DRAFT REPORT

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

OF

THE

ENERGIZING EDUCATION PROGRAMME PHASE III

FEDERAL UNIVERSITY DUTSIN-MA KATSINA

AUGUST 2023

TABLE OF CONTENT

TABLE OF CONTENT..2
LIST OF FIGURES..6
LIST OF PLATE..7
LIST OF TABLES..8
SYMBOLS OF UNITS OF MEASUREMENTS..10
LIST OF ACRONYMS AND ABBREVIATIONS..11
LIST OF ESIA PREPARERS..14
EXECUTIVE SUMMARY..15
CHAPTER ONE: INTRODUCTION..31
1.1 Background of the Subproject..31
1.2 Objectives of the ESIA..31
1.3 Scope of the ESIA Study..33
1.4. Study Approach/ Methodology in Details..33
1.5 Limitation of the study..35
1.6 Policy, Legal and Administrative Framework..36
1.6.6 Institutional Framework..51
1.6.6.10 State Institutions..54
1.7. Report Structure..56
CHAPTER TWO: PROJECT LOCATION AND JUSTIFICATION..57
2.1 Project Location..57
2.1.1 Description of the Project Site..58
2.1.2 Land Survey assessment..60
2.1.3 Existing Infrastructure..63
2.2. Need for the Project..63
2.3 Value of the Project..64
2.3.1 Project Benefits..64
2.4 Envisaged Sustainability..66
2.4.1 Technical Sustainability..66
2.4.2 Environmental Sustainability..66
2.4.3 Economic Sustainability..66
2.4.4 Social Sustainability..67
2.5 Project Alternatives..68
2.5.1 Analysis of Project Alternative..68
2.5.2 Site Alternatives..68
2.5.3 Solar Power Technology Alternatives..69
2.5.4 Solar Batteries Alternatives..70
2.5.5 Project Options..72
CHAPTER THREE: DESCRIPTION OF THE SUBPROJECT..73
3.1 Project Overview..73
3.2 Project Requirements..74
3.3 Project Components..78

3.4 Operation and Maintenance....93
3.5 Project Implementation Phase Activities....95
3.5.1 Preconstruction....95
3.5.2 Construction....95
3.5.3 Commissioning and Operation....96
3.5.4. Decommissioning....96
3.6 Project Interface Management and Schedule....99
3.7 Project Schedule....101
CHAPTER FOUR: DESCRIPTION OF EXISTING ENVIRONMENT....102
4.1 Preamble....102
4.2 Study Methodologies (Baseline Data Acquisition Methods)....104
4.2.1 Climate and Meteorology....104
4.2.2 Soils and Land Use....108
4.2.3 Terrestrial Vegetation....108
4.2.4 Water Quality Assessment....109
4.2.5 Wildlife Survey....109
4.2.6 General Quality Assurance and Quality Control Measures in Field Survey....110
4.3 Field Observations, Results and Discussion of Existing Environmental Conditions...112
4.3.1 Climate and Meteorology....112
4.3.2 Air Quality....116
4.3.3 Ambient Noise Level....118
4.3.4 Geology and Geophysical Investigations....118
4.3.5 Soil....121
4.3.7 Vegetation....132
4.3.8 Wildlife....136
4.4.1 Population Characteristics of the Project Area....143
CHAPTER FIVE: ASSOCIATED AND POTENTIAL IMPACTS....157
5.1 Introduction....157
5.2 Impact Assessment Overview....157
5.3 Identification of Environmental and Socio-economic Aspects and Impacts....157
5.3.2 Screening and Scoping for Potential Impacts....160
5.4 Determination of Impact Significance....164
5.4.1 Method for Determining Impact Magnitude....164
5.4.2 Determining Receptor Sensitivity....166
5.4.3 Significance....167
5.5 Impacts Discussion....170
5.5.1 Potential Positive Impacts....170
5.5.2Potential Negative Impacts....172
5.6 Risk and Hazard Assessment....187
5.6.1 Project Specific Risks and Hazards....187
5.7 Summary of Anticipated Impacts....188
CHAPTER SIX: MITIGATION MEASURES....190
6.0 INTRODUCTION....190
6.1 Mitigation measures and approach....190

CHAPTER SEVEN: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP) 208
7.1 Introduction 208
7.2 Objectives of the ESMP 208
7.3 Environmental and Social Management Measures 209
7.4 Environmental Monitoring Programme....226
7.5 Roles, Responsibilities and Accountabilities....229
7.6 Additional Management Plans....232
7.7 Environmental Monitoring Program 232
7.8 Training, Awareness and Capacity Building for Zonal Offices 233
7.8.1 ESMP Capacity Building Plan 234
7.9 Implementation Schedule and Reporting 234
7.10 Implementation Schedule and Reporting 235
7.11 ESMP Costing 236
CHAPTER EIGHT: REMEDIATION PLAN AFTER DECOMMISIONING/ CLOSURE 237
8.1 Introduction 237
8.2 Decommissioning Activities....237
8.3 Management of Decommissioning Activities 237
8.4 Abandonment Plan 239
8.5 Roles, Responsibilities and Accountabilities....240
CHAPTER NINE: STAKEHOLDER ENGAGEMENT AND GRIEVANCE REDRESS MECHANISM....242
9.1 Stakeholder Engagement 242
9.2 Objectives of Stakeholder Engagement....242
9.3 Disclosure and Participation Plan....243
9.3.3 Timetable for Disclosure 244
9.4 Stakeholder Identification and Analysis....245
9.5 Grievance Redress Mechanism 246
9.4.1 Grievance Redress Mechanism Process 247
CHAPTER TEN: CONCLUSION AND RECOMMENDATIONS 252
10.1 Conclusion 252
10.2 Recommendation 253
REFERENCES 254
ANNEX 257
Annex 1: Terms of Reference for the preparation of Environmental and Social Impact Assessment in Federal University Dustin Ma, Katsina State 257
Annex 2: Survey Questionnaire....269
Dear Respondent,....269
SECTION A: Household data 269
SECTION B: Health Status 270
SECTION C. Standard of Living / Socio-Economic Activities 1.0 Assets....271
2.0 Household Services 272
3.0 Sources of Water 272

4.0 Income 273
4.1 Remittances 273
SECTION D: Gender-Based Violence/Sexual Exploitation and Abuse 273
SECTION E: Resources/ Cultural Property 274
SECTION F: Intervention Project Activities Impact Evaluation 275
Section G: Grievance Redress Mechanism 276
Annex 3: Waste Management Plan 277
Annex 4: Proposed Federal University Dutsin-Ma Power System Master Plan 287
Annex 5: Biodiversity Management Plan. 288

LIST OF FIGURES

Figure 1. 1: Federal Ministry of Environment Environmental Impact Assessment Process ...35
Figure 2. 1: Map showing the location of EEP project site at FUDMA 57
Figure 2. 2: Closer view of the substation in the region of Katsina....60
Figure 2. 3: Federal University Dutsin-Ma Katsina Master Plan 62
Figure 2. 4: Four different types of solar collector designs 69
Figure 3. 1: Overview of Site Characteristics, Equipment and General Configuration 74
Figure 3. 2: Areas coverage of the proposed PV Plant at Federal University, Dutsin-Ma 75
Figure 3. 3: Simplified electrical configuration diagram....80
Figure 3. 4: Example of a Monofacial Si-mono photovoltaic module 82
Figure 3. 5: Example of string photovoltaic inverter....82
Figure 3. 6: String Inverter Single Line Diagram 84
Figure 3. 7: Example of Transformer 85
Figure 3. 8: Example of a Power Station 86
Figure 3. 9: Power station Single Line Diagram....87
Figure 3. 10: Typical Road Cross Section 88
Figure 3. 11: Elevation plans of the training Centre 89
Figure 3. 12: Distribution Network Layout for FUDMA 90
Figure 3. 13: Federal University of Duste-Ma Distribution Network Single Line Diagram ...91
Figure 3. 14: Streetlight layout 92
Figure 3. 15: Planned Road Network in FUDMA 93
Figure 3. 16: Typical EPC Construction Phase and Handover Protocol 101
Figure 4. 1: Soil Sampling, Air Quality/Noise Level Sampling Location Map for the Study: (SS=Soil Sampling point, SSC=Soil sampling Control point), (AQ=Air quality point, AQC-Air Quality Control point) 103
Figure 4. 2: Monthly mean Temperature for Katsina (2001 – 2021)....113
Figure 4. 3: Monthly Average Relative Humidity for the Period of Ten Years 113
Figure 4. 4: Monthly Average Rainfall for the Period of Ten Years....114
Figure 4. 5: Prevailing Wind Directions in the Study Area 115
Figure 4. 6: Mean sunshine hours in Dutsin Ma 2001 – 2021 115
Figure 4. 7: Cloud Cover and Visibility Data for Katsina 116
Figure 4. 8: Geological map showing Katsina State 120
Figure 4. 9: Topography map of Katsina State 121
Figure 4. 10: Administrative Structure of FUDMA....142
Figure 4. 11: % Respondent Gender Distribution in the Project Location 144
Figure 4. 12: % Respondent Age Distribution in the Project Location 144
Figure 4. 13: % Respondent Marital Status in the Project location 145
Figure 4. 14: % Respondent Occupation distribution pattern within the Project location 146
Figure 4. 15: % Respondent Residential status within the Project location 147
Figure 4. 16: % Respondent Ethnic groups within the Project location 147
Figure 4. 17: % Respondent Religion Groups within the Project location 148
Figure 4. 18: % Respondent Education Distribution within the Project location 148
Figure 4. 19: % Respondent Income Distribution within the Project location 149
Figure 4. 20: Housing Attributes in the Surveyed Project Community....150

Figure 4. 21: % Respondent's Land and Housing Tenure Characteristics 150
Figure 4. 22: % Respondent's Waste Disposal Method 151
Figure 6. 1: Matrix for Determination of Mitigation Measures 190
Figure 7. 1: Roles and Responsibilities: Pre-Construction, Construction & Operational Phases 229
Figure 9. 1: GRM process 247

LIST OF PLATE

Plate 2. 1: Project Location Environment 59
Plate. 2. 2: Proposed Site 59
Plate 2. 3: Existing Transformers in FUDMA 63
Plate 2. 4: Source of Water Supply within the Project Environment 63
Plate 4. 1: Consultation/Engagement with Key Staff 139
Plate 4. 2: Federal University of Dutsin-Ma 140
Plate 4. 3: Federal University of Dutsin-Ma Housing type 150
Plate 4. 4: Project Location Environment 151
Plate 4. 5: Source of Energy within the Project Environment 152
Plate 4. 6: Source of Water Supply within the Project Environment 153
Plate 4. 7: Consultation with the key staff of FUDMA 156

LIST OF TABLES

Table 2. 1 : Location characteristics 58
Table 2. 2: Final Site Coordinates for the Dutsin-Ma EEP 61
Table 2. 3: Potential SPV System Configurations and Design Assumptions based on 4.8 daily hours of peak power output 70
Table 3. 1: Area coverage 75
Table 3. 2: Waste Streams of Project Phases 78
Table 3. 3: Main characteristics of the fixed mounting structure 79
Table 3. 4: Key Project Characteristics 79
Table 3. 5: Photovoltaic module characteristics 81
Table 3. 6: Inverter characteristics 82
Table 3. 7: Inverters 83
Table 3. 8: Transformer characteristics 85
Table 3. 9: Power station characteristics 86
Table 3. 10: Power stations 86
Table 3. 11: Project Implementation Phase Activities 98
Table 3. 12: Staff requirements 99
Table 3. 13: Solar PV Project Interfaces 99
Table 4. 1: Soil Sampling Stations, Air Pollutants, Noise Measurements and Water Sample coordinates 102
Table 4. 2: Sampling Coordinates for Air Pollutants and Noise Measurements 107
Table 4. 3: Description of the Soil Sampling Stations and Coordinates 108
Table 4. 4: Code, Sample Type and Site Grid Coordinate of the Water Samples 109
Table 4. 5: Air Quality Characteristics of the Study Area 116
Table 4. 6: Regulatory Standards for Ambient Air Quality 117
Table 4. 7: Noise Level of the Study Area 118
Table 4. 8: Physico-Chemical Characteristics of Soil within the Study Area 122
Table 4. 9: Classification of Soil pH 123
Table 4. 10: Heavy Metals in Soil of Project Affected Area 126
Table 4. 11: Soil Texture Analysis 127
Table 4. 12: Soil Microbial Count of Project Area 128
Table 4. 13:Physico-chemical characteristics sampling of groundwater in the study area ... 128
Table 4. 14: Drinking Water Quality Standards 130
Table 4. 15: Target and Intervention values of some pollutants in groundwater 132
Table 4. 16 Microbial characteristics of groundwater in the project Site 132
Table 4. 17: Percentage of Trees According to Land use in the Study Area. 133
Table 4. 18: Percentage of Trees according to Management Practices (uses) in the Study Area 134
Table 4. 19: Federal University of Dutsin-Ma Faculties and Departments 140
Table 5. 1: Project Activities – Leopold's Environmental and Social Interaction Matrix (Impact Significance Matrix) 162
Table 5. 2: EEP III Solar Power Plant Impacts Categorisation 162
Table 5. 3: Event Magnitude Rankings 165
Table 5. 4: Receptor Sensitivity Ranking 166

Table 5. 5: Impact Significance 167
Table 5. 6: Leopold's Activity-Receptor Interaction Matrix (Impact Significance Matrix) 169
Table 5. 7: Summary of Potential Negative Impacts Associated with the Pre- Construction Phase of the proposed Project 176
Table 5. 8: Summary of Potential Negative Impacts Associated with the Construction Phase of the proposed Project 182
Table 5. 9: Summary of Potential Impact Associated with the Commissioning Phase of the proposed Project 183
Table 5. 10: Summary of Potential Negative Impacts Associated with Operational Phase of the proposed Project 186
Table 5. 11: Risk Assessment Matrix 187
Table 5. 12: Summarized Environmental and Social Impacts of Solar Power Plant 189
Table 6. 1: Summary of mitigation approaches for the University Solar Hybrid Power Projects 191
Table 6. 2: Mitigation Measures for the Potential Negative Impacts of the proposed Project 193
Table 7. 1: Environmental Management Plan for Pre-Construction Phase of the proposed Project 210
Table 7. 2: Social Management Plan for Pre-Construction Phase of the proposed Project ... 212
Table 7. 3: Environmental Management Plan for Construction Phase of the proposed Project 214
Table 7. 4: Social Management Measures for Construction Phase of the proposed Project .. 217
Table 7. 5: Environmental management for Commissioning phase 221
Table 7. 6: Social Management Measures for Commissioning Phase 221
Table 7. 7: Environmental Management Measures for Operational Phase 222
Table 7. 8: Social Management Measures for Operational Phase 224
Table 7. 9: Environmental Monitoring Programme for the proposed Project 227
Table 7. 10: The Roles and Responsibilities of the Stakeholders in the Implementation, Monitoring and Review of the ESMP 229
Table 7. 11: ESMP Capacity building plan 234
Table 7. 12: ESMP Implementation Schedule 234
Table 7. 13: Cost of ESMP 236
Table 9. 1: Stakeholder Engagement and Disclosure Methods 245
Table 9. 2: Grievance Recording Form 248
Table 9. 3: Classification and Categorisation of External Grievances 249

SYMBOLS OF UNITS OF MEASUREMENTS

Cubic metres	(m3)
Decibel	(dB)
Hectare	Area (Ha)
Hertz	(Hz)
Kelvin	(K)
Kilometres	(Km)
Kilovolt-ampere	(kVA)
Kilovolts	(Kv)
Kilowatts	(Kw)
Megawatt	(MW)
Meter per second	(m/s)
Metres	(M)
Volt	(V or E)
Watt per square meter	(W/m^2)
Watt	(W)

LIST OF ACRONYMS AND ABBREVIATIONS

AfDB	African Development Bank
APPI	Area of Potential Project Influence
ARAP	Abbreviated Resettlement Action Plan
BMP	Biodiversity Management Plan
BOD	Biochemical Oxygen Demand
COPE	Care of the People
CWD	Coarse woody debris
DRG	Debt Relief Gains
EA	Environmental Assessment, and Modification Reports
ECN	Energy Commission of Nigeria
EEP	Energizing Education Programme
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMF	Electromagnetic Field
EMS	Environmental Management Strategy
ERSED	Erosion and sediment control
ESCP	Erosion and Sediment Control Plan
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
FEED	Front End Engineering Design
FEPA	Federal Environmental Protection Agency
FGN	Federal Government of Nigeria
FMEnv	Federal Ministry of Environment
GPS	Global Positioning System
HSE	Health, Safety, and Environment
HT	High Tension
ICREEE	Inter-ministerial Committee on Renewable Energy and Energy Efficiency
LGA	Local Government Area
LT	Low Tension
NACOP	National Council on Power

NEEAP	National Energy Efficiency Action Plan
NEP	Nigeria Electrification Project
NEPP	National Electric Power Policy
NERC	Nigerian Electricity Regulatory Commission
NESREA	National Environmental Standards and Regulations Enforcement Agency
NIMET	Nigerian Meteorological Agency
NML	Noise Management Level
NOx	Nitrogen oxides
NSIFT	National Social Insurance Trust Fund
NUC	National University Commission
O&M `	Operations and maintenance
PAPs	Project Affected Persons
PCT	Plant Community Type
PESCP	Progressive Erosion and Sediment Control Plan (aka ESCP)
PMP	Project Management Plan
POCR	Pre-operation Compliance Report
RAP	Resettlement Action Plan
RAV	restricted access vehicles
RBL	Rating Background Level
REA	Rural Electrification Agency
SE4All	Sustainable Energy for All
Sp./spp.	Species/species (plural)
STEL	Short Term Exposure Limit
SWMP	Soil and Water Use Management Plan
TCN	Transmission Company of Nigeria
TCP	Traffic Control Plans
TMP	Traffic Management Plan
TWA	Time Weighted Average
VEZ	Vegetation exclusion zone (different to Asset protection zone surrounding infrastructure)
VLMP	Vegetation and Land Management Plan

WMP	Waste Management Plan
WPMP	Weed and Pest Management Plan

LIST OF ESIA PREPARERS

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(Source: Sustainailiti 2022)

EXECUTIVE SUMMARY

ES 1.0 INTRODUCTION

ES 1.1 Introduction

The Federal Government of Nigeria (FGN) received funds from the African Development Bank (AfDB) for the Nigeria Electrification Project (NEP), part of which is for consultancy services for the preparation of the Environmental & Social Impact Assessment (ESIA) for the proposed Energizing Education Programme (EEP).

The Energizing Education Programme (EEP) is a Federal Government of Nigeria initiative that is focus on developing dedicated off-grid and independent power plants, as well as rehabilitating existing distribution infrastructure, to supply clean and reliable power to 37 Federal Universities and 7 affiliated University Teaching Hospitals. In addition, the EEP shall provide street lights for illumination and safety as well as a world class renewable energy workshop/training centre for each EEP beneficiary institutions.

ES 1.2 Legal and Administrative Framework

In order to establish the proposed EEP in Federal University, Dustina-Ma, Katsina State, it is pertinent to be compliant with applicable laws at the Federal and State levels of Government as well as with International Conventions. The applicable national laws for the proposed project include: -

a) Environmental Impact Assessment (EIA) Act CAP E12 LFN 2004
b) EIA Sectoral Guidelines for Power Sector (2013)
c) National Policy on the Environment
d) Climate Change Act 2021
e) Natural Resources Conservation Act CAP 349 LFN 1990
f) Nigeria's Nationally Determined Contribution (NDC) under the Paris Agreement of the UNFCCC COP26
g) Guidelines on Environmental Audit 2010
h) National Environmental Standards & Regulations Enforcement Agency (NESREA) Act, 2018
i) Public Health Act CAP 103 LFN 1995
j) Electric Power Sector Reform Act, 2005
k) Roadmap for Power Sector Reform, 2010
l) National Energy Policy 2013

m) Nigerian Electricity Regulatory Commission (NERC) 2005
n) Energy Commission of Nigeria Act No. 19 of 1989
o) Land Use Act CAP L5 LFN 2004
p) Penal Code Act CAP 53 LFN 2008
q) The Nigerian Urban and Regional Planning Act CAP N138 LFN 2014
r) Employees Compensation Act 2011
s) FMEnv Abandonment Guidelines 1995
t) Katsina State Ministry of Resource and Development
u) Katsina State Ministry of Lands and survey
v) Katsina State Local Government & Chieftaincy Affairs

The applicable International laws are: -

a) The African Development Bank (AfDB) Operational Safeguards
b) International Union for the Conservation of Nature and Natural Resources (IUCN) Guidelines, 1996
c) Convention on International Trade in Endangered Species of Wild Fauna and Flora, CITES 1975.
d) Convention on the Protection of the World Cultural and Natural Heritage Sites (World Heritage Convention) 1972
e) United Nations Framework Convention on Climate Change (UNFCCC) 1992

ES 2.0 PROJECT JUSTIFICATION

ES .1 Need for the Project and the Benefits

The justification for the Project is primarily based on the need to power Nigeria's federal universities to better serve for research and educational development. The EEP is also part of measures ensuring that Nigeria achieves its carbon emission targets (20% carbon emissions reduction by the year 2030) as contained in her Nationally Determined Contributions (NDC), under the Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC) Conference of Parties (COP) 26.

The benefits of 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 provision of health care services by the University as a result

of steady power supply.

- Reduction in fossil fuel consumption by the benefiting institutions thereby leading to reduction in carbon emissions and ecosystem enhancement
- Significant reduction in the cost of generating power through diesel generators by the Institutions. Such savings can be used for other undertakings that are more beneficial to the Universities and Teaching Hospitals.
- Increase in social interactions of the students within the Universities and enhanced security that void opportunistic crimes and violence as a result of the street lights provide to further illuminate the campuses.
- Enhanced learning in renewable energy with certification from the training centres to be established as part of the Programme.
- Improvement in livelihood enhancement activities within the Universities.
- More direct and indirect employment opportunities during the programme development and operations.
- 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 Rural Electrification Agency (REA), AfDB 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 emissions by 20% by the Year 2030.

ES 2.2 Value of the Project

The total fund for the EEP Phase III component is US$123 Million that covers the initial Engineering, Procurement and Construction (EPC) thereafter the Operations and Maintenance (O&M) Contracts for all the sites. The selection of the EPC contractors is competitive to build, operate and maintain the power plant on each site as well as to build and equip the training centres for one year.

ES 2.3 Envisaged Sustainability of the Project

ES 2.3.1 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 the University. 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 the University's Works and Physical Planning Department.

ES 2.3.2 Economic Sustainability: The Project on completion shall significantly reduce generators use in the University, thereby save costs of diesel and generator maintenance. Also, the monthly payment to the Distribution Company for power supply will greatly reduce or even stop since the project shall be the dedicated source of power for the University. A cost-reflective service charge shall be implemented for all facilities of the University including the private businesses within the campus that connect to the power project, to generate revenue for the University. This generated revenue shall be put into maintaining the project on a sustainable basis and shall minimize the University's dependency on allocation from the Federal Government.

ES 2.3.3 Environmental Sustainability**:** The environmental sustainability measures for the Project include the use of renewable source of energy (solar) for electricity generation (because of the negligible greenhouse gas emissions compared to fossil fuel power plants). In addition, the establishment of REA Project Management Unit (PMU) shall entail experienced Environmental and Social Safeguards Specialists to oversee the implementation of the project, thus contributing to the environmental sustainability of the Project.

ES 2.3.4 Social Sustainability**:** Stakeholder's 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 from the onset. This has also assisted in laying the foundation for building good relationships with the stakeholders. In addition, a Stakeholders 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.

ES 2.4 Project Alternatives

Within the context of the proposed solar power project, varied alternatives were considered based on environmental, economic and operational factors. The alternatives include solar technology types, PV module types, and battery type. The use of polycrystalline silicon photovoltaic (PV) panels and lithium-ion batteries is preferred alternative taken for the proposed project.

ES 2.5 No Project Option

The "No Project Option" was considered and rejected because it will deny the University the necessary technology to enhance learning, research, security and protection of those in it. Also, the lack of or epileptic power supply is a setback to any institution of learning and can completely render the institution ineffectual.

ES 3.0 PROJECT DESCRIPTION

ES 3.1 The Rational for the Project

The socio-economic benefits attached to this rural electrification access intervention, the EEP, are significant and largely impact not only the power, education and healthcare sectors but also provides a measure to ensure Nigeria achieves its targets as contained in the Nation's Nationally Determined Contributions (NDCs) to the Paris Agreement of 2016.

The EEP is a key programme to be developed towards achieving the objectives to the Power Sector Recovery Programme (PSRP) which was approved by the Federal Executive Council (FEC) on 22nd March 2017.

ES 3.2 Project Site and Location

The project location is at the permanent site of Federal University Dustin-Ma, Katsina State (FUDMA) was established in 2011. The Federal University Dutsin-Ma is located in the Dutsin-Ma Local Government Area of Katsina State, which is located in the North-Western region of Nigeria, latitude 12.296554N, and longitude 7.441562E bordering Niger Republic, Kaduna, Kano and Jigawa States.

ES 3.3 Project Components and Activities

The EEP Phase III project in the Federal University Dustin-Ma, Katsina State shall be established as a 1.9 MW solar power system. The components include: - solar photovoltaic panels, lithium-ion batteries, shelter, wirings, steel rods and other installations on 10.0 Hectares land take within the University Campus.

The project comprises of four components:

- A solar PV farm complete with inverters and transformers,
- Substation,
- Transmission line and street lights, and
- Buildings (control room, site office, renewable energy workshop training centre (WTC) and residential areas).

The power plant will use solar panels fitted on fixed structures (mounts).

ES 4.0 Description of the Project Existing Environment

The description of environmental and social conditions of the project location is based on both desktop studies and field investigations. The field sampling was conducted by a team of environmental and social specialists covering 500m spatial boundary around the project site. Quality Assurance and Quality Control (QA/QC) was taken to keep the samples in stable state from the field to the laboratory for analyses. The field samples were analysed for physico-chemical and microbial parameters. The baseline data established for the project are as follows:

a) Climate and Meteorology

The field data was obtained through the usage of weather Tracker Kestrel 4500 model for the following components: Temperature, Relative Humidity, Pressure, Wind direction and Speed. Also, secondary data was obtained from Nigerian Meteorological Agency (NIMET) for the Katsina Station located at Katsina. Specifically, for the present study a request was made to the Nigerian Meteorological Agency (NIMET) for detailed meteorological data on Katsina over the past one decade (2011-2021).

Generally, Nigeria's climate is characterized by the dry and wet conditions associated with the movement of the Inter-Tropical Convergence Zone (ITCZ) north and south of the equator. The Inter-Tropical Convergence Zone (ITCZ) appears as a band of clouds, usually thunderstorms that circle the globe near the equator and Nigeria is located just north of the equator. When the ITCZ is to the south of the equator, the north-east winds prevail producing the dry-season and whenever it moves into the Northern Hemisphere, the south westerly wind prevails to bring rainfall and the rainy (wet) season.

The study area is located in the semi-arid climatic zone of Nigeria and characterized by two distinct seasons which are the hot dry season and a cool rainy season.

b) Air Quality and Noise level

For this study, air quality sampling including control were carried out at ten (10) different points within and around the project site. The parameters identified for the proposed project that can pollute the environment were determined using pre-calibrated digital handheld Air Quality Monitoring Equipment, namely a pre-calibrated Crowcon [TETRA5] Pro Environmental Test Meter. Baseline parameters including Particulate Matter, Oxides of nitrogen (NO_X), sulphur dioxide (SO_2) and carbon monoxide (CO), ammonia (NH_3), hydrogen sulphide (H_2S), and volatile organic compounds (VOCs) were measured during the study in the ambient environment of the project site, and the air quality characteristics results are presented in Table 4.4 with due reference to FMEnv standards.

The noise levels (Table 4.6) measured varied from 48.9 to 56.4 dB(A) in the period of survey. The main sources of sound in the study area are vehicular traffic and human activities. The results indicate the noise levels in the study area were below the maximum Allowable Laeq (Hourly 85 dB (A) limit of FMEnv.

c) Soil and Land Use

Soil samples were taken at selected locations within and around the proposed project site. The sampling stations were pre-selected using the co-ordinates on the obtained map. The coordinates were keyed into GPS receivers which were then used to pin point the exact locations within the project site. Soil samples were collected with a Dutch auger and described. At each observation point, two composite samples from 0 – 15 cm, 15–30 cm soil depths were taken at each sampling point. The environment at each observation point was also described in terms of vegetation, land use and erosion. In all, 20 soil samples were collected for laboratory analyses. All the soil samples collected were packed and preserved for onward transmission to the laboratory where they would be analysed. The baseline Physico-chemical analysis results are presented in table 4.7.

The microbiological characteristics of soil within the project area is presented in Table 4.11 Total Bacteria count revealed total viable count of 1.32x105 – 3.50x105 cfu/g for both topsoil and subsoil. Total Bacteria constitutes 40%, Total Fungi 35%, Hydrocarbon Utilizing Bacteria 15% and Hydrocarbon Utilizing Fungi 10% in topsoil while Total Bacteria constitutes 54%, Total Fungi 32%, Hydrocarbon Utilizing Bacteria 10% and Hydrocarbon Utilizing Fungi 4%. The most predominant organisms among the isolates are the Bacillus sp., Clostridium sp. And Pseudomonas sp.

d) Groundwater

Ground water samples were collected from One (1) point. The in situ/on site parameters on water quality were determined using HORIBA Water Quality Checker. These are water temperature, pH, electrical conductivity (EC), turbidity, dissolved oxygen (DO), salinity and total dissolved solid (TDS). The pH values of both the surface and ground.

e) Surface water

As at the time of the field work, there was no surface water collected.

f) Vegetation

Dutsin-ma is located in the Sudan savanna zone of the central part of Katsina state, relatively bounded by Safana and Dan-Musa local governments to the west, Kurfi and Charanchi local governments to the north, Kankia to the east, Matazu and Dan-Musa local governments in the south. Table 4.12 present the available indigenous trees in the study area, and has given the botanical and local names (Hausa and Fulani) equivalents of the seventy-five (75) indigenous trees found in the area. The research found out that majority of the trees was Acacia spp, Ziziphus spp, Cassia spp, Ficus spp and Combretum spp, which occur in considerable quantity. The study identified five (5) major land uses in the area, where more than 23% of the inventoried trees are on farmlands. This ensures their protection and good management by individual owners. Most the identified trees were of high economic value like Adansonia digitata, Butyrospermum pradoxum, Diospyros mespiliformis, etc which are privately owned, though grazing lands, cattle tracks and fallow lands presented a meaningful percentage of plants specie composition, their protection is not ensured as in the case of farmlands. Therefore, this lack of good care and protection on these land uses had made them to suffer degradation that led to the disappearance of some tree and shrub species as mentioned above.

g) ***Wildlife Survey***

The evidences of wildlife were collected from animal tracks and footpaths in across the project area, which were geo- referenced with a hand-held Global Positioning System (GPS). Direct and indirect methods were used to ascertain the presence of animal species in the area.

Direct Observation: - Actual sighting of animal species during the survey involved: spot identification, behavioural features and indices of varied species.

Indirect Observation: - This involved sighting of signs (e.g. footprints, spores and sounds) of the animals and information received from the farmers and local hunters residing in the project area.

Other signs that were used to identify the wildlife in the project area include: - faecal pellets and dung piles. The animals or varied animals encountered in the course of the survey were recorded according to Gaston *et al. (2000).*

The most common carnivores include the medium and small-sized mammals such as Hare (Lepus capensis), these predators are important in maintaining the balance in the ecosystem. The common herbivores include Red Eye Monkey (Presbitis rubicund), Cows (Bos primigenius), and Goats. Rodents include Squirrel (Alpine marmot), Bush Rat (Rattus fuscipes), grass cutter, squirrels and mice while primates were mainly monkeys. Historic record cited the presence of Hyenas, Lions, Warthogs, and Bush bucks. All the species are common and widespread and are not listed as endangered in the IUCN Redlist of endangered species. The observed reptiles include lizards and snakes. The predominant species are Varanus Albigularis (Monitor lizard), Agama agama (Common lizard), Bitis arietans (puff Adder), (Philothamus irregularis (Bush snake), Atractasis reticulata (Viper) Python snake (Python mulurus), Cobra snakes (Boulengerina annulata), and Viper snake (Crotalus basiliscus) – seen occasionally The observed species include spiders (Hysterocrates laticeps), ants (Camponotus pennsylvanius), sand flies (Diptera psychodidae), Grasshopper (Caelifera), Wasps (Polistes galicus), Bees (Anthophila), Dragon Fly (Anisoptera), Green Mantis (Sphodromatis virdis), Termite (Termitodae), Ants (Formicidae), and long nose weevil (Rhinotia hemistictus).

f) Stakeholders Engagement

Stakeholder engagement was conducted as part of the ESIA for the proposed project. This included a review of the legal and administrative framework, stakeholders' 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 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.

The questionnaires were administered systematically to ensure that the required number of questionnaires were returned by the respondents. The sample size was based on the prevailing situation at the time of the study. The entire public universities in Nigeria were on industrial strike when the study was carried out, hence, the number of people on the study campus was limited. Consequently, a total number of 55 households/individuals were randomly sampled, out of the 50 questionnaires distributed only 47 were retrieved in-situ which constitute 94% of the total number distributed.

ES 5.0 Associated and Potential Impacts of the Project

- Identification of the various potential impacts using interaction matrix to show the relationship/ interaction between the project environmental components and planned project activities.

- A screening of potential impacts associated with each phase of the project is performed using a Risk Assessment Matrix; and

A detailed evaluation of the individual impact producing factors that comprise each aspect of the project phases is then performed. The significances of the potential impacts are quantified using the same rationale as for the screening

There are several impacts identified for the project, both beneficial and adverse. The beneficial (positive) impacts shall be improved upon with enhancement measures and include: -

- More reliable and sustainable power supply for the University activities
- Combat climate change effects through the use of renewable energy technology
- Improve safety and security on the campus with street lightings powered by the project
- Increase work efficiency and business opportunities on the campus
- Enhance students to study, research and carry-on necessary experiments.

Notwithstanding, there are negative (adverse) impacts associated with the project which require mitigation measures as follows: -

- Displacement of those farming on the site
- Distortion of the natural ecosystem by clearing the site
- Displacement of biodiversity on the site
- Increased noise from vehicular movements and workers on the project
- Increased dust from construction activities
- Contamination of the ground water
- Indiscriminate dumping of waste generated on the project
- Health and safety risks including slips, falls, injuries, accidents on the site
- Used oil or other hazardous spills
- Low quality equipment/ installations and poor workmanship
- Poorly maintained equipment

- Irregular working hours
- Fire risk
- Social vices like insecurity, theft, encroachment, unauthorized movement, poaching/ hunting in the wild, GBV, etc.

ES 6.0 Mitigation Measures

For the significant negative impacts identified for the project phases, the proffered mitigation measures are as follows: -

a) Pre-Construction Phase

- Site clearing activities shall be limited to just enough space needed for the project on the site.
- The extent of vegetation to be cleared for the project shall be appropriately demarcated.
- The undeveloped areas around the project shall be vegetated with native plants.
- Site clearing shall be carried out with machinery that have optimal fuel-efficiency and less emissions.
- The site clearing shall only be carried out during daytime (weekdays from 8:00am to 5:00pm but weekends from 9:00am to 1:00pm).
- A traffic management plan (TMP) shall be developed for the project and operated by the EPC Contractor.
- Place caution signs strategically across the project site and put in place safety measures to prevent incidences/accidents.
- Drivers shall be assessed on competency level and trained appropriately for the project activities.
- Provision and enforcement of adequate PPE like gloves, safety boots, and hard hats for the project workers.
- Any labourer/ daily worker employed on the project shall be properly screened before commencing work.
- The site shall be secured with perimeter fencing and security men.

b) Construction Phase

- Excavation works shall only be carried out during fair weather conditions.
- Excavated soil shall be stockpiled on a dedicated spot in the project location for future

use.

- The work area for the project shall be clearly demarcated and cordon off to prevent encroachment into the site.
- The construction workers shall be provided with appropriate PPE to enable carry out the job safely.
- As many as possible construction workers shall be employed from the host communities.
- Gender-Based Violence (GBV) Action Plan for EEP shall be implemented for the Project throughout the lifecycle.
- All workers shall be required to sign a code of conduct to prohibit any form of Gender-Based Violence/Sexual Exploitation and Abuse (GBV/SEA) on the project.
- GBV sensitive channels for reporting in GRM shall be implemented for the Project.
- The EPC Contractor shall be required to hire at least a GBV officer.
- The EPC Contractor shall collaborate with appropriate government institutions or GBV service providers to address any form of GBV case.
- EPC Contractor shall provide separate conveniences for men and women use on the project site with appropriate caution signs.
- Health, Safety and Environment Policy shall be developed and implemented for the EEP to first prevent as well as adequately address any incident/accident. There shall be toolbox talks prior to commencement of work activities daily. Construction activities shall be limited to daytime only.
- At least a safety officer shall be engaged to monitor the compliance of workers to safety rules.
- Proper safety and caution signs shall be placed at strategically across the site.
- There shall be routine safety training specific to each job type for all workers on the site.

*c) **Commissioning Phase***

- On installing the components of the project in line with the manufacturers' standards, the packages shall be cleared off the site and properly disposed by accredited vendors.
- The entire site shall be cleared of all waste/unused materials, empty packages and appropriate receptacles for segregating wastes shall be placed in strategic points across the constructed facility.

- The components of the project shall be subjected to testing by experienced personnel in the EPC Contractor.
- On establishing that the components are functioning optimally, the project shall be handed over to the Operations and Maintenance (O & M) Contractor by the EPC Contractor.

d) Operations and Maintenance Phase

- Ensure that all materials/ resources needed to operate the project are available, stocked and regularly replenished.
- Appropriate PPE shall be provided and enforced for all workers pertaining to their duties on the project.
- Ensure regular and routine training of the workers on the project.
- Ensure the health and safety of the workers through enactment of the HSE Policy developed for the project.
- Appropriate safety and caution signs shall be placed at strategic points across the facility.
- Ensure strict compliance by employees to the SOPs that are established for the project.
- A grievance redress mechanism (GRM) procedure for receiving and addressing the concerns of employees shall be established for the project.
- The GBV Action Plan for EEP shall be sustained throughout the Project lifespan.
- All employees on the project shall be required to sign a Code of Conduct form to prohibit any form of Gender-Based Violence/Sexual Exploitation and Abuse (GBV/SEA).
- There shall be a GBV sensitive channel for addressing GRM on the project.
- The O & M Contractor shall be required to employ at least a Gender/GBV Officer.
- The O & M Contractor shall collaborate with relevant government institutions and/or GBV service providers to address any GBV case on the project.
- The O & M Contractor shall provide separate and sufficient conveniences for men and women to use on the facility with appropriate caution signs.

- An appropriate Waste Management Plan (WMP) has been developed (Annex 3) and will be implemented and reviewed regularly throughout the project lifespan.

ES 7.0 Environmental and Social Management Plan

The Environmental and Social Management Plan (ESMP) is part of the key elements of the ESIA study to satisfy long term objectives of managing and monitoring the diverse negative impacts of the proposed project. It covers the entire lifecycle of the Project and also includes desired outcomes; performance indicators; monitoring (parameters to be monitored and frequency); responsibilities and cost estimates required for implementation.

The recommended environmental and social management measures required to mitigate the identified impacts of the proposed project activities during pre-construction, construction, commissioning and operation phase are presented in tables 7.1 to 7.8.

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.

Regular Monitoring shall be conducted throughout the various phases of the project to ensure compliance with regulatory requirements as well as to evaluate the effectiveness of operational controls and other measures intended to mitigate potential impacts.

Consultations with the relevant stakeholders have been carried out and shall continue throughout the project lifecycle.

ES 8.0 Decommissioning and Rehabilitation Plan

Upon the completion of useful life cycle of a project, there is a need to abandon and/or decommission such project if it no longer becomes economically viable either as a result of depleted feed stock or competing technology. The average life span of the solar Photovoltaic (PV) power plant to be provided as part of the proposed Project is 25years (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.

During decommissioning, REA shall ensure that the project sites are returned to a safe and environmentally acceptable condition. 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;
- Restore the environment to allowable baseline conditions and monitor the process in line with legislative and regulatory requirements and best industry standards; and
- Assess the residual impacts, if any, that the project has on the environment; and specifically, if there are any future restrictions for other activities

In the event of decommissioning, REA, in conjunction with the leadership of the FUDMA, 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;
- 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.

ES 9.0 Conclusion and Recommendation

The proposed Energizing Education Programme (EEP) Phase III project to be established in the Federal University Dutsin-Ma is an eco-friendly development and is in compliance with the transition to adopt more renewable energy/power sources in the effort to combat global climate change effects. More importantly, it will improve the entire function of the University as well as other business ventures within the campus and enhance security for all on the campus.

In light of the Environmental and Social Management Plan (ESMP) that has been developed to adequately mitigate all the identified significant impacts, the EEP Phase III project is hereby recommended for EIA Approval and subsequent commencement of project activities.

ACKNOWLEDGEMENT

The Rural Electrification Agency is pleased to acknowledge with appreciation, the opportunity granted it by the Federal Government of Nigeria, the Federal Ministry of Finance, and the Federal Ministry of Environment to conduct this Environmental and Social Impact Assessment (ESIA) study for the 1.9 MW PV-Based Solar Captive Power Plant in the Federal University Dustin-Ma, Katsina State, Nigeria.

The contributions of the Environmental Consultant – Sustainabiliti Limited, contracted to execute this ESIA is sincerely acknowledged and commended. We are grateful to the management of the Federal University, Dustin-Ma, Katsina State for supporting this assessment through the provision of relevant information, access and human capital throughout the period of this assessment.

We also appreciate the support of all our other stakeholders too many to mention who actively participated in the ESIA process.

CHAPTER ONE: INTRODUCTION

1.1 Background of the Subproject

The Federal Government of Nigeria (FGN) has received financing from the African Development Bank for the Nigeria Electrification Project (NEP) and intends to apply part of the proceeds for Consultancy Services for the preparation of an Environmental & Social Impact Assessment (ESIA) for the Phase III of the Energizing Education Programme (EEP).

This is a Federal Government of Nigeria initiative tasked with developing off-grid, dedicated and independent power plants, as well as rehabilitating existing distribution infrastructure, to supply clean and reliable power to 37 Federal Universities and 7 affiliated University Teaching Hospitals. In addition, it will provide street lighting for illumination and safety, as well as world class Renewable Energy Workshop Training Centres (WTCs) at each of the EEP beneficiary institutions.

EEP Phase III is being funded by the African Development Bank (AfDB) in respect of 8 Universities and one affiliated Teaching hospital. The Universities under this Phase will utilize technologies based on solar technology power systems.

Federal University, Dustin-Ma, Katsina State is one of the 8 universities under the Nigeria Electrification Project EEP Phase III. The plan for the Federal University Dutsin-Ma, Katsina is a 1.9MW solar hybrid power plant with renewable energy workshop and training centre, street lighting installations and upgrading of distribution infrastructure.

The objectives of this component are:

i. Improve the quality of educational systems at tertiary institutions through the provision of reliable and sustainable power
ii. Develop and operate WTCs in which students will receive firsthand practical experience in renewable energy technologies/innovations
iii. Improve safety on campus through either the rehabilitation or installation of street lighting.

1.2 Objectives of the ESIA

The overall objectives of an ESIA are: 1) to avoid or minimize adverse environmental and social effects before they occur; 2) to integrate environmental and social concerns into decision-making. The ESIA is a systematic process which provides a framework for gathering and documenting information and views on the potential adverse environmental and social impacts of development activities. The objectives of the ESIA study are specifically as follows:

- Establish the existing state of the environment and identify sensitive components of the existing environment within the project area and Area of Potential Project Influence (APPI);
- Identify sensitive components of the existing environment within the project area and its environs;
- Appraise the project activities and determine any potential negative and positive impacts on the environment;
- Assess the scope of the proposed programme, and the likely impacts associated with same;
- Identify existing and expected environmental regulations that will affect the development and advise on standards, consents and targets;
- Bring all relevant information to the stakeholders, including Project affected persons (PAPs) and other interested parties and ensure their participation in the programme design;
- Contribute to optimization of the project design and planning by identifying those aspects of the construction location, and operations, which may cause adverse environmental, social, health and economic effects;
- Identify, where required, the need for development and implementation of a Resettlement Action Plan (RAP) / Livelihood Restoration Plan (LRP).
- Recommend measures during construction, commissioning and operations to avoid and ameliorate these effects and increase beneficial impacts;
- Recommend an environmental management program for the project life cycle, including compliance, monitoring, auditing and contingency planning; and
- Provide the basis for co-operation and consultation with regulatory and non-regulatory authorities and the public.

This assessment is an important part of the decision-making process, to ensure that environmental and social risks have been anticipated, avoided, mitigated and eventually compensated.

1.3 Scope of the ESIA Study

In line with the Terms of Reference (TOR), the scope of the ESIA study covers the following:

- Description of all actions/activities that will be carried out in the course of the Project development and implementation.
- Review of applicable local and international laws, regulations, standards and industry codes that apply to the proposed Project.
- Desktop review of relevant documents pertaining to the Project and the environment where the Project would be located. These documents include the Nigerian Electrification Project (NEP) environmental and social management framework (ESMF), amongst others.
- Perimeter survey of the Project site, including development of survey maps.
- 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,
- Laboratory analysis of field samples and data analysis
- Impacts identification and evaluation, and development of appropriate and practicable mitigation measures and EMP.
- Report preparation and disclosure.

1.4. Study Approach/ Methodology in Details

The ESIA of the proposed Project in the Federal University of Dutsin-Ma, Katsina has been carried out in line with the Federal Ministry of Environment (FMEnv) approved EIA process for mini-grid/ off-grid projects being implemented under the Nigeria Electrification Project (NEP). It also considers the requirements of relevant and applicable international standards and best practices such as the AfDB Integrated Safeguard Policies. The approach and methodology to be applied for undertaking the environmental and social impact assessment is as listed

- Reconnaissance survey to understand site specific issues;
- Desktop review of relevant programme documents;
- Scoping study with the beneficiary University Authorities and the host community to understand their perception of the programme and identification of key issues;

- Field data gathering/ baseline of the noise level, air, water, soil, ecology and biodiversity from the proposed project sites through primary and secondary data source surveys.
- Laboratory analysis of samples obtained from field data gathering.
- Identification of environmental and social risks associated with the programme;
- Impact assessment, development of mitigation measures; and
- Preparation of an environmental and social management plan (ESMP) (with timelines and responsibilities) to manage these risks and impact;
- Report compilation;
- Regulatory functions including report disclosure.

The Federal Ministry of Environment (FMEnv) developed guidelines to be used by project proponents in conducting EIA, in compliance with the EIA Act. Accordingly, the ESIA process follows the steps sequentially as outlined in the procedural guideline indicated in figure 1.1.

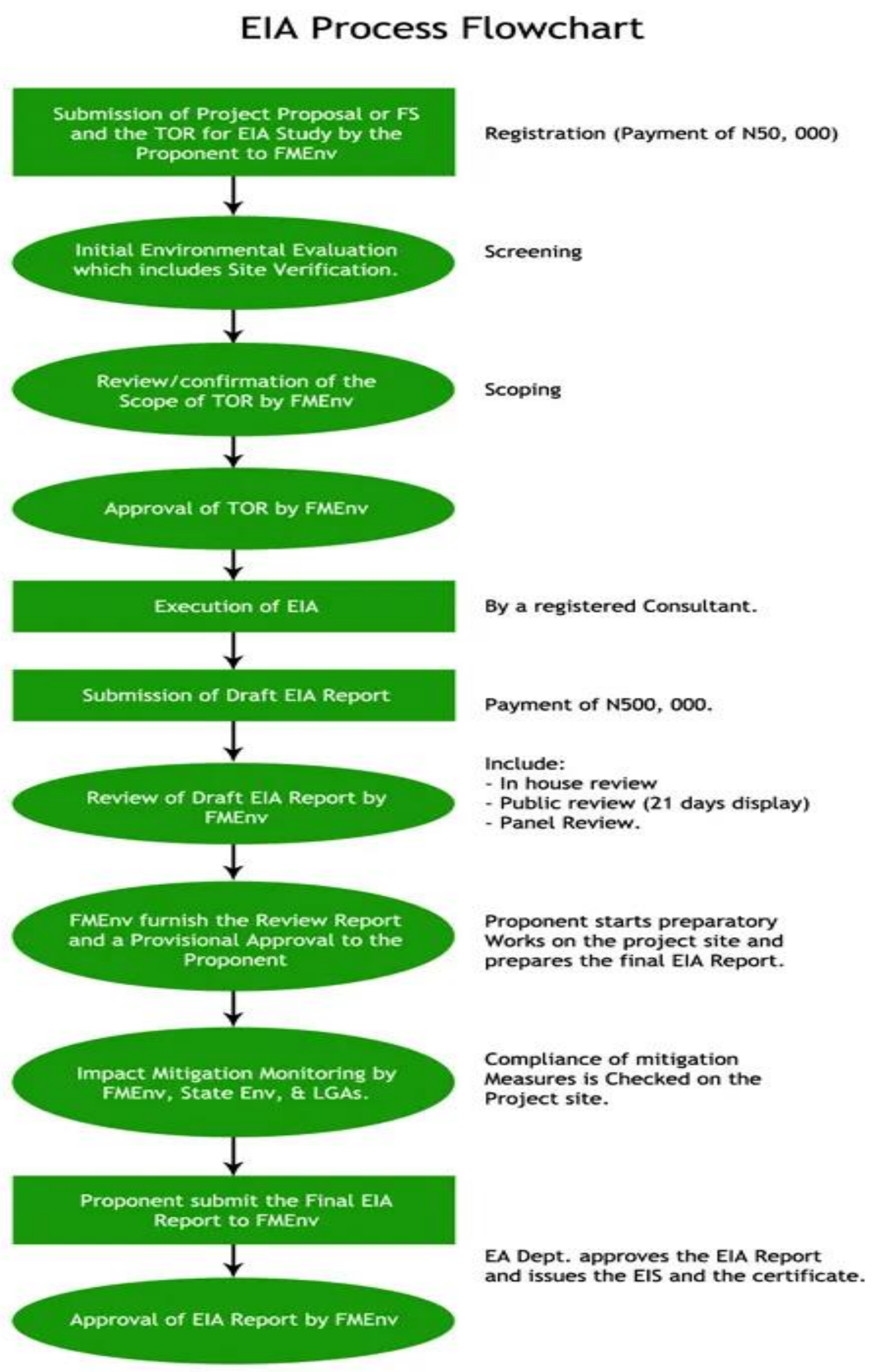

Figure 1. 1: Federal Ministry of Environment Environmental Impact Assessment Process
(Source: Environmental Assessment Department, Federal Ministry of Environment)

1.5 Limitation of the study

The ESIA study of the proposed project has been conducted in line with the relevant local and international guidelines and regulations to identify and assess the potential environmental and social impacts, and also to assign appropriate mitigation measures to address the identified negative impacts. However, the section of the stakeholder engagement in the course of the study was limited due to the prolonged national industrial action strike by the Academic Staff Union of Universities (ASUU) and the Non-Academic Staff Union (NASU) strike that restricted official meetings with relevant stakeholders. Thus, method of data collection used was limited to one-on-one interviews, focus group discussion where allowed, administration of questionnaire with project staff and other resident non-academic staff within the university, and secondary data. Number of survey samples and results are discussed in chapter four.

1.6 Policy, Legal and Administrative Framework

The proposed Project is part of the Federal Government of Nigeria's Energizing Education Programme, a component of the Nigeria Electrification Project being implemented by the Rural Electrification Agency. Several laws and regulations apply to the energy sector in Nigeria. In addition to the above, a number of laws, regulations, policies and instruments have been established to support environmental and social management, and the EIA process in Nigeria.

This section provides an overview of the relevant statutory regulations, legislations, and guidelines to the proposed Project and the ESIA study. The project shall ensure compliance with the relevant and applicable local and international regulations, policies, and standards throughout its life cycle.

1.6.1 FGN Requirements and Relevant Legislation

The Constitution of the Federal Republic of Nigeria (1999), as the national legal order, recognises the importance of improving and protecting the environment and makes provision for it. The relevant sections are:

- **Section 20** makes it an objective of the Nigerian State to improve and protect the air, land, water, forest and wildlife of Nigeria;
- **Section 12** establishes, though impliedly, that international treaties (including environmental treaties) ratified by the National Assembly should be implemented as law in Nigeria; and
- **Sections 33 and 34** which guarantee fundamental human rights to life and human dignity, respectively, have also been argued to be linked to the need for a healthy and safe environment to give these rights effect.

1.6.2 Policy, Legal and Institutional Framework

The EEP Phase III seeks to provide off-grid captive power plants for the generation and provision of dedicated and uninterrupted power supply to eight (8) Federal Universities and one (1) affiliated University Teaching Hospital across the six geopolitical zones of Nigeria and as a result, policies laws and regulations instituted by the Nigerian Government pursuant to this constitutional requirement and relevant to the programme will be complied with. These are discussed in the following sections.

1.6.3. Policy Framework

1.6.3.1. National Environmental Policy/ National Policy on the Environment (Revised 2016)

The national environmental policy launched by Government in November 1989 , revised in 2016 prescribed guidelines for achieving sustainable development in fourteen vital sectors of the nation's economy, namely: Human Population; Land Use and Soil Conservation; Water Resources Management; Forestry, Wildlife and Protected Natural Areas; Marine and Coastal Area Resources; Sanitation and Waste Management; Toxic and Hazardous Substances; Mining and Mineral Resources; Agricultural Chemicals; Energy Production; Air Pollution; Noise in the Working Environment; Settlements; Recreational Spaces, Green Belts, Monuments, and Cultural Property.

It also contains Nigeria's commitment to ensure that the country's natural and built environment is safeguarded for the use of present and future generations. This commitment demands that efficient resource management and minimization of environmental impacts be the core requirements of all development activities. Accordingly, this Policy seeks to promote good environmental practices through environmental awareness and education.

The goal of the National Policy on the Environment is to 'ensure environmental protection and the conservation of natural resources for sustainable development'. Its strategic objective is to coordinate environmental protection and natural resources conservation for sustainable development.

1.6.3.2 Social Protection Policies

Social protection policy has been on the agenda since 2004, when the National Planning Commission,supported by the international community, drafted a social protection strategy. More recently, the National Social Insurance Trust Fund (NSITF) drafted a social security strategy. The social protection policy approached social protection using a life-cycle and gender lens, recognizing both economic and social risks, including, for example, job discrimination and harmful traditional practices. The policy was organised around four main themes: social assistance, social insurance, child protection and the labour market.

However, only a few of the instruments of this approach were adopted in the national implementation plan, most notably the provision of specific and limited social assistance, social insurance (such as expanding national health insurance to the informal sector) and labour market programmes (such as developing labour-intensive programmes). Moreover, in practice, programmes to date have been focused largely on conditional cash transfers and two health financing mechanisms driven by the federal government with little inter-sectoral or state-federal coordination. A significant number of actors are involved in funding and implementing social protection, including those from government, donors, international non-governmental organisations and civil society. Federal government-led social protection includes three main programmes:

i. the conditional cash transfer in Care of the People (COPE) (funded initially through the debt relief gains (DRG fund) targeted at households with specific social categories (those with children of school-going age that are female-headed or contain members who are elderly, physically challenged, or are fistula or HIV/ AIDS patients);
ii. the health fee waiver for pregnant women and children under five (financed through the debt relief gains (DRG fund); and
iii. the community-based health insurance scheme, which was redesigned in 2011 because the previous scheme had design challenges.

Other social assistance programmes are implemented in an ad hoc manner by various government ministries, departments and agencies at state level, and some are funded by international donors. These include conditional cash transfer programmes for girls' education (in three states), child savingsaccounts, disability grants, health waivers, education support (such as free uniforms) and nutrition support. HIV and AIDS programming at state level also include social protection sub-components (although not as the primary objective), including nutrition, health and education support. Labour market programmes include Federal and State level youth skills and employment programmes, and Nigeria also has agricultural subsidies/inputs.

1.6.3.3 National Policy on Climate Change/ National Climate Change Policy for Nigeria 2021-2030

Given Nigeria's status as a fossil-fuel dependent economy with a large climate sensitive agricultural sector, the development of a climate change policy and response strategy is critical, as climate change presents a serious threat to poverty eradication and sustainable development in general. One of the key pillars of the Vision 20:2020 is investment in low carbon fuels and renewable energy. Achieving the goal of low carbon, high growth and resilient socio-economic system for equitable and sustainable socio-economic and environmental development faces some challenges which include stability and sustainability of the enabling environment, adequate institutional and human resource capacity and availability of adequate resources to address mitigation and adaptation initiatives to address climate change. Thus, the Government needs to ensure that economic growth, resource management and climate change mitigation and adaptation can all happen simultaneously if this willbe done effectively (Department of Climate Change 2017).

The National Climate Change Policy for Nigeria 2021-2030 was established to promote a low-carbon, climate-resilient and gender-responsive sustainable socio-economic development. The revised National Policy on Climate Change was to define a new holistic framework to guide the country's response to the development challenge of climate change.

1.6.3.4 ***The National Electric Power Policy (NEPP), 2001***

In order to ensure a safe, steady, reliable and progressively improved electric power sector in Nigeria, the Electric Power Reform Implementation Committee (EPIC) was inaugurated by the BPE and resulted in Federal Executive Council (FEC) of Nigeria approving the National Electric Power Policy in September 2001, which recommended, amongst others: establishment of the electric power sector regulator and the privatisation of the electric power sector. The National Electric Power Policy (NEPP), 2001 outlines the realization of an adequate and reliable supply of electricity in three phases - the privatization of the state-own utility NEPA and the introduction of the Independent Power Producers (IPPs); increasing the competition between market participants, partial removal of subsidies, and sale of excess power to distribution companies (DISCOs); and the freedom to select suppliers by large consumers and the creation of a fully liberalized and competitive market.

In 2004, the National Integrated Power Project (NIPP) was initiated to boost power supply by the launch of gas-powered stations. The National Electric Power Policy (NEPP) of 2001 resulted in the Electric Power Sector Reform (EPSRA) Act of 2005 establishing the Nigerian Electricity Regulatory Commission (NERC). The EPSRA provided the statutory basis for the privatisation of the power sector

1.6.3.5 The National Energy Policy (NEP) 2013

The National Energy Policy (NEP) 2013 is a revised version of the NEP 2003, emphasizes the effective and efficient use of energy and proposes major areas to be considered for energy efficiency and conservation including amongst others: transportation, services/commercial sector, and energy efficient building designs.

1.6.3.6 The National Energy Efficiency Action Plans of Nigeria

The first version of the National Energy Efficiency Action Plans (NEEAP) for Nigeria (2015 -2030) was approved on July 14, 2016 by the National Council on Power (NACOP). It has been formulated within the framework of United Nations' Sustainable Energy for All (SE4All) and adopted by the Inter-Ministerial Committee on Renewable Energy and Energy Efficiency (ICREEE). The NEEAP includes baseline data and information on energy efficiency activities and programmes in Nigeria, barriers to the development and promotion of energy efficiency in the country and suggested achievable energy efficiency targets, including gender disaggregated indicators, based on national potentials and socio-economic assessments. The implementation of the NEEAP is being monitored by the Federal Ministry of Power.

1.6.4 National Legal Framework

1.6.4.1The Environmental Impact Assessment Act No. 86, 1992/ Environmental Impact AssessmentAct Cap E12 LFN 2004

The EIA Act makes it mandatory for any person, authority, corporate body private or public, to conduct EIA prior to the commencement of any new major development or expansion that may likely have significant effects on the environment. The Act sets out the EIA objectives and the procedures for consideration of EIA of certain public or private projects.

The programme is considered to be a minor development, which is expected to have minimum impact on the environment. Hence, the programme is categorised as a Category II (B) EIA. The EIA guidelines (procedural and sectoral) issued by the FMEnv derives from this Act and the programme proponents shall conduct their activities in conformance with these guidelines.

1.6.4.2 Electric Power Sector Reform Act 2005

The Electric Power Sector Reform Act No. 6 of 2005 provides for the licensing and the regulation of the generation, transmission, distribution and supply of electricity. Part IV of the Act contains requirements for licensing and stipulates that no person may construct, own or undertake any of the following activities without a license, unless the generating capacity and distribution capacity is below 1 MW and 100 kilowatts (KW) respectively for electricity generation, excluding captive generation, electricity transmission, system operation, electricity distribution and trading in electricity.

1.6.4.3 Energy Commission of Nigeria Act CAP 109 LFN 1990

The Act was promulgated to create the Energy Commission of Nigeria (ECN) with responsibility for coordinating and general surveillance over the systematic development of the various energy resources of Nigeria. Subject to this Act, the ECN is charged with the responsibility for the strategic planning and co-ordination of national policies in the field of energy in all its ramifications. The mandates of ECN include statistical analysis of Electricity Generation, Transmission and Distribution.

1.6.4.4 Land Use Act of 1978 and Resettlement Procedures

The Land Use Act (Cap 202, 1990), now Cap L5 Laws of the Federation of Nigeria 2004, is the key legislation that has direct relevance to this project. Relevant sections of these laws that may relate to this project with respect to land ownership and property rights, resettlement and compensation are summarized in this section.

The Land Use Act is the applicable law regarding ownership, transfer, acquisition and all suchdealings on Land. The provisions of the Act vest every parcel of Land, in every State of the Federation, in the Executive Governor of the State. He holds such parcels of land in trust for thepeople and government of the State.

The Act categorized the land in a State to urban and non-urban or local areas. The administration of the urban land is vested in the Governor, while the latter is vested in the Local Government Councils. At any rate, all land irrespective of the category belongs to the State while individuals only enjoy aright of occupancy as contained in the Certificate of Occupancy, or where the grants are “deemed”.

The concept of ownership of land as known in the western context is varied by the Act. The Governor administers the land for the common good and benefits of all Nigerians. The law makes it lawful for theGovernor to grant statutory rights of occupancy for all purposes; grant easements appurtenant to statutory rights of occupancy and to demand rent. The Statutory Rights of Occupancy are for a definitetime (the limit is 99 years) and may be granted subject to the terms of any contract made between the state Governor and the Holder.

The Local Government Councils may grant customary rights of Occupancy for agricultural (including grazing and ancillary activities), residential and other purposes. But the limit of such grants is 500 hectares for agricultural purposes and 5,000 for grazing except with the consent of the Governor. The local Government, under the Act is allowed to enter, use and occupy for public purposes any land within its jurisdiction that does not fall within an area compulsorily acquired by the Government of the Federation or of the relevant State; or subject to any laws relating to minerals or mineral oils.

The State is required to establish an administrative system for the revocation of the rights of occupancy, and payment of compensation for the affected parties. So, the Land Use Act provides for the establishment of a Land Use and Allocation Committee in each State that determines disputes as to compensation payable for improvements on the land (Section 2 (2) (c)).

In addition, each Local Government is required to set up a Land Allocation Advisory Committee, to advise the Local Government on matters related to the management of land. The holder or occupier ofsuch revoked land is to be entitled to the value of the unexhausted development as at the date of revocation. (Section 6) (5). Where land subject to customary rights of Occupancy and used for agricultural purposes is revoked under the Land Use Act, the local government can allocate alternativeland for the same purposes (section 6) (6).

If Local Government refuses or neglects within a reasonable time to pay compensation to a holder or occupier, the Governor may proceed to effect assessment under section 29 and direct the Local Government to pay the amount of such compensation to the holder or occupier. (Section 6) (7).

Where a right of occupancy is revoked on the ground either that the land is required by the Local,State or Federal Government for public purpose or for the extraction of building materials, the holder and the occupier shall be entitled to compensation for the value at the date of revocation of their unexhausted improvements. Unexhausted improvement has been defined by the Act as:

''anything of any quality permanently attached to the land directly resulting from the expenditure of capital or labour by any occupier or any person acting on his behalf, and increasing the productive capacity the utility or the amenity thereof and includes buildings plantations of long-lived crops or trees, fencing walls, roads and irrigation or reclamation works, but does not include the result of ordinary cultivation other than growing produce.''

Developed Land is also defined in the generous manner under Section 50(1) as follows: land where there exists any physical improvement in the nature of road development services, water, electricity, drainage, building, structure or such improvements that may enhance the value of the land forindustrial, agricultural or residential purposes.

It follows from the foregoing that compensation is not payable on vacant land on which there exist no physical improvements resulting from the expenditure of capital or labour. The compensation payable is the estimated value of the unexhausted improvements at the date of revocation.

Payment of such compensation to the holder and the occupier as suggested by the Act may appear confusing as it raises the following question: Does it refer to holder in physical occupation of the landor two different parties entitled to compensation perhaps in equal shares? The correct view appears tofollow from the general tenor of the Act.

First, the presumption is more likely to be the owner of such unexhausted improvements. Secondly,the provision of section 6 (5) of the Act, which makes compensation payable to the holder and the occupier according to their respective interests, gives a pre-emptory directive as to who shall be entitled to what.

Again, the Act provides in section 30 that where there arises any dispute as to the amount of compensation calculated in accordance with the provisions of section 29, such disputes shall be referred to the appropriate Land Use and Allocation Committee. It is clear from section 47 (2) of the Act that no further appeal will lie from the decision of such a committee. If this is so, then the provision is not only retrospective but also conflicts with the fundamental principle of natural justice, which requires that a person shall not be a judge in his own cause.

The Act must, in making this provision, have proceeded on the basis that the committee is a distinct body quite different from the Governor or the Local Government. It is submitted, however, that it will bedifficult to persuade the public that this is so since the members of the committee are all appointees of the Governor.

Where a right of occupancy is revoked for public purposes within the state of the Federation; or on the ground of requirement of the land for the extraction of building materials, the quantum of compensation shall be as follows:

- *In respect of the land, an amount equal to the rent, if any, paid by the occupier during the year in which the right of occupancy was revoked.*
- *In respect of the building, installation or improvements therein, for the amount of the replacement cost of the building, installation or improvements to be assessed on the basis of prescribed method of assessment as determined by the appropriate officer less any depreciation, together with interest at the bank rate for delayed payment of compensation. With regards to reclamation works, the quantum of compensation is such cost as may be substantiated by documentary evidence and proof to the satisfaction of the appropriate officer.*
- *In respect of crops on land, the quantum of compensation is an amount equal to the value as prescribed and determined by the appropriate officer.*

Where the right of occupancy revoked is in respect of a part of a larger portion of land, compensation shall be computed in respect of the whole land for an amount equal in rent, if any, paid by the occupierduring the year in which the right of occupancy was revoked less a proportionate amount calculated in relation to the area not affected by the revocation; and any interest payable shall be assessed and computed in the like manner.

Where there is any building installation or improvement or crops on the portion revoked, the quantum of compensation shall follow that outlined in paragraph (ii) above and any interest payable shall be computed in like manner.

1.6.4.5The Nigerian Urban and Regional Planning Act CAP N138, LFN 2004

The Urban and Regional Planning Act is aimed at overseeing a realistic, purposeful planning of the country to avoid overcrowding and poor environmental conditions. In this regard, the following sections are relevant:

- **Section 30 (3)** requires a building plan to be drawn by a registered architect or town planner.
- **Section 39 (7)** establishes that an application for land development would be rejected if such development would harm the environment or constitute a nuisance to the community.

- **Section 59** makes it an offence to disobey a stop-work order. The punishment under this section, is a fine not exceeding ₦10,000 (Ten thousand naira) and in the case of a company, a fine not exceeding ₦50,000.
- **Section 72** provides for the preservation and planting of trees for environmental conservation.

1.6.4.6 Harmful Waste (Special Criminal Provisions) ACT CAP H1, LFN 2004

The Harmful Waste Act prohibits, without lawful authority, the carrying, dumping or depositing of harmful waste in the air, land or waters of Nigeria. The following sections are notable:

- **Section 6** provides for a punishment of life imprisonment for offenders as well as the forfeiture of land or anything used to commit the offence.
- **Section 7** makes provision for the punishment accordingly, of any conniving, consenting ornegligent officer where the offence is committed by a company.
- **Section 12** defines the civil liability of any offender. He would be liable to persons who havesuffered injury as a result of his offending act.

1.6.4.7 The Endangered Species Act, CAP E9, LFN 2004

This Act focuses on the protection and management of Nigeria's wildlife and some of their species in danger of extinction as a result of over exploitation. These sections are noteworthy:

- **Section 1** prohibits, except under a valid license, the hunting, capture or trade in animal species,either presently or likely, in danger of extinction.
- **Section 5** defines the liability of any offender under this Act.
- **Section 7** provides for regulations to be made necessary for environmental prevention and controlas regards the purposes of this Act.

Most of the proposed programme locations are on virgin land that serve as wildlife habitats which will be impacted by the programme. Hence, the programme activities shall be carried out to comply with the relevant provisions.

1.6.4.8 Inland Fisheries Act, Cap I10, LFN 2004

The Inland Fisheries focused on the protection of the water habitat and its species; the following sections is relevant:

- **Section 6** prohibits the taking or destruction of fish by harmful means. This offence is punishable with a fine of ₦3, 000 or an imprisonment term of 2 years, or both. One of the integral components of the solar hybrid systems is the battery storage. During the operational phase of the project there may be the possibility of battery leakages which may leach into water bodies for project locations with flowing rivers. The chemical contents of these batteries are toxic to aquatic life (fisheries), which necessitates the relevance of this Act.

1.6.4.9 National Commission for Museums and Monuments Act

The Act provides for the dissolution of both the Antiquities Commission and the Federal Department of Antiquities and to create a National Commission for Museums and Monuments, with the responsibilities to establish and administer national museums, antiquities and monuments; including, antiquities, science and technology, warfare, African, Black and other antiquities, arts and crafts, architecture, natural history and educational services among others. Sections 12 to 18 provide the process/steps for the declaration of antiquities as national monuments, while section 19 deals with restriction of excavations for the purpose of finding antiquities as well as issuance of permits and 20 deals with accidental discoveries. In case of any accidental find, the Commission shall be notified within seven (7) days.

1.6.4.10 The Factories Act, 1987 (Factory Act cap 126, LFN, 1990)

The Factories Act, as contained in the Laws of the Federation of Nigeria 1990, seeks to legislate and regulate the conduct of health and safety in the Nigerian work environment. It was enacted in June 1987 with the objective to protect the workers and other professionals against exposure to occupational hazards. The Director of Factories at the Federal Ministry of Employment, Labour and Productivity is responsible for the administration of the provisions or requirements of this Act. Section 13 allows an inspector to take emergency measures or request that emergency measures be taken by a person qualified to do so, in cases of pollution or nuisances.

This Act deals with working conditions at work sites, including construction sites, such as the type tobe undertaken under the EEP III. Hence, the occupational requirements applicable to construction sites, as well as other work sites to be used by the programme shall be subjected to the provisions of this Act.

1.6.4.11 Labour Act

This Act deals with labour issues, including payment of wages, recruitment, discipline, employee welfare, employment of women and child labour. Sections 54 to 58 which deal with employment of women, prescribed period of absence from work for nursing mothers and allows her half an hour twice a day during her working hours to attend to the baby for a period of up to six months after she resumes work. Section 55 also exempted women from night work, except when they are employed as nurses. Sections 59-64 deal with the employment of young adults.

1.6.4.12. Wages Board and Industrial Council Act, 1974

The Act provides for the establishment of a National Wages Board and Area Minimum Wages Committee for States and for Joint Industrial Councils for particular industries. It empowers theMinister to order or direct that an industrial wages board be established to perform, in relation to the workers described in the order and their employers, the functions specified in the provisions of this Act, including minimum wage. The minimum wage is currently ₦30,000.00 per month, and all individuals contracted/employed in relation to this programme shall not earn less than the minimum wage.

1.6.4.13. Workers' Compensation Act, 1987

The Act makes provisions for the payment of compensation to workmen for injuries suffered in the course of their employment. The compulsory insurance covers employees for injury or death resulting in the course of work or in work places. All types of workers are covered including those employed under a contract for service or an apprenticeship with an employer, whether by way of manual labour, clerical work or otherwise, and whether the contract is expressed or implied, is oral or in writing. The programme will employ both skilled and non-skilled labour and shall be subject to this law as applicable.

1.6.4.14 National Environmental Standards & Regulations Enforcement Agency (NESREA) Act, 2007

Administered by the Ministry of Environment, the National Environment Standards and Regulations Enforcement Agency (NESREA) Act of 2007, replaced the Federal Environmental Protection Agency (FEPA) Act. It is the embodiment of laws and regulations focused on the protection and sustainable development of the environment and its natural resources. The following sections are worth noting:

- **Section 7** provides authority to ensure compliance with environmental laws, local and international, on environmental sanitation and pollution prevention and control through monitory and regulatory measures.
- **Section 8 (1)(K)** empowers the Agency to make and review regulations on air and water quality, effluent limitations, control of harmful substances and other forms of environmental pollution and sanitation.
- **Section 27** prohibits, without lawful authority, the discharge of hazardous substances into the environment. This offence is punishable under this section, with a fine not exceeding, ₦1,000,000 (One Million Naira) and an imprisonment term of 5 years. In the case of a company, there is an additional fine of ₦50,000, for every day the offence persists.

1.6.4.15 National Environmental Regulations:

Section 34 of the NESREA Act, 2007 empowers the Minister of Environment to make regulations for safe and sustainable environment. In exercise of this power, the minster issued the national environmental regulations covering various environmental components and sectors of development. The regulations relevant to the programme are as follows:

- National Environmental (Energy Sector) Regulations, 2014. S.I. 63.
- National Environmental (Electrical/Electronic Sector) Regulations, 2011, S.I. No. 23
- National Environmental (Wetlands, River Banks and Lake Shores) Regulations, 2009. S. I. No. 26.
- National Environmental (Sanitation and Wastes Control) Regulations, 2009. S. I. No. 28.
- National Environmental (Watershed, Mountainous, Hilly and Catchments Areas) Regulations,2009. S. I. No. 27.
- National Environmental (Sanitation and Wastes Control) Regulations, 2009. S. I. No. 28.
- National Environmental (Noise Standards and Control) Regulations, 2009. S. I. No. 35.
- National Environmental (Air Quality Control) Regulations, 2013, S. I. No. 64,
- National Environmental (Soil Erosion and Flood Control) Regulations, 2010. S. I. No. 12.

- National Environmental (Surface and Groundwater Quality Control) Regulations, 2010. S. I.No. 22.
- National Environmental (Control of Vehicular Emissions from Petrol and Diesel Engines)Regulations, 2010. S. I. No. 20.

1.6.4.16. EIA Procedural Guidelines

This procedure prescribes the steps to be followed in the EIA process from project conception to commissioning and post commissioning impact mitigation, in order to ensure that the programme is implemented with maximum consideration of environmental factors. This ESIA study will be conducted in compliance with this guideline.

1.6.4.17 EIA Sectorial Guidelines (Infrastructures)

This provides general guidelines for EIA of projects in infrastructure sectors of Nigeria, with specific details for sub-sectors.

1.6.4.18. FMEnv ESMP Guidelines for Solar Mini-Grid Projects in Nigeria

The ESMP Guidelines for Solar Mini-Grid Projects in Nigeria was developed as an abridged form of the EIA Procedures Guidelines with the aim of simplifying the method of preparing ESMPs for proposed solar mini-grid projects. The simplified method is to also optimise the mini-grid projects EIA timeline and the cost of development.

1.6.4.19 State Legislations

Katsina State Environmental Protection Agency (KSEPA) Edict 1988

The edict states the functions of agency which are to:

- Liaise routinely and ensure effective harmonisation with the FMEnv in order to achieve the objectives of the National policy on environment;
- Co-ordinate the activities of ministries, parastatals, local government councils, departments, statutory bodies and research organisations on matters relating to environmental protection and conservation;
- Identify the ecological problems of the State including the devastating erosion and flood, brief the government on their sources and effects and find solutions to them;
- Monitor and determine degradations of coastlines, river basins and estuaries and carryout measures to protect and remedy their ecosystems;
- Identify water, air and soil pollution and their sources and carryout measures to prevent them;

- Monitor the implementation of the EIA and environmental audit report guidelines and procedures on all policies and projects within the State; and
- Carry out other activities as are necessary or expedient for the protection and sustainable development of the environment and for the full discharge of functions of the agency.

Katsina State Land Use Gazette KT. S.L.N. NO.1, 2015

The gazette discusses revised statutory land compensation rates payable for farmlands and economic trees as it relates to Katsina State. It stipulates the compensation rates for:

- Farmland per hectare in:
  - Katsina State Capital city (Katsina).
  - Local Government Headquarters of the state.
  - All rural areas (villages); and
  - Fadama Areas.
- Economic trees per piece.

Katsina State Waste Management Act

This Acts provides for the effective development and maintenance of sanitation in all areas of the State. The law further provides for proper disposition of excavated silt or earth and other construction materials after any construction project or repair works. Open burning of wastes is prohibited with stipulated penalties.

1.6.5 International Legislation

The International Conventions, to which Nigeria is a signatory, relevant to this programme are as follows:

- African Convention on the Conservation of Nature and Natural Resources
- Convention on Biological Diversity
- Endangered Species (Control of International Trade and Traffic)
- Conservation of Migratory Species of Wild Animals 1973
- Framework Convention on Climate Change 1992
- Convention to Combat Desertification 1994
- Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW)
- Human and Peoples' Rights on the Rights of Women in Africa 2005
- Civil and Political Rights Covenant

- Economic, Social and Cultural Rights Covenant
- Convention on the Elimination of All Forms of Violence Against Women
- Convention on the Rights of the Child

1.6.6 Institutional Framework

This section highlights the relevant institutions through which the planning and implementation of the programme will be effected. A number of institutions have been identified and will be involved in the overall implementation of this programme. These include:

- The Federal Government of Nigeria (FGN)
- Federal Ministry of Power
- Transmission Company of Nigeria (TCN)
- Federal Ministry of Environment (FMEnv)
- Nigerian Electricity Regulatory Commission (NERC)
- National Environmental Standards and Regulatory Enforcement Agency (NESREA)
- National University Commission (NUC)
- Relevant State Agencies: State Ministry of Lands, State Ministry of Environment and State Environmental Protection Agencies
- Local Government Authority (LGA)

The responsibilities and roles of each of the institutions are discussed below.

1.6.6.1 The Federal Government of Nigeria

Section 20 of the Constitution of Nigeria makes it an objective of the Nigerian State to improve and protect the air, land, water, forest and wildlife of Nigeria. Sections 33 and 34 which guaranteefundamental human rights to life and human dignity, respectively, can also be linked to the need for a healthy and safe environment to give these rights effect. The Executive Council of the Federation approves all national policies including the National Policy on Environment.

1.6.6.2 Federal Ministry of Environment

The Federal Ministry of Environment is responsible for the overall environmental policy of the country. It has the responsibility for EIA implementation, approval and issuance of certificates. It has developed certain guidelines andregulations to protect the environment and promote sustainable development. It will monitor the implementation of mitigation measures when the project commences. They can also issue directives to the project on specific actions related to the environment in the project area. The Ministry normally involves the states and sometimes local governments in this responsibility depending on the specific activity.

1.6.6.3 ***The National Environment Standards and Regulations Enforcement Agency (NESREA)*** ensures the embodiment of laws and regulations focused on the protection and sustainable development of the environment and its natural resources are monitored and complied with. NESREA ensures that the operational phase of the solar power system mini-grid project complies with national environmental standards and regulations.

1.6.6.4 The National Universities Commission

The National Universities Commission (the Commission) was established in 1974 by the National Universities Commission Act CAP N81 to advise the Federal and state governments of all aspects of university education and the general development of universities in Nigeria.

It is the dynamic regulatory agency acting as a catalyst for positive change and innovation for the delivery of quality university education in Nigeria. It is also the agency for channeling all external aid to the universities in Nigeria; To receive block grants from the Federal Government and allocate them as appropriate

1.6.6.5 The 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, and the National Energy Policy, 2013 as described earlier in section 1.6.4. The following parastatals are under the ministry: Energy Commission of Nigeria (ECN), Nigerian Electricity Regulatory Commission (NERC), Power Holding Company of Nigeria (PHCN), and Rural Electrification Agency (REA). The responsibilities of the Federal Ministry of Power are as follows:

- Initiating and formulating broad policies and programmes on the development of the power sector Initiating concessions in the power sector Licensing of electrical contractors and electric generating sets of 1MW capacity and below
- Conducting investigation on electrical accidents and to ensure safety in the electricity industry in Nigeria

- Conducting statutory tests and certification of electric poles (concrete, wooden, steel etc.) and other major electrical materials before they are used on the grid and networks in Nigeria
- Implementing renewable energy progammes/initiatives (solar, wind, biomass, small hydro etc.) Coordinating activities of the power sector
- Handling policy matters relating to research and development in the power sector
- Promoting the development of hydro power plants through public private partnership (PPP) Participating in bilateral and multilateral relations affecting the power sector
- Facilitating the overall coordination of the activities of the parastatals under its supervision

1.6.6.6 Nigerian Electricity Regulatory Commission (NERC)

The Nigerian Electricity Regulatory Commission (NERC) is an independent regulatory agency. NERC was established in 2005 as part of the economic reform agenda of the Obasanjo administration. The Electric Power Sector Reform Act, 2005 was the legislation that led to the establishment of NERC. The Commission is mandated to carry out the following, amongst others:

- Monitor and regulate the activities of the electricity industry in Nigeria;
- Issue licenses to market participants; and
- Ensure compliance with market rules and operating guidelines.

In order to create an enabling investment climate for rural electrification projects, NERC established the Mini-Grid Regulation in 2016; regulatory guidelines for mini-grids less than 100 kW and a light-handed regulation for mini-grids between 100 kW und 1 MW

1.6.6.7 Transmission Company of Nigeria (TCN)

TCN emerged from the defunct National Electric Power Authority (NEPA) as a product of the merger of the Transmission and Operations sectors on April 1, 2004. TCN was incorporated in November 2005. Being one of the 18 unbundled Business Units under the Power Holding Company of Nigeria (PHCN), TCN was issued a transmission License on 1st July, 2006. It was subsequently issued two licenses on June 10, 2013 for electricity transmission and system operations.

1.6.6.8 Rural Electrification Agency

The Rural Electrification Agency was set up by Section 88 of the Electric Power Sector Reform Act 2005 as the Implementing Agency of the FGN tasked with electrification of rural and unserved communities. The mission is to provide access to reliable electric power supply for rural dwellers irrespective of where they live and what they do, in a way that would allow for reasonable return on investment through appropriate tariff that is economically responsive and supportive of the average rural customer.

1.6.6.9 Federal Ministry of Women Affairs and Social Development

Promote actions to achieve the National Gender Policies, and a gender budget among policymakers. The goals of the gender policy among others include among others:

- Eliminate cultural/ religions gender-based biases and harmful cultural and religious practices which rise to inequalities in gender-role relations in the Nigerian society. A culture which is amendable to development must be dynamic.
- Tap the potential of women for development;
- Eliminate all forms of gender-based violence.
- Ensure equal access to women, boys and girls to both formal and informal education. Women education is a priority because it is the key to gender equity, justice and poverty reduction, improved skills and technological knowledge, as well as the general socio-economic development of the nation.

1.6.6.10 State Institutions

Katsina State Ministry of Resource and Development

This Ministry was set up to protect and develop the general environment of the State. Other objectives are to facilitate good governance in the protection, restoration, conservation, development and management of the environment and natural resources for equitable, sustainable socio-economic development.

Katsina State Ministry of Lands and survey

The ministry ensures efficient and effective land resource management which promotes equitable access, enabling environment for land delivery, land information and ability to contribute to sustainable socio-economic development of the state. Its objective is to acquire, develop, hold, manage, sell, lease and let any properties within the State. Improving the quality of life for citizens through efficient and effective utilization of available resources for the advancement of Human Settlement.

Katsina State Ministry of Women Affairs

The Ministry is charged with the development of women through education, training as entrepreneurs and creating a platform where issues of sexual harassment and discrimination are critically examined and steps are taken to stop such act.

Katsina State Local Government & Chieftaincy Affairs

This Ministry was created for the purpose of complementing the effort of the State Government to create an environment where the tradition and customs of the community are adhered to and also increase development of the community at the local government level.

1.6.7 Funding Agency Requirements

This programme is funded by the African Development Bank (AfDB). Therefore, the AfDB safeguard systems will be integrated in the project cycle. Other international environmental and social protection requirements in addition to national requirements will be considered in order to comply with international best practices. Both main environmental and social requirements that the project needs to comply with are described in the following sections.

1.6.7.1 The African Development Bank's Operational Safeguard

The programme has been assigned a category II by the African Development Bank in line with the guidelines within the Bank's ESAP for all power generating plants even though the generating capacity is between 1MW to 10MW. However, the **Operational Safeguards (OS1**) on Environmental and Social Assessment has been triggered because the component activities have the potential to generate some environmental and social impacts to identified receptors within its area of influence which if not well managed can lead to disruption of ecosystem services for the community. **Operational Safeguard (OS2**) is not triggered because there is no physical or economical displacement in this University. **OS3 on Biodiversity, renewable resources and ecosystem services** has also been triggered due to the activities of the EEP Phase III. However, this OS focuses on the issues of modified, natural and critical habitats, on the requirements to address impacts on ecosystem services; and the importance of applying the Mitigation Hierarchy (Avoid, Minimize, Reduce, Restore, Offset and Compensate). **OS 4 on Pollution Prevention and Hazardous Substances** is triggered since construction will involve use of fuels and possibly some hazardous materials. **OS 5 on Labour Conditions, Health and Safety** is applicable since the construction will involve a significant number of construction workers.

1.7. 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 LOCATION AND JUSTIFICATION

2.1 Project Location

This chapter highlights the project's location, existing infrastructures and the rationale for the proposed solar-hybrid power plant at the Federal University Dutsin-Ma, Katsina State, Nigeria as part of the Federal Government of Nigeria (FGN) Energizing Education Programme (EEP) Phase III. It also includes the description of alternatives and development options considered for the proposed Project.

The project site is located close to Department of Nursing inside the main campus in dutsin-ma Local Government Area of Kastina State. The site lies within Latitude 1200'0"N and 1300'0"N and Longitude 700'0"E and 900'0"E in Zone 32 of WGS84 datum. The university is located along Katsina-Kankara Road, Dutsin-Ma Local Government Area of Katsina State, North-Western region of Nigeria, latitude 12.296554N longitude 7.441562E, bordering Niger Republic, Kaduna, Kano, and Jigawa State.

The area of the project site is 10.031 HCTRS. Figure 2.1 is the map of the project area at FUDMA.

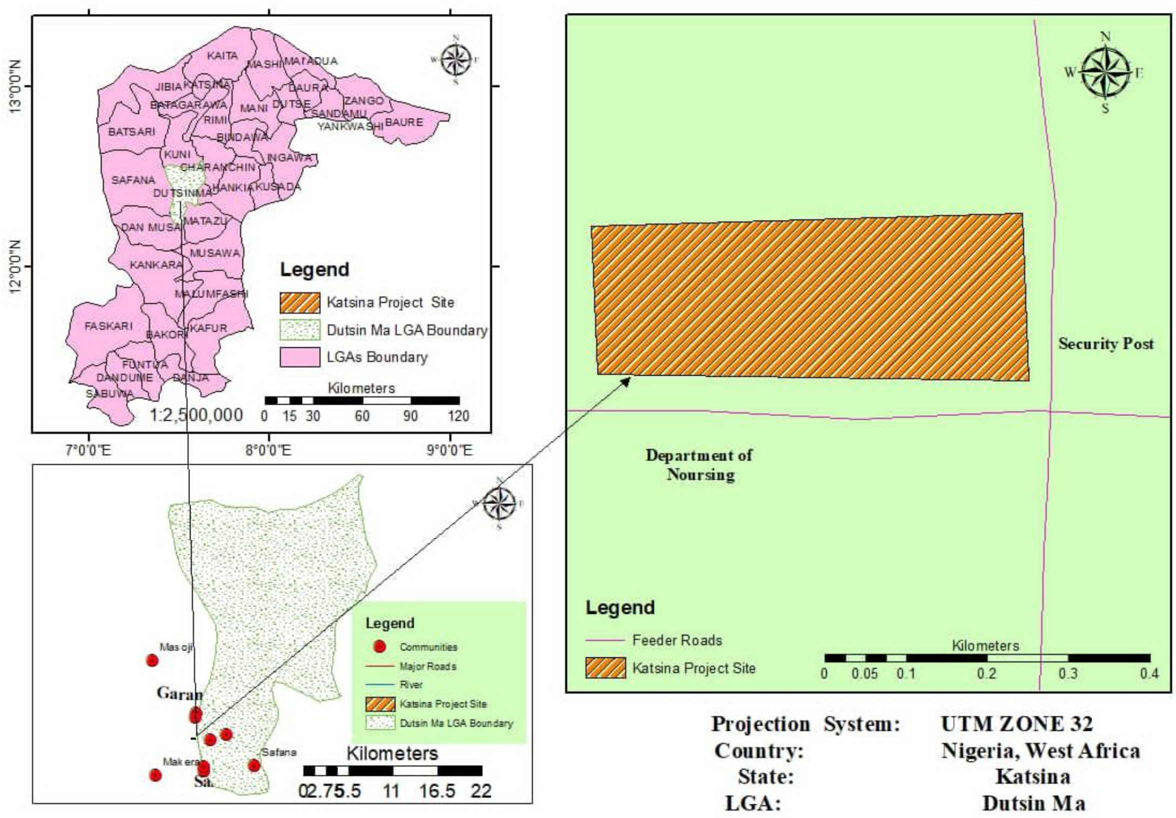

Figure 2. 1: Map showing the location of EEP project site at FUDMA
(Source: Sustainabiliti)

Federal University Dutsin-Ma, Katsina State

The Federal University Dutsin-Ma was established 2011, along with eight other Federal Universities, is in line with the Federal Government of Nigeria's determination to run a technology driven economy with the aim of achieving the vision 2020, to further improve the nation's knowledge base and expand access to education, which is a defining factor in the establishment of institutions of learning in Nigeria. The overall goal of the establishment was to tackle the challenges of inadequate space for eligible university applicants. Thus, the nine new Federal Universities, which were established in States where none existed, are positioned to strike a balance between access, equity and quality, thereby creating an avenue for indigenous appreciation of educational values.

The population of the FUDMA community can be estimated at over 12,000 for both staff and students based on the website information. This population, therefore, needs electricity to work effectively. The proposed development will go a long way in improving the running of the school's academic activities effectively.

2.1.1 Description of the Project Site

There is sparse vegetation at the project area and no farming or encumbrance on the project site as seen in plate 2.1 and plate 2.2. Table 2.1 is a summary of the location characteristics.

Table 2. 1 : Location characteristics

PV Plant location characteristics	
City / Town	Garangamawa
Region/ country	Katsina, Nigeria
Latitude	+12.30 °
Longitude	+7.44 °
Altitude	511.36 m a.m.s.l.
Time zone	UTC +1

Plate 2. 1: Project Location Environment
(Source: Field Survey for the proposed EEP 3, July 2022)

Plate. 2. 2: Proposed Site
(Source: Field Survey for the proposed EEP 3, July 2022)

Figure 2.2 is an extraction of the given and the surveyed perimeter.

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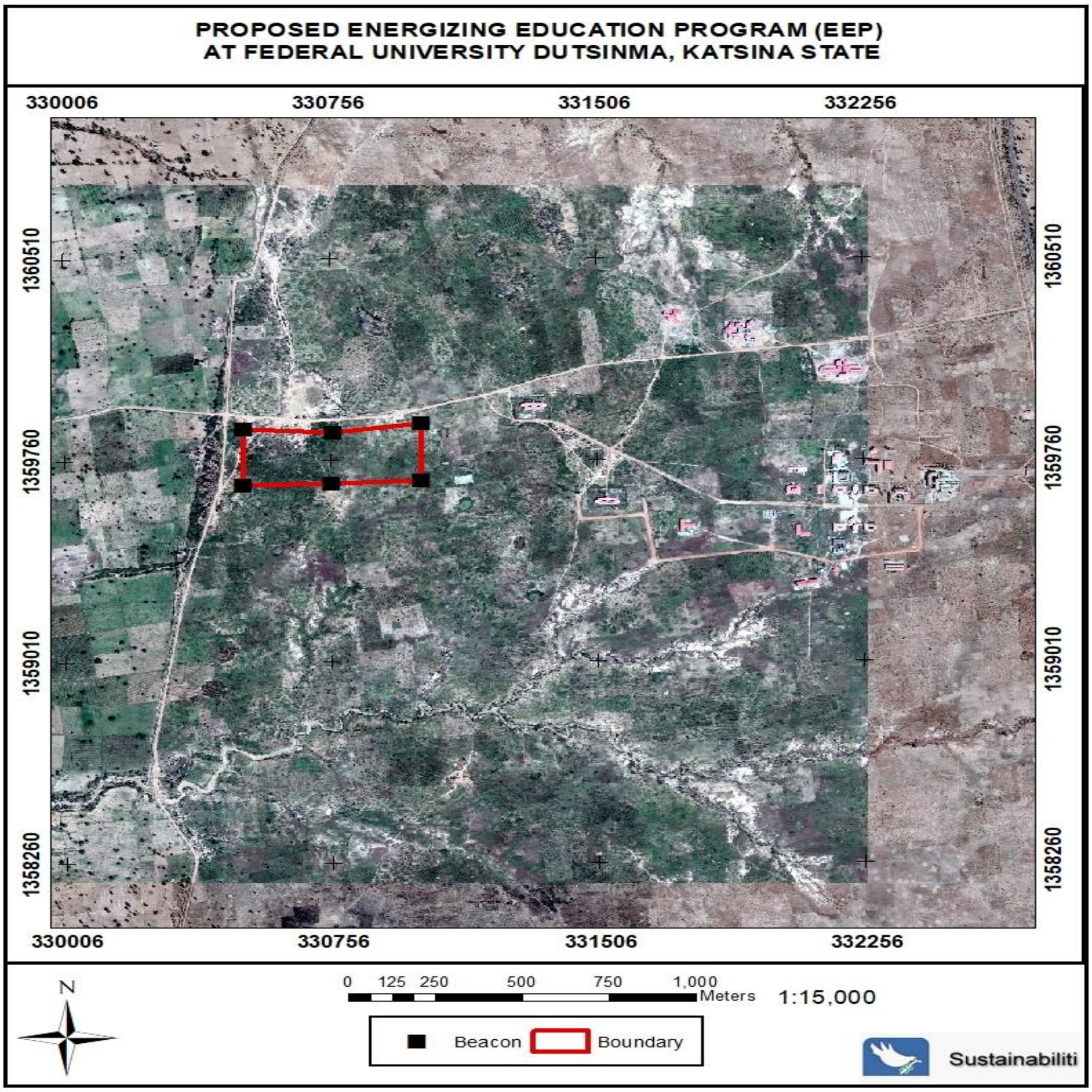

Figure 2. 2: Closer view of the substation within Federal University Dutsin-Ma Katsina
(Source: Sustainabiliti Ltd field studies, 2022)

2.1.2 Land Survey assessment

The site is located inside the main campus; however, a full land survey could not be conducted due to negative security report during the period of assessment and this limited the survey team from assessing the site. But as an option, satellite imagery was used to extract the required data which will serve as final data for establishment of the project boundary on the ground.

The initial coordinates provided, gave a size of 50 hectares against the quoted size of 10 hectares. The proposed site survey has been completed with a total surveyed size of 10.031 hectares. Site Coordinates is indicated in table 2.2. On improved security status the beacons will be erected and topography details finalized. Figure 2.3 is an indication of the surveyed project site within the master plan of the university.

Table 2. 2: Final Site Coordinates for the Dutsin-Ma EEP

SITE	SIZE(Hectares)	BEACON NO.	E (Longitude)	N(Latitude)
		PBKT7985	7.4438273	12.296807
		PBKT7986	7.4461052	12.2971271
FUDMA	10.031	PBKT7987	7.446102	12.2951886
		PBKT7988	7.4437864	12.2950907
		PBKT7989	7.4415086	12.295011
		PBKT7990	7.4415102	12.2969023

(Source: Sustainabiliti Ltd field studies, 2022)

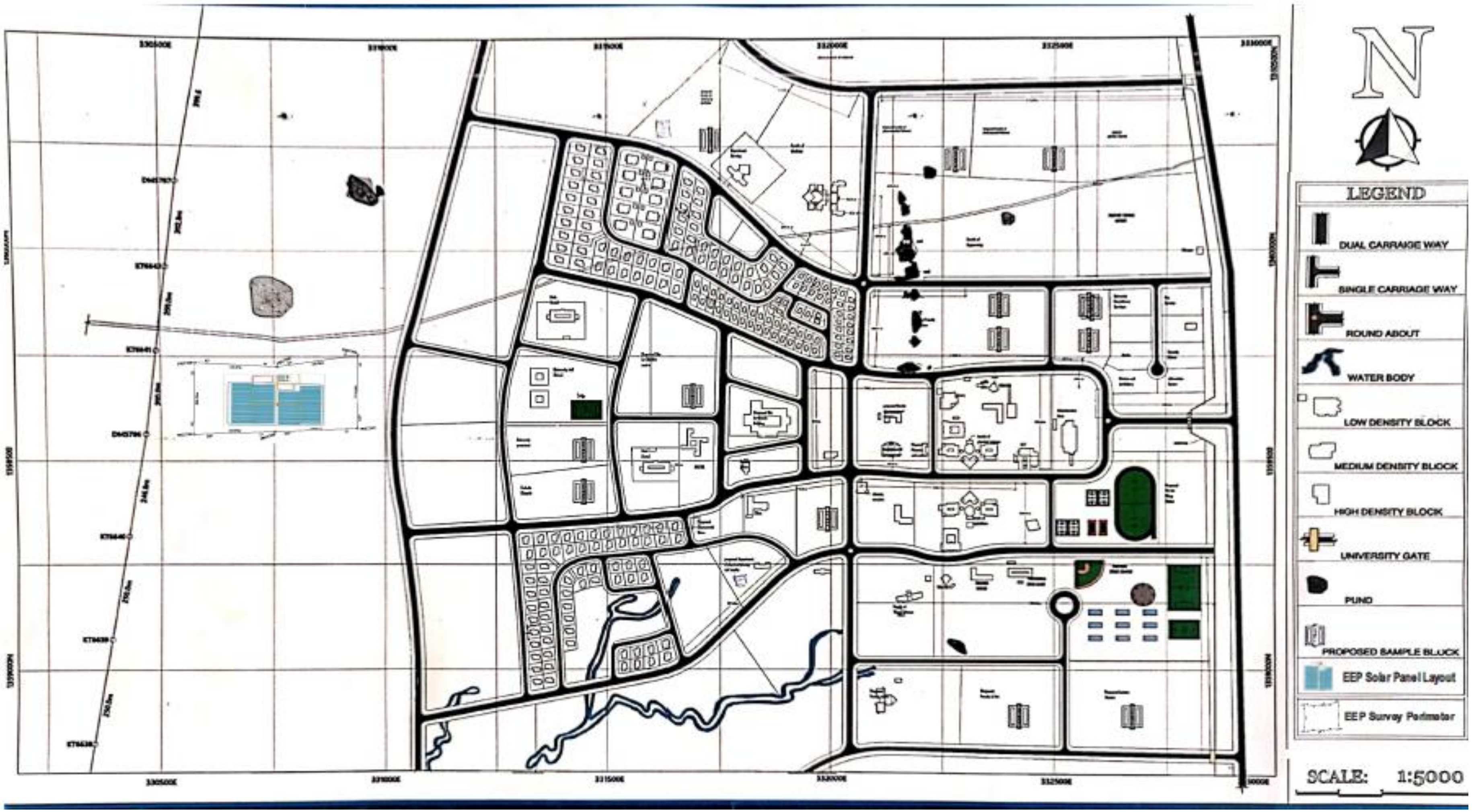

Figure 2. 3: Federal University Dutsin-Ma Katsina Master Plan
(Source: Adopted from Physical Planning and Works FUDMA Master plan)

2.1.3 Existing Infrastructure

There are 22 step-down transformers and 26 generators serving the school as alternative power supply (plate 2.3). Also, the University has 502 installed street lights and 35 boreholes for constant water supply. It was noted recently that the peak load demand experienced is 1.0MVA and the total power generated by the existing solar system is 85KW. Plate 2.4 shows the source of water at the project environment.

Plate 2. 3: Existing Transformers in FUDMA
(Source: Field Survey for the proposed EEP 3, July 2022)

Plate 2. 4: Source of Water Supply within the Project Environment
(Source: Field Survey for the proposed EEP 3, July 2022)

2.2. Need for the Project

Public tertiary institutions in Nigeria (especially the Federal Universities) remains the most preferred for a large percentage of students seeking admission in the country. However, majority of these universities are faced with the challenge of inadequate power supply from the national grid. In order to cope with this situation, most of the universities rely on diesel-fuelled generators for the generation of electricity, with significant economic and environmental implications. Part of the FGN's initiatives to address inadequate power supply in the country is the establishment of 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 African Development 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. Also, the EEP is part of measures in ensuring that Nigeria achieves its carbon emission targets (20% carbon emission reduction by the year 2030) as contained in its Nationally Determined Contributions (NDC), under the Paris Agreement.

The proposed Project in Federal University Dutsin-Ma, Katsina State, is part of the FGN's EEP Phase III, under NEP. The Project will help to significantly address the power supply challenges the University is currently facing, 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.

2.3 Value of the Project

NEP is being co-financed by the African Development Bank through a US$200 million loan facility. The total funding available for the EEP phase III component is US$123 Million. Funding breakdown of the EEP Phase III includes Engineering Procurement Construction (EPC) and Operations & Maintenance (O&M) Contracts – this will involve contracts with competitively selected EPC contractors to build, operate and maintain the power plants at each site and also build and equip the training centres for one year.

2.3.1 Project Benefits

The proposed Project is envisaged to have a range of associated benefits. The potential benefits of the proposed Project include but are not necessarily limited to the following:

- Increased electricity generation - when operational, the project is expected to generate about 3,493megawatt hours (MWh) of solar energy per year.
- the electricity generated will be sufficient to power approximately 180 additional facilities including student hostels and staff quarters.

- Stimulation of academic and research activities within the University as a result of access to constant and reliable power supply, thereby promoting educational advancement.
- Reduction in fossil fuel consumption by the University thereby leading to reduction in carbon emissions and improvement in eco-balance.
- Significant reduction in the cost of power generation by the University through diesel-fuelled generators. Such savings would be used to salvage other expense that will benefit the University.
- Increase in social interactions within the University. There will be enhanced security in the University as a result of more streetlights for illumination which would help keep off opportunistic crimes and gender-based violence.
- Manpower skills development and training - local engineers and technicians will attend training programs to teach them how to properly manage the solar field
- 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.
- 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, AfDB and other relevant Ministries, Departments and Agencies (MDAs).
- Contributing to the Nigeria's NDC to cut carbon emission by 20 % by the year 2030, under the Paris Agreement.

Thus, the socio-economic benefits attached to this rural electrification access intervention, the EEP, are significant and largely impact not only the power, education and healthcare sectors but also provides as a measure to ensure Nigeria achieves its targets as contained in Nigeria's Nationally Determined Contributions (NDCs) under the Paris Agreement 2016.

The EEP is a key programme to be developed towards achieving the objectives to the Power Sector Recovery Programme (PSRP) which was approved by the Federal Executive Council (FEC) on 22nd March 2017.

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 Federal University Dutsin-Ma, Katsina State. 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. In addition, adequate capacity building shall be provided to the University personnel that will be in charge of the day-to-day operation of the Project in the long run.

Upon completion of the construction phase, an O&M contractor will be engaged to operate and maintain the Project, in conjunction with the Works and Physical Planning Department of the Federal University Dutsin-Ma, Katsina State. 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. Selected students from the STEM departments will also receive hands-on training on the construction, operation and maintenance of the power plant.

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 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 co-financed by the AfDB. The total funding available for the EEP phase III component is US$123 Million. Funding breakdown of the EEP Phase III includes Engineering Procurement

Construction (EPC) and Operations & Maintenance (O&M) Contracts – this will involve contracts with competitively selected EPC contractors to build, operate and maintain the power plants at each site and also build and equip the training centres for one year.

Upon completion, the Project will augment the existing infrastructure to significantly reduce the use of diesel generators in the University thereby saving costs on diesel fuel and generator maintenance, amongst others. Also, the monthly payment to distribution company (Kano Electricity Distribution Company) for power consumption through the grid would stop, or reduce significantly since there will be interconnection to the grid, though the solar power plant will be the primary/ chief source of electricity for the University.

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.

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) is being 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. Furthermore, REA-PMU will establish a grievance redress mechanism (GRM) that will allow general public in the project area, affected communities or individuals, and PAPs to file complaints and to receive responses in a timely manner. The system will also record and consolidate complaints and their follow-up. This system will, be designed for handling complaints resulting from the project activities or its personnel.

2.5 Project Alternatives

Alternatives scenario for meeting the aspiration of Federal Government in the provision of improved power generation were evaluated. In particular, alternatives in relation to the type, scale and location of the project were reviewed. The options considered were: Site selection options, Generation technology options; Do nothing.

2.5.1 Analysis of Project Alternative

The power plant to be provided as part of proposed EEP Project has been conceptualized to be a renewable energy source, thus eliminating discussions on other possible sources of power generation such as the use of coal fired plant, oil-fuel plant, natural gas fired power plant, etc.

Setting up of a solar power project involves selection of environmentally and techno economically suitable site, land characteristics, meteorology, infrastructure, grid availability, water availability, rail and road connectivity, accessibility and shading aspects etc. Before selecting the solar hybrid system applicable to this location and matching the daily demand and the requisite renewable energy production, the comprehensive review of the measured data for the solar hybrid system for the Federal University Dutsin-Ma, Katsina State was carried out duly by the FEED Consultant. Thus, this section specifically focuses on the alternatives considered within the proposed solar-hybrid power plant.

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.

2.5.2 Site Alternatives

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 within the campus; ii) security; iii) absence of any physical structure on the site that could be affected by 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 physical structure which could trigger relocation; ii) poor accessibility; iii) technical considerations for installation of solar panels, for example, topography.

2.5.3 Solar Power Technology Alternatives

The solar technologies options available for the proposed power plant in the University are:

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

2.5.3.1 Concentrated Solar Power (CSP) Systems

Concentrated solar power (CSP) technologies harness thermal energy from the sun to drive a thermodynamic cycle. Thermal energy storage (TES) is realized through the addition of tanks, which allows CSP systems to generate electricity at times of little or no solar irradiance. This includes operating 24-h a day (baseline generation) or adjusting electricity generation during times of increased demand and high prices.

There are four different types of solar collector designs indicated in figure 2.4 parabolic troughs, heliostats (for power towers), linear Fresnel lenses, and dish receivers.

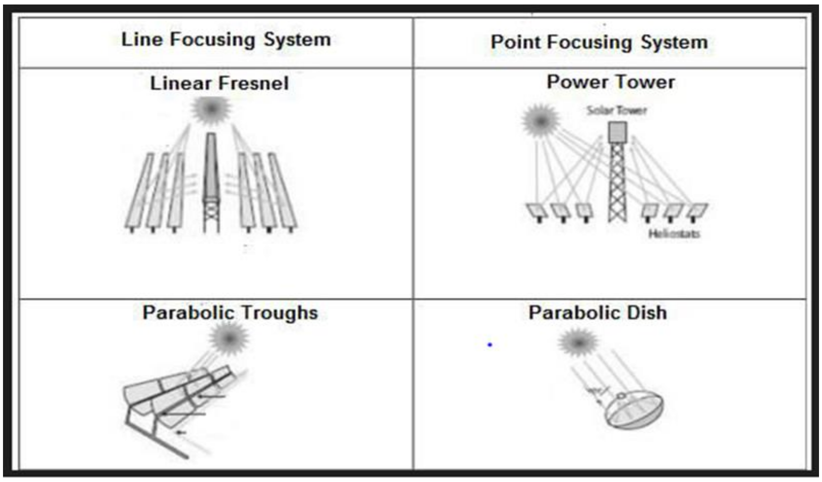

Figure 2. 4: Four different types of solar collector designs
(Source: The end of CSP as we know it? | Energiek (wordpress.com))

2.5.3.2 Solar Photovoltaic Power Systems

SPV systems utilize semiconductor-based materials (solar cells) which directly convert solar energy into electricity. SPV systems have many attractive features, including modularity, no fuel requirements, zero emissions, no noise and no need for grid connection. SPV systems can be classified according to three principal applications.

- Stand-alone solar devices purpose-built for a particular end use, such as solar HF radios, solar home lighting systems, or solar coolers. These dedicated SPV systems can either be configured to include some energy storage capacity or directly power electrical or mechanical loads, such as pumping or refrigeration;
- Stand-alone solar power plants, basically small power plants designed to provide electricity from a centralized SPV power plant to a small locality like village or a building; and
- Grid-connected SPV power plants, which are equivalent to any other generator supplying power to the electricity grid.

The PV technology option was selected for the proposed solar plant due to:

- Favourable project financing due to relatively lower costs than other solar technologies; Technology is most suitable for power plants up to 100 MW;
- Existing transmission infrastructure is adequate to deliver the energy produced from the plant; and
- Process involves a simple design with few technical components which reduces operation and maintenance costs and in general makes the plant more efficient

The final design preference is for Solar Photovoltaic Power Systems. Table 2. 3 indicates Potential SPV System Configurations and Design Assumptions based on 4.8 daily hours of peak power output.

Table 2. 3: Potential SPV System Configurations and Design Assumptions based on 4.8 daily hours of peak power output.

Description	**SPV Systems**		**SPV Mini-grid**	**Large Grid-connected**
			Power Plants	SPV Power Plant
Module Capacity	50 W_p	300 W_p	25 kW	5 MW
Life Span Modules	20 Years	20 Years	25 Years	25 Years
Life Span Batteries	5 Years	5 Years	5 Years	NA
Capacity Factor	20%	20%	20%	20%

(Source: REA FEED Projections)

2.5.4 Solar Batteries Alternatives

Solar batteries are mainly categorized by manufacturing material. There are four main types of solar batteries available on the market:

Lead-Acid Batteries

Lead-acid batteries are the oldest form of battery with technology dating back more than a century. As a result, lead-acid batteries are a tried-and-true when it comes to storage. Lead-acid batteries are categorized into two types: flooded lead-acid and sealed lead-acid batteries.

The lead-acid variety are considerably more inexpensive than other solar batteries. These batteries come with some challenges: shorter lifespan and lower depth of discharge. Lead-acid battery capacity is also comparatively lower than other batteries. These limitations can complicate the installation process.

Lithium-Ion Batteries

Lithium-ion batteries are relatively new. Their advanced technology has updated features. Many portable devices, such as mobile phones and laptops, use lithium-ion batteries. They are efficient, compact and lightweight. If not properly installed, lithium-ion batteries could experience thermal runaway and catch fire.

Nickel Cadmium Batteries

Nickle Cadmium (Ni-Cd) batteries are not as common as lead-acid or lithium-ion batteries. These batteries are also a century old. They were popular in the aircraft industry. Because of their sturdiness, Ni-Cd batteries are useful for large-scale applications, such as utility solar energy storage.

Known for durability, Ni-Cd batteries can operate at higher temperatures. They also don’t need complicated battery management systems and are almost maintenance-free. Ni-Cd batteries’ biggest drawback is that they are toxic. Even when recycled, they can become a major environmental concern.

Flow Batteries

Flow batteries are still in the development phase, and it may take some time before they are widely available in the market. Knowing about them now is worthwhile because this variety is expected to be a gamechanger in future solar panel storage methods. Within these batteries, water-based electrolyte liquid circulates between two different chambers. The chemical reaction of the charging process allows the battery to store and release electrical energy.

The biggest advantage of flow batteries is that they offer 100% depth-of-discharge capability. This means you can utilize all the energy stored in the battery without damaging it.

The final design option is in preference of lithium battery

2.5.5 Project Options

No Project Option

The no project alternative assumes that the project will not be carried out. This would result in the continued low power generation and epileptic power supply in the university. One of the reasons for the proposed Project in the University 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, and leaves the University to significantly rely on diesel-fuel generators for self-generation of power considering the current situation of electricity supply to the University through the grid. The use of generators has its environmental and socioeconomic cost in air pollution, noise pollution and maintenance issues. In addition, the potential benefits associated with the Project would not be realized. This has economic implications to the University and would not also be in line with the FGN's efforts in achieving its carbon emission targets. Thus, the No Project option is not considered a viable option to adopt.

Delayed Option

This option implies that the planned Project will be delayed until a much later date. The implication of delayed project option will mean that all the preliminary work and associated efforts/costs because of inflationary trends, will 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.

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: DESCRIPTION OF THE SUBPROJECT

3.1 Project Overview

The plan for Federal University of Dutsin-Ma Katsina is solar hybrid power system to augment the existing solar system operational in the university.

The rated power of the proposed PV Plant is 1650.0 kWac and the peak power is 1997.6 kWdc resulting in a DC/AC ratio of 1.21. The system would include a combination of fixed arrays facing south and embedded into the ground with concrete footings. The civil characteristics and general layout of the proposed plant are shown in figure 3.1.

The proposed plant would use a renewable method of generating electrical power by converting solar radiation into direct current electricity using silicon panels that exhibit the photovoltaic effect. Photovoltaic (PV) power generation employs solar panels composed of a number of solar cells containing silicone.

Power produced by the plant would be, converted to AC through inverters. Transformers would be installed to step up voltage so that it is compatible with the national grid. The stepped-up power would then be connected to the grid.

The following infrastructure would be established for the project:

- A solar PV plant constructed using poly crystalline PV modules, installed in regular arrays
- An overhead power line to connect the solar plant to national grid
- A system of inverters and step-up transformers
- Aboveground and underground electrical conduits and cabling which connect the arrays to the inverters and transformers
- Marshalling switchgear to collect the power from the PV arrays
- Internal access tracks to allow for maintenance of the site
- Supervisory control centre
- Site office and maintenance building
- Lay down and assembly area

Project: FEDERAL UNIVERSITY DUTSIN-MA, HYBRID SOLAR PV CAPTIVE SOLAR POWER PLANT

POWER		QUANTITIES	
Rated Power	**1650.0 kW**	Modules	*6444*
Peak power	**1997.64 kW**	Strings	*179*
DC/AC Ratio	**1.21**	Structures	*179*
PRODUCTION		Inverters	*15*
Specific production	**1815.5 kWh/kWp**	Power stations	*1*
Energy (year 1)	**3626.7 MWh**		
Performance ratio	**76.51%**		

SITE CHARACTERISTICS

LOCATION		TERRAIN SLOPES	
Site name	*FUDUTSIN-MA V1*	Average NS/EW	*1.27% / 1.29%*
Country	*Nigeria*	Max N-S	*12.87%*
Lat / Long	*12.30° / 7.44°*	Max E-W	*13.81%*
Net available area	*9.53 ha*	Elevation max/min	*517.78 / 504.71 m*

METEOROLOGICAL DATA		HORIZON	
GHI	*2297.7 kWh/m2*	Source	*SOURCE_PVGIS*
Temp	*26.31 °C*	Average	*0.6°*
Temp Max/Min	*40.11 / 13.42 °C*	Maximum	*1.1°*
Source	*PVGIS*		

EQUIPMENT

PV MODULE		FIXED MOUNTING STRUCTURE	
Company	*Canadian Solar Inc.*	Company	*Generic*
Model	*CS3K-310MS 1500V*	Model	*Generic - 1H*
Technology	*Si-mono, monofacial*	Type	*1H*
Peak Power	*310.0 Wp*	Pitch	*3.48 m*
Voltage Max	*1500.0 V*	Maximum modules	*0*

INVERTER		POWER STATION	
Company	*Huawei Technologies*	Power AC	*1650.0 kVA*
Model	*UN2000-100KTL-HV-D1-001*	Num. inverters	*18*
Rated Power	*110.0 kVA*	Num. transform.	*1*
Range MPPT	*880 - 1300 V*	Transf. Ratio	*0.8/20.0kV*
Voltage Max	*1500.0 V*	Service	*Indoors*

CONFIGURATION

CIVIL		ELECTRICAL WIRING	
Roads position	*Vertical and perimeter*	Configuration	*String inverter*
Roads width	*4*	String cables	*4 mm2 Cu*
Layout type	*ADAPTATIVE*	LV AC cables	*70 mm2 Al*
		MV cables	*150 mm2 Al*

Figure 3. 1: Overview of Site Characteristics, Equipment and General Configuration
(Source: REA NEP 3 FEED)

3.2 Project Requirements

Land: The area where the PV plant is to be built consists of the available areas, with a total surface area of 15.2 ha. One restricted area are not suitable for the installation of PV modules. The final available area covers a surface of 15.0 ha. The size of each area and the total suitable area for installation purposes is shown in Table 3.1.

Table 3. 1: Area coverage

Area name Size	Total
Available areas	Total 8.78
Restricted areas	Total 0.15 ha
Substation area	Total 0.1 ha
Total available area	**9.53 ha**

(Source: REA NEP 3 FEED)

Figure 3.2 shows the description of the substation (blue), the available area (white) and, the restricted area (red) within the coordinates of the project area.

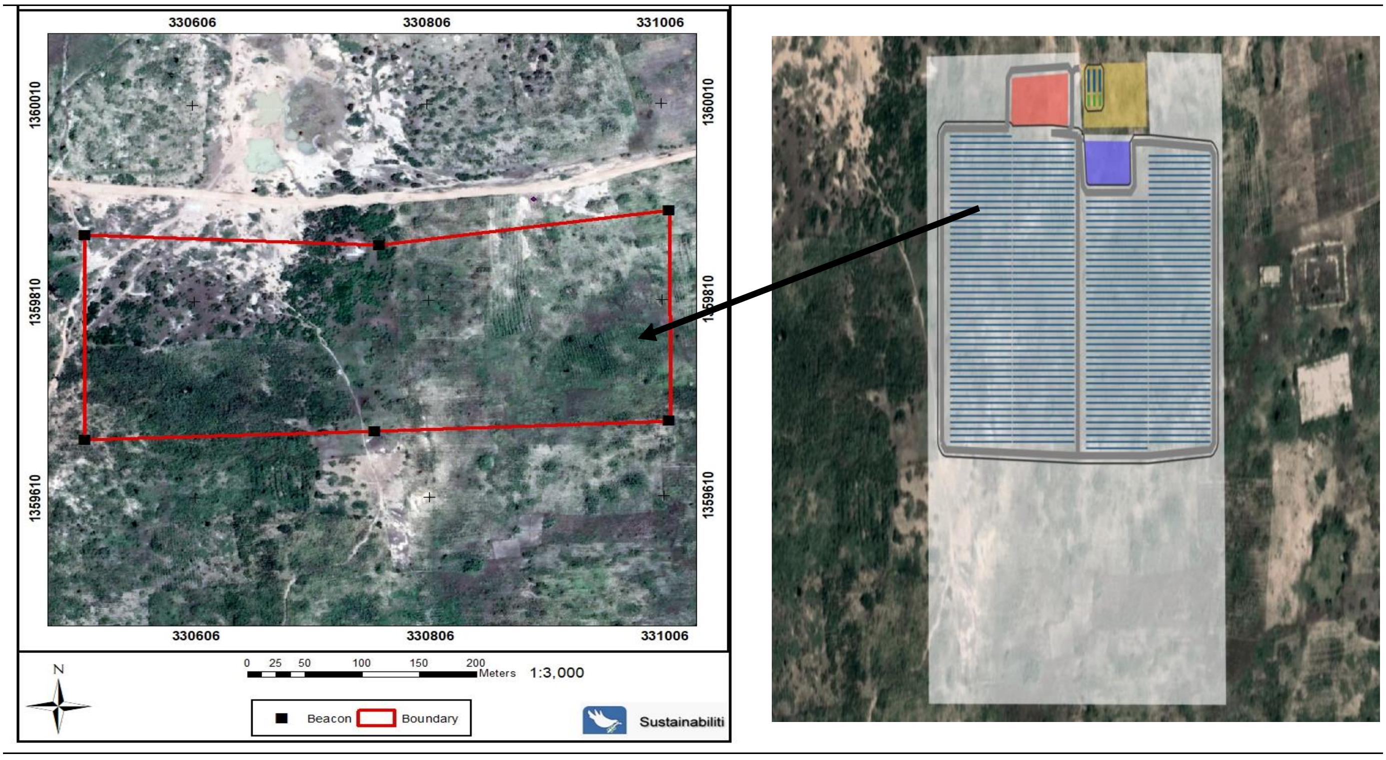

Figure 3. 2: Areas coverage of the proposed PV Plant at Federal University, Dutsin-Ma
(Source: REA NEP 3 FEED)

Water Use and Supply: Water usage would be minimal and would be mainly for the monthly cleaning of PV panels and domestic use. 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. The month with the most rainfall in Katsina is August, when the rain falls for 17.8 days and typically aggregates up to 119mm (4.69") of precipitation.
During the periods of rainy season, direct cleaning of the PV panels is estimated to occur not more than twice. However, during the dry season, the frequency of cleaning will depend on the rate of dust accumulation.

Based on the review of similar solar power projects, each PV panel would require approximately 5litres 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 made 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, boreholes yields improve significantly. Water requirement would be met by building rain/runoff water harvesting pond and also from groundwater extraction.

Reasonable efforts would be taken to conserve water through recycling and reuse during the operational phase. It should be noted that water runoff/discharge from the panel cleaning would be either evaporated or absorbed into the soil below the panels which keeps the used water within the water cycle. No drainage canal is required due to the low volume of water.

Health and Safety

Engineering, procurement and construction (EPC) contracts are the most common form of contract for the construction of solar PV power plants.

Occupational health and safety (OHS) is an issue that needs to be properly managed during construction in order to minimize the risk of preventable accidents leading to injuries and/or fatalities. Proper OHS risk identification and management measures should be incorporated in every project's management plan and standard EPC contractual clauses.

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 particularly in the following aspects:

Occupational Health and Safety:

- General Facility design and operation.
- Communication and Training.
- Physical Hazards.
- Chemical Hazards.
- Biological Hazards.
- Personal Protective Equipment (PPE).
- Special Hazard Environments.
- Monitoring.

Community Health and Safety:

- Water Quality and Availability.
- Structural Safety of Project Infrastructure.
- Life and Fire Safety (L&FS).
- Traffic Safety.
- Transport of Hazardous Materials.
- Disease Prevention.

Waste Management

It has been established that RETs are environmentally friendly during their useful life, in terms of obnoxious gaseous emissions as do fossil fuels, however, they are not 100% pollution-free at their end-of-life (EoL) period.

Generally, PV systems have ways of generating primary and secondary wastes streams. the primary wastes streams are direct components used in PV systems, whereas secondary waste streams comprise pollutants from nonrenewable energy resources used in the production and disposal of PV panels and the rest of the balance of system (BOS) components (wires, batteries, inverters, metallic frames). These large quantities of nonrenewable energy generated wastes (pollutants) are of high environmental impacts. A summary of expected waste stream from the project phases is outlined in table 3.2.

Table 3. 2: Waste Streams of Project Phases

Waste Stream	Sources	Waste Generation Phase		
		Construction (C)	Operation (O)	Decommissioning (D)
General rubbish, refuse, and putrescible wastes (Food wastes)	Wood splinter, domestic waste, food packs, used bottles	x	x	x
Cleared vegetation	During site clearing and preparation	x	x	x
Scrap metals	Used tubular and casings, used iron rods	x	x	x
Excavated materials	Foundation works	x		x
Damaged/ expired PV panels	PV modules	x	x	x
Expired inverters	Electrical installation		x	x
Damaged/ expired Batteries	Power generation		x	x
Sanitary waste	Training centre	x	x	x

(Source: Adapted from IFC 2015 Project Developer's guide to utility-scale solar photovoltaic power plants)

Solar PV network installation standards

There are many organizations that develop the standards and codes for PV systems. ASTM mainly known as the American Society of Testing and Materials has developed more than 12,000 international standards to improve the quality of the product and enhance safety. The PV standard developed by ASTM technical committee is E44.09 Photovoltaic electric power conversion. The International Code Council (ICC) is involved mainly with the development of a single set of comprehensive international model construction codes engrossed in building safety and fire prevention. The International Electro-Technical Commission (IEC) has published Technical Specifications IEC 62257, a set of standards covering technical and organisational aspects of mini-grids (design, installation, maintenance, contracting) and a checklist of good practices

The EEP program and system designer have taken cognizance of the national and international standards into consideration for the design and execution of this project.

3. 3 Project Components

The project comprises six components:

- A solar PV farm complete with inverters and transformers,
- Power station,
- Transmission line,
- Access road,
- Buildings (control room, site office, renewable energy workshop training centre (WTC)), and
- Street Light.

The power plant will use solar panels fitted on fixed structures (mounts). The main characteristics is summarized in Table 3.3. The advantages of solar energy include its non-polluting nature; it is non-depletable, reliable, and free fuel. The disadvantages of solar energy are that the solar energy concentration is very dilute, so collectors with large surface area are needed. In addition, solar radiation is neither constant nor continuous for terrestrial applications (i.e. low capacity factor). The solar energy received depends on latitude, season, time-of-day, and atmospheric conditions.

Table 3. 3: Main characteristics of the fixed mounting structure

Fixed structure characteristics	
Structure type	1H
Tilt angle	11.0 °
Poles type	Bi pole
Pitch distance	3.48 m
Designed for	MONOFACIAL modules
Minimum ground clearance	0.5 m
Gap between modules in the axis direction	0.0 mm
Gap between modules in the pitch direction	0.0 mm

(Source: REA NEP 3 FEED)

Table 3.4 gives a summary of the project's characteristics and figure 3.3 shows the electrical configuration of the PV plant.

Table 3. 4: Key Project Characteristics

Main characteristics	
Location	Nigeria, Katsina
Rated power (AC)	1650.0 kWac
Peak power (DC)	1997.6 kWdc
Ratio DC/AC	1.21
Civil characteristics	
Suitable plot area	9.53 ha

Main characteristics	
Ground coverage ratio (GCR)	28.00 %
Structure type	Fixed structure
Pitch distance	3.48 m
Electrical characteristics	
PV Modules (310.0 Wp)	6444
Power station (up to 1980.0 kW)	1
Number of inverters (up to 110.0 kVA)	15
Environmental Characteristics	
Gaseous Emissions	None
Discharges	Uncontaminated storm water to be diverted around plant, to be made to pass through sedimentation chamber before being finally discharged to natural watercourses as appropriate.
Noise	< 15 dB(A) at nearest noise sensitive premises ≤ 15 dB(A) at plant boundary
Roads	An existing single road offering access to the field will be rehabilitated within the university to link the plants perimeter. All other means of transportation will be held within the boundaries of the field.

(Source: REA EEP 3 FEED)

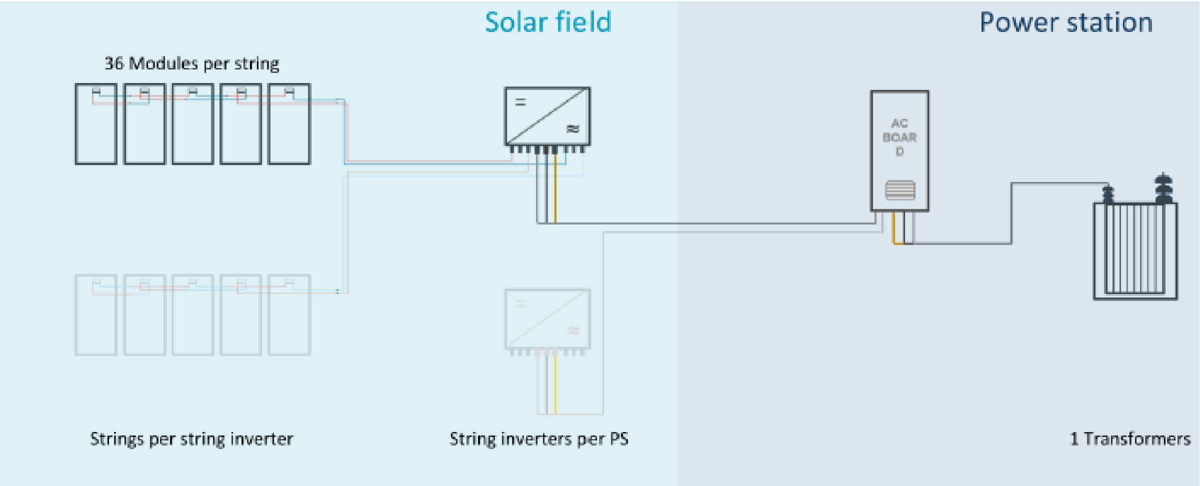

Figure 3. 3: Simplified electrical configuration diagram
(Source: REA NEP 3 FEED)

Component 1: Solar PV Farm

Solar PV Modules

A PV cell is a semiconductor device that converts sunlight into electricity using photovoltaic effect. Multiple cells can be combined to form a PV module. The efficiency of a PV module is measured by its ability to absorb light particles called photons. The more photons that are absorbed, the more efficient the panel is at converting light into electricity.

The proposed solar farm would consist of arrays modules, mounted on fixed structures to obtain a total project capability of about 1,997 (kWp) of direct current (DC). The feedstock (solar radiation) is readily available as a byproduct from sunlight, and the long-term supply is guaranteed. The panels are generally considered to have a lifetime of upwards of 30 years (Alsema, E.A., de Wild- Scholton, M.J., & Fthenakis, V.M. (2006).

The selected photovoltaic module is the CS3K-310MS 1500V Monofacial model, manufactured by Canadian Solar Inc. It has a peak power of 310.0 W, and the technology of the cells is Si-mono (figure 3.4) The features of the photovoltaic module are shown in Table 3.5.

Table 3. 5: Photovoltaic module characteristics

Main characteristics	
Module model	CS3K-310MS 1500V
Manufacturer	Canadian Solar Inc.
Technology Si-mono	Si-mono
Type of module	Monofacial
Maximum voltage	1500 V
Standard test conditions (STC)	
Peak power	310.0 W
Efficiency	18.67 %
MPP voltage	32.9 V
MPP current	9.42 A
Open circuit voltage	39.7 V
Short circuit current	9.98 A
Temperature coefficients	
Power coefficient	0.370 %/°C
Voltage coefficient	0.290 %/°C
Current coefficient	0.050 %/°C
Mechanical characteristics	
Length	1675.0 mm
Width	992.0 mm
Thickness	40.0 mm
Weight	18.5 kg

(Source: REA NEP 3 FEED)

Figure 3. 4: Example of a Monofacial Si-mono photovoltaic module
(Source: REA NEP 3 FEED)

Inverters

The inverter converts the direct current produced by the photovoltaic modules to alternating current. It is composed of the following elements:

• One or several DC-to-AC power conversion stages, each equipped with a maximum power point tracking system (MPPT). The MPPT will vary the voltage of the DC array to maximize the production depending on the operating conditions.

• Protection components against high working temperatures, over or under voltage, over or under-frequencies, minimum operating current, mains failure of transformer, anti-islanding protection, protection against voltage gaps, etc. In addition to the protections for the safety of the staff personnel.

In Figure 3.5, a commonly used photovoltaic inverter for utility-scale PV plants is shown. The single line diagram for the inverter is shown in figure 3.6.

Figure 3. 5: Example of string photovoltaic inverter
(Source: REA NEP 3 FEED)

Table 3. 6: Inverter characteristics

Inverter characteristics	
Main characteristics	
Inverter model	SUN2000-100KTL-HV-D1-001
Inverter type	STRING
Manufacturer	Huawei Technologies

Maximum DC to AC conversion efficiency	98.79 %
Input side (DC)	
MPPT search range	880 - 1300 V
Maximum input voltage	1500 V
Output side (AC)	
Rated power	110.0 kVA
Power at 30 C (datasheet)	110.0 kVA
Power at 50 C (datasheet)	100.0 kVA
Output voltage	800 V
Output frequency	50 Hz

(Source: REA NEP 3 FEED)

Table 3. 7: Inverters

Inverter	Quantity	DC inputs	Power DC
SUN2000-100KTL-HV-D1-001 (110 kWac)	14	12 string	134 kW
SUN2000-100KTL-HV-D1-001 (110 kWac)	1	11 string	123 kW

(Source: REA NEP 3 FEED)

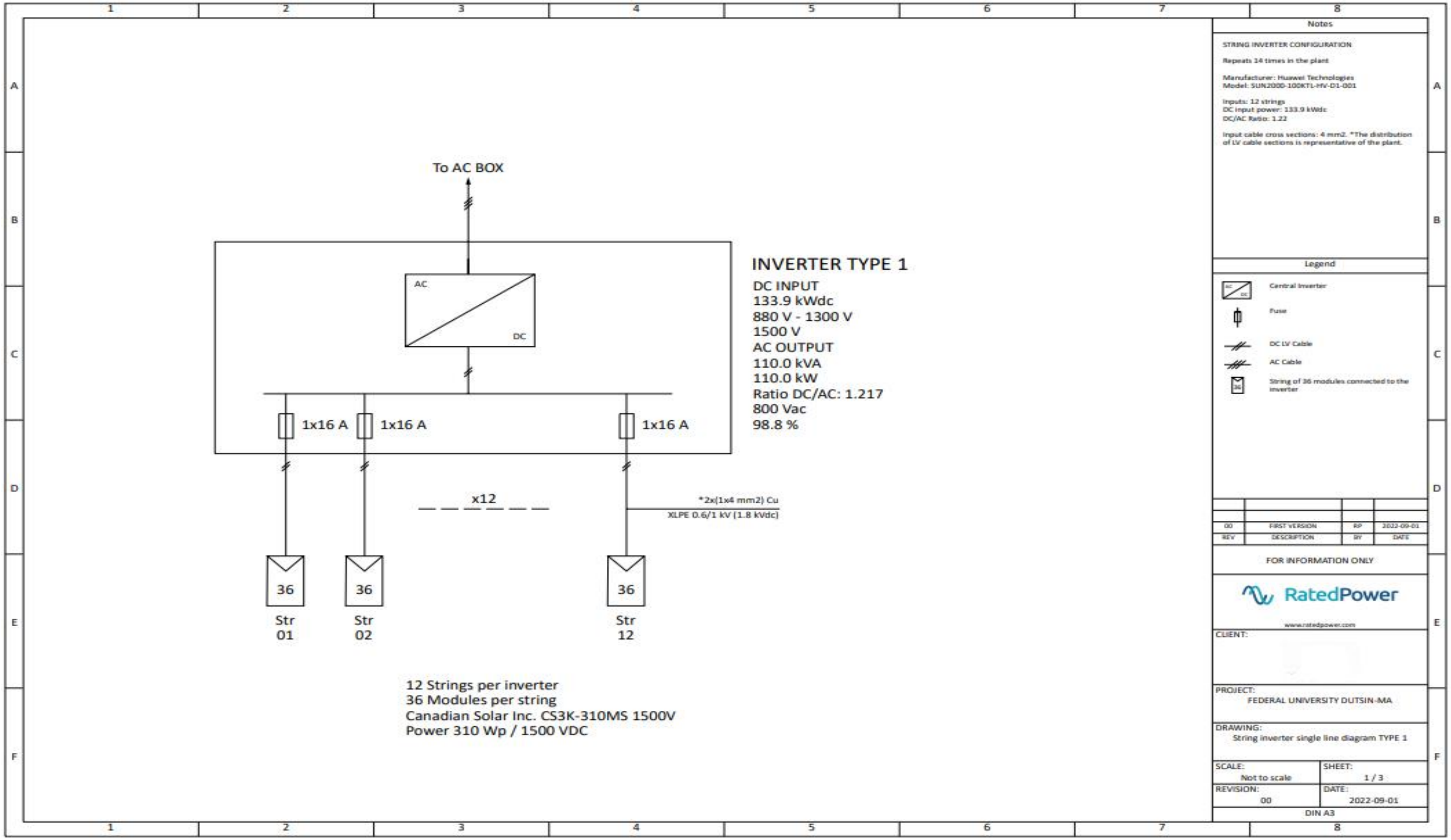

Figure 3. 6: String Inverter Single Line Diagram

(Source: EEP3 FEED)

Transformers

The transformer raises the voltage of the inverter AC output to achieve a higher efficiency transmission in the power lines of the photovoltaic plant. An example of a power transformer is shown in Figure 3.7.

Figure 3. 7: Example of Transformer
(Source: REA NEP 3 FEED)

The main features of the power transformer are shown in Table 3.8.

Table 3. 8: Transformer characteristics

Transformer characteristics	
Rated power	1980.0 kVA
Voltage ratio	0.8/20.0kV
Cooling system	ONAN
Tap changer	2.5%, 5%, 7.5%, 10%
Short circuit (Xcc)	0.08

(Source: REA NEP 3 FEED)

Weather Station

The Solar Monitoring Weather Station includes common meteorological sensors, mounting accessories, a data logger or the signal translator, power supply, and communications hardware. The equipment can be powered from a solar panel power system. The standard sensor array includes two pyranometers, a combined temperature and relative humidity sensor, wind speed and wind direction sensors, and surface mounted temperature sensors to measure solar panel temperature.

Component 2: Power station

The power stations or transformer stations are indoor buildings or containers. The voltage of the energy collected from the solar field is increased to a higher level to facilitate the evacuation of the generated energy. The power transformers will be housed in the power station. An example of a power Station is shown in Figure 3.8.

Figure 3. 8: Example of a Power Station
(Source: REA NEP 3 FEED)

The power station shall be supplied with medium voltage switchgears that include one transformer protection unit, one direct incoming feeder unit, one direct outcoming feeder unit and electrical boards. Particularly, for the first power station of each MV line, a direct incoming unit will not be installed.

The main features of the default power station are shown in Table 3.9. Figure 3.9 is the Power Station Single Line Diagram and the proposed FUDMA Power System Master Plan is reflected in Annex 4.

Table 3. 9: Power station characteristics

Power station characteristics	
Number of transformers	1
Voltage ratio	0.8/20.0kV
Service Indoors	Indoors

(Source: REA NEP 3 FEED)

Table 3. 10: Power stations

Power station	Quantity	Num of Inverters	Power AC	Power DC	DC/AC ratio
1	1	15	1.65 MW	1.998 MW	1.211

(Source: REA NEP 3 FEED)

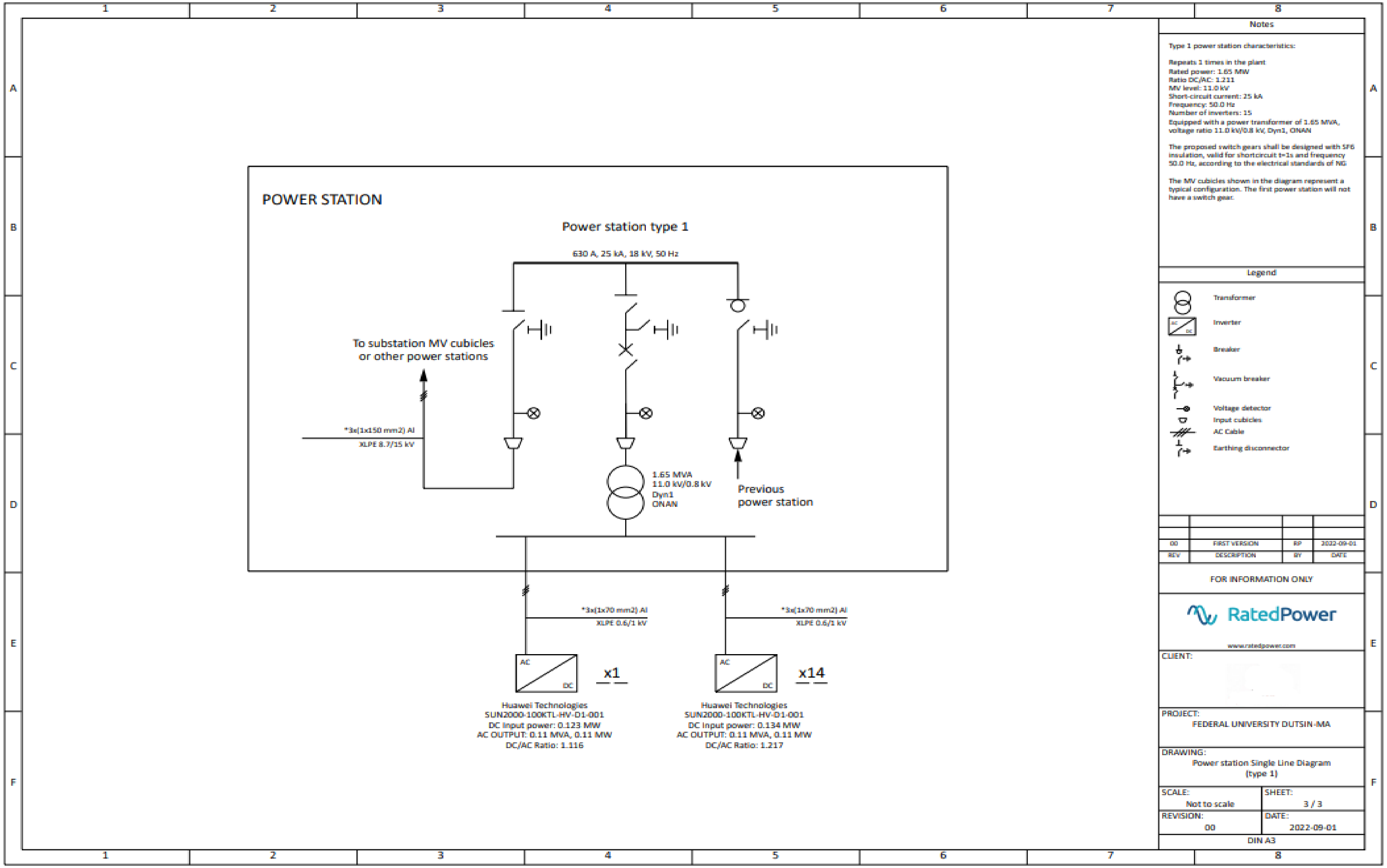

Figure 3. 9: Power station Single Line Diagram
(Source: EEP3 FEED

Component 3: Access Roads

A gravel paved earth access road within the facility will be constructed. The roads will link all project components and be laid out in an efficient manner to ensure easy access for operation and maintenance as well as access from outside the facility (figure 3.10).

For the design of the PV plant under study, roads of 4.0 m have been used. These roads run a total distance of 1189.09 m. Road ditches used for drainage and for channeling water are placed on one side of the roads.

A total perimeter of 931.4 m of chain link fence surrounds the different areas of the PV plant. The fence has at least 2.0 m of height and 3.0 m between posts. For every 50.0 m of fence, a light post of 4.0 m of height and a microwave barrier system are installed. For every 100.0 m of fence, a video camera post of 6.0 m of height is installed.

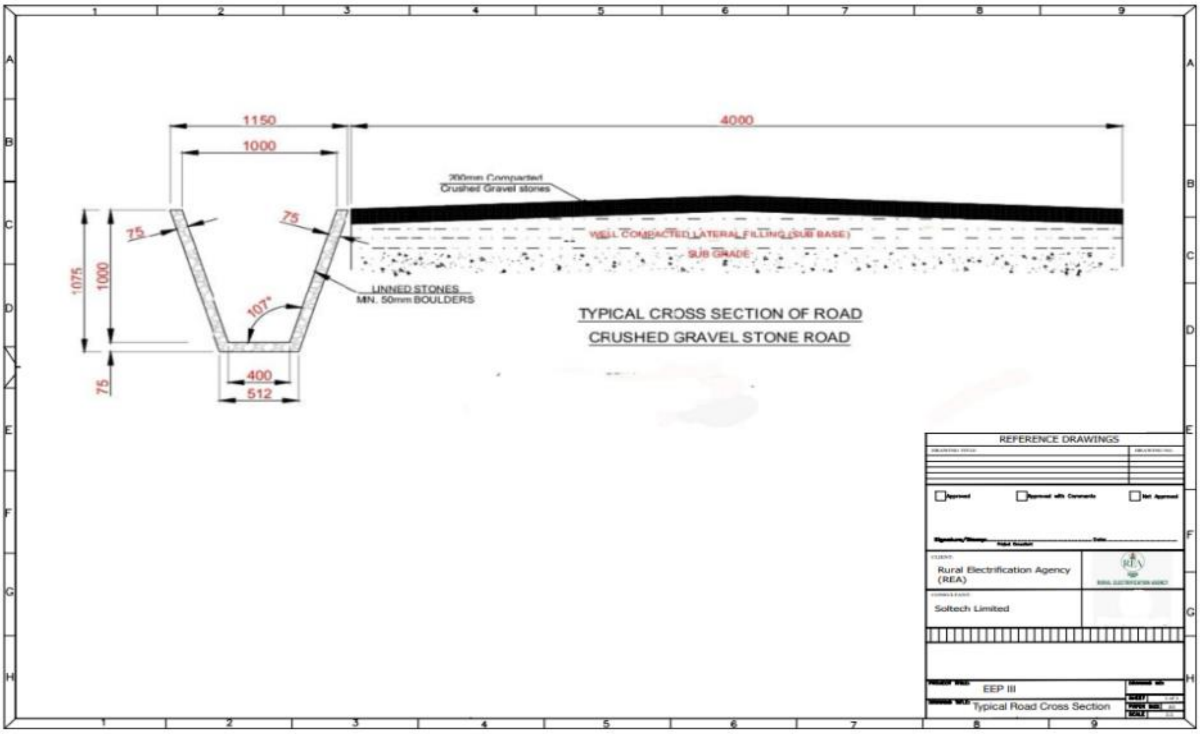

Figure 3. 10: Typical Road Cross Section
(Source: REA EEP 3 Front-end and Engineering Design)

Component 4: Buildings

Ancillary facilities include residential quarters for the security, maintenance, and control room staff who will be required full-time, a guard house and an office/control centre. Figure 3. 11 is the Elevation plans of the training centre.

Control Building

The control building would take up an area of approximately 30 m × 15 m. The main construction compound would temporarily require an area of approximately 60 m × 40 m, however; this area would be fully reinstated after construction.

Lay down and Staging Area

A staging area where solar panels would be assembled would be constructed within the project area. The entire area would be enclosed by a chain link fence with a gate. Regular cleaning of the solar panels would be accomplished by either rinsing with water, blowing with compressed air, or a combination of both. Expected waste from this area would include wooden crates, plastics wrappings and Styrofoam.

Figure 3. 11: Elevation plans of the training Centre
(Source: EEP FEED)

Component 5: Transmission Line

The power generated from the proposed solar power plant would be evacuated through an 11-kV transmission line to the university load center through underground cable. Figure 3.12 is the Distribution Network Layout for FUDMA, while Figure 3.13 is the harmonisation of the FUDMA’s Existing/Proposed Distribution Network in a Single Line Diagram

The path for the underground cable will be beside the existing road. The length of distribution network for FUDMA is 0km upstream and 5km downstream.

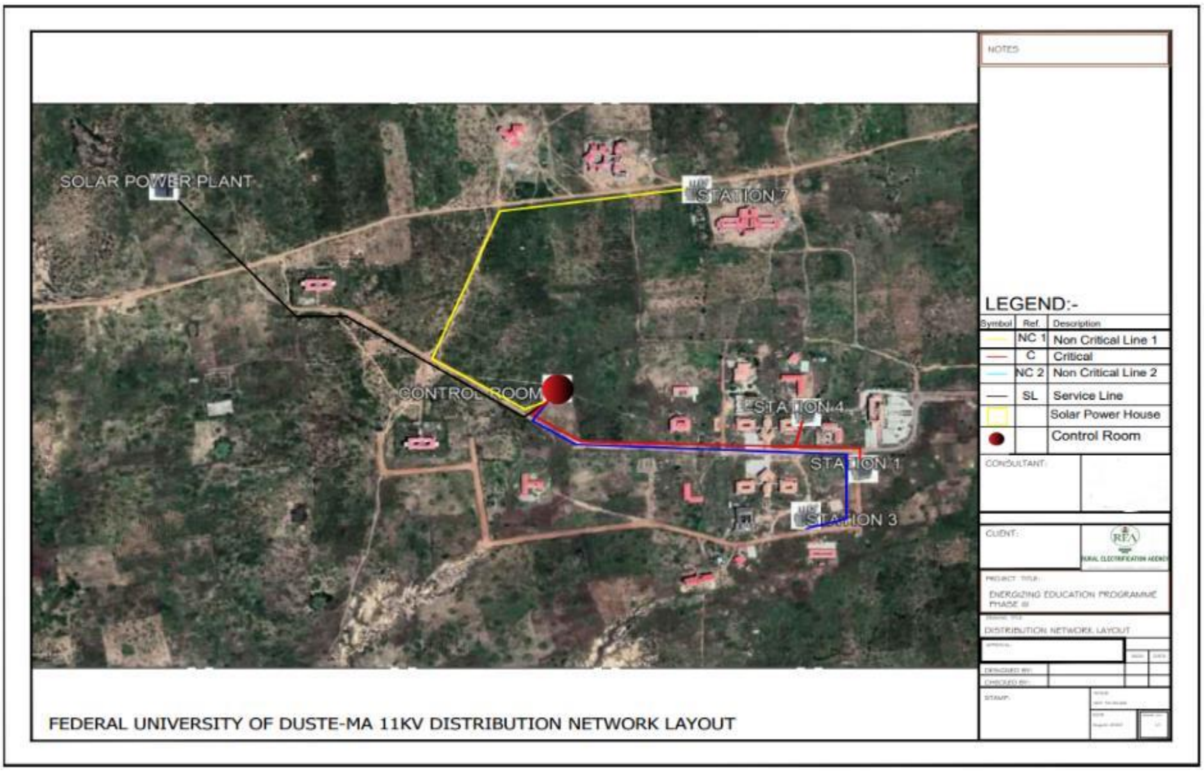

Figure 3. 12: Distribution Network Layout for FUDMA
(Source: REA EEP 3 Front-end and Engineering Design)

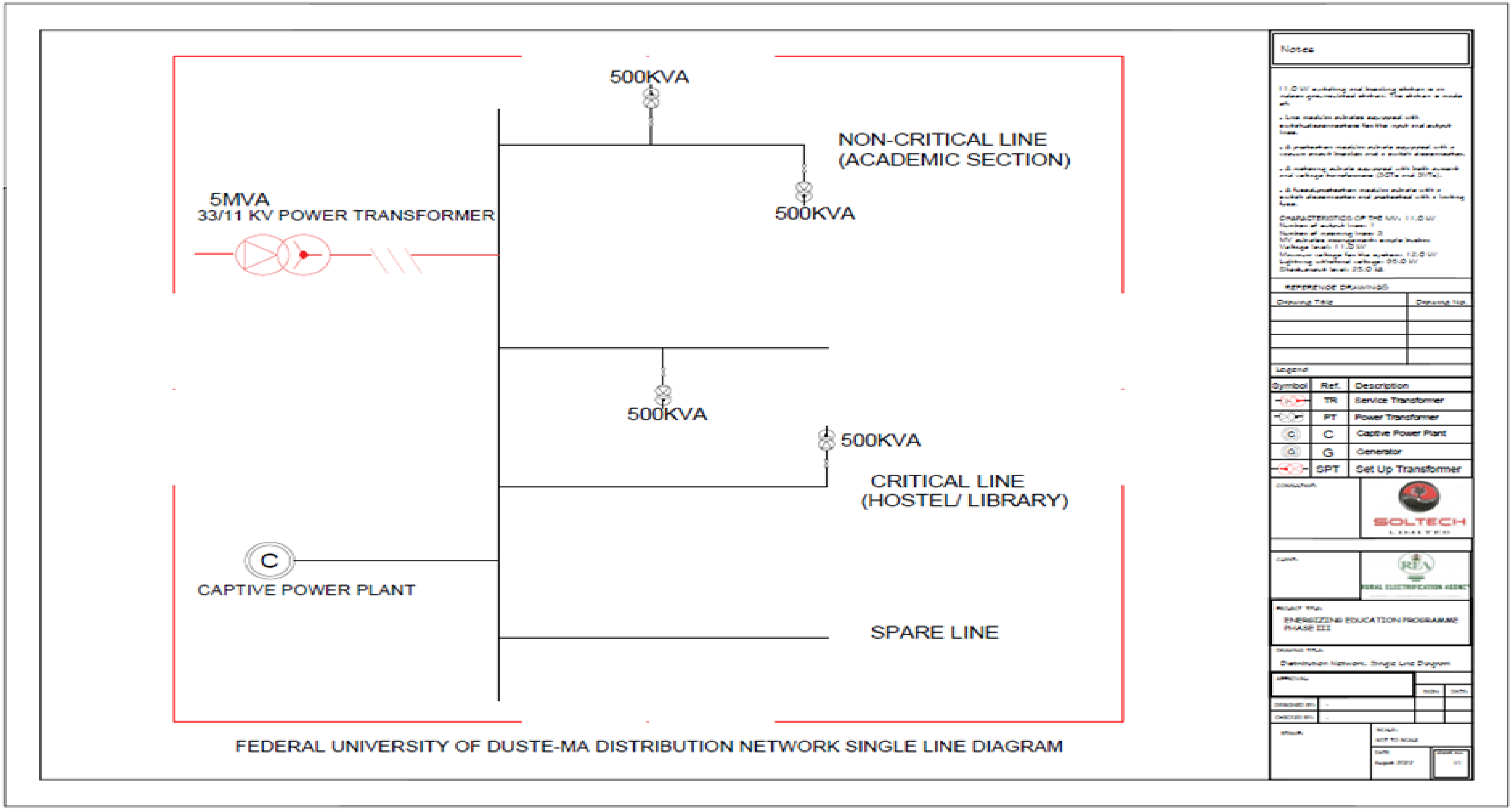

Figure 3. 13: Federal University of Duste-Ma Distribution Network Single Line Diagram

(Source: REA NEP 3 FEED)

Component 6: Street lights Quantity

122 one arm street light and 12 double arms street light will be provided to the university. On planned Streetlight Design (figure 3.14), the total length is 4km. Road widths are 6m, 7m and 16m for various segments.

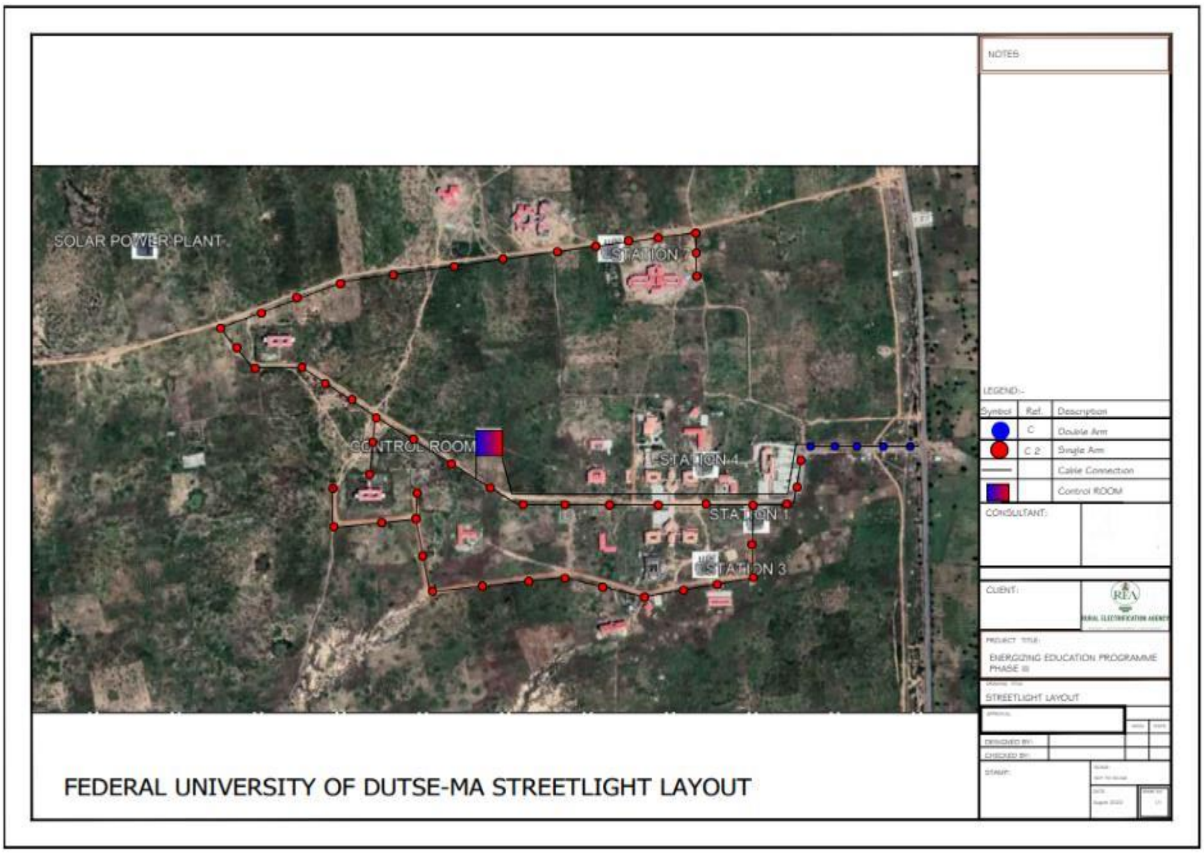

Figure 3. 14: Streetlight layout
(Source: REA EEP 3 Front-end and Engineering Design)

Although there are no streetlights installed in the new campus of FUDMA, various roads are planned with a total length of 4117m as shown in Figure 3.15.

Figure 3. 15: Planned Road Network in FUDMA

(Source: REA EEP 3 Front-end and Engineering Design)

3.4 Operation and Maintenance

Operation and maintenance of the system would be expected to occur on a limited basis at certain points during the system's estimated 25-year life cycle. To enhance the performance and reliability of the plant, the following types of maintenance will be carried out:

Preventive Maintenance, which involves routine inspection and servicing of plant equipment to prevent breakdowns. This includes panel cleaning, vegetation management, wildlife prevention, water drainage, monitoring of electrical components. It also involves retro-commissioning to improve the efficiency of the PV plant by detecting and solving problems in the system.

Corrective Maintenance, which involves repair of broken-down equipment. This includes on-site monitoring and mitigation, and critical and non-critical repairs of plant components.

Condition-based maintenance, which involves monitoring equipment and plant operations real- time and addressing potential problems early on in order to prevent plant downtime. This includes continuous monitoring via remote and on-site methods, warranty enforcement, and planned and unplanned equipment replacement.

Maintenance activities will be carried out by skilled manpower with backgrounds in electrical/electronic engineering and unskilled local labour where applicable. Specific maintenance activities include the following:

PV Modules

- PV modules need to be cleaned weekly in the dry season and monthly in the wet season to prevent accumulation of dust. Also, the cabling around the modules need to be checked regularly for damages.
- Panels need to be checked regularly for cracks and breaks.
- Panel testing needs to be conducted annually to ensure they live up to the manufacturer's warranty.

Electrical System

- Inverter components need to be checked to prevent breakdown which can occur during very hot weather conditions.
- Electrical wiring and earthing protection need to be checked for wear and tear. Also, the underground cabling needs to be monitored regularly for damages from pests. Infra-red technology may be employed to identify spots where there are electricity leaks.

Civil Structures

- Mounting structures need to be checked regularly for bending damage which can affect the PV modules
- Access roads, drainage works, plant foundation and array structures need to be checked by visual inspection for water damage during the rainy season

Vegetation

- Growth of shrubs and other vegetation needs to be curtailed to prevent shadowing effect on the solar panels leading to a decrease in the output from the plant. Weeds also need to be eliminated as they present a fire hazard.
- Vegetation around the transmission line RoW needs to be cleared quarterly to maintain a vegetation height at less than 2 ft (0.61 m).

A stock-pile of spare parts will be kept on-site to facilitate replacement of broken-down or out-dated solar panels and inverters. On-site security and inventory management will be implemented to prevent theft of spare parts and installed plant components.

Monitoring of the PV system components needs to be conducted to ensure increased system output and to reduce down-time. Traditional monitoring methods that compare actual energy generation against predicted energy generation will help to track the system's relative health.

3.5 Project Implementation Phase Activities

3.5.1 Preconstruction

Preconstruction works will last for 1-2months. The works at this stage will entail activities such as land identification, completion of engineering design for the Project and receipt of relevant approvals, mobilization of personnel, equipment and materials to site, site preparation and installation of temporary structures for material storage.

3.5.2 Construction

Construction activities would last about 12-18 months. The major facilities to be constructed will include:

- Civil works;
- Towers;
- Transformers;
- Control building;
- Weather station; and
- Transmission lines;

The proposed construction programme would be as follows:

- Construct the site access roads with gates and temporary fencing;
- Excavate the foundations;
- Construct the panel foundations;
- Construct the transformer and install the grid connection;
- Lay power and instrumentation cables;
- Construct the control station;
- Erect and connect the panels;
- Erect weather station;
- Commission the panels/transmission lines; and
- Carry out land reinstatement, remove temporary compounds and clear the site.

The construction will normally be completed during daytime hours; however, there will be requirements for extended hours during major concrete pours or other installations that cannot be interrupted. Summary of the implementation activities is indicated in table 3.4 and categories of staff requirement in table 3.5.

3.5.3 Commissioning and Operation

Following the completion of all works at the construction phase, the power plant will be commissioned for operations. The commission phase will involve 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. Standard operating procedures (SOPs) shall be developed by the EPS Contractor for the operation and maintenance of the solar panels, inverters, batteries, and other associated components of the Project.

Upon completion of the commissioning of the power plant and other ancillary infrastructures, the EPC contractor will hand over the power plant to the Operation and Maintenance (O&M) Consultant who will be charged with the responsibility of operating and maintaining the plant for a period of 1 year. At this period, the O&M Consultant will also train the technical unit staff of university for ease of handover at the end of the O&M period. Activities under this phase will include:

- Power generation and distribution to various sections of the University
- The preventative, corrective and predictive maintenance of the power plant and associated facilities.

Also, the training centre will be utilized in enhancing learning in renewable energy.

3.5.4. Decommissioning

Upon completion of the power plant, the project site area will be cleared out for proper housekeeping. This is different from the decommission of the site which will be undertaken at the end of life of the power plant. The plant has a life cycle of at least 25years, which is expected to be extended with proper and timely maintenance of the plant. Upon the end-of-life of the power plant, the decommissioning activities will include:

- 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).
- Removal of PV panels and equipment, demolition of structures and evacuation as well as site remediation.
- Waste management – recycling, disposal of unusable parts etc.

- Restoring the environment to allowable baseline conditions and monitoring of the process.
- Assessing the residual impacts, if any, that the project has on the environment.

Table 3. 11: Project Implementation Phase Activities

Pre-construction Phase Activities	Construction Phase Activities	Commissioning Phase Activities	Operational Phase Activities	Decommissioning Phase Activities
1.Completion of engineering design for the Project and receipt of relevant approvals, 2. Site clearing, preparation, and mobilization of equipment, materials and personnel to site.	1.Recruitment of low skilled workers (e.g. construction labour who will make up the majority of workers), semi-skilled workers (drivers, technicians, etc.), and skilled personnel (e.g. engineers and expatriates). 2. Civil, mechanical and electrical works; 3. Installation of PV panels and associated plant facilities; 4. Construction of a training centre; 5. Installation of streetlights as well as underground armoured cable for power evacuation. 6. Also, where required, an upgrade of some of the existing power distribution infrastructure within the University will be carried out.	1. 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. 2. 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	1.Power generation and distribution to various sections of the University 2. The preventative, corrective and predictive maintenance of the power plant and associated facilities. 3.In addition, the training centre will be put into use to enhance learning in renewable energy	1. Dismantling and removal of PV panels and associated infrastructure (mounting structure, power evacuation cable, inverters, transformers, batteries, etc.). 2. Removal of any sub-surface installations (e.g. underground cables). 3. Waste management. 4. Restoring the environment to allowable baseline conditions and monitoring of the process. 5. Assessing the residual impacts, if any, that the project has on the environment.

(Source: Adapted from IFC 2015 Project Developer's guide to utility-scale solar photovoltaic power plants)

Table 3. 12: Staff requirements

PERSONNEL
PRE-CONSTRUCTION STAGE
Manual Workers
Skilled Labor/ Professionals/ Managers
Security
CONSTRUCTION STAGE
Manual Workers
Skilled Labor/ Professionals/ Managers
Security
OPERATIONS STAGE
Cleaners
Security
Heavy maintenance
Light electrical maintenance
Infrastructure maintenance
Parts and Inventory management
DECOMMISSION STAGE
Manual Workers
Skilled Labor/ Professionals/ Managers
Security

(Source: Adapted from IFC 2015 Project Developer's guide to utility-scale solar photovoltaic power plants)

3.6 Project Interface Management and Schedule

Interface management is of central importance to the delivery of any complex engineering project, and solar PV projects are no exception. The main interfaces to be considered in a solar PV project are listed in Table 3.13. It may be modified, depending on the final contracting structure for this particular project and design.

Table 3. 13: Solar PV Project Interfaces

Item	Element	Organisations	Interface/ Comments
1	Consents	• All contractors • Landowner • Planning authority.	Monitoring of compliance with all planning conditions and permits.
2	Civil Works	• Civil contractor • Mounting or tracking system supplier • Central inverter supplier • Electrical contractor • Grid connection contractor • Security contractor	Site clearance. Layout and requirements for foundations, cable trenches, ducts, roads and access tracks.

Item	Element	Organisations	Interface/ Comments
3	Security	• Civil contractor • Electrical contractor • Security contractor • Communications contractor	Layout of the security system, including power cabling and communications to the central monitoring system.
4	Module Mounting or Tracking System	• Mounting or Tracking system supplier • Civil contractor • Module supplier • Electrical contractor	Foundations for the mounting or tracking system, suitability for the module type and electrical connections, and security of the modules. Earthing and protection of the mounting or tracking system.
5	Inverter	• Civil contractor (for central inverters) • Mounting system supplier (for string inverters) • Module supplier • Inverter supplier • Electrical contractor • Communications contractor	Foundations for larger central inverters, or suitability for the mounting system. Suitability of the module string design for the inverter. Interface with the communications for remote monitoring and input into the SCAdA system.
6	AC/DC and Communications Cabling	• Electrical contractor • Civil contractor • Communications contractor • Security contractor	Liaison with regard to cable routes, sizes, weights, attachments and strain relief requirements.
7	Grid Interface	• Civil contractor • Electrical contractor Inverter supplier network operator	Liaison with regard to required layout of building equipment and interface with onsite cabling installed by the site contractor. More interface outside the site boundary for the grid connection cable/line to the network operator's facilities.
8	Communications	• Electrical contractor • Security contractor • Communications contractor owner and Commercial operator	Interface between the security system, inverter system, central monitoring (SCAdA), the monitoring company, and the owner or commercial operator of the PV plant.
9	Commissioning	• All contractors	Commissioning of all systems will have several interface issues particularly if problems are encountered.

(Source: Adapted from IFC 2015 Project Developer's guide to utility-scale solar photovoltaic power plants)

3.7 Project Schedule

Appropriate sequencing of tasks is a vital part of the planning process. The overall sequence of works is generally: site access, site clearance, security, foundation construction, cable trenches and ducts, substation construction, mounting frame construction, electrical site works, communications, onsite grid works and then testing and commissioning. Each of these work areas should be broken down into a series of sub-tasks. Alongside, an assessment of the inputs required for each task (especially when interfaces are involved) will help develop a logical and efficient sequence.

The proposed Project is planned to be operational by the fourth quarter (Q4) of 2024. Figure 3.16 is a typical EPC Construction Phase and Handover Protocol.

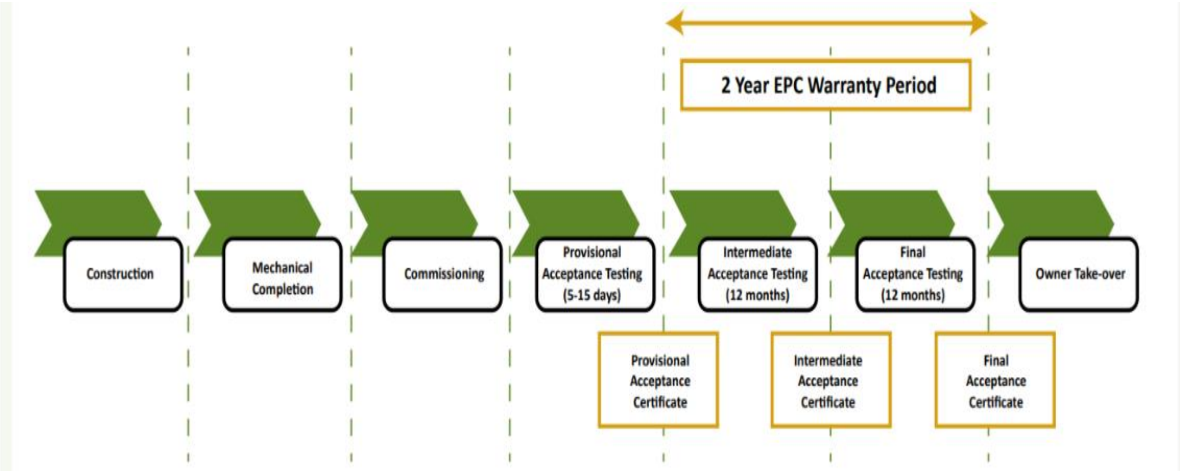

Figure 3. 16: Typical EPC Construction Phase and Handover Protocol
(Source: EEP 3 FEED)

CHAPTER FOUR: DESCRIPTION OF EXISTING ENVIRONMENT

4.1 Preamble

This chapter presents the environmental and social (biophysical, health and social) setting of the study area Federal University, Dutsin Ma and its environs for the proposed Energizing Education Program (EEP) Phase 3. The environmental characteristics of the project area were established through literature search, field sampling/measurements, laboratory analysis, stakeholder consultation and data interpretation. Gaps in environmental baseline information of the area were identified, and fieldwork activities designed to acquire additional data to fill these gaps was then planned and conducted.

Data from literature review were obtained from the existing reports of environmental studies around the proposed project area. Specifically, the environmental data for the ESIA of the proposed project covered both dry season and secondary data of wet season within the study area radius in which a waiver for one season data gathering was approved by the Federal Ministry of Environment.

A one-season fieldwork was embarked upon for the biophysical as well as social and health studies. The field sampling / measurements were carried out between 30th and 31st March for the dry season, adopting multi-disciplinary approach. FMEnv Guidelines and Standards were strictly adhered to in the course of field sampling and measurement. The environmental components covered include topography, climate/Meteorology, air quality, and noise soil, vegetation, animal ecology, aquatic systems including ecology and fisheries, geology/geophysics/hydrogeology, socio-economics, health status assessment and waste management. The sampling points were geo-referenced using Global Positioning System (GPS). The locations and its coordinates of each sampling points are shown in Figure 4.1 and Table 4.1.

Table 4. 1: Soil Sampling Stations, Air Pollutants, Noise Measurements and Water Sample coordinates

Air & Noise sample	Longitude	Latitude
AQ1	7.448034	12.29789
AQ2	7.444677	12.29673
AQ3	7.446118	12.29519
AQ4	7.445447	12.29603
AQ5	7.444003	12.29556
AQ6	7.441993	12.29537
AQ7	7.445885	12.29664

AQ8	7.45019	12.29938
AQC1	7.441662	12.2968
AQC2	7.744623	12.29988
Soil Point	**Longitude**	**Latitude**
SP1	7.448027	12.29788
SP2	7.444677	12.29672
SP3	7.446118	12.29519
SP4	7.445442	12.29605
SP5	7.444003	12.29556
SP6	7.441993	12.29537
SP7	7.445896	12.29662
SP8	7.450192	12.2994
SPC1	7.441676	12.29679
SPC2	7.744623	12.29988
Water Point	**Longitude**	**Latitude**
Water1	7.446118	12.29519
Water2	7.439781	12.29232

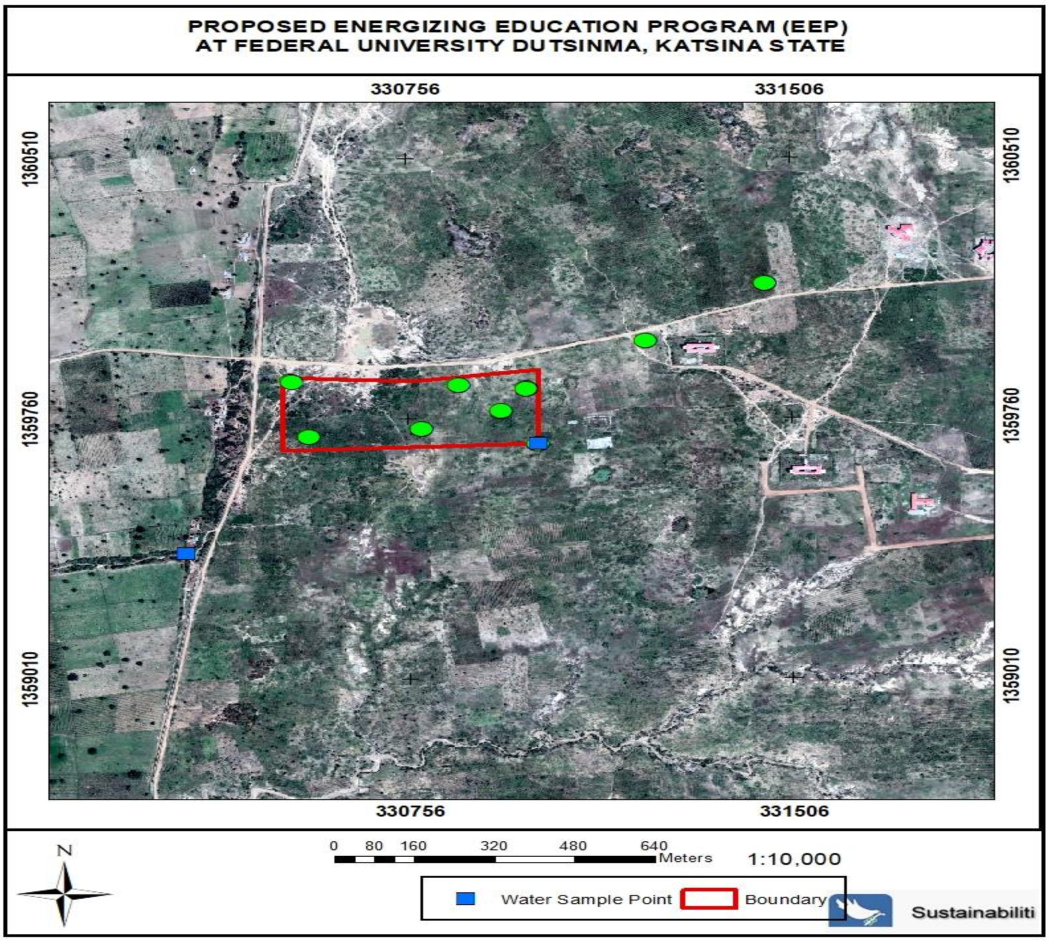

Figure 4. 1: Soil Sampling, Air Quality/Noise Level Sampling Location Map for the Study: (SS=Soil Sampling point, SSC=Soil sampling Control point), (AQ=Air quality point, AQC-Air Quality Control point)

(Source: Sustainabiliti Ltd 2022)

4.2 Study Methodologies (Baseline Data Acquisition Methods)

The specific investigations carried out for the ESIA comprised the following aspects of the study area:

(i) Climate and Meteorology
(ii) Air Quality
(iii) Noise Level
(iv) Geology and Geophysical studies
(v) Soil and Land Use
(vi) Terrestrial vegetation
(vii) Water quality
(viii) Hydrobiological Resources
(ix) Terrestrial Fauna
(x) Wildlife
(xi) Socio-economic status
(xii) Community Health
(xiii) Waste management

4.2.1 Climate and Meteorology

The field data was obtained through the usage of weather Tracker Kestrel 4500 model for the following components: Temperature, Relative Humidity, Pressure, Wind direction and Speed. Also, secondary data was obtained from Nigerian Meteorological Agency (NIMET) for the Katsina Station located at Katsina. Specifically, for the present study a request was made to the Nigerian Meteorological Agency (NIMET) for detailed meteorological data on Katsina over the past one decade (2011-2021).

4.2.2 Air Quality

Protocol of Measurement and Sampling Duration

For the purpose of documenting the existing air quality of the project area, Air quality monitoring was carried out at Ten (10) different points including control within and around the proposed project site.

The possible air pollutants from the proposed project were determined using pre-calibrated digital handheld Air Quality Monitoring Equipment such as pre-calibrated crowcon [TETRA5] Pro Environmental Test Meter.

Air Sampling for Particulates

Particulate matter (PM) was measured with PMD 351 Aerosol Mass monitor, an equipment from Temtop Instruments. It is handheld, battery operated and completely portable unit measuring five mass ranges of TSP: PM1, PM2.5, PM5, PM10, and TSP with a concentration range of 0 – 1 mg/m3 (and resolution of 0.1 µg/m3), a sampling time of 2 minutes and a flow rate of 2.83 l/min. To measure, it is placed at 1 m above the ground level, switched on in the environment of interest and the measured concentration read directly on the screen after particle capturing.

Air Sampling for Gaseous Pollutants

Oxides of nitrogen (NO_X), sulphur dioxide (SO_2) and carbon monoxide (CO), ammonia (NH_3), hydrogen sulphide (H_2S), and volatile organic compounds (VOCs) were measured during the study in the ambient environment of the project site. The various methods of sampling adopted are as described below.

NO_X - Measurements: NO_X concentrations were measured as NO_2 using an insitu single gas NO_X monitor Gas alert. The monitor is a 9.3 cm x 4.9 cm x 2.2 cm measuring instrument weighing about 0.1 kg with an instantaneous direct readout displays through which current NO_2 concentrations can be continuously monitored in ppm (parts per million) with a detection range of 0 – 20 ppm and 0.1 ppm resolution. It has facility for Short Term Exposure Limit (STEL) from which the NO_2 concentration for the last 15 minutes can be determined; the Time Weighted Average (TWA) from which the accumulated reading of the gas concentration since the monitor was turned on is divided by 8 hours; and the Peak Reading, which is the highest reading since the monitor was turned on. The monitor was calibrated March, 2021 with Calibration and Test Certificate S/N 021-905130 from Gas alert Systems. For every field measurement, the "Auto-Zero at Start-up" calibration is required and this was carried out during the study.

SO_2 Measurements: To measure the SO_2 concentrations during the field study, an insitu single gas SO_2 monitor Gas alert was used. The monitor is a 9.3 cm x 4.9 cm x 2.2 cm measuring instrument weighing about 0.1 kg with an instantaneous direct readout displays through which current SO_2 concentrations can be continuously monitored in ppm (parts per million) with a detection range of 0 – 20 ppm and 0.1 ppm resolution. It has facility for Short Term Exposure Limit (STEL) from which the SO_2 concentration for the last 15 minutes can be determined; the Time Weighted Average (TWA) from which the accumulated reading of the gas concentration since the monitor was turned on is divided by 8 hours; and the Peak Reading, which is the highest reading since the monitor was turned on. The monitor was calibrated in March, 2021 with Calibration and Test Certificate S/N 023-900636 from Gas alert Systems. For every field measurement, the “Auto-Zero at Start-up” calibration is required and this was carried out during the study.

Ammonia (NH_3) Measurements: NH_3 measurements were taken using an in situ non-integrated single gas ammonia monitor Gas alert. The monitor is a 9.3 cm x 4.9 cm x 2.2 cm measuring instrument weighing about 0.1 kg with an instantaneous direct readout displays through which current ammonia concentrations can be continuously monitored in ppm (parts per million). It has facility for Short Term Exposure Limit (STEL) from which the ammonia concentration for the last 15 minutes can be determined; the Time Weighted Average (TWA) from which the accumulated reading of the gas concentration since the monitor was turned on is divided by 8 hours; and the Peak Reading. It has detection range of 0 – 20 ppm with 0.1 ppm resolution.

Hydrogen Sulphide (H_2S) and Volatile Organic Compounds (VOCs):

These compounds were measured using JSM-131SE instrument. The monitor is a 9.3 cm x 4.9 cm x 2.2 cm measuring instrument weighing about 0.1 kg with an instantaneous direct readout displays through which current VOCs concentrations can be continuously monitored in ppm (parts per million). It has facility for Short Term Exposure Limit (STEL) from which the H_2S and VOCs concentrations for the last 15 minutes can be determined; the Time Weighted Average (TWA) from which the accumulated reading of the gas concentration since the monitor was turned on is divided by 8 hours; and the Peak Reading, which is the highest since the monitor was turned on. It has detection range of 0 – 200 ppm with 0.1 ppm resolution. The monitor was calibrated on March 2021 with Calibration and Test Certificate S/N O25-900527 from RAE Systems, 3775 North First Street, San Jose, California 95134, USA. However, for every field measurement, the “Auto-Zero at Start-up” calibration is required and this was carried out during the measurements.

CO Measurements: CO measurements were taken using an insitu non-integrated single gas carbon monoxide monitor Gas alert. The monitor is a 9.3 cm x 4.9 cm x 2.2 cm measuring instrument weighing about 0.1 kg with an instantaneous direct readout displays through which current carbon monoxide concentrations can be continuously monitored in ppm (parts per million). It has facility for Short Term Exposure Limit (STEL) from which the carbon monoxide concentration for the last 15 minutes can be determined; the Time Weighted Average (TWA) from which the accumulated reading of the gas concentration since the monitor was turned on is divided by 8 hours; and the Peak Reading, which is the highest reading since the monitor was turned on. It has detection range of 0 – 500 ppm with 1 ppm resolution.

4.2.3 Noise Level Measurements

Noise measurements were taken with a digital, battery-powered, sound pressure level meter (EXTEC Instruments, US Model 407735). The meter has both A and C weighting and 0.1 dB resolution with fast/slow responses. Its high- and low-metering ranges were 35 – 100 dB and 65 – 130 dB, respectively. The meter is also equipped with a build-in calibration check (94 dB), tripod mount, and analogue DC/AC conditioned outputs of 10mV/dB and utilized a 0.49 "(12.3 mm) condenser microphone.

The sampling locations and coordinates are shown in Table 4.2.

Table 4. 2: Sampling Coordinates for Air Pollutants and Noise Measurements

Field Code	GPS Coordinates	
	Longitude	**Latitude**
AQ1	7.448034	12.29789
AQ2	7.444677	12.29673
AQ3	7.446118	12.29519
AQ4	7.445447	12.29603
AQ5	7.444003	12.29556
AQ6	7.441993	12.29537
AQ7	7.445885	12.29664
AQ8	7.45019	12.29938

Field Code	GPS Coordinates	
	Longitude	Latitude
AQC1	7.441662	12.2968
AQC2	7.744623	12.29988

(Source: ESIA Field Survey, 2022)

4.2.5 Soils and Land Use

The proposed project site is within the premises of Federal University, Dutsin Ma. Hence there was no farming activity within and around the proposed project site. Soil samples were taken at selected locations within and around the proposed project site. The sampling stations were pre-selected using the co-ordinates on the obtained map. The coordinates were keyed into GPS receivers which were then used to pin point the exact locations within the project site. Soil samples were collected with a Dutch auger and described. At each observation point, two composite samples from 0 – 15 cm, 15–30 cm soil depths were taken at each sampling point. The environment at each observation point was also described in terms of vegetation, land use and erosion. In all, 20 soil samples were collected for laboratory analyses. The geographical co-ordinates for the sampling points are presented in Table 4.3. All the soil samples collected were packed and preserved for onward transmission to the laboratory where they would be analysed.

Table 4. 3: Description of the Soil Sampling Stations and Coordinates

No	Coordinates	
	Longitude (E)	Latitude (N)
SP1	7.448027	12.29788
SP2	7.444677	12.29672
SP3	7.446118	12.29519
SP4	7.445442	12.29605
SP5	7.444003	12.29556
SP6	7.441993	12.29537
SP7	7.445896	12.29662
SP8	7.450192	12.2994
SPC1	7.441676	12.29679
SPC2	7.744623	12.29988

(Source: ESIA Field Survey, 2022)

4.2.6 Terrestrial Vegetation

Vegetation distribution and land use observations were made and geo-referenced at intervals. Species composition, density and habitat conditions were studied in detail using the Quadrat and Belt Transect Methods. Sampling was carried out along transects at each site. All plants within each quadrat were systematically evaluated identified to species level and the number of individuals of each species enumerated. Specimens of plant species that could not be readily identified on the field were collected and pressed in a plant press and taken for proper identification. The lengths of the transects varied depending on the real extent of the vegetation being studied.

The number of strata in the vegetation was noted and the dominant species recorded. The height of the plants was measured with measuring tape and Haga altimeter. Where counting of individuals was not possible in situations where there are creeping plants, cover was measured according to Greig-smith (1983).

Land-use investigation was carried out along four cardinal points with the tracks serving as the baseline. The major crop species, farming system, habitat and non-farming activities along each of the cardinal points were documented. Plants that were of economic importance were identified and counted.

4.2.7 Water Quality Assessment

The water samples were collected from 2 locations. Two ground water was also sampled. There was no surface water as at the time of sampling. The *in situ*/on site parameters on water quality were determined using HORIBA Water Quality Checker. These are water temperature, pH, electrical conductivity (EC), turbidity, dissolved oxygen (DO), salinity and total dissolved solid (TDS). The pH values of both the surface and ground. The geographical co-ordinates of the sampling points involved are presented in Table 4.4.

Table 4. 4: Code, Sample Type and Site Grid Coordinate of the Water Samples

Sampling point	Sample type	Sampling point grid coordinate	
		Latitude	Latitude
1	University Admin block Borehole	7.446118	12.29519
2	University Entrance Gate Borehole	7.439781	12.29232

(Source: ESIA Field Survey, 2022)

4.2.8 Wildlife Survey

Data were collected from existing tracks and footpaths in each sample area which were geo-referenced with a hand-held Global Positioning System (GPS). Direct and indirect methods were used to ascertain the presence of animal species in the area.

Direct Observation: - Actual sighting of the animal species involving: spot identification, behavioural features and indices of various species were done during the survey.

Indirect Observation: - This involved sighting of signs (e.g. footprints, spoors and calls) left by an animal and information received from the farmers and local hunters living within the sampled area.

Other Indirect signs used to estimate animal abundance include: faecal pellets and dung piles. Each time an animal or group of animals is encountered, the following information were recorded according to Gaston *et a/. (2000).*

- Species type
- Number of animals counted
- Mode of detection (whether sight, vocalization or sound produced by an animal moving through the vegetation)
- Time sighted
- Observer's location
- Animal - Observer distance
- Animal activity when first detected

Information gathered from indirect observations which involved sighting of signs such as footprints and spoors, faecal pellets and dung piles left by an animal was also used in the determination of the faunistic composition. This was also augmented by information on the wildlife received from the farmers and local hunters living within the sampled area were also used in the determination of the faunistic composition of the project area. Other indirect observations used to estimate animal abundance include: faecal pellets and dung piles.

4.2.9 General Quality Assurance and Quality Control Measures in Field Survey

Quality Assurance/quality Control (QA/QC) procedures covered all aspects of the study, including sample collection, handling, laboratory analyses, data coding and manipulation, statistical analyses, presentation and communication of results. The methods of analyses used in this study were those specified in Federal Ministry of Environment Guidelines, EGASPIN 2002 and other internationally accepted analytical procedures, in order to ensure the reliability and integrity of the data obtained.

(i) Sample Collection and Handling

Sample collection and handling procedures to maintain the integrity of samples and enhance the quality of the results, were in accordance with Federal Ministry of Environment. Following procurement, all samples were immediately labelled indelibly, giving details of sampling point, location of sampling, date and time of sampling, name of personnel sampling, etc. To reduce sampling error, measurements were replicated and a number of spatially distributed samples were composited before sub sampling for analysis. The sample collection and handling procedures are summarized as follow:

- Standard field procedures and methods approved FMEnv were adopted.
- All sampling equipment was maintained in excellent condition, calibrated against international standards and adequate steps were taken to ensure that they function normally.
- Only new and thoroughly washed, rinsed and sterilized sampling containers were used.
- For heavy metal determination, sampling bottles were used and were rinsed with a solution of one-part nitric acid to four parts water, followed by copious amounts of distilled water. Water samples for BOD_5 determination were collected in black oxygen bottles and kept away from light source.
- All parameters without holding time were measured *in situ* on the field.
- Samples for other parameters were preserved as soon as they were collected. Dissolved oxygen samples were fixed with Winkler's Reagents; while heavy metal samples were acidified to a pH of about 2 with concentrated H_2SO_4 respectively.
- All samples were adequately labelled to preserve their identity. Label included sample reference code number, source, sampling date, etc.
- All samples were safely packed and transported to the laboratory base

Sample contamination and deterioration were avoided by pre-sterilising sampling tools and containers, pre-treating and preserving samples in transit in ice-cooled chest (<4oC) to the laboratory and storing samples at that temperature in refrigerators pending subsequent analysis especially for attributes having short-holding time such as total hydrocarbon, heavy metals and microbiology.

(ii) Sample Preservation

Sample contamination and deterioration were avoided by pre-sterilizing sampling tools and containers, pre-treating and preserving samples in transit in ice-cooled chests to the laboratory and stored at that temperature in refrigerators pending subsequent analysis. All parameters with short holding time such as pH and temperature were measured *in situ* on the field, while samples for delayed analyses were preserved by refrigeration (for general water chemistry), pH adjustment or chemical pre-treatment (for heavy metals, Total Hydrocarbon, Dissolved oxygen). Dissolved oxygen samples were acidified to a pH 2 with concentrated H_2SO_4 and NHO_3 respectively and samples for microbiology and benthos were stored immediately in ice-cooled chest (at 4ºC) in transit to the laboratory base where they were stored in refrigerators. Plankton samples were treated with 4% formalin solution.

4.3 Field Observations, Results and Discussion of Existing Environmental Conditions

4.3.1 Climate and Meteorology

The following sub-sections draw, where relevant, on data for Katsina state obtained from the Nigeria Meteorological Agency (NIMET, 2022), which covers 20 years (2001 – 2021). Data collected from the weather station as part of the field survey is also then presented where relevant, and compared to the data from NIMET.

Regional Overview

The study area is located in the semi-arid climatic zone of Nigeria and characterized by two distinct seasons which are the hot dry season and a cool rainy season.

Generally, Nigeria's climate is characterized by the dry and wet conditions associated with the movement of the Inter-Tropical Convergence Zone (ITCZ) north and south of the equator. The Inter-Tropical Convergence Zone (ITCZ) appears as a band of clouds, usually thunderstorms that circle the globe near the equator and Nigeria is located just north of the equator. When the ITCZ is to the south of the equator, the north-east winds prevail producing the dry-season and whenever it moves into the Northern Hemisphere, the south westerly wind prevails to bring rainfall and the rainy (wet) season.

Air Temperature

Due to the latitudinal location of the region within the tropics, the temperature in the study area is generally high with mean monthly minimum and maximum ranges of 15.5ºC–24.6ºC and 30.5ºC – 40.3ºC respectively (Figure 4.2). Usually, the highest maximum temperature occurs in February and March, the peak of the dry season, while the lowest temperature occurs in August, the peak of the wet season.

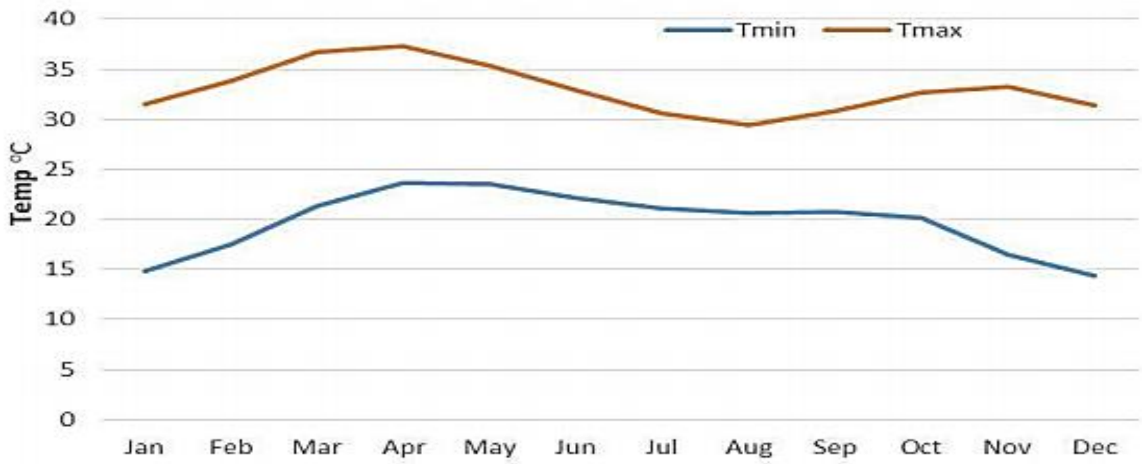

Figure 4. 2: Monthly mean Temperature for Katsina (2001 – 2021)
(Source: NIMET, 2021)

Relative Humidity (RH)

Mean monthly relative humidity values obtained from NIMET from 1987–2012 are presented in Figure 4.3. The minimum RH as shown in Figure 4.3 occurs in March, which is the peak of the dry season and the maximum occurs in August, which is the peak of the wet season. During the field monitoring, daily relative humidity of 46.3-91% was recorded for dry season. Maximum relative humidity values generally occurred between 0700h and 0900h while minimum relative humidity values were recorded between 1000h and 1600h.

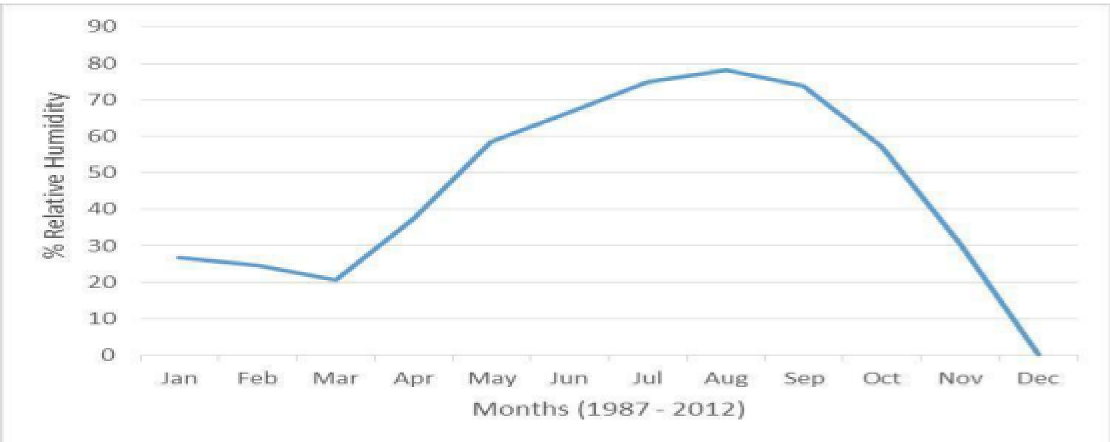

Figure 4. 3: Monthly Average Relative Humidity for the Period of Ten Years
(Source: NIMET, 2021)

Rainfall

The study area receives little or no rainfall from November to February, but significant rainfall from May onwards. The mean monthly rainfall (mm) for the period 1987 to 2012 (Figure 4.4), shows that August has the highest mean rainfall (624.7 mm), while from

September, the average rainfall reduces. There was no rainfall during field due to the harmattan period.

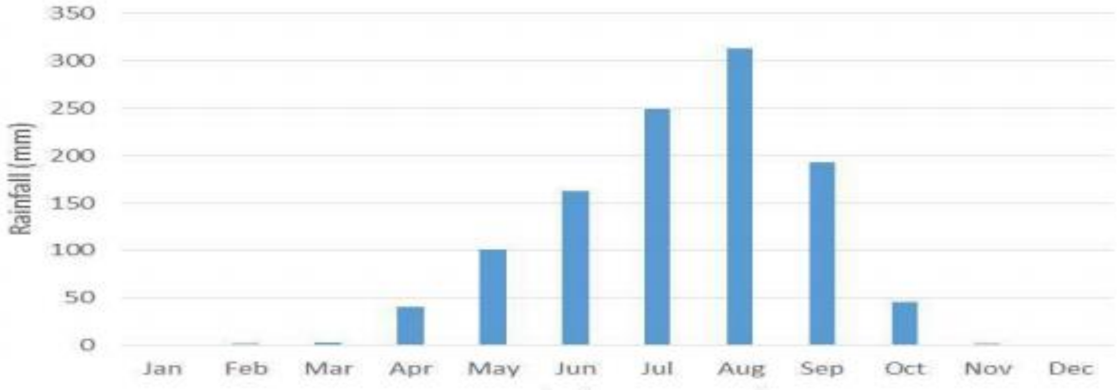

Figure 4. 4: **Monthly Average Rainfall for the Period of Ten Years**
(Source: NIMET, 2021)

Wind Speed and Direction

The Study area has a calm weather with wind speed ranging between 0.7 m/s to 6.2m/s (Figure 4.5). The mean surface wind speed and direction are influenced by seasonal variation. Two main air masses alternate with the season. During the dry season, the northeast winds predominate while the southwest winds are dominant during the wet season. The highest wind speed is recorded at the onset of the wet season when early rains are torrential and accompanied by squalls, lightning, and thunder. The wind speeds are lower in the nights than during the days. During the field survey, the mean wind speed varied from 0.5 to 2.5m/s and wind direction ranged from 068 to 270 degree.

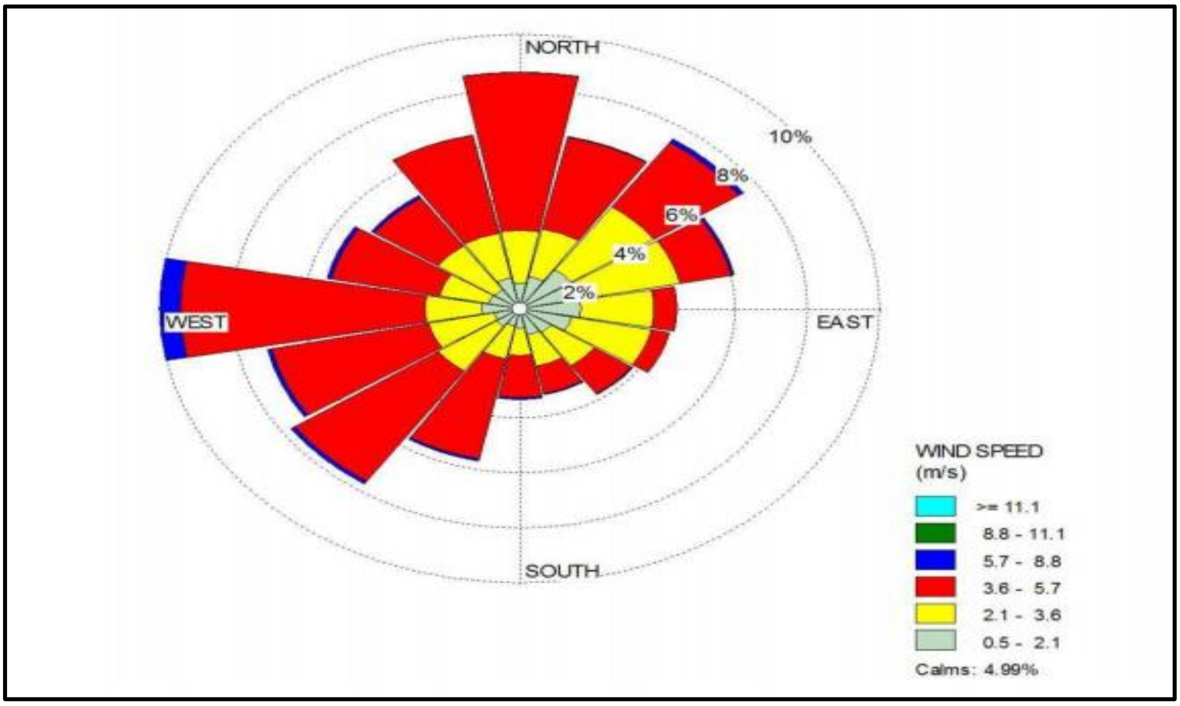

Figure 4. 5: **Prevailing Wind Directions in the Study Area**
(Source: NIMET, 2021)

Sunshine

Data obtained from NIMET for Dutsin Ma shows that the mean monthly sunshine period is between 4.8 hours to 7.6 hours per day (Figure 4.6). This is suitable for harnessing solar energy during day-time hours to generate electricity. Between July and October, the lowest sunshine period is recorded, while the maximum period is in November. The shortest period is in July, when there is a greater amount of cloudiness and rainfall. In November, the sunshine periods are higher due to the prevalent clear skies when the ITCZ has started its northward migration. The duration reflects the double maxima feature of the rainfall pattern.

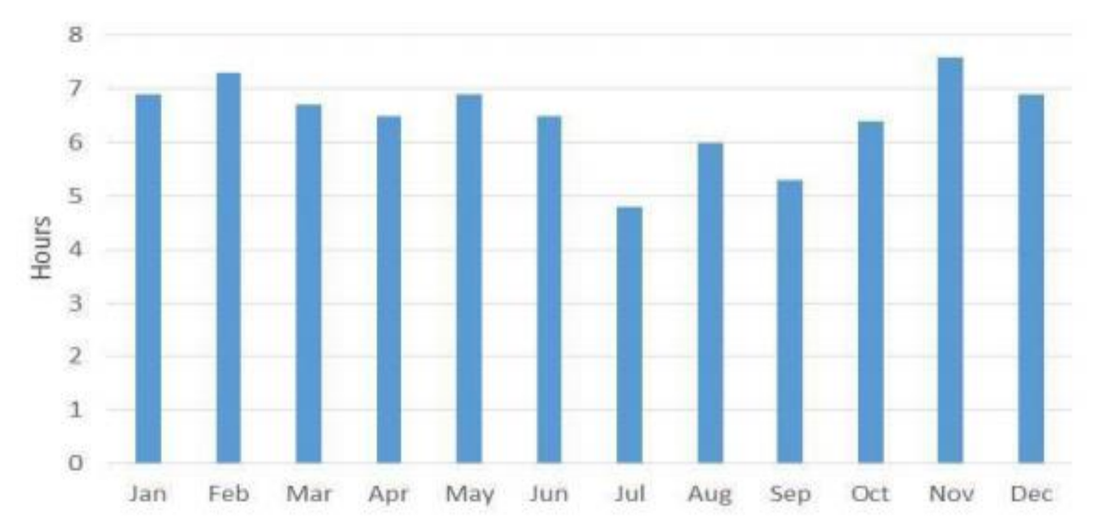

Figure 4. 6: Mean sunshine hours in Dutsin Ma 2001 – 2021
(Source: NIMET)

Visibility

As reported in Figure 4.7, the mean monthly visibility of the proposed project area ranges from 1.9–12.3 km. While the minimum is in September, the maximum is in January.

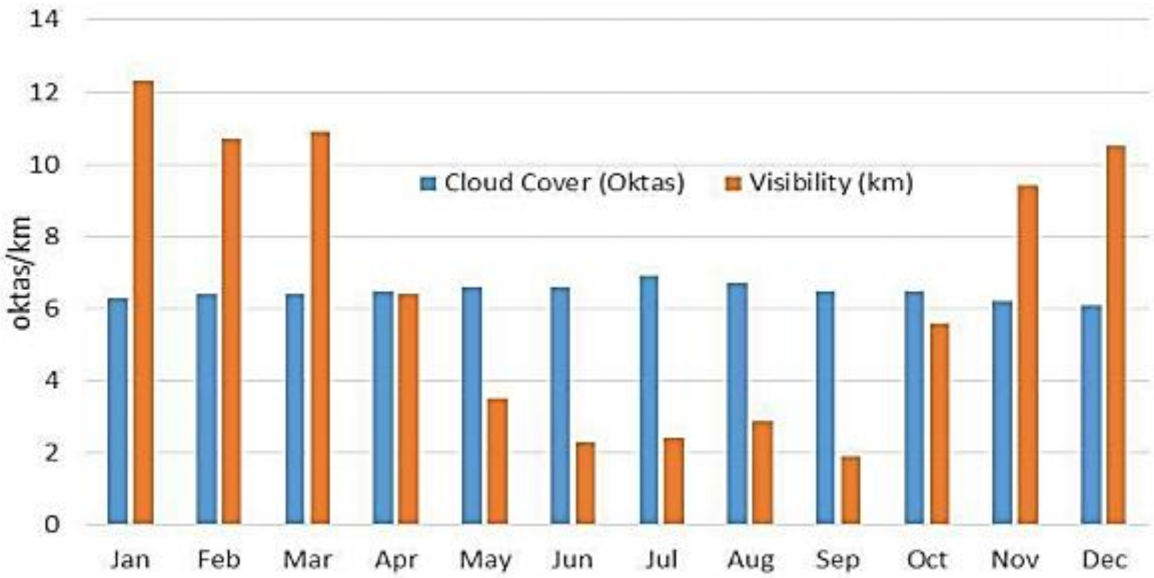

Figure 4. 7: Cloud Cover and Visibility Data for Katsina

(Source: NIMET, 2021)

Electric and Magnetic Force (EMF)

Electric and magnetic field (EMF) are invisible areas of energy, often referred to as radiation that are associated with use of electrical power and various forms of natural and manmade lighting. In all the locations monitored are of no significance to human health.

4.3.2 Air Quality

A summary of the findings of the ambient air quality measurements taken for the study area is presented in Table 4.5 with due reference to FMEnv standards (table 4.6).

Table 4. 5: Air Quality Characteristics of the Study Area

Field Code	PARAMETERS											
	CH_4	CO_2	CO	NO_2	SO_2	H_2S	NH_3	VOC	PM μg/m^3			TSP
	Ppm								$PM_{2.5}$	$PM_{5.0}$	PM_{10}	μg/m^3
AQ1	ND	460	9.0	0.04	ND	ND	ND	1.9	67.7	94.7	151.8	189.4
AQ2	0.02	472	8.1	0.06	ND	ND	ND	0.10	47.2	89.0	100.7	179.6
AQ3	ND	461	6.5	0.02	ND	ND	ND	1.3	69.3	81.6	93.0	136.5
AQ4	0.03	467	4.2	0.02	ND	ND	ND	1.7	83.9	98.1	129.3	210.5
AQ5	ND	438	3.3	0.01	ND	ND	ND	1.2	70.6	86.1	96.4	159.8
AQ6	ND	458	1.8	0.02	ND	ND	ND	0.7	66.5	78.9	89.1	168.9
AQ7	ND	448	1.3	0.04	ND	ND	ND	1.1	81.9	113.8	104.1	241.6

Field Code		PARAMETERS										
	CH_4	CO_2	CO	NO_2	SO_2	H_2S	NH_3	VOC	PM µg/m^3			TSP
	Ppm								$PM_{2.5}$	$PM_{5.0}$	PM_{10}	µg/m^3
AQ8	0.05	456	3.8	0.05	ND	ND	ND	2.0	86.0	105.7	136.8	220.5
AQC1	0.9	478	9.7	0.04	ND	ND	ND	2.5	97.4	149.8	208.6	268.1
AQC2	0.12	435	4.1	ND	ND	ND	ND	0.8	57.3	89.6	130.4	187.6

Source: ESIA Field Survey, 2022

Table 4. 6: Regulatory Standards for Ambient Air Quality

S/N	Contaminant	Averaging Period	Maximum Concentration (µg/m^3)	
			WHO	FMENV[a]
1.	CO	1 – Hr		
		8 – Hr		22,800 (20ppm)
		24 – Hr		11,400 (10ppm)
2.	NO_X	24 – Hr	200	75 – 113 (0.04-0.06ppm)
3	SO_2	1 – Hr	125	260(0.1ppm)
		24 – Hr		26(0.01ppm)
4	O_3	24 – Hr	100-120	
5.	$PM_{2.5}$	24 – Hr	25	
6.	PM_{10}	24 – Hr		
7	VOC			160
8.	TSP	1 – Hr		600
		24 – Hr		250

([a]*Source: FMEnv (1991))*

4.3.2.1 *Gaseous Pollutants*

Methane (CH_4)

The levels of Methane detected ranged from 0.02 to 0.9ppm in all sampled locations during this ESIA.

Nitrogen dioxide (NO_2)

Low levels of NO_2 were measured during the period of survey at all sampling locations. The values obtained (0.01 – 0.06ppm) are within the FMEnv limits of 0.04-0.06ppm (Table 4.4). Since NO_2 is a combustion product, their detection could be attributed to vehicular emissions.

Carbon Monoxide (CO)

The values of carbon monoxide obtained ranged from 1.3 – 9.7ppm which are still within the FMEnv limits of 10ppm. The high levels of CO obtained can be attributed to vehicular activities around the university premises.

Volatile Organic Compounds

The values obtained for VOC ranged from 0.10 – 2.5ppm below the FMEnv limit of 10ppm. The results indicate that there are no significant fugitive emissions of VOC at all sampling stations.

Hydrogen Sulphide (H_2S), Sulphur Dioxide (SO_2) and Ammonia

H_2S, NH_3 and SO_2 were taken to be within their set limits since they were not detected in any of the sampling locations

4.3.2.2 Suspended Particles

The measured particulate concentrations on the proposed project site were $PM_{2.5}$: 47.2 – 97.4 µg/m^3, $PM_{5.0}$: 78.9 – 149.8µg/m^3, PM_{10}: 89.1 – 208.6µg/m^3, and TSP: 136.5 – 268.1 µg/m^3.

As summarized in Table 4.4, particulates were detected in all the sampling locations of the proposed project site. As the study was conducted in the dry harmattan season exposed earth surface was the major source of particulates due to the dust re-suspension, vehicular emissions and domestic cooking were the major possible sources of particulates identified during the study.

4.3.3 Ambient Noise Level

The noise levels (Table 4.7) measured varied from 48.9 to 56.4 dB(A) in the period of survey. The main sources of sound in the study area are vehicular traffic and human activities. The results indicate the noise levels in the study area were below the maximum Allowable Laeq (Hourly 85 dB (A) limit of FMEnv.

Table 4. 7: Noise Level of the Study Area

Sampling Station	Noise Level L_{Aeq}(dBA)
AQ1	48.9
AQ2	50.6
AQ3	51.2
AQ4	51.9
AQ5	50.4
AQ6	54.1
AQ7	55.3
AQ8	54.7
AQC1	56.4
AQC2	62.7(

(Source: ESIA Field Survey, 2022)

4.3.4 Geology and Geophysical Investigations

4.3.4.1 Geology of the Project Area

The project area is regionally concealed within Gongola basin of the upper Benue trough of Nigeria. The rocks in Katsina State comprise the following main units: migmatite - gneiss Basement Complex, younger metasediments and metavolcanics, granites, younger granite, igneous rocks and sedimentary rocks (Ibrahim, 2010a). Parts of the State are underlain by granites with lateritic capping in some of them. There are also the Daura Igneous Complex rocks and the Gundumi and Chad sedimentary formations (Kogbe, 1975). Outcrops consist almost entirely of resistant migmatites, quartzites, conglomerates and granites, although there are small exposure of softer gneisses and semi-pelitic rocks in some stream channels. Rocks of the migmatite-gneiss Basement Complex constitute the majority in real extent (McCurry, 1970). The younger metasediments are the second most abundant rock type (occupying about 33% of the State), while most of the western part is underlain by the granites. Others include the Chad Sedimentary Formation and the Gundumi Formation which occupy about 15% of the total area of Katsina State. The least exposed rocks are the Daura Younger Granite rocks located in Zango LGA of the State. The contact relationship between most of the rocks could only be inferred, because exact contacts between the rocks have been concealed by overlying material (Rahaman, 1971). Figure 4.8 is the geological map of the project area.

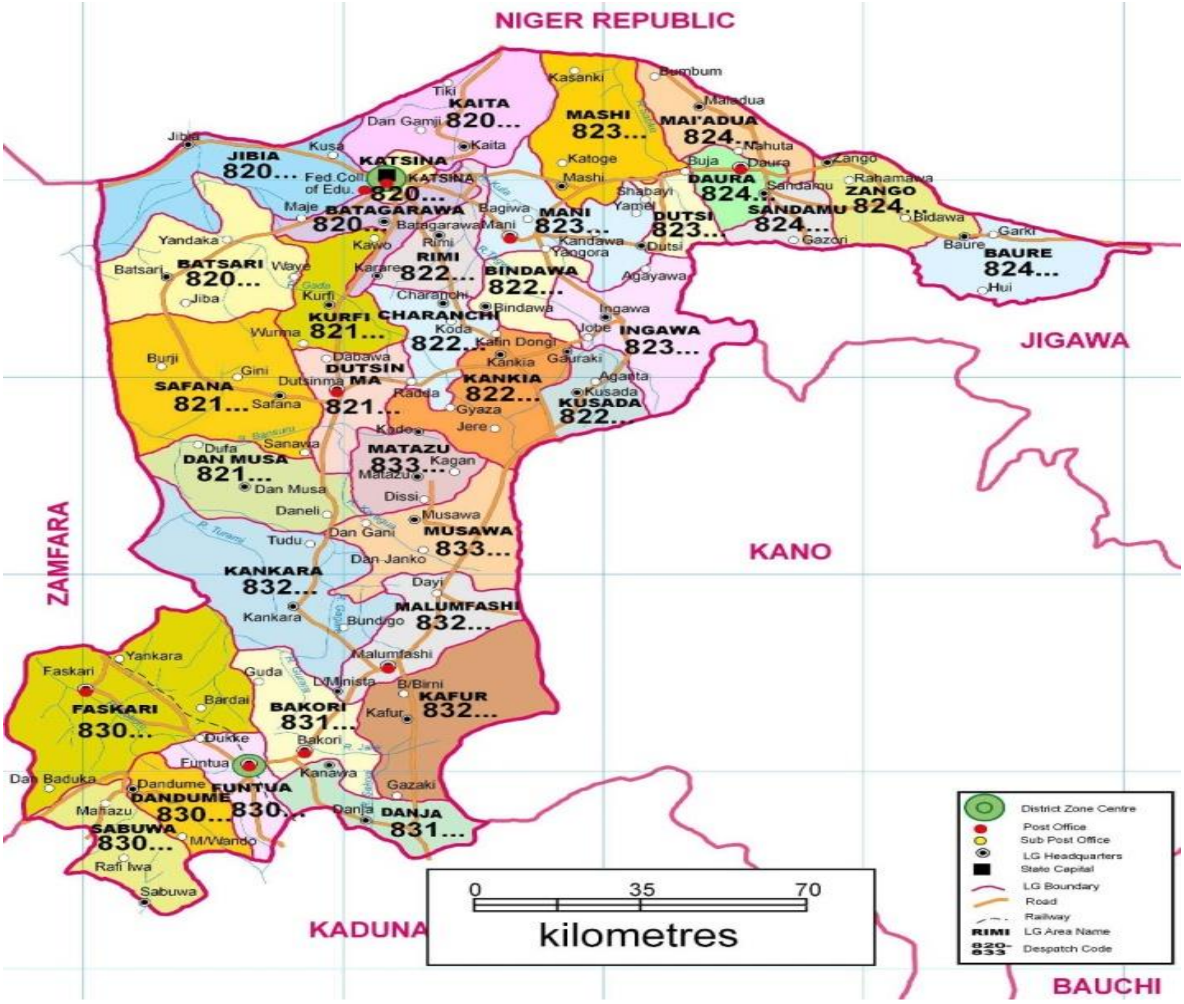

Figure 4. 8: Geological map showing Katsina State
(Source: Nigeria Zip Code 2023)

Local Geology and Hydrogeology

Generally, the relief of the region ranges from an average height of 450m to about 650m above mean sea level on the typical plains and it rises to as much as 750m at the rare isolated hills and rock outcrops found in some locations. The inclination of the relief of Katsina can be depicted by the stretch of the region from north to south. The southern fringe of the region begins from the northern margin of the Kaduna plains, around the local governments of Sabuwa, Dandume, Funtua and Danja. These local government areas share border with Kaduna State which is known to be occupying the base of the northern highland of Nigeria. These areas of the Katsina region are found in some places to have risen up to as high as 700 metres above mean sea level and with an average of 550m in the low laying areas. The area is slanted towards the north and northwest across Bakori and Kankara to the central areas of Safana, Dutsin-ma and Kankia. The relief of this part of the region ranges from 450m to 560m above mean sea level. From the central part, the topography continues descending across Katsina local government area to Jibia and Kaita areas at the extreme northern part of the State and the border with Niger Republic. At this point, the altitude falls to as low as 450m above mean sea level on the average (Figure 4.9)

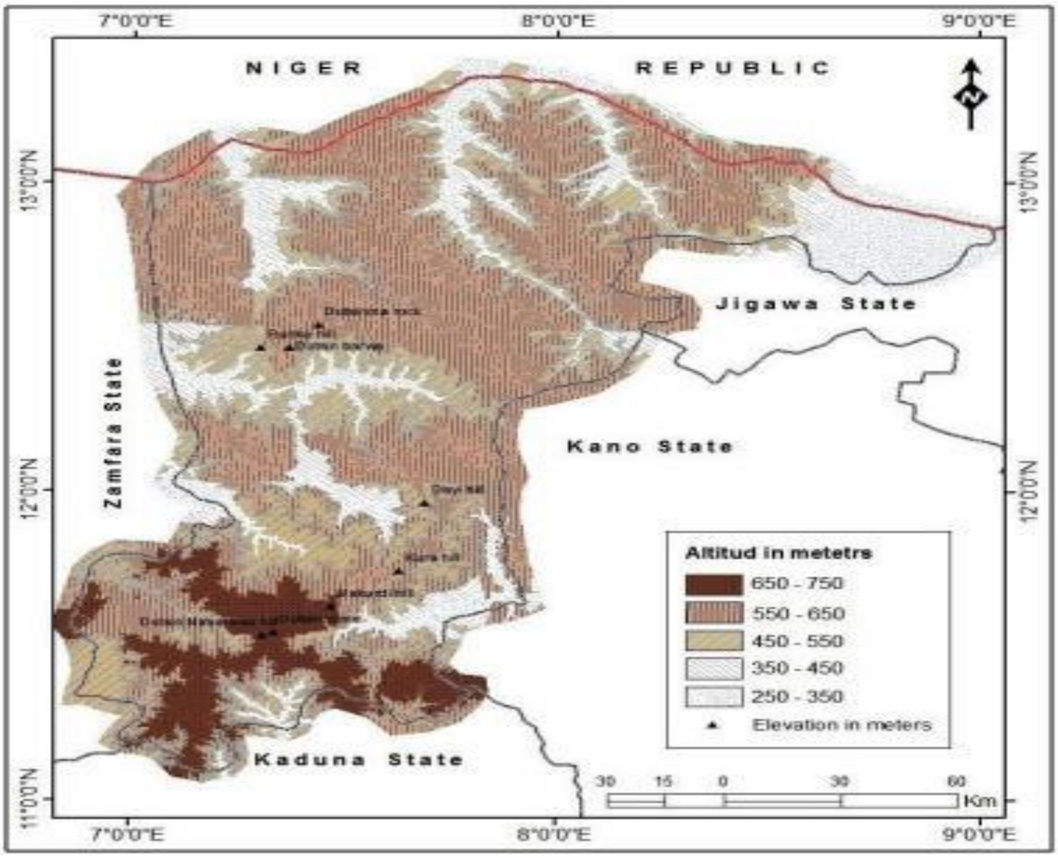

Figure 4. 9: Topography map of Katsina State
(Source: Geoinfotech)

4.3.5 Soil

4..3.5.1 Soil Physico-Chemical Characteristics

Soils of the area were observed to be matured with good internal drainage. Present findings also indicated that surface soils are quite compactible, particularly if spillage occurs. This is because of the relative ease of movement, into and within the 0 – 15 cm depth, by liquids and gases.

The results of the analyses undertaken in the laboratory on surface (0-15cm) and subsoil (15 - 30cm) samples were discussed. This is in accordance with the fact that the topsoil is particularly prone to impact from human activities that are part of the different phases of the Project. Discussions of soil samples results are presented in this section while detail results of findings from each sampling point is presented in Table 4.8.

Table 4. 8: Physico-Chemical Characteristics of Soil within the Study Area

Field Code		Ph		Avail-P	OC	OM	TN		Exch. Bases				Exch. Al	EC	THC
								Ca	S	Mg	K	Na			
		(H_2O)	($CaCl_2$)	(ppm)	(%)			(Cmol/kg soil)							(ppm)
SP1	0-15	5.4	5.6	8.90	0.72	0.28	0.06	10.5	9.61	5.55	0.63	2.31	0.17	0.17	0.26
	15-30	5.6	5.7	9.31	0.75	0.25	0.17	10.7	8.74	5.09	0.52	4.81	0.15	0.19	0.24
SP2	0-15	6.3	6.4	9.81	0.69	0.21	0.18	9.44	8.96	6.34	0.44	2.10	0.19	0.21	0.28
	15-30	6.3	6.6	10.15	0.72	0.27	0.18	9.65	8.34	6.56	0.41	2.05	0.18	0.19	0.30
SP3	0-15	5.8	5.6	9.88	0.81	0.24	0.19	8.78	8.65	5.87	0.98	2.10	0.19	0.26	0.22
	15-30	5.6	5.5	10.3	0.87	0.28	0.16	8.88	7.16	5.68	0.91	2.32	0.21	0.23	0.21
SP4	0-15	6.1	6.3	9.52	0.56	0.23	0.18	7.75	9.17	6.17	3.82	1.98	0.22	0.21	0.43
	15-30	6.2	6.3	9.61	0.58	0.38	0.15	7.89	7.19	6.28	2.49	1.45	0.24	0.18	0.42
SP5	0-15	5.4	5.2	8.59	0.47	0.15	0.12	10.0	8.42	6.12	1.96	3.51	0.26	0.41	0.34
	15-30	6.2	6.2	9.01	0.45	0.18	0.10	9.20	7.87	6.13	1.84	2..67	0.27	0.21	0.31
SP6	0-15	6.2	6.14	8.95	0.50	0.19	0.13	8.50	6.55	5.10	0.29	1.95	0.14	0.24	0.23
	15-30	5.4	5.6	8.91	0.46	0.14	0.14	8.64	6.78	5.20	0.13	1.89	0.16	0.44	0.21
SP7	0-15	5.7	5.5	9.90	0.71	0.17	0.17	6.78	7.99	5.18	1.40	1.74	0.18	0.16	0.25
	15-30	5.5	5.7	10.8	0.69	0.18	0.16	7.18	8.42	5.12	1.16	1.79	0.22	0.22	0.29
SP8	0-15	5.9	6.1	10.5	0.74	0.25	0.12	9.16	8.78	4.35	1.35	2.31	0.21	0.33	0.22
	15-30	6.3	6.4	10.0	0.71	0.22	0.14	9.21	8.21	5.22	1.12	2.25	0.17	0.30	0.27
SPC 1	0-15	6.0	5.6	9.10	0.61	0.30	0.19	10.6	8.45	4.16	0.59	2.16	0.21	0.28	0.41
	15-30	5.9	6.5	8.45	0.54	0.21	0.15	10.5	7.12	4.17	0.46	2.17	0.25	0.30	0.45
SPC 2	0-15	6.1	6.3	8.03	0.72	0.34	0.17	10.5	8.65	6.19	0.62	1.78	0.25	0.20	0.32
	15-30	6.1	6.6	8.31	0.70	0.26	0.11	11.9	7.11	6.22	0.36	2.22	0.21	0.28	0.30

(Source: Sustainabiliti Field Study 2022)

Soil pH

Soil pH is an indication of the acidity or alkalinity of soil, and it is measured in pH units. Soil pH is defined as the negative logarithm of the hydrogen ion concentration. The pH scale goes from 0 to 14 with pH 7 as the neutral point. As the amount of hydrogen ions in the soil increases the soil pH decreases, thus becoming more acidic. From pH 7 to 0 the soil is increasingly more acidic and from pH 7 to 14 the soil is increasingly more alkaline or basic. Extremely and strongly acid soils (pH 4.0-5.0) can have high concentrations of soluble aluminum, iron and manganese which may be toxic to the growth of some plants. A pH range of approximately 6 to 7 promotes the readiest availability of plant nutrients in soil. pH affects transformation processes among the various forms of nutrients. The values of pH from the sampled locations ranges from 5.4 – 6.6 pH classification is presented in Table 4.8, while the pH values for soil in the study area are presented in table 4.9.

Table 4. 9: Classification of Soil pH

Class of pH	pH Range
Extremely acidic	<pH4.5
Very strongly acidic	pH4.5 – 5.0
Strongly acidic	pH5.1 – 5.5
Moderately acidic	pH5-6 – 6.0
Slightly acidic	pH6.1 – 6.5
Neutral	pH6.6 – 7.5
Alkaline	pH7.6 – 8.0
Very alkaline	pH8.1 – 8.5
Strongly alkaline	≥pH8.6

(Source: Loganathan (1987))

Electrical Conductivity

Soil electrical conductivity, EC, is the ability of soil to conduct electrical current. EC is the most common measure of soil salinity and is indicative of the ability of an aqueous solution to carry an electric current. Plants are detrimentally affected, both physically and chemically, by excess salts in some soils and by high levels of exchangeable sodium in others. Soils with an accumulation of exchangeable sodium are often characterized by poor tilt and low permeability making them unfavourable for plant growth.

As shown in Table 4.8, value of EC in the soil ranges from 0.16 – 0.41mg/100g and 0.18 – 0.44 /100g top and subsoil respectively.

Total Organic Matter

Soil total organic matter is primarily plant residue in different stages of decomposition. The accumulation of SOM within soil is a balance between the return or addition of plant residues and their subsequent loss due to the decay of these residues by micro-organisms. TOM is important because it improves both the physical and chemical properties of soil and has several beneficial effects on agricultural soil quality. As shown in Table 4.8, the soils TOM range from 0.15 – 0.34% and 0.14 – 0.38% for both top and subsoil respectively.

Soil Nutrient

Several essential plant nutrients are obtained from the soil. Before a nutrient can be used by plants it must be dissolved in the soil solution. Many important soil properties are dependent to some degree on the quality of organic matter present. These properties include the absorption and retention of water, reserves of exchanged bases, and the capacity to supply nitrogen, phosphorus and other elements to growing crops, stability of soil structure, adequacy of aeration and pollutants bioavailability (Margesin and Schinner, 2005). In fact, pollutant concentrations in soil are normalized with the organic matter in conjunction with clay content (DPR, 2002). Nitrogen levels in both the top and sub soil fall within 0.06mg/kg – 0.19mg/kg. Soil Nitrogen of more than 0.15% is considered optimal for most crops. Nitrogen concentrations in soils generally fall sharply with depth, with most of the nitrogen being in the top one-meter layer of soils. Over 90%, of the nitrogen in the surface layers (A-horizon, plow-depth zone) of soil is in organic matter.

Total phosphate levels in the topsoil and subsoil falls within 8.45mg/kg – 10.8mg/kg, Phosphorus in soils is present in the soil solution (plant-available), as labile phosphate precipitates and adsorbed to soil particles, mainly clay minerals (potentially available to plants), as non-labile phosphate in the form of calcium, iron, and aluminium phosphate (not plant-available), in organic form, including P in soil organic matter (released after mineralization), and in living soil biomass. Phosphorus is utilized in the fully oxidized and hydrated form as orthophosphate. Deficiency of phosphorus may limit the growth of plants and the microbial decomposition of pollutants in soil. Phosphorus is likely to be deficient in hydrocarbon-impacted soils and subsoil. Potassium and sodium level in the soil are within the ranges of 0.29 to 3.82mg/100g and 1.45 to 4.81mg/100g respectively. Sulphates detected in the study area ranged from 6.55 to 9.61 mg/100g and calcium level detected in soil ranges from 7.18mg/100g – 11.9mg/100g for both top and sub soil respectively.

Total Hydrocarbon (THC)

THC is a mixture of chemicals, but they are all made mainly from hydrogen and carbon, called hydrocarbons. Some chemicals that may be found in THC are hexane, jet fuels, mineral oils, benzene, toluene, xylenes, naphthalene, and fluorene, as well as other petroleum products and gasoline components. However, it is likely that samples of THC will contain only some, or a mixture, of these chemicals. THC may enter the environment through accidents, from industrial releases, or as by-products from commercial or private uses and may be released directly into water through spills or leaks, with the possibility of sinking to the bottom sediments. THC in the soils ranges from 0.21 to 0.45mg/100g for both top and sub-soil. (Table 4.8)

Heavy Metals

The soil chemistry distinguishes heavy metals as a special group of elements because of their toxic effect exerted on plants upon their high concentration. However, there is no common opinion on the hazard degree on any heavy metals in soil. The term heavy metal is often broadly adopted to include other potentially hazardous elements, even if they do not meet the strict chemical definition. These are arsenic (As), cadmium (Cd), chromium (Cr), lead (Pb), nickel (Ni), and zinc (Zn). Soils normally contain low levels of heavy metals, however, in areas such as agricultural, industrial, or municipal wastes they are applied as fertilizer in concentrations which may be much higher. Excessive levels of heavy metals may be hazardous to man, animals, and plants. The result of the analysis in table 4.10 shows that heavy metal concentrations in the study area high, mostly exceeding the FMEnv Limit in some sampling points.

Table 4. 10: Heavy Metals in Soil of Project Affected Area

Field Code	Coordinates of Sampling Location			Mn	Fe	Cu	Zn	Cr	Pb	Ni	V	Ba	Cd
	Long. (ºE)	Lat. (ºN)		(ppm)									
SP1	7.448027	12.29788	**0-15**	8.10	7.11	5.19	3.45	6.21	0.88	0.13	0.11	1.05	0.03
			15-30	9.10	7.06	5.21	3.37	6.04	0.81	0.11	0.12	1.02	0.01
SP2	7.444677	12.29672	**0-15**	10.20	8.12	6.08	3.97	5.45	0.84	0.08	0.11	0.88	0.05
			15-30	10.18	8.04	6.01	4.18	5.14	0.83	0.06	0.03	0.71	0.02
SP3	7.446118	12.29519	**0-15**	8.11	6.76	4.15	4.49	5.22	0.65	0.10	0.12	0.67	0.07
			15-30	8.08	6.72	4.17	4.10	5.00	0.59	0.05	0.08	0.74	0.03
SP4	7.445442	12.29605	**0-15**	9.21	7.03	5.18	5.04	4.42	0.86	0.07	0.02	0.68	0.05
			15-30	9.17	7.08	5.20	4.92	4.96	0.74	0.03	0.01	0.53	0.02
SP5	7.444003	12.29556	**0-15**	8.14	6.69	4.61	5.62	5.32	0.61	0.05	0.04	0.51	0.03
			15-30	8.16	6.64	4.50	5.44	5.15	0.59	0.06	0.05	0.57	0.01
SP6	7.441993	12.29537	**0-15**	8.19	7.13	6.08	6.21	4.98	0.61	0.02	0.06	0.45	0.06
			15-30	9.11	7.06	6.01	6.42	5.14	0.60	0.01	0.03	0.51	0.02
SP7	7.445896	12.29662	**0-15**	9.87	8.21	4.15	6.63	6.55	0.69	0.10	0.08	0.48	0.04
			15-30	10.2	8.03	4.17	5.98	6.12	0.58	0.06	0.03	0.44	0.02
SP8	7.450192	12.2994	**0-15**	8.95	6.74	5.18	6.23	2.74	0.66	0.07	0.04	0.40	0.03
			15-30	8.54	6.76	5.20	6.12	2.71	0.64	0.05	0.03	0.50	0.01
SPC 1	7.441676	12.29679	**0-15**	9.13	7.41	4.61	5.95	3.14	0.73	0.04	0.05	0.58	0.05
			15-30	8.64	7.05	4.50	5.14	3.06	0.81	0.02	0.02	0.51	0.02
SPC 2	7.744623	12.29988	**0-15**	8.56	6.69	3.88	5.95	1.66	0.91	0.05	0.04	0.71	0.02
			15-30	8.11	6.15	3.75	5.54	1.41	0.72	0.02	0.03	0.56	0.01

(Source: Sustainabiliti Field Study 2022)

Soil Texture

The texture of a soil determines the water absorption/infiltration rate, the water holding capacity and migration of pollutant down the soil strata (Margesin and Schinner, 2005). It also determines the amount of soil aeration, ease of tilling, and soil fertility (Udoh 1986). Low clay and high sand soil is porous and will permit easy percolation of nutrients and pollutants to the groundwater table. Other parameters that determine the dynamics of pollutants in soil include bulk density and porosity. The bulk density gives a rough estimation of the aeration and permeability of a soil. The lower the bulk density, the higher is the permeability (Margesin and Schinner, 2005). Bulk density varies with structural conditions of the soil. As shown in Table 4.11, sand-sized particles of the surface soils and topsoil varied between 68% and 76%; Clay was between 2% and 12.0%; Silt was from 19.0% to 26.0% while the pattern of particle size distribution of the surface soils shows that the surface soils were well set in terms of workability with loamy soil being the dominant soil texture.

Table 4. 11: Soil Texture Analysis

Field Code	Coordinates of Soil Sampling Location			Particle Size Distribution (%)			Texture
	Long. (ºE)	Lat. (ºN)		Sand	Silt	Clay	
SP1	7.448027	12.29788	0-15	76	21	3	Sandy/Loam
			15-30	72	23	5	Sandy/Loam
SP2	7.444677	12.29672	0-15	74	21	5	Sandy/Loam
			15-30	71	26	3	Sandy/Loam
SP3	7.446118	12.29519	0-15	70	23	7	Sandy/Loam
			15-30	73	25	2	Sandy/Loam
SP4	7.445442	12.29605	0-15	70	21	9	Sandy/Loam
			15-30	71	22	7	Sandy/Loam
SP5	7.444003	12.29556	0-15	74	22	4	Sandy/Loam
			15-30	71	21	8	Sandy/Loam
SP6	7.441993	12.29537	0-15	69	22	9	Sandy/Loam
			15-30	72	19	9	Sandy/Loam
SP7	7.445896	12.29662	0-15	74	22	4	Sandy/Loam
			15-30	68	20	12	Sandy/Loam
SP8	7.450192	12.2994	0-15	71	21	8	Sandy/Loam
			15-30	70	22	8	Sandy/Loam
SPC 1	7.441676	12.29679	0-15	71	20	9	Sandy/Loam
			15-30	72	25	3	Sandy/Loam
SPC 2	7.744623	12.29988	0-15	71	21	8	Sandy/Loam
			15-30	69	20	11	Sandy/Loam

(Source: Sustainabiliti Field Study 2022)

Soil Microorganism

The microbiological characteristics of soil within the project area is presented in Table 4.12 Total Bacteria count revealed total viable count of $1.32x10^5$ – $3.50x10^5$ cfu/g for both topsoil and subsoil. Total Bacteria constitutes 40%, Total Fungi 35%, Hydrocarbon Utilizing Bacteria 15% and Hydrocarbon Utilizing Fungi 10% in topsoil while Total Bacteria constitutes 54%, Total Fungi 32%, Hydrocarbon Utilizing Bacteria 10% and Hydrocarbon Utilizing Fungi 4%. The most predominant organisms among the isolates are the B*acillus sp., Clostridium sp. And Pseudomonas sp.*

Table 4. 12: Soil Microbial Count of Project Area

S/N	LOCATIONS	Total Heterotrophic Bacteria cfu/g	Total Heterotrophic Fungi cfu/g	Hydrocarbon Utilizing Bacteria cfu/g	Hydrocarbon Utilizing Fungi cfu/g
1	**SOIL/1/1/0-15**	$2.2x10^5$	$6.51x10^3$	$5.21x10^2$	$3.51x10^2$
2	**SOIL/1/15-30**	$1.60x10^5$	$4.10x10^3$	$4.22x10^2$	$2.24x10^2$
3	**SOIL/2/0-15cm**	$2.95x10^5$	$4.21x10^3$	$3.31x10^2$	$2.85x10^2$
4	**SOIL/2/15-30cm**	$2.01x10^5$	$3.10x10^3$	$2.01x10^2$	$1.41x10^2$
5	**SOIL/3/0-15cm**	$2.23x10^5$	$3.54x10^3$	$4.55x10^2$	$3.21x10^2$
6	**SOIL/3/15-30cm**	$1.67x10^5$	$2.50x10^3$	$2.12x10^2$	$1.22x10^2$
7	**SOIL/4/0-15cm**	$1.64x10^5$	$1.80x10^3$	$3.24x10^2$	$2.75x10^2$
8	**SOIL/4/15-30cm**	$1.12x10^5$	$1.25x10^3$	$1.86x10^2$	$2.41x10^2$
9	**SOIL/5/1/0-15C**	$1.55x10^5$	$3.35x10^3$	$2.90x10^2$	$2.56x10^2$
10	**SOIL/5/15-30C**	$1.10x10^5$	$2.76x10^3$	$2.50x10^2$	$1.76x10^2$
11	**SOIL/6/0-15cm**	$3.40x10^5$	$4.12x10^3$	$3.31x10^2$	$2.75x10^2$
12	**SOIL/6/15-30cm**	$2.15x10^5$	$3.31x10^3$	$1.98x10^2$	$1.45x10^2$
13	**SOIL/7/0-15cm**	$2.24x10^5$	$2.59x10^3$	$4.45x10^2$	$3.10x10^2$
14	**SOIL/7/15-30cm**	$1.76x10^5$	$3.51x10^3$	$2.10x10^2$	$1.12x10^2$
15	**SOIL/8/0-15cm**	$1.61x10^5$	$2.04x10^3$	$3.54x10^2$	$2.85x10^2$
16	**SOIL/8/15-30cm**	$1.15x10^5$	$1.33x10^3$	$1.92x10^2$	$2.56x10^2$
17	**SOIL/1/1/0-15C1**	$1.64x10^5$	$3.35x10^3$	$2.90x10^2$	$2.71x10^2$
18	**SOIL/1/15-30C1**	$2.98x10^5$	$3.25x10^3$	$3.31x10^2$	$2.56x10^2$
19	**SOIL/1/1/0-15C2**	$2.55x10^5$	$3.12x10^3$	$2.32x10^2$	$1.41x10^2$
20	**SOIL/1/15-30C2**	$2.35x10^5$	$3.48x10^3$	$4.15x10^2$	$3.21x10^2$

(Source: Sustainabiliti Field Study 2022)

4.3.6. Groundwater Quality

4.3.6.1. Physico-chemical Characteristics

The results of physico-chemical parameters determined in groundwater within project area are presented in Table 4.13. The data represent the prevailing water quality status of the groundwater system within the project site, and a baseline data with which future environmental performance could be evaluated.

Table 4. 13:Physico-chemical characteristics sampling of groundwater in the study area

PARAMETERS	GW 1	GW 2	WHO Limits
Temperature ^{0}C	32.6	33.1	< 40
Colour Pt. Co scale	Colourless	Colourless	NS
Alkalinity	0.71	0.75	NS
Dissolved Oxygen	6.4	5.1	10

PARAMETERS	GW 1	GW 2	WHO Limits
Acidity	0.04	0.06	NS
pH Pt. Co scale	7.4	7.5	6.0-9.0
Turbidity NTU	ND	ND	5
Salinity mg/l	0.002	0.003	NS
Total Dissolved Solid mg/l	130	115	1000.00
Total Suspended Solid mg/l	10	12	30.00
Calcium Hardness mg/l	3.6	4.0	500
Magnesium hardness mg/l	1.21	1.60	600
Electrical Conductivity uS/CM	0.232	0.204	NS
Cyanide mg/l	ND	ND	0.07
Nitrite mg/l	ND	ND	NS
Sodium mg/l	0.01	0.01	200
Chloride mg/l	0.11	0.12	250
Calcium mg/l	2.63	3.90	NS
Nitrate mg/l	ND	ND	50
Sulphate mg/l	ND	ND	400
Ammonia mg/l	ND	ND	5.00
Magnesium mg/l	1.24	1.52	NS
Potassium mg/l	1.30	1.31	20
Fluoride mg/l	ND	ND	1.5
Phosphate	ND	ND	5
METALS			
Iron Total mg/l	0.06	0.04	0.3
Manganese mg/l	ND	ND	0.4
Copper mg/l	0.01	ND	2
Zinc mg/l	0.04	0.03	5.0
Cadmium mg/l	ND	ND	0.03
Chromium mg/l	ND	ND	0.05
Lead mg/l	ND	ND	<1.00
Nickel mg/l	0.004	0.003	0.02
Arsenic mg/l	ND	ND	<1.00
Barium mg/l	ND	ND	0.7
Vanadium	ND	ND	<0.05

(Source: Sustainabiliti Field Study 2022)

The conductivity and total dissolved solid (TDS) values were low, indicating freshwater aquifer. Classification of portability based on electrical conductivity ascribes <325 μScm^{-1} for fresh and potable water, while an aesthetic objective of 500 mg/l has been established for total dissolved solids (TDS) in drinking water (FEPA, 1991; WHO, 2008). At higher TDS levels, excessive hardness, palatability, mineral deposition and corrosion may occur. Results obtained from the samples fell within the range. The turbidity values 2.0 – 2.5 reveal that the sampled borehole was within the standard for drinking water standard of 5 NTU. The pH values showed

neutral condition which were within the Guideline values of 6.5 – 8.50 for drinking water (FEPA, 1991; WHO, 2008). The pH values reflect the hydrogeology of the area. Total alkalinity measured was because of the bicarbonate content with values within the 30 – 500 mg/l$CaCO_3$ WHO limit. The carbonate alkalinity detected in the samples was very low.
Magnesium hardness and Calcium Hardness values of the groundwater samples was 3.6 mg/l CaCO3 and 4.0 mg/l $CaCO_3$. Hardness in water comprises the determination of calcium and magnesium as the main constituents. Although barium, strontium and iron can also contribute to hardness, their concentrations are normally so low in this context that they can be ignored. The widespread abundance of these metals in soil formations leads often to very considerable hardness levels in surface and groundwater. One of several arbitrary classifications of waters by hardness include: Soft up to 50 mg/l $CaCO_3$; Moderately Soft 51-100 mg/l $CaCO_3$; slightly hard 101 - 150 mg/l $CaCO_3$; Moderately Hard151-250 mg/l $CaCO_3$; Hard 251-350 mg/l $CaCO_3$; excessively hard over 350 mg/l$CaCO_3$ (EPA, 2001).

The values recorded for the groundwater from the study fall within the moderately soft classification. Although hardness may have significant aesthetic effects, a maximum acceptable level has not been established because public acceptance of hardness may vary considerably according to the local conditions. Water supplies with a hardness greater than 200 mg/l$CaCO_3$ are considered poor but have been tolerated by consumers; those in excess of 500 mg/l$CaCO_3$ are unacceptable for most domestic purposes (WHO, 2008). It has been suggested that a hardness level of 80 to 100 mg/l (as $CaCO_3$) provides an acceptable balance between corrosion and incrustation. (WHO, 2008). Table 4.14 is the drinking water quality standard.

Table 4. 14: Drinking Water Quality Standards

Parameter	FEPAa	WHOb	EUc	USEPAd
pH	6.50 – 8.50	6.50 – 8.50	6.50 – 9.50	6.50 – 8.50
E. C. (µS/cm)	1000	-	2500	1000
TSS (mg/l)	<10.0	-	-	-
TDS (mg/l)	500	-	500	500
Turbi. (NTU)	5.0	5.0	-	-
Alkal. (Mg CaCO3/l)	-	30 – 500	-	-
T. Hard. (Mg CaCO3/l)	200	80 – 100		
Cl- (mg/l)	250	250	250	250
SO_4^{2-} (mg/l)	500	250	250	250
$NO3^-$ (mg/l)	50 (10 as N)	50.0	50.0	50.00
PO_4^{3-} (mg/l)	<5.0	-	-	-
S^{2-} (mg/l)	0.05	-	-	-
THB (cfu/ml)	-	-	100 at 22oC	-
Coliform (MPN/100ml)	-	Nil	Nil	-

Parameter	FEPAa	WHOb	EUc	USEPAd
E. coli (MPN/100ml)	-	Nil	Nil	-
Heavy Metals				
Cd	0.01	0.003	0.005	0.005
Cr	0.05	0.05	0.05	0.1
Cu	0.1	2.0	-	1.0
Fe	1.0	0.3	0.2	0.3
Hg	0.001	0.001	0.001	0.002
Mn	0.05	0.05	0.05	0.05
Ni	0.05	0.02	0.02	
Pb	0.05	0.01	0.01	0.015
V	0.01	-	-	-
Zn	5.0	3.00	-	5

a FEPA,1991;b WHO, 2002; c EU, 1998; d USEPA, 2002
(Source, World Health Organization, 2008)

Calcium and magnesium ions measured in the groundwater were 2.63 – 2.90 mg/l and 1.24 – 1.52 mg/l respectively, with calcium contributing more to the hardness. There is no evidence of adverse health effects specifically attributable to calcium and magnesium in drinking water. Hence, guideline values for calcium and magnesium have therefore not been specified (WHO, 2008). Undesirable effects due to the presence of calcium in drinking water may result from its contribution to hardness. However, mention has been made of the possible contribution of drinking-water to total daily intake of calcium and magnesium and that drinking-water could provide important health benefits, including reducing cardiovascular disease mortality (magnesium) and reducing osteoporosis (calcium), at least for many people whose dietary intake is deficient in either of those nutrients (WHO, 2008).

Low chloride, sulphate, and phosphate levels were recorded in groundwater samples compared to the WHO limits. Low anions concentrations also confirm the freshness of groundwater from the project site. Sulphide and Nitrate ion was not detected in the groundwater sample.

Oil and grease (O&G) was not detected from the sampled water. Total hydrocarbon was not detected in the ground water samples of the project influence area. The source could, however, be attributed to biogenic rather than anthropogenic contribution since petroleum hydrocarbon related activities was not in existence in the area as at the period of this ESIA study.

Heavy metals determined in the groundwater samples showed varied concentrations with Cd Not detected in the BH water sample. The concentration range of other metals are in the order of Fe> Zn> Mn> Cu. Copper and zinc recorded concentrations lower than their maximum allowable limits in drinking water, while Cr, Fe, Mn, Ni and Pb were all not detected in the BH water sampled. (Table 4.15) (DPR, 2002). The occurrence and concentrations of these metals in the samples reflect the general characteristic of groundwater systems in most parts of Nigeria, especially the Niger Delta region (Aiyesanmi et al., 2004), which are mostly influenced by the soil mineralogy.

Table 4. 15: Target and Intervention values of some pollutants in groundwater

Parameter	Target Value (µg/l)	Intervention Value (µg/l)
Cd	0.40	6.0
Cr	1.0	30.0
Cu	15	75
Hg	0.05	0.30
Pb	15	75
Ni	15	75
Zn	65	800
Mineral oil	50	600

(Source: DPR, 2002)

4.3.6.2. Groundwater Microbiological Characteristics

The microbial characteristic of groundwater samples from the project area is presented in Table 4.16. The total coliform and enterococci value were 2.5 cfu/100ml and 0.43×10^{2} cfu/100ml Fungi are, however, not recorded in the sample, showing no growth.

Table 4. 16 Microbial characteristics of groundwater in the project Site

Locations	Total coliforms Cfu/100ml	Faecal coliforms Cfu/100ml	Faecal streptococci Cfu/100ml	Enterococci Cfu/100ml
GW 1	2.5×10^{3}	ND	ND	0.5×10^{2}
GW 2	2.5×10^{2}	ND	ND	0.43×10^{2}

(Source: Sustainabiliti Field Study 2022.)

4.3.7 Vegetation

Vegetation as a resource provides some basic needs of life such as food, fuel wood conservation of land soil fertility and so on. Therefore, it plays a vital role in human development. It is believed that vegetation resources form the basis on which life of all organisms depends. Therefore, all living organisms solely depend on vegetation resources directly or indirectly due to which man cannot survive without vegetation resources. Plants as major suppliers of operate need for food, fuel, timber, shade etc, need proper protection and management for sustainable environment in addition to human development.

Dutsin-ma is located in the Sudan savanna zone of the central part of Katsina state, relatively bounded by Safana and Dan-Musa local governments to the west, Kurfi and Charanchi local governments to the north, Kankia to the east, Matazu and Dan-Musa local governments in the south. In absolute terms, basement complex area of Katsina State (Oguntoyimbo, 1983). The climate of the area is semi-arid classified as tropical wet and dry climate (AW), as classified by W. Koppens. Maximum day temperature reaches about 38o C in the month of March, April and May and minimum temperature is about 22^{o} C in December and January. (Udoh 1970)

Mohammed (1997) found out that, there were more than one hundred and twenty-one (221) useful plants in the semi-arid Northeastern Nigeria. The most common plant species found in the area among others include Acacia Spp., Euphorbia Spp., Hibiscus Spp., Ficus spp., Combretum spp., and Ziziphus Spp. The plants have various uses to the villagers. Several parts of the trees such as backs, branches, pods, roots, wood, gum, seeds, leaves etc, were used for different uses, like medicinal, cultural, fodder, human food, timber, agricultural, fuelwood, shade, soil protection and improvement etc. in Table 4.17. The following sections are based on results of field surveys at the project site.

Uses of plant vary among communities, regions and at world levels. This depends on technological, scientific and social advancement of the communities or nations. The inventoried trees were categorized into two groups, the first being general trees inventory and second categorization deals with the identification of various uses of the parts of the trees.

Table 4.17 present the available indigenous trees in the study area, and has given the botanical and local names (Hausa and Fulani) equivalents of the seventy-five (75) indigenous trees found in the area. The research found out that majority of the trees was *Acacia spp, Ziziphus spp, Cassia spp, Ficus spp and Combretum spp*, which occur in considerable quantity. The study identified five (5) major land uses in the area, where more than 23% of the inventoried trees are on farmlands. This ensures their protection and good management by individual owners. Most the identified trees were of high economic value like *Adansonia digitata, Butyrospermum pradoxum, Diospyros mespiliformis, etc* which are privately owned,though grazing lands, cattle tracks and fallow lands presented a meaningful percentage of plants specie composition, their protection is not ensured as in the case of farmlands. Therefore, this lack of good care and protection on these land uses had made them to suffer degradation that led to the disappearance of some tree and shrub species as mentioned above.

The following table presents a number of tree species and their percentages according to the land use found.

Table 4. 17: Percentage of Trees According to Land use in the Study Area.

Land use	**Number of Tree Species found**	**Percentage**
Farmland	75	81

Land use	Number of Tree Species found	Percentage
Fallow land	67	72
Grazing land	74	79
Settlement	46	49
Cattle track	68	73

(Source: Sustainabiliti Field Study 2022)

Generally, table 4.17 indicated that there is an overlap of trees among land uses this further clarify that almost every tree could be found on any land use. The majority of the trees is found on farmlands signify their importance and protection strategies. The table 4.17 indicated that farmlands carry the highest composition of tree species (81%). Large parts of the trees studied are on farmlands and privately-owned lands. Most of the trees provide humanfood or animal fodder. The parts used include leaves, fruits, pods or seeds.

Grazing land carries about 79% of the total trees and shrubs species in the study area, most of which are trees with few shrubs. Large numbers of trees such as *Acacia seyel*, *Acacia senegal*, *Anona senegalensis*, *Ziziphus mauritiana* are of great importance for animal grazing.

Cattle tracks and fallow lands carry 73% and 72% respectively. Thus, the use of cattle track and fallow lands cannot be over emphasized in the study area. Most trees and shrubs found in these places are used for animal grazing. However, some of these trees and shrubs are also on other land uses such as farmlands and grazing lands.

The trees in the study area have ample uses to the people of the area, as the research found seven different uses of the trees and shrubs in the study area. Some trees and shrubs have multiple uses ranging from medicinal, cultural, agricultural, human food, animal feed, construction and fuelwood uses. Various parts such as leaves, roots, backs, gum, flower, fruits, pods, seeds etc., of the trees are of so many uses. The table 4.18 gives us the general summary of multipurpose uses of the inventoried plants in the study.

Table 4. 18: Percentage of Trees according to Management Practices (uses) in the Study Area

Management practices	Total number of trees used	Percentage of the total number of trees
Medicinal	75	100
Cultural	41	44
Agricultural	21	23
Human food	39	42
Animal feed	59	63
Construction	40	43
Fuelwood	75	100

(Source: Sustainabiliti Field Study 2022)

Table 4.17 clearly presents the inventoried trees with their various uses and the parts used Fuel wood and medicinal uses were the key important uses of trees in the area shown from the summary table. Analysis of the data collected indicated that all the trees found in the area are useful medicinally and fuel wood wise, which indicated that, the two were equally important. Depending on trees for fuel wood could be attributed to the reasons that, majority of the people in the area is rural dwellers. They do not recognize alternatives to fuel wood such as kerosene, electric stoves and coal.

Medicinally, as seen above, the trees in the area play a very important role intraditional medicine practice. Inventoried trees like *Acacia seyel,Acacia senegal, Acacia nilotica, Acacia albida, Albizia chevalieri, Bosewellia dalzielli, Lannea barteri, Cassia saberiana, Commiphora africana Combretum glutinosum, Combretum molle, Euphorbia kamarunica, Ficus syscomorus, Ficus glumosa, Guiera senegalensis, Maerua angolensis, Parkia biglobosa, Prosopis africana, Securidaca longepedunculata, etc*, are significant in traditional medicine practice in the area. Fuelwood and traditional medicine demand led to serious destruction of forest resources which consequently resulted in the disappearance of some tree species such as *Euphorbia balsamifera, Pterocarpus ernaceus and Ecurinegavirosa* due to medicinal importance attached to them.

Moreover, 63% of the inventoried trees are used as animal fodder, more importantly during dry season when there is a shortage of grasses for livestock to graze. Trees like *Acacia albida, Aacia Senegal, Acacia seyel, Acacia nilotica, Azadirachta indica, Anogeissus leocarpus, Annona senegalensis, Lannea barteri, Parkia biglobosa, ziziphus mauritiana, Ziziphus spina-christi, Prosopis africana etc, their leaves, flowers, pods and seeds are important feed for livestock, because, they contain considerable amount of nutrients (Von maydell, 1990).*

A few trees were important for use as human food, cultural and construction uses. These carry 42%, 44% and 43% of the total inventoried trees and shrubs respectively. Trees like *Anogeissus leocarpus, Borassus aethiopum (big), Isoberlinia doka, Hyphaene thabaica (big), Prosopis africana,etc* are important providers of timber traditional medicine in the area. This is because of their resistance to termites and strength to carry heavy loads. There are certain trees in the area such as *Parkia biglobosa, Ziziphus mauritiana, Ziziphus spinachristi, Butyrospermum paradoxum, Diospyros mespiliformis, etc.,* that are important for use as human food either their leaves, seeds or fruits are as wild food to the people of the area.

The least importance or use of trees was agricultural which carry only 23% of the total inventoried trees and shrubs. Farmland fencing and improvement of soil fertility werethe only major uses identified. Trees like *Acacia seyel, Acacia Senegal, Acacia nilotica, Balanites aegyptiaca, Ziziphus mauritiana, Ziziphus mucronata, ziziphus spina-christi*, are mostly fencing, while *Acacia albida* is for soil fertility improvement.

In the study area private access to tree resources is largely enhanced due to the economic (food, fodder, fuel wood) and social (shade, fencing) benefits. The table above indicates no tree on private access in either cattle tracks or grazing lands. This is because, all trees found on these land uses are generally on open/free or common access as such most economic trees were not found. In-depth investigation revealed that most economic trees that had existed on such land use (cattle tracks and grazing lands) were misused leading to destruction and consequently disappearance from the area (Sustainabiliti field study 2022). Table 4.18 clearly categorized each tree on access and land use.

4.3.8 Wildlife

National Overview

Nigeria has a wide variety of plant and animal species. These include about 7,895 plant species, 20,000 insects, 1000 birds, 1000 fishes, 247 mammals, and 123 reptiles. An estimated 0.36% of these are threatened or endangered.

The following sections are based on observations at the project site, supported by published records for the local area where available.

Mammals

The most common carnivores include the medium and small-sized mammals such as Hare (*Lepus capensis*), these predators are important in maintaining the balance in the ecosystem.

The common herbivores include Red Eye Monkey (*Presbitis rubicund*), Cows (*Bos primigenius*), and Goats. Rodents include Squirrel (*Alpine marmot)*, Bush Rat (*Rattus fuscipes*), grass cutter, squirrels and mice while primates were mainly monkeys. Historic record cited the presence of Hyenas, Lions, Warthogs, and Bush bucks. All the species are common and widespread and are not listed as endangered in the IUCN Redlist of endangered species.

Reptiles

The observed reptiles include lizards and snakes. The predominant species are *Varanus Albigularis* (Monitor lizard), *Agama agama* (Common lizard), *Bitis arietans* (puff Adder), (Philothamus irregularis (Bush snake), *Atractasis reticulata* (Viper) Python snake (*Python mulurus*), Cobra snakes (*Boulengerina annulata*), and Viper snake (*Crotalus basiliscus*) – seen occasionally.

Insects

The observed species include spiders (*Hysterocrates laticeps*), ants (*Camponotus pennsylvanius*), sand flies (*Diptera psychodidae*), Grasshopper (*Caelifera*), Wasps (*Polistes galicus*), Bees (*Anthophila*), Dragon Fly (*Anisoptera*), Green Mantis (*Sphodromatis virdis*), Termite (*Termitodae*), Ants (*Formicidae*), and long nose weevil (*Rhinotia hemistictus*).

Amphibians

The observed species include flat backed toads (Amietophrynus macalutus), subdesert toads (*Amietophrynus xeros*), grassland frogs (*Ptychadena tellinii*), sand frogs (*Tomopterna crytotis*), newts (*Pleurodelinae*), crab (*Liocarcinucinus vernalis*), cane toad (*Rhinella marina)*, and parsley frogs (*Pelodytes punctatus*).

Birds

Birds recorded are listed in Appendix 2. They include birds of prey such as vultures, black kites, eagles, buzzards, and owls red eyed doves (*Stretopelia semitorquata*), guinea fowl (*Numida meliagaris*), cattle egret (*Bubulcus igris*) which are migratory, brown quail (*Coturnix ypsilophora*), village weavers (*Ploceus cucullatus*), canary (*Serinus canari domestica*), curckoo (*Guira guira*), crow (*Coryus*), African hooded vulture (*Necrosyrtes monachus*), stork (*Cicconidae*) – an occasional visitor. Other species include rollers, doves, plovers, shirkes, bee-eaters, and finches. These species are classified as least concerned and are not threatened by the proposed project directly.

4.4 Baseline Socioeconomic Characteristics of the Project Area

Baseline socio-economic characteristics and the results of the survey carried out at the Federal University, Dutsin-ma, Katsina State, are presented in this sub-section.

The socio-economic characteristics of an area provide vital statistics on existing livelihood activities that could be explored for various purposes including employment and social intervention during the construction and operation stages of projects. The socio-economic study also describes social and economic activities that may be potentially affected by any developmental activities such as the proposed Solar Project under phase III of the energizing education program (EEP) project by the government of Nigeria in collaboration with the donor agency.

The baseline socioeconomic information will serve as a yardstick to measure the project's impact on the University community throughout the project's life cycle.

Explicitly, some of the themes discussed include population characteristics, socio-cultural organization, development activities, university structure, existing facility with the campus, employment, income distribution, and stakeholder views on the project.

Data Collection Methodology

This study employed both primary and secondary data sources. The latter comprised government records, maps, information published in journals, websites, and books as well as approved EIA Reports while the former included pre-coded questionnaires, key informants, focus groups, direct observation, direct measurement, and specially prepared data collection formats and participatory research. Although the questionnaires largely contained closed-ended questions for easy recording of responses, some open-ended ones were included to allow respondents freedom in structuring their responses. This permitted the researchers to obtain clearer insights into questionnaire items.

Data collected on various socio-economic parameters from the project location were also analyzed using different appropriate tools.

Approach to Data Collection

An In-Depth Interview (IDI) was held with key senior staff of the University (Plate 4.1). In addition, an informal discussion was also held with some sampled respondents to further gather more data about the views of the stakeholders in respect of the proposed development. The verbal discussion was to augment the survey instrument (designed questionnaire). Furthermore, mixtures of data gathering approaches were further engaged to acquire more information on the human activities of the project/host community. These data gathering mixture approaches include:

- A review of secondary data including published articles and online materials including from the Federal University, Dutsin-Ma, web page;
- A reconnaissance survey to identify all human activities that are located close to the project site or that maybe affected directly or indirectly by the proposed intervention;
- Key informant interview (KII) with senior staff of the University; and
- Field observations (including photographs) were carried out for the graphical presentation of features for appraisal.

The questionnaires were administered systematically to ensure that the required number of questionnaires were returned by the respondents. The sample size was informed based on the prevailing situation at the time of the study. The entire public universities in Nigeria were on industrial strike when the study was carried out, hence, the number of people on the study campus was limited. Consequently, a total number of 55 households/individuals were randomly sampled, out of the 50 questionnaires distributed only 47 were retrieved in-situ which constitute 94% of the total number distributed. The survey material which was sectionalized under different sub-headings is attached as an appendix to this report.

Plate 4. 1: Consultation/Engagement with Key Staff
(Source: Field Survey for the proposed EEP 3, July 2022.)

Data Processing and Analysis

The retrieved questionnaires were processed using the statistical package for social sciences (SPSS) version 20. Similarly, figures/values generated from the SPSS was further plotted in MS Excel- version 2016. Generally, the results of the analysis were presented in figures/values, tables, and graphs.

Background of the Study Area *Federal University of Dutsin-Ma (FUMDA)*

The Federal University Dutsin-Ma is located in Dutsin-Ma Local government Area of Katsina State, which is located in the North-Western region of Nigeria, bordering Niger Republic, Kaduna, Kano, and Jigawa State which recently established university situated in Dutsin-Ma Katsina, in Katsina State (Plate 4.2). The University was among the nine new federal universities established in the six geo-political zones of Nigeria in 2010 by the Goodluck Jonathan administration.

Plate 4. 2: Federal University of Dutsin-Ma
(Source: Field Survey for the proposed EEP 3, July 2022.)

Federal University, Dutsin-Ma is a non-profit public higher education institution located in the urban setting of the small city of Dutsin-Ma (population range of 50,000-249,999 inhabitants), Katsina. Officially recognized by the National Universities Commission of Nigeria, Federal University, Dutsin-Ma (FUDMA) is a coeducational Nigerian higher education institution. Federal University, Dutsin-Ma (FUDMA) offers courses and programs leading to officially recognized higher education degrees in several areas of study. FUDMA also provides several academic and non-academic facilities and services to students including a library, as well as administrative services.

Presently, FUDMA has six faculties and over twenty-six departments. This includes the following as shown in table 4.19.

Table 4. 19: Federal University of Dutsin-Ma Faculties and Departments

S/No.	Faculty	Department
1.	Agriculture	Agriculture Animal and Environmental Biology Forestry
2.	Arts	English Language Arabic Studies Islamic Studies History Hausa
3.	Science	Biochemistry Chemistry Biology Food Science Industrial Chemistry Microbiology

S/No.	Faculty	Department
		Physics Physics Electronics Plant Science and Biotechnology Computer Information and Technology Fisheries and Aquaculture
4.	Social Sciences	Economics Accountancy/ Accounting Business Management Political Science Sociology Geography Library and Information Science
5.	Education	Education and Biology Education and Chemistry Education and English Language Education and Mathematics Education Administration Guidance and Counselling Human Kinetics and Health Education Special Education Early Childhood Education Teacher Education Science
6.	Medical Science	Nursing Science Radiography Human Anatomy

(Source: FUDMA)

New departments were created by the university and accredited by the National Universities Commission, NUC. The new departments include human anatomy, radiography, nursing science, chemical engineering, civil engineering, electric engineering, early childhood education, and fisheries and aquaculture among others.

University Community Administrative Structure

The administrative leadership structure of the FUDAM is shown in Figure 4.10. Administratively, the University is headed by a Vice-Chancellor (VC). The Vice-Chancellor is practically the head of the school day to day administration. The VC is joined by other principal officers in administering the school activities as shown in Figure 4.10; the other principal officers are the Deputy Vice-Chancellor, the registrar, the bursar, and the University Librarian.

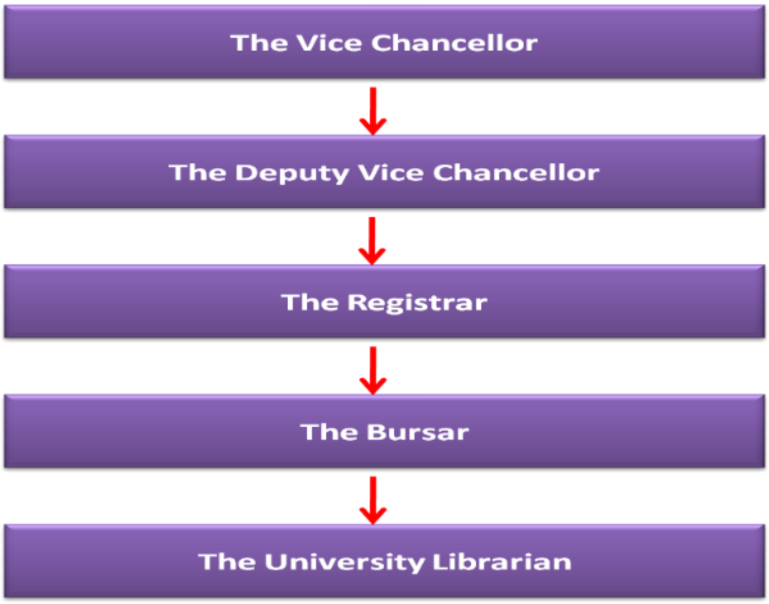

Figure 4. 10: Administrative Structure of FUDMA
(Source: Field Survey for the proposed EEP 3, July 2022)

Governing Council

The governing council is the highest decision-making body of the University. The council is headed by a Chairman/ Pro-Chancellor appointed by the Federal government of Nigeria through the ministry of Education. Other members of the council include the Vice Chancellor,

Deputy Vice-Chancellor, representatives from the University Senate, external members, and a representative from the federal ministry of educationare a member of the governing council respectively. Critical decisions about the FUDMA including the choice of the location of the proposed Solar project, and appointment/recruitment of principal officers among others are taken at the governing council level. However, membership in the council is tenure based.

Land Tenure and Ownership

Land means many things and how it is acquired, owned, used, and transferred is referred to as land tenure. Nigeria's Land Use Act defines people's right to land in the interest of socioeconomic development. As stipulated in the Land Use Act of 1978 of the Federal Republic of Nigeria, all land within the administrative boundary of a state is vested in the hand of the executive governor. In practice, land can be owned by an individual, organization, and community. Land tenure is the legal regime in which land is possessed or occupied. In other words, the principal methods of land acquisition in Nigeria are inheritance, purchase, lease, pledge, exchange, and gift.

Land rights can only be exercised when they must have been acquired in one way or another. During the survey/data gathering exercise, it was noted that the land for the proposed project is located within the acquired space of the Federal University Dutsin-Ma, a Permanent site. In other words, the FUDMA land where the proposed project is located was provided by the Katsina State Government.

4.4.1 Population Characteristics of the Project Area

The FUDMA Permanent site is the host of the project. Hence, the human population of the study area was limited to the students and staff of the school since the school is located at distance away from the traditional communities of Dutsin-Ma. The population of the FUDMA community can be estimated at over 12,000 for both staff and students based on the website information. This population, therefore, needs electricity to work effectively. The proposed development will go a long way in improving the running of the school's academic activities effectively.

Sampled Population/FUDMA Socioeconomic Characteristics

The basic socioeconomic indices of the sampled population which largely represent the economic situation at the study School are presented in this section. The importance of this appraisal is to examine the economic and human dimension of the host institution, particularly as regards source of power among other variables. The details discussed include gender, age distribution, marital status, ethnic group, religion, literacy level, occupation, household size, residential status with the duration of stay in the project area, income level, health status, etc. These vital socioeconomic traits could be used by the handler of the proposed facility in engaging with the University community during the construction and operation stages of the proposed project. The information could also further be used by the beneficiary school authority for critical decisions making. Meanwhile, it was noted that respondents answered the survey largely based on their accommodation which is outside the university's territorial boundary. In other words, at the moment, there is no accommodation for staff of the FUDMA within the campus but there are students hostels within the campus, due to the ASUU strike, the respondents were scanty, and more of the staff and a few visiting students, however, we were able to meet a reasonable number which questionnaires were distributed to.

Respondents Socio-Economic Characteristics

Gender Distribution

Male respondents account for about 78% while the female gender represents 22% of the total sampled population as illustrated in figure 4.11.

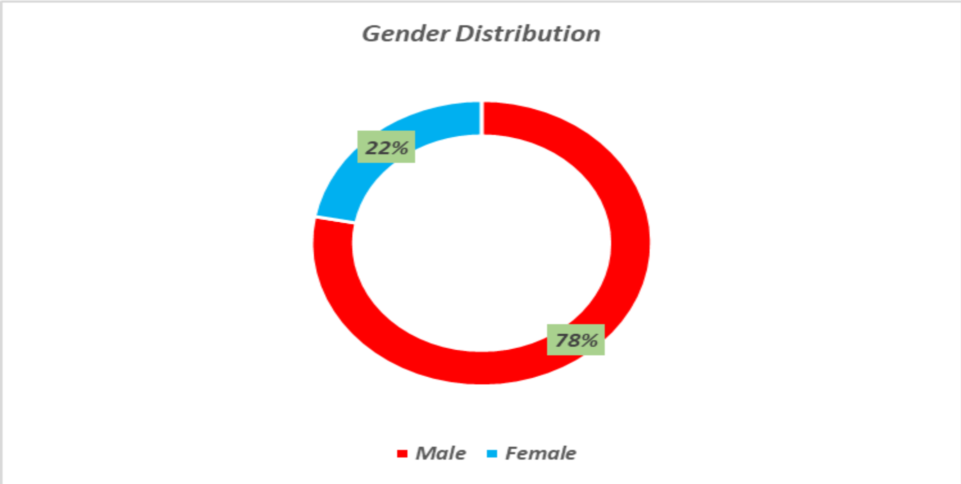

Figure 4. 11: % Respondent Gender Distribution in the Project Location
(Source: Field Survey for the proposed EEP 3, July 2022)

Age Distribution

As indicated in figure 4.12, there is the possibility of a higher youth population (active age group) in the project area as the respondents in the age group of 18 to 45 years (53%) account for the highest proportion in the sampled population. This is followed by the age group of 46 to 65 years (28%) while those that are above age 65 years account for 13%. The age group below 18 years accounts for only 6%. The age group distribution indicated by the respondents is expected in a university environment.

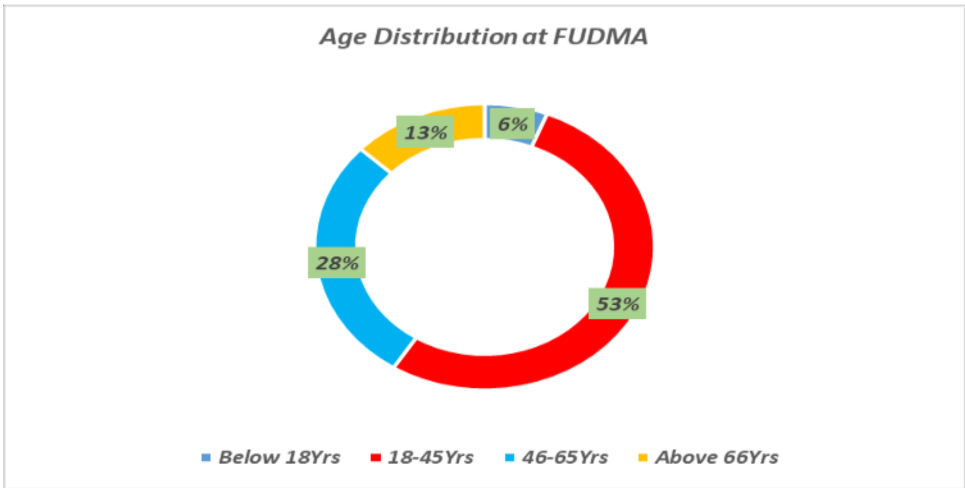

Figure 4. 12: % Respondent Age Distribution in the Project Location
(Source: Field Survey for the proposed EEP 3, July 2022)

Marital Status

As reflected in figure 4.13, Married respondents account for 56% while single account for 26% followed by divorced which accounted for 13%. The widowed only accounted for 5% of the respondents. It could therefore be envisaged that a great number of the people in the school, who are incidentally mainly staff of the FUDMA are married and have a sense of commitment. Married people are presumed to be more responsible in our society.

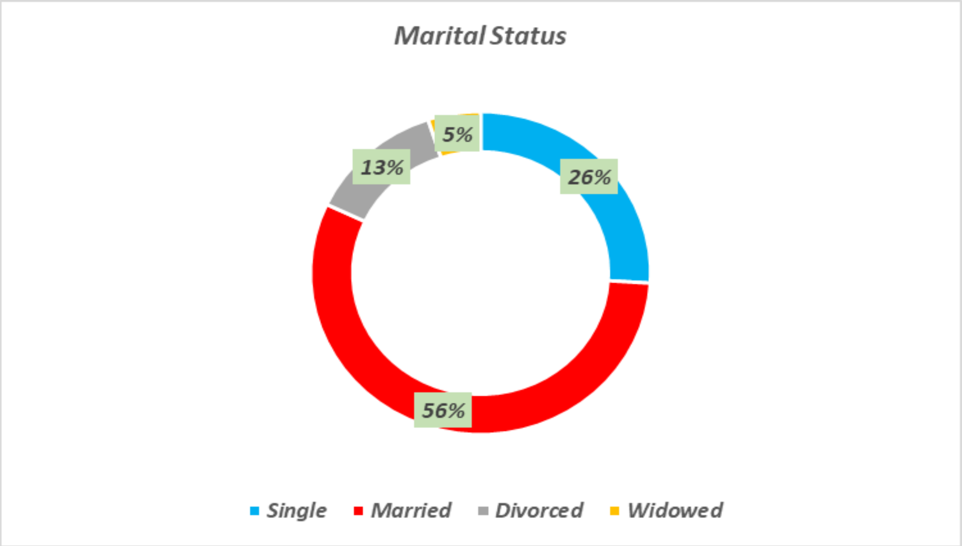

Figure 4. 13: % Respondent Marital Status in the Project location
(Source: Field Survey for the proposed EEP 3, July 2022)

Occupation

Civil servants (government workers) are the dominant livelihoods indicated by the sampled population (figure 4.14). This is not also unexpected due to the circumstance that surrounds the school and indeed all public Universities in Nigeria when the study was carried out. Consequently, occupations indicated by respondents are civil service (42%) followed by Salary employed and trading/business (13%) and (14%) respectively. The unemployed are the least among the respondent which accounted for 2% of the total respondents. Other businesses such as point of sale (POS) operators, Recharge card sellers are also found within the campus environment

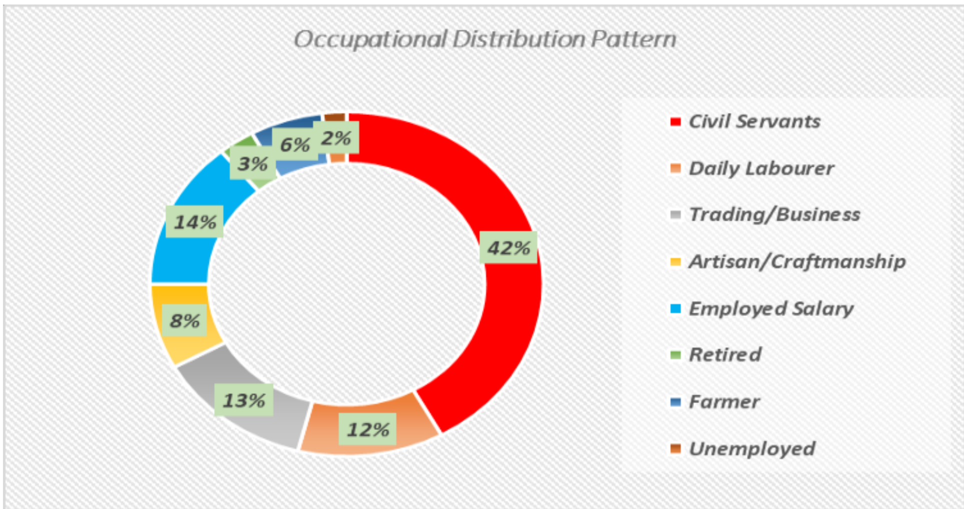

Figure 4. 14: **% Respondent Occupation distribution pattern within the Project location**
(Source: Field Survey for the proposed EEP 3, July 2022)

Residential Status

All of the sampled respondents indicated that the permanent residents are more in number, they accounted for 54% of the respondents and have lived there for 6-9 years, this is followed by the returnee residents due to work posting or retirement back to home and they have lived there for 3-5years. The least respondents are the non-residents who are in town occasionally for lectures or other academic-related activities and they have lived there for 0-2years. On the other hand, the relationship to a household head was 72% self, 23% spouse, and 5% Parent showing that more of the respondents were household heads while the dominant average household (HH) size indicated by the sampled respondents is 3 to 5 people showing (64%) of the respondents. Figure. 4.15 is an illustration of the Respondent Residential status within the Project location

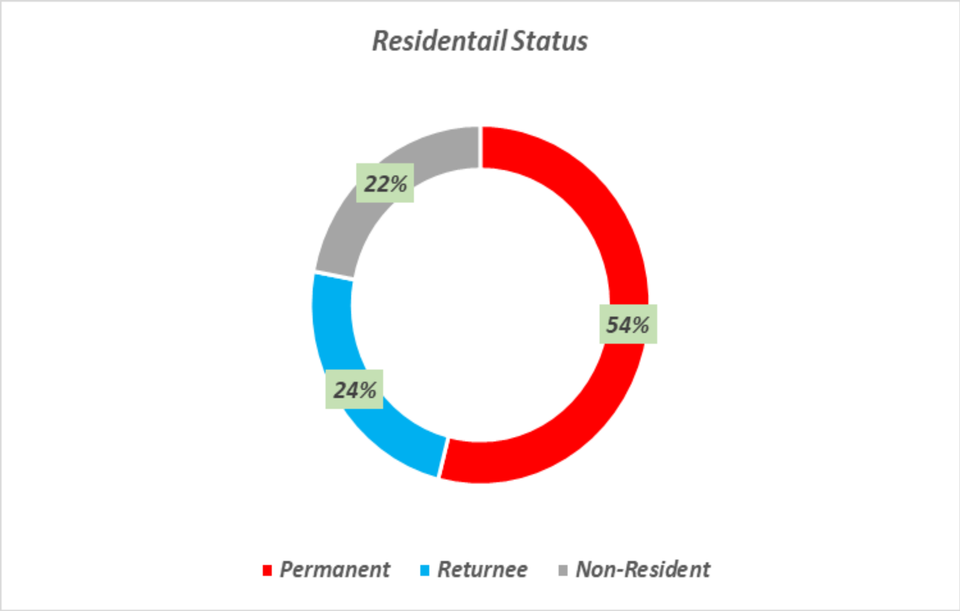

Figure 4. 15: % Respondent Residential status within the Project location
(Source: Field Survey for the proposed EEP 3, July 2022)

Ethnic Groups

Indicated ethnic groups by the respondents are Hausa-Fulani (38%), Egon 12%, Igala 8%, Yoruba (13%), and Igbo 14% while the other tribes generally constitute 15% of the respondents respectively (figure 4.16). The indicated ethnic groups by the respondents may not necessarily represent the real composition of the school staff. However, a federal establishment such as the FUDMA is expected to have multi-ethnic compositions.

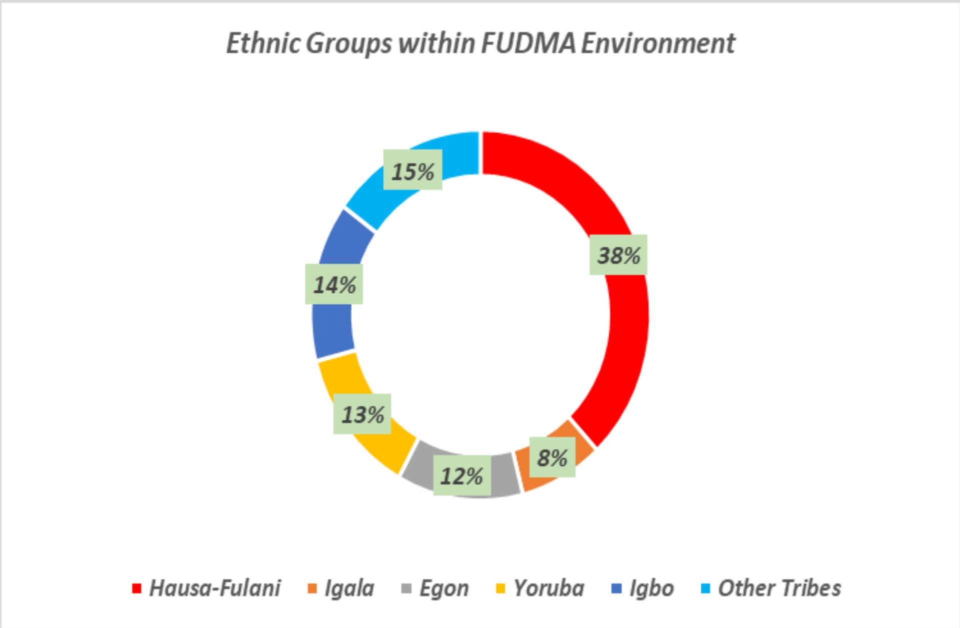

Figure 4. 16: % Respondent Ethnic groups within the Project location
(Source: Field Survey for the proposed EEP 3, July 2022)

Religion

As shown in figure 4.17, those that indicated Islam are the majority which constituted 68.7% of the Respondents, and twenty-eight of respondents practice Christianity, while the minority were the traditional religion constituting only 3.3% of the respondents as shown in the chart. It should there be noted that the study community does not discriminate against or denied anyone from practicing his/her religious belief.

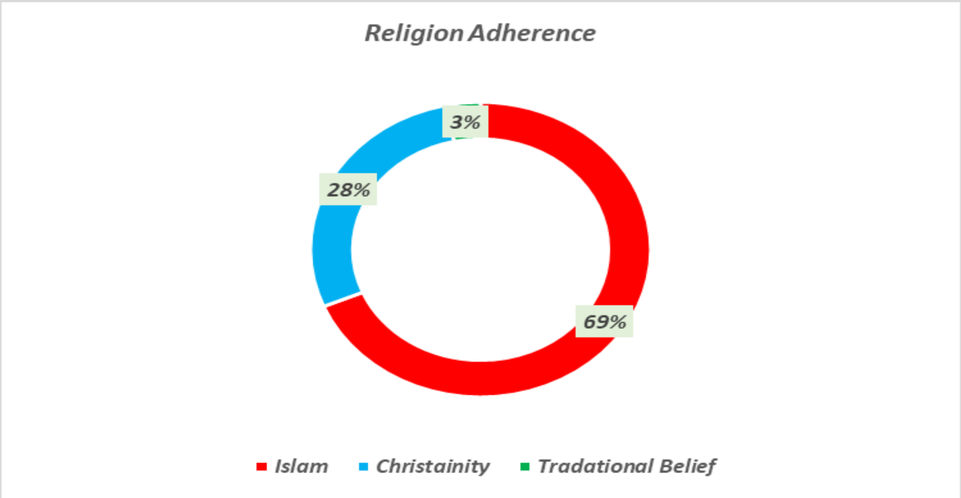

Figure 4. 17: **% Respondent Religion Groups within the Project location**
(Source: Field Survey for the proposed EEP 3, July 2022)

Education

Respondents' dominant education attainments are University graduate (42%) and University postgraduate (22%) as shown in figure 4.18. Others such as OND/NCE/HND account for 10%, Secondary School education is 14%, Primary School is 8% while no formal education accounted for 6% of the respondents. As expected of a university community, it could therefore be noted that there is a high level of literacy among people within the study area.

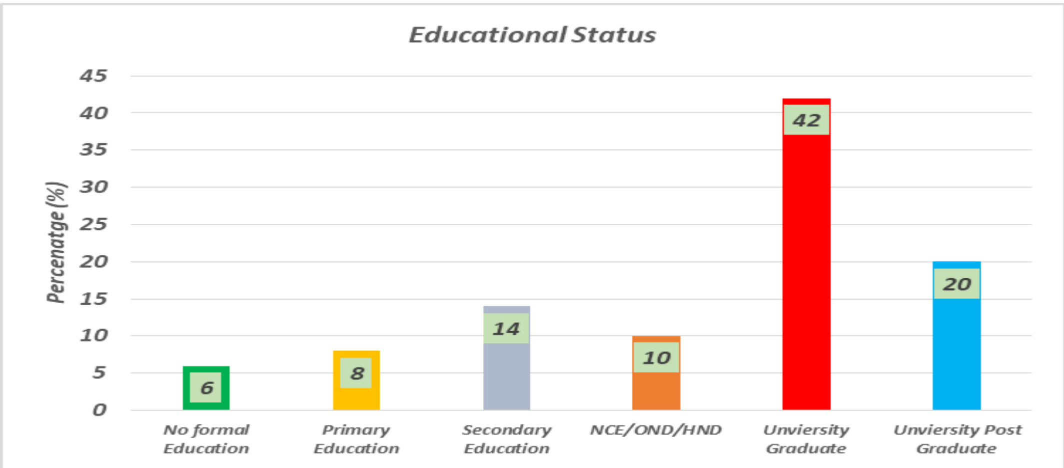

Figure 4. 18: **% Respondent Education Distribution within the Project location**
(Source: Field Survey for the proposed EEP 3, July 2022)

Income

The monthly income indicated by the respondents is: below ₦50,000 (28%), ₦50,000 to N100,000 (30%), while those earning Above N100, 000 accounted for 42% of the respondents (figure 4.19). It should be noted that some of the respondents, particularly the non-monthly salary earners are unable to estimate their monthly income as a result of improper financial record keeping. The respondents claimed that they do not actually keep records of their incomes but simply spend money as it comes.

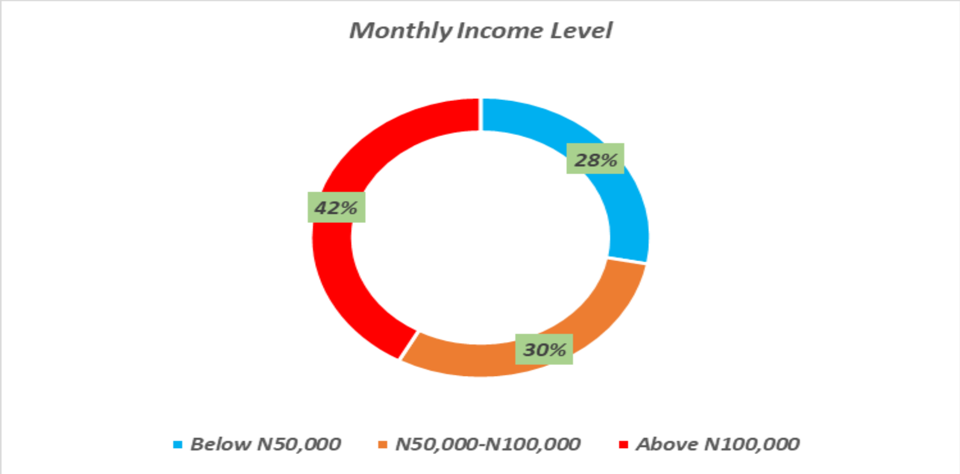

Figure 4. 19: **% Respondent Income Distribution within the Project location**
(Source: Field Survey for the proposed EEP 3, July 2022)

Housing Characteristics

Housing types and materials used in building construction are part of the indices of the quality of housing and standard of living within a particular community. The site location is Lafia which is the state capital and an urban location. The nature of building types and roof characteristics occupied by the respondents are described in figure 4.20 and plate 4.3. As indicated, all (100%) of the respondents live in cemented block houses. The roofing materials are a mixture of corrugated iron sheets (38%), aluminum (50%), and asbestos roofs (12%). presented in Figure 4.20 floor of the houses is majorly tiled (52%) while a few used rugs (24%) and the rest was Cemented floor. Respondents' household number of rooms includes 1-2 rooms (53%), 3-4 rooms (40%), and above 4 rooms only (7%). The common toilet facility among the respondents is the water closet (80%). Others are toilets outside dwelling buildings and they account for 20% of the respondents. Structure types within the project location are storey buildings, office complex structures, bungalows, shops, etc. Other structures are temporary like kiosks for (POS), makeshift for local restaurants and umbrella stands for recharge card sellers.

Figure 4. 20: Housing Attributes in the Surveyed Project Community
(Source: Field Survey for the proposed EEP 3, July 2022)

Plate 4. 3: Federal University of Dutsin-Ma Housing type
(Source: Field Survey for the proposed EEP 3, July 2022)

Respondents' Land and House Tenures

The tenure of the housing and land is presented in Figure 4.21. As shown in the figure, 48% of respondents indicated they live in rented apartments while 28% indicated they live in personal/owned apartments; in addition, 16% of the respondent indicated they live in leased tenure while only 4% indicated free house/accommodation. Similarly, the land tenure followed the same pattern as that of the housing tenure.

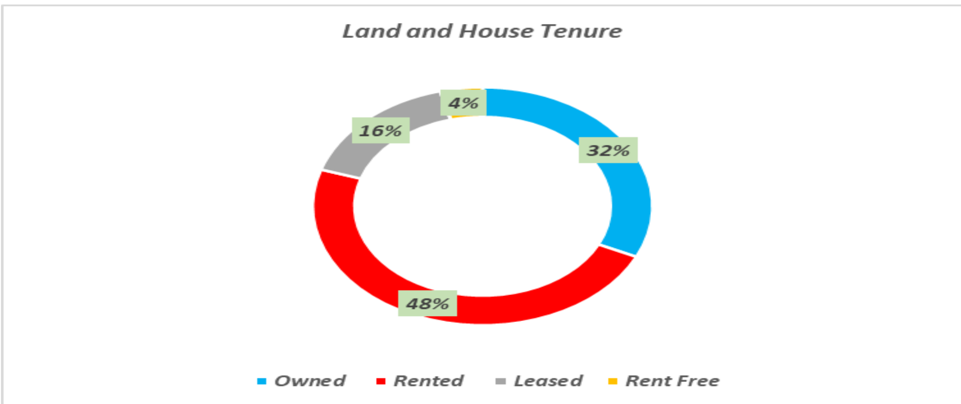

Figure 4. 21: **% Respondent's Land and Housing Tenure Characteristics**
(Source: Field Survey for the proposed EEP 3, July 2022)

Household Solid Waste Management

As shown in Figure 4.22, the household solid waste management methods adopted by the respondents in the study community include Waste Collectors 50%, waste burning 15%, 20% of the respondents dump their waste at nearby bush or farmland, and their backyards, while those make use of unapproved refuse dump site is 25%. In Katsina State, solid waste is managed by an agency of the state government known as Katsina State Environmental Protection Agency (KATSEPA) nonetheless, the waste collection service of the agency is often limited to the urban areas and is usually irregular. The project location is in the urban area of the state and also the state capital, results from the respondents show that most of the waste is evacuated by waste collectors.

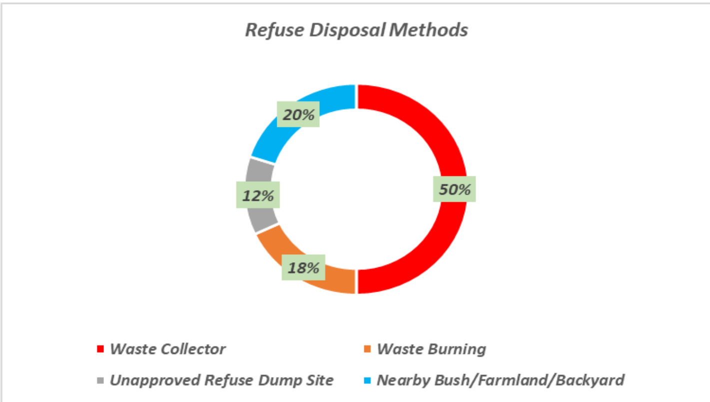

Figure 4. 22: % Respondent's Waste Disposal Method
(Source: Field Survey for the proposed EEP 3, July 2022)

Plate 4. 4: Project Location Environment
(Source: Field Survey for the proposed EEP 3, July 2022)

Sources of Energy

Sources of energy are not the same everywhere and it varies from one household to another. As indicated, the primary source of energy for lighting by the respondents is electricity supply from the national grid (68%), while those that depend on power generating sets as the primary source of energy account for 24%. Other sources of energy indicated are solar power and batteries which constitute only 8% of the respondents. Meanwhile, mixed energy use is common among many people in Nigeria due to the unstable power supply from the National Grid. Katsina State is connected to the Kano Electricity Distribution Company (KEDCO).

On the energy for cooking, the main sources indicated are cooking gas (68%), firewood (22%), charcoal (7%), and Kerosene (3%). It was observed that cooking with firewood is common among food vendors while charcoal is mostly used by those selling roasted food**.** Cooking gas remains one of the sources of clean energy used around the world.

Plate 4. 5: Source of Energy within the Project Environment
(Source: Field Survey for the proposed EEP 3, July 2022)

Sources of Water

Indicated sources of water for household use in the study area is majorly Borehole which dominated about 82% of the respondents (plate 4.6), however other sources indicated by the respondents are Well 14% and Rain harvesting 4%. Generally, households within the community depend on underground water for various uses due to the absence of Government pipe borne water specifically at the project location.

Plate 4. 6: Source of Water Supply within the Project Environment
(Source: Field Survey for the proposed EEP 3, July 2022)

Living Standard

Most of the respondents claimed that their standard of living has been the same over the previous three years. About 22% affirmed that it has been better while 26% indicated that it has gotten worse over the same period. Of those that claimed that the situation has got worse, they gave the reason that it was caused by the state of the country's economy occasioned by the effect of COVID-19 while some respondents stated otherwise. However, the majority of the respondents were excited about the proposed solar project and believed that the proposed solar power project will improve their situation through employment opportunities and constant power supply within the project community. The school would therefore welcome any further social intervention programme from any quarters including from the proponent and other donors.

Local Economy

As a university community, it is expected that there would be other means of livelihood outside civil servants. Observed economic activities within the school ranged from commercial tricycle operators, Motor Cycle riders, local food vendors, information and computer technology (ICT) services (such as computer/internet services and photocopy machine operator), POS vendors, Recharge card sellers, and petty trading. The economic activities of the campus are dominated by retail and it is scanty perhaps due to the industrial action (ASUU Strike) at the time of the study.

Health Status and Health Management Method

Prevailing Sickness

The baseline health condition of the people in the study area was assessed through a survey. The dominant health challenge/sickness indicated was malaria (70%) while typhoid and whopping cough account for 12% and 8% respectively. Other ailments such as stomach ache, cholera, pile, eye pains, and stomach ulcer jointly account for 10% of the total sampled population. Meanwhile, 94% indicated that activities of the proposed Solar power project within the school are not a threat and will not worsen their health conditions. It can therefore be noted that the prevailing ailment/sickness mostly affecting the residents of the community is Malaria. Generally, Malaria is a common disease in Nigeria and Africa.

Health Management

According to the respondents, most of these illnesses they suffer from are treated mostly by visiting a hospital/clinic, buying drugs from the local pharmaceutical stores, and traditional methods. Of those that visit the hospital for health treatment, 64% indicated that they have visited within the last six months followed by those that have visited a health facility in the last year (18%.). About 10% of the sampled population visited within the last five years while 8% had visited more than five years ago. It was observed that there is a health center/facility within the campus.

Generally, aside from the common health challenge of Malaria and typhoid which are African diseases, and the recent COVID-19 pandemic. The case fatality stood at 2.8%. As of 15th August 2022, 262,402 cases have been confirmed, 256,006 cases have been discharged and 3,147 deaths have been recorded in 36 states and the Federal Capital Territory of Nigeria.

The State has had its fair share of the pandemic, and cases recorded at the time of this study are given as 2,418 cases have been confirmed, 2,381 cases have been discharged and 37 deaths as of 15th August 2022. It was noted that there is no other health challenge that is peculiar to the study community. In addition, the sample population does not envisage any health challenges from sitting the project within the campus.

Globally, a permanent cure for the Coronavirus pandemic (COVID 19) has not been known or made available, however, it is admitted that the spread of the virus could be substantially reduced. In light of this, suggested measures by health authorities including the World Health Organization (WHO) and the Nigeria federal and Nasarawa State ministries of health are observed by the people in the project community.

Project Location Environmental Challenge/ Concern

Generally, from the respondents, there was no major environmental concern within the project location because the school has not been old at the permanent site and most of the facilities like roads and landscapes are still wearing a new look. However, some respondents emphasized on lack of adequate drainages within the project location which will help in flood control and erosion of roads. Some environmental concerns pointed out by the respondents are:

- Lack of Drainages
- Flooding
- Inadequate vegetation

Security

In terms of the security of lives and properties, it was noted that measures have been put in place within the campus to prevent insecurity. Security measures put in place are the establishment of outpost stations for the Nigeria Police Force (NPF) and Nigeria Security and Civil Defense Corps (NSCDC). Furthermore, internal(private) security is also engaged to mount some strategic locations including the University's main entrance gate. It was also noted that solar street lights are strategically mounted along the major roads for proper lighting at night while close circuit televisions (CCTVs) are located in some areas for surveillance. There is also a perimeter fence within the project community to safeguard against intruders. A proper stop and check are being conducted by the internal security at the main entrance gate.

Summary of the socioeconomic study and stakeholder consultation

- A socioeconomic study for the proposed Solar Project under phase III of the energizing education program (EEP) project by the government of Nigeria in collaboration with the donor agency has been carried out;
- The socioeconomic study was carried out through random questionnaires administration, in-depth interview (IDI), literature review, and community survey;
- The proposed Solar Power project for the Federal University of Dutsina-Ma (FUDMA) will be sited within the permanent site which is located along Katsina-Kankara Road, Dutsin-Ma Katsina, in Dutsin-Ma LGA of Katsina State.
- Administratively, the school is headed by the Vice-Chancellor and other principal officers;
- The planned project would be located on land that is presently not in use for any activities, consequently, no displacement of livelihoods, cultural properties, and human habitation is envisaged;
- The economy of the school is retailed and it includes commercial tricycle operators; shops, restaurants, POS, etc.
- The site location met the requirement indicated in the project technical;

- There is no major environmental challenge within the project location
- No youth restiveness is associated with the school;
- Various security measures are in place to ensure the safety of people and properties;
- Common health challenge of the people of the project area is Malaria and typhoid;
- The proposed development is expected to contribute positively to the academic learning of the University and reduce total dependency on the National Grid which is not sustainable and also the cost of powering the school through diesel-powered generators.

Plate 4. 7: Consultation with the key staff of FUDMA
(Source: Field Survey for the proposed EEP 3, July 2022)

CHAPTER FIVE: ASSOCIATED AND POTENTIAL IMPACTS

5.1 Introduction

The project has overall positive impacts by providing a competitive, cost-effective, pollution free reliable mode of solar power. It will certainly meet the ever-increasing demand of power and to bridge the gap between demand and supply of power. However, the proposed project may have some negative impact on the environment during site preparation, construction & operation phases. During the construction phase, the impacts may be regarded as temporary or short-term; while long-term impacts may be observed during the operation stage.

5.2 Impact Assessment Overview

The potential for an Environmental and Social impact exists where an environmental and social 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 assessment process was as follows:

- Identification of the various potential impacts using interaction matrix to show the relationship/ interaction between the project environmental components and planned project activities.
- A screening of potential impacts associated with each phase of the project is performed using a Risk Assessment Matrix; and
- A detailed evaluation of the individual impact producing factors that comprise each aspect of the project phases is then performed. The significances of the potential impacts are quantified using the same rationale as for the screening.

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.: preconstruction,

Construction, operation, and decommissioning.

5.3 Identification of Environmental and Socio-economic Aspects and Impacts

A number of project activities would be carried out in phases. These planned activities are what would impact on the environmental components positively or negatively. The PV-based power plant project activities are grouped into five phases as follows:

Pre-Construction phase: Involves activities such as award of contract, project design and planning, consultation, recruitment, site preparation and transportation of the utility scale PV-based power plant components to site.

Construction phase: It involves activities such as mobilization of workforce and equipment to site, digging, trenching, bulldozing, grading, soil compaction; and installation of temporary camp and power plant components. This phase is usually a short term one.

Commissioning phase: It involves the integrated application of a set of engineering techniques and procedures to check, inspect and test every operational component of the project, from individual functions, such as instruments and equipment, up to complex amalgamations such as modules, subsystems and systems.

Operational phase: This is usually 'long term', involving activities from post construction to pre-decommissioning. It commences once the power plant has been commissioned for use. Activities include use of natural resources (water for domestic uses and cleaning of solar modules), plant and equipment operations, routine maintenance of equipment and plant.

Decommissioning phase: It begins once the power plant use is discontinued or project life span has come to an end.

It should be noted that impacts can occur at any time; during these phases mentioned above i.e. pre-construction, construction and operational phases of the project. Some impacts may however occur in some or all phases of the project.

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.

The FMEnv EIA Procedural Guidelines and the African Development Bank Integrated Safeguard Systems Operational Safeguards, and ISO 14001 approach among other references were used in the identification process.

The assessment approach generally involved matching the various activities of the different stages of the proposed project (as described in chapter 3 of this report) with the components of the existing environment. Consequently, the possible changes (and extent of changes) in the environment as a result of the interactions have been identified/ evaluated, hence mitigation measures proffered in order to reduce, offset or ameliorate such changes. The potential/ associated adverse and beneficial impacts of the proposed power plant project on the existing environment were identified at this stage of the ESIA.

The Risk Assessment Matrix (RAM) has been employed in determining risks posed by the identified potential/associated impacts of the project in order to proffer appropriate mitigation measures. In predicting impacts, the experiential/practical 'worst case scenario' approach has been applied to determine the extreme effects of project activities on environmental components, while 'consensus of opinions' has been made use of to determine the importance of affected environmental components. The impact evaluation results make up the pedestal for developing the ESMP of the proposed project.

5.3.1 Potential Impact Characterization

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

a. **Negative**: An impact that is considered to represent an adverse change from the baseline or to introduce a new undesirable factor.
b. **Positive**: An impact that is considered to represent an improvement to the baseline or to introduce a new desirable factor.
c. **Direct**: Impacts that result from the direct interaction between a planned project activity and the receiving bio-physical and socio-cultural environment.
d. **Indirect**: Impacts that result from other activities that are encouraged to happen as a consequence of the project.
e. **Temporary**: Temporary impacts are predicted to be of short duration, reversible and intermittent/occasional in nature
f. **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

g. **Long-term**: Impacts that will continue for the life of the project, but cease when the project stops operating.
h. **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
i. **On-site**: Impact that is limited to the project site.
j. **Local**: Impacts that affect locally important environmental resources or are restricted to a single (local) administrative area or a single community.
k. **Regional**: Impacts that affect regionally important environmental resources or are experienced at a regional scale as determined by administrative boundaries.
l. **National**: Impacts that affect nationally important environmental resources; affect an area that is nationally protected; or have macroeconomic consequences
m. **Reversible**: An impact that the environment can return to its natural state
n. **Irreversible**: An impact that the environment cannot return to its original state, e.g. the extinction of an animal or plant species
o. **Cumulative**: 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
p. **Residual**: Both environmental and social impacts that will remain after the application of mitigation measures to project impacts during each of the project phases.

5.3.2 Screening and Scoping for Potential Impacts

The first step in identifying impacts associated with the project is the development of an interaction matrix which shows the relationship/ interaction between the project environmental and social components and planned project activities.

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.
- Detailed information on the environmental and socio-economic setting of the Project's area of influence.
- Consultation with relevant stakeholders.
- Review of other ESIA reports on similar projects/environments.

Table 5. 1: Project Activities – Leopold's Environmental and Social 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 Aquifer	Landscape/ Topography	Terrestrial Flora	Terrestrial Fauna	Land Use	Population	Utilities	Infrastructure	Employment/ Income	Gender issues	Construction workers	Workplace health and safety	General Public
Pre-construction Phase																
Site selection								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
Installation of power plant facilities, power storage batteries, upgrade of existing distribution infrastructure, installation of streetlights	X	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

(Source: Sustainabiliti Limited, 2022)

Table 5. 2: EEP III Solar Power Plant Impacts Categorisation

Project Activities	Associated and Potential Impacts	Direct	Indirect	Adverse	Beneficial	Reversible	Irreversible	Cumulative	Long term	Short term
Pre-construction Phase										
• Permitting • Stakeholders' engagement • Land Use • Recruitment • Mobilization to site	Employment opportunities arising from recruitment of workers									
	Business opportunities for local contractors through sub-contracting activities									
	Skill acquisition and enhancements to locals and future workforce									
	Improvement in quality of life for adequately compensated individuals									
	Conflicts over employment issues (quotas and methods)									
	Issues/ dispute on memorandum of understanding with project proponent									
	Influx of people (migrant workers, sub-contractors and suppliers) and increased pressure on existing social infrastructure									
	Increase in social vices (like theft, prostitution) resulting from increased number of people in the area									

Project Activities	Associated and Potential Impacts	Direct	Indirect	Adverse	Beneficial	Reversible	Irreversible	Cumulative	Long term	Short term
• Land preparation and clearing	Agitations over land disputes, wrong stakeholder identification, leadership tussles, etc									
	Loss of vegetation covers and forest products (fuel wood, timber, medicinal plants) due to site clearing and preparation activities									
	Increased risks of accidents leading to injury/ death and loss of asset during mobilization									
	Risks of armed robbery attack and hostage taking leading to injury/ death of personnel									
	Nuisance (noise and vibrations) from movement of heavy-duty equipment and vehicles affecting site workers and wildlife									
	Dust particles and vehicular emissions from increased movement									
	Generation of wastes such as scrap metal, wood, sand, concrete, paper, domestic waste etc									
Commissioning and Operational Phases										
• Testing and commissioning • Power generation • PV-Based Solar Power plant maintenance and servicing	Generation of electricity supply									
	Increased opportunities and quality of life (small, medium, large scale) due to enhanced power delivery									
	Improvement in air quality due to reduced emission from privately owned diesel or petrol generators									
	Reduced demand on petrol and diesel used for power generation									
	Injuries/ fatalities of personnel due to incidents/ accidents from operating the power plant									
	Soil/ groundwater contamination from accidental petrol /engine oil spill during refueling of vehicle									
	Workplace accidents/ incidents (cuts, trip, falls etc) leading to injury/ death of personnel during operations									
	Acquisition of skills by individuals to be employed to operate the plant									
	Depletion of groundwater resources for washing solar modules									
Decommission Phase										
• Mobilization of personnel and equipment • Power plant decommissioning • Abandonment / restoration	Loss of employment, business opportunities and decreased economic activity									
	Reduced power generation to the University and low power supply									
	Risks of injuries from possible collision with abandoned structures									
	Risk of accident and injury to workers during demolition of structures									
	Increased dust and vehicular emissions from decommissioning activities									
	Traffic obstruction on major roads from movement of vehicles during decommissioned process									
	Availability of land for alternative uses									
	Loss of site aesthetic qualities due to abandoned and dilapidated structures									

Key -

	Activity interacts with ecological or social component
	Activity does not interact with ecological or social component

(Source: Sustainabiliti Limited, 2022)

5.4 Determination of Impact Significance

The significance of impacts that could occur due to the implementation of the project's activities were established based on three steps which are:

- Impact Magnitude which combines the extent, duration, scale and frequency of an impact
- Value/ Sensitivity/ Fragility and importance of the relevant Receptor;
- Identification of the impact significance, which is the cumulative indicator of both of the above two key variables.

The magnitude of an effect requires quantifying the sources of potential environmental and socio-economic effects from routine and non-routine project activities such as the extent of land take or predicted change in noise levels. On the other hand, the receptor sensitivity is derived from factors such as:

- Legislative controls;
- Designated status within the land use planning system;
- Number of affected individual receptors;
- Ability of the resource or receptor to absorb change; and
- Public perception about the criticality or sensitivity of the receptors.

The determination of impact significance also entails considering compliance with environmental policies, quality standards and set pollution limits.

5.4.1 Method for Determining Impact Magnitude

Potential negative impacts were assigned Negligible, Low, Medium, and High labels based on their magnitude while for positive impacts, it sufficed to indicate that the project is expected to result in a particular positive impact without assigning a magnitude to it.

5.4.1.1 Defining Magnitude Levels for Biophysical Impacts

A **High Magnitude Impact** is considered to affect an entire area, physical system or species at sufficient magnitude to cause a significant measurable numerical increase in measured concentrations or levels (when compared with national or international limits and standards 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** occurs at sufficient magnitude to cause a measurable numerical increase in measured concentrations or levels 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 over a short time period, but does not affect other trophic levels or the population itself, and localized area.

A Negligible Magnitude Impact results in changes to the environment that may be immeasurable, undetectable or within the range of normal natural variation.

5.4.1.2 Defining Magnitude Levels for Socio-economic Impacts

For socio-economic impacts, the magnitude is based on the perspective of those who would be affected by the impact; this considers the likely perceived importance of the impact, the ability of people to manage and adapt to change caused by the impact 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 event magnitude rankings are shown in Table 5.3.

Table 5. 3: Event Magnitude Rankings

Importance	Attributes
High	• Highly undesirable outcome (e.g., impairment of endangered, protected habitat, species) • Detrimental, extended flora and fauna behavioural change (breeding, spawning, moulting) • Major reduction or disruption in value, function or service of impacted resource • Impact during environmentally sensitive period • Continuous non-compliance with international best practices • Negative change in livelihood status, household income/assets or living conditions affecting a high proportion of people resulting in economic loss and protests against the project. • Reputational damage and/or drop in business revenue that threatens the future viability of the economic activity. • Increased risk to public health leading to a fatality or injury. • Damage to public infrastructure (such as a sewer, water pipeline, etc.) leading to environmental or socio-economic impacts to other users.
Medium	• Negative outcome • Measurable reduction or disruption in value, function or service of impacted resource • Potential for non-compliance with international best practices • Negative change in livelihood status, household assets/income or living conditions. • Temporary disruption to businesses resulting in a small drop in business revenue. • Increased risk to public health that can be controlled using detailed mitigation measures. • Disruption to public infrastructure (such as a road closure) that results in an inconvenience to other users.
Low	• Imperceptible outcome • Insignificant alteration in value, function or service of impacted resource • Within compliance, no controls required • Minor disruption to livelihoods or living conditions resulting in a localized, reversible and temporary nuisance.

	• Temporary disruption to businesses that does not result in a loss of revenue or any reputational damage. • No change in the health status of local communities. • Temporary disruption to public infrastructure (such as a road closure) that results in minor inconveniences to affected communities.

(Source: Sustainabiliti Limited, 2022)

5.4.2 Determining Receptor Sensitivity

Receptor sensitivity refers to the socio-economic and environmental importance of the receptor, including human dependence on the receptor for food and income. It basically considers the type of receptor (namely, biological/ecological, human and physical receptor) and impacts that directly affect people. Vital natural resources are considered more important than indirect impacts.

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 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 is categorized as Low, Medium and High and the criteria for ranking the receptor sensitivity are defined in Table 5.4.

Table 5. 4: Receptor Sensitivity Ranking

Sensitivity	Criteria
Low	Receptor sensitivity is considered low when there is a moderate to high capacity and means to adapt to a given change and maintain / improve quality of life. Receptors of low sensitivity may include: • Individuals who are able to quickly adapt to temporary disruption in their living conditions, livelihood status or a change in the status of public infrastructure (such as a road closure). • Businesses with a robust economic model that are able to adapt easily to any restrictions placed upon their activities, or who are able to gain economically from such changes.
Medium	Receptor sensitivity is considered medium when there is limited capacity and means to adapt to a given change and maintain / improve quality of life. Receptors of medium sensitivity may include: • Individuals who rely heavily on their livelihood to maintain their socio-economic status and have a limited ability to adapt to change. • Businesses that have a limited ability to adapt to change and are sensitive to any reduction in economic revenue or reputation.

High	Receptor sensitivity is considered high in the case of vulnerable receptors, who have little capacity and means to adapt to a given change and maintain / improve quality of life (e.g. homeless people, Internally Displaced Persons community in temporary accommodation, people with low access to recourse (e.g. no land titles), people with no or low representation (e.g. migrants, seasonal herders with no permanent assets in the area). Receptors of high sensitivity may include: • Individuals with a marginal livelihood, low socio-economic income or poor-quality living conditions. • Individuals who are vulnerable due to their age, disability or other reason and who may require special assistance during engagement activities associated with the 3D seismic survey. • Businesses with a marginal economic existence which are not able to easily adapt to change.

(Source: Sustainabiliti Limited, 2022)

5.4.3 Significance

For both Environmental and Socio-Economic Impacts, impact significance, as a function of impact magnitude and receptor sensitivity, is ranked as Negligible, Minor, Moderate or Major as presented in Table 5.5.

Table 5. 5: Impact Significance

		Receptor Sensitivity		
		Low	**Medium**	**High**
Impact Magnitude	**High**	Minor	Moderate	Major
	Medium	Minor	Moderate	Major
	Low	Negligible	Minor	Moderate
	Negligible	Negligible	Negligible	Minor

(Source: International Association for Impact Assessment)

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 range from a threshold below which the impact is minor, up to a level that might be just short of breaching a permissible limit. Thus, impacts of **Negligible**, **Minor** or **Moderate** significance are considered as being mitigated as far as practicable and necessary, and therefore, do not require further mitigation.

An impact of major significance is one where an acceptable limit or standards may be exceeded, or high magnitude impact occurs to highly valued/sensitive receptors/resources and for such negative impacts, additional mitigation is required.

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 organized, which employed extensive use of screening matrices and predefined criteria for impact magnitude and receptor sensitivity. The significance was then developed as seen in Table 5.6.

Table 5. 6: 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 Aquifer	Landscape/ Topography	Terrestrial Flora	Terrestrial Fauna	Land Use	Population	Utilities	Infrastructure	Employment/ Income	Gender issues	Construction workers	Workplace health & Safety	General Public
Pre-construction Phase																
Site selection								2(2)								
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)					3(2)			++	2(2)	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(2)	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)

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

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

Receptor sensitivity ranking: 1 = Low; 2 = Medium; 3 = High.

(Source: Sustainabiliti Limited, 2022)

5.5 Impacts Discussion

5.5.1 Potential Positive Impacts

Improvement in power supply

The proposed Project seeks to provide independent and reliable power supply to Federal University, Dustin-Ma, Katsina through a solar energy source and thus, improve the quality of educational and other services within the institution as there will be longer hours available with better illumination for studying.

Reduction in Carbon Emission

Solar energy is one of the most promising alternatives to fossil fuels, especially as an attractive climate change mitigation option. Clear-cut advantages of solar energy such as utilizing the sun as a renewable source of electrons and heat, and the reduction of air and water pollution by fossil fuels, can be complemented by additional environmental co-benefit opportunities.

Ultimately, the activities of the project will contribute to the achievement of Nigeria's carbon emission reduction targets (20% reduction by the year 2030) in fulfilment of the nation's Nationally Determined Contributions (NDC) to climate change. To enhance this impact, the following measures shall be implemented:

- In cases where the power generated is insufficient to meet the power demands of the University in the next 10 to 20 years (due to expansion), the capacity of the power plant power shall be further upgraded to meet demand or power will 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.
- The project shall explore opportunities for carbon credits trading in the voluntary carbon market.

Reduction in Noise and Air Pollution

Within the project area, there will be reduced noise and pollutants from generator sets, and natural habitats and human health will be protected from pollution arising from the use of fossil fuels.

Improved Learning

The renewable energy training centre constructed during the project implementation will provide capacity development through learning of renewable energy technologies and practices in the University and consequently, the certification of trained individuals.

Increased Visibility and Safety

The installation of streetlights as part of the proposed Project will improve safety by reducing hazards associated with flammable fuels and candles and enhance security within the University.

Increased Socio-Economic Benefits

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 400 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 the necessary groups on specific jobs and skills required for the project, prior to the commencement of construction. Subsequently, the Institution 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 EEP GBV action plan 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 workforce are up-skilled and can be employed on the Project.
- During the operational phase of the Project, job opportunities will also be created. About 15 people 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.

5.5.2 Potential Negative Impacts

The potential adverse impacts from project activities are grouped into the following subjects and discussed further according to the different applicable phases – Preconstruction, Construction, Operation and Decommissioning phase:

- Land use
- Impacts from equipment, personnel and plant material movement;
- Impact on traffic;
- Impact on air;
- Impacts from noise and vibration;
- Impacts on terrestrial flora and fauna;
- Impact on water resources
- Impacts on waste generation;
- Impact on soil quality;
- Visual/ aesthetic impact;
- Social economic impacts;
- Health impacts; and
- Impacts from workplace hazards.

5.5.2.1 Preconstruction/ Mobilization Phase

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

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

Site selection

Approximately 10.0 ha of land within the Dustin-Ma University property has been earmarked and allocated by the University management for the proposed 1.9 MW solar-hybrid power plant and the training center. No additional land either from private or public property outside the University campus will be expropriated for the Project.

The Project site is characterized by wild vegetation which includes grasses, shrubs, and a few trees. There are no physical structures on the site. Thus, 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 (10.0 ha) will be cleared for the Project. However, the sensitivity /importance of the receptor is regarded as low since the Project site is a modified habitat, and none of the plant species identified within the Project site during the baseline survey was found to be endangered or threatened based on the International Union for Conservation of Nature (IUCN)-2018 classification scheme. Also, the local community has no direct or indirect ecosystem services that they benefit from the site. Furthermore, there are no protected/conservation areas within the site. The significance of the potential impact of site clearing on the existing terrestrial flora species of the Project site is therefore regarded as **minor**.

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

With regard to the clearing of the Project site prior construction phase, the potential impact on terrestrial fauna species may include loss of individual or localized population of fauna species or disturbance to avifauna species. This is unlikely to lead to a change in conservation status of the species since none of the fauna species (including avi-fauna) encountered or reported in the project site belongs to the IUCN classification of threatened animal species which include those classified as critically endangered, endangered or vulnerable. The sensitivity of the fauna species recorded on the Project site is thus regarded as **low**. The impact magnitude is considered to be **low** given that the site clearing activities would cover approximately 10.0 ha of land allocated for the Project. The potential impact is direct, irreversible, short term and localized. The impact significance is thus considered **minor**.

Potential Impact on Soil

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

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

Potential Impact on Air Quality and Ambient Noise

The pollutants which could impair air quality during site clearing activities are particulate matter in form of dust, and NOx, CO, Total Suspended Particulates (TSP), SOx from combustion engines of the earth moving equipment that will be used for clearing. Intermittent noise emissions could also occur from the operation of the machinery. The impact magnitude is considered to be low since the activities will be short-termed, intermittent, localized and reversible. The site clearing activities will take less than 1 week. The sensitivity of the air shed of the Project area is also regarded as low based on the results of air quality measurements conducted in the area during the field data gathering. The impact significance of site clearing on the ambient air environment of the Project site is considered to be **minor**.

Potential Impact on Workers Safety

Site clearing and preparation are potentially hazardous activities. Accidents may occur especially when those involved are unskilled. Such accidents may result in loss of man-hours which may ultimately affect the schedule date of completion of the Project development especially if the man-hour losses are high. The site clearing activities will take about 1 week and the number of workers required would be less than 10. The impact significance is considered to be **minor**.

Mobilization of equipment, materials and personnel to site

In executing the proposed project, a great deal of haulage/ movement would be undertaken all through the phases of the project. Movements would include: transportation of equipment and personnel for construction and operational phases; and movement of plant components to project site for construction and installation. Anticipated impacts during the mobilization of equipment and personnel to site will include:

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 safety along the project route, 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 within 1 week. The sensitivity of the receptors is adjudged as medium given that the existing vehicular movement in the University environment is high. The prominent means of transportation are cars, motorcycles/tricycles, and buses/trucks. 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**.

Table 5.7 summarizes the potential impacts associated with the pre-construction phase of the proposed Project.

Table 5. 7: Summary of Potential Negative Impacts Associated with the Pre- Construction Phase of the proposed Project

Activity	Receptor	Associated Impact	Significance
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, NOx, CO, SOx) • 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

(Source: Sustainabiliti Limited, 2022)

5.5.2.2 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 generation and disposal.

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

<u>Equipment, Personnel and Plant Material Movement</u>

As part of the construction phase, personnel and materials would be transported to site on need basis. Transportation could be from workers or visitors to the site. Vehicles to be deployed for construction purposes would include saloon, SUVs and heavy-duty vehicles (such as trucks, excavators, etc).

Movement of vehicles during this phase is important and cannot be avoided as such would impact significantly on the environment as well as on people living within the area in the following ways:

- Vehicular emission of pollutant gases (such as CO, SO_2 and NO_2) from vehicle exhaust;
- Contribution to global gas warming and ozone layer depletion from pollutant gases emitted from vehicles;
- Increased traffic movement of heavy-duty truck en-route project site;
- Potential accident to personnel and asset from vehicle movement during construction; and
- Dust emission arising from construction activities at the project site.

The impact from equipment, personnel and plant material movement on surrounding receptors is therefore considered to be of moderate significance prior to mitigation and steps will be taken to minimize the effects.

Civil and Electrical Works, and Installation of Plant Facilities

Potential Impact on Air Quality

At installation and construction phases of the project, the potential sources of emissions would include dust, particulate matter (PM), emissions from heavy trucks and earthmoving equipment that will be operated on the project site. Exhaust emissions during material transportation, stockpiling and equipment transfer during construction activities. It is proposed that the construction phase of the Project would take up to 12 months. These emissions will be localized to the construction site area and will be short-term, the extent of impact would therefore be **medium** and its significance is rated **minor**

Potential Impact on Noise Levels

The primary short-term noise and vibration impacts are associated with construction and decommissioning activities. During construction activities, work equipment will result in increased noise level and vibration in the area, although noise would not cause a major disturbance to its surroundings. 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. Noise may cause a major disturbance to fauna species such as birds and mammals in the area. These would move further into the forest to avoid the disturbance.

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. The potential impact magnitude is regarded as low due to the envisaged low extent of its effect. The overall impact significance is considered minor.

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. The impact magnitude is considered to be **medium** considering the number of PV panels to be installed and the distance for burial of the proposed underground cable from the Power Plant to the switchyard. The sensitivity of the soil environment in the Project area is regarded **medium** as the soil in the area is prone to erosion especially during the rainy season. Therefore, the impact significance is considered to be **moderate**.

Potential Impact on Terrestrial Flora and Fauna

The project would require the removal of clearing of vegetation to accommodate the power plant and ancillary structures. Increase in human activity, noise level, creation of areas of bare soil would create a resulting effect which would be the altering of the composition and diversity of flora species in the site as well as migration of fauna species that make use of the plants for food and shelter further away into the forest. 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**. Based on desktop reviews and field observation, the project area is not known as a migratory route for avifauna species. The impact significance is regarded as **minor**.

Potential Impact on Groundwater

The construction activities for the Project could lead to potential impacts on Groundwater of the Project area. These include increased sediment load in the drainage channels as a result of erosion; increased stormwater runoff from a decrease in infiltration; increased runoff from hard standing areas which could result in creation of drainage lines. 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 storage tanks.

There could also be decrease in amount of groundwater as a result of groundwater abstraction for project activities. It is planned that at least one borehole will be dug onsite to serve as source of water supply for the project activities. Currently, though there are boreholes within the University, there is no borehole on the project site. Also, the quality of the existing groundwater resources in the study area is considered to be good. 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 very minimal. There are several boreholes within the University campus as noted during the site visit. During the rainy season, the underground water aquifer increases; thus, boreholes yield improves significantly.

Potential impact on Gender

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 thereby reinforcing gender stereotypes and gender pay gaps. In attempts to reduce the gender knowledge gaps, select female students will undergo end-to-end on-the-job training and capacity building participating in the full construction activity.

Furthermore, there is the possibility that the proposed Project may increase the risk of GBV, as a result of shifting existing power dynamics and financial relationships. This is considered a minor risk as many women in the community are engaged in economic activities.

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 University community and the nearby community.

With regard to the presence of construction workers on site, the manner in which the workers conduct themselves can affect the University environment and local community in terms of disruption of existing 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 for the construction phase of the Project may be relatively high, the potential risk to social structures is regarded as high. However, given that the majority of the construction workers, especially unskilled labour force would be drawn from the local community, the impact significance is considered to be **moderate**.

Potential Impact on Infrastructure (Road)

It is envisaged that movement of personnel and equipment along the road leading to the University would increase once the project commences. The road is slightly busy during the day and as such may lead to intermittent traffic build up which may not last long with proper coordination. Construction activities may result in a significant increase in movement of vehicles for the transport of construction materials and equipment increasing the risk of traffic-related accidents.

The impact magnitude is considered as **low** due to the minimal number of Project vehicles and trucks to be used during the construction phase. Therefore, the impact significance is considered **minor**.

Potential Impact on Construction Workers Safety

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

Waste Generation and Disposal

Wastes from the project are grouped into solid wastes, liquid (wastewater) and air emissions. Solid wastes would include; wood, metals, food remains, glass, and refuse etc. Liquid wastes include sewage, while gaseous air pollutants (NO_x, SO_x and CO) would be from exhausts of vehicles. It should be noted however that during their normal operation PV systems emit no gaseous or liquid pollutants, and no radioactive substances.

Potential Impact on Soil

The proposed construction activities will lead to the generation of wastes. Improper handling of these wastes or their discharge into the surrounding environment without proper treatment would increase the level of micro-organisms (bacteria, viruses and fungi) that could be pathogenic to staff working in the area. The potential construction wastes to be generated include scrap metals, electrical cables, spent oils, wood/planks, paper waste, leftover sand and gravel, etc. The impact magnitude of the wastes on the soil is considered to be **low**. Thus, 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 spent oils. The impact magnitude is considered low. 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 waste can potentially have impact on the existing waste management facility of the University. Domestic wastes in FUDMA are collected in the University and disposed through the Waste management system of the State. Construction wastes such as scrap electrical components, batteries, damaged/defective panels and electrical cables (e-waste) cannot be disposed of in such manner. These wastes shall be returned to the manufacturers based on a take-back scheme or recycled as appropriate. The quantity of domestic wastes designated for the dumping site will thus be **low**. The impact of the waste on the waste management facility of the project area is considered **negligible**.

Table 5.8 summarizes the potential negative impacts associated with the construction phase of the proposed Project.

Table 5. 8: Summary of Potential Negative Impacts Associated with the Construction Phase of the proposed Project

Activity	Receptor	Associated Impact	Significance
Impacts from Equipment, Personnel and Plant Material Movement	Air Quality	• Vehicular emission of pollutant gases (such as CO, SO_2 and NO_2) from vehicle exhaust; • Contribution to global gas warming and ozone layer depletion from pollutant gases emitted from vehicles; • Dust emission arising from construction activities at the project site.	Minor
	Social system (road)	• Increased traffic movement of heavy-duty truck en-route project site.	Minor
	Health & Safety	• Potential accident to personnel and asset from vehicle movement during construction.	Minor
Civil and Electrical Works/ Installation Activities	Air Quality	• Air quality impacts due to emission from construction equipment (SPM, NOx, CO, SOx) • Increase in dust from cleared land and windblown stockpiles	Minor
	Ambient Nosie	• Increase in noise level due to construction activities	Minor
	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	Moderate
	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	• Decrease in groundwater aquifer as a result of groundwater abstraction for construction activities e.g. concrete mixing, equipment washing, etc. • Increased sediment load in the stream beside the Project site as a result of erosion; increased stormwater runoff from a decrease in infiltration; • increased runoff from hard standing areas could result in creation of drainage lines	Minor
	Gender	• Discrimination of women during employment GBV	Moderate
	Socio-economic and health	• Influx of people, increase in sexual transmitted diseases.	Moderate
	Infrastructure (road)	• Road damage, traffic and safety impacts.	Minor
	Construction workers safety	• Injury to construction workers during construction activities.	Moderate
Waste Generation and Disposal	Soil	• Soil contamination from solid and liquid construction waste streams.	Minor
	Groundwater	• Groundwater contamination of liquid construction waste streams.	Minor
	Infrastructure (waste management facility)	• Disposal of construction wastes to existing waste management facility in the Project area.	Negligible

(Source: Sustainabiliti Limited, 2022)

5.5.2.3 Commissioning Phase

Once the construction phase of the Solar Power Plant is completed, the Plant will be tested to ensure that it has been installed according to the pre-design and operational requirements.

Potential Impact on Noise

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 impact significance is however rated **minor**.

Potential Impact on Safety

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.

However, the potential hazard of to the public during the commissioning activities could be electrical shocks from exposure to wrong electrical connections. This is considered to have a **minor** impact on the general public.

Potential Impact on infrastructure (road)

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 of the commissioning phase (1 day), the impacts are considered to be **negligible**.

Table 5.9 summarizes the potential negative impacts associated with the commissioning phase of the proposed Project.

Table 5. 9: 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
	Campus Occupant's safety	• Wrong electrical connection leading to electrocution	Minor
	Population influx	• Increase in population during commissioning	Negligible
	Infrastructure (road)	• Road traffic and risk of accidents	Negligible

(Source: Sustainabiliti Limited, 2022)

5.5.2.4 Operational Phase

<u>Power Generation and Distribution</u>

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 and batteries are not envisaged to result in a maximum increase in background levels of 3 dB(A) at the nearest receptor location offsite. 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 experience discrimination may be denied training and employment opportunities. Male and female staff will be trained on the management and maintenance of the facility.

Although the number of personnel working at the Project site would reduce, the likelihood of impacts predicted during the construction phase may exist. Therefore, the impact significance is regarded as **minor.**

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. Thus, the potential impact of EMF radiation from the proposed Solar 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 Plant will lead to the generation of wastes which can contaminate the soil within the Project site and AoI. 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 Program (EPRP). 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 more during the dry season than in the rainy season.

Based on previous experience, each MW of panels would require approximately 5 litres of water per cleaning cycle. The water required for the cleaning purpose would be obtained from the boreholes proposed to be dug at the project site. Based on observations noted during the field survey and the estimated quantity of water required for occasional cleaning of the PV panels, water abstraction for the Project is not envisaged to have serious effect on the existing groundwater aquifer of the Project area as well as the local water use. Thus, the impact significance is considered **minor**.

Potential Impact on Occupational Health, and Safety of Workers

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

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

Table 5. 10: Summary of Potential Negative Impacts Associated with Operational Phase of the proposed Project

Activity	Receptor	Associated Impact	Significance
Power Generation and distribution	Noise	• Noise from batteries and inverters during power generation and evacuation	Negligible
	Gender	• Discrimination of women during employment. • GBV (sexual harassment, assault and poor working condition)	Minor
	Socio-economic (Visual prominence)	• Landscape alterations resulting in unpleasant changes in the visual character of the area	Negligible
	Socio-economic (health issues)	• Community health and safety impact due to electromagnetic field (EMF) radiation from the Solar 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	Soil	• Soil contamination from spent batteries and inverters	Minor
	Groundwater	• Groundwater abstraction from cleaning of PV panels	Minor
Generation and Disposal	Soil & Ground water	• Groundwater and soil contamination	Negligible
	Health, safety and welfare of staff during maintenance	• Electric shock, injuries to personnel during maintenance	Minor

(Source: Sustainabiliti Limited, 2022)

5.5.2.5 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 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

Risk assessment refers to the determination of the quantitative or qualitative estimate of risk(s) associated with recognized threats/hazards posed by the project's activities. The assessment of the risks and hazards associated with the proposed project involves:

- Identification of hazards/risks
- Assessing their likelihood of occurrence
- Estimating the consequence/severity of the hazards

Table 5. 11: Risk Assessment Matrix

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

(Source: Adapted from Adelaide Hills council- Example Risk Assessment Template)

5.6.1 Project Specific Risks and Hazards

The potential risks and hazards associated with the proposed project are:

5.6.1.1 Fire and Explosion

The major risk associated with the operation of the plant is fire and explosion because PV systems are subject to electrical faults like other electrical installations such as short circuits, ground faults and reverse currents. Failures within the plant system could cause hotspots that can ignite nearby combustible materials. Faulty installations or failure with DC/AC inverters can also cause photovoltaic fires. Overcharging, high temperatures and physical stress to Lithium-ion battery cells can cause thermal escape, 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. Thus, this hazard is classified as high risk.

5.6.1.2 Electrocution

Electrocution from direct contact with high-voltage electricity or tools, vehicles, ladders, and other devices that are in contact with high-voltage electricity could occur during the plant operation. This hazard is hardly likely to occur and it is of minimally severe consequence and is thus classified as moderate risk.

5.6.1.3 Occupational Hazards

During construction, workers carrying out activities at heights could be exposed to occupational hazards. Electrical accidents may also result in shocks and/or burns, muscle contractions, and traumatic injuries associated with falls after the shock. This hazard is fairly probable although, its severity is considered minimal thus it is classified as moderate risk.

5.7 Summary of Anticipated Impacts

These includes significant risks such as electric shock and injuries of workers during the construction phase as well as GBV risks and soil degradation. The execution of suitable mitigation measures presented in the next chapter will abate the effect of identified negative impacts/risks to the most minimal level possible and heighten the effects of the identified positive impacts.

Table 5.12 is a summary of the general potential site specific environmental and social impacts on the project.

Table 5. 12: Summarized Environmental and Social Impacts of Solar Power Plant

Environmental Impacts		
Direct Impacts	**Indirect Impacts**	**Cumulative Impact**
• Reduce noise and odours from gen sets • Protect natural habitats against deforestation • Reduce annual global fuel consumption and associated greenhouse gas emission as well as carbon emission • Land use and land use change • Land use / land filling • Localized air, water and soil pollution • Battery waste pollution • Flood/ Erosion Hazards • Occupational, Health and safety impacts on workers and communities	• Improve safety by reducing hazards associated with flammable fuels • Reduce indoor air pollution with significant effects on consumers' health • Material production • Fuel source production • End-user industry • Equity of access	• Improve quality of educational and health care services • Waste production • Greenhouse gas (GHG) emissions reduction • Population effects on threatened biodiversity
Social impacts		
Direct Impacts	**Indirect Impacts**	**Cumulative Impact**
• Longer hours and better illumination for studying • Social cohesion and development • Safety and equitable development for women • Improve access to information and communication technologies (ICTs as radio, TV, mobile phone, internet), i.e. news, business information, and distance education • Temporary access restrictions to properties/ land use	• Reduces expenditures on fuels – petrol, kerosene, candles, gasoline or dry cells, and increases savings up to 10 to 15 %. • Free up resources spent annually on fuel to be invested in more profitable businesses • Generate new income, stimulate economic activities, and offer new opportunities for small businesses by lengthening the day • Multiply trade activities and job creation to increase state income and facilitate overall socioeconomic development	• With renewable energy technologies, projects should be properly addressed with local/ host population to avoid social conflicts regarding way leaves, land use (agriculture) etc.

(Source: Sustainabiliti Limited, 2022)

CHAPTER SIX: MITIGATION MEASURES

6.0 INTRODUCTION

This chapter presents the mitigation measures proffered for the associated and potential impacts of the proposed 1.9 MW solar based power plant project in Federal University, Dustin-Ma, Katsina State. A comprehensive risk assessment matrix, as indicated in Figure 6.1, was used to determine the mitigation requirements for each of the impacts identified. The frequency, severity, sensitivity, scale, longevity, political, economic, legal, reputation/ image and communication/complaints were factors taken into consideration during these assessments.

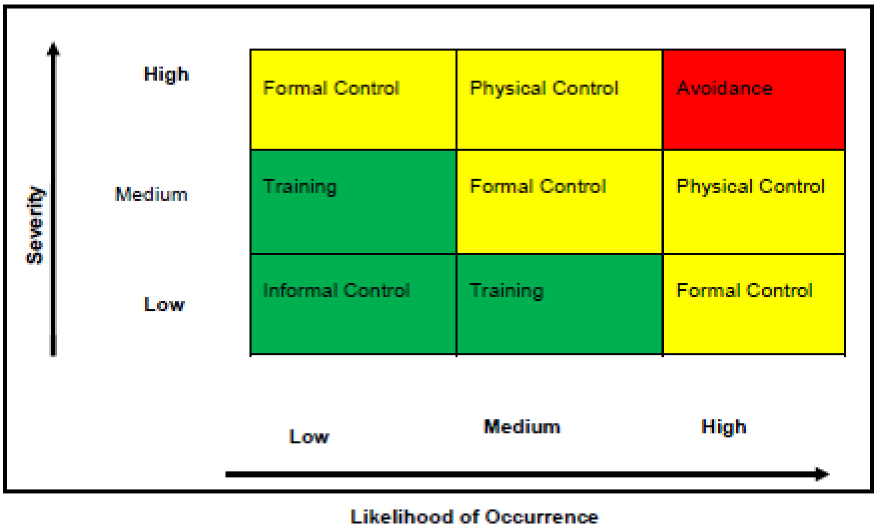

Figure 6. 1: Matrix for Determination of Mitigation Measures

(Source: www.researchgate.net/risk assessment matrix)

Mitigation measures designed to prevent, reduce or control the adverse impacts of the environmental and social aspects of the proposed project to as low as reasonably practicable were considered and documented in this chapter of the report.

Subsequently, the specific mitigation measures satisfying the mitigation requirement were established putting the following into consideration:

- available resources and competencies;
- on-site conditions; and
- Public concerns and technology.

6.1 Mitigation measures and approach

Mitigation refers to measures or interventions necessary to avoid, minimize, reduce or offset adverse impacts. Approach as indicated in table 6.1 for selecting appropriate mitigation measures include:

- Anticipate and avoid risks and impacts;
- Where avoidance is not possible, minimize or reduce risks and impacts toacceptable 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.

Table 6. 1: Summary of mitigation approaches for the University Solar Hybrid Power Projects

Project Phase	Mitigation hierarchy	Approach
Project design phase	Avoidance and minimization	• Micro-siting: changing the layout of project infrastructure to avoid sensitive areas • Re-routing, marking or burying powerlines to avoid collision risks and barrier effects
Construction phase	Avoidance	• Scheduling: changing the timing of construction activities to avoid disturbing biodiversity during sensitive periods
	Minimization	• Abatement controls to reduce emissions and pollutants (noise, erosion, waste) created during construction • Operational controls to manage and regulate contractor activity, such as exclusion of fencing around sensitive areas, designated machinery and lay-down areas, minimizing vegetation loss and disturbance to soil
	Restoration and rehabilitation	• Repair of degradation or damage to biodiversity features and ecosystem services from project-related impacts that cannot be completely avoided and/or minimized by revegetating of temporary-use and lay down areas as soon as reasonably practicable after construction activities are complete
Operational phase	Minimization	• Physical controls involving modification to infrastructure, or its operation, to reduce impacts (e.g. modifications to solar technology and their associated foundations, and modifying security perimeter fencing and overhead transmission lines) • Abatement controls including wastewater management and water conservation measures • Operational controls to manage and regulate contractor activity such as managing the timing of vegetation control activities at suitable intervals
End-of-life	Avoidance	• Scheduling: changing the timing of decommissioning activities to avoid disturbing biodiversity during sensitive periods (e.g. during breeding seasons)
	Minimization	• Abatement controls to reduce emissions and pollutants (noise, erosion, waste) during decommissioning and repowering • Operational controls to manage and regulate contractor activity through, for example, exclusion fencing around sensitive areas, designated machinery and lay-down areas)

Project Phase	Mitigation hierarchy	Approach
	Restoration and rehabilitation	• Repair of degradation or damage to biodiversity features and ecosystem services from project-related impacts that cannot be completely avoided and/or minimized by revegetating temporary-use and lay down areas as soon as reasonably practicable after construction activities are complete • Reinstatement of original vegetation, as far as feasible, following decommissioning

(Source: Sustainabiliti Limited, 2022)

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 lastresort. The implementation of the proffered mitigation measures highlighted in Table 6.2, are of negligible to minor significance. There are no potential long-term impacts associated with the Project that cannot be mitigated to acceptable levels of residual impact.

Table 6. 2: Mitigation Measures for the Potential Negative Impacts of the proposed Project

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
Pre-construction Phase					
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 and faming land	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. • 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. • Workers shall be sensitized on ecological protection.	Negligible
	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	Minor	• Removal of vegetation and soil cover shall be restricted to the areas required for the Project. • Soil conservation measures shall be implemented such as stockpiling topsoil or for 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.	Negligible
	Air quality and noise	• Air quality impacts due to emission from	Minor	• Site clearing equipment / machinery shall be operated and maintained under optimum fuel-	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
		site clearing equipment • Increase in ambient noise levels		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.	
	Workers Safety	• Injuries and accidents to workers during site clearing and preparation.	Minor	• Site clearing shall be limited to the day time as much as possible. • Unregistered labourers and touts shall not be engaged for off-loading materials • Provision of adequate personal protective equipment (PPE) such as nose masks shall be ensured. All employees will be required to wear the appropriate PPE whilst performing their duties.	Negligible
Mobilization of personnel, materials and equipment to site	Air quality and noise	• Air quality impacts from vehicular emissions • Increase in ambient noise levels	Minor	• Construction 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	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				reduce the risk of accidents in the Project area shall be provided. • Project related vehicles shall be regularly serviced and maintained. • Drivers' competency shall be assessed and where required, appropriate training shall be provided. This will include training on safe driving measures such as adherence to speed limits (of less than 10 km/h) in the Project area. • A procedure for recording traffic incidents/ accidents associated with the Project shall be developed and implemented. This will include date/time, location, reason for accident, corrective measures, etc. • Alternative access routes to the Project with less traffic and environmental footprints shall be assessed and used.	
	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					

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
Civil and Electrical Works/ Installation Activities	Soil	• Increased erosion potential as a result of construction activities such as excavation • Reduction in structural stability and percolative ability of soil resulting from compaction during civil works and installation activities	Moderate	• 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. • Installation of palisade fence during the construction phase to reduce any erosion potential	Minor
	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 local environment or neighbouring community	Minor	• 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.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				• 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. • 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	• Increased sediment load in the stream beside the site as a result of erosion • Increased runoff from hardstanding areas could result in creation of drainage lines, which could impact on site infrastructure. • 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 storage tanks. • Decreased amount of groundwater as a result	Minor	• The EPC Contractor will be required to design appropriate drainage system that takes due regards of the natural drainage system; • Where roads intersect natural, defined drainage lines, suitably sized pipe culverts or drive through causeways shall be installed or constructed; • Fuel, oil and used oil storage areas will be contained in bunds of 110 per cent capacity of the stored material; • The potential groundwater reserve of the project site will be further assessed by the EPC contractor prior to construction activities; • Spill containment and clean up kits will be available onsite and clean-up from any spill will be appropriately contained and disposed of at a registered landfill site. • Waste receptacles shall be provided within a secured area for collection of solid waste.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
		of groundwater abstraction for project activities.		• Construction vehicles and equipment will be serviced regularly, and will be serviced off site.	
	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. • Regular monitoring will be undertaken to ensure that alien plants are not increasing as a result of the disturbance that has taken place. • Hunting or deliberate killing of animals by construction workers shall be prohibited and monitored. • In order to reduce collision of vehicles with fauna, a 10 km/hr speed limit by construction-related vehicles shall be enforced in the Project area.	Negligible
	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	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				developed and implemented. This will include date/time, location, reason for accident, corrective measures, etc. • A 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.	
	Gender	• Discrimination during employment and training opportunities • GBV (sexual harassment, intimate partner violence, poor working)	Minor	• Equal treatment of workers shall be ensured. • The GBV Action Plan 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.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	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 compliance of workers to safety rules. • Proper safety signs and signage shall be placed at strategic locations within the site. • PPE such as safety boot, coverall, eye google, safety helmets, reflective vests, etc. shall be provided to construction workers and the level of PPE compliance shall be monitored. • Safety training focused on safe working practices, information on specific hazards, first aid and fire- fighting shall be included in the induction programme for workers. • A mechanism procedure for receiving and addressing the concerns of workers shall be put in place and implemented. • The site shall be secured with perimeter fencing and/or security. • Sanitary amenities and potable water shall be provided	Minor

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	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 • An induction and sensitization programme, including a Code of Conduct (CoC), 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	Minor

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				• Procedure for receiving and addressing community concerns shall be developed and implemented.	
Waste Disposal and Generation	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
	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 developed (Annex 3) shall be reviewed and implemented by the EPC Contractor • 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

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	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. • Portable spill containment and clean-up kits shall be available onsite. • Waste management plan (WMP) shall be 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.	Negligible
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

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	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 Procedures (SOPs) shall be ensured. • Prior to the Plant commissioning, appropriate emergency equipment (such as first aid box, fire extinguishers) shall be provided onsite. • Plant testing shall be restricted to the daytime. • The site shall be secured with perimeter fencing and/or security. • Sanitary amenities and potable water shall be provided.	Negligible
	Campus Occupants' safety	• Wrong electrical connection leading to explosion/fire.	Minor	• Plant testing shall be carried out by experienced personnel. • 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					

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	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.	Minor
	Gender	• Discrimination during employment and training opportunities • GBV (sexual harassment, intimate partner violence, poor working)	Moderate	• Equal treatment of workers shall be ensured. • Continuous implementation of the GBV Action Plan shall be sustained for the Project • All workers on the project shall be required sign a code of conduct to prohibit any form of Gender Based Violence/ Sexual Exploitation and Abuse (GBV/ SEA) • GBV sensitive channels for reporting in GRM shall be implemented for the Project • The O&M Contractor shall be required to hire a Gender/GBV officer. • Collaboration with appropriate government institutions or GBV service providers on potential GBV case management shall be sustained. • All workers shall be required to undergo regular training and refreshers on GBV • The O&M Contractor shall provide separate facilities for men and women and add GBV-free signage at the project site.	Minor

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
				• All gender-based violence incidents shall be reported and dealt with as per the law.	
Routine Maintenance, Waste Generation and Disposal	Soil	• Soil contamination from spent batteries and inverters	Minor	• General housekeeping to ensure the site is not overgrown with grasses shall be maintained • Waste bins shall be provided at designated locations on site for temporary storage of different waste streams. • General waste that cannot be reused or recycled shall be disposed of at an approved dumpsite. • WMP shall be developed by the O&M Contractor and 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.	Negligible
	Health, safety and welfare of staff during maintenance	• Electric shock, injuries to personnel during maintenance	Minor	• Appropriate PPE shall be provided for workers. • Maintenance workers shall imbibe the workplace safety rules via proper sensitization procedures. • Strict compliance to the SOPs shall be ensured.	Negligible

Project Activities	Receptors	Summary of Potential Impacts	Potential Impact Significance (before mitigation)	Mitigation Measures	Residual Impact (after implementation of mitigation measures)
	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. • Periodic monitoring of groundwater resources in the Project's area of influence shall be implemented.	Negligible

(Source: Sustainabiliti Limited, 2022)

CHAPTER SEVEN: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

7.1 Introduction

This section deals with the set of mitigation management measures to be taken to avoid, reduce, mitigate or compensate for adverse environmental, occupational and social impacts with the institutional arrangement, monitoring schedule, parameters to be monitored and soon including tentative monitoring budget. It includes the following aspects:

- Types of impacts and their mitigations
- Mitigation measures
- Environmental Code of Practices (to be attached to bidding documents and/ or contracts)
- Monitoring Plan
- Communication and documentation
- Cost of ESMP
- Integration with Project (contract clauses, others)
- Grievance resolution process
- Plan for stakeholder/ community engagement during pre-construction, construction, and operation phases; the plan should include community mobilization approach from both social and commercial perspectives.

Further to the impacts assessed in the previous chapter, this section presents more detailed mitigation measures and monitoring requirements that correspond to the impacts examined in the previous section, thus exploring them in more detail. Mitigation measures aim to offset any negative impacts that may result from the project, and monitoring is the process of measuring the success of mitigation measures in order to assess their effectiveness.

7.2 Objectives of the ESMP

The purpose of the Environmental and Social Management Plan (ESMP) is to ensure that Environmental and Social impacts identified during the ESIA process are effectively addressed during the construction, operation and closure of the project. The ESMP specifies the mitigation and management measures to which the Proponent is committed and shows how the Project will mobilize organizational capacity and resources to implement these measures.

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

The specific objectives of the ESMP are to:

- Promote Environmental and social management and communicate the aims and goals of the ESMP;
- Ensure that all workers, subcontractors and others involved in the Project meet legal and regulatory requirements with regard to environmental management including financial implications
- Incorporate environmental and social management into Project design and operating procedures;
- Serve as an action plan for environmental and social management for the Project;
- Provide a framework for implementing Project environmental and social commitments (i.e. mitigation measures identified in the ESIA).

7.3 Environmental and Social Management Measures

The recommended environmental and social management measures required to mitigate the identified impacts of the proposed project activities during pre-construction, construction, commissioning and operation phase are presented in tables 7.1 to 7.8.

Table 7. 1: Environmental Management Plan 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) POE (Site Engineer)	1,000
	• The total number of trees cleared shall be planted elsewhere harmonization with the university's plans. as allocated by the Director physical planning using plants or seeds of locally occurring species.	Inspection	Daily	Adherence to measures			
	• 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	Revegetated 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	Adherence measures to			
	• Hunting or deliberate killing of animals by workers shall be prohibited and monitored. • Workers shall be sensitized on ecological protection	Inspection	Daily	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	Revegetated land			
	• Use of silt traps or similar systems to reduce discharge of silt shall be ensured.	Inspection	Monthly	Adherence to measures			

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
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			
	• Site clearing activities shall be carried out onlyduring the daytime (08.00hr to 17.00hr during weekdays; and weekends 09.00hr-13.00hr)	Inspection	Daily	Adherence to measures			
Mobilization of Materials and Equipment to Site							
Air quality impacts from vehicular emissions; Increase in ambient noise	• 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) POE (Site Engineer)	300
	• All materials with potential to result in dust emissions shall be covered during transport.	Inspection	Once before vehicle commences journey	Adherence to measures	EPC Contractor		
	• Site roads and access roads shall be sprinkled as needed to prevent dust entrainment.	Inspection	Daily	Adherence to measures	EPC Contractor		
	• Onsite vehicle speed on unhardened roads and surfaces shall be limited to about 15 – 20km/h so as to reduce dust generation.	Inspection	Daily	Adherence to measures	EPC Contractor		
	• Unnecessary engine idling shall be avoided.	Inspection	Daily	Adherence to measures	EPC Contractor		
	• Site roads shall be sprinkled as needed to prevent dust entrainment.	Inspection	Daily	Adherence to measures	EPC Contractor		
							TOTAL- 1,300

(Source: Sustainabiliti Limited, 2022)

Table 7. 2: Social Management Plan 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 Selection							
Exposure to infectious diseases (e.g. HIV/AIDS, COVID-19)	• The EPC contractor shall implement the Nigeria Centre for Disease Control (NCDC) safety Guidelines during site clearing activities.	Implementation of NCDC guidelines	Prior to mobilization to site / site clearing and construction	Adherence to measures	EPC Contractor	REA (PMU)	2,000
	• Provision of functional hygiene facilities, wearing of nose masks and implementation of basic infection prevention measures during site clearing works	Hygiene facilities and implementation of infection prevention measures	Prior to mobilization to site / site clearing and construction	Adherence to measures			
Mobilization of Materials and Equipment to Site							
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 will be required to wear the appropriate PPE whilst performing their duties.	Availability of PPE	Daily	PPE compliance	EPC Contractor	REA (PMU) POE	3,500
	• Site clearing shall be limited to the day time as much as possible.	Inspection	Daily	Daily time log	EPC Contractor		
	• 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		
	• 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		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	• 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 Driver's licence	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 disciplinary action ranging from warning to dismissal.	Incident forms, GRM	Daily	Completed incident forms	EPC Contractor		
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 will be required to wear the appropriate PPE whilst performing their duties.	Availability of PPE	Daily	PPE compliance	EPC Contractor	REA (PMU) POE	
	• Unregistered laborers 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		
							TOTAL- 5,500

(Source: Sustainabiliti Limited, 2022)

Table 7. 3: Environmental Management Plan 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 POE	580
	• 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 POE	760
	• 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	GRM measures	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		
	• Machinery/equipment to be used for construction work shall meet industry best standard in relation to noise attenuation	Inspection	Before commencement of construction phase	Adherence to measures	EPC Contractor		
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 POE	300
	• 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		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
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 POE	300
	• 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 POE	**1,500**
	• Speed limits for all construction-related vehicles shall be established and enforced.	Inspection	Daily during construction phase	Adherence to measures	EPC Contractor		
	• 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		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	• 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	• The Waste Management Plan shall be implemented	Waste Management records	Weekly during construction phase	Adherence to measures	EPC Contractor	REA-PMU POE	450
	• 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 from solid and liquid construction waste streams.	• Hazardous substances and materials shall be stored in appropriate locations with impervious hardstanding and adequate secondary containment. • Portable spill containment and clean-up kits shall be available onsite.	Inspection	Daily during construction phase	Adherence to measures	EPC Contractor	REA-PMU POE	2,400
	• 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 POE FMEnv	
	• Hazardous substances and materials shall be stored in appropriate locations with impervious hard standing and adequate secondary containment. Portable spill containment and clean-up kits shall be available onsite.	Inspection	Daily during construction phase	Adherence to measures	EPC Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	• Waste management plan (WMP) (Annex 3) shall be implemented.	WMP implementation records	Daily during construction phase	Benchmarks stated in WMP	EPC Contractor		
							TOTAL- 6,290

(Source: Sustainabiliti Limited, 2022)

Table 7. 4: 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 POE	-
Temporary displacement of land users	• Displacement of current adhoc land users shall be managed within the university	Records of Reallocation of land for use	Once before start of construction		University Director Physical Planning	REA-PMU POE	
GBV (sexual harassment, intimate partner violence, poor working conditions)	• 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 POE FMEnv Federal Ministry of Women Affairs	700
	• 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		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	• 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	GBV/SEA service providers	
	• The EPC Contractor shall be required to hire a Gender/ GBV officer	Employ GRM Officer	Once before start of construction	Employment records and job description	EPC Contractor		
	• Collaboration with appropriate government institutions or GBV service providers on potential GBV case management shall be ensured	Engagement of GBV service provider	Once before start of construction	Records of ongoing engagement and consultation with GBV service providers	EPC Contractor		
	• The EPC Contractor shall provide separate facilities for men and women and add GBV-free signage at the project site	Erection of separate convenience facilities and display of GBV signage	Once before start of construction	Inspection of facilities to ensure adequacy	EPC Contractor		
Influx of people, increase in sexual transmitted diseases.	• Construction workers (e.g. semi-skilled and unskilled craftsmen) shall be drawn from the local community as much as possible. and Labour management plan developed and implemented	Employment records and prepare a labour management plan	Once before start of construction	Adherence to measures	EPC Contractor	REA-PMU POE FMEnv Federal Ministry of women affairs/ GBV/SEA service provider	1,500
	• 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		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	• Awareness education about GBV/ SEA/ 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	As required	Adherence to measures	EPC Contractor		
	• All workers on the project shall be required to sign a code of conduct to prohibit any form of Gender Based Violence/ Sexual Exploitation and Abuse	Signed code of conduct records	Once before start of construction	Adherence to measures	EPC Contractor		
	• Procedure for receiving and addressing community concerns shall be developed and implemented.	Consultations and grievance records	Monthly during construction phase	GRM Measures	EPC Contractor		
Injury to construction workers during construction activities	• Health and Safety Plan shall be developed and implemented.	Health and Safety plan implementation records	Daily during construction phase	Benchmarks stated in Health and Safety Plan	EPC Contractor	REA-PMU POE	4,000
	• Community members and 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 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	Availability of PPE	Daily during construction phase	PPE compliance	EPC Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	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.	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		
Influx of infected workers to the community. Exposure to infectious diseases (e.g. HIV/AIDS, COVID-19) during construction	• The EPC contractor shall implement the NCDC "Guidelines for employers and businesses in Nigeria" during construction works.	Implementation of NCDC guidelines	Prior to operations	Adherence to measures	EPC Contractor	REA-PMU POE	500
	• A risk assessment of the occupational exposure to infectious diseases during construction shall be conducted, and appropriate control mechanisms shall be implemented.	Hygiene facilities and implementation of infection prevention measures	Continuous during operations	Adherence to measures			
	• The EPC contractor shall develop policies and procedures for the identification and isolation of people with symptoms, as well as testing where appropriate	Conduct risk assessment, implement control measures	Continuous during operations	Adherence to measures			
	• Provision of functional hygiene facilities, wearing of nose masks and implementation of basic infection prevention measures during construction.	Policies and procedures	Continuous during operations	Adherence to measures			
							TOTAL- 6,700

(Source: Sustainabiliti Limited, 2022)

Table 7. 5: Environmental management 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 Planttesting	• Strict compliance to the Standard Operating Procedures (SOPs) shall be ensured.	SOPs	Once before commissioning	Adherence to measures	EPC Contractor	REA - PMU POE	
	• The EPC contractor shall develop Standard Operating Procedures (SOPs) for the operational phase of the Project	SOPs	Once before commissioning	Adherence to measures	EPC Contractor		
	• The Power Plant components shall be installed inline with the pre-established standards and as per manufacturer recommendations	SOPs	Once before commissioning	Adherence to measures	EPC Contractor		
TOTAL-0							

(Source: Sustainabiliti Limited, 2022)

Table 7. 6: Social Management Measures for Commissioning Phase

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performanc eIndicator	Implementation	Monitoring	
Plant testing							
Occupational health andsafety 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	PMU – REA POE	500
	• Adequate PPE shall be worn	Availability of PPE	Once before commissioning	Adherence to measures	EPC Contractor		
	• Prior to the Plant commissioning, appropriate emergency equipment.	Availability of emergency response equipment	Once before commissioning	Adherence to measures	EPC Contractor		
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	PMU – REA POE	-

	TOTAL-500

(Source: Sustainabiliti Limited, 2022)

Table 7. 7: 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							
Air emissions from the diesel generators	• Strict compliance to the standard operating procedures for the diesel generators shall be ensured.	Inspection	Monthly during operations	Adherence to measures	O&M Contractor	PMU – REA POE University Staff	1,200
	• Regular maintenance of diesel generators shall be ensured as required by the manufacturer	Inspection	Monthly during operations	Adherence to Measures			
Dust accumulation on the solar panels	• A cleaning schedule shall be developed and implemented for cleaning the panels installed at the project site during operations	Inspection	Monthly during operations	Adherence to measures			
	• The solar panels shall be inspected regularly for dust and rain damages and maintained according to manufacturer's instructions.	Inspection	Monthly during operations	Adherence to measures			
Noise from diesel generators and inverters during power generation and evacuation	• Inverters shall be maintained as per manufacturer's recommendations and operated as per original specifications.	Inspection	Monthly during operations	Adherence to measures			
	• The diesel generators shall be operated with the sound proof covers at all times.	Inspection	Monthly during operations	Adherence to measures			
	• Project personnel shall use appropriate PPE (e.g. ear muffs) to reduce exposure to noise impact.	Inspection	Monthly during operations	Adherence to Measures			
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			
Routine Maintenance, Waste Generation and Disposal							

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
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 POE University Staff	2,000
	• 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 Site	Weekly during construction phase	Adherence to measures	O&M Contractor		
Soil contamination from spilled fuel, used oil, 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	EHS Guidelines	O&M Contractor	REA PMU POE FMEnv	1,200
	• WMP shall be implemented.	WMP implementation records	Quarterly during operation phase	Benchmarks stated in WMP EHS Guidelines	O&M Contractor		
	• Hazardous substances and materials (e.g. fuel, lubricating oil, etc.) shall be stored in appropriate locations with impervious hard standing and adequate secondary containment.	Inspection	Continuously during operations phase	Adherence to measures EHS Guidelines	O&M Contractor		
	• Portable spill containment and clean-up kits shall be available onsite.	Availability of spill response equipment	Quarterly during operation phase	Functional spill equipment 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	
	• Operation workers shall be provided with adequate training on use, storage and handling of hazardous substances.	Training records	Quarterly during operation phase	Certificates of completion of trainings	O&M Contractor		
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 POE FMEnv	500
	• Strict compliance to the SOPs shall be ensured.	SOPs	Quarterly during operations	Adherence to measures	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 EHS Guidelines	O&M Contractor	REA PMU POE FMEnv	500
							TOTAL-5,600

(Source: Sustainabiliti Limited, 2022)

Table 7. 8: 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 conditions)	• The EEP Gender Action Plan (section 9.4-section 9.6.5) shall be implemented during operations, in addition to the overall Nigeria Electrification Project (NEP).	Implementation by the O&M Contractor	Continuously during operations	Evidence to show implementation of EEP GBV action plan	O&M Contractor	REA PMU University GBV/SEA service provider	2,200
	• All workers shall be required to undergo regular training and refreshers on GBV	Organize regular on-site training and refreshers	Monthly during operation	Records of attendance	O&M Contractor		

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
			phase			POE	
	• 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	O&M Contractor		
	• GBV sensitive channels for reporting in GRM shall be implemented for the Project	Establish GRM reporting channels	Once before start of operations	GRM records	O&M Contractor		
	• Separate facilities for men and women will be provided	Erection of separate convenience facilities	Once before start of operations	Inspection of facilities to ensure adequacy	O&M Contractor		
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 University POE	3,000
	• Appropriate safety signage shall be placed at strategic locations within the site.	Safety signs	Quarterly during operations	Adherence to measures	O&M Contractor		
	• Strict compliance to the SOPs shall be ensured.	SOPs	Quarterly during operations	Adherence to measures	O&M Contractor		
	• 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	O&M Contractor		
Exposure to infectious diseases (e.g. HIV/ AIDS, COVID-19)	• The O&M contractor shall implement the Nigeria Centre for Disease Control (NCDC) safety • Guidelines during operations.	Implementation of NCDC guidelines	Prior to operations	Adherence to measures	O&M Contractor	REA PMU University	

Summary of Potential Impact	Mitigation Measures	Monitoring			Responsible Party		Cost (US Dollars)
		Requirements / Parameters	Frequency	Performance Indicator	Implementation	Monitoring	
	• Provision of functional hygiene facilities, wearing of nose masks and implementation of basic infection prevention measures during operations	Hygiene facility and implementation of infection prevention measures	Continuous during operations	Adherence to measures	O&M Contractor	POE	
	• A risk assessment of the occupational exposure to infectious diseases during construction shall be conducted, and appropriate control mechanisms shall be implemented.	Conduct risk assessment implement controls	Continuous during operations	Adherence to measures	O&M Contractor		
	• The O&M contractor shall develop policies and procedures for the identification and isolation of people with symptoms, as well as testing where appropriate.	Implementation of policies and procedures	Continuous during operations	Adherence to measures	O&M Contractor		
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 POE	2,000
	• Strict compliance to the SOPs shall be ensured.	SOPs	Quarterly during operations	Adherence to measures			
							TOTAL- 7,200

(Source: Sustainabiliti Limited, 2022)

7.4 Environmental Monitoring Programme

Monitoring shall be conducted to ensure compliance with regulatory requirements as well as to evaluate the effectiveness of operational controls and other measures intended to mitigate potential impacts. Table 7.9 summarizes the environmental monitoring programme for the Project.

Table 7. 9: 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 ($)
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/ AfDB	Monthly monitoring; Monthly reporting	EPC Contractor	Construction Phase	500
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/ AfDB	Quarterly monitoring and reporting	EPC Contractor O&M Contractor	Construction Phase Operations Phase	500
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/ AfDB	Quarterly monitoring and reporting	EPC Contractor O&M Contractor	Construction Phase Operations Phase	700
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/ AfDB	Monthly monitoring; Quarterly reporting	EPC Contractor O&M Contractor	Construction Phase Operations Phase	500
Health and Safety	Workers and Operational areas	Observe compliance to PPE and unsafe working conditions	Health and Safety Plan	FMEnv/ NESREA/ AfDB	Daily monitoring; Quarterly reporting	EPC Contractor O&M Contractor	Construction Phase Operations Phase	1,200
Training	Workers	Observe compliance with existing training plan	Training plan and records	FMEnv/ NESREA/ AfDB	Quarterly monitoring and reporting	EPC Contractor O&M Contractor	Construction Phase Operations Phase	1,000
General Housekeeping	Construction sheds and operational areas	Observe cleanliness and aesthetics of Plant	Cleanliness and aesthetics of Plant	FMEnv/ NESREA/ AfDB	Daily monitoring; Quarterly reporting	EPC Contractor O&M Contractor	Construction Phase Operations Phase	500

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 ($)
Stakeholder Engagement	Local community Regulatory agencies	Observe evidence of stakeholder consultations	Stakeholder Engagement Plan	FMEnv/ NESREA/ AfDB	Quarterly monitoring and reporting	EPC Contractor O&M Contractor	Construction Phase Operations Phase	1,200
								TOTAL-6,100

(Source: Sustainabiliti Limited, 2022)

7.5 Roles, Responsibilities and Accountabilities

The Rural Electrification Agency Project Management Unit (REA-PMU) supervises the implementation of the ESMP throughout the project life span while conformance with the mitigation measures will be ensured by the Engineering, Procurement and Construction (EPC) contractor during the construction phase and by the operations and maintenance (O&M) contractor during the operational phase of the project. Table 7.10 indicates the Roles and Responsibilities of the Stakeholders in the Implementation, Monitoring and Review of the ESMP.

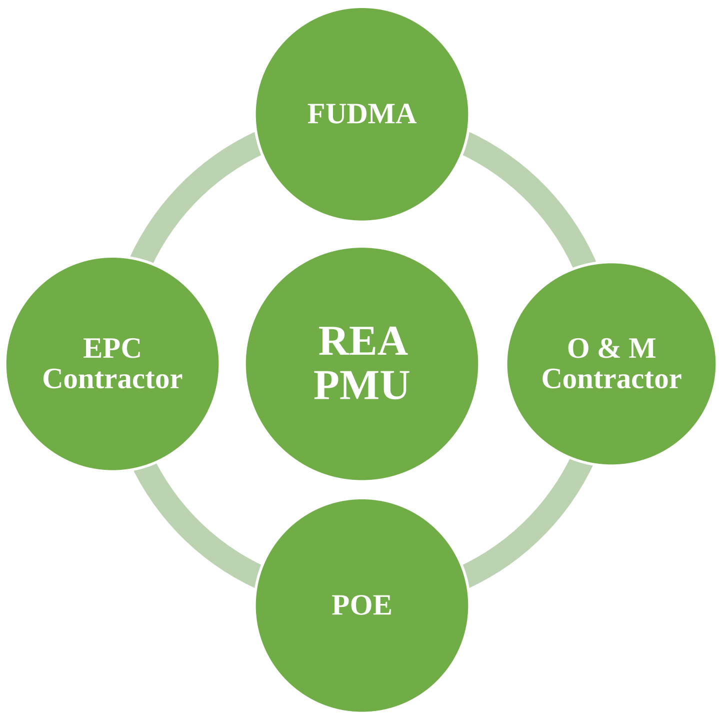

Figure 7. 1: Roles and Responsibilities: Pre-Construction, Construction & Operational Phases
(Source:REA and Sustainabiliti Limited, 2022)

Table 7. 10: The Roles and Responsibilities of the Stakeholders in the Implementation, Monitoring and Review of the ESMP

S/N	Stakeholder	Roles and Responsibilities
1	**FUDMA Director of Physical Planning**	**Pre-Construction Phase** • Earmark the areas for the project development from the survey land • 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 • Implement the restoration of livelihood to affected persons before mobilization to site **Operational Phase** • 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
2	**REA-PMU**	**Pre-Construction Phase**

S/N	Stakeholder	Roles and Responsibilities
		• Provide technical support to the University in the final selection of sufficient and suitable land for construction of power plant and training centre • Supervise the implementation of the restoration of livelihood to affected persons before mobilization to site • 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 **Construction phase** • Supervise the activities of the EPC contractor by reviewing reports on ESMP issues • Discuss ESMP improvements with FUDMA Director of Physical Planning to address non-compliance and upcoming issues • Monitor the implementation of the ESMP • Supervise the activities of the EPC contractor and ensure compliance ESMP with mitigation measures • Report to FUDMA Director of Physical Planning on ESMP compliance and non-compliance issues **Operational** • Appoint an O&M Contractor • Supervise the activities of the O&M Contractor by reviewing reports on ESMP issues • Discuss ESMP improvements with FUDMA Director of Physical Planning to address non-compliance and upcoming issues
3	**FUDMA Site Engineer**	**Pre-Construction Phase** • Attend adequate training on ESMP implementation • Supervise the activities of the EPC contractor and ensure compliance ESMP with mitigation measures • Report to FUDMA Director of Physical Planning on ESMP compliance and non-compliance issues **Operational phase** • Supervise the activities of the plant by reviewing reports on ESMP issues • Discuss ESMP improvements with FUDMA Director of Physical Planning to address non-compliance and upcoming issues
4	**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, POE and FUDMA Site Engineer on ESMP compliance and non-compliance issues • Implement ESMP requirements relevant to work being undertaken **Construction phase** • Implement ESMP requirements relevant to work being undertaken • Hire a Gender/GBV officer • Report to the REA-PMU, POE and FUDMA Site Engineer on ESMP compliance and non-compliance issue
5	**O&M Contractor**	• Implement ESMP requirements relevant to work being undertaken • Hire a Gender/ GBV officer • Report to the REA-PMU, POE and FUDMA Site Engineer on ESMP compliance and non-compliance issue
6	**FMEnv Representatives**	• Monitor the implementation of ESMP requirements (impact mitigation monitoring) relevant to work being undertaken

S/N	Stakeholder	Roles and Responsibilities
		• Discuss ESMP improvements with FUDMA Director of Physical Planning and REA-PMU to address non-compliance and upcoming issues • Operational phase • Monitor the implementation of ESMP requirements (environmental compliance monitoring) relevant to work being undertaken • Discuss ESMP improvements with O&M Contractor, FUDMA Director of Physical Planning, and REA-PMU to address non-compliance and upcoming issues
7	**NESREA Representatives**	• Monitor the implementation of ESMP requirements (environmental compliance monitoring) relevant to work being undertaken • Discuss ESMP improvements with O&M Contractor, FUDMA Director of Physical Planning, and REA-PMU to address non-compliance and upcoming issues
8	**State Ministry of Women Affairs and Social Development** **(GBV/SEA service provider)**	• Monitor the implementation of Gender mitigation measures relevant to work being undertaken • Discuss ESMP improvements with the Gender/GBV officer, FUDMA Director of Physical Planning, and REA-PMU to address non-compliance and upcoming issues **Operational** • Monitor the implementation of Gender mitigation measures relevant to work being undertaken • Discuss ESMP improvements with the Gender/GBV officer, FUDMA Director of Physical Planning, and REA-PMU to address non-compliance and upcoming issues
9	**Katsina State Ministry of Resource and Development**	• Monitor the implementation of ESMP requirements (impact-mitigation monitoring) relevant to work being undertaken • Discuss ESMP improvements with FUDMA Director of Physical Planning and REA-PMU to address non-compliance and upcoming issues **Operational** • Monitor the implementation of ESMP requirements (environmental compliance monitoring) relevant to work being undertaken • Discuss ESMP improvements with O&M Contractor, FUDMA Director of Physical Planning, and REA-PMU to address non-compliance and upcoming issues
10	**Safeguards Unit**	**Environmental Aspects** • Analyze potential community/individual sub-projects and their environmental impacts; • Ensure that project activities are implemented in accordance to best practices and guidelines set out in the site specifics; • Identify and liaise with all stakeholders involved in environment related issues in the project; and • Be responsible for the overall monitoring of mitigation measures and the impacts of the project during implementation. **Social Aspects** • Develop, coordinate and ensures the implementation of the social aspects of the ESMP; • Implement the grievance redress mechanism on the project • Identify and liaise with all stakeholders involved in social related issues in the project; • Conduct impact evaluation and beneficiaries' assessment; and • Establish partnerships and liaise with organizations, Community Based Organizations (CBOs) and Civil Society Organizations (CSOs).
11	**EPC and Works Contractor**	• After receiving and committing to the environmental procedures and Management Plans, • Contractors must fully carry out the measures of the environmental protection, health and safety procedure as indicated;

S/N	Stakeholder	Roles and Responsibilities
		• Any changes related to Environment, health and safety procedure must be referred to PMU for approval • In case of any violations on arising works either detected by Environmental consultant, Safeguard Specialists, or new arising works proposed by contractors, they must be reported to PMU for further actions. • If contractors decided to not follow instruction from PMU, construction activities will be halted until necessary actions are taken. • Contractors must assign at site, personnel in charge of Environment, health and safety procedure. • Compliance to BOQ specification in procurement of material and construction • Provide oversight function during construction and decommissioning

(Source: Sustainabiliti Limited, 2022)

7.6 Additional Management Plans

During the progression of the project, management plans will be expanded to include specific procedures to guide implementation by the relevant project personnel and institutions including contractors and subcontractors. Such documents will be prepared strictly in line with the requirements set out in the relevant international standards and guidelines and other applicable national and local regulations and guidelines. These additional management plans include the following:

- Stakeholder Engagement Plan
- Emergency Preparedness and Response Plan
- Traffic Management Plan
- Waste Management Plan (Annex 3)
- Occupational Health and Safety Plan
- Local and Employment Management Plan
- Erosion and Sediment Control Management Plan
- Water Conservation Plan
- Livelihood Restoration Plan

7.7 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. The key components of the environmental monitoring program that will be developed for this project include:

- Comprehensive identification of high-level issues, risks, opportunities and gaps in system and operating practices that can impact ability to achieve the required level of performance;
- Establishment of clear metrics to measure statistically significant performance improvement areas towards goals and targets;
- Establishment of processes to ensure documents and records that are critical to operational excellence are current, controlled and accessible;
- Establishment and maintenance of appropriate processes for regularly monitoring of HSE performance as well as conducting regular environmental audits and evaluations to ensure that the system is implemented and maintained and remains effective.

7.8 Training, Awareness and Capacity Building for Zonal Offices

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. It is important that employees at each relevant phase of the project are aware of the potential environmental impacts of their activities and the occupational hazards associated with the work; as well as their roles and responsibilities in achieving conformance with the management documented in this report. Thus, a formal training process will be organized for employees on environmental management programs, plans and procedures associated with the project.

All staff employed will be trained in the following:

- General operation of the plant;
- Environmental management;
- Specific job roles and procedures;
- Occupational health and safety; and
- Contingency plans and emergency procedures.

Training will include:

- Induction training on appointment;
- Specialist training (as required for specific job role); and
- Refresher training as required.

Training for local community on general environmental awareness and ESMP mitigation measures pertaining to community health, safety and security shall also be provided.

7.8.1 ESMP Capacity Building Plan

The various actors involved in the ESMP implementation will need capacity enhancement to ensure adequate understanding of ESMP/ OHS/ Waste Management/ Code of Conduct requirements amongst other areas identified. Proposed topics and target audience is outlined in table 7.11.

Table 7. 11: ESMP Capacity building plan

	Training Content	Participants	Delivery	Cost ($)
1.	Specific training on Environmental & Social Mgt.	Environmental & Social Safeguard Officer	PMU Consultant	4000
2.	Training on ESMP Implementation: mitigation, roles & responsibilities	Project Team	PMU Consultant	1000
3.	Training for contractors on ESMP mitigation measures, Code of Conduct, OHS requirements	Contractors' management and workers	PMU Consultant	1000
4.	Training of Contractor Drivers, fleet management, traffic control within FUDMA etc.	Contractor, contractor drivers, HSE officer, ESO	School of Transport, FUDMA/ Security Management	1000
5.	GBV/SEA/SH Prevention and Response Mechanisms	Project team Environmental & Safeguard Officer,	PMU Consultant	2000
6.	Grievance Redress Mechanism	Grievance Redress Committees: project level and management level GRCs	PMU Consultant	2000
			Total	**11,000**

(Source: Sustainabiliti 2022)

7.9 Implementation Schedule and Reporting

The project has an estimated completion period of 12-18months as outlined in table 7.12. Activities related to the ESMP Matrix as seen above should to be integrated into the overall construction schedule.

Table 7. 12: ESMP Implementation Schedule

S/No	Activity	Responsibility	Months											
			1	2	3	4	5	6	7	8	9	10	11	12 – 18
1	ESMP Disclosure	Project Team												
2	Develop Environmental/Social Requirements in Bid Documents	Project Team												

S/No	Activity	Responsibility	Months											
			1	2	3	4	5	6	7	8	9	10	11	12 – 18
3	Finalization and Approval of Engineering Designs	Design Consultant/ Project Team												
4	Allocate budget for ESMP Monitoring	Project Team												
5	Appoint Support Staff for ESMP	Project Team												
6	Review and Approval of Contractor's HSE, WMP, TMP etc	ESO/SSO												
7	Capacity building	Project Team												
8	Implementation of Environmental and Social Mitigation Measures	Contractor												
9	Supervision of pre-Construction and Construction activities	Project Team												
10	Supervision of ESMP Implementation	ESO/SSO and Engineering Consultant												
11	Environmental and Social Monitoring and Auditing	FMEnv, SMEnv,												
12	Reporting on ESMP Implementation	ESO/SSO												

(Source: Sustainabiliti 2022)

7.10 Implementation Schedule and Reporting

Implementation will be in line with the finalized overall project schedule, as all activities are integrated into the project design. This will take place from the planning stages to ensure quality equipment and support services are sourced, through construction, commissioning, operation to decommissioning phases. Once monitoring begins, any observation of an environmental problem, such as non-compliance or adverse impacts will be reported immediately by the officers responsible to respective authorities in REA and corrective/ remedial actions will be taken without delay to ensure optimal performance of the project while promoting environmental sustainability. Also, REA shall keep the regulatory authorities (FMEnv, NESREA, Katsina State Ministry of Resource and Development) informed of the project performance 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. These periodic HSE reports summarizing the status of the environment in the plant will be submitted to FMEnv. Any values exceeding regulatory limits will be specifically identified, together with an explanation of the circumstances involved and corrective measures to ensure compliance in the future.

7.11 ESMP Costing

Table 7.13 provides the summary of the cost estimate required to effective and efficiently implement the recommended mitigation measures and management plans required to address the potential and associated impacts of the proposed project. The total cost of implementing the ESMP is estimated at US$ **50,190** with the current Naira value of N775 to 1 dollar.

Table 7. 13: Cost of ESMP

S/N	ESMP ACTIVITES	COST (US dollars)
1.	Pre-construction phase	6,800
	Construction phase	12,990
	Operational phase	12,800
	Commissioning phase	500
2.	Cost of mitigation	6,100
3.	Capacity building	11,000
	TOTAL	**50,190**

(Source: Sustainabiliti Limited, 2022)

The duration of this estimate is expected to be 24 months, (based on EPC Construction Phase and Handover Protocol).

CHAPTER EIGHT: REMEDIATION PLAN AFTER DECOMMISIONING/ CLOSURE

8.1 Introduction

Upon the completion of useful life cycle of a project, there is a need to abandon and/or decommission such project if it no longer becomes economically viable either as a result of depleted feed stock or competing technology. The proposed solar project is expected to have a life span of 25 years. It is envisaged that technology and environmental policies could have changed so drastically by then, hence a definite decommissioning plan cannot be put in place for now. However, it is of importance that abandonment activities be planned in advance in accordance with the Nigerian regulatory requirements.

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 25years (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.

During decommissioning, REA shall ensure that the project sites are returned to a safe and environmentally acceptable condition. 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;
- Restore the environment to allowable baseline conditions and monitor the process in line with legislative and regulatory requirements and best industry standards; and
- Assess the residual impacts, if any, that the project has on the environment; and specifically, if there are any future restrictions for other activities.

8.3 Management of Decommissioning Activities

In the event of decommissioning, REA, in conjunction with the leadership of the FUDMA, 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;
- 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.

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 power plant that will be abandoned and/or removed;
- The proposed methods for abandonment or re-use of the plant 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).

In the event of the project being abandoned, this shall be done in accordance with strict compliance with legislative requirements and international best practices. 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 FUDMA, the Katsina State Ministry of Resource and Development. The abandonment process shall be carried out as follows:

- Relevant stakeholders shall be duly informed;
- Physical Asset Verification (PAV) of the facilities shall be carried out;
- National Sectoral Regulations, as they affect the abandonment of the project, shall be strictly complied with to ensure:
  - Restoration and rehabilitation of the environment;
  - Management of residual impacts of the project in strict compliance with extant National/ FMEnv sectoral regulations.
- In addition, a site close-out permit shall be obtained as appropriate and a close out report shall be prepared and archived for future reference.

8.5 Roles, Responsibilities and Accountabilities

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:

A. Contractor(s) Engaged for Decommissioning Activities

- Implement environmental and social measures and management actions put in place for the decommissioning activities.

B. REA-PMU

- Supervise the activities of the contractor(s) engaged for decommissioning purpose by ensuring that the recommended environmental and social and management actions are implemented.
- Discuss environmental and social management plan improvements with the Director of Works and Physical Planning Department in FUDMA to address non-compliance and upcoming issues.

C. Federal University Dustin-Ma Plant 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 FUDMA on contractor's performance regarding the implementation of environmental and social measures.

D. Director of Works and Physical Planning Department in FUDMA

- 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.

E. FMEnv/ Katsina State Ministry of Resource and Development

- 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.

CHAPTER NINE: STAKEHOLDER ENGAGEMENT AND GRIEVANCE REDRESS MECHANISM

Consultations are an important tool in identifying the major environmental and social issues that form a vital aspect of the preparation of this ESIA. A Stakeholder Engagement Plan (SEP) which aims at facilitating the development and sustainable implementation of various stages of the Project's life cycle from (pre-construction to, construction, operations, and decommissioning) was done during preparation of this ESIA document.

It describes the process by which stakeholders were identified; the means by which they were consulted; and the outcomes of the consultations to date. It also describes the actions that the Project took to disclose pertinent information to stakeholders.

9.1 Stakeholder Engagement

A Stakeholder Engagement Plan (SEP) is the process of managing stakeholder expectations which influences project decisions throughout the life cycle of the project. This process provides a plan to interact effectively with stakeholders and support the project interest.it is very important to plan these activities well so that they appraise the contribution of stakeholders on projects, manage their expectations also achieve project objectives.

Stakeholder engagement process focusing on free, prior and informed consultation (FPIC) shall be conducted with the community and other stakeholders, and take into account modalities of vulnerable and marginalized communities may be involved. The consultation shall include prior disclosure of information in a manner accessible and understandable to communities, key informant interviews, focus group discussion (male& female, youth) and public consultation. The consultation shall be documented with required facts, figures and evidence including participant list with contact details, photographs. Information shall be disclosed as per the requirement of National Regulations EIA Act No. 86 of 1992 (as amended by the EIA Cap E12 LFN 2004**)** and the African Development Bank's Integrated Safeguards System.

9.2 Objectives of Stakeholder Engagement

The objectives of public participation in an ESIA are to provide sufficient and accessible information to potentially interested and affected parties/stakeholders in an objective manner to assist them identify issues of concern, and provide suggestions for enhanced benefits and alternatives. 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:

- Identify key stakeholders that can influence the Project and its activities;
- 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;
- Identify the most effective methods and structures through which to disseminate project information, and to ensure regular, accessible, transparent and appropriate consultation;
- 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.

9.3 Disclosure and Participation Plan

Information disclosure is an important activity not just as a form of engagement but for also enabling the other engagement activities to be undertaken in an informed and participatory manner. This section outlines the process to be followed for the disclosure and participation as part of the EEP implementation.

It is required under the AfDB operational Safeguards that the Proponent will maintain and disclose as part of the environmental and social assessment, a documented record of stakeholder engagement, including a description of the stakeholders consulted, a summary of the feedback received and a brief explanation of how the feedback was taken into account, or the reasons why it was not.

9.3.1 Disclosure Mechanism

The process of information disclosure can be undertaken in two ways: either voluntary disclosure or disclosure as part of the regulatory requirements (EIA requirements, public hearing). While regulatory disclosure involves the provisioning of information as required by the authorities and agencies involved in the project, voluntary disclosure refers to the process of disclosing information to the various stakeholders in a voluntary manner.

This disclosure not only allows for trust to be built amongst the stakeholders through the sharing of information, but it also allows for more constructive participation in the other processes of consultation and resolution of grievances due to availability of accurate and timely information.

9.3.2 Process for Disclosure of Information

As a standard practice, this ESIA will be released for public review according to the AfDB disclosure procedures, and for a period of 21 days in accordance with Nigerian Regulatory Frameworks. Distribution of the disclosure material will be done by making them available at venues and locations convenient for the stakeholders and places to which the public have unhindered access. The language of the ESIA is in English. The report will be made accessible for the general public at the following locations:

- The EA Department of the Federal Ministry of Environment;
- The Katsina State Ministry of Resource and Development,
- The Federal University Dustin-Ma, Katsina State and
- Other designated public locations to ensure wide dissemination of the materials.

Electronic copies of the ESIA report will be placed on the website of the AfDB. This will allow stakeholders with access to Internet to view information about the planned development and to initiate their involvement in the public consultation process.

The mechanisms which will be used for facilitating input from stakeholders will include press releases and announcements in the media, notifications of the aforementioned disclosed materials to local, regional and national NGOs, relevant professional bodies as well as other interested parties.

9.3.3 Timetable for Disclosure

The disclosure process associated with the release of project E&S documentation will be implemented within the following timeframe:

- Placement of the ESIA report in public domain (FMEnv and AfDB website) – dates to be confirmed by REA.
- 21-day disclosure period – dates to be confirmed by FMEnv.
- Addressing stakeholder feedback received on the entire disclosure package – Dates to be confirmed by FMEnv and REA.

The ESIA will remain in the public domain for the entire period of project development and will be updated on a regular basis as the project progresses through its various phases, in order to ensure timely identification of any new stakeholders and interested parties and their involvement in the process of collaboration with the project. The methods of engagement will also be revised periodically to maintain their effectiveness and relevance to the project's evolving environment.

The outline presented in the table 9.1 summarizes the main stakeholders of the project, types of information to be shared with stakeholder groups, as well as specific means of communication and methods of notification. Table 9.1 provides a description of stakeholder engagement and disclosure methods recommended to be implemented during stakeholder engagement process.

Table 9. 1: Stakeholder Engagement and Disclosure Methods

Stakeholder Group	Project Information Shared	Means of communication/ disclosure
• Project Beneficiary	• ESIA report; • RAP/ aRAP • Regular updates on Project development.	• Public/Disclosure notices at university (FUDMA) • Electronic publications and press releases on the Project web-site. • Dissemination of hard copies at designated public locations. • Press releases in the local media. • Consultation meetings.
• AfDB	• ESIA Report; • RAP/ aRAP; • Regular updates on Project development.	• Electronic publications and press releases on the AfDB's web-site. • Submission of hard copies.
• Non-governmental Organizations	• ESIA Report, • Regular updates on Project development.	• Public notices. • Electronic publications and press releases on the project web-site. • Dissemination of hard copies at designated locations. • Press releases in the local media.

(Source: Sustainabiliti Limited, 2022)

9.3.4 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.

9.4 Stakeholder Identification and Analysis

9.5 Summary of the socioeconomic study and stakeholder consultation

- Socioeconomic study for the proposed Solar Project under the phase III of the energizing education program (EEP) project by the government of Nigeria in collaboration with the donor agency have been carried out;
- The socioeconomic study was carried through random questionnaires administration, in-depth interview (IDI), literature review, and community survey;
- The proposed Solar Power project for the University of Port Harcourt campus, Rivers State.
- Administratively, the school is headed by the Vice-Chancellor and other five principal officers;
- The planned project would be located on a land that is presently not in major use except for seasonal farming; consequently, no displacement of livelihoods (as staff farmers can harvest their crops and be allocated other portions of land in the University to continue farming), cultural properties, and human habitation is envisaged;
- Economy of the school is basically retails and it includes commercial tricycle operators;
- Site location met the necessary requirement indicated in the project technical;
- Major environmental challenge of the community is erosion and poor drainage system due to unpaved road networks;
- No youth restiveness is associated with the University;
- Various security measures are in place to ensure safety of people and properties;
- Common health challenge of the people of the project area is Malaria and typhoid;
- The proposed development is expected to contribute positively to the academic learning of the University and reduce cost of powering the school through diesel powered generators.

9.5 Grievance Redress Mechanism

This section shall describe the grievance redress mechanism for general grievances and GBV/SEA related grievances (including a GBV action Plan). The standard GRM of REA will support but not replace the site-specific grievance mechanisms established at subproject level.

Grievance redress mechanism (GRM) is a framework which enables local communities and relevant stakeholders of a project to raise issues (including logging, tracking, and grievances resolution) about the project which are addressed efficiently and effectively while issues as regards implementation are resolved. 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.

9.4.1 Grievance Redress Mechanism Process

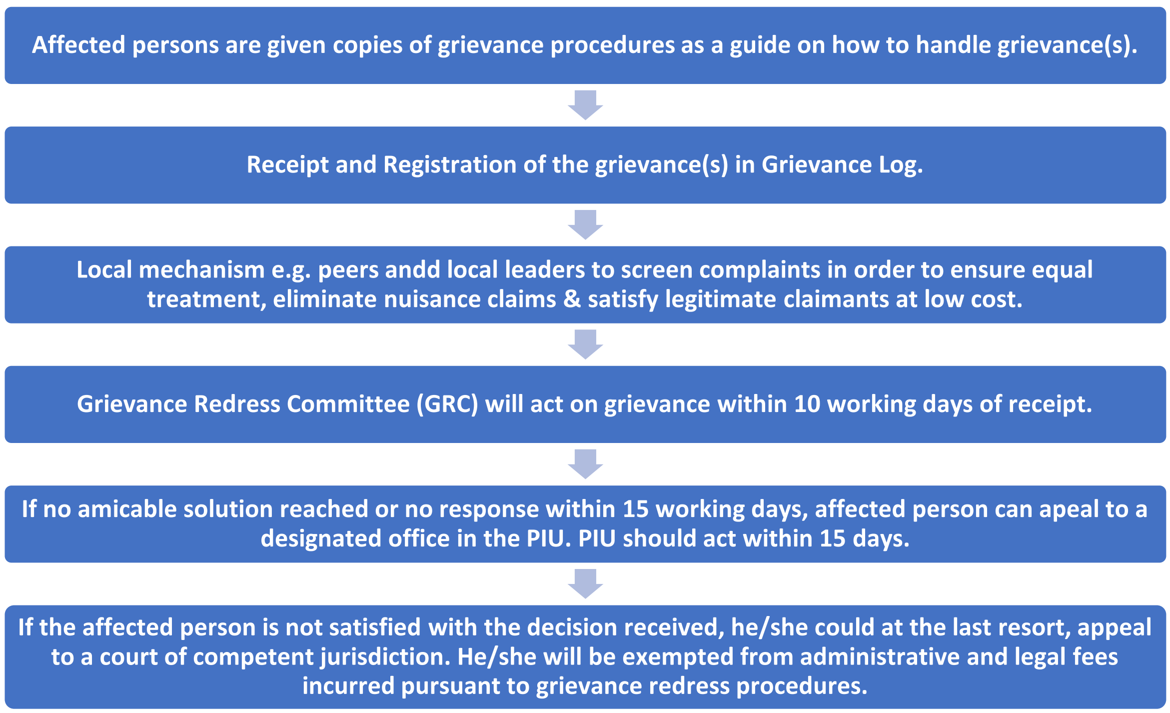

Figure 9. 1: GRM process
(Source: AfDB-Nigeria Electrification Project (NEP) Hawthorne Valley Farmscape Ecology Program).

9.5. Publicizing and Disclosure of the GRM

The GRM will be disclosed to the stakeholders through written and verbal communication. The mediums to be used for this purpose are public meetings, group discussions The GRM disclosure will be done along with the disclosure of other management plans.

9.6. Receiving and Recording Grievances

As part of the GRM, the grievances from the stakeholder or their representatives may be communicated verbally (in person or over a telephonic conversation) or in written form (in the format given) to the project representatives or to the designated Grievance Officer (GO) directly. If the grievance is received directly by the GO or other project representatives, it will be recorded directly into the Grievance Form as soon as the personnel return to site. A sample grievance form is as follows:

Table 9. 2: Grievance Recording Form

GRIEVANCE REGISTRATION	
Case No.:	Date:
Name:	
Office Location:	Unit:
Phone no:	
Details of grievance:	
Name of person recording grievances:	
Designation of recording person:	
Proposed date of response to grievance:	
Signature of recording person	Signature of complainant
GRIEVANCE REDRESSAL RESPONSE	
Decision of GO (give full details):	
Claimant accepts the outcome:	
Accepted	Not accepted
Signature of claimant:	
Signature of GO:	

(Source: Sustainabiliti Limited, 2022)

All project staff will be informed that they must pass all grievances, communications to the Grievance Officer (discussed in the following section) on site as soon as possible after they are received. Details of the person lodging the grievance shall be noted and passed along with the grievance. The Grievance Officer in turn will communicate all grievances to the Social Safeguard Officer for the project.

For assisting the communication of grievances, a Register will be maintained at the project office and site camp, at which any individual/ group can come have their complaint registered.

9.6.1 Maintaining a Grievance Register

Each grievance thus received, shall be recorded in a grievance register.

This grievance register shall be updated at each stage of the grievance redressal. Once the grievance is recorded in the register, a preliminary analysis shall be undertaken by the social standard officer/ manager to ensure that the grievance is within the scope of the GRM.

9.6.2 Acknowledgment of Grievance

Upon the completion of the recording of the grievance, the stakeholder will be provided with an acknowledgment of the receipt, along with a summary of the grievance.

Box 9.1: Acknowledgement Receipt for Claimant

This receipt is acknowledgement of grievance registration by__________, resident of ---community/staff of -------- department _______________________________________ on date _______________. His /Her case number is ________________ and the date for response is __________________. **Full name & signature of recording person**

(Source: Sustainabiliti Limited, 2022)

In case the grievance is assessed to be out of the scope of the GRM, a communication towards the same shall be made to the grievant, and an alternative mode of redressal shall be suggested.

9.6.3 Site Inspection and Resolution

For the purpose of verifying and resolving the grievances received, site inspection may not be required in all the cases. Depending upon the sensitivity of the issue, requirement of a site inspection will be identified.

A site inspection will be undertaken by the site level community liaison officers or the project member assigned by the Social Safeguard Officer. The purpose of the site inspection will be to check the validity and severity of the grievance. For this purpose, the personnel may also undertake discussions with the concerned external stakeholder. The inspection will be undertaken within ten days of receiving the grievance. The assigned individual will then work with other relevant members of the Project team to investigate the problem and identify measures to resolve the grievance as appropriate. The personnel to be involved in the grievance resolution shall be dependent upon the nature of the grievance, as discussed in table 9.3.

Table 9. 3: Classification and Categorisation of External Grievances

S/N	Nature of Grievance	Categorisation
1.	Compensation	Environmental and Social Safeguard Officers

S/N	Nature of Grievance	Categorisation
2.	Resettlement implementation related	University, Project Management, Social Safeguard Officer and Contractors
3.	Compensation on account of damage to community forest / property	Contractor, Social and Environmental Safeguard Officers
4.	Environmental impact, Community health, culture and customs /access to agriculture or mining site etc	Project Management, Environmental and Social Safeguard Officer
5.	Migrant worker related issues	Contractor, Social Safeguard Officer
6.	Sexual harassment / GBV	Human Resource Executive of Contractor/ Social Safeguard Officer of PMU
7.	Others	Contractor, Environmental and Social Safeguard Officers, Project Manager

(Source: Sustainabiliti Limited, 2022)

9.6.4 Resolution, Escalation, and Closure

Based on the understanding thus developed, the social safeguard officer, in consultation with the concerned departments, shall identify a suitable resolution to the issue. This could involve provision of information to clarify the situation, undertaking measures to remedy actual problems or compensate for any damage that has been caused either by financial compensation or compensation in-kind, and introduction of mitigation measures to prevent recurrence of the problem in the future. This resolution shall be accordingly communicated to the grievant within 10 working days of completing the site investigation.

In case the issue is beyond the purview of the social safeguard officer, it should be escalated to the Head PMU of the NEP (as appropriate). A communication regarding the same shall be provided to the grievant. The Head PMU of the NEP shall in turn endeavour to resolve the grievance within 10 working days of the escalation.

If, however, the grievance remains unsettled, and the Head PMU of the NEP is not able to identify an adequate resolution for the grievance, then an adequate response shall be given to the grievant along with a suggested alternative resolution to the grievance including to take the matter to the citizens' rights mediation-centre for the settlement before a law court is considered.

If at any stage, the grievant is not satisfied with the solution, s/he may choose to ask for an escalation of the grievance to the next level. Where a grievance is found to be not a real problem a clear explanation will be provided to the complainant.

9.6.5 Update of Records

The records of the grievance register shall be updated every working week with the present status of the grievance. Once the grievance is resolved, and the same has been communicated to the grievant, the grievance shall be closed in the grievance register. The grievance register should also provide an understanding of the manner in which the grievance was resolved. These instances shall then serve as references for any future grievances of similar nature.

Where there is evidence of recurring issues or grievance coming up on the project, it is necessary to flag this up to Head PMU of the NEP in order to assess if the project design requires updating.

CHAPTER TEN: CONCLUSION AND RECOMMENDATIONS

10.1 Conclusion

The Environmental and Social Impact Assessment (ESIA) of the proposed 1.9 MW based solar power plant in Federal University Dustin-Ma, Katsina State project has been conducted to meet government, financiers, regulators policies, laws & regulations, and stakeholders views, that proactive environmental and social actions be incorporated into project design/ plan.

The study was carried out in line with regulatory requirements for environmental and social management in Nigeria. One of such regulation is the Nigerian EIA Act Cap E12 LFN 2004, which stipulates that an EIA is compulsory for projects of this magnitude that have potential for significant environmental impacts. Also, the ESIA has been carried out to meet the African Development Bank's operational safeguards.

The ESIA process aims at providing detailed information for decision-making and to contribute to environmentally and socially sound and sustainable development.

Consultations with the relevant stakeholders have been carried out and shall continue throughout the project lifecycle. Consultation and engagement meeting ensured that all answers to questions concerning the proposed project were provided to the satisfaction of stakeholders.

Environmental and social baseline conditions (biophysical and socio-economic) as well as sensitive components of the study area were established through field data gathering/ sampling and complemented with information from literature/ desktop research, maps and information from articles on the area. The established baseline data will serve as future reference and for monitoring purposes.

Interactions between the biophysical and socio-economic components of the existing environment and the solar power plant project environmental aspects were used to identify, characterize and evaluate the potential and associated impacts of the proposed project. Thereafter, mitigation measures/ recommendations to ensure the sustainability of the project based on best industry practices, available technology and HSE considerations were developed for the significant impacts.

An Environmental, Social Management Plan (ESMP) was developed in the course of this study to ensure that procedures for managing adverse impacts of the power plant operations as well as the implementation of the environmental and social commitments made are maintained throughout the duration of the project. The ESMP also contains the environmental monitoring programme that would be used to monitor future changes to the environment from project activities. As a result, REA would ensure that air pollutants, noise and groundwater are monitored in line with FMEnv and AfDB's standards.

Finally, it is hoped that all necessary information/ evidence contained in this report is sufficient in the development of an Environmental Impact Statement (EIS) and acquisition of necessary permits for the operation of the solar power plant project.

10.2 Recommendation

The ESIA study recommends the following:

1. Continuous monitoring of the performance of the solar project by the PMU (Project Management Unit)
2. Close monitoring that the project is carried out within the recommendations of ethical allowance with regards to the populace.
3. The monitoring committee should ensure that there are no security disruptions to the personnel's carrying out the solar project/installations.

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ANNEX

Annex 1: Terms of Reference for the preparation of Environmental and Social Impact Assessment in Federal University Dustin Ma, Katsina State

1 INTRODUCTION/ BACKGROUND

The Federal Government of Nigeria (FGN) has received financing from the African Development Bank for the Nigeria Electrification Project (NEP) and intends to apply part of the proceeds for Consultancy Services for the preparation of an Environmental & Social Impact Assessment (ESIA).

2 DESCRIPTION OF THE PROJECT

The Nigeria Electrification Project (NEP) is focused on practical, medium-term opportunities to significantly upscale electricity access through off-grid with different components. i.e. ***Component 1: Solar Hybrid Mini Grids for Rural Economic Development; Component 2: Productive Use Appliances and Equipment;*** and ***Component 3: Energizing Education Programme (EEP).***

Component 3: Energizing Education Programme (EEP)

This EEP initiative will provide off-grid captive power plants for the generation and provision of dedicated and uninterrupted power supply to thirty-seven (37) Federal Universities and seven (7) affiliated University Teaching Hospitals ("UTHs") across the six geo-political zones in Nigeria. The project will be implemented in phases and this ToR is for the third phase of the EEP, which consists of eight (8) universities (see table below for list of universities). The scope of the EEP Phase III projects shall also include the provision of streetlights within the university campuses, a renewable energy work training centre, upgrade of the existing distribution network (if necessary), as well as the provision of power to the rural communities surrounding the universities in the long-term. The universities under this phase will utilize technologies based on solar hybrid (11MW) and/or gas (8.5MW) power systems.

The socio-economic benefits attached to this rural electrification access intervention are significant and largely impacts not just the power, education and healthcare sectors but also provides as a measure to ensure Nigeria achieves its targets as contained in Nigeria's Nationally Determined Contributions (NDCs) under the Paris Agreement.

The EE Programme received Presidential approval in 2016 as part of the Rural Electrification Strategy Implementation Plan and is a key programme towards achieving the objectives to the Power Sector Recovery Program.

Towards ensuring best practice and compliance with the NEP Environmental and Social Management Framework (ESMF) and the Environmental Impact Assessment (EIA) Act, this ToR specifically focuses on (i) the acquisition of the necessary Ministry of Environment approvals, through developing and furnishing the Ministry with an Environmental and Social Impact Assessment (ESIA) required for the implementation of the EEP projects under the Rural Electrification for the off-grid and in particular the PV solar systems (ii) achieving compliance with African Development Bank's Integrated Safeguards System, and (iii) the acquisition of certified Land Survey Plans approved by the Surveyor General.

3 STATUTORY LEGAL AND ADMINISTRATIVE FRAMEWORK

The statutory (legal and administrative) frameworks within which the consultancy activities shall be executed are provided in the following regulations, guidelines and standards (Note: these regulations are not exhaustive):

- African Development Bank's Integrated Safeguards System.
- The regulations, guidelines and standards of the Federal Ministry of Power as it concerns high voltage power transmission in Nigeria.
- All International Conventions/Treaties on Environmental Protection/Social Welfare to which Nigeria is a party.
- The regulations, guidelines and standards of the Federal Ministry of Environment concerning power generation and transmission activities in Nigeria.
- The regulations, guidelines and standards of the various State Ministries of Environment and Social Welfare.

4 OBJECTIVES OF THE ASSIGNMENT

The objective of this consultancy is to prepare an Environmental and Social Impact Assessment (ESIA) for power systems constructed under the Energizing Education Programme (EEP) component, in line with the requirements of the Federal Government of Nigeria and the African

Development Bank's Integrated Safeguards System to ensure that any adverse effects on the environment are properly mitigated.

This consultancy will also include the preparation of Land Survey Plans certified by the Surveyor General of the Federation, for the area of land earmarked for the projects at each of the beneficiary university sites.

Moreover, this study is scheduled to be undertaken at the same time as the Front-End-Engineering-Design (FEED) stage of the proposed EEP as the ESIA will aim to identify the key environmental issues at the conceptual design phase so as to enhance, where possible, 'alternative designs and process'.

By so doing, the ESIA team will provide environmental information to the engineering team at a very early stage of the basic engineering process for a successful integration of the Best Available Technologies (BAT) and control measures to ensure the Project's environmental performance. The results of the ESIA study are intended to be subsequently used during the Detailed Engineering, Procurement and Construction (EPC) stage of the project.

The successful Consultant shall work closely and report to the Managing Director of the Rural Electrification Agency (MD-REA) through the Environmental & Social (E&S) Team of the NEP Project Management Unit (PMU), to achieve the key objectives of the assignment, which shall include:

I. The specific activities, which the ESIA is to address includes:

- project design;
- construction; and
- operation of the university power plants and associated infrastructure.

II. Obtain all E&S related government required approvals and licenses and ensure full compliance of the project to relevant legal, regulatory, and other E&S requirements;

III. To consider project induced environmental and social impacts, whether they be adverse or positive impacts, including impacts on people living with disability, and identify means to either eliminate or minimize the adverse impacts whilst at the same time seeking to enhance the positives;

IV. Document the ecological and socioeconomic baseline conditions of the study area and the affected communities;

V. Determine the potential assets, to be affected directly by the project activities;

VI. Classify the types of assets to be affected by project activities (e.g. crops, farm-land, structures, traditional sites graveyards, shrines etc.);

VII. Conduct a Social Survey of the respective project location/sites and adjoining surrounding areas including:

- To describe the social environment (socio-cultural characteristics; various communities, languages, cultural beliefs/practices, occupation, means of livelihood, settlement pattern, gender issues, etc) of the project area;
- Identify any vulnerable groups, such as women and people with disabilities who may need special assistance or support;
- Identification of any communities or households that will need to be resettled following the implementation of the investment;
- Organize gender disaggregated stakeholder consultations before, during and at the close of the project to capture the concerns of the various stakeholders about the project including GBV (limited to desk review e.g. the country portfolio GBV assessment report): - this shall include but is not limited to the distribution of questionnaires and other information gathering techniques);
- Document the results of the consultations;
- Document the land tenure systems in the respective project areas and highlight any legacy issues pertaining to the initial acquisition of the land of the respective project sites;
- Include detailed land characteristics and use (i.e. topography, soil characteristics, terrain stability and susceptibility to erosion or landslip, existing land uses occurring at the

proposed site, and existing surface characteristics of the surrounding area). Further, existing land uses occupying the surrounding area should be delineated, particularly for those land uses which would be sensitive to the project, and which could contribute to cumulative effects on local resources;

- Review all relevant documentation pertinent to the conduct of this assignment;
- Include in the final ESIA report a detailed Environmental and Social Management Plan;
- Communicate the concerns captured, during consultation, to the REA-PMU through the appropriate channels to be established and incorporate same in the progress reports.

VIII. Conduct stakeholder engagement, including Grievance Redress Mechanisms (GRM), with women and people living with disability in the engagement process.

IX. Meet the requirements or recommendations of the applicable national and international regulations and standards;

X. Be guided by the African Development Bank's Integrated Safeguards System.

XI. Consultation and communication with relevant Regulatory Agencies/ Stakeholders at the Federal, State and Local Government level on the proposed Programme (disaggregated according to gender and disability inclusion), including:

- Federal Ministry of Environment;
- Federal Ministry of Women, Youth and Social Development;
- State Ministries of Environment;
- State Ministries of Youth and Social Development;
- Respective Local Government Councils;
- State Environmental agencies; and
- Community Based Organizations, (Civil Society, NGOs) in the affected States.

XII. Liaise with the E&S unit of the PMU to obtain final ESIA approval from the Federal Ministry of Environment.

XIII. Conduct Land Survey's at the respective project sites and produce Land Survey Plans for the respective beneficiary institutions.

5 SCOPE OF THE ASSIGNMENT AND GENERAL APPROACH

The Consultant, who shall be duly registered with the Federal Ministry of Environment, towards achieving the objectives detailed under Section 4, shall carry out the following activities:

I. **Desktop review and Mapping**:

- Issuance of Information Request Sheet
- Gathering of relevant project and environmental documents
- Desktop review of relevant documents
- Initial Identification and analysis of Stakeholders, with priority on affected communities
- Preparation of survey maps
- Preparation of detailed work plan
- Preparation of draft survey tool

II. **Field Data Gathering and Laboratory Analysis**

- Stakeholder meetings
- Baseline environmental data gathering
- Land-use mapping
- Land Survey – including boundaries, land title and location surveys establishing the extent, alignment, terrains/topography and acreage of the land, easements, or other legal interests
- Biophysical surveys (ecology, air quality, soil/water quality, etc.)
- Social baseline information including gender and disability dynamics of the project area
- In-depth interview sessions, focus group discussions and questionnaire administration
- Transportation and traffic surveys
- Identification of potential specific project affected groups vulnerable groups/persons/households people living with some form of disabilities
- Laboratory analysis in a laboratory, which should be fully accredited by the FMEnv

III. **ESIA Inception and Draft Report Writing**

- Detailed baseline descriptions
- Preparation of additional maps
- Identification of environmental and social aspects and impacts
- Analysis of alternatives
- Identification of measures needed for compensation and livelihood restorations, including any further plans that need to be prepared
- Draft ESIA
- Certified Land Survey Plans

IV. **Final ESIA Report Writing and Regulatory Activities**

- Submission of Draft ESIA Reports to the FMEnv and the African Development Bank
- Draft Final ESIA Reports to be reviewed by the FMEnv
- Submission of Draft ESIA Reports to E&S unit of REA-PMU
- Review of Draft Final ESIA Reports by E&S unit of the PMU
- Submission of Final ESIA Reports to the FMEnv
- Payment of final regulatory fees
- Issuance of ESIA Approval Letters by the FMEnv

6 REPORTING AND DELIVERABLES

The Consultant is expected to work closely and report to the E&S Unit of the PMU towards successfully executing the assignment.

Report Structure: In accordance with the detailed ESMF (adopted by the AfDB) prepared for the NEP, the indicative Table of Contents (ToC) of the ESIA is expected to be as follows:

Executive Summary

This section shall describe the subproject activities, critical environmental and social issues, significant findings and recommended actions.

1. Introduction

i. Background of the subproject

ii. Scope and objectives of the ESIA study

iii. Study methodology in details

iv. Limitations of the study

v. Composition of study team

2. Policy, Legal and Administrative Framework

i. FGN requirements and relevant legislation

ii. African Development Bank's Integrated Safeguards System.

iii. International agreements

3. Description of the Subprojects

i. Background and Rational of the Project

ii. Project Site and Location

- Description of the location of the proposed subproject with maps
- Project area of influence
- Nearby communities, environmentally sensitive areas, and heritage sites (For solar mini grid buffer zone should be 1 km)

iii. Technical Aspects

- Description of the subproject components, permanent and temporary facilities
- Project equipment and civil works
- Project ownership
- Summary of project structures and operating regime
- Construction activities
- Operation and maintenance
- Manpower requirements (including local and migrant workforce)
- Construction machinery, materials and other supplies (including estimated numbers/quantities)
- Land filling activities (if any)

- Power supply arrangements
- Waste generation and disposal (including estimated quantities)

4. Baseline Environmental Conditions

4.1 Physical Environment

i. Topography

ii. Geological Condition

iii. Meteorological Condition (rainfall, temperature, humidity, wind speed)

iv. Air Quality

v. Noise Quality

vi. Surface and Ground water quality

- Surface:(testing of: pH, TDS, DO, COD, BOD)
- Ground:(testing of: pH, Arsenic, TDS, alkalinity, Cl, Fe)

vii. Project location from flood level

viii. Soil Quality

ix. Water resources

x. Agro-ecological zones within project area of influence

xi. Seismicity

xii. Climate change and natural disasters

xiii. Land use

4.2 Biological Environment

i. Bio-ecological environment

ii. Flora and Fauna

iii. Protected areas

iv. Terrestrial Ecosystem, Protected areas and red book species

v. Vulnerability to Climate Change and Natural hazard

- Explain in detail about how the project will be affected by the climate change impact

- Explain how the project is vulnerable to various natural calamities including flood, earthquake, drought, cyclone etc

4.3 Baseline Socio-economic Conditions

i. Distribution of population in the project area in terms of religion, age, sex, ethnicity, income, household size, occupational patterns and their relevance with the project, poverty

ii. Project land

iii. Land use and ownership (including traditional use and ownership)

iv. Cropping and/or grazing patterns

v. Vulnerability of the Affected Peoples (APs)

vi. Employment

vii. Livelihood

viii. Physical and cultural resources (school, health post/ hospital, college, temple, monasteries etc.) in the project area

ix. Communication facility

x. Local amenities

5. Analysis of Project Alternatives

i. Reason to choose the technology

ii. Without project alternative

iii. Site Alternative

iv. Distribution line routes

v. Other temporary and permanent facilities

6. Stakeholder engagement including Grievance Redress Mechanism

Stakeholder engagement process focusing on free, prior and informed consultation (FPIC) shall be conducted with the community and other stakeholders, and take into account the modalities of vulnerable and marginalized communities who may be affected. The consultation shall include prior disclosure of information in a manner accessible and understandable to communities, key informant interviews, focus group discussion (male& female, youth) and public consultation. The consultation shall be documented with required facts, figures and evidence including a participant list with contact details, photographs. Information shall be disclosed as per the requirement of National Regulations and the African Development Bank's Integrated Safeguards System. This section shall describe the Grievance Redress Mechanism. The standard GRM of REA will support but not replace the grievance mechanisms established at subproject level.

7. Anticipated Environmental and Social Impacts and Mitigation Measures

i. General

ii. Area of Influence (AoI)

iii. Pre-construction Phase

- Land use / land filling
- Flood Hazards

iv. Construction Phase, Operational Phase and Decommissioning Phase

- Visual Amenity
- Birds and Bats Mortality
- Air Quality
- Noise
- Soil
- Water Resources
- Terrestrial Ecology
- Waste Generation
- Occupational Health and Safety
- Community Health and Safety
- Vulnerable Community
- Gender-based violence and sexual exploitation
- Employment Opportunities
- Traffic Management
- Archaeology and Cultural Resources
- Cumulative and induced impacts

v. Summary of Anticipated Impacts

8. Environmental and Social Management Plan (ESMP)

This section deals with the set of mitigation management measures to be taken to avoid, reduce, mitigate or compensate for adverse environmental, occupational and social impacts with the institutional arrangement, monitoring schedule, parameters to be monitored and soon including tentative monitoring budget. It would include the following aspects:

- Types of impacts and their mitigations
- Mitigation measures
- Environmental Code of Practices (to be attached to bidding documents and/ or contracts)
- Monitoring Plan
- Communication and documentation
- Cost of ESMP
- Integration with Project (contract clauses, others)
- Grievance resolution process
- Plan for stakeholder/ community engagement during pre-construction, construction, and operation phases; the plan should include community mobilization approach from both social and commercial perspectives.

9. Environmental and Social Benefits

This section will discuss how the project will provide benefits in the environmental sector and social life, both directly and/or indirectly.

10. Conclusion

This section shall provide the conclusion drawn from the study.

Annex 2: Survey Questionnaire

SURVEY QUESTIONNAIRE

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT PLAN (ESIA)

PHASE III: ENERGIZING EDUCATION PROGRAM (EEP) PROJECT

Dear Respondent,

Thank you for taking the time to complete the following survey. The purpose of this survey is to gain valuable insight on proposed infrastructure intervention by Rural Electrification Agency (REA) under the Power Sector Recovery Program (PSRP). The survey provides you the opportunity to contribute to the environmental and social components of the project implementation.

NOTE:

Please read each question carefully. Your answers are completely confidential and will be included only in summaries where individual answers cannot be identified. Unless otherwise instructed, please tick appropriate answer category that best describes your opinion. It will take approximately 20 minutes to complete this questionnaire.

SECTION A: Household data

Location/Name of School……………………………………..

1. Gender of Respondent: (a) Male (b) Female
2. Age: (a) Below 18 yrs (b) 18-45 yrs (c) 46-65 yrs (d) Above 66 yrs
3. Marital Status: (a) Single (b) Married (d) Divorced/Separated (e) Widowed
4. Occupation: (a) Civil Servant (b) Daily Labourer (c) Trading & Shop Keeping (d) Artisans (e) Employed (salary)(f) Retired (g) Famer (h) Unemployed (i) Others specify……………………
5. Residential Status: (a) Permanent Resident (b) Back Home (Returnee) (c) Non-Resident, Visiting
6. Ethnic Group: (a) Ebira (b) Igala (c) Hausa-Fulani (d) Igbo (e) Hausa Yoruba (f) others ……………………………………
7. Religion: (a) Islam (b) Christianity (c) Traditional

8. Relationship to Household Head (HH): (a) Self (b) Spouse (c) Child (d) Parent (e) Other, specify…...

9. Size of the HH ……………………………

10. How long have you been living/working in this area? (a) 0-2 yrs (b) 3-5 yrs (c) 6-9 yrs (d) 10 yrs and Above

11. Education: (a) NO formal education (b) Primary School (c) Secondary School

(d) Tertiary (Excluding University) (e) University Graduate (f) University Post Graduate

SECTION B: Health Status

1. How do you manage your health conditions when sick? (a) Attend hospital/clinic (b) Buys drugs from nearby chemist

(c) Traditional medicine (d) None (e) Others Specify………………………….

2. If you do attend hospital/clinic, when last did you visit one? (a) last six months (b) last one year (c) last five years (d) more than five years ago (e) Never visited one.

3. Please tick one or more of the under-mentioned ailment/sickness, you suffer from most accordingly?

Ailment	√	**Ailment**	√
Whooping Cough		Rheumatism	
Tuberculosis		Rashes	
Asthma		Eczema	
Dysentery		Ringworm	
Diarrhoea		Eye pains	
Cholera		Cataract	
Pile		Glaucoma	
Hypertension		Typhoid fever	
Congestive health problem		Malaria	
Pneumonia		Sickle cell anaemia	
Sexually transmitted diseases		Epilepsy	

7. Do you think your health condition will be affected by the proposed Infrastructure intervention? (a) Yes (b) No

8. If yes, how? ……………………………………

9. Please suggest how this can be averted during construction and implementation……………………………………………………………………………………………………

SECTION C. Standard of Living / Socio-Economic Activities 1.0 Assets

1.1 What sort of housing does your household live in?					
a. Construction material - Walls		Plastered mud	c. Number of rooms		1-2
		Cement blocks			3-4
		Other (specify)			Other (specify)
b. Construction material - roofing		Corrugated roofing	d. Other structures on plot		Animal Pen
		Aluminium			Granary
		Asbestos			Shops
		Tile			Kiosks
		Other (specify)			Other (specify)
e. Construction material - floor		Earthen			
		Concretes			
		Tiles			
		Other (specify)			
f. Toilet Facility		Pit latrine			
		Water closet			
		Toilet facility outside dwelling			
		Pier latrine			
		Other (specify)			
		None			
g. Tenure of housing		Owned			
		Rented			
		Occupied rent free			

		Other
h. Tenure of land		Owned
		Rented
		Occupied rent free
		Lease hold
		Others specify

1.2 Indicate household refuse disposal for solid waste? (Multiple options) (a) Depositing refuse at backyard of the house (b) Dumping in water body (c) Dumping in community refuse/garbage pit/dumpsite (d) Burning after gathering together (e) Waste collector (f) Other specify………

2.0 Household Services

2.1 Rank in order of availability and usability the source(s) of lighting for the household? (Please use 1, 2,...in hierarchical order with 1 indicating the most available and used source)

(a) PHCN	(b) Generator	(c) Lantern	(d) Candle	(e) Palm Oil Lamp	(f) Torchlight Battery	(g) Wood	(h) Kerosene	(i) Gas

2.2 Using the method in 2.1, indicate major source of energy for cooking?

(a) Fire Wood	(b) Coal	(c) Kerosene	(d) Electricity	(e) Animal dropping	(f) Gas	(g) Crop Residue/saw dust	Others

3.0 Sources of Water

Sources	for drinking	for cooking	for bathing and washing
a. Well			
b. Borehole/Water pump			
c. Community tap			
d. Piped water outside dwelling			
e. River			
f. Rain harvesting			
g. Water vendor			
h. Tanked water			

i. Other (specify)			

4.0 **Income**

Please, state your main income per month	₦

4.1 **Remittances**

1. Does anyone in the family who lives elsewhere send money to you?		1	YES	2	NO
2. If yes, how much (per month)	₦				

5. In your opinion, how has the standard of living of your household changed over the previous three years? (a) Same (b) Better (c) Worse
6. Is the option in 5 propelled by the state of the electricity provision/availability? (a) Yes (b) No
7. If 6 is YES, do you think the proposed infrastructure intervention will improve the situation? (a) Yes (b) No
8. If 7 is YES specify how the project will improve the situation ………………………

SECTION D: Gender-Based Violence/Sexual Exploitation and Abuse

1. Are there any provisions which restrict women's access to health and other social services? In particular which:

(Please specify in the space provided for this purpose "yes" or "no")

( ) require the consent of a male relative/husband for a married woman's medical examination or treatment or access to contraceptives or abortion,

( ) require parental consent in case of adolescents' access to contraceptives or abortion;

( ) allow medical practitioners to refuse provision of a legal medical service on grounds of conscientious objection

( ) prohibit certain medical services, or require that they be authorized by a physician, even where no medical procedure is required; in particular:

( ) IUDs (intrauterine devices) or hormonal contraceptives

( ) Emergency contraceptives, including the morning-after pill,

( ) Sterilization on request;

( ) Early abortion (in first trimester of pregnancy) at the pregnant woman's request

( ) Medically assisted reproduction (e.g., in vitro fertilization)

2. Are the following acts criminalized?

(Please specify in the space provided for this purpose "yes" or "no")
( ) adultery

( ) prostitution

(If yes, who is criminally responsible? (a) the sex worker (b) the procurer and/or the customer) (c) both

3. Are there any measures and programs put in place in order to increase women's participation safety e.g. in public urban spaces, in public transportation, etc.? (a) Yes (b) No (c) No idea

4. Are there specific training programs for medical and legal professionals on the issue of gender-based discrimination in the area of health and safety? (a) Yes (b) No (c) No idea

5. How do you ensure gender equity in the community? (a) Women are elected in public office (b) Females are given equal opportunity and access to education and employment (c) Quotas on genders are ensures in leadership of community-based organizations (d) Others specify…………………………………………...

SECTION E: Resources/ Cultural Property

1. Please indicate the environmental problems which your community experiences?
(a) Soil infertility (b) Poor drainage system (c) Bad road (d) Bad lands (e) environmental degradation (f) Degraded land (i) Destruction of infrastructures (j) Others (specify) …………………………..

2. Please indicate the environmental problems which your community would likely experience and whose cause can be linked to the proposed Infrastructure intervention project during construction? (a) Soil infertility

(b) Poor drainage system (c) Bad road (d) Low visibility (e) Erosion Problems (f) Flooding (g) Environmental degradation (g) Destruction of infrastructures (h) encroachment of land properties

(i) Pollution (air, surface water, ground water, noise) (j) others (specify) ………………………….

3. Do you think the proposed Infrastructure intervention project will affect any valued resource/cultural/archaeological property in your area? (a) YES (b) NO

4. If yes mention the name(s) of the valued resource/cultural/archaeological property …………………………

5. How will valued resource/cultural/archaeological property be affected? (a) Displacement of such valued cultural properties (b) Vandalisation of sacred items/locations (c) Possible theft of sacred/archaeological items (d) Others, specify:

……………………………

SECTION F: Intervention Project Activities Impact Evaluation

1. Are you aware of the proposed Solar Power Project? (a) Yes (b) No

2. If yes, from which source (a) Community meetings (b) Media (TV, Radio, Newspaper, Internet) (c) Others specify…………………………….

3. Do you think the proposed Infrastructure intervention project can cause restiveness in your community? (a) YES (b) NO

4. If 3 is yes how will the proposed Infrastructure intervention result in restiveness? (a) Disrespect of norms and culture by contractors (b) loss of farmland / Property (c) Possible theft of sacred/archaeological items (d) local people not employed during construction (e) Others, specify: ……………………………

5. How will the proposed Infrastructure intervention project impact on your livelihood and environment?

Positive impacts	Negative impacts
(a)	
(b)	
(c)	

6. Can you name some of the animals and other habitat that may be affected by the proposed Infrastructure intervention project?...

7. What do you expect from the activities of solar power Infrastructure intervention? (a) employment of Locals during construction (b) compensation for those whose properties will be affected (c) capacity building for maintenance during implementation (d) community input into final engineering design (e) Others please specify……………………..

Section G: Grievance Redress Mechanism

1. Have you had grievances issue in this community in the last three years? (a) Yes (b) No

2. If 1 is yes, what was the cause of the grievance? (a) Land issue (b) theft of valuables (c) vandalization of property (d) Others, please specify…………………………….

3. Who do you report your grievances in this community to? (a) School authority/management (b) Law enforcement (c) My landlord/CDA (d) traditional/community leader (e) Others, please specify………………………………

4. Are grievances satisfactorily addressed or resolved by option(s) chosen in question 3 above? (a) Yes (b) No

5. Are there any other issue(s) of concerned as regards the proposed intervention project in your area, please state clearly?..

Annex 3: Waste Management Plan

1.0 BACKGROUND

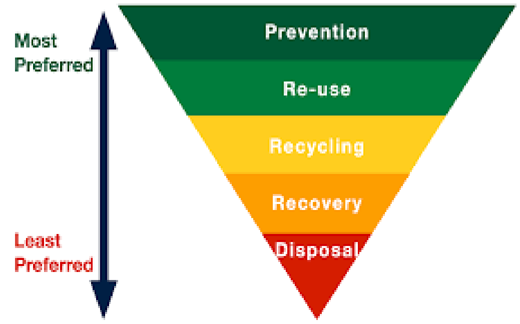
This waste management plan has been developed as part of the ESIA for the proposed Energizing Education Program III in Federal University Dustin-Ma, Katsina State. A Waste Management Plan (WMP) plays a key role in achieving sustainable waste management. The purpose of this plan is to ensure that effective procedures are implemented for the generation, handling, storage, transportation and disposal of waste that is generated from the activities on site. The plan prescribes measures for the collection, temporary storage and safe management/ disposal of the waste streams associated with the project and includes provisions for the recovery, re-use and recycling of waste.

This WMP has been compiled as part of the project Environmental and Social Management Plan (ESMP) and includes potential waste stream information based of previous experiences in similar projects. Construction practices and operations must be measured and analysed in order to determine the efficacy of the plan and whether further revision of the plan is required. This plan should be further updated should further detail regarding waste quantities and categorisation become available, during the construction and/or operational stages.

The document examines the possible types of wastes to be generated during the various phases of the proposed project as well as details of how the wastes can be handled. In putting this document together, due cognizance has been taken of the AfDB Integrated Safeguard Systems and also World Bank EHS Guidelines on Environmental waste management, which requires, among others:

- Establishing waste management priorities at the outset of activities based on an understanding of potential Environmental, Health, and Safety (EHS) risks and impacts and considering waste generation and its consequences.
- Establishing a waste management hierarchy that considers prevention, reduction, reuse, recovery, recycling, removal and finally disposal of wastes.
- Avoiding or minimizing the generation waste materials, as far as practicable.
- Where waste generation cannot be avoided but has been minimized, recovering and reusing waste.
- Where waste cannot be recovered or reused, treating, destroying, and disposing of it in an environmentally sound manner

2.0 GENERAL WASTE MANAGEMENT STRATEGY



An integrated approach to waste management is needed on this sub-project. Waste management is premised on certain principles, which include avoidance or prevention, minimization or reduction reuse, recycle, recover and proper disposal. For the current project, waste generation shall be limited to the lowest possible. Reducing volumes of waste is a priority; if reduction is not feasible, the maximum amount of waste is to be recycled; and wastes that cannot be recycled is to be disposed of in the most environmentally responsible manner as possible. The Waste Management Hierarchy, from most desirable to least desirable, is presented below:

- **Reduce**: Avoid waste by reducing the quantity of waste being generated. This is the simplest and most cost-effective way to minimise waste. It is the most preferred option.
- **Reuse**: Reuse is when a product is used again for the same or similar use, without reprocessing. Reusing a product more than once in its original form reduces the waste generation and energy consumption associated with recycling.
- **Recycle**: Recycling involves processing waste into a similar non-waste product, which consumes less energy than production from raw materials. Recycling prevents further environmental degradation, and saves landfill space and resources
- **Dispose**: Removing waste from worksites, compounds and offices, and discarding the material in a licensed landfill site, or other appropriately licensed facility.

In order to minimise and appropriately manage the waste generated on site, the following good management practices will be used:

- Reduction of waste generation (through management practices, avoiding or decreasing materials use, etc.) is the primary goal of this plan.
- Non-hazardous wastes will be segregated from hazardous wastes.
- Wastes to be sent to licensed recycling/dumpsites will be segregated by type.
- Effort will be made to minimise the quantity of hazardous materials used.
- Personnel that handle hazardous materials and wastes, will be trained for proper handling and management.

- Spills of hazardous materials will be prevented through careful and sensible management of the materials.
- Regular inspections of storage areas will be conducted. If damaged or leaking containers are detected, they will be replaced.
- Preventive maintenance will be performed on equipment to avoid potential spills.
- Waste storage areas will have secondary containment or spill trays.
- Under no circumstances will waste be disposed on site.

2.1 Classification of Wastes

The Project activities will lead to the generation of various non-hazardous and hazardous wastes.

2.1.1 Non-Hazardous Wastes

Typical non-hazardous wastes are given below:

- Domestic waste,
- Recyclable wastes (e.g. paper, glass, metals, wooden waste, trees, tin cans, textile, etc.),
- Packaging waste,
- Waste tires, and
- Excavation waste / Concrete waste generated from civil works and foundations.

2.1.2 Hazardous Wastes

Different type of hazardous wastes, that may potentially be generated as a result of the project activities, are given below:

- Electrical wastes including waste and/or damaged batteries and accumulators,
- Waste oil (from maintenance of equipment and vehicles, transformers, etc.),
- Waste paint, and
- Other hazardous waste related to operation and maintenance (O&M) and decommissioning activities.

2.2 Potential Sources of Waste

Avoiding the generation of waste remains of highest importance to (project) when considering waste minimisation and management measures.

Waste management and reuse strategies will be considered and implemented where practical and cost-effective as outlined in Table 1. On-site reuse opportunities will be maximised, with efforts made to implement reuse and off-site recycling initiatives.

Table 1 lists the waste generating aspects and identifies the range of solid, hazardous wastes that are likely to be generated by construction. It also outlines the proposed reuse, recycling or disposal method.

Table 1: Potential Waste Streams and Management Method

Activity / Waste Aspect	Types	Classification	Proposed Reuse / Recycling / Disposal Method
Site clearing and preparation	Vegetation (logs, mulched timber, weeds)	General Solid (non- putrescible)	Native Vegetation – Reuse as biodiversity measures such as habitat enhancement, compost for topsoil or soil conditioner, or modify mulching equipment to create woodchip
	Concrete, brick asphalt and gravel	General Solid (non- putrescible)	Crushed and used as backfill or as road base
	Scrap metal	General Solid (non- putrescible)	Off-site recycling
	Excavated Materials	General Waste	Beneficial soil material - reuse onsite. Balance cut and fill earthworks, where possible, to optimise reuse on the Project
	Potentially contaminated soils	Hazardous waste	Off-site disposal at an approved facility
Construction Waste	Steel reinforcing	General Solid (non- putrescible)	Off-site recycling
	Conduits and pipes	General Solid (non- putrescible)	Off-site recycling
	Concrete (solids and washouts) and asphalt	General Solid (non- putrescible)	Crushed and used as backfill or as road base
	Timber formwork	General Solid (non- putrescible)	Reuse onsite where possible or Off-site recycling
	Packaging materials, including wood, plastic, cardboard and metals	General Solid (non- putrescible)	Off-site disposal at an approved facility
	Empty oil and other drums	General Solid (non- putrescible)	Off-site recycling
	spill clean ups, paints and other chemicals	Hazardous waste	Off-site disposal at an approved facility
	Metals and bulk electrical cabling	General Solid (non- putrescible)	Off-site recycling

Activity / Waste Aspect	Types	Classification	Proposed Reuse / Recycling / Disposal Method
	Sediment basin discharge and solids (sediment)	General Solid (non- putrescible)	Beneficial reuse onsite
General Waste from compounds during construction and operation	Waste generated by the maintenance of equipment including air and oil filters, worn components and rags	General Solid (non- putrescible)	Off-site disposal at an approved facility
	Oil, grease, fuel, chemicals and other fluids	Liquid	Off-site disposal at an approved facility
	Damaged/ expired Batteries/ Inverters	Hazardous waste	Off-site Management according to the EPR with the producer or an approved FMEnv facility
	Domestic waste generated by workers including food packs, cans, bottles	General solid (putrescibles)	Off-site disposal at an approved facility
	Sanitary Waste/Sewage	General solid (putrescibles)	Off-site disposal at an approved facility
	Waste water / recycled water / stormwater	Liquid	Off-site disposal at an approved facility, or use of onsite sewer system
Office Waste	Paper, cardboard and plastic	General Solid (non- putrescible)	Off-site recycling
	Glass bottles and aluminium cans	General Solid (non- putrescible)	Off-site recycling
	Ink cartridges	General Solid (non- putrescible)	Off-site recycling
	Domestic waste including food waste generated by workers	General Solid (putrescible)	Off-site disposal at an approved facility

(Source: Sustainabiliti LTD)

3.0 PROJECT PHASE - WASTE MANAGEMENT PLAN

3.1 Preconstruction and Construction Phase

A plan for the management of waste during preconstruction and construction is detailed below. As previously stated, preconstruction and construction practices must be measured and analysed in order to determine the efficacy of the plan and whether further revision of the plan is required. A method statement detailing specific waste management practices during site clearing activities and construction shall be prepared by the Contractor prior to the commencement of works.

3.1.1. Waste Assessment / Inventory

- The Environmental Officer must develop, implement and maintain a waste inventory reflecting all waste generated during construction for both general and hazardous waste streams.
- Construction method and materials should be carefully considered in view of waste reduction, re-use, and recycling opportunities.
- Once a waste inventory has been established, targets for recovery of waste (minimisation, re-use, recycling) should be set.

3.1.2. Waste collection, handling and storage

- Each contractor/ subcontractor must implement their own waste recycling system, i.e. separate bins for food waste, plastics, paper, wood, glass cardboard, metals, etc.
- Portable toilets must be monitored and maintained daily.
- Below ground storage of septic tanks, if installed, must withstand the external forces of the surrounding environment. The area above the tank must be demarcated to prevent any vehicles or heavy machinery from driving around the area.
- Waste collection bins and hazardous waste containers must be provided by the principal contractor and placed at various areas around site for the storage of organic, recyclable and hazardous waste.
- A dedicated waste area must be established on site for the storage of all waste streams, before removal from site.
- Signage/ colour coding must be used to differentiate disposal bins for the various waste streams (i.e. paper, cardboard, metals, food waste, glass etc.).
- Hazardous waste must be stored within a bonded area constructed according to FMEnv requirements. The volume of waste stored in the bunds must not exceed 110% of the bund capacity.
- The location of all temporary waste storage areas must aim to minimise the potential for impact on the surrounding environment, including prevention of contaminated runoff, seepage, and vermin control.
- Waste storage shall be in accordance with all Regulations and best-practice guidelines and under no circumstances may waste be burnt on site.

- Vegetation removed from the site must be chipped, removed from the site and disposed of at an appropriate waste disposal facility or used as mulch on site.
- The Environmental Officer shall be responsible for ensuring the continuous sorting of waste and maintenance of the area. He/ She shall train other team members on waste handling and management.
- All waste removed from site must be done so by a registered/ licensed subcontractor, whom must supply information regarding how waste recycling/ disposal will be achieved. The registered subcontractor must provide waste manifests for all removals at least once a month.

3.1.3. Management of waste storage areas

- The position of all waste storage areas must be located away from water courses and ensure minimal degradation to the environment.
- Waste storage areas must be under roof or the waste storage bins/ containers must be covered with tarpaulins (or similar material) to prevent the ingress of water.
- Collection bins placed around site must be maintained and emptied on a regular basis.
- Waste must be stored in designated containers and not on the ground.
- Inspections and maintenance of bunds must be undertaken daily. Bunds must be inspected for leaks or cracks in the foundation and walls.
- It is assumed that any rainwater collected inside the bund is contaminated and must be removed and stored as hazardous waste, and not released into the environment. If any leaks occur in the bund, these must be removed immediately.

3.1.4. Disposal

- Waste generated on site must be removed on a regular basis, as determined by the Environmental Officer. This frequency may change during construction depending on waste volumes generated at different stages of the construction process.
- Waste must be removed by a suitably qualified contractor and disposed at an appropriately licensed landfill/ dumpsite site. Proof of appropriate disposal must be provided by the contractor.

3.1.5. Record keeping

The success of the waste management plan is determined by measuring criteria such as waste volumes, cost recovery from recycling, cost of disposal. Recorded data can indicate the effect of training and education, or the need for education.

It will provide trends and benchmarks for setting goals and standards. It will provide clear evidence of the success or otherwise of the plan. Records will include:

- Documentation (waste manifest, certificate of issue or safe disposal) must be kept detailing the quantity, nature, and fate of any regulated waste for audit purposes.
- Waste management must form part of the monthly reporting requirements in terms of volumes generated, types, storage and final disposal.

3.1.6. Training

Training and awareness regarding waste management shall be provided to all employees and contractors as part of on-site awareness sessions.

3.2 Operational and Maintenance Phase

It is expected that the operational and maintenance phases will result in the production of limited general waste consisting mostly of cardboard, paper, plastic, tins, metals and vegetation materials especially from the training centres. Limited hazardous wastes (end-of-life EEE) may also be generated during maintenance activities. All waste generated will be required to be temporarily stored at the facility in appropriate containers prior to disposal at a permitted landfill site.

The following waste management principles apply during the operational phase:

- The O&M contractor and Site Manager must develop, implement and maintain a waste inventory reflecting all waste generated during operation for both general and hazardous waste streams.
- Adequate waste collection bins at site must be supplied. Separate bins should be provided for general and hazardous waste.
- Recyclable waste must be removed from the waste stream and stored separately.
- All waste must be stored in appropriate temporary storage containers (separated between different operational wastes, and contaminated or wet waste) at each operational area prior to being taken to the waste storage area for final sorting (if required). Waste storage shall

be in accordance with all best-practice guidelines and under no circumstances may waste be burnt on site.

- Vegetation removed from the site must be chipped, removed from the site and disposed of at an appropriate waste disposal facility or used as mulch on site.
- Waste generated on site must be removed on a regular basis throughout the operational phase.
- Waste must be removed by a suitably qualified contractor and disposed at an appropriately licensed landfill site. Proof of appropriate disposal must be provided by the contractor.
- Waste EEE especially from damaged panels or end-of-life batteries shall be managed in line with the EPR plans set during purchase of all e-equipment associated with the project, and also in line with the FMEnv/NESREA regulations on e-wastes.

3.3 Decommissioning Phase

The project is expected to last for a minimum of 25 years, where with proper maintenance and management, it could last for up to 40years. Waste management principles applicable during this waste will include:

- Informing the appropriate ministries including FMEnv and NESREA about the decommissioning;
- Ensuring best practices in demolition and decommissioning to prevent pollution or contamination associated with improper waste handling.
- Use of the EPR as a standard for managing all associated e-wastes.
- Disposal of all other waste types using certified waste managers and at appropriate licensed landfills.

4.0 MONITORING OF WASTE MANAGEMENT ACTIVITIES

Records must be kept of the volumes/ mass of the different waste streams that are collected from the site throughout the life of the project. The appointed waste contractor is to provide monthly reports to the operator containing the following information:

- Monthly volumes/ mass of the different waste streams collected;
- Monthly volumes/ mass of the waste that is disposed of at a landfill site;
- Monthly volumes/ mass of the waste that is recycled; and

- Data illustrating progress compared to previous months.

This report will aid in monitoring the progress and relevance of the waste management procedures that are in place.

5.0 WASTE MANAGEMENT MITIGATION AND MONITORING COST

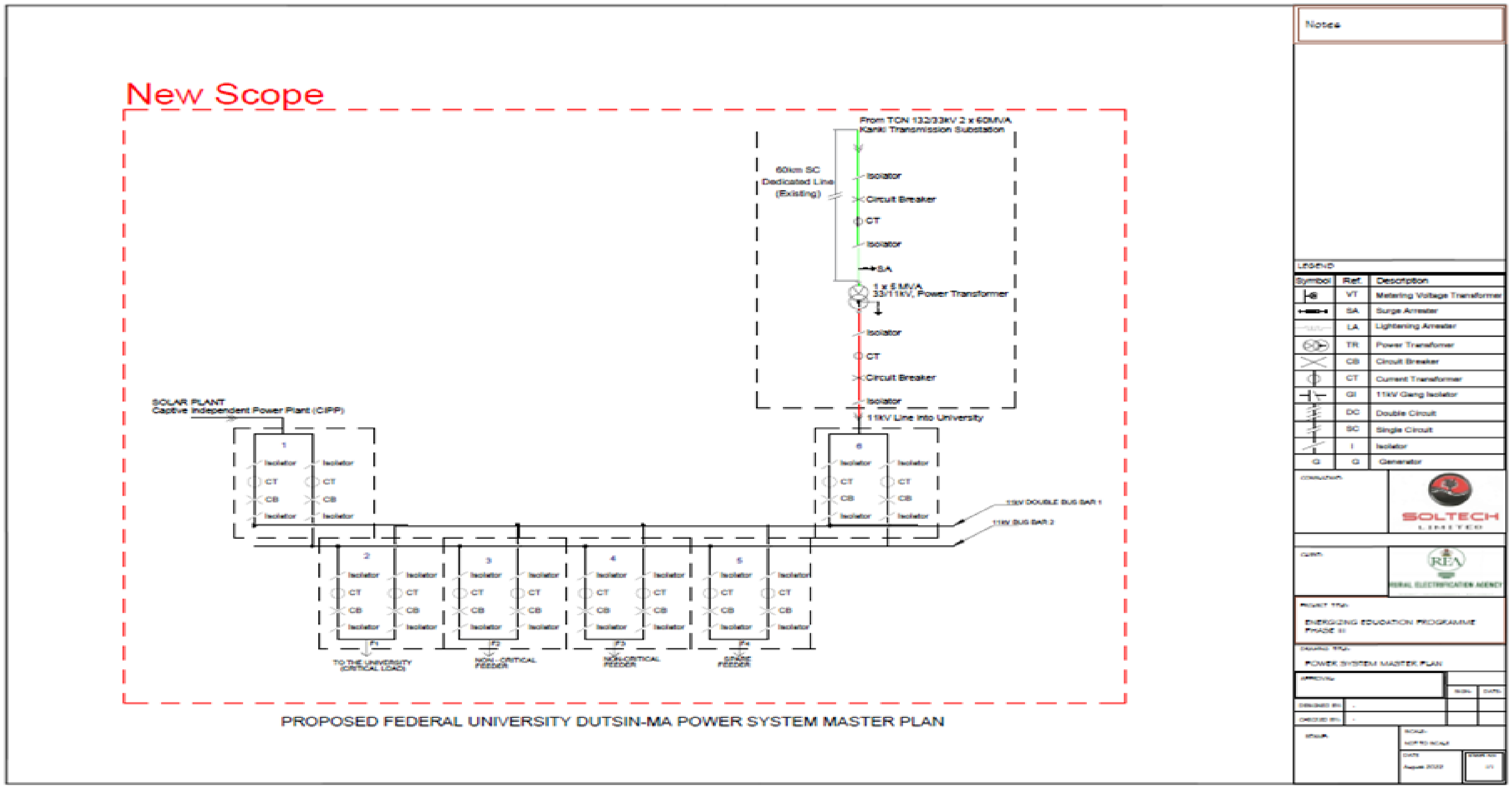
Finances must be allocated for proper waste management. The cost of mitigation and monitoring for waste management from pre-construction to operations and maintenance phase has been factored into each phase in the ESMP. This will cover trainings, PPE, receptables, containment areas and disposals.

The cost for decommissioning will be however be required to be developed at the decommissioning phase with the realities at that period.

6.0 CONCLUSION

The waste management plan iterated above has been prepared with a view to ensuring that all wastes generated from the proposed project are effectively disposed. The effectiveness of the plan is premised on a number of factors, including, prompt and timely carting away of the wastes and using the right materials and equipment. To this end, waste disposal will be carried out only by contractors certified/approved by the State Environmental Protection Agency, Katsina. In addition, adequate supervision shall be provided by the REA-PMU and the respective MDAs.

Annex 4: Proposed Federal University Dutsin-Ma Power System Master Plan



(Source: REA NEP 3 FEED)

Annex 5: Biodiversity Management Plan.

1. POTENTIAL ENVIRONMENTAL ASPECTS AND IMPACTS

The majority of the development footprint is covered by native grassland. The potential impacts of the project on the vegetation community would be both direct and indirect. The direct impacts include access roads, inverter stations and other buildings, parking and solar panel piles. The indirect impacts include areas under panels, between panel rows and areas not being used, which would experience difference levels of shading, rainfall and temperature.

During the project's planning phase, it became evident that there were some complex issues associated with the potential impacts upon native grassland as a result of installation of the solar panels and operation of the solar farm. Potential indirect impacts on native grassland include but are not limited to:

- Existing use of the native grassland over many decades for stock grazing, cropping and the impacts such grazing and other existing agricultural use of the native grassland might already be behaving upon grassland integrity and growth.
- What impact installation of the solar panels and associated aspects might have on the native grassland and use of the grassland habitat by fauna.
- Might there be negative, neutral or positive impacts to the native grassland as a result of the solar panel installation.
- What impacts factors such as shading from the solar panels might have on the native grassland.
- Opportunities to work with the ecology and natural seasons of the native grassland to avoid or minimize negative impacts while still being able to construct and operate the solar farm.

Key aspects of the Project that could result in impacts to biodiversity have been described in Table 1.1.

Table 1.1: Potential biodiversity impacts as a result of the project.

Impact	Frequency	Intensity	Duration	Consequence
Direct				
Habitat clearance for permanent and temporary construction facilities (e.g. solar infrastructure, compound sites, stockpile sites, access tracks).	Regular	High	Construction	• Direct loss of native flora and fauna habitat including: grassland habitat, woodland habitat and aquatic habitat in few university sites. • Potential over-clearing of habitat outside of the development footprint. • Injury and mortality to fauna during clearing of fauna habitat and habitat trees. • Disturbance to fallen timber, dead wood and bush rock.
Fire Break (10 m) creation and	Regular	Moderate	Construction and operations	• Alteration to grassland habitat and clearing of some woodland. • Impact on ground dwelling fauna.

Direct				
maintenance				
Vehicle movements	Regular	Moderate to high	Construction and operations	• Patches of bare ground created by repeated tyre movements.
Indirect				
Impact	**Frequency**	**Intensity**	**Duration**	**Consequence**
Edge and barrier Effects	Regular	Moderate	Operations	• Colonisation by weeds, non-native plants and pest animals.
Management of grassland biomass by mowing	Regular	High	Operations	• Potential degradation of native grassland by increased biomass reducing native species germination.
Management of grassland biomass by grazing	Regular	High	Operations	• Potential degradation of native grassland by producing nutrient rich patches from sheep waste under shaded panels. Nutrient enrichment may favour exotic animals over natives.
Shading by solar panels	Regular	Moderate	Operations	• Changes in soil moisture. • Changes in species abundance by benefitting certain species over others (likely positive).
Accidental spills and contamination from construction activities (including compound sites)	Rare	Moderate	Construction	• Pollution of waterways.
Earthworks	Regular	Moderate	Construction	• Erosion and sedimentation of waterways.
Noise	Regular	Low	Construction	• Construction machinery and activities may disturb local fauna.
Dust generation	Regular	Low	Construction	• Inhibit the function of plant species and communities, waterways.
Light spills during night works	Rare	Low	Construction	• Night works may alter fauna activities /movements.
Increased vehicle traffic	Regular	Low	Construction	• Increase potential for fauna mortality through vehicle strike.
General construction activities	Regular	Moderate	Construction	• Feral pest, weed and/or pathogen encroachment.
Vehicle movements	Regular	Moderate	Construction and operations	• Weeds spread to moderate condition PCT 45 grassland.

Direct				
Fencing	Regular	Low	Construction and operations	• Fauna fatalities.

2. BIODIVERSITY MITIGATION AND MANAGEMENT MEASURES

A range of mitigation requirements and control measures are identified in the EIA, and ESMP. Specific measures and requirements to address impacts to biodiversity are outlined in Table 2.1. The measures have been listed to cover broad activities and as such there may be some repetition of mitigation measures.

Table 2.1: Biodiversity management and mitigation measures

Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
Prior to the commencement of construction, the contractor must prepare A Biodiversity Management Plan for the development in consultation with DPP, and to the satisfaction of the PMU. This BMP: a. include a description of the measures that would be implemented for: • minimising the amount of native vegetation clearing within the approved development footprint; • minimising the loss of key fauna habitat; • managing potential indirect impacts on threatened and migratory species, including: — flora species and — fauna species; • rehabilitating and revegetating temporary disturbance areas; • protecting native vegetation and key fauna habitat outside the approved disturbance areas; • maximising the salvage of vegetative and soil resources within the approved disturbance area for • beneficial reuse in the enhancement or the rehabilitation of the site; and controlling weeds and feral pests;	• This BMP EIA • Coarse wood debris (CWD) reuse protocol • Pest and Weed Control Protocol • Ground Disturbance Protocol	Pre-construction	Site HSE Manager	• This BMP EIA

Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
Protecting and promoting the growth of native plant species (including Plant Community Types) and controlling the growth of exotic ground cover; b. include a seasonally-based program to monitor and report on the effectiveness of these measures against the detailed performance and completion criteria; and c. include details of who would be responsible for monitoring, reviewing and implementing the plan, and timeframes for completion of actions.	• Inspection and monitoring forms. • Grassland Monitoring program			
Prior to construction, surveys must be conducted for *Acacia albida*, , *Acacia seyel*, *Acacia nilotica*, *Azadirachta indica*, *Anogeissus leocarpus*, *Annona senegalensis*, *Lannea barteri*, *ziziphus mauritiana*, *Ziziphus spina-christi*, *Prosopis Africana*, *Acacia seyel*, *Acacia senegal* , *Albizia chevalieri*, *Bosewellia dalzielli*, *Lannea barteri*, *Cassia saberiana*, *Commiphora africana Combretum glutinosum*, *Combretum molle*, *Euphorbia kamarunica*, *Ficus syscomorus*, *Ficus glumosa*, *Guiera senegalensis*, *Maerua angolensis*, *Parkia biglobosa*, *Prosopis africana*, *Securidaca longepedunculata*, *Anogeissus leocarpus*, *Borassus aethiopum (big)*, *Isoberlinia doka*, *Hyphaene thabaica*, , *Butyrospermum paradoxum*, *Diospyros mespiliformis;* to determine presence or absence on the site. If a species credit is required for any of these species, then this must be incorporated into the final credit profile and offset strategy before construction commences.	EIA	Pre-construction	N/A	--------- EIA
Protection of native vegetation and fauna habitat to be retained				
Where trees are to be retained, an adequate VEZ will be provided around each tree for the duration of construction.	• Exclusion materials (temporary fencing/tape) • Vegetation Clearing Procedure	• Pre-construction • Construction	Site HSE Manager	EIA
Stockpiling and storage of materials and machinery will be avoided within the dripline (extent of foliage cover) of any native tree.	• This BMP • Mapped VEZs	Construction	• Site HSE Manager • Lead Civil Superintendent	EIA

Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
Any fallen timber, dead wood and bush rock (if present) encountered on site will be left in situ or relocated to a suitable place nearby. Rocks will be removed with suitable machinery so as not to damage the underlying rock or result in excessive soil disturbance.	• Vegetation Clearing Procedure • Vegetation Clearing Protocol • Mapped VEZs	Construction	• All plant operators • Site HSE Manager	EIA
Native vegetation areas to be retained will be delineated and construction activities will be excluded from these areas. Clearing and construction contractors will be given inductions that make clear the importance of these areas and component species.	• Mapped VEZs • Induction/training materials	• Pre-construction • Construction	Site HSE Manager	EIA
No plantings will occur within VEZs.	• This BMP • Mapped VEZs	• Construction • Operation	• Site HSE Manager • Lead Field Technician	DPP Consultation
Native grassland will be managed through mowing and/or grazing on the following recommendations: • November – December graze sheep/mow. Primarily this will reduce the level of dry matter from annual growing species for summer fire hazard. The annuals will tend to have a greater palatability/digestibility than the natives at this stage and be preferentially grazed. • Remove sheep/mow mid-August. This will allow annual grass seed heads to emerge evenly. • Mow to 5-10 cm mid-September/October when annual grasses flowering. This will prevent seed set of exotic annual species enhancing native abundance as well as reducing combustible load. • Destock/low stocking rate over summer. Enhance seed set of perennial native species. • Only mow/graze during dry season if grassland growth will result in average dry matter exceeding 5000 kg/ha DM.	• This BMP • Biomass assessment (each October) • Lease agreement with livestock owner(s) where applicable • Grassland monitoring results (after first year)	Operation	Site HSE Manager	Grassland Monitoring Program

Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
Awareness training during site inductions regarding enforcing site speed limits.	• Toolbox talks • Induction materials	Pre-construction Construction	Site HSE Manager	EIA
Plain wire is to be used on internal fencing where practicable and where it meets safety and security requirements of the solar farm.	• Infrastructure design plans • This BMP	Pre- construction	• Project Manager • Lead Civil Superintendent	EIA
Vegetation clearing protocols				
A Vegetation Clearing Procedure will be developed as required to: • Include best practice methods for the removal of woody vegetation and non-woody vegetation. • Trees will be removed in such a way as not to cause damage to surrounding vegetation. The root system areas will be rehabilitated by filling these areas with spoil from close by road construction. This spoil will have similar soil and grass composition and only come from within • the solar farm to promote germination of similar grass species. • A suitably qualified ecologist/expert to ensure that this process promotes the rehabilitation of these areas. • Require that where work cannot avoid encroaching into the Tree Protection Zone, it does not impinge on the structural root zones (SRZ) of trees to be retained. • All trees to be removed should be disposed of in accordance with the CDW procedure or WMP. • Vegetation clearing protocol includes staged habitat removal, and a requirement for an ecologist to be present during the felling of all hollow-bearing trees to ensure that potential impacts on fauna are minimized.	• Vegetation Clearing Procedure • *National Environmental (Control of Bush/ Forest fire and Open Burning) Regulations, S.1. No 15, 2011.* • National Environmental (Protection of Endangered Species in International Trade) Regulations, S. I. No. 16, 2011 • National Environmental (Control of Alien and Invasive Species) Regulations, S. I. No 32, 2013. • National Environmental (Soil Erosion and Flood Control) Regulations, S. I. No. 12, 2011.	Pre-construction	Project Manager	• Agency submissions • DPP consultation
A pre-clearing process will be implemented before clearing begins. Pre-clearing surveys will be carried out by an ecologist and will include general fauna surveys, general tree hollow	• Qualified Ecologist • Marking tape/spray	• Pre-construction • Construction	Site HSE Manager	Agency submissions

Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
inspections and waterway inspections. Habitat trees will be clearly marked with flagging tape.	• Vegetation clearing procedure			
Prior to the commencement of work, a physical boundary of the approved clearing limit is to be clearly delineated and implemented. The delineation of such a boundary may include the use of temporary fencing, flagging tape, parawebbing or similar.	• Mapped VEZs • Temporary fencing, flagging tape	• Pre-construction • Construction	Site HSE Manager	• DPP consultation
Trees with hollows should not be removed between 1 September and 1 January, in order to mitigate direct impacts to threatened fauna during the breeding season. Clearing of Hollow Bearing Trees will be avoided where possible.	Vegetation clearing protocol	• Pre-construction • Construction	• Project Manager • Site HSE Manager	Agency submissions
Clearing and construction contractors would be given inductions that make clear the importance of the VEZs and their component species.	• Mapped VEZs • Training materials	• Pre-construction • Construction	Site HSE Manager	EIA
The vegetation clearing protocol (section 5.2.1) will be followed for all vegetation clearing.	Vegetation clearing procedure	Construction	Site HSE Manager	Agency submissions
An Unexpected threatened species finds procedure (section 5.3) will be followed where any unexpected fauna is encountered	• Qualified ecologist • This BMP	• Pre-construction • Construction	Site HSE Manager	EIA
Minimise construction impact extent				
Construction activities and storage of materials for boundary fencing should be wholly contained within the proposal area. Disturbance to road reserves other than access points identified in the EIA must not occur.	• This BMP • Mapped project footprint and approved infrastructure locations • Ground disturbance permit procedure	• Pre-construction • Construction	• Site HSE Manager • Lead Civil Superintendent	EIA
Minimise clearing and avoid unnecessary disturbance associated with the construction and operation of the project.	• This BMP • Mapped project footprint and approved infrastructure locations	Construction	• Site HSE Manager • Lead Civil Superintendent	DPP consultation

Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
	• Ground disturbance permit procedure			

3. SPECIFIC WORKS AND KEY ACTIONS REQUIRED

3.1 CONSTRUCTION ACTIVITIES

This construction methodology is indicative of the staging that will be implemented at the project site. Some activities may occur in parallel, particularly given the size of the project site. The following methodology is indicative of construction sequencing and vehicle movements.

There are a lot of vehicle movements involved in the construction of the solar farm. Most of these movements terminate at the site entrance/laydown area.

The majority of vehicular traffic onsite is by light vehicle and restricted to internal access tracks only. The notable exceptions are during piling, tracker install, trenching and panel installation. Tracked piling rigs and wheeled forklifts will traverse the grasslands along and across each row. However, this is limited to only a handful of movements (pile delivery, piling, tracker install and panel fitting). Repetitive vehicle movements will be avoided to reduce soil impacts and time wastage. Tracked mini-piling machines will be used.

The schedule of work in Table 3.1 guides the key actions required for management of biodiversity for the project.

Table 3.1: Schedule of construction works

Project Phase	Potential Disturbance	Key actions and Mitigation	Performance Target
Construction site set up, construction of access.	• Disturbance to native groundcover from vehicle movements. • Disturbance and removal of fauna habitat including woody debris. • Spread of weeds, particularly high threat exotic plants.	• Clearly delineate the approved clearing and disturbance footprint using temporary fencing, flagging tape, Para webbing or similar. • Machinery, trucks and equipment will be restricted to designated parking areas. Disturbance to road reserves other than access points identified in the EIA must not occur. • Wash and inspect plant and vehicles as per Traffic Management Procedure. • Implement ground disturbance permit procedure prior to any clearing activity. • Pre-clearing surveys will be carried out by an ecologist and will include general fauna surveys, general tree hollow inspections and waterway inspections. Habitat trees will be clearly marked with flagging tape. • Trees with hollows will not be removed between 1 September and 1 January, in order to mitigate direct impacts to threatened fauna during the breeding season. • Implement Vegetation Clearing Protocol for vegetation removal. • Place CWD in remaining vegetated areas where practicable. • Record clearing and ground disturbance via spatial mapping. • Install and maintain erosion and sediment (ERSED) controls.	• No native vegetation other than the approved will be disturbed. • Direct impacts to native grassland must not exceed the identified in the EIA. • No mortality of native fauna during vegetation removal. • No pollution or siltation of aquatic ecosystems, wetlands, endangered ecological communities or threatened species habitat. • 5% low threat exotic plant cover. Remainder of the development site not to exceed 5% high threat exotic plant cover or 50% low threat exotic plant cover.
Internal road construction	• Erosion and sedimentation of drainage channels from levelling and bridge construction. • Disturbance to native fauna from lights and noise. • Disturbance of groundcover from stockpiles.	• Provide awareness training during site inductions and toolbox talks-emphasise the importance of native groundcover. • Machinery, trucks and equipment will be restricted to designated parking areas. No parking on roadside vegetation will occur.	• No native vegetation other than the approved will be disturbed. • Direct impacts to native grassland must not exceed identified in the EIA. • No dirty water leaves the site • Dirt tracking is minimised on sealed public roads.5% low threat exotic plant cover.

	• Spread of weeds, particularly high threat exotic plants.	• Plant and vehicles will be washed and inspected as per Traffic Management Procedure. • Stockpiling and storage of materials and machinery will occur only on designated direct disturbance areas. • Stockpiling and storage of materials will avoid the dripline (extent of foliage cover) of any native tree. • Direct any lighting away from woodland vegetation. • Install and maintain ERSED controls.	• Remainder of the development site not to exceed 5% high threat exotic plant cover or 50% low threat exotic plant cover.
Construction of solar farm infrastructure	• Erosion and sedimentation of drainage channels from levelling and bridge construction. • Disturbance to existing native fauna from lights and noise. • Disturbance of groundcover from stockpiles. • Spread of weeds, particularly high threat exotic plants.	• Provide awareness training during site inductions and toolbox talks- emphasise the importance of native groundcover. • Machinery, trucks and equipment will be restricted to designated parking areas. No parking on roadside vegetation will occur. • Stockpiles and storage of materials and machinery will avoid the dripline (extent of foliage cover) of any native tree. • Stockpiling and storage of materials will occur only on designated direct disturbance areas. • Direct any lighting away from woodland vegetation. • Plant and vehicles will be washed and inspected as per Traffic Management Procedure. • Topsoil will be stockpiled and replaced over direct disturbance areas as soon as practicable as per Rehabilitation and • Revegetation Protocol. • Install and maintain ERSED controls.	• No native vegetation other than the approved will be disturbed. • Direct impacts to native grassland must not exceed identified in the EIA. • 5% low threat exotic plant cover • Remainder of the development site not to exceed 5% high threat exotic plant cover or 50% low threat exotic plant cover.
Removal of temporary construction equipment	• Disturbance to existing native fauna from lights and noise. • Disturbance of groundcover from stockpiles. • Spread of weeds, particularly high threat exotic plants.	• Provide awareness training during site inductions and toolbox talks- emphasize the importance of native groundcover. • Machinery, trucks and equipment will be restricted to designated parking areas. No parking on roadside vegetation will occur.	• No native vegetation other than the approved will be disturbed. • Direct impacts to native grassland must not exceed identified in the EIA. • Moderate condition of Plant Community Type grassland not to

		• Stockpiles and storage will be occurring only on designated direct disturbance areas. • Direct any lighting away from woodland vegetation. • Plant and vehicles will be inspected and washed as per • Traffic Management Procedure. • Install and maintain ERSED controls.	exceed 2% high threat exotic plant cover, or 5% low threat exotic plant cover. • Remainder of the development site not to exceed 5% high threat exotic plant cover or 50% low threat exotic plant cover.

3.2 OPERATIONAL ACTIVITIES

3.2.1 Security and maintenance

Operational traffic within the panel area will be minimal with approximately 3-5 vehicles based permanently at the site. Periodical infrastructure upgrades may be required and will generate additional traffic movements for short periods. DPP will be contacted prior to any major upgrades or maintenance works and in the event of any incident affecting biodiversity.

Table 3.2: Schedule of operation works

Project Phase	Expected Disturbance	Key actions and Mitigation	Performance Target
Operation	• Minor ground disturbance from panel maintenance. • Disruption to the movement of native fauna. • Fauna mortalities due to contact with project infrastructure such as fences and panels. • Spread of high threat exotic plants.	• Awareness training for operational staff. • Record incidents of fauna mortalities and report threatened species encounters to DPP. • Wash and inspect vehicles as per the Traffic Management Procedure. • Implement Weed Management Procedure. • Implement Animal Pest Management Procedure as required.	• Moderate condition Plant Community Type grassland not to exceed 2% high threat exotic plant cover, or 5% low threat exotic plant cover. • Remainder of the development site not to exceed 5% high threat exotic plant cover or 50% low threat exotic plant cover. • No native fauna mortalities.
Grassland management	Impacts on native grassland condition from managing fuel load.	• Manage native grassland as per the Native Grassland Management Procedure. • Wash and inspect vehicles as per the Traffic Management Procedure.	• Moderate condition Plant Community Type grassland not to exceed 2% high threat exotic plant cover, or 5% low threat exotic plant cover. • Remainder of the development site not to exceed 5% high threat exotic plant cover or 50% low threat exotic plant cover.

4. COMPLIANCE MANAGEMENT

4.1 ROLES AND RESPONSIBILITIES

The Project Team's overall roles and responsibilities are outlined hereunder.

Key responsibilities relating to managing biodiversity during construction are:

- The EEE III Project Contractor is responsible for the development and maintenance of all management plans including the overarching environmental management strategy as listed in the EIA
- The EEE III Project Contractor /Project Manager is responsible for ensuring groundworks occur onsite in accordance with the BMP. This includes but is not limited to disturbance in designated areas only, traffic management restricting movements off internal access tracks, topsoil storage and reuse, rehabilitation of disturbed works are carried out as soon as practicable.
- The Site HSE Manager who manages the ground disturbance permit process and records a running total of vegetation clearing within the development site. The Site HSE Manager also manages the contracts with ecologists for environmental monitoring.
- The Lead Civil Superintendent is responsible for supervising construction workers and will ensure they are sufficiently trained in the protection of biodiversity and minimising disturbance detailed below. The Lead Civil Superintendent in conjunction with the Site HSE Manager will oversee weed control and rehabilitation of the site.
- The Onsite Logistics Manager is responsible for implementing the Traffic Management Plan, which includes controlling and recording heavy vehicle movements onsite. Workers involved in installing solar infrastructure will be trained and directed to limit vehicle movements between the rows of panels.

Key responsibilities relating to managing biodiversity during operation are:

- The Operator is responsible for the development and maintenance of all management plans including the overarching environmental management strategy as indicated in the EIA
- The Operations and Maintenance (O&M) Manager is responsible for ensuring groundworks occur onsite in accordance with the BMP. This includes but is not limited to disturbance in designated areas only, traffic management restricting movements off internal access tracks, topsoil storage and reuse, rehabilitation of disturbed works are carried out as soon as practicable. The O&A Manager also manages the contracts with ecologists for environmental monitoring as necessary.
- The Lead Field Technician now manages the ground disturbance permit process. The Lead Field Technician will oversee bushfire management, weed control and rehabilitation of the site to achieve biodiversity outcomes.
- The Engineering Supervisor is responsible for supervising maintenance works and will ensure workers are sufficiently trained regarding protection of biodiversity and minimising disturbance.

4.2 TRAINING

All employees, contractors and staff working on site will undergo induction training covering all procedures and protocols included within this BMP. Site induction provides an introduction to the ground disturbance permit and vegetation clearing processes, traffic movement restrictions and hygiene, threatened fauna identification and handling and locations of environmentally sensitive areas. Further details regarding staff induction and training are outlined in the EIA.

Staff and contractors will attend pre-commencement meetings at the beginning of each shift, which will include the details of any urgent biodiversity matters such as any breeched of protocols or procedures. Longer toolbox meetings will occur weekly where staff and contractors will be made aware of any less urgent biodiversity matters and reinforce training on implementing protocols and procedures.

4.3 INSPECTIONS AND MONITORING

Inspections of sensitive areas and activities with the potential to impact biodiversity will occur monthly for the duration of construction and annually for the operation of the project. General biodiversity monitoring will include a quantitative and ongoing assessment of grassland and woodland condition. Monitoring and evaluation of success will include a reflection on the seasonal conditions for the previous period.

Monitoring during construction will be monthly inspections of high disturbance areas, groundcover, protected woodland areas and boundary fence lines. These monthly inspections will include:

Details of Course Woody Debris (CWD) placement, recorded as it occurs.

- A review of any fauna killed or injured. Threatened fauna mortalities will be reported to DPP and the deaths of any birds resulting from contact with fences or solar panel will be recorded.
- Fauna relocations relating to vegetation clearing will be recorded.
- Areas of high and low threat exotic plants will be recorded and controlled on a seasonal basis

Biodiversity monitoring during operation will include:

- A quantitative assessment of groundcover will occur 6 months after construction. If groundcover is less than 70% cover during this time, corrective actions will be required. This will include consideration of soil conditions such as compaction, frequency of traffic movements, low seedbank storage, lack of soil moisture and nutrient imbalance. If soil chemistry the growth limiting factor, soil testing will be used to determine any need for amelioration.
- Feral animal and weed control surveys will occur on a seasonal basis.

Trigger points for corrective action include:

- Damaged exclusion fencing or signage.
- CWD stacked, not distributed.
- Any storage or infrastructure located underneath driplines of trees.
- Presence of injured or deceased fauna.
- Scours greater than 50 mm deep and 100 m long.
- Bare ground within native grassland patches greater than 20 m^2.
- High threat exotic plant cover greater that 2% of moderate condition plant community type
- Low threat exotic plant cover greater than 5% of moderate condition plant community type.
- High threat exotic plant cover greater than 5% for the remainder of the development site.
- Low threat exotic plant cover greater than 50% for the remainder of the development site.
- Groundcover achieves seed set across less than 70% of area.
- Observed feral animals or observations from neighbours.

A monitoring program summary is provided in Table 4.1

Table 4.1: Monitoring program summary – minimum requirements

BMP Section	Monitoring Plan	Timing / Frequency	Responsibility	Decision trigger / adaptive response	Reporting
Pre-construction					
Section 5.2.1	Inspection of VEZ marking and fencing (no-go zones) including individual trees.	At commencement of Project.	Site HSE Manager and Suitably qualified ecologist.	If fencing is damaged it is rectified.	On-site reporting.
Section 5.2.2	Survey before removal of tree vegetation. Hollows to be rechecked prior to clearing.	Before Clearing Commences on-site.	Suitably qualified ecologist.	Implement fauna handling procedure if native fauna is found roosting in hollows.	Ecologist Report.
Section 5.2.1	Visual inspection of vegetation clearance activities.	Weekly.	Site HSE Manager.	Clearing not aligned to survey, clearing to cease immediately.	On-site reporting.
Section 10.1	Issue Ground Disturbance permit.	Weekly During Construction.	Site HSE Manager.	Work will cease if no aligned to Ground Disturbance Permit.	On-site reporting.
During construction					
Section 5.2.1	Visual inspection of vegetation clearance activities.	Regularly at least weekly.	Site HSE Manager.	• If lack of exclusion fencing leads to damage to retained vegetation, stop work and report incident. Reinstate exclusion fencing as required. • Incident to be detailed at staff and contractor pre-commencement meetings at the beginning of each shift	• Site HSE Manager to inform DPE of non-compliance within 7 days. • Site HSE Manager to inform DPP immediately of incidents causing harm to threatened species, or ecological communities.

BMP Section	Monitoring Plan	Timing / Frequency	Responsibility	Decision trigger / adaptive response	Reporting
Section 5.4	Maintain a log of salvaged animals and actions taken to relocate them.	As required	Site HSE Manager.	If threatened species are identified, then triggers a review and report.	Ecologist Report.
5.4k	Inspections for fauna where footings have been left overnight.	Daily as required.	Site HSE Manager.	No work to proceed until fauna removed from footings.	On-site reporting.
	Inspection of rehabilitation works during construction.	Monthly.	Site HSE Manager.	N/A	On-site reporting.
5.4	Inspection to detect high and low threat exotic plant cover throughout development site.	Quarterly.	• HSE Manager and • Ecologist.	• High threat exotic plant cover of 2% and low threat exotic plant cover of 5% for moderate condition Plant community type. • High threat exotic plant cover of 5% and low threat exotic plant cover of 50% for the remainder of the development site.	• Site HSE Manager • Annual report to DPP.
	Inspection of high threat exotic plant cover control sites.	Monthly.	• HSE Manager and • Ecologist.	Following corrective action.	• Site HSE Manager • Annual report to DPP.
Post-construction					
	Maintain a log of mowing activities to be included with quarterly reporting on grassland management.	Quarterly.	Operations Manager.	Biomass equal to or exceeding 5000 kg/ha dry matter.	• Site HSE Manager • Annual report to DPP.
	Inspection of revegetated areas after all sowing is complete.	6 Monthly.	Operations Manager	Failed patches >5m^2. Seed set across less than 80% of the area.	• Site HSE Manager • Annual report to DPP.
Operation					

BMP Section	Monitoring Plan	Timing / Frequency	Responsibility	Decision trigger / adaptive response	Reporting
	Inspection of high and low threat exotic plant cover control sites	Quarterly	Operations Manager	• High threat exotic plant cover of 2% and low threat exotic plant cover of 5% for moderate condition PLANT COMMUNITY TYPE • High threat exotic plant cover of 5% and low threat exotic plant cover of 50% for the remainder of the development site.	• Lead Field Technician • Annual report to DPP.
	• Grassland monitoring program: • Re-sampling / Framework for Biodiversity Assessment in PLANT COMMUNITY TYPE • Sampling of at least thirty permanent 1 x 10 m plots for plant species richness and cover, % bare ground, litter and plants, and non-biomass vascular	• Six-monthly, and autumn spring. • Three years, starting autumn or spring construction • Five-yearly for the life of the project.	Expert ecologist	Increase in exotic species richness and cover	• Expert ecologist to undertake monitoring and analysis. • Annual reporting to Project Manager and DPP.

4.4 AUDITING

The Site HSE Manager will maintain a compliance register for the Project to ensure audits and reporting requirements are met within scope and within set timeframes. The compliance register will include a list of biodiversity commitments identified in the EIA, and this BMP.

Audits (both internal and external) will be undertaken to assess the effectiveness of environmental controls, compliance with this BMP and compliance with other relevant approvals, licenses and guidelines including:

- ❖ Independent Environmental Audit within six months from the commencement of construction. This will be prepared in accordance with the relevant Independent Audit Post Approval Requirements. A copy of the report will be submitted to DPP and REA PMU.

Corrective measures or actions to improve the environmental performance of the Project recommended by auditors will be reviewed by the senior management team and incorporated into strategies, plans or programs required under by the Development Consent.

The recommendations of the Independent Environmental Audit must be implemented to the satisfaction of the Secretary.

Additional audit requirements are detailed in the ESMP

4.5 REPORTING

Reporting requirements and responsibilities are documented in detailed in the ESMP.

EEE III Project Contractor will document the outcomes of pre-construction surveys required.
The Proponent will progressively monitor the clearing of native vegetation and provide a Compliance Report and mapping to ensure compliance. The Site HSE Manager will inform DPP of any non-compliance incident within 7 days of occurrence.

Any additional mitigation or management measures relevant to biodiversity have been incorporated into this BMP

Any independent environmental audit, and the Proponent's response to the recommendations in any audit will be made publicly available on the internet. Any other biodiversity matter will also be made publicly available as required by DPP.

4.6 REVIEW AND IMPROVEMENT

This BMP will be reviewed every three years. Continuous improvement of this BMP will be achieved by the ongoing evaluation of performance against the BMP environmental policies, objectives and targets to identify opportunities for improvement.

The continuous improvement process will be designed to:

- Identify areas of opportunity for improvement of environmental management and performance.
- Determine the cause or causes of non-conformances and deficiencies.
- Develop and implement a plan of corrective and preventative action to address non-conformances and deficiencies.
- Verify the effectiveness of the corrective and preventative actions.
- Document any changes in procedures resulting from process improvement.

5. PROTOCOLS AND PROCEDURES

5.1 GROUND DISTURBANCE PERMIT PROCESS

The ground disturbance permit process is integral to communicate the distinction between vegetation projection areas and the ground disturbance footprints which contractors will be working within. This process is also vital to enable the Contractor to track and control vegetation clearing on a daily, weekly and monthly basis.

The ground disturbance permit process is managed by the Site HSE Manager and is summarised below;

- Contractors are informed within their contract and site induction that all ground disturbing activities require them to obtain a ground disturbance permit prior to undertaking the work.
- The ground disturbance permit form is available in hard copy at the site office or through University Director of physical planning and must be submitted to the Site HSE Manager via email at least 48 hours before the work is undertaken.
- The Site HSE Manager will compare the proposed ground disturbance area to the project footprint detailed in the current approved development design.
- The Site HSE Manager will visit the site if required and mark out vegetation projection areas and 10 m buffer zones if applicable.
- The Site HSE Manager will either issue the permit unamended or contact the contractor for further clarification.
- Once the permit has been issued, the contractor may undertake ground works as per their contract.
- Once the work has been completed (date specified in the permit), the Site HSE Manager will inspect the site, request any additional clean up or remediation activities and sign-off that the conditions of the permit have been met.
- The Site HSE Manager will then record the disturbed area as part of a running total disturbed area for the project.

An example of the ground disturbance permit form is provided in Figure 5.1 below.

Project: EEE III Solar Farm	**Project No:**
Requested By:	
Habitat Clearing Start Date:	**Expected Completion Date:**

HABITAT CLEARING LOCATIONS – ATTACH DRAWINGS / SKETCHES IF NECESSARY

Location	Comments

This section to be completed by Ecologist and Site HSE Manager for clearing of trees, logs, rocky features, and other habitat features, with reference to constraints mapping.

Has the limit of clearing been clearly delineated?	☐ **Yes** ☐ **No**

All trees / vegetation / habitat to be retained identified and No-Go Areas fenced off?	☐ **Yes** ☐ **No**
State how identified:	☐ **Yes** ☐ **No**
Have habitat trees been identified and appropriately marked?	☐ **Yes** ☐ **No**
State how identified:	☐ **Yes** ☐ **No**
Are specific targeted surveys required?	☐ **Yes** ☐ **No**
State how survey was completed, including results:	☐ **Yes** ☐ **No**
Is there a risk of weed infestation or spread?	☐ **Yes** ☐ **No**
Are any animals present? (If Yes, relocation required)	☐ **Yes** ☐ **No**
Are any active nests/burrows present? (If Yes, relocation required)	☐ **Yes** ☐ **No**
If soil disturbance is to occur, has an ERSED Plan been created and have these controls been installed?	☐ **Yes** ☐ **No**
Have relevant workers been given toolbox talks on limit of clearing, fauna handling procedures and any other SHE Controls?	☐ **Yes** ☐ **No**
Can habitat features be re-used for habitat enhancement?	☐ **Yes** ☐ **No**
Can the habitat feature be re-used immediately?	☐ **Yes** ☐ **No**
If not re-used immediately, where will it be stockpiled?	
Comments:	

APPROVALS

Inspection completed by Ecologist: **Date:**

Ecologist Signature Required

Approval by Site HSE Manager: **Date:**

Site HSE manager Signature Required

SIGN-OFF (ONCE WORKS COMPLETED)

Have the conditions of the permit been met? **Date:**

Site HSE Manager Signature Required

Figure 5.1: Sample ground disturbance permit form

5.2 VEGETATION CLEARING PROTOCOL

When undertaking vegetation clearing, the following process shown in Figure 5.2 must be followed to minimise the area of disturbance and the amount of vegetation to be cleared.

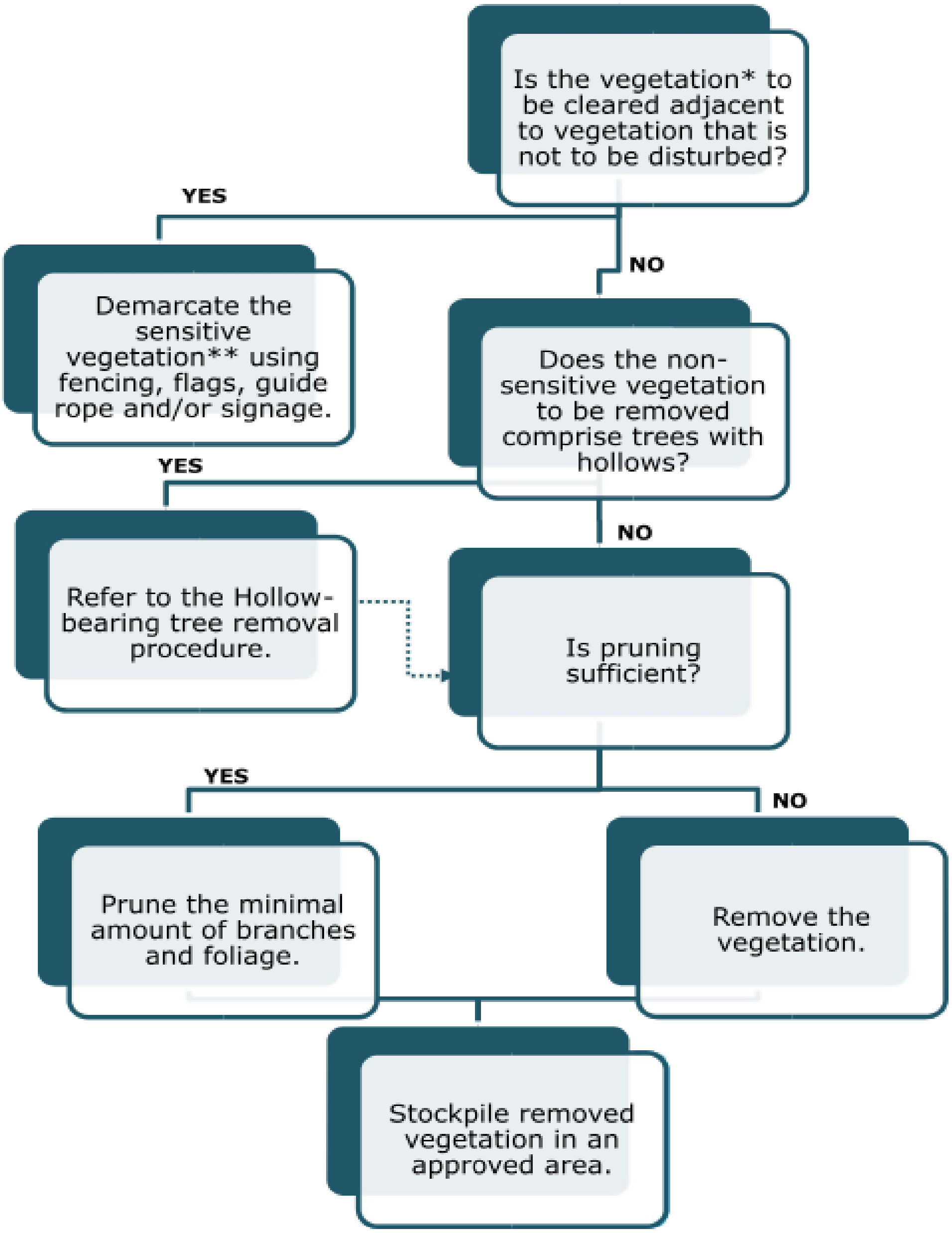


Figure 5.2: Vegetation clearance procedure

5.2.1 Vegetation Exclusion Zones

Sensitive vegetation will be protected by exclusion fencing and signage (e.g. Figure 5.3 and Figure 5.4). A 10 m VEZ will be established inside perimeter fencing. A 20 m VEZ will be established around internal woodland vegetation to ensure that sensitive vegetation is not impacted accidentally. The only exception to internal 20m zones is in the approved areas highlighted in Appendix C where it will remain a 10m Exclusion Zone. In these areas the project contractor will ensure an ecologist inspects these areas to ensure there will be no impact to protected vegetation root systems. This inspection will be documented and kept on record.

Exclusion fencing will define vegetation to be retained and beyond that a VEZ will be established to mitigate impacts from construction activities.

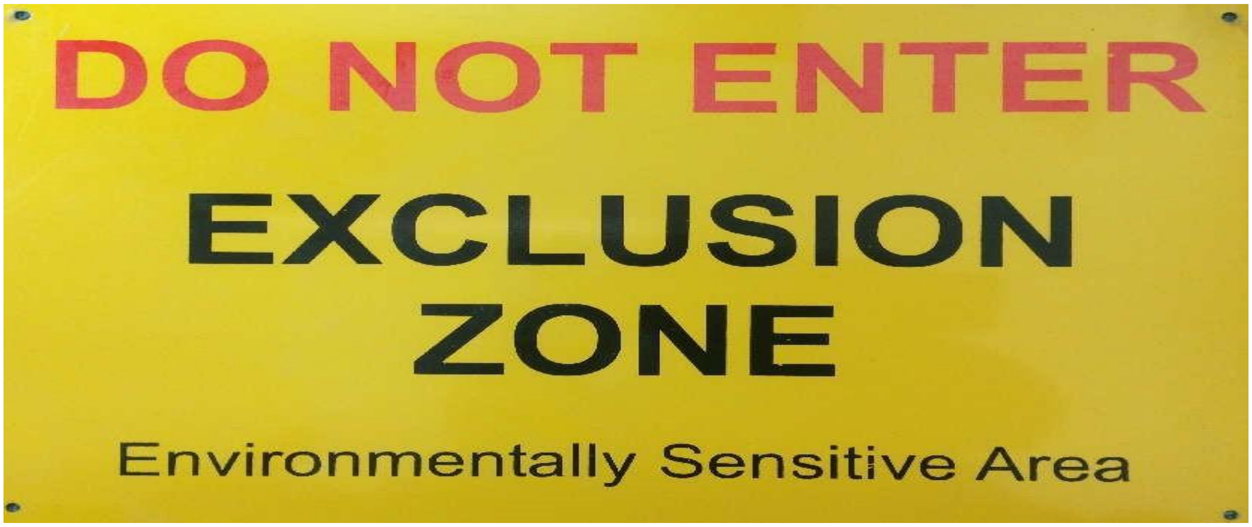


Figure 5.3: Example of exclusion zone signage.

Figure 5.4: Example of exclusion zone fencing.

5.2.2 Lopping, pruning and trimming procedure

Heavy machinery should not be used for pruning or trimming. Appropriate tools to use are loppers, chain saws and vehicle mounted saws.

In the first instance, hollow bearing limbs should be retained. If this is not possible the hollow bearing limb should be inspected by the Project Ecologist / suitably qualified expert and placed in adjacent un-disturbed vegetation to provide fauna habitat.

Tree limbs are to be removed using the three cut method as shown below in Figure 5.4.

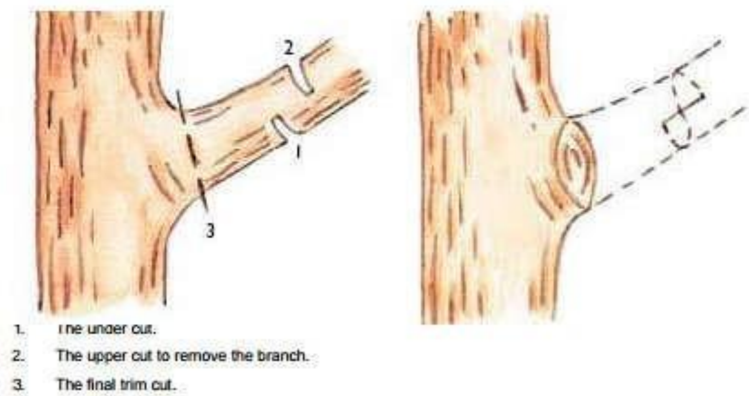


Figure 5.5: Tree cutting method

5.2.3 Hollow-bearing tree removal procedure

Hollow-bearing trees are important habitat feature for a variety of native animals such as possums, gliders, birds and bats. Before clearing any hollow-bearing trees, it is important to consider if animals are present. The following procedure (Figure 5.6) is a guide to give animals an opportunity to escape a hollow-bearing tree prior to it being removed.

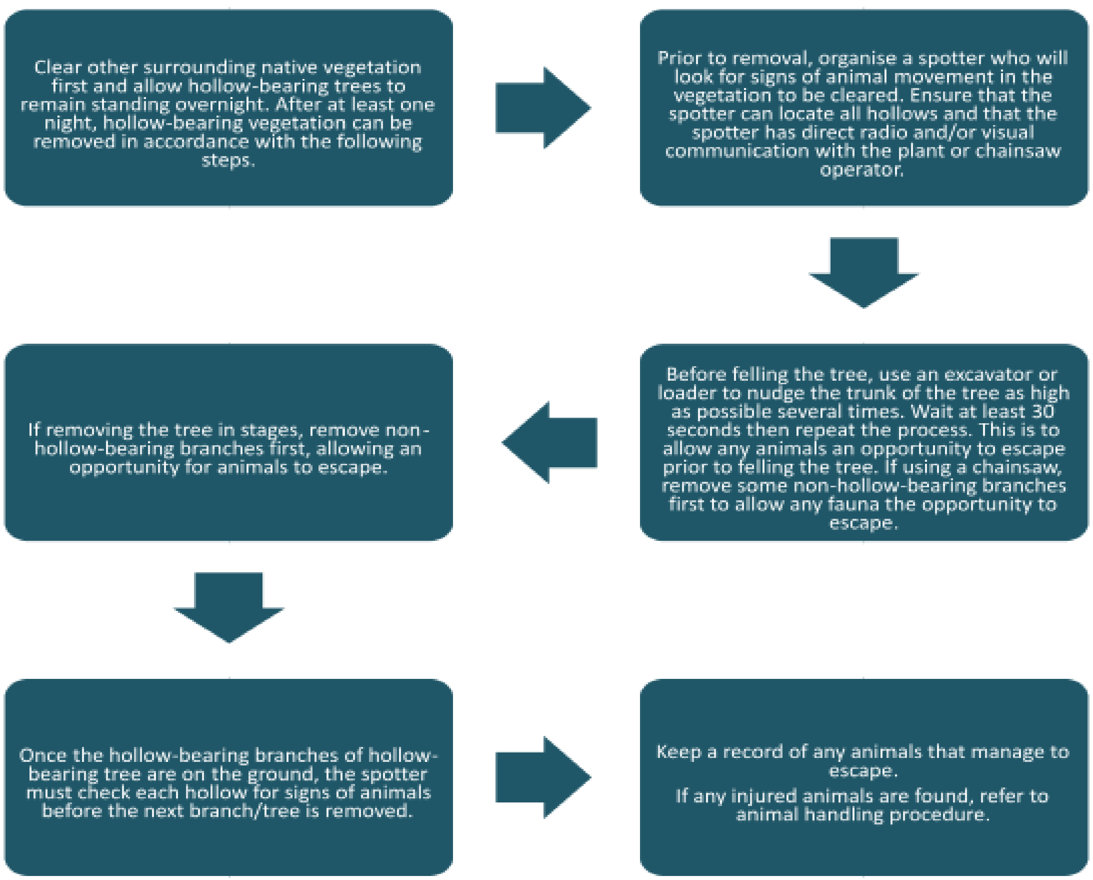


Figure 5.6: Hollow baring tree removal procedure

5.2.4 Removal of trees outside the approved clearing limits

The approved clearing limit is the line between the vegetation to be removed and the vegetation to be retained. It will be shown on all design plans as required. This is to be avoided where at all possible.

Where additional impacts to trees are proposed, the following process should be followed:

1. The Supervisor should notify the Site HSE Manager of the location and need for the tree impact via the ground disturbance permit process.
2. The Site HSE Manager/Lead Field Technician should assess that the tree (or other vegetation type) is not heritage listed, a habitat tree, nominated for retention or protected under relevant legislation and is legally able to be removed and/or trimmed. Alternatives to removing the tree should also be investigated at this stage.
3. The Site HSE Manager/Lead Field Technician should notify consult a heritage specialist if heritage significance is suspected, which may require a site visit.
4. The Supervisor should await written confirmation from the Site HSE Manager prior to re-commencing works around the tree(s).

5.2.5 Re-use of coarse woody debris

Felled timber greater than 600 mm (primarily tree trunks) will generally be removed from site. Felled timber greater than 200 mm and less than 600 mm will be used as CWD for habitat enhancement and to maximize the salvage of resources within the disturbance area for beneficial reuse. CWD can be used to enhance habitat values in existing vegetation and rehabilitated areas including derived native grassland (either in offset areas or areas adjoining impacted areas). CWD can provide:

- Habitat for micro invertebrates.
- Habitat for macroinvertebrates.
- Habitat for vertebrates using fallen timber for shelter, e.g. skinks, geckoes, dunnarts.
- Habitat for vertebrates using fallen timber for foraging, e.g. tree creepers, robins.
- A source of nutrients for native vegetation.
- Increased habitat complexity.

CWD will be placed within protected woodland areas as discrete logs rather than in piles to reduce fire risk and potential for use as shelter by feral animals such as rabbits. CWD will be placed at discrete intervals at densities to ensure that the CWD Benchmark for the receiving PCT is not exceeded. The density of CWD must take into account existing fallen timber. Removal, transportation, and placement of CWD will be carried out in a manner that minimises disturbance to native vegetation, including the canopy, trees, shrubs, standing dead timber, fallen timber, and groundcover, as well as topsoil.

CWD between 10 and 200 mm in diameter will be chipped and used for disturbed area rehabilitation.

5.3 UNPLANNED TREATENED SPECIES FINDS PROCEDURE

This procedure depicted in Figure 5.7 is derived from information provided by the WWF and Federal Ministry of Environment **wildlife rescue** centres. Any nests found in habitat features to be removed should be inspected by the Ecologist to determine whether fauna is using the nest, and whether relocation of the fauna and the nest to an adjacent area is viable.

As a general principle, any native animals found with the construction area should be avoided. Fauna should only be handled by a qualified ecologist or wildlife carer with relevant skills and experience (e.g. snake handling), and only when absolutely necessary.

Any onsite protected fauna found within a habitat feature to be removed should be captured and relocated according to the following steps. Any onsite protected fauna injured during a construction activity should be captured and a registered wildlife handler or veterinarian contacted.

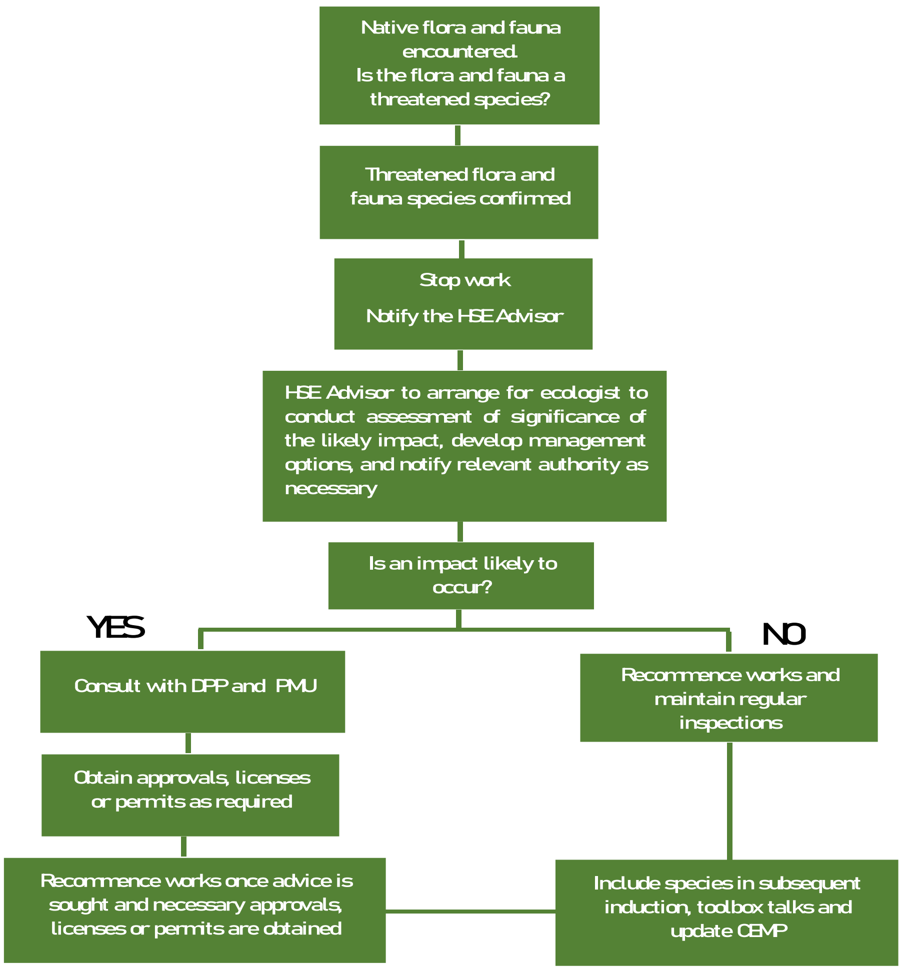


Figure 5.7: Threatened fauna encounter procedure

Step 1
Remove any threat to the animal that could cause or exacerbate an injury.

Step 2
Use appropriate equipment to capture the animal. This may include:

- Frogs: disposable gloves, disinfectant on hands and equipment between animals, disposable plastic bags (one per animal, one use only).
- Mammals: gloves, cloth bags/cotton pillow slips, up-to-date Bat Lyssavirus vaccinations.

Step 3

Contain the animal to minimise stress. Gently place the animal in a holding box specifically designed for holding animals. Cotton pillowslips may be used to cover mammals, or mammals may be placed inside them. Boxes should be placed in a quiet, safe, dark location (not in a vehicle unless temperature is constantly monitored). Do not give the animal food or water.

Step 4

Call the respective ecologist contact person or DPP, who will provide advice on what to do until a trained WILDLIFE rescuer can come to take the animal away.

Step 5

Release fauna into similar habitats, as near as possible to their capture location. Diurnal (day-active) fauna should be released during the day of capture. Nocturnal (night-active) fauna should be released at or after dusk. Arboreal fauna should be slowly released from their bag onto the trunk of a tree, with bats and gliders placed on a tree with rough or peeling bark and hollows.

Step 6

Details of fauna captured and relocated should be recorded in the following register. Any injury or death of a threatened species should be reported to the Site HSE Manager.

Table 5.1: Threatened species register

Date	Species	Location and time captured	Location and time released	Behaviour and condition on release	Details of any injuries/ death	Contact details of vet/wildlife handler if transferred to their care

5.4 NATIVE GRASSLAND MANAGEMENT PROCEDURE

Native grassland will be managed through mowing and/or grazing following specific recommendations of grassland. The objective for the grassland management regime is to effectively balance biodiversity outcomes and reduce the risk of fire, exacerbated by high fuel loads.

Early in the construction phase, grassland will be mowed to 100 – 200 m to facilitate the installation of panel infrastructure. Following this initial mowing, the grassland will then be managed throughout the remainder of the construction phase and then during operations for the life of the project.

5.5 PEST AND WEED MANAGEMENT PROTOCOL

The Project Manager or Site HSE Manager will initiate collaboration with adjoining landholders to control animal pests and exotic plant species that may traverse property boundaries. These initial communications will inform collaborative past and weed management measures into and during operation.

5.5.1 Animal Pest Management Procedure

Due to perimeter fencing limiting entry to the project site by large mammal pests such as feral cats, and rabbits, it is anticipated that most pest control activities will be limited to the control of small mammals such as rodents and invertebrates. Larger pest animals may however be present at the site early in during the construction phase and may enter the site periodically through the main access way.

Feral cats/ pest control

Reducing the impact of the feral cats relies on a mixture of control techniques comprising poison baiting, shooting, trapping, fencing and guard animals. All these techniques have a short-term effect on local numbers. No single control method will be successful on its own and when feral cats are removed from an area, reinvasion or immigration from existing untreated areas generally occurs within 2 to 6 weeks.

Rabbit pest control

The rabbit is a declared noxious animal. Landholders are obliged to control rabbit populations on their land. The aim of control is to reduce the impact of rabbits on farm enterprises and the natural environment. The success of rabbit control should be determined more by how many rabbits remain than by how many rabbits have been removed. Rabbits have the ability to rapidly re-invade and recolonize areas following control, so control programs should involve as large a number of properties as possible. Set clear, attainable objectives for control work, taking account of available financial and physical resources.

Two broad rabbit control strategies are applied to rural lands: the combination of poisons and harbour destruction in three Stages of rabbit control:

- Stage 1- Initial reduction.
- Stage 2- Follow up control.
- Stage 3 Advanced control.

Control methods include:

- Monitoring of population density prior to deciding a control method.
- Poisons.
- Harbour destruction.
- Fumigation.
- Shooting.
- Trapping.

Pesticide application record

Pesticide application will only be administered by authorised personnel wit Respective environmental accreditation –in accordance with SafeWork requirements.

Pesticides will only be applied in accordance label instructions for that product.

A Pesticide Application Record will be completed and public notifications made in accordance with relevant legislation, where pesticides are to be used in areas that could be accessed by members of the public.

Only pesticides registered for use near water may be used near any waterways.

5.5.2 Weed Management Procedure

During construction, the project has the potential to spread weeds through the movements of heavy machinery and light vehicles.

Weeds will be controlled through:

- An adaptive management approach whereby management actions will be adjusted to optimise the grassland growth addressing on-site observations as per the Native Grassland Management Procedure in section 5.4.
- For more intensive infestations of weeds, the use of selective herbicides may be warranted to prevent seed set and promote weed control. The advice of an ecologist and agronomist will be sort to advise on the control of weed infestations.
- Any supplementary feeding of livestock will use treated or processed feed to remove viable seeds and prevent weeds being introduced to the site.

A detailed weed management procedure is provided below.

Invasive weeds

The BMP lists the implementation of weed control measures to ensure invasive weed problems are not exacerbated. Once weeds are identified within the construction area, they should be marked up on relevant drawings.

Weed inspection

The Site HSE Manager/Lead Field Technician will inspect the project area for weeds as required:

- Prior to clearing and grubbing.
- When a potential weed infestation has been identified.
- Prior to rainy season till around August to identify high and low threat exotic plants before they go to flower and seed.

Exotic plant cover will be mapped with GPS following inspections including noting the specie(s) degree of infestation and capturing an image for monitoring purposes.

Weed treatment

A general guide to weed control and management is presented above. More detailed information, including herbicide types and application rates, can be sought from the project Ecologist.

Herbicide application record

Herbicide application will only be administered by authorised personnel with environment accreditation in accordance with SafeWork requirements.

Herbicides will only be applied in accordance label instructions for that product.

A Herbicide Application Record will be completed and public notifications made in accordance with relevant legislation, where herbicides are to be used in areas that could be accessed by members of the public.

Only herbicides registered for use near water may be used near any waterways.

Follow-up inspection

The Site HSE Manager/Lead Field Technician will ensure that a follow-up inspection is undertaken of identified exotic plant cover to ensure treatment was successful.

Where high threat exotic plants cannot be effectively destroyed prior to topsoil stripping, weed contaminated topsoil will be isolated and disposed of at an approved offsite licensed facility as directed by the Site HSE Manager/Lead Field Technician.

Ongoing management & monitoring

Monitoring of exotic plant cover will occur as part of the routine monthly inspections to determine effectiveness of management controls. The presence of any exotic plant cover and the necessary management actions will be noted on the Environmental Inspection Checklist (refer to EMS).