-depth interview was held with healthcare practitioner who has been in the community for more ten (10) years. A gender specialist was consulted to handle women's group discussion and study the gender issues within the community (Plate 4.8).

Plate 4.8: Socioeconomic survey activities in the study area
Source: EnvAccord Field Survey, 2019

4.4.2.5 Data Collection, Analysis and Reporting

During data gathering, this study made use of Computer Assisted Personal Interviewing (CAPI), a Survey CTO 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)
- Waste management
- Health Profile
- Gender Assessment
- Community Concerns and Perceptions

4.4.3.1 Demographic Profile of the Study Area

- *Population Distribution*

The proposed Project is situated within Jere LGA, Maiduguri, Borno State. Borno State has 57,799 km^2 total land surface area and is ranked 2nd among the 36 states in Nigeria by land mass. Using 2006 population census result and annual growth rate of 3.2% (NBS, 2018), Borno State has a 2019 population projection estimate of

approximately 6.3 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 50.8% of the total population and 46.3% of the population are within the age group of 0-14 years and finally 2.9% of the total population are within the age 65 years and above.

The proposed solar power Project will be situated in the University of Maiduguri, Borno state. The University was created by the federal government in 1975, with the intention of its becoming one of the country's principal higher-education institutions.

Jere LGA occupies a land size of 868km^2 and population density of 338.5km^2 (NBS, 2016). Using 3.2% (NBS, 2018) national population growth rate, the LGA has approximately 316, 982 inhabitants; 51.5% of the population being male and 48.5% being female. The survey data revealed that 84% of the sampled respondents during the study are male while 16% are female.

- *Culture, Ethnicity and Religion*

The major religion in Borno State is Islam. However, the state accommodates other religions practices like Christianity as there are few Christians living and worshipping in the state. However, there have been violent attacks on Christians and Muslims in the state due to insurgency. During the survey, all respondents within the community claimed to be practicing Islam as their religion.

The largest ethnic group in Borno State is the Kanuri, followed by Jere, Fulani, Hausa, Chibok, Higi, Banur, Kanakuru while the minority tribes are Jeba, Shuwa Arab, Marghi and Kibaku. The State is culturally heterogeneous as there are several tribes with diverse cultural practices in the state. The lifestyle in forms of dressing, music, dance, arts and crafts, festivals and traditional hospitality manifest the cultural heritage of the state.

Analysis of data obtained from the field survey showed that 55% of the sampled respondents are of the Kanuri tribe, 30% are of the Hausa tribe, 15% are of Fulani tribe.

- *Community Migration Status and Patterns*

There is historical migration into the study area. From the qualitative data gathered, including responses from community leader, it was deduced that different people migrated into Mairi community, especially during the insurgency that plagued the North East of Nigeria, as the community was regarded as safe haven. However, some people also move out of Mairi community to another villages, communities and states.

- *Crime, Security and Safety*

During the KIIs with community leader, it was stated that the community has been peaceful without the fear of insurgency, theft, conflict and youth misbehavior. Military patrol vehicles as well as civilian paramilitary organizations (Plate 4.9) can be found around the community ensuring the safety of the community members. Also, security check points are made available at every junction linking to the core areas of the community.

Plate 4.9: Civilian paramilitary security organization within the study area

- *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 observed within the community include internally displaced people, physically challenged, and elderly women and men. This classification is by virtue of their economic and social vulnerability. 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. However, none of the vulnerable groups identified during study have direct links or derive benefits from the proposed Project site.

❖ *Host Community Profile*

Box 4.1: Overview of the Project AoI – Demographic Profile

- **Mairi community is relatively heterogeneous in terms of ethnicity as there are many tribes in the community with Kanuri, Hausa and Fulani being the major tribes.**
- **Islam is the most prevalent religion in the community**
- **Trading and farming are the common livelihood activities in the community.**

Mairi is a popular community in Jere Local Government Area of Borno State. It is a semi-rural settlement, with a community leader who administers social, cultural and economic activities. The community housing settlement is a nucleated settlement.

During the baseline survey, 79.17% of the respondents were males while 20.83% were females. According to the data collected during the KII with the community leader, the community is majorly composed of Kanuri, Hausa and Fulani ethnic group. The dominant religion in the community is Islam, with 100% of survey respondents identified as Muslims.

The survey results and information obtained during KII put the average household size of the community at approximately 9 persons with more female in the household than male. In terms of age, the community also has a very youthful population; about 50% of household members were within the age group of 18-30 years, 35% were in the age group of 31-45 years; 10% of the survey respondents are in the age group of 46-65 years, and only 5% of the respondents were 66 years old and above.

With regard to education, 15% of the respondents had primary education, 25% had secondary education, and 25% had tertiary education, many of whom come from the University of Maiduguri while 10% had vocational training which supplements their lack of formal education and 25% had no formal education. In summary, the literacy level of the community is slightly above average.

As at the time of the survey (Plate 4.10), about 80% of the respondents were self-employed, 5% of the respondents were employed into public and private service while 15% of the survey respondents were students. About 76% of the respondents had been living in the community for more than fifteen years, 16% had been living in

the community between 6-10 years, and about 4% had been living in the community for 11-15 years while those who had been living in the community for less than one (1) year and between 1-5 years were 2% of the sampled respondents respectively. This suggests that the sampled respondents had a good knowledge of the community and were in the position to provide adequate information relating to the community.

Plate 4.10: Questionnaire administration during the field survey

About 45% of respondents within the community are married; among these married people 90% are in monogamous families while 10% are in polygamous families. The practice of polygamy is supported by their religion and culture. Also, 55% of respondents were single or soon to be married (Figure 4.19).

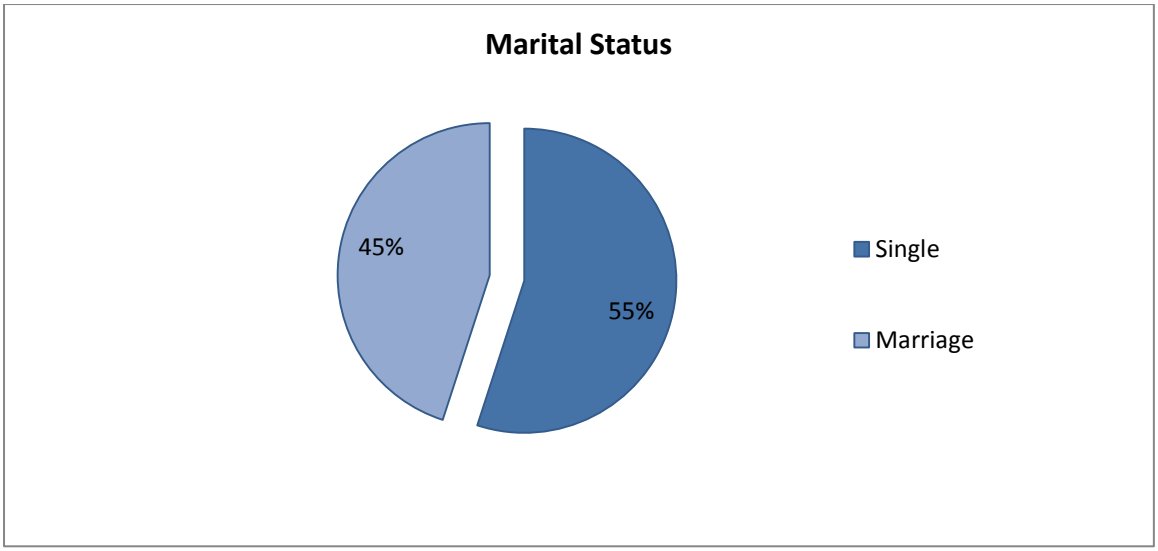

Figure 4.19: Graphical display of marital status among respondents in the community

4.4.3.2 Administrative and Socio-Cultural Institutions

- *Government Institutions*

Borno state, which has its capital in Maiduguri, comprises of 27 LGAs, one of which is in Jere LGA. The relevant government ministries in the State that have been consulted in respect of this Project at the State level include:

- Borno State Ministry of Environment
- Jere Local Government

- *Traditional Leadership Patterns and Representations*

The administration of Maiduguri City can be identified under three authorities. These are the traditional administration, the local government council and the State government. Each of these administrations has defined responsibilities in the governance of the city.

The traditional administration is the reminiscence of the pre-colonial local administrative system. It consists of four tiers in hierarchy consisting of the Shehu, Aja, Lawan and Bulama (Figure 4.20). The Shehu, who is at the apex of the system, is the paramount ruler of the entire Borno Emirate. He presides over an emirate council which is responsible for the appointments of 'Heads' to the lower hierarchy. Maiduguri is therefore the traditional capital from where orders are issued to the "heads" of the different units in the entire Emirate. However, actual traditional administrative activities are undertaken by the District Heads (Aja), Ward heads (Lawan) and Neighbourhood heads (Bulama) who have defined territories to administer in respective order in the hierarchy. The traditional community leaderof Mairi is Lawan Mala Abande (Plate 4.11)

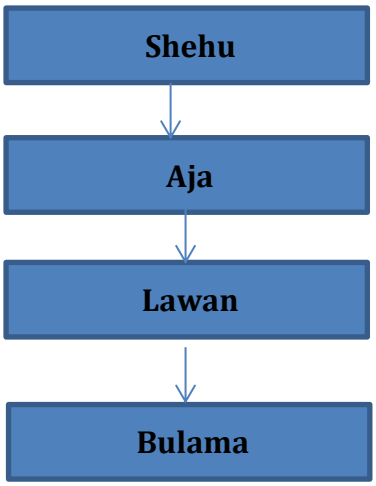

Figure 4.20: Local Administrative hierarchy

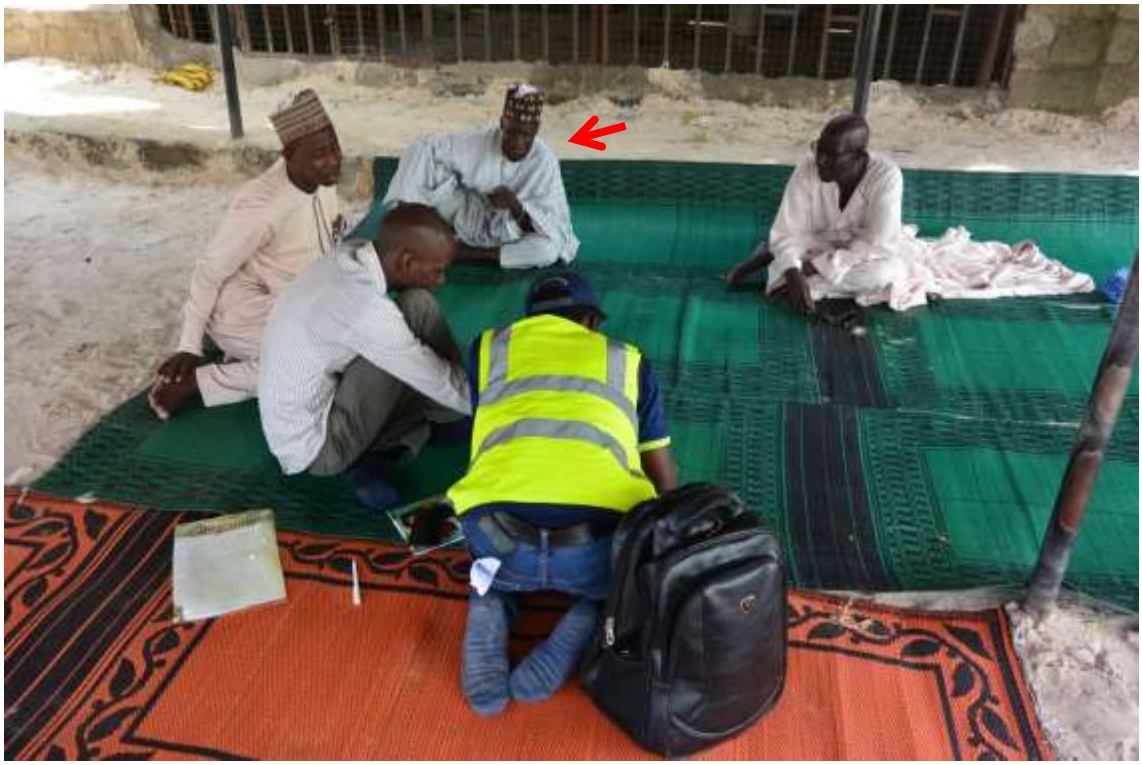

Plate 4.11: Key informant interview with the Lawan of Mairi

- *Community-based Organizations and Other Local Institutions*

Within the community, the most prevalent groups are youth and men organizations. During the KII, the community leader also stated that there are women organizations, youth association and elderly men who come together when it is required to discuss with the community leader about the security amongst other relevant issues.

- *Social Conflict*

During the data gathering survey, the team recorded that there was no conflict in the community as at the time of the survey. The community leader (Bulama) resolves domestic and minor conflicts within his jurisdictions. However, whenever the disputes go overboard, the case will be referred to the Lawan, who is the ward head of the community. The Lawan will make the final verdict and resolve the conflict. When the situation becomes escalated beyond Lawan, he will refer it to the Aja, the district head. Aja handles conflicts that are over the jurisdiction of the Lawan. This conflict management structure has been in existence for a long time and has become the leadership structure of several communities in Maiduguri.

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

- *Key Livelihoods*

Borno State is bordered by three countries namely: Niger, Chad and Cameroon. These countries constitute major trading partner to the State. Substantial amount of the state's livestock requirement comes from Chad and Cameroon. Borno State also provides ready market for her neighboring countries in terms of agricultural produce. Thus, there is a buoyant cross-border trade between the State and her international neighbours. On the local front, the State is bordered by three states namely: Adamawa, Gombe and Yobe, products including agricultural produce are being distributed. There are peculiar market days with distinct products for each local government in the State (Mohammed Danladi Tukur & Ahmed Funmilola Fausat, 2015).

Field observations showed that residents of Mairi engaged in various economic activities ranging from agricultural production, food processing, trading to tertiary activities such as banking and consultancy.

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

- **The principal economic activities in the study area are food processing, handicraft, commercial transport services, and products distributions.**
- **Trading, artisanship and formal sector employment are common in the community.**
- **Traders mostly sell goods foodstuff, fresh produce, cooked food and other items such as, electronics and mobile telecommunication networks recharge cards.**
- **There is a central market within the community.**

- *Trading*

Trading is a common economic activity within the community and majorly engaged in by men and women. As displayed in Plate 4.12, trading activities come in different form, hawking, shops either within a set or container, goods distribution and services. During field observation, some of the community members were observed

to be engaged in petty trading, selling and distribution of smaller items. There was designated market area where the trading activities took place, although there were also roadside shops in the community.

Plate 4.12: Trading activities observed within the community

- *Formal Employment*

The information available regarding formal employment in the study area are based on field observations, it can be deduced that government schools, private schools, teaching hospital, the University of Maiduguri are the few formal employers.

- *Income Levels and Poverty*

During the household survey, the respondents gave an estimate of their monthly income, about 60% of the sampled respondents earned between the ranges of N10,000 - N50,000 in the community, 16.67% earned less than N10,000 while 15.56% earned in the range of N50,000 - N100,000. About 7.78% of the sampled respondents earned above N100,000 per month.

It is believed that poverty levels have increased over time with reference to the insurgency in Maiduguri and Borno State in general. During the discussion with survey respondents, many of them complained about their loss of jobs, business and other livelihood activities since the emergence of the insurgency. Many companies had decommissioned their production; as people are no longer feeling safe in the

area. This has affected the economic activities of the community as people could not contribute towards the economy of the community, local government and state in general.

The cost of living in the community was not objectively ascertained. However, information obtained from the community members showed that the house rent was relatively high when compared to the income level of the members of the community, food price is relatively low; transportation cost is also relatively cheap depending on the distance of the journey. The cost of living in Mairi community is relatively low as most people in the community can afford the basics amenities.

4.4.3.4 Infrastructure and Services

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

- **Mairi community has access to public electricity supply from the national grid.**
- **The internal road networks are paved and tarred.**
- **There are educational facilities with the study area.**
- **The community has existing market accessible for members and non-members**

- *Access to Electricity*

In the study area, many households were connected to the national grid for electricity supply (Plate 4.13). The power supply is unreliable as reported by the survey respondents. During the survey, 100% of all the respondents affirmed that they have access to electricity, although the supply only last for few hours daily. There are no public or communally owned generators or any other alternative power supply, but a few residents have privately owned generators and solar panels to provide back-up electricity for their houses and businesses in the community. According to the energy consumption and power demand forecast for UNIMAID and the Teaching Hospital in 2018 by REA, the daily power supply from the national grid was between 5 to 22 hours daily (5 hours during dry season and up to 22 hours during wet season). In the North, they experience longer dry season, therefore, the need for an independent and stable power source.

Plate 4.13: Electricity poles observed in community

- *Access to Water*

In the Project area, private boreholes and wells are found in different areas, as displayed in Plate 4.13. A significant proportion of people in the study area have access to these sources of water.

According to the survey, 65% of the respondents have private borehole in their respective houses, 30% make use of the hand-dug wells and 5% buy water from vendors. During observation and discussion with the leaders of the community, some household members collect rain as their source of water whenever it is available.

Plate 4.14: Water supply facilities observed in the community

- *Telecommunication, Transportation and Road Infrastructure*

The common forms of transportation in the study area are commercial buses, cars, motorcycles, tricycles and trekking, it should also be noted that Maiduguri International Airport is about 15 km away from the community. The road networks within the community are fairly motorable (Plate 4.15).

Mairi community have access to all the available mobile telecommunication networks in Nigeria such as MTN, Airtel, Glo and 9mobile. This makes it easy to communicate socially and also carry out business transactions within any part of the community.

Plate 4.15: Telecommunication masts and roads observed in the community

- *Access to Education*

Literacy level in the Project area was below the national and state average. The survey (Figure 4.21) showed that 15% had primary education, 25% had senior secondary education, 25% had tertiary education and 10% attended one or more vocational training that serve as their form of education. About 25% had no formal education or any other form of education.

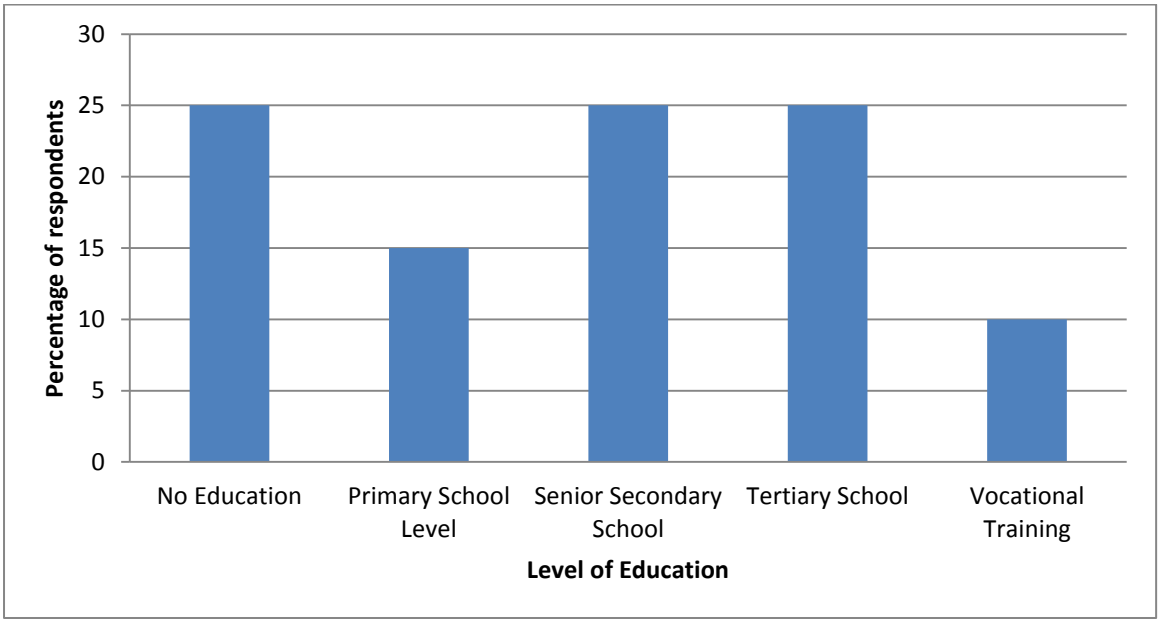

Figure 4.21: Level of education among respondents

- *Recreation*

During the survey, it was observed within the community that the common recreational activities are most often football activities on open fields. The men were found to be relaxing under a shade and discussing with their friends and colleagues (Plate 4.16).

Plate 4.16: Relaxation spots for men and elders within the community

4.4.3.5 Housing and Business Structure

Many building roofs had corrugated roofing sheets in different patterns and products; some were colour-coated corrugated metal roofing sheets and corrugated bitumen roofing sheets, amongst others. It was observed that there were rusted roofing sheets, which showed that some of the houses have been constructed long time ago. The housing structures in the communities are nucleated (clustered) settlement patterns. Some houses were built with fences to allow for privacy. Results from the household survey indicated that about 25% of the respondents live in single family bungalow houses, 10% live in block of flat, 65% live in tenement houses (Figure 4.22).In the University, the building structures were noted to be modern and nucleated.

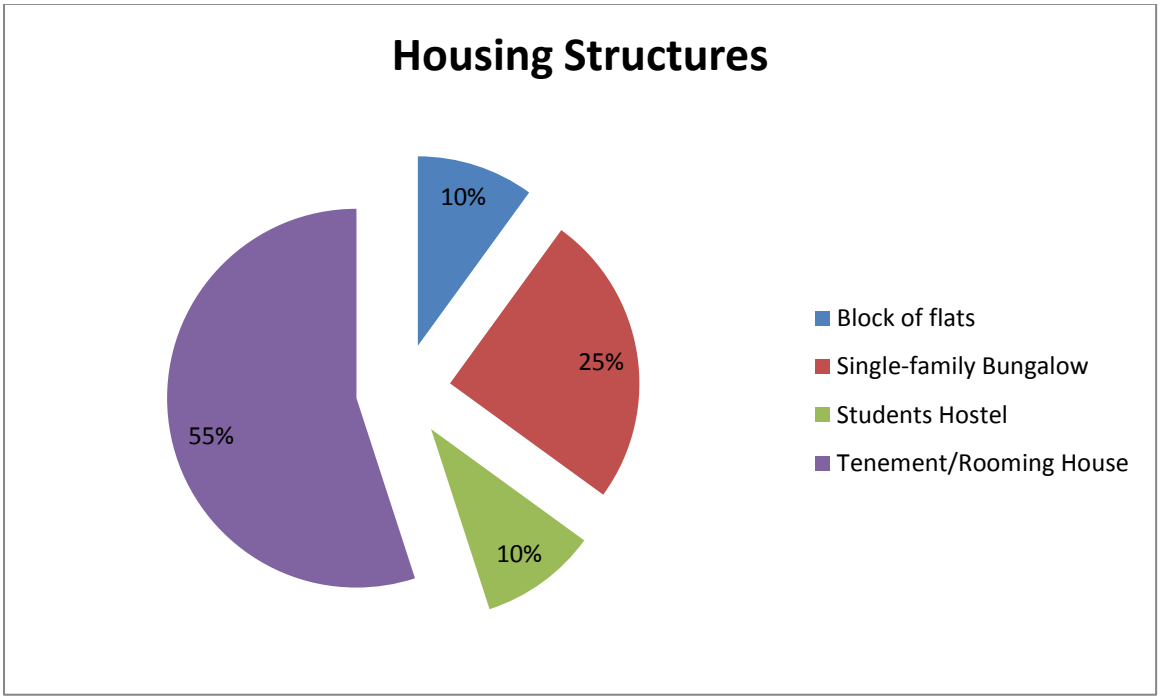

Figure 4.22: Frequency distribution of the type of houses within the community

Most houses however, have pit toilet within their compounds with 75% of the sampled respondents claimed the use of pit toilet while 25% used water system toilet. Material used in construction of the houses in the community is mostly cement block with corrugated sheets for roofing. The plastering material of most houses in the community is cement. Cement block houses are generally solid and durable.

The business structures (Plate 4.17) in the community are shop outlets traders have their shops in a designated area for market and some have their respective shops in front of their residential houses.

Plate 4.17: Housing and business structures observed in the community

4.4.3.6 Land Acquisition

In Mairi Community, lands are owned by individuals, families and the community. Individuals, indigenes and non-indigenes alike in the communities can own a piece of land and erect structures or put to any use of their choice as long as they are able to fulfil the transaction obligations with the land owner or the community. Rights over lands within a family are handed down from one generation to another. This makes it imperative that any negotiation to lease or acquire any land for personal, corporate or industrial use should be done through the traditional leadership in the community or directly with the land owner.

Traditionally, lands in the communities have been put to use for farming, grazing of livestock, housing, economic and infrastructural development purposes. When land is leased, it is for a specific period or duration. During KII with the community leader, he stated that the community has no benefits or services that they derive from the project site. Also, they have no claims on UNIMAID land as they are aware that it belongs to the Federal Government.

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 the farmers on the site, it was discovered that the farmers are staff of UNIMAID. They have obtained permission from UNIMAID Farm Manager to use some portion of the Project site temporarily for subsistence farming during the wet season. However, based on the information gathered during engagement, the farmers are aware that the proposed Project site belongs to the University. The crops planted include groundnut, millet, melons, and vegetables. Plate 4.18 shows the survey team interviewing some of the farmers on the site.

Plate 4.18: Discussion session with the farmers found on the proposed Project site

4.4.3.8 Health Profile

It was gathered that the community depend on the services of University of Maiduguri Teaching Hospital for healthcare services. The Teaching Hospital is well-equipped. Some pharmaceutical shops were observed in the community. These local pharmacists' shops sell drugs for curing ailments such as headache, malaria, fever, among others.

The survey team held KII with the Chairman, Medical Advisory Committee (CMAC) of the Teaching Hospital (Plate 4.19). He disclosed that due to the terror attacks in the state, trauma victims from insurgent attacks are usually brought to the hospital for treatment. The increase in patients from IDP camps has put a strain on the facilities in the hospital.

The hospital serves as one of the GBV service providers in Maiduguri and they have both the personnel and equipment to handle GBV cases. Also, other common health issues are strokes, kidney diseases, and infectious diseases (HIV, tuberculosis, etc.). However, construction is ongoing at the hospital to increase their capacity.

Plate 4.19: Interview with the CMAC of UNIMAID Teaching Hospital

Figure 4.23 shows that about 35% of respondents in the household survey rated their household general health status as excellent and about 65% considered the health status of their household members as good.

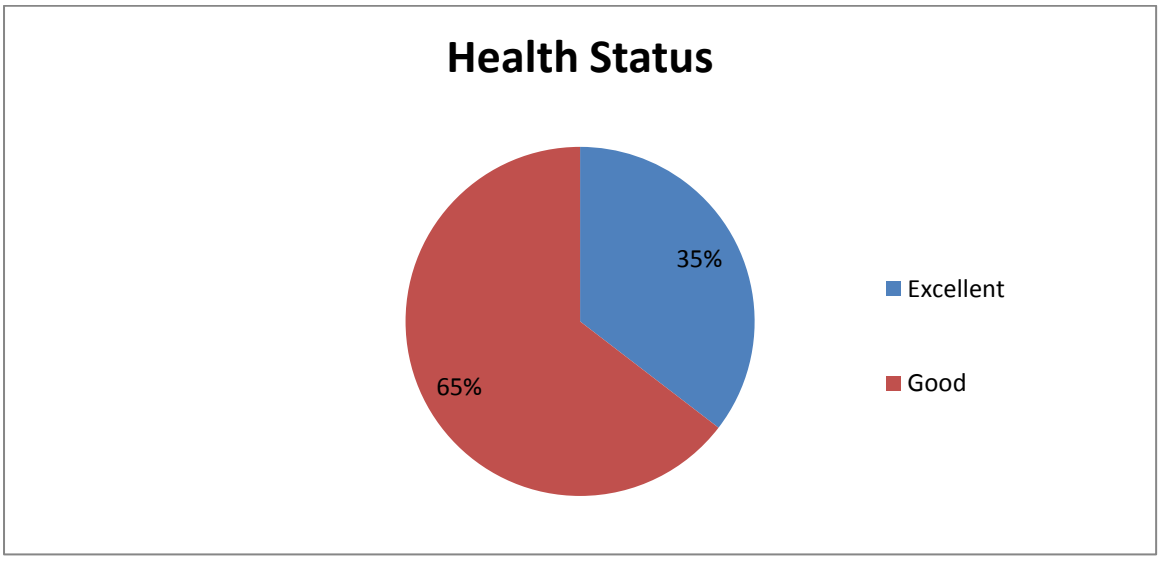

Figure 4.23: Showing distribution of respondent's general health status

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.

- *Gender Issues within the Study Area*

Women in the community are majorly full home keepers. Only a few of the women are engaged in commercial activities like in-door tailoring and sales of food. No major environmental, social or health challenge was reported by the women during FGD.

It was gathered that there was no identifiable measure for ensuring women participation within the community. All the leaders in religion and social associations within the community are men. Women are not prohibited from participating in social activities but the roles they take up are limited to the welfare aspect of any social event within the community.

During the FGD, it was observed that women within the community are not allowed to make any major decisions on their own. Either their husband or a male authority needs to be consulted before such decisions are made.

Women in the community engage in trades such as bean cake (Koisai/akara), fried groundnuts, vegetables/fruits, and groundnut cake (kuli-kuli). These businesses are usually small scale and for supplementing family income; the women also stated that lack of access to funds and poor power supply in the community were some of the issues they faced in the community. However, they stated that the trading activities give them some autonomy from their partners but does not prevent them from performing their domestic responsibilities as housewives.

As shown in Plate 4.20, the FGD with the women in the community revealed the vulnerability of the women within the community to gender based domestic violence due to the limitation placed on their lifestyle and their handicapped economic status. As a result, there are no specific measures for addressing and resolving gender based violence within the community.

It was also observed that marginalization of women is widespread within the community. This can be attributed to the patriarchal culture, tradition, religious beliefs, and social norms that continue to limit women and girls in the region. Thereby, resulting in their inability to participate fully in all aspects of household, economic activities and community life. A high percentage of the women stay indoors, limiting their knowledge of the major happenings and critical needs of their community. Their expectation and aspiration are limited because they do not have

any economic input hence, no support seems important than the provision of food for their families.

Plate 4.20: FGD session held with the women in the community

4.4.3.10 Community Concerns and Perception

The survey data revealed that none of the respondent is aware of the proposed solar power project. However, during the discussion with the men, youths and women, the Project components were carefully explained to the participants. The reaction was positive as participants believe that there is an impending economic advantage for them in terms of temporary jobs on site during the site clearing and constructions.

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 10.0 MW solar power plant and associated infrastructure in the University of Maiduguri (UNIMAID), Borno 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 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.

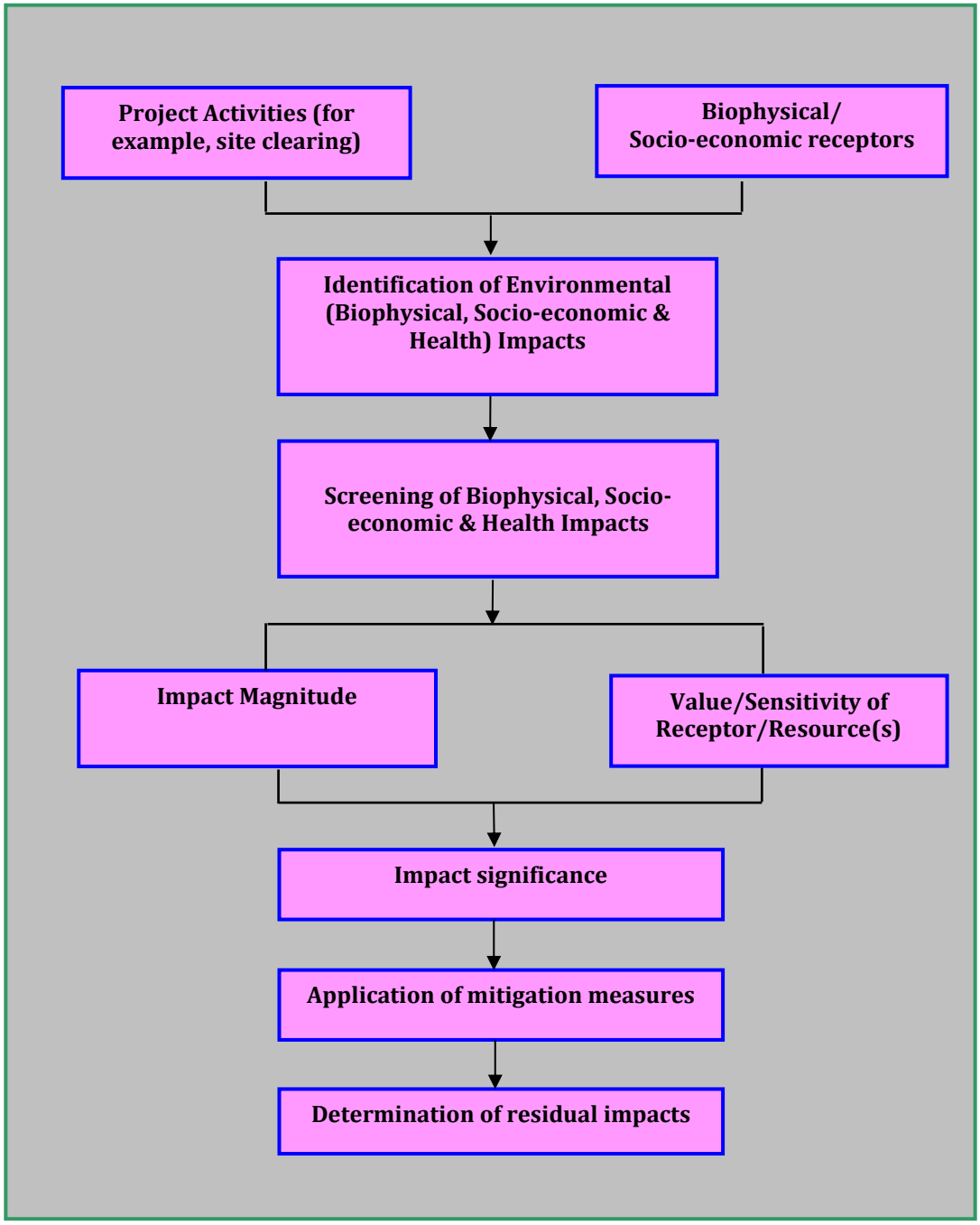

Figure 5.1: Overview of the Impact Assessment Process

5.3 Identification of Environmental and Socio-economic Aspects and Impacts

5.3.1 Environmental and Socio-economic Aspects

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/sensitive receptors
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.

5.3.4 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 including potentially affected community
- 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.

Environmental Receptor/Medium	Comment	Impact Indicators
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/ topography	The geomorphological land forms and terrain of the Project site and its surrounding environment.	Alteration in drainage pattern; 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. Loss of agricultural lands
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	Health and safety of employees	Accident, injury, fire,

Environmental Receptor/Medium	Comment	Impact Indicators
safety	involved in the operational phase of the Project operation.	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

5.4 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:

5.4.1 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:

5.4.1.1 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.

5.4.1.2 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).

5.4.2 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.

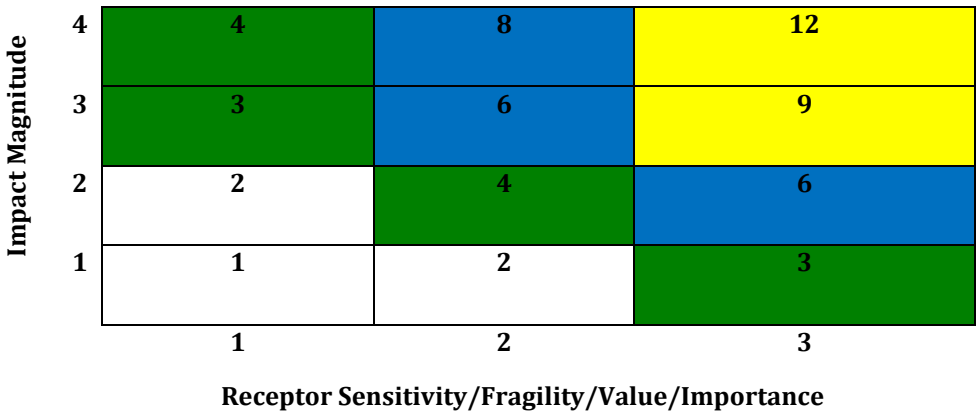

Figure 5.2: Impact Magnitude-Receptor Sensitivity Product Results

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.

5.4.3.1 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 and health	General Public
Pre-construction Phase																	
Site selection									2(3)								
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.

5.5 Impacts Discussion

5.5.1 Potential Positive Impacts

The proposed Project seeks to provide independent and reliable power supply to University of Maiduguri (UNIMAID) and the Teaching Hospital 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 6,000 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.

5.5.2 Potential Negative Impacts

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

- Potential impact of the proposed 10.0 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.

5.5.2.1 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***

The proposed Power Plant will be sited on approximately 20.0 ha of land while the total length of transmission line proposed for the Project is about 4.9 km. the Project site is within the property of UNIMAID but the underground transmission cable will pass through markets and other structures along the route to the Teaching Hospital.

No additional land take, either from a private or public property, will be expropriated for the Project. Appropriate consultations will be held with the State and Local government authorities before installation of the cable along the transmission route. A few dilapidated structures (UNIMAID property) were observed within the Project site but it was gathered that they have been unoccupied for more than 10 years. Currently, there are some farmers (mostly female) using the Project site for subsistence farming purposes especially during rainy season. They have no legal claims to the land but they have obtained permission to cultivate crops on the site from the University during the rainy season.

Also, there is a military trench that runs diagonally along the site which was installed by the Nigerian Military during the height of terrorist attacks in the state. During consultations with the University management, it was gathered that consultations will be held the concerned military authorities to relocate the trench further away from the proposed site. The impact significance of site selection for the proposed Project on the existing land use is rated **moderate**.

- ***Site Clearing and Preparation***

The Project site will be cleared of vegetation prior to construction activities. The site clearing activities would 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 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, 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. The sensitivity of the fauna species recorded on the Project site is thus regarded as low. The impact magnitude is considered to be moderate given that the site clearing activities would cover approximately 20.0 ha of land. The impact significance is 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 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 study 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. The topsoil (0-15cm) profile had a clay fraction varying from (75.27 – 83.57 %)while the proportions of other soil fractions were sand (14.01 – 19.62 %) and silt (0.89 – 8.92 %). For the subsoil (15-30cm), the clay fraction varied from (72.36 – 82.87 %) while the proportions of sand and silt fractions were 14.11 – 22.61 % and 0.92 – 9.75 % respectively. 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. Moreover, the topography of the proposed site is relatively flat. 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 NO_x, CO, SO_x, TSP 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 concentration of air pollutant criteria beyond the FMEnv, WHO, and the World Bank Ambient Air Emission Limits was recorded. The impact significance 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 ten (10). 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 AoI 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 low given that the existing vehicular movement along the road leading to the site is high. The prominent means of transportation are tricycles, cars, motorcycles, while buses and trucks are common. 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	• Loss of farmlands • Temporary disruption of business along the proposed transmission route • Relocation of military trench	Moderate
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

5.5.2.1.2 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, CO, NO_x,TSP, 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 less than 12 months. 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 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 50.4 to 52.9 dB(A) within the Project site; 55.8 to 67.1dB(A) within 1km AoI radius; 61.5 to 73.2dB(A) along the transmission route; and 51.6 to 61.9 dB(A) at the control/buffer areas. The measured noise levels at the Project site 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 male hostels within 500m radius of the Project site, the identified local community in the Project area – Mairi community – is situated about 2.5km 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 activities, installation of PV panels, mounting structures, and 11kv underground cable. These activities also have the potential to increase siltation as a result of accelerated erosion. However, there are no water bodies within 1 km radius of the project site.

However, for the proposed transmission route, the excavation and cable laying activities will involve the disturbance of the soil profile along the proposed route which is approximately 4.9km. This may result in reduction in structural stability and percolative ability of soil, loss of soil dwelling organisms, due to compaction during excavation activities, as well as increased susceptibility to erosion.

The impact magnitude is considered to be moderate due to the distance of the proposed underground cable from the Power Plant to the switchyard at the University and the Teaching Hospital. The sensitivity of the soil environment in the Project area is regarded low as no evidence of heavy metal and/or hydrocarbon pollution was recorded in soil samples from the study area based on the results of laboratory analysis. The impact significance is considered to be **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 or during refuelling of construction equipment onsite. The impact magnitude is considered low; the nearest existing groundwater source (borehole) to the Project site is approximately 300 m away at the praying ground close to the site.

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 study area as a result of water abstraction for construction activities such as concrete mixing and washing of construction equipment is considered to be **negligible** because the activities are minimal. There are several boreholes within the University campus as noted during the site visit. The groundwater table and the rate of water recharge in the study area is relatively high. However, during the rainy season, the underground water aquifer increases; thus hand dug wells and boreholes yields improve significantly.

<u>Potential impact on Gender</u>

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 communities revealed that women in the community are marginalized. Although they are allowed to work and trade to some extent; they are underrepresented in leadership positions. During the socioeconomic surveys, seclusion of women was observed within the local communities. These practices reflect both social and religious customs typical in the northern part of Nigeria.

During construction activities, women may experience discrimination as most employment and training opportunities may be provided to men, while women will be left with menial jobs. This may result in marginalization due to lack of adequate training, thereby reinforcing gender stereotypes and gender pay gaps. Furthermore, there is the possibility of gender-based violence cases (GBV) against women employed to work at the Project site.

However, FGD with the women in the local community revealed that GBV incidents were not prevalent within the community. Also the University 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 the north eastern regions of Nigeria 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 regard to the presence of construction workers on site, the manner in which the workers conduct themselves can affect the local community in terms of disruption of existing community/family structures due to influx of people. 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 6,000) for the construction phase of the Project is relatively high, the potential risk to local family structures is regarded as high. 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 amount of Project vehicles and trucks to be used during the construction Phase. Also, traffic survey of the major road leading to the University (Bama Road) indicated a high volume of vehicles (mostly tricycles, cars, and buses) on the road during peak periods. The impact sensitivity is rated medium. Therefore, the impact significance is considered **minor**.

Trenching activities along the transmission route to the Teaching Hospital may affect some of the existing infrastructure such as roads, markets, and businesses. Other underground infrastructure such as telecommunication cables and portable water which could be damaged during the cable laying was considered as the associated impact would be interruption of the services they provide. However, local authorities will be consulted to identify areas where underground water pipelines

and telecommunication cables are present. Trenching and cable laying activities are envisaged to take two to three weeks. The impact significance of the proposed Project on the existing infrastructure 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**.

Potential Impact on the General Public

Trenching and installation of cables during construction phase may result in annoyance to commuters and traders along the transmission route. Longitudinal excavation may cause narrowing of the road in some sections for a relatively short period. Also, the proposed transmission route may cut across some business property entrances, thus it is expected that the excavation will result in temporary loss of access as work progresses. This access difficulty will have more impact on small scale roadside traders. This group may be unable to display their wares and experience difficulty with reaching their customers. However, the excavation and cable installation activities are estimated to last for a short period (2-3 weeks). Therefore, the potential impact significance (prior to mitigation measures) on the general public is considered to be **minor**.

- ***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 approximately 300 m away. The impact sensitivity is medium because the

groundwater is a major source of potable water within the Project AoI. 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 0.90 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 below 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
	Groundwater	• Groundwater contamination	Minor
	Gender	• Discrimination of women during employment • GBV	Moderate
	Socio-economic and health	• Influx of people, increase in sexual transmitted diseases.	Moderate
	Infrastructure	• Road damage, traffic and safety impacts.	Minor

Activity	Receptor	Associated Impact	Significance
	(road)	• Temporary disruption of business along the proposed transmission route •	
	Construction workers safety	• Injury to construction workers during construction activities.	Moderate
	General public	• Temporary loss of space for traders to display their wares	Minor
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.	Minor

5.5.2.1.3 Commissioning Phase

Once the construction phase of the solar-hybrid power plant is completed, the Plant will be tested to ensure that it has been installed according to the pre-design and operational requirements. During the Plant 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), public address system, 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, the nearest sensitive receptor to the Project site (residential buildings) is approximately 200m away. The impact significance is rated **minor**.

Also, there is potential for occupational hazards during the Plant 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 population and infrastructure (road). Due to the short duration (1-2 hrs) of the commissioning phase, the impacts are considered to be **negligible**. Table 5.11 below 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, etc.) as a result of any wrong electrical connection.	Moderate
	Population influx	• Increase in population during commissioning	Negligible
	Infrastructure (road)	• Road traffic and risk of accidents	Negligible

5.5.2.1.4 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. residential buildings about 200 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 issues such as sexual harassment, intimate partner violence, assault (physical and psychological), could potentially occur during operations. 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 26,400 panels for 10.0 MW generation, it is envisaged that the proposed Project would consume approximately

132,000 litres 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 Infrastructure (Waste Management Facility)

Waste generated from operations and maintenance can potentially have impact on the existing waste management facility of the Project area. Waste in UNIMAID is either incinerated or disposed designated dumpsites outside the university. However, e-wastes (panels, spent batteries, inverters, etc.) and hazardous wastes (spent oil, oily rags, etc.) cannot be disposed of in such manner. These wastes shall be returned to the manufacturers based on a take-back agreement or handled by licensed waste contractors.

The Project shall engage the services of an accredited waste disposal contractor to dispose wastes at a Borno State Environmental Protection Agency (BOSEPA) approved dumpsite. However, the quantity of office and domestic wastes designated for disposal from the power plant will thus be low. The impact of the waste on the waste management facility of the UNIMAID 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 10) required for operational 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 during employment and training opportunities • GBV (sexual harassment, intimate partner violence, poor working conditions)	Moderate
	Socio-economic	• Landscape alterations resulting in	Negligible

Activity	Receptor	Associated Impact	Significance
	(visual prominence)	unpleasant changes in the visual character of the area	
	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 conditions	Moderate
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
	Infrastructure (waste management facility)	• E-waste generation • Waste disposal to existing waste management facility within the Project area	Minor
	Health, safety and welfare of staff during maintenance	• Electric shock, injuries to personnel during maintenance	Minor

5.5.2.2 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 activity within the Project area is farming. 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**.

5.6 Risk and Hazard Assessment

5.6.1 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.

Likelihood of occurrence	***Severity of potential damage/injury***			
	Negligible	***Marginal***	***Critical***	***Catastrophic***
Certain	***High***	***High***	***Extreme***	***Extreme***
Likely	***Moderate***	***High***	***High***	***Extreme***
Possible	***Low***	***Moderate***	***High***	***Extreme***
Unlikely	***Low***	***Low***	***Moderate***	***Extreme***
Rare	***Low***	***Low***	***Moderate***	***High***

Figure 5.3: Risk Assessment Matrix

5.6.2 Project Specific Risks and Hazards

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

5.6.2.1 Fire and Explosion

The major risk associated with the Plant operation 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**.

5.6.2.2 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**.

5.6.2.3 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**.

5.7 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 all 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 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 unmitigated potential negative impacts ranked as negligible are not included in the table. 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 (10.0 MW) is insufficient to meet the power demands of the University in the next 10 to 20 years, 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 Improvement in Delivery of Medical Services

The Project will improve the quality of medical services provided by the Teaching Hospital. All equipment and machines used in the hospital will function optimally due to adequate power supply from the Project. To enhance this impact, the following measures shall be implemented:

- Based on the data from the Energy Audit conducted at the Teaching Hospital, high priority areas have been identified. These sections of the Hospital shall be supplied with adequate power to for their equipment.
- Power usage at all sections of the Teaching Hospitals shall be monitored to ensure that peak hours are identified and supplied adequate power to meet their needs.
- Backup generators shall be installed at critical areas of the Teaching Hospital

6.5.4 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 6,000 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.
- The GBV action plan for EEP Projects shall be 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 20 people will 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.

6.5.5 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 farmlands ▪ Relocation of military trench ▪ Disruption of market activities	Moderate	▪ Livelihood Restoration Plan (LRP) shall be developed and implemented (in consistent with the requirements of OP 4.12, Annex A - Involuntary Resettlement Instruments) for the affected persons ▪ The affected farmers (University staff) on the site shall be identified and allowed to harvest their crops before commencement of construction activities ▪ UNIMAID shall provide alternative farmland within the University for the affected persons. ▪ The commitment for the provision of alternative land for the affected persons shall be documented in a letter signed by the University's Vice Chancellor. ▪ The Nigerian Military shall be consulted before the trench is filled up and relocated ▪ Alternative location for the trench shall be selected and agreed upon by the Nigerian Military and the University before commencement of the Project ▪ Consultations shall be held with the leaders of markets along the power evacuation route before commencement of trenching and cable laying	Minor
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	Minor	▪ Vegetation 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.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
		surroundings of the Project site		▪ 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.	
	Soil	• Removal of top soil and soil compaction associated with site clearing • Loss of top soil • Increased erosion potential • Reduction in structural stability and percolative ability of soil	Moderate	▪ 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. ▪ 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.	Minor
	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. ▪ Noise suppression equipment shall be fitted on machinery. ▪ Site clearing equipment shall be turned off when not in use. ▪ Equipment/machinery with lower sound power levels shall be selected and used for site clearing.	Negligible
	Workers Safety	• Injuries and	Minor	▪ Site clearing shall be limited to the day time as much	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
		accidents to workers during site clearing and preparation.		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.	
Mobilization of personnel, materials and equipment to site	Air quality and noise	• Air quality impacts from vehicular emissions • Increase in ambient noise levels	Minor	▪ 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. ▪ 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.	Negligible
	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	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				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 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. ▪ 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. ▪ Sanitary amenities and potable water shall be provided	Negligible
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	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

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
		civil works and installation activities		▪	
	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 ecology	Minor	▪ 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 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.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				▪ Noise complaints related to the construction activities shall be assessed and appropriately addressed. ▪ Noise monitoring at locations with persistent noise complaints shall be maintained.	
	Groundwater	• Groundwater 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
	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 will be undertaken to ensure that alien plants are not increasing as a result of the disturbance that has taken place.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				▪ 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.	
	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 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 damages as quickly as possible.	Negligible
	Gender	• Discrimination during employment and training	Moderate	▪ Equal treatment of workers shall be ensured. ▪ The GBV Action Plan for EEP shall be implemented for the Project	Minor

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
		opportunities • GBV (sexual harassment, intimate partner violence, poor working)		▪ 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.	
	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. ▪ Construction activities shall be limited to daytime as much as possible. ▪ Onsite safety officer shall be engaged to monitor the	Minor

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				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. ▪ The NEP GRM 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 relevant government agency ▪ The local community shall be informed of the Project activities prior to commencement of work. ▪ An induction and sensitization programme,	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				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 community concerns shall be developed and implemented.	
	General public	• Temporary disruption of business along the proposed transmission route •	Minor	▪ Consultations shall be held with the affected traders and market leaders before commencement of trenching and cable laying ▪ Trenching and cable laying activities shall be executed in phases along the route and in a timely fashion ▪ All excavated trenches shall be backfilled and	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				restored to original conditions as much as possible ▪ GRM Procedure for receiving and addressing community concerns and complaints 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 by the EPC Contractor 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 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 ▪ Strict compliance to the Standard Operating	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				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. ▪ Sanitary amenities and potable water shall be provided	
	Campus Occupants' safety	• Wrong electrical connection leading to explosion/fire.	Minor	▪ Strict compliance to the 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.	Negligible
Operational Phase					
Power Generation and Evacuation	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 implemented.	Negligible
	Gender	• Discrimination during employment and training opportunities	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	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
		• GBV (sexual harassment, intimate partner violence, poor working)		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.	
Routine Maintenance, Waste Generation and Disposal	Infrastructure (waste management facility)	• E-waste generation • Waste disposal to existing waste management facility within the Project area	Minor	▪ A Waste Management Plan shall be developed by the O&M Contractor 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.	Negligible
	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.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (without mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				▪ 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 EPR model. Prior to returning them to the manufacturers, they will be stored on impermeable surfaces within the site.	
	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 management 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; 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.	Negligible

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 10.0 MW solar-hybrid power plant and associated infrastructure in University of Maiduguri, Borno State as part of the Federal Government's Energizing Education Programme, have been analyzed and documented in Chapter Five 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 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 implication;
- 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) UNIMAID (Site Engineer)	-
	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	EPC Contractor	REA (PMU) UNIMAID (Site Engineer)	-
	Soil conservation measures shall be implemented such as	Inspection	Daily	Re-vegetated land			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	stockpiling topsoil or for the remediation of disturbed areas. Use of silt traps or similar systems to reduce discharge of silt shall be ensured.						
Air quality impacts due to emission from site clearing equipment; increase in ambient noise levels	Site clearing equipment / machinery shall be operated and maintained under optimum fuel efficient conditions.	Maintenance records; Fuel consumption records	Daily	Adherence to measures			
	Noise suppression equipment shall be fitted on machinery and unnecessary engine idling shall be avoided	Inspection	Daily	Adherence to 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	EPC Contractor	REA (PMU) UNIMAID (Site Engineer)	
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) UNIMAID (Site Engineer)	-
	All materials with potential to result in dust emissions shall be covered during transport.	Inspection	Once before vehicle commences journey	Adherence to measures			
	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			

Table 7.1b: Social 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	
Loss of farmlands	Livelihood Restoration Plan (LRP) shall be developed and implemented (in consistent with the requirements of OP 4.12, Annex A - Involuntary Resettlement Instruments) to restore livelihood of the affected persons.	OP 4.12, Annex A - Involuntary Resettlement	Prior to mobilization to site / site clearing and construction	Involuntary Resettlement (OP/BP 4.12)	UNIMAID Management	REA (PMU)	-
	UNIMAID shall provide a letter of commitment signed by the Vice Chancellor to provide alternative sites for the affected staff	Letter of commitment	Prior to mobilization to site / site clearing and construction	Signed Letter of commitment			
	The affected farmers (University staff) on the site shall be identified and given ample time to harvest their crops	Inspection	Prior to mobilization to site / site clearing and construction	Alternative farmlands for the affected farmers			
	The affected farmers shall be provided with alternative land within UNIMAID where they can continue their subsistence farming activities	Inspection	Prior to mobilization to site / site clearing and construction				
Relocation of military trench	The Nigerian Military should be consulted before the trench is filed up and relocated	Evidence of consultation	Prior to site clearing and construction	Evidence of consultation	UNIMAID Management EPC Contractor	REA (PMU)	2000
	Alternative location for the trench should be selected and agreed by the Nigerian Military and the University.	Inspection	Prior to site clearing and construction	Alternative location for the military trench			
Disruption of market activities	Consultations shall be held with the affected traders and market leaders before commencement of trenching and cable laying	Evidence of consultation	Prior to site trenching and cable laying	Evidence of consultation	UNIMAID Management EPC Contractor	REA (PMU)	200
	A Grievance Redress Mechanism	GRM	Prior to site	Records of			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	(GRM) shall be developed, implemented, and communicated to the market community		trenching and cable laying	complaints received and addressed			
Injuries and accidents to workers during loading and off-loading construction materials.	Provision of adequate PPE especially gloves, safety shoes, and hard hats to workers shall be ensured. All employees shall be required to wear appropriate PPE whilst performing their duties.	Availability of PPE	Daily	PPE compliance	EPC Contractor	REA (PMU) UNIMAID (Site Engineer)	500
	Unregistered labourers and touts shall not be engaged for off-loading materials.	Employment records of all staff on site	Once before commencement of mobilization	Labour Act	EPC Contractor		
Increase in vehicular movement and traffic including potential for road accident	A TMP shall be developed by the EPC Contractor and implemented	TMP implementation records	Daily	Benchmarks stated in the TMP	EPC Contractor	REA (PMU) UNIMAID (Site Engineer)	1000
	Appropriate signage and safety measures (barrier, formalized crossing points) to reduce the risk of accidents in the Project area shall be provided.	Safety signs and barriers	Before and during mobilization	Adherence to measures	EPC Contractor		
	The local community shall be Speed limit around community areas shall be limited to a maximum of 20km/hr	Evidence of consultation with local community	Before and during mobilization	Adherence to measures	EPC Contractor		
	Drivers' competency shall be assessed and where required, appropriate training shall be provided.	Drivers' competency assessments; training records	Once before commencement of mobilization	Passing of competency assessment or training completion certificates	EPC Contractor		
	A procedure for recording traffic incidents/accidents associated with the Project shall be developed and implemented.	Incident forms	Daily	Completed incident forms	EPC Contractor		
	Employee violations of speed limit and other traffic rules will result in	Incident forms, GRM	Daily	Completed incident forms	EPC Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	disciplinary action ranging from warning to dismissal						

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 UNIMAID (Site Engineer) FMEnv Borno 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		
Increase in noise level	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	REA-PMU UNIMAID (Site Engineer) FMEnv Borno State Ministry of Environment	-
	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	EPC Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
				World Bank Noise Limit			
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 UNIMAID (Site Engineer) FMEnv Borno 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 UNIMAID (Site Engineer) FMEnv Borno State Ministry of Environment	200
	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 will 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 UNIMAID (Site	1000

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	Speed limits for all construction-related vehicles shall be established and enforced.	Inspection	Daily during construction phase	Adherence to measures	EPC Contractor	Engineer) FMEnv Borno State Ministry of Environment	
	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		
	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 UNIMAID (Site Engineer) FMEnv Borno 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 prior to recycling and/or disposal	Waste consignment notes, waste receptacles on site	Weekly during construction phase	Adherence to measures	EPC Contractor		
Soil contamination	Hazardous substances and materials	Inspection	Daily during	Adherence to	EPC Contractor	REA-PMU	500

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
from solid and liquid construction waste streams.	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 phase	measures World Bank General EHS Guidelines		UNIMAID (Site Engineer) FMEnv Borno State Ministry of Environment	
	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		
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 UNIMAID (Site Engineer) FMEnv Borno 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		
	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 7.2b: 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 UNIMAID (Site Engineer) FMEnv Borno State Ministry of Environment	2000
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 UNIMAID (Site Engineer) FMEnv Borno State Ministry of Environment Borno State Ministry of Women Affairs and Social Development GBV/SEA service providers	
	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		
	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 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	EPC Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
				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 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 UNIMAID (Site Engineer) FMEnv Borno State Ministry of Environment Borno State Ministry of women affairs and Social Development GBV/SEA service providers	3000
	The local community shall be informed of the Project activities prior to commencement of work.	Evidence of communication with local community	Once before start of construction	Adherence to measures	EPC Contractor		
	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 / fraternization with the local community.	Induction records and training on the code of conduct	Once before start of construction	Adherence to measures	EPC Contractor		
	Awareness education about HIV/AIDS and other sexually transmitted diseases shall be created among the workforce and local communities.	Training records	Once before start of construction	Adherence to measures	EPC Contractor		
	Public access shall be restricted to construction area via security fencing and appropriate signage.	Inspection	Daily during construction phase	Adherence to measures	EPC Contractor		
	Procedure 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	EPC Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
				Grievances			
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 UNIMAID (Site Engineer) FMEnv Borno State Ministry of Environment,	4000
	Construction workers, including 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 workers to safety rules.	Qualified and dedicated safety officer	Once before commencement of construction	Adherence to measures	EPC Contractor		
	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	Inspection	Daily during construction phase	Adherence to measures World Bank General EHS	EPC Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	spill containment and clean-up kits shall be available onsite.			Guidelines			
	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		
Temporary loss of space to display their wares	Consultations shall be held with the affected traders and market leaders before commencement of trenching and cable laying	Consultations and grievance records	Weekly during construction phase	Adherence to measures	EPC Contractor	REA (PMU) UNIMAID (Site Engineer) Jere LGA	2000
	Trenching and cable laying activities shall be executed in phases along the route and in a timely fashion	Inspection	Weekly during construction phase	Adherence to measures			
	All excavated trenches shall be backfilled and restored to original conditions as much as possible	Inspection	Weekly during construction phase	Adherence to measures			
	Procedure 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			

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 UNIMAID (Site Engineer) FMEnv Borno 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		

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 UNIMAID (Site Engineer) FMEnv Borno 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.	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 UNIMAID (Site Engineer) FMEnv	-

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
						Borno 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 UNIMAID (Site Engineer) Borno State Ministry of Environment	-
	Site fencing if required shall be implemented.	Inspection	Once before operational phase	Adherence to measures			
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 UNIMAID (Site Engineer) FMEnv Borno 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 receptacles on	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	
		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 UNIMAID (Site Engineer) FMEnv Borno State Ministry of Environment	500
	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 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 UNIMAID (Site Engineer) FMEnv Borno State Ministry of Environment	-

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	O&M Contractor	REA-PMU UNIMAID (Site Engineer)	2000

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
				action plan			
	All workers shall be required to undergo regular training and refreshers on GBV	Organize regular onsite training and refreshers	Monthly during operation phase	Records of attendance		FMEnv Borno 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 UNIMAID (Site Engineer)	3000
	Appropriate safety signage shall be placed at strategic locations within	Safety signs	Quarterly during operations	Adherence to measures			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	the site.					FMEnv Borno State Ministry of Environment	
	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 personnel during maintenance	Appropriate PPE shall be provided for workers.	Availability of PPE	Quarterly during operations	Adherence to measures	O&M Contractor	REA-PMU UNIMAID (Site Engineer) Borno State Ministry of Environment	500
	Strict compliance to the SOPs shall be ensured.	SOPs	Quarterly during operations	Adherence to measures			

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 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:

UNIMAID 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

UNIMAID Site Engineer

- Attend adequate training on ESMP implementation
- Supervise the activities of the EPC contractor and ensure compliance ESMP with mitigation measures
- Report to UNIMAID 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 UNIMAID 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:

UNIMAID 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 UNIMAID Director of Physical Planning to address non-compliance and upcoming issues
- Monitors the implementation of the ESMP

UNIMAID Site Engineer

- Supervise the activities of the EPC contractor and ensure compliance ESMP with mitigation measures
- Report to UNIMAID 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 UNIMAID 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 UNIMAID Director of Physical Planning and REA-PMU to address non-compliance and upcoming issues

Borno 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, UNIMAID Director of Physical Planning, and REA-PMU to address non-compliance and upcoming issues

Borno Ministry of Environment Representatives

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

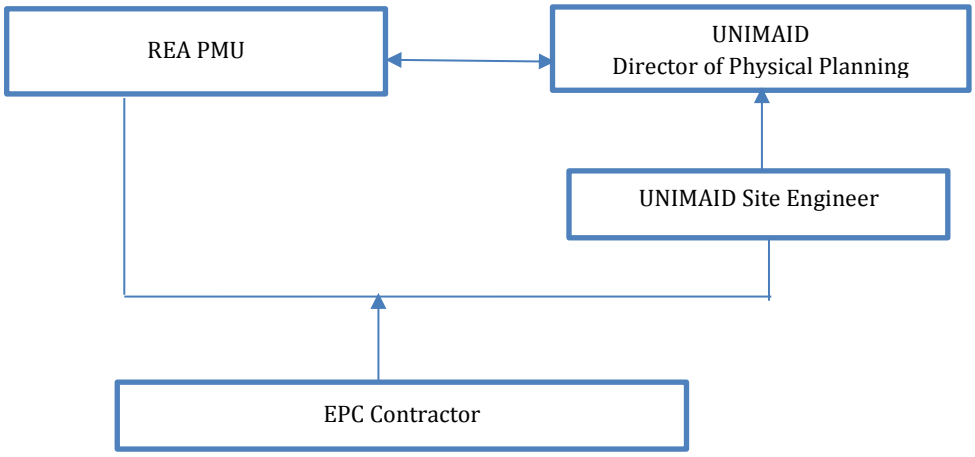

Figure 7.1: Roles and Responsibilities for the Pre Construction and Construction Phase

7.4.3 Operational Phase

UNIMAID 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 PMU to address non-compliance and upcoming issues

REA PMU

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

UNIMAID Site Engineer

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

- O&M Contractor Implement ESMP requirements relevant to work being undertaken

- Hire a Gender/GBV officer
- Report to the REA-PMU and UNIMAID 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 UNIMAID 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 UNIMAID Director of Physical Planning and REA-PMU to address non-compliance and upcoming issues

Borno 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, UNIMAID Director of Physical Planning, and REA-PMU to address non-compliance and upcoming issues

Borno 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, UNIMAID Director of Physical Planning and REA-PMU to address non-compliance and upcoming issues

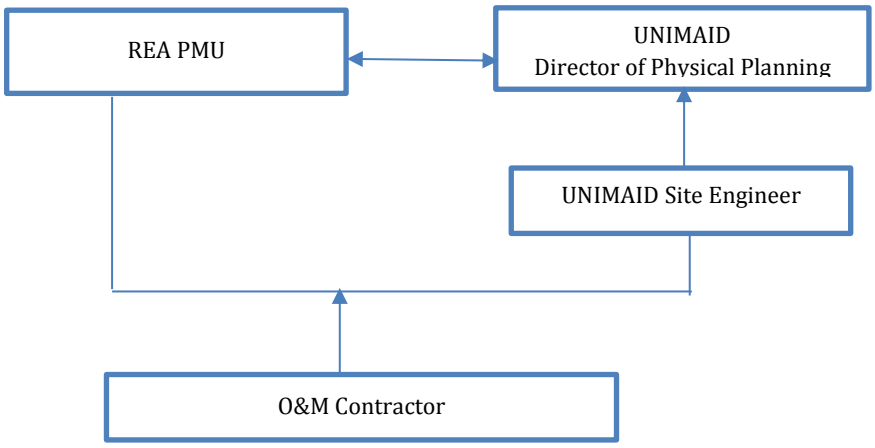

Figure 7.2: Roles and Responsibilities for the Operational Phase

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. An overview of the additional management plans is presented below.

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 UNIMAID 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 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;

7.5.3 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.

7.5.4 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;

7.5.5 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;

7.5.6 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;

7.5.7 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.

7.5.8 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.

7.5.9 EEP Gender-Based Violence (GBV) Action Plan

The 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 Livelihood Restoration Plan (LRP)

The LRP will be developed and implemented to manage the potential impacts of the Project on the local farmers that will be economically displaced. The LRP will be prepared and implemented in line with the requirements of the World Bank. At a minimum, it LRP will provide:

- a census survey of displaced persons and valuation assets;
- description of compensation and other assistance to be provided;
- engagement with displaced people about acceptable alternatives;
- institutional responsibility for implementation and procedures for grievance redress;
- implementation schedule;
- costs and budget;

- monitoring, evaluation and reporting

The LRP will be developed and implemented prior to the commencement of construction activities.

7.5.11 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

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	2000
9.	Livelihood Restoration Plan	Pre-construction	2,000
Total			17,500

7.6 Environmental Monitoring Program

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 O&M Contractor	• 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 O&M Contractor	• 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 O&M Contractor	• 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 O&M Contractor	• 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 O&M Contractor	• 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 O&M Contractor	• 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 O&M Contractor	• 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 below.

Table 7.7: Institutional Capacity Strengthening Plan

Target Audience	Training Overview	Cost Estimates (US Dollars)
Site Engineer, EPC contractor and their sub-contractors, O&M Contractor	In-depth understanding of the mitigation measures proffered by the ESMP. Training on implementation of all emergency response procedures; training on Health, Environment, Safety, and Security Management Plan	1000
Local community	General environmental awareness and mitigation measures proffered by the ESMP pertaining to community health, safety and security.	500
Total		**1,500**

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, Borno MEnv) 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 below 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 Solar Project.

Table 7.8: ESMP Costing

S/N	Fundamental ESMP Activities	Cost Estimates (US Dollars)
1.	Pre-construction phase E&S management activities	3,700
	Construction phase E&S management activities	16,200
	Commissioning phase E&S management activities	700
	Operational phase E&S management activities	8,000
2.	Preparation of additional management plans	17,500
3.	Institutional Capacity Strengthening Programme	1,500
4.	Monitoring and Evaluation Programme	19,000
Total		**66,600**

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 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 the UNIMAID, 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 UNIMAID, the Federal Ministry of Environment and the Borno 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 UNIMAID to address non-compliance and upcoming issues.

UNIMAID 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 UNIMAID on contractor's performance regarding the implementation of environmental and social measures.

Director of Works and Physical Planning Department in UNIMAID

- 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/Borno 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 UNIMAID (Site Manager and Director of Works and Physical Planning) FMEnv Borno 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.	Consignment notes for batteries to recycling plants	Daily	World Bank General EHS Guidelines			
	All impacted soil area shall be re-vegetated with native plant species	Inspection	Daily	Re-vegetated land			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	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 UNIMAID (Site Manager and Director of Works and Physical Planning) FMEnv Borno 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 UNIMAID (Site Manager and Director of Works and Physical Planning) FMEnv Borno State	2000
	Decommissioning activities shall be limited to day-time (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr).	Inspection	Daily	Adherence to measures			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	Equipment shall be turned off when not in use.	Inspection	Daily	Adherence to measures		Ministry of Environment	
	Equipment shall be properly maintained and serviced.	Inspection; Maintenance records	Once before commence ment	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 commence ment	Certificates of completion of trainings	Contractor(s) engaged for facility decommissioning	REA-PMU UNIMAID (Site Manager and Director of Works and Physical Planning) FMEnv Borno 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 containment. Portable spill containment	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	
	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 UNIMAID (Site Manager and Director of Works and Physical Planning) FMEnv Borno 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	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	
	decommissioning related traffic incidents/accidents shall be developed and implemented. This will include date/time, location, reason for accident, corrective measures, etc.						
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 UNIMAID (Site Manager and Director of Works and Physical Planning) FMEnv Borno 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 10.0 MW solar-hybrid power plant and associated infrastructure in University of Maiduguri, (UNIMAID), Borno State, 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 ESIA 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 for monitoring the Project during the operational phase and ensuring compliance to relevant environmental laws and regulations
	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 power Project
	Borno State Ministry of Environment			✓		The Ministry oversees the protection of environment in Borno State
	Borno State Environmental Protection Agency			✓		Responsible for waste management in Borno State
	Borno State Ministry of Women Affairs and Social Development			✓		Promotes the development of women with equal rights and corresponding responsibilities including gender inclusion
	Borno 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
	Jere Local Government Authority			✓		Local Government Authority for the Project site

Stakeholder Group and Interest in the proposed project	Stakeholder Name	Stakeholder Level				Connection to the Proposed Project
		International	National	State	Local	
Communities	Mairi Community				✓	Households, communities and groups that may be directly or indirectly affected by the proposed Project and its activities.
University Representatives	Management of UNIMAID				✓	Direct Project beneficiaries.
	Department of Physical Planning, works and Development				✓	
	UNIMAID Student Union Body				✓	
Project Affected Persons (PAPs)	Farmers on the Project site				✓	The farmers (University Staff) that will be displaced from the Project site
	Traders along the transmission route				✓	They will be affected during construction by the excavation and laying of transmission cables

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 (UNIMAID Management, Physical Planning, Students)	• Formal meetings • One-on-one consultations • Print media • Strategic collaboration • Information Centre
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 July 31st to August 2nd, 2019 with the following:

- Borno State Ministry of Environment
- Borno State Environmental Protection Agency
- Borno State Ministry of Women Affairs and Social Development
- Borno State Ministry of Youth and Sports
- UNIMAID Vice Chancellor
- UNIMAID Teaching Hospital Chairman of Medical Advisory Committee
- UNIMAID Director of Works, Physical Planning and Development
- UNIMAID Teaching Hospital Director of Works, Physical Planning and Development
- UNIMAID Student Union Government President
- Jere Local Government Representative
- Lawan of Mairi Land (host community)
- Mairi Market Leader/Park Chairman
- Farmers within the Project site

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 Scoping	Response during scoping meetings
Borno State Ministry of Environment	ESIA process and stakeholder consultation	– The Project is a welcome development – All Project information should be provided in the report – All stakeholders relevant to the Project should be identified, consulted and their contributions should be integrated in the ESIA	– All stakeholders to the Project have been identified and will be consulted during the ESIA study – The ESIA study will include an in-depth analysis of potential interactions of the Project with the physical and

Stakeholder	Priority Issues	Quotes/Comments during Scoping	Response during scoping meetings
		report – The ESIA should have comprehensive impact identification and analysis, and appropriate measures should be recommended for the impacts – Potential interaction of the Project on biophysical components should be considered – Impacts on the University community should also be considered – Job opportunities should be provided from the youths in the local community	socioeconomic components to determine the potential impacts and then mitigation measures will be provided to reduce the impacts – A percentage of the workforce for the Project will be drawn from the host community – A waste management plan that includes e-waste management will be developed and implemented for the Project
Borno State Environmental Protection Agency	ESIA process and stakeholder consultation	– There are designated dumpsites within the state but they are majorly for domestic waste – REA should develop a waste management that includes E-waste	– A waste management plan that includes e-waste management will be developed and implemented for the Project – Only accredited waste disposal companies will be contracted for the Project
UNIMAID Vice Chancellor	ESIA process and stakeholder consultation, Sustainability of the Project,	– The University has a dedicated team to ensure sustainability of the Project. – UNIMAID will ensure that there is adequate security for the project – Female students will not be marginalized from the Project and UNIMAID provides a safe environment for women	– All the points raised were duly noted for implementation.
UNIMAID Teaching Hospital Chief Medical Director	ESIA process and stakeholder consultation, Sustainability of the Project,	– Steady electricity is needed on a 24 hour basis at the Teaching Hospital – The components of the Project must be good quality and the cost of operation should be reasonable to ensure the sustainability of the project – Some of the Engineers	– The Project will provide uninterrupted power to the teaching hospital. – Only certified high quality components would be installed for the project – The engineers would be trained in the renewable energy training centre proposed for the Project

Stakeholder	Priority Issues	Quotes/Comments during Scoping	Response during scoping meetings
		at the Teaching Hospital should be trained on how to operate and maintain the power plant – The major concern of the Teaching Hospital is that the voltage supplied should be adequate to meet their needs	– An energy audit to determine the power needs has been conducted, the data from the audit will be used to design the Project to ensure that the power needs of the Teaching Hospital are met
UNIMAID Director of Works, Physical Planning and Development	ESIA process and stakeholder consultation	– The land selected for the Project site has been approved by the University. – There are no security issues associated with the site and the site is easily accessible – The Farm Manager of the University will be contacted to provide alternative farmlands to the farmers currently on the site – There are no plans for the abandoned structures on the site. – Waste in the University is burned in incinerators or disposed to dumpsites within Maiduguri – There are no plans for any major developments close to the Project site in the near future.	– A waste management plan that includes e-waste management will be developed and implemented for the Project – There will be opportunities for skill acquisition during the Project development –
UNIMAID Teaching Hospital Director of Works, Physical Planning and Development	ESIA process and stakeholder consultation	– The Teaching Hospital has adequate facilities to distribute the power generated for the Project – Power distribution within the Teaching Hospital is by 11 kVA underground cable – There are engineers within the department that can work on the operation and maintenance of the Project	– All the points raised were duly noted for implementation – There will be opportunities for skill acquisition during the Project development
President of UNIMAID Students Union	ESIA process and stakeholder	– There is room for improvement in current situation of power	– All the points raised were duly noted for implementation.

Stakeholder	Priority Issues	Quotes/Comments during Scoping	Response during scoping meetings
Government	consultation	supply in the University – The Project is a welcome development that will benefit the students. – The student union is willing to participate wherever necessary	
UNIMAID Farm Manager	Displacement of farmers from site	– The farmers on the site have obtained permission to use the land for the farming – The farming activities are subsistence level and the farmers are not permitted to plant major cash crops – They will be given adequate time to harvest their crops and provided with alternative lands to continue their farming activities	– The farmers should be notified about the Project in time – The farmers were consulted during the ESIA study
Jere Local Government	ESIA process and stakeholder consultation	– The Project is a welcome development – They have no issues with the Project	– A percentage of the workforce for the Project will be drawn from the host community
Lawan of Mairi 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 – The community is aware that the proposed Project site is UNIMAID's property	– A percentage of the workforce for the Project will be drawn from the host community
Mairi Market Leader	ESIA process and stakeholder consultation	– Trenching and Cable laying during construction phase may affect market activities along the transmission route to the Teaching hospital	– The cable laying from the Project site will be carried out in a short time to reduce the impact on the market
Farmers within the Project site	Stakeholder consultation	– They are all university staff who obtained permission for seasonal farming activities – They have not been informed about the Project – They are aware that the land belongs to the	– The University will c provide alternatives sites to the affected farmers – Also, the farmers will be given adequate time to harvest their crops before site clearing commences

Stakeholder	Priority Issues	Quotes/Comments during Scoping	Response during scoping meetings
		University but they would appreciate if alternatives can be provided for them	

Consultation with the identified stakeholders (including regulators and potentially affected communities) showed general acceptance of the proposed Project. Regulators such as the Borno State Environmental made suggestions relating to the proposed Project which were duly noted to be implemented accordingly. 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 10.0 MW solar-hybrid power plant and associated infrastructure in UNIMAID, 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 and Involuntary Resettlement Policy 4.12 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.
- Improvement in the delivery of medical services at UNIMAID Teaching Hospital.
- 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 and the Teaching Hospital through diesel-fuelled generators. Such savings would be used for other undertakings that will benefit the University and the Teaching Hospital.

- 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, the Teaching Hospital, 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. 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:

- Displacement of some farmers from the local community currently farming within the Project site.
- 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 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 UNIMAID, 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.

REFERENCES

1. Adelana, S. M. A., Olasehinde, P. I., Bale, R. B., Vrbka, P., Edet, A. E., Goni, I. B. (2008). An Overview of geology and hydrogeology of Nigera. In Applied groundwater studies in Africa. IAH Selected papers on Hydrogeology. 13: 171-198.
2. Alloway, B. J. (1990). *Heavy Metals in Soils*. Springer, Netherlands. 368 pp.
3. Azura (2012). Environmental Impact Assessment of the Proposed Azura-Edo Independent Power Project, 2012. 381 pp.
4. Babalola, S. J., & Akor, M. (2013). An empirical analysis of labour force participation of married women in Adamawa State, Nigeria. Journal of Emerging Trend in Economics and Management Sciences, 4(1), 1-7.
5. Beeson, S. and Jones, C. R. J. (1988). The Combined EMT/VES Geophysical Method for Sitting Boreholes. *Groundwater***26** (1): 54-63.
6. Bhatia, S. C. (2014). Energy resources and their utilization. Advanced Renewable Energy Systems. Pages 1-31
7. Bloomfield, S., Poweri, C. R. and Cotterell, M. (2016). *Batteries and Solar Power: Guidance for domestic and small commercial consumers*. BRE, Garston. 12 pp.
8. Chang, G. J. and Jennings, C. (1994). Magnetic Field Survey at PG&E Photovoltaic Sites. PG&E R&D Report 007.5-94.6.
9. Dee, N., J. Baker, N. Drobny, K. Duke, and D. Fahringer. (1972). Environmental evaluation system for water resource planning (to Bureau of Reclamation, U.S. Department of Interior). Battelle Columbus Laboratory, Columbus, Ohio, January, 188 pages
10. Doss, C., Deere, C.D. Abena, D. O. and Suchira J.Y. 2012 The Rural Gender Asset and Wealth Gaps. Evidence from Ghana, Ecuador, Uganda and Karnataka, India. Indian Institute of Management, Bangalore, India.
11. Energy Consumption Survey and Power Demand Forecast for the University of Maiduguri and University of Maiduguri Teaching Hospital, Borno State (2018). Prepared for Rural Electrification Agency in October, 2018.
12. Environmental and Social Management Framework (ESMF) for Nigeria Electrification Project (NEP). Prepared for Rural Electrification Agency in March, 2018. (http://rea.gov.ng/NEP_ESMF_WB%20_April_8_2019_revised.pdf)
13. Espinosa, D. C. R. and Tenorio, J. A. S. (2006). Recycling of nickel–cadmium batteries-Thermogravimetric behavior of electrodes. *Journal of Power Sources* **160**(1): 744-751.
14. Federal Ministry of Environment (1999): National Guidelines and Standards for Water Quality in Nigeria.
15. Federal Ministry of Environment (FMEnv) (1999). *Green Book: Guidelines and Standards for Environmental Pollution Control in Nigeria*. FMEnv. 298 pp.

16. Gayawan, Ezra; Adebayo, Samson B. (2015) : Spatial analysis of women employment status in Nigeria, CBN Journal of Applied Statistics, ISSN 2476-8472, The Central Bank of Nigeria, Abuja, Vol. 6, Iss. 2, pp. 1-17
17. Geophysical Service Incorporated (GSI) (2003). *St Lawrence Survey. Environmental Assessment Report*. Prepared by Canning & Pitt Associates Inc. and assisted by Robert Hamelin & Associates. 198 pp.
18. Harter, T. (2003). Groundwater Quality and Groundwater Pollution. FWQP Reference Sheet 11:2.
19. International Commission on Non-Ionizing Radiation Protection (ICNIRP) Guidelines (2010): For Limiting Exposure to Time-Varying Electric, Magnetic and Electromagnetic Fields (up to 300GHz). *Health Physics* **74** (4): 494-522.
20. International Energy Agency (IEA) (2014). *Technology Roadmap. Solar Thermal Electricity*. IEA. 52 pp.
21. International Finance Corporation (IFC) (2012). *International Finance Corporation Performance Standards*. World Bank Group. 196 pp.
22. International Finance Corporation (IFC) (2007). *Stakeholder Engagement*. A Good Practice Handbook for Companies Doing Business in Emerging Markets. World Bank Group. 201 pp.
23. IUCN (2016). IUCN Red List of Threatened Species. Retrieved from: www.iucnredlist.org.
24. Leopold, L. B., Clarke, F. E., Hanshaw, B. B. and Balsley, J. E. (1971). *A procedure for evaluating environmental impact. U.S*. Geological Survey Circular 645, Washington, D.C. 91 pp.
25. Liang, Y., Su, J., Xi, B., Yu, Y., Ji, D., Sun, Y., Cui, C. and Zhu, J. (2017). Life cycle assessment of lithium-ion batteries for greenhouse gas emissions. *Resources, Conservation and Recycling* **117:**285-293.
26. National Guidelines and Standards for Water Quality in Nigeria (1999).
27. National Population Commission (2010). 2006 Population and Housing Census Distribution by Sex, State, Local Government and Senatorial District. Priority Table, Volume III
28. Nigeria Bureau of Statistics, (2016). Annual Abstract of Statistics. Volume 1
29. Nigeria Bureau of Statistics, (2018). Demographic Statistics Bulletin.
30. Nigerian Bureau of Statistics (NBS) (2016). Data Sheet.
31. Nigerian Electricity Regulatory Commission (NERC) (2014). Solar Irradiation in Nigeria States.
32. Nigerian Meteorological Agency (NIMET) (2018). Data for Borno State, 2017.
33. Nigerian Population Commission (NPC) (2010). *NPC Priority Table Vol. IX – Size of Household*. NPC.
34. National Population Commission (NPC) [Nigeria] and ICF. 2019. *Nigeria Demographic and Health Survey 2018*. Abuja, Nigeria, and Rockville, Maryland, USA: NPC and ICF.

35. Odiegwu, P. (2009, October 27). 6.000MW: Can Yar'Adua Achieve December electricity deadline? Nigeria Tribune, p. 25.
36. Oyawoye, M. O. (1972). The basement complex of Nigeria. In Dessauvagie, F. and Whiteman, J. *Africa Geology*. University Press Ibadan, Nigeria. Pp: 18-27.
37. Paul Nwakpa. (2015). Research in Tertiary Institutions in Nigeria: Issues, Challenges And Prospects: Implication for Educational Managers. IOSR Journal of Humanities And Social Science (IOSR-JHSS). Volume 20, Issue 6, Ver. I (Jun. 2015), PP 45-49
38. REA 2017 Presentation. *Upscaling minigrids for least cost and timely access to electricity.* Energizing Economies Programme Review. Rural Electrification Agency. December 4th – 8th, 2017.
39. REA, 2017. *Baseline Survey and Energy Audit Report*. Rural Electrification Agency. October 2017. Version 1.0
40. Sambo, A. S. (2008). *Matching Electricity Supply with Demand in Nigeria*. National Workshop on the Participation of State Governments in the Power Sector: Matching Supply with Demand. Abuja, Nigeria.
41. Shukla, A. K. and Hariprakash, B. (2009). Secondary batteries – nickel systems. Electrodes: Cadmium. *Chemistry, Molecular Sciences and Chemical Engineering*412-417.
42. Smyth E, Vanclay F. (2017). The social framework for projects: a conceptual but practical model to assist in assessing, planning and managing the social impacts of big projects. Impact Assessment& Project Appraisal. 35:65–80
43. Sobulo, R. A. and Adepetu, J. A. (1987). Soil testing and fertilizer formulation crop production in Nigeria. *Proceedings National Fertilizer Seminar, Port Harcourt* 93 – 105.
44. Solar Resource Data: Solargis. © 2017 The World Bank
45. Sun, Z., Cao, H., Zhang, X., Lin, X., Zheng, W., Cao, G., Sun, Y. and Zhang, Y. (2017). Spent lead-acid battery recycling in China – A review and sustainable analyses on mass flow of lead. *Waste Management* **64:** 190-201.
46. The World Bank Group EHS Guidelines for Electric Power Transmission and Distribution (2007).
47. United Nations Development Program (UNDP) (2006). Human Development Report 2006. UNDP. 440 pp.
48. United Nations Environment Programme (UNEP) (2002). *EIA Training Resource Manual. Mitigation and Impact Management (2nd edition)*. UNEP. 56 pp.
49. United States Environmental Protection Agency (USEPA) (2000). *Meteorological monitoring guidance for regulatory modelling applications*. Office of Air Quality Planning and Standards, Research Triangle Park, USA. EPA 454/R-99-005.

50. Whitehead, A. H., Rabbow, T. J., Trampert, M. and Pokorny, P. (2017). Critical safety features of the vanadium redox flow battery. *Journal of Power Souces* **351** (31): 1-7.
51. World Bank Group (2007). *Environmental, Health, and Safety General Guidelines*. World Bank Group. 99 pp.
52. World Bank Safeguard Policies. Operational Manual (OP) 4.01 – Environmental Assessment. Revised in April 2013.
53. World Health Organization (2016). World Malaria Report. ISBN 978-92-4-151171-1 https://apps.who.int/iris/bitstream/handle/10665/252038/9789241511711-eng.pdf;jsessionid=2BF3F3AC29F8FA5D33C7FBF5AD04FFFC?sequence=1
54. World Health Organization (WHO) (2007), *World Health Organization Research Agenda for Extremely Low Frequency Fields.* WHO. 8 pp.
55. World Health Organization (WHO) (2000). *World Health Organization, Potable Water Quality Guidelines.* WHO. 71 pp.
56. Zhang, J., Chen, C., Zhang, X. and Liu, S. (2016). Study on the Environmental Risk Assessment of Lead-Acid Batteries. *Procedia Environmental Sciences* **31:** 873-879.

APPENDICES

APPENDIX 4.1

Socio-Economic Data Gathering tools

Key Informant Interview (KII) guide for meeting with Mairi Community Leader

environmental accord

Key Informant Interview Guide for Community Leader

Overview

This instrument is designed to collect information on the Environmental Impact Assessment (EIA) study for Energizing Education Programme (EEP) with this community. Your honest answers to the questions will, in no small way, assist in ensuring highly quality data.

Consent form.

Hello, my name is Abiola S. Bolarinwa, a social scientist from Environmental Accord Nigeria Limited. I am conducting an Environmental Impact Assessment of Energizing Education Programme (EEP) Proposed Power Plant in this community. The study is important in order to have baseline information of your community before the full operation of the proposed power plant and any other associated facilities. Your participation in this study is voluntary but we would very much appreciate your participation by your response to our questions. Whatever information you provide will be kept strictly confidential and will not be shown to other persons.

Respondent's Name: "LAWAN" MALA ABANDE of ~~MAIRI~~ MAIRI (Village head)

Position in Community Village head

Questions:

1. Can you provide a summary of the history of this community?
2. How did you emerge as a leader and how long have you been in this position as a community leader?
3. Can individual own and sell land in the community?
4. What are the roles assigned to women within your community?
5. How do you handle cases of ender based violence against women in your community?
6. Is there any land issues currently ongoing in the community?
7. Are there schools, hospitals, electricity, telecommunication, public and markets in the community?
8. What is the established mechanism for conflict resolution in the community?
9. What are the notable vices common about the youths of the community?

Attendance Sheet for KII with Mairi Community Leader

ENVIRONMENTAL ACCORD NIGERIA LIMITED
info@envaccord.com
http://www.envaccord.com

ATTENDANCE SHEET

environmental accord

PROJECT TITLE: ESIA OF UNIMAID SOLAR POWER PROJECT
DATE: 01-08-2019
VENUE: LAWAN OF MERI PALACE, MAIDUGURI

S/N	Name	Designation	Organization	Phone Number	Email	Signature
~~ABABA~~						
1	LAWAN KAMALA ABANDE	MAIRI	LAWAN	08166624446		[signature]
2	BULAMA BALE WAKIL	MAIRI	BULAMA	08086958667		[signature]
3	BABA MODU KALASA	MAIRI		08059459383		[signature]
4	ABUBAKAR KAMSULUM	STAFF	MAIRI	08032577961	kamsulumabk@gmail.com	[signature]
5	Albright Olaitan	Envi. Scientist	EnvAccord	08075731831	aolaitan@envaccord.com	[signature]

Focus Group Discussion guide and attendance with men of Mairi community

environmental accord

Focus Group Discussion Guide for Community Members
Group: Men within the host community

Overview

This instrument is designed to collect information on the Environmental Impact Assessment (EIA) study for Energizing Education Programme (EEP) with this community. Your honest answers to the questions will, in no small way, assist in ensuring that we have a reliable gender disaggregated data suitable for analysing gender based issues in the community.

Consent form.

Hello, my name is Abiola S. Bolarinwa, a social scientist from Environmental Accord Nigeria Limited. I am conducting an Environmental Impact Assessment of Energizing Education Programme (EEP) Proposed Power Plant in this community. The study is important in order to have baseline information of your community before the full operation of the proposed power plant and any other associated facilities. Your participation in this study is voluntary but we would very much appreciate your participation by your response to our questions. Whatever information you provide will be kept strictly confidential and will not be shown to other persons.

Socio-Demographic Characteristics of Respondents

Name of Community: MERI COMMUNITY
Name of Moderator: Abiola Bolarinwa
Date of Interview: _____

S/N	Name	Sex	Ethnic Origin	Religion	Educational level	Marital status
1.	Usman Lawan	M	Kanuri	Islam	Primary	Yes with 3 children
2.	Bulama Ngari	M	Shuwa	Islam	Primary	Yes with children
3.	Njidda Idris	M	Shuwa	Islam	Nil	Yes with children
4.	Kabiru muhammed	M	Fulani	Islam	Secondary	Yes with children
5.	Yashua Bala	M	Kilba	Christian	University	No
6.	Babagana Ibrahim	M	Kanuri	Islam	Primary	Yes with children
7.	AbuBaKar Mohammed	M	Kanuri	Islam	Primary	Yes with children

Focus Group discussion guide and attendance with women of Mairi community

Focus Group Discussion Guide for Community Members

(Women [redacted])

environmental accord

Overview

This instrument is designed to collect information on the Environmental Impact Assessment (EIA) study for Energizing Education Programme (EEP) with this community. Your honest answers to the questions will, in no small way, assist in ensuring that we have a reliable gender disaggregated data suitable for analysing gender based issues in the community.

Consent form.

Hello, my name is Abiola S. Bolarinwa, a social scientist from Environmental Accord Nigeria Limited. I am conducting an Environmental Impact Assessment of Energizing Education Programme (EEP) Power Plant in this community. The study is important in order to have a baseline information of your community before the full operation of the proposed power plant and any other associated facilities. Your participation in this study is voluntary but we would very much appreciate your participation by your response to our questions. Whatever information you provide will be kept strictly confidential and will not be shown to other persons.

Socio-Demographic Characteristics of Respondents

Name of Community: Mairi Community
Name of Moderator: [redacted] Rhoda Omotosho
Date of Interview: 4-8-19

S/N	Name	Sex	Ethnic Origin	Religion	Education al level	Marital status	Marital Age
1	HALIMA MODU	F	BORNO	MUSLIM	QURAN	MARRIED	40yrs
2	HAUWA ABDULLAHI	F	BORNO	MUSLIM	QURAN	MARRIED	35yrs
3	FATIMA MOHAMMED	F	BORNO	MUSLIM	QURAN	SINGLE	15yrs
4	BILITA MUSA	F	BORNO	MUSLIM	QURAN	MARRIED	21yrs
5	ZARA GERIMA	F	BORNO	MUSLIM	QURAN	MARRIED	40yrs
6	HAJJA FALMATA ABAKAR	F	BORNO	MUSLIM	QURAN	MARRIED	60yrs
7	AZARA MODU	F	BORNO	MUSLIM	QURAN	MARRIED	60yrs
8	AISHA MOHAMMED US	F	BORNO	MUSLIM	QURAN	SINGLE	15yrs
9	BILIU UMAR	F	BORNO	MUSLIM	QURAN	SINGLE	25yrs
10	FALMATA MODU	F	BORNO	MUSLIM	QURAN	MARRIED	28yrs

Focus Group discussion guide and attendance with youth of Mairi community

Focus Group Discussion Guide for Community Youths

environmental accord

Overview

This instrument is designed to collect information on the Environmental Impact Assessment (EIA) study for Energizing Education Programme (EEP) with this community. Your honest answers to the questions will, in no small way, assist in ensuring that we have a reliable data.

Consent

Hello, my name is Abiola S. Bolarinwa, a social scientist from Environmental Accord Nigeria Limited. I am conducting an Environmental Impact Assessment of Energizing Education Programme (EEP) Proposed Power Plant in this community. The study is important in order to have baseline information of your community before the full operation of the proposed power plant and any other associated facilities. Your participation in this study is voluntary but we would very much appreciate your participation by your response to our questions. Whatever information you provide will be kept strictly confidential and will not be shown to other persons.

Socio-Demographic Characteristics of Respondents

Name of Community: J Cp
Name of Moderator: Abiola Bolarinwa
Date of Interview: Aug 2/ 2019

S/N	Name	Sex	Ethnic Origin	Religion	Educational level	Marital status
	[illegible] Abubakar	M	Bura	Islam	Diploma	M
	Alh Sanusi Adamu	M	[illegible]	Islam	SSCE	M
	Musa Afanara	M	[illegible]	Islam		M
	Musa Adamu	M	Bur	Islam	SSCE	M
	Hussaini Buba	M	Fulani	Islam	SSCE	M
	Alh Mohd	M	[illegible]	Islam	SSCE	M
	Mohd Isa Usman	M	[illegible]	Islam	SSCE	M
	Abdullahi Sule	M	[illegible]	Islam	SSCE	M
	Ala Gana Bukar	M	[illegible]	Islam	SSCE	M
	Zarma Bunu	M	[illegible]	Islam	SSCE	M
	Abubakar Usman	M	Gwoza	Islam	—	M

APPENDIX 9.1

A sample Stakeholder Engagement register

Sample Stakeholder Engagement Register

Stakeholder category (choose from the list)	Individual or group (choose from list)	Stakeholder name	Organization	Position in their organization /	Location	Contact address	Contact phone	Contact email	Stakeholder interest	Stakeholder priority	Engagement objectives	Method of engagement	Date of engagement	Issues raise	Follow-up action

APPENDIX 9.2

Stakeholder Engagement Documents

Stakeholder engagement letter to Borno State Ministry of Environment

environmental accord

July 19, 2019

The Commissioner,
Borno State Ministry of the Environment,
Musa Usman Secretariat,
Maiduguri, Borno State.

MINISTRY OF ENVIR...
PERMANENT SECRETAR...
SIGN ... DATE 31/7
MAIDUGURI

Dear Sir,

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF UNIVERSITY OF MAIDUGURI AND TEACHING HOSPITAL SOLAR POWER PROJECT, MAIDUGURI, BORNO STATE: STAKEHOLDER CONSULTATION MEETING

Environmental Accord Nigeria Limited (EnvAccord) has been commissioned by Rural Electrification Agency (REA) to carry out an Environmental and Social Impact Assessment (ESIA) for the University of Maiduguri and Teaching Hospital Solar Power Project, Maiduguri, Borno State.

An important aspect of the ESIA process is stakeholder consultation. The consultation meeting provides an opportunity for notifying stakeholders of the project intention and receiving valuable feedback and participation. In this regard, representatives of the ESIA Study team propose to meet with you (as one of the identified key stakeholders) at your office as scheduled below:

Date: July 31, 2019

Time: 9 a.m prompt

In addition, please kindly find attached a Background Information Document (BID) containing background information about the project.

Please kindly contact the ESIA Project Manager on +2348075331833 or via email on aolaitan@envaccord.com should you require further information.

Thank you.

Yours faithfully,
For: ENVIRONMENTAL ACCORD NIGERIA LIMITED

Albright Olaitan
Project Manager

Environmental Accord Limited
36B Oguntona Crescent, Gbagada
(Phase 1), Lagos, Nigeria.

Tel: +234-802- 360 - 9591
Email: info@envaccord.com
Website: www.envaccord.com

Stakeholder engagement letter to Borno State Environmental Protection Agency (BOSEPA)

environmental accord

July 19, 2019

RECEIVED DATE 31/7/19

The Director,
Borno State Environmental Protection Agency,
Maiduguri, Borno State.

Dear Sir,

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF UNIVERSITY OF MAIDUGURI AND TEACHING HOSPITAL SOLAR POWER PROJECT, MAIDUGURI, BORNO STATE: STAKEHOLDER CONSULTATION MEETING

Environmental Accord Nigeria Limited (EnvAccord) has been commissioned by Rural Electrification Agency (REA) to carry out an Environmental and Social Impact Assessment (ESIA) for the University of Maiduguri and Teaching Hospital Solar Power Project, Maiduguri, Borno State.

An important aspect of the ESIA process is stakeholder consultation. The consultation meeting provides an opportunity for notifying stakeholders of the project intention and receiving valuable feedback and participation. In this regard, representatives of the ESIA Study team propose to meet with you (as one of the identified key stakeholders) at your office as scheduled below:

Date: August 1, 2019

Time: 11 a.m prompt

In addition, please kindly find attached a Background Information Document (BID) containing background information about the project.

Please kindly contact the ESIA Project Manager on +2348075331833 or via email on aolaitan@envaccord.com should you require further information.

Thank you.

Yours faithfully,
For: ENVIRONMENTAL ACCORD NIGERIA LIMITED

Albright Olaitan
Project Manager

Environmental Accord Limited
36B Oguntona Crescent, Gbagada
(Phase 1), Lagos, Nigeria.

Tel: +234-802- 360 - 9591
Email: info@envaccord.com
Website: www.envaccord.com

Stakeholder engagement letter to Borno State Ministry of Women Affairs and Social Development

July 19, 2019

The Commissioner,
Borno State Ministry of Women Affairs and Social Development,
Musa Usman Secretariat,
Maiduguri, Borno State.

Dear Sir,

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF UNIVERSITY OF MAIDUGURI AND TEACHING HOSPITAL SOLAR POWER PROJECT, MAIDUGURI, BORNO STATE: STAKEHOLDER CONSULTATION MEETING

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An important aspect of the ESIA process is stakeholder consultation. The consultation meeting provides an opportunity for notifying stakeholders of the project intention and receiving valuable feedback and participation. In this regard, representatives of the ESIA Study team propose to meet with you (as one of the identified key stakeholders) at your office as scheduled below:

Date: July 31, 2019

Time: 1 p.m prompt

In addition, please kindly find attached a Background Information Document (BID) containing background information about the project.

Please kindly contact the ESIA Project Manager on +2348075331833 or via email on aolaitan@envaccord.com should you require further information.

Thank you.

Yours faithfully,
For: ENVIRONMENTAL ACCORD NIGERIA LIMITED

Albright Olaitan
Project Manager

Environmental Accord Limited
36B Oguntona Crescent, Gbagada
(Phase 1), Lagos, Nigeria.

Tel: +234-802- 360 - 9591
Email: info@envaccord.com
Website: www.envaccord.com

BORNO STATE
MINISTRY OF WOMEN AFFAIRS
AND SOCIAL DEVELOPMENT
RECEIVED
DATE 31/7/2019

Stakeholder engagement letter to Borno State Ministry of Poverty Alleviation and Youth Empowerment

environmental accord
...superior sustainability solutions

July 19, 2019

The Commissioner,
Borno State Ministry of Sports and Youth Development,
Musa Usman Secretariat,
Maiduguri, Borno State.

Dear Sir,

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF UNIVERSITY OF MAIDUGURI AND TEACHING HOSPITAL SOLAR POWER PROJECT, MAIDUGURI, BORNO STATE: STAKEHOLDER CONSULTATION MEETING

Environmental Accord Nigeria Limited (EnvAccord) has been commissioned by Rural Electrification Agency (REA) to carry out an Environmental and Social Impact Assessment (ESIA) for the University of Maiduguri and Teaching Hospital Solar Power Project, Maiduguri, Borno State.

An important aspect of the ESIA process is stakeholder consultation. The consultation meeting provides an opportunity for notifying stakeholders of the project intention and receiving valuable feedback and participation. In this regard, representatives of the ESIA Study team propose to meet with you (as one of the identified key stakeholders) at your office as scheduled below:

Date: July 31, 2019

Time: 2 p.m prompt

In addition, please kindly find attached a Background Information Document (BID) containing background information about the project.

Please kindly contact the ESIA Project Manager on +2348075331833 or via email on aolaitan@envaccord.com should you require further information.

Thank you.

Yours faithfully,
For: ENVIRONMENTAL ACCORD NIGERIA LIMITED

Albright Olaitan
Project Manager

Environmental Accord Limited
36B Oguntona Crescent, Gbagada
(Phase 1), Lagos, Nigeria.
Tel: +234-802- 360 - 9591
Email: info@envaccord.com
Website: www.envaccord.com

Received 31/July 2019.
Dir Community Dev..
M.i of Pov Allev & YE empowerment.

Stakeholder engagement letter to Jere Local Government

July 19, 2019

The Chairman,
Jere Local Government Area,
Maiduguri,
Borno State,

Dear Sir,

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF UNIVERSITY OF MAIDUGURI AND TEACHING HOSPITAL SOLAR POWER PROJECT, MAIDUGURI, BORNO STATE: STAKEHOLDER CONSULTATION MEETING

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An important aspect of the ESIA process is stakeholder consultation. The consultation meeting provides an opportunity for notifying stakeholders of the project intention and receiving valuable feedback and participation. In this regard, representatives of the ESIA Study team propose to meet with you (as one of the identified key stakeholders) at your office as scheduled below:

Date: August 2, 2019

Time: 10 a.m prompt

In addition, please kindly find attached a Background Information Document (BID) containing background information about the project.

Please kindly contact the ESIA Project Manager on +2348075331833 or via email on aolaitan@envaccord.com should you require further information.

Thank you.

Received by the Supervisor Main motor park And forwarded to the Chairman for Consideration
2/08/2019

Yoursfaithfully,
For: ENVIRONMENTAL ACCORD NIGERIA LIMITED

Albright Olaitan
Project Manager

Environmental Accord Limited
36B Oguntona Crescent, Gbagada
(Phase 1), Lagos, Nigeria.

Tel: +234-802- 360 - 9591
Email: info@envaccord.com
Website: www.envaccord.com

Stakeholder engagement letter to the Vice Chancellor of University of Maiduguri

environmental accord

July 19, 2019

The Vice Chancellor,
University of Maiduguri,
Bama road, Maiduguri,
Borno State.

Dear Sir,

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF UNIVERSITY OF MAIDUGURI AND TEACHING HOSPITAL SOLAR POWER PROJECT, MAIDUGURI, BORNO STATE: STAKEHOLDER CONSULTATION MEETING

Environmental Accord Nigeria Limited (EnvAccord) has been commissioned by Rural Electrification Agency (REA) to carry out an Environmental and Social Impact Assessment (ESIA) for the University of Maiduguri and Teaching Hospital Solar Power Project, Maiduguri, Borno State.

An important aspect of the ESIA process is stakeholder consultation. The consultation meeting provides an opportunity for notifying stakeholders of the project intention and receiving valuable feedback and participation. In this regard, representatives of the ESIA Study team propose to meet with you (as one of the identified key stakeholders) at your office as scheduled below:

Date: August 2,2019

Time: 9 a.m prompt

In addition, please kindly find attached a Background Information Document (BID) containing background information about the project.

Please kindly contact the ESIA Project Manager on +2348075331833 or via email on aolaitan@envaccord.comshould you require further information.

Thank you.

Yoursfaithfully,
For: ENVIRONMENTAL ACCORD NIGERIA LIMITED

Albright Olaitan
Project Manager

Environmental Accord Limited
36B Oguntona Crescent, Gbagada
(Phase 1), Lagos, Nigeria.

Tel: +234-802- 360 - 9591
Email: info@envaccord.com
Website: www.envaccord.com

Stakeholder engagement letter to the Chief Medical Director of University of Maiduguri

environmental accord

July 19, 2019

OFFICE OF THE CHIEF MEDICAL DIRECTOR RECEIVED UMTH MAIDUGURI

The Chief Medical Director,
University of Maiduguri Teaching Hospital,
P.M.B. 1414, Bama Road, Maiduguri,
Borno State.

Dear Sir,

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF UNIVERSITY OF MAIDUGURI AND TEACHING HOSPITAL SOLAR POWER PROJECT, MAIDUGURI, BORNO STATE: STAKEHOLDER CONSULTATION MEETING

Environmental Accord Nigeria Limited (EnvAccord) has been commissioned by Rural Electrification Agency (REA) to carry out an Environmental and Social Impact Assessment (ESIA) for the University of Maiduguri and Teaching Hospital Solar Power Project, Maiduguri, Borno State.

An important aspect of the ESIA process is stakeholder consultation. The consultation meeting provides an opportunity for notifying stakeholders of the project intention and receiving valuable feedback and participation. In this regard, representatives of the ESIA Study team propose to meet with you (as one of the identified key stakeholders) at your office as scheduled below:

Date: August 1, 2019

Time: 10 a.m prompt

In addition, please kindly find attached a Background Information Document (BID) containing background information about the project.

Please kindly contact the ESIA Project Manager on +2348075331833 or via email on aolaitan@envaccord.comshould you require further information.

Thank you.

Yoursfaithfully,
For: ENVIRONMENTAL ACCORD NIGERIA LIMITED

Albright Olaitan
Project Manager

Environmental Accord Limited
36B Oguntona Crescent, Gbagada
(Phase 1), Lagos, Nigeria.

Tel: +234-802- 360 - 9591
Email: info@envaccord.com
Website: www.envaccord.com

Stakeholder engagement letter to the University of Maiduguri Department of Works, Physical Planning and Development

July 19, 2019

The Director,
Works, Physical Planning and Development Department,
University of Maiduguri,
Bama road, Maiduguri,
Borno State.

Dear Sir,

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF UNIVERSITY OF MAIDUGURI AND TEACHING HOSPITAL SOLAR POWER PROJECT, MAIDUGURI, BORNO STATE: STAKEHOLDER CONSULTATION MEETING

Environmental Accord Nigeria Limited (EnvAccord) has been commissioned by Rural Electrification Agency (REA) to carry out an Environmental and Social Impact Assessment (ESIA) for the University of Maiduguri and Teaching Hospital Solar Power Project, Maiduguri, Borno State.

An important aspect of the ESIA process is stakeholder consultation. The consultation meeting provides an opportunity for notifying stakeholders of the project intention and receiving valuable feedback and participation. In this regard, representatives of the ESIA Study team propose to meet with you (as one of the identified key stakeholders) at your office as scheduled below:

Date: July 30, 2019

Time: 2 p.m prompt

In addition, please kindly find attached a Background Information Document (BID) containing background information about the project.

Please kindly contact the ESIA Project Manager on +2348075331833 or via email on aolaitan@envaccord.com should you require further information.

Thank you.

Yours faithfully,
For: ENVIRONMENTAL ACCORD NIGERIA LIMITED

Albright Olaitan
Project Manager

Environmental Accord Limited
36B Oguntona Crescent, Gbagada
(Phase 1), Lagos, Nigeria.

Tel: +234-802- 360 - 9591
Email: info@envaccord.com
Website: www.envaccord.com

Attendance sheet of meeting with University of Maiduguri Department of Works, Physical Planning and Development

info@envaccord.com
http://www.envaccord.com

ATTENDANCE SHEET

environmental accord

PROJECT TITLE: ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR ENERGIZING EDUCATION PROGRAMME (PHASE 2) PROJECTS

DATE: 31-07-2019

VENUE: UNIMAID Dir of Planning Office

S/N	Name	Designation	Organization	Phone Number	Email	Signature
1	Engr. Yahya Habu	Director, Works, PPD	Unimaid	07037746632	yhabu@ymail.com	[signature]
2	Engr. Mohd Bello Ilorshi	Electrical Engr. I	Unimaid	08065346524	bello057@yahoo.com	[signature]
3.	Engr. Yeshua Bala	Electrical Engr. I	Unimaid	08069353740	yeshuabala@gmail.com	[signature]
4	Albright Olaitan	Environmental Specialist	Env Accord	08075531833	aolaitan@envaccord.com	[signature]
5.	Onotasho Phido	Female gender Specialist	Env Accord Ltd	08109438110	[illegible]@gmail.com	[signature]
6	Abiola Bolarinwa	Social Expert	Env Accord	08164155291	abolarinwa@envaccord.com	[signature]

Attendance sheet of meeting with University of Maiduguri Teaching Hospital's Chief of Medical Advisory Council

ENVIRONMENTAL ACCORD NIGERIA LIMITED
info@envaccord.com
http://www.envaccord.com

ATTENDANCE SHEET

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PROJECT TITLE: ESIA OF UNIMAID SOLAR POWER PROJECT
DATE: 01-08-2019

VENUE: UNIMAID TEACHING HOSPITAL. (MEETING WITH C-MAC)

S/N	Name	Designation	Organization	Phone Number	Email	Signature
1.	DR MALA BUKAR SANDABE	C-MAC	UMTH	07036414122	mbsandabe@yahoo.com	
2	Engr. Moh'd Bello Ibrahim	EET	Unimaid	08065346527	bello057@yahoo.com	
3	Engr Yeshua Bala	EET	Unimaid	08069353740	yeshuabala@gmail.com	
4	Kamsulum Abubakar	Technical	Unimaid	08022798134	kamsulumabk@gmail.com	
5	Albright Olatun	Env Scientist	Env Accord.	08075331833	aolatun@envaccord.com	

Attendance sheet of meeting with Department of Works at University of Maiduguri Teaching Hospital

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PROJECT TITLE: ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR ENERGIZING EDUCATION PROGRAMME (PHASE 2) PROJECTS

DATE: 02-08-2019
VENUE: UNIMAID TEACHING HOSPITAL

S/N	Name	Designation	Organization	Phone Number	Email	Signature
1	ENGR. MODU ALI GANA	ADES	UMTH	08035383385	modualigana@gmail.com	
2	ABDULLAHI HASSAN	T.O	U.M.T.H	08036793270	Apsun@gmail.com	
3.	OMOTUSHO AHUDA U.	FEMALE GENDER SPECIALIST	ENVACCORD LTD	[illegible]		
4.	Abiola Bolarinwa	Social Expert	EnvAccord	08164155291	abolarinwa@envaccord.com	
5	Engr M.B. GASHASHA	DDES	UMTH	0803081[illegible]	[illegible]@yahoo.com	
6	Albright Olatu	[illegible]	EnvAccord	[illegible]	[illegible]	

Attendance sheet of meeting with the Students Union Government of University of Maiduguri

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ATTENDANCE SHEET

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PROJECT TITLE: ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR ENERGIZING EDUCATION PROGRAMME (PHASE 2) PROJECTS

Key Informant Interview with Students Union Government

DATE: 07-08-19

VENUE: SUG OFFICE, UNIMAID

S/N	Name	Designation	Organization	Phone Number	Email	Signature
1	Farouk, Mohammad Aminu	SUG President	SUG	07030090148	mfaroukus@gmail.com	
2	Engr. Mohd Bello Ibrahim	Engr. II	Unimaid	08065346527	bello057@yahoo.com	
3	Mohammed Alkali	Tech. officer	Unimaid	08165581585	alkali57@gmail.com	
4	Oluwatosin Philip	Remote Sensing Specialist	Envaccord Ltd	0806543811 0		

Attendance sheet of meeting with Farmers within the proposed Project site

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PROJECT TITLE: ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR ENERGIZING EDUCATION PROGRAMME (PHASE 2) PROJECTS

DATE: 02-08-2019

VENUE: PROJECT SITE (MEETING WITH FARMERS ON SITE)

S/N	Name	Designation	Organization	Phone Number	Email	Signature
1.	Regina Martins	Farmer	Unimaid	07061508934		[illegible]
2.	Egli Stanley	Farmer	Unimaid	09036055516		[illegible]
3	Vesla danladi	Farmer	Unimaid	0806[illegible]0570	-	[illegible]
4	Cecilia Musa	Farmer	Unimaid	=		

Attendance sheet of meeting with Mairi market leader and Jere LGA representative

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PROJECT TITLE: ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR ENERGIZING EDUCATION PROGRAMME (PHASE 2) PROJECTS

DATE: 02 – 08 – 2019
VENUE: Chairman's office, Mairi Market

S/N	Name	Designation	Organization	Phone Number	Email	Signature
1.	Mamman Abba Bashi	Supervisor	Jere L. G.	08032363066	abbamamanb@gmail.com	[illegible]
2.	Bunu A. Tijjani	Chairman	Nurin main	08035615469	bunualitijjani@gmail.com	[illegible]
3.	Engr Yeshua Bala	Elect. Engineer	UNIMAID	08069353740	yeshuabala@gmail.com	[illegible]
4	Mohammed Saleh	T/O (Civil)	UNIMAID	08036514219	Mohd.Saleh@Gmail.com	[illegible]
5	Allonght Olutm	Social Scientist	EnvAccord	08075377033	[illegible]	[illegible]

Background Information Document Sent to Stakeholders

RURAL ELECTRIFICATION AGENCY

BACKGROUND INFORMATION DOCUMENT (BID)

FOR

UNIVERSITY OF MAIDUGURI AND TEACHING HOSPITAL SOLAR POWER PROJECT IN BORNO STATE

JULY, 2019

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF THE UNIVERSITY OF MAIDUGURI AND TEACHING HOSPITAL SOLAR POWER PROJECT

A1.1 Introduction

Energizing Education Programme (EEP) is an initiative of the Federal Government of Nigeria (FGN), to provide sustainable and clean power supply to 37 Federal Universities and 7 University Teaching Hospitals across the country. The EEP Project includes the provision of an independent power plant, upgrading existing distribution infrastructure, street lighting to improve security within the universities' campuses, as well as the development of a world class training centre on renewable energy for each university. University of Maiduguri (UniMaid) and the Teaching Hospital in Borno State are part of the beneficiaries of the programme.

The project is being implemented by the Rural Electrification Agency (REA) and developed in Phases. The Phase 2 Projects involves the deployment of solar technology for generation of power supply to meet the current demands and future needs in some selected tertiary institutions and teaching hospitals across Nigeria.

REA proposes the installation of a 12.0MW Solar Power Plant within UniMaid main campus for the generation and distribution of power to the university and teaching hospital. The aim of this document is to provide background information about the solar power project and to receive comments on any issues you may have, as one of the identified key stakeholders.

A1.2 Project Location

UniMaid is located along Bama road, Maiduguri while the Teaching Hospital is also sited along Bama road at about 3km northwest of the main campus (outside the boundary of the University). UniMaid and the Teaching hospital are located within Jere Local Government area of Borno State. The Land allocated as the project site inside the university is approximately 20.0 - 25.0 hectares land (GPS Latitude 11.79372°N and Longitude 13.30172°E) located close to UniMaid 3rd gate (Figure 1).

The proposed project site is a Greenfield area characterised by sparsely distributed trees, shrubs, and grasses (Plate 1). The land is also used for seasonal farming by the families of university staff living within the institution.

Figure 1: Satellite imagery of the proposed site within UniMaid.

Plate 1: Aerial picture of the proposed site within UniMaid

A1.3 Overview of the Project

The UniMaid Solar power project will involve the installation and operation of Solar panels and additional facilities to generate power for UniMaid as well as the Teaching Hospital. Solar panels will be installed on the site using piling foundations and the power generated will be transmitted to UniMaid powerhouse (also the switch yard) located about 1.8km and the Teaching Hospital powerhouse located

about 4.9km to the Project site.

The power house will also serve as the holding area for the batteries and inverters to be installed for the Project. Power distribution within the institution will be via the existing power infrastructure (overhead and underground cables). The power generated will be distributed within the university using the existing distribution networks within the university and the teaching hospital. Additional streetlights will be installed and powered by the proposed Project. Furthermore, a training and development centre for renewable energy will be constructed on the allocated land area for the proposed Project. The training center will be open to students of the University for learning and skill acquisition opportunities.

Upon completion of the Project, the University and the teaching hospital will be disconnected from the national grid. Also, the generating sets present within the university and the teaching hospital will be maintained as backup sources of power.

A1.4 Project Justification

Access to uninterrupted power supply in federal universities in Nigeria is a major challenge and barrier to effective research, student learning and institutional operations. Constant supply of electricity is of strategic importance in the conduct of research. In Nigeria, it has been extremely difficult to meet international research standards due to epileptic power supply in our tertiary institutions, which is a reflection of the generally poor supply of electricity in the country.

In view of this, the Federal Government of Nigeria through REA set up the Energizing Education Programme (EEP) for Federal Universities. Tertiary institutions that will benefit from this programme will be able to generate the power needed for all their operations. The EEP, is also a key programme to be implemented towards achieving a part of the Power Sector Recovery Programme (PSRP) objectives and provides a measure in ensuring that Nigeria achieves its carbon emission targets (to cut back on its carbon emission by 20 % on its own and 27 % with assistance from the climate change fund, in the next 15 years) as contained in its Nationally Determined Contributions (NDC), under the Paris Agreement.

The UniMaid solar power project will ensure the provision of clean, affordable and uninterrupted power supply which would boost research, learning, and academic activities within the university and teaching hospital and also contribute to improving the safety and quality of the environment.

A1.5 Project Activities

The project activities can be divided into pre-construction and construction, operation and decommissioning phase.

Pre-Construction Phase Activities:

- Mobilization of personnel and materials to site;
- Site clearing and land preparation.

Construction/Installation Phase Activities:

- Erection of piling foundations;
- Solar PV panels and ancillary component installation;
- Upgrading of existing power distribution infrastructure;
- Installation of additional streetlights;
- Construction of training and development center.

Operation Phase Activities:

- Testing and commissioning;
- Power generation and distribution;
- Equipment maintenance;
- Utilities consumption.

Decommissioning Phase Activities:

- Dismantling of equipment and associated facilities;
- Scrapping and dismantling of equipment;
- Restoration of site to pre-existing conditions.

A1.6 Preliminary Impacts and Mitigation Measures

Preliminary Potential Impacts

Potential and associated impacts of the project preliminary identified at this stage include the following:

Air Quality

- Vehicular emissions during mobilization of personnel and equipment to the site. (Impact would be localized).

Noise Emissions

- Noise emissions during the site clearing, panel installation, and fixture of other ancillary components (impact is site-specific).

Groundwater Quality

- Potential contamination of groundwater during operations as a result of washing the solar panels (the impact is site specific and negligible).

Flora and Fauna

- Site clearing may lead to loss of fauna due to destruction of habitats;

- Clearing of the land in preparation of erecting piling foundations may lead to loss natural vegetation and destruction of habitats.

Waste Generation

- Wastes from the installation activities may arise from a range of sources including the following: e-waste, packaging materials, wastes from workers, equipment, and materials (impact would be localized);
- General and hazardous wastes (spent batteries, damaged/discarded solar panels) produced as a result of the operational processes (impact is site-specific).

Transport and Access

- Increased road traffic during installation of the project (impact is localized).

Occupational Health and Safety

- Potential impacts to workers during installation and operation phases include;
  - Safety and fire hazards;
  - Electric shock during electrical works.

Community Health and Safety

- Increase in risk factors associated with communicable diseases;

Peoples Way of Life and Business

- Loss of farmlands;
- Training and employment opportunities;
- Stimulation of educational activities thereby promoting research and development;
- Acquisition of new skill due to technology transfer.

Mitigation Measures

In the light of the preliminary potential impacts identified, appropriate mitigation measures has been incorporated in the Project design and additional mitigation measures will be recommended in the ESIA report which will be put in place throughout the life cycle of the Project to minimize its environmental footprint.

"We would like to meet with you to discuss any opinions and concerns you may have about any of these potential impacts".

UNIVERSITY OF MAIDUGURI AND TEACHING HOSPITAL SOLAR POWER PROJECT: ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

We would like you to take part in this ESIA process so you can raise any issues and comments you may have about the Solar Power Project. Your comments are a key part of the study to see whether the Project should proceed and it is important that REA understands your comments so that they can be answered and dealt with in the ESIA.

To receive regular information throughout the ESIA process, you must register as an Interested and Affected Party. To register please send this form to Rural Electrification Agency (through its consultant, EnvAccord) at the address given below. If you want to make any comments at this stage please use this form. Alternatively, please do not hesitate to send an email or write separately to the e-mail address provided below.

You can make additional comments for the study team to record on a separate page or on the reverse side of this form. Please post this comment sheet to the address below as soon as possible and preferably on or before August 30, 2019 so that we can take your comments into consideration in the ESIA. The comments could also be emailed to the address below.

Please fill in your details	
Name:	Organization:
Telephone:	Position:
Cell phone:	Email:
Address:	

Please post or fax this form to the address below:

Environmental Accord Nigeria Limited
Attention: Albright Olaitan
Tel: +234 807-533-1833, +234-813-636-3762
Email: aolaitan@envaccord.com
Address: Environmental Accord Nigeria Limited
36B, Oguntona Crescent, Gbagada (Phase 1),
Lagos, Nigeria

Comments Form

It would be useful if you could answer the questions below but please feel free to provide any comments you would like to raise. Please continue on additional paper if required.

1. What are the primary comments that you have about this Project?

2. Do you have or know of any information that we should know for the ESIA (e.g. environmental information or community, social or economic information related to the Project location and/or the Project activities)?

Many thanks for your participation

APPENDIX 9.3

Grievance Redress Mechanism (GRM) for the Nigeria Electrification Project (NEP)